US Environmental Protection Agency
Office of Pesticide Programs

Appendix C: Status and Life History of the Pallid Sturgeon (*Scaphirhynchus albus*)

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C.1 Species Listing Status

The pallid sturgeon (*Scaphirhynchus albus*) was designated by the U.S. Fish and Wildlife Service (USFWS) as endangered on September 6, 1990 (USFWS, 1990; 55 FR 36641). A recovery plan addressing the pallid sturgeon was approved by the USFWS on November 7, 1993 (USFWS, 1993).

C.2 Description

Pallid sturgeon, shown in Figure C-1, have a flattened, shovel-shaped snout and a long, completely armored penduncle (the part of the body just in front of the tail fin) (Smith, 1979). The mouth is toothless, protrusible (capable of extending forward), and positioned under the snout. The skeletal structure is primarily cartilaginous (Gilbraith et al., 1988). Pallid sturgeon are similar in appearance to the more common, darker, shovelnose sturgeon. The position and relationship of barbels (fleshy protrusions located above the mouth on the ventral side) is the most reliable method of differentiating the two species in the field.

The pallid sturgeon is one of the largest fish species found in the Missouri and Mississippi River drainages. Adult pallid sturgeon collected from the upper Missouri River are generally larger (maximum recorded weight of 86 lbs) compared to adults collected from the middle Missouri River and Mississippi River (maximum weights ranging from 26 to 46 lbs) (USFWS, 1993).

Figure C-1 Pallid Sturgeon (USFWS photo/Ken Bouc/Nebraska Game and Parks Commission)

C.3 Historic and Current 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 tributary. Of the 250 pallid sturgeon reported by Bailey and Cross (1954), approximately 76 percent were collected from the Missouri River in Montana and the Dakotas; most were collected in the upper ends of the five main stem reservoirs as they were filling.

The pallid sturgeon is one of the rarest fish of the Missouri and Mississippi River basins, although they are reported to be widely distributed in the Missouri River and in the Mississippi River downstream from the mouth of the Missouri River (Carlson and Pflieger, 1981). The species inhabits 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).

The states within its range include Arkansas, Kansas, Kentucky, Illinois, Iowa, Louisiana, Mississippi, Missouri, Montana, Nebraska, North Dakota, South Dakota, and Tennessee. A map of the current range of the pallid sturgeon is shown in Figure C-2.

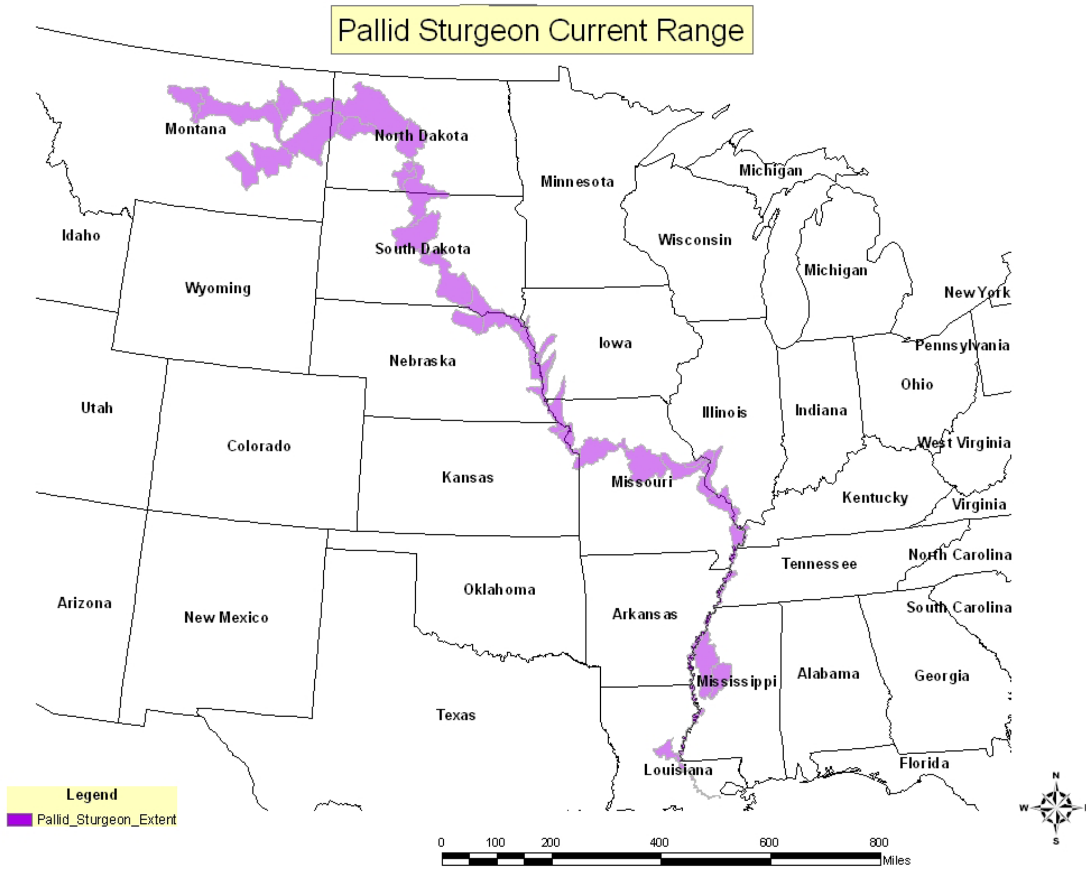

Figure C-2 Current Distribution of the Pallid Sturgeon

The USFWS Recovery Plan (USFWS, 1993) divides the range into six recovery-priority management areas, which are depicted in Figure C-3. These management areas were selected based upon the most recent pallid sturgeon records of occurrence and the probability that these areas still provide suitable habitat for restoration and recovery of the species. These areas are typically the least degraded and have the highest habitat diversity, and in some reaches still exhibit a natural channel configuration of sandbars, side channels, and varied depths. The confluence areas of major tributaries to the lower Missouri and Mississippi Rivers were emphasized in selecting recovery priority areas because of their importance as feeding and nursery areas for large-river fish.

The recovery-priority areas are as follows:

1. the Missouri River from the mouth of the Marias River to the headwaters of Ft. Peck Reservoir;
2. the Missouri River from Ft. Peck Dam to the headwaters of Lake Sakakawea, including the Yellowstone River upstream to the mouth of the Tongue River;

3. the Missouri River from 20 miles upstream of the mouth of the Niobrara River to Lewis and Clark Lake;
4. the Missouri River below Gavins Point Dam to its confluence with the Mississippi River (including 20 miles upstream and downstream of major tributaries; major Missouri River tributaries include but are not limited to 20 miles upstream and downstream of the Platte, Kansas, and Osage Rivers);
5. the Mississippi River from its confluence with the Missouri River to the Gulf of Mexico (including 20 miles upstream and downstream of major tributaries; major Mississippi River tributaries include but are not limited to 20 miles upstream and downstream of the St. Francis, Arkansas, and Yazoo Rivers); and
6. the Atchafalaya River distributary system to the Gulf of Mexico.

According to the draft 5-year review for the pallid sturgeon (USFWS, 2007 draft), current 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.

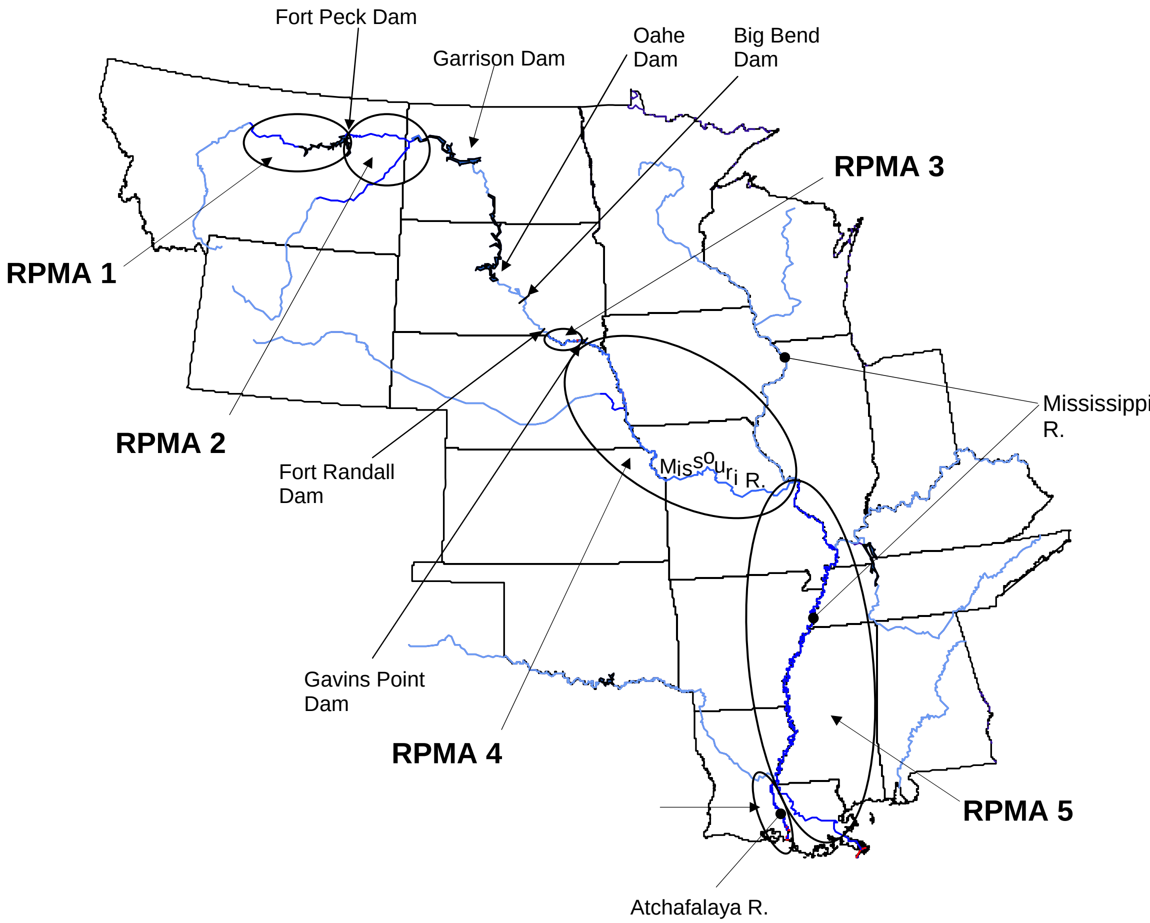

Figure C-3 Approximate Locations of the Recovery Priority Areas of the Pallid Sturgeon (USFWS, 1993). Map not to scale.

C.4 Habitat

Pallid sturgeons require large, turbid, free-flowing riverine habitat with rocky or sandy substrate (Gilbraith et al., 1988). They are well adapted to life on the bottom and inhabit areas of swifter water than does the related but smaller shovelnose sturgeon (Forbes and Richardson, 1909; Carlson et al., 1985). As previously discussed in Section C.3, pallid sturgeon tend to select main channel habitats in the Mississippi River and main channel areas with islands or sand bars in the upper Missouri River.

Much of the historical micro-habitat of the pallid sturgeon, including the large river ecosystem of the Missouri and Mississippi Rivers, has been altered by human development. Habitat research to date has been a characterization of where pallid sturgeon are located in the significantly altered environments of today. This research does not necessarily indicate preferred or required habitats, but instead may only indicate which habitats of those presently available are used by the pallid sturgeon.

Current Velocity: Based on information presented in the USFWS Recovery Plan (USFWS, 1993), the pallid sturgeon occupies river bottoms where water velocity ranges from 10 to 90 centimeters per second (cps) (0.33 to 2.9 feet/sec). These velocities are commonly found throughout the species' range. Pallid sturgeon collected from the Missouri River above Garrison Reservoir in North Dakota during spring and fall seasons of 1988 to 1991 were found in deep pools at the downstream end of chutes and sandbars, and in the slower currents of near-shore areas (USFWS, 1993). These areas may have provided good habitat for energy conservation and feeding.

Turbidity: Pallid sturgeon have historically occupied turbid river systems. Turbidity levels where pallid sturgeon have been found in South Dakota range from 31.3 Nephelometric turbidity units (NTU) to 137.6 NTU (USFWS, 1993).

Water Depth: According the USFWS Recovery Plan, pallid sturgeon have been found in water depths ranging from 1 to 8 m (USFWS, 1993).

Substrate: Pallid sturgeon are most frequently caught over sandy bottoms, which is the predominant bottom substrate within the species' range on the Missouri and Mississippi Rivers (USFWS, 1993). One pallid sturgeon was collected from the Yellowstone River in July 1991 by Watson and Stewart (1991); the predominant substrate at that capture site was mainly gravel and rock.

Temperature: Pallid sturgeon inhabit areas where the water temperatures range from 0°C to 30°C (32°F to 86°F), which is the range of water temperature of the Missouri and Mississippi Rivers (USFWS, 1993). There is no information to indicate temperature preference or the effects of temperature on the species.

C.5 Reproduction

Although the requirements for reproduction and spawning of the pallid sturgeon are not well understood, they are thought to spawn in swift water over gravel, cobble, or other hard surfaces (USFWS, 1993). Several researchers have suggested that pallid sturgeon use swifter water for spawning than shovelnose sturgeon (Erickson, 1992; Forbes and Richardson, 1909), so water velocity may have been a factor historically in keeping the two species isolated during spawning.

Pallid sturgeon are slow to reach sexual maturity, with males not reproducing until they are approximately five to seven years old, and females spawning for the first time at fifteen to twenty years (Erickson, 1992; Keenlyne and Jenkins, 1989). There are likely several years between spawning events for both males and females (Keenlyne, 1989). Time of sexual maturity and intervals between spawning years is likely to be influenced by available foraging, environmental conditions, and other factors. Spawning appears to occur between June and August (Kallemeyn, 1983).

Larval fish produced from the spawning event drift downstream from the hatching site (Kynard et al., 2002), and begin to settle in the lower portion of the water column 11 to 17 days post-hatch (Braaten et al., in review). Drift distance likely varies with ambient water velocity, but may be more than 124 miles (200 km) in the first 11 days (Braaten and Fuller, 2005).

According to Keenlyne et al. (1992), female pallid sturgeon fecundity in the upper Missouri River was measured at 170,000 eggs/female, with a mature egg mass weight of 1,952 grams representing 11.4 percent of the total body weight.

C.6 Food Habits

Food items of the pallid sturgeon range from aquatic insects to fish depending on life stage (Gerrity, 2005 and 2006; Wanner, 2006). There have been a number of studies examining the food intake of pallid sturgeon; however, little information exists on the food habits. It is believed pallid sturgeon are opportunistic suctorial feeders on benthic organisms (Held, 1969; Carlson et al., 1985; Keenlyne, 1997).

Much of the dietary research on pallid sturgeon has been completed in conjunction with research on the food consumption of the closely related shovelnose sturgeon. These studies show that the majority of both these species' diets are comprised of aquatic insects, although pallid sturgeon generally consume more fish than the shovelnose sturgeon (Carlson et al., 1985). These findings suggest that the pallid sturgeon occupy a higher trophic level than the shovelnose, which may help explain the greater decline in their population (Gerrity et al., 2006).

Recent studies have been conducted to determine the stomach contents of juvenile pallid sturgeon inhabiting the Missouri River via gastric lavage. Due to a lack of natural reproduction in the wild, these studies examined the diets of released hatchery-reared juvenile pallid sturgeon (HRJPS). Gerrity et al. (2006) examined the diets of 6- and 7-year-old HRJPS from the Missouri River above Fort Peck Reservoir, Montana. The results of the study, which are the first reported food habits data for juvenile pallid sturgeon in the wild, show that the majority of the diet (90%) by wet weight is comprised of fish. Sturgeon chub (*Macrhybopsis gelida*) and sicklefin chub (*M. meeki*) comprised 79% of the number of identifiable fish in juvenile pallid sturgeon stomach contents, while channel catfish (*Ictalurus punctatus*), flathead chub (*Platygobio gracilis*), sand shiner (*Notropis stramineus*), and shorthead redhorse (*Moxostoma macrolepidotum*) comprised the other 21%. The consumption of sicklefin chub and sturgeon chub by juvenile pallid sturgeon substantiates previous reports (Bramblett and White, 2001; Snook et al., 2002) that pallid sturgeon habitat use may be influenced by the presence of cyprinid prey. Ephemeroptera (mayflies), Trichoptera (caddisflies), Chironomidae (midges), and detritus each occurred in at least 10% of the juvenile pallid sturgeon diets; however, no prey other than fish comprised more than 10% of the diet by wet weight.

A similar study by Wanner (2006) examined the stomach contents of HRJPS collected below Fort Randall Dam, South Dakota in the Missouri River in 2003 and 2004. The stomach contents of 18 fish collected in 2003 revealed that approximately 48% and 36% composition by weight of prey items were fish and Chironomidae, respectively. The percent composition by weight of food items from 10 fish collected in 2004 was 73%

Ephemeroptera and only 3% fish. Additional food items recovered in the stomach contents of juvenile pallid sturgeon collected in 2004 included Odonata (dragonflies) and Isopoda (aquatic sow bugs) as well as the following species of fish: johnny darter (*Etheostoma nigrum*), and emerald shiner (*Notropis atherinoides*).

C.7 Growth and Longevity

Little is known about the age and growth of pallid sturgeon, although the oldest reported individual of this species is 41 years (Keenlyne et al., 1992). It is estimated that pallid sturgeon can live more than 40 years based on interpretation of pectoral fin ray cross sections (USFWS, 1993). The total length of pallid sturgeon in the lower Missouri and Mississippi Rivers is reported to be significantly greater than the shovelnose sturgeon (Carlson et al., 1985). According to cross sections of pectoral fin rays from pallid sturgeon from Lake Oahe in South Dakota, Fogle (1963) estimated a rapid growth rate during the first 4 years, with growth decreasing to 4 inches per year between the ages of 5 and 10.

C.8 Past and Current Threats

At the time of listing, habitat modification, lack of natural reproduction, commercial harvest, and hybridization were identified as the main reasons for the species' decline (USFWS, 1990). These issues continue to threaten the species' survival today. A summary of the threats to pallid sturgeon is provided below in Sections C.8.1 through C.8.6.

C.8.1 Habitat Modification

Destruction and alteration of habitats by human modification of the river system is believed to be the primary cause of decline in reproduction, growth, and survival of pallid sturgeon (USFWS, 1993). Successfully reproducing populations of pallid sturgeon are unlikely to recover without restoring the habitat elements (morphology, hydrology, temperature, regime, cover, and sediment/organic matter transport) of the Missouri and Mississippi Rivers necessary for the species' continued survival (USFWS, 1993). Threats to the pallid sturgeon associated with habitat modification within specific river reaches of its range are described in further detail below.

<u>Missouri River</u>

Human induced 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 have been the creation of a series of impoundments on the main stem of the upper Missouri River and channelization of the lower Missouri River for navigation. Since construction of mainstem dams, approximately one-third of the Missouri River has been impounded, one-third channelized, and the remainder has been impacted via changes to the hydraulic cycle and sediment transport (Hesse et al., 1989). Dam construction and channelization have reduced the surface area of the Missouri River by approximately one-half, doubled current velocity, decreased habitat diversity, and decreased sediment transport (Funk and Robinson, 1974; Gilbraith et al., 1988; USFWS, 2000a). Upper Missouri River dams and their operations have created physical barriers that block normal migration patterns, cause degraded and altered physical habitat characteristics, and alter the channel hydrograph (Hesse et al., 1989). Large impoundments have altered lotic features (i.e., channel morphology, current velocity, seasonal flows, turbidity, temperature, nutrient supply, and paths within the food chain) and replaced large segments of riverine habitat with lentic conditions (Russell, 1986; Unkenholz, 1986; Hesse, 1987). By restricting the Missouri River's ability to transport material, dams have also caused substrate changes leading to substantial deposition of material in reservoirs. This process buries gravel substrate that is important for pallid sturgeon spawning. Other areas of concern related to changed flow rates for pallid sturgeon are the relation between reproduction and flow and the loss of sediment deposited sandbars from tributaries that also play a key role in reproduction (South Dakota Department of Game Fish and Parks (SDDGFP), 2006).

<u>Mississippi River</u>

Although the Mississippi River is unimpounded for 1,152 Rmi from the confluence of the Missouri River to the Gulf of Mexico (RPMA 5 in Figure C-3), it has received a substantial amount of anthropogenic modification over time via alterations to its tributaries. Impoundments of major tributaries have 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).

Currently, the middle Mississippi River is fixed as a result of channel training structures; therefore, it no longer meanders through the floodplain, resulting in reduced channel width and surface area and reduced habitat diversity. Approximately 80% of the floodplain of the middle Mississippi River has been isolated from the main channel due to levee construction, allowing the conversion of floodplain habitats to agriculture and other uses. Destruction and/or isolation of backwaters, side channels, and wetlands has reduced riverine productivity (Theiling, 1999) by decreasing energy inputs (organic matter and carbon) into the main channel.

<u>Lower Mississippi River</u>

Anthropogenic alterations have been documented in the lower Mississippi River with identified decreases in aquatic habitats (Baker et al., 1991). 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) note a net loss in channel length, bank steepness, sandbars, sloughs, oxbow lakes, seasonally inundated floodplains, and floodplain habitat types when compared with features present in the lower Mississippi River prior to modification efforts. Effects of these changes on pallid sturgeon are unknown because there are no historical data for comparison.

Atchafalaya River

The Atchafalaya River has been significantly affected by reductions in sediment delivery via impoundment of two major tributaries including the Red and Black Rivers. 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 (USFWS, 2007 in review).

C.8.2 Lack of Natural Reproduction

Pallid sturgeon have rarely spawned in the wild for at least the last thirty years (McKean, 2003), and there has been only limited, localized evidence of recruitment of wild-spawned fish into the breeding population (Reed and Dean, 2005). The fish that are reproductively mature today were all spawned prior to dam construction (Gilbraith et al., 1988; June, 1976) and are thought to be nearing the end of their lifespans (USFWS, 2003). Hatcheries have been successfully spawning pallid sturgeon and releasing juveniles since 1997 (Krentz et al., 2005). Recaptures of released fish indicate that these young are surviving; however, it will be several years before they are old enough to reproduce (Shuman et al., 2005).

C.8.3 Commercial Harvest

Commercial harvest is another area of concern for future survival of the pallid sturgeon. The harvesting of other sturgeon species (e.g., the shovelnose sturgeon) is legal in several states where the pallid is located. Because the pallid sturgeon closely resembles the shovelnose sturgeon, it can be found in bycatch. In addition, researchers have found evidence of captured live pallid sturgeon specimens with marks on the belly, indicating that anglers have checked for eggs that can later be sold for caviar (SDDGFP, 2006).

C.8.4 Hybridization

Hybrids between pallid sturgeon and the more common shovelnose sturgeon have been found (Carlson et al., 1985) and are thought to be associated with the species' decline (Gilbraith et al., 1988; Keenlyne et al., 1994; USFWS, 1993). Hybridization between the two species probably did not occur until fairly recently, when extensive changes in the Missouri and Mississippi River systems degraded or eliminated riverine habitat (Grady et al., 2001). Genetic and morphological studies suggest that pallid and shovelnose sturgeon are separate species (Heist and Schrey, 2004; Simons et al., 2001; Tranah et al., 2001), although there is concern that the pallid sturgeon may disappear as a distinct species, given the dwindling population and little or no natural reproduction (Gilbraith et al., 1988; USFWS, 2003).

C.8.5 Disease/Iridovirus

The emergence of the iridovirus (an infectious disease that attacks various species of sturgeon) in the hatcheries has lead to concern that it could adversely affect wild populations. The source of the iridovirus is unknown, although evidence suggests that the disease may be transmitted vertically (through the eggs) (Adkinson et al., 1988; Georgiadis et al., 2001) or through the water to uninfected fish (Hedrick et al., 1990). The disease is primarily found in hatcheries, and is thought to be related to the stress of living in crowded hatchery conditions (SDDGFP, 2006).

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