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Sprague's Pipit (*Anthus spragueii*) Conservation Plan

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Executive Summary

Apparently widespread during early European settlement, Sprague's Pipits breeding distribution has contracted sharply from its historical range. Sprague's Pipits were recorded as abundant during early European exploration; currently, they are common only in remnant large grassland patches in the northern mixed-grass native prairie of North America. Much of the decline of Sprague's Pipits occurred in the late 19th and early 20th centuries as the short- and mixed-grass prairies were converted to agriculture. Since ca. 1900, approximately 75% of native Canadian prairie and 80% of aspen parkland have been converted from native grassland; in the United States, approximately 60% of native mixed-grass prairie has been converted to cropland.

Sprague's Pipits are short distance migrants, moving from breeding grounds in the northern prairies of southern Canada and northern United States to the wintering grounds in southern United States and northern México. The breeding range in Canada has contracted from the eastern and northern portions of the historic range in Alberta and Manitoba. Similarly, the breeding range in the United States has contracted to the north and west in North Dakota and Minnesota, and north in Montana. There are no details on the historical distribution of Sprague's Pipits on the wintering range in the southern United States and México.

In 1999, Sprague's Pipits were listed as "Threatened" in Canada by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC); the status was re-examined and confirmed in May 2000. Sprague's Pipits were officially listed under the Canadian Species at Risk Act (SARA) as "Threatened" on 5 June 2003. They are also protected under provincial Wildlife Acts in British Columbia, Alberta, Saskatchewan, and Manitoba. In the United States, Sprague's Pipits were petitioned for listing under the Endangered Species Act in 2008. On 14 September 2010 the U.S. Fish and Wildlife Service determined that this petition presented substantial information that listing Sprague's Pipits as "Endangered" or "Threatened" was warranted but precluded by higher listing priorities. Sprague's Pipits are listed as a "Species of Conservation Concern" by the U.S. Fish and Wildlife Service's Division of Migratory Bird Management and classified as "Endangered" by the state of Minnesota. Sprague's Pipits are a protected migratory bird species in México; they have no other official or legal designation there.

The principal causes for the declines in Sprague's Pipit populations are habitat conversion to seeded pasture, hayfield, and cropland, as well as overgrazing by livestock. Moreover, management favoring intensive cattle grazing and reduced fire frequency may lead to the degradation of remaining suitable grassland tracts over much of their range. Without proper fire intervals, shrubs and excessive vegetative litter may reduce habitat quality; in addition, grasslands may even eventually succeed to shrubland or savannah. Energy development, introduced plant species, nest predation and parasitism, drought, and fragmentation of grasslands are all threats that currently impact Sprague's Pipits populations throughout their present range.

Management for Sprague's Pipits consists of protecting, maintaining, and restoring native mixed-grass prairie in suitably large expanses. Converting cultivated land adjacent to native prairie to perennial cover, including seeding with a native grass mix, or one that includes a prostrate (versus erect) form of legume, could make smaller land tracts attractive to Sprague's Pipits. Management through fire, grazing, or mowing may assist in maintaining native grasslands in many areas; however, the intensity and frequency of disturbance is dependent upon soil productivity and climate factors, and thus the geographic area. Therefore, recommendations on fire, grazing and haying frequency and intensity should be area-specific.

The goals for the conservation of Sprague's Pipit populations are to maintain or increase the current population size, distribution and viability. This can be achieved by simply preventing further loss and degradation of native prairie within their historic range. To achieve this goal, management strategies and recommendations must be researched and developed that are specific to particular geographic regions. To this end, this Conservation Plan includes a prioritized list of actions and needs that will begin to achieve long-term range-wide conservation of Sprague's Pipits. In addition, several states and provinces have developed objectives and actions designed to address state-wide conservation of Sprague's Pipits. Updated information on life history and population status are included here in support of this goal. Implementing effective conservation measures will require the cooperation of a coalition of local, regional, national, and international partners.

Acknowledgements

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Taxonomy

Class: Aves

Order: Passeriformes

Family: Motacillidae

Scientific Name: *Anthus spragueii* Audubon 1844

Common Name: Sprague's Pipit

French: Pipit des Prairies; Pipit de Sprague

Spanish: Bisbita Ilamera

There are no unsettled taxonomic issues. There are no subspecies designated (American Ornithologists' Union 1957, Pyle 1997a). Sprague's Pipits were named *Alauda spragueii* by Audubon after Isaac Sprague. The first (type) specimen was documented as collected near Fort Union, North Dakota in 1843 by Audubon, although the location that John Bell and Edward Harris shot the first bird could have been in or near Montana (J. Marks, pers. comm.).

Molecular data indicate that the closest living relatives to the Sprague's Pipit are the Yellowish Pipit (*A. lutescens*) and the Short-billed Pipit (*A. furcatus*) of South America; these species form a clade to the other South American pipits. Thus, the Sprague's Pipit may only be distantly related to the American Pipit (*A. rubescens*) and other Old World pipits (Robbins and Dale 1999).

Legal Status

Global

Sprague's Pipits (pipits) are federally protected in the United States, Canada, and México under the Migratory Bird Treaty Act of 1918 as amended (16 U.S.C. 703-711: 40 Stat. 755; U. S. Fish and Wildlife Service 2008a). They are listed on the International Union for the Conservation of Nature (IUCN) Red List as Vulnerable (Hilton-Taylor 2000), but are not listed on the Convention on International Trade in Endangered Species list (Inskipp and Gillett 2005; Table 1).

The species' conservation status includes "Species of Special Concern/Watch List Species" by Partner's in Flight and National Audubon Society (Rich et al. 2004, Butcher et al. 2007). The Nature Conservancy has assigned it a global rank of "apparently secure", and rare (Table 1; NatureServe Explorer 2009). Sprague's Pipit is also considered a Species of Highest Tri-National Concern by Partners in Flight (Berlanga et al. 2010).

Canada

Sprague's Pipits were listed in 1999 by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as "Threatened"; the status was re-examined and confirmed in May 2000 (Committee on the Status of Endangered Wildlife in Canada 2002), based on status reports (Prescott 1997, Prescott and Davis 1998). Sprague's Pipits were officially listed under the Species at Risk Act (SARA) as "Threatened" on 5 June 2003 (Environment Canada 2008). Although this species remains relatively common in suitable habitat, numbers have declined significantly and there is evidence of a contraction of its range on the periphery (Prescott and Davis 1998, Environment Canada 2008).

Sprague's Pipits are protected under provincial Wildlife Acts in British Columbia, Alberta, Saskatchewan, and Manitoba (Table 1). In Alberta, Sprague's Pipits are a "Species of Special Concern": a species that without human intervention may soon become threatened with extinction in the province. This designation was made on the basis of rapidly declining populations and a lack of research into the biology and management of the species (Prescott and Davis 1998). Sprague's Pipits have no legal designation in Saskatchewan and are listed as "Threatened" in Manitoba. Pipits are included on the "Red List" of species considered to be candidates for designation as "Threatened" or "Endangered" in British Columbia. However, the very small number of reports for Sprague's Pipits in British Columbia suggests that its occurrence there is accidental or casual, and it may be removed from the "Red" list in the future (Prescott 1997).

United States

Sprague's Pipits are a Candidate for listing as "Endangered" or "Threatened" under the Endangered Species Act of 1973 as amended (16 U.S.C. 1531 *et seq.*; U. S. Fish and Wildlife Service 2008b, 2010). After being been petitioned for listing in 2008 (WildEarth Guardians 2008), the U. S. Fish and Wildlife Service (USFWS) determined that the petition presented substantial information indicating that listing the Sprague's Pipit is warranted but precluded by higher listing priorities (U. S. Fish and Wildlife Service 2010). Sprague's Pipits were listed as a "Species of Conservation Concern" by the USFWS Migratory Bird Management Office in 2008 (U. S. Fish and Wildlife Service 2008c). Sprague's Pipits are classified as "Endangered" in Minnesota (Table 1). They are considered a "Sensitive Species" in Region 1 (Northern Region) of the U. S. Forest Service (U. S. Forest Service 2005).

México

Sprague's Pipits are a protected migratory bird species in México; they have no other official or legal designation (Secretaría de Medio Ambiente y Recursos Naturales 2002).

Table 1 is a summary of the legal status of Sprague's Pipit in the states and provinces where it occurs.

Table 1. Status and trends of Sprague's Pipits throughout their range. "Status" definitions from NatureServe Explorer (2009). BCC=Birds of Conservation Concern-2008 (U.S. Fish and Wildlife Service 2008c); COSEWIC=Committee on the Status of Endangered Wildlife in Canada (2002); ESA=Endangered Species Act (U.S. Fish and Wildlife Service 2008b); BBS=Breeding Bird Survey (Sauer et al. 2008); IUCN=International Union for Conservation of Nature.

Area	Status	State or Province Status	BBS Trend (1966-2007)	BBS Trend (1980-2007)	Species Status
United States	N4B, N4N	Candidate 1 (ESA), BCC National Concern	-2.4 (*p*=0.35; *n*=49)	-3.1 (*p*=0.47; *n*=45)	Regular breeder, migrant and winter resident
Montana	S2B	Species of Greatest Conservation Need[1]	-0.6 (*p*=0.85; *n*=21)	-0.3 (*p*=0.90; *n*=20)	Regular breeder and migrant
North Dakota	S3B	Species of Conservation Priority	-2.0 (*p*=0.62; *n*=25)	-2.4 (*p*=0.75; *n*=23)	Regular breeder and migrant
South Dakota	S2B	Species of Greatest Conservation Need[1]	-12.7 (*p*=0.36; *n*=3)[2]	-3.5 (*p*=0.75; *n*=2)[2]	Regular breeder and migrant
Minnesota	S1B	Endangered[3]			Rare breeder
Wyoming	S4N	None			Rare migrant
Kansas	SNA	None			Uncommon to rare migrant and casual winter resident
Nebraska	SNRN	None			Uncommon spring and fall migrant
USFWS Region 6	n/a	BCC Regional Concern	-2.4 (*p*=0.35; *n*=49)	-3.1 (*p*=0.46; *n*=45)	Regular breeder and migrant
Arizona	S2N	None			Regular winter resident and migrant
New Mexico	S2N	Species of Greatest Conservation Need[1]			Regular winter resident and migrant
Texas	S3N	None			Regular winter resident
Oklahoma	SNRN	Species of Greatest Conservation Need[1]			Uncommon to rare migrant and casual winter resident
USFWS Region 2	n/a	BCC Regional Concern			Regular winter resident and migrant
Canada	N4B	Threatened (COSEWIC)	-4.3 (*p*=0.00; *n*=120)	+3.2 (*p*=0.05; *n*=111)	Regular breeder
Alberta	S4B	Species of Special Concern[4]	-4.1 (*p*=0.01; *n*=61)	-3.1 (*p*=0.23; *n*=58)	Regular breeder
Saskatchewan	S4B	None	-4.2 (*p*=0.05; *n*=45)	-3.0 (*p*=0.13; *n*=40)	Regular breeder
Manitoba	S2B	Threatened	-4.6 (*p*=0.31; *n*=14)	-10.2 (*p*=0.18; *n*=13)	Regular breeder
BBS survey-wide	G4	Vulnerable (IUCN)[5]	-3.9 (*p*=0.00; *n*=169)	-3.7 (*p*=0.03; *n*=156)	Regular breeder
México	n/a	None	n/a	n/a	Regular winter resident

Other records: State/province (NatureServe Explorer 2009): Alabama (SNR), Arkansas (SNA), British Columbia (none), California (none), Colorado (SNA), Georgia (S3), Louisiana (S3S4N), Mississippi (SNA), Missouri (SNA)

[1]State Wildlife Action Plan
[2]Reflects data with an important deficiency
[3]Minnesota Department of Natural Resources (http://www.dnr.state.mn.us/ets/birds.html)
[4]Alberta Species at Risk (http://www.srd.alberta.ca/BioDiversityStewardship/WildSpecies/Birds/Songbirds/SpraguesPipit.aspx)
[5]IUCN Red List (Hilton-Taylor 2000)

Description

Sprague's Pipits are grassland specialists endemic to the mixed-grass prairie in the northern Great Plains of North America (Robbins and Dale 1999). Sprague's Pipits are a passerine about 14 cm in length (range: 10-18 cm). The wings and tail are dark brown with two pale indistinct wing-bars and mostly white outer retrices, the crown, nape and upperparts are buffy with blackish streaking and the face is buffy with a pale eye-ring creating a large-eyed appearance. The underparts are whitish, the breast has fine blackish streaks, and the breast and flanks are often faintly washed with buff. The bill is relatively slender, short, and straight, with a blackish upper mandible and a pale lower mandible with a blackish tip. The tarsi are yellow to pale pinkish brown and are relatively long with an elongated hind claw (Pyle 1997a, 1997b).

Molt and Juvenile Plumage.—Hatching year individuals may be separated from adults by the primary coverts which appear tapered and worn compared with the broader, less worn basic primary coverts of adults (Pyle et al. 2008). Knowledge of the molts of this species is preliminary and based on a small number of specimens (Pyle 1997a, 1997b; Pyle et al. 2008).

Range

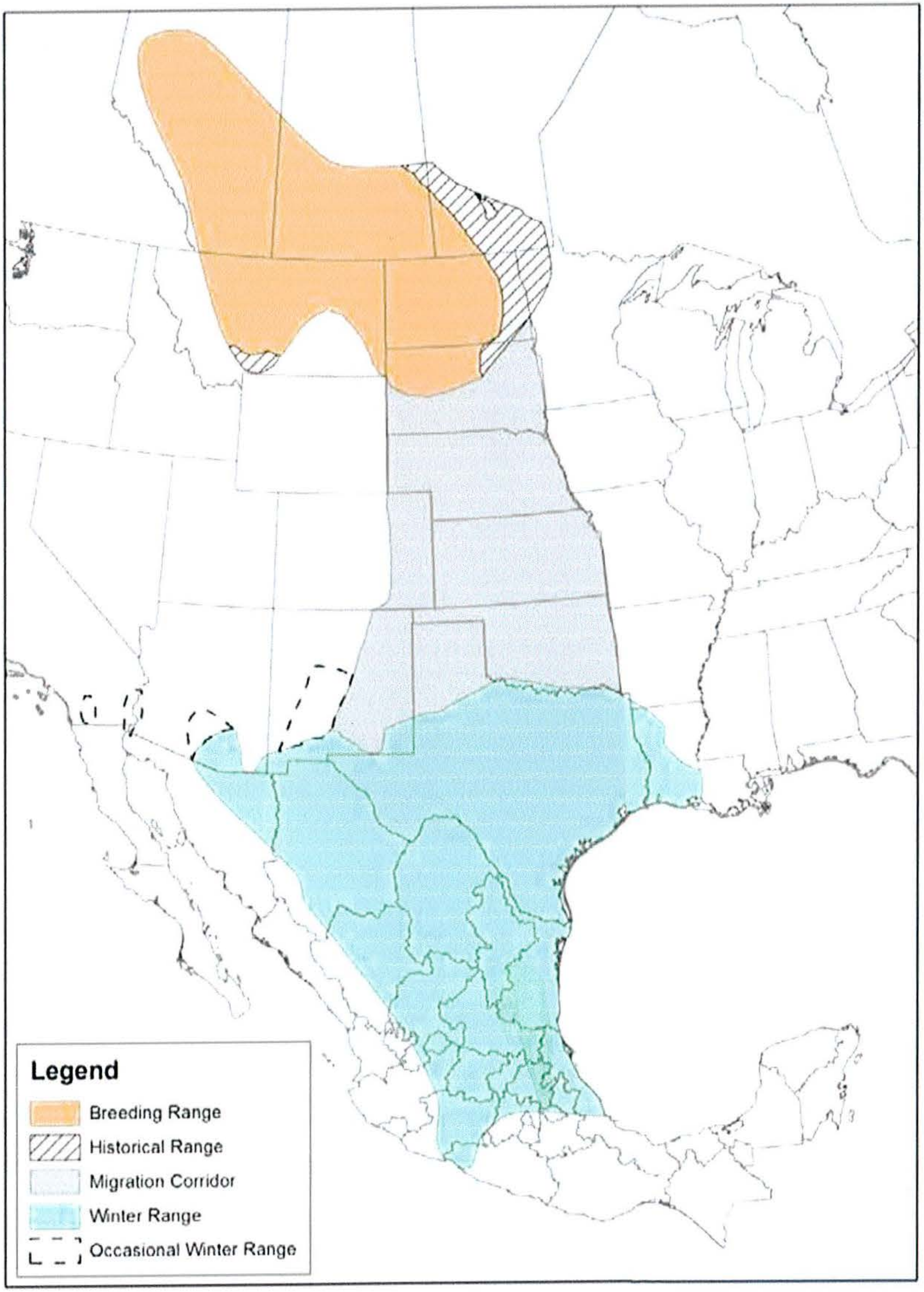

Figure 1. Current and potential historical range for Sprague's Pipit.

Sprague's Pipits are short to medium distance migrants, moving from breeding grounds in the northern prairies of southern Canada and northern United States to the wintering grounds in southern United States and northern México (Fig. 1; Robbins and Dale 1999). Sprague's Pipits migrate through the Great Plains states of the United States (Fig. 1).

Canada

Breeding.—Sprague's Pipits are largely confined to the grassland and aspen parkland regions of the prairie provinces (Fig. 1; Godfrey 1986, Prescott and Davis 1998) and breed in southeast Alberta west to the Rocky Mountain foothills, throughout southern Saskatchewan (Robbins and Dale 1999) and west-central (Prescott and Davis 1998) and southwestern Manitoba (Robbins and Dale 1999). Historically common in Manitoba (Coues 1874, Carey et al. 2003), their range has contracted and Sprague's Pipits are now rare, though locally they may be numerous (Carey et al. 2003). In south-central British Columbia a single breeding record was recorded in 1991, the first breeding record in that province; no subsequent breeding has been documented, although pipits have occasionally been observed (Prescott and Davis 1998). Historically, they probably bred near Kimberly, British Columbia in 1959 (Prescott and Davis 1998).

Migration.—Sprague's Pipits generally arrive in Canada in the spring in mid-Apr and depart in the fall by mid-Oct.

Winter.—Sprague's Pipits do not winter in Canada.

United States

Breeding.—Sprague's Pipits breed in the northern Great Plains, with their highest numbers occurring in the central mixed-grass prairie (Fig. 2). Their breeding range is primarily in north-central and eastern Montana, to North Dakota through to northwestern and north-central South Dakota (Fig. 1). They occur casually in northwestern Minnesota and locally in southern South Dakota (Stewart 1975, South Dakota Ornithologists' Union 1991, American Ornithologists Union 1998, Robbins and Dale 1999, Tallman et al. 2002).

Migration.—Spring migration primarily occurs through the central Great Plains in Apr and May (Johnsgard 1979, Thompson and Ely 1992), with two early Nebraska reports from 17 Mar (Sharpe et al. 2001). The latest date they were observed in Texas is 14 May (B. Freeman, pers. comm.). Fall migration primarily occurs through the Great Plains from late Sep through early Nov, with a few sightings from 30 Aug (Sharpe et al. 2001), and extending in some

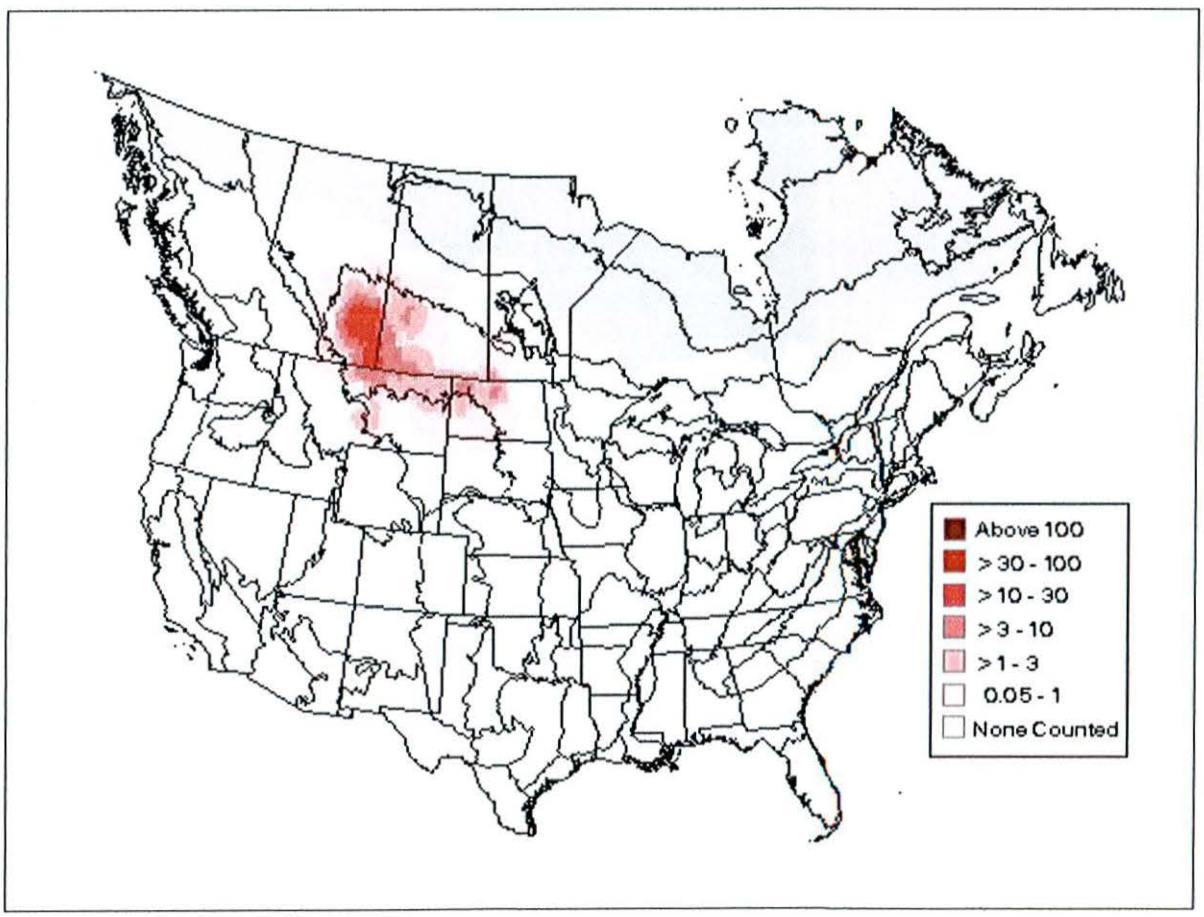

Figure 2. Relative abundances of Sprague's Pipits in their breeding range; data from the Breeding Bird Survey for 1996-2007 (Sauer et al. 2008).

years through the first week of Dec in New Mexico (W. H. Howe, pers. comm.). Sprague's Pipits are rarely seen on migration, which has been attributed to a number of reasons, including: 1) many short-distance grassland species migrate high and at night without using stopover sites, potentially including Sprague's Pipits (Thompson and Ely 1992; SLJ), however, it is uncertain whether their night flight calls that were recorded in Nebraska and Kansas came from migrants or from birds flushed from the ground (W. Evans, pers. comm.); 2) they have solitary and cryptic behavior during the non-breeding season (Prescott and Davis 1998); 3) many observers are largely unfamiliar with the flight call notes (Seyffert 2001; W. H. Howe, pers. comm.); and 4) there are few migration studies in grasslands (J. M. Ruth, pers. comm.) or few observers in remote grassland areas (M. Howery, pers. comm.).

Sprague's Pipits are generally described as being an uncommon migrant immediately south of the breeding range (Fig 1). They are described as "accidental" in Iowa, "a rare migrant" in Wyoming and Illinois, and generally uncommon in Oklahoma. They are occasionally found from late Sep through Nov in eastern New Mexico, but the later records are probably late migrants (W. H. Howe and J. M. Ruth, pers. comm.). In Oklahoma, Sprague's Pipits have been documented in the central and western two-thirds of the main body of the state, and in the southern portion of the panhandle. They are undocumented in the eastern third of Oklahoma (M. Howery, pers. comm.). Sprague's Pipits are found in all months except Jun through Aug in Texas; those seen inland and north of the primary wintering areas are probably migrants, although some individuals may linger into the winter there (Freeman 1999). Sprague's Pipits are a rare migrant in California and a casual fall migrant in the eastern United States (Robbins and Dale 1999).

Winter.—Sprague's Pipits winter in the United States from the southeast corner of Arizona, southern New Mexico, central and southern coastal prairies in Texas, through southern Oklahoma. There are regular sightings in southern Louisiana and Arkansas (Root 1988) and occasional sightings in southern Kansas and Missouri, Tennessee, northwestern Mississippi, and other portions of Texas (Fig. 1; American Ornithologists' Union 1998). Winter distribution data show highest densities in Texas (National Audubon Society 2009).

México

Breeding.—There are no breeding occurrences in México.

Migration.—There is no migration information from México.

Winter.—Sprague's Pipits winter in northern México from northeastern Sonora, Chihuahua, Coahuila, and Nuevo León south to northern Michoacán, Puebla, central Veracruz, and perhaps Guerrero (Fig. 1; Howell and Wilson 1990, Howell and Webb 1995, American Ornithologists' Union 1998). Christmas Bird Count (CBC; National Audubon Society 2009) data show Sprague's Pipits occur every year in northern Chihuahua and some years in Coahuila. There is very limited data from México documenting the status and distribution of Sprague's Pipits.

Historical Changes

Canada.—The eastern and northern portions of the historical breeding range of Sprague's Pipits has contracted in Alberta, Manitoba, and Saskatchewan (Committee on the Status of Endangered Wildlife in Canada 2002). Range contractions may occur temporarily due to climatic conditions, however; there are suspected long-term range contractions for Sprague's Pipits in the Canadian provinces that are their primary range. In the 1980s and 1990s, Pipits were not recorded from the Peace parkland of northwestern Alberta; this may not represent a "dramatic" reduction in the breeding range as they were probably never widespread here (Prescott and Davis 1998). In Saskatchewan, Sprague's Pipits were described in the 1930s as "not uncommon", by the 1950s, the species was described as being "rather rare" (Prescott and Davis 1998). In Manitoba, Sprague's Pipits have declined dramatically. Sprague's Pipits were once one of the commonest prairie birds in the western portion of the province (Carey et al. 2003). Their range has contracted several hundred kilometers south from areas north and east of Winnipeg in Manitoba; they are now considered "fairly rare" or "virtually absent" from areas where they were once a regular, but uncommon summer resident. Pipits are still fairly numerous, although localized, in parts of southwest Manitoba (Carey et al. 2003).

United States.—The range for Sprague's Pipits in the United States has contracted notably on its periphery. Changes and declines in abundance have contracted the range west and north in North Dakota and Minnesota and to the north in Montana. Data on South Dakota are inconclusive.

As he traveled near present-day Lostwood National Wildlife Refuge (NWR) in northwestern North Dakota in 1873, Elliot Coues remarked on the "...trio of the commonest birds..." encountered: Baird's Sparrow (*Ammodramus bairdii*), Sprague's Pipits, and Chestnut-collared Longspur (*Calcarius ornatus*), stating "...Sprague's Pipits were sometimes so numerous that the air seemed full of them..." (Coues 1878, Madden et al. 1999). After fewer than 100 years of settlement and agricultural development, Sprague's Pipits in North Dakota have declined to the point that they are no longer among the 15 most common birds and are currently absent in the easternmost counties (Stewart 1975). In Montana, there have been no breeding records in the southern and south-central counties since

1991 or earlier (Lenard et al. 2003), although some singing males have been noted in Jun (C. Wightman, pers. comm.). In South Dakota, pipits are absent in the eastern portion of the state and considered a rare and local summer resident (South Dakota Ornithologists' Union 1991, Tallman et al. 2002). The only breeding records are a nest found in 1907 and fledglings in 1996 (Tallman et al. 2002). The species was recorded in the summer months during the first South Dakota Breeding Bird Atlas (1988-1993) in McPherson, Dewey, Corson, Perkins and Pennington counties. There are also summer records in Edmunds and Harding counties in the 2000's (R.P. Russell, pers. comm.). Sprague's Pipits may always have been local and uncommon breeders in South Dakota, but historical data is lacking.

In Minnesota, Sprague's Pipits range has contracted substantially since European settlement and since the 1920s there has been a steady decline in numbers and breeding numbers and occurrence in the state. Currently, it is only a casual visitor and unknown as a breeding species (R. P. Russell, pers. comm.). Prior to 1890, the species could be found throughout the southwestern and south-central parts of Minnesota, breeding as far south as Pipestone and adjacent counties and as far east as Ottertail County (Roberts 1932). It was a common breeder in Kittson County in the northwest corner of the state in 1898, then no other data until 1928 when a dedicated trip to the Red River Valley found that it was only a casual summer resident on virgin prairie areas of the northwest valley (Roberts 1932). In recent years, a few birds have been observed on fall migration with Sep records from Dakota County in the southeast and Duluth in the northeast and Oct records from Cottonwood and Wilkin counties in the west. Likely these are birds straying eastward from breeding populations to the west or northwest of Minnesota (R. P. Russell, pers. comm.). The Minnesota County Biological Survey recorded a few birds at one site in Roseau County in 1991 and a single bird at another site in the same county in 2009 (S. Stucker, pers. comm.).

México.--There is no information on historical range in México.

Biology

Breeding

Arrival.—Sprague's Pipits arrive on the breeding grounds from the third week of Apr to mid-May (Maher 1973, Stewart 1975, SLJ); some individuals linger on the wintering grounds into early May. Pair formation begins shortly after arrival on the breeding grounds and eggs are laid between the second week of May through early Aug (Sutter 1996, Davis 2003, Jones et al. 2010). In Montana, the median nest initiation date was 25 May; the earliest date a nest was initiated was 7 May, while the latest date a nest was initiated was 31 Jul (Jones et al. 2010). Nest initiation dates tended to differ among years, and did not appear to be influenced by arrival dates (Davis 2003, SLJ).

Breeding Display.—Sprague's Pipits are unique in being so easy to hear yet so difficult to see with their "...prolonged and unique aerial display..." (Robbins 1998). The male's flight song is delivered high above the prairie in a series of high-pitched jingling notes that are audible>300 m. Males often hurry from view immediately after returning to the ground at the end of the display. Sprague's Pipit display bouts are prolonged, and persistent male display occurs from the time of arrival (approximately the third week of Apr) through the third week of May at Lostwood NWR in North Dakota (Robbins 1998). This was followed by a period of two to three weeks where display rates were reduced, followed by another period of elevated display rates (Robbins 1998) with some display into mid-Aug (Robbins and Dale 1999). This bimodal display regime is probably related to the breeding cycle, with display rates decreasing once a first clutch of eggs is laid and copulation opportunities decrease (Robbins 1998, Robbins and Dale 1999). This display is also observed, although rarely, during early migration in late Apr or very early May in Texas (Freeman 1999).

Territoriality.—Sprague's Pipit breeding territories are used for both nesting and feeding. These territories are presumably established and maintained through the aerial display. Occasionally, territorial males interrupt aerial displays and give chase to other presumed males that pass through the territory (Robbins and Dale 1999). Mapping of territory boundaries in 2007 indicated pipit territories rarely crossed trails (Dale et al 2009); territories were reported as 2.5±0.5 (SD) ha (n=30; Davis and Fisher 2009). In North Dakota, males were not uniformly distributed; all territories were located in elevated areas with short grass and relatively low sedge and forb densities (Robbins 1998).

Foraging Behavior.—Sprague's Pipits typically forage alone throughout the day in all seasons. They walk or run while gleaning food from the ground surface or grasses, typically in grass that is several centimeters tall (Robbins and Dale 1999).

Diet.—The diet of Sprague's Pipits during the breeding season is almost entirely comprised of arthropods with a small amount of vegetable matter (Robbins and Dale 1999). Sprague's Pipits feed primarily on arthropods during migration and on wintering grounds, with the addition of seeds during the later part of the winter (Emlen 1972, Robbins and Dale 1999).

Nest Characteristics.—Sprague's Pipits build ground nests in grasslands primarily with native grasses of intermediate height and density, with little bare ground and few shrubs; many times the nest is at the base of a dense tussock of grass (Sutter 1997, Dieni and Jones 2003). Coarse and fine dried grasses (about 5-15 cm in length) were woven into a cup; long grass growing adjacent to the nest is sometimes interwoven with loose grass forming a dome (Sutter 1997). This canopy can range from almost a complete dome to almost full exposure (Harris 1933, Sutter 1997). Nest entrances frequently have runways that extend up to 15 cm in length (Harris 1933, Sutter 1997). Nests were usually <100 m from roads and far (mean 20.7 m) from the nearest perch (shrubs and rocks) (Sutter 1996, 1997).

Nesting Behavior.—The female remains on the nest until an approaching observer is close. Once flushed, she flies low for a few meters then lands in the grass or climbs in an undulating flight to circle the area. When undisturbed, she approaches the nest by flying low to within a few meters and then walks to the nest. Incubation and brooding is primarily by females; although males will incubate and brood at an unknown rate (SLJ). Adult pipits responded aggressively to researcher presence if nestlings or dependent young were nearby (Davis and Fisher 2009), and during late incubation or with taped call playback (SLJ).

Incubation.—In Montana, the mean incubation time was 12.2±0.12 days (range: 7-15 days, n=85; Jongsomjit et al. 2007, Jones et al. 2010). In Saskatchewan from 1996-2000 the incubation period was 13 days (Davis 2003); mean incubation from Manitoba and Saskatchewan combined was 13.4±0.3 days (n=9; Davis 2009).

Clutches per Year.—The hatching rate for Sprague's Pipits in Montana was 85% (Jones et al. 2010). Re-nesting and second broods have been occasionally

Habitat

Breeding

Sprague's Pipits are closely associated with native grassland throughout their range (Sutter 1996, 1997; Sutter and Brigham 1998; Madden et al. 2000; Grant et al. 2004) and are less abundant (or absent) in areas of introduced grasses than in areas of native prairie (Kantrud 1981, Johnson and Schwartz 1993, Dale et al. 1997, Madden et al. 2000, Grant et al. 2004). Generally, pipits prefer to breed in well-drained native grasslands with high plant species richness and diversity. They prefer higher grass and sedge cover, less bare ground, and an intermediate average grass height when compared to the surrounding landscape, <5-20% shrub and brush cover, no trees at the territory scale, and litter cover <12 cm (Sutter 1996, Madden et al. 2000, Dechant et al. 2003, Dieni and Jones 2003, Grant et al. 2004). The amount of residual vegetation remaining from the previous years' growth also appears to be a strong positive predictor of Sprague's Pipits occurrence (Madden 1996, Sutter 1996, Prescott and Davis 1998, Sutter and Brigham 1998) and where they put their nests (Dieni and Jones 2003, Davis 2005).

Sprague's Pipits prefer breeding sites in grasslands with a range of vegetative structure, which may vary geographically. In Saskatchewan, in native pastureland, Sprague's Pipits occurred more frequently in areas with <10% bare soil and <10% clubmoss (*Selaginella densa*; Davis et al. 1999). In Montana, nest abundance was positively associated in sites with ≤ 22% clubmoss cover and dominated by native grass (*Stipa*, *Bouteloua*, *Koeleria*, and *Schizachyrium* spp.); abundance was negatively associated with prickly pear cactus (*Opuntia* spp.) cover, and density of low-growing shrubs (Dieni and Jones 2003). In North Dakota, Sprague's Pipits were negatively impacted by increasing tall shrub (>1 m) and brush (<1 m) cover and increasing litter depth >12 cm (Grant et al. 2004). They had a negative reaction to tall shrub cover in the landscape and, with other grassland endemics, preferred areas with <20% shrubs; however, they were not woodland-sensitive at the landscape scale but were negatively associated with trees at the territory scale (Grant et al. 2004).

Sprague's Pipits rarely occur in cultivated lands, and are uncommon on non-native planted pasturelands (Owens and Myres 1973, Sutter 1996, Davis et al. 1999, McMaster and Davis 2001). They have not been documented to nest in cropland (Owens and Myres 1973, Koper et al. 2009), in land in the Conservation Reserve Program (Higgins et al. 2002) or in dense nesting cover planted for waterfowl habitat (Prescott 1997). However, territorial displays have been recorded in non-native grasslands where the structure of the vegetation was similar to that of native vegetation (Dale et al. 1997, Sutter and Brigham 1998, Davis et al. 1999, Higgins et al. 2002, Dohms 2009). In Saskatchewan, Sprague's Pipits have been documented nesting in non-native hayfields at Last Mountain Lake National Wildlife Area (Dale 1983); conversely, they were not associated with hayfields in the Missouri Coteau (Dechant et al. 2003).

Nests and Nest Sites.—In Montana, Sprague's Pipit nest sites were in grasslands primarily with native grasses of intermediate height and density, with little bare ground or clubmoss and few shrubs, and in nest patches with greater litter cover and depth, while avoiding areas with prickly pear cactus cover (Dieni and Jones 2003). They tended to nest in patches that had little or no clubmoss cover, nor was clubmoss ever used as a nesting substrate (Dieni and Jones 2003). These nest site data were consistent with findings reported from Saskatchewan (Sutter 1997), except there was no evidence of selection against forb cover (Dieni and Jones 2003). Selection for vertical habitat characteristics by this species appears to be occurring at the scale of the nest site rather than the nest (Dieni and Jones 2003, Grant et al. 2004). In Saskatchewan, Sprague's Pipits nest sites were most abundant in areas with intermediate cover values, higher grass and sedge cover, higher maximum height, lower forb and shrub cover, lower bare ground cover, and lower forb density than random sites; average vegetation characteristics at nest sites were: 52.7% grass and sedge cover, 10.5% forb and shrub cover, 15.2% litter cover, 16.8% bare ground cover, 55.6 forb contacts per m^2, 27.7 cm maximum vegetation height, 2.4 cm litter depth, and vegetation density of 1.1 contacts above 10 cm and 3 contacts below 10 cm (Davis et al. 1999).

Patch Size.—Sprague's Pipits are likely influenced by the size of grassland patches and the amount of grassland in the landscape (Davis 2004). In southern Saskatchewan, Davis (2004) found that Sprague's Pipits abundance was influenced by the size and configuration of suitable grassland patches and the amount of grassland in the landscape. Pipits also had a 50% probability of occurring on patches ≥ 145 ha (95% CI=69-314 ha); pipits were absent from grassland patches <29 ha (Davis 2004). A smaller edge:area ratio had higher pipit abundances, and was an important predictor of their occurrence (Davis 2004). No consistent effect of patch size was found on nest success (Winter et al. 2006; SLJ).

Management.—Grazing, fire, and mowing are the most common management techniques used in grasslands to create or restore suitable habitat for Sprague's Pipits or to prevent further degradation. The effects will vary with intensity and frequency, as well as environmental conditions, such as moisture, soil type, plant species composition and geography (see Threats, below; Maher 1973, Owens and Myres 1973, Karasiuk et al 1977, Kantrud 1981, George et al. 1992).

Migration

No data. Migration habitats are poorly known. Where pipits have been seen during migration, the habitats used are similar to those documented on the breeding and wintering grounds, including pastures, prairie-dog (*Cynomys* spp.) towns, fallow cropland, and short-, mixed- and heavily grazed tall-grass prairies (Thompson and Ely 1992).

Winter

United States.—Winter habitats are similar to breeding habitats; i.e., large grasslands areas that may or may not primarily consist of native grass (Dieni et al. 2003, Desmond et al. 2005). In southern Texas, Sprague's Pipits were located almost exclusively in grass-forb prairie (27 individuals/km^2), and rarely in shrub grassland (2 individuals/km^2; Emlen 1972). Sprague's Pipits southern distribution is coincident with the occurrence of *Andropogon* spp. grasses (Root 1988), although this may be due to limited sample sizes. In Arizona and New Mexico they are found in extensive areas of well developed desert grasslands (Merola-Zwartjes 2005).

In Texas, Sprague's Pipits winter in heavily grazed grasslands dominated by little bluestem (*Schizachyrium scoparium*) and *Andropogon* spp, and in large, over-grazed pastures (Grzybowski 1982); they are often found in patches where the grass is very short (Freeman 1999). Large numbers were also found on approximately 2000 ha (~5000 acres) of former rice fields, that had been re-planted to Bermuda grass (*Cynodon* spp.) a decade or more earlier and heavily grazed; in these fields, pipits occurred most frequently on the saline outcroppings where there was little vegetation (B. Ortego, pers. comm.). The 2nd highest densities of wintering pipits in Texas were observed on grasslands at the Attwater Prairie Chicken NWR in Colorado County and the Mad Island complex in Matagorda County These areas each consists of > 4000 ha (~10,000 acres) of native grasslands with moderate grazing and with the dominant grasses being normally about 0.2 m high. Pipits were also found frequently on turf grass farms, golf courses, heavily gazed Bermuda grass (Freeman 1999; B. Ortego, pers. comm.) and areas of burned pasture (Freeman 1999).

In both Texas and México, Sprague's Pipits are often observed using roads through appropriate habitat (Freeman 1999; B. Ortego, pers. comm.). These are typically either paved or unpaved secondary or tertiary roads with grass shoulders in agricultural settings without much traffic (Freeman 1999; B. Ortego, pers. comm.).

México.—In northwestern Chihuahua, Sprague's Pipits showed strong association with open grasslands, both densely and sparsely vegetated, and were not found in grassy agricultural borders or overgrazed *ejido* lands, and they were negatively associated with shrub abundance (Desmond et al. 2005). Comparisons of avian species assemblages on *ejido* land and an adjacent private ranch found that overgrazed *ejido* land did not support Sprague's Pipits (Desmond et al. 2005). A seasonal study of bird distribution in Cuatro Ciénegas, Coahuila, México (Contreras-Balderas et al. 1997) noted that Sprague's Pipits were found in three vegetation types: 1) scrub dominated by creosote bush (*Larrea tridentata*); 2) mesquite dominated by catclaw acacia (*Acacia greggi*); and 3) alkali scrub dominated by *Atriplex* sp., salt-tolerant grasses (*Sporobolus, Distichlis*, and *Monanthochloe* spp.) and mesquite (*Prosopis laevigata*).

In north-central México (Sonora, Chihuahua, Durango, Coahuila, and portions of Nuevo León and San Luis Potosí), Sprague's Pipits were a widespread winter resident in Chihuahuan desert grasslands (Panjabi et al. 2010). Densities have some annual variation, however, estimates of global densities were similar across years (2007–2009; Panjabi et al. 2010). Shrub cover had a strong negative influence on pipit abundance, with grass and other cover variables important positive predictors (Panjabi et al. 2010).

Population Trends and Estimates

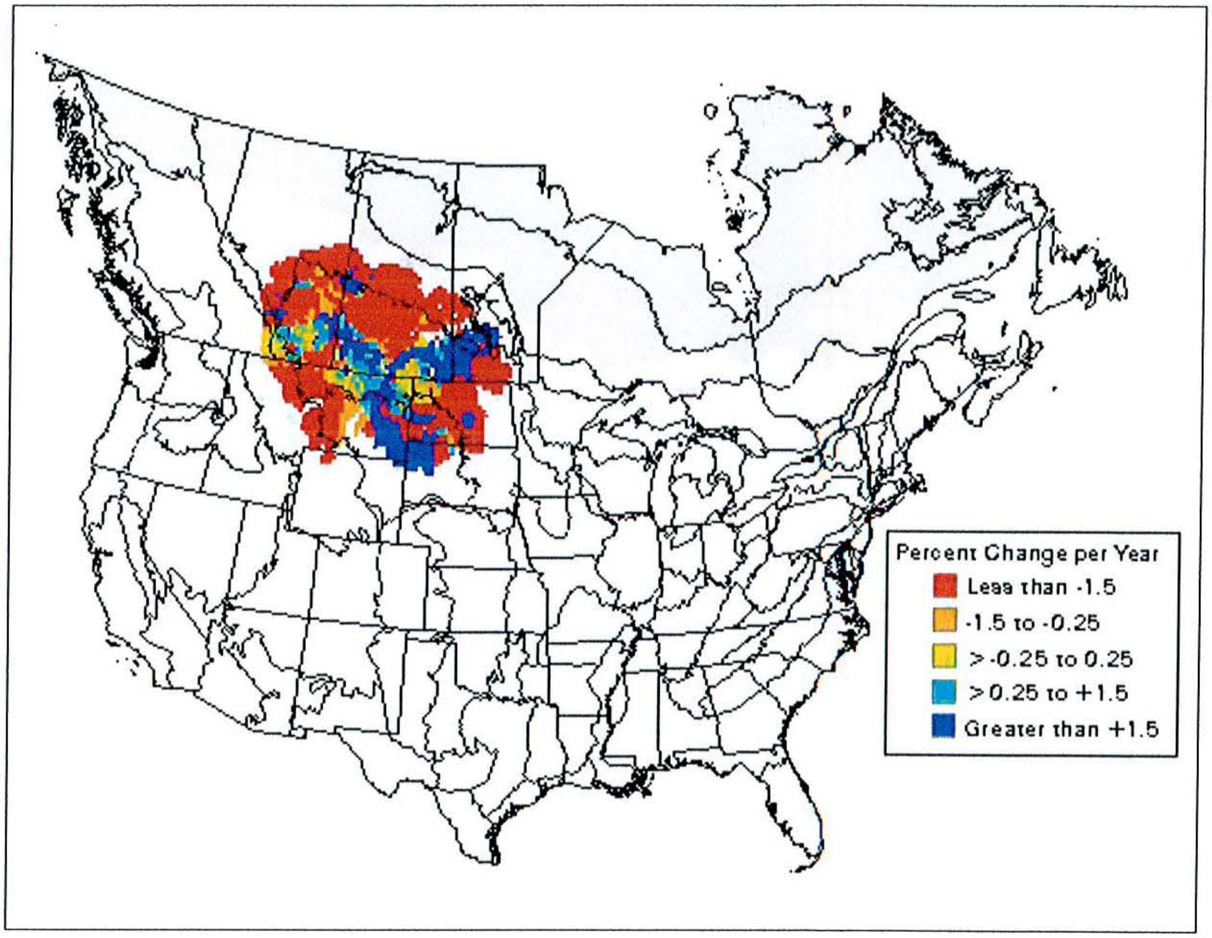

Figure 3. Trends for Sprague's Pipit, percent change per year; data from the Breeding Bird Survey for 1996-2007 (Sauer et al. 2008). These trends do not necessarily reflect statistical significance (see Table 1)

Trends

Breeding Bird Survey

Rangewide.—Breeding Bird Survey (BBS) data show Sprague's Pipit populations experiencing a statistically significant rangewide decline of 3.9% per year (1967-2007, n=169, p=0.00; Table 1; Sauer et al. 2008). The most dramatic population decreases occurred in Canada (6.0% per year between 1966 and 1996; n=37, p=0.09; Sauer et al. 2008). On a continental scale, most areas show declining populations over the past 30 years, with non-significant increases occurring only in the southwestern portion of the breeding range (Fig. 3; Sauer et al. 2008). Population monitoring in Sprague's Pipits is complicated by their nomadic behavior in response to annual weather conditions (Fig. 4; Root 1988, Jones et al. 2007).

Canada.—Sprague's Pipit experienced a 4.8% annual decline between 1966 and 2005; pipit populations in all jurisdictions and physiographic strata experienced their largest declines between 1966 and 1979 (Environment Canada 2008). A recent analysis of BBS routes within the Prairie Habitat Joint Venture indicates a 4.5% annual decline between 1970 and 2005; 2.8% annual decline in the prairie region compared with a 6.4% decline in the northern parkland region (Environment Canada 2008). Trend results for Grassland Bird Monitoring-Canada (1996–2004) show a decline of 10.5% annually in the prairie region compared with a 1.8% annual decline measured by the BBS in Bird Conservation Region (BCR) 11 for the same period (B. Dale and B. Collins, pers. comm.).

Declines in Alberta, where the species reaches its highest continental abundance, have been more rapid (10% per year) over the same period (Environment Canada 2008). Declines are also steep in Saskatchewan,

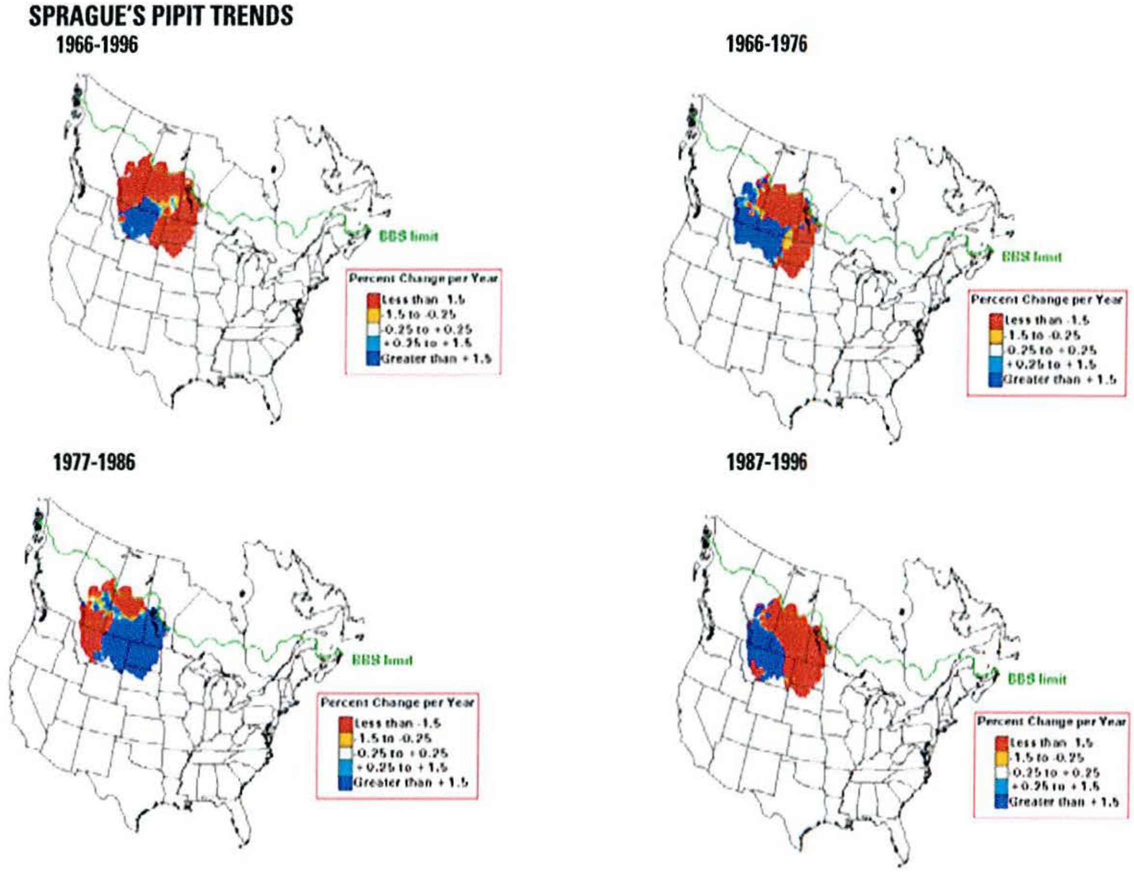

Figure 4. Trends for Sprague's Pipit for different time periods, data from the Breeding Bird Survey (J. R. Sauer, pers. comm.). Trends do not reflect statistical significance (see Sauer et al. 2008).

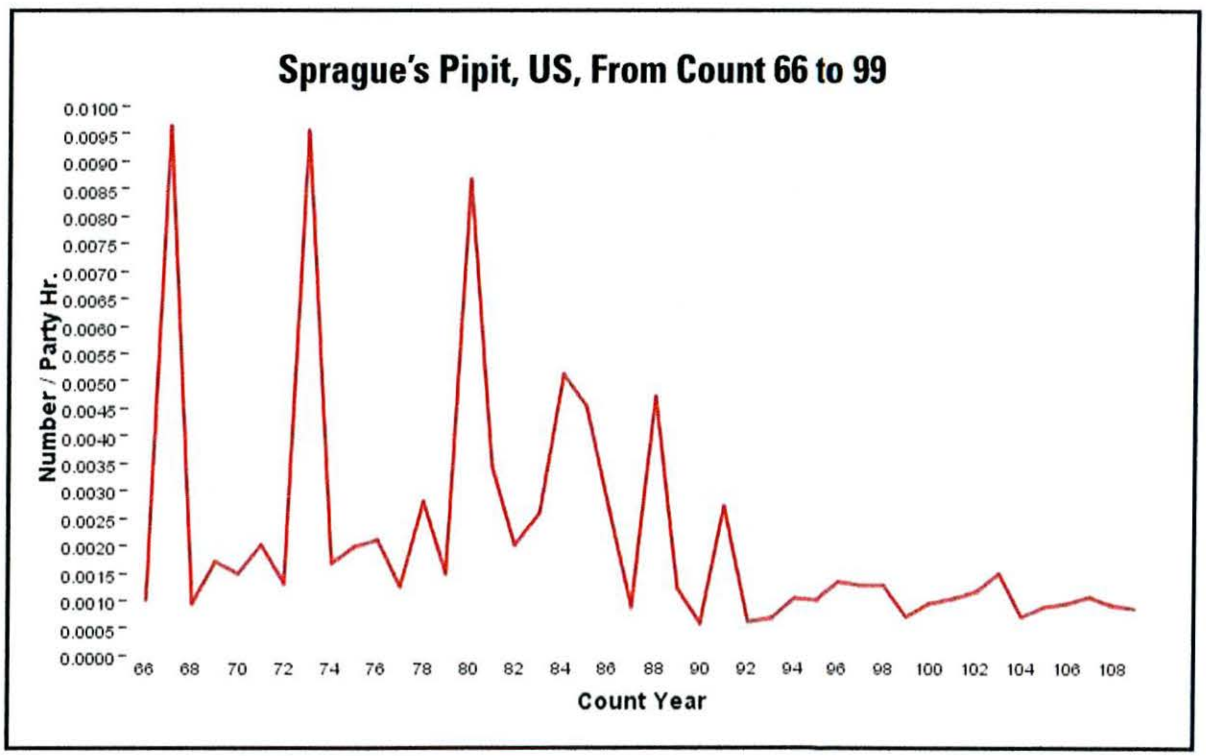

Figure 5. Christmas Bird Count data showing yearly variation in Sprague's Pipit densities for the U.S. (National Audubon Society 2009).

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4.2% per year ($n=45$, $p=0.05$) for the survey period (1966–2007; Environment Canada 2008). Sprague's Pipits populations in Saskatchewan have declined 4.8% per year since 1966, and 7.9% per year since 1980 (Prescott 1997).

United States.—In the United States trends are largely non-significant (Table 1; Sauer et al. 2008). There was no change in the population size of Sprague's Pipits in North Dakota between 1967 and 1993 (Igl and Johnson 1997).

Christmas Bird Count

United States.—CBC data show large yearly swings in numbers (Fig. 5; National Audubon Society 2009), and in general, the abundance of pipits was too low and sporadic for CBC data to yield meaningful information (Root 1988). Some of this variation may be due to measurement error, or to Sprague's Pipits nomadic behavior in response to annual weather conditions (Root 1988). There is also some annual variation in the areas of the highest winter densities; however, while poorer quality sites are inconsistent in the number of pipits from year to year, the higher quality sites consistently have high numbers of pipits each winter (B. Ortego, pers. comm.).

In another analysis of CBC data (National Audubon Society 2009), the 40-year (winters of 1996 through 2005) trend data for Sprague's Pipits showed a decline for Texas (2.54%), Louisiana (6.21%), Mississippi (10.2%), and Arkansas (9.27%), although abundances were very low and variable (U. S. Fish and Wildlife Service 2010). Overall, the 40-year trend showed a median declining population of approximately 3.23% annually; however, no tests of statistical significance were given (U. S. Fish and Wildlife Service 2010).

México.—CBC data (National Audubon Society 2009) data show Sprague's Pipits occurring every year in northern Chihuahua (Ejido San Pedro) and some years in Coahuila. Few individuals have been observed, with only one pipit documented in 1979, 1980, and 1986. Beginning in 1989, pipits were observed in northern México in all years. The highest number of individuals was in 1996, with 54 reported on one circle, and in 2004, with 48 individuals reported on five circles (National Audubon Society 2009). Generally, there is limited CBC data from México and therefore, CBC data could be misleading in the relative importance of México to wintering populations (J. M. Ruth, pers. comm.).

Historic

Anecdotal accounts from early naturalists suggest that Sprague's Pipits were one of the most common grassland songbirds in the northern Great Plains. Since its discovery, the Sprague's Pipit has suffered greatly throughout its breeding range from conversion of short- and mid-grass prairie to agriculture by Euro-Americans. There have been dramatic declines in pipits as prairie has disappeared through cultivation, overgrazing, and invasion by exotic plants (see Historical Changes, above; Prescott and Davis 1998).

Population estimates

Breeding.—Using BBS data, a global population estimate of 870,000 birds was derived (Sauer et al. 2003, Rich et al. 2004); however, this was calculated using a standard set of assumptions and calculations (Rosenberg 2004) that are unverified with the existing data and is a rough estimate with unknown, but potentially large, error. Similarly, populations have been estimated for the sub-regions of the U.S. states and Canadian provinces (Blancher et al. 2007). These estimates range from 400,000 (47.9% of the global population) in Alberta to 3000 (0.3% of the global population) in South Dakota (Blancher et al. 2007).

Wintering.—CBC data show that the highest wintering densities of Sprague's Pipits are recorded in north-central Texas (Prescott and Davis 1998, Sauer et al. 2008); however, this data has noteworthy biases (B. Ortego, pers. comm.). Grzybowski (1982) described the highest numbers in the central coastal prairie region of Texas and the highest numbers reported on a CBC route was 196 individuals at Corpus Christi in the winter of 1966-1967; currently, either Matagorda or Attwater Prairie Chicken CBC routes have the highest tallies with ca. 36 individuals (B. Ortego, pers. comm.). The small numbers of individual pipits on the CBC in southern Oklahoma and northern Texas may be due in part to the sometimes slow migration these birds exhibit during the dates of the CBC period; in mid to late Jan, the Sprague's Pipits are difficult to locate north of the coastal plain and become more common in southern Texas (B. Freeman, pers. comm.). The largest wintering populations in the Unites States were in coastal short-grass prairie in southern Texas, where "…many hundreds…" were observed in a single day in a 154 km^2 (60 sq. mile) area; the numbers of individuals peaked in Mar and early Apr (B. Freeman, pers. comm.). However, since abundance data is largely lacking from México, it is unknown how much of the population generally winters in México.

Densities

Breeding.—Densities of 21.5-41.2 pairs/100 ha were reported on native prairie in Saskatchewan (Maher 1973). A partially randomized survey of Saskatchewan grasslands found Sprague's Pipits on 18% of 1858 half-circles in native pasture (Antsey et al. 1995). In 1996-1997, a BBS-type study reported Sprague's Pipits on 32.5% of 1650 point counts in southwest Saskatchewan and southeast Alberta (Dale et al. 1997). In Alberta in 1994 and 1995, Sprague's Pipits were encountered on 54.1% of 741 point counts (Robbins and Dale 1999). In Montana, from 2001-2007, 49.8–71.3% of point counts ($n=1410$ points) detected Sprague's Pipits (C. Wightman, pers. comm.).

Wintering.—Densities of wintering pipits in the coastal prairies of Texas were 64 to 90 birds/100 ha (Grzybowski habitats than in native grasslands (McMaster and Davis 2001); however, nest survival is similar (Dohms 2009).

Since most native grasslands in the mixed-grass prairie in both Canada and the United States are grazed by livestock, Sprague's Pipits are susceptible to habitat degradation as a result of high-intensity grazing (see Grazing, below; Prescott and Davis 1998, Madden et al. 2000). Other grassland changes can alter the structure of vegetation so that it is no longer attractive to pipits. These changes include increased woody vegetation in the form of tree plantings and shrub encroachment, and invasive grasses and forbs (Johnson and Igl 1995, Dechant et al. 2003, Environment Canada 2008).

Sprague's Pipits nested in patches that had little or no clubmoss cover, nor was clubmoss ever used as a nesting substrate (Dieni and Jones 2003) although at the territory scale, pipits were positively correlated with ≤22% clubmoss cover (Dieni and Jones 2003). The potential for clubmoss to increase during drought sometimes makes it a management target; generally accepted methods of clubmoss removal, e.g., burning, grazing, mechanical and chemical treatments (Crane 1990), may themselves alter grassland conditions making the area unsuitable for nesting Sprague's Pipits, particularly in the short-term.

Burning.—Sprague's Pipits have evolved with periodic fires on the prairies, and may be limited by reduced fire frequencies that have accompanied human settlement. Reduced fire frequency allows encroachment by woody vegetation and invasive grasses and forbs, excessive growth of vegetation, and excessive accumulation of litter (Madden 1996, Environment Canada 2008), degrading breeding habitat in many geographic areas (Environment Canada 2008).

Large increases in Sprague's Pipit populations were recorded two years after a burn in Saskatchewan (Environment Canada 2008). Sprague's Pipits did not occur on North Dakota grasslands that had not been burned for over eight years; breeding abundances were highest two to seven years after a fire (Madden 1996). In more arid regions, Sprague's Pipits were common on native pastures that had not been burned for more than 15 years (Sutter 1996, Dale et al. 1997) and 26 years (Dieni and Jones 2003, Jones et al. 2010). Thus, the effects of burning likely vary with frequency, soil type, and moisture regimes, and land productivity. In the arid regions of the mixed-grass prairie, fire frequency recommendations are 8-20 years (Askins et al. 2007). Burning can have adverse short-term effects on Sprague's Pipits abundance and occurrence; however, it may have long-term benefits through improved habitat quality, if it occurs in an appropriate periodicity (Prescott and Davis 1998, Environment Canada 2008).

Grazing.—Livestock grazing can greatly influence vegetation structure, and, therefore, influence Sprague's Pipits occurrence and abundance (Prescott and Davis 1998). The effects of cattle grazing on Sprague's Pipits distribution depend on a variety of factors, including grazing intensity and frequency, as well as environmental conditions, such as moisture, soil type, and plant species composition (Maher 1973, Owens and Myres 1973, Karasiuk et al. 1977, Kantrud 1981, George et al. 1992). Therefore, the response of Sprague's Pipits to grazing intensity and frequency likely varies with geography.

While Sprague's Pipits generally avoid heavily-grazed pastures (Maher 1973, Owens and Myres 1973, Prescott and Wagner 1996, Sutter 1996, Davis et al. 1999), lightly- to moderately-grazed pastures have been identified as optimal habitat for pipits throughout much of their breeding range (Owens and Myres 1973, Davis et al. 1999, Robbins and Dale 1999, Dechant et al. 2003). In North Dakota, a greater abundance of Sprague's Pipits was reported from moderately to heavily grazed pastures (Kantrud 1981). Intensive grazing, however, may render some grassland habitat unsuitable, both indirectly through impacts to vegetation structure and directly through reproductive failure due to disturbance and trampling of nests (Environment Canada 2008).

In the eastern portion of Sprague's Pipits range, in the mesic mixed-grass prairie, disturbance (primarily fire at appropriate intervals, and secondarily grazing, at appropriate rates) can be used to create and maintain healthy pipit habitat (Kantrud 1981, Madden et al. 1999). In the drier, less densely-vegetated mixed-grass prairie particularly in the southwestern portions of Sprague's Pipits range, it has been documented that the number of Sprague's Pipits decreased significantly with increased grazing intensity (Maher 1973, Dale 1983, Robbins and Dale 1999). During 1994-2007, a small but consistent breeding population was documented at Bowdoin NWR in north-central Montana in idle mixed-grass prairie (Dieni and Jones 2003, Jones and Dieni 2007, Jones et al. 2007, Jones et al. 2010).

The effects of grazing must also take into account vegetation potential in the form of structure (i.e., vertical and horizontal density) as well as plant species composition, which varies within and across geographic locales. Cattle presence can also result in increased abundances of cowbirds (Duffy 2000, Danley et al. 2004).

Fire and Grazing, Combined.—In units that were burned, and then grazed, pipit numbers were similar to those in units that were only burned; Sprague's Pipits had lower abundances the first year after treatment, and increased in the second and third year, whether grazing was added or not (Danley et al. 2004). However, cowbirds occurred 2.4 times more frequently on burned and grazed units then those only burned (Danley et al. 2004). The implications of increased cowbird abundance on pipit populations are currently unmeasured.

Mowing.—Haying in native prairie may have negative impacts on Sprague's Pipits populations (Prescott and Davis 1998, Robbins and Dale 1999, McMaster et al. 2005). Sprague's Pipits are not common on planted hayfields, and haying native prairie during the nesting season may substantially lower reproductive success through mechanical destruction of nests and adults, or by reducing vegetative cover and exposing nests to predators and inclement weather (Dale et al. 1997, Davis 2005). Mowing has been found to destroy approximately 50% of ground nests and the productivity of breeding birds in hayfields is below that required to maintain stable populations (Dale et al. 1997, Prescott and Davis 1998). In Manitoba, native hayland was more attractive to Sprague's Pipits than brome/alfalfa hayland or idle native grassland, but it was less attractive than non-native pasture. In Alberta, hayed native fescue was less attractive to Sprague's Pipits than idle fescue, but more attractive than grazed fescue (Robbins and Dale 1999). In Saskatchewan, Sprague's Pipits were significantly more common in idle native grassland than in either annually or periodically hayed exotic grasses (Robbins and Dale 1999, McMaster et al. 2005).

Introduced Vegetation.—Sprague's Pipits have a strong negative response to exotic grasses (Sutter 1996, Madden et al. 2000, Grant et al. 2004). Consequently, the introduction of Eurasian plant species has had a negative effect on Sprague's Pipit populations. In Manitoba, Sprague's Pipits were significantly more abundant in native prairie than in introduced vegetation (Wilson and Belcher 1989). Singing males were two to three times more abundant in native grass than in crested wheatgrass (*Agropyron cristatum*) and four to 25 times more abundant in native grass than in brome-dominated grassland in south-central Saskatchewan (Prescott and Wagner 1996). They were more than twice as abundant in native grass than crested wheatgrass or absent from crested wheatgrass in southern Alberta sites (Prescott and Wagner 1996). Greater Sprague's Pipit densities were significantly correlated with native grasses at Lostwood NWR in North Dakota (Madden 1996). Exotic plant species planted for the Conservation Reserve Program and for nesting cover for waterfowl are generally not used by Sprague's Pipits (see Threats, Breeding, Habitat, above; Robbins and Dale 1999).

Pesticides.—Use of pesticides to control grasshoppers may impact Sprague's Pipit populations, since grasshoppers are an important food item for the adults and nestlings during the breeding season (George et al. 1992, Environment Canada 2008). Anecdotal observations suggest that Sprague's Pipits may occasionally forage in cropland and thus could be exposed to pesticides (Environment Canada 2008). The amount of time pipits could be exposed to pesticides during the breeding and non-breeding season is unknown.

Fragmentation.—Fragmentation of native prairie has likely contributed to the decline of Sprague's Pipit populations through a reduction in average patch size, increased isolation of habitat patches, an increase in the ratio of edge:area to interior habitat (Davis 2004, Davis et al. 2006) and potentially, an increase in parasitism (Davis and Sealy 2000). In fragmented landscapes, habitat interior species such as Sprague's Pipits (Davis 2004) may experience lower reproductive success when nesting near habitat edges, where they are more susceptible to nest predators and brood parasites (Prescott and Davis 1998, Davis et al. 2006). Sprague's Pipit abundance was inversely correlated with distance to cropland and to water (Koper and Schmiegelow 2006a, 2006b; Koper et al. 2009). Pipits had higher densities by at least 0.3 individuals per point count per km away from cropland, and the average number of individuals per point count increased by at least 0.4 per km away from water, with distance to road having no effect (Koper and Schmiegelow 2006b).

Roads.—Sprague's Pipits may avoid roads and trails during the breeding season (Sutter et al. 2000) and the increased roads densities associated with energy development effects Sprague's Pipits habitat (Dale et al. 2009, Linnen 2008). The type of road (e.g., secondary or tertiary, the presence of deep ditches on the sides, heavily graveled) and the level of traffic are the potential issues in determining the degree of effect roads and trails have on Sprague's Pipit populations (N. Koper, pers. comm.; SLJ; see Winter, below).

In Saskatchewan, Sprague's Pipits were significantly more abundant along trails (wheel ruts visually indistinct from surroundings) than along roadsides (fenced surfaced roads with adjacent ditches), which may be attributed to the 20 - 30% reduction of suitable habitat associated with the road right-of-way (Sutter et al. 2000). Sprague's Pipits avoidance of roads in this study may be due to the roadside habitat which also tended to have non-native vegetation, dominated by smooth brome (*Bromus inermis*) (Sutter et al. 2000). Other data found that there was no significant effect of roads (Koper et al. 2009); there was no effect of trails on pipit nest survivorship in Montana (SLJ).

Linnen (2008) examined the effects of oil and gas disturbances, including road establishment and suggested that Sprague's Pipits tended to occur in lower numbers and at fewer sites near natural gas wells and trails than in interior habitat patches; however, the relationship was not statistically significant (Linnen 2008). Dale et al. (2009) documented that pipit territories rarely crossed trails. However, the method used to map the breeding territories was not detailed and no tests of statistical significance were reported (Dale et al. 2009), thus sampling error was never eliminated as a possible explanation.

Depredation.—Predation is the primary factor influencing nest survival throughout the species' range (Davis and Sealy 2000, Davis 2003, Jones and Dieni 2007, Jones et al. 2010) and in some years, predation can result in near complete nesting failures (Davis 2005). It is difficult to determine whether current predation rates are higher than historic levels; changes in predator communities, habitat structure, and composition and configuration of current grassland habitat could increase the risk of predation; however, little data are available.

Nest Parasitism.—Cowbird parasitism rates on Sprague's Pipit nests vary throughout their range. Habitat fragmentation potentially increases the rate of cowbird parasitism, and the degree of impact from parasitism on nest survival (Davis and Sealy 2000). However, pipits do not seem to be a good host for cowbirds; the cost of parasitism to pipit populations overall is unknown (see Parasitism, above; Davis 2003, Jones et al. 2010).

Climate Change.—Sprague's Pipits are susceptible to climate change (Price 1995). Modeling and predictions of climate change indicate that pipits will become extirpated as a breeding species in the United States and the lower third of Canada due to increasing temperature (Price 1995). It is also predicted that Sprague's Pipits may shift their range north, as southern areas become too warm (Price 1995). The impact of climate change at a population level is unknown. Prolonged periods of cool and wet weather may impact local Sprague's Pipit populations by reducing productivity (Environment Canada 2008). In addition, predictions for harsher, drier temperatures in México, changes in frequency and intensity of drought could impact wintering Sprague's Pipit populations further. These predictions may also affect migration areas (C. M. Rustay, pers. comm.).

Drought.—Drought can be a significant factor affecting Sprague's Pipits nesting habitat and possibly food supply at the local level (Environment Canada 2008) and also affecting wintering habitats (Dieni et al. 2003, J. M. Ruth, pers. comm.). Sprague's Pipits disappeared or declined from many transects in North Dakota during a severe drought in 1988 (George et al. 1992, Niemuth et al. 2008); pipits rebounded once the drought cycle was reversed (George et al. 1992). The effects of drought could be exacerbated by the impact of grazing and fire, particularly in the xeric areas of their range (Askins et al. 2007).

Energy Development.—Energy exploration and extraction are expected to continue to be a threat to Sprague's Pipits habitat and populations into the future as demands for resources increase globally (Environment Canada 2008). Sprague's Pipits abundance decreases within 300 m of oil wells (Linnen 2008). A substantial amount of new oil and gas production is predicted to occur throughout Sprague's Pipits' breeding range, particularly in Alberta (Environment Canada 2008). Currently, no regulatory mechanisms exist for many of these activities to ensure that drilling and associated activities avoid nesting habitat. In the United States, much of the Sprague's Pipit's breeding range overlaps major areas of oil production in eastern Montana, western North Dakota and northwestern South Dakota. Areas with a high density of oil production may also decrease migration and wintering habitats available.

Wind energy has been increasing in recent years; more than 45% in 2007 and more than 50% in 2008 (A. Manville, pers. comm.). Area and patch size (Davis 2004) are important habitat attributes for Sprague's Pipits, and habitat fragmentation a threat to their populations. Wind projects can fragment native prairie habitat through the construction of roads, turbines, electrical grids, and associated facilities; several of the states where Sprague's Pipits breed or winter are the top states potential for wind energy development (Elliott et al. 1991). Sprague's Pipits negatively respond to shrub and tree densities, and it is likely that they exhibit negative responses to other vertical structures in their habitat (e.g., wind turbines, telecommunication towers, power line towers), although specific data are limited.

The effects of increased biofuel production (converting native prairie to agriculture) would likely further decrease breeding habitat.

Industrial Noise.—Industrial noise caused reduced pairing success and influenced age structure in some breeding bird species (Environment Canada 2008, Barber et al. 2009). Expanding energy development (wind energy and oil and gas) in grassland regions may result in increased noise levels and subsequently interfere with male song in Sprague's Pipits. The effect of anthropogenic noise on Sprague's Pipit breeding success is unmeasured.

Winter

Sprague's Pipits are federally protected on their winter range in the United States and México under the Migratory Bird Treaty Act (U.S. Fish and Wildlife Service 2008a). Enforcement of regulatory mechanisms are inadequate to protect individuals in México; no regulatory mechanism currently protects Sprague's Pipit habitats on their winter range.

Specific threats on the winter range in the United Sates or México are many of the same issues identified as threats on the breeding range, (e.g., over-grazing, fragmentation, degrading, and conversion of grasslands, invasive species, and climate change) although the level of each threat may be different.

Protected Sprague's Pipit habitat exists in the United States largely on public lands. Although not protected specifically for pipits, large grassland tracts are protected by the National Wildlife Refuge System, National Parks, Bureau of Land Management and Forest Service lands in the southern United States. Smaller areas of grassland are protected by The Nature Conservancy and other private land owners committed to managing lands for conservation. In México, few truly protected areas of grassland exist. A few private reserves containing pipit habitat (e.g., the Reserva Ecológica El Uno in northern Chihuahua) have been established. Few national or state-level protected areas exist in México for Sprague's Pipits and those that do, such as the Janos Biosphere Reserve, offer limited protection against landscape-level disturbance. These protected areas would not be enough to sustain pipit populations throughout their winter cycle.

Although large numbers of Sprague's Pipits frequent heavily grazed pastures on the Texas coast during winter (Freeman 1999), this is in contrast to observations in México that heavy grazing is a threat to pipits (Desmond 2004; below). This apparent conflict may be due to a number of causes, including the level of grazing, as "heavy" is largely undefined; differences in the environmental conditions, such as moisture, soil type, and plant species composition, or to lack of data, as most information from the wintering range is limited in scope.

United States

In general, there are few data from the wintering range in the United States, and little is known about the level of the threats here. Sprague's Pipits occur on the largest patches of grasslands in Texas, but are also found on turf-grass farms, grassy roadsides, and other areas with short grass, and on heavily grazed areas (Freeman 1999). They will also use areas with introduced Bermuda grass, with high concentrations of pipits found in saline openings in a large exotic grassland that were heavily grazed (B. Ortego, pers. comm.). Overgrazing, conversion of grasslands, drought, climate change, energy development, and fire suppression are all potential threats to grasslands in the southern United States, but the relative levels are unknown.

Sprague's Pipits appear to use roads frequently on the wintering grounds (Freeman 1999; B. Ortego, pers. comm., SLJ) and during migration (SLJ). The loss of native coastal prairie in Texas is extensive; however, Sprague's Pipit do use introduced grasses at some level during the winter period.

México

Overgrazing by domestic livestock and agricultural practices are the most extensive land uses thought to threaten habitat for Sprague's Pipits in Chihuahua, México (Desmond 2004). In addition, large-scale habitat alterations are occurring throughout the Chihuahua Desert (Desmond 2004). These include conversion of grasslands to agriculture and the large-scale conversion of desert grasslands to shrub dominated systems. These changes are occurring from current and historic overgrazing by domestic livestock, loss of native herbivores, fire suppression, drought, and climate change (Desmond 2004). Shrub encroachment into areas of extensive grasslands is also occurring and may have contributed to reduced numbers of grassland obligate passerines, including Sprague's Pipits (Desmond 2004). Sprague's Pipits were found in significant numbers after a wet year in Chihuahua, but were local and rare in dry years (Dieni et al. 2003). The relative levels of the threats to Sprague's Pipits on the winter range are unknown.

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Management

Management for Sprague's Pipit consists primarily of protecting, maintaining, and restoring native mixed-grass prairie in large expanses (Stewart 1975; Sutter 1996, 1997; Davis 2004). In general, Sprague's Pipit abundances are higher in native grass then in non-native fields. The breeding habitat attributes important to Sprague's Pipits abundance include prairie dominated by native grass, with a particular structure, and area size (see Habitat above; Sutter 1996, 1997, Davis et al. 1999, Table *in* Dechant et al. 2003, Dieni and Jones 2003). Converting cultivated land adjacent to native prairie to perennial cover, including seeding with a native grass mix or one that includes a prostrate (versus erect) form of legume could make smaller tracts attractive to pipits (Winter et al. 2006). The conservation value of large prairie tracts is obvious, but several small habitat patches surrounded by treeless landscape might offer similar conservation value for grassland passerines as a single large prairie patch (Davis 2004, Winter et al. 2006).

Successful management of many grassland habitats often requires some form of disturbance. In many cases, management through fire, grazing, mowing or herbicides can assist in maintaining native grasslands appropriate for Sprague's Pipits; however, the intensity and frequency of disturbance is dependent upon soil productivity, geographic area, and climate. Idling grassland habitat can reduce its suitability for Sprague's Pipits in the mesic portions of their range (e.g., moist mixed grasslands and aspen parkland regions), while disturbance can reduce habitat suitability if the timing, frequency, intensity, or duration of disturbance is inappropriate, particularly in the drier portions of their range (Askins et al. 2007). The following discussion is primarily for the breeding range, unless otherwise mentioned; there is little data on migration or wintering habitat and their management.

Patch Size.—Large native prairie grasslands are needed for Sprague's Pipit conservation. Native grassland tracts of ≥145 ha should be retained for breeding (Davis 2004, Anonymous 2007) although some high quality smaller patches (≤ 29 ha) could provide conservation value, if the landscape is neutral (e.g., no trees or other vertical structure) for Sprague's Pipits, rather than hostile (e.g., development) (Winter et al. 2006).

Preclude Woody Vegetation.—Optimal breeding habitat for Sprague's Pipits will require the removal of woody vegetation from the interior of grassland patches (Grant et al. 2004). In native and planted grasslands this can be accomplished through burning, grazing, mowing, herbicides, or manual removal, as long as the treatment does not result in long-term damage to the grassland (Anonymous 2007) or cause excessive vegetation disturbance, increases in small mammal predators due to leaving slash piles, or excess removal of litter. Avoid planting trees and/or shrubs within 100 m of native grasslands (Anonymous 2007).

Invasive Grass and Forb Species.—Removing exotic plant species, especially smooth brome, sweet clover (*Melilotus* sp.), and alfalfa (*Medicago* sp.) in native grasslands will improve habitat for pipits. Monitor roadsides for invasive species, and remove these species before they move into native prairie (Anonymous 2007).

Mowing.—Mow haylands on a rotational schedule of every other year. Although hayfields are limited in their use by pipits, mowed hayfields can provide better habitat than those idled (Denchant et al. 2003, Anonymous 2007). Delaying mowing until after 15 Aug, should allow >70% of Sprague's Pipit nests to fledge. Minimum dates for mowing of hayfields are after 15 Jul in the dry mixed-grass prairie, after 21 Jul in the xeric mixed-grass prairie, and southern aspen parkland and after 31 Jul in the northern aspen parklands (Anonymous 2007).

Prescribed Fire.—In general, prescribed burning reduces shrub encroachment as well as residual grass cover and may reduce or restrict invasion of exotic plants (Robbins and Dale 1999). Fire is important to maintain Sprague's Pipits' breeding habitat, especially in the eastern portion of the species' range. In Saskatchewan, Sprague's Pipits were most abundant two to three years, and sometimes up to seven years, post-fire; none were present on native prairie that had not been burned or grazed for more than eight years (Anonymous 2007). In North Dakota, burning grasslands every two to four years over a 15-year period resulted in the highest abundance when compared to unburned areas or areas burned only once or twice in 15 years (Madden et al. 1999). Recommendations for timing of burns in the aspen parklands in Canada are 5-10 year intervals, 10 - 15 year intervals in moist mixed-grass regions, and as much as 20-26 year intervals in the mesic mixed-grass prairies or not at all if the vegetation structure can be maintained (Anonymous 2007, Askins et al. 2007). Optimal burning intervals will vary with local and climatic conditions, such as during a drought (where the interval may be significantly longer).

On the wintering grounds, in the coastal prairie of Texas, herbicides are used to control invading mesquite

(*Prosopis* spp.) and huisache (*Acacia smallii*) in the prairie. The burn intensity and frequency needed to control mature brush is generally not practical in Texas and burning tends to only control the small brush at lower intensities (B. Ortego, pers. comm.).

Grazing.—Grazing reduces residual grass cover and may stimulate growth of native plants and prevent or slow invasion by exotic plants (Robbins and Dale 1999). Grazing during the breeding season should be light to moderate (Dechant et al. 2003), although intensity varies geographically. Moderate intensity grazing should be used in the aspen parklands, low to moderate grazing intensities in the mesic mixed-grass prairie, and low grazing intensities or no grazing in the xeric or semi-arid mixed-grass prairie, where disturbance is rarely needed to make the habitat attractive to Sprague's Pipits (Anonymous 2007). However, these terms are relative and difficult to quantify. Local focus should be on getting absolute, rather than relative, measures of vegetation as inherent problems exist in defining, for example, "heavy" or "moderate" or "low" grazing levels (Madden et al. 2000).

There is little data on optimum grazing levels on the wintering grounds, and some conflicting information from the United States and México. It seems likely that different grazing management prescriptions would be needed for Sprague's Pipits in the desert grasslands of the arid southwestern United States and northern México then in areas of Texas coastal prairie. However, information is so limited it is difficult to make recommendations.

Both fire and grazing should be conducted on smaller habitat patches rather than over large areas to achieve an increased vegetation mosaic and to provide a mix of native habitats (Fuhlendorf et al. 2006). Grazing, fire and herbicides could be used together, in conjunction, and in rotation, to achieve the desired conditions (Fuhlendorf et al. 2006).

Restoration.—Restoration programs can be used to enhance the attractiveness and reproductive potential of irregular shaped grassland patches by focusing efforts on increasing patch size and minimizing the amount of edge habitat (Davis 2004). Seed with finer grasses in forage mixes, and seed herbaceous species that grow well in a stand with other species. Do not seed with coarse, tall, or dense growing grasses like smooth brome, or with aggressive competitors, like crested wheatgrass, where litter levels are too low and bare ground coverage is too high (Anonymous 2007).

Roads.—Construction of built-up roads (e.g., dikes) in native or planted grasslands should be avoided. Use native grasses and forbs to re-vegetate pipelines, roads, and other linear development (Anonymous 2007).

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Conservation

This Conservation Plan (Plan) is designed to highlight actions needed to achieve conservation for Sprague's Pipits. This Plan includes a prioritized list of actions and needs that will begin to address the requirements to achieve the long-term rangewide conservation of Sprague's Pipits; actions are prioritized within each major group (Table 2).

The goals for the conservation of Sprague's Pipits are to increase and maintain population size and distribution throughout the pipit's historic range and to prevent further loss and degradation, including fragmentation, of native prairie within its historic range. In addition, the restoration of currently unsuitable habitat is a conservation priority.

No current recovery strategy exists for Sprague's Pipits in United States or México. Implementing these strategies will encompass different issues in each of the three countries. Canada currently has a recovery plan (Environment Canada 2008) and the United States has completed a status review (U. S. Fish and Wildlife Service 2010). In México, implementation will be primarily dependent on NGOs and will require gathering basic baseline data and developing educational programs.

Other Species Covered

Other species that could benefit by habitat management, modification and protection for Sprague's Pipits, in the portions of their breeding and wintering ranges that overlap, include Northern Bobwhite (*Colinus virginianus*), Marbled Godwit (*Limosa fedoa*), Upland Sandpiper (*Bartramia longicauda*), Common Nighthawk (*Chordeiles minor*), Grasshopper (*Ammodramus savannarum*), Baird's, LeConte's (*A. leconteii*), and Savannah (*Passerculus sandwichensis*) sparrows, Dickcissel (*Spiza americana*) and Western and Eastern (*Sturnella magna*) meadowlarks.

Species that could be negatively affected by proposed Sprague's Pipit habitat management include species that use tree and brush vegetation in a grassland savannah, including Loggerhead Shrikes (*Lanius ludociianus*) and Clay-colored Sparrows (*Spizella pallida*). Grassland species requiring tall and dense or short and sparse grass, including Mountain Plovers (*Charadrius montanus*) and McCown's Longspurs (*Rhynchophanes mccownii*), may be negatively affected locally by habitat management for Sprague's Pipits.

Canada

In Canada, conservation goals will be accomplished through grassland conservation initiatives, such as stewardship and management agreements, conservation easements, policy reform, and tax incentives (Environment Canada 2008). Voluntary stewardship agreements have been widely used by conservation groups as a means of establishing and building relationships with producers, and this will be one of Canada's main tools (Environment Canada 2008). Management agreements are typically short-term (10–15 years) formal agreements that are legally binding and represent an agreement between a producer and conservation organization. Incentives are provided (e.g., watering system development, fencing materials, forage seed, etc.) to encourage landowners to alter current management regimes for species at risk, including Sprague's Pipits (Environment Canada 2008).

The Canadian recovery strategy lists the primary actions required to effectively recover Sprague's Pipit populations (Environment Canada 2008). Action plans are scheduled for development by 31 Mar 2011, to cover jurisdictions within the range of Sprague's Pipits in Canada (Environment Canada 2008). Critical habitat determinations in Canada are scheduled for development in 2010 (Environment Canada 2008).

United States and México

Knowledge of the response of breeding Sprague's Pipits to invasive species, and the effects of both timing and method of eradication actions are needed to make informed management recommendations. Grazing, haying, and prescribed burning are all recommended management tools for maintaining native prairie grasslands for breeding Sprague's Pipits (Hagen et al. 2005). Determining the best timing and intensity of these management tools are important to maximize benefits and reduce disturbance both to breeding pipits and their habitat. However, recommendations can vary across the pipit's range, and management of other high priority wildlife species (e.g., prairie-dogs or Mountain Plovers) could conflict with recommendations developed for Sprague's Pipits. This reinforces the need for local evaluation of management actions that can then be integrated into a rangewide perspective.

Although data is available on timing and breeding distribution, identifying all of the important sites used by wintering Sprague's Pipits, particularly in México, has not been completed. As a general strategy, conservation will initially require identifying important migration and wintering areas, assessing their functional ability to support Sprague's Pipits, and then, if warranted, developing conservation actions and evaluation measures for these areas. The effects of energy development

Table 2. Prioritized conservation plan and actions for Sprague's Pipit (SPPI). "Lead for current work" represents groups and individuals currently working on this aspect of SPPI biology in each of the three countries; "Potential" refers to partners with the knowledge and potential to collaborate in this area. "Critical" habitat is used for Canada under the SARA listing as threatened; for the United States and México, it is used in the non-legal sense, meaning important habitat types and areas. Organization abbreviations: CRT = Canada Recovery Team; CWS = Canadian Wildlife Service; FWS = U.S. Fish and Wildlife Service; FWS-ES = FWS Bismarck Ecological Services Office; FWS-MBNG = FWS Migratory Birds, Nongame, Region 6; FWS-HAPET: FWS HAPET Office, Regions 6 and 3; USGS = U. S. Geological Survey, Biological Research Division; USFS = U. S. Forest Service; USBLM = U. S. Bureau of Land Management; USDOD = U. S. Department of Defense; TNC = The Nature Conservancy; CEC = Commission for Environmental Cooperation; RMBO = Rocky Mountain Bird Observatory; NCC = Nature Conservancy of Canada; INEGI = Instituto Nacional de Estadística y Geografía; CONANP = Comisión Nacional de Áreas Naturales Protegidas; WWF = World Wildlife Fund; PLJV = Playa Lakes Joint Venture; PPJV = Prairie Potholes Joint Venture; PPP-LCC = Prairie Landscape Conservation Cooperative; JV-LCC = Joint Ventures and Landscape Conservation Cooperatives. Individuals abbreviations: NK = Nicola Koper, University of Alberta, Edmonton; SKD = Stephen K. Davis, University of Regina, Saskatchewan; MD = Martha Desmond, New Mexico State University; SLJ = Stephanie L. Jones, FWS.

					Lead for current work				
Priority	**Sub-priority**	**Section**	**Sub-section**	**Description**	**Canada**	**United States**	**México**	**Potential**	**Comments**
1		**Habitat**							
	1.A		*Protect and restore larger tracts of native grasslands.*						
	1			Use conservation easements (voluntary and paid) or purchase of larger tracts of land with native grassland protecting large tracts of existing native grasslands from conversion and fragmentation.	NCC	TNC, FWS	TNC, ProNatura	USBLM, USFS, State Agencies, USDOD, WWF	No specific easement programs have yet been planned for SPPI; existing grassland easement programs can be used.
	2			Identify priority areas to target habitat conservation activities.	CRT, NCC	FWS-ES, FWS-HAPET	TNC, WWF	TNC, CEC	Evaluate the potential to convene regional groups to establish priorities, maybe through TNC.
	3			Convert non-native uplands, including hay and pasture, to native vegetation; join tracts of restored and native grasslands to form larger tracts.				FWS, TNC	
	4			Establish protected natural areas.	Parks Canada	FWS, FS, USBLM	CONANP		Janos Biosphere Reserve recently declared in Chihuahua, México.
	1.B		*Identify important (critical) habitat*						
	1			Use current technology and other data to document and map the existing grassland habitat critical for SPPI.	CRT	FWS-HAPET, PPJV	TNC, WWF	PPP-LCC	TNC, states, and others may have information from México.
	2			Update land cover data with ground-truthing to verify current and future model predictions, and to confirm habitat suitability and SPPI use.	CRT	PLJV	INEGI	States, FWS, JV-LCC	Texas & other states will be completing a land cover classification in the next couple of years.

Table 2, continued

Priority	Sub-priority	Section	Sub-section	Description	Lead for current work: Canada	Lead for current work: United States	Lead for current work: México	Potential	Comments
		3		Develop and refine predictive models of occurrence and abundance using existing data to identify potential source breeding areas. Produce geographic information system (GIS) maps to delineate regions of high probability of occurrence and abundance, in all seasons.	CRT	FWS-HAPET, PPJV		PPP-LCC	Study ongoing on landscapes and spatial analysis linking populations to habitat (Montana).
		4		Conduct field surveys to verify predictive models and collect SPPI location and abundance data on the breeding range. High-ranking sites confirmed to have high densities of SPPI should be identified.					
		5		Assess wintering areas in s. U S and n. México to identify and protect areas with high value for SPPI populations.			RMBO, TNC	JV-LCC	
	1.C		*Identify important habitat components*						
	1.C.b		*Breeding*						
		1		Determine influence of exotic vegetation and confirm whether suitable habitat includes only native vegetation on the breeding range.	SKD				
		2		Determine influence of wetlands and topography on density and reproductive success. Determine whether high-density wetland landscapes are source SPPI habitat.	NK				
	1.C.w		*Wintering and Migration*						
		1		Determine the extent of SPPI use of grazed rangelands on the wintering range, and how SPPI respond to various grazing regimes.				MD	
		2		Determine habitat needs on wintering range, including influence of non-native vegetation, precipitation, and diet and seed resources.				MD	SPPI seem to use non-native quite readily in some locations, on the wintering range.
		3		Determine influence of exotic vegetation and confirm suitable habitat types on the wintering range.					
2		**Management**							
		1		Implement best management practices, and determine whether current recommendations are valid, for different geographic areas and seasons.				FWS, USFS, USBLM	

Table 2, continued

Priority	Sub-priority	Section	Sub-section	Description	Lead for current work			Potential	Comments
					Canada	United States	México		
	2			Identify and implement appropriate restoration and management tools to improve and maintain the quality of habitat used by SPPI in all seasons.				FWS, USFS, USBLM	
	3			Determine how various habitat management practices for grasslands in different regions of the range effect this species. Test and monitor a variety of existing grassland restoration projects within the range of this species for its benefits to SPPI.	NK			FWS, USFS, USBLM	
	4			Implement techniques to recover SPPI populations in areas that have experienced declines and range contractions.				CWS, FWS, JV-LCC	
	5			Remove woody vegetation from existing open grasslands. Identify geographic regions where woody vegetation encroachment is prevalent and the relative importance of woody vegetation to SPPI during breeding.	NK				
	6			Convert shrub-encroached grasslands back to more open grasslands (e.g., removal of mesquite) on the wintering grounds.				JV-LCC, USBLM, TNC, ProNatura	
	7			Identify areas where haying of SPPI habitat is common; establish and implement guidelines for haying during the breeding season. Determine whether incentives are required to offset costs to producers.	NK				Probably an issue in sw. Manitoba more than the other areas of Canada; not known to be an big issue in other portions of the range.
3		**Inventory, Monitoring and Assessment**							
	1			Increase grassland bird monitoring using the Grassland Bird Monitoring programs in Canada and the U.S.	CWS	FWS-MBNG, FWS-HAPET			
	2			Encourage and solicit increased participation in the BBS and increase the number of trained observers and routes in grassland habitat.	CWS	FWS-MBNG, FWS-HAPET	USGS	USGS	
	3			Evaluate the existing inventory and monitoring data for both populations and habitat to identify data gaps, particularly on the wintering range.				USGS	

Table 2, continued

Priority	Sub-priority	Section	Sub-section	Description	Lead for current work: Canada	Lead for current work: United States	Lead for current work: México	Potential	Comments
	4			Determine the quantity and quality of grassland habitat, and monitor changes in quantity and quality over time.	CWS	FWS-HAPET, FWS-ES, PPJV		PPP-LCC, TNC, JV-LCC	Targeting grassland conservation: an estimate of land–use conversion risk in the Northern Great Plains (parts of ND, SD, and MT).
	5			Inventory and monitor the distribution and habitat use for SPPI on the wintering grounds.		FWS-R2	RMBO,TNC		
	6			Collect location and abundance information and establish a database with this data. Create maps showing locations of SPPI and areas of high density and persistence.	CRT	RMBO			
	7			Use existing programs (e.g., avian checklist, bird atlas, e-Bird, Natural Heritage programs), and collated sightings from bird enthusiasts, to refining the extent distribution in all seasons, particularly on the winter range and during migration.					
	8			Establish long-term study plots throughout the breeding range to monitor demographic parameters.	NK, SKD	SLJ			
4		**Research**							
	4.A		*Demographics*						
	1			Increase demographic information for SPPI throughout different geographic areas; conduct studies to target unknown aspects of basic biology for SPPI.	NK, SKD	SLJ			
	2			Conduct analysis on the extent and direction of road bias in surveys and on nest survival for SPPI.		SLJ			
	3			Conduct an analysis on changes in arrival dates due to changes in weather on survivorship.		SLJ			
	4			Develop and assess techniques to recover SPPI populations in areas that have experienced declines and range contractions.					
	5			Do a population viability analysis.		SLJ			

Table 2, continued

Priority	Sub-priority	Section	Sub-section	Description	Lead for current work: Canada	Lead for current work: United States	Lead for current work: México	Potential	Comments
	2			Conduct analysis on the extent and direction of road bias in surveys and on nest survival for SPPI.		SLJ			
	3			Conduct an analysis on changes in arrival dates due to changes in weather on survivorship.		SLJ			
	4			Develop and assess techniques to recover SPPI populations in areas that have experienced declines and range contractions.					
	5			Do a population viability analysis.		SLJ			
	6			Conduct research to determine site fidelity, return rates and survivorship.					
	4.B		*Habitat and Management*						
	1			Increase basic knowledge on the effects of haying, grazing, burning and brush control, and other management actions on demographic parameters, e.g., parasitism rates, survivorship. Make recommendations for management.	NK				
	2			Determine the fire regimes that create suitable SPPI habitat in different geographic areas. Determine at what levels fire may be a threat to SPPI habitat, if any.	NK				
	3			Determine the grazing levels and seasons that create suitable SPPI habitat in different geographic areas and seasons. Determine what levels grazing becomes a threat to SPPI habitat.					
	4			Determine the impact of cattle grazing on Brown-headed Cowbird parasitism rates.					
	5			Determine the relative effects of threats, including habitat loss and degradation, pesticide exposure, predation, etc. on continuing declines.	NK				

Table 2, continued

Priority	Sub-priority	Section	Sub-section	Description	Lead for current work: Canada	Lead for current work: United States	Lead for current work: México	Potential	Comments
	6			Determine whether non-native grassland habitats act as ecological sources or sinks and whether management (and if so, what type of management) improves habitat suitability, reproductive success, and survival of SPPI, in all seasons.	SKD				
	4.C		*Wintering and Migration*						
	1			Describe migration and wintering distribution, habitats, and abundance.					
	2			Conduct research to determine wintering habitat components that are important, including distribution, amount, and protection status of nonbreeding habitat.					
	3			Determine degree of wintering habitat threats, and limiting factors.					
	4			Determine site fidelity on wintering range.					
	4.D.		*Threats*						
	1			Determine the relative level of the threats identified, on both breeding and wintering ranges, and their relative importance to continuing declines and range contractions.	NK		WWF, TNC		
	2			Effects of tall structures (e.g., buildings, towers, wind developments) on both habitat components (e.g., invasive plant species, fragmentation) and on mortality and survivorship rates.					
	3			Energy Development. Determine the direct and indirect effects oil and gas, solar, and wind energy development have on presence, abundance, survival, and productivity of SPPI. Establish appropriate guidelines to mitigate these effects. These issues will apply to all geographic area in SPPI's range, and to all seasons.					

Table 2, continued

Priority	Sub-priority	Section	Sub-section	Description	Lead for current work: Canada	Lead for current work: United States	Lead for current work: México	Potential	Comments
	4			Climate Change. Gain an understanding of the consequences of changing weather patterns, including annual variation in population size and resiliency of SPPI to climate change. Use existing climate change models to evaluate possible changes in grassland habitats.		SLJ			
	4.E		*Area-sensitive*						
	1			Determine the suitability of small grassland patches as SPPI breeding habitat, including variability of SPPI responses temporally and spatially.	NK, SKD	USGS			
	2			Determine the functionality of small grassland patches, and the effects of the surrounding landscape.	SKD				
5		**Education and Outreach**							
	1			Publish and distribute land use guidelines and practices that benefit SPPI, in different geographic areas. Where BMPs for SPPI already exist, make them readily available.	NK	FWS-MBNG			
	2			Outreach to Mexican NGOs and government agencies to work on SPPI populations and habitats.		TNC, ProNatura, JV-LCC			
	3			Develop of education and outreach tools for SPPI to for public and landowner education and outreach on the value of conserving intact native prairie. Develop education and communication programs targeted at youth, land managers, and the general public increasing awareness of SPPI and their habitat requirements.					
	4			Integrate Sprague's Pipit recovery needs into land management programs and grassland conservation initiatives.		JVs			
	5			Produce outreach documents to inform and influence land use decisions and policies that affect grassland habitat.		JVs			

on Sprague's Pipits are not fully understood, but any prairie conversion and fragmentation of suitable habitats will further decrease their breeding populations. Pre-project investigations should be made a priority in areas suggested for wind power or oil and gas development.

Recommended conservation actions are prioritized as follows:

1. Identify essential habitat throughout Sprague's Pipits' range.

2. Identify essential winter areas and Sprague's Pipits distributions throughout their wintering range.

3. Identify the types and intensity of current threats during the breeding, migration, and wintering seasons.

4. Determine factors limiting Sprague's Pipit populations, and the causes of breeding range contractions. Identify the relative importance of factors during the breeding, and wintering seasons to limit populations. Assess which environmental factors could be limiting Sprague's Pipits population growth, during all seasons.

5. Determine if Sprague's Pipits are positively responding to management actions designed for their conservation in local areas.

Conservation Strategies

The conservation action plan is divided into major sections, addressing priority actions that contribute and enhance this Plan. The specific actions are prioritized and described in Table 2.

1. Habitat Protection and Restoration

The primary cause of Sprague's Pipits historical declines are the loss, conversion, degradation, and fragmentation of native grasslands.

1A. *Protect and restore larger tracts of native grasslands.*—The 1st priority action to stem these declines is to protect and restore the remaining native prairie and grasslands.

1B. *Identify important source habitat.*—Identify geographic areas that are important as source habitat for pipit populations. Identify those priority areas and essential habitats to preserve.

2. Management

Recommendations for management actions should be primarily designed to improve and restore grasslands for Sprague's Pipit nesting and wintering populations. These recommendations should be evaluated and refined to create habitat in specific geographic area.

3. Monitoring, Surveys and Assessment

Monitoring and assessment will play important roles in the adaptive management process by ensuring that critical information gaps are filled and enabling recovery activities and goals to be evaluated. On the breeding grounds, Sprague's Pipit populations seem to be adequately monitored for trends by the BBS, but no large-scale program monitors native grassland habitat. Determining the quantity and quality of grassland habitat and monitoring changes in quantity and quality over time are required to assess whether recovery efforts are successful.

4. Research

Sprague's Pipits are one of the least studied avian species (Robbins and Dale 1999), and past research has focused primarily on distribution, habitat use, area requirements, demographics, and productivity. Currently, ongoing research is focusing on demographics and management.

4A. *Demographics.*—The primary factors causing population declines and range contractions in different regions are unknown. Demographic data throughout the range and across the full annual cycle are necessary to determine potential source and sinks areas. Complete a population viability assessment across the range of breeding demographic data

4B. *Habitat.*—Although pipits are most abundant on native grassland, they will breed in planted pastures in some regions; however, the conditions under which this occurs are unknown. Further work is needed on whether these anthropogenic habitats act as an ecological source or sink or whether management can improve habitat suitability, reproductive success, and survival of pipits.

4C. *Wintering and Migration.*—The current status of migration and wintering distribution and habitats are unknown, along with the factors that threaten the quantity and quality of these habitats.

4D. *Threats.*—A priority is to identify of degree and intensity of current threats on breeding, migration, and wintering grounds. It will be necessary to identify exactly where and what level of risk perceived threats pose to Sprague's Pipit populations.

5. Education and Outreach

Development of education and outreach tools were recurring themes in every category of the recommended conservation actions. Sprague's Pipit conservation will require public and landowner education and outreach on the value of conserving intact native prairie. In addition, education and communication programs targeted at youth, land managers, and the general public are needed to increase awareness of pipits and their habitat requirements. Education and outreach activities will enhance, and explain many of the actions above. Integrating Sprague's Pipit recovery needs into land management programs, and getting recommendations included in local, state, provincial, NGO and federal agency plans is crucial to success.

Completed and Ongoing Conservation Actions

Completed actions

• Completion of conservation action plan by the Region 6 Migratory Bird Office, Nongame (this document).

• Publication of results of demographic studies in Saskatchewan (Davis 2003, 2004, 2005, 2009; Davis et al. 2006; Davis and Fisher 2009; Dohms and Davis 2010) and Montana (Dieni and Jones 2003, Jones and Dieni 2007, Jones et al. 2007, Jones et al. 2010).

• Publication of the results of management studies in Canada (Koper and Schmiegelow 2006a, 2006b; Koper et al. 2009).

• Increased monitoring and evaluation of Sprague's Pipits using the GBM-Canada (Dale et al. 2003) and GBM-US (Jones and Niemuth 2009) programs.

• Evaluation of Sprague's Pipits populations and habitats for current listing actions from Canada (Environment Canada 2008) and the United States (U. S. Fish and Wildlife Service 2010).

Current and Ongoing Actions

Current and ongoing actions are focusing on landscape composition, habitat, and population densities for Sprague's Pipit in all three countries. However, much research is still needed. Some of the ongoing programs include:

• Demographic information, including nesting success, juvenile and adult survival, and other parameters are being conducted on native (Davis et al. in prep., SLJ) and non-native grasslands, along with effects of management actions on demographic parameters.

• Identification of predators over a larger geographic area using camera data (Davis et al. in prep.), along with demographic parameters from cameras (SLJ).

• Research using stable isotope analyses is being conducted to identify connectivity to Sprague's Pipit wintering grounds, determine its molting patterns, and assess levels of dispersal and recruitment in grassland- and cropland-dominated landscapes in central Saskatchewan (Crawford et al. 2009).

• Research in Grasslands National Park, Saskatchewan is determining the effect of grazing on pipit abundance and reproductive success (Koper et al. 2009; Koper et al. *in prep.*).

• Surveys in northern México are ongoing, determining distribution, habitat and densities (Levandoski et al. 2008, Panjabi et al. 2010).

• The Bureau of Land Management and Montana Natural Heritage Program have been conducting surveys of breeding birds in north Valley County, Montana from 2001-2007 (n=1410 point counts) and these are continuing (C. Wightman, pers. comm.).

• Montana Fish, Wildlife and Parks are funding a monitoring program in the Montana portions of Sprague's Pipit's range. The program began in 2009, and involves point count and vegetation surveys. Surveys are continuing (C. Wightman, pers. comm.).

Conclusion

Developing a specific Action Plan by a coalition of partners is necessary to implement the conservation strategies recommended here. The Action Plan should relate to a sub-portion of each strategy and should include the identification of the partners that might undertake each sub-strategy. However, there are currently no specific funding sources available for Sprague's Pipit conservation in the United States and México. Therefore, implementing effective conservation measures will require the cooperation of a coalition of local, regional, national, and international partners. In addition to this Action Plan, several states and provinces have developed objectives and actions designed to address conservation of Sprague's Pipits, and many states and provinces have developed actions as part of their wildlife programs (e. g., Hagen et al. 2005, Environment Canada 2008). The conservation of Sprague's Pipits will be an action for a wide group of partners, and will require implementation in three countries, three provinces, many U. S. and Mexican states, and by public and private organizations.

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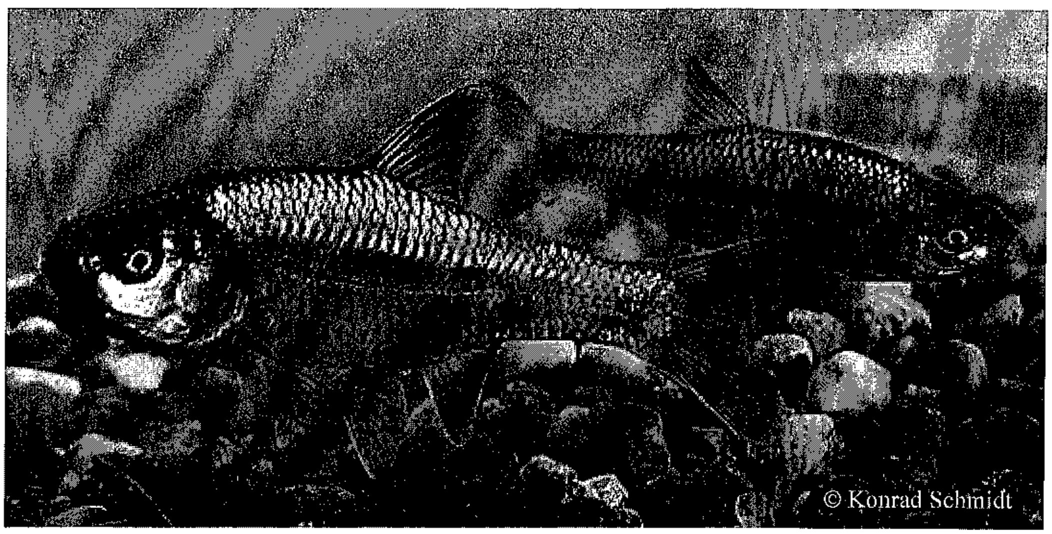
Topeka Shiner (*Notropis topeka*) Management Plan for the State of South Dakota



Summer 2003

South Dakota Department of Game, Fish & Parks
Wildlife Division Report No. 2003-10

Topeka Shiner (*Notropis topeka*) Management Plan for the State of South Dakota

Approved / Date: ______________________ 5/19/03
Secretary, Department of Game, Fish & Parks

Approved / Date: ______________________ 6/10/03
Secretary, Department of Environment and Natural Resources

Approved / Date: ______________________
Secretary, Department of Agriculture

Approved / Date: ______________________
Secretary, Department of Transportation

Topeka Shiner (*Notropis topeka*) Management Plan for the State of South Dakota

This management plan is a cooperative effort between various local, state, and federal entities. Funding for this plan was provided by the U.S. Fish & Wildlife Service through an Endangered Species Act Section 6 grant to the South Dakota Department of Game, Fish & Parks. Jeff Shearer (SD GF&P) drafted most portions of this management plan. Steve Wall (SDSU) provided the Topeka shiner distribution map. The following individuals were involved in providing ideas and comments during planning meetings:

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List of Abbreviations

This document was written according to the style suggested by the American Fisheries Society. Acronyms that are used throughout this document are defined below.

BHSU....Black Hills State University
BMP.... best management practice
CAFO....confined animal feeding operation
CRP....Conservation Reserve Program
CSP....Conservation Security Program
CWA....Clean Water Act
DSU.... Dakota State University
EPA....Environmental Protection Agency
EQIP....Environmental Quality Incentives Program
EROS....Earth Resources Observation Systems
ESA....Endangered Species Act
EWP....Emergency Watershed Program
FEMA.... Federal Emergency Management Agency
FHA....Federal Highway Administration
FSA.... Farm Services Agency
GIS....Geographic Information Systems
GRP....Grasslands Reserve Program
HCP....Habitat Conservation Plan
IBI....index of biotic integrity
NPDES....National Pollution Discharge Elimination System
NRCS....Natural Resource Conservation Service
NRI....National Resource Inventory
NWI.... National Wetlands Inventory
RC&D.... Resource Conservation and Development
SDCA....South Dakota Cattlemen's Association
SDCGA....South Dakota Corn Grower's Association
SD Dept. of Ag.... South Dakota Department of Agriculture
SD DENR....South Dakota Department of Environment and Natural Resources
SD DOT.... South Dakota Department of Transportation
SD GF&P....South Dakota Game, Fish & Parks
SDSU.... South Dakota State University
TMDL....Total Maximum Daily Load
UN-Omaha....University of Nebraska - Omaha
USCOE.... United States Army Corps of Engineers
USFWS.... United States Fish and Wildlife Service
USGS....United States Geological Survey
WHIP....Wildlife Habitat Improvement Program
WRP.... Wetland Reserve Program

Introduction

The U.S. Fish and Wildlife Service (USFWS) listed the Topeka shiner (*Notropis topeka*) as endangered under the Endangered Species Act (ESA) in January 1999 (USFWS 2001). Prior to listing, limited survey data suggested the shiner only occupied 10% of its historic range (USFWS 1998). Recent studies in South Dakota have documented the Topeka shiner in 80% of historically known streams, along with many streams where Topeka shiners were not previously reported. These recent findings suggest Topeka shiners are more abundant in South Dakota than other states within its range.

This state management plan is a cooperative effort between various local, state, and federal entities within South Dakota. While South Dakota Game, Fish and Parks (SD GF&P) took the lead in drafting this plan, entities, such as the USFWS, Natural Resource Conservation Service (NRCS), U.S. Army Corps of Engineers (USCOE), South Dakota Department of Environment and Natural Resources (SD DENR), South Dakota Department of Transportation (SD DOT), South Dakota Department of Agriculture (SD Dept. of Ag.), conservation districts, state universities, and private organizations (SD Cattlemen's Assoc., SD Farm Bureau), provided input at various levels. Local groups and private landowners will have opportunities for participation through outreach activities.

The goals of this state management plan are to:

- Maintain habitat integrity in Topeka shiner streams.
- Establish a point-based management goal for the State of South Dakota in contribution towards national recovery efforts.

Specific objectives needed to meet these plan goals include:

- Management actions that address stream hydrology, geomorphology, and water quality.
- Establishment of a monitoring and assessment protocol to evaluate South Dakota's point-based recovery goal.
- Development of public outreach and education strategies to inform all entities involved about Topeka shiner management in South Dakota.

> A short-term intended purpose of this plan is to exclude the need to designate critical habitat in South Dakota by identifying and enacting those conservation strategies listed in this plan.

The State of South Dakota considers a flexible, adaptive, and proactive management approach to be an appropriate and effective means of achieving continued conservation of the Topeka shiner in South Dakota while contributing to national recovery efforts. Flexible management of the Topeka shiner will best be directed through a Habitat Conservation Plan (HCP), which may alleviate certain consultation procedures currently required under Section 7 of the ESA. This state management plan will provide a crucial component in establishing an HCP. Specific functions of this plan are: 1) to provide a planning framework from which specific operational plans or tools can be developed and implemented; 2) to provide a basis upon which legal agreements, such as an HCP, can be developed; 3) specific to South Dakota Game, Fish & Parks to fulfill endangered species commitments made in the Cooperative Agreement for the Conservation of Endangered and Threatened Animals; and 4) to make use of the state expertise related to fish communities, their related habitats, and existing programs designed to promote and restore healthy ecosystems. This plan takes a watershed-level approach to identify needs and strategies for the long-term conservation of Topeka shiner habitat. A watershed-level approach will allow for a greater number of options in implementing conservation strategies to address major concerns that may impact Topeka shiner populations.

Description

The Topeka shiner is a small minnow (family Cyprinidae) first discovered by C.H. Gilbert in Shunganunga Creek near Topeka, Kansas (Minckley and Cross 1959). This shiner averages 1.5 to 2 inches in length with a maximum length of 3 inches. Distinguishing characteristics include a chevron-shaped black spot at the base of its caudal fin, a dusky stripe along the lateral line, a dark, olivaceous colored body, and a distinct dark stripe preceding the dorsal fin. Dark pigment gives the body a crosshatch pattern above the lateral line while the body is white below the lateral line. Breeding males have an orange-tinted head and fins (Pflieger 1997, USFWS 1998).

Life History

Topeka shiners spawn from late-May to mid-August, depending on water temperature. Spawning occurs over gravel nests of green sunfish (*Lepomis cyanellus*) and orangespotted sunfish (*L. humilis*). Topeka shiner males occupy a small territory around the periphery of the nest. Hatch (2001) reported breeding males and females occurring over silt-covered rubble and concrete rip-rap as well. Topeka shiners are sexually mature by their second summer and few individuals live to three years of age (Pflieger 1997). The diet of the shiner is quite diverse, ranging from plant material to zooplankton. However, small aquatic insects, especially midges (family Chironomidae), make up a large portion of the Topeka shiner's diet (Dahle 2001, Kerns and Bonneau 2002).

Habitat

Topeka shiners generally occupy small, prairie streams with groundwater inputs, high water quality, and sand or gravel substrates (Pflieger 1997). Some Topeka shiner locations in South Dakota reported by Wall et al. (2001) and Cunningham (2002) were degraded streams with silt substrates, off-channel backwater areas, borrow pits, and sloughs connected to occupied streams. Recruitment potential in these habitat types is unknown. Other studies (Clark 2000, Dahle 2001, Hatch 2001) have reported this species in backwater areas as well. Topeka shiners have also been collected in varying abundance from streams with incised channels, high bank erosion, and intensive grazing pressure along the riparian zone (Jeff Shearer, SD GF&P, personal observation). Regardless of the habitat selected, groundwater flow is especially important to Topeka shiners during dry conditions. Based on a GIS model developed by Wall et al. (2001), the potential of Topeka shiner presence increased as the potential for groundwater delivery to streams increased. Groundwater inputs into streams help lower water temperatures and maintain water levels in isolated pools. These isolated pools provide important habitat during periods of intermittency and act as a dispersal source when more perennial flows return to the stream (Kerns and Bonneau 2002).

Range

Historically, the Topeka shiner was widespread throughout the central prairie region of the Missouri, Mississippi, and Arkansas River drainages. The species' range included eastern South Dakota, southwestern Minnesota, Iowa, Nebraska, Kansas, and Missouri (Bailey and Allum 1962, Gilbert 1980). Currently, highly disjunct populations of Topeka shiners occupy 10% of the species' historic habitat (USFWS 1998). However, recent studies in South Dakota indicate the Topeka shiner still occupies a high percentage of known historic locations (Cunningham and Hickey 1997, Cunningham 1999, Blausey 2001, Wall et al. 2001, Cunningham 2002). With the exception of the Elm River all other historic locations fall within the boundaries of the shiner's current range in South Dakota.

Reasons for Range-wide Decline

Declines in Topeka shiner populations can not be isolated to a single factor; moreover, any combination of changes at the systemic and local levels may have contributed to a reduction in the species' range and abundance. Alterations at the systemic level, such as conversion of the prairie landscape and wetland drainage and more localized impacts, such as point source discharges, most likely acted in combination to reduce individual populations and negatively affect the Topeka shiner rangewide.

Habitat alterations may have the most pronounced impact on Topeka shiner populations. Land use changes (e.g., urbanization, development, and intensive agriculture) that alter stream hydrology and geomorphology lead to changes in sediment load and water regime. Watershed activities, such as tributary impoundment, water withdrawals, and stream channelization, often result in channel erosion, siltation, and altered water levels, potentially impacting Topeka shiner habitat (Tabor 1993, Pflieger 1997). Reduction in groundwater inputs due to wetland loss and water withdrawal may further reduce stream reaches inhabited by Topeka shiners (Wall et al. 2001). Drought may also reduce the number of stream reaches inhabited by Topeka shiners. However, the effect of drought on stream hydrology is not the same as the effects of human alterations. Topeka shiners, as well as other native prairie fish, have adapted to natural stream flow fluctuations. Human-induced changes to stream hydrology rarely mimic natural flow disturbances in timing, frequency and magnitude. Other impacts include stocking of predatory game fish (e.g., largemouth bass *Micropterus salmoides*) in impounded streams (Layher 1993, Schrank et al. 2001, Winston 2000, 2002) and introduction of non-native species (e.g., blackstripe topminnow *Fundulus notatus*, western mosquitofish *Gambusia affinis*; Pflieger 1997).

Legal Status

The Topeka shiner was proposed as a federally endangered species in the Federal Register on October 24, 1997 by the USFWS (USFWS 1997). On January 14, 1999, the Topeka shiner became officially listed as endangered under the ESA (USFWS 1998). The Topeka shiner is state-endangered in Missouri and Nebraska. Kansas and Iowa list the species as state-threatened, and Minnesota listed the Topeka shiner as a species of concern. The shiner is not state-threatened or endangered in South Dakota. The abundance and distribution of the Topeka shiner in South Dakota precludes the need for state listing. A recent downgrade in the Topeka shiner's state rank from S2 (imperiled) to S3 (vulnerable) reflects new knowledge regarding distribution and abundance in South Dakota. The global rank of the Topeka shiner is G3 (vulnerable; SD GF&P 2003). The South Dakota Natural Heritage Program monitors and recognizes the Topeka shiner as a sensitive species. Entities that are required to address federal- and state-listed species use the South Dakota Natural Heritage database extensively during environmental review of federally funded projects.

Topeka Shiner Research in South Dakota

Research concerning the Topeka shiner in South Dakota has focused primarily on species' distribution and associated habitat. Woolman (1896 cited in Bailey and Allum 1962) reported Topeka shiners in South Dakota in 1892. However, no surveys have extensively documented Topeka shiner distribution prior to 1997. Cunningham and Hickey (1997) and Cunningham (1999) documented Topeka shiner distribution and provided a qualitative assessment of habitat in various tributaries of the James, Vermillion, and Big Sioux basins. Cunningham (2002) documented additional Topeka shiner locations and conducted a population estimate in three streams. Blausey (2001) quantitatively measured water quality and physical habitat attributes at the reach scale and compared these measurements with fish community data collected at 61 tributary sites. Regression models from this study indicate that Topeka shiners were associated with areas of low livestock use, overhanging vegetation, low siltation, and run/glide habitats composed of fine gravel and cobble substrates. Wall et al. (2001) developed a GIS model that classified the probable occurrence of Topeka shiner presence based on habitat and land use features. The GIS model was 89% accurate in predicting Topeka shiner presence and absence at high and low probability sites (i.e., the model correctly predicted whether shiners would be present or absent 89% of the time). Stream size, flow regime (i.e., intermittent to perennial), groundwater potential, gradient, and stream size discrepancy (i.e., position within the watershed or stream network) significantly influenced Topeka shiner presence (Wall et al. 2001).

Development of microsatellite markers through genetics research conducted at Black Hills State University (BHSU) is being used to estimate genetic diversity and determine genetic population structure for Topeka shiners in South Dakota (Sarver 2001). A survey for microsatellite variability for Topeka shiner populations in primary recovery units, development of a non-invasive method for collecting tissue samples for DNA extraction, and development of major histocompatability complex markers are the foci of current research. Genetics research will allow resource managers to determine the best source of broodstock for fish propagation, thus providing critical information in other states where reintroduction efforts might be needed. Furthermore, genetics information will identify specific populations in need of special management considerations.

The SD DOT has funded two studies to examine the impacts highway construction projects may have on Topeka shiner populations. Wall and Berry (2002) measured a variety of dimensions on pipe culverts for 232 culverts at 81 sites on stream segments with a high potential for Topeka shiner presence (see Wall et al. 2001). These measurements were used to determine potential problems to fish movements, such as blockage, gradient, water velocity, embeddedness, and degree of perch (i.e., drop between culvert lip and water surface). This study found that 9% of sites posed an immediate risk to fish passage, 27% of sites were of moderate risk, and 64% of sites had low priority for mitigation (Wall and Berry 2002). Cunningham (2002) compiled a set of bridge and highway best management practices (BMPs) that would minimize on-site erosion and impact to the stream. These BMPs should meet permit regulatory requirements for construction projects in Topeka shiner streams.

The SD DOT has also been working with USFWS and other agencies to further refine these BMPs for bridges and box culvert replacements and culvert extension construction. The Topeka shiner-spawning period restriction prohibits instream work from May 15th to July 31st. This work restriction period causes major conflicts as it is also the prime construction season for SD DOT activities. Ongoing pilot projects and discussions are aimed to alleviate construction conflicts while satisfying regulatory requirements. A box culvert extension pilot project in eastern South Dakota is currently testing BMPs for winter construction in Topeka shiner streams. Further refinement of BMPs while establishing greater flexibility for instream work is the intent of this pilot project. Furthermore, the SD DOT is providing training to department administration and field staff, consultants, and contractors of the importance of implementing and monitoring erosion and sediment controls on all waterbodies in the state while emphasizing the need for special measures to be taken on Topeka shiner streams. The BMPs for Topeka shiner streams are included as Appendix A.

Goal Statement

All entities involved in developing and implementing this plan have an interest in protection and restoration of the Topeka shiner and its habitat. These interests may be inherent in the agency's mission or bound by obligations under state or federal law. For example, South Dakota Codified Law 34A-8-6 reads: "The Department of Game, Fish and Parks and the Department of Agriculture shall perform those acts necessary for the conservation, management, protection, restoration and propagation of endangered, threatened and nongame species of wildlife."

The overall goal of this plan is to establish guidelines to maintain habitat integrity in Topeka shiner streams in South Dakota. The State of South Dakota feels the best way to maintain the current abundance and distribution of Topeka shiners is to maintain the existing stream habitat. The intent of these guidelines is to work towards future delisting of the species pursuant to the ESA. The purposes of the ESA are to "provide a means whereby the ecosystems upon which the endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth in subsection (a) of this section." Given the relative abundance and intact distribution of Topeka shiners in South Dakota, the State of South Dakota feels a point-based system sets a more realistic management goal than that proposed in the draft Federal Topeka Shiner Recovery Plan. This state plan proposes the following point-based management goal for each basin within eastern South Dakota: James River Basin, 900 points; Vermillion River Basin, 600 points; Big Sioux River Basin, 1300 points. These point values were based on approximately 70% of all known stream occurrences of the Topeka shiner between 1997 and 2002 in eastern South Dakota. Point values do not allow for a reduction in Topeka shiner populations or stream quality, but are designed to account for the natural variability of stream fish populations (see Population Monitoring and Assessment for justification and further details). These stream numbers exceed those occurrences reported in the final rule to list the Topeka shiner as endangered (USFWS 1998) and to establish recovery criteria of the draft Federal Topeka Shiner Recovery Plan (USFWS 2001).

Relationship to Federal Recovery Plan

The draft Federal Topeka Shiner Recovery Plan (Federal Plan) developed by the Topeka Shiner Recovery Team lists recovery criteria that must be met in order to downlist or delist the Topeka shiner. A draft of the Federal Plan was under internal review during the time this state management plan was developed. The Federal Plan divides the shiner's range into primary and secondary recovery units. The James, Vermillion, and Big Sioux River basins along with the Rock River watershed in Minnesota comprise Primary Recovery Unit 3 (PRU 3). In order to downlist or delist the Topeka shiner, populations must meet the recovery criteria of "stable or increasing over a period of 10 years" in PRU 3. The State of South Dakota feels the point-based management criteria (discussed in the Goal Statement) provides a more tangible value to work towards rather than the recovery criteria proposed in the Federal Plan. Point-based management criteria establish a baseline population and provide a measurable value that can be monitored and assessed. Point-based management criteria also take into account the natural variability (e.g. drought / flood cycles) that influence Topeka shiner populations. Even in undisturbed watersheds, stream fish populations can not consistently maintain a "stable or increasing" status due to the natural variability of prairie streams (see Factor E and Population Monitoring and Assessment). Furthermore, the Federal Plan does not provide a baseline population; measurable value to determine if populations are increasing, stable, or decreasing; or methodology for assessing population status.

Past activities in South Dakota and actions set forth in this state management plan are consistent with those activities recommended in the Federal Plan. The Federal Plan recommends implementing the following actions in order to downlist or delist the Topeka shiner: 1) conduct studies on the biology and life history requirements of the Topeka shiner, 2) monitor populations and habitat of the Topeka shiner, 3) reestablish Topeka shiner in suitable stream or off-channel habitats within its historic range, 4) design and implement a public awareness and education program, and 5) implement and maintain an adaptive management program and ensure appropriate research and management activities are carried out in order to attain recovery of the Topeka shiner (USFWS 2001). Past and on-going research regarding the biology and life history of the Topeka shiner in South Dakota is previously discussed (see Topeka Shiner Research in South Dakota). Future research will focus on further documenting shiner occurrences in unsurveyed watersheds, population genetics, and determining proper BMPs for projects that may impact the Topeka shiner and its habitat. Population and habitat monitoring is discussed under the Population Monitoring and Assessment section. The Topeka shiner's current distribution in South Dakota does not necessitate reintroduction at historic locations. Those historic locations without a recent documented occurrence of the Topeka shiner are located in close proximity to currently known Topeka shiner locations; therefore, the potential for natural recolonization exists. The Public Outreach and Education section will discuss current and future outreach activities. The Management Actions section will address adaptive management activities.

Distribution of Topeka Shiners in South Dakota

The Topeka shiner occupies tributaries of the James, Vermillion, and Big Sioux rivers in South Dakota. Meek (1892 cited in Bailey and Allum 1962) was the first to report Topeka shiners in South Dakota in the Big Sioux River near Sioux City (Union County). Bailey and Allum (1962) and Nickum and Sinning (1971) also reported Topeka shiners in the mainstem Big Sioux River, presumably during periods of extended drought when tributaries were dry. The Topeka shiner was reported in 7 watersheds in the James, 5 watersheds in the Vermillion, and 4 watersheds in the Big Sioux River basins before 1997, and observed in 13 watersheds in the James, 8 watersheds in the Vermillion, and 17 watersheds in the Big Sioux River basins since 1997. In recent years (1997-2002) new occurrences of Topeka shiners have been reported in 9 watersheds in the James, 5 watersheds in the Vermillion, and 17 watersheds in the Big Sioux River basins. Topeka shiners have not been documented in 3 watersheds in the James, 1 watershed in the Vermillion, and 3 watersheds in the Big Sioux River basins since 1990 (Table 1). These numbers do not indicate a range expansion since all historic sites were not sampled recently, and vice versa. Furthermore, sampling intensity has varied between study periods.

Threats vs. Effects Analysis for Topeka Shiner Populations in South Dakota

This plan addresses the five factors utilized by the USFWS in listing, delisting, or downlisting actions:

A. Present or threatened destruction, modification, or curtailment of habitat or range.
B. Overutilization for commercial, recreational, scientific, or educational purposes.
C. Disease or predation.
D. Inadequacy of existing regulatory mechanisms.
E. Other natural or manmade factors.

By meeting the definition of a threat for at least one of these factors, a species meets the definition of threatened or endangered as described in Section 4(a)(1) of the ESA. Each factor is evaluated based on its potential as a threat or effect to Topeka shiner populations in South Dakota. For the purposes of this report a threat is an impact that, if uncorrected, will likely result in further decline or extirpation of the species from a significant portion of its range. An effect is an impact that may reduce localized populations, but will not result in the overall decline or extirpation of Topeka shiner populations from South Dakota.

A. The present or threatened destruction, modification, or curtailment of habitat or range

Information on the historic range of the Topeka shiner in South Dakota is somewhat lacking. The historic distribution of the Topeka shiner and most other nongame fish in South Dakota was determined through a compilation of various surveys and reports from past fisheries investigations. Range estimations are complicated by the qualitative, and sometimes incomplete, nature of historic data. However, these records are the only source lending insight into the historic distribution of Topeka shiners.

Evermann and Cox (1896) conducted the first fisheries survey of the upper Missouri River basin reporting Topeka shiners in 4 streams in the James River basin. Churchill and Over (1933) provided a description of the Topeka shiner and stated that "these minnows are found occasionally in the small creeks of the eastern and southern part of the state." Churchill and Over (1933) go on to state that Topeka shiners are not "sufficiently numerous to be of particular importance" as a baitfish, suggesting that the abundance of this species has always comprised a small percentage of the overall fish community. Bailey and Allum (1962) reported the Topeka shiner at 5 locations in the Big Sioux and Vermillion River basins. Bailey and Allum (1962) stated that the Topeka shiner "...was formerly common in the Big Sioux, Vermillion, and James river drainages of South Dakota, but is now rare;" however, no sources were cited documenting the shiner's once common occurrence. Beckman and Elrod (1971) reported Topeka shiners in the embayments of the Cheyenne, Moreau, and Grand rivers in Lake Oahe. This finding is questionable as these sample locations were in a large reservoir, not a small prairie stream. Furthermore, Beckman and Elrod (1971) documented no occurrences of the sand shiner *Notropis stramineus*, a ubiquitous species similar in appearance to the Topeka shiner. This finding is not recognized as a viable Topeka shiner occurrence in the South Dakota Natural Heritage database and will not be included as part of the shiner's historic range for this report. The only evidence suggesting a reduction in the species' range is the failure of recent surveys (Cunningham and Hickey 1997, Blausey 2001) to record Topeka shiners in the Elm River. The Elm River is the northernmost documented occurrence of the Topeka shiner (Elsen 1977). All other historic locations are within the boundaries of the species' current distribution in South Dakota. No data currently exist to demonstrate an increase or decrease in the Topeka shiner's range in South Dakota.

Land use practices that alter the hydrologic and geomorphic processes of streams can have detrimental effects to aquatic habitat. Habitat impacts, such as wetland loss, sedimentation, channelization, and resource extraction, are often cited as reasons for declines of Topeka shiner populations throughout its range. The relevancy of each impact as it relates to Topeka shiner populations in South Dakota is discussed.

<u>Wetland Drainage</u>

The ecological functions of wetlands are diverse, but their influence on stream hydrology and groundwater inputs is especially critical to Topeka shiners.

Wetlands buffer stream flows by reducing flood peaks and maintaining base flows during periods of drought. Groundwater discharge into streams also provides a thermal refuge for fish during periods of intermittency. Higher peak flows increase streambed scouring, channel incision, and bank erosion, and hence channel degradation. Wetland loss alters stream hydrology, thus potentially creating an environment unsuitable for Topeka shiner inhabitance through elevated flow velocities, loss of groundwater inputs, and decrease of habitat heterogeneity. Blausey (2001) and Kuitunen et al. (2000) suggest that Topeka shiners prefer streams with low velocities (0 m/s - 0.3 m/s). Wall et al. (2001) identified groundwater potential and flow regime as positive indicators of Topeka shiner presence. The probability of Topeka shiner presence increased as potential for groundwater delivery to streams increased and flow regime moved from temporary to perennial. South Dakota is one of the few prairie states to still retain the majority, approximately 65%, of its wetland resources (Johnson and Higgins 1997) with wetland densities still commonly exceeding 100 wetlands per square mile in eastern South Dakota (Higgins et al. 2002). Prevention of wetland loss would aid efforts to maintain stream hydrology as close to unaltered conditions as possible.

Sedimentation

Sedimentation from natural sources has always occurred in stream systems; however, alterations to the landscape can change a stream's sediment load. A primary reason for increased sedimentation to aquatic systems in the Midwest is loss of native prairie (Menzel et al. 1984, Karr et al. 1985, Cross and Moss 1987). Streams with increased sediment loads often become shallower and wider, leading to a loss of habitat, warmer waters, and more frequent flooding. Loss of spawning substrate by siltation may reduce Topeka shiner recruitment. Siltation of gravel substrate may greatly reduce invertebrate productivity, especially in riffles (Berkman and Rabeni 1987), and potentially limit the shiner's food source. Hatch and Besaw (2001) classified Topeka shiners as opportunistic omnivores; however, insect (especially midges) larvae comprised a large portion of the shiner's diet. The loss of pool habitat through siltation would reduce critical areas required by the shiner to sustain periods of intermittency (Wall et al. 2001). While sedimentation continues to impair stream reaches in South Dakota (SD DENR 2002b), these problems are being address through various Total Maximum Daily Load (TMDL) projects (SD DENR 2002a).

Stream Channelization

Channelization alters stream hydrology and geomorphology. Stream systems are dynamic, but channel type remains at equilibrium under natural conditions (Leopold et al. 1964, Leopold 1994). Channelization leads to upstream degradation and downstream aggradation, resulting in an unstable channel type and altered fish habitat (Rosgen 1996). Upstream head cutting, bank slumping, and channel incision, which disconnect a stream from its floodplain and backwaters, are all forms of channel degradation. Downstream aggradation results from increased sediment loads in the channel. Monotony in habitat (i.e., dominated by runs) often characterizes channelized streams. However, the presence of Topeka shiners in pools, backwaters, and side channels (Pflieger 1997, Blausey 2001, Hatch 2001) suggests the need for a diversity of habitat types. Regression models indicate shiner association with stable, well-vegetated banks that are low in height. Topeka shiners are also associated with low incision channels with gravel substrates (Blausey 2001). Three percent of eastern South Dakota streams have been modified (Johnson and Higgins 1997); however, future channelization for municipal, urban, or other land use projects would be subject to endangered species review during permitting process required by Section 404 of the Clean Water Act (CWA). High water years, such as those of the mid- to late-1990s, may present the need for greater flood control measures in eastern South Dakota (FEMA 1994). Caution should be exercised so that flood control measures do not present long-term ecological changes to stream systems.

Resource Extraction

Resource extraction, such as water withdrawals and gravel mining, for municipal, agricultural, and domestic uses have the potential to impact aquatic systems when conducted improperly. Irrigation and municipal water withdrawal can lower water tables and groundwater delivery to streams, causing streams to experience longer periods of intermittency. As previously stated, positive indicators of Topeka shiner presence include groundwater potential and flow regime (Wall et al. 2001). Topeka shiners show a tendency to inhabit clear, cool prairie streams (Pflieger 1997), thus groundwater percolation through the streambed plays a critical role in sustaining water temperature and dissolved oxygen levels during periods of low flow, especially drought. The preference of perennial flows by Topeka shiners indicates the importance of groundwater percolation and springs in maintaining base flow conditions. Observations of irrigation withdrawal alterations to stream flow have been reported (Wall et al. 2001). Stream miles impacted by irrigation dewatering are unknown, though believed to be small. Of greater impact may be the groundwater aquifer withdrawals from urban areas, specifically Sioux Falls, South Dakota. Although the Sioux Falls area represents a small portion of the overall Topeka shiner range in South Dakota, this urban area consists of approximately 124,000 people (16% of the state population; U.S. Census Bureau 2002). Instream gravel mining operations can pose a threat to streams through direct alteration of stream channels and downstream sedimentation problems. SD GF&P and SD DENR authorize permits for mining operations, most of which occur outside the stream channel.

The present destruction, modification, or curtailment of range or habitat is not a threat to Topeka shiners in South Dakota. The threatened destruction, modification, or curtailment of range or habitat is difficult to assess, but the State of South Dakota feels this impact is not a threat to Topeka shiner populations. Impacts to the Topeka shiner's habitat have not occurred in South Dakota to the extent that these impacts have affected habitat in other parts of the shiner's range. Agriculture remains the primary landuse throughout the Topeka shiner's range. The loss of native prairie and resulting sedimentation and eutrophication of streams resulting from intensive agricultural production is often cited as a primary reason for declines in Topeka shiner populations (Minckley and Cross 1959, USFWS 1998, Mammoliti 2002). Until recently, agricultural receipts for livestock have been higher than agricultural receipts for crops in South Dakota (USDA 2000a). Thus, South Dakota's agricultural economy has operated on a grass-based system (i.e. more land is reserved for grazing as opposed to row crop production). A grass-based system has noticeable benefits (e.g. retention of wetland basins, unaltered stream reaches, untilled riparian zones) to Topeka shiner watersheds in South Dakota. Recent data suggest South Dakota's agricultural economy is moving towards a production-based system (USDA 2000b, Higgins et al. 2002, Kurt Forman, USFWS, *personal communication*). Potential impacts this shift towards production agriculture may have on Topeka shiner populations are difficult to predict and unknown. However, efforts to preserve a grass-based land use (i.e. grazing) along flood plains and riparian areas combined with good stewardship practices should mitigate for many threats land use changes may present to Topeka shiner populations in South Dakota.

Table A. Potential / Actual Threats, due to Factor A, Influencing Topeka Shiner Populations in South Dakota.

Factor			Magnitude Of Threat	Immediacy of Threat	Comments
A.1. present	destruction	habitat	no threat	no threat	trends do not support
A.2. present	modification	habitat	no threat	no threat	trends do not support
A.3. present	curtailment	habitat	low	non-imminent	due to groundwater withdrawals
A.4. threatened	destruction	habitat	unknown	unknown	
A.5. threatened	modification	habitat	unknown	unknown	landuse changes, impacts unknown
A.6. threatened	curtailment	habitat	unknown	unknown	

B. Overutilization for commercial, recreational, scientific, or educational purposes
This impact is of little threat to Topeka shiners in South Dakota. Most commercial bait dealers within the state collect baitfish (e.g., fathead minnow *Pimephales promelas*) from rearing ponds or isolated wetland basins, not streams. The incidental take of Topeka shiners during bait collection by individual anglers may occur on occasion. However, South Dakota's fishing rules and regulations prohibit the use or take of state or federally listed species as bait. South Dakota Codified Law 34A-8-9 also prohibits the possession of a threatened or endangered species. The collection of endangered fish species for educational or scientific purposes requires a scientific collector permit issued by SD GF&P and USFWS. Only under special circumstances does this permit allow take of Topeka shiners.

The impacts of overutilization for commercial, recreational, scientific, or educational purposes do not present a threat to Topeka shiner populations in South Dakota. Any incidents resulting in take of Topeka shiners from these purposes occurs on a limited or isolated basis and would only have minor effects to the entire Topeka shiner population within South Dakota.

Table B. Potential / Actual Threats, due to Factor B, Influencing Topeka Shiner Populations in South Dakota.

Factor		Magnitude of Threat	Immediacy of Threat	Comments
B.1. overutilization	commercial	no threat	no threat	
B.2. overutilization	recreational	no threat	no threat	
B.3. overutilization	scientific	no threat	no threat	
B.4. overutilization	educational	no threat	no threat	

C. Disease or predation

The impacts of disease on Topeka shiner populations are relatively unknown. Occurrences of scoliosis (deformity of the vertebrae) were reported in Missouri (USFWS 1998). No reports exist in South Dakota of Topeka shiner specific diseases or abnormalities. Most diseases incurred by Topeka shiners are likely stress-induced resulting from degraded habitat conditions (e.g., elevated water temperatures, organic pollution, low dissolved oxygen levels). Mitigation of impacts to Topeka shiner habitat will address any stress-induced diseases resulting from poor habitat conditions. The lack of data regarding diseases incurred by Topeka shiners prevents further evaluation of this impact.

Predation is not as significant an impact on Topeka shiners in South Dakota as in southern parts of the shiner's range. Predation by introduced game fish, such as largemouth bass *Micropterus salmoides*, white bass *Morone chrysops*, or crappie *Pomoxis* spp., is often associated with tributary impoundment (impoundments discussed in further detail under Factor E). Several studies (Layher 1993, Schrank et al. 2001, Winston 2000, 2002, Mammoliti 2002) have documented impacts of introduced game fish on Topeka shiner populations following stream impoundment in Kansas and Missouri. Hatch (2001) also noted the extirpation of Topeka shiners from several off-channel habitats following the introduction of largemouth bass in Minnesota. Blausey (2001) reported largemouth bass and black crappie *Pomoxis nigromaculatus* in relatively high abundance, but no Topeka shiners, near a historical site on the Elm River below Elm Lake. Introduced game fish were uncommon in the vast majority of tributaries sampled by Cunningham and Hickey (1997), Cunningham (1999), Blausey (2001), and Cunningham (2002). Berry and Kolander (1994) noted that first-winter mortality of stocked largemouth bass was high (85% - 100%). High mortality rates were attributed to depletion of energy reserves and cold stress during long winter periods (Berry and Kolander 1994). Most streams in eastern South Dakota remain unimpounded. Without impounded areas, the harsh physicochemical nature of prairie streams may make these systems unsuitable for introduced game fish (Shearer and Berry 2003).

The impacts of disease and predation do not threaten Topeka shiner populations in South Dakota. The lack of information on diseases in Topeka shiner populations makes assessment of the magnitude or immediacy of this factor difficult; however, no surveys or genetics research has reported a disease specific to this species. Predation by introduced game fish may occur on an isolated basis, especially where private individuals have intentionally introduced game fish. The extent of these introductions is unknown, though presumed to be small due to the rarity of game fish in recent stream surveys. SD GF&P

is the agency charged with managing the recreational fisheries in South Dakota's public waters; however, SD GF&P does not stock game fish into Topeka shiner streams or any other streams of similar size in eastern South Dakota. Therefore, the State of South Dakota considers the impact of game fish predation on the overall Topeka shiner population to be low, especially given the low occurrence of large-scale impoundments on Topeka shiner streams (discussed under Factor E).

Table C. Potential / Actual Threats, due to Factor C, Influencing Topeka Shiner Populations in South Dakota.

Factor	Magnitude of Threat	Immediacy of Threat	Comments
C.1. disease	unknown	unknown	no data to support
C.2. predation	low	non-imminent	likely occurs in isolated areas

D. Inadequacy of existing regulatory mechanisms
Special measures protect the Topeka shiner and its habitat in South Dakota. The South Dakota Natural Heritage Program monitors and tracks Topeka shiner locations and reviews all federally funded projects that may impact sensitive species, including the Topeka shiner. Scientific collector permits, administered by SD GF&P, only allow take of Topeka shiners under special circumstances. Bait regulations outlined in South Dakota's fishing rules and regulations prohibit the take of state or federally listed species. The SD DOT has developed BMPs (Appendix A) for use during highway construction projects in Topeka shiner watersheds. These BMPs should prevent fish blockage due to improper culvert placement and reduce sedimentation problems due to on-site erosion. The SD DENR regulates water quality (water quality standards, wastewater discharge, confined animal feeding operations) and water quantity (municipal water withdrawal, crop irrigation) impacts through various permits. The Topeka shiner receives special protection as a federally listed species under the ESA. Accordingly, the USFWS reviews all projects with a federal nexus that may impact the Topeka shiner or its habitat. The NRCS is developing guidelines for project development and implementation that may impact endangered species. Projects involving the dredging or filling of waterways (e.g., impoundments) require a CWA Section 404 permit issued by the USCOE. As long as Topeka shiners maintain their current distribution and abundance in South Dakota, existing regulatory mechanisms should be adequate.

This factor does not pose a threat to Topeka shiner populations in South Dakota. Those agencies involved directly with Topeka shiner management or projects / activities that may impact Topeka shiners and their associated habitat have enacted procedural and regulatory mechanisms to protect the species in compliance with state and federal laws. The design of these mechanisms is not necessarily to protect every individual Topeka shiner, but to prevent the long-term destruction or loss of stream habitat. Further regulatory mechanisms may not result in increased protection for the Topeka shiner or its habitat in South Dakota.

Table D. Potential / Actual Threats, due to Factor D, Influencing Topeka Shiner Populations in South Dakota.

Factor			Magnitude of Threat	Immediacy of Threat	Comments
D.1. inadequate	existing	regulations	no threat	no threat	

E. Other natural and manmade factors
No other natural (species competition, niche overlap, hybridization) or manmade (urbanization, impoundments) factors are known to pose an imminent threat to Topeka shiners in South Dakota. The only exotic fish throughout the Topeka shiner's range is the common carp *Cyprinus carpio*. Other exotic fish (e.g., bighead carp *Hypophthalmichthys nobilis*, grass carp *Ctenopharyngodon idella*, rudd *Scardinius erythrophthalmus*) in South Dakota do not currently occupy the same streams as Topeka shiners, but range expansion is difficult to predict. Cunningham (2002) reported two possible incidents of hybridization between Topeka shiners and sand shiners. Fish that share phenotypic characteristics with Topeka shiners and sand shiners have also been observed in Minnesota streams as well. However, sand shiners have a great deal of intraspecific variation within the species (Dr. Jay Hatch, University of Minnesota, *personal communication*). No reports of hybridization in the southern extent of the Topeka shiner's range exist. Potential Topeka shiner hybridization and influencing factors is an area warranting further research. Currently, data are lacking regarding potential hybridization between sand and Topeka shiners; therefore, the status of this impact can not be assessed.

Flooding and drought are not a threat to the overall viability of Topeka shiners in South Dakota. Streams in the Northern Glaciated Plains naturally experience cyclical weather patterns ranging from extended drought to prolonged flooding (Milewski 2001, Shearer and Berry 2003), as evidenced by long-term stream flow records (USGS 2000). Topeka shiners, and other native prairie fish, have adapted to these naturally variable systems. In fact, Minckley and Cross (1959) indicated that Topeka shiner spawning success was among the highest of any species during periods of intermittency. Kerns and Bonneau (2002) noted that Topeka shiners, especially juveniles, were the last fish to succumb in drying pools. While native fish populations may fluctuate with changes in annual stream flow, the species will remain persistent (Shearer and Berry 2003). However, adaptation of native fish to natural disturbance should not be interpreted as the ability to tolerate all levels of human-induced disturbance.

Past impacts of point source pollution (e.g., wastewater discharge, industrial effluent) on streams in eastern South Dakota have been documented (Dieterman and Berry 1998), and most likely had adverse effects to Topeka shiner populations. Since enactment of the Clean Water Act in 1977; however, the SD DENR and U.S. Environmental Protection Agency (USEPA) have closely monitored point source impacts. Currently, municipal wastewater treatment and confined animal feeding operations are much improved over past methods and wastewater discharge must not violate designated use criteria for the receiving stream. Conflicts may arise in the future given the close proximity of urban areas, such as Sioux Falls, to Topeka shiner streams (see Figure 1). Nonpoint source pollution from urban areas will soon be addressed as urban areas and the SD DOT are required to initiate storm water management programs under the National Pollution Discharge Elimination System (NPDES) Phase II storm water regulations. The SD DENR Section 319 and TMDL programs also address nonpoint source pollution problems (SD DENR 2002a). Urban storm water runoff is now required to meet regulatory requirements and will be less of an issue. While point and nonpoint sources may still effect Topeka shiner populations in isolated areas, there is no evidence to suggest this impact currently poses a threat to shiner populations within South Dakota.

Impoundments can be either detrimental or beneficial to Topeka shiners depending on many variables, such as impoundment size, location within watershed, and watershed condition, etc. The presence of large-scale impoundments can pose a threat to Topeka shiner populations. These types of impoundments severely alter a stream's natural hydrology. Furthermore, recreational interests often result in the stocking of non-native piscivores (impacts discussed under *disease and predation*). Large-scale impoundments exist on eight Topeka shiner streams in eastern South Dakota. These impoundments include Elm Lake, Elm River; Ethan Lake, 12-Mile Creek; Staum Dam, Shue Creek; Lake Mitchell, Firesteel Creek; Lake Cavour, Redstone Creek; Wilmarth Lake, West Branch Firesteel Creek; Centerville Dam, Vermillion River; and Lake Vermillion, East Fork Vermillion River). The Centerville Dam (Vermillion River) does not impede fish movement due to a breach in the dam structure. These impoundments may have adverse effects on Topeka shiner populations within their respective streams. The State of South Dakota feels this threat is moderate in magnitude within South Dakota, especially given its relation to Factor A (modification of habitat) and Factor B (predation). However, given the low occurrence (8 dams on 38 streams) of large-scale impoundments within Topeka shiner watersheds, this threat should be considered non-imminent.

Small-scale impoundments, such as those created by the USFWS Partners for Fish and Wildlife Program, can be beneficial to prairie stream hydrology if strategically placed throughout their associated watersheds to help sustain and restore historic watershed functions. With 35% of wetland acreage lost (Dahl 1990) and 75% of native grassland converted (USDA 2000b) to predominately agricultural use in eastern South Dakota, runoff rates have greatly increased into receiving streams. Impoundments, created to function like natural wetlands (i.e., trap sediment, capture overland runoff, recharge groundwater, filter nutrients, etc.), have a positive effect on prairie stream hydrology and associated native species. Some small-scale impoundments may have adverse effects to individual shiner populations; however, early consultation during the planning stages of these projects can alleviate negative impacts to Topeka shiners.

Overall, other natural and manmade factors do not pose a threat to Topeka shiner populations in South Dakota. Impacts, such as point source pollution and large-scale impoundments, may have adversely affected Topeka shiner populations in the past, but given the shiner's current distribution and abundance it appears these impacts do not pose an imminent threat to the species. The State of South Dakota is not aware of any synergistic effects to Topeka shiner populations.

Table E. Potential / Actual Threats, due to Factor E, Influencing Topeka Shiner Populations in South Dakota.

Factor		Magnitude of Threat	Immediacy of Threat	Comments
E.1. other	flood / drought cycles	no threat	no threat	
E.2. other	hybridization	unknown	unknown	
E.3. other	point source impacts	low	non-imminent	likely effects from isolated incidences
E.4. other	urbanization	low	non-imminent	only occurring in small portion of total range within South Dakota
E.5. other	small-scale impoundments	no threat	no threat	
E.6. other	large-scale impoundments	moderate	non-imminent	relates to Factor B (predation) and Factor A (modification of habitat)
E.7. other	synergistic effects	unknown	unknown	potential adverse impacts, but not demonstrable

Management Actions

The overall goal of this management plan is to maintain habitat integrity in Topeka shiner streams, thus management objectives will focus on those primary issues that influence habitat integrity: hydrology, geomorphology, and water quality. Given the current abundance and distribution of Topeka shiners in South Dakota, meeting the objectives of this plan proves more feasible than those recovery efforts required to restore shiner populations in other states. Strategies and tasks presented under each objective should maintain and enhance habitat in Topeka shiner streams through local- and watershed-level BMPs, conservation programs, and regulatory incentives. A combination of local- (e.g., riparian zone restoration) and watershed-level BMPs (e.g., grassland easements) may provide the best means for improving site-specific stream habitat and watershed integrity as a whole (Roth et al. 1996, Wang et al. 2002). The objectives below address those habitat effects discussed under *Present or threatened destruction, modification, or curtailment of habitat or range*. Order of listing or numbering does not denote level of importance or priority. However, it is important to note that the three issues (hydrology, geomorphology, and water quality) discussed below are interconnected in the context of watershed integrity and impacts or improvements to one may result in changes (negative or positive) to the others.

The conservation of existing habitat will provide the best option in meeting the goal of this plan. Since the vast majority of streams in eastern South Dakota flow through private land, landowner involvement will be a crucial aspect in maintaining Topeka shiner populations. However, landowner participation in any programs listed in this plan is strictly voluntary. This plan does not establish any new or additional regulations or restrictions for private landowners with regards to endangered species, but provides interested landowners and land users with a variety of conservation program options. Options may include cost share programs (e.g., Conservation Reserve Program or

Environmental Quality Incentives Program) or endangered species programs (e.g., Safe Harbors Agreements or HCPs). Appendix B provides a description of relevant programs.

Many strategies discussed in this plan relate to practices and programs already implemented throughout eastern South Dakota. Topeka shiner watersheds with few protected acres or stream reaches with high erosion would best benefit from additional conservation enrollments. The South Dakota Gap Analysis Program at South Dakota State University has identified these areas for all Topeka shiner watersheds in South Dakota. Appendix C provides an example of Gap analysis for Topeka shiner watersheds.

Hydrology

Objective 1.1: Maintain and restore the natural hydrology of streams containing Topeka shiners.

Discussion:
Stream hydrology refers to the precipitation, evaporation, runoff, and infiltration of water that occurs within a watershed. Stream systems, in the strictest sense, can be recognized as self-adjusting conveyors of water and sediment. Alterations to stream hydrology disrupt the transport of water and sediment, ultimately impacting aquatic habitat. Those land use activities that alter water delivery to streams, retention time within the basin, and infiltration rates change the natural hydrology of stream systems. The resulting effects on Topeka shiners may range from sedimentation due to increased erosion or surface runoff, longer periods of intermittent flows, and loss of groundwater inputs. Those practices that restore and maintain the natural flow regime are critical for the persistence of native fish species (Poff et al. 1997).

Strategy 1.1A: Utilize wetlands (both created and restored) to enhance groundwater recharge and reduce overland runoff in historic areas of high wetland loss.

Task: Conduct research on optimal wetland design, placement, and function in relation to stream hydrology and Topeka shiner habitat parameters.

Programs / tools:

GIS Modeling
Field research
USFWS – NWI
USGS gauging stations

Task: Provide technical and financial assistance to landowners interested in creating or restoring wetland areas.

Agencies / organizations:

Conservation districts
NRCS
USFWS - Partners for Fish and Wildlife

SD GF&P
Ducks Unlimited

Programs / tools:

Grass waterways – CRP
USFWS – Wetland Easements
WRP
WHIP
DENR Section 319 Program

Task: Inform the public on the importance of wetlands to wildlife and watershed quality.

Programs / tools:

Demonstration sites
SDSU Extension
Classroom presentations
Terry Redlin Fresh Water Institute
DENR Information and Education Outreach

Strategy 1.1B: Identify and restore those Topeka shiner watersheds whose hydrographs have been most altered from historic conditions.

Task: Develop and use existing computer models to 1) assess land use alterations to stream hydrology, 2) assess which conservation measures would be most practical and effective for restoring stream hydrology.

Programs / tools:

GIS Land use Analysis – NRI, EROS Landsat imagery
Streamflow modeling
USGS gauging stations

Task: Provide landowner incentives to increase native vegetative cover and other conservation measures in areas identified by hydrologic models.

Programs / tools:

CRP
GRP
WHIP
Grassland Easements – USFWS
Dense nesting cover – GF&P
Native warm season grass establishment – GF&P
USFWS grassland easements
DENR Section 319 Program

Task: Maintain current levels of grassland resources by ensuring viability of agricultural herbivory.

Agencies / organizations:

Agricultural associations

NRCS
Grassland Managed Intensive Grazing
USFWS - Partners for Fish and Wildlife
SD Dept. of Ag.
SD DENR
USFWS

Programs / tools:

DENR Section 319 Program
Grassland Easements
Conservation Commission Grants

Task: Provide technical assistance to urban, residential, and development planners in designing storm water systems that minimize runoff "peaks" into streams following precipitation events.

Agencies / organizations:

SD DENR
SD DOT

Geomorphology

Objective 1.2: Reduce those impacts that adversely alter the geomorphology of Topeka shiner streams.

Discussion: Geomorphology refers to the physical features (e.g., channel dimensions, substrate, gradient) that characterize a stream. Geomorphology and riparian vegetation are the principle factors influencing aquatic habitat. Land use practices and manmade structures (e.g., large-scale impoundments) often have direct and / or indirect impacts to a stream's geomorphic features. The resulting channel degradation (i.e., erosion) or aggradation (i.e., sedimentation) changes the aquatic habitat to which native fish have adapted. Impacts to Topeka shiner streams may include loss of instream pool habitat, loss of spawning substrate, channel incision, and increased stream velocities.

Strategy 1.2A: Encourage erosion control measures along riparian zones and slopes adjacent to Topeka shiner streams. Encourage minimal disturbance of these areas during construction projects.

Task: Work with government agencies to develop BMPs that minimize erosion from construction / project activities.

Agencies / organizations:

SD DOT
USCOE
NRCS
SD DENR
SD GF&P
USFWS

Task: Provide financial and technical assistance to landowners interested in reestablishing native vegetation along riparian zones, especially along areas with high erosion potential.

Agencies / organizations:
- USFWS - Partners for Fish and Wildlife
- Conservation Districts
- NRCS

Programs / tools:
- CRP
- Habitat fence construction
- WHIP
- GRP
- EQIP
- Grassland Easements
- Conservation Commission Grants
- Small watershed program
- EWP
- DENR Section 319 Program

Task: Minimize riparian disturbance in areas with high erosion potential.

Programs / tools:
- Alternate watering sources for livestock – EQIP
- Conservation Commission Grants
- Habitat fence construction
- Stream bank stabilization
- Provide livestock shelter / wintering areas outside riparian areas – tree plantings
- DENR Section 319 Program

Strategy 1.2B: Restore altered habitat in stream reaches critical to Topeka shiners.

Task: Identify those stream reaches in Topeka shiner watersheds that have been most altered by land use changes.

Programs / tools:
- GIS Modeling
- Field research – habitat assessments

Task: Provide technical and financial assistance to landowners interested in restoring habitat in degraded stream reaches.

Agencies / organizations:
- SD GF&P
- NRCS
- SD DENR

USCOE
Conservation Districts
USFWS

Strategy 1.2C: Review stream mitigation projects and inform government agencies, the public, and landowners about the adverse impacts of stream channelization to watershed health.

Task: Review projects that may adversely alter habitat in Topeka shiner streams.

Agencies / organizations:

SD GF&P
SD DENR
USCOE
USFWS
SD DOT

Programs / tools:

Terry Redlin Fresh Water Institute

Task: Inform all entities involved with stream projects on the adverse impacts of channelization to stream habitat and associated fish and wildlife species.

Agencies / organizations:

SD GF&P
SD DENR
USCOE
SD DOT
Conservation Districts
NRCS
USFWS

Programs / tools:

Terry Redlin Fresh Water Institute

Water Quality

Objective 1.3: Minimize non-point source water quality impacts in streams containing Topeka shiners.

Discussion:
Point source impacts (e.g., wastewater discharge) to stream systems have been greatly reduced since enactment of the Clean Water Act in 1977; however, non-point source impacts (e.g., habitat loss) are often cited for the continued decline of aquatic resources (Karr and Chu 1999). One of the main impairments to South Dakota streams is sediment and nutrient runoff (SD DENR 2002b). Impacts to Topeka shiner streams may range from altered trophic structure due to excessive nutrient inputs to stress-induced mortality due to elevated water temperatures. Non-point source impacts to stream hydrology and geomorphology are previously discussed.

Strategy 1.3A: Reduce nutrient inputs into Topeka shiner streams from urban and agricultural sources.

Task: Provide technical assistance to urban, residential, and development planners to improve water quality from storm water discharge systems.

Agencies / organizations:

SD DENR

Task: Continue routine inspections of sewage treatment facilities to ensure compliance with water quality standards.

Agencies / organizations:

SD DENR
State and county health departments

Task: Continue technical assistance for permitting and designing confined animal feeding operations.

Agencies / organizations:

SD DENR
EPA
SD Dept. of Ag.
USDA
Animal Waste Team

Task: Provide incentives for landowners to establish riparian buffers or filter strips along agricultural fields with high runoff potential.

Agencies / organizations:

USFWS - Partners for Fish and Wildlife

Programs / tools:

EWP
CRP
WHIP
EQIP
Small watershed program
CSP
DENR Section 319 Program

Task: Continue to provide technical assistance to farmers and ranchers interested in developing and implementing BMPs on their land.

Agencies / organizations:

SD Dept. of Ag.
SD DENR
USFWS - Partners for Fish and Wildlife
SD GF&P
Conservation Districts
NRCS

Programs / tools:
DENR Section 319 Program

Population Monitoring and Assessment

Population monitoring is an important component in the management of any fish species; however, the physical nature of certain stream systems presents challenges to monitoring efforts. The stochastic nature of prairie streams, such as those in the Northern Glaciated Plains (Omernik 1987), leads to systems predominantly influenced by abiotic (e.g., climate, geology, etc.) controls that foster persistent fish communities with variable populations (Poff and Ward 1989, Milewski 2001, Shearer and Berry 2003). For example, fish populations in eastern South Dakota streams naturally fluctuate on an intra- and inter-annual basis (Walsh 1992, Braaten and Berry 1997). Population changes for fish species, such as the Topeka shiner, that are rare, have a patchy distribution, and have variable recruitment (Minckley and Cross 1959, Wall et al. 2001) are especially difficult to assess. For these reasons, multi-metric indices that monitor change at the community level combined with physical habitat and land use assessments would be a better approach to evaluating the viability of Topeka shiners and their habitat as opposed to statistical evaluations of population surveys.

Multi-metric indices, such as the index of biotic integrity (IBI), measure structural and functional attributes of the fish (or other faunal) community while integrating information from the individual to the ecosystem level. These indices are sensitive to a broad range of environmental disturbances, robust to incorporate natural variation, and adaptable for regional application (Karr and Chu 1999). Habitat assessments, such as those used by Wang et al. (1998) and Goldstein et al. (2002), evaluate geomorphic and hydrologic changes resulting from systemic- (e.g., land use) and local-level (e.g., riparian conditions) alterations. A change in a stream's geomorphic and hydrologic features, such as substrate, channel width, and flow velocities, ultimately means altered fish habitat. Land use changes alter aquatic habitat, which is the principle determinant of a stream's biological potential (Goldstein et al. 2002). Therefore, a direct assessment of the fish community, physical habitat, and land use changes should provide a thorough analysis of biological integrity for a given stream.

This monitoring protocol will evaluate South Dakota's recovery goal at two levels: the species (i.e., Topeka shiner), and overall fish community. We recognize the need to specifically evaluate Topeka shiner populations within watersheds. Given the natural variability of individual populations we feel it is important to consider the overall fish community as well. For example, the absence of Topeka shiners from a site should not count against a basin's recovery goal point total when physical habitat and the overall fish community improve.

Baseline Data

The recent surveys by Cunningham and Hickey (1997), Cunningham (1999, 2002), Blausey (2001), Wall et al. (2001), and the East Dakota Water Development District (SD GF&P 2002) represent the most comprehensive information available on Topeka shiner distribution in South Dakota. Baseline streams will be those with a Topeka shiner occurrence reported between 1997 and 2002 in the South Dakota Natural Heritage database. This includes 13 streams in the James, 8 streams in the Vermillion, and 17 streams in the Big Sioux River basins (Table 1). Topeka shiners in disconnected oxbow channels, riverine wetlands, and dugouts are considered individuals of the same population inhabiting the adjacent stream. The first several years of monitoring fish community composition and stream habitat will provide initial Topeka shiner population, biotic integrity, and habitat conditions.

Wetland resources, grassland resources, and drainage activity are three land coverage components critical to the assessment of Topeka shiner watersheds. This information will provide a direct assessment of those issues addressed in the management actions that influence stream habitat. Techniques will be developed to assess these three components, establish baseline conditions, and monitor any changes in future years. National Wetland Inventory (NWI), Farm Service Agency slides, USGS topographical maps, NRCS wetland inventory maps, National Resource Inventory (NRI), Earth Resources Observation Systems (EROS) Landsat imagery, and other Geographic Information System (GIS) databases will be used to assess land use changes.

Monitoring Site Selection

Three sampling sites per watershed will be established (114 total sites) with each site sampled once every three years. Three sites per watershed should be a fair compromise between obtaining a representative sample of the watershed and considering time restraints. Smaller watersheds (e.g., unnamed tributary to 12-Mile Creek) may require fewer sites, large watersheds (e.g., Firesteel Creek) may require more sites. Monitoring sites will be located at known Topeka shiner locations or stream reaches with a high probability of Topeka shiner presence (see Wall et al. 2001). Site access and landowner cooperation will determine final site location.

Monitoring Protocol

Those methods used by Blausey (2001) and Milewski (2001) will be used to sample fish communities and physical habitat. These methods will provide a measure of fish community composition and relative abundance, channel features, and surrounding land use. A modification to these methods will be the use of multiple seine hauls, thus allowing confidence intervals and depletion estimates to be calculated. The monitoring protocol will allow a crew of two people to sample one site per day. Sampling will take place between mid-June and late-September when stream flows are most stable.

A modified IBI will analyze fish community data. The modified IBI will be similar to those indices used by Milewski et al. (2001) and Shearer and Berry (2002). The IBI assigns an index score to a site or stream and classifies the stream into categories (e.g., good, fair, poor). Biotic integrity changes when the IBI score changes categories (e.g., fair to poor) between sampling visits. Watersheds with continually low or declining IBI scores should be the focus of conservation efforts. The draft Federal Plan recommended the development of a monitoring protocol similar to the IBI to assist and management of the Topeka shiner (USFWS 2001). The monitoring protocol proposed for South Dakota streams is consistent with those recommendations.

Topeka shiner populations will be evaluated on a presence / absence basis. The natural variability of streams in South Dakota and associated fluctuations in fish populations may hamper statistical analyses. The Missouri Dept. of Conservation (1999), through the use of population modeling software (Gibbs 1995), determined that at least 12 sample sites per watershed were needed to detect a 15-year trend in Topeka shiner populations with 90% accuracy. Given the same statistical power, error rate, and coefficient of variation, 456 sites sampled annually would be required to detect a 15-year trend in South Dakota's Topeka shiner watersheds. Thus monitoring efforts designed to detect a statistically relevant trend would not be feasible.

Physical habitat measurements will be used to assess changes in channel geomorphology, such as width / depth ratio, substrate composition, and stream classification (Rosgen 1996). A watershed-, basin-, county-, and / or state-level analysis of landuse will provide a systemic-level assessment, lending insight into possible reasons for the decline or improvement in fish communities and physical habitat.

Monitoring Funding and Implementation

The Division of Wildlife within SD GF&P will be the primary funding agency for monitoring and assessment of Topeka shiner populations. Funding from the Division of Wildlife is contingent upon revenue generated from the sale of hunting and fishing licenses in combination with federal funds and following approval by the SD GF&P Commission. SD GF&P currently does not have the available staff to carry out annual monitoring of Topeka shiner populations; therefore, monitoring efforts will be contracted to an outside entity or conducted by seasonal employees. Monitoring efforts should begin during the summer of 2004 or 2005. SD GF&P will seek cooperation from other state agencies in funding for Topeka shiner monitoring as well.

Management Goal Evaluation

Each basin will receive baseline point totals as follows:

	James River basin	Vermillion River basin	Big Sioux River basin
Baseline Conditions*	1300	800	1700
Management Goal	900	600	1300

* baseline conditions based on those Topeka shiner streams documented between 1997 – 2002 at 100 points / stream.

The management goal for each basin does not propose a decline in stream condition. Baseline and management goal point totals differ because of natural variation in annual stream flows. Baseline Topeka shiner populations (1997-2002) were measured following a period (1993-1999) when stream flows were above the historic mean for each basin in eastern South Dakota (USGS 2000). These elevated stream flows allow fish to extend their range and create additional habitat that may not be available during drought years.

As habitat fluctuates with changes in annual stream flows fish species' abundance and distribution may vary from year to year (Poff and Ward 1989, Shearer and Berry 2003). Therefore, a management goal based on data collected during high flow conditions may establish unattainable standards during low flow or drought years. The degree to which Topeka shiner populations fluctuate between wet and dry years is unknown. Thus, management goal criteria may require adjustment following annual monitoring between high and low flow years.

South Dakota's management goal will be evaluated every three years. The following six scenarios will evaluate each stream's contribution towards the basin management goal:

Scenario	Rank	Point Value*
Topeka shiners present / IBI scores increase	1	+ 100
Topeka shiners absent / IBI scores increase	2	+ 50
Topeka shiners present / IBI scores stable	3	+ 50
Topeka shiners absent / IBI scores stable	4	0
Topeka shiners present / IBI scores decrease	5	- 50
Topeka shiners absent / IBI scores decrease	6	- 100

* point value assessed based on three-year change.

Example: Medary Creek initial point value for 2003, 100 points
Medary Creek 2006 scenario – shiner present / IBI increases, contribution to basin management goal 150 points.

A stream's overall point value will be the average of sampling site values. The scoring system weights point values based on biotic integrity, thus the presence or absence of Topeka shiners does not influence each basin's management goal as much as watershed health.

Public Outreach / Education

Public outreach and education will play a critical role in informing the citizens of South Dakota about the Topeka shiner. Cooperating agencies, landowners, and the general public need to be informed about the state management plan as well as the Topeka shiner in general. Outreach efforts will focus on the past and present status of the Topeka shiner, why the species was federally listed, why a state Topeka shiner management plan is important, and what South Dakota has done in managing the shiner and in working towards delisting.

Outreach Objective: Develop an awareness program that informs the public on the status of the Topeka shiner, the importance of maintaining watershed health, the management efforts in South Dakota, and the importance and function of the Topeka shiner state management plan.

Task: Continue coordination with federal, state, and local entities through the

Topeka shiner advisory group to identify potential problems and management options for the shiner.

Task: Provide biannual press releases to various agricultural (e.g., SD Cattlemen's Assoc., SD Farm Bureau) and conservation (e.g., conservation districts) groups on current state and federal activities involving the Topeka shiner. Appendix D is the first press release concerning the state management plan.

Task: Utilize media sources to inform the public about Topeka shiner recovery efforts in South Dakota. Several articles have already appeared in newspapers throughout eastern South Dakota and a feature on South Dakota Public Radio.

Task: Establish at least one demonstration site in each basin that provides a good example of land management BMPs and associated stream health. Demonstration sites can be established cooperatively with other watershed and conservation commission projects.

Task: Develop and maintain a state Topeka shiner website that presents information and documents concerning the Topeka shiner in South Dakota. Website is currently maintained at:
http://www.state.sd.us/gfp/DivisionWildlife/Diversity/index.htm
http://www.sddot.com/pe/projdev/environment_topshiner.asp

Task: Publish an annual article in the South Dakota Conservation Digest regarding the Topeka shiner and / or watershed related topics. Appendix E is a copy of the 2002 Conservation Digest article.

Task: Prepare and deliver a presentation on the Topeka shiner and state management plan at professional society meetings and workshops. Four presentations are currently scheduled for Winter / Spring 2003.

Task: Develop a handout and poster on the Topeka shiner for public display at area nature centers (e.g., Sioux Falls Outdoor Campus) and quantities for general distribution.

Evaluation

Activities in South Dakota that contribute to national recovery efforts of the Topeka shiner will be summarized in an annual progress report. Annual progress reports will include a list of projects completed, status of current projects, other relevant activities, and a summary of monitoring and assessment data. These reports will be submitted to the local and regional USFWS office. Further evaluation may include an annual meeting between those entities involved in developing this state management plan.

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Table 1. Identified Topeka shiner sites within the James, Vermillion, and Big Sioux River watershed basins. This table only provides county locations of Topeka shiner sites and should not be used for regulatory interpretation.

Historic Locations (pre-1997)

Stream	Basin	County	Year(s) observed
Shue Creek	James	Beadle	1989
Elm River	James	Brown	1975
Enemy Creek*	James	Davison	1896
Firesteel Creek*	James	Davison	1896, 1975
Prairie Creek	James	Yankton	1896
Rock Creek*	James	Miner	1896
Redstone Creek	James	Sanborn	1989
Vermillion River*	Vermillion	Clay, Turner	1934, 1991, 1992
West Fork Vermillion River*	Vermillion	McCook, Turner	1991, 1992
East Fork Vermillion River	Vermillion	McCook, Turner	1991, 1992
Swan Lake	Vermillion	Turner	1943
Turkey Ridge Creek*	Vermillion	Turner	1991, 1992
Big Sioux River	Big Sioux	Brookings, Lincoln, Union, Moody	1892, 1958, 1970
Lake Tetonkaha Inlet	Big Sioux	Brookings	1949
Willow Creek	Big Sioux	Minnehaha	1939
Flandreau Creek*	Big Sioux	Moody	1970

Current Locations (1997 – 2002)

Stream	Basin	County	Year(s) Observed
West Branch Firesteel Creek	James	Aurora	1998
Pearl Creek	James	Beadle	1997 - 1999
Middle Pearl Creek	James	Beadle	1997, 1999
Shue Creek	James	Beadle	1999
Unnamed Trib. to 12-Mile Creek	James	Davison	2002
12-Mile Creek	James	Davison, Hanson	1998, 1999, 2002
Enemy Creek*	James	Davison	1998, 1999
Firesteel Creek*	James	Davison	1997, 1999
Dry Creek	James	Hutchinson	2000
North Branch Dry Creek	James	Hutchinson	2000
South Branch Lonetree Creek	James	Hutchinson	2000
Wolf Creek	James	Hutchinson	1997
Rock Creek*	James	Miner	2000
Vermillion River*	Vermillion	Clay, Turner	1999
Blind Creek	Vermillion	Lincoln	1999
Long Creek	Vermillion	Lincoln	1999
Saddle Creek	Vermillion	Lincoln	1999
West Fork Vermillion River*	Vermillion	McCook, Turner	1998, 1999
Camp Creek	Vermillion	Turner	2000
Outlet of Silver Lake	Vermillion	Turner	2000
Turkey Ridge Creek*	Vermillion	Turner	1999, 2001, 2002
Medary Creek	Big Sioux	Brookings	1997 – 2000
North Deer Creek	Big Sioux	Brookings	2000
Tributary to Deer Creek	Big Sioux	Brookings	2000
South Fork North Deer Creek	Big Sioux	Brookings	1998
6-Mile Creek	Big Sioux	Brookings	1997, 1999, 2000
Peg Munky Run	Big Sioux	Deuel	2002
Hidewood Creek	Big Sioux	Deuel	1999

Table 1 continued.

Current Locations (1997 – 2002)

Stream	Basin	County	Year(s) Observed
Stray Horse Creek	Big Sioux	Hamlin	2002
4-Mile Creek	Big Sioux	Minnehaha	1999, 2002
Beaver Creek	Big Sioux	Minnehaha	1999
Slip-up Creek	Big Sioux	Minnehaha	1999
Split Rock Creek	Big Sioux	Minnehaha	1998, 1999
Springwater Creek	Big Sioux	Minnehaha	1999
West Pipestone Creek	Big Sioux	Minnehaha	1999, 2001
Pipestone Creek	Big Sioux	Moody	1998 - 2002
Spring Creek	Big Sioux	Moody	2000
Brookfield Creek	Big Sioux	Moody	1999

Sources: Evermann and Cox 1896, Bailey and Allum 1962, Wall et al. 2001, South Dakota Natural Heritage Program 2002

* Indicates those historic stream locations where Topeka shiners have been documented recently (Topeka shiners recently documented in Flandreau Creek in Minnesota, Hatch 2001). Note that all historic locations were not sampled recently and some current Topeka shiner streams were not historically sampled.

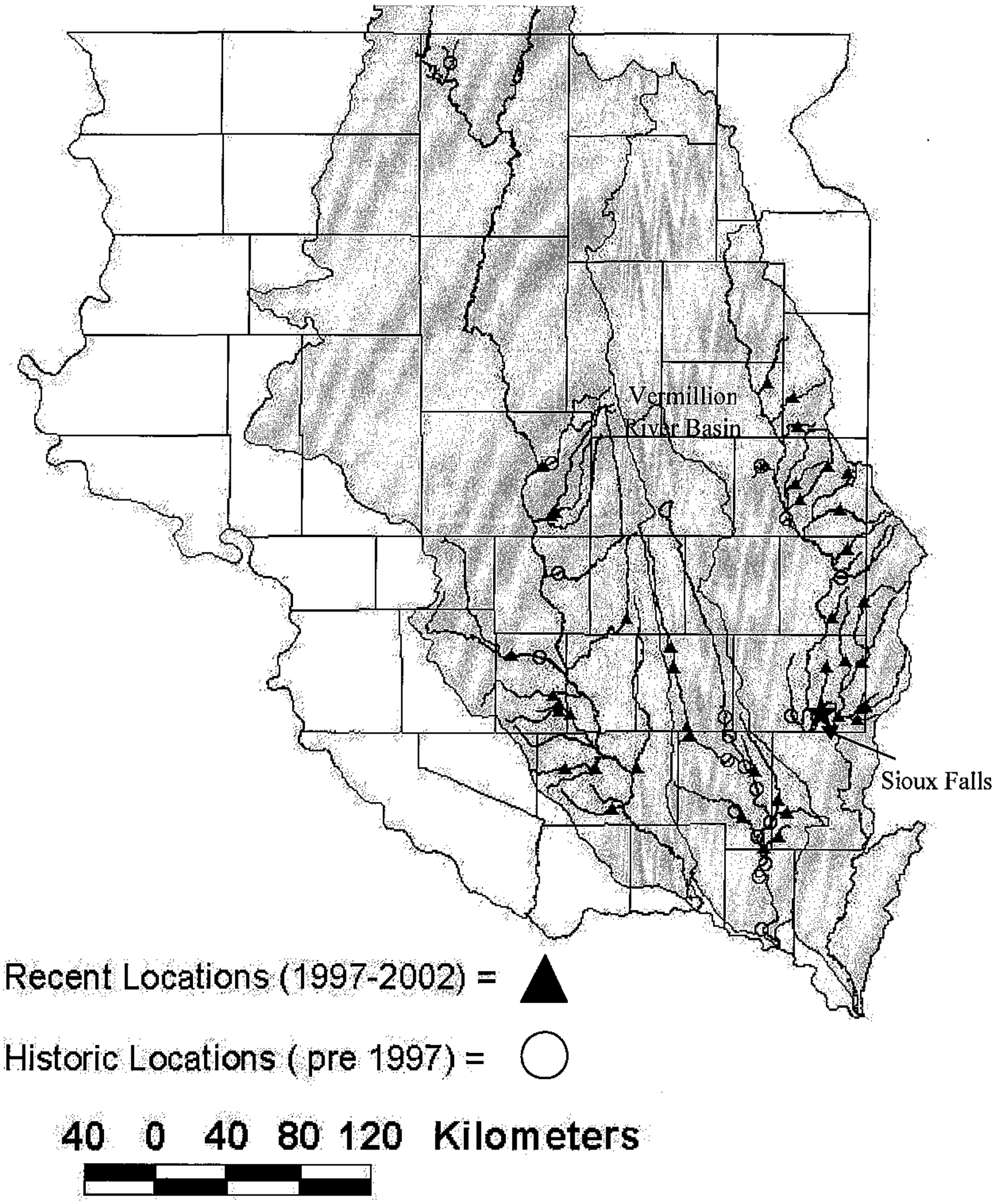


Figure 1. Map of documented Topeka shiner locations within eastern South Dakota. Locations based on those occurrences reported in the South Dakota Natural Heritage Database. Figure should not be used for regulatory interpretation.

Appendix A. Best management practice guidelines used by the Department of Transportation for highway construction activities that involve Topeka shiner streams.

STATE OF SOUTH DAKOTA
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
CONSTRUCTION PRACTICES IN STREAMS
INHABITED BY THE TOPEKA SHINER

APRIL 2, 2003

I. DESCRIPTION

This project crosses a stream inhabited by the Topeka Shiner, a federally endangered species. In order to maintain the habitat necessary to support the Topeka Shiner, several conditions shall be met by the Contractor during construction. The conditions are outlined in the following paragraphs.

II. MATERIALS (None Required)

III. CONSTRUCTION REQUIREMENTS

A. GENERAL CONSTRUCTION

Construction activities within the stream are prohibited from May 15 to July 31, unless the stream is completely separated from construction areas by a Temporary Water Barrier or cofferdam. If work is to be done behind a Temporary Water Barrier or cofferdam between May 15 and July 31, the barrier must be in-place and initially de-watered prior to May 15. Temporary Water Barriers and cofferdams shall also be in-place and initially de-watered prior to ice up if winter work is planned. Construction activities at all times along the stream banks, and in areas that drain into the stream will not be permitted unless comprehensive and effective erosion and sediment controls, that will prevent sediments from entering into the stream, are in-place and functioning properly. Erosion and sediment controls shall be left in place and maintained in good working condition until these areas are stabilized and re-vegetated.

The Contractor shall minimize disturbance of the work area by limiting the working pad surface area, and limiting removal of riparian vegetation to the greatest extent possible. Exposed surfaces shall not be left exposed for greater than one day if work is not occurring daily at that location. Exposed work areas shall be protected at the end of each workday with erosion control mats, plastic sheeting or other approved methods. All areas disturbed by construction activities shall be stabilized and restored with native vegetation when work in those areas is complete. Disturbed construction areas left for more than a day without continuous work that are not permanently seeded and mulched shall be covered with temporary mulch.

The Contractor shall perform monitoring of erosion and sediment controls on a continuous basis, with thorough inspections during rainfall events, and immediately make needed repairs or adjustments.

All temporary storage facilities for petroleum products, other fuels, and chemicals must be located and protected to prevent accidental spills from entering streams within the project area. Cement sweepings, washings, treatment chemicals, or grouting and bonding materials are prohibited from entering into the stream directly or from any locations where they can be washed into the stream by storm water runoff, as these materials are toxic to aquatic life.

No mechanized equipment will be allowed in the stream. If equipment cannot access the work area from shore, work platforms supported by piling driven into the channel bottom shall be constructed. Work berms shall not be constructed in the stream and erosion control measures shall be added to work berms adjacent to the stream.

Unrestricted fish passage must be provided at all times. Construction of temporary dams or diversions using earthen material is not allowed within the stream. Excavated material from the streambed shall not be released back into the stream. Every effort must be made to limit the extent of streambed disturbance and to isolate and capture sediment released during all phases of construction. In-stream dredging and disturbance of the streambed, not provided for in the plans, will not be allowed. This includes no removal of stream bottom substrate for construction materials. If modifications to the streambed cannot be avoided, the physical habitat features (pool-riffle-run sequences) must be restored to pre-construction conditions. Photo documentation of the stream before, during, and after construction must be provided. Water from wet materials excavated and removed from within a Temporary Water Barrier or cofferdam shall have sediment removed prior to the effluent reentering the stream. Sediment removal methods may include a detention pond, complete filtration at an upland site or trickling through vegetation.

The Contractor shall submit a detailed Construction Plan, a minimum of 14 days prior to starting work, to the Engineer for approval. The plan shall include an Erosion and Sediment Control Plan with a complete description of products, materials and methods of installation and removal. The plan shall also include products, materials and methods of construction for Temporary Water Barriers and cofferdams including de-watering, handling, storage, and disposal of excavated material and pumped effluent. The Construction Plan shall include all necessary information to provide assurance that the special environmental conditions are adequately addressed. The plan will be forwarded to the Environmental and Bridge Offices for review and approval with a copy forwarded to the US Fish & Wildlife Service. Work shall not proceed without approval of the construction plan by the Environmental and Bridge Offices.

Oversight for final water enclosures, de-watering, fish seining and any fish transfer or movement shall be conducted by a Biologist under contract to SDDOT.

A pre-construction meeting shall be held with the Contractor, all Sub-Contractors, Project Engineer and personnel from the Environmental Office to ensure all permit conditions and plans are clearly understood.

The Contractor shall be familiar with provisions of the 404 Permit. The Contractor shall notify the Engineer if in-stream construction methods or material will be used that are not covered in the 404 Permit, so an amendment to the 404 Permit can be processed if necessary. The contractor shall provide an estimated date at the pre-construction meeting when the Biologist will be needed on site to monitor final water enclosures, de-watering, fish seining or any fish transfer. The contractor shall notify the Biologist two days before he is needed on site. The telephone number and name of the Biologist will be supplied to the Contractor at the pre-construction meeting.

The project will be inspected and evaluated daily by the Engineer to ensure that all construction requirements and environmental conditions are being met and that the stream and habitat are being protected. The Engineer has the authority to recommend that different or additional controls be implemented to more effectively protect the stream. Construction methods that result in fish mortality shall cease and may resume only after the Engineer, in consultation with the Biologist, approves an acceptable plan. The Engineer shall be notified immediately if field conditions change, or if the project must be modified, so that coordination of permits and approvals can be expedited.

B. TEMPORARY WATER BARRIERS

Temporary water barriers can consist of sheet piling, water filled bladders, portable cofferdams, sand bag dikes, or similar acceptable methods that completely and effectively isolate the stream from the work area. Temporary Water Barriers shall be clean and free of contaminants and sediments that can effect water quality. They shall also be installed by methods that minimize the introduction of sediments and contaminants into the water. Barriers that are constructed in the water shall be enclosed at the upstream side first and every effort shall be made to move any trapped fish out the downstream side before the downstream side is enclosed. If Temporary Water Barriers are overtopped after initial de-watering, every effort shall be made to move or remove trapped fish from within the enclosure before completely de-watering again. Movement of fish must be supervised by the biologist.

Any excavation or removal of muck and debris from behind a Temporary Water Barrier enclosure shall be done by such methods that sediment and debris do not enter into the stream. The use of temporary platforms may be required to catch any materials that may fall into the stream during removal.

C. COFFERDAMS

Where cofferdams are required for deep foundations, the same provisions given for Temporary Water Barriers shall apply for cofferdams with the following exceptions:

The contractor shall provide a walkway along the inside perimeter of cofferdams, within one foot of the water surface, to provide access for seining operations. The last sheet piling to be installed shall be at the downstream end. A net or seine shall be used, vertically, inside the sheet pile cofferdam beginning at the upstream end to gradually force fish out the open downstream end. The cofferdam may then be completely enclosed by driving the last sheet pile.

Design of cofferdams shall be as specified in Section 423 of the Standard Specifications.

D. DE-WATERING

De-watering and construction activities within water enclosures shall not be done until the Biologist has confirmed that all the fish have been moved from within the enclosure. The intent is to ensure that no fish remain trapped within the enclosure after it is closed and de-watered.

Initial de-watering or de-watering after overtopping has occurred shall be done by an approved pumping method and shall not occur unless the Biologist is present or has cleared the enclosure for de-watering. Initial de-watering or de-watering after overtopping has occurred shall be done with pumping methods that will not transport fish through pumps or trap fish against intakes.

Effluent from the de-watering operation shall be pumped to an upland site and the sediment removed prior to the effluent reentering the Stream. Sediment removal methods may include a detention pond, complete filtration at an upland site or trickling through vegetation.

E. TEMPORARY WORKS (FALSEWORK AND WORK PLATFORMS)

Falsework or work platforms shall conform to section 423 of the Standard Specifications and any applicable requirements of this provision.

Temporary piling shall be cutoff at or driven flush with the streambed, or extracted when no longer needed.

The Contractor shall consider how falsework or work platforms will be installed and removed when preparing the Construction Plan and include any special construction methods or sequencing that may be required to protect the Topeka Shiner.

Design of temporary works shall be as specified in Section 423 of the Standard Specifications.

F. REMOVAL OF STRUCTURES & OBSTRUCTIONS

Removal of structures and obstructions shall conform to section 110 of the Standard Specifications and any applicable requirements of this provision.

Construction, demolition and/or removal operations conducted over or in the vicinity of the stream, shall be controlled to prevent materials from falling in the waterway. Any materials that do fall into the waterway or into areas below the ordinary high water elevation (2-year flow) must be removed promptly by hand or with equipment located above the stream bank. A platform suspended below the bridge shall be constructed to prevent material from entering the Stream during demolition of the superstructure. A platform or similar device shall be constructed around the piers located in the Stream to prevent material from entering the water during demolition of those piers. A Temporary Water Barrier shall be constructed around areas of removal that are below the waterline.

G. BOX CULVERTS

Construction of box culverts shall comply with all applicable requirements of this provision.

Temporary diversion channels for box culverts shall be constructed according to standard plate number 734.10. Temporary diversion channels shall be complete and in place prior to May 15 for work between May 15 and July 31 and shall also be in-place prior to ice up if winter work is planned. The contractor shall construct the temporary diversion channel to allow unrestricted fish passage even if the channel is dry at the start of construction.

The contractor shall include details of products, materials and methods of construction for temporary diversion channels with his Construction Plan.

H. BOX CULVERT EXTENSIONS

Construction of box culvert extensions shall comply with all applicable requirements of this provision.

The contractor shall divert the stream and use phased construction to maintain unrestricted fish passage during construction activities. The contractor shall use phased construction and construct the stream flow diversion even if the channel is dry at the start of construction.

The temporary stream diversion for box culvert extensions shall be constructed according to the plan details. Temporary stream diversions shall be complete and in place prior to May 15 for work between May 15 and July 31 and shall also be in-place prior to ice up if winter work is planned.

The contractors detailed Construction Plan shall include stream diversion layout for each phase, box extension construction joints, bar splicing details, diversion sequence, and any other special construction methods or sequencing that may be required to protect the Topeka Shiner.

IV. METHOD OF MEASUREMENT

A. **Temporary Water Barriers:** Temporary water barriers will be measured to the nearest foot.

B. **Cofferdams:** Measurement for cofferdams will be as per Section 423.4 of the Standard Specifications.

C. **Dewatering:** Measurement for dewatering will not be made.

D. **Temporary Works:** Measurement for temporary works will be as per Section 423.4 of the Standard Specifications.

E. **Removal of Structures and Obstructions:** Measurement for removal of structures and obstructions shall be as per Section 110.4 of the Standard Specifications.

F. **Temporary Diversion Channel for Box Culverts:** Measurement for temporary diversion channel for box culverts shall be in accordance with Standard Plate number 734.10.

G. **Temporary Stream Diversion for Box Culvert Extensions:** Measurement for temporary stream diversions for box culvert extensions will be on a per each basis.

H. **Erosion Control for Box Culvert Extension:** Measurement for erosion and sediment control for box culvert extensions will not be made.

V. BASIS OF PAYMENT

A. **Temporary Water Barriers:** Temporary water barriers will be paid for at the contract unit price per foot. Payment for this bid item shall be made only once at each plan shown location, regardless of the number of times the barrier is changed or moved. Payment will be full compensation for labor, equipment, materials, and all incidentals necessary for constructing the temporary water barrier.

B. **Cofferdams:** Payment for cofferdams shall be as specified in Section 423.5 of the Standard Specifications.

C. **Dewatering:** Payment for Dewatering will not be made. All costs associated with dewatering shall be incidental to the other bid items.

D. **Temporary Works:** Payment for temporary works shall be as specified in Section 423.5 of the Standard Specifications.

E. **Removal of Structures and Obstructions:** Payment for removal of structures and obstructions shall be as specified in Section 110.5 of the Standard Specifications.

F. **Temporary Diversion Channel for Box Culverts:** Payment for temporary diversion channels for box culverts shall be in accordance with Standard Plate number 734.10.

G. **Temporary Stream Diversion for Box Culvert Extensions:** Temporary stream diversion for box culvert extensions will be paid for at the contract unit price per each. Payment for this bid item will be made only once, regardless of the number of times the diversion is changed or moved at this site. Payment will be full compensation for labor, equipment, materials, and all incidentals necessary for constructing the temporary diversion channel.

H. **Erosion Control for Box Culvert Extension:** Erosion control for box culvert extension will be paid for at the contract lump sum price. The contract lump sum price shall be full compensation for all labor, equipment, materials, and incidentals necessary to install and maintain erosion and sediment control measures for box culvert extensions.

* * * * *

Appendix B. Conservation programs for landowners. Program descriptions were adopted from agency websites, website links are provided below.

Conservation Reserve Program (CRP) - FSA / NRCS
The Conservation Reserve Program (CRP) provides technical and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. The voluntary program provides assistance to farmers and ranchers in complying with Federal, State, and tribal environmental laws, and encourages environmental enhancement.

The Conservation Reserve Program reduces soil erosion, protects the Nation's ability to produce food and fiber, reduces sedimentation in streams and lakes, improves water quality, establishes wildlife habitat, and enhances forest and wetland resources. It encourages farmers to convert highly erodible cropland or other environmentally sensitive acreage to vegetative cover, such as tame or native grasses, wildlife plantings, trees, filterstrips, or riparian buffers. Farmers receive an annual rental payment for the term of the multi-year contract. Cost sharing is provided to establish the vegetative cover practices.

Wetland Reserve Program (WRP) - NRCS
The Wetlands Reserve Program is a voluntary easement program offering landowners the opportunity to protect, restore, and enhance wetlands on their property. The USDA Natural Resources Conservation Service (NRCS) provides technical and financial support to help landowners with their wetland restoration efforts. The NRCS goal is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program. This program offers landowners an opportunity to establish long-term conservation and wildlife practices and protection.

Environmental Quality Incentives Program (EQIP) - NRCS
The Environmental Quality Incentives Program (EQIP) was reauthorized in the Farm Security and Rural Investment Act of 2002 (Farm Bill) to provide a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. EQIP offers financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land.

EQIP offers contracts with a minimum term that ends one year after the implementation of the last scheduled practices and a maximum term of ten years. These contracts provide incentive payments and cost-shares to implement conservation practices. Persons who are engaged in livestock or agricultural production on eligible land may participate in the EQIP program. EQIP may cost-share up to 75 percent of the costs of certain conservation practices. Incentive payments may be provided for up to three years to encourage producers to carry out management practices they may not otherwise use without the incentive. However, limited resource producers and beginning farmers and ranchers may be eligible for cost-shares up to 90 percent.

Wildlife Habitat Incentive Program (WHIP) - NRCS

The Wildlife Habitat Incentives Program (WHIP) is a voluntary program for people who want to develop and improve wildlife habitat primarily on private land. Through WHIP USDA's Natural Resources Conservation Service provides both technical assistance and up to 75 percent cost-share assistance to establish and improve fish and wildlife habitat. WHIP agreements between NRCS and the participant generally last from 5 to 10 years from the date the agreement is signed. WHIP has proven to be a highly effective and widely accepted program across the country. By targeting wildlife habitat projects on all lands and aquatic areas, WHIP provides assistance to conservation minded landowners that are unable to meet the specific eligibility requirements of other USDA conservation programs.

Small Watershed Program - NRCS

The Small Watershed Program, including River Basin operations, works through local government sponsors and helps participants solve natural resource and related economic problems on a watershed basis. Projects include watershed protection, flood prevention, erosion and sediment control, water supply, water quality, fish and wildlife habitat enhancement, wetlands creation and restoration, and public recreation in watersheds of 250,000 or fewer acres. Both technical and financial assistance are available.

Conservation Security Program (CSP) - NRCS

The Conservation Security Program (CSP) is a voluntary program that provides financial and technical assistance for the conservation, protection, and improvement of soil, water, air, energy, plant and animal life, and other conservation purposes on Tribal and private lands. The program provides payment for producers who practice good stewardship on their agricultural lands and incentives for those who want to do more. CSP assistance was authorized in the Farm Security and Rural Investment Act of 2002 (Farm Bill) and the program may be available in fiscal year 2003.

Grassland Reserve Program (GRP) - NRCS

The Grassland Reserve Program is a new voluntary program in which landowners receive financial incentives to restore and protect grasslands. Eligible land includes restored, improved, or natural grassland, rangeland, pastureland and prairie. Practice cost share will be up to 75% on restored grasslands, 90% on virgin grasslands (prairies).

Emergency Watershed Program (EWP) - NRCS

The Emergency Watershed Protection (EWP) program helps protect lives and property threatened by natural disasters such as floods or wildfires. EWP provides funding to project sponsors for such work as clearing debris from clogged waterways, restoring vegetation, and stabilizing riverbanks. The measures that are taken must be environmentally and economically sound and generally benefit more than one property owner. NRCS provides up to 75 percent of the funds needed to restore the natural function of a watershed. The community or local sponsor of the work pays the remaining 25 percent, which can be provided by cash or in-kind services.

Partners for Fish and Wildlife - USFWS
The Partners for Fish and Wildlife program is a cooperative effort between the Fish and Wildlife Service, private landowner, and other interested entities to restore and improve degraded or marginal habitat. The Partners program improves fish and wildlife habitat on private land, contributes to the land's health and rural quality of life, restores habitat through voluntary partnerships with private landowners, emphasizes landowner choice and control, and offers advice and funding for habitat projects on private lands.

Grassland and Wetland Easements - USFWS
Perpetual easements purchased from willing landowners for grassland or wetland habitat. Grassland easements allow the landowner to continue grazing the land and hay after a certain data, but prohibit the conversion of grassland into row crop production. Wetland easements restrict the dredging, burning, or filling of wetlands. Easements purchased on previously drained or filled wetlands may be restored through USFWS funding and technical assistance.

Safe Harbor Agreements - USFWS
Safe Harbor Agreements are voluntary arrangements between the USFWS and cooperating non-Federal landowners. The agreements benefit endangered and threatened species while giving the landowners assurances from additional restrictions. Following development of an agreement, the USFWS will issue an "enhancement of survival" permit, to authorize any necessary future incidental take to provide participating landowners with assurances that no additional restrictions will be imposed as a result of their conservation actions.

Habitat Conservation Plan (HCP) - USFWS
Habitat Conservation Plans (HCPs) are an agreement between the USFWS and non-Federal entities designed to protect a species while allowing development. An HCP allows the U.S. Fish and Wildlife Service to permit the take of endangered or threatened species incidental to otherwise lawful activities, when the taking is mitigated by conservation measures. This process should reduce conflicts between listed species and private development and provide a framework that would encourage "creative partnerships" between the private sector and local, state and federal agencies in the interest of endangered and threatened species and habitat conservation.

Conservation Commission Grants - SD Dept. of Ag
Grants from the Coordinated Soil & Water Conservation Grant Fund are available for projects that show a natural resource conservation benefit to the state. Any organized conservation district within the state may make an application to the State Conservation Commission. These grants are competitive in nature and there is limited funding for these grants. The following examples are projects that have received funding in the past: windbreak tree planting establishment and renovations including windbreaks for wildlife habitat, field erosion control, farmstead and livestock protection, water development to provide for livestock water needs away from the riparian area to promote healthy regeneration of those areas for erosion control benefits, waterway construction and seeding, rangeland / pastureland improvement projects, water quality improvement

projects including some of the above practices as well as overall assessment of the condition of the watershed and to identify sources of water quality impairments, and no-till cropping system incentives.

Dense Nesting Cover - GF&P
Dense nesting cover, or DNC, is a mixture of cool season grasses (those that green up early in the spring) and legumes, like alfalfa and yellow sweet clover. DNC is the cornerstone habitat type for many species of wildlife. Species, like pheasant, use it for nesting, rearing their broods, roosting and loafing. DNC is high quality nesting cover designed to maximize nesting activity and reproductive success. A lot of the Conservation Reserve Program lands in South Dakota are established with a DNC mixture.

Wetland Restoration - GF&P
Wetlands are the most dynamic ecosystem in South Dakota. Wetlands are important for flood control, water purification and wildlife habitat. GF&P is keenly interested in protecting and restoring wetlands. Through this practice, landowners that have wetlands that have been drained can receive a cost-share and technical assistance to have them restored.

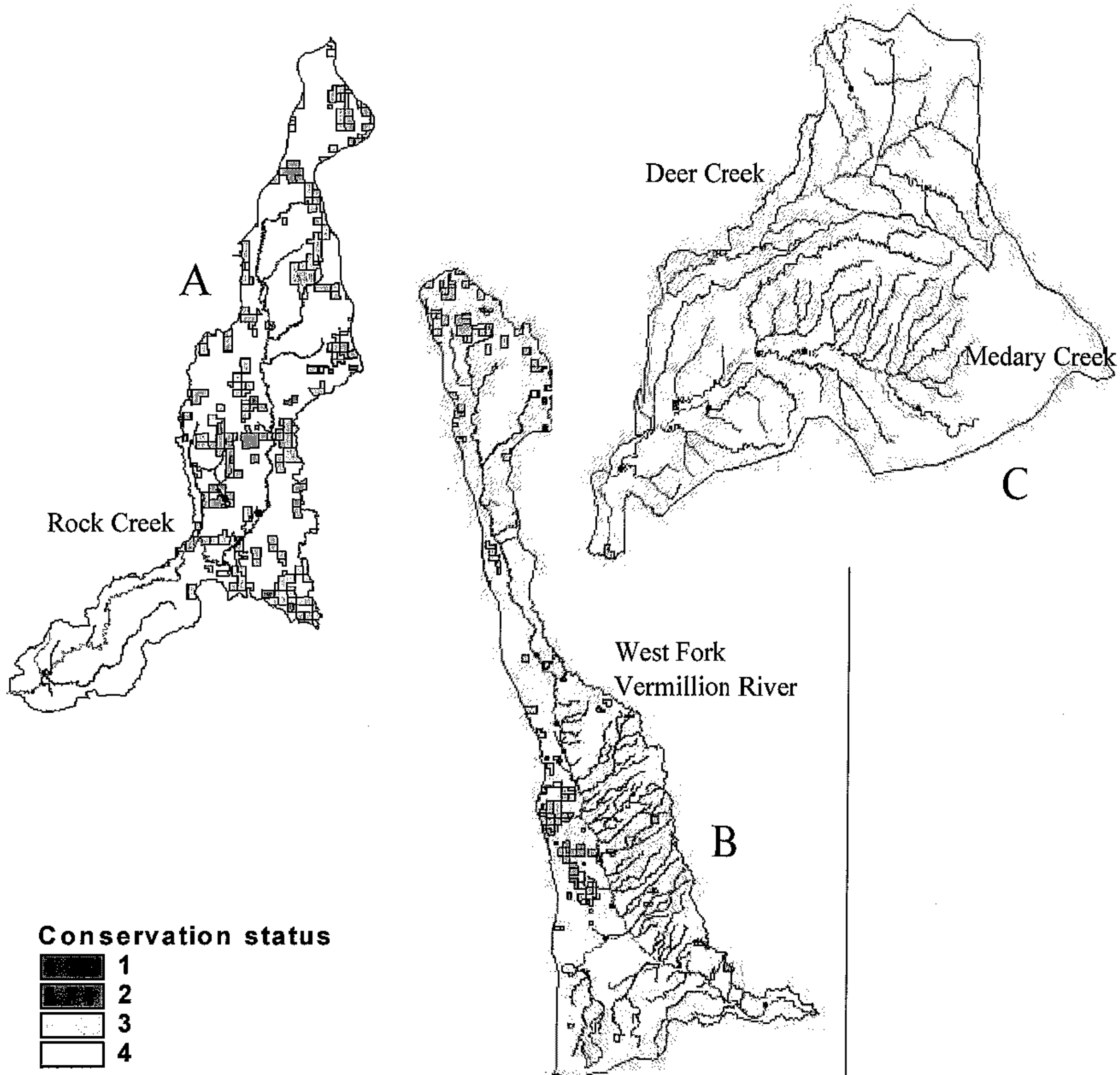
Habitat Fence Construction - GF&P
Important habitats often require protection from livestock. In special cases GF&P will help landowners protect these habitats by helping to pay for the cost of constructing a fence.

Native Warm Season Grass Establishment - GF&P
Once, a large portion of eastern South Dakota consisted of a grassland community that was very tall and did most of its growing in the middle of summer. It's hard to find better winter roosting habitat for resident wildlife than native warm season grasses. The stems are rigid and tend to stand up to a lot of weight from snow. NWSG plantings are also important to some species for nesting, brood rearing, loafing and even as a source of food.

Sources:
http://www.nrcs.usda.gov/
http://partners.fws.gov/
http://endangered.fws.gov/
http://www.state.sd.us/doa/forestry/state_conservation_programs.htm
http://www.state.sd.us/denr/DFTA/WatershedProtection/wpprg.htm
http://www.state.sd.us/gfp/privatelands/

Appendix C. Example of Gap analysis application to three Topeka shiner watersheds in eastern South Dakota. Figure and text from Berry et al. (2002). Figure not intended for regulatory interpretation.

Figure description:
Three sub-basin maps showing three types of gaps between land parcels in four conservation classes and stream segments in four classes of habitat priority for the Topeka shiner (red = high, green = moderate to high, orange = low to moderate and blue = low priority habitat). A = some headwaters and high-priority segments touch protected parcels; B = gaps between protected land and high priority habitat and headwaters; C = little to no protected land. Black dots = Topeka shiner locations. Sub-basins are not to scale.



Status Code Description:

We assigned one of four status codes for the intensity of land protection in each conservation parcel. Status One denoted permanent protection from land cover conversion, such as that found in most national parks. Status Two denoted permanent protection but with uses that might degrade existing natural communities somewhat (e.g. wildlife food plots in a state park). Status Three denoted permanent protection but with extractive uses that were low intensity (e.g. logging) or localized (e.g. mining). The Status three group was larger than others because of the many permanent conservation easements in wetlands, grasslands, and riparian areas that the US government has on private land. We probably underestimated this group because the most recent data are for years before 1995. Status Four was usually assigned to private lands that had no legal mandates to prevent conversion of natural habitat types or only short-term conservation easements (e.g. 10-yr grassland reserve easements). Much private land is well managed, but the intent of the Gap analysis program is long-term habitat conservation.

Appendix D. Press release from GFP News regarding state management plan.

TOPEKA SHINER STATE MANAGEMENT PLAN BEING DEVELOPED

PIERRE - South Dakota's Dept. of Game, Fish and Parks (GFP) is collaborating with other local, state, and federal entities in South Dakota to develop a state management plan for the Topeka shiner, a federally endangered minnow.

"The primary purpose of this state plan is to have a working document that identifies land and stream stewardship opportunities through interagency coordination," said GFP Aquatic Ecologist Jeff Shearer. "In addition, the state plan will determine landowner interest in a variety of partnership programs through public outreach activities. The development and implementation of this plan may also avoid the need for the U.S. Fish and Wildlife Service to list critical habitat for the Topeka shiner in South Dakota."

Topeka shiner management plans have been implemented elsewhere, such as Missouri and Fort Riley, Kansas; however, South Dakota's situation is unique.

"Currently, the shiner's distribution and population status are very similar to historic levels in South Dakota," Shearer noted. "For this reason, South Dakota has the opportunity to establish more flexible guidelines in managing the Topeka shiner, an option not available in other states where drastic population declines have occurred."

"The Topeka shiner state management plan will provide South Dakota with a prime opportunity to address specific state needs while still supporting national recovery efforts," said Game, Fish and Parks Secretary John Cooper.

The planning process will continue through the spring of 2003. A draft of the management plan should be available for public comment by late Feb. 2003.

To receive information regarding planning meetings, contact Jeff Shearer (605) 773-2743 or visit the GFP website at www.state.sd.us/gfp/Diversity/index.htm.

-GFP-

Appendix E. Topeka shiner article published in South Dakota Conservation Digest.

Upon first glance the Topeka shiner looks like just another minnow one would find in a typical prairie stream. But when the U.S. Fish and Wildlife Service (USFWS) listed the Topeka shiner (*Notropis topeka*) as a federally endangered species in January 1999, this otherwise ordinary minnow started receiving much greater attention. Outside South Dakota, various human impacts to the landscape caused drastic declines to the shiner's range and population. Within South Dakota, however, the Topeka shiner tells a different tale.

The Topeka shiner is a small minnow (family: Cyprinidae) native to the prairie streams of the Great Plains. Named after the town near which it was first discovered (Topeka, KS), this shiner can reach three inches in length and live up to three years. While easily confused with the sand shiner, a common minnow found throughout much of South Dakota, the Topeka shiner can be identified by a dark stripe in front of its dorsal fin and a distinct wedge-shaped spot at the base of its tail. Males are more easily distinguished during the spawning season by their colorful, orange fins, as they occupy a small territory over gravelly substrate often around the periphery of sunfish nests. Food items range from zooplankton to plant material, though small aquatic insects are an important source.

Topeka shiners prefer small, quiet prairie streams with cool temperatures and good water quality. This shiner occupies a variety of habitats, such as runs, pools, and backwater areas. Preferred stream types tend to have clean gravel or sand substrates with vegetated banks of grasses and forbs. Groundwater flow into streams is especially important to Topeka shiners and other stream fish during late summer months to maintain cool, perennial flows. Though the Topeka shiner is a schooling fish, it is often associated with red shiners, bigmouth shiners, sand shiners, orangespotted sunfish, and black bullhead.

Eastern South Dakota lays on the northwestern edge of the Topeka shiner's range. Other states within the specie range include southwestern Minnesota, Iowa, Nebraska, Missouri, and Kansas, where studies suggest the shiner now occupies only 10% of its historic range. The picture is much brighter in South Dakota. The Topeka shiner occupies tributaries of the James, Vermillion, and Big Sioux rivers in eastern South Dakota. Recent studies by South Dakota State University, East Dakota Water Development District, and the South Dakota Department of Game, Fish and Parks have documented Topeka shiners in 80% of tributaries where the shiner was historically documented along with many new sites.

So how could a fish that has declined throughout most of its range be doing so well in South Dakota? Though a difficult question to answer, a closer examination of watershed-level activities may lend some insight. Human activities, whether intensive agriculture, construction and development, or point source pollution (e.g. wastewater discharges), often result in multiple impacts to aquatic systems. As is the case with many imperiled fish in the Midwest, declines in Topeka shiner abundance have been linked to habitat degradation, tributary impoundment, water withdrawals, sedimentation, and other water quality problems. Indeed, South Dakota streams face many of these problems, but perhaps to a lesser degree than streams have suffered elsewhere. Many streams in southwestern Minnesota and Iowa are channelized with row crop fields leading to the edge of the stream's bank. Most streams in South Dakota are not channelized, and while row crop agriculture is a major industry, most land adjacent to streams is reserved for grazing. Tributary impoundments and stockdams are extensive throughout many Kansas watersheds. Although stockdams are prevalent throughout central and western South Dakota, the vast majority of eastern streams remain free flowing. While these are just some of the differences between South Dakota and the rest of the shiner's range, the demise of a species is often a result of a complex interaction of many variables.

Why should the plight of this small minnow concern us? After all, the shiner is not a game fish and most people have never seen one. But it's the message the Topeka shiner, and other "indicator" species, relay that's of importance. Eventually, all organisms (including people) are affected when a system becomes degraded, indicator species just respond sooner. The shiner can tell a story of a watershed's past health and warn us of future problems. Luckily, the story portrayed in South Dakota is one of optimism. Early indications suggest that shiner populations are at least stable. The current status of the shiner in South Dakota is, in part, a testimony of good stewardship practices by landowners. Sustainable management of the land has, in turn, sustained the natural diversity of streams.

Some landowners are concerned about having endangered species on their land, often citing fear of government restrictions. However, landowners should not feel apprehensive about having Topeka shiners on their land, but rewarded in knowing they've preserved a part of the watershed's integrity. The USFWS reviews federally funded projects and works with all parties involved to avoid impacts to species protected by the Endangered Species Act. Activities involving a federal permit, license, or funding require consideration of endangered species. Since the vast majority of day-to-day activities on private lands do not involve these federal ties, the presence of Topeka shiners, or any other federally listed species, should not unduly concern landowners.

Conservation and management activities for the Topeka shiner are taking place at both the federal and state level. The USFWS is drafting a Topeka shiner recovery plan, which will list potential threats, recovery goals, and conservation programs for the shiner. The USFWS is also designating critical habitat for the Topeka shiner. Critical habitat is an area deemed essential for the conservation and recovery for a particular species. Activities at the state level in South Dakota are more region specific for our own management goals.

South Dakota Game, Fish and Parks is currently working with other entities, including local, state, and federal interests, in the state to develop a Topeka shiner state management plan. The plan will allow for management of the Topeka shiner at the state level while still supporting national recovery efforts. The plan would identify habitat enhancement opportunities and landowner interest in partnership programs through local, state, and federal cooperation. Additionally, a completed plan should allow South Dakota to be excluded from critical habitat designation. Overall, South Dakota's goal is to maintain current populations and habitat, a much easier task than that faced by other states within the Topeka shiner's range.

On a national scale, the Topeka shiner has a long road to recovery that will require extensive efforts by many interest groups. Despite this long road, there are bright spots along the way. Good stewardship and conservation practices have allowed South Dakota to set an example for other states. By following South Dakota's lead, other states will not only witness a recovery in their Topeka shiner populations, but improvements to their watersheds as a whole.

Appendix F. Management plan briefing developed by SD GF&P.

Topeka Shiner State Management Plan

What is it?
The state management plan is a document that will establish conservation guidelines for the Topeka shiner in South Dakota. The plan will discuss the current status of Topeka shiners, relevant research on the Topeka shiner, list possible impacts to the shiner and its habitat in SD, and address conservation strategies and tools (e.g. CRP, WRP) to mitigate potential impacts.

Several tasks of the state management plan will include:

- identify state-specific activities that support national recovery needs;
- coordinate with local, state, and federal agencies to identify opportunities for habitat enhancement;
- avoid the need to list critical habitat for the Topeka shiner in South Dakota; and
- determine private landowner interest in various partnership programs that are compatible with Topeka shiner needs.

Why do we need a state management plan?
Topeka shiner populations are more abundant and widespread in South Dakota than in other parts of the shiner's range. Recent surveys have documented the Topeka shiner in 80% of historically occupied streams as well as many new locations. Despite relatively abundant populations, Topeka shiners in South Dakota are regulated by the same guidelines in the Endangered Species Act as Topeka shiners in other states. It is the State's intention to avoid the need to list critical habitat in South Dakota and establish more flexible guidelines for management of the species through a completed management plan. These guidelines would alleviate some of the conflicts that occur during various projects involving Topeka shiner streams.

Who is involved with the state management plan?
Part of SD Game, Fish & Parks' mission is to conserve, manage, and protect South Dakota's wildlife resources; therefore, it is GF&P's responsibility to take the lead in developing and implementing the state management plan. Local, state, and federal entities are involved in providing input and comments, as the state plan will affect a variety of interests.

Stage of development
Initial plan developments started in June 2002 where a multi-agency meeting was held to discuss planning efforts and involvement. Plan goals, objectives, and components will be discussed at the next meeting (Fall 2002). A final draft plan should be finished by August 2003. Public involvement activities are being developed, including a future website at: http://www.state.sd.us/gfp/Diversity/index.htm

Appendix G. Press release from GFP News regarding the 30-day comment period on draft Topeka Shiner Management Plan for the State of South Dakota.

TOPEKA SHINER STATE MANAGEMENT PLAN AVAILABLE FOR COMMENT

PIERRE – The South Dakota Topeka Shiner Management Plan is now available for public comment. Game, Fish and Parks officials invite interested individuals to review the document and offer comments and suggestions to improve upon it.

"The main purpose for this state management plan is to outline opportunities for inter-agency cooperation to maintain and improve Topeka shiner habitat and watershed health as a whole," said Aquatic Ecologist Jeff Shearer. "Given the relatively intact distribution of Topeka shiners in South Dakota, the best way to support national recovery efforts is by maintaining existing habitat in eastern South Dakota streams."

People who wish to comment on the draft plan must have written comments submitted by March 21. The draft plan is available online at www.state.sd.us/gfp/DivisionWildlife/Diversity/ index.htm, by contacting Jeff Shearer at (605) 773-2743 or by e-mail at jeff.shearer@state.sd.us. Submit comments to: Jeff Shearer, S.D. Game Fish and Parks, 523 E. Capitol Ave., Pierre, S.D. 57501.

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Appendix H. Summary of comments submitted on the draft copy of the management plan during comment period (February 21, 2003 – March 21, 2003). Comments are copied verbatim as submitted.

Agencies / organizations / individuals that submitted comments:
South Dakota Game, Fish & Parks
South Dakota Dept. of Environment and Natural Resources
South Dakota Department of Transportation
South Dakota Department of Agriculture
Natural Resource Conservation Service – Brookings Field Office
U.S. Fish & Wildlife Service – Brookings Wildlife Habitat Office
U.S. Fish & Wildlife Service – Pierre Ecological Services Office
Lower James RC&D
South Dakota Farm Bureau
South Dakota Grasslands Coalition
South Dakota Cattlemen's Association
South Dakota Stockgrower's Association
South Dakota Corn Grower's Association
South Dakota Izaak Walton League
Harold Kerns – Missouri Dept. of Conservation
Carmen Blausey
Robert Hemmer
Gordon Williamson
Wendy Lieberg-Lockwood
Kelly Lieberg
Arens Engineering

Comments relating specifically to the Topeka shiner management plan:
The following list addresses those comments relating specifically to the management plan. Comments are followed by a reply. The reply states whether or not the comment will be incorporated into the plan and the reason for doing or not doing so. Comments are not listed in any specific order.

- Various suggestions regarding formatting, style, and organization of the plan were submitted embedded within a copy of the draft plan. These changes were made to the best extent possible but are not listed below.

Comment 1: Regarding the first impact; the present or threatened destruction, modification, or curtailment of habitat or range, SDCGA believes land-use practices that alter the hydrologic and geomorphic process provide benefits to a safe environment. SDCGA cautions the Department to occupational, industry and municipal activities that occur with such land use practices regarding wetlands, sedimentation, stream channelization, and resource extraction.
Reply: These activities will be considered as well.

Comment 2: Specific to South Dakota farmers, the state's abundant rainfall gives producers a big advantage over growers in drier farm states. However, during "wet years" which results in an over abundance of precipitation and saturation of property, farmers need a sound field drainage system to remove excess water and ensure that conditions remain suitable for crop growth. Such drainage systems for wet or saturated lands provide benefits to South Dakota farmers and residents of the state.

Reply: The discussion of drainage in this plan is only intended to address the negative impacts drainage systems can have on stream hydrology.

Comment 3: SDCGA agrees that the impacts of sedimentation on stream systems are wide ranging and South Dakota producers reap the rewards of sound management practices. Specifically, the draft plan state, "The loss of native prairie is often cited as a primary reason for increased sedimentation to aquatic systems in the Midwest." However, South Dakota's sizeable shiner populations should be evident of producers' existing land management practices that have minimized sedimentation of stream systems in the state.
Reply: Sound management practices have benefits to both producers and streams. However, certain alterations to the landscape have the potential to alter a stream's sediment load if proper management practices are not implemented.

Comment 4: SDCGA agrees that channelization alters stream hydrology and geomorphology. In doing so, channelization provides civic municipalities with greater control to prevent property losses resulting from periodic flooding in flood plain zones. With most communities and towns settled on strategic waterways, stream channelization is a necessary flood control measure.
Reply: Stream channelization is addressed in this plan to point out the adverse effects such activities may have on a stream system. Other flood control measures exist that can benefit both the stream and communities.

Comment 5: Regarding resource extraction, the draft plan states, "Resource extraction such as water withdrawals and gravel mining, for municipal, agricultural, and domestic uses have the potential to impact aquatic systems when conducted improperly. Irrigation can lower water tables and groundwater delivery to streams..." SDCGA believes agricultural irrigation is not an issue in South Dakota since the state generally receives adequate rainfall and the cost benefit of irrigation on already rich farming soil fields yields only marginal return to producers. Instead, focus of this section should be directed specifically at urban municipal governments.
Reply: The threats analysis on resource extraction indicates that water withdrawals (whether for agricultural or municipal purposes) are not a threat to Topeka shiner populations in South Dakota.

Comment 6: Specifically, the City of Sioux Falls generates nearly all of it's water intake from water wells and pumping stations strategically located around the Big Sioux River and surrounding underground area aquifers to supply the water needs for a population of over 120,000 residents. SDCGA believes more emphasis is needed for resource extraction from municipal governments instead of agricultural producers for resource extraction to be a valid point of consideration in the state's management plan.
Reply: This will be added.

Comment 7: Regarding the third impact: Disease and predation, SDCGA believes the state's draft plan is inconstant and incomplete. The draft plan states, "Little is known about the impacts of disease on Topeka shiner populations." If this wordage is correct, SDCGA believes a logical first step should be in-depth scientific studies on the impact of disease on shiner populations conducted by the U.S. Fish & Wildlife Service. Such basic information would provide information beyond stress-induced habitat conditions.
Reply: Suggested research will be added; however, this does not make the plan's assessment of disease incomplete.

Comment 8: The draft plan state, "Predation may not be as significant an impact on Topeka shiners in South Dakota as in other parts of the shiner's range." Such wordage does not guarantee however, that predation is not a threat. In the Department's own words, "Predation by introduced game fish most likely occurs, especially in areas where game fish have been intentionally introduced." This confirms that predation will occur and diminish shiner populations in the state. Furthermore, the draft plan state, "...the extent of these introductions is unknown" and indicates that the department does not entirely know the impact that predation will have on shiner populations in South Dakota.
Reply: The plan's assessment of predation and reasoning for predation not being a threat to Topeka shiner populations will be clarified.

Comment 9: SDCGA believes that more information needs to be collected on disease and predation before the Department can say for certain that disease and predation do not constitute a threat to the Topeka shiner populations in South Dakota.
Reply: No evidence exists to suggest disease or predation are threats to Topeka shiner populations in South Dakota. Topeka shiner populations have persisted throughout their historic range in South Dakota; therefore, we see no past or present evidence of threats from disease or predation.

Comment 10: Regarding the fifth impact: Other natural and manmade factors, the draft plan states, "No other natural (species competition, niche overlap, hybridization) or manmade (urbanization, impoundments) factors are known to threaten Topeka shiners in South Dakota," SDCGA believes such factors do exist that have the potential to threaten shiner populations in the state.
Reply: We respectfully disagree. There is no evidence that suggests other natural or manmade factors are currently threatening Topeka shiner populations in South Dakota. However, this does not mean that unforeseen future impacts will not develop.

Comment 11: SDCGA believes that shiner hybridization needs further research before concluding such action is not a threat. The Department's draft states, "Potential Topeka shiner hybridization and influencing factors is an area warranting further research" and as such, SDCGA believes further research should proceed regarding this possible threat.
Reply: We agree that potential hybridization between Topeka shiners and sand shiners warrants further research. However, only two occurrences of possible Topeka / sand shiner hybrids have ever been reported. Only observational data exist suggesting these individual fish were hybrids, there have been no genetics or morphometrics research to verify these findings.

Comment 12: SDCGA also has concerns for not including cyclical weather patterns for consideration as indicated by, "The natural effects of drought or floods should not be considered threats to Topeka shiner populations." SDCGA believes that adverse weather conditions have the potential to increase or decrease shiner population numbers. Such population changes could result in a skewed data at during the course of a population sampling in identified stream segments. As such, SDCGA suggests populations samplings should include a "factor" for dry years of drought that would impair shiner populations in the state.
Reply: The natural effects of drought or floods is in reference to the cyclical weather patterns, this section will be reworded for clarification. Fish populations do increase or decrease naturally with annual precipitation changes. Population monitoring protocols do take into account this natural variability so conclusions are not made based on skewed data.

Comment 13: SDCGA has concerns with the impacts of point source pollution such as wastewater discharge and other industrial effluents. Communities and industries that discharge the legally acceptable waste limits into river and stream segments impound a water body. Such impoundments impact those stream segments downstream from such sources. Other urbanization factors for consideration should include new developments and the potential for run-off resulting in rain downpours that infiltrate storm sewers and subsequent outflow into rivers. Consequently, SDCGA believes urban areas have the potential to impact areas downstream and severely diminish shiner populations. SDCGA asks the Department to reconsider the impacts of point source pollution as threats to the Topeka shiner in South Dakota.
Reply: Urban areas are still subject to the state water quality standards regulated by the SD DENR. These standards are designed to prevent significant impairment to state waters. We feel point source pollution is not a threat to Topeka shiner populations as long as these standards are upheld.

Comment 14: Regarding the Department's "Management Actions": The overall goal of this management plan is to maintain or improve habitat integrity in Topeka shiner streams. Thus, management objectives will focus on those primary issues that influence habitat integrity: hydrology, geomorphology, and water quality. SDCGA believes South Dakota's sizeable Topeka shiner populations can be attributed to existing land practices being utilized by producers who livelihood is tied to the productivity of their land. Additional funding sources and opportunities to combat sedimentation, erosion or surface runoff will not only benefit shiner populations in the state, but also the productivity of farmers with increased incentives offered through various governmental programs.
Reply: Agreed.

Comment 15: As such, SDCGA has concerns with some of the identified tasks for Objective 1.1: Maintain and restore the natural hydrology of streams containing Topeka shiners. SDCGA recommends including tiling as a beneficial option aimed at removing excess water and reducing overland runoff. Sound field drainage systems provide environmental benefits by removing excess water from fields and helping to reduce runoff. SDCGA recommends educating the public on the importance of tiling and other Best Management Practices such as stream stabilization, terraces, grass waterways and buffers.
Reply: Tiling may be beneficial to removing excess water and reducing overland runoff, but we respectfully disagree on the environmental benefits of tiling to the natural hydrology of stream systems.

Comment 16: SDCGA also expresses concern with tasks identified for Strategy 1.1B. Mainly the task to provide technical assistance to urban, residential, and development planners in designing storm water systems that minimize runoff "peaks" into streams following precipitation events." This is a concern since the Department did not list point source pollution as an impact to shiner populations in South Dakota nor the general threat of urbanization.
Reply: This strategy is designed to address the impacts runoff from impervious surfaces following storm events have on stream hydrology, not point source pollution.

Comment 17: Along the same thought, SDCGA is concern with Objective 1.3: Minimize non-point source water quality impacts in streams containing Topeka shiners. The Department lists non-point source water as an objective and even establishes a strategy to combat the objective with five tasks. However, the Department does not consider non-point sources as an identifiable threat to the Topeka shiner in South Dakota. If no such threat is listed, why has the Department developed strategies and tasks associated with non-point sources?
Reply: Tasks listed for this objective are being implemented throughout South Dakota. Listing of these tasks are to identify those actions needed to ensure non-point source pollution does not become a threat to Topeka shiner populations in the future.

Comment 18: Regarding the section on Population Monitoring and Assessment, SDCGA believes population monitoring is an important component in the management of any state plan. As such, the Department will face challenges to monitoring populations of the shiner.
Reply: Agreed.

Comment 19: Since the Department has chosen not to include weather patterns and conditions such as floods and droughts as threat to the shiner, SDCGA believes population samplings should include a "factor" for dry years of drought that would impair shiner populations in the state.
Reply: Conditions, such as drought, are taken into consideration when monitoring stream fish populations.

Comment 20: SDCGA also believes that for a proper monitoring protocol to be used, the current fifteen (15) year trend should be extended to include a thirty (30) year trend.
Reply: The monitoring protocol in this plan does not establish a 15-year trend. Monitoring the shiner on a 30-year basis is too long of a time frame for a species that has a maximum life span of 3 years.

Comment 21: Regarding the section on Public Outreach / Education, SDCGA believes producer groups and municipalities working with the Department will provide a critical role in informing citizens of South Dakota about the Topeka shiner. SDCGA is pleased to work with governmental agencies or departments to help educate and inform our producer members. SDCGA invites the Department to maintain its existing working relationship currently being displayed in the shiner issue.
Reply: Agreed.

Comment 22: The second sentence reads, "...landowner involvement will be an important aspect in maintaining Topeka shiner populations." I would change the word "important" to either critical or crucial. I don't believe we (whether in Missouri or South Dakota) can overemphasize the dependence we have on private landowners in the recovery of this species.
Reply: Agreed.

Comment 23: I was surprised to see your sampling protocol for Topeka shiner monitoring include their peak spawning period. With the critically low numbers of Topeka shiners in Missouri, we established our sampling protocol outside the spawning time for this species.
Reply: Stream sampling between June and September is the only feasible period in eastern South Dakota. Ice cover and spring floods prevent sampling earlier, stream intermittency and cold weather prevent sampling later.

Comment 24: The draft would have benefited from a review of the committee before release to the public.
Reply: Agreed, however, the short period of time between completion of the draft and submission a final draft prevented a longer review process.

Comment 25: This document seems to be indicating three conflicting paths for managing the Topeka shiner. The plan correctly states that the Topeka shiner population in South Dakota is in good shape. Maintenance of status quo should serve them well. The management actions include activities like research and funding programs to "improve" habitat which goes beyond maintaining status quo. Then a point system is proposed with baselines for current conditions followed by "recovery" goals for a point reductions in each drainage. We can't resolve the conflicted language.
Reply: Wording in the plan will be clarified. Recovery goals do not propose a reduction in the status quo. The management goal acknowledges that the established baseline conditions set after "wet" years can not be maintained during "dry" years. Maintaining the status quo of the Topeka shiner is the best option; however, Topeka shiner numbers are not stable. Thus management goal and baseline point totals differ.

Comment 26: Will the way future impoundment projects are discussed create some problems for constructing ponds through the fish and wildlife and NRCS small dams projects? We suggest you revisit the language. You may simply need to specify the reference is to large impoundments as it is seems to be in opposition statements made in the next paragraph.
Reply: Agreed, this point was clarified to refer to large impoundments.

Comment 27: We suggest that both watershed projects and conservation districts should be included as technical assistance providers. The Grassland Managed Intensive Grazing, Buffer Sales and Animal Waste Teams should be mentioned.
Reply: These will be added.

Comment 28: There is no mention of 319 (watershed) projects in the document as a source of funding for Best Management Practices. This should be added.
Reply: These will be added.

Comment 29: Outreach activities are rather weak. They are mostly target agency and organizations. More use should be made of the media to reach a greater segment of the population.
Reply: Media outlets have been used, these will be added to the plan.

Comment 30: We recommend that the demonstration sites be established cooperatively with watershed, conservation commission, etc. projects to maximize use of resources and eliminate duplication of effort.
Reply: Agreed.

Comment 31: If the incidents of altered stream flow have been observed why can't you determine the extent of dewatering.
Reply: One incident of stream dewatering was reported by Wall et al (2001). The total extent of stream miles impacted by dewatering would require a much more indepth study. Clarification will be made in the plan.

Comment 32: The extent of gravel mining is not unknown. These activities are permitted.
Reply: This will be added, however, some concern has been raised regarding activities without a permit.

Comment 33: Page 17, 1.1A Task 2 after WHIP add EPA 319 Projects. Task 3 after Classroom presentations add Terry Redlin Fresh Water Institute. 1.1B Task 2 after native warm season grass GFP add

EPA 319 Projects. Page 18, 1.2A Task 2 after NRCS add EPA 319 Projects. Page 19, 1.2C Task 1 after USFWS add Terry Redlin Fresh Water Institute. Task 2 after USFWS add Terry Redlin Fresh Water Institute. Page 20, 1.3A Task 3 to my knowledge EPA does not provide technical assistance. Dept. of Ag should read USDA and SDDA. Task 4 after CSP add EPA 319 Projects. Task 5 after NRCS add EPA 319 Projects.
Reply: These will be added.

Comment 34: Perhaps you could list those BMPs such as an Animal Nutrient Management System or riparian restoration etc. that do not require an on-site inspection for installation. Some conservation districts currently require all BMPs to undergo an on site inspection by the USFWS if OWs are present in the area while others do not.
Reply: These will be added.

Comment 35: Conservation Districts are county entities in grass roots management planning with producers. They are typically underfunded and short staffed. I would ask that they are not asked to extend any of their precious resources on a recovery program for a fish (topeka shiner), that is not threatened in this state. p 19&20.
Reply: Conservation districts are simply listed as one possible tool for certain tasks. This listing does not commit them to any new activities outside the day-to-day tasks conservation districts already carry out.

Comment 36: There is a huge demand for EQUIP funds by producers in South Dakota. These funds should not be redirected to a recovery program for the topeka shiner, whose "distribution and population status are very similar to historic levels...."
Reply: Listing of any conservation program in this plan does not redirect funding for recovery of the Topeka shiner. Programs are listed to point out various voluntary options that are available to interested entities.

Comment 37: Need to add in a section to state the overall goal of the document. Such as expanding on the first sentence from Page 16, Management actions section.
Reply: This change will be added to the introduction.

Comment 38: Life History, 1st paragraph. First sentence uses dates from late-May to mid-August. Should be end of July.
Reply: The Topeka shiner spawning period varies with water temperature. Shiners have been observed spawning during August. The late-May to end of July period refers to the spawning period restriction time for construction activities on shiner streams.

Comment 39: Life History, 1st paragraph. Clarify why believed few individuals live to three years or cite a reference.
Reply: Reference will be added.

Comment 40: Habitat, 1st paragraph, 2nd sentence. "Some Topeka shiner locations...streams with silt substrate..." Clarify in Life History section if there are expected recruitment possibilities in this habitat.
Reply: No information regarding expected recruitment, will be clarified.

Comment 41: Habitat continued, 1st paragraph, 2nd sentence. If it is based on the model wouldn't it be "potential presence"?
Reply: Statement based on data collected during field surveys, not model predictions.

Comment 42: Habitat continued, 1st paragraph, last sentence. Clarify that this assumes that there is a return of flows prior to dry down in an intermittent system or due to drought and that during this time the isolated pools maintain required habitat components. All within the short life span.
Reply: This will be clarified.

Comment 43: Topeka Shiner Research in South Dakota, 1st paragraph, 2nd sentence. State "...no surveys had taken place to specifically document Topeka shiner distribution prior to 1997." However, the Range

section, 1st paragraph, 3rd sentence refers to the historic range. These statements conflict and need clarification if earlier studies did not look at the basin / watersheds level to allow delineating historic ranges and thus separate from qualitative data later collected.
Reply: This will be clarified under Factor A of the Threats Analysis section.

Comment 44: Topeka Shiner Research in South Dakota, 1st paragraph, 2nd to last sentence. "This model was 89% accurate in predicting Topeka shiner presence." This statement is based on what? Does it mean that when the model predicted shiners would be present that upon field checking a certain percentage of them that shiners were only found 89% of the time? Or that when the model was applied to known sites only 89% of the sites showed up on the model?
Reply: This will be clarified.

Comment 45: Topeka Shiner Research in South Dakota, 2nd paragraph, last sentence. Refers to "This information will allow resource managers to determine the best source of broodstock for fish propagation…". This statement may be correct in regards to what is being researched. However, in context of the management plan that has the goals focusing around maintaining and improving habitat that statement is a bit misleading. The rest of the management plan does not incorporate the use of broodstock and propogation into it and this should be clarified at this point that it is not being researched as part of the implementation identified in this plan.
Reply: This will be clarified. There is not a need for propagation and stocking of Topeka shiners in South Dakota, however, this may be a required practice in other states. Genetics research was mainly justified to better understand the genetic distinctiveness of South Dakota populations. Identification of potential brood stock is a secondary benefit of this research.

Comment 46: Topeka Shiner Research in South Dakota, 3rd paragraph, 4th sentence. Study percentages stated 9% and 64%. What is the status of the other 27%?
Reply: This will be clarified.

Comment 47: Distribution of Topeka Shiners in South Dakota, last two sentences. The first of these sentences shows the breakdown of watersheds by basin. The recent year sentence also needs the basin breakdown for comparison and consistency. Clarify the "…have not been documented in 9 watersheds since 1990 (Table 1)." Table 1 shows only 8.
Reply: This will be clarified and changed.

Comment 48: Legal Status. States that "The species is not state-listed in Nebraska or South Dakota." It is stated why it is not in South Dakota but why isn't it in Nebraska?
Reply: The Topeka shiner was recently listed in Nebraska. This change will be made.

Comment 49: Goal Statement, 1st paragraph, 1st sentence. Use of term "vested interest" not recommended. By definition this means with goals for personal advancement or advantage at the expense of others. Not a message that should be sent on an issue that can already be viewed by some as subjective and political.
Reply: This change will be made.

Comment 50: Goal Statement, 1st paragraph. First paragraph may work better in the legal status section and then the Goal Statement section would start right off with the currently second paragraph that clearly contains goal information.
Reply: The group consensus was that the Goal Statement should start off with statement about agency obligations for wildlife and resource protection.

Comment 51: Goal Statement, 2nd paragraph, 1st two sentences. "The overall goal…streams in South Dakota *to maintain current population levels*", and "The intent of these….delisting of the *species pursuant to* the ESA."
Reply: This plan is designed to focus on stream habitat as opposed to species populations. By preserving current habitat, we feel current population levels will be maintained. Changes will be made to the second sentence.

Comment 52: Goal Statement, 2nd paragraph. When mentioning the recovery goal point system provide a reference to the Recovery Goal Evaluation section.
Reply: This change will be made.

Comment 53: Plan Development and Implementation, 1st paragraph. Nice paragraph but it belongs earlier in the plan in the Introduction section. Also be sure that all acronyms (SDSU, DSU, BHSU) have been spelled out at one point. In a document that utilizes several acronyms it is often recommended that an appendix listing them be utilized.
Reply: These changes will be made, a list of acronyms will be added towards the beginning of the plan.

Comment 54: Plan Development and Implementation, last paragraph. Areas that may best benefit need to indicate that the value of an adjacent buffer may balance out negative impacts identified further up the landscape. There is a reference to reaches with no protection with no definition of what those would be. Also, provide an appendix map showing what the Gap Analysis Program application identifies and how it looks.
Reply: These changes will be made.

Comment 55: Threats to Topeka Shiner Populations in South Dakota, 1st paragraph. Edits, "This plan address *all* five *factors* utilized...." Add sentence relating that a species may be determined to be a threatened or endangered species due to one or more of the five factors described in Section 4(a)(1) of the ESA. Also, after the first paragraph, provide a list to show what all five factors are.
Reply: These changes will be made.

Comment 56: List of five factors. List them by A, B, etc to be consistent with the way they are listed in the 50 CFR Part 17 Final Rule to List the Topeka Shiner as Endangered.
Reply: This change will be made.

Comment 57: Resource Extraction. 3rd sentence: Delete "As stated above" unless the above text clearly states the connections between the uses mentioned and groundwater/flow regime interactions. 4th sentence: Replace "evolved" with something such as "show tendencies or preferences". Evolved implies evolution and is generally should not used in this context for general public documents.
Reply: "As stated above" will be changed to "as previously stated." The term "evolved" will be replaced.

Comment 58: Disease or Predation, last paragraph. Move the last paragraph to be the first paragraph.
Reply: The last paragraph is intended to summarize the discussion regarding Disease and Predation.

Comment 59: Inadequacy of Existing Regulatory Mechanisms, 1st paragraph. 1st sentence, "...Topeka shiner location and reviews all federally funded projects..." How is this done? Is there an established protocol? 3rd from last sentence: "The NRCS has developed guidelines for project development and implementation..." should be changed to read "The NRCS is developing guidelines for project development and implementation..."
Reply: Each project is reviewed on a case by case basis. At a minimum, known locations of federal candidate and listed species are shared with the requesting entity. Additional information on state listed and state sensitive species and potential project impacts to rare species is often requested of the SD Natural Heritage Database. The second change will be made.

Comment 60: Other Natural and Manmade Factors, 2nd paragraph, last sentence. Future impoundment projects in Topeka shiner watersheds are highly unlikely..." Need to clarify large-scale due to Fish and Wildlife Service Partners for Fish and Wildlife Program activities. Large-scale projects however are also a very politically active issue in the upper Big Sioux watershed as being looked at by the Pelican Lake Water District and Upper Big Sioux Watershed Board. This same issue is stated in the last paragraph the last two sentences.
Reply: This will be clarified.

Comment 61: Management Actions, 1st paragraph. 1st sentence: Good sentence and it should also be utilized in the Introduction section. 4th sentence: Define the italics part as being the primary factor from the Threats to Topeka Shiner Populations in South Dakota.
Reply: These changes will be made.

Comment 62: Objective general comments: Make header larger, center, and bold to stand out. Clearly define them with a single word (hydrology, geomorphology, and water quality) as defined in Management Actions paragraph. Possibly include the rest of the text from the Objective statement as a "Purpose" statement for the objective.
Reply: These changes will be made.

Comment 63: Discussion. Define hydrology in the first sentence as is done for geomorphology in the discussion associated with the next section.
Reply: Hydrology will be defined.

Comment 64: Task and Tools sections general comments. Be consistent in utilizing all or no acronyms and make sure they are easily defined (i.e. in an appendix for acronyms). Do not mix NRCS programs (CRP, WRP, etc.) into lists that also contain agencies. Possibly use as a subhead list if needed under the appropriate implementing agency.
Reply: This will be clarified. Agencies and programs will be separated under different headings: Agencies/organizations and Programs/tools.

Comment 65: Objective 1.3 The 1st sentences states "non-point source" while the Management Actions introduction paragraph just lists it as water quality in general. Should be defined the same in both sections.
Reply: This will be clarified.

Comment 66: 1st paragraph, last sentence. "...groundwater sources, and change from rural to the urban landuse." Should read "...groundwater sources, and changes in landuse." Significant changes in farm or grassland management can have definite impacts and should be included in this category.
Reply: These changes will be made.

Comment 67: Monitoring Protocol. How and by whom will the sites be selected? 2nd paragraph, 4th sentence: Should state that the watersheds to be focused on would be known or historic location ones.
Reply: It has not been determined who will carry out monitoring activities.

Comment 68: Monitoring Site Selection. Section should be located before the protocol.
Reply: This change will be made.

Comment 69: Recovery Goal Evaluation: The baseline scores (1300, 800, 1700) indicate that not only the shiners were but the IBI scores increased for all locations. The 1300, 800, and 1700 correlate to the number of known watersheds since 1997 if all are given 100 points. If these baseline values are used, then the statement is being made that currently biotic integrity is increasing in all known shiner watersheds. Is it then assumed that stated recovery goals come from new locations? If so, then the goal of this management plan is actually being measured by increasing additional populations and habitat and not the protection of the existing populations and habitats. Thus the plan needs to be revised throughout to reflect that change.
Reply: This section will be clarified. Scores for assessing the recovery goal are set to monitor and evaluate year-to-year change. An example will be included to clarify this. Plan goal is still to maintain existing habitat, not to increase populations.

Comment 70: Table 1. Format to fit on one page. Expand out the "Stream" column to be sure only one line is needed per entry and then the document should easily fit.
Reply: Table will be reformatted, but still may not fit on one page.

Comment 71: Appendix general comments. Make "Appendix A" header larger and bold to stand out. Include page numbers in the Table of Contents or possibly number the pages (A-1, A-2, etc.) to indicate location in the Appendix and overall document.

Reply: Appendices and rest of the plan are formatted in accordance to those suggestions by the American Fisheries Society. Page numbers will be added to the Table of Contents.

Comment 72: Appendix A, WRP "The Wetland Reserve Program is a voluntary *easement* program."
Reply: This change will be made.

Comment 73: Appendix A, CSP "...the program *may* be available in fiscal year 2003 *pending funding*."
Reply: This change will be made.

Comment 74: Need to add the Grassland Reserve Program to the list since it is previously cited on page 18, Strategy 1.2A, Task, Tools.
Reply: This change will be made.

Comment 75: Overall this management plan seems to be a good general tool to assist in overall management goals of a watershed but it does not define specific actions or agencies that will implement them. The current Goal Statement says, "The intent of these guidelines is to work towards future delisting of the species from the ESA." However, this document is very broad and the Appendix B that would include the type of information listed is not included in the draft document.
Reply: Plan implementation will be discussed at a later date. Information to be included in Appendix B had not yet been submitted for inclusion in this draft document. This information has since been added.

Comment 76: Reasons for Decline: Farm Bureau recognizes the reasons in the section as potential reasons for decline in South Dakota. The second paragraph states the reduction in groundwater inputs due to wetland loss and irrigation withdrawal may further reduce stream reaches inhabited by Topeka shiners. It should also state that less-than-normal annual rainfall has the same effect.
Reply: This will be added. However, it is important to note that drought years are natural events, reduction in groundwater inputs due to wetland loss, irrigation withdrawal, and municipal water uses are manmade factors.

Comment 77: A paragraph should be added stating that South Dakota has no proof of a declining population on a statewide basis.
Reply: This is correct, currently no data exist to document a decline (or increase) in population levels. This will be clarified under "The present or threatened destruction, modification, or curtailment of habitat or range" rather than adding a new paragraph. "Reasons for Decline" is intended to state possible factors effecting Topeka shiners throughout their entire range, not necessarily those specific to South Dakota.

Comment 78: Goal Statement: Farm Bureau support the intent to work toward delisting of the species because of the lack of, or inaccurate, data used during the listing of the Topeka shiner. If delisting cannot be accomplished, down listing the Topeka shiner from endangered to threatened, and development of a workable 4d rule, is second best.
Reply: Agreed. However, delisting or downlisting of the Topeka shiner across its entire range is an action that is broader than this state plan. Actions throughout the entire range will require cooperation from all states within the shiner's range. SDGF&P currently is contracting genetics work that may help in delisting the Topeka shiner within South Dakota, although delisting and downlisting decisions are ultimately made by the USFWS.

Comment 79: We support the concept of a flexible management plan for the species because of the present excellent habitat and distribution of the species. Whether or not a 4d rule is put in place, we need a mechanism to substantiate data for delisting in the future.
Reply: Agreed. The intent of the Monitoring and Assessment portion of the plan is not only to assess recovery goal status, but also to collect the needed information to support delisting.

Comment 80: We support the concept of the point based recovery goal. Farm Bureau recommend applying a 30-year weather cycle to the point based system. In the dry years of the cycle the system should be able to average points or apply a weight factor to the scoring because of changes due to natural conditions.

Reply: Changes due to cycling wet / dry years will be factored into the point system.

Comment 81: Farm Bureau agrees with the statement "The present or threatened destruction of range or habitat is not a threat to Topeka shiners in South Dakota." There must be a balance reached in the reduction of sediment and clean water. We must use sound science in conservation practices that protect the environment and are economically feasible for the producer.
Reply: Agreed.

Comment 82: Management Actions: The terms maintain or improve habitat, maintain and enhance habitat, maintain or restore are used many times in this section. Maintaining current habitat is a useful term in management of the Topeka shiner. The use of restore, improve, or enhance may be beyond the scope of accomplishment due to economic and natural conditions. We should not overlook the species adaptation ability. If the species is adapting to the present conditions, restoring, enhancing, and improving habitat could have a negative effect on the species.
Reply: This will be clarified. Enhancement or restoration may only be necessary if the state is not meeting its recovery goal. Habitat improvements or enhancements that restore streams to their natural conditions should not, however, have negative impacts on the species.

Comment 83: Farm Bureau is concerned with where the money will come from to carry out the tasks. These management actions appear to be voluntary at present. Past history indicates they could become mandatory in the future. Our concern is another potential unfunded requirement placed on producers.
Reply: It is important to note that many tasks listed in the management actions are already being carried out by individual entities as part of their regular program activities (i.e. technical assistance provided for permitting and designing of confined animal feeding operations); therefore, these tasks already have funding mechanisms in place. Other tasks that are voluntary (i.e. establishing native grassland cover) are based on voluntary programs (e.g. CRP) that are not administered through this plan. Therefore, listing of any tasks can not add any additional mandatory requirements to producers.

Comment 84: We need to strive for balanced conservation practices. We must have flexibility in reduction of sediment by means of conservation practices. Large storm events can cause soil to move from one place to another. Removing the storm sediment from field deposition or dugouts needs to take place with a minimum of red tape or delay. Placement of terraces, filter strips, and closed drainage systems need to be used in the flexible conservation plan to obtain the needed balance.
Reply: This plan can not, however, substitute for any federal regulations during the Section 7 consultation process for projects that may involve endangered species. Agreements, such as a Habitat Conservation Plan, should aid in reducing the delays caused by federal regulatory requirements.

Comment 85: This section appears to be written from a biologist's point of view. We cannot save every shiner on every stream in South Dakota no matter what we do or do not do. Many of the tasks in this draft are carried out on private lands. The concern is will GF&P become another agency the producer must check with before they do anything on the land?
Reply: Agreed, we can not save every shiner every time regardless of the circumstances. The habitat approach taken by this plan should avoid the need to focus on individuals of a population. The logic being as long as the stream as a whole is taken care of, the shiner will persist. Since the Topeka shiner is not state-listed, SD GF&P does not need to be consulted by a producer on activities that may impact the shiner or its habitat. SD GF&P's role has been an advisory role from the perspectives of knowledge of fisheries management and stream hydrology.

Comment 86: South Dakota Farm Bureau believes that producers gain little or nothing in the draft management plan over the listing of critical habitat for Topeka shiners by USFWS. Our concern is that the voluntary tasks of the draft management plan could become mandatory tasks in the future. We do not need one more level of bureaucracy to deal with.
Reply: A Topeka shiner plan was drafted for South Dakota with the intention of avoiding the need to list critical habitat. The decision by the USFWS to no longer exclude critical habitat on the basis of Section 3(5)(a) of the ESA undermines those planning efforts. SDGF&P will continue to seek exclusion of critical

habitat. Tasks listed in this state management plan carry no legal or regulatory authority, but are part of a voluntary, alternative approach to the strict enforcement of the ESA.

Comment 87: We urge state agencies to request delisting of the species because of new data available. If delisting is refused by USFWS, we request that state agencies ask for down listing the species from endangered to threatened.
Reply: As stated previously, delisting or down listing will require cooperation by all states and the USFWS within the Topeka shiner's range. These actions are beyond the scope of any one agency within South Dakota; however, a comparable effort by all states within the Topeka shiner's range could facilitate downlisting or delisting.

Comment 88: The plan raises no significant concerns from our review. We are pleased to see an emphasis on stream geomorphology / hydrology, we like the monitoring planned, and the goal to establish demonstration sites in each basin.
Reply: None.

Comment 89: Baseline and Monitoring of Wetland Resources within Topeka shiner range: As pointed out in the Management Plan, streams with ground water inputs and high in water quality are important to the Topeka shiner. Also pointed out is that alteration at the systemic level, such as wetland drainage, is a reason for Topeka shiner decline. With this information in hand, it is imperative to have good baseline data regarding number and acreage amounts of wetlands in the present Topeka shiner range. I suggest you develop a method to quantify the number and amount of wetlands within the current range. Tools to be used for this baseline data gathering could include NWI, NRCS wetland determination and inventory maps, FSA slides, USGS topographical quadrangles, etc. Once the technique is created to determine wetland number and amount, the same technique can be used in respective years for monitoring. To paraphrase your goal, the overall goal is to maintain and improve habitat integrity in Topeka shiner streams. Unless good baseline information is known for Topeka shiner watersheds, determination of maintenance or improvement is occurring will be impossible.
Reply: Agreed, this will be added to the monitoring protocol.

Comment 90: Baseline and Monitoring of Grassland Resources within Topeka shiner range: Again, good baseline information of current grassland in the present range is needed. The plan states, landuse practices that alter the hydrologic and geomorphic processes of streams can have detrimental effects. Also stated in the plan is that the loss of native prairie is often cited as a primary reason for increased sedimentation to aquatic systems in the Midwest. To accurately quantify maintenance of grassland in the current Topeka shiner range, a baseline of grassland quantity and annual monitoring are needed. Potential tools to establish a baseline could include GIS landuse cover type, maps, NRCS National Resource Inventory data, etc. Again, unless accurate current information is determined about Topeka shiner habitat and their corresponding watersheds, the goal of maintaining habitat will not be quantifiable.
Reply: Agreed, this will be added to the monitoring protocol.

Comment 91: Monitoring of Drainage Activity: A reason stated for the decline of the Topeka shiner is habitat alteration. Landuse changes such as intensified agriculture have led to habitat alteration. Corresponding with intensified agriculture is intensified drainage be it either wetland drainage or pattern tiling of upland sites. Within the last several years, the landscape within the current range of the Topeka shiner has experienced an exorbitant amount of subsurface perforated drainage tile installation. It is well documented in peer reviewed journals that drainage tile alters natural rates of water discharge into receiving streams. The plan notes both good water quality and ground water influence are important to the Topeka shiner. A system of documenting both wetland drainage and upland pattern tiling within the current range of the Topeka shiner needs to be developed and implemented if the goal of habitat maintenance is to occur. DENR, SD Dept. of Agriculture, NRCS or other agencies could be involved in the development of a system and documentation of all drainage activity within the current Topeka shiner range.
Reply: Agreed, this type of monitoring should be developed and will be explored in the future.

Comment 92: In 1999, meetings to consider listing the Topeka shiner as threatened or endangered were held. The USF&WS reported that in South Dakota the shiner occupied only 20% of its native range in our state, causing great concern for the species. In September of 2002, the USF&WS reported that the shiner occupies 80% of its original habitat. Inaccurate figures were given then or are being used at this present date due to an 80% shiner occupation in the same basin acreage. This constitutes a 60% increase in 3+ years of an "endangered" species listing with no recovery plan in place. SDCA questions the need of any such plan due to the good stewardship of the landowners that have provided the habitat for the shiner since this land was settled in the late 1800s.
Reply: Any data that refer to a 20% range occupancy of the Topeka shiner in South Dakota in 1999 are inaccurate. Data collected between 1997 and 2000 by SDSU and surveys contracted by SDGFP demonstrate that the Topeka shiner occupies about 80% of historic locations along with many new locations not previously documented (some of these new locations were never before sampled, some were). Data are not available to show an increase or decrease in the Topeka shiner's range in South Dakota. Trends in range expansion or reduction can only be demonstrated following annual or periodic sampling at fixed locations. This type of sampling has not been previously conducted on eastern South Dakota streams.

Comment 93: We need to prove our state's environmental health to the rest of the nation thus justifying the de-listing of the shiner. Let's not allow other state's inequities cripple our state. Our goals need to redirect the USF&WS to worry about where the shiner is not rather than according to their own numbers, worry about a population located in a state environment capable of a 60% increase in a three year time period.
Reply: One way of delisting the Topeka shiner is for each state to meet its recovery goals. South Dakota has a much easier task of meeting our recovery goals than other states where the Topeka shiner has experienced large population declines. Data regarding increasing in Topeka shiner populations previously addressed. Listing and delisting actions are generally based on an analyses throughout the species' range, not based on one state's population numbers.

Comment 94: SDCA does not support the use of Farm Bill to finance any endangered species programs. As anyone involved in production agriculture can attest, one should not count on income from a government program until the check has cleared the bank. The federal programs (Conservation Reserve Program or Environmental Quality Incentive Programs) that the SDGF&P proposes to fund the "protection" of a population that has documentation of high numbers, still have not been appropriated and are in limbo in Washington, D.C. Let landowners use these possible resources for endeavors other than a quixotic chase. If you want to increase habitat acreages, pay for it. Current proposed cost-share for establishing habitat and associated practices in the EQIP program calls for 40 to 75 percent cost-share to establish practices associated with grassland habitat and related livestock use. If more Topeka shiner habitat includes grasslands, then offer incentives and practices at a higher rate. For example look at the increase in tree planting when programs were offered at 90% cost-share. It is not economically attractive to offer a planned grazing system to a producer along a Topeka shiner stream with 50% cost-share for the fencing and 50% for alternative water sources. Sound grassland management, and more of it, will result in more habitat for the Topeka shiner.
Reply: This plan does not propose the use of any Farm Bill program to finance an endangered species program. Farm Bill programs listed in this plan are simply suggestions as possible tools for meeting listed tasks. SDGFP does not administer the Conservation Reserve Program or Environmental Quality Incentive Program and therefore can not propose the funding of endangered species management with such programs. The goal of this management plan is to maintain the habitat Topeka shiner streams currently have; sound grassland management will play an important part in meeting this goal.

Comment 95: Perhaps funding could come from the USF&WS's ample budget, which is used to buy unpopulated Pacific islands and atolls from private corporations. That money could be redirected to support an endangered species recovery program in an area where the species needs a foothold, instead of asking one of the country's least populated states to finance a plan that supports a great deal of the whole country's minnow population. Our GF&P must address this situation. Safe harbor agreements and habitat conservation plans are better used where there is a legitimate concern and/or documented decline of an endangered species (e.g. Nebraska, Kansas, Missouri, Iowa, Minnesota and other places that have had shiners). Why spend money for conservation on a state with healthy populations?

Reply: Endangered Species Act programs, such as Habitat Conservation Plans and Safe Harbor Agreements, can have realized benefits to the landowner as well. These programs can alleviate the formal consultation process and other ESA restrictions when properly implemented. These benefits alone may be desirable in a state with an intact Topeka shiner distribution, but which still must comply with ESA guidelines that cover the shiner across its entire range.

Comment 96: Threats to the Topeka Shiner Populations in South Dakota: These should be real threats in South Dakota. Why use threats utilized by the USF&WS in areas were the fish is declined to extinction? Why not identify South Dakota's threats to the shiner? Could it be that there are not any currently to deal with?
Reply: The plan clearly states that those threats utilized by the USFWS in listing and delisting actions are not threats to Topeka shiner populations in South Dakota. If South Dakota wishes to become involved in petitioning to delist the Topeka shiner, these same threats must be addressed.

Comment 97: The SDCA would view a shift in balance of our state's land resources from the status quo to be detrimental not only to the shiner but also to our state's economic viability. A documented dependence on our current agricultural land use by the shiner is illustrated by the high sampling occurrence listed by the agencies tasked to initially assess the shiner's numbers in South Dakota.
Threats to our state's current land use model are:

1. unrealistic regulations that act as a parasite on our industry as we compete globally with foreign commodities.
2. non-scarcity of foreign resources due to slash and burn management practices.
3. a strong U.S. dollar due to a stable democracy.
4. less stringent food safety concerns due to the lack of resources and technology in underdeveloped countries. Foreign countries are able to carry on without these environmental and safety responsibilities, thus becoming more economically efficient as they enter the global market. This enables them to undercut our prices. If our USF&WS does not work to address or acknowledge these concerns, our country may gain ecological stability, but lose economic stability. Our goal should be a balance of both.

Reply: Addressing these threats is beyond the scope of this management plan.

Comment 98: The present or threatened destruction, modification or curtailment of habitat or range: Cattlemen and other agri-businesses have worked hard to atone for past management practices that were production-oriented, not sustainable production/conservation oriented. Cattlemen have identified the need to enact grazing management of current grasslands in order to match grazing times to grass species' production cycles. Heterosis enables more beef off of the same acres. This shift of management efficiency was started in the thirties with the dust bowl and continues today. Genetically Modified Commodities require less cultivation and chemical use. A variety of other practices, such as more carefully calculated grazing rotation schedules, also increase resource conservation.
The threats listed by the GF&P plan (Wetland drainage, Sedimentation, Stream Channelization and Resource Extraction) are not realistic threats for the level that the GF&P claims these occur across the range. We still have a robust, healthy shiner community in spite of the "threats." The SDCA puts forth that these actions are so rare now that they become moot, thus begging for more current, pertinent and realistic threat concerns in order to be pro-active in a plan, not reactive. List future possibilities that would affect what is working today to keep the shiners at such high numbers.
Reply: The draft plan clearly states that wetland drainage, sedimentation, stream channelization, and resource extraction are not threats to Topeka shiner populations in South Dakota.

Comment 99: Wetland drainage is no longer as grave a concern as it was prior to the swamp buster bill.
Reply: Wetland loss is no longer as extensive as in the past, this will be clarified in the plan.

Comment 100: Stream channelization occurs on a much greater level for urban purposes than agricultural use. Identify this and address it (ex. Sioux Falls' Phase III flood plan, which involves channelization of waters around Sioux Falls). Currently, urban areas impact the shiner with this threat 99.6% more than agricultural use ever does. Compare NRCS records and Army Corps of Engineers data to verify this.

Reply: A distinction between stream channelization for municipal and agricultural purposes will be made in the plan.

Comment 101: Sedimentation has occurred ever since the tall grass prairie was gifted with, on average, 12" of topsoil. Lewis and Clark noted the sedimentation on their travels. This land, although having no European influence on it, still had heavy sedimentation. The shiner evolved under these conditions.
Reply: Sedimentation has always occurred naturally in streams. Streams, such as the White River and historic Missouri River, have always had high sediment loads. However, other streams, such as the Big Sioux River and many headwater prairie streams, flowed clear most of the year. Sedimentation occurs naturally, but landuse changes can substantially alter (increase or decrease) a stream's sediment load.

Comment 102: Resource Extraction is minimal compared to other states due to our state's grass-based economy, which is not dependent on the huge quantities of water that other states utilize for crop irrigation and huge urban populations. SDCA encourages the GF&P to consult with the DENR to obtain current laws and usage records concerning the states waters.
Reply: The draft plan states resource extraction is not a threat in South Dakota.

Comment 103: The other states, according to Vernon Tabor, a biologist with the USF&WS in Manhattan, KS, have had very extensive non-native predator fish stocking programs in the past. Our state has never had enough conservation group/political group pressure put on it to stock these game fish, which prey on the shiner. We also have not had the state finances to have an extensive statewide stocking system as other states have had and currently have. The large mouth bass single-handedly may have been the worst management decision ever implemented as far as the shiner is concerned.
Reply: The effects of predatory game fish are discussed under Disease and Predation. For various reasons, game fish are not stocked into eastern South Dakota tributaries, and thus do not pose a threat to Topeka shiner populations in South Dakota.

Comment 104: Recreation has no threat to the shiner? Ask the biologists from the USF&WS about that statement.
Reply: There are no apparent recreational threats involving the Topeka shiner in South Dakota.

Comment 105: Along streams that originate out of state (Split Rock Water Body), be sure to hold those states accountable for headwater stocking of fish.
Reply: Game fish (e.g. largemouth bass) were rare and often absent from recent surveys of South Dakota streams whose headwaters originate out-of-state. These introduced game fish can not survive in these stream environments and therefore do not pose a threat to Topeka shiners in South Dakota.

Comment 106: Genetic identification of the initially identified shiner and its currently perceived species needs to be verified to ensure that the same species then is the same today.
Reply: Genetics research has been conducted on the Topeka shiner. There is no evidence to suggest a change in the genetic identify of the species.

Comment 107: Drought and floods have to be considered in the plan for the study of their effect on populations of shiners. A timeframe needs to be established for taking those events into consideration and allowing for recovery time. If this is not assessed, a false cause of takings could be identified and an unnecessary adjustment or action could occur, affecting the whole of the biotic community.
Reply: The natural variability of droughts and floods on Topeka shiner populations will be assessed as annual monitoring is conducted. These natural events will be considered to prevent any misevaluation of a watershed's status.

Comment 108: On page 15, paragraph 5, sentence 4, include "Confined Animal Feeding Operations" in that sentence right before or after "municipal wastewater treatment".
Reply: This change will be made.

Comment 109: The opening statement does not mention anything about maintaining the current integrity of the existing habitat that sustains the world's most vibrant, numerous populations of the Topeka shiner.

We should be proud of our current levels and be the example to other parts of the region in regard to what to do for proper shiner management.
Reply: This change will be made.

Comment 110: Once again, the SDCA cautions against using Farm Bill dollars to fund endangered species maintenance and development due to the fickleness of appropriations and the original intent and spirit of the Farm Bill to fund farm programs. This concept is very important to the continued success of South Dakota lands' health.
Reply: Use of Farm Bill dollars previously addressed.

Comment 111: The most important strategy we, as a group, can provide, has been stated by the evidence of Kurt Forman of the USF&WS and by the testimonies of myself and other cattlemen. This has also been supported by the DENR in my conversations with Jerry Miller of that office, our state's Department of Agriculture, and many others involved in this matter.

The SDCA puts forth the following objective in lieu of the current Objective 1.1. Due to the emphasis our state's government, industries and landowners have put on adding value to our current herbivory/commodity production balance we have thus far created in our state the biggest Topeka shiner population in the world. We feel the plan should address the biggest catalyst of shiner habitat, herbivory, and do what is needed to protect that industry on local, state and national levels, assuring shiners for years to come.
Objective 1.1 Recognize and expand the interdependence of herbivory and commodity agriculture production in order to maintain the healthy population status of the Topeka shiner.
Task: Ensure the viability of agricultural herbivory in order to maintain current levels of grassland resources.
Tools: SDGF&P
USF&WS
DENR
EPA 319money
NRCS
Agriculture associations
Task: Educate agencies and the public about the roles that herbivory and commodity agriculture play in maintaining and sustaining the populations of the Topeka shiner found in our state and the country.
Tools: SDGF&P
USF&WS
DENR
EPA
NRCS
Reply: The current strategies will be reworded to incorporate these ideas.

Comment 112: Under Strategy 1.1: Any student of grass production knows that retaining as much water as possible is important to rangeland/cropland success. If we can decrease horizontal movement of water and the involved soil of major storm events by implementing terracing and tiling to slow the movements of these events, we will increase water stores upland of water bodies.
Reply: The idea of strategy 1.1 is to restore stream hydrology in areas where groundwater influences have been severely altered, not necessarily increase water stores in upland areas.

Comment 113: Second Task: Non-land owner and land owner education on the importance of proper conservation best management practices, including but not limited to, tiling, terracing, buffer strips, waterways, stream bank stabilization and other management tools. Use soil/water retention indices to monitor results and provide monetary funding in the form of incentives for decreased runoff and increased soil conservation.
Tools: NRCS
FSA
Producer organizations
Private conservation groups

USF&WS
SDGF&P
Reply: The current strategies will be reworded to incorporate these ideas.

Comment 114: Under Strategy 1.2A: To best complete this task and successfully complete this endeavor (third task) include EPA 319 funding. EQIP would be better used for other conservation measures due to uncertain funding and intended usage.
Reply: 319 Program will be added.

Comment 115: Under Objective 1.3: Non-point source impacts have been addressed by the EPA, SD DENR, county agencies and producer groups for years. Our state DENR has gone on record stating that we have some of the cleanest waters since they began monitoring. If the shiner can survive to this point, and local, state, and federal agencies continue to manage this resource, the water, and subsequently the shiner, should increase in quality and number.
Reply: This objective is intended to support those activities that are currently addressing non-point source impacts (TMDL projects) as well as address those non-point source impacts that continue to impair state water designated use criteria. These impacts are listed by waterbody in the SD DENR 305(b) report to Congress that is submitted once every two years.

Comment 116: In the discussion of Objective 1.3: Karr and Chu identify the threats to a decreasing population, but fail to provide input on the factors contributing to the increasing or stable population South Dakota enjoys.
Reply: Karr and Chu (1999) only discuss watershed impacts in general terms, their discussion does not focus on South Dakota or the Topeka shiner. This citation is used to support the conclusion that non-point source impacts are still a threat to various waters throughout the Midwest.

Comment 117: Population Monitoring and Assessment: This is a very key component to the survival of the minnow. We as cattlemen are concerned with the fact that the monitoring of an endangered species will occur every three years when the streams that they haunt are so dynamic in form. A sampling site may be completely gone due to drought or successive flooding during the three-year interval. Money to fund this ongoing protection and subsequent study, of an endangered species, must come from the budget of the USF&WS.
Reply: Monitoring will be conducted on an annual basis. The state recovery goal will be evaluated once every three years. Monitoring strategies are able to incorporate the variability due to drought and floods in an annual assessment.

Comment 118: Multi-metric indices and index of biotic integrity (IBI) are open to interpretation of successive stages an ecosystems goes through.
Reply: Multi-metrics indices and the IBI have been repeatedly tested and verified in many aquatic systems throughout the U.S. These indices are designed to be robust to account for any natural changes to a stream system. Many state agencies throughout the U.S. utilize these indices for annual assessment of surface water conditions.

Comment 119: Regarding paragraph three of the Population Monitoring and Assessment: What happens if the predator fish that benefits from the increased shiner population is present when no shiners are? Why would we not want shiners and conducive habitat together? How will we measure the takings from native predator fish and be able to accurately credit the loss to the fish and not the landowners above the water.
Reply: This paragraph will be clarified. We would want Topeka shiners and conducive habitat together; however, absence of Topeka shiners from a site does not necessarily indicate degradation, especially when habitat conditions have not changed. It is important to consider the biological community, habitat, and surrounding landuse before determining a site has been degraded. Predation by native fish is a natural occurrence. Monitoring strategies are designed to distinguish between natural and anthropogenic occurrences.

Comment 120: Baseline Data: This is also very important to start with. The SDCA feels that if 20% sampling was found originally and used to list the shiner, now the 80% more found should show a great

national increase and be used to assess the species de-listing. Mapping, monitoring, modeling, soil profiling, erosion monitoring and any information used to determine the fate of people in a State in the United States of America should be ground proven data only.
Reply: Data relating to a 20% and 80% range occurrence was previously addressed.

Comment 121: Monitoring Protocol: This must take into consideration where we are in the 30-year weather patterns. We are currently coming down on the descending curve and must be careful to adjust the population on this when starting.
Reply: Annual stream flow changes due to drought or flooding will be taken into account.

Comment 122: Concern was stated about land-use data being unavailable. If data is needed to defend the justification of continued listing of the shiner, the SDGF&P and the USF&WS must be charged with its funding.
Reply: These data were not intended to justify listing of the species, this data will be used, in part, to assess South Dakota's recovery goal status. The data are available; however, the scale of different data sets is not consistent and may hinder analysis.

Comment 123: The evidence that has been compiled on this issues compels us to believe that the current management practices have been highly effective in the preservation and promotion of the Topeka shiner minnow. It has shown what those of us in the agricultural business have long believed, that the best choices for agriculture are often the best choices for the environment. The Topeka shiner minnow is a living example of that. We at SDCA believe that there are much more pressing uses of the time and resources of the state of South Dakota than further study and implementation of a management plan for a species that, by all appearances, needs no management plan. Therefore, we think the emphasis of this plan should be on the delisting of this species, rather than the management of it.
Reply: The overall goal of this plan is to maintain current habitat conditions. The intent of these guidelines is to work towards delisting of the Topeka shiner. If the Topeka shiner is to be delisted through the recovery process, each state must demonstrate that they are meeting their respective recovery goals. This plan lists those actions necessary for South Dakota to meet its state recovery goal, and thus work towards delisting of the Topeka shiner.

Comment 124: The plan needs to be more specific on what the overall goals are. The goals should be listed or bulleted in the introduction or executive summary and then appear again prior to the objectives.
Reply: Goals will be specified in the introduction.

Comment 125: On page 8 it appears that the goals are to maintain and improve habitat, delisting, and point-based management. When reading through the management actions, starting on page 16 it appears that the goals are maintaining and improving habitat, monitoring and assessment and public outreach/education. From a planning perspective shouldn't these be objectives or actions that would be used to meet the goals?
Reply: Correct, this will be clarified.

Comment 126: Instead of saying we are going to maintain and improve habitat the goal should be to:
Goal 1: Maintain 70% of baseline populations for the next 10 years
Objective 1: Maintain and restore the hydrology of 3 streams in each critical segment containing Topeka shiners.
Reply: South Dakota's recovery goal is to maintain roughly 70% of baseline populations based on 1997-2002 data. However, focusing on habitat rather than the species allows the plan to address watershed-level concerns.

Comment 127: In our last meeting it was our understanding that the overall goal was still to petition to de-list or down list. And that the plan should be designed to allow management activities to take place by maintaining a certain population level. Is this the intent of the current draft plan? Will this plan allow us to manage the Topeka Shiner on a watershed basis or species level? This needs to be clearly outlined in the plan.

Reply: The plan will allow South Dakota to manage the Topeka shiner on a watershed basis, this will be clarified. The plan will work towards delisting by setting a recovery goal in South Dakota. As long as this recovery goal is met, South Dakota is meeting its contribution towards the national recovery effort. Delisting or downlisting of the Topeka shiner; however, will require cooperation from the USFWS and state agencies throughout the shiner's range, not just those entities in South Dakota.

Comment 128: The plan should have a specific timeline for implementation.
Reply: Agreed, this will have to be discussed at a later time and incorporated into the plan. This is a strategic plan; however, and specific operational activities are not intended to be covered in this document.

Comment 129: The background information should be put in the appendix.
Reply: The background information will be combined and reformatted.

Comment 130: If the issue concerning listing of critical habitat is no longer an option, do we still need to complete the plan by August 2003? If not, this will give us more time to develop a plan that can be substituted for section 7 of the ESA and meet SD recovery goals.
Reply: The USFWS has indicated that the plan must demonstrate "functional equivalency" to substitute for section 7 of the ESA, and that this is a difficult task to accomplish. The plan will be completed as originally planned and SDGF&P will still pursue the possibility of excluding critical habitat in South Dakota.

Comment 131: I applaud your efforts at looking beyond the mere presence/absence of Topeka shiners as an assessment of the status of these prairie streams. The concern I have is the fact that the bottom line in dealing with an endangered species is that the habitat may appear to be great, if the species isn't present, you haven't fulfilled the obligation of protecting/maintaining/enhancing the species of concern.
Reply: Agreed. However, species presence / absence is also dictated by natural controls (e.g. drought), which are beyond any actions an agency can mitigate.

Comment 132: Page 27, Literature Cited – The Missouri Department of Conservation citation should list Jefferson City, Missouri instead of Columbia, Missouri.
Reply: This will be changed.

Comment 133: The William L. Pflieger citation for the Fishes of Missouri should list this as the Revised Edition and list Jefferson City, Missouri and not Columbia, Missouri.
Reply: This change will be made.

Comment 134: Table of Contents, Appendices. List the appendices separately with title and page number for ease in referencing.
Reply: This change will be made.

Comment 135: Under this plan unrealistic measures are identified to "protect" a species of fauna that is in great abundance in the waterways of eastern South Dakota.
Reply: Measures listed in this plan have been and are being implemented through South Dakota. This plan does not add any new measures to watershed protection outside those measures already implemented by local, state, and federal entities.

Comment 136: Our office has reviewed the draft Management Plan and has submitted comments to Mr. Jeff Shearer of your staff. We hope to review a new draft of the Management Plan if significant changes are made to the existing version. The current draft contains substantial information and obviously involved considerable effort within the time available. We believe that changes may be necessary to further focus the Management Plan's specific objectives and ultimately improve its utility. A focus on a more complete analysis of threats to the species in South Dakota with associated measurable management objectives to address each threat may create a more definitive and achievable conservation strategy. Some assurances of the State's ability to implement the Management Plan and to ensure its effectiveness will be necessary.
Reply: Further analysis of threats will be completed to the extent practically for inclusion in this management plan. Threat analysis beyond those presented in this plan can be completed at a later date.

Comments not relating specifically to the Topeka shiner management plan:
The following list addresses those comments not specific to the Topeka shiner state management plan. This does not mean these comments do not relate to the Topeka shiner or management of endangered species in South Dakota. These comments are not followed by a reply.

Comment 137: The South Dakota Stockgrowers Association agrees with Peter Gober, USFWS, that "The Topeka Shiner should not be a listed species." The situation being that the Topeka Shiner has already been added to the Endangered Species List, the South Dakota Stockgrowers Association concurs with the comments submitted by the South Dakota Cattlemen's Association concerning the Topeka Shiner Critical Habitat Management Plan.

Comment 138: We especially urge government agencies to rely on landowners, specifically ag producers, to manage private and publicly-held land. Private management will provide optimum benefits for both agricultural use and wildlife conservation.

Comment 139: Due to an untimely response to a request for information made to the FWS, I would like to express my concerns to the critical habitat designation assigned to Turkey Ridge Creek and those ramifications as they relate to the ongoing viability of Swan Lake located in Turner County, SD.

I ask that you consider the following paragraph in lieu of the associated link in your determination to the planning and management of the Topeka Shiner in South Dakota. I am contending that the present and future "human development" as it relates to all facets of recreation and property would be and has been "highly impacted" by the protection measures already taken and proposed concerning the Topeka Shiner. These comments will be filed with the Swan Lake Association. Thank you.

> " In accordance with sections 3(5)(C) of the Act, not all areas that can be occupied by a species will be designated critical habitat. Within the geographic area occupied by the species we designate only areas currently known to be essential. Essential areas should already have the features and habitat characteristics that are necessary to conserve the species. We will not speculate about what areas might be found to be essential if better information becomes available, or what areas may become essential over time. If the information available at the time of designation does not show that an area provides essential life cycle needs of the species, then the area should not be included in the critical habitat designation. We will not designate areas within the geographic area occupied by the species unless at least one of the primary constituent elements, as defined at 50 CFR 424.12(b), is present. Moreover, areas occupied by certain known populations of the Topeka shiner have not been proposed as critical habitat. For example, we did not propose critical habitat for some small scattered populations or habitat in areas highly impacted by human development. http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=2002_register&docid=02-20939-filed"

Comment 140: The reasons supporting the critical habitat designation are reasons the species declined in other states, not South Dakota. This is not valid reasoning, since the practices in South Dakota have heretofore allowed for a strong population of Topeka shiners, while practices that other states have become dependent on have reduced their numbers. These states are not grass-based financially and must make sacrifices for the shiner like we have proven in South Dakota that we have and will continue to do so. Upon that justification, we must insist to the USF&WS that the shiner be de-listed based upon South Dakota's track record of successfully carrying on normal practices while supporting the nation's last remaining bastion of Topeka shiners.

Comment 141: P. 38 states "Currently, the shiner's distribution and population status are very similar to historic levels in South Dakota". I feel there should be no critical habitat designation in South Dakota based on a successful history of habitat management to date in South Dakota.

Comment 142: There is a great deal of confusion amongst the different agencies and even within agencies on what conservation practices may impair shiner habitat or which ones might improve habitat. People in the field need more expedient permit approval. There currently is not enough manpower in the COE or USFWS to handle the statewide workload. Sometimes BMP projects are delayed for months waiting for approval.

Comment 143: I want to express my opinion in regard to stream management in SD. What I have seen in the past 55 years is tremendous damage to streams from cattle producers. I could show you hundreds of winter feedlots situated on the "high ground" directly above natural drainages. I could show you hundreds of summer pastures that surround what were once nice streams but are now trampled into "seasonal wetlands", choked with cattails, bulrushes and other grasses. These "wetlands" were once well defined streams but as you know, cattle gravitate to the stream bed in the heat of summer and destroy the banks and bottoms. Until there is some protection of the waterways from direct and indirect effects of cattle, our streams are doomed. Of course water flows downhill, and as these streams cease to flow, or flow with strong levels of livestock pollutants, into our drinking water basins, the water supply for human survival is increasingly threatened.

Comment 144: I wish to make the following comments for your record. Turkey Ridge Creek is a known and valuable habitat for the Topeka Shiner in South Dakota. Turkey Ridge Creek flows adjacent to Swan Lake but does not naturally flow into the Lake. In the early 1900's, Swan Lake Association made provisions for a man made inlet structure which allowed for Turkey Ridge Creek stream flow into Swan Lake. Swan Lake has a relatively small natural drainage basin. As such, additional stream flow is normally required to maintain an adequate water depth in Swan Lake. For 90 years, Turkey Ridge Creek stream flow was used for maintaining the Swan Lake depth. During that time, the Topeka Shiner maintained a continual presence in Turkey Ridge Creek.

The Turkey Ridge Creek stream flow water quality was not always of the best water quality, thus at time had an detrimental effect on the Swan Lake water quality. In the mid 1990's, the existing Turkey Ridge Creek stream inlet structure to Swan Lake had been closed. Since 1990's, Swan Lake Association has been working with State and Federal agencies to develop an acceptable Swan Lake stream flow plan from Turkey Ridge Creek. The prime components of the plan included taking the stream flow during period of acceptable Turkey Ridge Creek water quality while maintaining adequate Turkey Ridge stream flow for the Topeka Shiner downstream of Swan Lake.

After the completion of the Topeka Shiner Management Plan for South Dakota, Swan Lake Association is interested in working with the State and Federal agencies to finalize the Swan Lake stream flow from Turkey Ridge Creek management plan and the construction of the new Turkey Ridge Creek inlet structure. The Swan Lake water depth has suffered since the closure of the existing Turkey Ridge Creek stream inlet structure to Swan Lake.

Comment 145: I am writing in response to your invitation for comments on the Topeka Shiner Management Plan for South Dakota. As a lifelong resident and longtime taxpayer of Moody County, my primary concern is with the added costs that are incurred with regard to the construction of bridges.

Normally one or two bridges are replaced each year within Moody County, and this is an activity which has been taking place for many years without the restrictions that have been put in place recently. If the Topeka Shiner has survived and even flourished under these conditions, it seems that it should be unnecessary to put bridge construction on hold for 2 ½ months each year during a time (May-June-July) when construction is most efficient. My other point is that the part of a stream or river that is impacted is usually quite small in comparison to the total length of the stream or river.

It seems to me that the amount of silt and other pollutants introduced into the water during bridge construction is small compared to what enter during heavy spring and summer rains. I have no objections to the goals of the management plan other than that I would like to have bridge construction allowed all year long.

Comment 146: I am commenting on the SD Topeka Shiner Management Plan. Please include exceptions in the plan for sources of recreation that are being detrimentally effected by the Topeka Shiner on the endangered species list. We own a cabin and land on Swan Lake, near Viborg, for the purposes of recreation and the lake is so dry now. We have spoken to many other property owners at Swan Lake and something needs to be done soon. We invested our money, time, etc to Swan Lake and it now doesn't have water coming in. Please bring this to the attention of everyone involved in this process. SD has few lakes and we need to preserve what we have.

Appendix I. South Dakota Game, Fish and Parks letter requesting review of State Plan.

DEPARTMENT OF GAME, FISH AND PARKS
Foss Building
523 East Capitol
Pierre, South Dakota 57501-3182

December 11, 2003

Mr. Chuck Davis
U.S. Fish and Wildlife Service
Denver Federal Center
PO Box 25486
Denver, CO 80225-0486

Dear Chuck:

Please find enclosed a copy of the Topeka Shiner (*Notropis topeka*) Management Plan for the State of South Dakota (State Plan). South Dakota Game, Fish and Parks (SDGFP) outlined in an August 5, 2003 letter to the U.S. Fish and Wildlife Service (USFWS) our request to exclude South Dakota from the final designation of critical habitat based upon the conservation goals and objectives set forth in the State Plan. This cooperative plan was prompted by an offer from the USFWS to exempt lands from critical habitat designation upon approval of a species management plan. Our planning effort included representatives from local, state and federal agencies with the most potential to have long-term impacts on this species in South Dakota. We were also able to engage several highly influential organizations with strong ties to landowners and agriculture, a link that will be critical to the continued success of our cooperative, multi-agency Topeka shiner management approach.

As indicated in a December 9, 2003 conference call between SDGFP and USFWS personnel, we are submitting this letter requesting the prompt review of the enclosed State Plan relative to the evaluation criteria under the USFWS's Policy for Evaluation of Conservation Efforts (PECE). The focus of this letter is to highlight how the State Plan mitigates for potential threats, provides assurances that conservation efforts have been and will continue to be implemented, and highlights the effectiveness of past conservation efforts. It is imperative that the Service provide specific feedback to us if the Plan does not comply with the PECE criteria so that we can make adjustments as needed to ensure South Dakota is exempted from critical habitat designation when the final designation is published in 2004.

The State Plan provides an objective analysis of threats versus effects for the five factors utilized by the USFWS in listing, delisting, or downlisting actions. Large-scale impoundments (discussed under *other natural and manmade factors*) were the only threat considered to be moderate in magnitude within South Dakota. However, the immediacy was considered non-imminent due to the low occurrence of large-scale impoundments on Topeka shiner streams. Since the Topeka shiner became listed, no large-scale impoundments have been constructed on

Chuck Davis
December 11, 2003
Page 2

Topeka shiner streams. Working through the section 7 consultation process of the ESA, this threat has been effectively neutralized in the five years this species has been listed. Our agency cooperates extensively with the USFWS through the Section 6 program and other SDGFP programs to provide information, such as survey data, to facilitate the Section 7 consultation process. Our agency is also an active reviewer of all Corps of Engineers (Corps) permits issued under section 404 of the CWA.

This cooperation between the Section 6 and Section 7 programs of the ESA has worked in South Dakota to prevent construction of any impoundments on Topeka shiner streams since the species was listed. This clearly demonstrates that this threat, impoundments on Topeka shiner streams, has been curtailed effectively by the processes in place. Per the PECE Policy, these long established and fully functional processes have addressed the threat of impoundment construction on Topeka shiner streams in South Dakota. Furthermore, agencies that traditionally funded or authorized impoundments, such as the Natural Resource Conservation Service (NRCS), the USFWS, SDGFP, and the Corps have demonstrated a willingness to either not fund or not authorize impoundment construction on Topeka shiner streams.

All other threats were considered low in magnitude or not a threat to Topeka shiner populations in South Dakota. The low magnitude threats involved discharges into Topeka shiner streams relating to water quality issues in South Dakota.

State and federal laws provide assurances that many conservation efforts referenced in the State Plan will be implemented. The Natural Heritage Program within SDGFP recognizes the Topeka shiner as a species of concern. Subsequently, SDGFP provides an environmental review for projects that may impact the Topeka shiner. The South Dakota Department of Environment and Natural Resources (SDDENR) addresses low-impact threats, such as point source discharges, under the National Pollution Discharge Elimination System authorized by Section 402 of the Clean Water Act. Non-point source impacts are mitigated by the SDDENR through Clean Water Act Section 319 projects.

Both of those State programs have developed processes for the USFWS to review these actions for Section 7 ESA compliance. These existing and functional processes have satisfactorily met Section 7 compliance, which further demonstrates that these safeguards are eliminating this minor threat. Finally, the State also provides section 401 water quality certification for all projects proposed to be authorized by the Corps under the section 404 program. To date, the State has determined all such issued Corps permits on Topeka shiner streams meet water quality certification. That final oversight authority on Corps 404 permits is in statute. We believe these State programs have ensured water quality constraints have not to date nor will they rise to the level that would compromise Topeka shiner streams.

The South Dakota Department of Transportation in conjunction with the USFWS has developed best management practices (BMPs) for highway construction work that involves Topeka shiner streams. Similarly, the NRCS has developed BMPs and guidelines for project development and implementation that may impact Topeka shiner streams. The Corps has worked extensively with the USFWS on Section 404 activities involving Topeka shiner streams. All projects involving a federal nexus require Section 7 consultation with the USFWS. In addition to those conservation efforts aimed at alleviating threats are the many habitat-based programs, such as the Conservation Reserve Program, offered by SDGFP, USFWS, and NRCS that provide net benefits Topeka shiners through improved watershed health.

Our review of the actual threats identified in the listing package for the Topeka shiner and elaborated upon in the State Plan indicate that the threats for this species have been and will continue to be effectively neutralized in South Dakota. Accordingly, we believe that sufficient measures are in place with an extensive track record that negate known threats for the Topeka shiner and the State Plan meets the intent of the PECE Policy. Therefore, South Dakota should be excluded from the need to list critical habitat. In addition, the State Plan outlines the many activities that are being undertaken by us and others that benefit Topeka shiners. For example, we have worked cooperatively with the NRCS, to ensure funding mechanism such as the Environmental Quality Incentives Program (EQIP) and the Wildlife Habitat Incentive Program (WHIP) place a higher priority on measures and projects that benefit Topeka shiner streams. These actions are in addition to the many ongoing conservation programs being undertaken by NRCS.

The current range and distribution of Topeka shiners in South Dakota is the best evidence we can provide towards that our activities and the mandated and cooperative activities of our conservation partners are effective Topeka shiner conservation efforts. With the addition of the Elm River following 2003 surveys, recent data indicates the Topeka shiner now occupies all of its historic range within South Dakota. As illustrated in the State Plan, South Dakota does not have the habitat threats that have greatly diminished Topeka shiner populations in other states.

The actions described above, when combined with ongoing actions undertaken to ameliorate the threats to the Topeka shiner, have resulted in high quality habitat and robust Topeka shiner populations in South Dakota. We believe that the ongoing programs and activities undertaken by a diverse group of individuals, organizations, and agencies have contributed to the presence of South Dakota's high quality aquatic habitats. There is considerable concern that critical habitat designation will have a chilling effect on the willingness of private landowners to participate in many of voluntary programs that benefit Topeka shiners in South Dakota. This negative impact has great potential to damage existing relationships with landowners and to discourage future partnerships that are so critical to endangered species recovery and management. The State Plan, if
successful in eliminating the need for critical habitat designation, would eliminate this unintended and detrimental consequence. Furthermore, our multi-agency, multi-partner effort provides a much stronger recovery and management framework than a planning effort that depends on the commitment of a single agency.

Through the above outlined actions, which eliminate threats to Topeka shiners, further beneficial activities, maintain viable populations and institute a comprehensive monitoring program, we believe the State Plan and subsequent efforts satisfy the PECE Policy.

Chuck Davis
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Page 4

In addition to providing a strategic framework for Topeka shiner conservation, the State Plan also forms a basis for a Habitat Conservation Plan (HCP). An HCP will complement the State's adaptive management approach to meet goals and objectives as well as facilitate implementation of the point-based monitoring system. SDGFP is currently involved in development of an HCP for other listed species. Those experiences will provide a background for a potential Topeka shiner HCP.

As stated earlier, we ask that the USFWS provide a prompt analysis of the State Plan relative to its compliance with PECE criteria. Your feedback is critical to our continuing refinement of the State Plan and efforts towards Topeka shiner conservation. Thank you for your time in this matter.

Sincerely,

John L. Cooper
Department Secretary

cc: Ralph Morgenweck, USFWS Region 6 Regional Director
John Blankenship, USFWS Region 6 Deputy Regional Director
Pete Gober, USFWS, Pierre, South Dakota
Governor M. Michael Rounds

Appendix J. U.S. Fish and Wildlife Service reply letter to South Dakota Governor M. Michael Rounds.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Mountain-Prairie Region

IN REPLY REFER TO:

MAILING ADDRESS:
Post Office Box 25486
Denver Federal Center
Denver, Colorado 80225-0486

STREET LOCATION:
134 Union Blvd.
Lakewood, Colorado 80228-1807

FWS/R6
ES

MAR 08 2004

Honorable M. Michael Rounds
Governor of South Dakota
State Capitol
500 East Capitol Avenue
Pierre, South Dakota 57501-5070

Dear Governor Rounds:

Thank you for your letter of October 9, 2003, as well as letters dated August 5, 2003, and December 11, 2003, from the South Dakota Department of Game Fish and Parks Department (Department) related to Topeka shiner issues in your State. I apologize for the lateness of this formal response. The letters discussed a number of important subjects that have either been in flux due to recent litigation or raised important policy questions that required input from our Washington Office.

The primary issues outlined in the State's correspondence involved a 5-year status review, the Draft Recovery Plan, Critical Habitat designation of streams in South Dakota, and a review of South Dakota's Topeka Shiner Management Plan (Plan).

5-Year Review

The Endangered Species Act, under section 4(c)(2), requires the Service to review at least once every 5 years the information available respective to a species status. As you note in your October 9 letter, there is extensive new information on the Topeka shiner, including an increase in the number of known locations. This is largely due to the cooperation of State and Federal agencies and private landowners in conducting surveys.

The Service agrees with your recommendation to undertake a 5-year review for Topeka shiners and we will begin that process this year.

Draft Recovery Plan

The Service, States, and others have been working on a Recovery Plan for the Topeka shiner. We agree with your analysis that significant new information exists which may affect the Topeka shiner's listing status. We anticipate that completion of a Draft Recovery Plan will be delayed to incorporate this new information so that the draft Recovery Plan reflects the conclusions of the 5-year review.

Critical Habitat

Streams and stream segments in South Dakota were proposed as critical habitat on August 21, 2002. The Department developed a Topeka Shiner Management Plan to demonstrate that adequate management is occurring in South Dakota and, therefore, critical habitat designation in the State is unnecessary. We will soon publish an amended critical habitat proposal and a notice of availability for the draft economic analysis and draft environmental assessment in the Federal Register. We will make a final decision on the critical habitat designation by July 17, 2004. Your previous letters, conservation efforts, and comments will be part of the information used to make the final decisions on whether to designate critical habitat in South Dakota.

A fundamental consideration we must evaluate is whether excluding certain areas of critical habitat may cause the Topeka shiner to be in danger of extinction. Our review of the information for Topeka shiners in South Dakota indicates that significantly more populations are known to exist in 2004 than were known to exist when the species was listed 5 years ago. These discoveries provide evidence of the species' persistence in South Dakota.

Another consideration that will impact our final decision of designating critical habitat in South Dakota is whether the benefits of exclusion outweigh the benefits of including specific areas. This evaluation will be based on the best biological information available and an economic analysis. We recognize the many efforts that South Dakota currently undertakes or proposes in the State Plan provide conservation benefits to the Topeka shiner. Some of these State commitments involve partnerships that may be more difficult or impossible if critical habitat is designated. This is particularly germane given that the majority of Topeka shiner habitat is on private land or adjacent to private land, where many of the most effective recognized conservation efforts are built upon voluntary participation and minimization of regulatory burdens.

Management Plan for the State of South Dakota

Your December 11, 2003, letter and the State Plan outline the rationale for exempting South Dakota from critical habitat, as well as the multitude of ongoing beneficial activities that influence the status of the Topeka shiner in South Dakota. Principal to your rationale for exemption are the conservation efforts underway to address the threats to this species that were identified when the species was listed.

Honorable M. Michael Rounds 3

We have reviewed the State Plan and note that many of the conservation benefits arise from partnership efforts currently being implemented. We agree that the partnerships highlighted in your State Plan are among the best methods to further recovery of listed species. Those established, ongoing efforts, recognized by the many partners in the State Plan, give confidence that the State goal of maintaining habitat integrity by focusing on the hydrology, geomorphology, and water quality of Topeka shiner habitat can be achieved. Finally, the monitoring and reporting aspects of the State Plan will allow evaluation of the conservation efforts being undertaken in South Dakota and document status changes to the species, which is a critical part of the species' recovery process.

To further our evaluation of the State Plan, we developed a table of the Plan's action items (enclosed) that includes the status of such actions along with other conservation measures the State has undertaken. Many of these actions already are being implemented and have proven effective, while others, such as the monitoring and assessment portion of the plan, will allow ongoing evaluation and opportunities for refinement as needed.

We believe the various components of the State Plan, including an evaluation of the threats to the species in South Dakota, use of partnerships involving multiple entities to conserve this species, and monitoring, will benefit long-term conservation of the species.

Policy for Evaluation of Conservation Efforts (PECE)

We initially requested that your plan should comply with our PECE, which is used for listing decisions that are based on commitments in existing conservation plans. The PECE recognizes that formalized conservation efforts can offset or neutralize known threats to a species or its habitat and thereby affect listing decisions. The State Plan outlines a Topeka shiner population monitoring and assessment effort that will continue to document the status of this species in South Dakota. However, we will evaluate the potential exclusion of Topeka shiner critical habitat under section 4(b)(2) of the Act, which provides that the Secretary may exclude any area from designation if the benefits of such exclusion outweigh the benefits of designation. We will use, in part, the economic analysis we have prepared in our analysis of benefits.

Other Considerations for the State Plan

Secretary Cooper's December 11, 2003, letter provides additional information regarding threats analyses and measures being undertaken to reduce or eliminate threats to Topeka shiners. We recommend that letter and this response be appended to the State Plan as additional information.

Appendix B of the State Plan outlines Conservation Programs available to landowners. The Service also has an active wetland and grassland easement program that is available to landowners in eastern South Dakota. These programs would fit well with the other conservation programs outlined in Appendix B. Detailed information on these programs is best attained from one of the five Wetland Management Districts located in eastern South Dakota.

Honorable M. Michael Rounds 4

In summary, we agree that an updated status assessment for the Topeka shiner is warranted, and the results of that review will need to be included in the Draft Recovery Plan. The State Plan will provide significant conservation benefits to the Topeka shiner and we will give serious consideration to the State's request for exclusion from critical habitat designation. I also commend the Department for undertaking development of the State Plan. If I can be of further assistance please do not hesitate to contact me.

Sincerely,

Richard A. Coleman

ACTING Regional Director

Enclosure

ACTION ITEM	STATUS
Establish the South Dakota Topeka shiner working group.	Complete and Ongoing
Develop and implement the State Plan.	Complete (2003) and Ongoing
Conduct surveys to determine extent of Topeka shiner range in South Dakota.	Complete and Ongoing
Design long term monitoring and assessment plan.	Complete
Develop an education and outreach program to provide information on the Topeka shiner and watershed health.	Ongoing
Develop and maintain a Topeka shiner website for information on this species.	Complete and Ongoing
Complete genetic analyses of different Topeka shiner populations in South Dakota.	Complete
Incorporation of Topeka shiner recovery and conservation efforts in State strategic planning documents on different levels.	Ongoing
Secure matching funds from the Service and others to conduct surveys and ecological studies and for various habitat restoration and enhancement activities.	Complete and ongoing
Conduct research in relationship to stream hydrology and Topeka shiner habitat.	Ongoing
Provide technical and financial assistance to landowners interested in creating or restoring wetland areas.	Complete and Ongoing
Provide landowner incentives to increase native vegetative cover.	Complete and Ongoing
Work with government agencies to develop best management practices that minimize erosion.	Complete and Ongoing
Provide financial and technical assistance to landowners to reestablish native vegetation along riparian zones.	Complete and Ongoing
Provide technical and financial assistance to landowners and other agencies interested in restoring habitat in degraded stream reaches.	Complete and Ongoing
Review projects that may adversely alter Topeka shiner streams.	Complete and Ongoing
Continue working with the Service to provide information and assistance on section 7 consultation issues.	Ongoing
Continue working with section 6 funds to further identify and Topeka shiner areas and strategy for long term conservation.	Ongoing
Provide technical assistance to urban, residential and development planners to improve water quality from water discharge systems.	Complete and Ongoing
Work with Natural Resource Conservation Service to have Topeka shiner streams get higher priority for EQIP and WHIP funding.	Complete and Ongoing
Provide incentives for landowners to establish riparian buffers or filter strips along agricultural fields with high runoff potential.	Complete and Ongoing
Continue technical assistance for permitting and designing confined animal feeding operations.	Ongoing
Continue routine inspections of sewage treatment facilities to ensure compliance with water quality standards.	Ongoing

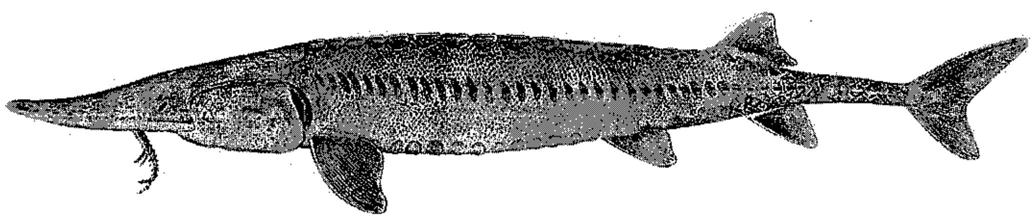
U.S. Fish & Wildlife Service

Revised RECOVERY PLAN

for the

Pallid Sturgeon (*Scaphirhynchus albus*)

Original Plan Approved: November 1993



Prepared by:
Pallid Sturgeon Recovery Coordinator
U.S. Fish and Wildlife Service
Montana Fish and Wildlife Conservation Office
Billings, Montana

For

Mountain-Prairie Region
U.S. Fish and Wildlife Service
Denver, CO

January 2014

U.S. Fish & Wildlife Service

Revised RECOVERY PLAN

for the

Pallid Sturgeon (*Scaphirhynchus albus*)

Original Plan Approved: November 1993

Mountain-Prairie Region
U.S. Fish and Wildlife Service
Denver, CO

Approved: [signature]
Deputy Regional Director, Region 6, U.S. Fish and Wildlife Service

Date: 1·29·14

015438

DISCLAIMER

Recovery plans delineate reasonable actions that are believed necessary to recover and/or protect listed species. Plans are prepared by the U.S. Fish and Wildlife Service, sometimes with the assistance of recovery teams, contractors, State agencies, and others. Plans are reviewed by the public and subject to additional peer review before they are adopted by the U.S. Fish and Wildlife Service. Objectives will only be attained and funds expended contingent upon appropriations, priorities, and other budgetary constraints. Recovery plans do not obligate other parties to undertake specific tasks. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service only after they have been signed by the Regional Director or Director as approved. Approved recovery plans are subject to modification as dictated by new findings, changes in species' status, and the completion of recovery tasks.

Copies of all documents reviewed in development of the plan are available in the administrative record, located at the U.S. Fish and Wildlife Service's Montana Fish and Wildlife Conservation Office, Billings, Montana.

Suggested literature citation:

U.S. Fish and Wildlife Service. 2014. Revised Recovery Plan for the Pallid Sturgeon (*Scaphirhynchus albus*). U.S. Fish and Wildlife Service, Denver, Colorado. 115 pp.

Recovery plans can be downloaded from: http://ecos.fws.gov/tess_public/SpeciesRecovery.do

ACKNOWLEDGMENTS

The U.S. Fish and Wildlife Service would like to gratefully acknowledge contributions of the following individuals or groups in developing this revision to the Recovery Plan for the Pallid Sturgeon (*Scaphirhynchus albus*).

The Pallid Sturgeon Recovery Team:

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U.S. Fish and Wildlife Service

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Bobby C. Reed
Louisiana Dept of Wildlife and Fisheries

Ryan Wilson
U.S. Fish and Wildlife Service

* Pallid Sturgeon Recovery Team member when document revision was first initiated, however individual no longer serves on the Recovery Team.

Additional appreciation is extended to the following individuals, groups, or agencies for their technical assistance, editing, and/or review of this document:

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University of Missouri

Kimberly A. Chojnacki
U.S. Geological Survey

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Southern Illinois University

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U.S. Fish and Wildlife Service

Paul Hartfield
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Kenneth J. Sulak, Ph.D.
U.S. Geological Survey

Nebraska Game and Parks Commission

Missouri Department of Conservation

Montana Fish Wildlife and Parks

National Park Service

South Dakota Department of Game, Fish, and Parks

The Upper Basin Pallid Sturgeon Workgroup

The Middle Basin Pallid Sturgeon Workgroup

The Lower Basin Pallid Sturgeon Workgroup

U.S. Army Corps of Engineers

EXECUTIVE SUMMARY

CURRENT SPECIES STATUS: The Pallid Sturgeon was listed as endangered under the Endangered Species Act on September 6, 1990 (55 FR 36641-36647). Since listing, the status of the species has improved and is currently stable. New information related to habitat extent and condition, abundance, and potential recruitment in the Mississippi and Atchafalaya rivers has improved our understanding of the species in these areas. While the numbers of wild Pallid Sturgeon collected in the Missouri, Mississippi and Atchafalaya rivers are higher than initially documented when listed and evidence for limited recruitment exists for the lower Missouri and Mississippi rivers, the population has not been fully quantified. This increase in observations is the result of increased monitoring efforts, improvements in sampling techniques, and greater emphasis on research in the impounded portion of the range. Despite increased efforts, data regarding recruitment, mortality, habitat use, and abundance remain limited. Population estimates for wild Pallid Sturgeon within some inter-reservoir reaches of the Missouri River indicate the extant wild populations are declining or extirpated. To prevent further extirpation, a conservation propagation program has been established. The Pallid Sturgeon Conservation Augmentation Program (PSCAP) appears to be successful in maintaining the species' presence within the Missouri River basin. However, if supplementation efforts were to cease, the species would once again face local extirpation within several reaches.

HABITAT REQUIREMENTS AND LIMITING FACTORS: The Pallid Sturgeon is native to the Missouri and Mississippi rivers and adapted to the pre-development habitat conditions that historically existed in these rivers. These conditions generally can be described as large, free-flowing, warm-water, and turbid rivers with a diverse assemblage of dynamic physical habitats. Limiting factors include: 1) activities which affect in-river connectivity and the natural form, function, and hydrologic processes of rivers; 2) illegal harvest; 3) impaired water quality and quantity; 4) entrainment; and 5) life history attributes of the species (i.e., delayed sexual maturity, females not spawning every year, and larval drift requirements). The degree to which these factors affect the species varies among river reaches.

RECOVERY STRATEGY: The primary strategy for recovery of Pallid Sturgeon is to: 1) conserve the range of genetic and morphological diversity of the species across its historical range; 2) fully quantify population demographics and status within each management unit; 3) improve population size and viability within each management unit; 4) reduce threats having the greatest impact on the species within each management unit; and, 5) use artificial propagation to prevent local extirpation within management units where recruitment failure is occurring.

Achieving our recovery strategy will require: 1) increased knowledge of the status of Pallid Sturgeon throughout its range; 2) better understanding of Pallid Sturgeon life history, ecology, mortality, and habitat requirements; 3) improve assessments of all potential threats affecting the species; and 4) application of information gained through research and monitoring to effectively implement management actions where recovery can be achieved (see Recovery Outline/Narrative).

RECOVERY GOAL: The ultimate goal is species recovery and delisting. The intermediate goal is downlisting the species from endangered to threatened.

RECOVERY OBJECTIVES: The recovery objectives include the implementation of effective management actions that will reduce or alleviate the impacts from threats to the species within each management unit and across the species' range. Recovery actions to address threats within management units should be informed by adequate knowledge of pallid sturgeon abundance, population structure, life history, ecology, mortality, and habitat requirements specific to those units.

RECOVERY CRITERIA: Pallid Sturgeon will be considered for reclassification from endangered to threatened when the listing/recovery factor criteria (p. 54) are sufficiently addressed such that a self-sustaining genetically diverse population is realized and maintained within each management unit for 2 generations (20-30 years). Delisting will be considered when the listing/recovery factor criteria are sufficiently addressed and adequate protective and conservation measures are established to provide reasonable assurance of long-term persistence of the species within each management unit in the absence of the Endangered Species Act's protections.

In this context, a self-sustaining population is described as a naturally spawning population that results in sufficient recruitment of Pallid Sturgeon into the adult population at levels necessary to maintain a genetically diverse wild adult population in the absence of artificial population augmentation (see *Criteria for Reclassification to Threatened Status* p. 54). Additionally, in this context a genetically diverse population is defined as one in which the effective population size (N_e) is sufficient to maintain adaptive genetic variability into the foreseeable future. These criteria should be achieved and adequately demonstrated within each management unit prior to consideration for reclassification. Because the nature of threats to the species and impediments to recovery vary among management units, it is likely that individual units may achieve population sustainability criteria earlier than others. As populations recover and the inter-relationships of populations on the landscape are better known, the data will be reviewed to determine whether the designation of distinct population segments (DPSs) is warranted.

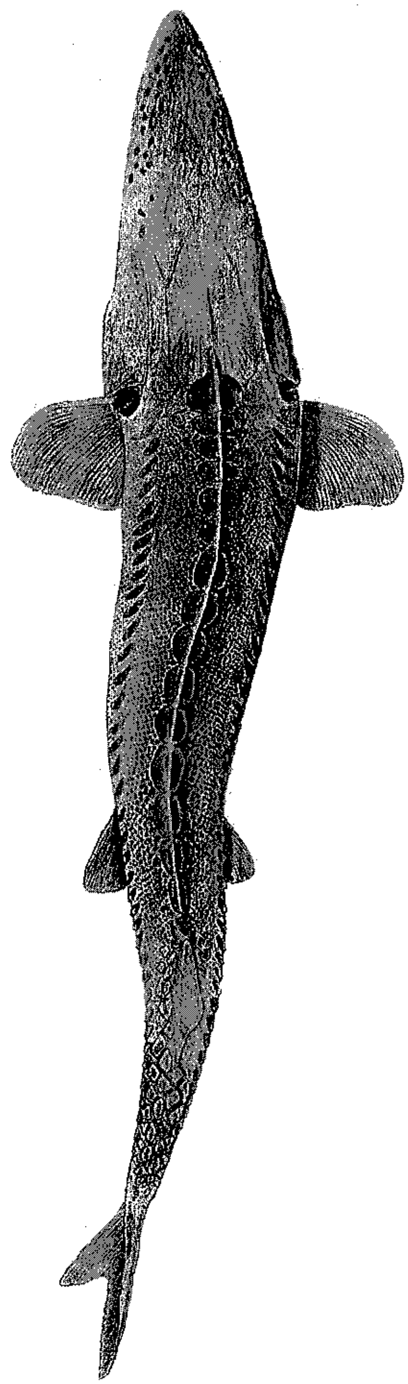
ACTIONS NEEDED (see *Recovery Outline/Narrative* pp. 58-74):

1. Conserve and restore Pallid Sturgeon individuals, populations, and habitats.
2. Conduct research necessary to promote survival and recovery of Pallid Sturgeon.
3. Obtain information on population genetics, status, and trends.
4. Maintain the Pallid Sturgeon Conservation Augmentation Program where deemed necessary.
5. Coordinate and implement conservation and recovery of Pallid Sturgeon.
6. Post downlisting or delisting planning.

ESTIMATED COST OF RECOVERY TASK IMPLEMENTATION (not adjusted for inflation): The estimated cost to implement this recovery plan and achieve species recovery is $239,170,000.

Of this amount, the estimated costs for downlisting from endangered to threatened is $221,820,000 and post reclassification costs are estimated to be $17,350,000. More detailed descriptions of the recovery tasks can be found in the *Recovery Outline/Narrative* (pp. 58-74) and a prioritized list of recovery tasks can be found in the *Implementation Schedule* (pp. 75-78).

DATE OF RECOVERY: The estimated earliest date for status reclassification from endangered to threatened is 2030 and from threatened to recovered is 2047 provided recovery tasks are implemented and recovery criteria are met. These estimates may change as new data become available.



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FIGURES

Abbreviated units used in this plan

cfs	cubic feet per second
ft	foot (feet)
ft/s	foot (feet) per second
km	kilometer(s)
m	meter(s)
m/s	meter(s) per second
mg/l	milligram(s) per liter
mi	mile(s)
NTU	nephelometric turbidity units
Rkm	River kilometer(s)
Rmi	River mile(s)

Acronyms used in this plan

CLMU:	Central Lowlands Management Unit
CPMU:	Coastal Plain Management Unit
DPS:	Distinct Population Segments
GPMU:	Great Plains Management Unit
IHMU:	Interior Highlands Management Unit
PCB:	Polychlorinated Biphenyls
PSCAP:	Pallid Sturgeon Conservation Augmentation Program
RSD:	Relative Stock Density
USFWS:	U.S. Fish and Wildlife Service

Part I: Background

History

Pallid Sturgeon (*Scaphirhynchus albus*), as well as other sturgeon species, are often referred to as "living dinosaurs". This moniker results from existence of fossilized sturgeon believed to be precursors to, or possibly common ancestors of, contemporary *Scaphirhynchus* species that coexisted with dinosaurs during the Cretaceous period of the Mesozoic era. Evidence for this coexistence is based on North American fossil sturgeon specimens (*Priscosturion longipinnis* and *Protoscaphirhynchus squamosus*) which date up to 78 million years before present (Grande and Hilton 2006; Hilton and Grande 2006; Grande and Hilton 2009). Today, eight species and one subspecies of sturgeon belonging to the family Acipenseridae inhabit North America; specifically these are:

- Pallid Sturgeon (*Scaphirhynchus albus*) – *E*;
- Shovelnose Sturgeon (*Scaphirhynchus platorynchus*) – *T-SOA*;
- Alabama Sturgeon (*Scaphirhynchus suttkusi*) – *E*;
- White Sturgeon (*Acipenser transmontanus*) – *E*;
- Green Sturgeon (*Acipenser medirostris*) – *T*;
- Lake Sturgeon (*Acipenser fulvescens*);
- Shortnose Sturgeon (*Acipenser brevirostrum*) – *E*;
- Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*); – *E (4 DPS) and T (1 DPS)*
- Gulf Sturgeon (*Acipenser oxyrinchus desotoi*) – *T*;

Seven of these species are on the Federal list of endangered and threatened wildlife and plants, of which two species are listed as threatened (*T*), four are listed as endangered (*E*), one has DPSs that are either listed as threatened or endangered, and one is treated as threatened due to its similarity of appearance (T-SOA) to the listed Pallid Sturgeon (detail provided under Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes). While the Lake Sturgeon is not federally listed, it has declined throughout its native range and receives special protections in most states and provinces where it occurs.

The Pallid Sturgeon was listed as endangered on September 6, 1990 (55 FR 36641-36647).

Species Description and Taxonomy

The Pallid Sturgeon was first recognized as a species different from Shovelnose Sturgeon by S. A. Forbes and R. E. Richardson in 1905 based on a study of nine specimens collected from the Mississippi River near Grafton, Illinois (Forbes and Richardson 1905). They named this new species *Parascaphirhynchus albus*. Later reclassification assigned it to the genus *Scaphirhynchus* where it has remained (Bailey and Cross 1954; Campton et al. 2000).

General Description

Pallid Sturgeon have a flattened shovel-shaped snout; a long, slender, and completely armored caudal peduncle (the tapered portion of the body which terminates at the tail); and lack a spiracle (small openings found on each side of the head) (Forbes and Richardson 1905). As with other sturgeon, the mouth is toothless, protrusible (capable of being extended and withdrawn from its natural position), and ventrally positioned under the head. The skeletal structure is primarily composed of cartilage rather than bone.

Pallid Sturgeon are similar in appearance to the more common Shovelnose Sturgeon. Both species inhabit overlapping portions of the Missouri and Mississippi river basins. In their original description, Forbes and Richardson (1905) noted that Pallid Sturgeon differed from Shovelnose Sturgeon in size, color, head length, eye size, mouth width, barbel length ratios, ossification, gill raker morphology, number of ribs, and size of the air bladder. Bailey and Cross (1954) identified several additional differences between the two species, including barbel arrangement and position, barbel structure (i.e., diameter and papillae), and both dorsal and anal fin ray counts. They also developed a suite of diagnostic measurement ratios intended to eliminate the effects of size, age, and possibly geographic variation. In general, mature Pallid Sturgeon attain larger sizes than mature Shovelnose Sturgeon and they have longer outer barbels and shorter inner barbels with inner barbels originating anterior to outer barbels. Additionally, Pallid Sturgeon have wider mouths and naked bellies generally lack the mosaic of embedded scutes that armor the ventral surface of the Shovelnose Sturgeon.

Several of these diagnostic characters and ratios change with age of the fish (allometric growth), making identification of juvenile and subadult fish difficult. Fishery biologists have found that in most cases the seven morphometric ratios described in Bailey and Cross (1954) as well as subsequent indices developed by Wills et al. (2002) were not mutually exclusive when used to compare Pallid to Shovelnose sturgeon in the middle Mississippi River (Bettoli et al. 2009) or when used to compare both species from different geographic reaches (Murphy et al. 2007a). Also, these indices do not work well on smaller-sized specimens (Kuhajda et al. 2007). This lack of uniform applicability of morphometric indices may be attributable to greater morphological differences documented between upper Missouri River Pallid Sturgeon and Pallid Sturgeon samples in the middle and lower Mississippi and Atchafalaya rivers (Murphy et al. 2007a). Additionally, Pallid Sturgeon from the upper Missouri River live longer and grow larger than those found in the lower Missouri and Mississippi rivers (Figure 1).

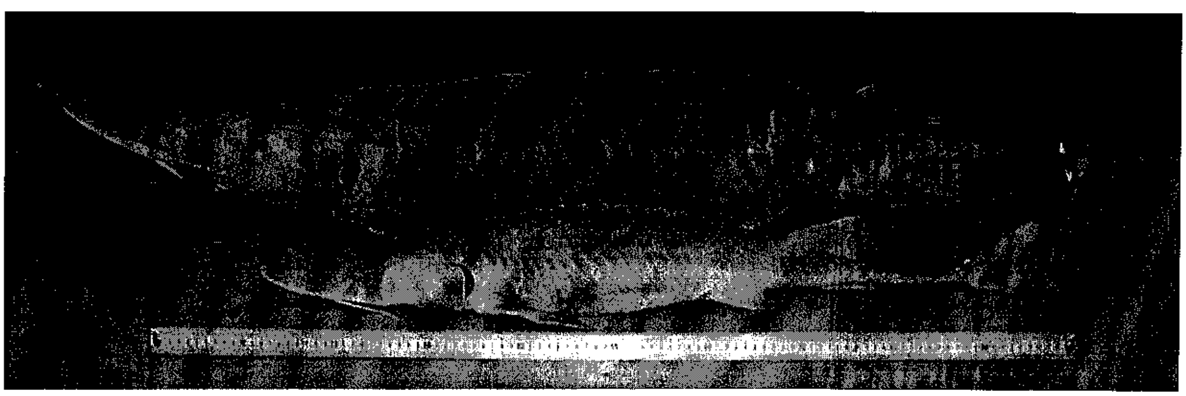

Figure 1 Preserved adult Pallid Sturgeon: the larger specimen (background) is from the upper Missouri River and the smaller specimen (foreground) is from the lower Mississippi/Atchafalaya Rivers. Both specimens are among the larger specimens recorded from each region. (Photo courtesy Dr. Bernard Kuhajda, Tennessee Aquarium Conservation Institute).

Historical Distribution and Abundance

The historical distribution of the Pallid Sturgeon (Figure 2) includes the Missouri and Yellowstone rivers in Montana downstream to the Missouri-Mississippi confluence and the Mississippi River possibly from near Keokuk, Iowa[1] downstream to New Orleans, Louisiana (Coker 1929; Bailey and Cross 1954; Brown 1955; Carlson and Pflieger 1981; Kallemeyn 1983; Keenlyne 1989 and 1995).

Pallid Sturgeon also were documented in the lower reaches of some of the larger tributaries to the Missouri, Mississippi, and Yellowstone rivers including the Tongue, Milk, Niobrara, Platte, Kansas, Big Sioux, St. Francis, Grand, and Big Sunflower rivers (Bailey and Cross 1954; Brown 1955; Keenlyne 1989; Ross 2001; Snook et al. 2002; Braaten and Fuller 2005; Peters and Parham 2008). The total length of the Pallid Sturgeon's range historically was about 5,656 River kilometers (Rkm) (3,515 River miles (Rmi)).

Because the Pallid Sturgeon was not recognized as a species until 1905, little detailed information is available concerning early abundance. Forbes and Richardson (1905) suggested that the lack of prior recognition of the species might have been attributable to scarcity, noting that Pallid Sturgeon accounted for about one in five hundred individuals of the *Scaphirhynchus* sturgeon collected from the central Mississippi River. The species was reported to be more abundant in the turbid lower Missouri River where some fishermen reported one in five sturgeon as Pallid Sturgeon (Forbes and Richardson 1905). However, it is probable that commercial fishermen failed to accurately distinguish the species in their sturgeon catches. As late as the mid-1900s, it was common for Pallid Sturgeon to be included in commercial catch records as either Shovelnose or Lake sturgeon (Keenlyne 1995). Although considered to be nowhere common, Bailey and Cross (1954) indicated that Pallid Sturgeon were considerably more abundant in larger turbid rivers than in clear or moderately turbid waters.

Correspondence and notes of researchers suggest that Pallid Sturgeon were often encountered in portions of the Missouri River as late as the 1960s (Keenlyne 1989). While there are fewer than 40 historical (pre-listing) records of Pallid Sturgeon from the Mississippi River (Kallemeyn 1983, Keenlyne 1989), this may be attributed to a lack of historical systematic fish collections from that portion of the range.

Present Distribution and Abundance

Since listing in 1990, wild Pallid Sturgeon have been documented in the Missouri River between Fort Benton and the headwaters of Fort Peck Reservoir, Montana; downstream from Fort Peck Dam, Montana to the headwaters of Lake Sakakawea, North Dakota; downstream from Garrison Dam, North Dakota to the headwaters of Lake Oahe, South Dakota; from Oahe Dam downstream to within Lake Sharpe, South Dakota; between Fort Randall and Gavins Point Dams, South Dakota and Nebraska; downstream from Gavins Point Dam to St. Louis, Missouri; in the lower Milk and Yellowstone rivers, Montana and North Dakota; the lower Big Sioux River, South Dakota; the lower Platte River, Nebraska; the lower Niobrara River, Nebraska; and the lower Kansas River, Kansas (Figure 3). Pallid Sturgeon observations and records have increased with

[1] Bailey and Cross (1954) considered the observation near Keokuk, Iowa as "dubious" and remark the species is likely represented by "stragglers from down river."

sampling effort in the Mississippi River basin. In 1991, the species was identified in the Atchafalaya River, Louisiana (Reed and Ewing 1993) (Figure 3).

The contemporary downstream extent of Pallid Sturgeon ends near New Orleans, Louisiana (Killgore in litt., 2008). Additionally, the species has been documented in the lower Arkansas River (Kuntz in litt., 2012), the lower Obion River, Tennessee (Killgore et al. 2007b), as well as navigation pools 1 and 2, i.e., downstream from Lock and Dam 3, in the Red River, Louisiana (Slack et al. 2012) (Figure 3).

In 1995, a preliminary estimate found about 45 wild Pallid Sturgeon existed in the Missouri River upstream of Fort Peck Reservoir (Gardner 1996). More recent data suggest that substantially fewer wild fish remain today. For example only three wild Pallid Sturgeon were collected during 2007 – 2013, indicating wild Pallid Sturgeon numbers in the Missouri River upstream of Fort Peck Reservoir are too low for a reliable population estimate (Tews in litt., 2013). An estimated 125 wild Pallid Sturgeon remain in the Missouri River downstream of Fort Peck Dam to the headwaters of Lake Sakakawea including the lower Yellowstone River (Jaeger et al. 2009). While current abundance estimates are lacking for the entire Missouri River downstream of Gavins Point Dam, Steffensen et al. (2012) generated annual population estimates for both wild and hatchery-reared Pallid Sturgeon for the reach of the Missouri River extending from the Platte River confluence downstream 80.5 Rkm (50 Rmi). Their results estimated wild Pallid Sturgeon at 5.4 to 8.9 fish/Rkm (8.7 to 14.3fish/Rmi) and hatchery produced Pallid Sturgeon at 28.6 to 32.3 fish/Rkm (46.1 to 52.0 fish/Rmi). Extrapolating these estimates to the entire lower Missouri River suggests that the wild population may consist of as many as 5,991 mature individuals (Steffensen et al. 2013). This population may be stabilizing as a result of the Pallid Sturgeon Conservation Augmentation Program (PSCAP), but remains neither self-sustaining nor viable (Steffensen 2012; Steffensen et al. 2013). Garvey et al. (2009) generated an estimate of 1,600 (5 fish/Rkm, 0.8 fish/Rmi) to 4,900 (15.2 fish/Rkm, 24.5 fish/Rmi) Pallid Sturgeon for the middle Mississippi River (i.e., mouth of the Missouri River Downstream to the Ohio River confluence). In 2009, a sturgeon survey in the Upper Mississippi River captured a single Pallid Sturgeon below lock and dam 25 near Winfield, Missouri (Herzog in litt., 2009). No estimates are available for the remainder of the Mississippi River. Since 1994, the PSCAP has released hatchery-reared Pallid Sturgeon within the Missouri River, portions of the Yellowstone River, and sporadically in the Mississippi River. Supplementation data are summarized within the stocking plan (USFWS 2008).

Habitat Preferences

Pallid Sturgeon are a bottom-oriented, large river obligate fish inhabiting the Missouri and Mississippi rivers and some tributaries from Montana to Louisiana (Kallemeyn 1983). Pallid Sturgeon evolved in the diverse environments of the Missouri and Mississippi river systems. Floodplains, backwaters, chutes, sloughs, islands, sandbars, and a dynamic main channel formed the large-river ecosystem that met the habitat and life history requirements of Pallid Sturgeon and other native large-river fishes.

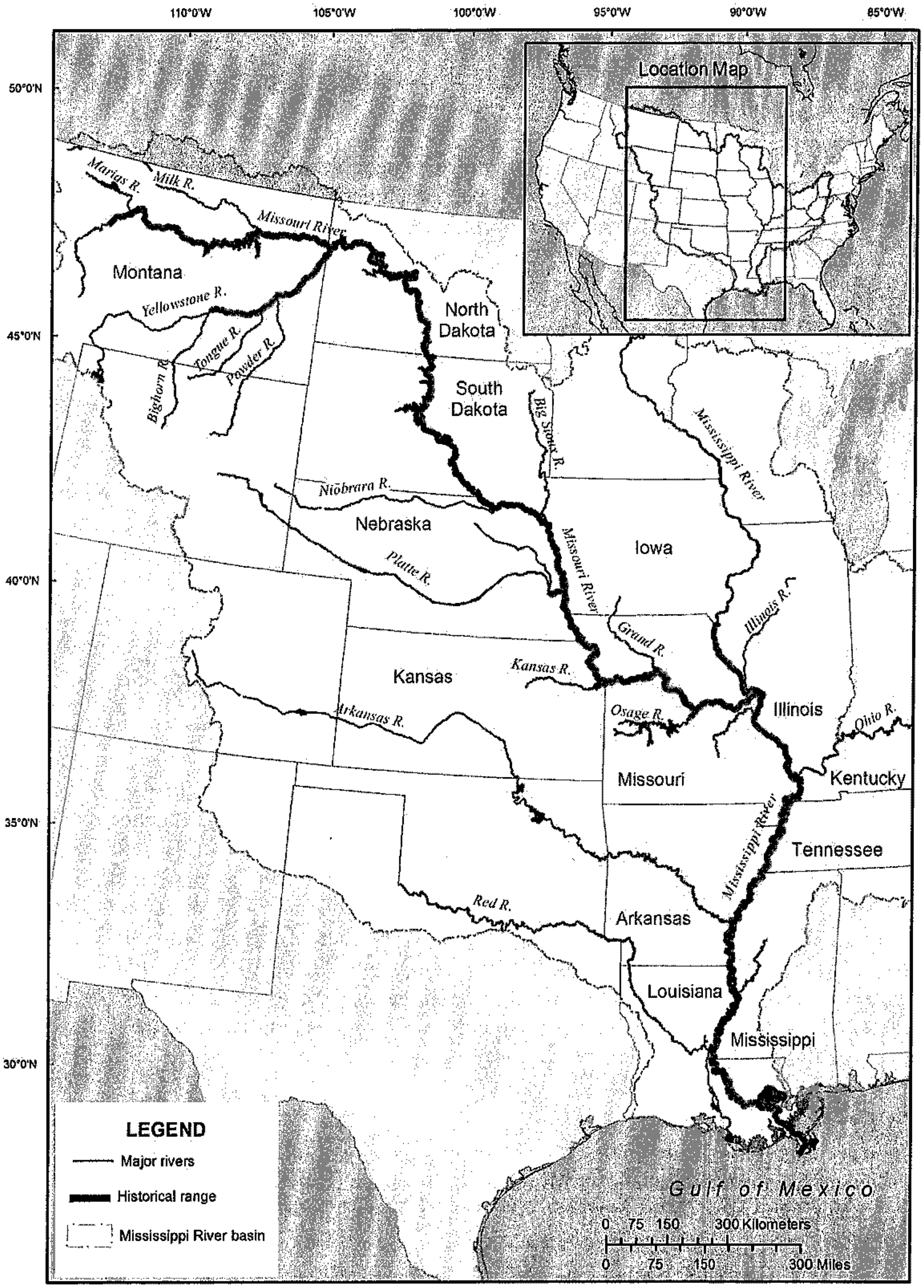

Figure 2 Map of prominent rivers in the Mississippi River Basin. Bold line approximates historical range of Pallid Sturgeon (Coker 1929; Bailey and Cross 1954; Brown 1955; Carlson and Pflieger 1981; Kallemeyn 1983; Keenlyne 1995).

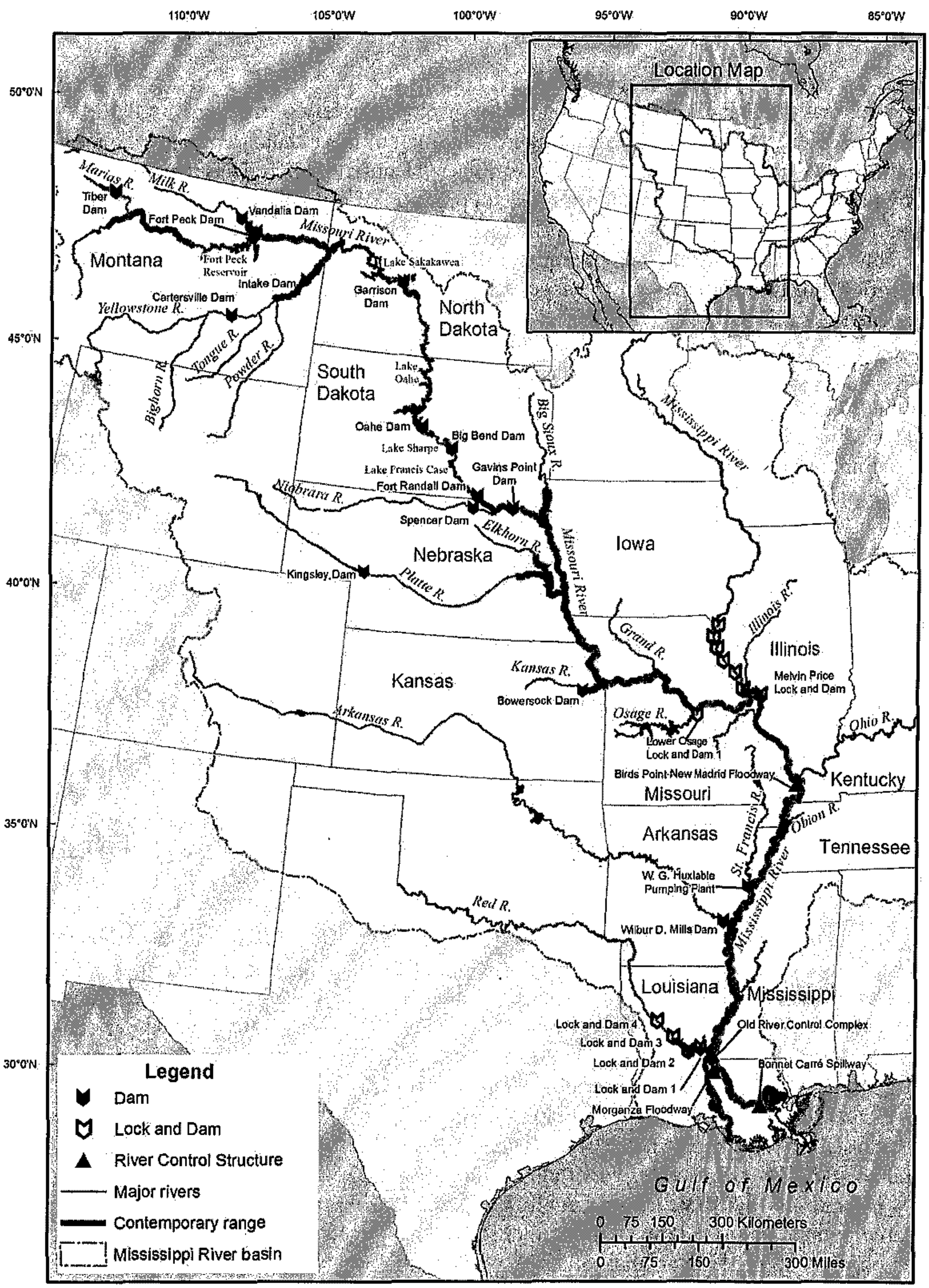

Figure 3 Post-development map of prominent rivers in the Mississippi River Basin. Bold line approximates current range of Pallid Sturgeon and includes both wild and hatchery-reared fish. (Data: National Pallid Sturgeon Database, U.S. Fish and Wildlife Service, Bismarck, North Dakota).

Habitat Use

Research into habitat usage has produced some useful insights in many portions of the Pallid Sturgeon's range. However, it should be cautioned that much of these data are based on habitat characterizations in altered environments, in some cases substantially altered environments, including an altered hydrograph and temperatures, suppression of fluvial processes, stabilized river banks, loss of natural meanders and side channels, fragmented habitats, and increased water velocities. Thus, the following information and current understanding of habitat use may not necessarily reflect preferred habitats for the species, but rather define suitable habitats within an altered ecosystem.

Pallid Sturgeon primarily utilize main channel, secondary channel, and channel border habitats throughout their range. Juvenile and adult Pallid Sturgeon are rarely observed in habitats lacking flowing water which are removed from the main channel (i.e., backwaters and sloughs). Specific patterns of habitat use and the range of habitat parameters used may vary with availability and by life stage, size, age, and geographic location. In the upper portions of the species' range, juvenile hatchery-reared Pallid Sturgeon select main-channel habitats (Gerrity 2005). In the Yellowstone and Platte rivers, adult Pallid Sturgeon select areas with frequent islands and sinuous channels while rarely occupying areas without islands or with straight channels (Bramblett and White 2001; Snook et al. 2002; Peters and Parham 2008). While adult Pallid Sturgeon in the channelized lower Missouri River primarily use channel border habitats associated with engineered structures, they have been documented utilizing side channels, as well as newly inundated floodplain habitats with flowing water associated with historic discharges from Gavins Point Dam (Justin Haas in litt., 2013). In the middle Mississippi River, Pallid Sturgeon select for areas downstream from islands that are often associated with channel border habitats and select against main-channel habitats (Hurley et al. 2004). Other Mississippi River capture locations tend to be near the tips of wing-dikes (an engineered channel training structure), steep sloping banks, and channel border areas (Killgore et al. 2007b; Schramm and Mirick 2009).

Habitat requirements of larval and young-of-year Pallid Sturgeon remain largely undescribed across the species' range, primarily as a result of low populations of spawning adults and poor recruitment. However, some authors have postulated that early life-stage habitats in channelized river reaches may be similar among *Scaphirhynchus* species (Phelps et al. 2010; Ridenour et al. 2011). Young of year *Scaphirhynchus* in the lower Missouri River were found in habitats associated with the main channel border and moderate velocities (0.5-0.7 meters per second (m/s), 1.6-2.3 feet per second (ft/s)) (Ridenour et al. 2011). Age- 0 *Scaphirhynchus* sturgeon in the Middle Mississippi River were more often found in channel border and island-side channel habitats and positively associated with low velocities (~0.1 m/s, 0.33 ft/s), moderate depths (2-5 m, 6.6-16.4 ft), and sand substrate (Phelps et al. 2010). No Pallid Sturgeon were positively identified among the specimens collected in either study, thus, while these data offer useful insights, empirically derived larvae and young-of-year Pallid Sturgeon data are lacking.

Substrate

Pallid Sturgeon have been documented over a variety of available substrates, but are often associated with sandy and fine bottom materials (Bramblett and White 2001; Gerrity 2005; Snook et al. 2002; Swigle 2003; Peters and Parham 2008; Spindler 2008) and exhibit a selection for sand over mud, silt, or vegetation (Elliott et al. 2004). Substrate association appears to be seasonal (Koch et al. 2006a; Koch et al. 2012). During winter and spring, sand, sand and gravel, and rock substrates are used and during the summer and fall sand substrate is most often used (Koch et al. 2006a). In the middle Mississippi River, Pallid Sturgeon transition from predominantly sandy substrates to gravel during May which may be associated with spawning (Koch et al. 2012). In these river systems and others, Pallid Sturgeon appear to use underwater sand dunes (Bramblett 1996; Constant et al. 1997; Snook et al. 2002; Elliott et al. 2004; Jordan et al. 2006) which may serve as some form of holding, resting, or feeding area.

Depths and Velocity
Pallid Sturgeon are primarily benthic fishes, that is they spend the majority of their time at or near the river bottom. Across their range, Pallid Sturgeon have been documented in waters of varying depths and velocities. Depths at collection sites range from 0.58 m to > 20 m (1.9 to > 65 ft), though there may be selection for areas >0.8 m (2.6 ft) deep (Bramblett and White 2001; Carlson and Pflieger 1981; Constant et al. 1997; Erickson 1992; Gerrity 2005; Jordan et al. 2006; Peters and Parham 2008; Wanner et al. 2007). Despite the wide range of depths associated with capture locations, one commonality is apparent: this species is typically found in areas where relative depths (the depth at the fish location divided by the maximum channel cross section depth expressed as a percent) exceed 75% (Constant et al. 1997; Gerrity 2005; Jordan et al. 2006; Wanner et al. 2007).

Bottom water velocities associated with collection locations are generally < 1.5 m/s (4.9 ft/s) with reported averages ranging from 0.58 m/s to 0.88 m/s (1.9 ft/s to 2.9 ft/s) (Carlson and Pflieger 1981; Elliott et al. 2004; Erickson 1992; Jordan et al. 2006; Swigle 2003; Snook et al. 2002).

Turbidity
Pallid Sturgeon have been collected from a variety of turbidity conditions, including highly altered areas with consistently low turbidities (i.e., 5-100 nephelometric turbidity units (NTU)) to comparatively natural systems like the Yellowstone River with seasonally high turbidity levels (> 1,000 NTU) (Braaten and Fuller 2002, 2003; Erickson 1992; Jordan et al. 2006; Peters and Parham 2008). Currently, the effects from altered turbidity levels are poorly understood. Given their small eye structure, four barbels with taste buds, taste buds on lips, and ampullary electroreceptors on the underside of the snout, the species appears to be highly adapted to low-visibility environments. It is reasonable to infer that the historically high turbidity levels in the Missouri and Mississippi rivers was a component of the natural ecological processes under which the species evolved. Thus, rivers defined by high turbidity levels that fluctuate seasonally and annually are considered important because the species' life history traits (i.e., predator avoidance or feeding mechanisms) evolved in low visibility environments.

Life History
Pallid Sturgeon can be long-lived, with females reaching sexual maturity later than males (Keenlyne and Jenkins 1993). Based on wild fish, estimated age at first reproduction was 15 to 20 years for females and approximately 5 years for males (Keenlyne and Jenkins 1993). Like most fish species, water temperatures influence growth and maturity. Female hatchery-reared Pallid Sturgeon maintained in an artificially controlled hatchery environment (i.e., near constant

16 to 20° C, 61 to 68 ° F temperatures) can attain sexual maturity at age 6, whereas female Pallid Sturgeon subject to colder winter water temperatures reached maturity around age 9 (Webb in litt., 2011). Hatchery-reared Pallid Sturgeon in the lower Missouri River reached sexual material at ages 9 and 7 for males and females, respectively (Steffensen 2012). However, as of 2012, no 1997 year-class hatchery-reared Pallid Sturgeon, released in the upper Missouri River between Fort Peck Dam and Lake Sakakawea, have been found to be sexually mature. Thus, age at first reproduction can vary between hatchery-reared and wild fish and is dependent on local conditions.

Females do not spawn each year (Kallemeyn 1983). Observations of wild Pallid Sturgeon collected as part of the Pallid Sturgeon Conservation Augmentation Program (PSCAP) in the northern part of the range indicates that female spawning periodicity is 2-3 years (Rob Holm, USFWS Garrison Dam Hatchery, unpublished data).

Fecundity is related to body size. The largest upper Missouri River fish can produce as many as 150,000-170,000 eggs (Keenlyne et al. 1992; Rob Holm, USFWS Garrison Dam Hatchery, unpublished data), whereas smaller bodied females in the southern extent of the range may only produce 43,000-58,000 eggs (George et al. 2012). Spawning appears to occur between March and July, with lower latitude fish spawning earlier than those in the northern portion of the range. Adult Pallid Sturgeon can move long distances upstream prior to spawning; a behavior that can be associated with spawning migrations (U.S. Geological Survey 2007; DeLonay et al. 2009). Females likely spawn at or near the apex of these movements (Bramblett and White 2001; DeLonay et al. 2009). Spawning appears to occur adjacent to or over coarse substrate (boulder, cobble, gravel) or bedrock, in deeper water, with relatively fast, converging flows, and is driven by several environmental stimuli including day length, water temperature, and flow (U.S. Geological Survey 2007; DeLonay et al. 2009).

Incubation rates are governed by and dependant upon water temperature. In a hatchery environment, fertilized eggs hatch in approximately 5-7 days (Keenlyne 1995). Incubation rates may deviate slightly from this in the wild. Newly hatched larvae are predominantly pelagic, drifting in the currents for 11 to 13 days and likely dispersing several hundred km downstream from spawn and hatch locations (Kynard et al. 2002, 2007; Braaten et al. 2008, 2010, 2012a; Phelps et al. 2012).

Diets

Data on food habits of age-0 Pallid Sturgeon are limited. In a hatchery environment, exogenously feeding fry (fry that have absorbed their yolk and are actively feeding) will readily consume brine shrimp, suggesting zooplankton and/or small invertebrates are likely the food base for this age group. Data available for wild age-0 *Scaphirhynchus* indicate mayflies (Ephemeroptera) and midge (Chironomidae) larvae are important (Sechler et al. 2012).

Juvenile and adult Pallid Sturgeon diets are generally composed of fish and aquatic insect larvae with a trend toward piscivory as they increase in size (Carlson and Pflieger 1981; Hoover et al. 2007; Gerrity et al. 2006; Grohs et al. 2009; Wanner 2006; French 2013).

Based on the above diet data and habitat utilization by prey items, it appears that Pallid Sturgeon will feed over a variety of substrates (Hoover et al. 2007; Keevin et al. 2007). However, the abundance of Trichoptera in the diet of fish studied in some reaches suggests that harder substrates like gravel and rock material may have become important feeding areas (Hoover et al. 2007), though it remains unknown if this was historically the case or a contemporary response to stabilization and channel maintenance activities increasing the abundance of localized rock material.

Population Genetic Structure

Genetic information suggests evolutionary differences across the range. Campton et al. (2000) used approximately 500 base pairs of the mitochondrial DNA control region to examine genetic variation within and among three Pallid Sturgeon groups; two from the upper Missouri River and one from the Atchafalaya River. The Pallid Sturgeon from the upper Missouri River and Atchafalaya Rivers did not share any haplotypes ($P < 0.001$), and the genetic distance between these two groups (0.14%) was nearly as great as the genetic distance between Pallid and Shovelnose sturgeon in the upper Missouri River (0.15%). The authors note that this may represent reproductive isolation and genetic divergence between these two populations of Pallid Sturgeon that is nearly as old as the isolation between Pallid and Shovelnose sturgeon.

Tranah et al. (2001) examined genetic variation within and among the same three Pallid Sturgeon groups as Campton (2000) using five microsatellite loci. The two upper Missouri River groups, separated by Ft. Peck Dam, did not differ significantly from each other. However, Pallid Sturgeon genetic samples from the upper Missouri River population did differ from samples collected from the Atchafalaya River ($F_{st} = 0.13$ and 0.25; both $P < 0.01$). Thus, Pallid Sturgeon collected from the Missouri River in Montana (the northern fringe of their range) are reproductively isolated from those sampled from the southern extreme of their range and likely represent genetically distinct populations (Tranah et al. 2001).

Subsequent work on allele frequencies at 16 microsatellite loci identified significant differences between upper Missouri River Pallid Sturgeon samples when compared with samples from the lower Missouri, Mississippi, and Atchafalaya rivers (Schrey 2007). While samples from the middle Missouri River (i.e., collected between Gavins Point Dam, South Dakota, downstream to Kansas City, Missouri) appeared to be genetically intermediate between the northern and southern samples (Schrey 2007).

These data indicate that genetic structuring exists within the Pallid Sturgeon's range consisting of two distinct groups at the extremes of the species' range with an intermediate group in the middle Missouri River (Campton et al. 2000; Tranah et al. 2001; Schrey 2007). These data suggest a pattern of isolation by distance, with gene flow more likely to occur between adjacent groups than among geographically distant groups, and thus, genetic differences increase with geographical distance. Additionally, data indicate that these genetic differences translate into biological differences (i.e., differences in growth rates, metabolic rates, and consumption rates) indicative of local adaptations (Meyer 2011). However, Pallid Sturgeon from the upper Missouri River are the most distinct from the other groups sampled (Schrey and Heist 2007). Anthropogenic changes to the upper Missouri River have affected migratory opportunities and, thus, gene flow; main-stem dams have reduced, altered, or eliminated both emigration and immigration. The genetic structuring detected within the range likely predates these anthropogenic features (Schrey and Heist 2007) suggesting that before the dams, historical reproductive isolating mechanisms were present within the range or at least portions of the range.

Reasons for listing/current threats

Section 4(a)(1) of the Endangered Species Act requires that reclassification decisions be based on the five factors outlined below. These threats are explained here to provide a context for actions necessary to restore the species to healthy population levels no longer meeting the definition of endangered, and ultimately, no longer meeting the definition of threatened. Section 3 of the Endangered Species Act defines a species as "endangered" if it is in danger of extinction throughout all or a significant portion of its range and as "threatened" if it is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

Factor A: Present or Threatened Destruction, Modification or Curtailment of its Habitat or Range

The following known and potential threats that affect the habitat or range of Pallid Sturgeon are discussed in this section, and include: 1) large river habitat alterations, including river channelization, impoundment, and altered flow regimes; 2) water quality; 3) entrainment; and 4) climate change.

RIVER CHANNELIZATION, BANK STABILIZATION, IMPOUNDMENT, AND ALTERED FLOW REGIMES

Modification and curtailment of Pallid Sturgeon habitat and range are attributed to large river habitat alterations, including river channelization, bank stabilization, impoundment, and altered flow regimes. Following is a brief summary of these activities by river system.

MISSOURI RIVER

Historically, the Missouri River was dynamic, ever-changing, and composed of multiple channels, chutes, sloughs, backwater areas, side channels, and migrating islands and sandbars. As early as 1832, Congress endorsed an act approving the removal of snags from the river (Funk and Robinson 1974). In 1884, the Missouri River Commission was formed to improve navigation on the river (Funk and Robinson 1974). Revetments of woven willow and rock were used to stabilize banks, and dikes were built to narrow the channel and close off chutes. However, commercial navigation declined with the expansion of railroad networks. In 1902 the Missouri River Commission was dissolved and responsibility for the Missouri River was given directly to the U.S. Army Corps of Engineers (Funk and Robinson 1974). In 1912, Congress approved a navigation channel 1.8 m (6 ft) in depth from Kansas City, Missouri downstream to the confluence with the Mississippi River near St. Louis, Missouri. Subsequently, the Rivers and Harbors Act of 1945 authorized an increase in channel depth to 2.7 m (9 ft) and width to 91.4 m (300 ft) from Sioux City, Iowa downstream to the confluence. A self-scouring channel was largely completed by 1967 (Funk and Robinson 1974).

During the last century, the Missouri River was altered as a result of the Flood Control Act of 1944 to address societal needs. The most obvious habitat changes were the installation of dams in the upper Missouri River and some tributaries (Figure 4) as well as channelization and stabilization of the lower Missouri River for navigation. These anthropogenic modifications greatly reduced the river's ability to satisfy the life history requirements of Pallid Sturgeon by: 1) blocking movements to spawning and feeding areas; 2) affecting historical genetic exchange among reaches, (i.e., reducing or eliminating emigration and immigration); 3) decreasing turbidity levels by trapping sediment in reservoirs; 4) reducing distances available for larvae to drift; 5) altering water temperatures; 6) altering conditions and flows in spawning areas; 7) altering flows and temperatures associated with spawning movements; and 8) possibly reducing food sources by lowering productivity (Hesse et al. 1989; Keenlyne 1989; USFWS 2000a; Bowen et al. 2003).

Flows in the Missouri and Yellowstone rivers between Fort Peck Dam and Lake Sakakawea influence Pallid Sturgeon spawning movements and migrations within this reach. In general, Pallid Sturgeon reside in the Missouri River downstream from the confluence of the Missouri and Yellowstone rivers during fall and winter months (Fuller and Braaten 2012). As discharge increases in the spring, adult Pallid Sturgeon respond by migrating upstream. Typically, radio-tagged adult Pallid Sturgeon migrate into the unregulated Yellowstone River (Fuller and Braaten 2012) to spawn. Spawning adults are believed to avoid the colder, less turbid flows in the Missouri River above the Yellowstone confluence. However, during the spring of 2011, a disproportionate number of adult Pallid Sturgeon migrated up the Missouri River and remained upstream of Wolf Point, Montana (Figure 4) during the spawning period (Fuller and Haddix 2012). This change in migration behavior coincided with exceptionally higher than normal releases at Fort Peck Dam, as well historically high discharge from the Milk River. Following this spawning migration, a genetically confirmed wild Pallid Sturgeon larva was collected (Fuller and Haddix 2012). This is the first documented confirmation of spawning success in the Missouri River downstream from Fort Peck Dam; confirming that suitable spawning areas exist in this reach of the Missouri River and that Pallid Sturgeon can and will utilize this reach for spawning if conditions are suitable.

Water levels in the reservoirs impounded by Fort Peck Dam (Fort Peck Reservoir) and Garrison Dam (Lake Sakakawea) (Figure 4) may be impediments to larval Pallid Sturgeon survival by limiting the amount of riverine habitat available for Pallid Sturgeon to complete the transition from free embryos to exogenously feeding larvae. Pallid Sturgeon free embryos and larvae can passively drift as much as 245 to 530 km (152 to 329 mi) depending on water column velocity and temperature (Kynard et al. 2002; Braaten et al. 2008). Studies to assess larval Pallid Sturgeon drift dynamics (Braaten et al. 2008, 2010) released hatchery-reared Pallid Sturgeon free embryos and larvae in 2004 and 2007. Subsequent sampling has collected juvenile Pallid Sturgeon derived from these releases (Braaten et al. 2012b). Survivorship of released embryos and larvae to age-1 is related to age at release (days post-hatch) and correlated with release location; survivorship of the younger free embryos (i.e., 5 days post hatch) to age-1 was only observed from the most upstream release site (Braaten et al. 2012b). These data indicate that free embryos, as young as five days post-hatch, are able to survive to age-1 in the Missouri River between Fort Peck Dam and Lake Sakakawea, provided they have adequate dispersal distance to complete the developmental transition to feeding larvae. These observations support the hypothesis by Kynard et al. (2007) which implicates total drift distance as a limitation on natural recruitment in this reach of the Missouri River. Thus, within a given reach of river the distance required to complete the early life history requirements is dependent on reach length, river discharge, velocity, habitat complexity, and temperature.

In addition to limiting drift distance and duration, affecting spawning cues for adults, and inundating habitats, an altered hydrograph also affects downstream temperature profiles and reduces sediment transport. Cold water releases from dams have been attributed to spawning delays in several native riverine fishes and changing fish community composition downstream (Wolf 1995; Jordan 2000). Canyon Ferry, Hauser, and Holter dams are upstream of Great Falls, Montana. Though they do not impose any migratory barriers for Pallid Sturgeon, these structures, like other main-stem Missouri River dams, can affect sediment and nutrient transport and maintain an artificial hydrograph. Thus, the main-stem and tributary dams upstream of Fort Peck Dam (Figure 4) affect downstream reaches by reducing both sediment input and transport. The results are a reduction of naturally occurring habitat features like sandbars. Discharge and sediment load, together with physiographic setting, are primary factors controlling the morphology of large alluvial rivers (Kellerhals and Church 1989). Seasonally high turbidity levels are a natural component of pre-impoundment ecological processes. Reduced sediment transport and the associated decrease in turbidity could affect Pallid Sturgeon recruitment and feeding efficiency.

The relationship between high turbidity levels and larval Pallid Sturgeon survival is unclear. In laboratory studies, increased predation on White Sturgeon yolk-sac larvae was observed at low turbidity levels, suggesting that high turbidity levels associated with a natural hydrograph and natural sediment transport regimes may offer concealment for free-drifting sturgeon embryos and larvae (Gadomski and Parsley 2005). Given that the diet of Pallid Sturgeon is generally composed of fish and aquatic insect larvae with some preference for piscivory as they mature (see *Life History* section, above), higher pre-impoundment turbidity levels may have afforded improved foraging effectiveness by providing older juveniles and adults some level of concealment. From the headwaters of Lake Sakakawea above Garrison Dam, North Dakota to Gavins Point Dam, South Dakota (Figure 4), the Missouri River retains little of its historical riverine habitat; most of this reach is impounded in reservoirs. However, some Pallid Sturgeon persist in the more riverine reaches within a few of these reservoirs, though successful spawning and recruitment is unlikely. Because of the presence of Pallid Sturgeon in some inter-reservoir reaches, those occupied reaches have been included in recovery efforts (Erickson 1992; Jordan et al. 2006; Wanner et al. 2007). Despite these data, most of these inter-reservoir reaches are poorly understood and further research is needed to evaluate and define their significance to species' recovery.

The Missouri River downstream of Gavins Point Dam is over 1,296 Rkm (800 Rmi) in length, is unimpeded by dams, and is biologically and hydrologically connected with the Mississippi River. However, this reach is highly impacted be past and present anthropogenic modifications. For example, in the unchannelized reach extending from Gavins Point Dam downstream for approximately 95 Rkm (59 Rmi) side channel and backwater habitats have changed (Yager et al. 2011). Changes include 77% and 37% reductions, respectively, in total and mean area of side channels, as well as decreases of 79% and 42%, respectively, in total and mean length of side channels (Yager et al. 2011). Channelization of the Missouri River downstream from this reach has reduced water surface area by half, doubled current velocity, decreased habitat diversity, and decreased sediment transport (Funk and Robinson 1974; USFWS 2000a).

Although the Missouri River downstream of Gavins Point Dam is not impounded, it is influenced by the operation of upstream dams. Additionally, nearly all major tributaries to this reach have one or more dams which cumulatively affect flows and sediment transport. Damming and channelizing the Missouri River and tributaries adversely affects Pallid Sturgeon (USFWS 2000a, 2003).

MISSOURI RIVER TRIBUTARIES

At the time of listing, few observations of Pallid Sturgeon occurred in waters outside of the main-stem Mississippi, Missouri, and Yellowstone rivers; tributary observations were attributed to special circumstances associated with high-flow conditions (55 FR 36641-36647). While historical captures of Pallid Sturgeon occurred near the mouths of tributaries or within close proximity to tributary confluences with the Missouri River, more recent observations indicate that Missouri River tributaries may be more important than originally recognized when the species was listed. These habitats appear to be important to the Pallid Sturgeon during certain times of the year or perhaps during certain life stages. Tributaries identified below are based on documented observations of Pallid Sturgeon and should not be considered a definitive list. This list may be revised if new data become available.

Marias River

Historically, the Marias River (Figure 4) influenced the Missouri River downstream from their merger. The influence of the Marias River on the Missouri River is not only limited to physical features but also affects the fish communities. Several large migratory species such as Paddlefish (*Polyodon spathula*), Blue Sucker (*Cycleptus elongatus*), and Shovelnose Sturgeon presently or historically were known to migrate up the Marias River, presumably to spawn (Gardner and Jensen 2007). It is possible that Pallid Sturgeon also may have historically migrated up the Marias River to spawn. Operations of Tiber Dam (Figure 4) on the Marias River at Rkm 132 (Rmi 82) have now altered the natural flow and sediment regime of the Marias River and may have affected its use by fish species including Pallid Sturgeon (Gardner and Jensen 2007). While historical data documenting occupation by wild Pallid Sturgeon are absent, hatchery-reared Pallid Sturgeon recently have been captured in the lower 1 Rkm (0.6 Rmi) (Gardner 2010).

Milk River

The Milk River (Figure 4) is ecologically important to the Missouri River downstream of Fort Peck Dam as it contributes flows, sediment, and warmer water temperatures. The Milk River is subject to irrigation diversions that can substantially alter the hydrograph in this system. Correspondingly, several barriers effectively block migrations within this system. The lowermost is Vandalia Diversion Dam (Figure 4) located near Rkm 188 (Rmi 117). In 2004, a radio-tagged wild adult Pallid Sturgeon was documented in the Milk River approximately 4 Rkm (2.5 Rmi) above the confluence with the Missouri River (Braaten and Fuller 2005; Fuller in litt., 2011). Additionally, a radio-tagged adult was reported entering the Milk River in 2010 (Fuller and Haddix 2012), and subsequently in 2011, 4 males and 1 female migrated into the Milk River;

the furthest upstream location was approximately 57.9 Rkm (36 Rmi) (Fuller in litt., 2011; Fuller and Haddix 2012)

Yellowstone River

The Yellowstone River is the largest tributary to the Missouri River (Figure 4). While often referred to as "the last undammed river," this descriptor is a misnomer. At about the same time that Forbes and Richardson (1905) were describing Pallid Sturgeon as a species, the first and lowermost of six low-head diversion dams was being constructed across the river. This structure, Intake Dam (Figure 4), was constructed by the Bureau of Reclamation approximately 115 Rkm (71 Rmi) from the confluence with the Missouri River and effectively limits upstream movements of Pallid Sturgeon (Bramblett and White 2001) and entrains fish from the river into the irrigation delivery canal (Jaeger et al. 2005).

Adult Pallid Sturgeon use the lower Yellowstone River seasonally, moving upstream from the Missouri River in early spring as water temperatures rise and discharge increases (Bramblett 1996; Fuller and Braaten 2012). Aggregations of adult Pallid Sturgeon in the lower Yellowstone River during late June through mid-July have been attributed to spawning activity (Bramblett 1996; Bramblett and White 2001; Fuller and Braaten 2012). Recent evidence confirms spawning occurs in the lower Yellowstone River. Fuller et al. (2008) documented a gravid female Pallid Sturgeon released her eggs where a large congregation of males were present. However, no Pallid Sturgeon larvae were documented in sampling efforts. Subsequently, in 2012, reproductive success was confirmed with the collection of a wild Pallid Sturgeon larvae (Braaten in litt., 2013). While it is suspected that spawning occurs in the lower Yellowstone River in most years (Fuller and Braaten 2012), recruitment remains undetected.

Upstream movements of both adult and juvenile Pallid Sturgeon are affected by Intake Dam. This barrier appears to be prohibiting adult fish from accessing upstream habitats which may be suitable for spawning (Bramblett and White 2001; Jaeger et al. 2005). However, to date, two hatchery-reared juvenile Pallid Sturgeon, released below Intake Dam, have been documented upstream of the dam (Backes in litt., 2013). While the specific mechanisms of migration over or around the dam are unknown, these collections suggest that Pallid Sturgeon may utilize habitats upstream of Intake Dam if they are accessible. Additionally, about half of juvenile hatchery-reared study fish released upstream of Intake Dam did not emigrate during the study period, suggesting that habitats upstream of Intake Dam may be capable of supporting Pallid Sturgeon (Jaeger et al. 2005). The prevailing hypothesis suggests that naturally-produced Pallid Sturgeon larvae in the lower Yellowstone River will drift into Lake Sakakawea as long as spawning occurs downstream of Intake Dam (Braaten et al. 2008). This information indicates that available drift distance for larvae is artificially truncated by Intake Dam on the upstream end and water levels in Lake Sakakawea at the downstream end. This lack of drift distance is an ongoing threat limiting recruitment in the upper Missouri River.

Pallid Sturgeon also have been entrained in the irrigation canal associated with Intake Dam (Jaeger et al. 2004). In 2012, a new irrigation water-control structure was completed that incorporates fish screens intended to eliminate entrainment losses. However, to date, upstream fish passage concerns at Intake Dam remain unresolved. Providing fish passage at Intake Dam can facilitate Pallid Sturgeon recovery by improving access to historically occupied habitats and providing the potential for increased larval drift distances.

Yellowtail Dam on the Bighorn River and Tongue River Dam on the Tongue River (Figure 4), both major tributaries to the Yellowstone River, have altered sediment transport and flows into the lower Yellowstone River. Other anthropogenic modifications on the Yellowstone River include bank stabilization projects to protect private property and transportation infrastructure, as well as municipal, industrial, and agricultural water withdrawal projects.

Niobrara River
Wild Pallid Sturgeon were documented in the lower Niobrara River (Figure 2) around the mid-1900s (Mestl in litt., 2011). Since that time, the lower reach of the Niobrara River has been affected by rapid aggradation due to the siltation at the head of Lewis and Clark Lake on the Missouri River. Approximately 2.2 to 2.8 m (7.5 to 9.5 ft) of aggradation, observed since the 1950s, has changed the lower Niobrara River from a "relatively deep, stable channel with large, bank-attached braid bars to a relatively shallow aggrading channel with braid bars" (Skelly et al. 2003). It is not known to what degree channel aggradation has affected habitats for Pallid Sturgeon.

Pallid Sturgeon habitat in the lower Niobrara River also may be affected by water withdrawals. The Nebraska Department of Natural Resources declared a portion of the lower Niobrara River as fully appropriated (Nebraska 2007), but the Nebraska Supreme Court reversed the fully appropriated designation in 2011 (Nebraska in litt., 2011). Although habitat suitability has changed substantially over the last five decades, the Niobrara River still retains braided channels with shifting sand bars representative of pre-channelization conditions of rivers throughout the Pallid Sturgeon's historical range (Peters and Parham 2008). Recently, three hatchery-reared Pallid Sturgeon originally released in the Missouri River were documented in the Niobrara River downstream of Spencer Dam (located at approximately Rkm 63 (Rmi 39) (Figure 3)); two were approximately 1.6-1.9 Rkm (1.0-1.2 Rmi) upstream of the confluence with the Missouri River while the other was approximately 9.6 Rkm (6 Rmi) upstream of the confluence (Wanner et al. 2010). Additional data are necessary to determine what role this tributary serves for the recovery of Pallid Sturgeon.

James River
The James River (Figure 4) is a north to south flowing prairie river that joins the Missouri River near Yankton, South Dakota. While historical data documenting occupation by Pallid Sturgeon are absent, a telemetry tagged adult pallid sturgeon moved 5.3 Rkm (3.3 Rmi) up the James River during its upstream spawning migration in 2011. It was subsequently recaptured downstream after spawning, though it is uncertain whether it spawned in the James River or in the Missouri River downstream of the confluence (DeLonay in litt., 2013). Additional data are necessary to determine what role this tributary serves for the recovery of Pallid Sturgeon.

Big Sioux River
The Big Sioux River (Figure 4) is a north to south flowing prairie river that originates in South Dakota and drains into the Missouri River downstream of Gavins Point Dam, the lowermost dam on the Missouri River. Historical observations of Pallid Sturgeon in this system are absent.

However, there is one contemporary report of an angler caught Pallid Sturgeon approximately 112 Rkm (70 Rmi) upstream of the confluence with the Missouri River (Stukel in litt., 2009) as well as documentation of one tagged Pallid Sturgeon that moved upstream 21.1 Rkm (13.1 Rmi) into this river from the Missouri River (DeLonay et al. 2009). Additional data are necessary to determine what role this tributary serves for the recovery of Pallid Sturgeon.

Platte River

The Platte River (Figure 4) is a Missouri River tributary downstream of Gavins Point Dam. With increased sampling efforts, a corresponding increase in the numbers of both hatchery-reared and presumed-wild Pallid Sturgeon have been observed in the lower Platte River (i.e., the Loup River Power Canal outlet near Columbus, Nebraska downstream to the confluence with the Missouri River) since the species was listed. Pallid Sturgeon have been well documented within the lower-most reaches of this river (i.e., up to the Elkhorn River confluence) (Snook et al. 2002; Swingle 2003; National Research Council 2005; Peters and Parham 2008). More recently there have been increased observations of Pallid Sturgeon upstream of the confluence of the Platte and Elkhorn rivers; effectively extending the contemporary range up to near Columbus, Nebraska (Hamel in litt, 2010; Hamel and Pegg 2013). Additionally, Pallid Sturgeon have been documented in the Platte River during the spring, summer and fall periods (Hamel in litt., 2009; Hamel and Pegg 2013). Finally, limited data indicate that the lower Platte River is likely used for spawning (Swigle 2003; Chojnacki in litt., 2012). These data indicate the lower Platte River provides suitable habitat, supports multiple life stages of the species, and should be viewed as important for species recovery.

Although not developed as a navigation corridor, the Platte River has been influenced by anthropogenic alterations that likely affect Pallid Sturgeon habitat. Water demands for industrial, municipal, and agricultural purposes led to construction of low-head diversion dams on the upper Platte River as well as large impoundments on the Platte River and its tributaries. Eschner et al. (1983) state that the Platte River and its tributaries "…have undergone major changes in hydrologic regime and morphology since 1860." These authors describe a process where islands eventually attached to the floodplain, became vegetated, and eventually fixed in place resulting in decreased channel widths. These authors attribute many of these changes in channel morphology to water development and diversions. Similarly, Rodekohr and Englebrecht (1988) noted the Platte River is more constricted than it was in 1949. Despite some of these changes, there appears to be sufficient beneficial qualities within the lower Platte River, such that Pallid Sturgeon occupy and utilize this reach (Swigle 2003; National Research Council 2005: Peters and Parham 2008; Hamel and Pegg 2013). However, the availability and quality of habitat within the lower Platte River can be affected by water withdrawal in conjunction with periods of drought (National Research Council 2005). Sampling within the Missouri River near the confluence of the Platte River also results in substantially more Pallid Sturgeon captures when compared against other Missouri River sampling sites downstream to the Kansas River confluence (Steffensen and Hamel 2007, 2008). This suggests that the Platte River not only provides suitable habitat, but it also provides some positive benefits to Pallid Sturgeon habitat in the Missouri River.

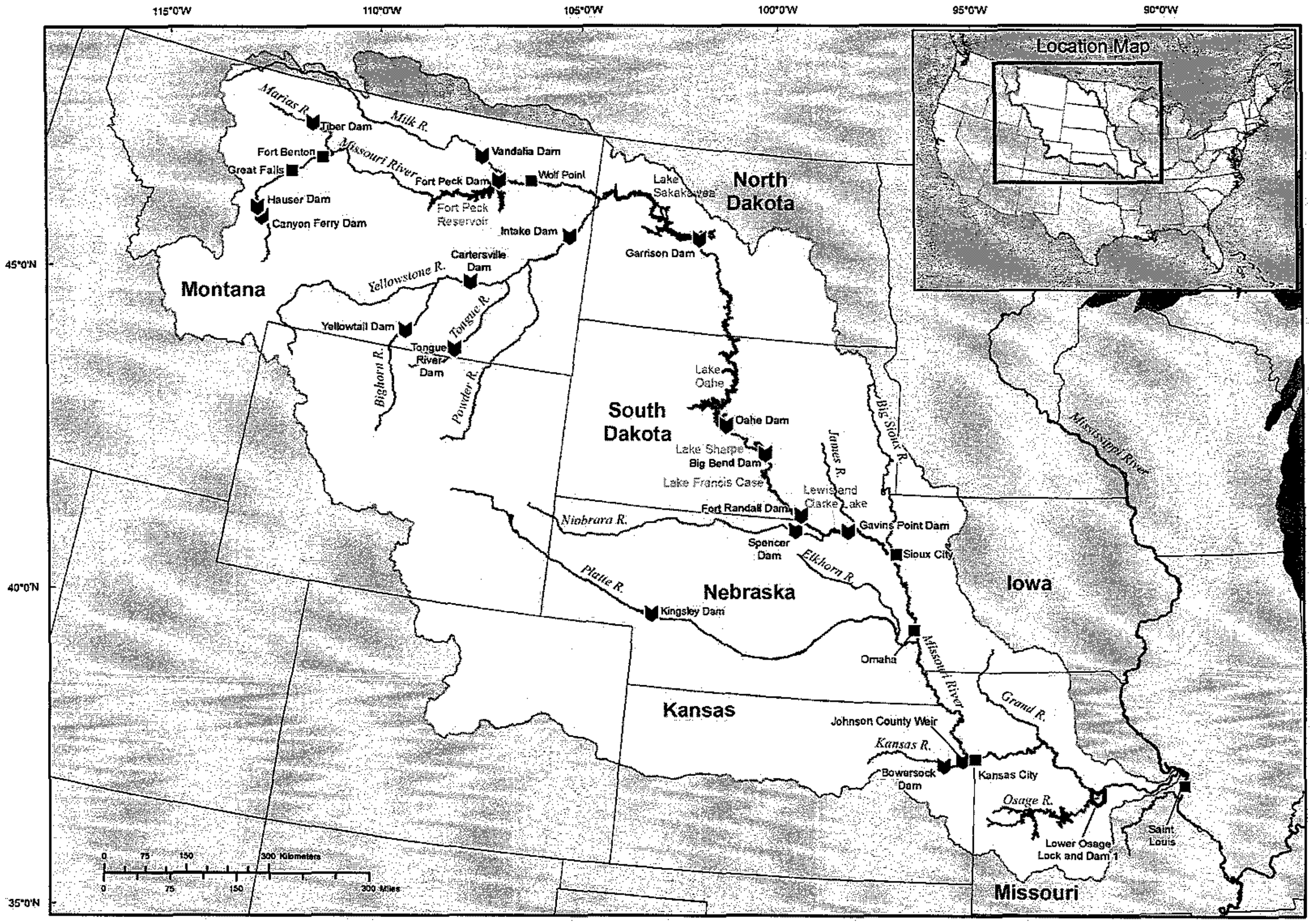

Figure 4 Map of prominent structures within the Missouri River Basin.

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Elkhorn River
The Elkorn River is a north-west to south-east flowing tributary to the lower Platte River (Figure 4). When Pallid Sturgeon were listed, this river served merely as a reference point demarking its confluence with the Platte River as the upstream extent of Pallid Sturgeon in the Platte River. However, this river possesses many characteristics of streams currently used by Pallid Sturgeon and there are documented occurrences of Pallid Sturgeon in the Elkhorn River. Nebraska Game and Parks Commission records report angler catches of two Pallid Sturgeon; one each in 1999 and 2002 (National Research Council 2005). The 2002 record is reported to have occurred three miles upstream of Snyder, Nebraska, effectively extending the contemporary range of Pallid Sturgeon in this river (Figure 3). Additional data are necessary to determine what role this tributary serves for the recovery of Pallid Sturgeon.

Kansas River
The Kansas River (Figure 4) has anthropogenic alterations that likely affect some aspects of Pallid Sturgeon life history. Bowersock Dam (Rkm 82, Rmi 51) near Lawrence, Kansas was constructed in the 1870s (Figure 4). In 1952 six juvenile specimens (294-415 mm, 11.6-16.3 in) were collected below this dam during a period of record flooding (Bailey and Cross 1954). Because this barrier was installed prior to Pallid Sturgeon being identified as a species, there is little historical occupancy data for reaches upstream. The Johnson County Weir is another potential barrier to Pallid Sturgeon movement in the lower Kansas River (Rkm 23.7, Rmi 14.7). This structure was built in 1967 to maintain sufficient water delivery for municipal purposes. To date, 15 Pallid Sturgeon, most confirmed to be of hatchery origin (Niswonger, in litt., 2011), have been collected from the lower Kansas River. All known hatchery fish were originally stocked in the Missouri River.

Osage River
The Osage River is one of the larger Missouri River tributaries in Missouri (Figure 4). Pallid Sturgeon have been documented near the confluence of the Osage and Missouri rivers, including three hatchery-reared Pallid Sturgeon in the lower Osage River between Lock and Dam #1 (Rkm 19.4; Rmi 12.1) and the confluence with the Missouri River in 2010 (USFWS 2010, 2012).

Grand River
The Grand River (Figure 4) is a turbid tributary that was highly channelized during the same period that Pallid Sturgeon were likely declining. However, this system continues to support a predominantly native fish assemblage with species such as Lake Sturgeon occasionally being captured. While historical data documenting occupation by Pallid Sturgeon are absent, hatchery-reared Pallid Sturgeon have been captured in the lower 3 Rkm (1.8 Rmi) (Chillicothe News in litt., 2009; DeLonay et al. 2009).

MISSISSIPPI RIVER
The Mississippi River (Figure 5) is often divided into upper, middle and lower reaches. Like the Missouri River, the Mississippi River has been anthropogenically altered, beginning in the early portions of the 18^{th} century as the French began to settle along the Mississippi River (Cowdrey 1977). These early efforts were generally localized and limited in scope. It was not until the 19^{th} century that large-scale efforts to improve navigation and flood control began to have more substantial impacts. Snagging (removing dead trees from the river) was one of the first efforts to

facilitate using the river as a transportation corridor. In the early 1800s and funded with Federal appropriations, snag boats removed large woody debris from the middle and lower Mississippi River between St. Louis, Missouri and New Orleans, Louisiana (Simons et al. 1974; Cowdrey 1977).

The next major efforts to improve navigation involved maintaining navigable channels. In the mid-1800s, construction of jetties and dredging provided the first successful large-scale reduction of sediment deposition and the subsequent forming of sandbars that blocked shipping routes (Cowdrey 1977). Flood control became an increasingly important focus of the United States Congress as more people settled in the Mississippi River valley and the human costs of flood damage increased. Small and localized levee systems were in existence in the 1700s; however, it was not until the 19th and 20th centuries that levee networks increased in size and scope. As the levee system was completed, flood stages increased resulting in the need to shunt flood waters from the river (Cowdrey 1977). Following the flood of 1927, the Flood Control Act of 1928 included provisions for strengthening and raising existing levees and included floodways and spillways (Cowdrey 1977); examples of the latter being the Birds Point-New Madrid floodway, the Old River Control Complex, the Morganza floodway, and the Bonnet Carré spillway (Figure 5).

In addition to the dams on the upper Missouri River, flows into the middle and lower Mississippi River also are influenced by a series of locks and dams in the upper Mississippi and Ohio rivers. The earliest lock and dam structures were constructed in 1867 near Keokuk, Iowa. By 1940, the locks and dams from Minneapolis, Minnesota down to Alton, Illinois, were in place and operational. Finally, revetments and various structures have been used to reduce erosion and restrict flows in many areas. Willow mattresses and cypress pilings, later replaced by articulated concrete mats and rock riprap, were used to prevent loss of riparian land and control flow patterns (Cowdrey 1977). This reduction in river bank erosion has reduced the amount of sediments and large woody debris entering the system. Subsequent loss of connectivity and channel sinuosity occurred as habitats were channelized and off-channel habitats became isolated from normal riverine flow. Modifications to the Mississippi River occurred largely from construction of the locks and dams, levees, tributary alterations, channel cut-offs, and channel maintenance structures.

Upper Mississippi River

The upper Mississippi River, as it relates to Pallid Sturgeon, is defined as being upstream of the confluence of the Missouri and Mississippi rivers to Lock and Dam 19 near Keokuk, Iowa (Figure 5). This reach is approximately 260 Rkm (162 Rmi) in length. The lower most lock and dam (Lock and Dam 26 near Alton, Illinois) is located approximately 8 Rkm (5 Rmi) upstream of the Missouri-Mississippi river confluence (Figure 5). Although fish passage through the six lock and dam structures is impeded for many species, it can occur through the lock chamber or the dam gates during flood events. A single historical Pallid Sturgeon observation in the upper Mississippi River near Keokuk, Iowa (Coker 1929) was considered as "dubious" and likely to represent "stragglers" (Bailey and Cross 1954). Recent sampling, however, has documented the movement of several Pallid Sturgeon through the lowermost locks and dams from the middle Mississippi River into the pools of the upper Mississippi River (Herzog in litt., 2009; Herzog

2010). The extent of use within this impounded reach of the upper Mississippi River is poorly understood and further research is needed to assess its role in species recovery.

Middle Mississippi River

The middle Mississippi River is defined as the Missouri-Mississippi river confluence near St. Louis, Missouri to the Mississippi-Ohio river confluence near Cairo, Illinois (Figure 5). This reach is approximately 313 Rkm (195 Rmi) in length.

In 1881, Congress approved plans to regulate the middle Mississippi River, and by 1973 this reach of the Mississippi River had experienced levee construction, more than 160 km (100 mi) of revetments, and installation of more than 800 dikes to maintain a minimum navigation channel depth of 2.7 meters (9 feet) (Simons et al. 1974). Lock and Dam 27, (Chain of Rocks dam and canal) is located at Rkm 298.5 (Rmi 185.5) near Granite City, Illinois. The canal structure was completed to facilitate navigation around the shallow bedrock that occurred in this reach. Large quantities of rock were dumped over the existing bedrock to create a low-head dam necessary to make the lock canal navigable. Although no Pallid Sturgeon have been documented in the canal, both Pallid and Shovelnose sturgeon concentrate below the Chain of Rocks dam during fall and winter low-flow events (Killgore et al. 2007a).

The cumulative effects of these alterations include an average reduction in river width, river bed degradation, a slight increase in the maximum river stage, a reduction in minimum river stage, and a constricted flood plain (Simons et al. 1974).

Lower Mississippi River

The lower Mississippi River (LMR) is defined as the Mississippi River from the Mississippi-Ohio rivers confluence to the Gulf of Mexico (Figure 5). This reach of the contemporary river is approximately 1,541 Rkm (958 Rmi) in length.

Between 1929 and 1942, bendway cutoffs shortened the LMR by 245 Rkm (152 Rmi) over a 809 km (503 mi) reach (Winkley 1977). The LMR was reduced an additional 88.5 Rkm (55 Rmi) between 1939 and 1955 by constructing artificial channels that bypassed natural river meanders (Winkley 1977). This channel length reduction resulted in the river entrenching in steeper gradient reaches and eroding large amounts of material from the channel banks and bed. Deposition of this material in the lower gradient reaches resulted in a semi-braided channel, and by the 1970s, the river began to reestablish a meandering condition (Winkley 1977). Dikes and bank armoring have been employed in the LMR to stabilize the channel and direct flows to reduce the need for dredging.

Levee construction began in the New Orleans area in the 1700s. Today, excluding a few tributary mouths, levees line the west side of the river and fill in low areas between natural bluffs on the east side (Cowdrey 1977; Baker et al. 1991). These levees are estimated to have reduced the floodplain area by as much as 90% depending on flood magnitude (Baker et al. 1991). Although the LMR channel has been enclosed by levees, numerous and extensive sandbars, vegetated and seasonal islands, and secondary channels remain, equating to a 1.6 million acre floodplain that retains floodplain backwaters and sloughs that are seasonally connected to the river (Schramm et al. 1999). Despite extensive alteration, the lower Mississippi River retains significant amounts of in-channel complexity and floodplain connectivity thought to be important to Pallid Sturgeon.

MISSISSIPPI RIVER TRIBUTARIES

As previously stated, data post-listing indicate that main-stem tributaries and tributary confluences may be used more frequently than previously recognized. Several captures of Pallid Sturgeon have occurred within tributaries, near the mouth of tributaries, and within close proximity to tributary confluences with the Mississippi River. These habitats may be important to the Pallid Sturgeon during certain times of the year or perhaps during certain life stages.

Meramec River

This tributary to the middle Mississippi River, located near Rkm 254 (Rmi 158) (Figure 5), is a large river within Missouri that contains transitional habitats within its lower reaches. There are no historical accounts of Pallid Sturgeon in this river; however, Pallid Sturgeon have been documented in the Mississippi River near the Meramec River confluence (Koch et al. 2006a). It is not known whether Pallid Sturgeon historically migrated within this system, and additional data are necessary to determine what role this tributary serves for the recovery of Pallid Sturgeon.

Kaskaskia River

The Kaskaskia River is located near Rkm 188 (Rmi 117) near Chester, Illinois (Figure 5). This is Illinois' second largest river system at 515 Rkm (320 Rmi) long draining about 10% of the State. Several Pallid Sturgeon have been documented at the confluence with the Mississippi River (Koch et al. 2006a). While movement into the Kaskaskia River by Pallid Sturgeon has not been documented, movement into this river may be impeded by a lock and dam near the mouth. In addition, the watershed of the Kaskaskia River has been modified over the last 100 years by urbanization, channelization, and levee and dam construction. It is unknown whether Pallid Sturgeon historically migrated within this system, and additional data are needed to determine if this tributary serves any role for the recovery of Pallid Sturgeon.

Ohio River

The Ohio River (Figure 5) is the largest tributary to the Mississippi River system within the range of Pallid Sturgeon. While Pallid Sturgeon have been collected from the Mississippi River near the Ohio River confluence, there are no recent reports of Pallid Sturgeon and no confirmed records of presence in this system. It is possible Pallid Sturgeon could occur in this river up to the Olmstead Lock and Dam (Figure 5), but additional data are needed to determine if this tributary serves any role for the recovery of Pallid Sturgeon.

Obion River

A single Pallid Sturgeon has been documented in the Obion River (Figure 5). This fish was originally tagged in the Mississippi River near Osceola, Arkansas and was subsequently recaptured in the Obion River near Bogota, Tennessee (Killgore et al. 2007b). It is unknown whether Pallid Sturgeon historically migrated within this system and additional data are needed to determine if this tributary serves any role for the recovery of Pallid Sturgeon.

Saint Francis River

The Saint Francis River (Figure 5) flows through south-east Missouri into Arkansas where it confluences with the Mississippi River. In 1994 hatchery-reared Pallid Sturgeon were documented in the lower Saint Francis River (Graham in litt., 1994) downstream from the W. G. Huxtable Pumping Plant (Figure 5). Subsequently, a tagged female Pallid Sturgeon was found to have entered the Saint Francis River in 2013. This fish remained in the river April 14-17. (Lewis in litt., 2013). Additional data are necessary to better understand use of this river by Pallid Sturgeon and what role this river serves in Pallid Sturgeon recovery efforts.

Arkansas River

The Arkansas River (Figure 5) confluences with the Mississippi River near Rkm 933 (Rmi 580). Pallid Sturgeon currently can access the lower 64 Rkm (40 Rmi) from the confluence with the Mississippi River upstream to the Wilbur D. Mills Dam. To date, three Pallid Sturgeon have been documented entering this lower reach during the late-winter through spring (February – April) (Kuntz in litt., 2012). Additional efforts are ongoing to better understand usage of this tributary by Pallid Sturgeon and what role this tributary serves for the recovery of Pallid Sturgeon.

Red River

The Red River (Figure 5) was a tributary to the Mississippi River during the 19th and early 20th centuries. However, anthropogenic alterations in the 1960s connected the Red River with the Atchafalaya River when the Old River Control Complex was completed. While historical Pallid Sturgeon presence data are lacking, contemporary observations have documented a limited number of Pallid Sturgeon in the lower Red River; specifically the reaches downstream from Lock and Dam 3 (Slack et al. 2012). Additional data are necessary to better understand use of this river by Pallid Sturgeon and what role this river serves in Pallid Sturgeon recovery efforts.

Atchafalaya River

The Atchafalaya River (Figure 5) is a distributary of the lower Mississippi River that begins just south of Cochie, Louisiana and extends downstream to Morgan City, Louisiana (Rkm 180/Rmi 112), where it flows into the lower Atchafalaya River and ultimately to the Gulf of Mexico. At approximately Atchafalaya River Rkm 156 (Rmi 97), the Wax Lake Outlet was constructed in 1942, providing a shorter route for flood waters to leave the Atchafalaya River. Prior to 1859, the Atchafalaya River received Mississippi River water from overbank flooding. Snagging and channel excavation to support of navigation during the late 19th and early 20th centuries resulted in channel enlargement and increased flows into the Atchafalaya River from the Mississippi and Red rivers. By the 1950s the Atchafalaya River threatened to capture most of the lower Mississippi River flow and in 1963 the U.S. Army Corps of Engineers constructed the Old River Control Complex to prevent this capture by regulating flows into the Atchafalaya River.

The Old River Control Complex (i.e., Low Sill, Overbank, and Auxiliary) at approximately Mississippi Rkm 505 (RM 314) can carry a combined maximum discharge of 700,000 cfs. With the completion of the Sidney A. Murray, Jr. Hydroelectric Station in 1990, just upstream of the Old River Control Complex, the flows are now split between the hydroelectric station and the Old River Control Complex structures with flows released to maximize hydro-power production.

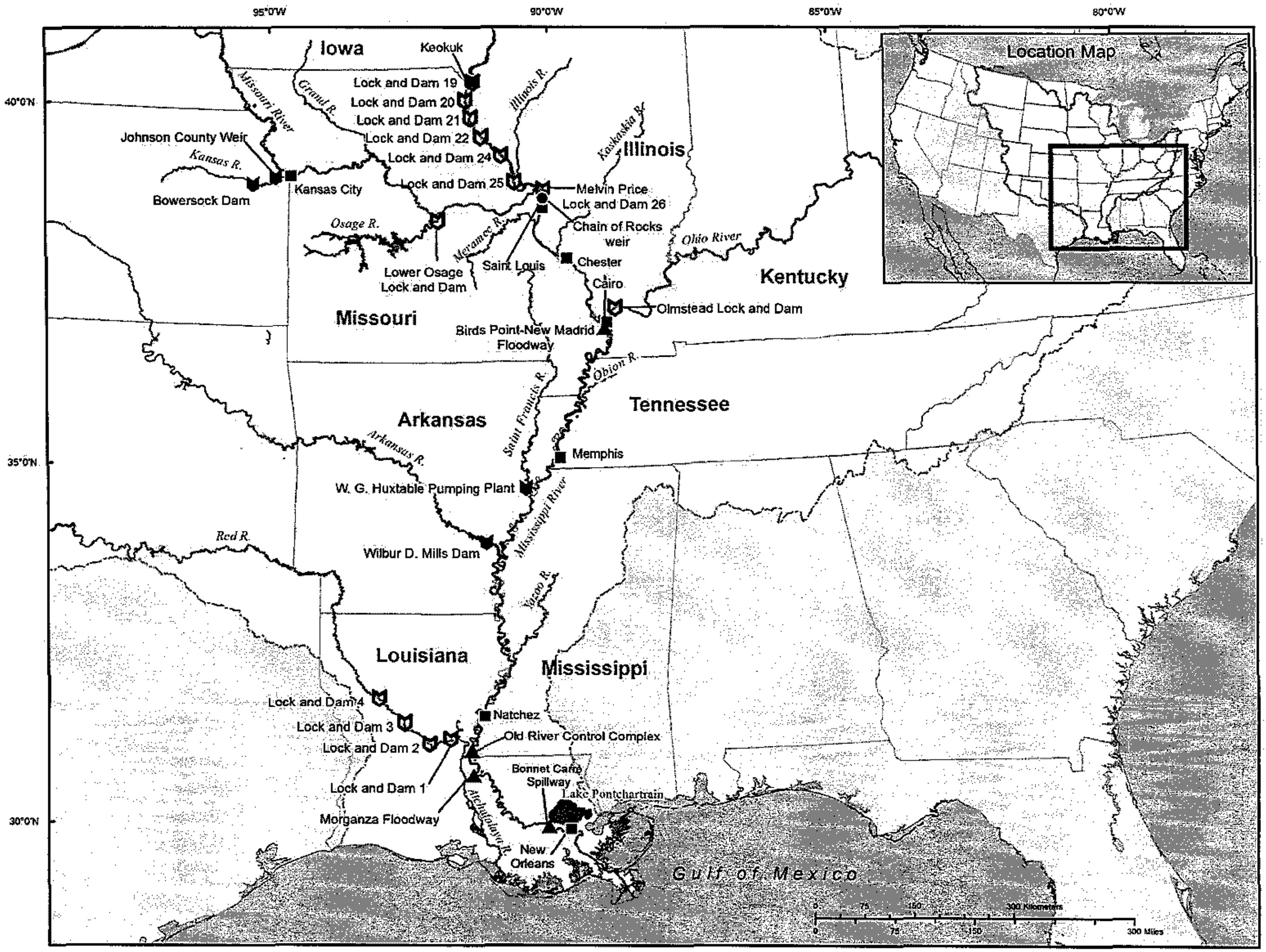

Figure 5 Map of prominent structures in the Mississippi River Basin.

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The Old River Control Complex, in coordination with the hydro-power plant, carries 30% of the combined discharge from the Mississippi and Red rivers, maintaining Mississippi River discharge into the Atchafalaya River at levels comparable to the 1950s. The Atchafalaya River has been leveed to prevent flooding of communities and agricultural lands from Rkm/Rmi 0 to Rkm 85 (Rmi 53). Downstream of Rkm 85, the river levees only contain flows less than the average annual discharge; all greater discharges flow overbank. Most Pallid Sturgeon reported from this river have been captured immediately below the Old River Control structures where almost all sampling occurs (Reed and Ewing 1993). However, Pallid Sturgeon use of the middle and lower Atchafalaya River has been documented (Constant et al. 1997; Schramm and Dunn 2007, Herrala and Schramm 2011).

There is no evidence that Pallid Sturgeon occupied the Atchafalaya River distributary prior to the mid-20th century capture of Mississippi River flows. To date, hatchery fish released in the Mississippi River below Natchez, Mississippi (2 specimens), and above Memphis, Tennessee (1 specimen) have been captured in the Atchafalaya River; confirming that Pallid Sturgeon can be entrained from the Mississippi River into the Atchafalaya River. It is possible that many of the Pallid Sturgeon observations in the Atchafalaya River are the result of entrainment from the Mississippi River; the magnitude of which has not been quantified.

Summary of Impacts from River Channelization, Bank Stabilization, Impoundment, and Altered Flow Regimes

The species was essentially extirpated from approximately 28% of the historical range due to impoundment, and the remaining unimpounded range has been modified by channelization and bank stabilization, or is affected by upstream impoundments that alter flow regimes, turbidity, and water temperatures (Hesse et al. 1989; Keenlyne 1989; USFWS 2000a). River channelization, bank stabilization, impoundment, altered flow regimes, and their effects are documented throughout the range of the Pallid Sturgeon and each can negatively affect Pallid Sturgeon life history requirements. The most obvious effects to habitat are associated with the six main-stem Missouri River dams. These dams and their operations have: 1) truncated drift distance of larval Pallid Sturgeon (Kynard et al. 2007; Braaten et al. 2008), 2) created physical barriers that block normal migration patterns, 3) degraded and altered physical habitat characteristics, 4) greatly altered the natural hydrograph (Hesse et al. 1989), and 5) produced subtle changes in river function that influence both the size and diversity of aquatic habitats, connectivity (Bowen et al. 2003), and benthos abundance and distribution (Morris et al. 1968). Moreover, these large impoundments have replaced large segments of riverine habitat with lake conditions. River channelization, and bank stabilization within the Missouri River basin has altered river features such as channel morphology, current velocity, seasonal flows, turbidity, temperature, nutrient supply, and paths within the food chain (Russell 1986; Unkenholz 1986; Hesse 1987). In addition to the main-stem Missouri River dams, important tributaries like the Yellowstone, Platte, and Kansas rivers have experienced similar affects due to dams and water resource development, as well as bank stabilization efforts within their respective watersheds. Other issues that have influenced habitat formation and maintenance are associated with maintaining navigation channels on portions of the Missouri River and efforts to control flooding. The Mississippi River has received a substantial amount of anthropogenic modification through time, and some changes resulting from those modifications have likely been detrimental to Pallid Sturgeon. These anthropogenic habitat alterations likely adversely affect Pallid Sturgeon by altering the natural form and functions of the Mississippi River (Simons et al. 1974; Baker et al. 1991; Theiling 1999; Wlosinski 1999). Anthropogenic alterations to tributaries may have contributed to habitat degradation in the Mississippi River as well. Impoundment of major tributaries reduced sediment delivery to the main channel (Fremling et al. 1989) resulting in channel degradation and reduction in shallow water habitats (Simons et al. 1974; Bowen et al. 2003). Thus, the effects from dams, bank stabilization, and channelization activities, individually and cumulatively when implemented within the range of Pallid Sturgeon, should be considered threats to the species.

WATER QUALITY

Much of the available information regarding the likely effects to Pallid Sturgeon from contaminants comes from information obtained for Shovelnose Sturgeon, which can be used as a surrogate species to evaluate environmental contaminant exposure. Shovelnose Sturgeon are considered a suitable surrogate species for Pallid Sturgeon in that they live for 20 years or longer, inhabit the same river basins, spawn at similar intervals and locations, and accumulate similar inorganic and organic contaminants (Ruelle and Keenlyne 1994; Buckler 2011). However, while inferences can be drawn from data related to Shovelnose Sturgeon, limitations of using this species as a surrogate for Pallid Sturgeon are based on life history differences between the two species. Pallid Sturgeon have a longer life-span, attain a larger size, are more piscivorous, and contain a higher percentage of body fat (Ruelle and Keenlyne 1994). These differences may contribute to different contaminant effects or pathways; Pallid Sturgeon may be at greater risk than Shovelnose Sturgeon to contaminants that bioaccumulate and cause reproductive impairment because they have a more piscivorous diet, greater maximum life-span, and a longer reproductive cycle than Shovelnose Sturgeon.

Contaminants /Pollution: Contaminants detected in Shovelnose Sturgeon throughout the Missouri, Mississippi, Platte, and Atchafalaya rivers include: organochlorines, metals, aliphatic hydrocarbons, polycyclic aromatic hydrocarbons, polychlorinated biphenyls (PCBs), and elemental contaminants (Allen and Wilson 1991; Welsh 1992; Welsh and Olson 1992; Ruelle and Henry 1994; Palawski and Olsen 1996; Conzelmann et al.1997; Coffey et al. 2003; Schwarz et al. 2006).

A few field studies have included Shovelnose Sturgeon health assessments in an effort to evaluate environmental contaminant exposure and effects to Pallid Sturgeon (Coffey et al. 2003; Schwarz et al. 2006). Organochlorine pesticides and PCBs were detected at concentrations of concern in Mississippi River Shovelnose Sturgeon tissue samples. Adverse health problems observed included abnormal reproductive biomarkers and enlarged livers (Coffey et al. 2003). A similar evaluation in the lower Platte River identified PCBs, selenium, and atrazine as contaminants that may adversely affect sturgeon reproduction (Schwarz et al. 2006).

Shovelnose Sturgeon collected from the Platte, lower Missouri and Mississippi rivers have exhibited intersexual characteristics (having both male and female gonad tissue) (Harshbarger et al. 2000; Wildhaber et al. 2005; Koch et al. 2006b; Schwarz et al. 2006). Intersexual Shovelnose Sturgeon from the middle Mississippi River were found to have higher concentrations of organochlorine compounds when compared to normal male Shovelnose Sturgeon (Koch et al. 2006b). One Pallid Sturgeon exhibited both male and female reproductive organs (DeLonay et al. 2009). Although the effects of intersex on sturgeon reproduction are unknown, intersex in other fish species has been linked to decreased gamete production, lowered sperm motility, and decreased egg fertilization (Jobling et al. 2002). Koch et al. (2006b) observed reduced numbers of spermatozoa in highly contaminated and intersexual Shovelnose Sturgeon that may suggest limited reproductive success.

Laboratory studies also have evaluated environmental contaminant exposure and effects to Shovelnose Sturgeon. Papoulias et al. (2003) injected unhatched Shovelnose Sturgeon larvae with PCB 126 and Tetrachlorodibenzo-p-dioxin. They found yolk sac and pericardial swelling, hemorrhaging of the eyes and head, shortened maxillaries, and delayed development. While the experimental exposure concentrations of PCB 126 was at levels beyond what might be found in the wild, the negative effects from Tetrachlorodibenzo-p-dioxin exposure concentrations were at levels that are conceivable in the Mississippi River (Papoulias et al. 2003)

To date, few studies have measured environmental contaminant concentrations in Pallid Sturgeon. Tissue samples from three Missouri River Pallid Sturgeon and 13 other Pallid Sturgeon, mostly collected from the Mississippi River had metals (e.g., mercury, cadmium, and selenium), PCBs, and organochlorine pesticides (e.g., chlordane, dichloro-diphenyl-trichloroethane, and dieldrin) at concentrations of concern (Ruelle and Keenlyne 1993; Ruelle and Henry 1994). In addition to the previously mentioned reports on contaminants in Pallid Sturgeon, raw contaminants data for Pallid Sturgeon from North Dakota, Illinois, and Louisiana are currently being compiled.

Point-source discharges may adversely affect Pallid Sturgeon and their habitat. Wastewater treatment plant effluent can contain hormonally active agents. Endocrine disruption in fish exposed to estrogenic substances discharged by wastewater treatment plants is well documented (Purdom et al. 1994; Routledge et al. 1998; Cheek et al. 2001; Schultz et al. 2003). In addition to wastewater treatment plants, drinking water treatment plants also are a concern. In April 2004, several radio-tagged Pallid Sturgeon were repelled from the mouth of the Platte River immediately following a milky discharge from a drinking water treatment facility upstream (Parham et al. 2005). Further investigation found that the facility was not in compliance with its discharge permit which expired in 1993, and that the discharge likely contained several toxic irritants including ferric sulfate, calcium oxide, hydrofluosilicic acid, chlorine, and ammonia.

Several fish consumption advisories within the range of Pallid Sturgeon are attributable to contaminants (Buckler 2011). The State of Tennessee closed commercial fishing on portions of the Mississippi River because of concerns over chlordane and other contaminants (Tennessee 2008 a and b). The Missouri Department of Health and Senior Services has issued a "do not eat" advisory for Shovelnose Sturgeon eggs and recommends consuming no more than one Shovelnose Sturgeon per month because of concerns over PCB, mercury, and chlordane levels (Missouri 2010). Illinois issued a sturgeon consumption advisory due to PCBs and chlordane levels on the Mississippi River between Lock and Dam 22 to Cairo, Illinois (Illinois 2010). The Kansas Department of Health and Environment (2010) has issued a consumption advisory for bottom-feeding fish, including sturgeon, due to PCB levels in the Kansas River downstream of

Bowersock Dam to Eudora. Fish consumption advisories have been issued for the Missouri River from Omaha to Rulo, Nebraska (Nebraska 2010). Although fish consumption advisories are for the protection of human health, river segments with such designations also have been associated with adverse health effects in the Shovelnose Sturgeon themselves, including enlarged livers, abnormal ratios of estrogen to testosterone, and intersexual characteristics (Coffey et al. 2003; Schwarz et al. 2006).

Because more information is needed to evaluate the exposure and effects of environmental contaminants to Pallid Sturgeon, a basin-wide contaminants review for Pallid Sturgeon was initiated in 2008. To date, this investigation has identified pesticides, metals, organochlorines, hormonally active agents, and nutrients as contaminants of concern throughout the species' range. Further assessments should be targeted in these areas to evaluate the exposure and effects of the impairing contaminants on Pallid Sturgeon and their reproductive physiology.

Additionally, injuries resulting from chance encounters with discarded human-made objects like gaskets and rubber bands have been documented in the Mississippi River; approximately 5% of Shovelnose Sturgeon and 9% of Pallid Sturgeon exhibit scars or deformities from such injuries (Murphy et al. 2007b). Mortalities have not been reported or estimated.

Dissolved Oxygen: Little is known about Pallid Sturgeon tolerances of low dissolved oxygen concentrations and limits have not been quantified for all life stages. However, data from other sturgeon species are insightful. In general, sturgeon are not as tolerant of hypoxic conditions (very low dissolved oxygen levels) as are other fishes (Secor and Gunderson 1998; Niklitschek and Secor 2005). Temperature and dissolved oxygen levels can affect sturgeon survival, growth and respiration with early life stages being more sensitive than adults (Secor and Gunderson 1998).

Like many sturgeon species, Pallid Sturgeon are primarily benthic organisms within 10-12 days post hatch (Kallemeyn 1983; Kynard et al. 2007). This benthic life history strategy can result in sturgeon encountering hypoxic. Like most organisms that encounter unsuitable habitats, juvenile and adult sturgeon have some ability to avoid unfavorable environmental conditions via migration (Auer 1996). In reservoirs, White Sturgeon will avoid those areas where riverine features become more lake like (transition zone) and oxygen levels approach 6 mg/l (Sullivan et al. 2003). Under hypoxic conditions, juvenile Atlantic Sturgeon will move upward in the water column to access more oxygen-rich water (Secor and Gunderson 1998).

Anthropogenic changes within the range of Pallid Sturgeon that affect dissolved oxygen concentrations could be affecting survival and recruitment. Measurements on the lower Missouri River from 2006-2009 showed that large rises in the river during spring and summer may result in dissolved oxygen levels falling to < 2 mg/l and remaining below 5 mg/l for several days (Blevins 2011). Dissolved oxygen levels of 3 mg/l and water temperatures of 22-26 °C (71.6-78.8 °F) appeared lethal for juvenile Atlantic Sturgeon and Shortnose Sturgeon (Secor and Gunderson 1998; Campbell and Goodman 2004). Reduced growth was observed in Atlantic Sturgeon at lower non-lethal levels (Secor and Gunderson 1998). In the upper Missouri River basin, larval Pallid Sturgeon are likely transported into or through reservoir transition areas. Because they are weak swimmers at this early life stage (Kynard et al. 2007), they are less able to migrate away from any encountered hypoxic conditions. Study efforts have been initiated to better evaluate the effects of riverine to reservoir transition areas on Pallid Sturgeon survival.

Temperature: The Pallid Sturgeon is ectothermic, that is its body temperature is dependent on water temperatures. As a result, water temperatures influence nearly every aspect of the Pallid Sturgeon's life history requirements. As described previously, water temperatures affect rates of sexual maturity, spawning migrations, gonad development, rates of embryonic development, larval drift distances, and habitat quality (Keenlyne 1995; Kynard et al. 2002; U.S. Geological Survey 2007; Braaten et al. 2008; DeLonay et al. 2009; Webb in litt., 2011).

Anthropogenic changes within the range of Pallid Sturgeon that have substantially affected historical water temperatures are bottom release dams. The water in deep reservoirs thermally stratifies resulting in a colder and denser water layer at depth. When this cold water is released, it substantially cools the riverine environments downstream. As an example, average and maximum water temperatures immediately downstream of Fort Peck Dam can be reduced by as much as 6° C (10.8° F) and 10.4° C (18°F), respectively (Fuller and Braaten 2012). While the magnitude of these effects decrease with increased distance from the dam, these cooling effects still influence 290 Rkm (180 Rmi) of the Missouri River downstream. Even at this distance, the average and maximum temperatures are still 1° C (1.8° F) cooler than Missouri River reaches above Fort Peck Reservoir (Fuller and Braaten 2012).

Thus, the altered temperature profiles of riverine habitats downstream from large bottom-release dams influence nearly every aspect of the life-history requirements and habitats of Pallid Sturgeon. While the magnitude of effects from altered temperature profiles vary by dam, they may be the most problematic in the inter-reservoir reservoir reaches of the impounded Missouri River.

Summary of Impacts related to Water Quality

Overall water quality can have both immediate and long-term effects on the species. New information, post-listing suggests that water quality can impact Pallid Sturgeon during many life phases and localized and/or regionally poor or degraded water quality should be viewed as a threat to the species. However, additional data are needed to quantify and qualify the magnitude of these threats in some river reaches.

ENTRAINMENT

Another issue that can cumulatively have negative consequences for Pallid Sturgeon range-wide is entrainment loss. The loss of Pallid Sturgeon associated with cooling intake structures for power facilities, towboat propellers, dredge operations, irrigation diversions, and flood control points of diversion has not been fully quantified, but entrainment has been documented for both Pallid and Shovelnose sturgeon.

Adult Shovelnose Sturgeon (and likely adult Pallid Sturgeon) exhibit relatively high prolonged swimming speeds (Adams et al. 1997; Parsons et al. 2003) and would be at lower entrainment risk than young fish. Juvenile Pallid and Shovelnose sturgeon exhibit comparable swimming abilities (Adams et al. 2003). They are not strong swimmers relative to other species and are at greater risk of entrainment (Adams et al. 1999a), but they also exhibit a variety of complex swimming behaviors which may increase their ability to resist flow (Hoover et al. 2005). *Scaphirhynchus* larvae are weak swimmers and experience high rates of mortality under simulated propeller entrainment and high rates of stranding under simulated vessel-induced drawdown (Adams et al. 1999b; Killgore et al. 2001).

Water Cooling Intake Structures: Preliminary data on the Missouri River indicate that these structures may be a threat that warrants more investigation. Initial results from work conducted by Mid-America at their Neal Smith power facilities located downstream of Sioux City, Iowa, found hatchery-reared Pallid Sturgeon were being entrained (Burns & McDonnell Engineering Company, Inc. 2007a and 2007b). Over a 5-month period, four known hatchery-reared Pallid Sturgeon were entrained, of which two were released alive and two were found dead.

Towboat propellers: Empirically derived propeller entrainment data for Pallid Sturgeon are lacking. However, available propeller entrainment data for Shovelnose Sturgeon collected in the Mississippi River upstream of Lock and Dam 26 (Figure 5), indicates it occurs and can be lethal (Killgore et al. 2011; Miranda and Killgore 2013) with mortality estimates being as high as 0.53 Shovelnose Sturgeon per 1 Rkm (0.6 Rmi) of towboat travel (Gutreuter et al. 2003). Because barge operation occurs in waters occupied by Pallid Sturgeon and propeller entrainment induced mortality has been documented for Shovelnose Sturgeon, it is reasonable to conclude that towboat propellers can entrain and harm Pallid Sturgeon. However, comparable studies have not been conducted in waters commonly occupied by Pallid Sturgeon, thus, the magnitude of this threat is difficult to assess and additional research is needed.

Dredge Operations: The U.S. Army Corps of Engineers has initiated work to assess dredge entrainment of fish species and the potential effects that these operations may have on larval and juvenile *Scaphirhynchus.* Available data collected in the middle Mississippi River near the Chain of Rocks weir (Figure 5) indicate that Shovelnose Sturgeon can be entrained and this entrainment is relatively lethal (Ecological Specialists, Inc. 2010). However, the risk of dredge entrainment is likely to vary by dredge design (i.e., mechanical or hydraulic) and swimming capabilities (Hoover et al. 2011). Dredging in locations where Pallid Sturgeon congregate could result in entrainment and mortality. Small Pallid Sturgeon likely are at risk of being entrained in dredges and additional data for escape speed, position-holding ability, orientation to the current and response to noise, and dredge flow fields are being used to develop a risk assessment model for entrainment of sturgeon by dredges (Hoover et al. 2005).

Irrigation Diversions: Entrainment of hatchery-reared Pallid Sturgeon has been documented in the irrigation canal associated with the Lower Yellowstone Irrigation Project's Intake Diversion Dam on the Yellowstone River (Figure 4) where some of these fish are believed to have perished (Jaeger et al. 2004).

Flood control points of diversions: Two hatchery-reared juvenile Pallid Sturgeon released in the Mississippi River and one adult hatchery-reared Pallid Sturgeon released in either the lower Missouri or middle Mississippi river were entrained by the Old River Control Complex as they were subsequently collected in the Atchafalaya River. During May and June 2008, 14 Pallid Sturgeon were collected behind the Bonnet Carré spillway (Reed in litt., 2008; USFWS 2009a).

Subsequently, in 2011, the Bonnet Carré spillway was opened again to alleviate flooding. Following closure, 20 Pallid Sturgeon were collected behind the spillway (U.S. Army Corps of Engineers 2012) indicating that entrainment occurs at this facility during the rare occasions when flood waters need to be shunted from the Mississippi River to Lake Pontchartrain. One interesting observation in 2011 was the collection of a tagged Pallid Sturgeon from behind the Bonnet Carré spillway that was previously collected behind the spillway and released into the Mississippi River in 2008 (U.S. Army Corps of Engineers 2012). Additionally, the Birds Point–New Madrid and the Morganza Floodways (Figure 5) were also opened in 2011. While subsequent sampling did not document Pallid Sturgeon within either floodway, 26 Shovelnose Sturgeon were reported as entrained in the Birds Point–New Madrid Floodway and no sturgeon were reported in the Morganza Floodway (U.S. Army Corps of Engineers 2012). Additional smaller structures exist or are planned for diverting water and sediments from the Mississippi River for marsh enhancement and hurricane protection in coastal Louisiana. Pallid Sturgeon entrainment potential and significance is unknown.

Summary of Impacts of Entrainment

Entrainment of juvenile and adult Pallid Sturgeon has been documented to occur in the few instances it has been studied. Thus, it is a greater threat than anticipated in the original version of this plan. The level of larval sturgeon entrainment is unknown. The overall effects from entrainment are variable and depend on population demographics, exposure time, quantity of un-screened diversion points, and duration of diversion point usage (i.e., year-round versus seasonal or sporadic operation). Further evaluation of entrainment associated with towboat propellers, dredging operations, water diversion points, and commercial navigation is necessary across the Pallid Sturgeon's range to adequately evaluate and quantify this threat.

CLIMATE CHANGE

Although not a threat specifically identified in the Pallid Sturgeon listing package (55 FR 36641-36647), our analyses under the Endangered Species Act include consideration of ongoing and projected changes in climate. The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change. "Climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (Intergovernmental Panel on Climate Change 2007). The term "climate change" refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (Intergovernmental Panel on Climate Change 2007). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of climate interactions with other variables (e.g., habitat fragmentation) (Intergovernmental Panel on Climate Change 2007). In our analyses, we use our expert judgment to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change. Both the Intergovernmental Panel on Climate Change and U.S. Global Change Research Program identify that the trend in global climate patterns is one of warming; average temperatures in the United

States are at least 1.1°C (2°F) higher than they were 50 years ago (Intergovernmental Panel on Climate Change 2007; U.S. Global Change Research Program 2009).

Within the range of Pallid Sturgeon, predicted affects appear to be shifts in runoff patterns: discharge peaks are anticipated to occur earlier and potentially be larger, late season river flows may be reduced, and water temperatures may rise (Intergovernmental Panel on Climate Change 2007). These changes to the water cycle are anticipated to affect water use (U.S. Global Change Research Program 2009), which may alter existing reservoir operations. Broadly, these potential effects to Pallid Sturgeon could be altered spawning behavior (i.e., movement and timing), reduced survival of early life stages and young-of-year, and reduced late-season habitat suitability due to reduced flows and presumably warmer temperatures. Another predicted outcome is increased or prolonged periods of drought (Intergovernmental Panel on Climate Change 2007; U.S. Global Change Research Program 2009). Increased water demand coupled with reduced late-season flows could significantly affect in-channel habitats which in turn may affect other species that are food items for Pallid Sturgeon.

These effects would likely occur first, or be most pronounced, in the more northern portion of the Pallid Sturgeon range; the Intergovernmental Panel on Climate Change (2007) study suggests that in general, temperature increases correlate with latitude. Thus, higher northern latitudes appear to have relatively higher predicted warming trends. However, reduced annual runoff predicted in the Missouri River basin may be offset by the anticipated increased runoff in the upper Mississippi River basin (U.S. Global Change Research Program 2009) resulting in minimal effects within the middle and lower Mississippi River basins.

Summary of Impacts of Climate Change

At this time, it is difficult to evaluate long-term effects from climate change as there have been many anthropogenic influences across the species' range. Assessing this potential threat and teasing out relationships associated with climate change will be difficult without careful consideration of other already confounding factors.

Factor A Summary

The present or threatened destruction, modification or curtailment of its habitat or range, remains a threat. However, the magnitude of this threat varies across the species' range, due in part to on-going efforts to mitigate anthropogenic effects and the proportion of perturbations relative to the volume of habitat available. For example, the effects from dams (i.e., altered hydrographs and temperature profiles, altered ecologic processes, habitat fragmentation, and conversion of riverine reaches to reservoir) may be the single greatest factor affecting the species in the upper Missouri River basin. While in the middle and lower Missouri River, as well as the middle Mississippi River, water quality, entrainment, and maintenance of the channel for navigation purposes and the associated impacts are significant threats. Additionally, the effects from other threats described below, may be more limiting to the species in these areas. The same applies to the lower Mississippi River. Currently main-stem riverine habitat is not fragmented by dams and many natural ecological processes can still create a diversity of physical habitats believed important for the species. However, data are limited related to overall water quality.

Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Overutilization for commercial, recreational, scientific, or educational purposes is one of the threats to Pallid Sturgeon identified in the listing determination (55 FR 36641-36647). Given the endangered status of Pallid Sturgeon, use for scientific or educational purposes is regulated under section 6 cooperative agreements or under section 10 of the Act. All recreational and commercial harvest of Pallid Sturgeon is prohibited by Section 9 of the Endangered Species Act as well as State regulations throughout its range.

While these regulations effectively protect Pallid Sturgeon from recreational harvest and overutilization for scientific and educational purposes, they do not prevent lethal take of Pallid Sturgeon as a result of species misidentification associated with commercial Shovelnose Sturgeon fishing. To address this threat, beginning in 2010, Shovelnose Sturgeon are treated as threatened where the two sturgeon species coexist, under the similarity of appearance provisions of the Endangered Species Act (75 FR 53598-53606). This rule extends take prohibitions to Shovelnose Sturgeon, Shovelnose-Pallid Sturgeon hybrids, and their roe when associated with a commercial fishing activity in areas where Pallid Sturgeon and Shovelnose Sturgeon commonly coexist. Continued monitoring will provide data on the effectiveness of this regulation.

Factor B Summary

Current State regulations and protections afforded under the Endangered Species Act, including the similarity of appearance rule, coupled with adequate enforcement, appear sufficient to manage, to the maximum extent practicable, the threat from overutilization for commercial, recreational, scientific, or educational purposes. However, absent protections under the Endangered Species Act, adequate State harvest regulations and enforcement will be necessary to protect the species from overharvest.

Factor C: Disease or Predation

DISEASE

Fish pathogens have the potential to produce severe disease outbreaks, but they may also simply exist in a carrier state. Fish pathogens include viral, bacterial, and parasitic agents. In some instances, disease outbreaks can severely deplete local populations, but these extreme events have not yet been documented in wild Pallid Sturgeon populations. Some pathogens of notable importance for Pallid Sturgeon recovery include Viral Hemorrhagic Septicemia Virus and the Missouri River sturgeon iridovirus.

Viral Hemorrhagic Septicemia Virus is a fish disease that has caused large-scale mortalities in numerous species (Kim and Faisal 2010) and has been described as an "extremely serious pathogen of fresh and saltwater fish" (APHIS 2006). While it has not been documented to affect Pallid Sturgeon, it also has not been found within the range of the species. However, Viral Hemorrhagic Septicemia Virus has been documented in the Great Lakes (APHIS 2006). Various shipping canals have created a connection between the Great Lakes and the Mississippi River so it is possible that through time, this virus could reach areas occupied by Pallid Sturgeon.

Because this pathogen can cause large-scale mortalities in fish populations, and it has a wide range of potential carriers, we believe it is important to monitor for Viral Hemorrhagic Septicemia Virus within the range of Pallid Sturgeon.

Missouri River sturgeon iridovirus is a concern in the context of Pallid Sturgeon recovery because it causes mortality in hatchery-reared Pallid Sturgeon (Kurobe et al. 2011) and its effect on free-ranging sturgeon populations is unknown. The Missouri River sturgeon iridovirus was originally documented during artificial propagation efforts of Shovelnose Sturgeon at the Gavins Point National Fish Hatchery in 1999. However, this iridovirus also can infect Pallid Sturgeon (Kurobe et al. 2011). This disease is known to cause substantial mortality in hatchery-rearing environments (Kurobe et al. 2011). Study fish surviving initial viral outbreaks still harbor the virus even though they may appear healthy (Hedrick et al. 2009; Kurobe et al. 2011). While initially identified in a hatchery environment, additional testing has documented that this virus is found in the wild; of 179 *Scaphirhynchus* tested from the Atchafalaya River between November 2003 and May 2004, 8 (4%) were confirmed as positive for the virus and 5 (2.8%) were suspected of carrying the virus. Subsequent testing with more sensitive methods also confirmed the presence of the virus in the wild (Hedrick et al. 2009), suggesting that it may be endemic in the Missouri River. The effect of the virus on wild populations is not known.

PREDATION

Little information is available implicating piscivory as a threat affecting the Pallid Sturgeon. Predation on larval and juvenile fishes of all species occurs naturally. However, habitat modifications that increase water clarity and artificially high densities of both nonnative and native predatory fishes could result in increased rates of predation. Pallid Sturgeon larvae and fry passively drift post-hatch (Kynard et al. 2007; Braaten et al. 2008). This behavior exposes naturally-spawned Pallid Sturgeon to predation which was moderated historically by high fecundity and turbid waters. However, anthropogenic changes that affect habitats could result in increased vulnerability to predation. In the impounded areas of the upper Missouri River, larvae may be transported into the clear headwaters of reservoirs like Fort Peck and Lake Sakakawea. These reservoirs are or have been artificially supplemented with predatory species like Walleye (*Sander vitreus*).

Maintaining artificially elevated populations of certain species in these reservoirs has been hypothesized as a contributing factor in poor survival of larval and juvenile Pallid Sturgeon. Walleye and Sauger (*S. canadensis*) are capable of eating wild paddlefish up to 167 mm (6.6 inch (in.) body length, 305 mm (12 in.) total length) and, thus, likely could consume naturally-produced Pallid Sturgeon larvae, fry, and fingerlings (Parken and Scarnecchia 2002). When looking at data for sample locations closest to reservoir headwaters, it appears that no age-0 paddlefish were found in Walleye, but were present in Sauger, a native species closely related to walleye. Though Braaten and Fuller (2002, 2003) examined 759 stomachs from 7 piscivore (fish eating) fishes in Montana, they found no evidence of predation on sturgeon. Other studies have, however, documented *Scaphirhynchus* sturgeon as food items. Hogberg and Pegg (2013) found sturgeon in the stomachs of Flathead Catfish (*Pylodictis olivaris*) studied in the lower Missouri River. Predation vulnerability of Pallid Sturgeon (> 40 mm) by Channel Catfish (*Ictalurus punctatus*), Smallmouth Bass (*Micropterus dolomieu*), and Walleye appears to be low, provided other prey species are available (French 2010; French et al. 2010). More data are needed to adequately assess predation effects on eggs, and larval Pallid Sturgeon in order to evaluate implications on recruitment success (see also Invasive Species/Aquatic Nuisance Species under Factor E Other Natural or Manmade Factors Affecting its Continued Existence).

Factor C Summary

When listed, neither disease nor predation were discussed as threats, primarily due to limited information. New data have highlighted both disease and predation as issues of potential concern and they should be considered as likely threats. At this writing, data are inadequate to quantify the magnitude of the threat either may pose.

Factor D: Inadequacy of Existing Regulatory Mechanisms

Regulatory mechanisms are required for Pallid Sturgeon recovery and to ensure long-term conservation of the species. These mechanisms affect many aspects of legal protection, such as habitat and flow protection, regulation and/or control of nonnative fishes, regulation of hazardous-materials spills, and harvest. In determining whether the inadequacy of existing regulatory mechanisms constitutes a threat to Pallid Sturgeon, our analysis focused on existing State and Federal laws and regulations that could potentially address the main threats to the species described under Factors A and B, and potential new threats described under Factor E.

State Regulations

Water Quality
All States whose waters are occupied by Pallid Sturgeon have enacted legislation intended to preserve water quality. Generally these State regulations (see Appendix A) parallel comparable Federal legislation; in some cases, State statutes may impose requirements that are more stringent than the Federal law. In all cases, Clean Water Act requirements must be adhered to and are enforced in conjunction with State statutes and regulations implemented by the State administrative agencies.

Water Quantity
Many States have enacted legislation and processes specifically to allocate water resources (see Appendix A). Generally, water use permits are obtained from the appropriate State or local administrative agencies. Most States have instream-flow laws intended to maintain "beneficial use" of water left in streams for wildlife. However, these laws typically only protect minimum flows believed necessary to maintain the fishery and, in some states, may afford little protection. For example, water development/usage in Montana is governed by western water law. Under this system, in-stream water rights held by Montana Fish Wildlife and Parks are newer (junior) to many water users with an older (senior) water right. As a result, during extreme drought situations, senior water right owners have priority rights to water, in other words, their rights will be met prior to those of Montana Fish Wildlife and Parks. Once senior rights are satisfied, the remainder can be left in the river and used for fish and wildlife. This could lead to a water depletion situation in areas occupied by Pallid Sturgeon. Additionally lacking in many states, are completion of adjudication processes and full inventories of all water allocations. Without these

data it is difficult to determine if important rivers and tributaries for Pallid Sturgeon have been or could become over-allocated resulting in future adverse effects.

Harvest

In addition to Federal protection under the Endangered Species Act, Pallid Sturgeon are protected by State designations such as "endangered," "threatened," or "sensitive." These designations typically prohibit intentional take and harvest of any Pallid Sturgeon. Depending on local demographic conditions, these designations may need to remain in place within some States after the species is delisted. When delisted, States within the Pallid Sturgeon's range have the authority to continue State protections or to manage and establish commercial and recreational harvest limits for the species within their borders. Long-range migratory species are often considered 'interjurisdictional' and may be co-managed with neighbor States or through organizations like the Mississippi Interstate Cooperative Resources Association; an organization of 28 State agencies that formed a partnership to improve management of aquatic resources in the Mississippi River Basin. State regulations currently provide protections against take of Pallid Sturgeon associated with commercial, recreational, scientific, and educational purposes. For the most part, these regulations are adequate to protect Pallid Sturgeon from direct intentional taking. However incidental harvest of Pallid Sturgeon during commercial Shovelnose Sturgeon harvest has been documented in several States where Pallid and Shovelnose sturgeon are sympatric. This resulted in a Federal rule treating Shovelnose Sturgeon as threatened under the Endangered Species Act due to similarity of appearance to Pallid Sturgeon (75 FR 53598-53606). To be delisted, State regulatory mechanisms and/or designations will need to ensure continued long-term management and protection for the species.

Summary of State Regulations

While States have implemented many regulations to protect and conserve resources through a mechanism of project proposal review and permitting, these efforts likely are limited by a lack of biological and/or ecological data on Pallid Sturgeon and their ecological thresholds. For example, levels of contaminants that generate negative effects in Pallid Sturgeon have not been fully quantified, limiting the ability to establish protective State standards. Another limitation of State permitting processes is cumulative effects evaluations. Considering cumulative environmental effects in the permitting process requires an understanding of ecological thresholds, baseline conditions, and life history requirements for many species, as well as their response to multiple environmental stressors. Unfortunately, with respect to the Pallid Sturgeon, much of this remains unknown. Finally, when the species is delisted, State regulations will be necessary to manage and protect the species.

Federal Regulations

In addition to State regulations, activities that affect either Pallid Sturgeon or its habitat are regulated under Federal laws. Notable Federal regulations that address Pallid Sturgeon and their habitat are; the Clean Water Act, River and Harbors Act of 1899, Federal Power Act, National Environmental Policy Act, and the Fish and Wildlife Coordination Act .

The Clean Water Act (33 U.S.C. §§1251 et seq.) regulates pollutant discharges into the nation's waters. This is accomplished through defining, monitoring, and regulating water quality standards for all surface waters, establishing industry wastewater standards, and protecting aquatic life and habitats through permitting. Pertinent regulations can be found at 40 C.F.R., CH 1, subchapter D-water programs (§§ 110, 112, 116, 117, 122-125, 129-133), 40 C.F.R., CH 1, subchapter N-effluent guidelines and standards (§§ 401-471), and 40 C.F.R., CH 1, subchapter O-Sewage sludge (§§ 501, and 503). The Clean Water Act affords substantial protections to the Pallid Sturgeon, its habitat, and life history requirements through establishing water quality standards and reducing the effects from the discharge of harmful pollutants, contaminants and discharge of dredge or fill material. However, residual effects from historical practices and a lack of species specific information on the sensitivity of the Pallid Sturgeon to common industrial and municipal pollutants may be limiting the full conservation potential of the Clean Water Act as it relates to pollutant discharge and water quality standards.

In addition to regulating pollutant discharges, the Clean Water Act also allows the U.S. Environmental Protection Agency to establish regulations for cooling water intake structures (§ 316b). Losses of Pallid Sturgeon through impingement or entrainment from these structures have been documented (see Factor A: Present or Threatened Destruction, Modification or Curtailment of its Habitat or Range, above). Section 316(b) of the Clean Water Act requires the U.S. Environmental Protection Agency to provide reasonable assurances that aquatic organisms are protected from impingement or entrainment. In 2004, the agency issued regulations (69 FR 41575-41624) to minimize entrainment and impingement mortality associated with cooling water intakes at power production facilities. However, these regulations were suspended in 2007 (72 FR 37107-37109). In 2011, the public comment period was reopened for proposed Section 316(b) requirements for all existing power generating facilities and existing manufacturing and industrial facilities (76 FR 43230-43231). While data are limited or lacking, providing reach-specific information on Pallid Sturgeon population size, habitat use, and behavior would be necessary to expect reasonable assurances that the species is protected under subsequent 316(b) provisions of the Clean Water Act. For example, local effects to Pallid Sturgeon associated with entrainment loss may be proportional to species abundance and/or habitat use, as well as intake design and/or location. Additionally, at low population levels or in areas heavily used by the species, the threat from entrainment may be highest. Conversely, entrainment losses may have little or no impact when population levels are robust or in areas seldom frequented by the species.

The Rivers and Harbors Act (33 U.S.C. §§401,403,407 et seq.) prohibits the construction of any bridge, dam, dike or causeway over or in navigable waterways of the U.S. without Congressional approval. Structures authorized by State legislatures may be built if the affected navigable waters are totally within one State, provided that the plan is approved by the Chief of Engineers and the Secretary of Army (33 U.S.C. 401).

The Federal Power Act (16 U.S.C. §§791-828) provides for cooperation between the Federal Energy Regulatory Commission and other Federal agencies, including resource agencies, in licensing and relicensing power projects. The Federal Energy Regulatory Commission is authorized to issue licenses to construct, operate and maintain dams, water conduits, reservoirs, and transmission lines to improve navigation and to develop power from any streams or other bodies of water over which it has jurisdiction which includes many of the rivers inhabited by Pallid Sturgeon. An amendment in1986, the Electric Consumers Protection Act, required several provisions to benefit fish and wildlife. Specifically, each license is to contain conditions to protect, enhance, and mitigate fish and wildlife affected by the project (16 U.S.C. §§803 et seq.). These conditions are to be based on recommendations received from the USFWS, the National Marine Fisheries Service, and State fish and wildlife agencies pursuant to the Fish and Wildlife Coordination Act. Additionally, there are requirements under 16 U.S.C. §81, related to operation of navigation facilities, they specify " The Commission shall require the construction, maintenance, and operation by a licensee at its own expense ...such fishways as may be prescribed by the Secretary of the Interior or the Secretary of Commerce, as appropriate." The Federal Power Act has facilitated conservation of Pallid Sturgeon and their habitats through improved coordination with fish and wildlife management agencies and has the ability, where applicable, to restore connectivity for Pallid Sturgeon through mandated fish passage requirements.

The National Environmental Policy Act (42 U.S.C. §§4321-4347 as amended) requires all Federal agencies in the executive branch to consider the effects of their actions on the environment. This act allows cooperating agencies and interested parties to assess proposed Federal projects and their potential significant impacts to the human environment. In general, participants review proposed actions and provide recommendations to the action agency to minimize or avoid environmental impacts. Affects to endangered species are commonly included in these environmental assessments or environmental impact statements; however, endangered status is not required for such considerations. As such, the processes necessary to comply with this act would include considerations of Pallid Sturgeon and their habitats in project planning. However, while this act provides for disclosure of environmental impacts, it does not require minimization. Thus, the degree to which this act offers protection to the Pallid Sturgeon is variable and based upon voluntary adoption of conservation measures. Compliance with this act would be improved and provide increased benefit with better information on habitat use and needs of Pallid Sturgeon within the Missouri and Mississippi river basins.

The Fish and Wildlife Coordination Act (16 U.S.C. §§661-667e as amended) requires that Federal agencies funding, sponsoring, or permitting activities give consideration and coordination of wildlife conservation with respect to water resources development programs. Under the Fish and Wildlife Coordination Act, Federal agencies must consult with the USFWS and the State fish and wildlife agencies where the "waters of any stream or other body of water are proposed or authorized, permitted or licensed to be impounded, diverted . . . or otherwise controlled or modified" under a Federal permit or license. Consultation is to be undertaken for the purpose of "preventing loss of and damage to wildlife resources." Through the Fish and Wildlife Coordination Act, Pallid Sturgeon and their habitats are given due consideration in water development activities. However, while the Fish and Wildlife Coordination Act may result in implementation of conservation measures (i.e., screening of water diversion structures) on new water projects, this act does not afford protections for projects implemented or permitted prior to its enactment.

Summary of Federal Regulations

Federal environmental regulations have substantially increased environmental protections throughout the Pallid Sturgeons' range. However, there are instances where these regulations may not have been adequately followed (Government Accountability Office 2011), possibly resulting in negative effects for the species. In other instances, the implementation of these laws does not offer adequate protection to the Pallid Sturgeon in that it does not address the specific threats that the species faces. In some cases, lack of empirically derived data, specific to Pallid Sturgeon or lack of access to available data may be limiting the efficacy of existing Federal regulations.

Factor D Summary

Federal, State, and local regulatory protections have been developed to minimize and mitigate known and potential threats to fish and other aquatic species, as well as their habitats, from anthropogenic activities. While some of these regulatory mechanisms have been helpful and benefited the species, recovery progress made to date is the result of the Endangered Species Act and its enforceable provisions to ensure conservation of listed species. Absent protections under the Endangered Species Act, current existing State and Federal regulations may be inadequate to ensure long-term protection for the species. However, some of this perceived inadequacy of existing regulatory mechanisms to conserve Pallid Sturgeon primarily relates to a lack of specific information on population size, habitat use, and sensitivity or vulnerability to contaminants, entrainment, and other threats or a lack of easy access to these data where available. As examples:

- State and Federal environmental regulations enacted to reduce or eliminate environmental contaminants and preserve water quality provide regulatory authority to develop and establish standards and implement pollution control programs. The standards established pursuant to these regulations and through State and Federal permitting processes have benefitted the Pallid Sturgeon by protecting and improving water quality. However, data suggest that residual contaminants or their derivatives are still negatively affecting the species (see Factor A: Present or Threatened Destruction, Modification or Curtailment of its Habitat or Range, above). Developing specific information on the sensitivity of the Pallid Sturgeon to common industrial and municipal pollutants and their derivatives will allow for reviewing and if necessary modifying water quality standards specifically to benefit the species.

- Hybridization was identified as a threat to the species when it was listed (55 FR36641-36647) and is discussed further under Factor E below. At the time, the prevailing hypothesis relates hybridization with habitat alterations that resulted in a breakdown of natural reproductive isolating mechanisms. However, more recent information suggests that additional data are needed to fully understand the extent and magnitude of hybridization as a threat (USFWS 2007). If hybridization is related to habitat alterations, conserving and restoring habitats may be the only method to reverse this trend. Use of available regulatory mechanisms to address the threat of hybridization is currently limited by lack of information on the natural reproductive isolating mechanisms between Shovelnose and Pallid sturgeon.

- A number of invasive aquatic species have been introduced into the range of Pallid Sturgeon (see Factor E: Other Natural or Manmade Factors Affecting its Continued Existence, below);

however, the threats they may pose to its conservation are poorly known. Numerous State and Federal regulations, including but not limited to, the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (as amended), Injurious Wildlife provisions of the Lacey Act (18 U.S.C. 42; 50 CFR 16), Asian Carp Prevention and Control Act, and Clean Boating Act of 2008, have been developed to: 1) prevent introduction of new invasive species into the wild; 2) halt the spread of invasive species to unoccupied areas; and 3) to control them in areas where they were introduced. Information on the spread and abundance of invasive species, as well as their effects on reach specific Pallid Sturgeon populations is necessary to determine whether these regulatory mechanisms are adequate to protect the species.

As our knowledge of the species increases, existing regulatory mechanisms can be more effectively evaluated, improved, and implemented.

Factor E: Other Natural or Manmade Factors Affecting its Continued Existence

Potential new threats identified subsequent to the 5-year review (USFWS 2007) or new information has resulted in additional evaluation of: 1) energy development, 2), hybridization, and 3) invasive species/aquatic nuisance species.

ENERGY DEVELOPMENT

Gas and Oil Exploration: Exploration of natural gas and oil deposits occurs in portions of the Pallid Sturgeon's range. Preliminary assessment of the impacts of seismic air guns, a tool used for exploration, suggests that they may have negative effects on larval Pallid Sturgeon (Krentz in litt. 2010). Additional research is necessary to fully evaluate the extent and magnitude of these effects.

Gas and Oil Pipelines: The federal authority for pipeline safety is the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration. This agency reports that there were 2.3 million miles of pipelines in the United States carrying natural gas and hazardous liquids (primarily petroleum, refined petroleum products, and other chemicals). Many pipelines cross rivers within the range of Pallid Sturgeon; some of which are buried under the river bed.

While not directly within the historical range of Pallid Sturgeon, the 2011 rupture of the Silvertip Pipeline crossing under the Yellowstone River serves as a reminder that accidental releases of hazardous materials can occur. Depending on the timing, magnitude, and the material leaked, a ruptured pipeline could pose a threat to Pallid Sturgeon.

Summary of Impacts from Energy Development

Increased demand for energy resources has led to an increased interest in new technology for development and exploration. Oil and gas exploration techniques have the potential to take Pallid Sturgeon yet the ability to evaluate these takings will be nearly non-existent given the nature of the river systems these fish live in.

The conveyance of oil and gas through pipelines could result in localized negative effects should a rupture occur resulting in the substances being transported spilling into waters occupied by Pallid Sturgeon. The U.S. Department of Transportation's Office of Pipeline Safety is responsible for regulating the safety of design, construction, testing, operation, maintenance, and emergency response of domestic oil and natural gas pipeline facilities. Additionally, there are state offices responsible for managing, permitting, and inspecting pipelines.

Strict adherence to existing environmental laws will be necessary to minimize effects and more data will be needed to adequately evaluate and monitor impacts related to energy development.

HYBRIDIZATION

The original version of this recovery plan (USFWS 1993) identified hybridization as a threat to Pallid Sturgeon. This was, in part, based on limited observations of sturgeon (N=12) collected from the middle Mississippi River that appeared morphologically-intermediate to Shovelnose and Pallid sturgeon (Carlson and Pflieger 1981; Carlson et al. 1985) and the belief that hybridization was contemporary (i.e., post 1960 and influenced by anthropogenic changes to habitat). Subsequent genetic and morphological studies have been conducted to explore hybridization between Pallid and Shovelnose sturgeon (Phelps and Allendorf 1983; Carlson et al 1985; Campton et al. 2000; Tranah et al. 2001 and 2004; Kuhajda et al. 2007; Ray et al. 2007; Murphy et al. 2007a). Below is a brief review of the current literature regarding the treatment of intermediate-character sturgeon and putative pallid/shovelnose hybridization in the Mississippi River basin.

Carlson et al. (1985) used principal components analysis based on morphometric measures described in Bailey and Cross (1954) and found that morphologically-intermediate specimens fell in between the Pallid and Shovelnose sturgeon groups leading to their hybridization origin hypothesis. Efforts to confirm hybridization used a suite of allozyme markers (Phelps and Allendorf 1983). These results neither supported nor refuted the hybridization origin hypothesis and only suggested that Pallid and Shovelnose sturgeon share close taxonomic affinities. Tranah et al. (2004) assessed the genetic origins of 10 morphologically intermediate sturgeon collected from the Atchafalaya River. These results were consistent with the hypothesis that hybridization occurs between Pallid and Shovelnose sturgeon. However, this study simply demonstrated that morphologically-intermediate fish had intermediate genotypes. Schrey (2007) analyzed 529 *Scaphirhynchus* samples from the upper Missouri, lower Missouri, middle Mississippi, and Atchafalaya rivers using sixteen microsatellite loci. Like Tranah et al. (2004), the author also found that genetically-intermediate fish tended to also be morphologically-intermediate.

While there are competing hypotheses that may explain morphologically intermediate fish (Murphy et al. 2007a; Ray et al. 2007), there appears to be a positive correlation between genotype and phenotype (Tranah et al. 2004; Schrey 2007). The latest genetic analysis confirms introgressive hybridization between Pallid and Shovelnose sturgeon occurs and likely has been occurring for several generations, perhaps as many as 60 years (Schrey et al. 2011). However, the significance of hybridization as a factor in the status of Pallid Sturgeon is poorly understood. Hybridization between two species could result in the eventual loss of one or both parental forms (Arnold 1992; Allendorf et al. 2001; Rosenfield et al. 2004). Conversely, a few have postulated that hybridization played a role in past sturgeon speciation (Birstein et al. 1997; Vasil'ev 1999; Robles et al. 2005), indicating that hybridization may have always been a process occurring in

the evolution of sturgeon species and it can lead to the creation of new species (Arnold 1992). However, regardless of whether similar events might have led to new sturgeon species in the past, the Endangered Species Act instructs us to address threats to the integrity of listed species. While the mode and rate of *Scaphirhynchus* hybridization is difficult to assess, understanding the evolutionary relationship between Shovelnose and Pallid sturgeon is important to better be able to assess potential threats that hybridization may impose on Pallid Sturgeon recovery.
Summary of Impacts Related to Hybridization

While we know that experimental mating of Pallid Sturgeon with Shovelnose Sturgeon can produce living offspring (Kuhajda et al. 2007), accurate assessment of hybridization in the evolution of *Scaphirhynchus* and its relative threat to Pallid Sturgeon recovery will require statistically testing the hypothesis of hybridization against alternatives. Since hybridization is occurring in *Scaphirhynchus* and likely has been occurring for many decades (Schrey et al. 2011), it is important to determine the cause (i.e., historical/natural or contemporary), extent, and frequency or rate of occurrence of hybridization. Once these processes are elucidated, simulation/modeling exercises can address the actual risks associated with *Scaphirhynchus* hybridization. If it is determined that alteration of habitats has influenced temporal or spatial reproductive isolating mechanisms resulting in increased rates of hybridization, addressing this threat will likely rely on both site-specific and ecosystem improvement efforts; many of which are identified in the Recovery Outline/Narrative section below.

INVASIVE SPECIES/AQUATIC NUISANCE SPECIES

Although not a threat specifically identified in the Pallid Sturgeon listing package (55 FR 36641-36647), the potential impact of invasive and aquatic nuisance species can be applied to Listing Factor A- The present or threatened destruction, modification, or curtailment of its habitat or range and Listing Factor C- Disease or Predation. Several species with the potential for impacting Pallid Sturgeon have become established in parts of the species' range. These include the Asian carps (Common Carp (*Cyprinus carpio*), Grass Carp (*Ctenopharyngodon idella*), Silver Carp (*Hypophthalmichthys molitrix*), Bighead Carp (*Hypophthalmichthys nobilis*) and Black Carp (*Mylopharyngodon piceus*)) as well as the zebra mussel (*Dreissena polymorpha*). Populations of Asian carp appear to be expanding exponentially in parts of the Mississippi River basin; similarly the range of the zebra mussel continues to expand (Kolar et al. 2005).

According to the American Fisheries Society (Policy 15), potential negative impacts by nonnative species have been categorized into five broad categories: habitat alteration, trophic alteration, spatial alteration, gene pool deterioration and disease transmission. Documenting these impacts in large river ecosystems is especially difficult. Few studies have documented the impacts from these species in the Mississippi Basin. However, data are available from other watersheds that shed insight into potential effects from invasive species.

If food resources were limited from the presence of large populations of planktivores (e.g., Asian carps), early life-stage Pallid Sturgeon could face increased competition with native planktivorous fishes such as Gizzard Shad (*Dorosoma cepedianum*), Bigmouth Buffalo (*Ictiobus cyprinellus*) and Paddlefish (Kolar et al. 2005). Several authors have expressed concern that, because nearly all fish feed on zooplankton as larvae and juveniles, Asian carps have high potential to impact native fishes in the Mississippi River basin (Laird and Page 1996; Chick and Pegg 2001; Chick 2002). The diets of Bighead and Silver Carp have significant overlap with those of Gizzard Shad and Bigmouth Buffalo (Sampson et al. 2009). In addition to directly competing for food resources, Asian carps also could affect recruitment by predation on Pallid Sturgeon eggs or drifting larvae. Miller and Beckman (1996) have documented white sturgeon eggs in the stomachs of Common Carp. Additionally, disease or parasites can be spread by Asian carp. Goodwin (1999) noted that Channel Catfish became infested with anchorworm when cultured with Bighead Carp. Heckmann et al. (1986 and 1995) reported that this tapeworm was spread to two endangered species when baitfishes were released into Lake Mead, Arizona and Nevada. Currently, the Asian tapeworm is known to infest native fishes in five States; however, none are in the Mississippi River drainage (Kolar et al. 2005).

Zebra mussel colonization has occurred in areas occupied by Pallid Sturgeon but data are limited on direct effects. In juvenile Lake Sturgeon, data show that zebra mussel occupancy changes the nature of the bottom substrates and a reduced foraging effectiveness with mussel presence resulting in avoidance of those areas by study fish more than 90% of the time (McCabe et al. 2006).

Summary of Impacts From Invasive and Aquatic Nuisance Species

Potential threats from invasive or aquatic nuisance species include increased predation on eggs, larval, or juvenile life stages, competition for food in the case of the carps, exclusion of native species from preferred habitats, spread of diseases or parasites, and alteration of habitat quality. Further study is needed to fully qualify and quantify the magnitude of this probable threat to Pallid Sturgeon.

Factor E Summary

Energy development and invasive species are two threats that may have substantial deleterious effects on Pallid Sturgeon populations. Strict adherence to existing environmental laws will be necessary to minimize effects from these threats and more data will be needed to adequately evaluate the extent and magnitude of these effects.

Conservation Measures

Numerous planning and conservation measures have been implemented range-wide to reduce localized effects from identified threats. The following is not intended to provide a comprehensive list of all conservation activities range-wide, but rather highlight projects and efforts that have been or will be implemented to address some of the threats to Pallid Sturgeon described previously.

MISSOURI RIVER

Within the Missouri River basin, where channelization and dams have fragmented habitats and altered natural riverine processes and no evidence for Pallid Sturgeon recruitment exists, many efforts are being explored or implemented to restore ecological function, as well as utilizing the PSCAP to prevent local extirpation. Restoration efforts include, but are not limited to: creating side channel habitats, restoring connectivity to backwater areas, notching dikes, providing fish passage, and manipulating flows through the dams. In addition to habitat restoration efforts and the PSCAP, a basin-wide Pallid Sturgeon population monitoring program has been established to track changes in species abundance and status.

FORT BENTON TO FORT PECK RESERVOIR, MONTANA

Reservoir operations on tributaries within this reach have been modified from past practices. Releases from Tiber Dam (Figure 4) were modified to occasionally accommodate a high flow discharge period. During 1995, 1997, and 2002, the Bureau of Reclamation provided a June peak release of 4,080, 4,500, and 5,300 cfs, respectively, to benefit downstream fisheries. A response by Pallid Sturgeon was not detected; however, present numbers of Pallid Sturgeon in this reach may be too low to detect or elicit a response. An indirect response to these increased discharges may be the recent establishment of Sturgeon Chub (*Macrhybopsis gelida*) in the lower Marias River. Sturgeon chub are an important prey species of Pallid Sturgeon (Gerrity et al. 2006) and were documented only recently in the Marias River in 2002.

Augmentation and monitoring efforts continue to support and evaluate the Pallid Sturgeon population within this reach.

FORT PECK DAM, MONTANA TO LAKE SAKAKAWEA, NORTH DAKOTA

In addition to artificial supplementation with hatchery-reared Pallid Sturgeon, discussions and exploratory designs have been ongoing in an effort to increase water temperatures in the Missouri River immediately downstream of Fort Peck Dam. Several options have been considered ranging from releasing surface water over the spill-way to modifying the intake structures or installing a large "curtain" around the intakes such that they draw down and release warmer surface waters. To date, warm water releases have not been implemented due in part to insufficient water levels.

The Yellowstone River is the largest tributary to the Missouri River in this reach. A multi-agency effort has been ongoing since the early 2000s to develop and implement fish passage and entrainment protection at Intake Dam. In 2007, the Water Resources Development Act provided the U.S. Army Corps of Engineers the authority to assist the Bureau of Reclamation with design and implementation of fish passage and entrainment protection at Intake Dam. A new water diversion structure, complete with fish screens, was initiated in 2010 and operational in 2012. Final passage options, intended to maximize Pallid Sturgeon passage probabilities to areas upstream of Intake Dam, are still being developed.

FORT RANDALL DAM TO GAVINS POINT DAM, SOUTH DAKOTA AND NEBRASKA

Augmentation efforts are being implemented to help reestablish a population in this reach. The Niobrara River is the largest tributary in this reach. Spencer Dam is a fish passage barrier on the Niobrara River. To date, preliminary discussions among interested parties have begun to explore passage options at this structure, but there are no substantial efforts yet to address this issue.

GAVINS POINT DAM SOUTH DAKOTA/NEBRASKA TO THE MISSISSIPPI RIVER CONFLUENCE

At over 1,296 Rkm (800 Rmi), this is the longest unimpounded reach of the Missouri River. Release of hatchery-reared Pallid Sturgeon produced as part of the PSCAP was initiated in 1994 and has occurred annually since 2002 in this reach. Available data indicate the PSCAP has lessened the likelihood of local extirpation, but long-term population viability currently remains uncertain (Steffensen 2012). Additionally, by 2011 an estimated 1,393 hectares (ha) (3,443 acres (ac)) of shallow water habitat has been created by constructing site-specific projects like chutes and revetment chutes, dredging to connect back-water areas, as well as side-channel construction (U.S. Army Corp of Engineers and US Fish and Wildlife Service 2012). Based on current and anticipated commitments, habitat restoration in this reach will continue, effectively increasing the quantity and quality of potential sturgeon habitats.

The Platte River is an important tributary to the Missouri River in this reach. The largest anthropogenic factor affecting habitat in the lower Platte River is upstream water withdrawals. The National Research Council (2005) identified that periods of drought could negatively affect habitats in the lower Platte River. During July 2012, a fish kill incident was reported in the lower Platter River following a period of prolonged drought. One dead hatchery-reared Pallid Sturgeon was confirmed (Nebraska in litt., 2012). A Cooperative Agreement between Nebraska, Colorado, Wyoming, and the U.S. Department of Interior was developed forming the Platte River Recovery Implementation Program to improve and maintain habitat for species, including Pallid Sturgeon. Evaluation of the success of this program is needed to determine if program efforts are indeed meeting the needs of the species.

MISSISSIPPI RIVER

Limited conservation stocking efforts have sporadically occurred in the Mississippi River; however, all stocking was discontinued due to increasing numbers of wild Pallid Sturgeon being collected and evidence for some level of natural recruitment (i.e., Columbo et al. 2007; Killgore et al. 2007a, b). Conservation efforts in the Mississippi River include land procurement; habitat conservation and restoration; sturgeon surveys; population quantification, modeling and monitoring; and habitat use studies. Additionally, commercial Shovelnose Sturgeon fishing has been closed by State and Federal regulations to prevent incidental harvest of Pallid Sturgeon in areas previously open to sturgeon caviar harvest.

UPPER MISSISSIPPI RIVER

While few Pallid Sturgeon have been documented in the Upper Mississippi River, the U.S. Army Corps of Engineers has continued to evaluate fish passage through the locks and dams. In addition, the fish community and habitat diversity is being address through U.S. Army Corps of Engineers elements of the Upper Mississippi River Restoration-Environmental Management Program. These elements include the Habitat Rehabilitation and Enhancement Projects and Long Term Resource Monitoring (U.S. Army Corp of Engineers in litt., 2013). Habitat enhancement projects include dike modifications, construction of chevron dikes, side channel enhancement, island construction, and reconnection of the river to the floodplain. Furthermore, since 1943 the Upper Mississippi River Conservation Committee (see http://www.umrcc.org/) has partnered with agencies and others to further cooperative conservation efforts for fish and habitat within the Upper Mississippi River.

MIDDLE MISSISSIPPI RIVER

The U.S. Army Corps of Engineers has initiated a program to restore side channel connectivity and improve habitat diversity in this reach. Projects include dike modifications, construction of chevron dikes, side channel enhancement, placement of woody debris piles, and incorporation of woody debris into dikes. More than 1,700 ha (4,200 ac) of flood-prone land have been purchased from willing sellers (USFWS 2009b). This land has been placed into conservation status by inclusion into the National Wildlife Refuge System. The Middle Mississippi National Wildlife Refuge has resulted in improved floodplain connectivity along 96 km (60 mi) of the Mississippi River downstream from St. Louis, Missouri. Pallid Sturgeon population quantification and monitoring efforts have been conducted in the Middle Mississippi River over the past decade, adding greatly to knowledge of habitat use and species abundance in this river reach.

LOWER MISSISSIPPI RIVER

During the 1980s, the U.S. Army Corps of Engineers established the Lower Mississippi River Environmental Program to develop methods to minimize effects of channel maintenance activities on fisheries and other natural resources in the lower Mississippi River. This program evaluated and modified revetment design, as well as dike design and placement to increase fishery habitat complexity. In 2001, the U.S. Army Corps of Engineers Mississippi Valley Division, initiated informal consultation with the USFWS under section 7(a)(1) of the Endangered Species Act to use Lower Mississippi River Environmental Program designs and additional measures to conserve and manage listed species associated with the lower Mississippi River navigation channel. Annual meetings with the U.S. Army Corps of Engineers, the USFWS, and State agencies are held to evaluate planned construction and maintenance activities, and to identify habitat restoration and improvement opportunities.

In addition, the Mississippi Valley Division and the Districts work with the Lower Mississippi River Conservation Committee (a Federal and State agency partnership) to identify and initiate secondary channel restoration opportunities within the leveed floodplain. Under its Mississippi River Conservation Initiative, this group has identified approximately 220 priority restoration opportunities in the Lower Mississippi River. Over the past decade, more than 64 km (40 mi) of secondary channel habitats have been rehabilitated helping to restore hundreds of acres of seasonally flooded habitats and over 200 dike notches have been constructed to maintain and/or increase in-channel habitat complexity (DuBowy 2010). Other construction modifications implemented to protect and enhance habitats include the construction of hardpoints in lieu of revetment and chevrons to encourage small island formation.

The U.S. Army Corps of Engineers' Engineer Research and Development Center has been conducting distribution and abundance studies on Pallid Sturgeon for more than 10 years. This center has evaluated susceptibility of sturgeon to entrainment through dredging and diversion structures, identified engineering modifications to minimize entrainment potential, assessing the benefits of dike notching, sturgeon utilization of in-river engineered structures, seasonal and spatial distribution of young-of-year sturgeon, and young-of-year sturgeon diets. Other research and monitoring efforts include a multi-agency, multi-year telemetry study to identify Pallid Sturgeon habitat associations and movements in the Atchafalaya River and in a short reach of the Mississippi River. Additionally, the USFWS is funding and coordinating research efforts to improve identification of river sturgeon species, and to quantify hybridization levels and trends in sturgeon of the Lower Mississippi River.

Part II: Recovery

Recovery Strategy

The primary strategy for recovery of Pallid Sturgeon is to: 1) conserve the range of genetic and morphological diversity of the species across its historical range; 2) fully quantify population demographics and status within each management unit; 3) improve population size and viability within each management unit; 4) reduce threats having the greatest impact on the species within each management unit; and, 5) use artificial propagation to prevent local extirpation within management units where recruitment failure is occurring. Pallid Sturgeon recovery will require an increased understanding of the status of the species throughout its range; developing information on life history, ecology, mortality, and habitat requirements; improving our understanding of some poorly understood threat factors potentially impacting the species; and using that information to implement management actions in areas where recovery can be achieved (see *Recovery Outline/Narrative*).

Management Units

Suitable habitat for Pallid Sturgeon is typically found within the flowing reaches of the Missouri, middle and lower Mississippi, and Atchafalaya rivers, and in portions of major tributaries like the Yellowstone and Platte rivers. However, some recovery tasks include actions at main stem dams/reservoirs and in other major tributaries when those actions would benefit Pallid Sturgeon in downstream reaches.

Originally, the U.S. Fish and Wildlife Service established six recovery priority management areas to focus recovery efforts at locales believed to have the highest recovery potential in 1993 (USFWS 1993). Since that time, our understanding of the species has improved and warrants redefining those management areas into four management units. These management unit boundaries are based on: 1) genetic data (Campton et al. 2000; Tranah et al. 2001; Schrey and Heist 2007); 2) morphological differences (Kuhajda et al. 2007; Murphy et al. 2007a); 3) biogeography of other fish species and speciation associated with physiographic provinces (Metcalf 1966; Wiley and Mayden 1985; Burr and Page 1986; Cross et al. 1986); 4) common threats; and 5) the potential need and ability to implement differing management actions to address varying threats within a management unit. As genetic and stock structure data are further refined, these management units may be correspondingly adjusted.

Like the original recovery priority management areas, these management units possess riverine reaches that are currently occupied habitats and typically represent the least degraded areas that retain the highest configuration of sandbars, side channels, and varied depths (Pallid Sturgeon Recovery Team 2006 and 2007). However, differing threats may affect each management unit independently (e.g., main-stem impoundments are a threat in the upper portion of the species' range but are not implicated as a threat in the most downstream reaches of the species' range). All river reaches within the species' historical range not specifically identified in the following management unit descriptions should not immediately be excluded from recovery activities if new information indicates these areas are deemed necessary to either prevent local extirpation or to facilitate recovery.

The management units (Figure 6) identified in the recovery strategy described above are defined as:

> The Great Plains Management Unit (GPMU) (Figures 6 and 7) is defined as the Great Falls of the Missouri River, Montana to Fort Randall Dam, South Dakota. This unit includes important tributaries like the Yellowstone River, as well as the Marias and Milk rivers. The upper boundary is at the Great Falls of the Missouri River as this is a natural barrier above which Pallid Sturgeon could not migrate historically. The lower boundary was defined as Fort Randall Dam to ensure consistent management practices on an inter-reservoir reach of the Missouri River.
>
> The Central Lowlands Management Unit (CLMU) (Figures 6 and 8) is defined as the Missouri River from Fort Randall Dam, South Dakota to the Grand River confluence with the Missouri River in Missouri and includes important tributaries like the lower Platte and lower Kansas rivers.
>
> The Interior Highlands Management Unit (IHMU) (Figures 6 and 9) is defined as the Missouri River from the confluence of the Grand River to the confluence of the Mississippi River, as well as the Mississippi River from Keokuk, Iowa to the confluence of the Ohio and Mississippi rivers.
>
> The Coastal Plain Management Unit (CPMU) (Figures 6 and 10) is defined as the Mississippi River from the confluence of the Ohio River downstream to the Gulf of Mexico including the Atchafalaya River distributary system.

Recovery Criteria

Section 3 of the Endangered Species Act, defines an endangered species as one that is in danger of extinction throughout all or a significant portion of its range, and a threatened species as one that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. Accordingly, a recovered species is one that no longer meets these definitions. Determining whether a species should be reclassified from endangered to threatened or delisted requires assessment of the same five categories of threats which were considered when the species was listed.

Recovery criteria define those conditions that are believed necessary to indicate that a species should be reclassified from endangered to threatened or delisted. Thus, when satisfied, recovery criteria are mileposts that measure progress toward recovery. Recovery criteria are provided below. Because the appropriateness of downlisting or delisting is assessed by evaluating the five threat factors identified in the Endangered Species Act, the recovery criteria below pertain to and are organized by these factors. These recovery criteria are our best assessment, at this time, of what needs to be completed so that the species may be downlisted to threatened status or removed from the list entirely. Because we cannot envision the exact course that recovery may take and because our understanding of the vulnerability of a species to threats is very likely to change as more is learned about the species and its threats, it is possible that a status review may indicate that downlisting or delisting is warranted although not all recovery criteria are met. Conversely, it is possible that the recovery criteria could be met and a status review may indicate

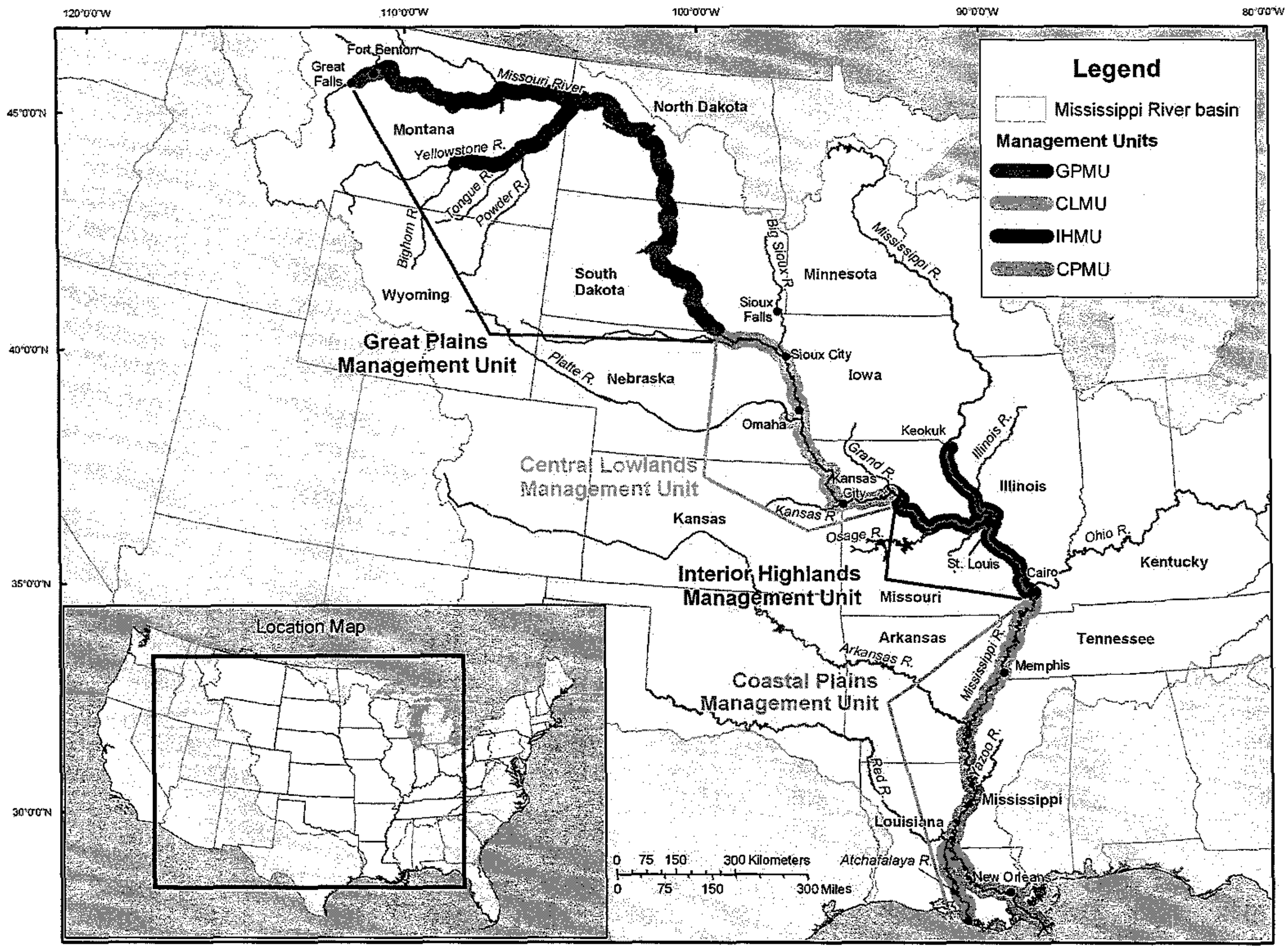

Figure 6 Map depicting Pallid Sturgeon management units.

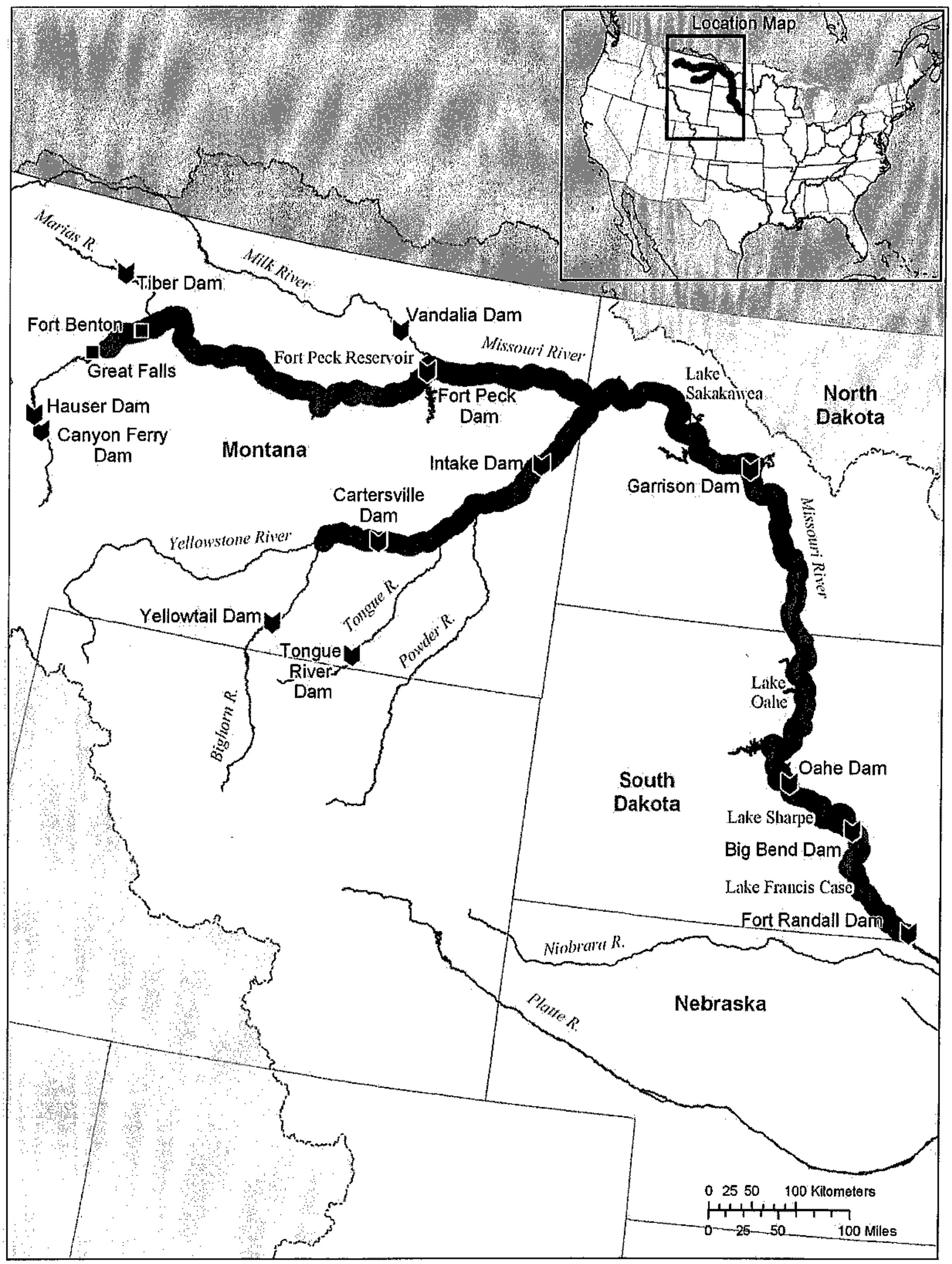

Figure 7 Map depicting the Great Plains Management Unit.

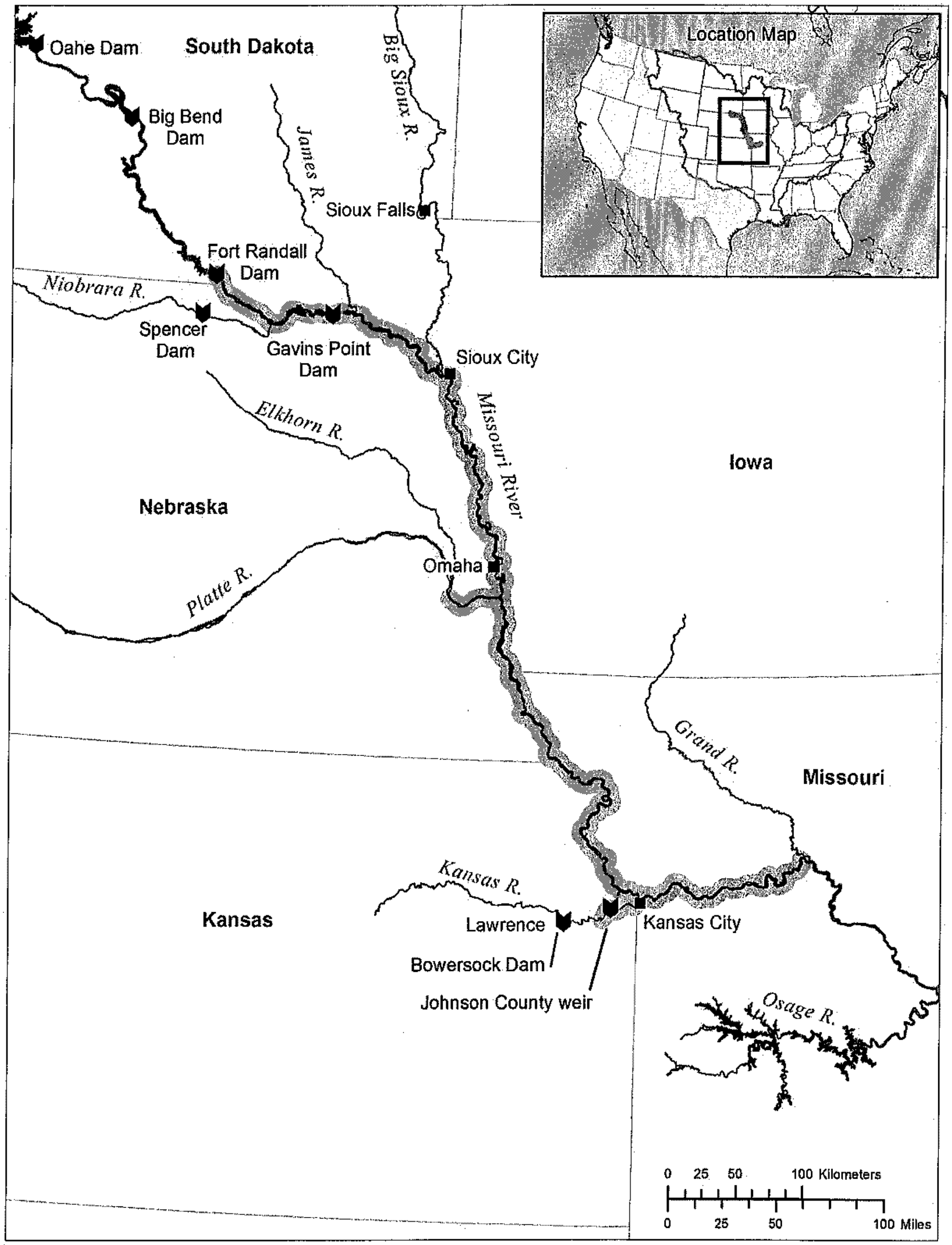

Figure 8 Map depicting the Central Lowlands Management Unit.

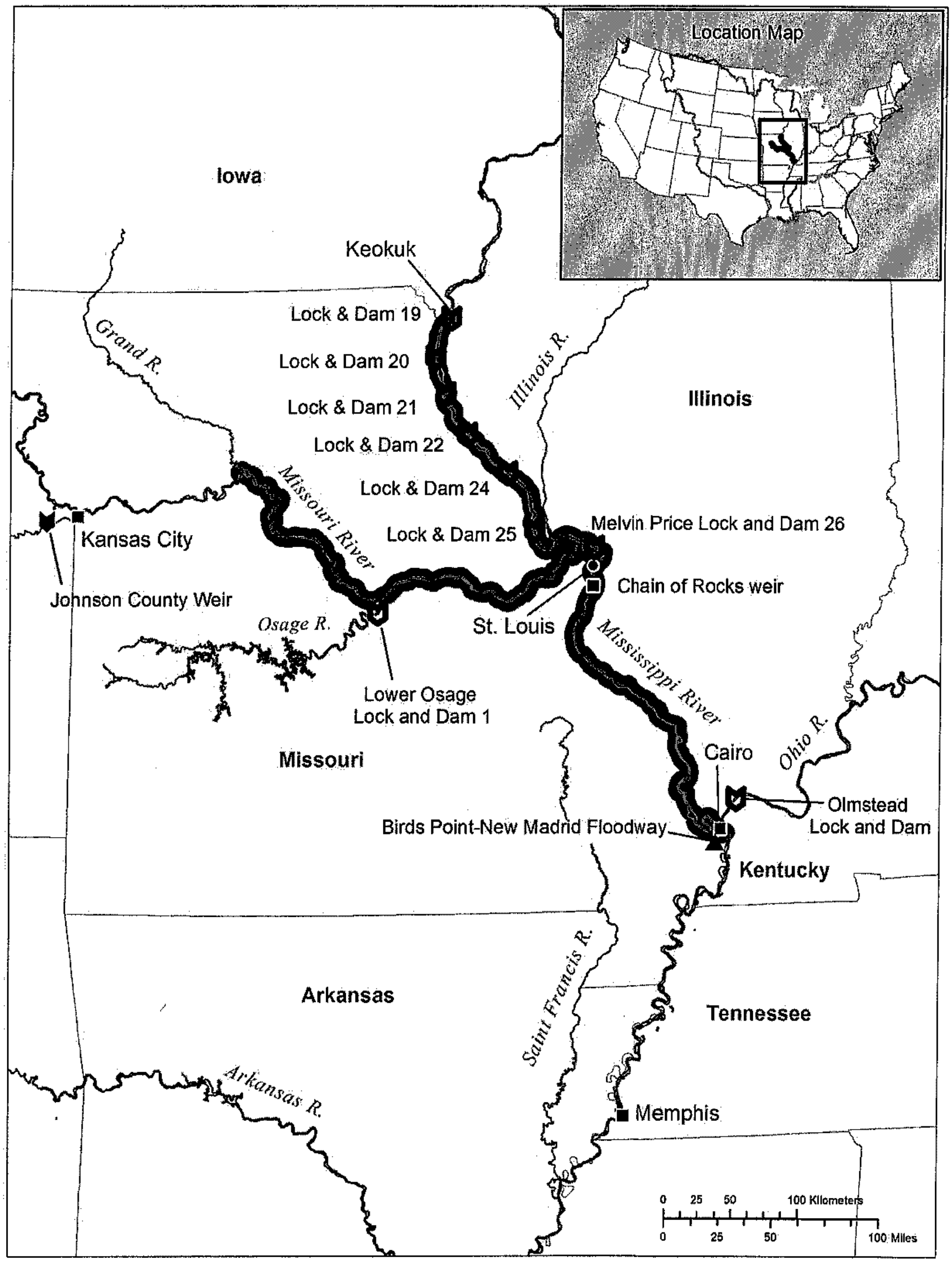

Figure 9 Map depicting the Interior Highlands Management Unit.

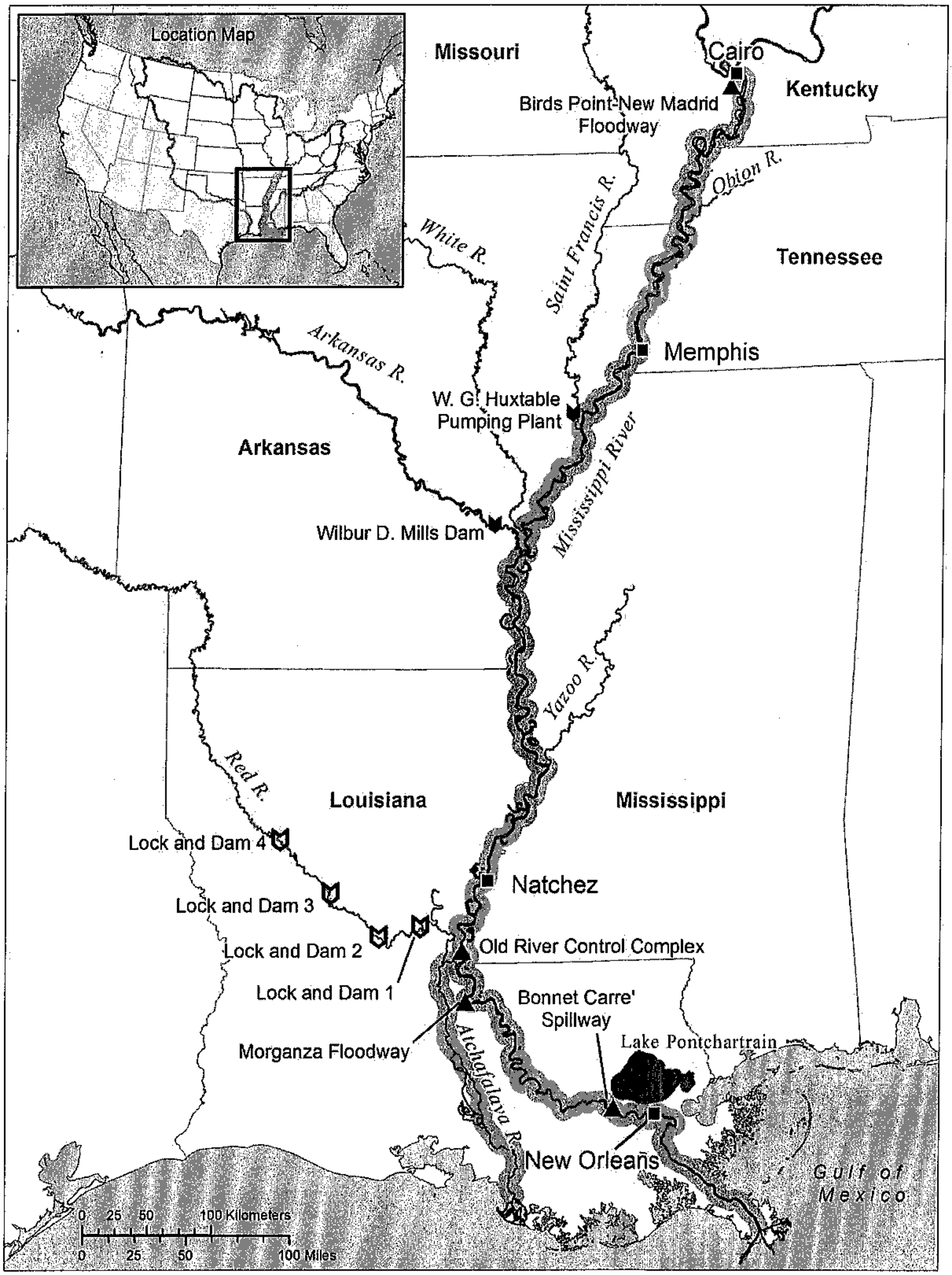

Figure 10 Map depicting the Coastal Plains Management Unit.

that downlisting or delisting is not warranted; for example, a new threat may emerge that is not addressed by the recovery criteria below that causes the species to remain threatened or endangered.

Criteria for Reclassification to Threatened Status

Pallid Sturgeon will be considered for reclassification from endangered to threatened when the listing/recovery factor criteria are sufficiently addressed such that a self-sustaining genetically diverse population of 5,000 adult Pallid Sturgeon is realized and maintained within each management unit for 2 generations (20-30 years). In this context, a self-sustaining population is described as a spawning population that results in sufficient recruitment of naturally-produced Pallid Sturgeon into the adult population at levels necessary to maintain a genetically diverse wild adult population in the absence of artificial population augmentation. Metrics suggested to define a minimally sufficient population would include incremental relative stock density of stock-to-quality-sized naturally produced fish (Shuman et al. 2006) being 50-85 over each 5-year sampling period, catch-per-unit-effort data indicative of a stable or increasing population, and survival rates of naturally produced juvenile Pallid Sturgeon (age 2+) equal to or exceeding those of the adults (see Justification for Population Criteria below for details). Additionally, in this context a genetically diverse population is defined as one in which the effective population size (N_e) is sufficient to maintain adaptive genetic variability into the foreseeable future ($N_e \geq 500$), conserve localized adaptions, and preserve rare alleles.

Criteria for Delisting Species

Pallid Sturgeon will be considered for delisting when the criteria for reclassification to threatened status have been met and sufficient regulatory mechanisms are established to provide reasonable assurances of long-term persistence of the species within each management unit in the absence of the Act's protections.

Listing/Recovery Factor Criteria

The following listing factors (A through E) are applicable to the reclassification and delisting criteria described above, although differences may apply in the methods used to achieve them. Addressing these criteria to sufficient levels can be facilitated by implementing the recovery tasks described under the RECOVERY OUTLINE/NARRATIVE section.

Listing Factor A: Present or Threatened Destruction, Modification or Curtailment of its Habitat or Range.

This factor will be considered addressed when:

(1) Habitat conservation and restoration efforts establish and maintain riverine habitats capable of meeting and sustaining all life history requirements of the species (i.e., sufficient habitat is available to support a self-sustaining population within each management unit as described under "Criteria for Reclassification to Threatened Status");

(2) Regulations and enforcement provide reasonable assurances that water quality parameters and contaminants of concern meet or exceed the latest national recommended water quality criteria (e.g., U.S. Environmental Protection Agency 2009);

(3) Entrainment losses from all sources (i.e., water cooling intake structures, dredge operations, irrigation diversions, etc.) are minimized such that attributable mortality does not impair maintenance of self-sustaining populations;
(4) The potential effects associated with changes in climate are assessed and mitigated or minimized.

Listing Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes.
This factor shall be considered addressed when take of Pallid Sturgeon associated with commercial, recreational, scientific or educational uses is fully controlled by State regulation, and has little to no effect upon the sustainability of the species within each management unit.

Listing Factor C: Disease or Predation
Disease and Predation were not implicated in the reduction of the species. Existing State and Federal regulations have been established to minimize pathogen introduction from outside the Pallid Sturgeon's range. The threat from predation will be considered addressed when sufficient data to assess the effects of intraspecific competition from nonnative/invasive species are available, and, if needed, regulations and management measures are established to minimize competition and predation threats to the species.

Listing Factor D: Inadequacy of Existing Regulatory Mechanisms
This factor shall be considered addressed when adequate mechanisms are in place and enforcement provide reasonable assurance that excessive non-natural mortality is reduced to sustainable levels and adequate regulations protect habitat and habitat forming processes sufficient to maintain self-sustaining populations within each management unit or when the underlying threat has been addressed such that regulatory mechanisms are no longer needed. For example, overutilization must be addressed for either downlisting or delisting to occur. Under the current protections afforded by the Endangered Species Act and similarity of appearance regulations, existing protections may be sufficient to support downlisting. However, delisting will require State harvest regulations that will provide adequate protection from overutilization in the absence of the Act's protections.

Listing Factor E: Other Natural or Manmade Factors Affecting its Continued Existence
This factor shall be considered addressed when:
(1) Energy development and new technologies are evaluated and assessed and, if necessary, measures are implemented to minimize any adverse effects from these activities;
(2) Once simulation studies can assess if alterations of habitats have influenced temporal or spatial reproductive isolating mechanisms resulting in increased rates of hybridization, this threat will likely be addressed by both site-specific and ecosystem improvement efforts such that actual risks associated with pallid/shovelnose hybridization are mitigated.
(3) Invasive species or aquatic nuisance species are regulated and reduced such that deleterious effects (i.e., predation and competition) are minimized.

Justification for Population Criteria

The following targets, when met, should provide sufficient assurances that the population criteria for recovery have been met.

ADULT POPULATION TARGETS:

The requirements of a minimum adult population capable of maintaining adaptive genetic variability long-term will need an effective population size (N_e) of at least 500 (Franklin and Frankham 1998) to perhaps as high as 5000 (Lande 1995). To estimate the census size (N) necessary to meet these criteria, one needs to understand how N_e relates to N. The relationship between N_e and N can be affected by a variety of factors, however, values for N_e /N averaged 0.10-0.11 based on published estimates from 102 species (Frankham 1995). Using Frankham's average values (1995) and the following formula, a theoretical minimum estimate of breeding adults can be obtained.

$$\frac{Ne}{N} = 0.1 \text{ or } N = \frac{Ne}{0.1}$$

If the desired N_e is 500 to 1,000 as suggested by Franklin and Frankham (1998) or 5000 as described in Lande (1995), a theoretical range of 5,000-50,000 adults would constitute a desired adult Pallid Sturgeon population. Reed et al. (2003) used population viability analysis to estimate minimum viable population sizes of many vertebrate taxa (n=102). They found, on average, that 7,000 breeding adults, along with sufficient habitat to support them, was a minimum requirement for long-term maintenance of a species.

Based on the above data, the minimum desired adult Pallid Sturgeon population within each management unit will be 5,000.

Because empirically derived data have not been analyzed for Pallid Sturgeon, this minimum target should be considered interim until Pallid Sturgeon specific data are evaluated and incorporated into an appropriate population viability analysis to derive management unit or, if designated, DPS specific minimum viable adult population estimates. In this fashion, the delisting and downlisting targets will be modified in an adaptive fashion based on available data and analyses.

Measuring Natural Recruitment

Recruitment failure has been documented in the Great Plains Management Unit, and only limited evidence of recruitment exists within the other management units (USFWS 2007). Concerns over limited recruitment (i.e., potential for local extirpation) resulted in the establishment of the PSCAP. While artificial propagation and stocking measures are helping to maintain the species, successful natural spawning and recruitment is necessary for recovery. To evaluate when this has been achieved, reliable population trend estimates will be needed.

Annual survival rates of hatchery-reared Pallid Sturgeon are relatively high ($\geq$ 0.8) for age 2+ fish (Hadley and Rotella 2009; Steffensen et al. 2010). These rates likely are comparable to those of age 2+ wild fish given that most age 2+ hatchery-reared fish were at large for at least 1 year and subject to comparable selection pressures as wild fish; the presence of wild juvenile

Pallid Sturgeon (age 2+) can provide inferences into potential adult recruitment levels. Thus, documenting presence or absence of wild juvenile Pallid Sturgeon in annual survey efforts is one approach to help assess if short-term natural recruitment is occurring within a management unit.

Because length frequency data are commonly collected in fishery surveys, these data remain useful and provide a cost-effective index to monitor a fish population and are more suitable long-term than the short-term presence/absence method described above. The general applicability and limitations of using stock density indices as a tool for assessment of length frequency data are described by Willis et al. (1993). The applicability of stock density indices to Pallid Sturgeon data are discussed in Shuman et al. (2006 and 2011). Additionally, stock density indices also have been applied to monitor trends in Shovelnose Sturgeon (Quist et al. 2002). In the context of long-term fish population monitoring, incremental relative stock densities (RSD) are appropriate to use (Willis et al. 1993); thus, incremental-RSD values of stock-sized fish as described by Shuman et al. (2006) likely will provide a useful measure to monitor recruitment. In addition to length frequency data, catch-per-unit effort data and survival rates also will be important data (Willis et al. 1993) to identify when natural recruitment is sufficient to sustain the species long-term.

Interim long-term targets for Pallid Sturgeon recruitment will be based on indices indicative of adequate recruitment; (i.e., incremental-RSD of stock to quality-sized naturally produced fish (Shuman et al. 2006) being 50-85 over each 5-year sampling period, catch-per-unit-effort data indicative of a stable or increasing population, and survival rates of naturally produced juvenile Pallid Sturgeon fish (age 2+) equal to or exceeding those of the adults).

Distinct Population Segment Overview

We may consider splitting this species-level listing into multiple DPSs in the future. Section 3 of the Endangered Species Act defines "species" to include "any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature." Pursuant to the Act, the USFWS considers if information is sufficient to indicate that listing, reclassifying, or delisting any species, subspecies, or, for vertebrates, any DPSs of these taxa may be warranted. In 1996, the USFWS and National Marine Fisheries Service published a joint policy guiding the recognition of DPSs of vertebrate species (61 FR 4722-4725). Under this policy, we consider two factors to determine whether the population segment is a valid DPS—1) discreteness of the population segment in relation to the remainder of the taxon, and 2) the significance of the population segment to the taxon to which it belongs. If a population meets both tests, it is a DPS, and then the population segment's conservation status is evaluated according to the standards in section 4 of the Endangered Species Act for listing, delisting, or reclassification (i.e., is the DPS endangered or threatened).

Analysis for Discreteness

A population segment of a vertebrate taxon may be considered discrete if it satisfies either one of the following conditions—(1) is markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors (quantitative measures of genetic or morphological discontinuity may provide evidence of this separation); or (2) is delimited by international governmental boundaries within which differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist that are significant in light of section 4(a)(1)(D) of the Act.

Analysis for Significance
If we determine a population segment is discrete, we next consider available scientific evidence of its significance to the taxon to which it belongs. The DPS policy states that this consideration may include, but is not limited to, the following factors: 1) persistence of the discrete population segment in an ecological setting unusual or unique for the taxon; 2) evidence that loss of the discrete population segment would result in a significant gap in the range of the taxon; 3) evidence that the discrete population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historic range; and/or 4) evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics.

If DPS are designated in the future, the criteria for reclassification and delisting would then be applicable to each designated DPS rather than to all management units as now indicated. Any determination to divide the currently listed entity into DPSs would go through the rulemaking process, which means that we would request public comments and peer review on our proposed course of action before we would make a final determination.

Recovery Outline/Narrative
The following recovery tasks were developed in concert with the Upper, Middle, and Lower Basin Pallid Sturgeon Workgroups and depict those items believed necessary to recover Pallid Sturgeon within each management unit. The following section is written to cover both broad scale approaches and, where possible, provide management unit specific details.

1. CONSERVE AND RESTORE PALLID STURGEON HABITATS, INDIVIDUALS AND POPULATIONS

1.1 RESTORE HABITATS AND FUNCTIONS OF THE MISSOURI AND MISSISSIPPI RIVER ECOSYSTEMS AT SUFFICIENT LEVELS AND QUALITY TO MEET THE LIFE HISTORY REQUIREMENTS OF THE SPECIES.

Anthropogenic alterations to the Missouri and Mississippi Rivers and their tributaries have affected natural riverine processes that Pallid Sturgeon evolved with. These anthropogenic habitat alterations adversely affect Pallid Sturgeon by altering the natural form and functions of these rivers (Simons et al. 1974; Fremling et al. 1989; Baker et al. 1991; Theiling 1999; Wlosinski 1999; Bowen et al. 2003). Restoration activities that return lost ecological process are necessary for the species to satisfy its life history requirements. However, the extent needed to accomplish this is currently not quantifiable. Thus, it will be necessary to improve our understanding of critical life history needs and tailor restoration efforts that will improve ecological conditions to address them.

1.1.1 DETERMINE EFFECTS OF DAMS ON LIMITING RECRUITMENT AND SURVIVAL OF PALLID STURGEON

Dams greatly reduced the river's ability to satisfy the life history requirements of Pallid Sturgeon by: 1) blocking movements to spawning and feeding areas; 2) affecting historical genetic exchange among reaches, (i.e., affecting emigration and immigration); 3) decreasing turbidity levels by trapping sediment in reservoirs; 4) reducing distances available for larvae to drift; 5) altering water temperatures; 6) altering conditions and flows in spawning areas; 7) altering flows and temperatures associated with spawning movements; and 8) possibly reducing food sources by lowering productivity (Hesse et al. 1989; Keenlyne 1989; USFWS 2000a; Bowen et al. 2003).

Modifying current dam operations to restore a more natural hydrograph can facilitate meeting the species' life history requirements to promote species recovery. Modifying dam releases (increasing or decreasing), at the appropriate time, may improve spawning cues over baseline conditions and lowered discharges in the summer may reduce larval drift rates in truncated reaches. Additionally, lower pool elevations in some key reservoirs, (i.e., Fort Peck Reservoir and Lake Sakakawea) could increase the amount of available habitat for drifting larvae and provide additional rearing habitat for juvenile Pallid Sturgeon (Bramblett 1996; Gerrity 2005). Because drift rates of larval Pallid Sturgeon are related to water velocity and temperature (i.e., larval Pallid Sturgeon drift distance increases with increased velocity) (Kynard et al. 2007; Braaten et al. 2008), reducing dam releases during the larval drift period to levels that mimic the natural hydrograph may benefit Pallid Sturgeon by reducing channel velocities with a corresponding decrease in total larval drift distance. Additional features that may reduce drift distances are slower velocity seasonal secondary channels or other off channel low velocity areas. A reduction in drift rate and distance could help retain larvae in suitable riverine habitats rather than them being transported into downstream reservoirs.

Additional studies are needed to fully understand the effects main-stem Missouri River and tributary dams have on disrupting various life history requirements of the species and to implement actions to mitigate these effects. Spillway releases and altered flow scenarios should be evaluated to assess their ability to improve habitats (i.e., flow conditions, increase sediment transport, floodplain access, and normalize temperature profiles) in downstream reaches. Areas specifically identified for study are:

GPMU

(1) Determine reservoir pool elevations at Fort Peck Reservoir and Lake Sakakawea necessary to provide adequate larval drift distance.
    (a) If pool level elevation modifications will increase larval survival, adjust reservoir operations to maintain pool elevations necessary to provide adequate larval drift distances and to maximize juvenile rearing habitat.

(2) Evaluate spillway releases from Fort Peck Dam to improve flow, turbidity, and temperature conditions downstream.
    (a) If necessary, implement spillway releases to improve flow, turbidity, and temperature conditions downstream.

(3) Evaluate flow scenarios from Fort Peck Dam to increase retention times and/or reduce larval development times (i.e., reduce drift rates and/or increase water temperatures) for larval Pallid Sturgeon.
   (a) If necessary, modify releases from Fort Peck Dam to increase retention times and/or reduce larval development times (i.e., reduce drift rates and/or increase water temperatures) for larval Pallid Sturgeon.

(4) Evaluate temperature control options on Fort Peck Dam to improve temperature conditions downstream.
   (a) If necessary, implement temperature control options to improve temperature conditions downstream.

(5) Evaluate flow scenarios from dams (Canyon Ferry, Tiber and others) upstream of Fort Peck Reservoir to improve habitat conditions and drift rates for larval Pallid Sturgeon.
   (a) If necessary, modify flows from dams (Canyon Ferry, Tiber and others) upstream of Fort Peck Reservoir to improve habitat conditions and drift rates for larval Pallid Sturgeon.

(6) Evaluate flow-release scenarios from Yellowstone River tributary dams (Yellowtail Dam and Tongue River Reservoir) to improve habitat conditions and drift rates for larval Pallid Sturgeon.
   (a) If necessary, modify flows from Yellowstone River tributary dams to improve habitat conditions and drift rates for larval Pallid Sturgeon in the Yellowstone River.

CLMU

(1) Evaluate spillway releases and/or flow-release scenarios from Missouri River dams (Fort Randall and Gavins Point dams) to improve habitat conditions in downstream reaches.
   (a) If necessary, implement spillway releases and/or alter flows to improve turbidity and temperature conditions in downstream reaches.

(2) Evaluate temperature control options on Fort Randall Dam to improve temperature conditions downstream.
   (a) If necessary, implement temperature control options on Fort Randall Dam to improve temperature conditions downstream.

(3) Evaluate the feasibility of increasing sediment transport downstream from Gavins Point Dam (i.e., assess the feasibility of: relocating the dam to a point upstream of the Niobrara River confluence, re-routing the Niobrara River to confluence with the Missouri River downstream of Gavins Point Dam, modifying flows from the dam, or removing Gavins Point Dam).
   (a) If feasible and necessary, implement method of increasing sediment transport downstream from Gavins Point Dam.

(4) Modify flows from Gavins Point Dam to facilitate successful migration, spawning, and survival of pallid sturgeon upstream of the Platte River confluence.
   (a) If feasible and necessary, implement flow modifications re-create elements of the hydrograph necessary for the appropriate and successful migration and spawning of pallid sturgeon above the Platte River.

1.1.2 RESTORE HABITAT CONNECTIVITY WHERE BARRIERS TO FISH MOVEMENT OCCUR

Evaluating the degree to which a structure may impede movements is necessary to determine if passage is needed at a particular structure. Additionally, existing structures that are barriers to fish movement likely prevent spread of aquatic nuisance species so careful analysis is need to consider the tradeoffs associated with removing barriers. Passage assessments must consider this as well as the importance for recovery. Following is a list of barriers by management unit that either have been assessed for passage needs or need to be further evaluated.

GPMU

(1) Restore fish passage at Intake Diversion Dam, Yellowstone River.
    (a) Evaluate success of fish passage at Intake Dam once completed.
(2) Evaluate need for passage of Pallid Sturgeon at Cartersville Diversion Dam, Yellowstone River.
    (a) Restore passage at Cartersville Dam if deemed necessary for Pallid Sturgeon recovery.
(3) Evaluate need for passage of Pallid Sturgeon at Vandalia Diversion Dam, Milk River.
    (a) Restore passage at Vandalia Diversion if deemed necessary for Pallid Sturgeon recovery.

CLMU

(1) Evaluate need for passage of Pallid Sturgeon at Spencer Dam, Niobrara River.
    (a) Restore passage at Spencer Dam if deemed necessary for Pallid Sturgeon recovery.
(2) Evaluate need for passage of Pallid Sturgeon at the, Johnson County Weir, Kansas River.
    (a) Restore passage at Johnson County weir if deemed necessary for Pallid Sturgeon recovery.
(3) Evaluate need for passage of Pallid Sturgeon at the Bowersock Dam, Kansas River.
    (a) Restore passage at Bowersock Dam if deemed necessary for Pallid Sturgeon recovery.

IHMU

(1) Evaluate need for passage of Pallid Sturgeon at Chain of Rocks Weir, Mississippi River.
    (a) Restore passage at Chain of Rocks Weir if deemed necessary for Pallid Sturgeon recovery.
(2) Evaluate need for passage of Pallid Sturgeon at Melvin Price Locks and Dam, Mississippi River.
    (a) Restore passage at Melvin Price Locks and Dam if deemed necessary for Pallid Sturgeon recovery.

(3) Evaluate need for passage of Pallid Sturgeon at Lower Osage Lock and Dam #1, Osage River.
    (a) Restore passage at Lower Osage Lock and Dam #1if deemed necessary for Pallid Sturgeon recovery.

CPMU
(1) Evaluate need for passage of Pallid Sturgeon at the Wilbur D. Mills Dam on the Arkansas River.
    (a) Restore passage at the Wilbur D. Mills Dam if deemed necessary for Pallid Sturgeon recovery.
(2) Evaluate need for passage of Pallid Sturgeon at the W. G. Huxtable Pumping Plant on the St. Francis River.
    (a) Provide passage at the W. G. Huxtable Pumping Plant if deemed necessary for Pallid Sturgeon recovery.
(3) Evaluate the potential need for passage at the Old River Control Complex, Atchafalaya River.
    (a) Restore passage at the Old River Control Complex if deemed necessary for Pallid Sturgeon recovery.

1.1.3 CREATE PHYSICAL HABITAT AND RESTORE RIVERINE FUNCTION

The loss of physical habitat needed by Pallid Sturgeon has been documented. However, not all efforts to restore habitat will generate equal benefits. As an example, the practice of modifying dikes has been implemented at various locations within the Missouri and Mississippi rivers as means to create habitat and restore riverine function. However, evaluation of these practices suggests that the intended benefits may not be fully manifesting themselves (Ridenour et al. 2009: Schloesser et al. 2012). Thus, it is essential to evaluate existing efforts to create habitat as compared to using natural processes associated with flow and sediment manipulation from dams to form instream habitats. Additionally, when habitat restoration sites are cleared and grubbed, it may be beneficial to leave clearing and grubbing material in the project site as a source of woody debris. Important activities by management unit are identified below. Finally, operation of dams upstream of spawning areas can influence total drift distance needed for larval fish (Kynard et al. 2007). Reduction in flows at Fort Peck Dam also may assist with reducing total drift distance of larval fish.

GPMU, CLMU, IHMU
(1) Assess relationship of discharge to physical habitat creation and larval fish drift (shallow water habitat, sand bars) in river reaches important for recovery.
    (a) Monitor the outcomes of flow manipulations from dams, and use resulting information to improve techniques, using adaptive management principles.
    (b) Decrease releases from Fort Peck Dam during the larval drift period (based on monitoring and research, this drift likely occurs in late June to early July) to reduce larval drift rates.

(2) Maintain lower reservoir pool levels downstream from important spawning areas to increase larval drift distance and provide both juvenile and adult habitats (see also Recovery Task 1.1.1).

GPMU, CLMU, IHMU, CPMU

(1) Protect, enhance, and restore habitat diversity and connectivity.
   (a) Pursue options to incorporate levee setbacks to increase flood plain connectivity.
   (b) Reconnect perched or disconnected side channels.
   (c) Develop programs that increase woody debris in these systems.
(2) Develop and maintain standardized monitoring programs to evaluate effects of habitat manipulation and annual variations to determine degrees of response in Pallid Sturgeon.
   (a) Monitor the outcomes of habitat manipulations, and use resulting information to improve habitat restoration and construction techniques, using adaptive management principles.

1.1.4 PROVIDE AND PROTECT INSTREAM FLOWS

Instream flows can be affected by water withdrawal. Over allocation of water resources can affect instream habitats by reducing the hydrograph or extreme flow depletions can render river reaches as uninhabitable for portions of the year. Understanding existing water allocations and projected withdrawal patterns is essential to evaluating the magnitude of effects associated with depletions and implementing flow protection strategies necessary to meet the life history needs of Pallid Sturgeon. Additionally, instream flows also can be affected daily and seasonally through reservoir operations. The following tasks are intended to increase the understanding of the effects of water depletion and reservoir operations on Pallid Sturgeon and their habitats and may be useful in better understanding the effects of climate change.

GPMU, CLMU, IHMU

(1) Develop an instream flow plan for riverine reaches important to Pallid Sturgeon recovery.
   (a) Assess tributary water allocations to determine depletion effects on habitat formation and maintenance.
   (b) Determine what flows are necessary to meet Pallid Sturgeon life history requirements.
      (i) Consider precipitation pattern models and climate change forecasts when developing flow requirements.
   (c) Implement flow protection strategies based on instream flow plan.
(2) Evaluate dam discharges during spring, summer, and fall (both main-stem and tributaries) to protect instream flows.
   (a) Manipulate reservoir releases if needed to protect or restore flows for recovery of Pallid Sturgeon.

1.1.5 QUANTIFY AND MINIMIZE EFFECTS OF ENTRAINMENT

Studies at water diversion points have documented entrainment of Pallid Sturgeon. However, not all sites have been assessed to determine and quantify entrainment effects. Thus, it will be necessary to assess and quantify entrainment losses of Pallid Sturgeon at industrial, municipal, and agricultural water intakes, pumping facilities, and other diversion structures. The U.S. Environmental Protection Agency administers the Clean Water Act and should develop and implement section 316 (b) standards that will minimize entrainment of adult and juvenile Pallid Sturgeon. The Bureau of Reclamation and Natural Resources Conservation Service develop and operate many irrigation projects within the range of Pallid Sturgeon. Where necessary these projects should be fitted with screens that will minimize or prevent entrainment.

GPMU, CLMU, IHMU, CPMU

(1) Assess potential for entrainment losses at industrial, municipal, and agricultural water intakes, pumping facilities, and other diversion structures.
    (a) Implement strategies to prevent/minimize entrainment.

CLMU, IHMU, CPMU

(1) Assess potential for entrainment losses associated with commercial navigation/towboat entrainment.
    (a) Implement strategies to prevent/minimize entrainment.
(2) Inventory and assess potential for entrainment losses associated with dredging and gravel mining operations.
    (a) Implement strategies to prevent/minimize entrainment.

1.1.6 PROVIDE PROTECTION FOR IMPORTANT HABITAT FORMING PROCESSESS

Natural erosion and deposition processes create dynamic and diverse riverine habitats. Protecting these ecological processes will facilitate naturally creating habitats important for Pallid Sturgeon. There are tools being developed that can help guide these actions. Examples include the land Capability Potential Index (Jacobsen et al. 2007) and the Channel Migration Zone delineation developed as part of the cumulative effects study on the Yellowstone River (Thatcher et al. 2009) This measure will involve developing new programs and expanding existing ones to develop partnerships necessary to conserve these important areas.

GPMU, CLMU, IHMU, CPMU

(1) Develop and implement non-regulatory mechanisms to retain natural riverine ecological processes.
    (a) Develop programs that provide conservation incentives to willing participants.
        (i) Establish easements to reduce bank armoring in reaches important for Pallid Sturgeon.

(ii) Enroll adjacent riparian lands from willing participants in long-term conservation easements.

(iii) Purchase land from willing sellers and place in public trust (i.e., refuges, State parks).

(iv) Establish water conservation programs to offset anticipated lower late-season flows associated with climate change.

(b) Develop additional landscape-level tools to improve assessment and prioritization of non-regulatory conservation efforts.

1.2 MINIMIZE THREATS FROM EXISTING AND PROPOSED HUMAN-CAUSED ACTIVIES

Current State and Federal regulations generally benefit Pallid Sturgeon by providing oversight on anthropogenic activities. However, not all State and Federal regulations have established standards that are applicable to Pallid Sturgeon. In many instances, necessary data are lacking to establish thresholds or for comprehensive review. However where empirically derived Pallid Sturgeon data exist, improving data exchange, (i.e., a centralized easily accessible repository for Pallid Sturgeon data accessible by agency regulatory personnel) will allow for improved evaluation of effects within the permitting processes.

1.2.1 ENSURE COMPLIANCE WITH EXISTING STATE AND FEDERAL ENVIRONMENTAL REGULATIONS

The U.S. Environmental Protection Agency and State environmental divisions have rules and regulations designed to maintain water quality standards. These standards may need to be modified to protect Pallid Sturgeon based on Task 2.1.4.

The U.S. Army Corps of Engineers is responsible for administering Section 404 of the Clean Water Act. Efforts conducted to fulfill components of Tasks 1.1.1-1.1.3 will need to be considered in future 404 permits to limit inputs into those areas where habitats have been restored or protected to benefit Pallid Sturgeon.

The Federal Energy Regulatory Commission regulates interstate transmission of electricity as well as licensing hydropower projects. As part of the licensing process, Federal Energy Regulatory Commission should evaluate projects and their potential effects on Pallid Sturgeon life history requirements.

Any future introductions of nonnative fish species (i.e., aquaculture) may introduce diseases, increase competition, or result in predation on Pallid Sturgeon. Stocking new nonindigineous species anywhere in the Missouri and Mississippi river watersheds must not occur until after a risk assessment is completed that considers potential adverse effects to Pallid Sturgeon.

GPMU, CLMU, IHMU, CPMU

(1) Develop a viable data sharing platform that will enable both regulatory and action-agencies access to the best available science for improved species consideration in consultations, permit issuance, and restoration efforts.

(2) Work with States to develop a policy that will establish risk assessment evaluations prior to introduction of new nonindigenous and exotic species in the Missouri and Mississippi river basins. Only introductions proved not to be deleterious to Pallid Sturgeon should be allowed.

(3) Continue to enforce State and Federal water quality standards.

1.2.2 EVALUATE INVASIVE SPECIES/AQUATIC NUISANCE SPECIES

Potential threats from invasive or aquatic nuisance species include increased predation on eggs, larval, or juvenile life stages, competition for food in the case of the carps, exclusion of native species from preferred habitats, spread of diseases or parasites, and alteration of habitat quality. Further study is needed to fully qualify and quantify the magnitude of this probable threat to Pallid Sturgeon. The results of these investigations should be used to implement eradication or control efforts consistent with Pallid Sturgeon recovery.

GPMU, CLMU, IHMU, CPMU

(1) Where applicable, assess the effects of invasive or aquatic nuisance species to increase the understanding of these organisms and the magnitude of their status as a threat to Pallid Sturgeon.
    (a) If necessary, implement control measures to minimize adverse effects resulting from of invasive or aquatic nuisance species.

2. CONDUCT RESEARCH NECESSARY FOR SURVIVAL AND RECOVERY OF PALLID STURGEON

2.1 RESOLVE SPECIES IDENTIFICATION ISSUES IN THE LOWER MISSOURI AND MIDDLE MISSISSIPPI RIVERS.

The lower Missouri and Mississippi rivers contain sturgeon specimens that appear phenotypically and genotypically intermediate between Pallid and Shovelnose sturgeon. Development of accurate species classification indices and genetic tests are essential to ensure correct species assignment for population status evaluations.

2.1.1 DEVELOP METHODS FOR ACCURATE SPECIES ASSIGNMENT

IHMU, CPMU

(1) Use genetic and morphological data to test for significant agreement among these methods.

(2) If no association exists, reevaluate morphological characters in light of the genetic data.
    (a) Develop improved morphological based identification methods.

2.2 OBTAIN INFORMATION ON LIFE HISTORY AND HABITAT REQUIREMENTS OF ALL LIFE STAGES OF PALLID STURGEON

While much has been learned about the species since it was listed, data gaps still exist that prevent us from understanding how to recover the Pallid Sturgeon. Filling these gaps will facilitate management actions and improve efforts to address the five listing factors. Where spawning has been found to occur, spawning habitats must be characterized. If spawning habitats are limited or found to be excessive due to system alterations in certain reaches, this information should be considered when habitat restoration projects are developed (see Task 1.1.3). After spawning success has been documented, spawning success/failure should be quantified in each management unit based on collections of eggs, larvae and young-of-year. These data will help guide adaptive programs to improve efficiency in habitat conservation and restoration efforts.

2.2.1 EVALUATE SEXUAL MATURITY AND SPAWNING LIFE HISTORY PARAMETERS

GPMU, CLMU, IHMU, CPMU

(1) Evaluate if spawning occurs, identify spawning areas, and characterize spawning habitat within each management unit.
(2) Estimate sex ratios, spawning periodicity, and reproductive structure of adult population.
(3) Identify and evaluate spawning site fidelity.

2.2.2 FILL INFORMATION GAPS FOR AGE-0 TO AGE-1 PALLID STURGEON

GPMU, CLMU, IHMU, CPMU

(1) Improve methods to better distinguish larvae and juvenile Pallid Sturgeon from larvae and juvenile Shovelnose Sturgeon.
(2) Quantify spawning success/failure in the Missouri and Mississippi rivers and tributaries based on collections of larvae and/or young-of-year.
(3) Quantify drift-transport distance/retention of larvae in the Missouri and Mississippi rivers and tributaries.
(4) Test the hypothesis that larvae and juveniles cannot survive in reservoirs.
(5) Investigate imprinting during the early life history stages as a mechanism to stimulate homing/spawning site fidelity.
(6) Quantify growth and survival rates from hatch through the transition to exogenous feeding, and from the onset of exogenous feeding through the termination of the growing season as related to environmental conditions (e.g., temperature, dissolved oxygen, food type, and ration size).
(7) Identify and describe habitat requirements for larvae and age-0 juveniles.
    (a) Use this information to determine if habitat is limiting this life stage.

2.2.3 FILL INFORMATION GAPS FOR AGE-1 TO SEXUAL MATURITY PALLID STURGEON

GPMU, CLMU, IHMU, CPMU

(1) Identify and describe habitat requirements for juvenile Pallid Sturgeon.
 (a) Use this information to determine if habitat is limiting this life stage.
(2) Diet information;
 (a) Obtain appropriate diet information
 (b) Quantify diets and describe trophic linkages.
 (c) Assess if food/feeding is limiting this life stage.

2.2.4 INVESTIGATE EFFECTS OF ENVIRONMENTAL CONTAMINANTS ON ALL PALLID STURGEON LIFE HISTORY STAGES

Current data are lacking to adequately quantify this threat under existing environmental laws. Research suggests a link between environmental contaminants and potential reproductive problems in several sturgeon species (Feist et al. 2005; Koch et al. 2006b). Research on the effects of contaminants on Pallid Sturgeon reproductive mechanisms should continue as part of Pallid Sturgeon recovery efforts. Once contaminants affecting Pallid Sturgeon are identified and their effects are understood, plans may need to be developed to eliminate point and non-point sources into the Missouri and Mississippi river watersheds. These actions will need to be coordinated with the U.S. Environmental Protection Agency, State agencies with jurisdiction over water quality, and the USFWS' contaminants program. These data will be necessary to evaluate current water quality parameters and contaminants of concern relative to Pallid Sturgeon. If necessary, these data will help establish water quality standards sufficient to meet the life history requirements of the species.

GPMU, CLMU, IHMU, CPMU

(1) Monitor contaminant levels in wild populations to identify problem contaminants.
(2) Determine effects of problem contaminants on growth, survival, and reproduction of Pallid Sturgeon.
 (a) Evaluate contaminant effects on adult fish, gamete development, and reproductive success.
 (b) Evaluate contaminant effects on embryo/larval and juvenile development and survival.
(3) Identify and remedy sources of problem contaminants.

3. OBTAIN INFORMATION ON POPULATION GENETICS, STATUS, AND TRENDS

Having adequate information on this species' demographic structure and trends through time is fundamental to evaluate when recovery criteria requirements have been met. Consistent range-wide monitoring efforts are essential to evaluating the species responses to recovery tasks as well as threats as they are addressed.

3.1 DEVELOP AND IMPLEMENT STANDARD MONITORING PROCEDURES FOR PALLID STURGEON THROUGHOUT THE RANGE

Monitoring is essential to understanding the species' status, evaluating responses to management actions, and tracking recovery progress (Campbell et al. 2002). Currently, there is no funded systematic monitoring program. Existing monitoring efforts on the Missouri River are primarily conducted through the Pallid Sturgeon Population Assessment Program and are focused on detecting changes in Pallid Sturgeon and other species' population trends in response to habitat restoration practices. Data from these efforts have been useful in evaluating success of some recovery tasks like stocking, survival, distribution, and population growth; however, geographic expansion of this program could provide much or all of the data necessary to facilitate evaluating delisting and downlisting criteria. While assessment efforts on the Missouri River are a good foundation for monitoring, large river reaches fall outside of existing funded monitoring efforts, including; the middle and lower Mississippi River, the Atchafalaya River, the Missouri River upstream of Fort Peck Dam, and the Yellowstone River. Thus, large portions of the range have limited or no standardized monitoring.

GPMU, CLMU, IHMU, CPMU

(1) Develop and implement a range-wide Pallid Sturgeon monitoring program that will provide adequate data to evaluate progress toward downlisting and delisting criteria.
(2) Implement range-wide standardized reporting requirements for population monitoring projects.
(3) Continue to update, as needed, and implement the "Biological procedures and protocols for researchers and managers handling Pallid Sturgeon" range-wide.
(4) Develop a range-wide standardized database to integrate monitoring, propagation, stocking, and genetic data to meet reporting requirements that measure progress toward recovery.

3.2 MONITOR GENETIC MAKEUP OF PALLID STURGEON

Additional research is necessary to evaluate genetic differences across the species' range. Currently, there is a data gap in the lower Mississippi River and portions of the lower Missouri River. These data are essential for defining genetically meaningful management units and for understanding evolutionary trends, reproductive exchange among areas, and hybridization.

GPMU, CLMU, IHMU, CPMU

(1) Develop and implement a range-wide monitoring program that will provide adequate genetic data to guide stocking practices.
(2) Implement range-wide standardization among genetic labs work with Pallid Sturgeon.
(3) Implement range-wide standardized analysis and reporting requirements for all genetic data.

(4) Integrate archival catalogs of genetic samples and genetic results with standardized monitoring and stocking databases.
(5) Continue to assess relationship and justification of management units.
(6) Continue to maintain a range-wide tissue sample archiving as described in the "Biological procedures and protocols for researchers and managers handling Pallid Sturgeon".

3.3 ASSSESS STRUCTURE OF PALLID STURGEON POPULATION RANGE-WIDE FOR CONSIDERATION OF DISTINCT POPULATION SEGMENTS.

When Pallid Sturgeon were listed in 1990 (55 FR 36641-36647), data were not available regarding range-wide population structure, and a policy on DPSs did not exist. Subsequently, the Departments of Interior and Commerce jointly developed a DPS policy in 1996 (61 FR 4722-4725). This policy describes elements necessary to identify a DPS: 1) population discreteness and 2) population significance.

Data indicate that the population of Pallid Sturgeon in the upper Missouri River may meet the DPS policy criteria of discreteness (61 FR 4722-4725). They are genetically distinct from Pallid Sturgeon in the middle and lowermost portions of the range (Campton et al. 2000; Tranah et al. 2001; Schrey 2007; Schrey and Heist 2007), and they are physically separated by multiple dams. However, these studies lack adequate samples from portions of the Mississippi River, making it difficult to discern if additional discrete populations exist.

GPMU
(1) Evaluate population significance as defined in the DPS policy
(2) Evaluate conservation status as defined in the DPS policy.
(3) If conservation status assessment indicates a change is appropriate which will meaningfully advance conservation or significantly limit unnecessary regulation, identify and list appropriate DPS(s), if appropriate.

CLMU, IHMU, CPMU
(1) Continue collection and evaluation of genetic, ecological, behavioral, and physiological data to identify if additional populations meet the discreteness criteria as defined in the DPS policy.
(2) If additional discrete populations exist, evaluate their significance as defined in the DPS policy.
(3) If additional discrete and significant populations exist, evaluate their conservation status as defined in the DPS policy.
(4) If conservation status assessment indicates a change is appropriate which will meaningfully advance conservation or significantly limit unnecessary regulation, identify and list appropriate DPS(s), if appropriate.

3.4 CONDUCT A POPULATION VIABILITY ANALYSIS

A population viability analysis (PVA) should be conducted to further quantify population levels for recovery goals.

Criteria addressing minimum viable population size and demography will be useful in assessing if populations can persist through natural reproduction and, thus, will be an important component to evaluate the criteria for downlisting or delisting Pallid Sturgeon. A PVA also can be a useful tool for developing minimum viable population size estimates (Reed et al. 2003). All monitoring activities (see task 3.1) should consider the data requirements necessary to conduct PVA and should be designed to provide these data (Morris et al. 2002).

GPMU, CLMU, IHMU, CPMU

(1) Identify and collect data necessary to develop management unit or DPS (if designated) specific PVAs.

(2) Estimate management unit or DPS (if designated) specific minimum viable population size.

(2) Update PVA models as new data are available to facilitate downlisting and delisting criteria evaluations.

4. IMPLEMENT AND EVALUATION A CONSERVATION PROPAGATION AND STOCKING PROGRAM

4.1 IMPLEMENT CONSERVATION PROPAGATION AND STOCKING PROGRAM

Current stocking efforts are conducted in accordance with a range-wide stocking plan (USFWS 2008). This plan should be amended if necessary using adaptive management principles as new data become available from Tasks 3.1-3.3 and 4.2.

GPMU, CLMU, IHMU, CPMU

(1) Annually review, update if necessary, and implement range-wide stocking and propagation plans using the most recent information.

(2) Annually review and update the tagging plans with the most recent information.
- (a) Improve tagging mechanisms to minimize tag loss/failure in hatchery produced fish.
  - (i) Ensure that genetic samples are collected from all fish used in propagation efforts.
  - (ii) Continue to evaluate tag placement location for improved PIT tag retention.
  - (iii) Ensure that all monitoring crews have appropriate tag reading equipment.
- (b) Ensure that all field crews throughout the Missouri and Mississippi River drainages have appropriate equipment to read tags.
- (c) Implement tagging plan.

4.2 EVALUATE SUCCESS OF PROPAGATION AND STOCKING PROGRAM

GPMU, CLMU, IHMU, CPMU

(1) Evaluate Pallid Sturgeon supplementation using various age classes of progeny.
  - (a) Use data to derive Pallid Sturgeon specific survival rates where stocking occurs.
  - (b) Use data to refine stocking strategies:
    - (i) Determine optimal stocking numbers,
    - (ii) Determine optimal stocking size,
    - (iii) Determine optimal stocking time and location.
  - (c) Evaluate dispersal of hatchery progeny.
  - (d) Evaluate effectiveness of hatchery products within each management unit.
  - (e) Determine when stocking is no longer needed.

(2) Ensure that hatchery stocking and propagation records are incorporated into integrated a range-wide species recovery database.

4.3 RESEARCH METHODS TO IMPROVE SPAWNING, CULTURING, REARING, AND STOCKING OF PALLID STURGEON

GPMU, CLMU, IHMU

(1) Continue to refine efficient, effective spawning techniques in the hatcheries and in the field.

(2) Conduct trials to determine spawning requirements of broodstock (e.g., optimal spawning temperature) and methods for maximizing survival and growth of progeny collected from broodstock.

(3) Continue to refine techniques to improve hatchery product quality and survivability.

(4) Continue to refine and improve cryopreservation techniques.
  - (a) Insure cryopreservation program is adequately funded to maintain preserved sperm as long as necessary.

5. COORDINATE AND IMPLEMENT CONSERVATION AND RECOVERY OF PALLID STURGEON

5.1 WORK WITH STAKEHOLDERS/PARTNERS TO MAINTAIN AND / OR INCREASE PALLID STURGEON NUMBERS RANGE-WIDE (IN ALL MANAGEMENT UNITS).

GPMU, CLMU, IHMU, CPMU

(1) Collaborate with governmental agencies at all levels; local universities, land managers, private land owners, industry, and the general public to recover the Pallid Sturgeon.
  - (a) Enlist State agencies / State managers in regional and range-wide recovery efforts for the Pallid Sturgeon.
  - (b) Determine ways to improve communication and find innovative methods to work closely with Federal and State regulatory partners to improve upon recovery efforts for this fish.

(c) Engage local communities, businesses, aquariums, non-governmental organizations, and others to support Pallid Sturgeon.

5.2 COMMUNICATE WITH STURGEON RESEARCHERS, MANAGERS, AND THE PUBLIC

GPMU, CLMU, IHMU, CPMU

(1) Develop a method to integrate and incorporate information from all researchers and biologists working with Pallid Sturgeon.
- (a) Ensure that Federal endangered species permits are reviewed in a timely manner and coordinated such that annual reporting requirements are met and that Pallid Sturgeon collection and morphologic data and genetic tissue samples are provided to the appropriate repositories.
- (b) Identify disparate data sources necessary to evaluate progress toward downlisting and delisting criteria.
  - (i) Develop a range-wide data management and archiving strategy/plan to relationally link data necessary to evaluate progress toward downlisting and delisting criteria.
  - (ii) Implement data management and archiving strategy/plan.
  - (iii) Review and update data management and archiving strategy/plan as data needs and as technology changes.
- (c) Annually update central database using permit reporting data.
- (d) Improve and maintain central clearinghouse of Pallid Sturgeon bio-data and encounter history.

(2) Develop a web-based application related to Pallid Sturgeon life history that has direct links to scientific literature and current research.

(3) Improve dissemination of up-to-date information on Pallid Sturgeon (including research, new program updates, etc.).
- (a) Hold a range-wide "*Scaphirhynchus*" conference at least every 5 years.
- (b) Produce and share basin specific reports on Pallid Sturgeon through a user friendly outlet.
- (c) Encourage and support publication of research, management, and other recovery-related information.

(4) Collaborate with partners and develop an outreach program that highlights the Pallid Sturgeon and its ecosystem and the importance of protecting this fish
- (a) Develop and distribute information and education materials on Pallid Sturgeon and its ecosystem.
- (b) Increase public awareness of the laws and needs for protecting Pallid Sturgeon and their habitats.
- (c) Provide cultured Pallid Sturgeon to aquaria and comparable facilities where they can be viewed by the public.
- (d) Develop activities and materials for grade, middle, and high school teachers.

(e) Establish signs at all public boat ramps accessing the Missouri and Mississippi rivers describing Pallid Sturgeon.

6.0 POST DOWNLISTING OR DELISTING PLANNING

(1) Work with partners (including State and Federal agencies and others) to develop a post delisting management and monitoring strategy as progress is gained toward full recovery of this species.
(a) Develop and implement a post downlisting or delisting range-wide monitoring plan.

Part III: Implementation Schedule

Recovery plans are intended to assist the USFWS and potential Federal, State, and private partners in implementing actions to recover and/or protect endangered species. The following Implementation Schedule outlines recovery tasks, task priorities, task descriptions task duration, and estimated task costs for this recovery plan (2014-2047).

Parties with authority, responsibility, or expressed interest to implement specific recovery tasks are identified in the Implementation Schedule. The identification of agencies within the Schedule does not imply a requirement or that prior approval has been granted by that party to participate nor does it constitute and additional legal responsibilities beyond existing authorities, i.e., Endangered Species Act, Clean Water Act, Federal Land Policy and Management Act, etc. Recovery plans do not obligate other parties to implement specific tasks and may not represent the views, official positions, or approval of any individuals or agencies involved with developing the plan, other than the USFWS.

Recovery tasks are assigned numerical priorities to highlight the relative contribution they may make to species recovery. Priority numbers in column 1 of the schedule are defined as follows:

Priority 1 All actions that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2 All actions that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.

Priority 3 All other action necessary to provide for reclassification or full recovery of the species.

The cost estimates provided in the Schedule identify foreseeable expenditures that could be made to implement the specific recovery tasks. Accurate cost estimates were not practicable to derive for some recovery tasks due to the complex nature of the action (i.e., availability of willing sellers of private property rights, changes in existing laws, etc.). Additionally, some of the costs of identified tasks may be wholly or partially funded under existing State or Federal programs intended to fulfill the requirements of existing laws or regulations outside of the Endangered Species Act, but ultimately may provide benefits to Pallid Sturgeon. As such, these costs are difficult to estimate and not included in the calculation of the costs estimates for downlisting and delisting.

Actual expenditures by identified agencies/partners will be contingent upon appropriations and other budgetary constraints.

Key to acronyms used in Implementation Schedule

BOR	U.S. Bureau of Reclamation
COE	U.S. Army Corps of Engineers
ES	Ecological Services Division (USFWS)
EPA	U. S. Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
FR	Fisheries Division (USFWS)
NRCS	Natural Resources Conservation Service, U.S. Department of Agriculture
LE	Law Enforcement (USFWS)
RF	Refuge Division (USFWS)
STATES	State agencies located within the range of the species
USGS	U. S. Geological Survey
WAPA	Western Area Power Administration

Implementation Schedule

Pallid Sturgeon Recovery Plan Implementation Schedule												
Priority	Task #	Task Description*	Task Duration	RESPONSIBLE PARTY			COST ESTIMATES (thousands of dollars)					COMMENTS/NOTES
				USFWS		OTHER	2014 -2018	2019 -2024	2025 -2030	2031 -2040	2040 -2047	
				REGION	DIVISION							
1	1.1.1	Determine effects of dams on limiting recruitment and survival of Pallid Sturgeon	3	6	FR, ES	BOR, COE, STATES	300	600				Costs estimate based on focused research projects for evaluation of identified structures.
1	1.1.2	Restore habitat connectivity where barriers to fish movement occur	5+	6	FR, ES, RF	BOR, COE, STATES	43,000	40,000	27,000			Cost estimates impossible to derive as each barrier will likely require a unique solution.
1	1.1.3	Create physical habitat and restore riverine function	5+	3,4,6	FR, ES	COE, BOR,	6,000	6,000	3,000			
1	1.1.4	Provide and protect instream flows	5+	3,4,6	FR, ES	COE, BOR, NRCS,USFWS, STATES						Cost estimates impossible to derive.
1	1.1.5	Quantify and minimize effects of entrainment	5+	3,4,6	FR, ES	COE, BOR, EPA, NRCS, FERC, STATES	27,000	18,000	17,000			
1	1.1.6	Provide protection for important habitat forming processes	5+	3,4,6	FR, ES, RF	COE, BOR, EPA, NRCS,STATES	5,000	5,000	5,000	5,000	5,000	
1	1.2.1	Ensure compliance with existing State and Federal environmental regulations	ongoing	3,4,6	ES	COE, BOR, EPA, FERC, STATES						Cost may be absorbed under existing programs.
2	1.2.2	Evaluate invasive species/ Aquatic Nuisance Species	3+	3, 4, 6	FR, ES	USFWS, STATES						Cost may be absorbed under existing programs.
1	2.1.1	Develop methods for accurate species assignment	3	3,4,6	FR, ES	USFWS, COE	150	150				
1	2.2.1	Evaluate sexual maturity and spawning life history parameters	3	3,4,6	FR, ES	USGS, COE, BOR, STATES	750	750				
1	2.2.2	Fill information gaps for - Age-0 to Age-1 Pallid Sturgeon	3	3,4,6	FR, ES	USGS, COE, BOR, STATES	750	750				
1	2.2.3	Fill information gaps for - Age-1 to sexually mature Pallid Sturgeon	3	3,4,6	FR, ES	USGS, COE, BOR, STATES	750	750				

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Implementation Schedule (continued)

Pallid Sturgeon Recovery Plan Implementation Schedule												
Priority	Task #	Task Description*	Task Duration	RESPONSIBLE PARTY			COST ESTIMATES (thousands of dollars)					COMMENTS/NOTES
				USFWS		OTHER	2014 - 2018	2019 - 2024	2025 - 2030	2031 - 2040	2040 - 2047	
				REGION	DIVISION							
1	3.1	Monitor Pallid Sturgeon population	5+	3,4,6	FR	COE, BOR, USGS, STATES	3,000	3,000	3,000	3,000	3,000	
1	3.2	Monitor genetic makeup of Pallid Sturgeon	5+	3,4,6	FR, ES	COE, USFWS, STATES	200	200	200	200	200	
3	3.3	Assess population for consideration of DPSs	5+	3,4,6	FR,ES	USFWS		20				Some cost may be absorbed under existing programs.
2	3.4	Conduct a population Viability Analysis	4	3,4,6	FR, ES	USGS, COE, BOR		100	100			Data analysis. Data collection costs absorbed under existing programs
1	4.1	Conservation propagation and stocking program	5+	3,6	FR	COE, BOR, STATES	925	1025	550			
1	4.2	Evaluate success of propagation and stocking program	5+	3,4,6	FR	COE, BOR, STATES	75	75	50	50		Data analysis. Data collection costs absorbed under existing programs
2	4.3	Research to improve spawning, culturing, rearing and stocking	3	3,4,6	FR, ES	USGS, COE, BOR, STATES	150	150				Cost may be absorbed under existing programs
1	5.1	Work with stakeholders/partners to maintain and/or increase Pallid Sturgeon numbers range-wide.	ongoing	3,4,6	FR, ES, RF	USGS, COE, BOR, STATES	200	200	200	200	200	Cost may be absorbed under existing programs
3	5.2	Communicate with sturgeon researchers, managers, and the public.	5+	3,4,6	FR, ES	USGS, COE, BOR, STATES	200	200	200	200	200	Cost may be absorbed under existing programs
3	6.1	Post downlisting or delisting planning.	3	3,4,6	FR, ES	USGS, COE, BOR, USFWS, STATES, WAPA, NRCS			100	100		

*detailed description available in Recovery Outline/Narrative section.

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APPENDIX A: State Regulatory Requirements

The table that follows lists the major state laws that establish requirements, permits, approvals, or consultations that may apply to projects in or near waterways that may affect water quality or quantity.

The citations in this table are those of the general statutory authority that governs the indicated category of activities to be undertaken.
Under such statutory authority, the lead state agencies may have promulgated implementing regulations that set forth the detailed procedures for permitting and compliance.

Definitions of abbreviations used in the table are provided here.

ACA Arkansas Code, Annotated
IAC Iowa Code
ILCS Illinois Compiled Statutes
KAR Kentucky Administrative Regulations
KSA Kansas Statues Annotated
LAC Louisiana Administrative Code
MCA Montana Code Annotated
MSC Mississippi Code
MRS Missouri Revised Statutes
NDCC North Dakota Century Code
NRS Nebraska Revised Statute
SDAR South Dakota Administrative Rules
TCA Tennessee Code Annotated

Table B State Statues Related to Water Quality and Usage.

	AUTHORITY CITATION
Arkansas	Arkansas Water and Air Pollution Control Act (ACA §§ 8-4-101 et seq.) Arkansas Water Resources Development Act of 1981 (ACA §§ 15-22-601 to 15-22-622) Arkansas Natural and Scenic Rivers System Act (ACA §§ 15-23-301 to 15-23-315) Flood Control (ACA §§ 15-24-101 et seq,)
Illinois	Environmental Protection Act (ILCS §§ 415-5-1 et seq.) Water Pollutant Discharge Act (ILCS §§ 415-25-.01 et seq.) Watershed Improvement Act (ILCS §§ 505-140-.01 et seq.) Water Use Act of 1983 (ILCS §§ 525-45-1 et seq.)
Iowa	Surface Water Protection and Flood Mitigation Act (IAC §§ 466B.1 to 466B.9) Initiative on Improving Our Watershed Attributes (I on IOWA) (IAC §§ 466-1 to 466-9) Protected Water Area Systems (IAC §§ 462-B.1 to 462-B.16) Public Lands and Waters (IAC §§ 461-A.1 to 462-A.80) Soil Conservation Districts Law (IAC §§ 161-A.1 to 161-A.80)
Kansas	State Water Resource Planning (KSA §§ 82a-901 to 82a-954) Bank Stabilization Projects (KSA §§ 82a-1101 to 82a-1103)
Kentucky	Designation of uses of surface waters (401 KAR 5:206) Anti-degradation policy (401 KAR 5:030) Surface Water Standards (401 KAR 5:031)
Louisiana	Louisiana Environmental Quality Act (LAC §§30-II-2001 to 2566) Surface Water Quality Standards (LAC §§ 33-IX-1101 et seq.)
Mississippi	Mississippi Air and Water Pollution Control Law (MSC §§ 49-17-1 to 49-17-43)
Missouri	Missouri Clean Water Law (MRS §§ 640.010 et seq. and §§ 644.006 et seq.)
Montana	Aquatic Ecosystem Protections (MCA §§ 75-7-101 et seq.) Flood Plain and Floodway Management (MCA §§ 76-5-101 et seq.) Surface Water and Groundwater (MCA §§ 85-2-101 et seq.) Public Water Supplies, Distribution and Treatment (MCA §§ 75-6-101 et seq.) Water Quality (MCA §§ 75-5-101 et seq.) Montana Water Use Act (MCA § 85-2-101 et seq.).
Nebraska	Environmental Protection Act (NRS §§ 81-1501 et seq.)
North Dakota	Control, prevention, and abatement of pollution of surface waters (NDCC §§ 61-28-01 et seq.)
South Dakota	Surface Water Quality Standards (SDAR §§ 74-51-01 et seq.)
Tennessee	Tennessee Water Quality Control Act of 1977 (TCA §. 69-3-101 et seq.) General Water Quality Criteria (§§1200-4-3-01 et seq.) Use Classification for Surface Waters (§§1200-4-4-01 et seq.)

APPENDIX B: Summary of Public Comments

On March 15, 2013, we published a notice in the Federal Register soliciting public comments on our release of a draft revised recovery plan for the endangered Pallid Sturgeon (51 FR 16526).

The new revised recovery plan constitutes the first revision of the recovery plan since 1993. The revised recovery plan documents the current understanding of the species' life history requirements, identifies probable threats that were not originally recognized, includes revised recovery criteria, and based on improved understanding of the species, describes those actions believed necessary to eventually delist the species.

In our announcement, we request assistance in the recovery plan revision effort by providing the public with the opportunity to review the revised plan and solicited any additional information related to Pallid Sturgeon that was not already included in the draft revision. Specifically, we requested any new information, analyses, or reports that summarize and interpret: population status and threats, demographic or population trends; genetics and competition; dispersal and habitat use; habitat condition or amount; and adequacy of existing regulatory mechanisms, management, and conservation planning.

Concurrent with the public comment period, we solicited independent peer review of the document from four individuals prominent in the field of sturgeon biology, ecology, and/or large river ecosystems.

The 60-day public comment period closed on May 14, 2013 and we are grateful for the contributions from those who provided information during this review and comment period. This input ultimately improved the information contained within this revision to our 1993 Pallid Sturgeon Recovery Plan.

Peer-review and public comments ranged from minor editorial suggestions to providing new information. As appropriate, we have incorporated all applicable comments into the text of this revised recovery plan. All comment letters are on file at the Montana Fish and Wildlife Conservation Office, 2900 4th Ave. North, Suite 301, Billings, Montana 59101.

List of Commenters:

PEER REVIEWERS:

Dr. Craig Paukert
Missouri Cooperative Fish and Wildlife Research Unit
University of Missouri
302 Anheuser-Busch Nat Res Bldg.,
Columbia, MO 65211

Dr. Mark Pegg
School of Natural Resources
University of Nebraska
402 Hardin Hall
Lincoln, NE 68583

Dr. Kenneth J. Sulak
U.S. Geological Survey
Southeast Ecological Science Center
7920 NW 71st St.
Gainesville, FL 32653

ADDITIONAL COMMENTERS:

Montana Fish Wildlife and Parks

Missouri Department of Conservation

National Park Service,
Biological Resource Management Division

Nebraska Game and Parks Commission

South Dakota Dept. of Game, Fish, and Parks

U.S. Army Corps of Engineers,
Mississippi Valley Division

Following are those substantive comments that were not addressed in the final Pallid Sturgeon Recovery Plan, along with our response to each comment. Comments are arranged into the following categories – general information, downlisting/delisting criteria, and recovery tasks.

GENERAL INFORMATION

Comment 1: One reviewer questioned how we can conclude the Pallid Sturgeon population is stable when very large sections of the range have no population estimates?

Response 1: In this context, a stable population is one that is in a relatively steady-state either artificially or naturally. A stable designation, however, is not meant to imply that the population is viable, self-sustaining, or recovered. Our conclusion that the Pallid Sturgeon population is stable is based on a variety of factors including, but not limited to:

1) The success of the Pallid Sturgeon Conservation Augmentation Program (PSCAP). As a result of the PSCAP, multiple year-classes have been established and current survival estimates suggest that long-term persistence of the species is anticipated to occur in those reaches where localized extirpation appeared imminent prior to implementation of the PSCAP.

2) Long-term sampling data in many portions of the range with relatively consistent catch-per-unit-effort data;

3) Population abundance estimates, where available; and

4) Implementation of the Similarity of Appearance Rule to reduce or eliminate harvest of Pallid Sturgeon in association with commercial shovelnose sturgeon harvest.

Comment 2: One commenter suggested the section describing the diets of Pallid Sturgeon should mention the importance of native large-river minnow species.

Response 2: We acknowledge that limited data suggest that native turbid-adapted cyprinid species have been documented as a food item for Pallid Sturgeon and several species of these minnows have declined coincident with Pallid Sturgeon. However, while it has been documented that Pallid Sturgeon consume native large-river minnow species, where they are relatively abundant, their overall importance to Pallid Sturgeon is difficult to ascertain. Future research will attempt to examine species relationships and dependencies.

Comment 3: One reviewer questioned whether the Kansas River was ever historically occupied by Pallid Sturgeon and one commenter indicated support for increased emphasis on the potential importance of tributaries to the recovery of Pallid Sturgeon.

Response 3: Information gained following the original version of this plan warrants further investigation into the potential roles tributary rivers play in overall Pallid Sturgeon recovery. One explanation of the low observations of Pallid Sturgeon in tributaries, post-listing, could be attributable to low sampling efforts, low population sizes, or both. Currently, increased sampling and monitoring efforts across the species' range have resulted in more tributary observations including those in the Kansas River. Additionally, in portions of the range, hatchery-reared Pallid Sturgeon account for many of the observations in tributaries. Thus, more information is needed to fully assess the role of certain tributaries in Pallid Sturgeon recovery.

Comment 4: One reviewer noted that fundamental empirical knowledge of how many Pallid Sturgeon exist for major portions of the species' range are lacking (i.e., between Gavins Point Dam and St. Louis, Missouri and the Mississippi River downstream of the Ohio River confluence). Additionally, it was noted that no population segment currently exceeds either the 500 or 5000 minimum adequate population size explained within the plan. Finally, it was suggested that Pallid Sturgeon in the northern most reaches of its range should be considered as critically endangered, since abundance estimates do not approach the lower threshold of 500 individuals in the effective breeding population.

Response 4: We summarized the available information related to abundance estimates in the Present Distribution and Abundance section within the draft version of this plan. Based on additional information received during the comment period on the draft version of this plan, this section was updated in the final version.

The recommendation for considering population segments as critically endangered as compared to endangered may be the result of terminology used by different groups. While the International Union for Conservation of Nature distinguishes between critically endangered and endangered species by defining a critically endangered species as one being at an extremely high risk of extinction in the wild and an endangered species as one being at a very high risk of extinction in the wild, the Endangered Species Act does not. Under the Endangered Species Act, an endangered species is one defined as "...any species which is in danger of extinction throughout all or a significant portion of its range...", thus, in accordance with Federal law we use the latter definition for Pallid Sturgeon.

Comment 5: Several commenters discussed proposed hydrokinetic installations in the Mississippi River. The comments ranged from concerns over what effects these structures may have on Pallid Sturgeon and how they would be monitored to providing references for research efforts that may offer insight into the probable effects from these structures.

Response 5: Between the completion of the first draft and final draft revision to this plan, the large numbers of preliminary permits issued for exploration of hydrokinetic power in the Mississippi River were withdrawn by the permit holders. Thus, the section on hydrokinetic power was removed from the energy development discussion in the final version of this plan. However, if future permit applications suggest this potential threat may re-emerge, it will be reconsidered in the context of species recovery planning.

Comment 6: One reviewer indicated that not enough attention has been given to looming problems due to global warming and climate change.

Response 6: We agree that there are many uncertainties associated with the possible effects from climate change. Given these uncertainties, it is difficult to predict what future conditions might be and how those conditions may affect currently recommended practices. However, recovery plans can and should be updated, as needed, to ensure that both new and changing threats are acknowledged, described, and suitable recovery tasks are identified.

Comment 7: One commenter suggested adding additional language to the Water Quantity section under Factor D: Inadequacy of Existing Regulatory Mechanisms to clarify various nuances related to water rights held by Montana Fish Wildlife and Parks, and water reservations held by County Conservation Districts and municipalities.

Response 7: The intent of this section within the plan is not to provide a thorough account of the nuances associated with instream flow reservations, nor to discuss the nuances of water rights and reservations, but rather to provide a very simple illustrations to the reader such that they may better understand the relationship between junior and senior water rights under western water law. Our recommendations to resolve the concerns identified above are discussed in the Recovery Outline/Narrative under section 1.1.4.

Comment 8: One reviewer indicated that important placenames or landmarks used in the text and important in delineating the extent of listed reaches are not shown in some figures (e.g., Figure 2 and 3).

Response 8: Due to the scale of the maps used in various figures (e.g., Figure 2 and 3) some prominent landmarks were not labeled in order to prevent overcrowding of feature labels. We chose instead to highlight the contemporary range of the species within the map (bold and red line) to visually illustrate the reaches being described within the text.

Comment 9: One commenter expressed concern over the Platte River Recovery Implementation Program's ability to improve and maintain habitat for species, including Pallid Sturgeon and described a fish kill on the Lower Platte River during the late summer of 2012 which included two confirmed Pallid Sturgeon. The commenter attributed this fish kill to water withdrawal and low flows during a prolonged drought and concluded that flows are not always sufficient to maintain Pallid Sturgeon in the Platte River. Additional information provided included modeling efforts at the University of Nebraska suggesting river discharge and the daily variability in discharge were the biggest factors leading to the occurrence of Pallid Sturgeon in the lower Platte River and that maintenance of adequate flows and a natural hydrograph are vital to the management of the Platte River to aid Pallid Sturgeon recovery.

Response 9: The Platte River Recovery Implementation Program was developed to offset the adverse effects to federally listed species resulting from federal water-related activities in the Platte River basin above the Loup River confluence (i.e., central Platte River). One of the goals of the Platte River Recovery Implementation Program is to test the assumption that, by managing flows for federally listed species in the central Platte River, benefits would accrue to Pallid Sturgeon habitat located downstream in the lower Platte River. Members of the Platte River Recovery Implementation Program have committed to provide 130,000-150,000 acre feet of managed flows for central Platte River species by the end of calendar year 2019. As a partner in the Platte River Recovery Implementation Program, we are committed to ensuring defined benefits for all federally listed species in the Platte River basin including the Pallid Sturgeon in the lower Platte River.

We acknowledge the commenter was correct when they stated that a fish kill on the lower Platte River during the summer of 2012 resulted in the confirmed death of at least two Pallid Sturgeon and many Shovelnose Sturgeon. This fish kill was likely the result of high temperatures and low flows, which led to unfavorable conditions for fish. We will work with Platte River Recovery Implementation Program partners and water users in the lower Platte River basin to minimize the death of additional Pallid Sturgeon by avoiding low flow conditions.

Comment 10: One reviewer noted the terms "sub-adult" and "juvenile"were used in the draft plan, but never defined and recommended it might be useful to define the terms "juvenile" and "sub-adult" to distinguish these from one another, and from adults.

Response10: In the draft version of this plan, we used sub-adult and juvenile synonymously. In the final version of this plan we use the term juvenile in reference to all fish that are not considered embryos or larvae, and those that have not reached sexual maturity.

DOWNLISTING/DELISTING CRITERIA

Comment 11: One commenter recognized the current difficulties with identifying small Pallid Sturgeon and expressed concerns that identifying natural recruitment based on young-of-year or juvenile Pallid Sturgeon as a recovery criteria may not be realistic.

Response 11: As described in this plan under the General Description heading, Pallid Sturgeon are similar in appearance to Shovelnose Sturgeon and taxonomic (i.e., morphomerisitic) characters and ratios can vary with age of the fish (allometric growth), making identification of juvenile fish difficult. This lack of uniform applicability of morphometric indices also may be attributable to greater morphological differences documented between the upper Missouri River Pallid Sturgeon and Pallid Sturgeon inhabiting the middle and lower Mississippi and Atchafalaya rivers. Another confounding factor is genetic introgression between Shovelnose and Pallid sturgeon. Genetic analysis confirms introgressive hybridization between Pallid and Shovelnose sturgeon occurs and likely has been occurring for several generations, perhaps as many as 60 years, however; it is poorly understood how this may affect identification accuracy based on taxonomic (i.e., morphomerisitic) characters. To better resolve these issues, we have funded a comprehensive study within the lower Mississippi River to independently compare genomic species identification with identification based on taxonomic (i.e., morphomerisitic) characters to better evaluate concordance among these two methods. Until these results are completed, we consider that a combination of genetic and taxonomic (i.e., morphomerisitic) characters is more reliable than taxonomic character identification alone.

Comment 12: Several reviewers and commenters discussed the current goal of 5,000 adults per management. In general the nature of these comments were:

1) One reviewer sought clarity on if this was achievable or measurable and if we would use confidence intervals in determining whether the goal was met.

2) One reviewer indicated that the goal was reasonable.

3) One commenter sought clarity on how the adult population size would be determined and defined three possible analytical approaches.

4) One commenter expressed concern about this goal and the carrying capacity of currently available habitat.

Response 12: As part of the recovery planning process, we are required to provide objective and measurable recovery criteria. In this plan (see Adult Population Targets section), we defined a minimum target of 5,000 adult fish in each management. This target was determined by using the minimum effective breeding population size to derive an initial minimum target for each management unit. However, we also recognize that this target should be considered interim until empirically-derived Pallid Sturgeon specific data are developed, evaluated, and incorporated into an appropriate population viability analysis to derive management unit or, if designated, DPS specific minimum viable adult population estimates. Thus, the delisting and downlisting targets defined in this plan can and should be updated and modified in subsequent plan revisions, as appropriate, in an adaptive fashion based on available data and analyses.

Finally, at present, there is not a universal standard approach to deriving reliable population estimates for Pallid Sturgeon. We are, however, required to review and consider the best commercially and scientifically available data when making listing-related decisions. As such, we will consider the validity of the methods used based on the data available, the variability in the data (i.e., confidence intervals surrounding a population point estimate), assumptions made, and appropriateness of methodology employed as population estimates are developed.

Through the above process, we anticipate that future management unit specific, or, if designated, DPS specific minimum viable adult population targets, would account for and consider carrying capacity of available suitable habitats during the estimation development.

Comment 13: Two reviewers and several commenters raised questions or concerns about the use of stock density indices as a measure of recruitment. In general, the nature of these comments or questions were to seek clarity on:

1) How does an incremental-RSD equate to a specific number of adult pallid sturgeon?

2) The application of Shuman et al. (2006) to calculate stock density estimates range-wide and the applicability of these to all management units due to latitudinal gradients in growth and morphology.

3) Stock density indices and Catch-per-unit-effort are useful tools to assess population structure and recruitment, but how do they fit into the recovery criteria?

Response 13: We specified incremental-RSD values for stock to quality sized fish (as described by Shuman et al. (2006)) being 50-85 over each 5-year sampling period as a means to monitor and assess if adequate recruitment was occurring within each management unit. Thus, the incremental-RSD values specified are not intended to be directly related to a specific number of adults. However, with the application of appropriate survival rate information, inferences in predicted future adult trends maybe possible to derive.

We have concluded that the application of Shuman et al. (2006) to calculate stock density estimates are appropriate because relative stock density indices are a valid method to quantify length frequency data. The length categories utilized in stock density development are derived from and based upon percentages of the world-record length of the species in question (Willis et al. 1993). The values described in Shuman et al. (2006) were derived as a percentage of the largest fish on record. Therefore, the stock density length categories are expected to be appropriate across the range of the species. Additionally, in developing this interim target, we considered reach-specific variability across the Pallid Sturgeon's range and identified the interim target incremental-RSD of stock to quality-sized naturally produced fish as a range from 50-85, rather than a set value, to account for range-wide variability.

Finally, we also recognize that the utility of the incremental-RSD index relies on the ability to accurately discern small Pallid Sturgeon from Shovelnose Sturgeon which seems to become increasingly harder to do in the lower reaches of the species' range and can require genetic testing. Thus, we included other variables that are not solely dependent on identification of the smaller-sized Pallid Sturgeon (i.e., catch-per-unit-effort data indicative of a stable or increasing population and survival rates of naturally produced fish (age 2+) equal to or exceeding those of the adults). These indices, used in conjunction with incremental-RSD of stock to quality-sized naturally produced fish being 50-85, should provide sufficient confidence when evaluating if the downlisting or delisting criteria have been met.

Comment 14: One commenter suggested the stated Pallid Sturgeon generation time (20-30 years) is too short.

Response 14: The definition we used for generation length is defined as the average age of parents of individuals in a cohort of offspring. Generation length (IUCN 2010) offers insights into the turnover rate of breeding individuals in a population, and is considered greater than the age at first breeding and less than the age of the oldest breeding individual. Additionally, based on the IUCN guidelines (2010) we agree with their assertion that in the context of this plan that it is appropriate to extrapolate generation length from closely related well-known taxa (Shovelnose Sturgeon in the case of this plan) and to apply it to lesser-known and potentially threatened taxa.

Given the limited data on management-unit-specific age structure for this species, we estimated the generation length for each species as age at first reproduction + 1/natural mortality rate as defined by the IUCN (2010). We assumed a stable age structure with an earliest age of maturity, averaged over both sexes, of 10 for Pallid Sturgeon (Keelyne & Jenkins 1993) and 5 for shovelnose sturgeon (Keenlyne 1997). The annual mortality rate for both species was assumed to be 5% for adults after reaching sexual maturity (Bratten et al. 2009, Keenlyne 1997). The estimate for Pallid Sturgeon and Shovelnose Sturgeon, using primarily upper basin information, generated a generation length time of 22 and 12, respectively. The range provided is given to reflect variance across the species' range (i.e., anticipated shorter generation lengths and possible earlier maturity in the lower portions of the species' range).

Comment 15: One commenter agreed that the potential application of the DPS policy could provide a mechanism to reconsider reach-specific listing status for the Pallid Sturgeon while keeping full Endangered Species Act protection for identified DPSs that have not yet experienced recovery. However, they expressed concerns that the criteria used to designate a DPS (i.e., discreteness and significance) may be biased towards listing rather than downlisting.

Response 15: We appreciate the expression of support for our inclusion of the Distinct Population Segment Overview section in this plan. We recognize that the DPS policy provides flexibility under the Endangered Species Act and that there may be current data gaps that will need to be filled in order to make an adequate determination under the DPS policy.

RECOVERY TASKS

Comment 16: Several reviewers commented on the lack of recovery task prioritization.

Response 16: Identified recovery tasks are assigned numerical priorities to highlight the relative contribution they may make towards species' recovery. The following ranking schema is utilized in Part III: Implementation Schedule in this plan.

The priority numbers found in column 1 of the implementation schedule are defined as follows:

Priority 1	All actions that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.
Priority 2	All actions that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.
Priority 3	All other action necessary to provide for reclassification or full recovery of the species.

Through this process we have identified a general prioritization of recovery actions.

Comment 17: One reviewer questioned the availability of data to support the plan's recommendation to provide fish passage, while another commenter agreed that fish passage was an important concept for assisting with Pallid Sturgeon Recovery.

Response 17: Numerous lines of evidence indicate that increasing habitat connectivity can provide benefits and facilitate recovery. Newly hatched Pallid Sturgeon larvae are predominantly pelagic, drifting in the currents for 11 to 13 days and dispersing 245 to 530 km (152 to 329 mi), depending on water column velocity and temperature. Within portions of the species' range, requisite drift distances are lacking due to fragmentation (e.g., Intake Dam on the Yellowstone and Fort Peck Dam on the Missouri). Thus, providing access to spawning areas upstream of some barriers can increase the available drift distances. Additionally, historical and current data indicate suitable habitats exist upstream of several known barriers. These are some examples of the data leading us to conclude, that for some barriers providing fish passage is a reasonable recovery tasks which, if implemented, will help to address the threats of habitat loss, alteration, and degradation within the historical range of the species. Where possible, we tried to identify and highlight areas where fish passage efforts may assist overall recovery by increasing access to tributary habitats.

Comment 18: One commenter questioned the need to provide fish passage at the Wilbur D. Mills Dam constructed to block the old Arkansas River channel and indicated that restoring fish passage at this site would be challenging.

Response 18: At this time, we have not concluded whether Pallid Sturgeon passage at the Wilbur D. Mills Dam is necessary or essential for recovery of Pallid Sturgeon. In both the draft and final version of this plan, we recognized this barrier on a large tributary to the Mississippi River as a possible recovery option. However, we have not recommended doing anything at this structure at the present time. We believe this issue (the need to provide passage of Pallid Sturgeon at the Wilbur D. Mills Dam) should be further evaluated. If data were to indicate that providing passage would further conservation of the species and is deemed necessary for recovery, then we would recommend that passage be restored at this site.

Comment 19: One commenter indicated they were unaware of any published studies documenting Pallid Sturgeon utilizing woody debris, or that woody debris is essential to their forage base.

Response 19: While direct data defining linkages between Pallid Sturgeon and/or their common forage base directly using woody debris may be unavailable, it should not be simply discounted. Natural riverine processes, prior to anthropogenic alteration, included bank erosion that recruited large woody debris into the riverine environment. The important ecological role of woody debris in river environments is well documented in numerous publications (e.g., Fishcenich and Morrow 1999; Boyer et al. 2003; Archer 2009) some of which include: contributing organic matter, providing substrate for invertebrates, generating hiding cover and velocity breaks for fishes, as well as affecting river channel morphology, sediment deposition, hydraulic characteristics, and increased habitat diversity.

Given that historical snag removal efforts were effective at removing woody debris from extensive portions of Missouri and Mississippi rivers and bank stabilization activities have limited natural erosion process that would allow woody debris recruitment, we have identified the need to develop programs or efforts that can help restore woody debris to these rivers as a means of restoring riverine function or creating habitats. This recommendation then focuses more on ecosystem restoration to benefit the species; a fundamental purpose defined within the Endangered Species Act. The three studies cited in the above paragraph include:

Archer, M. W. 2009. Retention, movement, and the biotic response to large woody debris in the channelized Missouri River. Master's thesis. University of Nebraska, Lincoln.

Boyer, K. L., D. R. Berg, and S. V. Gregory. 2003. Riparian management for wood in rivers. Pages 407-420 in S. V. Gregory, K. L. Boyer, and A. M. Gurnell, editors. The ecology and management of wood in world rivers. American Fisheries Society, Symposium 37, Bethesda, Maryland.

Fischenich, C., and J. Morrow, Jr. 1999. "Streambank Habitat Enhancement with Large Woody Debris," EMRRP Technical Notes Collection (ERDC TN-EMRRP-SR- 13), U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Comment 20: One reviewer and two commenters expressed concerns related to the Pallid Sturgeon Conservation Augmentation Program. The concerns ranged from stocking taking up resources that could be used to implement other recovery tasks, the need to begin shifting emphasis from the propagation program to monitoring of introduced, hatchery-reared pallid sturgeon (i.e., dispersal of hatchery progeny into the Mississippi River, effects on genetic diversity and fitness, and general behavior as they mature), and risks of introducing or amplifying pathogens into the river systems through hatchery-reared fish.

Response 20: From a recovery planning perspective, priority is given to those actions that must be taken to prevent extinction, local extirpation, or populations declining to an irreversible level. In the context of this plan, the use of artificial propagation is identified as a method to prevent localized extirpation. Where appropriate, we prioritized efforts in developing and implementing the Pallid Sturgeon Conservation Augmentation Program. The focus of this program is to preserve the remaining wild genetic diversity before it is lost due to recruitment failure and localized extirpation, as well as to bolster population numbers within reaches where conservation augmentation is deemed necessary. These efforts have been successful at preventing local extirpation and capturing genetic diversity; essentially providing additional time to implement other necessary aspects of the recovery program.

Additionally, in this plan we discuss the use of artificial propagation, where deemed necessary, in the Recovery Outline/Narrative. Specifically, we identified the need to annually review, update if necessary, and implement range-wide stocking and propagation plans using the most recent information, as well as using the best available information to evaluate effectiveness of hatchery products within each management unit, and to determine when stocking is no longer warranted. We will continue to work closely with our partners and seek input and guidance from the Pallid Sturgeon recovery team and basin working groups to help ensure the range-wide stocking and augmentation plan is governing stocking efforts appropriately.

Comment 21: One reviewer commented on the development of a population viability analysis (Task 3.4) cautioning that there must be fundamental empirical pallid Sturgeon population data in place from a multi-year mark-recapture research effort. Additionally, this reviewer identified other data deficiencies for developing a population viability analysis, including; population size, population structure (modes and valleys), and mortality rate.

Response 21: We generally agree that there are prerequisite data that must be acquired before a population viability analysis should be attempted. As such, we ranked the recovery tasks to reflect this. For example, in the implementation schedule, the items under Task 3.1 Monitor Pallid Sturgeon Population, e.g., developing and implement a range-wide Pallid Sturgeon monitoring program that will provide adequate data to evaluate progress toward downlisting and delisting criteria, are identified as priority 1. Whereas task 3.4 Conduct a Population Viability Analysis is ranked as a priority 2 item.

Comment 22: One reviewer and two commenters highlighted what they see as apparent deficiencies in fundamental knowledge and suggested an outline of priority needs as follows:

1) Develop the fundamental knowledge of population abundance and structure for each major reach occupied by the species over its range (i.e., a range-wide population assessment),

2) Finding bottlenecks to recruitment,

3) Identify spawning grounds, and

4) Identify important habitats used by key life history stages.

Response 22: We agree and believe our prioritization list provided in the Implementation Schedule aligns with and addresses the general concern identified. It should also be noted that many of the specific items mentioned are included in ongoing research activities (i.e., developing population estimates, survival rate estimation, studying spawning movements and locations, etc.).

Comment 23: One commenter questioned why some recovery tasks under Section 1.1.1 use the word "evaluate" and inferred from this that potential implementation of restoration efforts is not a focus of near-term conservation efforts. The commenter ultimately recommended increased emphasis on implementation over evaluation to address issues related to dams that are well understood and documented.

Response 23: As part of the recovery planning process, we identify limiting biology or life history requirements, the recognized and probable threats to the species relative to the identified listing factors, and delineate reasonable measures believed necessary to assure sustainable recovery. Through this process, we have identified that dams are one of the primary anthropogenic landscape-level alterations associated with Listing Factor A: Present or Threatened Destruction, Modification or Curtailment of its Habitat or Range. To help address the threat from dams, we have outlined a series of reasonable potential actions to facilitate achieving a self-sustaining population of Pallid Sturgeon within each management unit such that downlisting and eventual delisting can be realized.

For example, looking at the recommendation under the Recovery Outline/Narrative under section 1.1.1 (2), we recommend evaluating spillway releases from Fort Peck Dam to improve flow, turbidity, and temperature conditions downstream, specifically to benefit Pallid Sturgeon in terms of promoting species recovery, and further identify actively implementing this activity if it proves feasible and useful in facilitating recovery of the species. However, the exact magnitude, duration, and timing of spillway releases necessary to improve flow, turbidity, and temperature conditions specifically necessary for Pallid Sturgeon recovery are unknown. Thus, we conclude that this action should be evaluated such that necessary prescribed flows can be developed and subsequently implement if feasible.

Comment 24: One commenter recommended inclusion of language in the plan that emphasizes the importance of Pallid Sturgeon recovery in all historically occupied river reaches that currently are considered suitable Pallid Sturgeon habitat, or can be restored to such levels through habitat restoration and that the success criterion for the fish passage project at Intake Dam on the Yellowstone River be based on Pallid sturgeon measures (e.g., passage, spawning, and recruitment).

Response 24: When this plan was developed, there was a strong emphasis from the Upper Basin Pallid Sturgeon Workgroup to seek and implement fish passage and entrainment protection measures at Intake Dam and sufficient data are available to warrant this management action. Thus, this plan identifies the need to restore fish passage at Intake Dam as mentioned above. However, this plan does not define the exact mechanism through which fish passage and entrainment protection would be achieved. Those specifics are being developed in coordination and cooperation with recovery partners and are subject to various processes (i.e., National Environmental Policy Act).

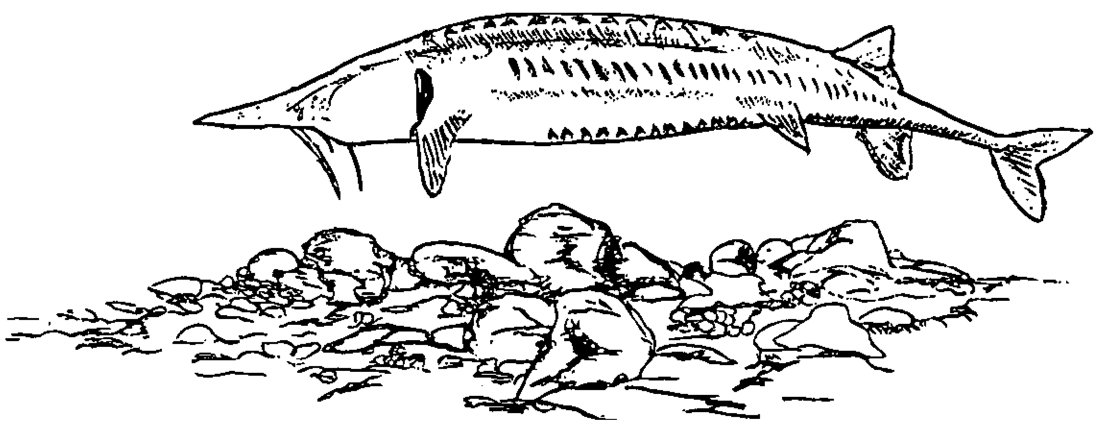
We are committed to working with partners to help ensure defined benefits for this federally listed species in the Missouri and Mississippi River basins are met, but want to reiterate that the goal of this species recovery program is to sufficiently address the threats to Pallid Sturgeon such that the species no longer fits the definition of threatened or endangered.

Comment 25: One commenter questioned if levee setbacks have been implemented within the range of the Pallid Sturgeon and acknowledge that the concept of increasing floodplain connectivity can improve aquatic habitat conditions. However, this commenter indicated that this type of restoration would have limited applicability because of cost and that benefits would be very reach specific. This commenter concluded that there is no published evidence to support the contention that Pallid Sturgeon require floodplain connectivity because they are main-channel inhabitants and the majority of the food items observed in the digestive tract of Pallid Sturgeon, at least in the Lower Mississippi River, originate in main-channel environments.

Response 25: We agree that increasing floddplain connectivity can improve aquatic habitat conditions and, ultimately, improving the ecosystem upon which Pallid Sturgeon depend. We also recognize that restoring this connectivity will have varying degrees of benefit which may be largely dependent upon levee proximity to the existing channel, the degree of localized channelization, and existing riparian habitat features. The Recovery Task category this is listed under is Create Physical Habitat and Restore Riverine Function which specifically relates to protecting, enhancing, and restoring habitat diversity and connectivity. It is anticipated that site specific planning and evaluation will be required to implement the various components associated with this task. Finally, while data documenting Pallid Sturgeon usage of the inundated floodplain is currently unpublished, Nebraska Game and Parks Commission has documented Pallid Sturgeon usage of floodplain habitats associated with the Missouri River flooding in 2011 (Justin Haas in litt., 2013; Kirk Steffensen, personal communication).

Pallid Sturgeon
(Scaphirhynchus albus)

5-Year Review
Summary and Evaluation



U.S. Fish and Wildlife Service
Pallid Sturgeon Recovery Coordinator
Billings, Montana

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5-YEAR REVIEW
Pallid sturgeon (*Scaphirhynchus albus*)

1.0 GENERAL INFORMATION

1.1 Reviewers

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1.2 Methodology Used to Complete the Review

On July 7, 2005, the U.S. Fish and Wildlife Service (USFWS) announced a 5-year review of Black-footed ferret (*Mustela nigripes*) and Pallid sturgeon (*Scaphirhynchus albus*) (70 FR 39326-39327). Through this notice, a public comment period also was initiated with a conclusion data of September 6, 2005. During this comment period, the lead office received one written comment from the Lower Brule Sioux Tribe, South Dakota, indicating that no pallid sturgeon have been reported being caught on or near the reservation during the past 5 years.

All data compilation and the drafting of this document was a group effort consisting of the Pallid Sturgeon Recovery Team, the Team's Genetic Advisory Group, and Regions 3, 4, and 6 of the USFWS. Initial data compilation for this status review was the result of a request from the Pallid Sturgeon Recovery Team Coordinator sent to biologists most familiar with pallid sturgeon demographics within all the Recovery Priority Management Areas (RPMAs) as defined in the Pallid Sturgeon Recovery Plan (USFWS 1993). This request was to summarize all demographic data from each RPMA. These demographic data as well as the most recent genetics data were summarized and presented to the Pallid Sturgeon Recovery Team and the Pallid Sturgeon Recovery Team's Genetic Advisory Group on September 28-29, 2005. The Pallid Sturgeon Recovery Team, Genetics Advisory Group, and USFWS lead and cooperating field offices compiled all available data and completed sections 2.3, 2.4, and 5.0.

The USFWS oversaw production and considered all available information to assemble this review and made all recommendations regarding appropriate status, application of the Distinct Population Segment Policy (1996), application of other relevant policies (see below), adequacy of recovery criteria, species status and classification determinations, and priority number designation. Peer review of this document was completed in accordance with the peer review plan (see Appendix A). Peer reviewer comments and responses to peer reviewers also are presented in Appendix A.

Sections 3(3), 10(a)(1)(A) and 10(j) of the Endangered Species Act (ESA) of 1973, as amended authorize the use of artificial propagation and experimental populations to further the conservation and recovery of threatened and endangered species. To clarify these roles and responsibilities, the USFWS and National Marine Fisheries Service (NMFS) jointly published a *Policy Regarding Controlled Propagation of Species Listed under the Endangered Species Act* (65 FR 56916-56912, September 20, 2000).

The NMFS has subsequently published a *Policy on the Consideration of Hatchery-Origin fish in Endangered Species Act Listing Determinations for Pacific Salmon and Steelhead* (70 FR 37204-37216, June 28, 2005). This latter policy was developed in response to the *Alsea Valley Alliance* v. *Evans* Federal court decision (aka "Hogan decision") which explicitly stated that hatchery-origin fish must be included with the listing of an endangered or threatened species under the ESA if those hatchery-origin fish are considered biological members of the listed entity (species, subspecies, distinct population segment, or evolutionary significant unit). This latter policy of NMFS also states, "Hatchery fish will be included in assessing an ESU's (evolutionarily significant unit) status in the context of their contributions to conserving natural self-sustaining populations."

Pallid sturgeon are currently listed as endangered under the ESA. Artificial propagation of pallid sturgeon is one component of the existing Recovery Plan and is currently ongoing. As a result, tens to hundreds of thousands of juvenile pallid sturgeon are produced and released annually via artificial propagation and captive spawning of wild-caught adults in accordance with the pallid sturgeon stocking and augmentation plan (USFWS 2006a).

The following statement is for the purpose of defining how hatchery-reared pallid sturgeon were viewed in this review, and implementing the ESA for pallid sturgeon in a manner consistent with the joint USFWS-NMFS *Policy Regarding Controlled Propagation of Species Listed under the ESA* and the *Alsea Valley Alliance* v. *Evans* Federal court decision. The following statement also is intended to be consistent with the NMFS' policy on the consideration of hatchery-origin fish in ESA listing determinations for Pacific salmon and steelhead.

The USFWS considers hatchery-reared pallid sturgeon, resulting from artificial propagation or captive breeding, to be members of the listed species and are, thus, protected under the provisions of the ESA, except as described in Section 10. All assessments of the status of pallid sturgeon under the ESA will consider the contributions of hatchery-origin fish to conserving natural self-sustaining populations. For the purpose of assessing the status of pallid sturgeon, the USFWS must consider the data available regarding the role of hatchery-reared pallid sturgeon in support of the conservation of naturally-spawning pallid sturgeon and the ecosystems upon which they depend, consistent with section 2(b) of the ESA (16 U.S.C. 1531(b)).

Current data indicate that hatchery-reared pallid sturgeon are essential to preventing local extirpation in portions of the range (RPMA 1 and 2) and have been used to reestablish pallid sturgeon in a small portion of the species' range (RPMA 3). However, it is too early to determine if these artificially propagated pallid sturgeon will spawn and naturally reproduce, and thus it is unclear if these hatchery-reared fish are contributing to conserving natural self-sustaining populations.

1.3 Background

1.3.1 Federal Register Notice Citation Announcing Initiation of this Review

70 FR 39326-39327, July 7, 2005

1.3.2 Listing History

Federal Register Notice: 55 FR 36641-36647
Date listed: September 6, 1990
Entity listed: Species
Classification: Endangered

1.3.3 Associated Rulemakings

NA

1.3.4 Review History

- A previous USFWS 5-year review for pallid sturgeon was noticed on November 6, 1991 (56 FR 56882). In this review, all currently listed species were simultaneously evaluated with no species-specific, in-depth assessment of the five factors, threats, etc., as they pertained to the different species' recovery. The notices summarily listed these species and stated that no changes in the designation of these species were warranted at that time. In particular, no changes were proposed for the status of the pallid sturgeon in the review.

- Although not technically a 5-year review per our regulatory requirements, on November 7, 1993, we announced the availability of the Pallid Sturgeon Recovery Plan. This document summarized the status of the species and biological requirements of the species as best known at the time.

1.3.5 Species' Recovery Priority Number at Start of Review
2C

1.3.6 Recovery Plan or Outline
Name of plan: Pallid sturgeon (*Scaphirhynchus albus)* Recovery Plan
Date issued: November 7, 1993
Dates of previous revisions: NA

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment Policy

2.1.1 Is the species under review a vertebrate?
_X_Yes
___No

2.1.2 Is the species under review listed as a DPS?
___Yes
_X_No

2.1.3 Was the DPS listed prior to 1996?
NA

2.1.4 Is there relevant new information for this species regarding the application of the DPS policy?
___Yes
_X_No

Currently there are data that suggest some form of genetic structuring range-wide and even suggest discernable genetic groups (Heist and Schrey 2006a and b; Tranah et al. 2001). However, these data are incomplete or lacking for portions of the species' range.

Therefore, current data appear insufficient to warrant application of the DPS policy at this time. However, as new data are developed and analyzed those data will be considered and the applicability of DPS policy will be reevaluated.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

___Yes
_X_ No

The 1993 recovery plan noted the short-term recovery objective for the pallid sturgeon is to prevent species extinction. Delisting criteria were deemed "undeterminable" in 1993. And while this recovery plan outlined "interim" downlisting criteria (see section 2.2.3 below), the criteria were vague due to our limited understanding of the species and immediate focus on preventing extinction.

2.2.2 Adequacy of Recovery Criteria

2.2.2.1 Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat?

No

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?

No

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information. For threats-related recovery criteria, please note which of the 5 listing factors* are addressed by that criterion. If any of the 5 listing factors are not relevant to this species, please note that here.

Interim Downlisting Criteria: 1) a population structure with at least 10% sexually mature females occurring within each recovery-priority management area has been achieved; and 2) when sufficient population numbers are present in the wild to maintain stability.

Evaluation Of Interim Recovery Criteria: In the 14 years since the recovery plan (USFWS 1993) was approved, we have learned much about the species, its threats, and its needs. We now believe that the best scientific and commercial information available suggests these downlisting criteria are no longer relevant to a potential future downlisting as written. Each recovery priority management area

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*1)Present or threatened destruction, modification or curtailment of its habitat or range;
2) Overutilization for commercial, recreational, scientific, or educational purposes;
3) Disease or predation;
4) Inadqequacy of existing regulatory mechanisms;
5) Other natural or manmade factors affecting its continued existence.

(RPMA) is faced with problems beyond just total population numbers and male-to-female ratios. A self-sustaining population can not be maintained without adequately addressing identified threats. A revision of the recovery plan is suggested (see section 4.0 for a complete list of recommended future actions).

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

The pallid sturgeon is a member of the genus *Scaphirhynchus*. This species is a bottom-oriented, large rivers obligate inhabiting the Missouri and Mississippi Rivers from Montana to Louisiana (Kallemeyn 1983) and the Atchafalaya River (Reed and Ewing 1993). Within this range, pallid sturgeon tend to select main channel habitats (Sheehan et al., 1998) in the Mississippi River and main channel areas with islands or sand bars in the upper Missouri River (Bramblett 1996). Food habits of this species range from aquatic insects to fish depending on life stage (Gerrity 2005, Gerrity et al. 2006, Wanner 2006). The species can be long lived with females reaching sexual maturity later than males (Kallemeyn 1983). Spawning appears to occur between June and August, and females may not spawn each year (Kallemeyn 1983). Larval fish produced from the spawning event drift downstream from the hatching site (Kynard et al. 2002), and begin to settle from the lower portion of the water column 11 to 17 days post hatch (Braaten et al. in review).

2.3.1.1 Abundance, Population Trends, Demographic Features, or Demographic Trends

At the time the pallid sturgeon (*Scaphirhynchus albus*) was listed under the ESA on September 6, 1990 (55 FR 36641-36647), the species was known from two small populations of large, old-aged sturgeon isolated by dams surviving in the upper Missouri River, and from various rare collection records from the lower Missouri River and the Mississippi River near Grafton, Illinois, at the mouth of the Illinois River (Forbes and Richardson 1905). In their discussion, Forbes and Richardson (1905) indicate that "...about one in five hundred of the shovelnose sturgeons taken in central Mississippi [River] belongs to this new species ..." and note that catches of the new species comprised about one-fifth of total sturgeon collected near West Alton, Missouri, suggesting that pallid sturgeon were believed more abundant in the Missouri River at that time. Bailey and Cross (1954) defined the range of pallid sturgeon in the Mississippi River as extending from the mouth of the Missouri River to New Orleans, Louisiana; however, they apparently located no collection records of the species between these two points. Records of pallid sturgeon from the upper Mississippi River at Keokuk, Iowa, were discounted by Bailey and Cross (1954) as "...stragglers from downriver." However, in 2000 the Illinois Department of Natural Resources (Atwood in litt. 2006) reported catching one pallid sturgeon in the tail waters of Melvin Price Locks and Dam. This structure is in the upper Mississippi River approximately 7 mi (11.3 km) upstream from the mouth of the Missouri River.

In 1991, the species was documented from the Atchafalaya River in central Louisiana (Reed and Ewing 1993).

Because the pallid sturgeon was not recognized as a species until 1905, few data are available concerning the species' early abundance and distribution (Pflieger 1975). Even as late as the mid-1900s, it was common for pallid sturgeon to be tallied in the commercial catch as either shovelnose, *Scaphirhynchus platorynchus*, or lake sturgeon, *Acipenser fulvescens*, (Keenlyne 1995). Correspondence and notes of researchers suggest that pallid sturgeon were still fairly common in many parts of the Mississippi and Missouri River systems as late as 1967 (Keenlyne 1989). Bailey and Cross (1954) also noted the presence of pallid sturgeon in the Missouri River from around Fort Peck Reservoir, Montana, and perhaps from Fort Benton, Montana, down to its mouth, as well as from within the Kansas River, Kansas.

The Pallid Sturgeon Recovery Plan (USFWS 1993) identified six RPMAs for implementation of recovery tasks based on most recent pallid sturgeon records of occurrence, and the potential of these areas for recovery of the species. The pallid sturgeon RPMAs (Figure 1) are defined in the Pallid Sturgeon Recovery Plan (USFWS 1993).

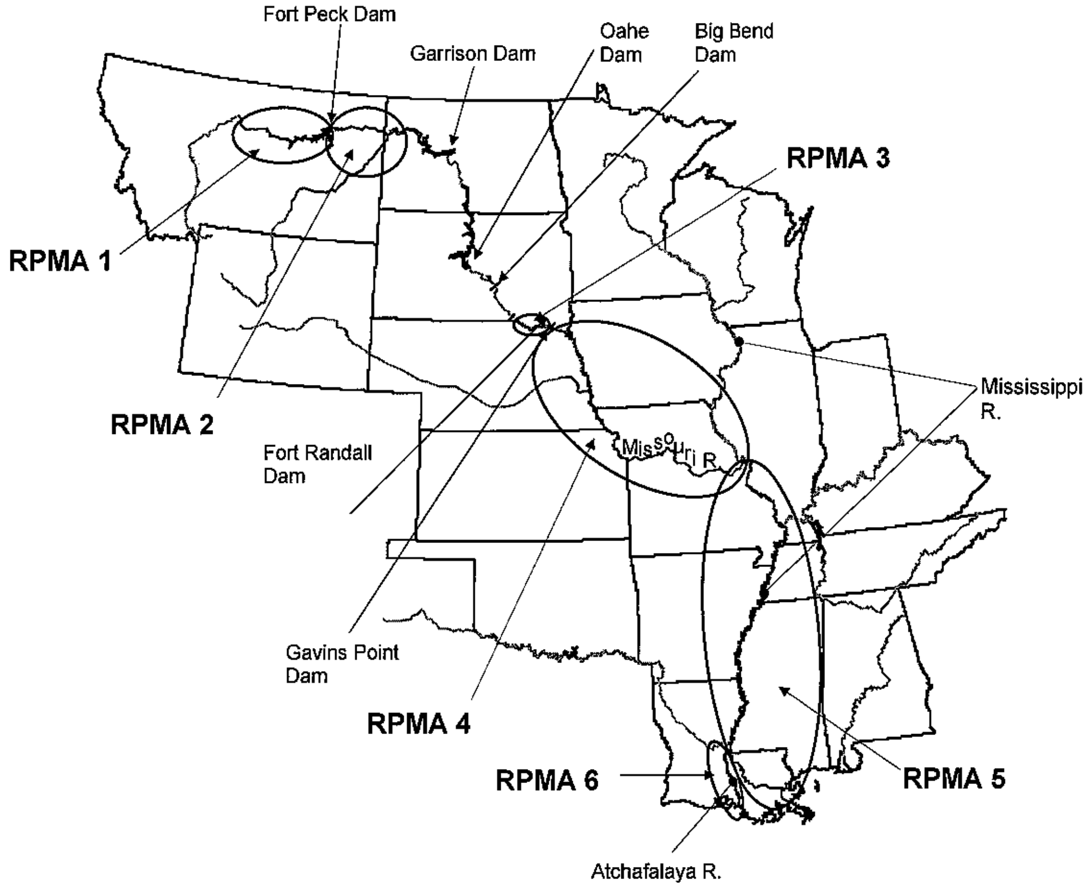


Figure 1. Map depicting Missouri and Mississippi Rivers with major dams identified. Outlined areas (ovals) correspond with approximate location of RPMAs as defined in the Pallid Sturgeon Recovery Plan (USFWS 1993). Map not to scale.

Demographic Data by Recovery Priority Management Area

Following is a summary of demographic data by RPMA. In addition to abundance information (including both wild and hatchery raised data), the following illustrates significant size differences within the species among different portions of the range (see also figures 14 and 15). This issue is discussed in further detail in section 2.3.1.6 below.

RPMA 1

RPMA 1 is defined as the Missouri River from the headwaters of Fort Peck Reservoir upstream to the confluence of the Marias River, Montana (USFWS 1993) (Figure 1). The status of wild pallid sturgeon in RPMA 1 has remained relatively unchanged since listing and continues to decline. According to data obtained from the National Pallid Sturgeon Database (USFWS 2006b), a total of 52 wild pallid sturgeon (individual fish) has been collected in RPMA 1 during 15 years of sampling (1990-2005) (Figure 2). The length frequency data suggests these are all adult fish. Current population estimates suggests that as few as 45 wild pallid sturgeon still remain in RPMA 1 (Bill Gardner, Montana Fish Wildlife and Parks (MFWP), pers. comm., 2005). There is an obvious absence of smaller sized wild pallid sturgeon despite utilization of sampling gear (gill nets, trammel nets, seines, and or trot-lines) capable of collecting smaller sized hatchery-reared pallid sturgeon (Figure 2). The size and age of surviving fish suggest that spawning, recruitment, or both, are severely limited or absent within this reach. However, the population is being supplemented with hatchery produced fish (USFWS 2006a) in efforts to prevent local extirpation. Supplementation of RPMA 1 with hatchery produced pallid sturgeon has occurred sporadically since 1997, and is required to maintain the species within this RPMA. Based on recapture data from the National Pallid Sturgeon Database (USFWS 2006b), pallid sturgeon from all stocking events have produced recaptures and are contributing to the current population structure (Figures 2 and 3).

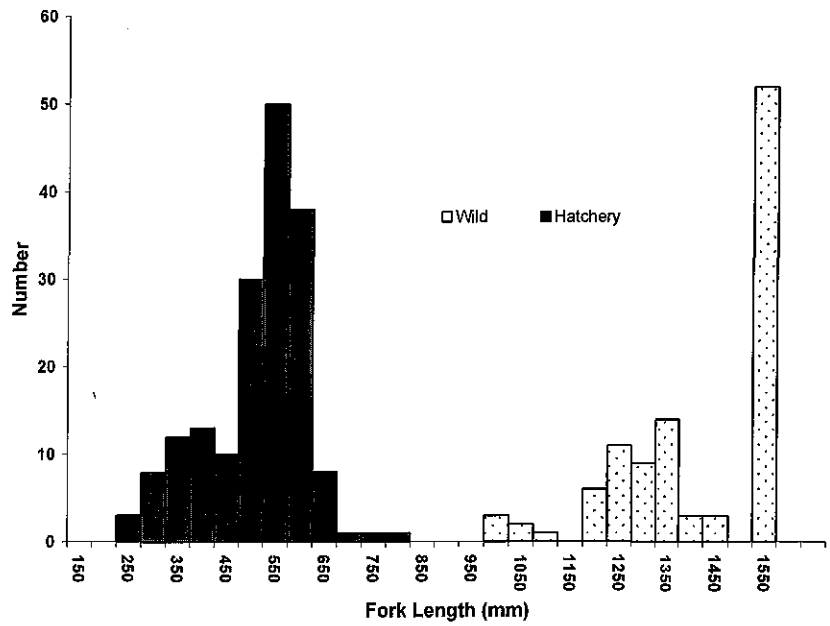


Figure 2. Upper Missouri River (RPMA 1) length frequency histogram representing each total individual wild and hatchery pallid sturgeon collected 1990-2005 for which there were length data (Wild n=52, Hatchery n=175). Data compiled from National Pallid Sturgeon Database (USFWS 2006b).

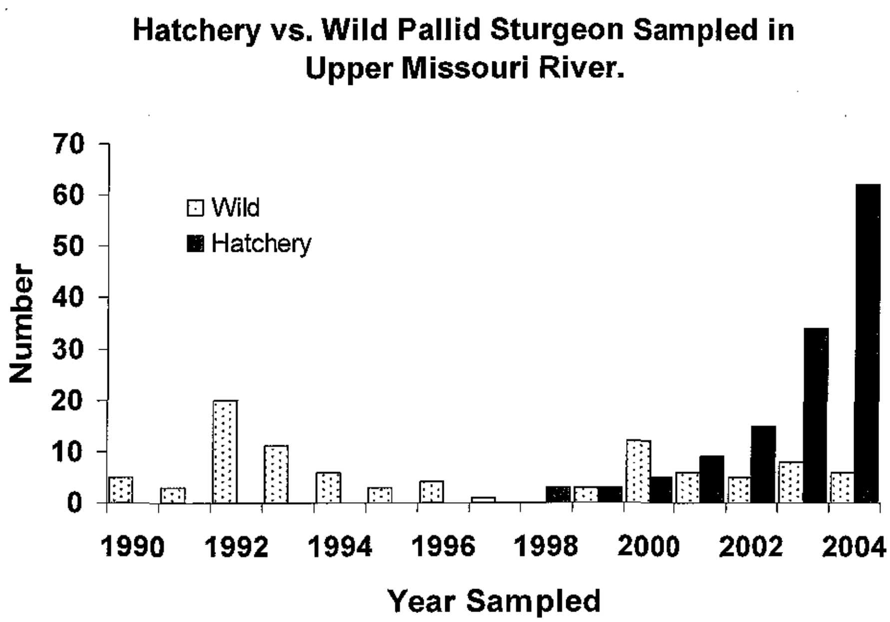


Figure 3. Upper Missouri River (RPMA 1) wild pallid sturgeon and hatchery produced pallid sturgeon collected with all gear types 1990-2004. Data compiled from National Pallid Sturgeon Database (USFWS 2006b).

RPMA 2

The Missouri River below Fort Peck Dam to the headwaters of Lake Sakakawea and the lower Yellowstone River up to the confluence of the Tongue River, Montana, is defined as RPMA 2 (Figure 1). The wild pallid sturgeon population in RPMA 2 continues to decline. According to data compiled from the National Pallid Sturgeon Database (USFWS 2006b), 527 wild pallid sturgeon captures occurred during 16 years of sampling (1990-2006). However, many of the adults were collected multiple times during those years. Removing recaptured pallid sturgeon from the query, indicates a total of 245 unique individual pallid sturgeon were collected during this timeframe. Available length frequency data indicate that these were essentially all adult fish (Figure 4). There is an obvious absence of smaller-sized wild pallid sturgeon despite utilization of sampling gear (gill nets, trammel nets, seines, and trot-lines) capable of collecting smaller sized hatchery-reared pallid sturgeon (Figure 4). The size and associated age of surviving fish suggest that spawning, recruitment, or both are severely limited within this reach. However, the population is being supplemented with hatchery-reared fish to prevent local extirpation (USFWS 2006a). Recent population estimates suggests that approximately 136 wild adult pallid sturgeon still remain in RPMA 2 (Klungle 2004). The length frequency data indicate that, up until the time supplementation began, all collected pallid sturgeon were adults except for one small fish collected in 1993 (Figures 3 and 4). This suggests that, like RPMA 1, spawning, recruitment, or both are limiting viability within this reach. Supplementation of RPMA 2 with hatchery produced pallid sturgeon has occurred sporadically since 1998 with various numbers being stocked depending on hatchery success for any given year (USFWS 2006a). To date, pallid sturgeon from all stocking events have produced recaptures and are contributing to the current population structure (Figures 4 and 5).

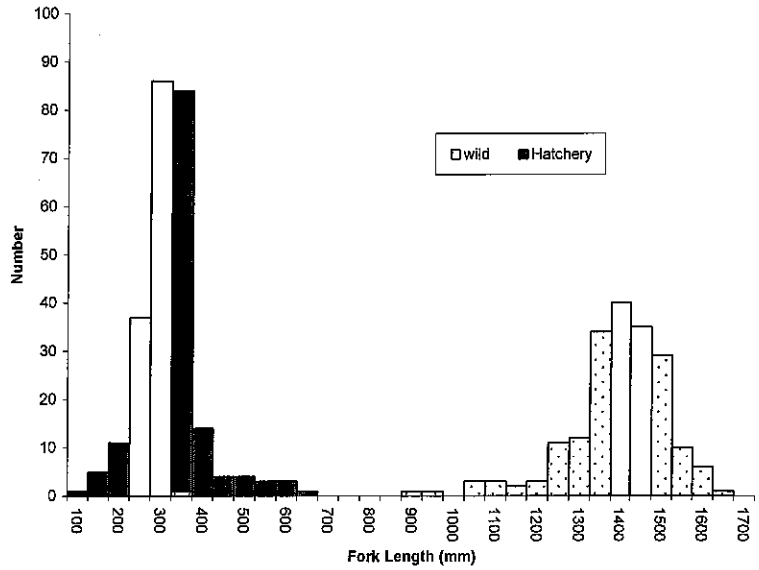


Figure 4. Upper Missouri River (RPMA 2) length frequency histogram representing each total individual wild and hatchery pallid sturgeon collected 1990-2006 for which there were length data (Wild n=192, Hatchery n=252). The 350-millimeter (mm) wild individual pallid sturgeon was collected in 1993. Data compiled from National Pallid Sturgeon Database (USFWS 2006b).

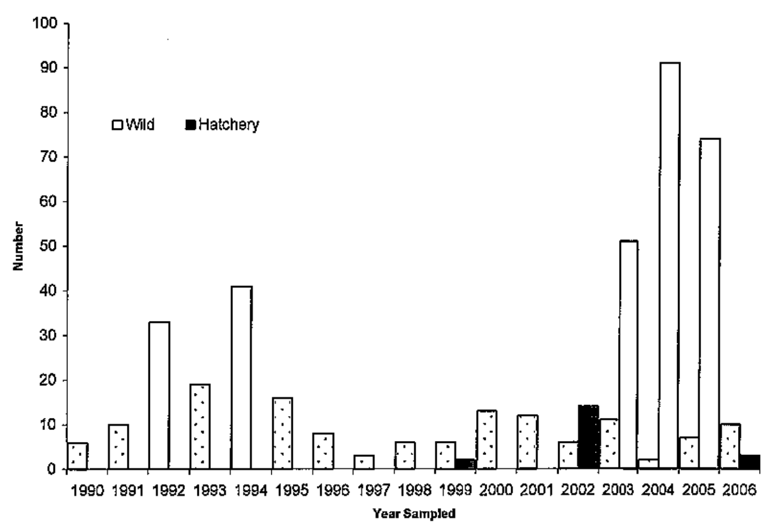


Figure 5. Upper Missouri River (RPMA 2) wild pallid sturgeon and hatchery produced pallid sturgeon collected 1990-2006. All 2006 data entries were not completed at the time this graph was made. Data compiled from National Pallid Sturgeon Database (USFWS 2006b).

RPMA 3

RPMA 3 is the Missouri River from 20 miles (mi) (32 kilometers (km)) upstream of the mouth of the Niobrara River to Lewis and Clark Lake (Figure 1). There is no native wild population of pallid sturgeon known to survive in RPMA 3 and the current population consists entirely of hatchery stocked fish. According to the National Pallid Database (USFWS 2006b), the last record of a wild species from this area, that was not translocated, was the collection of a single pallid sturgeon circa 1991. Prior to this (1952-1991), there was a small number of wild pallid sturgeon collected from this area. Figure 6 represents all wild pallid sturgeon collected in RPMA 3 including the collection of a translocated wild pallid sturgeon in 2003. Research within RPMA 3 during 1998 and 1999 (prior to stocking hatchery-reared pallid sturgeon in this reach) did not document a single pallid sturgeon, but numerous shovelnose sturgeon[**] were collected. A total of 102 pallid sturgeon has been collected in RPMA 3 during 2 years of sampling (2003-2005) (Figure 7). All of these were hatchery-reared with the exception of a few translocated wild pallid sturgeon. These data suggest that prior to supplementation, pallid sturgeon were extremely rare or extirpated in RPMA 3. Supplementation of RPMA 3 with hatchery-reared pallid sturgeon has occurred sporadically with various numbers being stocked depending on hatchery success for any given year. Recent work by Shuman et al. (2005) indicates that these stocked pallid sturgeon are surviving and growing (mean growth of age-6 and older fish was <0.06 mm/day (mm/d), mean growth for ages 2-4 was 0.238 mm/d, and the youngest year class (2004) grew 1.249 mm/d) in this reach with all stocked year classes (1997-1999 and 2001 and 2002) being collected in their samples (see also Figures 6 and 7).

[**]The shovelnose sturgeon, smallest of the ancient sturgeon species in North America, is similar in appearance to the pallid sturgeon. Like pallid sturgeon, the shovelnose has bony plates instead of scales, a ventral sucker-type mouth and large barbels or whisker-like sensors in front of its mouth. While shovelnose sturgeon have a flattened and shovel-shaped snout, the head shape of a pallid sturgeon may appear longer and skinnier. The shovelnose is generally darker in color (tan to gray or yellowish green dorsally, light ventrally) than the pallid sturgeon (greyish-white) and attains smaller maximum size. The shovelnose sturgeon rarely exceeds 15 lbs in weight, while the pallid can exceed 6 ft (2m) in length and weigh over 80 lbs (36 kg). Also, the belly of the adult shovelnose sturgeon is covered with bony plates while pallid sturgeon bellies tend to feel smooth to the touch. The barbels are positioned differently when the two species are compared. Generally, in the shovelnose all four barbels insert in a roughly even line perpendicular to the species midline, and are evenly spaced in front of the mouth. In the pallid, the outer barbels insert posterior to the inner barbels. The shovelnose sturgeon is strictly a freshwater species that was historically found throughout most of the Mississippi and Missouri River basins, from Montana south to Louisiana, and from Pennsylvania west to New Mexico. While the shovelnose has not experienced the range reduction of some of the larger Mississippi River Valley sturgeons (i.e., lake and pallid sturgeons), it is no longer found in Pennsylvania, New Mexico, and large parts of Kansas, Kentucky, Tennessee, and other States where it was once abundant. For more information see http://www.fws.gov/Midwest/Fisheries/library/broch-shovelnose.pdf.

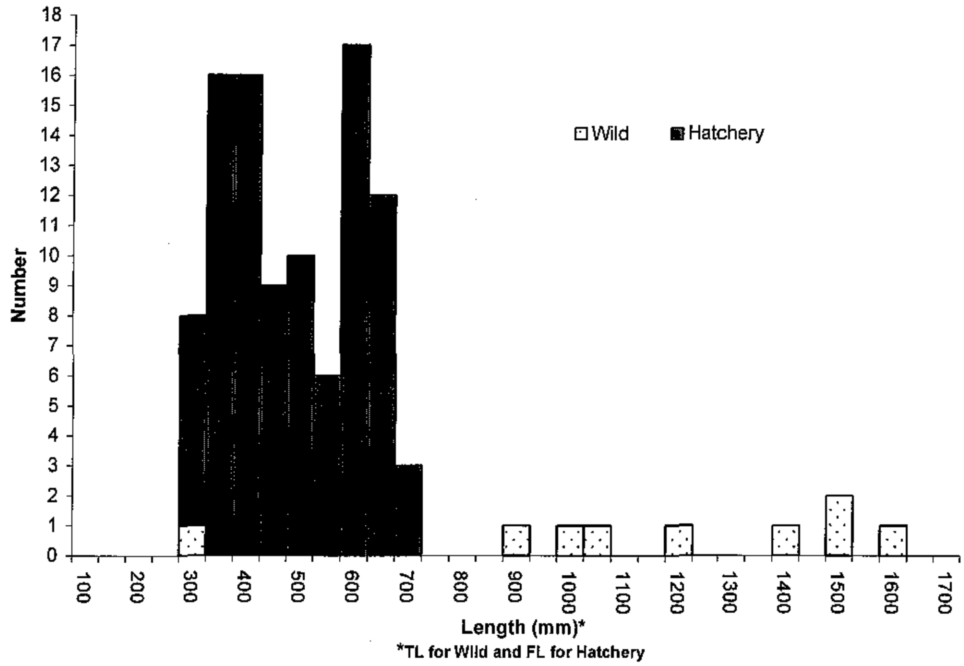


Figure 6. Upper Missouri River (RPMA 3) length frequency histogram representing each total individual wild pallid sturgeon collected 1952-2003 and hatchery pallid sturgeon collected 2001-2005 for which there were length data (Wild n=9, Hatchery n=96). The length reported is total length, not fork length for wild pallid sturgeon. The change is related to how data were reported prior to listing in 1991. The translocated 2003 fish is based on fork length (1,430 mm). The 300-mm wild pallid sturgeon was collected in 1952. Data compiled from National Pallid Sturgeon Database (USFWS 2006b).

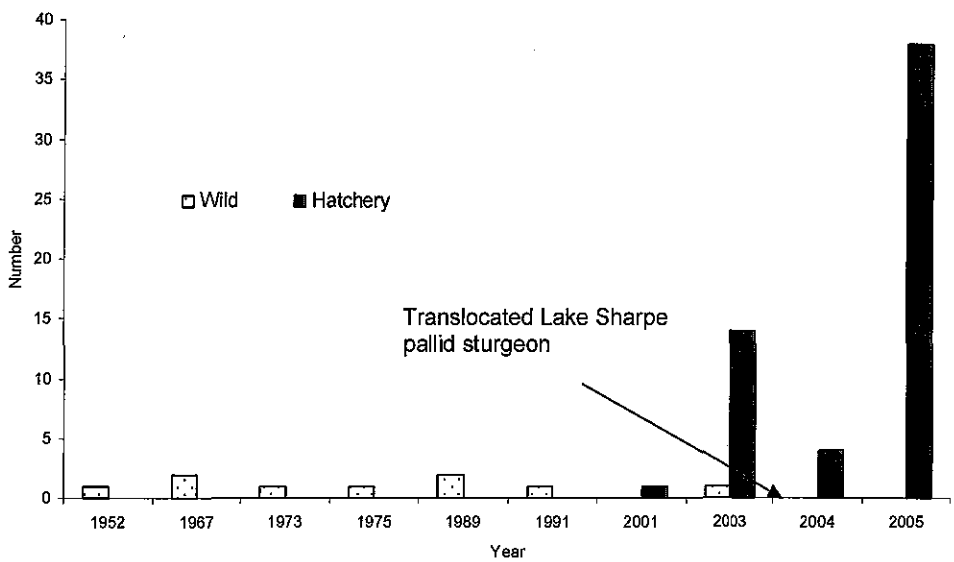


Figure 7. Upper Missouri River (RPMA 3) wild pallid sturgeon and hatchery produced pallid sturgeon collected 1952-2005. The fish collected in 2003 was a translocated pallid sturgeon form Lake Sharpe, South Dakota. Data compiled from National Pallid Sturgeon Database (USFWS 2006b).

RPMA 4

The Missouri River downstream of Gavins Point Dam, South Dakota to the Missouri River/Mississippi River confluence, including major tributaries such as the Platte River, defines RPMA 4 (Figure 1). Although pallid sturgeon captures in RPMA 4 continue to increase with fishing effort, population levels and trends, habitat use, and movement patterns remain unknown. In the late 1990s, the USFWS Columbia Fishery Resources Office collected larval sturgeon in the Lisbon Chute on the Missouri River. Three were confirmed as larval pallid sturgeon and seven others were identified as probable pallid sturgeon (Krentz 2000) (identification by Darrel Snyder, Colorado State University Larval Fish Laboratory). Larval sturgeon (species not confirmed) also have been documented in the Missouri River below Gavins Point Dam by Nebraska Game and Parks Commission (NGPC) (Gerald Mestl, NGPC, pers. comm., 2005) and the Missouri Department of Conservation (MDC) (Herzog et al. 2005) and in the lower Platte River (Hofpar 1997, Reade 2000). Some of these smaller fish may have been pallid sturgeon, but accurately identifying these larval fish to species is difficult (Kuhajda et al. In Press). Recent studies also identify low numbers of unmarked pallid sturgeon (larger than fry) being collected from the lower Missouri River (Kennedy et al. 2006; Utrup et al. 2006). Augmentation with hatchery-reared pallid sturgeon has occurred sporadically since 1994 (USFWS 2006a), and the collection of individuals from all stocked cohorts indicates that hatchery supplementation is contributing to the population (Barada and Steffensen 2006; Kennedy et al. 2006; Steffensen and Barada 2006; Utrup et al. 2006). Of a total 156 pallid sturgeon captured between 1999 and 2005, 51 are believed to be wild, 82 were of hatchery origin, and 24 were of unknown origin. These fish were identified as wild if they did not possess a physical mark (i.e., coded wire tag or elastomere tag) indicating they were from a hatchery and were of a size class greater than what was associated with known hatchery-released fish. Fish labeled as hatchery origin had a distinguishing physical mark. Unknown individuals were consistent in length with known hatchery fish, but had no notable marks. These are considered unknown because certain marking techniques, like PIT tags, have been documented to fail. However, data within the National Pallid Sturgeon Database (USFWS 2006b), for the period 1990-2005, notes 117 unique wild pallid sturgeon for RPMA 4. Available length frequency data for these fish indicates the majority to be adults. A few have been reported that are of sub-adult sizes (<600 mm), yet these sub-adult pallid sturgeon were all collected after supplementation commenced in 1994. Retrospective testing of the unmarked fish has revealed that 23 of the 24 unmarked pallid sturgeon were of hatchery origin, and the remaining unknown origin fish remained in that category because parental genetic samples were not available for all families released downstream of Gavins Point Dam and they could have originated from one of the unsampled families (DeHaan et al. submitted). The apparent lack of naturally produced or unknown origin pallid sturgeon in smaller size classes, coupled with higher relative abundances of hatchery origin pallid sturgeon (Figures 8 and 9) and frequent captures of smaller size class shovelnose sturgeon, suggests that the sampling gear and effort being used are effective and that natural recruitment of pallid sturgeon is sporadic or limited in RPMA 4 (Barada and Steffensen 2006, Kennedy et al. 2006, Steffensen and Barada 2006, Utrup et al. 2006). These data also indicate that hatchery stocked fish are being collected and contributing to the population (Figures 8 and 9).

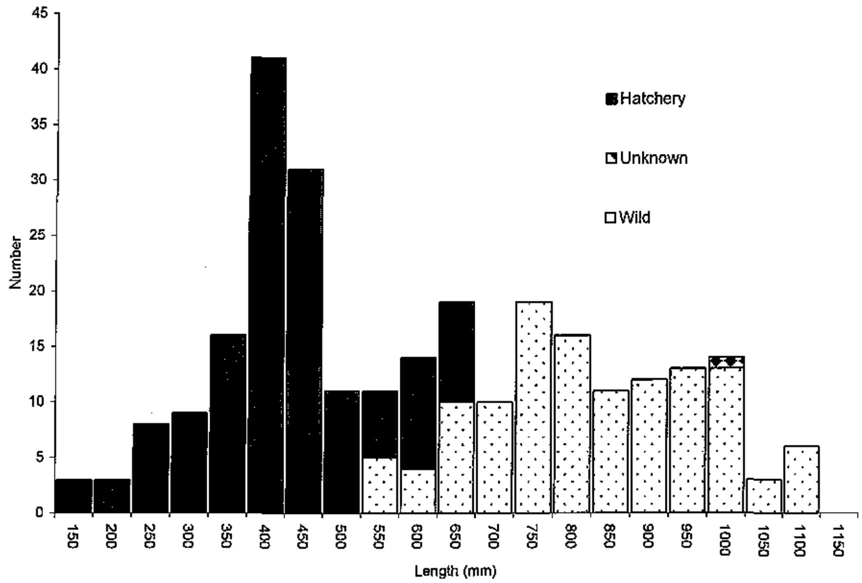


Figure 8. Middle and lower Missouri River (RPMA 4) length frequency histogram representing each total individual wild pallid sturgeon collected 1990-2005 for which there were length data. Unknown fish represented in this graph are pallid sturgeon whose origin is unknown. Their lengths are consistent with hatchery-reared pallid sturgeon yet they had no physical marks and did not match to known parents when genetically analyzed. Data compiled from National Pallid Sturgeon Database (USFWS 2006b).

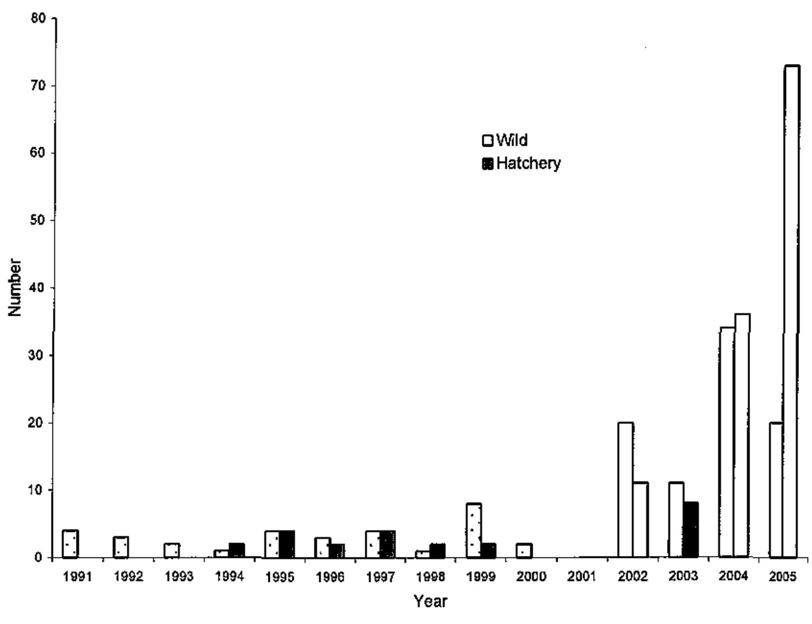


Figure 9. Middle and lower Missouri River (RPMA 4) wild pallid sturgeon and hatchery produced pallid sturgeon collected with all gear types 1991-2005. Data compiled from National Pallid Sturgeon Database (USFWS 2006b).

RPMA 5

The Mississippi River from its confluence with the Missouri River to the Gulf of Mexico defines RPMA 5 (Figure 1). While not identified in the Recovery Plan, the Mississippi River is often subdivided into two segments: 1) the lower Mississippi River, extending 953 River miles (Rmi) (1,533.7 River kilometers (Rkm)) from the Gulf of Mexico to Cairo, Illinois; and 2) the middle Mississippi River, extending 200 Rmi (321.9 Rkm) from near Cairo, Illinois, to just above the mouth of the Missouri River confluence near St. Louis, Missouri. The availability of demographic data in RPMA 5 (Figure 10) for pallid sturgeon has increased since the species was listed. Although pallid sturgeon captures in RPMA 5 continue to increase with fishing effort, population levels and trends, habitat use, and movement patterns remain unknown. Only 28 records of pallid sturgeon were recognized from the Mississippi River when the species was listed in 1990 and the recovery plan was published in 1993 (USFWS 1993). During the past 6 years, over 300 pallid sturgeon (both sub-adult and adult size classes) have been collected from the Mississippi River (Figures 10 and 11). However, caution must be applied when looking at total catch because some of the collected pallid sturgeon reported by D. Herzog, (MDC) may also have been reported by Jack Killgore (U.S. Army Corps of Engineers (USACE) during their collaborative efforts. According to the National Pallid Sturgeon Database (USFWS 2006b), 279 unique pallid sturgeon have been collected in RPMA 5 between 1990 and 2004. It is unclear what percentage of these may be hatchery origin pallid sturgeon with failed physical marks. Jack Killgore, USACE, (pers. comm., 2005) indicated that, between the winter of 2004 and the spring of 2005, 39% (7 of 18) of the pallid sturgeon sampled were hatchery stocked recaptures with a coded wire tag (CWT). Prior to 2004, pallid sturgeon were not checked for coded wire tags, a physical mark that was utilized on hatchery-reared pallid sturgeon stocked from Missouri's Blind Pony fish hatchery.

Middle Mississippi River

From 2002 through 2005, the USACE, MDC, and Southern Illinois University conducted a joint pallid sturgeon research project in the middle Mississippi River using trawling, gillnets, and trotlines as the primary sampling gears. As part of this project a little over 64,000 hours of effort (combined for all gear types) was expended to catch a total of 148 pallid sturgeon. Of the 148 pallid sturgeon collected, 12 individuals (8%) were hatchery origin fish determined by the presence of coded wire tags. This 8% is likely underrepresenting the total number of hatchery origin fish in this sampling effort because scanning for coded wire tags was not a standard practice until 2004 (Jim Garvey, Southern Illinois University, pers. comm. 2006).

Herzog et al. (2005) documented successful reproduction by the collection of larval pallid sturgeon in the middle Mississippi River, though the origin of these larval pallid sturgeon from within the middle Mississippi River is not known. Wild pallid sturgeon collected from this reach ranged between 500 and 1,000 mm fork length (FL; the length measured from the anterior most portion of the fish to the median caudal fin rays) (Figure 10). Pallid sturgeon above 600 mm FL are believed to be of reproductive size, and the capture of small adult and sub-adult pallid sturgeon around and below this size may indicate that some level of recruitment is likely occurring in the middle Mississippi River or lower Missouri River, or could be a product of undetected marks in hatchery origin pallid sturgeon. Limited supplementation with hatchery-reared pallid sturgeon has occurred in the middle Mississippi River (USFWS 2006a).

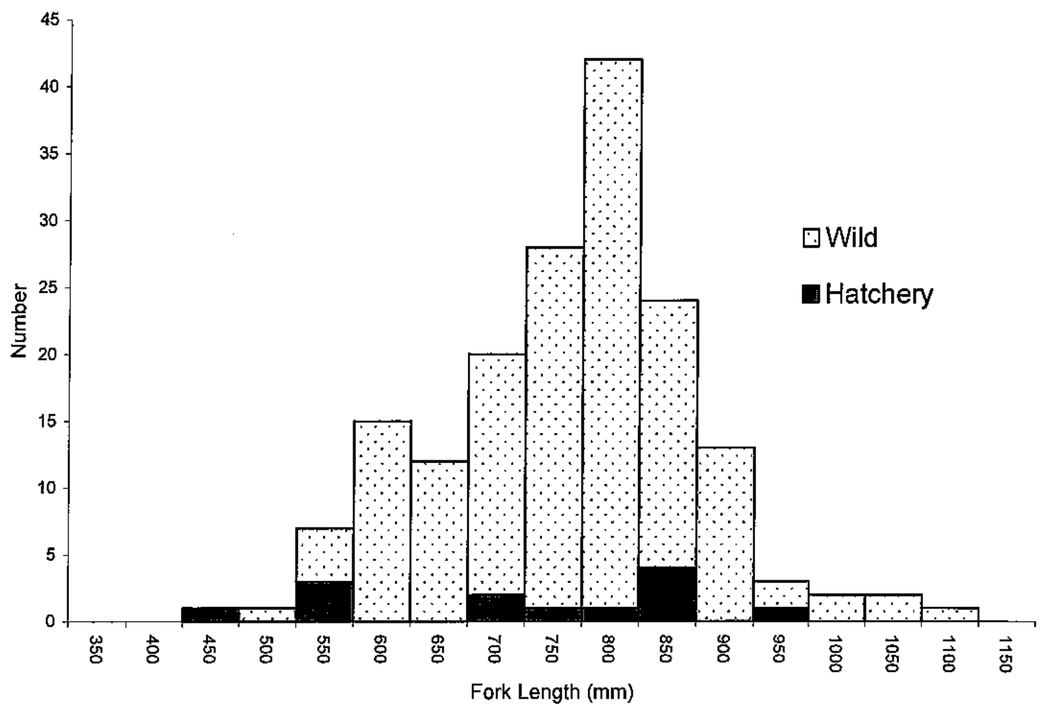


Figure 10. Middle Mississippi River (RPMA 5) length frequency histogram representing each total individual wild and known hatchery-reared pallid sturgeon collected 1991-2005 for which there were length data. The middle Mississippi River is the reach of the Mississippi River from the confluence of the Ohio River near Cairo, Illinois, to the confluence of the Missouri River, near Saint Louis, Missouri. Data compiled from National Pallid Sturgeon Database (USFWS 2006b).

Lower Mississippi River

The USACE sampled the lower Mississippi River (below the Ohio River to the mouth) from 2000 to 2006. During this time, 162 pallid sturgeon were collected from over 130 locations (i.e., specific Rmi/Rkm) between Rmi 145 to 954 (Rkm 233 to 1535) (J. Killgore, USACE, pers. comm., 2005), with 3 recaptures. Sizes of pallid sturgeon collected range between 400 and 1,000 mm FL (Figure 11). This data set includes at least 30 "sub-adult" pallid sturgeon (i.e., <600 mm FL), showing some level of recruitment in the lower Mississippi River population. It is possible that recruitment of pallid sturgeon in RPMA 5 is higher than that reflected in sampling data. Although morphologically distinct pallid sturgeon as small as 450 mm FL are occasionally captured (Figure 11), some young-of-year and sub-adult pallid sturgeon may be misidentified as shovelnose or hybrids.

One recent study found that character indices do not correctly identify small upper Missouri River hatchery-reared juvenile pallid sturgeon (<250 mm standard length; the length from the tip of the upper jaw to the posterior end of the vertebral column that is most commonly used in taxonomic studies) from shovelnose or hybrid sturgeon, or reliably separate larger pallid sturgeon (up to 600 mm standard length) from hybrid sturgeon (Kuhajda and Mayden 2001). Measurements taken from 48, 10-month old hatchery-reared juvenile pallid sturgeon (309 to 413 mm FL) spawned from Atchafalaya River stock and reared at the Natchitoches NFH, incorrectly identified all but two of these hatchery-reared pallid sturgeon as hybrids, and the two exceptions were incorrectly identified as shovelnose sturgeon (Jan Dean, USFWS, pers. comm., 2005). These juvenile fish were reared from morphologically distinct pallid sturgeon confirmed by genetic analysis.

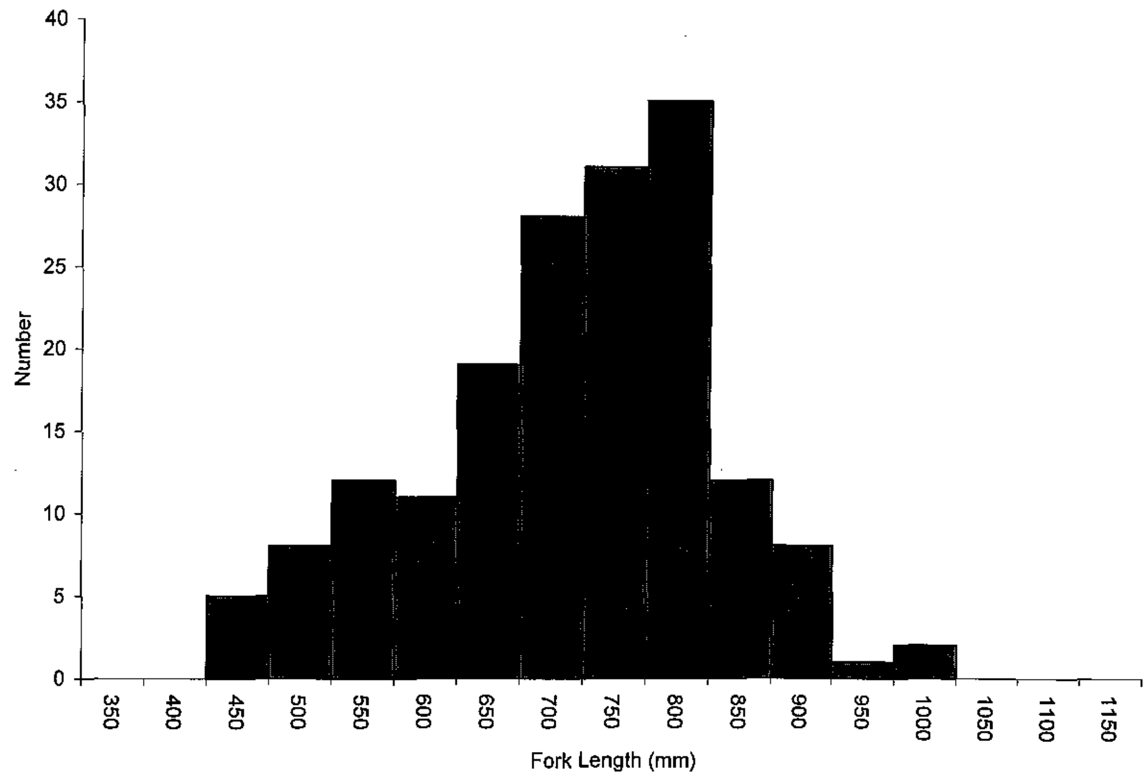


Figure 11. Lower Mississippi River (RPMA 5) length frequency histogram representing wild pallid sturgeon collected during 1991-2005 for which there were length data (n=172). The lower Mississippi River is the reach of the Mississippi River from the confluence of the Ohio River near Cairo, Illinois, to the Gulf of Mexico. Data compiled from National Pallid Sturgeon Database (USFWS 2006b).

Murphy et al. (in press) also have found greater morphological variation in specimens of pallid and shovelnose sturgeon from the Mississippi River than what is accounted for in current identification indices. These studies suggest that at least some young-of-year, sub-adult, or small adult pallid sturgeon can be misidentified in the field as hybrid or shovelnose sturgeon. Captures of pallid sturgeon in the Mississippi River have been associated with islands, sand bars, gravel bars, and dikes, in both the main channel and in secondary channels.

RPMA 6

RPMA 6 is the Atchafalaya distributary system to the Gulf of Mexico (Figure 1). Collection data from this RPMA reflects an improvement in our understanding of the pallid sturgeon population trend. Prior to listing in 1990, pallid sturgeon had not been documented from the Atchafalaya River. In 1991, seven pallid sturgeon were collected from the Atchafalaya River near the Old River Control Complex, in Concordia Parish, Louisiana (Reed and Ewing 1993). A few years later (1993-95) an additional 106 pallid sturgeon captures were reported (Constant et al. 1997). A conservative total of 499 individual pallid sturgeon have been collected from the Atchafalaya River since 1991 (Figure 12). A conservative approach to species identification was used, based upon morphometric measurements, to identify pallid versus intermediate or "hybrid" sturgeon, and thus actual number of pallid sturgeon captured from the Old River Control Complex (ORCC) is likely underrepresented in these data. There have been at least 37 wild adult pallid sturgeon recaptures in the ORCC area since 1991, of which 32 have been during 2004-2006 (J. Dean, USFWS, pers. comm., 2006).

The length distribution of pallid sturgeon captures has remained relatively consistent over the past 7 years, although the population appears to be comprised of predominantly adult pallid sturgeon >650 mm FL (Figure 12). However, gears used to sample this area are larger mesh and may not reliably sample sturgeon smaller than 400 mm. It is currently unknown if this consistent length frequency distribution through time combined with the occasional collection of smaller pallid sturgeon, results from local reproduction and recruitment, the passage of sub-adult and/or adult pallid sturgeon from the Mississippi River through the ORCC into the Atchafalaya River, or is simply a product of gear selectivity/bias.

Gill net collections at the Old River Control Complex regularly capture shovelnose sturgeon between 400 and 750 mm FL. The pallid sturgeon are larger, measuring (with occasional exceptions) above 650 mm FL (e.g., Figure 12). It has been noted in the discussion under RPMA 5, above, that there are difficulties in separating juvenile *Scaphirhynchus* to species. This also is true in RPMA 6. For example, trawl sampling for 2 days below Old River Control Complex during June 2005, resulted in the capture of six young-of-year *Scaphirhynchus* (196 to 410 mm total length (the length measured from the anterior most portion of the fish to the tip of the caudal fin rays). Three of these fish were marked indicating they were hatchery-reared juvenile pallid sturgeon released during fall and winter of 2004, and the other three had no physical mark and were considered wild young-of-year sturgeon. A character index was used on all six fish and misidentified the three hatchery-reared pallid sturgeon as hybrids, and identified two of the unknown wild sturgeon as shovelnose and the other as a hybrid (Jan Dean, USFWS, pers. comm., 2005). Further investigation is required to determine if allometric growth is resulting in the misidentification of some juvenile or sub-adult pallid sturgeon as shovelnose or "hybrids/intermediates" (e.g., Figure 13), and to document local reproduction and recruitment in RPMA 6.

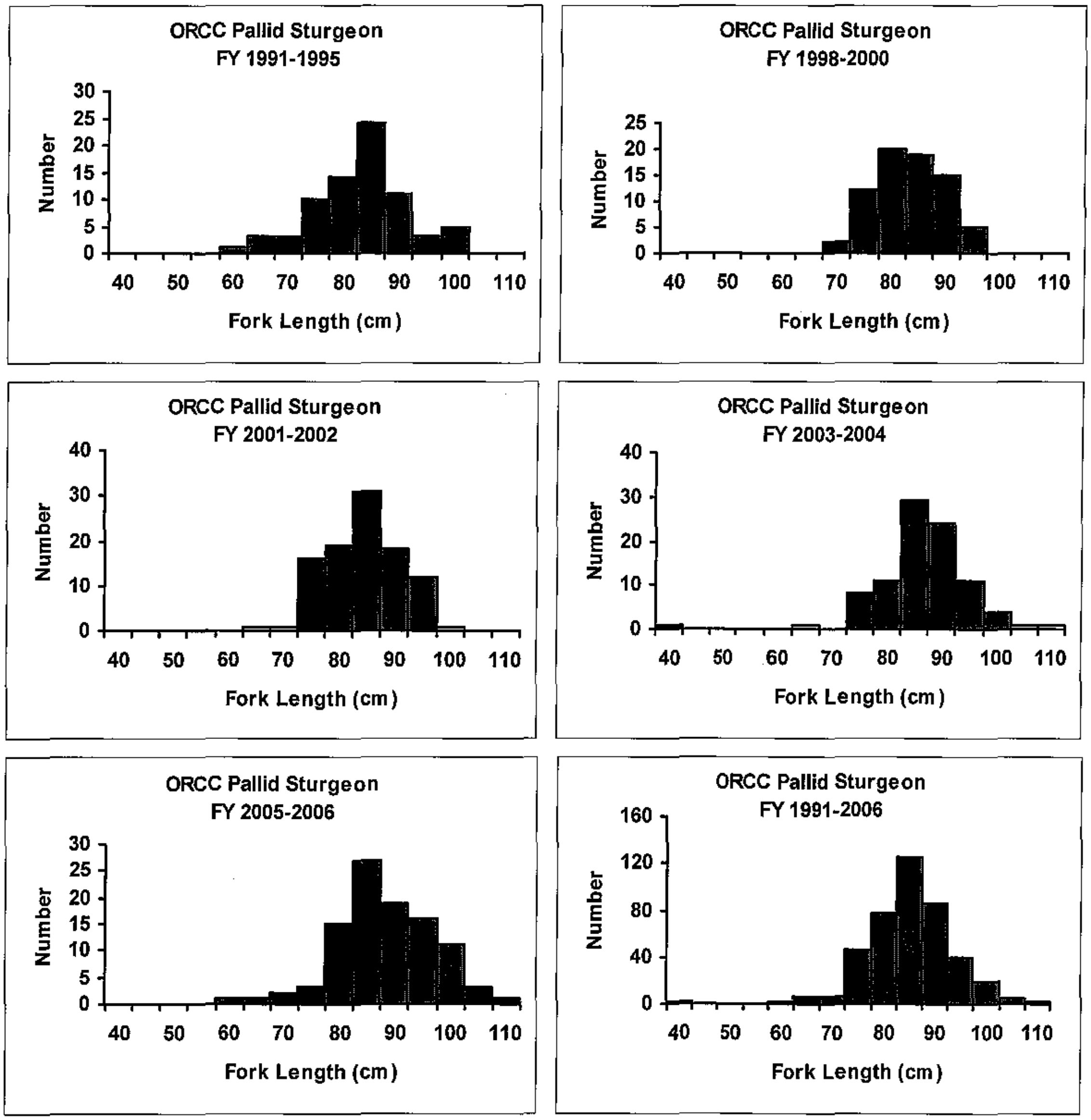


Figure 12. Conservative representation of pallid sturgeon length frequency data collected from the Atchafalaya River, 1991-2006. The actual number of pallid sturgeon captured from the Old River Control Complex area during that time likely exceeds 500 individuals. A conservative approach, based upon morphometric measurements, was used here to separate pallid sturgeon from intermediate character sturgeon. Data provided by J. Dean, USFWS and reported by Federal Fiscal Year (October-September) not calendar year (January-December).

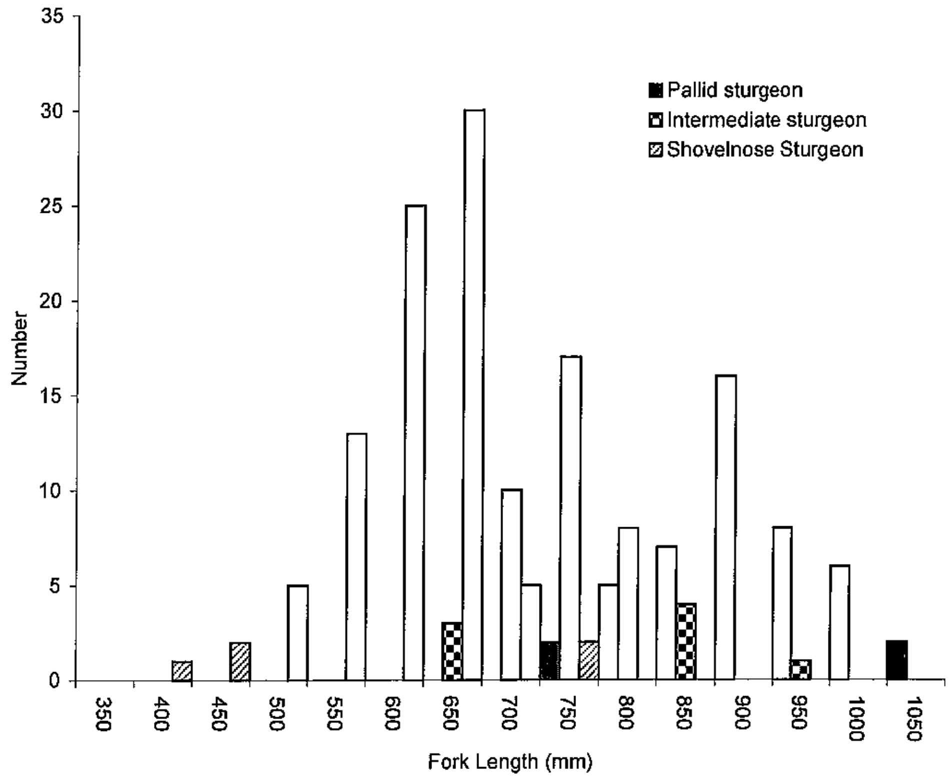


Figure 13. Length frequency histogram representing total pallid sturgeon (n=46), intermediate characteristic sturgeon (n=43) and shovelnose sturgeon (n=83) collected from the Atchafalaya River during 2005. Data provided by Jan Dean, USFWS.

2.3.1.2 Genetics, Genetic Variation, or Trends in Genetic Variation

While morphological differences among pallid and shovelnose sturgeon have been described (Bailey and Cross 1954, Keenlyne et al. 1994), genetic differentiation has been more difficult. Initial genetic studies were unable to distinguish pallid from shovelnose sturgeon by examining 37 allozyme loci (Phelps and Allendorf 1983), restriction fragment length polymorphism (RFLP) analysis of five protein coding genes (Morizot 1994), or comparing sequence variation at two mitochondrial loci (1137 bases of cytochrome b and 829 bases of the control region (D-loop) (Simons et al. 2001). These results have been variously interpreted as a lack of reproductive isolation between the species (Phelps and Allendorf 1983), a low evolutionary rate within the genus *Scaphirhynchus* (Simons et al. 2001), or that pallid and shovelnose sturgeon have recently diverged, undergone rapid morphological differentiation, and the type of genetic markers examined had not yet diverged enough to distinguish the species (e.g., Campton et al. 2000).

Campton et al. (2000) and Tranah et al. (2001) were able to find genetic markers that distinguish pallid from shovelnose sturgeon. Campton et al. (2000) found significant haplotype frequency differences, based on approximately 500 base pairs, between the 2 species at the mitochondrial DNA control region. This initial finding of genetic distinction between pallid and shovelnose sturgeon was supported by Tranah et al. (2001) who examined the same samples using five nuclear DNA microsatellite loci. The concordant conclusions from these studies using different genetic markers were the first to support the genetic distinction between pallid and shovelnose sturgeon.

Intercrosses (hybridization) Between Pallid and Shovelnose Sturgeon

The pallid sturgeon was listed as endangered over its entire range (USFWS 1990). Recent concerns have been raised regarding the genetic structuring of the species across its range. Following listing, genetic data have been evaluated to help better understand the range-wide population structure of pallid sturgeon.

The presence of sturgeon that appear to be morphologically intermediate between pallid and shovelnose sturgeon, were presumed to represent pallid-shovelnose sturgeon hybrids (Keenlyne et al. 1994, Carlson et al. 1985) and spurred an effort to determine the genetic origins of these fish. Tranah et al. (2004) combined the data from Campton et al. (2000) and Tranah et al. (2001) and added 4 additional microsatellite loci to the data set to determine the genetic origins of 10 morphologically intermediate sturgeon collected from RPMA 6. All fish were classified as pallid, shovelnose or hybrid sturgeon via the hybrid index method of Campton (1987).

Results of Tranah et al. (2004) support earlier morphometric-based conclusion on the presence of hybrids (Keenlyne et al. 1994) suggesting that intercrossing or gene flow between the two species (pallid and shovelnose sturgeon) is more pronounced in the middle Mississippi and Atchafalaya Rivers than elsewhere (e.g., upper Missouri River). Tranah et al. (2004) also suggested that while shovelnose and pallid sturgeon are distinct morphologically, they are undergoing hybridization in the lower Mississippi and Atchafalaya Rivers. Morphometric data also may indicate hybridization in the lower Missouri River (Grady et al. 2001a; Grady et al. 2001b; Doyle and Starostka 2003) based on the presence of morphologically intermediate sturgeon. The extent to which these hybrids are going beyond the first generation (introgressive hybridization) is currently unknown. Tranah et al. (2004) suggest that female pallid sturgeon are mating with shovelnose sturgeon males and the hybrids are subsequently backcrossing with the more numerous shovelnose sturgeon. This finding should be treated as preliminary because a small number of fish classified morphologically as hybrids were examined.

Allendorf et al. (2001) theorized that pallid and shovelnose sturgeon in the lower Mississippi River have not evolved reproductive isolation to the same degree as pallid and shovelnose sturgeon in the upper Missouri River and suggested there may be no pure pallid sturgeon in the lower Mississippi River because all sturgeon located in that reach comprise a hybrid swarm. Although microsatellite studies have provided evidence of hybridization between pallid and shovelnose sturgeon in the Missouri, Mississippi, and Atchafalaya Rivers (Tranah et al. 2001; Heist and Schrey 2006a and b), these and other studies (Ray et al. in press) have also demonstrated that shovelnose and pallid sturgeon remain genetically distinct from each other in the Missouri, Mississippi, and Atchafalaya Rivers, and a third group, hybrids/intermediates, are present.

These genetic comparisons of hybrids need to be considered in the context of studies with hatchery-reared pallid, shovelnose, and hybrids that show small pallids may be regularly misidentified as hybrids based on morphological characters (Kuhajda and Mayden 2001; Kuhajda et al. in press; Murphy et al. in press). More information is needed on the evolutionary dynamics of intermediate forms between pallid sturgeon and shovelnose sturgeon to understand if they are natural or if anthropogenic modification has forced an overlap of breeding areas and thus a realized threat.

Population Structure of Pallid Sturgeon

Campton et al. (2000) used approximately 500 base pairs of the mitochondrial DNA control region to examine genetic variation within and among 3 pallid sturgeon populations, 2 of which were located in the upper Missouri River (RPMA 1 and 2) and 1 from RPMA 6 river system. The pallid sturgeon from these geographically divergent areas did not share any haplotypes ($P < 0.001$), and the genetic distance between these two groups (0.14%) was nearly as great as the genetic distance between pallid and shovelnose sturgeon in the upper Missouri River (0.15%). The authors note that this may represent reproductive isolation and genetic divergence between these two populations of pallid sturgeon that is nearly as old as the isolation between pallid and shovelnose sturgeon. Another explanation offered in Campton et al. (2000) is that northern and southern pallid sturgeon arose independently from different ancestors and are not a monophyletic lineage, thereby representing two separate species.

Tranah et al. (2001) examined genetic variation within and among the same three pallid sturgeon samples. The allele frequencies at five microsatellite loci indicated the two upper Missouri River groups, separated by Ft. Peck Dam, did not differ significantly from each other. Conversely, pallid sturgeon genetic samples from the upper Missouri population did differ from samples collected from the Atchafalaya River ($F_{st} = 0.13$ and 0.25; both $P < 0.01$). They concluded pallid sturgeon collected from RPMA 1 and 2 (the northern fringe of their range) are reproductively isolated from those sampled from RPMA 6 (southern extreme of their range) and should be treated as genetically distinct populations.

Heist and Schrey (2006a) found significant F_{st} differences between the upper Missouri River pallid sturgeon samples when compared with samples from the middle Mississippi River. Heist and Schrey (2006b) subsequently examined samples collected from the upper portion of RPMA 4. These samples were collected below Gavins Point Dam, South Dakota, downstream to Kansas City, Missouri. Heist and Schrey (2006b) note that pallid sturgeon in this part of the range appear to be genetically intermediate between the upper and lower Missouri River pallid sturgeon samples.

In 2006, Dr. Ed Heist and Aaron Schrey provided an overview of their research to the Pallid Sturgeon Recovery Team (Team) and the Team's Genetics Advisory Group during a conference call (see Appendix B). The results were based on output from the software package STRUCTURE. This program does not require *a priori* species identification and identifies natural groupings among samples to minimize Hardy-Weinberg deviations and linkage disequilibrium. When only putative pallid sturgeon samples were analyzed, three genetic groups of pallid sturgeon appear across the species range. The three groupings are a well differentiated upper Missouri River group and two less differentiated groups in the lower Missouri/middle Mississippi and Atchafalaya River samples.

These data (Campton et al. 2000, Tranah et al. 2001, Heist and Schrey 2006a) suggest that the genetic structuring within the pallid sturgeon's range represents two distinct groups at the extremes of the species range with a middle intermediate group representing the lower Missouri and middle Mississippi Rivers. This pattern is suggestive of a pattern of isolation by distance, with gene flow more likely to occur between adjacent groups than among geographically distant groups, and thus, genetic differences increase with geographical distance.

2.3.1.3 Taxonomic Classification or Changes in Nomenclature

NA

2.3.1.4 Spatial Distribution, Trends in Spatial Distribution, or Historic Range

The historical range of pallid sturgeon is the Missouri and Mississippi River systems from near Fort Benton, Montana, to Head of Passes, Louisiana. Historically, larger tributaries like the Yellowstone, Platte, Lower St. Francis, and Big Sunflower Rivers also were utilized as well as the Atchafalaya River distributary (see also 2.3.1.1 above). Currently, pallid sturgeon habitat in the upper Missouri River is highly fragmented and reduced. RPMA 1 contains approximately 174 Rmi (280 Rkm) of flowing river conditions, RPMA 2 extends for 186 Rmi (300 Rkm), while RPMA 3 provides approximately 52 Rmi (85 Rkm) of riverine conditions between Ft. Randall Dam and Lewis and Clark Lake. Riverine conditions extend virtually uninterrupted for about 2,000 Rmi (3,200 Rkm) between Gavins Point Dam in the middle Missouri River and the Gulf of Mexico (RPMAs 4 and 5). RPMA 6 contains approximately 140 Rmi (224 Rkm) of the Atchafalaya River. The Old River Control Complex forms a potential uni-directional barrier to fish movement between the Mississippi and Atchafalaya Rivers. The structures associated with the Old River Control Complex likely could allow movement of fish from the Mississippi River into the Atchafalaya River, but could constitute a velocity type barrier to movement from the Atchafalaya River into the Mississippi River. Collection of lake sturgeon (*Acipenser fulvescens*) and one pallid sturgeon, known to have been released in the middle Mississippi River, below the Old River Control Complex, indicates passage from the Mississippi River into the Atchafalaya River does occur (B. Reed, Louisiana Department of Wildlife and Fisheries, pers. comm., 2006; Hartfield in litt, 2006). However, passage or lack of passage in the opposite direction has not been determined.

2.3.1.5 Habitat or Ecosystem Conditions

Missouri River

Anthropogenic modifications to the Missouri River restrict the life cycle requirements of pallid sturgeon by blocking movements to spawning and feeding areas, destroying spawning areas, altering conditions and flows of potential remaining spawning areas, and reducing food sources by lowering productivity (Keenlyne 1989; USFWS 2000a). The most obvious habitat changes were creation of a series of impoundments on the main stem of the upper Missouri River and channelization of the lower Missouri River for navigation. Upper Missouri River dams and their operations have--1) created physical barriers that block normal migration patterns, 2) degraded and altered physical habitat characteristics, and 3) greatly altered the natural hydrograph (Hesse et al. 1989). Moreover, these large impoundments have replaced large segments of riverine habitat with lentic conditions. Damming of the upper Missouri River has altered lotic features such as channel morphology, current velocity, seasonal flows, turbidity, temperature, nutrient supply, and paths within the food chain (Russell 1986; Unkenholz 1986; Hesse 1987).

Fort Peck Reservoir forms the lower boundary of RPMA 1 (Figure 1) and some theorize that this reservoir is a major impediment to larval pallid sturgeon survival. Currently, shovelnose sturgeon within RPMA 1 are self-sustaining (B. Gardner, MFWP, pers. comm., 2005) while pallid sturgeon are not. Recent work by Gerrity (2005) indicates that immature hatchery-reared pallid sturgeon are more likely to utilize the lower reaches of RPMA 1 than are shovelnose sturgeon. The reaches frequented by Gerrity's study fish are attributable to the low pool levels in Fort Peck Reservoir. These lower reaches can be inundated at higher reservoir pool levels, and loose their lotic attributes. Thus it may be considered that behavioral differences occurring between the two sturgeon species results in divergent life history traits. Differences in larval drift (Kynard et al. 2002, 2005) or habitat selection in more upstream reaches (Gerrity 2005) may result in better survivorship of immature shovelnose sturgeon compared to pallid sturgeon. Similar to the observations of Gerrity (2005), Bramblett (1996) found that pallid sturgeon used 25 km of riverine habitat that would be inundated by Lake Sakakawea at full pool in RPMA 2. Canyon Ferry, Hauser, and Holter Dams are upstream of Great Falls, Montana, and likely do not impose any migratory barriers because passage at the natural falls likely did not exist historically. However, these structures, like most dams, reduce sediment and nutrient transport, maintain an artificial hydrograph, and delay thermal cues. A reduction in sediment input and transport has been shown to reduce naturally occurring habitat features like sandbars. Kellerhals and Church (1989) identify that discharge and sediment load, together with physiographic setting are primary factors controlling the morphology of large alluvial rivers. One other dam of importance in the system is Tiber Dam located on the Marias River. The Marias River may have been a historically important tributary for pallid sturgeon (B. Gardner, MFWP, pers. comm., 2005).

Fort Peck Dam was constructed in 1937 and Garrison Dam was completed in 1954. Fort Peck Dam forms the upper boundary of RPMA 2 and Lake Sakakawea forms the lower boundary (Figure 1). Fort Peck Reservoir and Lake Sakakawea may be impediments to larval pallid sturgeon survival. Support for this theory is provided in recent studies. Kynard et al. (2002) studied drift in *Scaphirhynchus* "free embryos." They determined that post-hatch larvae begin to migrate on day 0 and that pallid sturgeon larvae may migrate at a slower rate than shovelnose sturgeon, but they migrate for a longer time. Subsequent work was conducted with larval pallid sturgeon released within RPMA 2 as part of a larval drift study. These data suggest that pallid sturgeon larvae can drift 152 to 329 mi (245 to 530 km) depending on water column velocity (Braaten et al. in review). This drift distance would likely transport naturally spawned pallid sturgeon larvae into the headwaters of Fort Peck Reservoir and Lake Sakakawea. Braaten et al. (in review) speculate that differences in larval drift rates found between shovelnose and pallid sturgeon might explain why the two species experience different recruitment levels in the upper Missouri River. As part of this 2004 study various ages (in days) of fry were stocked, and in 2005 four non-physically marked pallid sturgeon were genetically traced back to the 11- to 17-day-old fry released as part of this drift study (William Ardren, USFWS, pers. comm., 2005). This indicates that fry released at ages 11 to 17 days are able to survive to age-1 in RPMA 2 and provides some evidence that the limitation on natural recruitment could be somewhere between the actual spawning event and the first couple of weeks after hatch.

Another limiting factor is an altered hydrograph and temperature profile attributable to water releases and reduced sediment transport from Fort Peck Dam. A reduction in sediment transport can reduce naturally occurring habitat features like sandbars (Kelllerhals and Church 1989). The Yellowstone River, a major tributary to the Missouri River, was likely a historically important tributary for spawning. Bramblett (1996) documented that pallid sturgeon prefer the Yellowstone River over the Missouri River below Fort Peck, many fish move into the lower Yellowstone River during spawning season, ripe fish occur in the Yellowstone River, and aggregations of fish during spawning season strongly suggest that pallid sturgeon spawning occurs in the lower 10 to 15 Rkm of the Yellowstone River. However, in the early 1900s, the Bureau of Reclamation (BOR) completed work on the Lower Yellowstone Irrigation Project with the completion of a full channel low-head dam (Intake Dam, circa 1910) across the Yellowstone River approximately 71 Rmi (114 Rkm) upstream from the Missouri and Yellowstone River confluence. This dam has effectively reduced the migratory potential of pallid sturgeon within the Yellowstone River system (Bramblett and White 2001, Jaeger et al. 2005). Telemetry work conducted in the Yellowstone River with juvenile pallid sturgeon (Jaeger et al. 2005) identified that about half of the study fish stocked upstream of Intake Dam remained there. Telemetered pallid sturgeon also have been entrained in the irrigation ditch served by Intake Dam (Jaeger et al. 2004). Larval drift work by Braaten et al. (in review) suggests that larval drift of fish naturally produced in the Yellowstone River will likely result in the fry drifting into Lake Sakakawea, and the ongoing threat to spawning success in the Yellowstone River is likely to be downstream drift of larvae into Lake Sakakawea (Bob Bramblett, Montana State University, in litt. 2006 (see Appendix A)). Other anthropogenic modifications include bank stabilization projects and water withdrawal projects.

The primary threat to pallid sturgeon existence within RPMA 3 is historical hydrograph alterations and habitat fragmentation. Fort Randall Dam was completed in 1956 and Gavins Point Dam was completed about a year later. Fort Randall Dam forms the upper boundary of RPMA 3 and Gavins Point Dam forms the lower boundary (Figure 1). The habitat threats associated within RPMA 3 are an altered hydrograph and temperature profile, a reduction in sediment transport, and fragmentation that could preclude adequate drift distance for larval pallid sturgeon. However, other native riverine species successfully spawn within this reach.

RPMA 4 has over 800 Rmi (1,296 Rkm) available for pallid sturgeon, is not impounded, and is biologically and hydrologically connected with RPMA 5, but is not immune from anthropogenic modifications. Channelization of the Missouri River within RPMA 4 has reduced water surface area by half, doubled current velocity, decreased habitat diversity, and decreased sediment transport (Funk and Robinson 1974, USFWS 2000a). RPMA 4 can be characterized into three distinct reaches: the unchannelized, upper channelized, and lower channelized reaches. The unchannelized Missouri River reach in RPMA 4 extends approximately from Gavins Point Dam (Rmi 811/Rkm 1305) downstream to the mouth of the Big Sioux River (Rmi 736/Rkm 1184). The upper channelized portion of RPMA 4 extends from the Big Sioux River (Rmi 736/Rkm 1184) to the Kansas River (Rmi 367.5/Rkm 591), and the lower channelized reach extends from the Kansas River confluence downstream to St. Louis, Missouri (Rmi 0). The reason for the distinction of the channelized reaches is that, though they are channelized, they may provide varying degrees of habitat suitability. The upper channelized river is in its current location by construction, has no natural hydrological event, is of uniform size and construction activities, and has lost most of its sandbars, islands, and shallow water habitat. The lower reach was channelized in its natural location, has frequent high water events during the spring and summer months, and contains a wide range of dike types and sizes (USFWS 2006a).

The lower Platte River is a major Missouri River tributary in RPMA 4 and likely is/was important habitat for pallid sturgeon. The lower Platte River is defined in Snook et al. (2002) as the Platte River from the confluence with the Missouri River upstream to the Loup River. Snook (2001) documented that hatchery-reared pallid sturgeon (1992 year class produced at Blind Pony State Fish Hatchery, Missouri) released (1994) in the lower Platte River tended to remain in this reach, and speculate that habitat features like sand bars were important features for the species. In 2003, Swingle (2003) collected two presumed wild pallid sturgeon in the lower Platte River and subsequently followed their movement via telemetry. One of these was a gravid female collected early May 2001 that subsequently moved into the Missouri River on June 9, 2001, suggesting the lower Platte River may be an important tributary for spawning.

Mississippi River

RPMA 5 is unimpounded for 1,153 Rmi (1,922 Rkm) from the confluence with the Missouri River to the Gulf of Mexico (Figure 1). The Mississippi River has received a substantial amount of anthropogenic modification through time, and some changes resulting from those modifications have likely been detrimental to pallid sturgeon. These anthropogenic habitat alterations likely adversely affect pallid sturgeon by altering the natural form and functions of the Mississippi River (Simons et al. 1974; Baker et al. 1991;

Theiling 1999; Wlosinski 1999). Anthropogenic alterations to tributaries may have contributed to habitat degradation in the Mississippi River as well. Impoundment of major tributaries reduced sediment delivery to the main channel (Fremling et al. 1989) resulting in channel degradation and reduction in shallow water habitats (Simons et al. 1974; USFWS 2000b).

Middle Mississippi River

The middle Mississippi River historically had a meandering pattern and shifted its course many times over the years, leaving oxbow lakes and backwaters (Theiling 1999). The undeveloped river was shallow and characterized by a series of runs, pools and channel crossings that provided a diversity of depth along the main channel (Theiling 1999). Currently the middle Mississippi River channel is fixed as a result of channel training structures and no longer meanders across the floodplain. This has reduced channel width and surface area, and thereby reduced habitat diversity. Side channels have been cutoff from the main river channel by closing structures. Many of these have been lost over time due to sedimentation. In the middle Mississippi River, the river is no longer free to migrate and produce new side channels due to channel training structures (e.g., wingdams, revetments, closing structures). Additionally, bendway weirs inhibit the establishment of point bars on inside bends of the river channel.

Channel training structures also have altered the natural hydrograph of the middle Mississippi River by contributing to higher water surface elevations at lower discharges than in the past and to a downward trend in annual minimum stages (Simons et al. 1974; Wlosinski 1999). The downward shift of annual minimum stages can be partially attributed to the degradation of the low-water channel by wingdams (Simons et al. 1974). River stages fluctuate as much as 45 feet (ft) (15 meters (m)) annually, effectively dewatering some secondary channels during low stages (Fremling et al. 1989).

Approximately 80% of the floodplain in the middle Mississippi River has been isolated from the main channel due to levee construction. This has allowed the conversion of floodplain habitats to agriculture and other land uses. Isolated backwaters, side channels, and wetlands have been degraded or lost. Destruction and isolation of these floodplain features has reduced riverine productivity (Theiling 1999) by decreasing energy inputs (organic matter and carbon) into the main channel.

Lower Mississippi River

Anthropogenic alterations have been documented in the lower Mississippi River with identified decreases in aquatic habitats (Baker et al. 1991). Construction of bendway cutoffs to facilitate navigation in the lower Mississippi River locally increased bed gradient and current velocities. As the river responded to the cutoffs, it first became entrenched, and then developed a semi-braided condition and a wider channel (Winkley 1977). Dikes constructed to offset this geomorphic response contributed to bed degradation. Historically, bed degradation resulted in dewatering of some side channels during periods of low discharges (Fremling et al. 1989). Levee construction effectively increased river stage and velocities at higher discharges by preventing water spillover onto the adjacent floodplains effectively isolating the floodplain (Baker et al. 1991). Wasklewicz et al. (2004) found that the upper and lower reaches of the lower Mississippi River have experienced increases in peak, mean, and minimum monthly stages, while the middle portion of the lower Mississippi River has experienced decreases in peak, mean, and minimum river stages. Separately, tributary impoundments, bendway cutoffs, and dike and levee construction changed localized patterns of channel erosion and deposition in the Mississippi River; collectively they resulted in a degradation trend throughout the system. Baker et al. (1991) documented a net loss in channel length, steep bank, sandbar, slough, oxbow lake, seasonal inundated floodplain, and floodplain pond habitat types when compared against features believed present in the lower Mississippi River prior to modification efforts. They documented an increase in low river stage pool habitat that was attributed to the extensive dike system, but noted that these artificial pools may not serve the same ecological function as lost natural slackwater habitats associated with the floodplain. Even so, 92 secondary channels remain in the lower Mississippi River between Rmi 132 and 946 (Rkm 212 and 1522), and although there has been a net loss in secondary channel habitats above +5 Low Water Reference Plane[***] over the past 40 years, elevations around 0 Low Water Reference Plane have remained relatively consistent and there has been a net increase in acreage of -5 Low Water Reference Plane shallow water habitats (Tom Keevin, USACE, pers. comm., 2006). Effects of these changes on pallid sturgeon are unknown, because there are no historical data for comparison.

Atchafalaya River

RPMA 6, the Atchafalaya River, has been significantly affected by reductions in sediment delivery. The Old River Control Complex was designed and constructed to stabilize the distribution of water and sediments between the Mississippi and Atchafalaya Rivers at the same proportions that occurred in 1950, and to prevent the Mississippi River from changing course. However, impoundment of its two major tributaries, the Red and Black Rivers, significantly reduced the sediment load from those sources. This reduction in sediment along with the construction of a hydropower plant just above Old River Control Complex has precipitated channel and bank erosion throughout the Atchafalaya River.

[***] Note that the Low Water Reference Plane is defined in Baker et al. (1991) as "...the river level corresponding to a discharge that is exceeded 97% of the time based on the 20-year period of record from 1954 to 1973. This elevation is assigned a value of 0 ft and river stages are referenced to this standard."

Because historical data regarding populations of pallid sturgeon is lacking or incomplete, and information on spawning sites, spawning behavior, and juvenile and adult habitat needs and uses are lacking, the significance and effects of changes in riverine habitats on pallid sturgeon are not entirely clear. However, lower capture rates in the upper and lower Missouri and middle Mississippi Rivers suggest that pallid sturgeon are more seriously affected where habitat modification has been greatest (USFWS 2000a).

2.3.1.6 Other

The larvae of *Scaphirhynchus* are pelagic, exhibiting swim-up and drift behavior immediately after hatching. Downstream drift of larval pallid sturgeon begins day-0 at hatching and continues up to day-13, with a decline after day-8 (Kynard et al. 2002, 2005). Field studies of drift dynamics and behavior of larvae pallid sturgeon, conducted in a Missouri River side channel, suggested that they may drift 152 to 329 mi (245 to 530 km), depending on water velocity, during the first 11 days, and tend to become more benthic between days 11-17 (Braaten et al. in review), suggesting that river distance and suitable habitat available below spawning areas may be important to survival of *Scaphirhynchus* larvae, and a key factor in recruitment success of river sturgeon.

Pallid sturgeon are thought to spawn in the spring or early summer like other sturgeon species. However, the capture of *Scaphirhynchus* larvae and post-larvae in the Mississippi River during fall months, as well as spring, could be interpreted as an extended season or a second spawn in the lower latitudes of distribution (Paul Hartfield, USFWS, pers. comm., 2006).

In addition to range-wide genetic structuring identified in section 2.3.1.2., there are morphological differences documented between the upper Missouri River pallid sturgeon and pallid populations in the lower Mississippi and Atchafalaya Rivers (Kuhajda and Mayden 2001). The upper Missouri River pallid sturgeon are characterized by large sizes in excess of 60 lb, and large pointed snouts, while pallid sturgeon from the lower Missouri, Mississippi, and Atchafalaya Rivers typically have shorter and rounder snouts and fish size rarely exceeds 15 lb (Figures 14 and 15). However, pallid sturgeon exhibiting morphological traits similar to the northern sample (Figures 14 and 15) from the lower Missouri and middle Mississippi Rivers (Appendix B) have been collected. This suggests that there may be a fair amount of phenotypic plasticity in the species.

Sheared principal components analysis of 19 head measurements (e.g., snout shape, placement of barbels, size and placement of mouth) show that a size-free comparison between upper Missouri River pallid sturgeon, shovelnose sturgeon, and known hatchery-reared hybrids are quite different from lower Mississippi and Atchafalaya Rivers pallid, shovelnose, and intermediate sturgeons (Figure 16, see also Appendix B).

These morphological data suggest different populations of pallid sturgeon in the upper Missouri and lower Mississippi/Atchafalaya Rivers. These differing groups of pallid sturgeon also appear to occur in very distinct physiographic regions. The upper Missouri River lies within the Great Plains Region of the Interior Plains Province above the Fall Line, and the lower Mississippi/Atchafalaya Rivers lie within the Mississippi Alluvial Plain of the Coastal Plain Province. There are many examples of freshwater fishes having distinct populations within a species or distinct species within a lineage across different physiographic regions (Wiley and Mayden 1985).

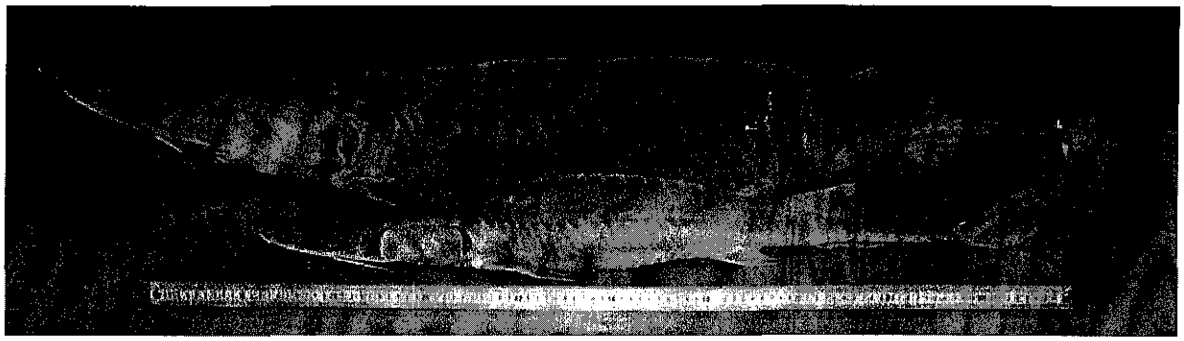
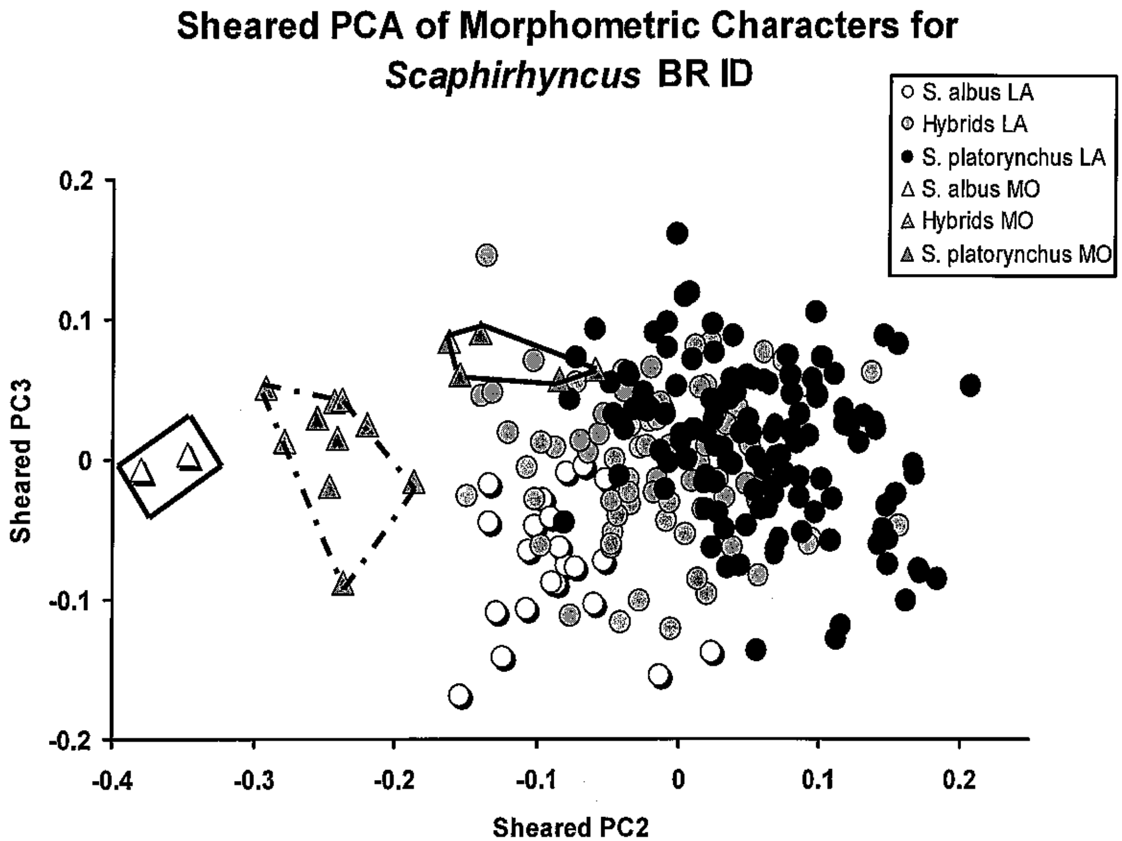


Figure 14. Adult pallid sturgeon: the northern specimen (largest) from the upper Missouri River (RPMA 2) and smaller southern specimen from the lower Mississippi/Atchafalaya River RPMA 5 or 6) (bottom). Both specimens represent some of the largest specimens from each region. (Photo courtesy of Dr. Bernard Kuhajda, University of Alabama.)

Figure 15. Adult pallid sturgeon: northern specimen from the upper Missouri River (right) and southern specimen from the lower Mississippi/Atchafalaya River (left). Both specimens represent some of the largest examples from each region. (Photo courtesy of Dr. Bernard Kuhajda, University of Alabama.)



Scaphirhynchus

Figure 16. Sheared principal components analysis of 19 head measurements of upper Missouri River pallid sturgeon, shovelnose sturgeon, and known hatchery-reared hybrids (MO) and lower Mississippi/Atchafalaya River pallid, shovelnose, and intermediate sturgeons (LA). Each point represents measurements from an individual fish. (Courtesy of Dr. Bernard Kuhajda, University of Alabama.)

2.3.2 Five-Factor Analysis

2.3.2.1 Present or Threatened Destruction, Modification or Curtailment of its Habitat or Range

Habitat

Pallid sturgeon habitat has been dramatically altered during the past 60 years. Approximately 51% of the pallid sturgeon's historical range has been affected to some degree by channelization, 28% has been impounded, and the remaining 21% is affected by upstream impoundments that alter flow regimes, depress both turbidity and water temperatures, and have continuing bank stabilization activities that limit channel meandering (Keenlyne 1989, USFWS 2000a). Following listing in 1990, efforts have been taken to improve or restore habitats in various sections of the Missouri and Mississippi River systems, though most of these efforts have occurred during the last several years and little data are available to evaluate the success of implemented restoration projects. Below is a summary of what has been accomplished or determined since the Pallid Sturgeon Recovery Plan was completed in 1993.

Fort Benton to Fort Peck Reservoir Montana (RPMA 1)

There have been some significant changes in reservoir operations on tributaries within RPMA 1. Operations of Tiber Dam, located on the Marias River a tributary to the Missouri River, have been recently modified to occasionally accommodate a high flow discharge period in June. During 1995, 1997, and 2002 BOR provided a June peak release of 4,080, 4,500, and 5,300 cfs, respectively for downstream fisheries benefits. These releases were 1.8 to 2.3 times the average June peak discharge that has occurred since construction of Tiber Dam (1957-1994) (B. Gardner, MFWP, pers. comm., 2006). A direct response by pallid sturgeon was not observed; however, present numbers of pallid sturgeon could now be too low to detect or elicit a response. An indirect response to flow operational changes may be the recent establishment of sturgeon chub in the lower Marias River. Sturgeon chub are an important prey species of pallid sturgeon (Gerrity et al. 2006) and were documented only recently in the Marias River in 2002. The BOR is conducting a 5-year study to evaluate how operations of their four dams in the upper Missouri River system (including Tiber) affect pallid sturgeon recovery.

Recent research suggests that drought-induced lower water levels in Fort Peck Reservoir may increase available habitat for hatchery-reared juvenile pallid sturgeon as well. Gerrity (2005) noted that low water levels in Fort Peck Reservoir created an additional 34 mi (56 km) of riverine habitat upstream of the reservoir and this suggests that maintaining lower reservoir pools may be beneficial in creating additional riverine habitat for pallid sturgeon. In addition to providing juvenile pallid sturgeon habitat, the additional riverine reach produced by low water levels in Fort Peck Reservoir also should provide some additional drift distance for larval sturgeon. However, it is yet to be determined if the additional drift distance is sufficient to promote survival of naturally produced larvae.

Fort Peck Dam, Montana to Lake Sakakawea, North Dakota (RPMA 2)

Little direct manipulation of habitat has occurred in this reach to specifically benefit pallid sturgeon. However, there are several efforts in progress that ultimately will lead to habitat connectivity or flow manipulations that may be beneficial.

The Yellowstone River is the largest tributary to the Missouri River in this reach. However, about 71 Rmi (115 Rkm) from the confluence of the Yellowstone and Missouri Rivers is a low-head dam that effectively blocks the migration of pallid sturgeon (Bramblett and White 2001). To address this barrier, a joint effort involving the Irrigation District, MFWP, USACE, BOR, USFWS, and The Nature Conservancy is underway. The primary goal of this effort is to develop suitable fish passage on the Yellowstone River at the Intake Diversion Dam and screening to prevent entrainment in the canal. Preliminary estimates suggest this project will not be completed for at least 3 to 5 years.

Another potential manipulation of existing conditions to benefit pallid sturgeon is proposed flow releases from the Fort Peck Dam spillway that could utilize warm surface water to improve temperatures and flows. The Missouri River biological opinion (USFWS 2000a) identifies these releases as important to maximizing the amount of warm water habitat available below the dam. Utilizing warm water releases to simulate natural conditions to improve spawning cues for the species have been precluded due to reservoir levels being too low to utilize the spillway. Recommendations in the Biological Opinion are based on snow pack, and identify flows ranging from 20,000 to 30,000 cfs between mid-May and the end of June. Higher flows would be recommended during higher snow pack years. To date, utilizing warm water releases to simulate natural conditions to improve spawning cues for the species have been precluded due to extended drought conditions. Like RPMA 1, the drought conditions have decreased pool levels in Lake Sakakawea resulting in more available riverine habitat. However, it is yet to be determined if this additional riverine habitat is sufficient to promote survival of naturally produced larvae.

Fort Randall Dam to Gavins Point Dam, South Dakota and Nebraska (RPMA 3)

This is the smallest RPMA identified in the Recovery Plan. Work in this reach indicates that it possesses necessary habitat and is suitable for pallid sturgeon supplementation efforts (Jordan et al. 2006). The largest tributary in this reach is the Niobrara River. Spencer Dam is a fish passage barrier on the Niobrara River and preliminary discussions, among USFWS and the State of Nebraska, to address fish passage have occurred. However, there is no real effort yet to address this concern. Development and associated bank stabilization projects still occur in this reach. These projects individually may not have a substantial impact on habitat, but cumulatively they may be reducing sediment by stopping channel meandering and the creation of new habitat. The loss of sediment inputs affects channel habitat diversity. Siltation in the upper reaches of Lewis and Clark Reservoir appears to be producing more riverine like habitat in this RPMA. However, it is yet to be determined if this additional riverine habitat is sufficient to promote survival of naturally produced larvae.

Gavins Point Dam South Dakota/Nebraska to the Mississippi River Confluence (RPMA 4)

This is the longest Missouri River RPMA identified in the Recovery Plan and has seen the most attention in terms of habitat improvement efforts. This is in part attributed to the 2003 amendment to the Missouri River Biological Opinion (USFWS 2000a). This amendment identified development of shallow water habitats between Sioux City and the Platte River. This was later extended upstream to Ponca State Park, Nebraska, and downstream to the mouth of the Osage River, Missouri. Approximately 1,400 to 1,800 acres (ac) (566 to 728 hectares (ha)) of shallow water habitat was constructed in 2004 by notching dikes and constructing site-specific projects like dredging to connect back-water areas, and pilot channel construction (USACE and USFWS 2004).

In addition to increasing shallow water habitat in this reach, the Biological Opinion (USFWS 2000a) identifies manipulation of flows from Gavins Point Dam, to stimulate a biological response from fishes as well as potentially create habitat, as an important reasonable and prudent alternative. To accomplish this, a spring rise was proposed of +17,500 cubic feet per second (cfs) (total 49,500 cfs) 1 year out of 3 with an annual summer low flow of 21,000 cfs. It is believed that these releases will begin to provide the conditions that simulate the range of historic natural fluctuations of the Missouri River. Increased discharge in the spring followed by low discharge in the summer is hypothesized to provide missing cues suspected as one cause of little to no spawning/recruitment of pallid sturgeon in this reach. A minor spring rise was implemented from Gavins Point Dam in 2006. Peak discharge of this pulse was about 25,000 cfs.

Recently there have been a variety of efforts to physically improve aquatic habitat diversity and abundance, and restore some measure of connectivity in the Missouri River and tributaries to benefit not only sturgeon but other native river species. Adult pallid sturgeon have been collected in both Upper Hamburg Bend and Plattsmouth Chutes (K. Steffensen, NGPC, pers. comm., 2005). The presence of pallid sturgeon in these created/restored habitats demonstrates their suitability for at least periodic use by multiple life stages of sturgeon. In 1998, larval pallid sturgeon were found in a naturally created chute in Missouri (Krentz 2000), suggesting that restored chutes and shallow water habitat may indeed be beneficial. Currently, efforts are underway to develop a better understanding of important habitat features that may improve restoration project designs and substantially increase our limited database on sturgeon habitat use. Based on current and anticipated commitments for aquatic habitat restoration in this RPMA, the next several years should produce increased quantity and quality of potential sturgeon habitat in RPMA 4. At present the data are incomplete or lacking to determine if these efforts are sufficient to maintain a self-sustaining population in RPMA 4.

The importance of the lower Platte River for pallid sturgeon has been documented (Snook 2002, Swigle 2003). The largest factor affecting habitat in the lower Platte River is upstream water withdrawl. A Cooperative Agreement between Nebraska, Colorado, Wyoming, and the U.S. Department of Interior (USFWS and BOR 2006) has been developed to improve and maintain habitat for species like pallid sturgeon. To date, the Platte River Recovery Implementation Program has been signed by the Department of the Interior Secretary and the Governors from Nebraska, Wyoming and Colorado. Though this program has been signed by all parties, authorizing legislation is needed to implement the thirteen year program. Planned flow improvements in the central Platte River are expected to improve conditions for pallid sturgeon in the lower Platte River. Research and monitoring will occur to assess these potential affects. Without authorizing legislation in place, agreed-upon program activities that provide ESA compliance can only be implemented to a limited extent under existing ESA authorities. For example, acquisition of program habitat lands and water projects can not occur using Federal appropriations until after the proposed legislation has become law.

Mississippi River (RPMA 5)

Middle Mississippi River

A Biological Opinion on the upper Mississippi River includes a jeopardy opinion for pallid sturgeon in the middle Mississippi River (USFWS 2000b) in part due to habitat alterations required to maintain a 9-foot navigation channel. Practices that alter habitats include--channel training structures, locks and dams, dredging and spoil disposal, and flood control projects.

Following listing of pallid sturgeon as endangered, the USACE St. Louis District issued Design Memorandum No. 24 "Avoid and Minimize Measures" in October 1992. This program was developed to minimize effects associated with maintenance of the 9-foot channel. Under this program, several projects have been completed to restore side channel connectivity and habitat diversity. Also, in recent years, as a result the jeopardy biological opinion for operation and maintenance of the 9-foot navigation channel, the USACE has initiated several "pilot" projects aimed at improving habitat diversity in the middle Mississippi River. These projects include dike modifications, construction of chevron dikes, side channel enhancement, placement of woody debris piles, and incorporation of woody debris into dikes. Specific details can be found in the Biological Opinion (USFWS 2000b).

Efforts to purchase flood prone areas have increased following flooding in 1993. By 2000, approximately 4,300 ac (1,740 ha) of former agriculture lands had been purchased from landowners who decided farming was not economically feasible in flood prone areas. Protection and restoration of these flood prone areas could provide increased flood plain access and connectivity to restore allochnous inputs. Potential restoration of these nutrient inputs are hypothesized to be indirectly beneficial to the pallid sturgeon by increasing overall stream productivity and result in a beneficial trophic effect as well as directly beneficial by preventing further practices (e.g., rip-rap, side channel cut offs) that may be detrimental to pallid sturgeon habitats. Much of the original land purchased was incorporated into the Mark Twain National Wildlife Refuge (NWR). Also, in 2000, Mark Twain NWR was split into five separate refuges with Harlow, Wilkinson, and Meissner becoming the new Middle Mississippi River NWR.

During 2005 to 2006, through donations from the American Land Conservancy, 2,110 ac (853 ha) on Kaskaskia Island, also known as Horse Island, was conveyed to the Middle Mississippi River NWR establishing the Horse Island Division (Cail in litt. 2006). Kaskaskia Island is an approximately 16,000-ac (6,475-ha) oxbow complex created when the Mississippi River changed course during the flood of 1881 (Cail in litt. 2006). The Mississippi River carved a new channel connecting to the southern portion of the Kaskaskia River, establishing Illinois State property on the west side of the big river. Prior to conveyance to the USFWS, the American Land Conservancy enrolled 2,110 ac (853 ha) in the Wetland Reserve Program (Cail in litt. 2006). Wetland restoration and reforestation on more than 400 ac (162 ha) resulted in support from the Natural Resource Conservation Service. The Kaskaskia River is just upstream from land acquired on Horse Island, and is a tributary that joins the Mississippi River in the vicinity of where fishery biologists have reliably captured pallid sturgeon.

Also during 2005-2006, funds from the Illinois Clean Energy Community Foundation and the North American Wetlands Conservation grant program has resulted in the conveyance of 722 ac (292 ha) to the USFWS and 318 ac (128 ha) to Ducks Unlimited on Rockwood Island (Cail in litt. 2006). Rockwood Island is a 2,500-ac (1,011-ha) island and side channel complex containing both forested and agriculture lands, and an active 2.5-mi (4-km) side channel. The active side channel provides habitat for big river fishes and other wetland obligates (Cail in litt. 2006). These lands are unprotected by levees and offer the opportunity for fish and wildlife restoration activities in the future.

Current acres/hectares for the Middle Mississippi River NWR include Meissner Island 78 ac/31 ha, Harlow Island (1,225 ac/496 ha), Beaver Island (249 ac/101 ha), Horse Island (2,110 ac/853 ha), Rockwood Island (722 ac/292 ha), and Wilkinson Island (2,532 ac/1,025 ha), which total 6,916 ac/2,799 ha (Cail in litt. 2006). In July 2004, the Mark Twain NWR Complex Comprehensive Conservation Plan and Environmental Assessment were approved, resulting in approved acquisition boundaries for the Middle Mississippi River NWR enclosing 14,758 ac/5,972 ha (Cail in litt. 2006).

The Middle Mississippi River NWR lands currently are spread along 60 mi (96 km) of the Mississippi River below St. Louis, Missouri. Protection and restoration of these areas has been attributed with improved floodplain connectivity as well as improved habitat conditions (USFWS 2000b). With the previously identified practices in place, the USFWS' Biological Opinion (USFWS 2000b) still indicates that maintaining the 9-foot navigation channel "is likely to jeopardize the continued existence of pallid sturgeon." As such, four reasonable and prudent alternatives (RPAs) were identified. These are-- 1) conduct a study of pallid sturgeon habitats on the middle Mississippi River, 2) facilitate development of a pallid sturgeon conservation and restoration plan, 3) implement the habitat restoration plan developed in item 2, and 4) implement short-term restoration measures that are believed to benefit pallid sturgeon until RPA 1-3 are completed.

Lower Mississippi River

Between 1929 and 1942, 16 bendway cutoffs were constructed by the USACE that shortened the river 152 mi (245 km) over a 503-mi (809-km) reach (Baker et al. 1991). In response to this 30% reduction in channel length, the river became entrenched in steeper gradient reaches, eroding large amounts of material from the channel banks and bed. Deposition of this material in the lower gradient reaches resulted in a semi-braided channel, and by the 1970s the river was attempting to reestablish a meandering condition (Winkley 1977). Increasing flood flows due to loss of outlets, and construction of levees in major tributaries and the Mississippi River contributed to overall channel instability. Because of these geomorphic adjustments to anthropogenic changes, an aggressive program of bank revetment and dike construction was required to fix and maintain the navigation channel, and to protect the levee system. Although successful in its overall intent to facilitate navigation and provide flood control benefits, this program reduced secondary channel formation, floodplain connectivity, and both lentic and lotic sandbar formation in the lower Mississippi River (Baker et al. 1991).

In 1981, the USACE established the Lower Mississippi River Environmental Program, with a goal of protecting fisheries and other natural resources in the lower Mississippi River. Input from the Lower Mississippi River Environmental Program resulted in experimentations with dike placement and notches as measures to protect secondary channels and maintain shallow water and fisheries habitats. In 2001, the USACE Mississippi Valley Division, initiated informal consultation under section 7(a)(1) with the USFWS to develop and implement additional measures to conserve and manage listed species associated with the lower Mississippi River navigation channel. Under this process, the Memphis and Vicksburg Districts hold annual meetings with the USFWS and State conservation agencies to review and modify, if necessary, construction and maintenance plans and activities to minimize potential impacts to listed species, avoid further loss of secondary channel habitats, and to restore and improve secondary channel areas when possible (USACE in litt. 2004, 2005, and 2006). The USACE Mississippi Valley Division and the Districts also are working with the Lower Mississippi River Conservation Committee, State agencies, and the USFWS to identify and initiate secondary channel restoration opportunities. However, results of the Lower Mississippi River Environmental Program and section 7(a)(1) conservation actions have not been quantified and it is currently unknown if habitat degradation trends in the lower Mississippi River have been reduced, stopped, or reversed.

Atchafalaya River (RPMA 6)

The Atchafalaya River is a distributary to the Mississippi River. Water enters the Atchafalaya River from the Mississippi River through the Old River Control Complex and an adjacent hydropower plant. Construction of these structures has altered habitats by reducing sediment transport into the Atchafalaya River (Reed and Ewing 1993) and the structures likely are effective barriers for fishes trying to move from the Atchafalaya system into the Mississippi River.

Impoundment of the Red and Black Rivers, also has significantly contributed to the reduction of sediments moving into the Atchafalaya River, precipitating bank and channel erosion. Other habitat alterations in this RPMA contributing to channel habitat degradation include construction of levees and navigation dredging. Effects of these habitat alterations on pallid sturgeon are unknown, since there is little to no information on pallid sturgeon from the Atchafalaya River prior to 1991 (USFWS 1993).

While there have been substantial anthropogenic alterations to riverine habitat throughout the range of pallid sturgeon, there have also been numerous activities design to improve current habitat conditions. Available demographic data do not indicate that these habitat improvement activities have resulted in improved pallid sturgeon populations within the Missouri River and data are insufficient to assess affects of these improvements in the Mississippi River. Thus while the threat of destruction, modification or curtailment of habitat or range may not be increasing, past activities may not have been rectified to such a point that the threat can be considered addressed.

2.3.2.2 Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Commercial or recreational harvest of pallid sturgeon is a threat to the species and is prohibited by section 9 of the ESA and by State regulations throughout the range. Collection of adults for any purpose imposes a potential reproductive loss within any given RPMA. Overutilization of pallid sturgeon for scientific or educational purposes is likely negligible. Following the species listing, possession of pallid sturgeon is governed through the ESA 10(a)1(A) permit program. Take associated with these activities is quantifiable and appears to be very small. Overexploitation for commercial or recreational purposes is harder to quantify and likely poses a bigger threat as greater numbers of reproductively capable adults can be lost in a relatively short time frame. However, incidental and illegal harvest of pallid sturgeon has been documented in the Mississippi River, and may be a significant impediment to survival and recovery of the species in some portions of its range (see 2.3.2.2., below). Other forms of overutilization are not known to currently affect the species.

Overexploitation

Commercial harvest of sturgeon for roe and meat was a traditional fishery in the Missouri and Mississippi River systems. Because pallid sturgeon and shovelnose sturgeon are very similar in appearance, increasing trends in shovelnose harvest increases the likelihood of unintentional harvest of pallid sturgeon.

Williamson (2003) presented data from the MDC that showed an increase in commercial catch of shovelnose sturgeon from 5,850 pounds (lb) (2,653 kilograms (kg)) in 2000 to 12,370 lb (5,610 kg) in 2001. A total of 7,472 lb (3,389 kg) were reported in 1999. To reduce the effects of harvest on pallid sturgeon, Montana, North Dakota, South Dakota, Nebraska, and Iowa have closed commercial sturgeon fishing on the Missouri River. Missouri still allows commercial harvest, but has limited harvest by closing commercial sturgeon fishing on the Missouri River upstream of the Kansas River to the Iowa border. Incidental or purposeful illegal harvest of pallid sturgeon associated with commercial fishing likely is having a negative impact on the demographics of this species and should be viewed as a potential threat to pallid sturgeon in RPMA 4 where commercial harvest is still allowed.

There is a paucity of historical information on commercial harvest of sturgeon for roe and meat in the middle and lower Mississippi River. Cook (1958) provides commercial harvest information for the years 1894, 1899, 1903, 1908, 1922, and 1931. This report details total pounds harvested and from which river, but most of these data are reported as "sturgeon" with one reference to shovelnose. There appears to have been a decreasing trend in sturgeon harvest through time with a high of 8,600 lb (3,900 kg) reported in 1899 to a low of 100 lb (45 kg) reported in 1931. Williamson (2003) provided data reported by the Illinois Department of Natural Resources and the Kentucky Department of Fish and Wildlife Resources for commercial catch of shovelnose sturgeon. In Illinois, the Statewide commercial catch of shovelnose sturgeon flesh increased from 8,853 lb (4,015 kg) in 1990 to 65,462 lb (29,693 kg) in 2001. The amount of roe taken increased from 47 lb (21 kg) reported in 1999 to 8,197 lb (3,718 kg) reported in 2001. In Kentucky, the commercial catch of shovelnose sturgeon in the Mississippi River increased from 25 lb (11 kg) (flesh) in 1999 to 8,324 lb (3,775 kg) in 2002. The harvest of roe was reported at 1,021 lb (463 kg) in 2001 and 731 lb (331 kg) in 2002. Overharvest of sturgeon is a major concern in pools 12-26 of the Mississippi River. Harvest of shovelnose sturgeon roe by licensed Illinois fishermen has increased almost 10-fold since the late 1990s (Figure 17).

Several States have initiated restrictions to reduce take of pallid sturgeon. Commercial take of any species of sturgeon was prohibited by Mississippi and Louisiana during the early 1990s to avoid incidental take of endangered or threatened sturgeon species. For similar reasons, Arkansas prohibits sturgeon fishing in the Mississippi River and restricts commercial take of shovelnose sturgeon to tributaries. Tennessee, Missouri, Kentucky, and Illinois continue to allow commercial harvest of shovelnose sturgeon. Iowa currently does not allow commercial shovelnose sturgeon harvest on the Missouri River, but does allow commercial harvest on the Mississippi River.

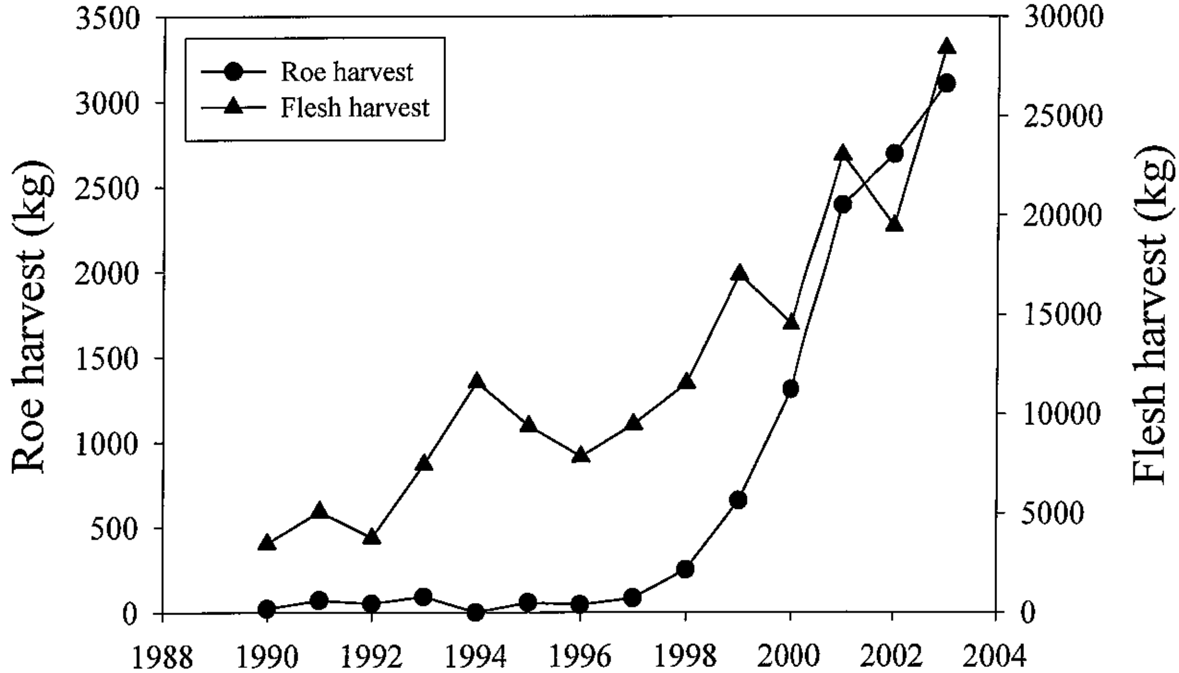


Figure 17. Reported commercial harvest (i.e., by licensed Illinois harvesters) of shovelnose sturgeon roe and flesh from Pools 12-26 of the Mississippi River.

The restrictions imposed through State fishing regulations have helped; however, there is still evidence of incidental take of pallid sturgeon associated with commercial harvest of shovelnose sturgeon. Pallid sturgeon remains have been discovered in fish markets (Sheehan et al. 1997) and pallid sturgeon with egg biopsy scars have been documented by biologists from the USFWS Columbia Fishery Resource Office, Columbia, Missouri (Wyatt Doyle, USFWS, pers. comm., 2006). In the spring of 2006, at least three adult pallid sturgeon were found in the possession of a commercial fisherman illegally fishing Arkansas waters (Keevin in litt. 2006). In that same year, there also were nearly 100 sturgeon carcasses found in a dumpster near the Chain of Rocks area in St. Louis, Missouri. Of the 100 carcasses, there was 1 suspected pallid sturgeon. Region 3 of the USFWS also has reported there are between 6 to 14 document cases of illegal or unintentional harvest of pallid sturgeon that are being investigated or part of ongoing investigations by State or USFWS law enforcement officials (Mike Oetker, USFWS, pers. comm., 2006). Preliminary age studies of pallid sturgeon spine sections in the middle Mississippi River where harvest of shovelnose sturgeon is permitted, have estimated maximum pallid sturgeon age at 15 years, with mortality rates of 37 to 39% (Colombo et al. in press). Estimates for the lower Mississippi River, where shovelnose sturgeon harvest is not permitted, place maximum age at

21 years, with a mortality rate of 12% (J. Garvey, Southern Illinois University, J. Killgore, USACE, data presented at the pallid sturgeon Recovery Team meeting September 28-29, 2005, held in Lakewood, Colorado). The higher age and lower mortality estimates for pallid sturgeon within the lower Mississippi River, where commercial harvest of shovelnose sturgeon is prohibited, suggests that incidental take of pallid sturgeon by commercial harvest is more prevalent in the middle Mississippi River. This suggests that incidental and illegal take during commercial harvest of shovelnose sturgeon is having a substantial and detrimental effect on the pallid sturgeon in the middle Mississippi River.

Overexploitation is a factor that must be considered in pallid sturgeon conservation. Unintentional and illegal take of pallid sturgeon for commercial purposes will likely increase in the middle Mississippi and lower Missouri Rivers as commercial pressures on domestic sturgeon increase due to the importation ban of beluga sturgeon (*Huso huso*) caviar into the United States and the general trend toward reduced caviar exports from the Caspian Sea sturgeon stocks (CITES 2006). This recent ban has limited supply and likely has attributed to an increase in roe prices.

The threat of overutilization for commercial, recreational, scientific, or educational purposes has diminished since listing, due in part to changes in regulations involving harvest and scientific collections. However, illegal take of pallid sturgeon still occurs and thus this threat, while reduced since listing, has not been eliminated (see also 2.3.2.4 Inadequacy of Existing Regulatory Mechanisms).

2.3.2.3 Disease or Predation

An iridovirus is known to infect pallid and shovelnose sturgeon. This disease originally surfaced during artificial propagation efforts and is known to cause substantial mortality in a hatchery rearing environment (USFWS 2006a). The iridovirus was first identified by histology from a female pallid held at Garrison Dam National Fish Hatchery (USFWS 2006). Subsequent testing has documented that this virus is found in the wild. Of 179 *Scaphirhynchus* tested from the Atchafalaya River between November 2003 and May 2004, 8 (4%) were identified as virus positive and 5 (2.8%) were considered virus suspect. Both pallid and shovelnose sturgeon tested either positive or suspect. When manifested, this disease is known to cause substantial mortality in a hatchery rearing environment, but the effect of the virus on wild populations is poorly understood (USFWS 2006). Documenting the natural background level of the virus in the wild is needed to identify an acceptable baseline percentage of virus-positive individuals in a given sample size.

Little information is available documenting piscivory as a threat limiting the recovery of the pallid sturgeon. Predation on larval fishes of all species occurs naturally. However, habitat modifications that increase water clarity and artificially high densities of both non-native and native predatory fishes could limit a species' natural ability to sustain itself.

Pallid sturgeon larvae and fry drift freely immediately post-hatch as "free embryos" (Kynard et al. 2002, Braaten et al. in review). This drift distance would likely expose any naturally spawned pallid sturgeon to predation and transport naturally spawned pallid sturgeon larvae into the headwaters of Fort Peck Reservoir and Lake Sakakawea. In addition to these reservoirs creating a more lentic environment, they are or have been artificially supplemented with predatory species like walleye (*Sander vitreum*). Maintaining elevated populations of certain species in these reservoirs has been hypothesized as a contributing factor in poor survival of larval and juvenile pallid sturgeon. Parken and Scarnecchia (2002) reported that walleye and sauger (*S. canadense*) in Lake Sakakawea (just downstream of RPMA 2) were capable of eating wild paddlefish (*Polyodon spathula*) up to 6.6 inch (in.) (167 mm) body length (12 in./305 mm total length) and thus likely could consume naturally produced pallid sturgeon larvae and smaller hatchery produced pallid sturgeon released as part of supplementation efforts. When looking at these data for their sample location closest to the headwaters area, it appears that no age-0 paddlefish were found in walleye, but were present in sauger, a native species closely related to walleye. Braaten and Fuller (2002, 2003) examined 759 stomachs from 7 piscivores species in Montana and found no evidence of predation on sturgeon. However, in all species sampled, unidentified fish or fish fragments were present. More data are needed to adequately evaluate predation effects on pallid sturgeon recruitment success.

2.3.2.4 Inadequacy of Existing Regulatory Mechanisms

One regulatory challenge that has not been fully addressed since the Recovery Plan was finalized is accidental or intentional take of pallid sturgeon as a result of commercial harvest.

Generally, shovelnose sturgeon can be distinguished from pallid sturgeon by their smaller size as mature adults. However, this can be an inaccurate gauge at the upper size range for shovelnose sturgeon, since both species experience a wide range of size variation depending on their geographic home range (Table 1).

Table 1. Maximum and average sizes of large adult shovelnose and pallid sturgeon.

RIVER	PALLID STURGEON maximum length	SHOVELNOSE STURGEON maximum length (range)	SHOVELNOSE STURGEON average large size
Mississippi River	1,350 mm	1,000-1,050 mm	800 mm
Lower Missouri River	1,162 mm	800-804 mm	720 mm
Upper Missouri River	1,638 mm	1,400-1,500 mm	900 mm

Currently, biologists use character indices as tools to distinguish between pallid sturgeon and shovelnose sturgeon. These tools, developed by taxonomists, use as many as 13 morphometric body measurements and meristic ray fin counts to differentiate between the two species. However, in a recent meeting of the Pallid Sturgeon Recovery Team and its Genetics Advisory Group, data were presented showing limited success using character indices when compared to genetic confirmation of species (Kuhajda et al. in press; Murphy et al. in press, see also Appendix B). Geneticists and taxonomists have shown a gradient of morphometric and genetic differences throughout these species' geographic range and suggest that recent evolutionary divergence also may complicate genetic distinction. It can be difficult for trained biologists to differentiate between shovelnose and pallid sturgeon. Pallid sturgeon are at risk in States allowing commercial harvests of shovelnose due to the difficulty in distinguishing between the two species (see also 2.3.2.2. Overutilization for commercial, recreational, scientific, or educational purposes: Overexploitation). Currently, efforts by Iowa and Missouri to restrict commercial harvest of shovelnose sturgeon to certain areas likely have reduced this threat, but may not have eliminated it. Tennessee, Missouri, Kentucky, Iowa, and Illinois continue to allow regulated commercial harvest of shovelnose sturgeon for flesh or roe. Applicable commercial harvest regulations are as follows:

- Tennessee has established a 24- to 32–in. (609- to 813-mm) FL harvestable size limit and fishing season (October 15 to May 15) for roe harvest on the Mississippi River and has closed a portion of the river to commercial harvest due to contaminants concerns (Tennessee Wildlife Resources Agency 2006).
- Missouri has established a 24- to 30–in. (609- to 762-mm) FL harvestable size limit and fishing season (November 1 through May 15) on the Missouri River. Also, there are areas closed to harvest, including Kansas City upstream to the State line and approximately 30 Rmi around the mouth of the Osage River (15 mi above and below the confluence). The restrictions for the Mississippi River are a 24- to 32–in. (609- to 813-mm) FL harvestable size limit and a fishing season (October 15 to May 15).

Commercial anglers are required to purchase a permit (MDC 2006) and harvested shovelnose sturgeon are to remain whole and intact while on waters of the State and adjacent banks. Nonresidents are not allowed to harvest shovelnose sturgeon on the Missouri River.

- Kentucky has established a 24- to 32-in. (609- to 813-mm) FL harvestable size limit, a season (October 15 through May 15), and monthly catch reporting requirements for commercial fisherman (Kentucky 2006).
- In July 2006, the Iowa Natural Resources Commission adopted changes to their commercial fishing regulations that establish a minimum shovelnose sturgeon fork length of 27 in. (686 mm). A maximum fork length of 34 in. (863 mm) also was established for the Mississippi River bordering Wisconsin. These regulation changes identify a closed season for shovelnose sturgeon harvest (May 16 through October 14) and require that shovelnose sturgeon remain intact until the fish are delivered to a processing facility (Iowa 2006).
- Illinois currently has no size limits on shovelnose sturgeon, but does require monthly reporting of roe harvest. Also, there are areas closed to commercial fishing on the Mississippi River, such as Quincy Bay, including the waterfowl management area and other USFWS NWR Waters (Illinois 2006).

While these self-imposed regulations are intended to assist with protecting *Scaphirhynchus* in the middle Mississippi River, their long-term effects have yet to be demonstrated. Recent work, by Colombo et al. (in press), indicates that the current minimum size length of 24 in. (609 mm) is not sufficient to maintain a sustainable shovelnose sturgeon fishery long term. The size range of pallid sturgeon overlaps harvestable length shovelnose sturgeon in these States and thus unintentional or illegal harvest is likely continuing because the two species can be difficult to discern from each other. This concern also is highlighted in Colombo et al. (in press). Their data suggests that in the middle Mississippi River, pallid sturgeon annual mortality rates are very similar to those calculated for the commercially harvested shovelnose sturgeon and suggest that harvest-induced mortality is negatively affecting pallid sturgeon mortality rates.

As caviar prices rise and commercial pressures on shovelnose sturgeon increase, incidental and illegal take of pallid sturgeon is expected to increase in the middle Mississippi and lower Missouri Rivers, and may become an issue in the lower Mississippi and Atchafalaya Rivers. In light of the existing regulatory, advisory, and enforcement mechanisms, the difficulties in distinguishing between pallid sturgeon and shovelnose sturgeon still exist (see also 2.3.2.2. Overutilization for commercial, recreational, scientific, or educational purposes). Accidental or intentional take of pallid sturgeon can occur and be difficult to enforce. Given the potential difficulty in enforcing regulations where the two species overlap, these regulatory mechanisms may not adequately address the illegal harvest of pallid sturgeon. Addressing unintentional or illegal take is essential for recovery and current regulatory and enforcement mechanism may be inadequate to fully address this threat.

2.3.2.5 Other Natural or Manmade Factors Affecting its Continued Existence

Contaminants

Currently there are several fish consumption advisories for shovelnose sturgeon attributable to contaminants. Contaminant levels in pallid sturgeon also have been noted, but data are minimal. Elevated levels of polychlorinated biphenyls (PCBs), cadmium, mercury, and selenium have been detected in tissue samples from three pallid sturgeon collected from the Missouri River in North Dakota and Nebraska (Ruelle and Keenlyne 1992). Ruelle and Keenlyne (1992) also noted detectable concentrations of chlordane, DDE, DDT, and dieldrin. The effects of contaminants on pallid sturgeon reproduction also are poorly understood. However, research involving white sturgeon (*Acipenser transmontanus*) in the Columbia River found lower condition factors, gonadal abnormalities, and hermaphrodism in fishes with elevated levels of metabolites of DDT (DDE and DDD) as well as total PCBs and mercury (Feist et al. 2005). Shovelnose sturgeon collected from the lower Missouri River have a consumption advisory because of concerns relating to overelevated levels of PCB and chlordane (DHSS 2006), and also lower Missouri River shovelnose sturgeon have been noted to exhibit intersexual characteristics (Wildhaber et al. 2005). Intersexual shovelnose sturgeon from the middle Mississippi River were found to have higher concentrations of organochlorine compounds when compared against male shovelnose sturgeon (Koch et al. 2006). Current data are lacking to adequately understand and address this problem under existing environmental laws, but contaminant research suggests a link between environmental contaminants and potential reproductive problems in several sturgeon species (Feist et al. 2005; Koch et al. 2006). Research on the effects of contaminants on pallid sturgeon reproductive mechanisms should continue as part of pallid sturgeon recovery efforts.

The State of Tennessee closed commercial fishing on the Mississippi River from the State line to downstream of Meeman-Shelby State Park (Rmi 745) because of concerns over chlordane and other contaminants (Tennessee 2004). Currently, the Missouri Department of Health and Senior Services (2006) has issued a "do not eat" advisory for shovelnose sturgeon eggs because of concerns over PCB and chlordane levels. Illinois has a sturgeon consumption advisory (PCBs) on the Mississippi River between Lock and Dam 22 to Cairo, Illinois.

Entrainment

Another issue that is negatively impacting pallid sturgeon throughout its range is entrainment. The loss of pallid sturgeon associated with water intake structures has not been accurately quantified. The U.S. Environmental Protection Agency published final regulations on Cooling Water Intake Structures for Existing Facilities per requirements of Section 316(b) of the Clean Water Act. The rule making was divided into three phases. However, only Phase I and II appear applicable to inland facilities; Phase III applies to coastal and offshore cooling intake structures associated with coastal and offshore oil and gas extraction facilities. The following rule summaries are based on information found at the website <http://www.epa.gov/waterscience/316b/>.

Phase I rules, completed in 2001, require permit holders to develop and implement techniques that will minimize impingement mortality and entrainment. Phase II, completed in 2004, covers existing power generation facilities that are designed to withdraw 50 million gallons per day or more with 25% of that water used for cooling purposes only. This rule, implemented through National Pollutant Discharge Elimination System permits, is intended to minimize negative affects associated with water cooling structures. This rule provides permit holders with five alternatives to ensure compliance:

1) Demonstrate that it will reduce or has reduced its intake flow commensurate with a closed-cycle recirculating system and, therefore, is deemed to have met the impingement mortality and entrainment performance standards, or that it will reduce or has reduced the design intake velocity of its cooling water intake structure to 0.5 ft/s and, therefore, is deemed to have met the impingement mortality performance standards;
2) Demonstrate that its existing design and construction technologies, operational measures, and/or restoration measures meet the performance standards and/or restoration requirements;
3) Demonstrate that it has selected and will install and properly operate and maintain design and construction technologies, operational measures, and/or restoration measures that will, in combination with any existing design and construction technologies, operational measures, and/or restoration measures, meet the specified performance standards and/or restoration requirements;
4) Demonstrate that it meets the applicability criteria for a rule-specified technology or a technology that has been pre-approved by the Director and that it has installed, or will install, and will properly operate and maintain the technology; or,

5) Demonstrate that it is eligible for a site-specific determination of best technology available to minimize adverse environmental impacts and that it has selected, installed, and is properly operating and maintaining, or will install and properly operate and maintain, design and construction technologies, operational measures, and/or restoration measures that the Director has determined to be the best technology available to minimize adverse environmental impact for the facility.

Section 316(b) of the Clean Water Act requires the U.S. Environmental Protection Agency to insure that aquatic organisms are protected from impingement or entrainment. As part of the Phase II ruling, some power plants have begun conducting required entrainment studies.

Preliminary data on the Missouri River suggests that entrainment may be a serious threat that warrants more investigation. Initial results from work conducted by Mid-America at their Neal Smith power facilities found hatchery-reared pallid sturgeon were being entrained (Jordan in litt. 2006, Ledwin in litt. 2006, Williams in litt. 2006). Over a 5-month period, four known hatchery-reared pallid sturgeon have been entrained, of which two were released alive and two were found dead. Ongoing entrainment studies required by the Clean Water Act will provide more data on the effects of entrainment. However, addressing entrainment issues may not occur immediately and continued take of hatchery-reared or wild pallid sturgeon will limit the effectiveness of recovery efforts.

In addition to cooling intake structures for power facilities, concerns have been raised regarding entrainment associated with dredge operations and irrigation diversions. Currently little data are available regarding the effects of dredge operations. However, the USACE, St. Louis District, and the Dredging Operations and Environmental Research Program have initiated work to assess dredge entrainment of fish species and the potential effects that these operations may have on larval and juvenile *Scaphirhynchus*. Data for escape speed, station-holding ability, rheotaxis and response to noise, and dredge flow fields are being used to develop a risk assessment model for entrainment of sturgeon by dredges. If funds become available during the upcoming year (2007), field work will be expanded to include trawling of frequently dredged areas and examining dredge spoil. Entrainment has been documented in the irrigation canal supplied by Intake Dam on the Yellowstone River (Jaeger et al. 2004) (see also 2.3.1.5. Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem)). Given that entrainment has been documented to occur in the few instances it has been studied, further evaluation of entrainment at other water withdrawal points is warranted across the pallid sturgeon's range to adequately evaluate this threat.

Hybridization

The Pallid Sturgeon Recovery Plan (USFWS 1993) identifies hybridization as a threat to pallid sturgeon. This was, in part, based on work by Carlson et al. (1985) who identified sturgeon in the middle Mississippi River that were intermediate in character between shovelnose and pallid sturgeon. In addition, sturgeon with intermediate characteristics were reported in commercial catch records from the lower Missouri and middle and lower Mississippi Rivers.

The presence of morphologically intermediate forms presumed to represent pallid-shovelnose sturgeon hybrids (Keenlyne et al. 1994; Carlson et al. 1985) spurred an effort to determine the genetic origins of these fish. Recent genetic tools have been utilized to explore the concept of hybridization between pallid and shovelnose sturgeon (See also 2.3.1.2. Intercrosses between Pallid and Shovelnose Sturgeon).

Tranah et al. (2004) combined the data from Campton et al. (2000) and Tranah et al. (2001) and added 4 additional microsatellite loci to the data set to determine the genetic origins of 10 morphologically intermediate sturgeon collected from the Atchafalaya River. All fish were classified as pallid, shovelnose or hybrid sturgeon via the hybrid index method of Campton (1987). These results are consistent with the hypothesis of hybridization between pallid and shovelnose sturgeon. However, this study simply demonstrated that morphologically intermediate fish had genetically intermediate genotypes (Don Campton, USFWS, pers. comm., 2005). The data represent a circular argument for "hybridization" because the data set on which the conclusions were based also was the data set used to parameterize the "hybrid index" function. Moreover, Tranah et al. (2004) did the analyses separately for fish in the upper Missouri and Atchafalaya Rivers. As a result, genotypically-intermediate fish in one region would not necessarily have been genotypically intermediate fish in the other region, because the level of divergence between regions within species was as large as the divergence between species within regions (Campton et al. 2000, also suggested in Heist and Schrey 2006b). Based on these data, one cannot distinguish true "hybridization" (i.e., secondary contact following allopatric speciation) from sympatric speciation and assortative mating. Both mechanisms would yield a positive correlation between genotype and phenotype, which is what Tranah et al. (2004) measured. Likely, the correlation would collapse if Tranah et al. (2004) had performed their "hybrid index" analyses for all fish and both regions combined. Because pallid and shovelnose sturgeon are very closely related evolutionarily, particularly compared to other congeneric species of fishes in North America, the available data do not allow us to reject the hypothesis that pallid sturgeon (as a morphological phenotype) may have had a polyphyletic origin relative to shovelnose sturgeon.

Hence, based on the available genetic information, neither the allopatric speciation/hybridization hypothesis nor the sympatric speciation/polyphyly hypothesis can be rejected at this time.

More information is needed on the evolutionary dynamics of intermediates between pallid sturgeon and shovelnose sturgeon to understand if they are natural or a threat that has resulted from anthropogenic alterations to spawning habitat or cues.

2.4 Synthesis

The primary threats identified for pallid sturgeon in the final rule and in the Recovery Plan (USFWS 1993) were--1) curtailment of range, 2) habitat destruction and modification, 3) low population size, 4) lack of recruitment, 5) commercial harvest, 6) pollution/contaminants, and 7) hybridization. Significant new information gathered since listing is summarized below in relation to the species' status and associated threats.

Range/Habitat

The curtailment of range and habitat destruction/modification were primarily attributed to the construction and operation of dams on the upper Missouri River and modification of riverine habitat by channelization of the lower main stem Missouri and Mississippi Rivers. Dams substantially fragmented pallid sturgeon range in the upper Missouri River. However, free-flowing riverine conditions currently exist throughout the lower 2,000 mi (3,218 km) (60%) of the pallid sturgeon's historical range. Although the lower Missouri River (RPMA 4) continues to be impacted by regulated flows and modified habitats, actions have been developed and are being implemented to address habitat issues. Recent studies and data from the Mississippi River (RPMA 5) suggests that riverine habitats are less degraded than previously believed, and that they continue to support diverse and productive aquatic communities, including pallid sturgeon. Although there are ongoing programs to protect and improve habitat conditions in RPMAs 1, 2, 3, 4, and 5, positive effects from these programs on pallid sturgeon have not been demonstrated or quantified.

Population Size

Data for the Missouri River continue to indicate that wild pallid sturgeon in RPMA 1 and 2 are large, mature, and likely old individuals, and provide little to no evidence supporting a naturally self-sustaining population. There appears to be no natural wild population surviving in RPMA 3. Sampling in RPMA 4 during the past decade continues to confirm a small population of wild pallid sturgeon in the lower Missouri River. Pallid populations in RPMAs 1-3 are being augmented with hatchery produced fish in order to ensure persistence of the species until threats are adequately addressed to promote a self-sustaining population. Data collected after the Recovery Plan was developed indicate that pallid sturgeon numbers are higher in the Mississippi and Atchafalaya Rivers than initially documented in 1993 (see Demographic Data by Recovery Priority Management Area sections discussing RPMA 5 and RPMA 6). However, this increase in collections can be associated with increased sampling efforts and not quantified with catch-per-unit effort data. When listed, there were only 28 recognized records of pallid sturgeon from the Mississippi River, with no recognized records from the Atchafalaya River.

According to the National Pallid Sturgeon Database (USFWS 2006b), there have been a total of 279 individual pallid sturgeon collected from RPMA 5 and 499 collected from RPMA 6. However, the sampling effort within these RPMAs does not adequately sample all size/age classes. Population estimates are currently unavailable due to limited sampling in RPMA 5 and 6.

Recruitment

While there are documented cases of natural reproduction in RPMAs 2, 4, and 5, data on natural recruitment of pallid sturgeon continues to be limited throughout the species' range. Current wild pallid sturgeon populations in RPMA 1 and 2 are comprised of old-aged individuals, and RPMAs 1, 2, and 3 are dependent on hatchery augmentation programs for recruitment. No wild pallid sturgeon have been collected in the last 10 years within RPMA 3 that were not translocated, and no spawning or recruitment has been detected. Addressing recruitment bottlenecks in the three upper Missouri River RPMAs is critically important for the species to become self sustaining and be recovered in those reaches. A few sub-adult or young adult wild pallid sturgeon have been collected in RPMA 4, along with a few larval pallid sturgeon. Larval pallid also have been collected in the middle Mississippi River, but no data are available to accurately evaluate recruitment levels. The presence of smaller-sized cohorts of pallid (400-600 mm) in both RPMA 5 and 6, coupled with age data indicating that no pallid sturgeon were beyond 15 years old in the middle Mississippi River (Colombo et al. In Press), suggests that some level of recruitment is occurring. Additional efforts are needed to document population demography, reproduction, and recruitment in RPMAs 4, 5, and 6.

Commercial Harvest

Illegal commercial harvest of pallid sturgeon is occurring in portions of RPMAs 4 and 5. Data show lower ages and higher mortality rates of pallid sturgeon in areas where shovelnose sturgeon are commercially harvested (Colombo et al. in press). This threat is likely to increase as caviar sources are reduced world-wide and caviar prices increase.

Pollution and Contaminants

Data continue to be incomplete regarding the effects of contaminants on pallid sturgeon viability or rates of hermaphrodism. Studies of shovelnose sturgeon in the Missouri and Mississippi Rivers documents hermaphrodism (Wildhaber et al. 2005), which may be the result of exposure to certain forms of water pollution (Koch et al. 2006). Limited data also have documented elevated contaminants levels in pallid sturgeon (Ruelle and Keenlyne 1992), but there are no known documented instances of pallid sturgeon being collected exhibiting intersexual characteristics.

Hybridization

Microsatellite studies (Tranah et al. 2004; Heist and Schrey 2006a) have provided some genetic evidence for intermediates between pallid and shovelnose sturgeon in the Missouri, Mississippi, and Atchafalaya Rivers. However, it is currently unknown if all morphologically intermediate sturgeon are hybrids, if some hybridization is natural, or if hybridization is a result of habitat or other environmental changes.

If these intermediates represent the effect of natural intercrossing between the monophyletic pallid sturgeon and shovelnose sturgeon due to anthropogenic influences, then intercrossing may indeed be perceived as a threat to the species. However, if genetically intermediate sturgeon are the result of sympatric speciation and a polyphyletic evolutionary origin of pallid sturgeon (e.g., as suggested by Campton et al. 2000 as a competing, alternative hypothesis), then these intermediate fish could be considered a natural occurrence and the previously-identified mechanisms suggested for causing hybridization may not exist and intermediate sturgeon are a component of natural evolutionary processes and may not really pose a threat.

In summary, the status of wild pallid sturgeon has not improved since listing in the Missouri River. Successful hatchery and stocking programs appear to be useful in preventing local extirpation in the Missouri River, but the notable lack of natural recruitment suggests an overall declining status. New information on habitat extent and conditions, population size, potential recruitment in the Mississippi River, and new information on population size in the Atchafalaya River has improved our understanding of the species in these areas. The immediate risk of local extirpation in RPMAs 1 and 2 has been reduced by implementation of an artificial propagation program, and the species has been reintroduced in RPMA 3. Stocking also has occurred in RPMAs 4, 5, and 6. However, if supplementation efforts were to cease, the species would be facing local extirpation in RPMAs 1, 2, 3, and possibly 4 (the Missouri River RPMAs). Numbers of wild pallid sturgeon are higher in the Mississippi and Atchafalaya Rivers than initially documented, but data regarding recruitment and spawning success, survivorship from one age class to the next, habitat needs and use, and overall abundance are still very limited. Currently it is not possible to accurately estimate the population abundance in the Mississippi and Atchafalaya Rivers and the pallid sturgeon's population status is unknown.

Genetic and morphological differences have been documented between upper Missouri River pallid sturgeon (RPMAs 1 and 2) and lower Missouri and lower Mississippi/Atchafalaya River populations (RPMAs 4, 5, and 6) (Campton et al. 2000, Tranah et al. 2001, Heist and Schrey 2006 a and b, Kuhajda et al.). Additional information on genetic and morphological differences is needed to clearly identify past relationships of the populations, and the significance of gene flow among them.

Although information on pallid sturgeon throughout its range has increased considerably since listing, threats to the pallid sturgeon remain essentially the same. The continued existence of the species is threatened by habitat loss and inadequate regulatory mechanisms in all or portions of its range, and limited data suggests that contaminants may have some affect on reproduction (see 2.3.2.5 Other Natural or Manmade Factors Affecting its Continued Existence). These threats have precipitated the need for population augmentation in portions of it range. In addition to these threats, the lack of adequate information on spawning, recruitment and habitat requirements; and a lack of information on population size, recruitment, and trends in RPMAs 4, 5, and 6 makes it difficult to identify positive species response to many recovery activities. The species continues to meet the definition of endangered and no change in classification is needed. However, should sufficient data become available to support Distinct Population Segments, future reclassification may consider listing Distinct Population Segments.

Significant Portion of the Range

We assessed the pallid sturgeon in each identified RPMA throughout its range. Assessing sturgeon in units smaller than RPMAs is not feasible, due to data collection methods and fishing regulations that apply to streams within the range of the species. As noted above, a lack of adequate information on population size, recruitment, and trends exists in RPMAs 5 and 6. In RPMAs 1, 2, 3, and 4, which represent about half of the range of the pallid sturgeon, data indicate that without artificial supplementation efforts, the species could face local extirpation. Therefore, we conclude that the pallid sturgeon does not meet our criteria for downlisting to threatened status or for delisting in any portion of its range.

3.0 RESULTS

3.1 Recommended Classification:

____ **Downlist to Threatened**
____ **Uplist to Endangered**
____ **Delist** (Indicate reasons for delisting per 50 CFR 424.11):
 ____ Extinction
 ____ Recovery
 ____ Original data for classification in error
_X_ **No change is needed**

3.2 New Recovery Priority Number NA (Remains 2C)

3.3 If a reclassification is recommended, indicate the Listing and Reclassification Priority Number (USFWS only): NA

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- Identify and implement measures to eliminate or significantly reduce illegal and accidental harvest of pallid sturgeon.

- Update the Recovery Plan to include the most recent information regarding genetics, distribution, life history, abundance and trends, threats, and conservation measures. The revised recovery plan shall include objective and measurable downlisting and delisting criteria that when achieved eliminate or sufficiently minimize threats to the species, per the 5 listing factors, such that it no longer rises to the level of threatened or endangered under the ESA.
- Continue further study of issues where the extant of the threat is not well understood (such as hybridization and pollution/contamination).
- Reevaluate RPMAs as they relate to conservation needs of the drainage populations. Consider identifying management units based on genetic data.
- Develop a science-based, independently reviewed program that evaluates implementation of recovery criteria as well as provides periodic reports of recovery success.
- Develop and implement standardized methodology to test for and quantify iridovirus in wild populations of *Scaphirhynchus*.
- Develop and implement methods to measure and monitor riverine habitats in the Mississippi River, and their response to engineering actions.
- Develop and implement a standardized monitoring program for the Mississippi and Atchafalaya Rivers (e.g., Missouri River Population Assessment Program) to ensure adequate demographic data are collected to assess the population structure of the pallid sturgeon in these reaches.
- Implementation of the Population Assessment Program (Drobish 2006) to monitor supplementation efforts and obtain adequate samples to thoroughly understand the demographic trends of the species.
- Implement rangewide standardized reporting requirements, i.e., catch-per-unit effort, to enable rangewide population status trend comparison.
- Identify spawning cues and habitats utilized by pallid sturgeon throughout its range.
- Conduct telemetry research to identify habitat utilization in un-impounded areas to better understand the true requirements of the species in terms of range and variety of habitats used.

Data Needed for Next 5-year Review

- Population and habitat studies in the Mississippi and Atchafalaya Rivers to establish base-line conditions for monitoring status and conservation success, and for measuring habitat trends.
- Spawning habitats and cues remain unknown; this information is essential to successful management and conservation.
- Information on migration cues, food habits, and food availability throughout the range.

- Genetic information to determine similarities and evolutionary relationships among populations throughout the range of pallid sturgeon, including their evolutionary relationships to shovelnose sturgeon.
- Experiments to assess relationships of morphology differences and causes of those differences in terms of environmental differences and genetics.
- Assessment of habitat construction projects in the Missouri and Mississippi Rivers and determination of their value for recovering pallid sturgeon and addressing the threats associated with habitat modifications.
- Evaluation of the value of spring pulses for pallid sturgeon and its habitat.
- Survival and growth of stocked juvenile pallid sturgeon and assessment of data to determine the success of supplementation efforts where it is occurring and to develop survival estimates for hatchery-reared pallid sturgeon.
- Genetic information to determine the amount and significance of hybridization between pallid and shovelnose sturgeon.
- Estimates of immigration and emigration of both wild and hatchery-produced pallid sturgeon to generate viable population assessments.
- Data to evaluate population trends, i.e., catch-per-unit effort and quantification of natural recruitment range-wide.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW OF PALLID STURGEON (*Scaphirhynchus albus*)

Current Classification Endangered

Recommendation resulting from the 5-Year Review

___ **Downlist to Threatened**
___ **Uplist to Endangered**
___ **Delist**
_X_ **No change is needed**

Appropriate Listing/Reclassification Priority Number, if applicable _____

Review Conducted by George Jordan, Pallid Sturgeon Recovery Coordinator

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve [signature] for Henry Maddux   Date 5/4/07

REGIONAL OFFICE APPROVAL:

Lead Regional Director, Fish and Wildlife Service

Approve [signature]   Date 5/7/07

Cooperating Assistant Regional Director, Fish and Wildlife Service Region 3

✓ Concur _____ Do Not Concur

Signature [signature]   Date 5/29/07

for **Cooperating Assistant Regional Director, Fish and Wildlife Service Region 4**

✓ Concur _____ Do Not Concur

Signature Warren E. Walsh   Date 6/13/07

APPENDIX A
Summary Of Peer Review
For The 5-Year Review Of Pallid Sturgeon (*Scaphirhynchus albus*)

A. Peer Review Method

General: On July 7, 2005, the USFWS announced the initiation of a 5-year review for Pallid Sturgeon and requested submission of any new information (70 FR 39326). In accordance with the peer review requirements of the Office of Management and Budget's Final Information Quality Bulletin for Peer Review, in fall 2006 we initiated peer review of the science relevant to the draft Pallid Sturgeon 5-year review and our use of said science.

Solicitations were sent to State agencies, professional societies, and/or universities, to nominate potential peer reviewers. We requested that these groups consider the following criteria for any potential nomination.

- Expertise: The reviewer should have knowledge, experience, and skills in one or more of the following areas: pallid sturgeon *Scaphirhynchus albus* or similar species biology; conservation biology; small and declining population dynamics and extinction risk analysis; land development and use, invasive species, and other environmental pressures within the range of these species; land planning and management; modeling; and/or evaluation of biological plausibility.
- Independence: The reviewer should not be employed by the USFWS or other agencies within the Department of Interior. Academic and consulting scientists should have sufficient independence from the USFWS or Department if the government supports their work.
- Objectivity: The reviewer should be recognized by his or her peers as being objective, open-minded, and thoughtful. In addition, the reviewer should be comfortable sharing his or her knowledge and perspectives and openly identifying his or her knowledge gaps.
- Advocacy: The reviewer should not be known or recognized for an affiliation with an advocacy position regarding the protection pallid sturgeon under the ESA.
- Conflict of Interest: The reviewer should not have any financial or other interest that conflicts or that could impair his or her objectivity or create an unfair competitive advantage.

Nominations were requested by October 6, 2006. While expertise was the primary consideration, the USFWS selected peer reviewers (considering, but not limited to, these nominations) that added to a diversity of scientific perspectives relevant to 5-year review. Under certain circumstances some conflict may be unavoidable in order to obtain the necessary expertise. If such a situation arises, promised to disclose these real or perceived conflicts in the 5-year review and the agency shall inform potential reviewers of this likely disclosure at the time they are recruited. We anticipated sending the document to the peer reviewers no later than October 20, 2006. Responses were requested by December 1, 2006.

We solicited reviews from six qualified experts. The USFWS provided each peer reviewer with information explaining his or her role and instructions for fulfilling that role, the draft 5-year review, public comments received in response to our *Federal Register* notice initiating the 5-year review (70 FR 39326, July 7, 2005), a full list of citations noting whether the source has been peer reviewed, and all citations (or for some longer documents, the relevant pages of the document) in electronic format on a CD. The purpose of seeking independent peer review was to ensure use of the best scientific and commercial information available and to ensure and to maximize the quality, objectivity, utility, and integrity of the information upon which the draft 5-year review is based, as well as to ensure that reviews by recognized experts were incorporated into the final document.

Peer reviewers provided individual, written responses to the USFWS. Peer reviewers were advised that their reviews, including their names and affiliations, would (1) be included in the official record for this review, and (2) once all reviews are completed, would be available to the public upon request.

About Public Participation

The public was provided an opportunity to comment on this planned peer review process from September 9, 2006 (when the peer review plan was posted online) through October 6, 2006. The public was invited to send comments on this peer review plan to George Jordan, Pallid Sturgeon Recovery Coordinator, 2900 4th Avenue North, Room 301, Billings, Montana 59101. Comments on this plan also may be submitted by electronic mail to >r6espeerreview@fws.gov<. The subject line should read "Pallid Sturgeon (*Scaphirhynchus albus*) 5-Year Review: Summary and Evaluation."

The public had an opportunity to provide input on the 5-year review from July 7, 2005, through September 6, 2005 (70 FR 39326, July 7, 2005). This Notice announced our initiation of a 5-year review of the species and requested submission of any new information.

Contact

For more information, contact George Jordan, Pallid Sturgeon Recovery Coordinator 406-247-7365 or George_Jordan@fws.gov.

B. Peer Review Charge

Peer reviewers were asked not to provide advice on policy. Instead, the charge to the reviewers was to review the science relevant to the 5-year review and our use of said science, focusing their review on identifying and characterizing scientific uncertainties. Additionally, peer reviewers were asked to consider the following questions and to provide any other relevant comments, criticisms, or thoughts:

1. Is our description and analysis of the biology, habitat, population trends, historic and current distribution of the species accurate?

2. Does the 5-year review provide accurate and adequate review and analysis of the factors affecting the species (habitat loss and modification, overutilization, disease, predation, existing regulatory mechanisms)?
3. Are our assumptions and definitions of suitable habitat logical and adequate?
4. Are there any significant oversights, omissions or inconsistencies in the 5-year review?
5. Are our conclusions logical and supported by the evidence we provide?
6. Did we include all necessary and pertinent literature to support our assumptions and conclusions?

C. Peer Review Comments

1. Robert G. Bramblett Review

To Whom It May Concern:

My review is structured with page numbers and quotes from the Pallid Sturgeon *(Scaphirhynchus albus)* 5-Year Review: Summary and Evaluation, U.S. Fish and Wildlife Service, followed by my comments. I added emphasis using italics and bold font in some quotes and comments.

Sincerely,

Pages 3 and 4 - "relevant new information that would lead you to consider listing this species..."

I am not an expert on DPS designation or genetics; however, it is apparent from Heist and Schrey (2006a; 2006b), that pallid sturgeon populations have a genetic structure that indicates isolation by distance. This is indicated even without a full set of data, or with data missing from parts of the species range. Tranah et al. (2001) conclude that "pallid sturgeon in the upper Missouri and Atchafalaya rivers should be managed as genetically distinct populations."

It seems probable that pallids from the upper Missouri are markedly different from those in the lower Mississippi and Atchafalaya Rivers. Although it would be difficult to draw a line or lines that separate pallid sturgeon DPSs, it seems obvious that genetics from geographically distant populations should not be mixed. I recommend having a population geneticist evaluate considering DPS status for pallid sturgeon and if this is inconclusive, that a more complete set of genetic samples be obtained and a complete analysis be performed.

Page 8 - "wild pallid sturgeon population trend is relatively unchanged." This statement is not supported in this report, and may not be accurate. There is just one population estimate given (without confidence intervals) thus a trend cannot be determined. The report also states that recruitment is severely limited; therefore, we have to assume that unless there is zero mortality the trend for wild pallid sturgeon is a decline in numbers.

"however, the population is being ***successfully*** supplemented with hatchery produced fish." This statement is not supported in the text. There are no data presented on the growth, survival, and abundance of stocked fish. Without these data the success of supplementation cannot be assessed. Figure 3 shows that hatchery produced pallid sturgeon are being captured, but does not indicate if they are growing, surviving, or may reasonably be expected to achieve sexual maturity.

Page 9 - "wild pallid population trend has remained relatively unchanged since listing" this statement is not supported and likely not accurate. It is difficult to obtain inference on population trends and success of stocking programs from Figures 3 and 5 because it is not known whether these data represent standardized sampling or stocking efforts. Catch-per-unit effort would be more demonstrative, if sampling was standardized to season, location, and method.

A total of 245 individuals captured from 1990-2006, coupled with the most recent estimate of 136 (without confidence intervals) would suggest a strong decreasing population trend. As in RPMA 1, long-term success of hatchery augmentation is not demonstrated.

Pages 11-12 - Specific detail from the Shuman *et al.* (2005) report would help the reader assess the level of growth and survival.

"These data suggest that prior to supplementation, pallid sturgeon were extremely rare in RPMA 3." These data suggest that pallid sturgeon were extremely rare or ***extirpated*** from RPMA 3.

Pages 13-14 - "These data also indicate that hatchery stocked fish are being collected and contributing to the population (Figures 8 and 9)."

Important additional information could be gleaned from these data. For example, in Figure 9, in 2004, 36 hatchery pallid sturgeon were captured and in 2005, 72 hatchery pallid sturgeon were captured. How many net-hours did it take to capture these; i.e., what was the catch-per-unit-effort (CPUE)? How many stocked cohorts were in the catch? If multiple sampling efforts were conducted, what was the recapture rate? Recapture data could be used to do multiple mark-recapture estimates that could then be used to assess recruitment to the sampling gear and the survival of stocked cohorts. By estimating some of these parameters, we could start to get at actual estimates of abundance and population trends. If we knew the survival rate of stocked fish, we could predict how many will live to attain sexual maturity thereby projecting the likelihood of success for the stocking program. I recommend that an expert population modeler be contracted to assess these types of population parameters for each RPMA using the National Pallid Sturgeon Database.

Pages 15-18 - This section reports capture of stocked fish, but no description of where, where, or how many fish were stocked.

Figure 10 - Is it correct that hatchery fish ranged as large as 900-950 mm? This is a significant finding if fish > 600 mm are considered adults. Were these hatchery fish sexually mature? Is this the only documented recruitment to adulthood of stocked pallid sturgeon?

"Although these ratios must be interpreted with caution, they demonstrate an improvement in knowledge of, and ability to collect pallid sturgeon in large river habitats."

These ratios are difficult to interpret. For example, a 1:18 ratio could represent a total of one pallid captured to 18 shovelnose captured or 100 pallids captured to 1,800 shovelnose captured, so we do not know if overall catch went up or down. Also, the increase in pallid to shovelnose ratio is difficult to interpret if sampling was not standardized. The changing ratios could indicate many things, including sampling different habitat types, locations, times, flow conditions, capture efficiencies, increased pallid sturgeon abundance, or decreased shovelnose sturgeon abundance.

Page 19 - As mentioned previously, these recapture data could be used to calculate population estimates with confidence intervals. This would improve assessment of abundance and population trends.

"The BK character index misidentified all three hatchery-reared young-of-year as hybrids, and identified two of the wild young-of-year as shovelnose and other as a hybrid."

Is it feasible to sample genetics on all or a subsample of all putative pallid sturgeon captured range-wide? This also would have the benefit of providing data to clarify the genetic structure of pallid sturgeon in regard to DPS status.

Page 20 - The histograms indicate that these pallid sturgeon average about 400-500 mm smaller than pallid sturgeon captured at RPMAs 1 and 2. Are these fish smaller at the same age, or younger fish? If smaller at the same age, this may have bearing on DPS status.

Page 21-24 - "The three groupings are a well differentiated upper Missouri River Group and two less differentiated groups in the lower Missouri Middle Mississippi, and Atchafalaya river samples." Is this sufficient evidence to ***consider*** DPS designation (as on Pg. 3) for perhaps the upper Missouri group. If DPS listing is not appropriate, perhaps this decision needs to be supported in light of the genetic evidence presented on pages 21-24 and in the citations.

Page 25 - Similar to the observations of Gerrity (2005), Bramblett (1996) found that pallid sturgeon used 25 km of riverine habitat that would be inundated by Lake Sakakawea at full pool. Bramblett, R.G. 1996. Habitats and movements of pallid and shovelnose sturgeon in the Yellowstone and Missouri rivers, Montana and North Dakota. Doctoral dissertation. Montana State University, Bozeman.

Page 26 - "A reduction in sediment transport could reduce naturally occurring habitat features like sandbars."

Reduction in sediment inputs does reduce naturally occurring habitat features, including sandbars. Discharge and sediment load, together with physiographic setting are proimary factors controlling the morphology of large alluvial rivers (Kellerhals 1989). Kellerhals, R., and M. Church. 1989. The morphology of large rivers: characterization and management. Proceedings of the international large river symposium. Canadian Special Publication of Fisheries and Aquatic Sciences 106:31–48.

"The Yellowstone River, a major tributary to the Missouri River, was likely a historically important tributary for spawning."

The Yellowstone River undoubtedly was and likely remains an essential spawning location. Bramblett (1996) documented the following: pallid sturgeon prefer the Yellowstone River over the Missouri River below Fort Peck, many fish move into the lower Yellowstone River during spawning season, ripe fish occur in the Yellowstone River and aggregations of fish during spawning season strongly suggest that pallid sturgeon spawning occurs in the in the lower 10 to 15 Rkm of the Yellowstone River. The ongoing threat to this spawning aggregation is downstream drift of larvae into Lake Sakakawea. Although Lake Sakakawea is described as a potential impediment to larval pallid sturgeon survival on page 25-26, it is not specifically addressed in the context of the Yellowstone River pallid sturgeon spawning aggregation.

Pages 30-31 - More evidence to consider a DPS?

Page 32 (and in other RPMAs with dams) - Although previously addressed, is it not appropriate to include the effect of shortened riverine reaches on larval drift as "present destruction or modification of habitat?"

Page 41 - "However, Parken and Scarnecchia (2002) reported that walleye, *Sander vitreum*, and sauger, *S. canadense*, in Lake Sakakawea (just downstream of RPMA 2) were capable of eating wild paddlefish (*Polyodon spathula*) up to 167 mm body length (305 mm total length), but Braaten and Fuller (2002, 2003) examined 759 stomachs and found no evidence of predation on sturgeon by seven piscivore species in Montana."

This is unclear. Parken and Scarnecchia (2002) results suggest a predation threat in Lake Sakakawea, but the results of Braaten and Fuller (2002, 2003) do not lessen the suggestion of a threat because they sampled from the Missouri River, whereas Parken and Scarnecchia (2002) sampled in the reservoir. Presumably, it would more difficult to detect predation on *Scaphirhynchus* the nearer you are to the spawning location because the larvae would be smaller and digested more rapidly, as well as probably drifting through the area for a relatively short time period. Did Parken and Scarnecchia (2002) find any *Scaphirhynchus* in the stomachs they sampled? Did they sample near the headwaters of Lake Sakakawea?

Page 46 - "Studies since listing continue to show small, **declining** old-age wild populations of pallid sturgeon in RPMA 1 and 2," this statement conflicts with previous statements on Pages 8 and 9, e.g., "wild pallid sturgeon population trend is relatively unchanged."

"Pallid populations in RPMAs 1-3 are being **successfully** augmented with hatchery produced fish."

It is not my intent to criticize the crucial stocking program, but I do not think it is important to acknowledge that augmentation success will only come if these fish survive to adulthood. Further challenges remain in terms of rectifying recruitment bottlenecks, otherwise stocked fish will have to be brought back to the hatchery for gamete collection, repeating the propagation/ stocking cycle. I am concerned that some readers may interpret "successful augmentation" as "problem solved."

Page 47 - "The presence of smaller-sized cohorts of pallid (400-600 mm) in both RPMA 5 and 6 suggest some level of recruitment is occurring." Can this be said without supporting age data given the context of overall smaller size of these southern pallid sturgeon?

2. Gene Zuerlein Review

November 28, 2006

George R. Jordan
Pallid Sturgeon Recovery Coordinator
USFWS, Jameson Federal Building
2900 4th Avenue, Room 301
Billings, MT 59101

Reference: Five-year review for pallid sturgeon per Section 4(c)(2) of the Endangered Species Act of 1973

Dear George,

The compilation of current information on pallid sturgeon by the Recovery Team, Genetics Advisory Team, and U.S. Fish and Wildlife Service has been substantial and insightful. In regard to the *draft* report entitled-Pallid Sturgeon (Scaphirhynchus albus), 5-Year Review: Summary and Evaluation, I have the following comments:

1. Is our description and analysis of the biology, habitat, population trends, historic and current distribution of the species accurate?

Comment - In the demographic data by RPMAs starting on pg 8, the National Pallid Sturgeon Database is often referred to, but no citation is ever used. Is this database owned by the USFWS, and if so, should it not be cited according to scientific protocols? Since it appears to be a living, working document, perhaps it should be cited as a USFWS document? Utilization of the data base to extract the number and length frequency of wild v. hatchery pallids in each RPMA is helpful in discerning approximate age of the pallids under review.

On page 13 under RPMA 4, line 9 refers to larval *Scaphirhynchus* being documented from the Platte River (G. Mestl, NGPC, pers. comm. 2005). There are a number of studies documenting larval *Scaphirhynchus* being sampled from the lower Platte River in Nebraska (Hofpar 1997, Reade 2000). The lower 100 miles of this river contains geomorphologic features conducive to habitat needs of sturgeon and prey species including shifting sand bars, braided channels, side channels, varied depths, and periodic flooding to maintain in channel characteristics conducive to sturgeon and other big river species, including blue sucker. Snook (2001) studied the movements and habitat use of hatchery-reared pallid sturgeon in the lower Platte. Likewise (Swingle 2003) studied movements and habitat use of 17 shovelnose and 2 wild caught pallids from July 2000 through October 2002. Parham et al. (2005) studied the movement of 15 pallid sturgeon in the lower Platte between 2000-2004. Of the 15 pallids caught, 6 carried either elastomere or pit tags and 9 carried no identification and were presumed to be wild fish. Additional reports and publications with Dr. Ed Peters and colleagues on the lower Platte River are currently underway. Further, a Cooperative Agreement between the States of Nebraska, Colorado, Wyoming, and the U.S. Department of the Interior is being consummated to improve and maintain habitat for four threatened and endangered species-the whooping crane, interior least tern, and piping plover in the central reach of the Platte as well as the pallid sturgeon in the lower Platte River. To date the governors of Nebraska and Colorado have signed on as well as Interior Secretary Kempthorne. The Wyoming governor is expected to sign soon. When signed, the Platte River Recovery Implementation Program (USFWS and USBR 2006) will help address pallid sturgeon needs in the lower Platte River.

On page 15 and 16 under RPMA 5, descriptors to the different reaches are delineated by Rmi and Rkm. While this is appropriate, if the Mississippi reaches also were identified with natural features such as from the Gulf of Mexico upstream to the mouth of the Ohio River, from the mouth of the Ohio upstream to the confluence with the Missouri River it might be easier for readers to identify with.

2. Does the 5-year review provide accurate and adequate review and analysis of the factors affecting the species (habitat loss and modification, overutilization, disease, predation, existing regulatory mechanisms)?

Comment - Habitat loss in each RPMA is descriptive, but you may want to briefly describe what was lost in order to bring home the immense amount of riverine habitat which was eliminated from the functioning river ecosystem. For example, on page 27 in the RPMA 4 reach about 552,000 ac of aquatic and terrestrial habitat was eliminated from the natural channel and meander belt prior to 2003 (USACE 2004). Riverine habitat loss equated in acres adds perspective, although when percentages were used they also were useful. This includes most sandbars, secondary channels, and shoal areas.

Comment - The review on Hybridization (pg 45) and Appendix B (Genetic Analysis data using the software Structure) is informative and interesting. Researchers should be applauded for this innovative genetic analysis, but acknowledgement and the statement that identification of three genetic groups of pallid sturgeon should be regarded as tentative appears to be warranted. Although the six mainstem dams and embankments were closed (Peck 1937, Garrison 1953, Oahe 1958, Big Bend 1963, Ft. Randall 1952, Gavins Point Dam 1955), given the long life span of this species, only one or two generations have potentially passed since the river has been segmented for genetic isolation. On the other hand, one tagged hatchery pallid stocked in RPMA 3 near Verdel (Rmi 851.5) on June 6, 2000, was subsequently recaptured in Omadi Bend (Rmi 721) some 130.5 miles downstream on March 3, 2006. A second tagged hatchery pallid stocked in RPMA 3 was subsequently recaptured below Gavins Point Dam (RPMA 4). Specifically, this pallid also was stocked at Rmi 851 near Verdel which is upstream of Lewis and Clark Lake on March 21, 2002. Over 2 years later it was recaptured on July 20, 2004, at Rmi 447.7 near St. Joseph, Missouri. Both of these pallids must have passed through the Gavins Point Dam power house because a drought was going on in the basin and no gates were open during this time frame. It is a known fact that paddlefish above Gavins Point Dam occasionally pass through and survive electrical generator turbines and of course occasional dam gate openings associated with high water releases. Consequently, downstream movement is possible but not upstream movement because there are no fish passageways built on any of the mainstem dams. In the future, when the USACE addresses passing trapped sediment in the system (USFWS 2003a), especially the delta built up on the upper end of Lewis and Clark Lake behind Gavins Point Dam, there is the potential that passing sediment below Gavins Point Dam also could incorporate a fish passageway within this small dam.

3. Are assumptions and definitions of suitable habitat logical and adequate?

Comment - Given the fact that pallid sturgeon were only listed in 1990 and there is descriptions of riverine habitat types lost in the systems (RPMA 1-6) it is probably the best that can be anticipated until ongoing monitoring and research study data can be analyzed. It may take a number of years to help delineate what habitat parameters within the RPMAs are being used throughout its range to include depth, velocity, etc. What riverine habitat components are used by the different life cycle stages also is important to discern, not to mention adequate food organisms needed by the different life stages of pallid sturgeon. This species cannot thrive in a vacuum, and habitat for prey fish species is important for older pallid sturgeon. Hesse (1994) stated the declining status of selected chubs and minnows in the Missouri River in Nebraska from 1971-1993 most likely contributed to the demise of sauger, catfish, burbot, and sturgeon among other species. Wanner (2006) citing (Held 1969) refers to pallid and shovelnose sturgeon as opportunistic suctorial feeders on benthic organisms using barbels, an inferior mouth, and modified fleshy lips. Wanner (2006) also cites (Coker 1930; Cross 1967; and Carlson et al. 1985) in that while adult pallids utilize aquatic insects, there is a greater proportion of fish (mostly cyprinids) in their diet compared to shovelnose sturgeon. Most likely, there are other sources of information on prey species in other RPMAs which can be resourced for the next 5-year review.

4. Are there significant oversights, omissions or inconsistencies in the 5-year review?

Comment - I do not think so. I believe the pg 46 (II.D.) Synthesis is on target and that a change in pallid sturgeon status is not currently warranted for the specified reasons. I recommend that the National Pallid Sturgeon Database be scrutinized further to determine if there are other cases of marked (elastomeres etc.) pallids stocked and subsequently recaptured between RPMA 3 and RPMA 4. Results should then be shared with genetic researchers for their consideration.

5. Are our conclusions logical and supported by the evidence we provide?

Comment - Overall, authors and reviewers used the body of literature and references available to document and substantiate statements and conclusions, especially the hybridization hypotheses discussed on page 45-46.

6. Did we include all necessary and pertinent literature to support our assumptions and conclusions?

Comment - Yes. Overall, the 5-year review document is a substantial piece of work, but like many things in science, there is always new things to learn. Recently, Hay (2006) used a multi-year, multi-location data base of biological sampling to develop statistical models relating biotic responses to variables representing discharge, temperature, and turbidity in the Missouri River from Fort Randall Dam, South Dakota, to Rulo, Nebraska. Results from macroinvetebrate modeling indicated greater drift densities were related to higher flows out of Fort Randall Dam (RPMA 3) and low flows and reduced turbidity below Gavins Point Dam (RPMA 4). For larval fish modeling, water temperature was the most important predictor variable. Greater temperatures or degree days consistently increased the probability of finding larval fish and the resulting drift densities. Greater catch per unit effort of age-0 or age-1 fish were generally related to less variable discharge in the unchannelized reaches and to greater, rising discharge in the channelized reaches below Sioux City. Overall, his results suggest that a more natural discharge, temperature, and turbidity regime would benefit native fish and invertebrate species in the Missouri River.

Thanks for the opportunity to review this worthwhile document.

Gene Zuerlein
Certified Fishery Professional
Fisheries Division
Nebraska Game and Parks Commission

NEW CITATIONS

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Editorial Comments
Pallid Sturgeon (*Scaphirhynchus albus*), 5-Year Review: Summary and Evaluation
Gene Zuerlein, Nebraska Game and Parks Commission

1. Page 5. Throughout the document there are a number of names with personnel communication behind them without the year listed. See pg 5-B. Atwood, pg 18-J. Killgore, pg 32-B. Gardner, pg 34 K. Steffensen, pg 39-R. Short. Like wise, there are names listed in the text portion of the report which are not listed under Personal Communications on pg 57-58. These include K. Steffensen, NGPC pg 34; R. Short, Wisconsin pg 39; T. Keevin, USACE pg 42.

2. Page 8. figure 1 should be Figure 1. Standardize throughout the report. See pg 11 on figure 1; pg 19 on figure 1.

3. Page 17. I believe Figure 10: Middle Mississippi River (RPMA 4) should be labeled (RPMA 5). On pg 15 the RPMA 5 is defined as the Mississippi River from its confluence with the Missouri River to the Gulf of Mexico. The Middle Mississippi River is the reach between the confluence of the Ohio River near Cario, IL and the confluence of the Missouri, near Saint Louis, MO.

4. Page 18. I believe Figure 11: Lower Mississippi River (RPMA 4) should be labeled (RPMA 5). The Lower Mississippi River is the reach of the Mississippi River from the confluence of the Ohio River near Cario, IL to the Gulf of Mexico.

5. Page 49. Although a number of tributaries have been mentioned through the Missouri River Basin in relationship to the various RPMAs. It might be appropriate under the Data needed for the next 5-year review to state any tributary data generated from pallid sturgeon studies also should be reviewed. I know Dr. Ed Peters is planning on publishing his work on radio-tagged pallids in the Lower Platte River.

6. Page 51. Duffy, W.G. et al . 1996. is cited but I could not find it in the text of the report. I may have missed it, but you should check again. On page 53, Kallemeyn, L.W. 1983 also is cited but I could not find it in the report text.

7. Page 50. Braaten, P.J., and D.B. Fuller. 2004. Pg 29 has this citation as 2005.

8. Page 50-56. A number of citations are used as acronymns. It would clarify these citations if they were spelled out in parentheses after they were used. Example: pg 51, DHSS. 2006 could read MDHSS (Missouri Department Health & Senior Services). 2006. Pg 54, MDC. 2006. could read MDC (Missouri Department Conservation). 2006.

9. Page 4. Ray et al. In Press is cited but it is missing in the Literature Cited section on pg 54.

10. Page 22. Ray et al. 2005. is cited but is missing in the Literature Cited section on pg 54.

11. Page 55. TWRA. 2006 could read TWRA (Tennessee Wildlife Resources Agency). 2006.

12. Page 34. USACE 2004 is cited, but missing in the Literature Cited section.

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13. Page 22. Carleson should be Carlson.

3. Vince Travnichek Review

Dr. Vince Travnichek provided comments directly on hard copy of the draft 5-Year review. His comments were primarily editorial in nature.

Critique of Draft 5-Year Pallid Sturgeon Review Document

December 6, 2006

Jim Garvey, Southern Illinois University

This report summarizes the current state of knowledge about the pallid sturgeon throughout its range in the Mississippi and Missouri River basins. I largely agree with the synthesis and conclusions. Below, I make some comments that might provide some food for thought. Of course, all of these comments are colored by my perception of the population in RPMAs 4-6.

General Thoughts

1. Should the report include a section on the potential problems associated with barge entrainment and channel dredging? Unless I missed these issues in the report, they probably need to garner some mention. Jack Killgore's group is currently involved in a St. Louis District-funded project exploring the impact of tow boats on fish communities. Although I am unsure of the source, there was some talk of sturgeon being entrained by dredging. You might want to check with Jack or Tom Keevin about this issue.
2. All the evidence points to a large population that is separated genetically by distance; however, there are no distinct boundaries among populations, with the exception of the Upper Missouri, of course. In my view, it might be instructive to have the report more forcefully state that conservation stocking must account for these geographic differences by collecting broodstock from the specific RPMAs (and perhaps even at specific locations within each RPMA) and restrict stocking to the location-specific lineages. I know there continues to be controversy about this; however, this is the risk averse approach for now until we understand more about genetics and reproductive site fidelity.
3. You mention in the report that there is marked phenotypic plasticity within the pallid sturgeon. We really need to disentangle the genetic versus environmental effects on growth and morphology. Although I realize that this report is not a SOW, we need someone to conduct some common garden experiments to determine whether the size and other physical differences among populations are due to environmental history or genes.
4. Is the eventual goal to recover pallid sturgeon without the need for hatchery supplementation? Or is stocking always going to be included? This needs to be clearly addressed in the report. It seems that the data clearly show that the dams will always reduce survival during early life. Thus, reproduction always will need to be artificially supplemented in this case.

Specific Comments

1) It might be useful to specifically show the major barriers on Figure 1 and how they correspond to the RPMAs.

2) If I correctly understand the data in Figures 3, 5, and 9, it is important to note that the presence of hatchery-reared fish does not seem to be concurrent with a continued decline of wild-produce fish. In so many instances, populations become dominated by hatchery products while the wild fish continue to decline. One of my concerns is that hatchery fish may cause some degradation of wild stocks; however, this does not appear to be the case with the limited information at hand.

3) There are an awful lot of references to personal communications and unpublished data (guilty as charged) and I think this is important to point out. We, as the community of researchers working with this important species, need to get the word out in the primary, peer-reviewed literature. Perhaps you can do a brief analysis of the literature to date, telling us how the information is distributed between reports and papers. I also would like to see a graph of cumulative number of publications through time.

4) I am unsure whether this is possible, but the report really needs to emphasize that the demarcations between the RPMAs are physical for the Upper Missouri but largely administrative for the lower Missouri and Mississippi River. I am of course biased, but I do believe (and the genetics seems to be supportive) that the southern populations are largely mixing and need to be managed in this fashion. This is implicit throughout much of the report but needs to come out strongly, in my view. Of course, the habitat issues are indeed different between the lower RPMAs but the populations might be mixing.

5) (p. 35) You note that pallid sturgeon have been reliably caught in the Kaskaskia River tributary. Unfortunately, there is a lock and dam directly in the mouth and we have never documented movement into that river to my knowledge. In fact, we have receivers sitting in the mouths of the major tributaries of the MMR and have never documented passage by pallids into them. We do reliably capture pallids near the Kaskaskia River tributary and the island area.

6) You might want to point out that we are currently at the juncture between 1 and 2 of the reasonable and prudent alternatives of the FWS Biological Opinion for the MMR (p. 36). Not sure if we are done with 1 yet, although Tom Keevin has convened a preliminary group to help draft the MMR Conservation Plan.

7) Colombo et al. (in press) is accepted and revised for publication in the Journal of Applied Ichthyology. It would fit nicely in the discussion starting on p. 38.

8) To be fair to Illinois, they are trying to implement regulations – just not there yet (p. 43). Colombo et al. (in press) evaluate some of the implemented size limits and dates and the current regulations do not appear to be sufficient for shovelnose and certainly not for pallids.

9) We all know (with supporting data) that the Chain of Rocks (Lowhead Dam 27, UMR) is a hot spot for sturgeon of both species. Would it be prudent to suggest closing access to all fishing at this area? We suspect that sturgeon are taken incidentally by recreational fishermen with no knowledge of the status of the species.

10) Another important piece of information for decisions about the potential development of DPSs (P. 48), in addition to the genetics, is the extent of movement of these fish between RPMAs. The report should be pretty stern about facilitating increased cooperation among the groups doing telemetry in the Missouri, the MMR, and now the lower Mississippi River, where telemetry efforts are planned by Hal Schramm et al.

11) For the lower RPMAs, we need estimates of immigration and emigration of both wild and hatchery-produced pallids to generate viable population assessments.(p. 49).

12) After completing our final report for the St. Louis District, it appears that we need to understand what makes successful recruitment occur in the lower RPMAs and make more of those conditions. This might help us to improve reproduction and eventually curb the need for supplemental stocking in this part of the pallid sturgeon's range (p. 49).

4. William T. Slack Review

6 December 2006

Mr. George Jordan
U.S. Fish and Wildlife Service
Pallid Sturgeon Recovery Coordinator
2900 4th Avenue North, Room 301
Billings, MT 59101

Dear Mr. Jordan:

I appreciated the opportunity to serve as a reviewer for the Pallid Sturgeon-5 Year Review and have enclosed my comments regarding the document. I have served as a reviewer for numerous peer-review scientific journals and approached this document in the same critical manner. Overall, I feel the document does well in providing the most up-to-date information on the status of pallid sturgeon as well as indicating potential threats to its recovery. As directed in your cover letter, reviewers were asked to consider the following questions during their evaluation of the document.

1) Is our description and analysis of the biology, habitat, population trends, historic and current distribution of the species accurate?

   YES, except for spawning/nursery habitat. See Objective 3.

2) Does the 5-year review provide accurate and adequate review and analysis of the factors affecting the species (habitat loss and modification, over utilization, disease, predation, existing regulatory mechanisms)?

   YES, except for spawning/nursery habitat. See Objective 3.

3) Are our assumptions and definitions of suitable habitat logical and adequate? **NO. There is no description of spawning habitat, or at least proposed spawning habitat. Identifying spawning habitat and describing the spatial and temporal use of this habitat within RPMAs by both pallid and shovelnose sturgeon should be a high priority. The Recovery Plan states little is known regarding reproduction or spawning activities of**

pallid sturgeon (in 1993). Nothing is included in the current document to indicate gains in information along that front. Habitat loss and alteration are generally listed as primary causes in the decline of pallid sturgeon throughout its range. However, it is ironic that we provide these as causes without having any substantial data on specific habitats such as spawning and/or nursery habitat. Comments are mentioned within the 5-Year Review document (i.e., page 47) indicating that documentation of recruitment within RPMAs is essential to meeting recovery objectives; however, identifying and/or quantifying habitat specific to aspects of recruitment (i.e., spawning habitat) are not listed. Spawning habitats and cues are noted as a concern within the "Data needed for the next 5-year review" section but not prioritized specifically as a "Future Action." Shovelnose sturgeon provide the best surrogate to model potential spawning and/or nursery habitats. Efforts should be placed on targeting those habitats within RPMAs as potential pallid sturgeon spawning areas.

4) Are there any significant oversights, omissions or inconsistencies in the 5-year review?

   See Objective 3.

5) Are our conclusions logical and supported by the evidence we provide? **YES**

6) Did we include all necessary and pertinent literature to support our assumptions and conclusions? **YES**

In addition, minor editorial and formatting suggestions are noted directly on the document. Specific points of concern are presented below:

- Do not need labels at the top of each figure. This information is often redundant with the specific figure heading. In those cases where the label is not redundant, incorporate those data/information directly into the figure heading. Also, include sample sizes (n = ___) for histograms, either on the figure or in the figure heading. Information provided in Figure 12 would make it much easier to follow the associated text in the document if sample sizes were listed for each sample period on the figure. Most figure headings are descriptive enough to stand alone from the text but others need to include additional information to better support the figure (i.e., Figure 13).

- Inconsistent use of terms throughout the document (e.g., hatchery-reared vs. hatchery reared; lower/upper vs. Lower/Upper when used to describe specific zones within an RMPA). Inconsistency with citation format in Literature Cited section, particularly with edited volumes.

- Page 14. Need to clarify text on how wild, hatchery and pallid sturgeon of unknown origin were being defined. Numbers of individuals within each category are listed but I am unsure based on the information presented within the document as to how these were determined.

- Page 19. Concerns with catch data presented for RPMA 6: Sampling effort yields absolute number and those numbers are depicted in Figure 12 and 13. Text for RPMA 6 notes "about" and "estimate" for catch effort during specified sampling periods (FY). The actual numbers that were recorded should be stated within the text. Because of the difficulties in distinguishing between intermediates, pallid and shovelnose in RPMA 6, the workers feel that the absolute number of pallid recorded for the Area underestimates the total number that are likely there and thus use the term "conservative" for their total estimate of population size.

- Page 19, 20. Patterns depicted in Figure 12 illustrate a consistent frequency pattern that also may reflect gear selectivity. Text describes that shovelnose are regularly captured (40-75 cm FL) and that there is no obvious problem with recruitment. In addition, pallid sturgeon are consistently captured (60-100 cm FL) from the same area and the population size is considered large. It is my understanding that commercial fishermen are routinely involved in the sampling at ORCC and that similar gears are used from year to year. Isn't it just as conceivable to argue that gear selectivity is as much a reason for the pattern that is depicted (gill net mesh adequately samples sturgeon 400-100 cm FL) as is the argument that younger and older fish are migrating from the area through the ORCC? Data presented by Heise (2003) for Gulf sturgeon in the Pascagoula River notes a similar year-to-year size frequency pattern, and attributes the pattern to gear selectivity for large-sized adult Gulf sturgeon.

  Heise, R.J. 2003. The migratory patterns of Gulf sturgeon, Acipenser oxyrinchus desotoi, within the Pascagoula River drainage and potential influences on its behavior. Ph.D. Dissertation, University of Southern Mississippi. Hattiesburg, MS

- Page 19, 20. This is the only section within the entire document that presents data within a fiscal year. Reader is not made aware of what defines the fiscal year as State and Federal resource agencies often have different fiscal years (October through September versus July through June).

- Page 22. Intercross. Is this the most appropriate term to use for this section? This section is discussing the concept of natural hybridization, backcrossing and genetic introgression between pallid and shovelnose and trying to put a single term on the concept...intercross. Wouldn't interbreed be a more all encompassing term than intercross?

- Page 23. Dugo et al. (2004) article enclosed; Data presented in this work illustrates a similar pattern in Gulf sturgeon of genetic distance associated with geographic distance. Populations from adjacent watersheds with less genetic distance than those populations from watersheds at extremes in the range.

- Page 24. Use of the term "importance". Section II.C.1.a. notes the rarity of the animals throughout its proposed range at the time of the description of the pallid sturgeon. Its occurrence in the Yellowstone, Platte, St. Francis, Big Sunflower and Atchafalaya illustrates that its historic range was likely greater than currently recognized, but you cannot say that those river systems were "important". You do not have the historic data to support this.

- Page 25. Discussion about Fort Peck Reservoir and its influence on survival of larval pallid sturgeon. It is unclear from the text as why immature pallid sturgeon are more likely to utilize lower reaches of RPMA 1 than shovelnose sturgeon AND how this influences survival of larval pallid sturgeon.

- Page 27. How do we know that habitat alterations within RPMA 5 have "reduced rearing habitat" when those habitats have not been adequately described and quantified throughout this reach. Comments noted in Objective 3 follow along this thread.

- Page 28. Text notes 92 secondary channels remain in lower Mississippi River. Is this based on Baker et al. (1991) data or does it reflect more current information from Keevin (2006)?
- Page 29. There is a scant amount of information for shovelnose in the Red, Black and Ouachita rivers (see Douglas 1974). Can this data be used to speculate on potential habitat and range of pallid sturgeon within those systems (particularly the Red) prior to the construction of ORCC. Shovelnose are still being captured in sufficient numbers at ORCC to suggest that habitat for spawning within those systems is still available.
- Page 29. The occurrence of larval and post-larval river sturgeon in the lower Mississippi River around Vicksburg in the fall (September, October; MS Museum of Natural Science Ichthyology Collection) suggests either fall spawning or long distance drift from upriver spawning areas. Comments in the document text propose drift of pallid sturgeon larvae from the Missouri River as a scenario for long distance drift. Data presented on page 26 and summarized on page 29 states that larval pallid sturgeon may drift 200-310 miles depending riverine current velocities but that drift declines after 8 days post-hatching. Given these parameters, 200-310 Rmi upstream of Vicksburg (USACE Rmi 440) would be between Rosedale, Mississippi (Rmi 640), and Memphis, Tennessee (Rmi 750), thus the source would not necessarily have to be the Missouri River.
- Page 32. Have sturgeon chub become reestablished in the Marias River or is this the first documentation of sturgeon chub within the river. Argument is made that occurrence of sturgeon chub is favorable for recovery of pallid sturgeon as it is an important prey species, but if the sturgeon chub had never occurred in the system it may be a mute point in arguing significance toward pallid sturgeon recovery.
- Page 33. Unsure exactly what is inferred with "bank stabilization" as it relates to development. Does this imply "bulkheading" or "armoring" of shorelines with .rip-rap and/or sheet pilings? This phenomenon has been noted to significantly affect inshore nursery habitats of coastal fisheries in Mississippi (Peterson et al. 2000). I would expect similar impacts in freshwater systems which would likely cause a cascading trophic effect.

    Peterson, M.S. et al. (2000). Habitat use by early life-history stages of fishes and crustaceans along a changing estuarine landscape: differences between natural and altered shoreline sites. Wetlands Ecology and Management 8(2/3):209-219.

- Page 34. It is unclear from reading the text what is being "identified" in the Biological Opinion.
- Page 35. Text needs to be included to illustrate how USACE practices to maintain the navigation channel (training structures, locks and dams, dredging, etc) alter habitat. Fleeting needs to be defined.
- Page 38. Little historic data on commercial harvest in lower Mississippi River. Cook (1958) provides an excellent account of fisheries in Mississippi waters includes data for river sturgeon harvest from Mississippi River and associated tributary systems. Prudent to include those comments rather than note that there is little historic data on commercial harvest in Lower Mississippi River. A copy of the document is included in the packet of review comments.

- Page 41, section II.C.2.D. Inadequacy of existing regulatory mechanisms. The entire section is very choppy and not written very concisely. Redundant information persists throughout the section (pallid and shovelnose can be difficult to distinguish). Section needs to be reworked for better flow and to present the information in a more concise manner.

- Page 44. Entrainment. More description is needed to determine how Phase I rules differ from those implemented in Phase II. Phase I covers facilities. Phase II covers existing facilities with specifics on water withdrawal and cooling. How do facilities in Phase I differ from those in Phase II?

- Page 45, 46. Comments dealing with hybridization. Very well written and makes the points very well. Hybridization may occur between the two with a resulting intermediate morphological phenotype and intermediate genotype, and that additional research is needed to address whether hybridization in the wild is the result of natural processes or anthropogenic influences.

- Page 46. Use of "significantly". This term is used as an opinion of the writer. Impact by regulated flows has not been quantified and thus any assessment of its impact on pallid sturgeon is qualitative. "Significantly" implies quantified comparisons evaluated with statistical analyses. Similarly, riverine habitat has been fragmented but dams do not continue to significantly fragment the habitat (implies increase in fragmentation). Habitat was fragmented by dams and will continue as such until either dams or removed (less fragmented) or .added (more fragmented).

- Page 49. Recommendations for Future Actions AND Data needed for next 5-year review. Section should include focused and directed research efforts towards addressing the extent of movement by pallid and shovelnose across range. Some telemetry work has been done within the upper portions of the range where physical constraints within the system (locks and dams, defined pools) allow for a more logistic project. RPMA 4 and 5 are large areas and movement within and between these areas as well as projects addressing the extent of movement between RPMA 5 and 6 are desperately needed. Admittedly there are some pilot projects underway but dedicated funding towards projects of this scale is much needed.

- Page 49. Recommendations for Future Actions. Cease augmentation of wild stock with hatchery reared stock in RPMA 4, 5 and 6 UNTIL more information is obtained on movement within and between RPMAs. In addition, recent data obtained from research within RPMA 4, 5 and 6 suggests these populations are much larger than once perceived and stocking within these areas may not be necessary to meet recovery objectives

- Page 49. Recommendations for Future Actions. Identify spawning habitat and describing spatial and temporal use of this habitat within RPMAs by both pallid and shovelnose sturgeon to address potential mechanism for observance of hybrids/intermediates within these areas.

- Page 49. Recommendations for Future Actions. One direction note for "Future Actions" is to model the Missouri River Populations Assessment Program for RPMA 5 and 6. This is a step in the right direction but implementation of such a program is in need of dedicated funding. Many of the partnering states already have USFWS Section 6 funding in place as well as funding appropriated under the USFWS State Wildlife Grant program. However, in most cases those funds are already dedicated toward research of equal importance. A monitoring project of this scale will require teams of personnel and sufficient equipment to perform the task. What agency/entity will coordinate these efforts?

Thank you again for the opportunity and I hope my critique of the draft document and my enclosed comments will be helpful in preparing the final document for the Pallid Sturgeon 5-Year Review. Please feel free to contact me directly if you have any questions regarding my review.

Sincerely,

William T. Slack, Ph.D.
Nongame Research Biologist
Curator of Fishes

5. David L. Galat Review

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MISSOURI COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT COOPERATORS:
U.S. GEOLOGICAL SURVEY
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December 11, 2006

George R. Jordan
U. S. Fish & Wildlife Service
Pallid Sturgeon Recovery Coordinator
Jameson Federal Building
2900 4th Avenue North, Room 301
Billings, MT 59101.

Dear George,

Thank you for the opportunity to provide a review of the U. S. Fish & wildlife Service's Pallid Sturgeon 5-Year Review. Clearly, much effort has gone into producing this report, particularly given the exponentially increasing amount of research and monitoring on Scaphirhynchus *sturgeons since the USFWS Biological Opinions (BiOPs). Here are my replies to your questions with the numbers corresponding to the questions posed.*

1. I believe that there are numerous inaccuracies in the draft description and analysis of the biology and population trends of pallid sturgeon and these concerns are detailed below with reference to specific aspects of the draft review.
2. I realize it is difficult to include an exhaustive evaluation of all available information in this review; I've noted below instances of significant omissions of information related to factors that may be affecting the species' status.
3. No comment.
4. Omissions and oversights that I've identified are detailed below.
5. I do not concur that the evidence provided herein and in the documents cited adequately support the conclusion of the pallid sturgeon's status remaining "stable" since it's listing in 1990. My concerns and requests for clarification are detailed below.
6. I've noted some omissions in the literature and urge the report preparers to analyze and incorporate results from all of the most recent pallid sturgeon population assessment and habitat–use project reports as well as pertinent literature for other sturgeon species.
To assist in reviewing my comments, I have assigned line numbers to the entire document (attached) and specific comments relate to these using the following format: ***Pg xx, 100-103*** *where the number following the page number refer to specific lines in text. There also are a few editorial comments made in "Track Changes" directly on the draft.*
I commend the authors for incorporating much of the valuable information that has been acquired since the species was listed in 1990 into this review and using it to evaluate the species' current status. I hope you will find my comments and recommendations useful to your review and to furthering conservation of the species.

Sincerely,

David L. Galat
Assistant Unit Leader- Fisheries
And Associate Professor

Species status is listed as "stable" on pg. 2 I.C.2.

I am unable to locate sufficient scientific evidence within this document to justify the Report's author's reaching this finding. Five factors contribute to this conclusion: (1) What the ESA/FWS official policy is for the contribution of artificially propagated pallid sturgeon and their stocking is to determination of "status" is unclear. (2) Information reported and apparently used to make the conclusion of the species' status is insufficient or incorrectly applied to make determinations about the species' abundance or population status. (3) For a population to be stable there should be large numbers of small individuals present within a length-frequency distribution, illustrating that recruitment is replacing mortality. This is particularly important for long-lived fishes such as sturgeon where growth of old individuals is minimal. (4) The authors have not included relevant references that report a continued decline of the species. (5) The report's Synthesis section emphasizes the highly imperiled status of this species. Text that follows addresses each of these factors.

(1) A critical issue that I believe should be addressed in this review is to clarify for the reader the policy of ESA and FWS on the role stocking pallid sturgeon plays in the species recovery. Can it be used to "rejuvenate" critically low populations in order to increase numbers sufficiently so that natural recruitment at some point can maintain the population or increase it? Peregrine falcons and California condors are examples of where this approach has been successfully applied. I think it might be useful to the public to illustrate similar examples for endangered riverine fishes to lend additional credibility to the stocking program. An equally important question I hope can be clarified in this status review is what is the ESA/FWS's policy relative to inclusion of stocked fish in determinations of defining the pallid sturgeon's population status. Specifically, can a population maintained by stocking for some period of time be classified as "stable" as appears to be the case with pallid sturgeon based on this review, or is *natural* recruitment required for the population of pallid sturgeon to remain "stable"? This is an important consideration I hope can be clarified since much of the information reported on pallid catches in this review relates to stocked fish and stocked fish relative to "wild" fish.

(2) A fundamental requirement for a wild population to be *stable* is that recruitment (presumably natural vs. artificial propagation, but see previous comment) into the population needs to balance mortality losses. A population that is *increasing* has recruitment exceeding mortality, and a *declining* population has mortality exceeding recruitment. Therefore, statements about a population's status should be supported with evidence concerning recruitment and mortality. Can you more effectively summarize the evidence that recruitment is balancing mortality as evidence for concluding the population's status is stable?

(3) All length-frequency distributions in the review show comparatively few small pallid sturgeons relative to "mature" individuals. Length frequency distributions (where length is a surrogate measure of age) of a healthy population are dominated by small size classes (young fish) (Van Den Avyle & Hayward 1999). Rarity of small size classes from most RPMAs could be a consequence of several factors acting independently or collectively: (i) sampling effort is biased towards larger size classes; (ii) sampling gears deployed are inefficient at capturing small size classes or the habitats where they may reside are ineffectively sampled (e.g., main-channel thalweg); (iii) difficulty of taxonomically separating small pallid sturgeon from small shovelnose sturgeon results in under-reporting small size classes of pallid sturgeon; or (iv) natural recruitment of pallid sturgeon to sub-mature sizes is not occurring. I recommend this review address each of these factors so that statements about population trends or condition of the pallid population can be substantiated.

Rather there is circumstantial evidence within the document that appears to support continual decline of the species throughout it range in the Missouri River. Here are some relevant quotes from the draft 5-year review for RPMAs to support this observation:

Pg. 8, 300-302; RPMA 1. "The size and age of surviving fish suggest that spawning, recruitment or both are severely limited within this reach. Supplementation of RPMA 1 with hatchery produced pallid sturgeon has occurred sporadically since 1997, and is required to maintain the population."

Pg. 9, 352-355; RPMA 2. "The length frequency data indicate that up until the time supplementation began, all collected pallid sturgeon were adults except for one small fish collected in 1993. This suggests that, like RPMA 1, spawning, recruitment or both are limiting viability within this reach."

Pg. 11, 378-384; RPMA 3. "There is no native wild population of pallid sturgeon known to survive in RPMA 3 (figure 1), the Missouri River from 20 miles (32.2 km) upstream of the mouth of the Niobrara River to Lewis and Clark Lake, and the current population consists entirely of hatchery stocked fish. According to the National Pallid Database, the latest wild record of the species from this area, that was not translocated, was the collection of a single pallid sturgeon circa 1991. Prior to this (1952-1991), there were a small number of pallid sturgeon collected from this area."

Pg 14, l-443-448; RPMA 4. "The low numbers of naturally produced or unknown origin pallid sturgeon in smaller size classes coupled with higher relative abundances of hatchery origin pallid sturgeon (Figure 9) and frequent captures of smaller size class shovelnose sturgeon suggests that the gears being used are effective and that natural recruitment of pallid sturgeon is sporadic or limited in RPMA 4 (Barada and Steffenson 2006, Kennedy et al. 2006, Steffenson and Barada, 2006, Utrup et al. 2006)."

Pg 19, 585-587; RPMA 6. "The length distribution of pallid sturgeon captures has remained relatively consistent over the past 7 years, although the population appears to be comprised of predominantly adult fish >65 cm FL (Figure 12)."

(4) Doyle and Stroska (2003) conclude for the lower Missouri River, "Pallid sturgeon continue to decline at a rapid rate. Within the 200 river-miles sampled, the ratio of pallid to river sturgeon decreased from 1:311 in a 1996-2000 study to 1:387 in 2002.

(5) The synthesis section summary reports catches of adult pallids remain low, recruitment of pallids is infrequently observed, pallid catches are largely composed of old-aged individuals, illegal commercial harvest appears to be increasing, inter-sex specimens of *Scaphirhynchus* are now being observed, and hybridization is now well documented – yet the overall conclusion is: "In summary, the status of pallid sturgeon has improved since listing due to successful hatchery and stocking programs in reaches of the Missouri River; new information on habitat extent and conditions, population size, and potential recruitment in the Mississippi River; and new information on population size in the Atchafalaya River."

For this reviewer, it seems the conclusion of a "stable" pallid population status conflicts with a substantial amount of the evidence provided herein or the references cited. Additionally, some of the information presented in this review appears misinterpreted (see previous and following comments), thus making it impossible to objectively evaluate trends in abundance or population status of pallid sturgeon throughout its range. Low numbers of pallids ≤350 mm TL collected, insufficient information on changes in pallid CPUE over time, lack of quantitative population estimates, increased fishing mortality, disease, contaminant levels and hybridization lead me to question the report's conclusion that the species' status remains stable.

Perhaps you can help your readers understand this conclusion in the final draft by clarifying what is meant by "stable", what specific criteria were used to reach this conclusion and what other options for the species' status exist (e.g., uncertain, declining, improving?) and what are the criteria for their designation?

What is a population? A *population* is a group of fish of the same species that are alive in a defined area at a given time (Wooten 1990). In fisheries it is generally determined by mark-recapture studies, the methods of which are described in numerous texts (e.g., Bagenal 1978, Wooten 1990, Van Den Avyle & Hayward 1999). Population is not synonymous with catch, or abundance. This status review appears to use the terms "population" or "population trend" very loosely, and in my opinion largely incorrectly. I strongly recommend including the Przemyslaw and Wildhaber (accepted) paper "Population viability analysis of lower Missouri River shovelnose sturgeon with initial application to the pallid sturgeon" in this review as it illustrates very well the type of information necessary to quantify population trends.

Reporting only catch information as is done in this status review does not contribute substantively to evaluation of a species' abundance or its population's status (see other comments) unless it is adjusted for effort, i.e., catch per unit of sampling effort or CPUE. For example, reporting catches as in II.C.1.a. "Abundance, population trends..." (pgs. 5-20) is misleading as does not provide the reader with accurate data about abundance or population trends. See above comment about the rigorous approach that is necessary to evaluate population trends. Statements about patterns in numbers of pallids collected over time also are misleading, unless catch data are adjusted by effort (e.g., see 2004 and 2005 Population Assessment Reports for segments 9-14 for examples of reporting CPUE). For example, pallid sturgeon sampling has likely increased markedly following RPAs in the 2000 and 2003 Biological Opinions. If effort to capture pallids has doubled from 2000 to 2005, then catches also will need to have doubled for relative abundance (not population size) to be considered "stable." Increases in catch over time without adjustment for effort may lead to erroneous conclusions about relative abundance.

Additionally, annual catch data as presented in Figures 3, 5, 7, and 9 provides inappropriate information from which to evaluate population status (see previous comments about misuse to the term *population* throughout this report).

Conservation Measures (Pgs 32-37). A substantial amount of this review is devoted to detailing the various ongoing Missouri and Mississippi rivers mitigation, rehabilitation, or restoration programs. I think it would benefit this status review to summarize more specifically if, or how, these programs have shown a demonstrated benefit to pallid sturgeon recovery. If there are measurable benefits, please detail. If measurable benefits are not yet able to be documented, why not? Too early, other reasons? In cases where measurable benefits have not been documented, could you detail *expected* benefits from these programs? This will provide a reference point against which future status reviews can be compared. Unless or until measurable objectives of conservation measures to benefit pallid sturgeon recovery are articulated the ability to evaluate success within an adaptive management framework will be challenging. This status review would be an ideal vehicle to provide this guidance.

Quality of evidence used to evaluate pallid sturgeon status. *There is much contention over the status of pallid sturgeon throughout its range. It is imperative given the questions being raised by basin stakeholders over the quality of science surrounding pallid sturgeon decisions (See Spring Rise Process at http://missouririver.ecr.gov/) that scientific evidence used to assess pallid sturgeon status be of the highest quality and subjected to independent science review. This is most effectively accomplished through publication in peer-reviewed outlets. The use of "personal communication" is discouraged and should be used with great caution as (1) validity of personal communication statements cannot be independently confirmed, and (2) it is not possible for the reader to separate opinion from scientifically supported evidence.*

I recommend considering the principles for independent review for Corps projects in the National Research Council (2002) report to assist in developing guidelines for pallid sturgeon science.

References. *The reference to Kuhajada et al. in press of larvae as "may have been pallid sturgeon" is not provided in the references on CD provided reviewers, nor is the Murphy et al. in press reference, although both are in the Report references. Please add both and any others listed in Literature Cited, but not included on CD in the final product. Status report readers need to be able to access all citations or they should be deleted as preparers of the report should not have exclusive access to any information. Other manuscripts submitted from the Scaphirhynchus Symposium and very relevant to pallid sturgeon status also should be incorporated into this review (e.g., Przemyslaw and Wildhaber accepted) and made available as soon as they are accepted for publication.*

Pg 8, 292-295. "The wild pallid sturgeon population trend has remained relatively unchanged in RPMA 1 since listing, however, the population is being successfully supplemented with hatchery produced fish (U.S. Fish and Wildlife Service 2006)."

I cannot determine what evidence was used to reach this conclusion and similar statements for other RPMAs? Do we know what the population was at listing to provide a baseline against which to compare subsequent population estimates? Reporting length frequency data (e.g. Figure 2) or yearly catch data (see previous comment) tells us nothing about **population** size or its trends. To evaluate the hypothesis that *size frequency of catches is stable over time* (note that size frequency distributions provide no evidence of population trends, but just the distribution of lengths within catches) one needs to see diagrams like Figure 2 for each year or at least for 3 to 5-year intervals (e.g., see Figure 12) and then test if the frequency distributions are statistically similar over time. If too few individuals are captured then there is insufficient data to make a conclusion – not conclude that the population is stable.

Pg 8, 298-300. "Current population estimates suggests that as few as 45 wild pallid sturgeon still remain in RPMA 1 (Bill Gardner, Montana Fish Wildlife and Parks (MFWP, personal communication, 2005)."

Formal analyses yielding population estimates would be very valuable. Can you include the results of this and methods applied along with estimates of confidence intervals so the reader can evaluate its robustness? The potential value and import to recovery of population estimates is great and thus they should be published (preferably in a peer reviewed outlet) if they are to be used to affect recovery actions. See general comments about using "personal communications"

Pg 13, 420-428. Identifying larval and juvenile pallid sturgeons is exceedingly difficult. All tentative IDs of larval pallid sturgeon must be verified by recognized experts (e.g., Darrel Snyder, Colorado State University Larval Fish Laboratory) before they are reported. I am aware that the USFWS Office 1990s larvae were confirmed by Synder, but please include confirmation of those reported by Mestl, Herzog, and others – or acknowledge their tentative status. The following statement (Pg 17, L528-532), "One recent study found that character indices do not correctly identify small Upper Missouri River hatchery reared juvenile pallid sturgeon (<250 mm SL) from shovelnose or hybrid sturgeon, or reliably separate larger pallid sturgeon (up to 600 mm SL) from hybrid sturgeon (Kuhajda and Mayden 2001).", implies that statements made about recruitment of pallid sturgeon or capture of small unmarked pallids should be viewed with caution when assessing population status. Until genetic techniques are available to provide a probability statement of larvae being a pallid sturgeon (Heist et al. proposal recently approved for funding through the SSP program), conclusions about pallids population status based on larvae or juveniles are suspect.

Pg 18, 552-554. *"Although these ratios must be interpreted with caution, they demonstrate an improvement in knowledge of, and ability to collect pallid sturgeon in large river habitats."*

I agree with this statement, and in particular urge you to note that such ratios, unless adjusted for differential gears used or differential collection effort, are not helpful to evaluate the status of pallid sturgeon populations.

Pg 24, 800-802. *"A single low head dam in the middle Mississippi River near the mouth of the Missouri River between RPMA 4 and 5 is not believed to impede movement of fish." Please include the name of this dam. If the sentence refers to Chain-of-Rocks, then I agree with the statement. However, if the sentence is referring to Melvin Price (Lock and Dam 26), then there is substantial evidence that Mississippi River locks and dams impede up-river movement of migrating fishes in general (see Wilcox et al. 2004). This is why the Upper Mississippi River Navigation and Ecosystem Sustainability Program is proposing multi-million dollar fish passage facilities on navigation dams.*

Pg 25, 835-837. *"Recent work by Gerrity (2005) suggests that immature pallid sturgeon are more likely to utilize the lower reaches of RPMA 1 than are shovelnose sturgeon." This statement is incorrect as Gerrity examined* hatchery reared *juvenile pallid sturgeon (HRJPS). Please revise.*

Pg 29, 1035-1042. *"It has been considered that pallid sturgeon spawn in the spring or early summer as do other sturgeon species. However, the capture of* Scaphirhynchus *larvae and post-larvae in the Mississippi River during fall months as well as the spring, could be interpreted as an extended season or a second spawn in the lower latitudes of distribution (P. Hartfield,* *USFWS, personal communication, 2006).* An alternative hypothesis to explain this could be later Missouri River spawning dates occurring in more northern latitudes and later downstream drift of those post-larvae pallid sturgeon being collected in the Mississippi River."

The italicized alternative hypothesis cannot explain presence of larvae *in the Mississippi River during the late summer and fall months for two reasons. First, the hypothesis that larval* Scaphirhynchus *drift downstream to the Mississippi River from more northern latitudes – but do not grow, as would be necessary for them to remain as larvae while drifting downriver - untenable given the high energetic demands of larval fishes and the high mortality if they do not feed once the yolk is absorbed (Fuiman and Werner 2002). Second, U.S. Fish and Wildlife Service Columbia Missouri Fishery Resources Office's data shows that age-0* Scaphirhynchus ≤ *60 mm TL were collected from the lower Missouri River from April to October 2004 (see Figure 1 attached) supporting for the Missouri River Hartfield's hypothesis of a protracted spawning season for the Middle Mississippi. Additionally, Wildhaber et al (2006) using histological analysis of shovelnose sturgeon ovaries reported "spawning condition" females (oocyte reproductive stage V: follicles are black) in the lower Missouri River from January through August, although the greatest percentage of stage IV (pre-spawning: follicles enlarge, begin to turn black) and stage V females were collected in April and May. The evidence for a protracted spawning season for* Scaphirhynchus *sturgeons is quite substantial.*

Pg 33, 1174-1176. *"Work in this reach indicates that it possesses necessary habitat and is suitable for pallid sturgeon recovery efforts (Jordan* et al. In press*)."*

This paper deals with activity patterns and habitat use of 3-year old stocked pallid sturgeon in RPMA 3. It is my understanding that recovery requires successful natural reproduction which was not evaluated in the cited paper. The study showed that resource conditions within RPMA 3 were suitable for growth of sub-adult pallids – this is not the same as "suitable for recovery". Revise report text to more accurately reflect the studies conclusions.

Pg 34, 1206-1208. *"Increased discharge in the spring followed by low discharge in the summer may provide missing cues suspected as one cause of little to no spawning/recruitment of pallid sturgeon in this reach."*

How does this statement relate reports of a protracted spawning for Scaphirhynchus *and the observation of larval* Scaphirhynchus *in the lower Yellowstone and upper Missouri Rivers in years with high, low, or no spring rise (Pat Braaten, PowerPoint presentation to Spring Rise Process, 2005)? My point here is that evidence for the necessity of a spring rise as a spawning cue for* Scaphirhynchus *is equivocal, making the statement above a hypothesis. I suggest revising text to say, "... in the summer* is hypothesized *to provide missing..."*

Pg 34, 1223-1226. *Suggest revising the sentence by adding italicized word "potential": "Based on current and anticipated commitments for aquatic habitat restoration in this RPMA, the next several years should produce increased quantity and quality of* potential *sturgeon habitat in RPMA 4..."*

Finding a few pallids using a rehabilitated habitat is certainly a positive observation, but statements about their value should be made with caution until more definitive evidence is available. For example, larval and adult pallids also have been captured in the channelized lower Missouri River; does this mean we should channelized currently unchannelized reaches to further restoration efforts?

Pgs 35-36. Mississippi River (RPMA 5). *The text here summarizes a variety of acquisitions of flood-prone floodplain areas. These will certainly benefit rehabilitation of the Mississippi River floodplain ecosystem, but what evidence is there that these areas will specifically benefit pallid sturgeon that as a fluvial specialist species (Galat et al. 2005) is highly unlikely use floodplain habitats? It believe it is misleading to imply that mitigation projects for Missouri or Mississippi River navigation and bank stabilization programs that restore floodplain lands have a* direct *benefit on pallid sturgeon recovery. I'm aware of no evidence in this document or other literature that supports this hypothesis. These acquisitions are admirable as part of a broad ecosystem restoration program, but it currently is somewhat of a stretch to argue they specifically benefit pallid sturgeon recovery.*

Pg 40. 1479-1480. *"Little peer-reviewed information is available documenting piscivory as a threat limiting the recovery of the pallid sturgeon."*

I find it disconcerting that here the review remarks there is little peer reviewed information supporting piscivory on pallid sturgeon, yet the majority of evidence on other aspects of pallid sturgeon biology and ecology provided in this review up until this point (genetics excluded) also has been derived from non-peer reviewed agency reports or equally non-peer reviewed personal communications. Such selective statements suggest the authors are biased against certain hypotheses of what factors are contributing to pallid sturgeon declines. Note that Quist et al. (2004) report predation as a general research hypothesis related to pallid sturgeon recovery (10.4, Pg 27). Additionally piscivory is considered a potentially important source of predation to hatchery stocked white sturgeon as Gadomski, D. M. and M. J. Parsley (2005) conclude "Our study demonstrated that predation is a likely cause of mortality of age-0 white sturgeon and may be contributing to the year-class failures that have been observed. In addition, the results from this study could be used to reduce the predation risk of artificially propagated white sturgeon released to augment declining populations since fish could be reared to sizes where their vulnerability is low." Finally, Pflieger and Grace (1987) considered increased predation by non-native fishes coupled with increased water clarity as a result of impoundment to be a potentially significant factor affecting populations of native Missouri River fishes.

The Braaten and Fuller progress reports (also not non-peer reviewed) are cited as evidence that piscivory is not an important factor in sturgeon mortality. Their study examined food habits for only two months per year and did not evaluate post-stocking diets of potential piscivores downstream for pallid sturgeon stocking sites.

Clearly evidence for the importance of piscivory as a factor contributing to pallid sturgeon mortality is equivocal and deserves further study to support or refute the hypothesis, discounting it with anecdotal evidence will not make it go away.

Credibility of this report requires objectivity in reporting all *viable hypotheses. The* peer-reviewed *literature indicates predation is clearly a potential factor that could be affecting mortality of pallid sturgeon and particularly hatchery reared and stocked juveniles. As such, it deserves equal consideration with other the poorly documented hypotheses for population declines treated in this review.*

Pg 46. Population size section and specifically line 1742. *"Pallid sturgeon population size in the Missouri River is well documented." This statement and much of what is in this section is unsubstantiated. The only information reporting population size in this report that this reader remembers seeing is that of Gardner for the upper Missouri River as a personal communication.*

See previous comments on the review's misuse of the term population size *for catch or number sampled. Statements regarding changes in numbers of fish collected in various RPMAs cannot be used to make conclusions about population size unless they are adjusted by effort expended or used as input to quantitative population estimates (e.g., mark-and-recapture studies).*

Pg 49, 1849. I recommend revising, "Develop objective and measurable recovery criteria" to add ... *and a science-based, independently reviewed program that evaluates implementation of recovery criteria and develops periodic report cards of recovery success.* Objective and measurable recovery will not be successful unless accompanied by research and monitoring that is directly tied to evaluating recovery criteria and programs are made accountable to provide quantitative products that address the measurable criteria. See Barko et al (2006) for examples of an adaptive management science process being implemented in the Upper Mississippi River and Weimer et al. (2006) for guidelines to develop protocols and information products for the application of adaptive management within DOI. Both sources can aid in developing objective and measurable recovery criteria and in their effective implementation, evaluation, and revision based on new information.

Pg 49, 1849. I very much agree with this recommendation and urge the FWS and COE to examine the Tear et al. (2005) paper: Setting measurable objectives in conservation, and follows its recommendations.

Pg 49, 1861-1879. Data needed for next 5-year review. Given the exponential increase in research and monitoring on *Scaphirhynchus* sturgeons as a result of the BiOp RPAs it will be a formidable task to thoroughly evaluate pertinent information for the next 5-year review. I strongly urge you to encourage the various research, monitoring, and evaluation programs (RM&E) to perform their own rigorous 5-year analyses related to the specific objectives of each program. Moreover, I encourage the FWS to provide each of the programs with specific questions they need answers to that will facilitate these programs providing products to the COE and FWS that are meaningful for decision making. Perhaps this will make your difficult task 5 years from now somewhat less challenging?

Improving use of science in pallid sturgeon conservation. River biologists and scientists are considered to be experts in their fields and are being asked to provide decision makers with reliable advice. The extent to which their advice is reliable depends on following principles of good science. Efforts to conserve the endangered Florida panther were severely compromised due to implementation of unreliable inferences. I recommend reviewing the Conroy et al. (2006) paper where they provide guidelines that should be equally applicable to developing reliable science for pallid sturgeon recovery.

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D. Response to Peer Review

RESPONSE TO REVIEWER COMMENTS (Dr. R.G. Bramblett):

Pg. 3 and 4 While data are available that indicate population structuring range-wide, listing Distinct Population Segments (DPSs) must comply with the 1996 DPS plicy. Inherent in that policy is the criteria of discreteness and significance. Genetic data suggest an isolation by distance model indicating some historical level of gene flow among adjacent groups. This brings up the question of both discreteness and significance. At this time, the species is afforded full protection of the ESA and applicable regulations and laws. Listing DPSs at this time will not improve or increase protection. However, given the current data, it may be warranted to pursue DPS listing in the Upper Basin if data support a change in status (down listing or delisting) in other portions of the species' range.

As written on both page 8 and 9, the population trend at the time of listing was believed to be declining thus the statement that the wild population trend is relatively unchanged from the time of listing appears accurate. However, these sentences were reworded for clarity.

The identification of successful supplementation is somewhat open to debate and depends on one's definition of success. Because of the life history of pallid sturgeon and short duration that supplementation efforts have occurred, it is not yet possible to evaluate the long-term success of supplementation efforts, that is there are not sufficient data to adequately evaluate growth and survival. The language was modified to strike the word successfully. However, the catch data does indicate that stocked fish are surviving and as new data become available, better assessment of growth, survival, and ability to reach sexual maturity will be evaluated

Pg 11-12 Additional data from Shuman *et al* (2005) has been added. Extirpated was added to sentence.

Pg 13-14 Concerns were added to the data needs section of the 5-year review

Pg 15-18 Additional data has been added regarding capture of stocked fish.

The 1992 year class of hatchery reared pallid sturgeon released from Blind Pony in 1994 should be recruiting to adulthood, so yes, the 700-950 mm pallid sturgeon in Figure 10 are the only current known hatchery released fish that are of a size consistent with adults. Incidentally, in 2006 siblings of those fish (1992 year class from blind Pony) held at Gavins Point NFH were documented to have spermiated as part of propagation efforts this year.

The use of palid sturgeon to shovelnose sturgeon ratios is common in the literature. However, simply reporting the ratios without supplemental data does little to support what these ratios mean. These ratios can be misleading, and as presented are not good indicators of population status or trend. To avoid confusion, this section has been removed.

Pg 21-24 See comments above regarding DPS listing.

Pg 25 Comments incorporated into body of text

Pg 26 Comments incorporated into body of text

Pg 30-31 See comments above regarding DPS listing

Pg 32 Language has been added to highlight this issue

Pg 41 Reworded for clarity.

Pg 46 Language added to help address this concern.

Pg 47 Colombo *et al (In Press)* have age data indicating that pallid sturgeon sampled from the MMR were 15 years and younger. Reference has been added.

RESPONSE TO REVIEWER COMMENTS (Gene. Zuerlein):

Editorial comments were incorporated.

1. National Pallid Sturgeon Database has been cited as USFWS 2006b and added to literature cited section. Hofpar (1997) and Reade (2000) references have replaced G. Mestl pers. comm. Language added to highlight the importance of lower Platte River as well a Snook (2002) and Swingle (2003) references. Language discussing cooperative agreements among states to protect habitat in the Platte has been incorporated into section II.C.2. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms) - III.C.2.a. Present or threatened destruction, modification or curtailment of its habitat or range.
2. The descriptive nature of habitat loss appears sufficient for the purpose intended. Details of documented habitat loss can be found in the Biological Opinions and thus only a general overview is provided in this document.
3. Language added relative to importance of prey species.
4. No response/changes identified.
5. No response/changes identified.
6. No response/changes identified.

RESPONSE TO REVIEWER COMMENTS (Dr. Vince Travnichek):

Editorial suggestions were incorporated.

RESPONSE TO REVIEWER COMMENTS (Dr. Jim Garvey):

General Thoughts

1. Language was added to indicate that work is being implemented to evaluate the entrainment concerns and dredge operations.
2. Implementation of appropriate supplementation activities is described in the Pallid sturgeon range-wide stocking and augmentation plan (US Fish and Wildlife Service 2006a). This plan is updated regularly to insure appropriate data are incorporated into implementing the most risk averse approaches.
3. The current data representing genetics and morphology are presented in this document. What is described here by the reviewer has been addressed in the data needed for next 5-year review section.
4. While the main-stem Missouri river dams will likely always have an effect, there are efforts underway to improve drift distance to improve early life survival. At this time, supplementation is considered a short term effort to prevent local extirpation until adequate habitat improvement measures have been implemented to restore self-sustaining populations.

Specific Comments

1. Dam locations have been incorporated into Figure 1.
2. This appears to be more of a general comment from the reviewer. Language has been added to indicate the decline of wild fish in the Missouri RPMA discussions.
3. This appears to be more of a general comment from the reviewer. The 5-year review and associated bibliography should help address the reviewer's comments. However, a graph of cumulative publications through time seems outside the scope of the 5-year review process.
4. Identification of the demarcations of the upper RPMA's being based on physical features becomes more evident with the addition of dam locations in Figure 1.
5. The reference to collection of pallid sturgeon in the Kaskaskia River has been modified to more accurately reflect that pallids are collected near this river, and not implying in the river.
6. RPA implementation of the Mississippi River Opinion (USFWS 2000b) is discussed within the document. This likely will be important data for the next 5-year review.
7. Columbo *et al.* (In Press) references has been incorporated, where appropriate.
8. Because Illinois has not implemented regulations to protect *Scaphirhynchus* (at the time of drafting) it has not been identified. If changes are implemented they will be incorporated into the next 5-year review.
9. Overexploitation associated with similarity of appearance has been documented and discussed in this document. It is outside the scope of this document to suggest closing seasons. That recommendation should be considered and reviewed by the basin workgroups and Pallid Sturgeon Recovery team.
10. While this is important, the Recovery Team and Basin Workgroups are the appropriate venue to insure coordination.
11. Added to data needed for next 5-year review section.
12. Supplementation practices are described in the Pallid sturgeon range-wide stocking and augmentation plan (USFWS 2006a). Updates of this document appear to be a more appropriate venue to address this comment.

RESPONSE TO REVIEWER COMMENTS (Dr. William T. Slack):

Editorial comments provided on hard copy were incorporated.

Response to Bullet Items

Bullet 1 Labels have been removed from the top of figures.

Bullet 2 Document was edit to improve consistency on term and citation formats.

Bullet 3 Language was added to clarify Wild, Hatchery, and Unknown designations.

Bullet 4 Reworded for clarity.

Bullet 5 Language added to incorporate potential for gear selectivity/bias

Bullet 6 Figure description modified to highlight the reporting by Federal fiscal year.

Bullet 7 The term intercross is used synonymously with hybrid or intermediate. Intercross is defined in the context of the USFWS and NMFS policy on controlled propagation (Harrelson and Nammack 2000) as "Any instance of interbreeding or genetic exchange between individuals of different species, subspecies, or distinct population segments of a vertebrate species."

Bullet 8 Seems to be more of general comment. It does appear to reflect what is reported in Dugo et al. However, we currently are not fortunate enough to have adequate movement data nor adequate analysis or identification of regionally isolated alleles to fully comprehend fine scale genetic relationships within the pallid sturgeon population.

Bullet 9 Correct, historical data are lacking. However, Bramblett (1996) documented the following: pallid sturgeon prefer the Yellowstone River over the Missouri River below Fort Peck, many fish move into the lower Yellowstone River during spawning season, ripe fish occur in the Yellowstone River, and aggregations of fish during spawning season strongly suggest that pallid sturgeon spawning occurs in the lower 10-15 RKM of the Yellowstone River. *In 2003,* Swingle (2003) collected two presumed wild pallid sturgeon in the lower Platte River and subsequently followed their movement via telemetry. One of these was a gravid female collected early May 2001 that subsequently moved into the Missouri River on June 9, 2001, suggesting the lower Platte River may be an important tributary for spawning. Work by these authors suggest that these two tributaries are currently important and thus likely were historically. However, this section was modified and the word important was replaced with "were also utilized."

Bullet 10 Gerrity (2005) did not determine why juvenile pallid sturgeon utilized the lower reaches of RPMA 1 when compared with immature shovelnose sturgeon and thus it is not reported. Language was added that may help clarify how or why selection for downstream reaches, by pallid sturgeon, could influence survival. Manly this has been attributed to conversion of lotic habitats to more lentic environments when the reservoir is at higher pool levels.

Bullet 11 Introductory paragraph has been revised.

Bullet 12 Tom Keevin was the source of the number of the side channels. The asterisk is there to identify where the low water reference plane definition came from. Many readers may not be familiar with the LWRP yet it seemed cumbersome to include the Baker reference with in the sentence.

Bullet 13 This seems to be more of a question than a comment. Early in the development of the recovery plan, a cautious approach was applied regarding using range of shovelnose to describe range of pallid sturgeon. For example, there is a historical population of shovelnose sturgeon in the Bighorn River as far upstream as Wyoming. This has led some folks to consider that the Bighorn River could have been historically important for pallid sturgeon. However, this is mostly speculatory and thus does not appear in literature.

Bullet 14 Data presented on page 26 and summarized on page 29 is calculated for velocities of 0.35 and0.55 m/s. I am not aware of average velocities on the Mississippi River so you may very well be right. Reference to late season larval and post-larval river sturgeon in the Mississippi River, possibly coming from the Missouri River, has been removed from section ***II.C.1.f. Other:*** where it was speculated.

Bullet 15 There are little historical data pertaining to this species to determine if it is a new colonization event or re-colonization of previously occupied habitat. However, establishment of a species believed to utilize habitats similar to pallid sturgeon as well as documented forage for pallid sturgeon suggests there likely is some potential benefit.

Bullet 16 Bank stabilization is used loosely to define those activities intended to fix a stream banks current location. Armoring with rip-rap or other materials, sheet pile walls, etc., is what is intended.

Bullet 17 The modification of flows from Gavins Point Dam to stimulate a biological response from fishes as well as potentially create new habitat is an RPA and that is what is identified in the Biological Opinion. Some minor verbiage change to promote clarity.

Bullet 18 These activities are described in the Biological Opinion.

Bullet 19 Cook reference was added.

Bullet 20 Section restructured to improve clarity and reduce redundancies.

Bullet 21 More description added to section describing Phase I and Phase II rules.

Bullet 22 No changes suggested.

Bullet 23 Significantly has been changed to substantially and structural corrections were made.

Bullet 24 Changes made to address.

Bullet 25 The current stocking and augmentation plan does not provide for supplementation within RPMA 5 or 6. Available data support a need to supplement within RPMA 4. Revisions to the stocking and augmentation plan have been made by the Pallid Sturgeon Recovery Team to better insure appropriate genetic supplementation through this program.

Bullet 26 Identification of spawning habitat added to future actions.

Bullet 27 This comment, while quite valid, is outside the scope of the 5-year review.

RESPONSE TO REVIEWER COMMENTS (Dr. D. L. Galat):

Comment 1: Species status is listed as "stable" on pg 2 I.C.2.

This designation of "stable" was not the result of this review. Instruction to authors, (not provided to peer reviewers) requests the status (increasing, decreasing, stable, presumed extinct, only in captivity, unknown) as indicated in most recent biennial Recovery Report to Congress or annual data call (note the date of this Report or data call). This determination of "stable" is on a year to year basis and by definition in this process, Stable means: "*Species for which the information available indicates that the species status neither improved nor declined over the last year (i.e., population numbers remained constant, and threats did not affect species status during reporting period).*"

During this initial development, the status was listed as "stable." This report factors the entire range of the species and not just the Missouri River. What also is not indicated in that section of this review is that the annual data call for 2006 indicates a declining long term trend, stating "*Again sufficient habitat improvements have not been made to ensure self sustaining populations. Continued stocking by hatcheries, while necessary, is maintaining an artificially robust population.*" Finally, final formatting changes for the 5-year review have removed this reference to species status.

1) Language was added to help clarify relevant policies.
2) There are few if any data available to determine if recruitment is balancing mortality. Thus this review relies on length frequency data and is assuming length to be indicative of age.
3) Language has been added, where appropriate, to discuss sampling effort bias, effectiveness of gears used on smaller size-classed sturgeon, and the apparent lack of recruitment success in the Missouri River.
4) Because of the potential for misinterpretation and lack of clarification, references to ratios of pallid to shovelnose sturgeon have been omitted in the final version.
5) Language was added for clarity to more accurately reflect and differentiate between the status in the Missouri, Mississippi, and Atchafalaya Rivers.

What is a population?

Much of the criticisms described are justifiable. Currently there do not appear to be data available for PVA type work. Also, there are currently little, if any, references to relative abundance. There are only a few instances where crude population estimates are provided (RPMA 1 and 2). Increased catch with increasing effort is to be expected and on occasions where those data are provided (RPMA 5 and 6), the determination of status remains "unknown."

Conservation Measures (Pgs 32-37)

Much of the conservation measured described herein have not had adequate time and/or data collected to be documented. Expected benefits should be detailed in the respective biological opinions and that process. Likely a more appropriate vehicle to describe measurable objectives for pallid sturgeon recovery is the Pallid Sturgeon Recovery Plan. This review recommends the measurable and objective criteria be developed and incorporated into an updated plan.

Quality Of Evidence Used To Evaluate Pallid Sturgeon Status

At present there is not an adequate mechanism to require agency funded biologists to publish in peer-reviewed outlets and thus much of the data are contained in agency reports or other "gray literature" or is contained in the collective knowledge and experience of individual biologists/researchers. Personal communications were minimized and only utilized where absolutely necessary. The ESA requires use of "...the best scientific or commercial data available." The best available scientific data for rare, poorly known species are often not peer-reviewed. There is an abundance of good data specific to individual projects that are not necessarily worthy of stand alone publication, or not ready to be published. If the information is relevant, and the source is credible, then the Service is required by the ESA to consider the information. This 5-year review considered available relevant data in assessing the appropriateness of the current classification of the species. It is outside the realm of this document to develop guidelines for pallid sturgeon science.

References

Every effort was made to obtain electronic copies of referenced materials for the peer reviewers. The pallid sturgeon recovery coordinator hopes to provide electronic copies of referenced material (available for download) for those interested. This will be dependant on workload and may occur until after this review is complete.

Pg 8, 292-295

The statement in question is discussing the trend in the population and not discussing the actual population demographics. For this RPMA, there was a declining trend at the time of listing and no new data are available to suggest this declining trend has changed. Language added for clarity.

Pg 8, 298-300

It is agreed that a more formal analysis of population estimates for all RPMAs is necessary. However, confidence intervals for the data in question were not available.

Pg 13, 420-428

This section identifies the larval pallid sturgeon, identified by Dr. Snyder, and subsequent sentences merely indicate the presence of larval *Scaphirhynchus* suggesting some of those could have been pallid sturgeon and noting it is difficult to accurately identify these smaller fish.

Pg 18, 552-554

Because of these concerns and the potential for misinterpretation, the pallid sturgeon to shovelnose sturgeon ratio references have been removed from the final version of the report.

Pg 24, 800-802

This section is referring specifically Middle Mississippi River and by association the Chain-of Rocks.

Pg 24, 835-837

Change made to indicate those were hatchery-reared juveniles monitored by Gerrity.

Pg 20, 1035-1042

Changes made.

Pg 33, 1174-1176

The paper by Jordan *et al.* 2006 concludes that RPMA 3 is suitable for recovery efforts (see last line of abstract). This is not to be confused with actual recovery of the species which this paper makes no conclusions about. It basically closes with the following statement: "*However, whether conditions are present to enable a self-sustaining population, the ultimate determinate of recovery success, remains unknown.*" No revision to text is warranted.

Pg 34, 1206-1208

Changes made.

Pg 34, 1223-1226

Suggested changes incorporated.

Pg 35-36, Mississippi River (RPMA 5)

Language added to improve clarity.

Pg 40, 1479-1480

Language was added to address this concern.

Pg 46, Population size section and specifically line 1742.

Section wording changed to address this concern.

Pg 49, 1849

Noted and changed.

Pg 49, 1849

Seemed to be more of a general statement. Comments noted.

Pg 49, 1861-1879

Seemed to be more of a general statement. Comments noted.

Improving use of science in pallid sturgeon conservation.

Seemed to be more of a general statement. Comment noted.

APPENDIX B
Final Meeting Summary
Of August 24, 2006, Pallid Sturgeon Genetics Conference Call

Genetics Advisory Group/Pallid Sturgeon Recovery Team
Conference Call Summary

Participants

George Jordan*
Heather McSharry
Seth Willey
Bobby Reed*
Jan Dean*
Mike Ruggles
Doug Latka*
Robin Waples**
Kim Scribner**
Ed Heist**
Aaron Schrey
Bill Ardren**
Steve Krentz*
Bill Gardner*
Tracy Hill*
Dave Herzog*
Rob Wood**
Bernie Kuhajda*
Paul Hartfield
Gerald Mestl*
Jane Ledwin
Aaron Delonay*
Tim King**

* Pallid Sturgeon Recovery Team member
** Genetics Advisory Group Member

The purpose of the call was to revisit available genetic data to discuss adequacy and relevance to the pallid sturgeon 5-year review as well as what those data mean regarding management/recovery efforts.

The call was initiated at 0908 and concluded at 1245 MDT August 24, 2006. These minutes were finalized and released on September 7, 2006.

Following introductions, Dr. Ed Heist and his research assistant Aaron Schrey presented their research results. The data presented were microsatellite analysis of 16 loci for 539 tissue samples from *Scaphirhynchus* (approximately 60 from the upper Missouri River, approximately 60 from the middle Missouri River, close to 100 from the lower Missouri River, 150 from the middle Mississippi River, and 100 from the Atchafalaya River). The data presented indicate reproductive isolation among most sample areas. Significant F_{st} values were identified in all comparisons except the Lower Missouri River Samples when compared against the middle Mississippi and Atchafalaya River samples (Figure 1).

	Upper Missouri	Middle Missouri	Lower Missouri	Middle Mississippi	Atchafalaya
Upper Missouri	------	**0.033***	**0.064***	**0.065***	**0.079***
Middle Missouri		------	**0.022***	**0.037***	**0.050***
Lower Missouri			------	**0.001**	**0.014**
Middle Mississippi				------	**0.029***
Atchafalaya					------

Figure 1. Pairwise F_{ST} between Samples in Pallid Sturgeon. (* = significant at $p < 0.05$). Figure and data courtesy of Dr. Ed Heist and Aaron Schrey. Dr. Heist then presented data indicating a strong patter of genetic isolation by distance (Figure 2).

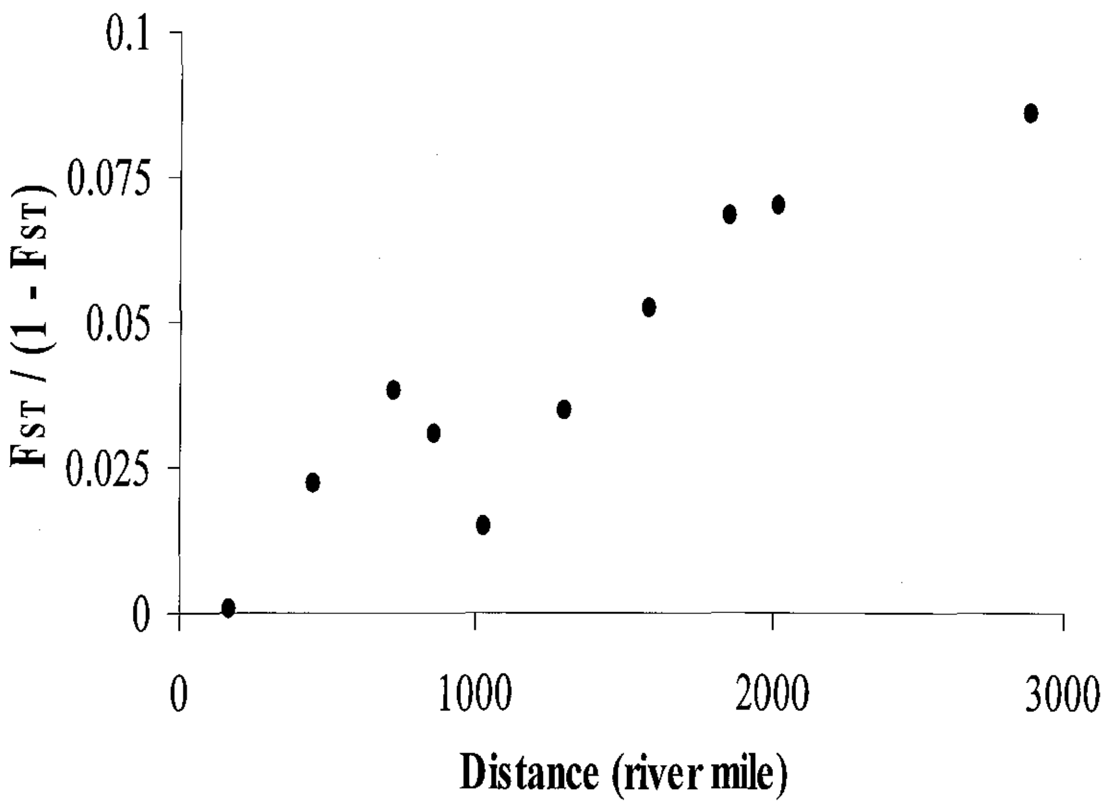

Figure 2. Graph of $F_{st}/(1-F_{st})$ over river miles to demonstrate Isolation by distance. Figure and data courtesy of Dr. Ed Heist and Aaron Schrey.

Finally, genetic grouping data were presented. The results were based on output from the software package STRUCTURE. This program does not require *a priori* species identification and identifies natural groupings among samples to minimize Hardy-Weinberg deviations and linkage disequilibrium. The results presented when all Scaphirhynchus samples (pallid sturgeon, shovelnose sturgeon, and hybrids) were combined from all identified geographic areas result in two groups. However, when only putative pallid sturgeon samples were analyzed, the three genetic groups of pallid sturgeon appear across the species range. The three groupings are a well differentiated upper Missouri River Group (green) and two less differentiated lower Missouri, middle Mississippi, and Atchafalaya River group (blue and yellows) (Figure 3 and 4).

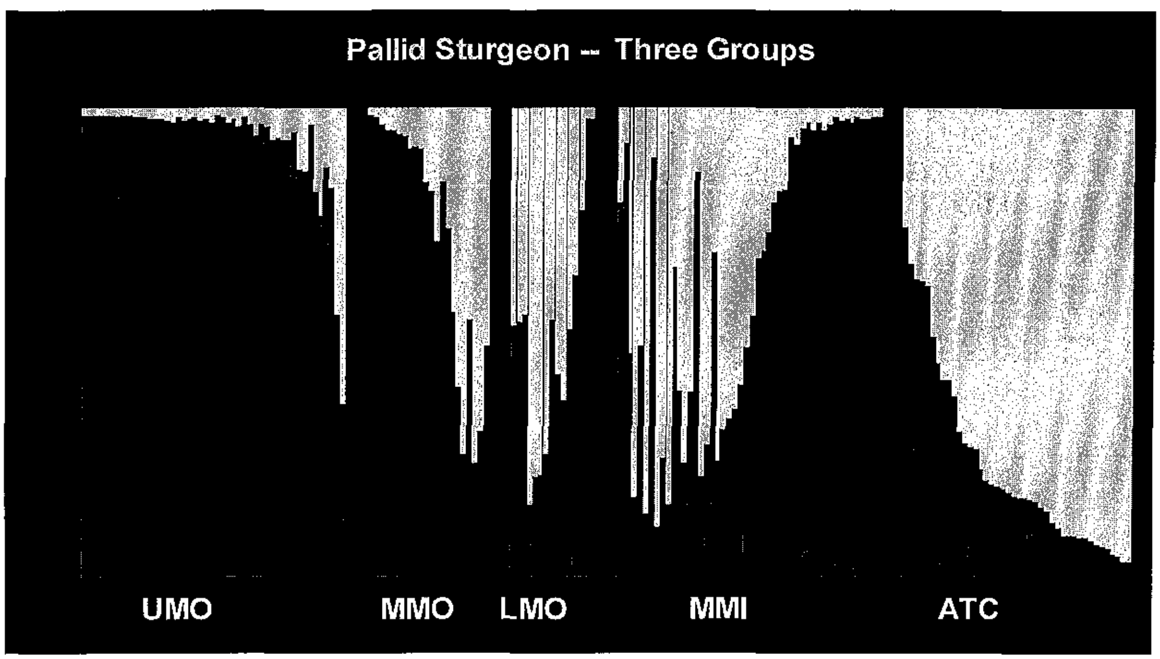

Figure 3. Genetic grouping of pallid sturgeon samples indicating one well-differentiated upper MO group (green) and two less-differentiated lower MO/Miss/ATC groups (blue and yellow). Figure and data courtesy of Dr. Ed Heist and Aaron Schrey.

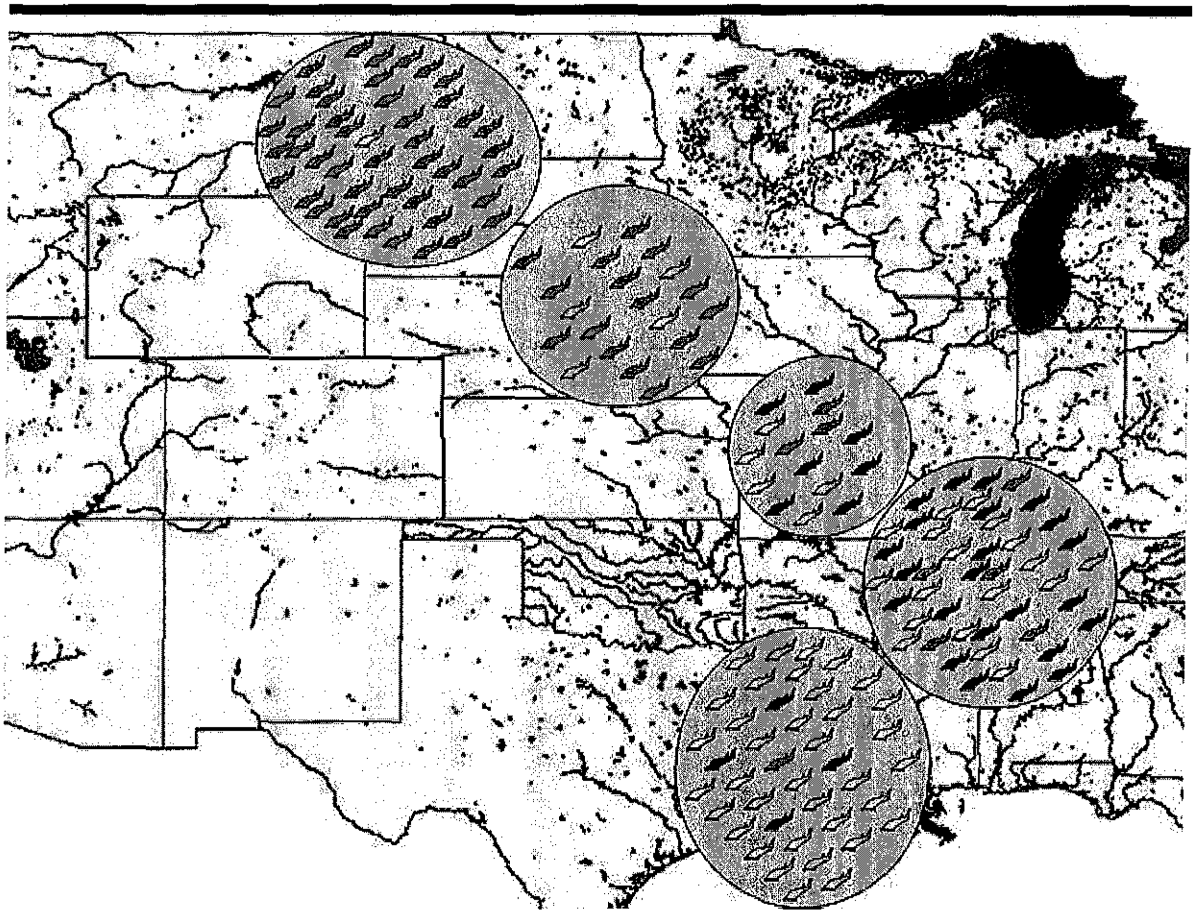

Figure 4. Genetic makeup of five geographic samples (upper Missouri, middle Missouri, lower Missouri, middle Mississippi, and Atchafalaya) of pallid sturgeon. Each fish icon represents an individual sturgeon and the color of the icon indicates which of the three apparent genetic groups to which the fish was most closely assigned. Figure and data courtesy of Dr. Ed Heist and Aaron Schrey.

The conclusions presented by Dr. Heist were:

- Pallid sturgeon exhibit significant differences in microsatellite allele frequencies among regions.
- Upper Missouri River pallid sturgeon samples are most distinct, and genetic structure among lower basin samples is less pronounced and the middle Missouri River samples appearing intermediate to upper Missouri and lower basin samples.
- Stock structure appears to exhibit an "isolation by distance effect"
- Hybridization occurs range-wide yet pallid sturgeon and shovelnose sturgeon are maintaining themselves.

Following this presentation the call was opened to participants for questions and discussions. Following is a summary of the discussions:

A question about the timing of the sample collections and the effects on the data was posed. The samples were collected from pallid sturgeon in an opportunistic fashion, not specifically during spawning periods. This would result in a less detailed picture, yet despite this, there is a surprisingly clear image of isolation by distance (Figure 2).

A brief discussion of hybridization occurred. Hybrids or genetically intermediate *Scaphirhynchus* were found in the samples. Despite the presence of genetically intermediate fish, there are very good [genetically] pallid sturgeon and shovelnose, throughout the range. The data suggests that within the upper Missouri less intermediates or no evidence of "back-crossing" middle Mississippi and Atchafalaya River data suggest a higher number of genetic intermediates in those areas.

In general, there was a pretty high level of confidence in the data analyzed. However, it was noted that the identification of 3 genetic groups of pallid sturgeon should be regarded as very tentative. Robin Waples (Genetics Advisory Group member) cautioned that the software package STRUCTURE has can have difficulty accurately distinguishing among closely related gene pools.

It also was noted that there was apparent gaps in sampling locations. For example there are no lower Mississippi River data, and a large geographical separation between the middle and lower Missouri River samples. These gaps in data could be attributable to some of the differentiation being noticed and completing the samples could provide a better understanding of genetic structuring range-wide.

Following the discussion and presentation of Dr. Heist's genetic data, Dr. Kuhajda provided information on morphometric variation documented with pallid sturgeon.

Dr. Kuhajda presented photos of morphometric variation in pallid sturgeon collected at the extremes of the species range (Figures 5 and 6) as well as a sheared principal components analysis morphometric measurements collected from upper Missouri River pallid sturgeon, shovelnose sturgeon, and known hatchery-reared hybrids (MO) and lower Mississippi/Atchafalaya River pallid, shovelnose, and intermediate sturgeons (Figure 7).

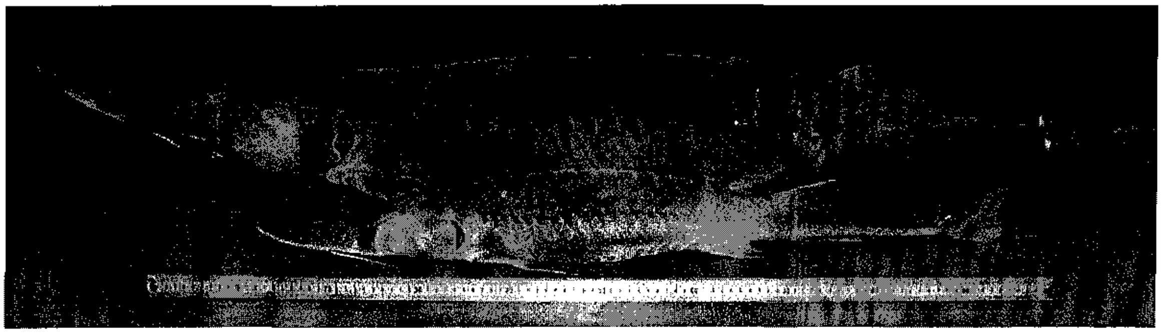

Figure 5. Adult pallid sturgeon, representing a northern specimen from upper Missouri River (top) and southern specimen from the Lower Mississippi/Atchafalaya River (bottom). Both specimens represent some of the largest specimens from each region. Photo courtesy of Dr. Kuhajda.

Figure 6. Adult pallid sturgeon, including northern specimen from upper Missouri River (right) and southern specimen from the Lower Mississippi/Atchafalaya River (left). Both specimens represent some of the largest specimens from each region. Photo courtesy of Dr. Kuhajda.

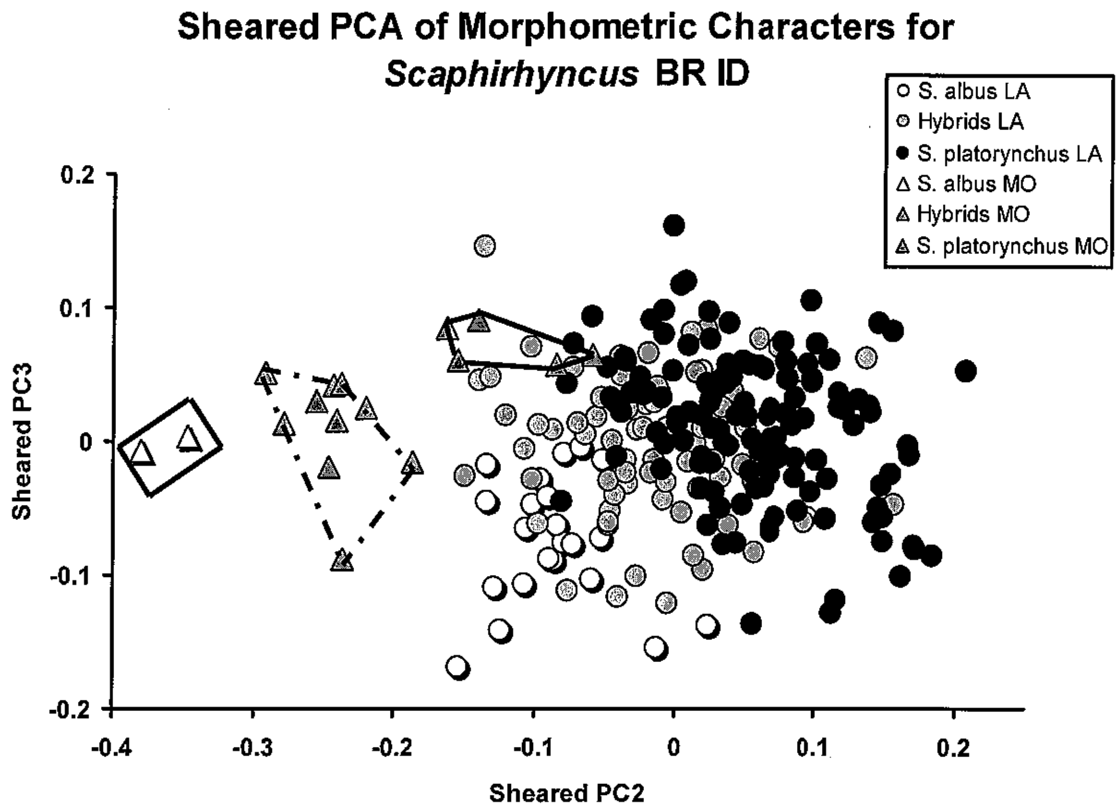

Figure 7. Sheared principal components analysis of 19 head measurements of upper Missouri River pallid sturgeon, shovelnose sturgeon, and known hatchery-reared hybrids (MO) and lower Mississippi/Atchafalaya River pallid, shovelnose, and intermediate sturgeons (LA). Each "dot" represents measurements on an individual fish. Data courtesy of Dr. Kuhajda.

There was some discussion about the photos and data presented. It was postulated that the larger fish were potentially twice as old as smaller fish. The upper basin pallid sturgeon was likely 40+ years old and current data suggest that middle Mississippi pallid sturgeon generally reach ages up to 15 years and lower Mississippi pallid sturgeon generally reach ages up to 20-25 years. Others suggested the size differences could be attributed to a shorter growing season in north latitudes. However, it was indicated that work done by Conover (1990) and others [Power and McKinley 1997] suggests that for some species the opposite is true. In lower latitudes the water temperature heats up faster and may exceed optimum growth temperatures faster than in more northern latitudes, effectively producing a shorter optimum growing season in the south. Dr. Kuhajda explained that the Principal Component Analysis removes overall body size from the equation and is not likely a factor affecting the results identifies in Figure 6.

A reference to a publication (Ruban and Sokolov 1986) also was mentioned that identified morphometric and meristic variation in Siberian Sturgeon, *Acipenser baeri*, some of which were attributed to differing (warmer) temperatures during early developmental periods and demonstrate a high plasticity in the species. Tracy Hill and Dave Herzog indicated that they collected pallid sturgeon in the lower Missouri and middle Mississippi river with varying rostral shapes with some looking very similar to the upper basin specimen (Figures 5 and 6); suggesting some phenotypic plasticity in the species.

Following the data presentations, the general discussion moved towards the data and what does it mean for recovery actions and the existing stocking plan?

Concerns were apparent about the designatable units identified with in the current stocking and augmentation plan. The circles on the map [page 15 of the plan] appear arbitrary. The circles were adapted from Dr. Heist's data coupled with stocked juvenile pallid sturgeon collection data. May not be the best approach.

A point was made that genetics alone should not be the only data utilized to define stock structure or recoverable units. Genetic data coupled with biogeographic data and other unique traits is a more sound approach. Utilizing the data provided by Dr. Heist and biogeographical information could more accurately help define recovery areas or recovery units. For example, it was suggested that physiographic provinces may be better lines to delineate brood collection areas and stocking boundaries. One possible dividing line could be drawn between the central lowlands and great plains physiographic provinces. This fall line pretty close aligns with the data separating the green group from the yellow and blue groups in Figure 4 above. It was suggested the Platte River might be an appropriate landmark between these provinces.

Summary

- There are data supporting reproductive isolation among pallid sturgeon groups.
- There appear to be three groups of pallid sturgeon, a well differentiated group in the upper Missouri (RPMA 1, 2, and the upper reaches of RPMA 4) and two poorly differentiated groups in the lower Missouri, Mississippi, and Atchafalaya based on the current level of data.
- Genetic structure of pallid sturgeon appears to follow an isolation by distance model.
- Genetic data alone are not sufficient for delineation of population management units. Need to consider biogeography and other traits.
- Current model in stocking plan may not best fit conservation of genetic structure as it pertains to supplementation efforts for recovery.

Recommendations

- Collect genetic samples to fill in geographic sampling voids
- May want to consider recoverable units as they relate to recovery activities.
- Revisit stocking and augmentation plan to re-evaluate current supplementation practices.

Conover, D.O. 1990. The relation for capacity for growth and length of growing season: Evidence for and implications of countergradient variation. Transactions of the American Fisheries Society 119:416-430.

Power, M., and R.S. McKinley. 1997. Latitudinal variation in lake sturgeon size as related to the thermal opportunity for growth. Transactions of the American Fisheries Society 126:549-558.

Ruban, G.I., and L.I. Sokolov. 1986. Morphological variability of Siberian Sturgeon, *Acipenser baeri*, in the Lena River in relation with its culture in warm waters. UDC 639.3:597,442:591.49. Originally published in Voprosy Ikhtiologii. 3:470-475.

CHAPTER 2—The Districts

USFWS

Wildlife protection is a priority of district management.

Every unit of the Refuge System has a purpose for which it was established. This purpose is the foundation upon which all programs are built, from biology and public use to maintenance and facilities. No action that the Service or the public takes may conflict with this purpose. The goals, objectives, and strategies identified in this CCP are intended to support the purposes for which each district was established.

A wetland management district provides oversight for all of the Service's small land tracts in a multicounty area. The three districts manage 445 WPAs (100,094 acres) and more than 1 million acres of conservation easements in 25 counties in South Dakota. These district lands (totaling 1,136,965 acres) are part of the National Wildlife Refuge System, a network of lands set aside to conserve fish and wildlife and their habitat.

The Service purchases WPAs with funds generated from the sale of Federal Duck Stamps to protect and restore waterfowl habitat. These areas are managed primarily for the production of migratory birds. Conservation easements, also purchased using Duck Stamp funds, are on private lands where landowners have sold some of their property rights to the Service for protection and restoration of wildlife habitat.

This chapter describes the history, special values, purposes, vision, goals, and planning issues for the three South Dakota districts.

2.1 Establishment, Acquisition, and Management History

The Huron, Madison, and Sand Lake WMDs were established with the major objectives of wetland preservation, waterfowl and wildlife production, and maintenance of breeding grounds for migratory birds. The districts also provide a northern staging area and habitat for migration.

Habitat Protection

The Service manages the WPAs for the benefit of waterfowl, other migratory birds, threatened and endangered species, and resident wildlife. The districts protect habitat primarily with two tools—WPAs and conservation easements—briefly described below.

- WPAs are public lands purchased by the Federal Government for increasing the production of migratory birds, especially waterfowl. The purchase of land is also known as "ownership in fee title," where the Federal Government holds ownership of land on behalf of the American public. Money to buy WPA lands generally comes from the sale

© Chris Bailey

Mallard drakes in flight.

of Federal Duck Stamps. This important program was developed to ensure the long-term protection of waterfowl and other migratory bird breeding habitat, primarily in the Prairie Pothole Region of the northern Great Plains (figure 3). All WPAs are within districts managed by Service staff. WPAs are open to the public for hunting, fishing, bird watching, trapping, hiking, and most other nonmotorized and noncommercial outdoor recreation. (Recreational trapping has been authorized by 50 CFR part 31.16.)

- Conservation easements are acquired to protect migratory bird species habitat on private land. Typically used where acquisition in fee title is not desirable or needed, perpetual easements are bought from willing landowners within a wetland management district. Conservation easements have several advantages over the outright purchase of lands by the Service. First, they are more cost effective in terms of both initial purchase and long-term management responsibilities. While conservation easement contracts do require attentive enforcement to ensure their integrity, they do not carry the other burdens of ownership—for example, maintenance of facilities such as fences and signs, control of invasive plants, and mowing of ditches. Second, the operator owns and manages the land in much the same way as was done before the conservation easement purchase. The program was developed and carried out by managers, biologists, and realty specialists with an interest in protecting resources at the landscape scale while minimally affecting, and even complementing, other agricultural practices. A single-habitat conservation easement is often referred to as either a "wetland easement" or a "grassland easement." Wetland easements generally prohibit draining, burning, and leveling. Grassland easements generally prohibit the cultivation of grassland habitat, while still permitting the landowner traditional grazing uses.

The Service initially focused only on the protection of wetlands in the Prairie Pothole Region. However, data also revealed the importance of upland grasslands to successful nesting of waterfowl. With the continued conversion of grassland to cropland and consistent declines in the populations of grassland-dependent birds, the need to protect adjacent grassland habitats became evident. Like a wetland easement, a grassland easement transfers limited perpetual rights to the Service for a one-time, lump-sum payment. The purpose of a grassland easement is to prevent the conversion of grassland to cropland while minimally restricting existing agricultural practices. More specifically, the purposes of the grassland easement are to improve the water quality of wetlands by reducing soil erosion and the use of chemicals and fertilizers on surrounding uplands; to improve upland nesting habitat for all ground-nesting birds, especially waterfowl, and enhance nesting success on private lands; to perpetuate grassland cover established by other Federal programs (for example, the Conservation Reserve Program [CRP]); and to provide an alternative to the purchase of uplands in fee title, thus maintaining lands in private ownership. Grassland easements restrict the landowner from altering the grass by digging, plowing, disking, or otherwise destroying the vegetative cover. Haying, mowing, and seed harvest are restricted until July 16 of each year. The landowner can graze without restriction.

Wetland easements are administered similarly to grassland easements. These easements restrict the landowner from altering wetlands through draining, burning, or filling. When they are dry, the landowner can farm wetlands without restriction. Areas of wetland habitats supporting more than 25 duck pairs per square mile are eligible for the program.

The Federal Migratory Bird Conservation Fund finances the acquisition of WPAs and conservation easements by providing the U.S. Department of the Interior (Department) with monies to acquire migratory bird habitat. The 1958 amendment to the Migratory Bird Hunting and Conservation Stamp Act (Duck Stamp Act) (16 United States Code [U.S.C.] 718) authorized the Small Wetlands Acquisition Program and provided for the acquisition of WPAs in addition to the previously authorized habitats. Receipts from the sale of Duck Stamps are used to acquire habitat under the provisions of the Migratory Bird Treaty Act (16 U.S.C. 715). The Service's perpetual conservation easements are key components of the Small Wetlands Acquisition Program; these easements, together with WPAs, have contributed greatly to the conservation and maintenance of prairie-nesting migratory birds.

The districts administer other conservation easements that were not acquired through the Small Wetlands Acquisition Program. The most common of these are Farmers Home Administration conservation

Table 2. Grassland and wetland easements in the three districts.

District	County	Purchase date	Tract	Number of acres	Number of tracts	Total acres
First Grassland Easement Purchase						
Huron	Sanborn	12/05/1990	188G	529.00	455	141,944.89
Madison	McCook	12/30/1991	191G	129.20	243	53,612.46
Sand Lake	Walworth	06/22/1990	83G	436.00	905	332,314.83
Total					1,603	527,872.18
First Wetland Easement Purchase						
Huron	Hand	10/09/1963	11X	29.00	1,424	85,579.90
Madison	Deuel	01/18/1963	10X	31.00	1,573	55,218.10
Sand Lake	McPherson	07/20/1962	12X	242.00	3,497	231,761.16
Total					6,494	372,559.16

easements—also known as Rural Economic and Community Development easements, Farm Service Agency "Ag-Credit easements," and U.S. Department of Agriculture (USDA) conservation easements, depending on the status of the USDA program responsible for these properties at the time they were in Federal inventory. The 1985 Farm Bill Consolidated Farm and Rural Development Act was the initial authorization for Farmers Home Administration easements. The Farmers Home Administration was given authority to establish easements for conservation, recreation, and wildlife purposes on properties that were foreclosed on by the Federal Government ("inventory" properties), and the Service was designated easement manager for those easements worthy of inclusion into the Refuge System.

District Descriptions

The three districts support all the waterfowl species that occur in the Prairie Pothole Region. The three districts manage more than 1.5 million acres within the 27-county planning area in South Dakota (for an accurate breakdown of these acres please see "Service Activities in South Dakota" in chapter 1). Each of the three districts is described below.

Huron WMD

The Huron WMD was established in 1992. The district was established encompassing lands that were previously under the management of both the Lake Andes and Sand Lake WMDs. This area was too far from the previous management offices to afford reliable and efficient management, resulting in minimal management of lands acquired prior to district establishment.

Huron WMD encompasses eight counties—Beadle, Buffalo, Hand, Hughes, Hyde, Jerauld, Sanborn, and Sully—in east-central South Dakota, an area of approximately 6,869 square miles. In 2010, the district administered 62 WPAs totaling approximately 17,574 acres, wetland easements totaling approximately 86,333 acres, grassland easements totaling approximately 145,205 acres, and conservation easements totaling approximately 10,100 acres (figure 5). Although at least one WPA is located in every county, the majority are currently in Beadle, Hand, and Jerauld Counties.

Important features of Huron WMD include the following:

- The district contains the smallest number of fee-title acres. Due to the smaller size of this district, staff has the ability to manage and monitor intensively.
- The district is subject to the most rapid agricultural growth and development of the three districts; this growth is expected to continue.
- The district presents opportunities to increase easement acres—meaning an opportunity to protect more native prairie.
- Management focuses on restoration of native prairie with fire and grazing.
- The Huron WMD is one of only three districts with an active Friends Group.

Issues faced by Huron WMD include the following:

- The location is challenging. Many hours of travel are required to manage and monitor district lands.
- Significant conversion of grasslands to agriculture continues within the district.

Madison WMD

The Madison WMD was established in 1969. It evolved from the withdrawal of four counties from Waubay WMD and five counties from Lake Andes WMD. Deuel, Brookings, Hamlin, Kingsbury, Miner, Moody, McCook, Lake, and Minnehaha Counties are included within the district, covering an area of 5,804 square miles. Minnehaha is the largest South Dakota county by population, with 148,281 inhabitants. The district extends west from the Minnesota border through the Big Sioux Basin and Prairie Coteau ecoregions (see discussion in chapter 4). Tallgrass prairie and agricultural lands comprise most of the district. As of January 2010, the Madison WMD administered 221 WPAs totaling approximately 38,778 acres, wetland easements totaling approximately 57,074 acres, grassland easements totaling approximately 72,263 acres, tallgrass prairie easements totaling approximately 11,006 acres, and Farmers Home Administration easements totaling approximately 6,500 acres (figure 6).

Important characteristics of Madison WMD include the following:

- The district consists primarily of tallgrass prairie (with some mixed-grass prairie). The district contains Prairie Coteau, James River Lowland, Big Sioux Basin, and Loess Prairies.
- The district has the largest human population of the three South Dakota districts.
- The district is home to many lakes and semipermanent or permanent wetlands.
- The district contains the least amount of native prairie of the three districts.
- Such notables as early pioneer artist Harvey Dunn and author Laura Ingalls Wilder of "Little House on the Prairie" are from this area. Wilder's book, "On the Shores of Silver Lake," was written about her childhood memories of life next to a beautiful prairie wetland that still attracts many visitors each year.

Issues faced by Madison WMD include the following:

- The largest human population leads to issues with encroaching urban development.
- More lakes mean more people—meaning more jet skis and more wildlife disturbance.
- Wetland drainage issues require more enforcement. Wetlands may be wet only about 50 percent of the time; people want to drain wetlands so that they can produce crops.
- There is extensive agricultural tillage; native grass is diminishing at an alarming rate.

SAND LAKE WMD

The Sand Lake WMD was established in 1961. The largest district in the country, it originally encompassed 11 counties—Brown, Spink, McPherson, Edmunds, Faulk, Campbell, Walworth, Potter, Corson, Dewey, and Sully—in north-central South Dakota, covering an area of approximately 12,000 square miles. In 1992, Sully County was transferred to the newly established Huron WMD. The current 10-county district extends west to the Missouri River and includes part of the James River Basin to the east. The western portion of the district is characterized by mixed-grass prairie. Transition prairie and agricultural lands characterize the eastern portion. In 2010, the district administered 162 WPAs totaling approximately 43,742 acres, wetland easements totaling approximately 234,986 acres, grassland easements totaling approximately 398,589 acres, and conservation easements totaling approximately 14,815 acres (figure 7).

Important characteristics of Sand Lake WMD include the following:

- The district extends from James River Lowland in the southeastern corner to the Missouri Plateau in the northwestern corner, with most of its fee title and easement lands in the Missouri Coteau and Drift Plains.
- The district straddles the Missouri River and includes some easements west of the Missouri River.
- Wetland drainage and tiling are not as great an issue as in other districts.

Issues faced by Sand Lake WMD include the following:

- The Sand Lake WMD is a very large entity, and it currently shares staff with the Sand Lake National Wildlife Refuge. This shared arrangement provides minimal operational staffing for the district.
- Headquarters are at the Sand Lake refuge. This location is not ideal, because it is far from the majority of landholdings.
- Controlling invasive plants is an ongoing effort for district staff.
- Tillage is occurring at an accelerated rate.

2.2 Special Values

Early in the planning process, the planning team and public identified the outstanding qualities of the three districts. District qualities are the characteristics and features of each district that make it special, valuable for wildlife, and worthy of inclusion in the Refuge System. It was important to identify the special values of each district to recognize its worth and to ensure that the special values of the districts are preserved, protected, and enhanced through the planning process. District qualities can be distinct and important biological values, as well as simple values such as providing a quiet place to see a variety of birds and enjoy nature.

The following summarizes the qualities that make the districts unique and valued:

- The districts have a very high density of wetlands to support waterfowl and migratory birds.
- Very large blocks of intact native prairie ecosystem are protected through the districts' conservation easements and fee-title ownership.
- The districts provide protected and managed wetlands and uplands for breeding and staging habitat for waterfowl and shorebirds during migration along the central flyway.
- The districts provide diverse and abundant possibilities for public use.
- The districts provide for quality environmental education.

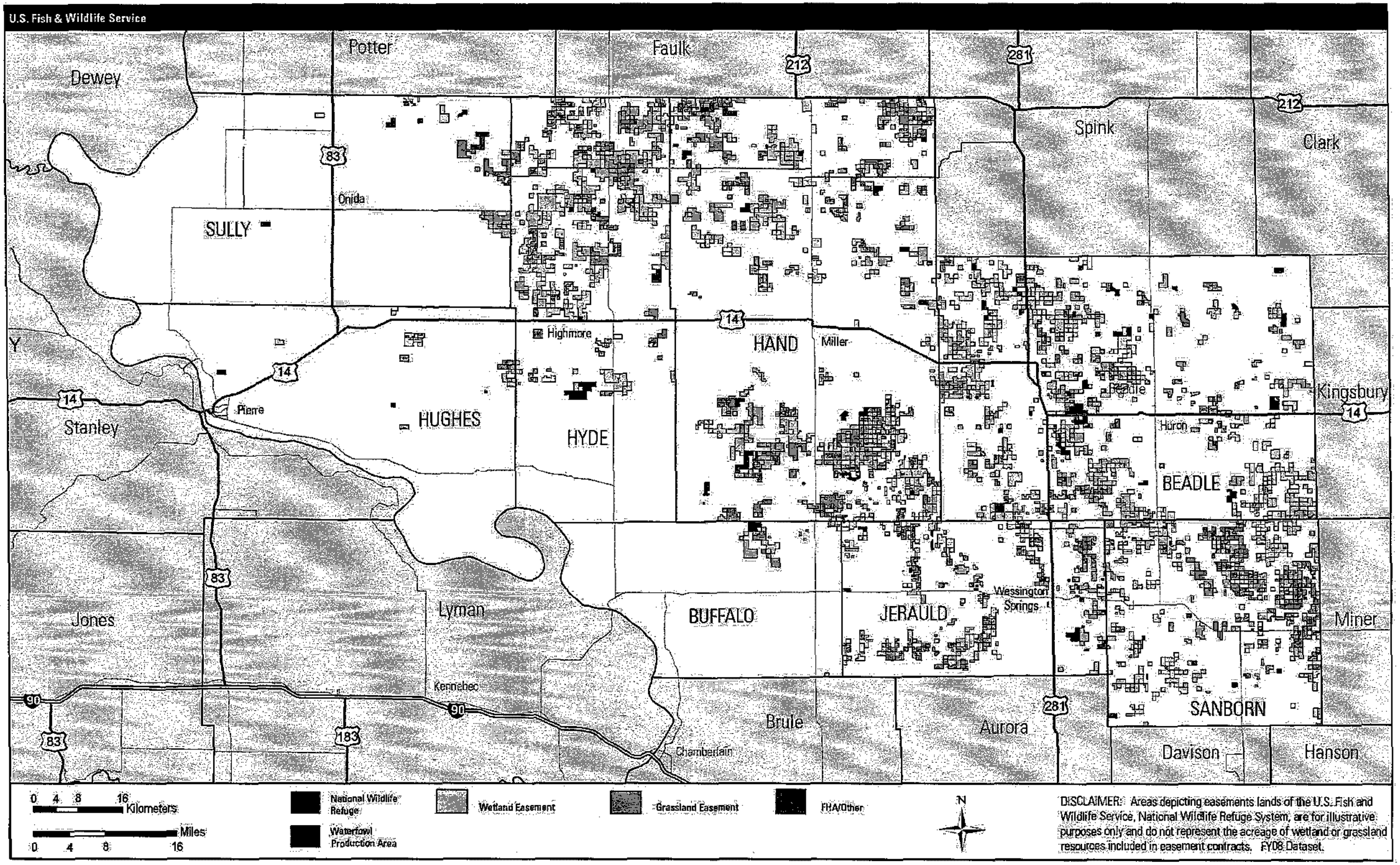

Figure 5. Service-managed lands in the Huron WMD.

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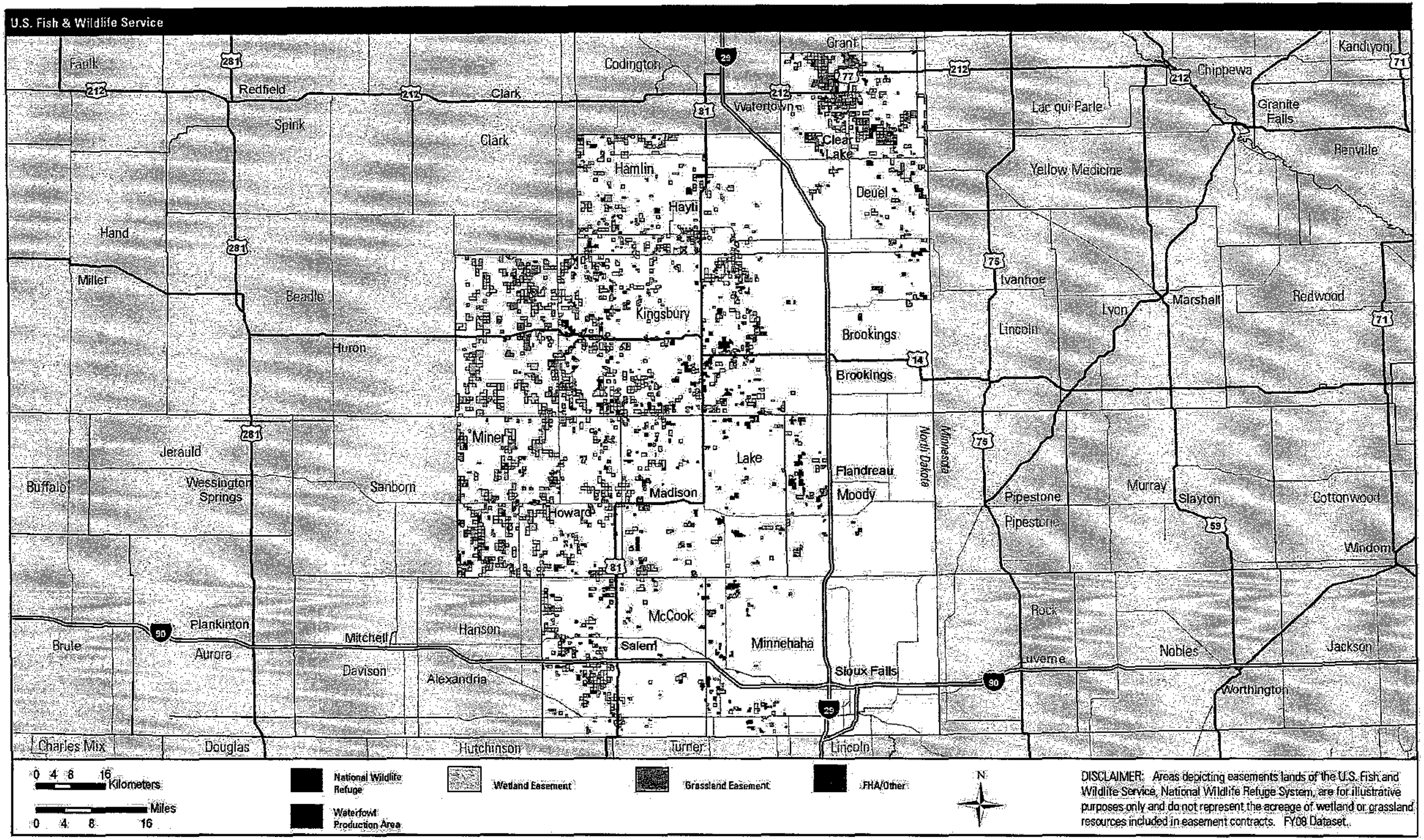

Figure 6. Service-managed lands in the Madison WMD.

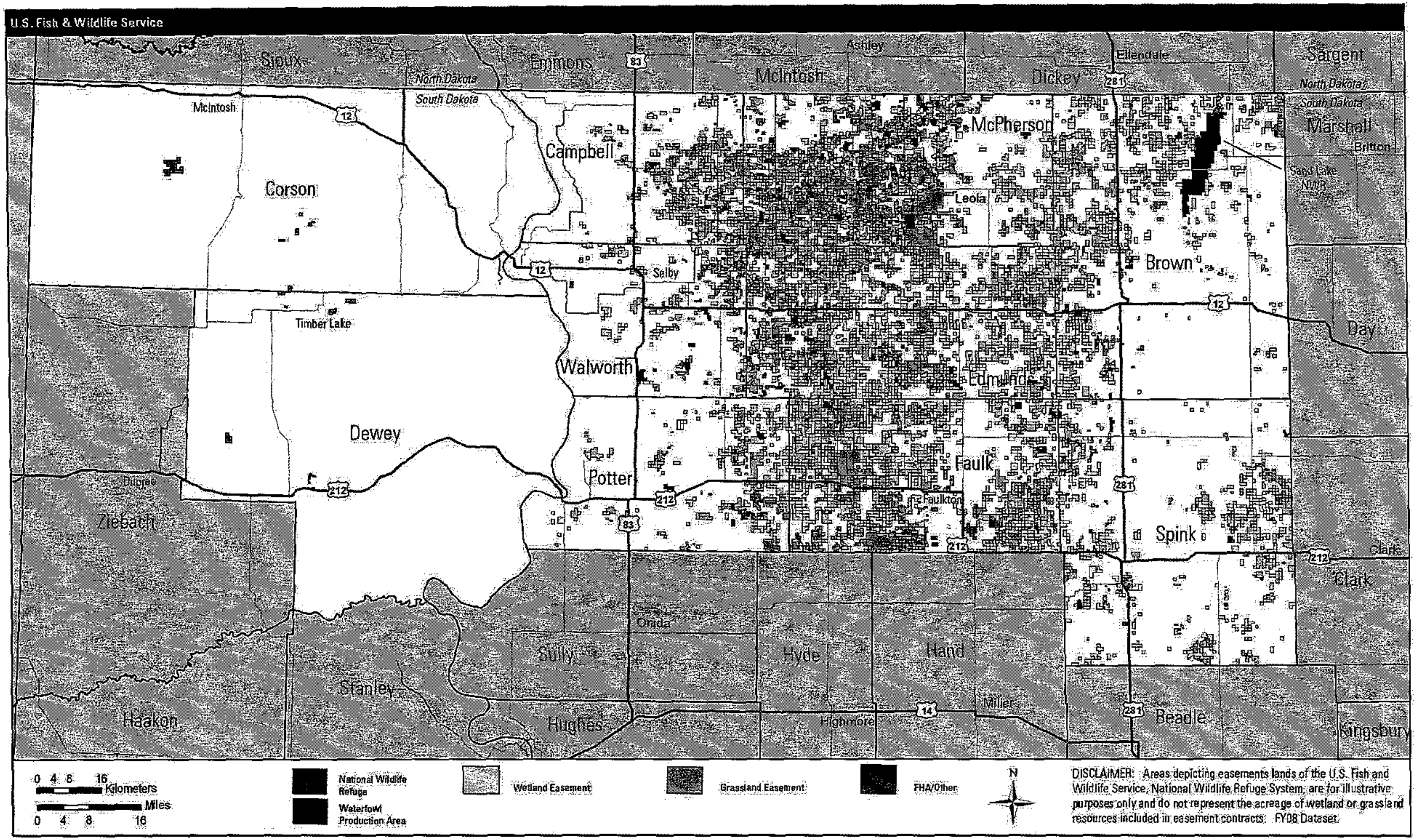

Figure 7. Service-managed lands in the Sand Lake WMD.

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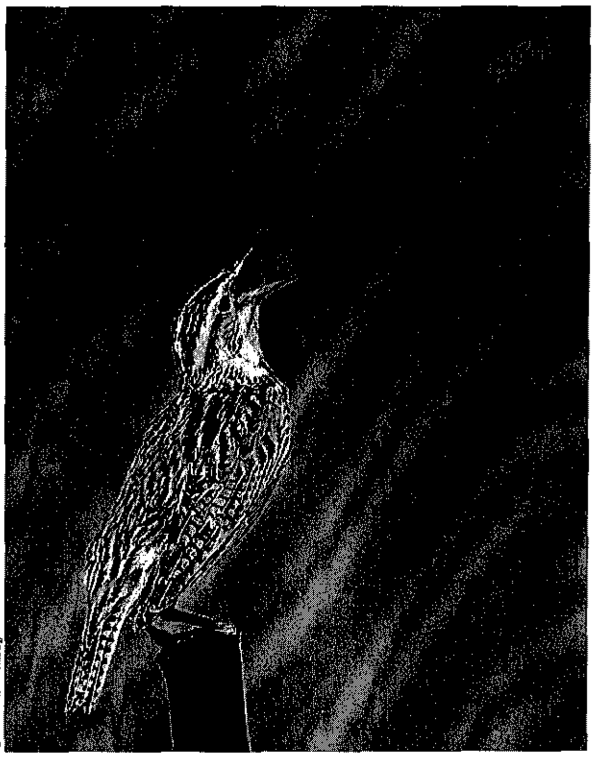
2.3 Purposes

The districts were created to administer the Small Wetlands Acquisition Program to save wetlands from various threats—particularly drainage. By 1991, grassland easements were also being protected under this program. The main authorities in establishment of the program are briefly discussed below:

- Migratory Bird Hunting and Conservation Stamp Act (16 U.S.C. 718d[c])—"as waterfowl production areas subject to all provisions of the Migratory Bird Conservation Act … except the inviolate sanctuary provisions." The Duck Stamp Act provides for the conservation, protection, and propagation of native species of fish and wildlife, including migratory birds that are threatened with extinction.
- Migratory Bird Conservation Act (16 U.S.C. 715d[2])—"for any other management purposes, for migratory birds." This act addresses the obligations of the United States under the Migratory Bird Treaty Act through the following mechanisms:
  - Lessening the dangers threatening migratory game birds from drainage and other causes.
  - The acquisition of areas of land and water to furnish in perpetuity reservations for the adequate protection of such birds.
  - Authorizing appropriations for the establishment of such areas, their maintenance and improvement, and for other purposes.



© Chris Bailey

Western meadowlark singing.

The purpose of the districts is "to assure the long-term viability of the breeding waterfowl population and production through the acquisition and management of waterfowl production areas, while considering the needs of other migratory birds, threatened and endangered species, and other wildlife" (memorandum from Region 6 Assistant Regional Director Richard A. Coleman, December 2006). This purpose statement was developed for all Region 6 wetland management districts. Because the purposes and management capabilities and challenges are similar for the three districts, the Service has elected to address them collectively in this CCP.

2.4 Vision

At the beginning of the planning process, the Service developed a vision for the three districts. The vision is a concept that describes the essence of what the Service is trying to accomplish in the three districts. It is a future-oriented statement intended to be realized by the end of the 15-year CCP planning horizon.

Clear blue skies frame spectacular views of grasslands and wetlands teeming with migratory waterfowl and other wildlife in the Huron, Madison, and Sand Lake Wetland Management Districts. Here, future generations will experience the whistle of the northern pintail, the song of the western meadowlark, and the distant boom of the prairie chicken. Located in the Prairie Pothole Region of South Dakota, these districts preserve timeless landscapes in the face of change. Conservation of these lands is achieved through hard work and the support of friends and neighbors who value natural places as an essential component of their quality of life.

2.5 Goals

The following goals have been developed to guide management decisions as they pertain to natural communities, uses, and management activities.

Native Prairie

Conserve, restore, and improve the biological integrity and ecological function of the native prairies to support

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healthy populations of native plants and wildlife and promote the natural role of fire and grazing in shaping and managing these landscapes.

Planted Grasslands

Manage planted grasslands to contribute to the production and growth of continental waterfowl populations, other migratory birds, threatened and endangered species, and other wildlife.

Wetlands

Protect, restore, and enhance prairie pothole wetlands to support diverse plant communities and provide habitat to waterfowl, shorebirds, wading birds, and associated wetland-dependent wildlife.

Research and Monitoring

Provide a learning platform that uses science, monitoring, applied research, and adaptive management to advance understanding of the Prairie Pothole Region and management of these areas.

Consumptive Uses

Provide visitors with quality opportunities to enjoy hunting, fishing, and trapping in waterfowl production areas and expand their knowledge and appreciation of the prairie landscape and the National Wildlife Refuge System.

Bridgette Flanders-Wanner/USFWS

Biologist Shilo Comeau on a wetland field visit.

Nonconsumptive Uses

Provide visitors with quality opportunities to enjoy, observe, photograph, and appreciate the prairie ecosystem while expanding their knowledge of and support for the National Wildlife Refuge System.

Operations and Administration

Through effective communication and innovative partnerships, secure and efficiently utilize funding, staffing, and volunteer programs for the benefit of all natural resources in the districts.

Partnerships

Promote and develop partnerships with landowners, public and private organizations, and other interested individuals to maintain, restore, and enhance a diverse and productive landscape in the Prairie Pothole Region.

Environmental Education and Interpretation

Provide quality educational opportunities for persons of all abilities to learn about, understand, and appreciate prairie landscapes and the role of the National Wildlife Refuge System.

2.6 Planning Issues

Several key issues were identified through the analysis of comments collected from Service staff and the public and a review of the requirements of the Improvement Act and NEPA. Substantive comments (those that could be addressed within the authority and management capabilities of the Service) were considered during the formulation of the alternatives for future management. Summaries of these key issues are below.

Wetland and Upland Habitats

All three districts have a primary purpose to provide optimal habitat conditions for the needs of a suite of waterfowl and other migratory birds and, to a lesser extent, native resident wildlife. Aggressive management of wetland and upland habitats must be conducted to achieve goals and objectives. Wetland and upland habitats need to be protected and enhanced through management. Habitat protection needs to be evaluated through a system of prioritization so that different approaches to protection—either fee-title acquisition or conservation easement—can be evaluated.

Invasive Plants

The districts include uplands that were previously farmed. Farmed uplands have since been restored to mixes of tame and native grasses. These areas are interspersed with native uplands, the bulk of which are largely dominated by native vegetation character but are compromised by invading species. The primary invasive forbs are leafy spurge, Canada thistle, sow thistle, and absinth wormwood. Smooth brome, Kentucky bluegrass, and crested wheatgrass are primary invasive grass species. These nonnative forbs and grasses substantially degrade the quality and suitability of upland habitat for many native wildlife species.

Energy Development

While the Service works to minimize the negative effects of energy development, the demand for energy is an increasing factor in habitat quality and preservation in the districts. The production of biofuels and wind energy has the potential to impact the effectiveness of many district programs. The Service supports research that helps to understand the effects on wildlife of renewable energy projects such as wind farms and the conversion of grassland to cropland for ethanol production. For example, the effects of wind turbines on birds remains a challenging matter to investigate. Through studies and analysis, the Service is currently evaluating wind turbines to determine their effects on wildlife. In addition, it is unknown if wind power will affect the potential for future habitat protection through conservation easements.

Prairie Conversion

Native prairie is suffering conversion to other uses at an alarming rate. Prairie is being converted for crop production, creating additional demand for irrigation water. Conservation groups should assume an active role, in partnership with the agricultural community, to protect the Federal Farm Bill and its conservation provisions, such as the CRP and the "Swampbuster" and "Sod Saver" provisions in the 1985 Farm Bill (amended 1990, 1996, 2002).

© Chris Bailey

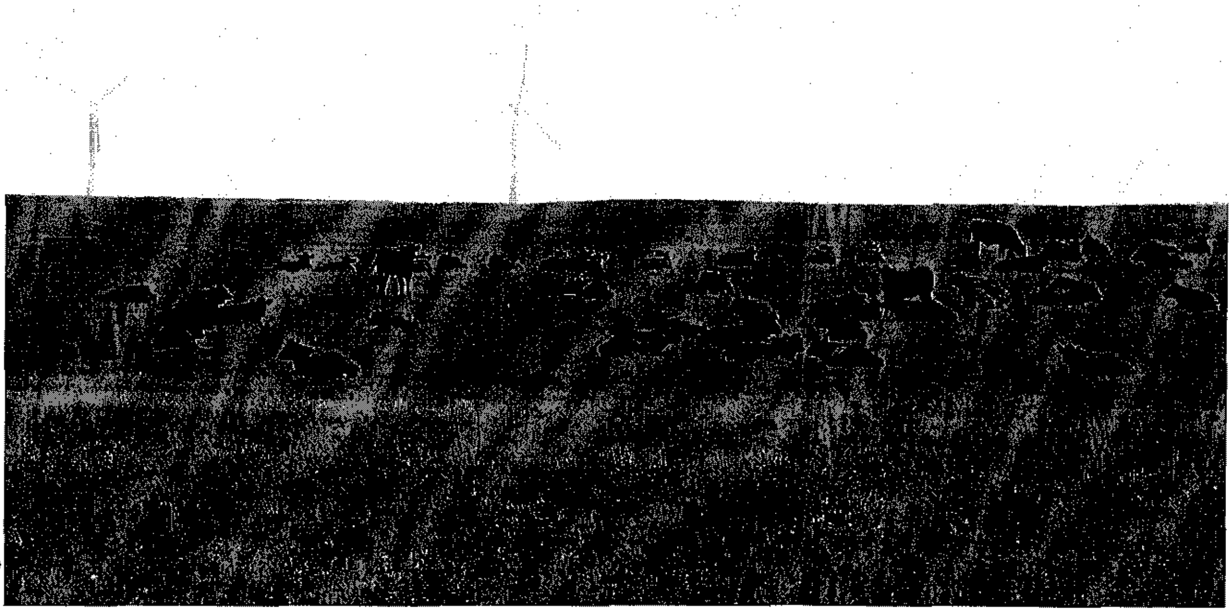
Red foxes thrive in human-influenced environments.

Predator Management

Several species—particularly red fox, coyote, striped skunk, Franklin's ground squirrel, mink, badger, and raccoon—occur at higher than historical levels due to modifications of habitat and other factors. These species can adversely affect—primarily by predation on nests of grassland-nesting bird species—waterfowl and other migratory bird populations. Such predation reduces the likelihood that the Service can attain wildlife population goals and objectives for the districts. Woody vegetation has a negative influence on grassland songbirds because it provides habitat for predators and attracts forest-edge bird species that may displace grassland species.

Visitor Services

Hunting, fishing, wildlife observation and photography, and environmental education and interpretation are uses currently authorized on lands administered



Bridgette Flanders-Wanner/USFWS

District lands serve multiple purposes.

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by the districts. A growing demand for public recreation in South Dakota and the nation makes these six wildlife-dependent recreational uses, as specified in the Improvement Act, an issue of primary interest.

Partnerships

The Service puts a high priority on working in partnership with conservation and agricultural groups to support conservation programs such as Federal Farm Bill legislation, SDGFP projects, water quality and watershed projects, and private conservation efforts.

Operations

Funding and staff are not sufficient to fulfill the purposes and meet the goals of the districts. Identification of priorities and efficient direction of resources will always be an issue for the districts. The Service's staff needs to identify and describe unfunded needs to be able to compete effectively for additional money from within the Service as well as from partners and other sources. District facilities need to be evaluated and upgraded.

Monitoring and Research

Monitoring habitat and wildlife populations is an essential element in achieving the districts' primary goals and objectives. Basic data about recruitment, mortality, and habitat use for a representative group of species must be collected and analyzed on a regular basis to make appropriate decisions for maintaining the viability of the habitats on which these species depend. Using the districts for field research could contribute valuable strides in development of new directions in management and expansion of the knowledge of field biologists.

Western Prairie Fringed Orchid
(Platanthera praeclara)

5-Year Review:
Summary and Evaluation

February 2009

Photo: J. Challey

U.S. Fish and Wildlife Service
Twin Cities Field Office
Bloomington, Minnesota

5-YEAR REVIEW
Western Prairie Fringed Orchid (*Platanthera praeclara*)

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5-YEAR REVIEW
Western Prairie Fringed Orchid (*Platanthera praeclara*)

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional Office: Carlita Payne, Midwest Region, (612) 713-5339

Lead Field Office: Phil Delphey, Twin Cities Field Office, (612) 725-3548

Cooperating Ecological Services Field Offices:

Carol Aron, North Dakota Field Office, (701) 250-4402
Hayley Dikeman, Oklahoma Field Office, (918) 382-4519

Cooperating Regional Offices:

Seth Willey, Mountain-Prairie Region, (303) 236-4257
Wendy Brown, Southwest Region, (505) 248-6664

The following persons also provided helpful comments:

Mel Nenneman – Valentine National Wildlife Refuge
Gary Willson (RT)[1] – National Park Service
Tom Nagel (RT) – Missouri Department of Conservation
Tim Smith – Missouri Department of Conservation
Bill Watson (RT) – Cedar Falls, Iowa

1.2 Methodology used to complete the review:

The review was conducted by Phil Delphey in the Twin Cities Field Office in coordination with other field offices in the Mountain-Prairie and Southwest Regions. The Service solicited information from the public through a *Federal Register* notice (71 FR 16177) and also reviewed reports and scientific papers that had been completed since the November 1991 5-year review (which includes the species' 1996 approved recovery plan). We reviewed each document for significant information, beginning with the earliest document not cited in the recovery plan (i.e., Fauske and Rider 1996 – see References). In addition, we relied extensively on a database containing information on each occurrence of western prairie fringed orchid, which the Service maintains at its Twin Cities Ecological Services Field Office.

[1] "RT" indicates that this person is a member of U.S. Fish and Wildlife Service's Western Prairie Fringed Orchid Recovery Team.

1.3 Background:

1.3.1 Federal Register Notice citation announcing initiation of this review:

71 FR 16176, March 30, 2006.

1.3.2 Listing history

Original Listing
FR notice: 54: 39857-39863
Date listed: September 28, 1989
Entity listed: *Platanthera praeclara*
Classification: Threatened

1.3.3 Associated rulemakings: None

1.3.4 Review History: Western prairie fringed orchid was included in a five-year review of all species listed before January 1, 1991 (56 FR 56882). The five-year review resulted in no change to the listing classification of threatened.

1.3.5 Species' Recovery Priority Number at start of 5-year review: 8C. A recovery priority of 8C denotes that the degree of threat is moderate, the recovery potential is high, the listed taxon is a species (e.g., as opposed to a subspecies), and that the species may be in conflict with construction, other developmental projects, or other forms of economic activity.

1.3.6 Recovery Plan

Name of plan: Western Prairie Fringed Orchid (*Platanthera praeclara*) Recovery Plan
Date issued: September 30, 1996
Dates of previous revisions, if applicable: N/A

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate? *No*

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria? *Yes*

2.2.2 Adequacy of recovery criteria

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat? *No*

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:

The recovery criteria in the 1996 recovery plan (U.S. Fish and Wildlife Service 1996) are:

Platanthera praeclara will be considered for delisting when sites that include occupied habitat harboring 90 % of plants in each ecoregion are protected at protection levels 4 through 9 (The Nature Conservancy 1996) and managed in accordance with a Service-approved management plan or guidelines. This plan must assure implementation of management practices that provide the range and spatial distribution of successional and hydrologic regimes required to maintain the species and its pollinators in self-sustaining, naturally occurring populations, and must remain in effect following delisting. Implementation of these criteria is further clarified in the strategy of recovery section above and in the recovery narrative below.

The recovery criteria may be divided into two distinct components – ensuring that (1) a minimum proportion of plants within each inhabited ecological region occur on lands that are protected from habitat destruction and (2) management of these protected habitats is conducive to the conservation of western prairie fringed orchid. Below we refer to these as the protection and management criteria, respectively.

Protection Criterion:
...sites that include occupied habitat harboring 90 % of plants in each ecoregion are protected at protection levels 4 through 9 (The Nature Conservancy 1996)...

Under this criterion, plants are protected only if they are on sites that are "permanently safe from conversion from grassland into any other use" (see Strategy of Recovery section in the recovery plan - U.S. Fish and Wildlife Service 1996:17). Levels 4 through 9 ensure protection in different ways, as listed below. The Nature Conservancy's 10 levels of protection are (The Nature Conservancy 1996):

0 No protection
1 Notification – Landowner or site manager notified of the species' presence

2 Voluntary protection provided by landowner or site manager
3 Bequest – Will, right of first refusal, or other landowner/agency commitment
4 Lease, license, or management agreement
5 Undivided or remainder interest conveyed to a conservation entity
6 Public land designation
7 Conservation easement
8 Fee title or beneficial interest with management control
9 Dedication

This criterion addresses the following threats:

- Conversion of habitat to cropland
- Inter-seeding of non-native species, especially creeping foxtail (*Alopecurus arundinaceus* Poir, also called Garrison creeping foxtail), into wet prairie in Nebraska. Inter-seeding of non-native species is only likely to occur on sites managed primarily for agriculture.

The recovery criteria do not specifically address the viability of protected populations. For example, an ecoregion could meet this criterion even if none of the protected populations are viable. Actions 421-423 in the recovery plan's step-down outline (U.S. Fish and Wildlife Service 1996:19-22) describe research needed to provide a basis for a population viability analysis (PVA) and action 424 calls for the development of a PVA for the species. The results of these actions could be used to revise the recovery criteria to address the viability of protected populations; a PVA based on demographic monitoring in Minnesota may be nearing completion (Nancy Sather, Minnesota Department of Natural Resources, pers. comm., 4/9/07).

We used data provided by the states and others to assess progress towards meeting the protection criterion.[2] Consistent with the recovery plan, we considered a population to be extant if one or more plants were recorded within the last 25 years – i.e., in 1983 or later – unless the population was known to be extirpated (e.g., Elkins Prairie in Kansas, which was plowed up in 1990). In addition, we used the highest counts for each population to determine the number of plants protected at each site. The plan does not state how plants are to be counted to assess progress towards the recovery, but the maximum number of flowering plants in any given year has been used by others to describe sizes of western prairie fringed orchid populations (e.g., Seifert-Spilde 2001) and Sather (1997) used the highest number of plants reported for sites to measure progress towards meeting the protection criterion for one ecological section.

[2] This data is maintained in a Microsoft Access database at the Service's Twin Cities Ecological Services Field Office in Bloomington, Minnesota.

Alternatively, some authors have proposed using *mean* counts as a basis for assessing the conservation status of threatened plants (Bowles et al. 1999). The use of maximum counts of flowering plants (non-flowering plants are too difficult to find to include in censuses) may overestimate actual population sizes, but it is sufficient for determining the proportion of plants protected from conversion.

We counted *as protected* only those populations whose protection level was known to meet or exceed level 4, as defined in the recovery plan (U.S. Fish and Wildlife Service 1996:68) and assumed that populations whose protection level is unknown were unprotected. This is likely valid because our data sources, typically state conservation agencies, are usually aware of the status of populations that are under some type of protective ownership or agreement, but are often uncertain of the exact protective status of populations that are in private ownership. There are 75 populations with unknown protection levels in Nebraska and 7 in Minnesota.

The Western Prairie Fringed Orchid Recovery Plan (U.S. Fish and Wildlife Service 1996) based recovery on the status of populations within each ecoregional section occupied by the species (Bailey et al. 1994). Bailey's ecoregions are mapped at successively finer levels of detail. From coarse to fine they are: domain, division, province, section, and subsection. The Western Prairie Fringed Orchid Recovery Plan based recovery on the status of populations among the ecoregional *sections* occupied by the species. Since 1996, the boundaries of these sections have been revised to improve correspondence between finer-scale map boundaries and important ecological features such as glacial lines and landforms (ECOMAP 2007; McNab et al. 2007). These changes included modifications to the section boundaries that were used by the Service to guide western prairie fringed orchid recovery (U.S. Fish and Wildlife Service 1996:87). Therefore, we will describe progress toward meeting the recovery criterion in the context of revised ecoregional sections map (Figure 1, Table 1).

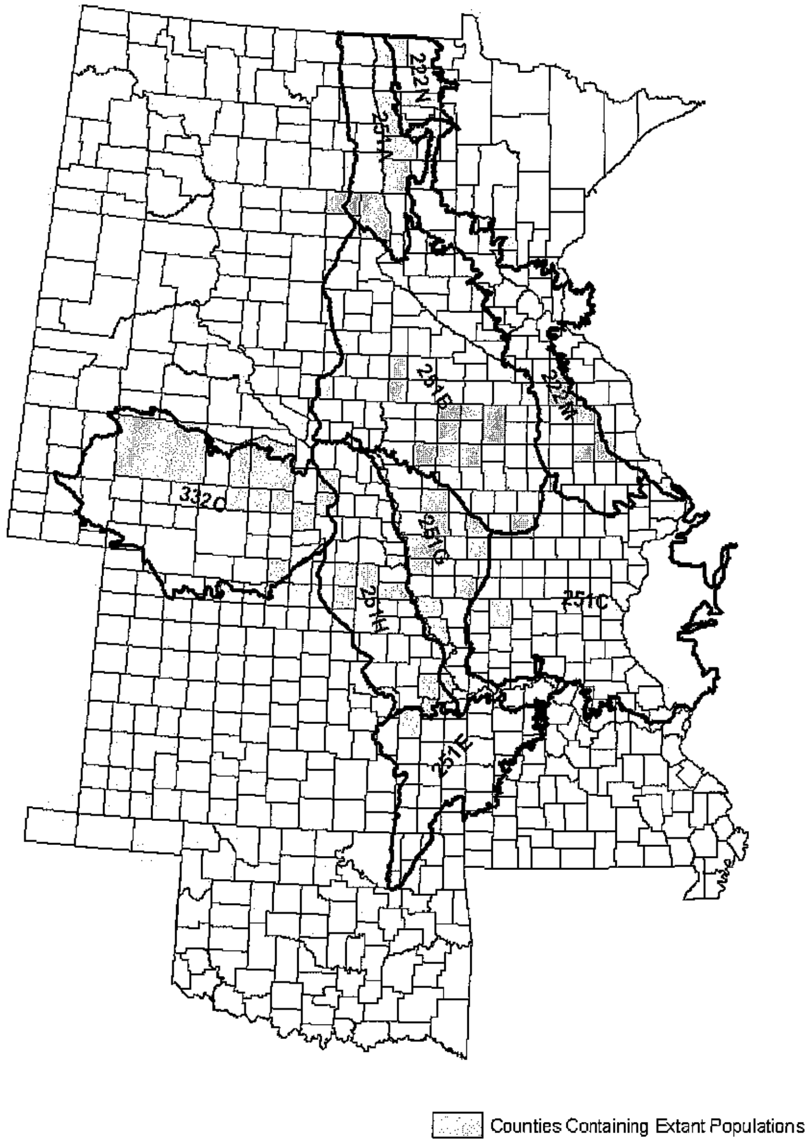

Figure 1. Revised ecological sections (McNab et al. 2007) that contain extant populations of western prairie fringed orchid.

Table 1. Abundance of western prairie fringed orchid plants in each revised ecological section (Figure 1) and on sites with protections levels 4-9 (USFWS 1996:68). Numbers are based on high counts of flowering plants for sites known or presumed to be extant (at least one plant observed after 1982 and not otherwise known to have been extirpated) and were calculated based on data in the Service's files on September 23, 2008. Note that further investigation may be necessary to determine if sites are also protected from hydrologic alterations and from impacts of pesticides and herbicides.

Section Name	Section	Total Plants	Total Plants on Sites with Protection Levels 4-9	% Plants on Sites with Protection Levels 4-9
Minnesota and Northeast Iowa Morainal-Oak Savannah	222M	125	123	98
Lake Agassiz-Aspen Parklands	222N	11,788	10,064	85
Red River Valley	251A	12,768	11,770	92
North Central Glaciated Plains	251B	1,127	714	63
Central Dissected Till Plains	251C	51	51	100
Osage Plains	251E	14	0	0
Missouri Loess Hills	251G	938	515	55
Nebraska Rolling Hills	251H	158	71	45
Nebraska Sand Hills	332C	2,171	769	35
Total		29,140	24,077	83

Due to the revision of the section boundaries, there are two sections (McNab et al. 2007) that now contain *P. praeclara* that were not addressed in the recovery plan – 222N and 251H. In addition, the name of section 251G was changed from the Central Loess Section to the Missouri Loess Hills Section. Finally, sections 332D and 332E no longer contain any *P. praeclara* populations due to the relocation of the boundaries for these sections.

Based on this analysis, 90% or more of the plants in sections 222M, 251A, and 251C have been protected and the protection criterion has nearly been met in section 222N with 85% of plants under protective ownership. Protection actions are still needed to meet the recovery criteria, however, in the remaining five sections. Two sections, 251C and 251E, each contain only one recorded extant population.

Management Criterion:
... and managed in accordance with a Service-approved management plan or guidelines. This plan must assure implementation of management practices that provide the range and spatial distribution of successional and hydrologic regimes required to maintain the

species and its pollinators in self-sustaining, naturally occurring populations, and must remain in effect following delisting.

This criterion addresses the following identified threats:

- Overgrazing
- Intensive hay mowing that may reduce primary productivity and seed dispersal and facilitate invasion of exotic cool season grasses
- Lack of management (woody plant invasion)
- Invasive species, including some cool season grass species
- Actions to control invasive species
- Herbicide use

The Service has not approved any management plans with clear reference to this recovery criterion or developed general management guidelines for the species. The recovery plan provides the following guidance, however, for evaluating management plans:

1. Populations must be protected from hydrologic alterations and pesticide impacts (p. 17);
2. Appropriate management must be implemented for at least three management cycles (e.g., if guidelines call for prescribed fire at a specified interval or range of intervals, the guidelines would not be fully implemented until the third prescribed burn has taken place at the appropriate intervals);
3. "Where sites are too small to permit natural succession to occur, manage communities to maintain the species' specific microhabitat requirements" (pp. 22-23);
4. "(F)ocus on maintaining or restoring the composition, function, and structure of the ecosystem on which *western prairie fringed orchid* depends, even though specific autecological and synecological information is lacking for the species" (p. 24);
5. Management practices should "duplicate the natural processes of the tallgrass prairie ecosystem" (p. 24);
6. Regularly review management practices and refine them as relevant research becomes available (p. 24).

Although this criterion has not been achieved, these six guiding principles for evaluating management plans may serve as interim guidelines to assess the adequacy of management of sites where western prairie fringed orchid is under protective ownership levels 4-9.

Sheyenne National Grasslands Management Plan

The Forest Service's "Recovery Strategy for the Western Prairie Fringed Orchid on the Sheyenne National Grassland" (USDA Forest

Service 2001) may be the most explicit management plan focused on the conservation of specific western prairie fringed orchid populations. Therefore, we will use it here as an example of how the Service might evaluate management plans in light of the recovery plan's management criterion.

This strategy is intended to:

1. Implement management direction found in the Dakota Prairie Grasslands Land and Resources Management Plan and the Western Prairie Fringed Orchid Recovery Plan (USFWS 1996).
2. Provide a broad umbrella under which management activities will occur that will not adversely impact western prairie fringed orchid.
3. Provide the framework for implementing a realistic western prairie fringed orchid monitoring program specific to Sheyenne National Grasslands (SNG).
4. Provide the impetus to guide changes in allotment management plan revisions relative to management of western prairie fringed orchid and its habitat.

Threats Not Adequately Addressed by Recovery Criteria

Recovery criteria should address all threats to the species that are contributing to its status as threatened or endangered and should be objective and measurable to be effective in measuring progress toward recovery. The recovery criteria do not adequately address the following threats that were identified in the listing rule, recovery plan, or after the approval of the recovery plan:

- Off-site drainage that would directly or indirectly lower water levels in the *P. praeclara* rooting zone
- Pesticide and herbicide impacts
- Low seed set in small and isolated populations

The recovery plan clearly acknowledges the need for sites to be protected from "the plow", pesticide impacts, and hydrologic alterations (U.S. Fish and Wildlife Service 1996:17), but the *recovery criteria* do not appear to adequately address the latter two threats. Even if protective ownership and appropriate management guard against drainage within the protected site, drainage on neighboring properties or projects with broad effects could still affect otherwise protected populations. Likewise, inadequate protection from the effects of herbicide and pesticide use carried out on or adjacent to occupied sites may also threaten some populations. Therefore, our summary of protection at levels 4-9 (Table 1) may adequately address the potential threat of "the plow" and collection of plants from small populations, but may not adequately account for the level of threat posed by hydrologic alterations and pesticides.

Development of a population viability criterion may address the threat of small and isolated populations with low seed set if populations facing this threat would have to reach viable levels to be counted toward recovery.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:

Pollination Biology

Although Western prairie fringed orchid forms tubers and vegetative shoots from existing plants, pollination is required for seed production (U.S. Fish and Wildlife Service 1996:7). Western prairie fringed orchid is pollinated by a few species of sphinx moths (Sphingidae, Table 2) (Vik in prep.; Westwood and Borkowsky 2004:17). Vik (in prep.) found that 96% of flowers with signs of moth visits ('pollinia missing', 'pollen deposited', or 'scales deposited') produced seed pods, whereas only 23% of flowers with none of these signs produced seed. Several studies have identified or reconfirmed various sphinx moths as pollen vectors (i.e., species observed with attached pollinia of *Platanthera praeclara*, Table 3) since 1996. Western prairie fringed orchid pollinia typically attach to the center of the moths' eyes (Vik in prep.; Westwood and Borkowsky 2004:18) and Sheviak and Bowles (1986) concluded that potential pollinators have a distance of 5.8-6.4 mm between the outer eye margins and probosces that are "sufficient to reach common nectar levels" (34-43 mm long). Westwood and Borkowsky (2004), however, concluded that in Manitoba a slightly shorter proboscis length of 30-35 mm may be sufficient to obtain nectar, based on a mean distance to nectar of 32.83 mm (n = 1016, SE = 0.2). They also found that distance to nectar decreased during the flowering period due to increasing volumes of nectar. Therefore, a proboscis as short as approximately 28 mm may be sufficient to reach nectar late in the flowering period (Borkowsky 2006:88). This was supported by Vik (in prep.), who captured 20 *Hyles euphorbiae* with attached pollinia in North Dakota between 2004 and 2007 – this species may have a proboscis as short as 28 mm (Table 2).

Table 2. Documented pollen vectors for *Platanthera praeclara*. Except for *Hyles euphorbiae*, minimum proboscis lengths shown in table are based on measurements reported by Fauske and Rider (1996), representing extremes of material available at the North Dakota State Insect Reference Collection. For *Hyles euphorbiae* Jordan et al. (2006) reported simply "Proboscis length", not minimum proboscis length.

Species (Source)	Min. Length of Proboscis (mm)
Sphinx drupiferarum (Cuthrell 1994; Westwood and Borkowsky 2004)	31.6
Lintneria eremitus (Harris et al. 2004; Vik in prep.)	
Eumorpha achemon (Cuthrell 1994; Westwood and Borkowsky 2004)	32.2
Hyles euphorbiae (Jordan et al. 2006)	28
H. gallii (Westwood & Borkowsky 2004)	31.7
H. lineata (Vik in prep.)	32.5
Paratraea plebeja (Ashley 2001)	

Pollinator abundance and pollination rates may vary among geographic areas. Westwood and Borkowsky (2004:18) described the period of overlap between western prairie fringed orchid flowering and pollinators' flight periods as "restricted" at the Tallgrass Prairie Preserve (TPP) in southern Manitoba and suggested that low populations of pollinators may restrict seed production in southern Manitoba in some years. In 2001 and 2002, for example, about 1 of every 31 flowers produced seed 0.032 (seed capsules/flower, Borkowsky 2006:93). Of the 15 species of sphinx moths they captured at TPP, they confirmed only two species as pollen vectors (Table 3) and concluded that two other species, *Sphinx chersis* and *S. kalmiae*, may also be able to transfer pollen (Westwood & Borkowsky 2004:18). One of the confirmed pollen vectors, *S. drupiferarum* is "uncommon" near the TPP and populations of the other, *Hyles gallii*, fluctuate greatly in southern Manitoba (Westwood & Borkowsky 2004:19). Fauske and Rider (1996) speculated that cool and wet springs delay blooming in western prairie fringed orchid and may contribute to asynchrony with peaks in pollinator abundance in some situations. Cool and wet weather during the growing season may also depress local populations of pollinators, increasing reliance on sphinx moths emigrating from other areas (Fauske and Rider 1996:7).

Ultraviolet light may be used to artificially increase seed production, although it is not clear if and when this may be appropriate. Borkowsky (2006) lighted western prairie fringed orchid plants with ultraviolet light in Manitoba in 2001 and 2002 to determine its effects on pollination. In 2002, the mean percentage of pollinaria removed was significantly higher among plants in the ultra-violet (UV) light treatment than among controls and a greater proportion of the flowers in the UV treatment produced seed capsules (Borkowsky 2006:50).

It may be necessary to use a variety of techniques when attempting to identify *P. praeclara* pollen vectors at a site. Vik (in prep.), for example, captured 23 *Lintneria eremitus* (seven with attached pollinia) in net traps and only one in a standard light trap. About ten years earlier, Cuthrell (1994) had captured no *L. eremitus* in the same geographic area using only light traps.

The apparent importance of *Hyles euphorbiae* as a *P. praeclara* pollen vector at SNG is especially interesting. *Hyles euphorbiae*, the leafy spurge hawk moth, was released as a potential biological control of leafy spurge (*Euphorbia esula*) from 1960 to 1985, but an adult was not recorded in North Dakota until 2000 (Vik in prep.). Vik (in prep.) found it to be the predominant hawk moth at SNG during her study of potential *P. praeclara* pollinators from 2004 to 2007, comprising 69% of all moths captured with net traps over flowers and standard light traps. Collection dates ranged from June 14 to August 16.

Some observations suggest that non-sphingid moths may cause pollination in *P. praeclara*. *Catocala* spp. (Noctuidae) moths have been observed pulling western prairie fringed orchid pollinia down onto female flower parts at SNG in North Dakota. At least one plant caged with a *Catocala* spp. moth before and throughout its flowering period produced swollen pods, which is typically indicative of successful reproduction (Marion Harris, North Dakota State University, pers. comm., 3/24/07).

Habitat - Effects of Soil Moisture and Flooding

Soil moisture is a critical determinant of growth, flowering, and distribution of western prairie fringed orchid. At Sheyenne National Grassland soil moisture in the top 10 cm was higher in swales with western prairie fringed orchid than in swales without western prairie fringed orchid (Wolken et al. 2001) and 60% percent of orchids had their root systems entirely within 10 cm of the soil surface – maximum and mean rooting distances were 16 and 12 cm, respectively (Wolken 1995; Wolken et al. 2001). At Pipestone National Monument in southwest Minnesota, two variables – late August precipitation and October-March precipitation – explained 77% of the variation in numbers of flowering western prairie fringed orchid in the subsequent growing season (Willson et al. 2006:39). The late August period corresponds with plant senescence and development of a perennating bud, whereas the latter period encompasses the period of winter dormancy (Willson et al. 2006:39). Precipitation during late August was positively related to the number of flowering western prairie fringed orchid, whereas the relationship between flowering and October-March precipitation was the inverse (Willson et al. 2006:40). A preliminary analysis based on demographic monitoring, however, indicates that spring precipitation may have a greater impact on population growth than fall precipitation (N. Sather, pers. comm., 4/2/07). Therefore, precipitation may have effects on flowering and survival during different periods of the year.

Drought depresses the number of western prairie fringed orchid plants appearing aboveground, increases the proportion of vegetative plants, or both (Ashley 2001:9; Sather 2000:6). Viable seeds that persist from previous years (i.e., the seed bank) may be important for post-drought recovery of western prairie fringed orchid populations (Hof et al. 2002).

Although moist soil near the ground surface is critical to maintain western prairie fringed orchid populations, standing water may adversely affect populations depending on the depth and duration of flooding. Flooding decreases survival of all affected western prairie fringed orchid plants (Sieg and Wolken 1999), but flowering plants are more likely than vegetative plants to survive (Sieg and Wolken 1999). The hollow stems of flowering plants may conduct oxygen to roots and their greater height increases the odds that at least part of the plant remains above water and is able to photosynthesize. Plants are more likely to persist if they continue at least some photosynthesis during floods, as opposed to relying entirely on energy reserves (Sieg and Wolken 1999:199). Even among flowering plants, taller plants are more likely to survive flooding (Sieg and Wolken 1999).

Water may also disperse western prairie fringed orchid seeds (Sieg and Wolken 1999). From (2002) described western prairie fringed orchid seeds as "highly water resistant" due to hydrophobic and impermeable structures surrounding the embryo and found that the testa (seed coat) contained "considerable air space" that could "keep seeds afloat in water for long periods of time." Flooding at SNG resulted in a shift in the population from low swales to higher landscape positions where soil moisture was still suitable (Sieg and Wolken 1999). At sites with little topographic variation, the development of flowering plants may be reduced or eliminated during flood years or in subsequent years (see Sather 2002).

Wolken et al. (2001) developed a logistic regression model based on the percent cover of two associated plant species (*Juncus balticus* and *Stachys palustris*), the concentration of soluble magnesium, and August soil moisture between 0-2 cm below the surface that correctly classified 84% of swales that did or did not contain western prairie fringed orchid at SNG. The coverage of *Juncus balticus* alone allowed for the correct classification of 66% of the swales containing western prairie fringed orchid and soil moisture in the top 10 cm was greater in swales that contained western prairie fringed orchid than in swales where the species was absent (Wolken et al. 2001).

Mycorrhizal Associations, Seed Biology, and Artificial Propagation

Western prairie fringed orchid is dependent on mycorrhizal fungi, especially for seed germination and for nutritional support before plants are capable of photosynthesis (Sharma 2002). Orchids "face almost certain extinction in the wild if their mycorrhizal symbionts (mycobionts) were to disappear" and survival of the mycorrhizal species depends on the conservation of orchid habitats (Zettler et al. 2003). Western prairie fringed orchid is likely dependent on certain fungal species that are typical of its tallgrass prairie and wet meadow habitats (Sharma 2002:26) – that is, there may be a stronger association between the fungal species and the habitats of western prairie fringed orchid than there is specifically between the fungi and the species (Zettler et al. 2003:212).

Sharma et al. (2003a) isolated both *Ceratorhiza* and *Epulorhiza* spp. from a protocorm and adult plants in Minnesota, although adult plants and field-incubated seeds in Missouri yielded only *Epulorhiza* isolates. Western prairie fringed orchid may preferentially associate with *Ceratorhiza* species (Sharma et al. 2003a), which "appear to be the dominant orchid mycobionts in Midwestern prairies" (Sharma 2002). Sharma et al. (2003) found that fungus derived from mature western prairie fringed orchid plants "failed to promote seedling development to advanced growth stages." Therefore, fungal associates likely vary among life stages.

Inoculation with appropriate fungal isolates facilitates western prairie fringed orchid seed germination and enhances *in vitro* plant development (Sharma 2002; Sharma et al. 2003b). *In vitro* germination rates were higher for seeds inoculated with mycorrhizal fungi (31%) than for uninoculated seeds (13%). From et al. (2005) successfully propagated western prairie fringed orchid without symbiotic fungi (asymbiotically), but mean germination percentages of cold-stratified seed placed on asymbiotic media were only 2-4%. Protocorms that developed from seeds sown in association with symbiotic fungi (i.e., symbiotically germinated) developed a shoot when inoculated with an *Epulorhiza* sp. mycobiont, but only developed leaves and "mycotrophic ability" when cultured with a *Ceratorhiza* sp. (Sharma 2002:74). Protocorms were more likely to develop to later stages when inoculated with an isolate derived from a seedling (Sharma 2002; Sharma et al. 2003b). Therefore, Sharma et al. (2003b:114) recommended inoculating seeds with fungal isolates from both seedlings and "naturally-occurring protocorms" to produce plants for conservation projects.

Studies of western prairie fringed orchid development suggest that seeds sown in actual prairie habitats of the species may be unlikely to develop into above-ground plants until at least one to two years after being sown (Alexander 2006; Sharma 2002; Sharma et al. 2003b, Figure 2). Western prairie fringed orchid seeds field-sown in nylon mesh bags at sites in Minnesota and Missouri yielded only protocorms with a few rhizoids and no visible leaf primordium after 20 months (Sharma 2002; Sharma et al. 2003b). At Sheyenne National Grassland, Alexander (2006:128) divided 18,717 seeds among 30 packets and planted them in western prairie fringed orchid habitat. After one year, she dug up the seed packets and divided the seeds into five groups (Figure 2). Plants may develop more quickly from seeds inoculated with a mycorrhizal symbiont and germinated *in vitro* (e.g., in a Petri dish) - some seeds sown in this way by Sharma (2002:138), for example, produced leaf-bearing seedlings within six to nine months.

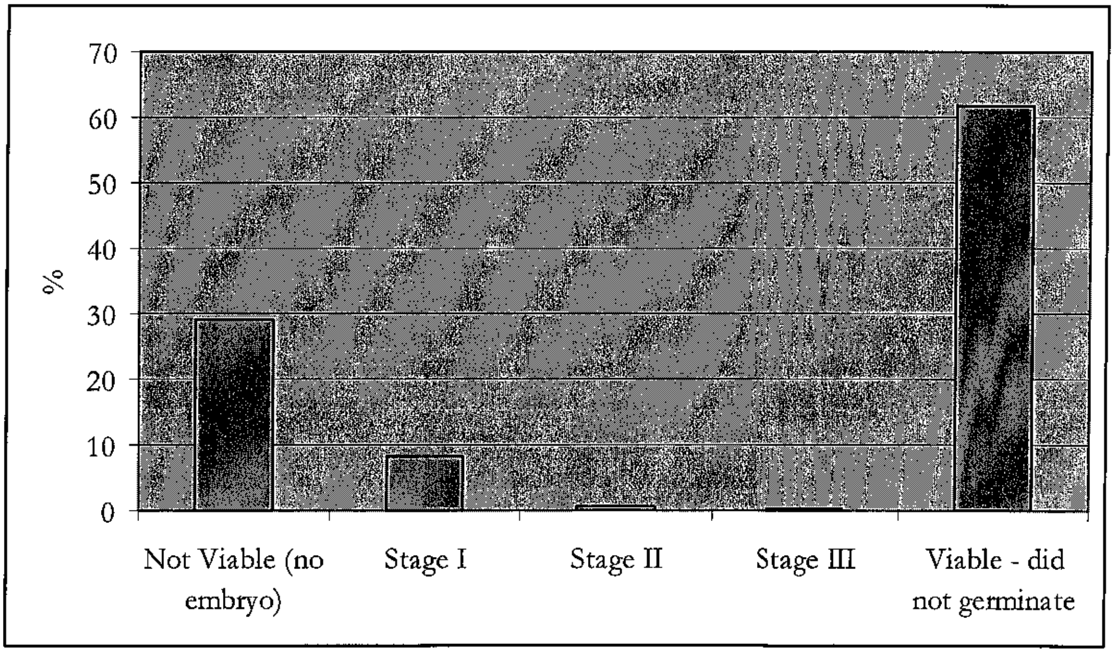

Figure 2. Developmental state of seeds recovered from seed packets twelve months after being sown in western prairie fringed orchid habitat at Sheyenne National Grasslands in 2004 (Alexander 2006). Stage I seeds (n = 1706) had doubled in size and showed signs of rupturing the seed coat one year later; Stage II seeds (n = 94) had developed to the protocorm stage; Stage III seeds (n = 51) had developed at least the tip of the first leaf and 5427 seeds lacked viable embryos (i.e., were non-viable). 11,584 seeds that were evidently viable had not germinated after one year *in situ*.

Cold stratification of seeds for at least six months combined with the addition of fungal mycobionts may maximize production of plants *in vitro*. For example, protocorms that developed from seeds stratified for six months developed *in vitro* to later stages than protocorms grown from seeds stratified for only four months (Sharma et al. 2003b); non-stratified seeds did not germinate (Sharma 2002). Western prairie fringed orchid seeds consist of a testa (seed coat) surrounding a carapace-like structure that contains a "rudimentary" embryo consisting of approximately 32 cells and containing nutrient bodies consisting primarily of calcium and potassium (From 2002). The testa is easily removed "by gently rubbing," but it and the carapace appear to function as separate layers that are each highly hydrophobic and impermeable to water (From 2002). Western prairie fringed orchid seeds delay germination even after removal of the testa, suggesting that chemical inhibitors are present in other structures (From 2002).

Sharma et al. (2003b:110) found that seed viability varied from 9-37% among five populations and was highest in the small populations sampled. Related propagation studies yielded advanced stage protocorms only from the small populations studied (Sharma 2002:98). In North Dakota, Alexander (2006, see above) found that only 5% of seeds sown in packets in North Dakota germinated after one year.

Dormancy and Mortality

In a preliminary analysis of 408 plants in four Minnesota populations, 4-12 % of monitored plants were dormant each year from 1986 to 1994 – approximately one-third of the plants experienced one or more periods of dormancy lasting one to three years (Sather 1997). Dormancy may last as long as eight years, but more than half of all dormancy episodes may be as short as one year (Quintana-Ascencio et al. 2004:17). Annual mortality rates of monitored plants were as low as 1.2 % and, in a drought year, as high as 13.5 % (Sather 1997).

2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

Drought has significant and, in some cases, widespread effects on western prairie fringed orchid flowering and survival. Some Nebraska populations, for example, were depressed by a drought in 1999 (Steinauer 2000), although populations at Valentine National Wildlife Refuge (VNWR) in the Nebraska Sandhills mostly recovered to near high levels in 2005. In 2006, some VNWR populations remained at high levels, whereas others declined (M. Nenneman, unpubl. data, 2007). Drought conditions also affected western Iowa beginning in 1999 and continuing into 2000 when Watson (2001a:9-10) found flowering plants at only two of six western Iowa populations monitored and only in especially wet portions of the habitats. In contrast, northeast Iowa received high levels of precipitation in 1999 and Watson (2000:10) observed a record high number of flowering plants at Hayden Prairie in 2000.

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

In 2002, Sharma completed a protein electrophoresis study that included eight Minnesota populations. She looked at variation in allozymes among 13 loci, 10 of which were polymorphic. She found that the number of alleles was higher in larger populations and that heterozygosity was positively correlated to population size (Sharma 2002:112). The high incidence of monomorphism among small populations indicated that genetic drift, not inbreeding, has caused low genetic variation and a loss of heterozygosity in these populations (Sharma 2002:119; Sharma 2005).

2.3.1.4 Taxonomic classification or changes in nomenclature:

No new information has come to light since the 1991 5-year review.

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):

Some background is warranted for this section. Published accounts and herbarium records suggest *P. praeclara* was widespread and perhaps locally common prior to European settlement (Bowles and Duxbury 1986). Historically, Brownell (1984) and Lobeck (1957) suggest western prairie fringed orchid was distributed throughout much of the western Central Lowlands and eastern Great Plains physiographic provinces of the central United States and Interior Plains in extreme south-central Canada. There are no recent records from South Dakota and Oklahoma, although surveys in potential habitat may be warranted in South Dakota and there is a current proposal to reintroduce the species in Oklahoma. In Iowa, southeastern Kansas, Missouri, and eastern Nebraska the species is now extirpated from a significant number of counties where it occurred historically. A single collection reported from Wyoming (Bowles 1983, Sheviak and Bowles 1986) is of dubious origin (Bjugstad and Fortune 1989).

In 2000, the Nebraska Game and Parks Commission conducted surveys to document new populations of western prairie fringed orchid along the Cedar Creek drainage of Garfield and southwestern Holt Counties in the central and eastern Sandhills region. This region had maintained "soil moisture levels favorable for the orchid development" during the prevailing severe drought when orchid numbers were depressed elsewhere in the state (Steinauer 2000:2-3). Of the 16 newly recorded populations discovered, all but 3 consisted of fewer than 15 plants at the time of the survey. Additional surveys in the Nebraska Sandhills may identify additional populations of western prairie fringed orchid (Steinauer 2000:4).

In Kansas, a survey of 249 native prairie remnants contained within a five-county area in the range of western prairie fringed orchid found no new western prairie fringed orchid populations and confirmed the extirpation of one population, which was plowed under by the landowner (Kindscher et al. 2005).

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

Reed canary grass was described as a species associated with western prairie fringed orchid in the recovery plan, but was not described as a threat. Watson (2001a:11) described it as a threat, however, to one Iowa population.

2.3.1.7 Other Information:

Habitat Management

The persistence of western prairie fringed orchid is dependent on periodic disturbance by fire, mowing, or grazing, but these practices may also cause adverse effects and must be carefully implemented. Late May fires in Kittson County, Minnesota, for example, destroyed above-ground parts of western prairie fringed orchid plants for the entire growing season (Minnesota Department of Natural Resources 2000) and were implicated in the complete absence of plants at Blue Mounds State Park and Burnham Wildlife Management Area in Minnesota in 1986 and 1999, respectively. As with the conservation of other rare prairie species that exist in fragments of a once vast ecosystem, successful management consists of careful application of practices that are essential for conserving the habitat, while ensuring that associated adverse effects are avoided or minimized.

Adverse effects of fires in late May in Minnesota could last for two growing seasons, but minimal effects observed at some sites suggest that their impacts may vary due to differences in soil moisture and fuel loads (Sather 2000:6-7). Sather (2000:7) recommended avoiding burns in Minnesota after May 1 unless site inspections indicate that orchids are not yet aboveground. She later (Sather 2004) indicated, however, that western prairie fringed orchid may emerge as early as mid-April in southwest Minnesota. In 2002, a small fire experiment at Pipestone National

Monument showed no effects of fire on flowering of the orchid when the locations of plants were burned on May 2 (Willson et. al 2006). Therefore, the timing of prescribed burns is best adjusted annually to western prairie fringed orchid phenology.

A study to assess the impacts of fall burning, spring burning, haying, and no management on western prairie fringed orchid was initiated at Pembina Trail Preserve Scientific and Natural Area in northwestern Minnesota in 1999. Each of the four treatments is replicated 21 times on the preserve within a series of 30 x 30 meter cells (Minnesota Department of Natural Resources 2002). The study is intended to assess the effects of typical management practices used on sites inhabited by western prairie fringed orchid in northwestern Minnesota, including four-year fire rotations, annual haying, and no treatment (idle). Baseline data on western prairie fringed orchid and associated species were collected annually from 1995 to 1999 and used to optimally assign management cells among treatments before experimental treatments were initiated (Minnesota Department of Natural Resources 2002) Since then, all management treatments have been conducted as scheduled and data have been collected annually, including number of flowering and vegetative western prairie fringed orchid plants per cell and number of flowers and seed pods per cell. A mid-project data summary and analysis are pending.

Sheyenne National Grassland contains several large populations of western prairie fringed orchid, all or most of which are subject to grazing. The Forest Service (USDA Forest Service 2001) ran a RAMAS stage model to predict the effects of grazing management there on the viability of the impacted western prairie fringed orchid populations. Populations were divided into "core" (n = 11), "satellite" (n = 13), and "other" (n = 6) populations. Core populations contained the highest numbers of flowering plants, were recognized for their importance in maintaining the geographical distribution of the species at SNG, and supported above ground plants in both wet and dry years. The RAMAS stage model was run under the assumption that one-third of the eleven core populations and one-tenth of the thirteen satellite populations, respectively, would be protected from grazing during the period when western prairie fringed orchid is particularly susceptible to the effects of livestock grazing (June 1 to September 15, USDA Forest Service 2001) – delaying grazing until after September 15 may be crucial for maximizing seed production because seed number and embryo size may still be increasing as late as September 9 at SNG (Alexander 2006). The resulting model predicted a population growth rate of 1.12. Continued monitoring is necessary to validate the model's predictions.

Disease

No diseases that affect western prairie fringed orchid were noted in either the final listing rule (USFWS 1989) or the recovery plan. Carlson et al. (2001) noted that anthracnose leaf blight, which may have been exacerbated by insect herbivory, adversely affected orchid growth and flowering in Nebraska in 2000.

Effects of Invasive Species Control

Application of herbicides to control invasive plant species may also harm or kill western prairie fringed orchid, but effects vary among herbicides and with the timing of application. Herbicide damage to western prairie fringed orchid has been documented at Sheyenne National Grassland, with damage as high as 85% of plants within an allotment in at least one case (USDA Forest Service 2003:5). Erickson et al. (2006:464-465) found that imazapic applied at rates typically used for control of leafy spurge (140 g/ha), tended to cause western prairie fringed orchid to remain in a vegetative state ten months after treatment, be shorter, have fewer and deformed flowers, and produce less seed. In plots where the herbicide quinclorac was applied, however, they detected no effects on growth, persistence, or reproduction of western prairie fringed orchid. Kirby et al. (2003) evaluated the effects of three herbicides used to control leafy spurge and found no significant effects on the reemergence or density of western prairie fringed orchid in plots at SNG that were sprayed with three herbicides in mid-September when above ground orchid parts were senescent. Studies longer than two years, however, may be necessary to completely assess herbicide effects on reemergence, flowering, and seed production, especially if herbicide applications will be repeated in future years. Biological controls (*Aphthona* spp. - flea beetles) may also reduce leafy spurge, but may not be as effective as herbicides (Erickson and Lym 2004).

Arrested Floral Development

Sather (2000) documented arrested floral development in populations in extreme northwest Minnesota in 1998 and in southeast Minnesota in 2000. Plants developed buds that failed to develop into flowers. Among plants that developed buds in 1998 at demographic monitoring plots in northwest Minnesota, 95% aborted floral development in the bud stage (Sather 2000:4). Watson (2001b) recorded similar "arrested development" of flowers at Hayden Prairie in northeast Iowa in 2001 and suggested that it was caused by an "intense dry spell" that began in mid-June.

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

For each category of threat we provide a list of threats identified in the 1989 listing rule, the recovery plan, or since the approval of the recovery plan. We then discuss any information that we have obtained since 1996 regarding the magnitude (scope and severity) and imminence of new or previously identified threats. We also discuss measures that may be taken to alleviate these threats.

Threats Described at the Time of Listing

The Service described the following threats to western prairie fringed orchid at the time of listing [54 FR 39857 (28 September 1989)]:

- Conversion of suitable habitat to cropland
- Overgrazing
- Intensive hay mowing that may reduce primary productivity and reduce seed dispersal
- Drainage
- Lack of management (succession)
- Small, isolated populations with low seed set
- Herbicide use
- Collection of plants from small populations

Threats Described in the 1996 Recovery Plan

In its recovery plan (U.S. Fish and Wildlife Service 1996) the Service mostly reiterated the threats it described in the final listing rule, but emphasized that conversion of habitat to cropland was the greatest remaining threat to southern populations. It also emphasized that little was known about how to ensure that burning, grazing, and mowing are conducted in a manner not adverse to western prairie fringed orchid populations and pointed out that actions that directly or indirectly lower water levels in the rooting zone of plants "have the potential of serious adverse impacts." In addition, it implied that potential impacts of pesticides to western prairie fringed orchid and its pollinators were also a threat (U.S. Fish and Wildlife Service 1996:17). The listing rule included herbicides as a threat, but not pesticides.

In the recovery plan, the Service also clarified that invasion by exotic species is a threat not specifically addressed in the 1989 final listing rule. The recovery plan mentions leafy spurge (*Euphorbia esula*) and musk thistle (*Carduus nutans*) as the most severe threats in the northern and southern portion of the species range, respectively. It also mentions that actions to control these species may also threaten western prairie fringed orchid.

The recovery plan discusses potential threats posed by native and non-native herbivores, including mammals and insects. Although herbivore impacts may be significant locally in some years (Borkowsky 2006:62), it is not clear whether native herbivores threaten any populations. The recovery plan (p. 13) mentions several herbivores that have fed on western prairie fringed orchids. Since completion of the recovery plan, at least one additional taxon, rose chaffer beetles (assumed to be *Macrodactylus subspinosus*, Scarabaeidae), was found feeding on western prairie fringed orchid. Rose chaffer beetles fed on a significant number of western prairie fringed orchid plants in Nebraska's Pierce and Madison counties in 2002 and the affected plants later exhibited fungal infections. Levels of this herbivory decreased after 2002, but persisted at least until 2005 (Gerry Steinauer, Nebraska Game and Parks Commission, pers. comm., 2005). Watson (2001b) found predated seed capsules that contained unidentified insect pupae at Kalsow Prairie in Iowa in 2001.

Threats Described Since 1996

Inter-seeding of non-native species, especially Garrison creeping foxtail (a cultivated variety of *Alopecurus arundinaceus* Poir), into wet prairie or wet meadows to increase livestock forage is now promoted in Nebraska (G. Steinauer, pers. comm., 2005; Volesky et al. 2003). This grass may pose a previously unrecognized threat if it is introduced into sites inhabited by western prairie fringed orchid (G. Steinauer, pers., comm. 2005). Morse et al. (2004:37) list nine reproductive characteristics typical of invasive plant species, including:

- Has quickly spreading rhizomes or stolons that may root at nodes
- Resprouts readily when broken, cut, grazed, or burned
- Reproduces readily both vegetatively and by seed or spores

According to a plant guide produced by U.S. Department of Agriculture, *Alopecurus arundinaceus* "produces numerous aggressive underground rhizomes" and is able to "recover quickly from grazing" (USDA NRCS 2004). The following excerpt from this guide strongly suggests that it could become a threat if planted near or into habitats occupied by western prairie fringed orchid:

"In addition to aggressive rhizomes, creeping foxtail proliferates by windborne and waterborne seeds. Rapid reproduction can be useful in repairing damaged sites; however, creeping foxtail's ability to spread quickly may create management problems in canals, irrigation ditches, and other waterways."

Staff at Valentine National Wildlife Refuge in Nebraska have been finding "small patches" of Garrison creeping foxtail on the refuge and are spraying each one with herbicide (Mel Nenneman, Valentine National Wildlife Refuge, Valentine, NE, pers. comm., 7/18/07). Exotic, cool-season grasses also are invading and increasing in western prairie fringed orchid habitats in Nebraska – a long-term trend that may be exacerbated by annual mid-summer haying (G. Steinauer, pers. comm., 2005).

Comprehensive List of Identified Threats

In summary, the following have been identified as threats in the 1989 listing rule, the 1996 recovery plan, or since the recovery plan:

- Conversion of habitat to cropland
- Overgrazing
- Intensive hay mowing that may reduce primary productivity and seed dispersal and facilitate invasion of exotic cool season grasses
- Drainage
- Lack of management (succession)
- Actions that directly or indirectly lower water levels in the rooting zone of plants
- Invasive species, including some cool season grass species
- Inter-seeding of non-native species, especially creeping foxtail (*Alopecurus arundinaceus* Poir, also called Garrison creeping foxtail), into wet prairie in Nebraska
- Collection of plants from small populations
- Actions to control invasive species
- Small, isolated populations with low seed set
- Herbicide and pesticide impacts on western prairie fringed orchid and its pollinators

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

The following identified threats (see list above) are included in this category:

- Conversion of habitat to cropland
- Overgrazing
- Intensive hay mowing that may reduce primary productivity and seed dispersal and facilitate invasion of exotic cool season grasses
- Drainage
- Lack of management (succession)

- Actions that directly or indirectly lower water levels in the rooting zone of plants
- Invasive species, including some cool season grass species
- Inter-seeding of non-native species, especially creeping foxtail (*Alopecurus arundinaceus* Poir, also called Garrison creeping foxtail), into wet prairie in Nebraska

The U.S. Forest Service is currently implementing a grazing management plan at Sheyenne National Grassland that is intended, in part, to conserve western prairie fringed orchid populations. Effective monitoring and evaluation of grazing and its effects on western prairie fringed orchid populations at SNG may be important for designing grazing strategies elsewhere in the species' range. Most importantly, however, it will be crucial for determining whether grazing management is effective in conserving the important populations at SNG – 91% of the protected plants in the Red River Valley ecological section (251A, Table 1) are on SNG.

The Service identified intensive hay mowing that may reduce primary productivity and reduce seed dispersal as a threat at the time of listing in 1989. Steinauer (pers. comm., 2005) reconfirmed the importance of this threat in Nebraska, pointing specifically to annual mid-summer haying as a practice that is facilitating the long-term invasion of western prairie fringed orchid habitats by exotic cool season grasses. The research project at Pembina Trail Preserve Scientific and Natural Area described above (section 2.3.1.7, Habitat Management) includes an assessment of annual late summer (August/September) haying on western prairie fringed orchid survival and reproduction in northwest Minnesota. This study may shed some light on the relative impacts of this management practice, at least in the northern part of the species' range.

Although the Service has not compiled a complete list of threats to western prairie fringed orchid for each site, invasive species are noted as a current threat to about 20% of extant sites. Leafy spurge and reed canary grass are the two most frequently reported threats (Table 4). The Service should improve its tracking of invasive species threats for each site, in cooperation with the states and others, to determine the relative importance range wide of each invasive species. Invasive species should be identified as a threat to an extant population if they are present at the site <u>and</u> if current or anticipated management is unlikely to be sufficient to control them to the extent that they would no longer pose a threat to western prairie fringed orchid at the site. The latter may be primarily a function of management resources and, for private lands, landowner cooperation.

Table 3. Invasive species reported as threats from sites inhabited by western prairie fringed orchid.

Species	No. Sites Reported as Threat
Leafy spurge (*Euphorbia esula*)	12
Reed canary grass (*Phalaris arundinacea*)	11
Smooth brome (*Bromus inermis*)	5
Redtop (*Agrostis gigantea*)	4
Canada thistle (*Cirsium arvense*)	2
White sweet clover (*Melilotus alba*)	2
Sericea lespedeza (*Lespedeza cuneata*)	2
Crown vetch (*Securigera varia*)	2
Timothy (*Phleum pratense*)	1
Clover (*Trifolium sp.*)	1
Bird's-foot trefoil (*Lotus corniculatus*)	1

The recovery plan recognized the potential threat of lowering groundwater levels (U.S. Fish and Wildlife Service 1996:12), but did not discuss any specific population that may be threatened in this way. The Forest Service (USDA Forest Service 2001), however, recognized this as a potential threat to populations at SNG in North Dakota. Since 1996, we have a better understanding of the extent of the rooting zone (see "Habitat - Effects of Soil Moisture and Flooding", above) and have also seen that soil moisture during late summer (late August in southwest Minnesota, Willson et al. 2006) affects abundance of flowering plants in the following growing season. Effects on soil moisture levels in the top 10 cm seem especially critical (Wolken et al. 2001).

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

Only one identified threat may be included under this category - collection of plants from small populations (54 FR 39857 [September 28, 1989]). We are aware of only one report that mentioned this as a potential threat to a western prairie fringed orchid population. Watson (2001b) reported that trails made by humans wound through Sheeder Prairie in Iowa and seemed to 'converge on areas where flowering orchids were located' and coincided with observations of missing flowers.

2.3.2.3 Disease or predation:

The recovery plan describes instances of herbivory by native and non-native species, but does not clearly recognize herbivory by wildlife as a threat to the species. Although wildlife herbivory by a variety of vertebrates and invertebrates likely occurs in all populations, it may have significant effects only on small populations and in years when drought or other factors may depress numbers of flowering plants and increase populations of insect herbivores (Fauske and Rider 1996). Watson (2001a:11) suggested that small western prairie fringed orchid habitats in predominantly agricultural landscapes may be vulnerable to white-tailed deer herbivory. In 2000, for example, white-tailed deer (*Odocoileus virginianus*) apparently damaged approximately one-third (9 of 32) of the inflorescences at Hayden Prairie. In those situations, buffers around occupied sites (e.g., restored habitats on lands currently used for agriculture) may reduce the vulnerability of western prairie fringed orchid if they would disperse deer foraging. Fauske and Rider (1996) found that insect herbivory had no significant effect on flowering at SNG in 1995 after four years of above average precipitation. Previous studies (Cuthrell 1994) had found significant effects of insect herbivores, suggesting that this type of herbivory fluctuates in inverse proportion to precipitation.

Above (in section 2.3.2, "Threats Described in the 1996 Recovery Plan"), we discuss the observations of significant damage during at least one year by rose chaffer beetles in Nebraska. Rose chaffer beetles predated a significant number of western prairie fringed orchid plants in Nebraska's Pierce and Madison counties in 2002 and the predated plants later exhibited fungal infections. Levels of this herbivory decreased after 2002, but persisted at least until 2005 (G. Steinauer, pers. comm., 2005).

2.3.2.4 Inadequacy of existing regulatory mechanisms:

Regulatory Protection in Canada

In 1996, western prairie fringed orchid was listed as endangered under the Manitoba Endangered Species Act, which specifically prohibits acts that destroy, disturb, or interfere with the habitat of an endangered species (Environment Canada 2006:6). In June 2003, the species was also listed as Endangered under the Canadian Species at Risk Act (Environment Canada 2006:6).

State Regulatory Protections

Among the six states in which the species occurs, it is listed as endangered in one, threatened in three, and is not listed under any endangered species statute in the remaining two states (Table 4).

Table 4. Summary of listing status and protections afforded under state endangered species statutes.

State	Status	Summary of Protections
IA	T	"(A) person shall not take, possess, transport, import, export, process, sell or offer for sale, buy or offer to buy, nor shall a common or contract carrier transport or receive for shipment" the species without a permit. (Iowa Code chapter 481B)
KS	None	The Kansas state endangered species statute provides no authority to list plants as endangered or threatened.
MN	T	"Minnesota's Endangered Species Statute and the associated Rules impose a variety of restrictions, a permit program, and several exemptions pertaining to species designated as endangered or threatened. A person may not take, import, transport, or sell any portion of an endangered or threatened species. However, these acts may be allowed by permit issued by the DNR; plants on certain agricultural lands and plants destroyed in consequence of certain agricultural practices are exempt; and the accidental, unknowing destruction of designated plants is exempt." (Minnesota Department of Natural Resources. 2008. Endangered, threatened and special concern species. <http://files.dnr.state.mn.us/natural_resources/ets/endlist.pdf>. Accessed 2008 June 20.
MO	E	State regulations (3 CSR 10-4.111) prohibit the "exportation, transportation or sale of any endangered species of plant or parts thereof, or the sale of or possession with intent to sell any product made in whole or in part from any parts of any endangered species of plant."
NE	T	Under Nebraska Code, Section 37-806, it is unlawful to export, possess, process, sell or offer for sale, deliver, carry, transport, or ship, by any means whatsoever, any listed species.
ND	None	n/a

The protection afforded by state statutes and associated regulations seems to focus primarily on protecting western prairie fringed orchid from unauthorized commercial use and, in Minnesota and Iowa, "take" of the species. Commercial use of western prairie fringed orchid is not one of the twelve identified threats to the species (see section 2.3.2, "Comprehensive List of Identified Threats") and direct take of plants would address only one of these threats (collection of plants from small populations). Moreover, two of the six states (Kansas and North Dakota) that together contain about 42% of all western prairie fringed orchid plants have no direct legal or regulatory protection for western prairie fringed orchid.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Three identified threats fall under this category:

- Actions to control invasive species
- Small, isolated populations with low seed set
- Herbicide and pesticide impacts to western prairie fringed orchid and its pollinators

Fauske and Rider (1996) observed fewer pollinators at a site in North Dakota where herbicides apparently reduced the density of nectar sources and western prairie fringed orchid, suggesting that the impacts on other nectar species should be considered when using herbicides to control invasive species. Erickson et al. (2006:464-465) found that imazapic applied at rates typically used for control of leafy spurge (140 g/ha), tended to cause western prairie fringed orchid to remain in a vegetative state ten months after treatment, to be shorter, to have fewer and deformed flowers, and to produce less seed. In plots where the herbicide quinclorac was applied, they detected no effects on growth, persistence, or reproduction of western prairie fringed orchid. (Also see "Effects of Invasive Species Control" in section 2.3.1.7, above.)

In some cases, drift of herbicides from adjacent properties or roadsides may pose a threat. For example, herbicide applied to control roadside weeds drifted into Powell Prairie in Iowa in 2001 – only one orchid may have been damaged, although damage would have likely been worse if some shrubs along the road had not blocked much of the drift (Watson 2001b:12). In this case, the county was contacted to make them aware of the threat posed by roadside spraying. Similar incidents in Polk County, Minnesota, have been addressed with annual pre-season coordination between the Minnesota Department of Natural Resources and the county highway department.

2.4 Synthesis

Significant progress has been made to protect western prairie fringed orchid populations in some portions of its range (see above – Table 1), where approximately 83% of the plants are on sites with protection, but substantial protective actions are still necessary in some ecological sections, especially 332C (Nebraska Sand Hills), 251H (Nebraska Rolling Hills), 251G (Missouri Loess Hills), and 251B (North Central Glaciated Plains). These sections are concentrated in the central and southern portions of the species' range. Populations under protective ownership must also be appropriately managed and not subject to threats from hydrologic alteration or impacts of pesticides and herbicides to be considered contributing to recovery.

As noted above, the Sheyenne National Grassland has prepared and begun implementing a comprehensive grazing management plan with a stated intention of conserving western prairie fringed orchid populations. Effective and comprehensive monitoring will be necessary to confirm that grazing will be implemented in a manner appropriate to the conservation of western prairie fringed orchid. The outcome of implementing the grazing plan will have a major impact on the recovery of the species in the Red River Valley ecological section (251A).

At present, the recovery criteria may not adequately address all current threats to the species. The Service will work with the recovery team to determine how the recovery criteria may be revised to address all current threats and the recent changes in ecoregional mapping and to ensure that criteria are objective and measurable. Issues that have arisen since the approval of the recovery plan that need to be addressed include: 1) drainage and other actions that directly or indirectly lower water levels in the rooting zone of plants; 2) collection of plants from small populations; 3) small, isolated populations with low seed set; and 4) herbicide and pesticide impacts to western prairie fringed orchid and its pollinators. It is unclear whether collection of plants from small populations is still a threat that is significantly affecting the likelihood that *P. praeclara* will become endangered in the foreseeable future. If the Service determines that it is a threat to the species, then the recovery criteria should be revised to address it. Development of a population viability criterion may address the threat of small and isolated populations with low seed set because populations facing this threat would have to reach viable levels to be counted toward recovery.

Previously recognized and new threats affect the existence of the western prairie fringed orchid to the extent that it may become endangered in the foreseeable future throughout all or a significant portion of its range. Therefore, this species continues to meet the definition of threatened. The listing classification of the western prairie fringed orchid should remain as threatened under the Endangered Species Act.

3.0 RESULTS

3.1 Recommended Classification:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (*Indicate reasons for delisting per 50 CFR 424.11):*
    ____ *Extinction*
    ____ *Recovery*
    ____ *Original data for classification in error*
__X_ No change is needed

3.2 New Recovery Priority Number

We do not propose a change in the recovery priority number for western prairie fringed orchid.

Brief Rationale:

Although numerous threats to western prairie fringed orchid have been identified, a significant proportion of populations in some ecological regions have been protected from direct habitat destruction (e.g., plowing). Substantial actions to protect populations from habitat destruction, however, are still needed in some ecological sections. Therefore, it is still appropriate to describe the level of threats as "moderate." Significant questions remain as to how to best manage western prairie fringed orchid, but a fair amount of new information to guide management planning has been obtained since the approval of the recovery plan in 1996. The ongoing study in northwestern Minnesota and implementation of the grazing management plan at SNG, for example, will likely provide managers with useful information to conserve this species. Although many populations are small, especially in some ecoregions, we think that the recovery potential for the species is still "high", primarily due to the large proportion of populations that occur on areas protected from habitat destruction in some ecological sections (Table 1).

3.3 Listing and Reclassification Priority Number: N/A.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- Revise the recovery criteria to include clear and measurable standards to determine whether western prairie fringed orchid plants are part of a viable population. The recovery criteria require that plants be under protective ownership or control and appropriately managed to count towards recovery in each ecoregion. There are no standards within the criteria, however, to assess whether these plants are part of populations that are viable. Although not addressed by the recovery criteria, actions 42 (Determine parameters required to maintain viable self-sustaining populations) and 424 (Conduct a population viability analysis for the species) do address this issue and a preliminary population viability analysis has been completed based on demographic monitoring.

- Ensure that any revised recovery criteria are objective and measurable and address the following threats, as appropriate:

    - Drainage and other actions that directly or indirectly lower water levels in the rooting zone of plants
    - Isolation and low reproduction of small populations
    - Herbicide and pesticide impacts to western prairie fringed orchid and its pollinators
    - Collection of plants from small populations
    - Effects of invading exotic species and actions to control those species
    - Inter-seeding of non-native species into wet prairie in Nebraska, especially creeping foxtail (*Alopecurus arundinaceus* Poir, also called Garrison creeping foxtail)

- Describe a process by which the Service will evaluate management plans for the purposes of measuring progress towards recovery. This should include a description of the Service's review process (e.g., who will conduct and approve these reviews for the Service) and the basis for evaluating the adequacy of each plan. The following excerpts from the recovery plan may be useful for evaluating management plans until more specific guidance is developed:

    - Populations must be protected from hydrologic alterations and pesticide impacts (p. 17).
    - Appropriate management must be implemented for at least three management cycles (e.g., if guidelines call for prescribed fire at a specified interval or range of intervals, the guidelines would not be fully implemented until the third prescribed burn has taken place at the appropriate intervals, p. 17).
    - "Where sites are too small to permit natural succession to occur, manage communities to maintain the species' specific microhabitat requirements" (pp. 22-23).
    - Plans should focus "on maintaining or restoring the composition, function, and structure of the ecosystem on which western prairie fringed orchid depends" (p. 24).

- Management practices should "duplicate the natural processes of the tallgrass prairie ecosystem" (p. 24).
- The plan should include a process for regular review and refinement of the management practices as relevant research becomes available (p. 24).

- Compile existing management plans for sites where western prairie fringed orchid is extant and protected from conversion and determine whether they are adequate to ensure the conservation of the respective western prairie fringed orchid populations.

- Implement recovery action 33 – Develop or maintain appropriate mowing regimes (U.S. Fish and Wildlife Service 1996:20). Steinauer (2000:4) briefly summarized the importance of the Nebraska's eastern Sandhills region for the conservation of western prairie fringed orchid and suggested that significant progress towards the species' conservation could be made by modifying haying practices at some sites.

- Conduct additional surveys in the Nebraska Sandhills when soil moisture levels may be suitable for significant levels of flowering. Additional surveys in this region may identify additional populations of western prairie fringed orchid (Steinauer 2000:4), but significant surveys have not been conducted since 2000 (recovery action 52 – Identify and search potential new sites [U.S. Fish and Wildlife Service 1996:22]).

- Improve tracking of invasive species threats for each site, in cooperation with the states and others, to determine the relative range-wide harm of each invasive species. Invasive species should be identified as a threat at a site if they are present <u>and</u> if current or anticipated management is unlikely to be sufficient to control invasives to the extent that the invasive(s) will no longer pose a threat to western prairie fringed orchid.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Platanthera praeclara*

Current Classification: Threatened

Recommendation resulting from the 5-Year Review

____ **Downlist to Threatened**
____ **Uplist to Endangered**
____ **Delist**
X **No change is needed**

Appropriate Recovery Priority Number: 8C
Appropriate Listing/Reclassification Priority Number, if applicable:

Review Conducted By: Phil Delphey

FIELD OFFICE/REFUGE APPROVAL:
Lead Field Supervisor/Refuge Manager, Fish and Wildlife Service

Approve Tony Sullivan Date 12/5/08

REGIONAL OFFICE APPROVAL:
Assistant Regional Director, Ecological Services, Fish and Wildlife Service, Midwest Region

Approve Lynn M. Lewis Date 2/5/09

The Lead Region must ensure that other regions within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. Written concurrence from other regions is required.

ACTING
Cooperating Regional Director, Fish and Wildlife Service, Southwest Region
Signature ____ Date 4/27/09 X Concur ____ Do Not Concur

ACTING
Cooperating Regional Director, Fish and Wildlife Service, Mountain-Prairie Region
Signature Mike Stempel Date 2/18/09 X Concur ____ Do Not Concur