US Environmental Protection Agency
Office of Pesticide Programs

Appendix I:
Baseline Status and Cumulative Effects to the Pallid Sturgeon

August 31, 2007

APPENDIX I: BASELINE STATUS AND CUMULATIVE EFFECS TO THE PALLID STURGEON

I.1: CUMULATIVE EFFECTS

Cumulative effects include the effects of future state, tribal, local or private actions that are reasonably certain to occur in the action area considered in this risk assessment. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation under section 7 of the Act. According to information contained in available U.S. Fish and Wildlife Service (USFWS) biological opinions for the pallid sturgeon, USFWS is unaware of any additional state, tribal, local or private actions that are reasonably certain to occur in the action area producing cumulative effects beyond those ongoing effects already considered in the Environmental Baseline.

I.2: ENVIRONMENTAL BASELINE

The environmental baseline is defined as the effects of past and ongoing human induced and natural factors leading to the status of the species, its habitat, and ecosystem, within the action area. The environmental baseline is a snapshot of the pallid sturgeon's status at this time. However, the baseline condition of the assessed sturgeon's habitat varies across locations and within each stream/river. Details of the pallid sturgeon's habitat description and known locations are included in Appendix C. Given the large amount of habitat and extent of the action area included of this assessment, the discussion of environmental baseline includes a general discussion of factors that may affect the pallid sturgeon within the action area. This information is presented in Section I.2.1. Based on the results of the endangered species risk assessment for the pallid sturgeon, an "LAA" determination was concluded for indirect effects to the sturgeon via direct effects to herbaceous/grassy riparian vegetation. Additional information on the baseline status of the pallid sturgeon was gathered from recent USFWS biological opinions, which are summarized in Table I.1. More detailed information on the current status of the pallid sturgeon population is presented in section I.2.2.

I.2.1. Factors affecting species environment within the action area

Pallid sturgeon are threatened by many factors, including habitat loss and degradation, hybridization, commercial fishing, and contaminants/pollutants. These threats to the species appear to be increasing and continue to adversely affect the pallid sturgeon. Additional threats to the species further compound the species status. Entrainment due to dredging operations and commercial navigation traffic represents an unknown, but perhaps significant, threat to the species through direct mortality. The presence of exotic Asian carp has increased dramatically in the Missouri and Mississippi Rivers. These species compete with native river fish for food and habitat and may present a significant long-term threat to the pallid sturgeon. Sections I.2.1.1 through I.2.1.6 provide details on each of the major issues facing pallid sturgeon populations within the entire action area.

I.2.1.1 Habitat Loss and Degradation

Destruction and alteration of big-river ecological functions and habitat that were once provided by the Missouri and Mississippi Rivers are believed to be the primary cause of declines in reproduction, growth, and survival of pallid sturgeon (USFWS 1993). The physical and chemical elements of channel morphology, flow regime, water temperature, sediment transport, turbidity and nutrient inputs that once functioned within a big river ecosystem have been dramatically altered by the construction of mainstem and tributary dams, construction of navigation projects (e.g., channelization) and subsequent isolation of the floodplain through flood control projects. Although restoration projects have been implemented in the Lower Missouri River and Middle Mississippi River, the rate of change has not stabilized, and habitat diversity, quantity and quality are declining. However, implementation of positive actions for habitat creation and maintenance on the Missouri River and Middle Mississippi River should result in stabilization and improvement in habitat conditions over the long-term.

The Missouri River Levee System (MRLS) is a continuing Federal Project for flood damage reduction and other purposes along the Missouri River. The MRLS was authorized by the Flood Control Act of 1944. A number of Federal levee projects are currently under construction or development. They include the Missouri River Levee Unit L385 project in Riverside, MO; the Kansas City, Missouri and Kansas City, Kansas Flood Protection Project; the Missouri River Levee Unit L142, across from Jefferson City, Missouri; and the L15 levee near the confluence of the Missouri and Mississippi Rivers, within St. Charles County, Missouri.

Although most of those projects are designed to provide 500-year flood protection to urban areas, several levee units are designed to protect what is now largely agricultural land. The effects of levee building are many. Not only do levees reduce connectivity between the river and floodplain (e.g., reduce riverine recharge and fisheries access to floodplain wetlands and other habitats, reduce nutrient and organic material exchange, etc.), but they also lead to additional levee projects to address higher river stages (upward spiraling effect of flood heights), and induce development in the adjacent floodplain. Levees and floodplain encroachment also reduce the Corps' flexibility to operate the river for flood control and limit habitat restoration opportunities to compensate for past and ongoing project-related effects to both federally listed species and native river species of special concern.

Out of the pallid sturgeon's total range, approximately 3,515 river miles (28%), is impounded, 21% has been affected by upstream impoundments (altered hydrograph, temperature and sediment budget), 51% is channelized (Keenlyne1989). The number of impounded river miles fluctuates from year to year depending on the amount of inflow into the reservoirs (i.e., drought or flood conditions) and the Corps' operations. The affected channelized river miles of the Lower Missouri River and Middle Mississippi River are also affected by operation and maintenance of upstream impoundments, which impact sediment transport. The altered hydrograph and temperature effects are attenuated as the river progresses downstream (Robb Jacobson, USGS, pers. comm.) and enters the

Mississippi River. The result is a highly fragmented range of habitats with varying suitability for pallid sturgeon. Due to intensive study efforts in recent years, catch records have increased, indicating that pallid sturgeon remain scarce but are widely distributed throughout their range.

I.2.1.2 Commercial Harvest

It has previously been reported that mortality of pallid sturgeon occurs as a result of illegal and incidental harvest from both sport and commercial fishing activities. Herzog (2002) reports that the commercial fishers observed over the years are non-discriminate in their take of sturgeon (including pallid sturgeon). Recently, the Missouri Department of Conservation (MoDOC) has documented incidental/illegal harvest of pallid sturgeon as a result of commercial sturgeon fishing (Craig Gemming, MoDOC, pers. comm.). The value of native sturgeon roe has increased dramatically in recent years due to the collapse of the Russian caviar industry. As the commercial harvest of shovelnose sturgeon roe increases, it is expected that there will be an increased incidental by-catch of pallid sturgeon, possibly resulting in a further decrease in pallid sturgeon populations. For example, Williamson (2003) summarized reports from various states for the harvest of shovelnose sturgeon (flesh and eggs). According to the Illinois Department of Natural Recources, the statewide harvest of shovelnose sturgeon roe has increased from 47 pounds reported in 1990 to 8,197 pounds in 2001. The MoDOC reports that the commercial shovelnose sturgeon catch (flesh and roe) in Missouri increased from 12,183 pounds in 1999 to 65,128 pounds in 2001 for the Mississippi River and from 7,472 pounds in 1999 to 12,370 pounds in 2001 for the Missouri River. The increase harvest pressure of shovelnose sturgeon has also created concern for the population status of this species. Herzog (2002) reports that the catch per unit effort for Middle Mississippi River shovelnose sturgeon collections declined from 527 fish (25 net nights) in 1997 to 30 fish (20 net nights) in 2002 The high was 1,052 fish (54 net nights) in 1998. As a result, the MoDOC has proposed regulation changes to further protect sturgeon populations, and the Iowa Department of Natural Resources has closed commercial sturgeon fishing in the Missouri River (Steve Krentz, USFWS, pers. comm.).

I.2.1.3 Pollution/Contaminants

Environmental contaminants may play a role in the decline of pallid sturgeon. Fish consumption health advisories occur from Kansas City to the mouth of the Mississippi; this area represents 45% of the pallid sturgeon's total range. In addition, PCBs, cadmium (Cd), mercury (Hg), and selenium (Se) were detected at elevated but below lethal levels in tissues of three pallid sturgeon tissues from the Missouri River in North Dakota and Nebraska. Detectable levels of chlordane, DDE, DDT and dieldrin were also reported (Ruelle and Keenlyne, 1994). The 2000 Biological Opinion also hypothesized that the "prolonged egg maturation cycle of pallid sturgeon, combined with bioaccumulation of certain contaminants in eggs, could make contaminants a likely agent adversely affecting eggs and embryo, development or survival of fry, thereby reducing reproductive success." Environmental contaminants, although suspected to have a role in sturgeon

dynamics, have only recently begun to be more fully examined in relation to sturgeon reproduction and health in both the Middle Mississippi River (MMR) and Missouri River, and more information is needed.

Coffey et al. (2000) conducted a preliminary contaminant investigation on fish collected from a chlordane consumption advisory site (contaminants known to be present) in the Middle Mississippi River and from a reference site without advisories (contaminants not known to be present). Results indicate that wild shovelnose collected from the consumption advisory site exhibited enlarged livers, often an indicator of contaminant exposure. In addition, plasma estrogen and testosterone ratios were >1 for three males and vitellogenin (an egg production protein with no known function in males) was induced in two of these three males. Two other males exhibited intersex characteristics after histological examination (Harshbarger et al. 2000). Sturgeon are gonochoristic, which means that sexual expression is entirely genetically mediated and does not change within the life of an individual. This is different from other species capable of hermaphrodism and sexual conversion from one sex to the other. Examples of this include many colorful marine fish species that inhabit coral reef environments. For this reason, intersex characteristics are rare for this species (Van Eenennaam and Doroshov, 1998). High tissue concentrations of organochlorine compounds and metabolites were detected in affected fish. These preliminary data suggest that the role of environmental contaminants on sturgeon dynamics needs to be further evaluated.

Coffey et al. (2001) also conducted a risk assessment for Middle Mississippi River pallid sturgeon. Using conservative assumptions in most parts of the assessment, they determined that water and sediment may carry contaminants at levels that reduce the food base and increase exposure and bioaccumulation in tissue. Most notable were the eight heavy metals found in sediments that have been detected in fish tissue, including in sturgeon, above adverse effect thresholds (As, Cd, Cu, Pb, Hg and Se). This is also the case for DDD, DDE, chlordane and dieldrin.

Papoulias et al. (draft preliminary results, 2003) sampled adult shovelnose sturgeon monthly in the Lower Missouri River between May 2001 and June 2002. The preliminary study results show an unusually high incidence of sturgeon with characteristic gonadal anomalies consistent with abnormal hermaphroditism (AH) AH in an animal is characterized by possessing either male and female gonads or abnormal gonads exhibiting both male and female characteristics within the same organ (ovo-testes). Ovo-testes were identified in 25 of 379 shovelnose collected (Papoulias et al.). Most fish appeared to be genetic males with the addition of eggs/oocytes on the surface of the testes. Papoulias and Tillitt (2004) noted observing the incidence of intersex as high as 13% among male shovelnose sturgeon. It is unknown whether this condition occurs in pallid sturgeon. Papoulias and Tillitt (2004) state that factors that may cause hermaphroditism in sturgeon and the consequences on reproduction are unknown. Senescence, genetic, abnormalities, hybridization, radiation, chemicals, diet, temperature, and environmental disturbance have all been implicated in the literature. Papoulias et. al. (2003) found that "gonadal abnormalities may indicate the potential for reproductive impairment in this species (shovelnose sturgeon) and others and should be investigated."

I.2.1.4 Hybridization

The rate of hybridization between pallid sturgeon and shovelnose sturgeon is increasing and remains highest in the Lower Missouri River and Middle Mississippi River reaches of the action area. Seven pallid/shovelnose sturgeon hybrids were collected in the MMR and 15 were collected in the Lower Missouri River as part of a Mississippi Interstate Cooperative Resources Agencies (MICRA) study from 1996 to 2000. The rate of hybridization increased from 1 in 365 (0.27%) river sturgeon in the late 1970s (Carlson et al. 1985) to 1 in 235 (0.42%) in the 1990s (Grady et al. 2001). Based on visual identification of sturgeon collected at the Old River Control Structure, 10% were pallid sturgeon, 35% were hybrids, and 55% were shovelnose sturgeon (Dean 2002). More reports of hybrid catches are listed in Table I.4.

I.2.1.5 Entrainment

Sand and Gravel Dredging - In 1998, the Corps' Waterways Experiment Station published a Technical Note that summarizes existing literature regarding potential impacts to aquatic organisms caused by entrainment during dredging and dredged material disposal operations (Reine and Clarke 1998). Entrainment is defined as the direct uptake of aquatic organisms by the suction field generated at the draghead or cutterhead of the dredge equipment (Reine and Clarke 1998). Armstrong et al. (1982) reported entrainment rates that ranged from 0.001 to 0.135 fish/cubic yard of dredged material (cy) for both pipeline and hopper dredging activities. They found that both small and large fish were entrained in similar proportions and concluded that large fish did not actively avoid the dredge any more than small fish. Armstrong et al. (1982) reported an initial mortality rate of 37.6%. Larson and Moehl (1990) reported entrainment rates ranging from <0.001 to 0.341 fish/cy during a 4-year study at the mouth of the Columbia River in Oregon. The majority of fish entrained were demersal, or bottom dwellers, with a few pelagic, or open water, species also collected (Larson and Moehl 1990). Buell (1992) monitored entrainment by the hydraulic dredge *R.W. Lofgren* during dredging operations in the Columbia River. Buell reported an entrainment rate of 0.015 fish/cy for white sturgeon (*Acipenser transmontanus*). Substantial numbers of juvenile white sturgeon (300 to 500 mm) were entrained in an area largely attributed to dredging and referred to as the local "sturgeon hole". However, the overall entrainment rate reported by Buell (1992) is comparable to rates reported for other species of fish. To date, no studies have been completed in the Missouri or Mississippi Rivers to evaluate possible fish entrainment due to commercial sand and gravel dredging or navigation channel maintenance. The Corp has previously stated that entrainment of pallid sturgeon due to navigation channel maintenance dredging cannot be ruled out (USACE 1999).

Towboats - The effect of towboat propellers on fish populations is a concern associated with potential increases in commercial navigation traffic on the Upper Mississippi River (Killgore et al. 2001). To date, there has been no evaluation of the baseline effects of current navigation traffic in either the Missouri or Mississippi Rivers. Cada (1990)

reported that fish eggs and larvae that pass through water currents induced by a propeller may come in contact with the blade and can experience stresses from pressure changes and shear forces. Killgore et al. (2001) evaluated the mortality of icthyoplankton entrained through a scale model of a towboat propeller. Fish species tested included larval shovelnose sturgeon, larval lake sturgeon, the larvae and eggs of paddlefish, larval blue sucker and juvenile common carp. Fish were subjected to treatments at various shear stress levels ranging from 634 to 4,743 dynes/cm2 (1 dyne = the force that would give a free mass of 1 g an acceleration of 1 cm/s2) (Killgore et al. 2001). They found mortality to be a linear function of shear stress for all species and life stages. Larger larvae (e.g., shovelnose sturgeon) experienced lower mortality, while smaller larvae (e.g., lake sturgeon and blue suckers) experienced higher mortality (>75 percent). All larval species experienced delayed mortality, particularly at higher stress levels, however, common carp juveniles and paddlefish eggs did not experience delayed mortality (Killgore et al. 2001). Shear stress from propeller jet velocities can exceed 5,000 dynes/cm2. Killgore et al. (2001) concluded that shear stress due to towboat traffic is likely to be a contributing factor in the mortality of ichthyoplankton entrained during vessel passage; however, the magnitude of mortality is dependent on individual size of ichthyoplankton. Based on this information, it is likely that towboat traffic is a source of incidental mortality to larvae of pallid sturgeon. The extent of mortality is likely to be a function of the amount of tow traffic in a given river system, towboat speed and traffic levels during the time of year when larvae are most susceptible to shear stress (e.g., early developmental phase) (Killgore et al. 2001).

Gutreuter et al. (2003) developed a method to estimate mortality rates of adult fish caused by entrainment through the propellers of commercial towboats operating in river channels. They estimated entrainment mortality rates of adult fishes in Pool 26 of the Upper Mississippi River and Alton Pool of the Illinois River where fish kills attributed to entrainment were observed. Their estimates of entrainment mortality rates were 0.53 fish/km of towboat travel for shovelnose sturgeon. They concluded that their approach applies more broadly to commercial vessels operating in confined channels, including other large rivers and intra-coastal waterways. Based on this information, it is likely that towboat traffic is a source of incidental mortality to adult pallid sturgeon.

I.2.1.6 Invasive Species

Since issuance of the 2000 Biological Opinion, Asian carp populations have greatly increased in the Missouri River and Mississippi River systems. Bighead carp (*Aristichthys nobilis)* and silver carp (*Hypophthalmichthys molitrix)* have become the most abundant large fish in portions of the Lower Missouri River (Duane Chapman, USGS, pers. comm.). The abundance of these fish, coupled with their ability to consume massive quantities of phytoplankton and zooplankton, presents a great risk to the productivity of the Missouri River and Mississippi River aquatic food web.

Bighead and silver carp have the potential to consume and retain large quantities of energy from lower trophic levels of the river's food web, negatively impacting pallid

sturgeon and other native fishes. In addition, pallid sturgeon larvae may be preyed upon by bighead and silver carp while they are part of the ichthyoplankton.

Bighead Carp - Bighead carp are known to school and occupy the upper to middle layers of the water column. They prefer large rivers and depend on velocity, a spring rise in the hydrograph and temperature regimes to spawn (Lin 1991). Bighead carp have a large suction volume, fast growth rates and voracious appetites enabling them to decimate large concentrations of zooplankton quickly. Preliminary data from the Missouri River indicates that bighead carp can also feed on detritus, which gives them an alternate food source in periods when zooplankton concentrations are low (Duane Chapman, USGS, pers. comm.).

Laird and Page (1996) state that bighead carp have the potential to deplete zooplankton populations that could negatively impact the food availability for many larval fish, adult filter feeding fish, and native mussels to a significant degree. Most species of fish in the Missouri and Mississippi Rivers have a larval stage in which the fish are part of the plankton, and thus can be vulnerable to Asian carp predation. Bighead carp host a number of disease causing agents, including 2 bacteria, 1 fungus, 22 protozoa, 6 trematoda, 3 cestoda and 3 copepoda species (Jennings 1988). The impact of these agents on native fish has not been assessed.

Silver Carp - Silver carp are known to school and occupy the upper to middle layers of the water column. Similar to bighead carp, silver carp feeding ecology shifts as the fish ages. As adults, they feed primarily on phytoplankton with zooplankton as a secondary food source. Due to a modified gill structure, the fish filters food items at a ratio of 248:1. Silver carp also feed on organic detritus and associated bacteria, indicating opportunistic feeding behavior. In large numbers, the silver carp has the potential to cause enormous damage to native species because it feeds on plankton required by larval fish and native mussels (Laird and Page 1996) and has the potential to compete with adult native fish that rely on plankton for food (Pflieger 1997). Intraspecific feeding competition between silver carp and endemic fishes in backwater habitats, lakes, pools, etc., appears to be the greatest threat. Silver carp may also displace native river fish from spawning habitats.

Grass Carp - Grass carp (*Ctenopharyngodon idella*) are herbivorous and depend on floodplain habitats for successful recruitment. In most rivers where grass carp reproduce successfully, floodplains provide a large volume of still, shallow, warm water containing vegetative cover. There are few macrophytes in the Missouri or Mississippi Rivers. However, ongoing efforts to reconnect the floodplain in these river systems, while essential to native species, will also likely benefit grass carp.

I.2.1.7 Summary of Biological Opinions and Incidental Take Statements

Table I.1: Summary of Biological Opinions and Incidental Take Statements

Federal Action	Citation	Location	Take	Jeopardy
USACE Continued operation and maintenance of the nine-foot channel navigation project on the Upper Mississippi River	**USFWS 2000a**	Upper Mississippi River	1. Interim (10y) a max of 1.2 acres/mile/year of main channel habitat and a maximum of 0.8 acres/year/mile of side channel habitat is anticipated to be lost. 2. Incidental take in the form of habitat alteration due to the dredging program is likely to continue for the next 50 years. 3. 10 young-of-the-year pallid sturgeon/year and 1 juvenile/adult pallid sturgeon/year could be taken as a result of sturgeon monitoring. This incidental take is expected to be in the form of death of individual pallid sturgeon.	**Likely to result in jeopardy**
USACE Operation of the Missouri River Main Stem Reservoir System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System (An amendment to USFWS 2000)	**USFWS 2003**	**Missouri River Basin**	**Unquantifiable Incidental Take due to:** 1. Loss of spawning cue from altered hydrograph 2. Mortalities of early life stages from altered hydrograph 3. Loss of quantity and quality of spawning and nursery habitat due to reduced sediment transport and deposition. 4. Loss of genetic purity and exchange due to hybridization caused by habitat loss 5. Mortalities of early life stages from entrainment. 6. Mortalities of adults from stress of capture and spawning for propagation program. 7. Mortalities of all life stages from stress of capture and handling for research, monitoring and assessment programs, and from specimens retained for identification. anticipated to be low due to high rates of recapture	**Not likely to result in jeopardy following implementation of reasonable and prudent measures**
Upper Mississippi River-Illinois Waterway System Navigation Feasibility Study is an investigation addressing navigation system improvement and ecological restoration needs for the Upper Mississippi River and Illinois Waterway system for the years 2000-2050.	**USFWS 2004**	Upper Mississippi River and the navigable portions of the Minnesota, St. Croix, Black, and Kaskaskia Rivers. Floodplain portions of Illinois, Missouri, Iowa, Wisconsin and Minnesota bordering these navigable waters, which totals over 2.6 million acres.	**Increased Navigation**- will kill 4 juvenile and 2 adults over a 50 year period **Entrainment due to dredging**- ≤ 1 juvenile/adult and 20 larval pallid sturgeon per year will be killed **Entrainment by propeller**-delayed mortality and non-fatal injuries-unquantifiable harassment **Project Mitigation** - physical displacement and short-term decreases in food abundance which is unquantifiable harassment. **Ecosystem Restoration Program -** habitat modification will displace pallid sturgeon. Short-term decreases in forage food abundance which is unquantifiable harassment.	**Not Likely to result in jeopardy**

I.2.2 Baseline Status

The current distribution of the pallid sturgeon includes the Missouri River, Middle and Lower Mississippi River, the Atchafalaya River and the lower reaches of the Yellowstone, Platte, Kansas, St Francis and Big Sunflower Rivers (Constant et al. 1997). Pallid sturgeon in the Upper Missouri River (2 populations) are genetically distinct from pallid sturgeon in the Atchafalaya River, suggesting that northern and southern populations are reproductively isolated (Tranah et al. 2001).

Pallid sturgeon are widely distributed throughout their range and occur in small numbers relative to the closely related shovelnose sturgeon. Increasingly, the total numbers of pallid sturgeon collected during sampling reflect higher numbers of released hatchery reared fish and hybrids than wild fish. The collection of larval and juvenile pallid sturgeon is becoming more common due to increased effort and gear efficiency. However, the low numbers of these age classes suggests to most sturgeon researchers that pallid sturgeon reproduction is a rare event and recruitment from reproduction has not been documented. It should be noted that the numbers of larval and juvenile pallid sturgeon collected may also be an artifact of sampling gear bias and/or a variable level of effort aimed at these size classes. Evidence of recruitment of wild origin pallid sturgeon is lacking. The species is largely being maintained through artificial propagation programs, particularly in the Upper Missouri River where the sub-population below Fort Peck Dam is predicted to be extirpated by 2018. An exception to this is the Lower Mississippi River, where the species status is largely unknown with the exception of recent collections in several locations. Hybridization with the closely related shovelnose sturgeon in the Lower Missouri River and Mississippi remains a concern (Keenlyne et al, 1994).

Restoration stocking - In response to obvious declines in pallid sturgeon numbers and the notable lack of recruitment, MoDOC began an augmentation effort by releasing fingerlings raised at Blind Pony State Fish Hatchery. Since 1994 when stocking of hatchery raised pallid sturgeon began, young-of-year fingerlings, and age one and two juveniles have been stocked in all Recovery Priority Management Areas. (See Appendix C p3-5 of this assessment for a full description of the RMPAs) No stocking occurred in 2001 when concerns of disease in hatchery tocks postponed stocking for one year. In all, 16 stocking events have occurred range-wide; 13 within the action area for the 2003 Biological Opinion (USFWS 2003). Table I.2 details the total number of hatchery released pallid sturgeon in the action area.

Table I.2: Pallid Sturgeon Stocked by Year in Each Recovery Priority Management Area from 1994 to 2003. Excerpt from USFWS 2003 p.128

RPMA	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Subtotals
#1	0	0	0	0	690	0	0	0	2058	0	2748
#2	0	0	0	0	780	0	679	0	3061	4124	8644
#3	0	0	0	0	0	0	514	0	1025	601	2140
#4	2432	0	0	2015	0	0	0	0	7406	9241	21094
#5	4526	0	0	1666	0	0	0	0	0	0	6192
#6	0	0	0	0	35	0	0	0	0	0	35
Subtotal	6958	0	0	3681	1505	0	1193	0	13550	13966	
									TOTAL		**40,853**

The survival and condition factor of stocked pallid sturgeon juveniles is under investigation on the Upper Missouri River. Gardner (2003) reported 6-year old pallid sturgeon stocked in 1998 at average fork length of 11.5 inches, grew to average fork length of 20.7 inches in 2003. Average weight during that period increased from 0.18 pounds to 1.12 pounds. Gerrity et al. (2003) calculated change in condition factor for 41 pallid sturgeon stocked in the Upper Missouri River, age 1-6, and revealed a slight decline in condition from date of stocking, but observed most appeared healthy. The outcome of stocking as a tool to avoid extinction and to recover pallid sturgeon will not be known for some time. To be successful, stocked pallid sturgeon must mature to spawn in suitable habitat, recruit to the population, then spawn again.

Population Dynamics -As is shown in Table I.3 (USFWS 2004 Table 5-1), data collected and reported throughout the range of the pallid sturgeon are inconsistent and difficult to compare between reaches. The Service has concluded from the data represented in Table J.2 and discussed in the text below that there is a continuous and ongoing decline in the population of adult pallid sturgeon in the Upper Missouri River reaches. Additionally, for both the Lower Missouri River alone, as well as the Lower Missouri River and the Middle Mississippi River combined, there appears to be a shift in the relative abundance of pallid sturgeon to shovelnose and other river sturgeon. Data from Grady et al. (2001) and MoDOC indicate that shovelnose sturgeon populations are either stable or declining, respectively. This indicates that there is a true reduction in the abundance of pallid sturgeon reflective of a lower ratio of pallid sturgeon compared to other sturgeon species.

Table I.3: Estimates of Adult Pallid Sturgeon and Ratio of Pallid Sturgeon to other Sturgeon (Excerpt from USFWS 2004 p97)

Upper Missouri River	Middle Missouri River	Lower Missouri River	Middle Mississippi River	Lower Missouri River/Middle Mississippi River Combined	Lower Mississippi River
200-300 Duffy et al. 1996	25-50 (GPD to FRD)	1:311 (0.32%) Grady et al. 2001	1:89 (1.1%)[1] USACE 2003	1:398 (0.25%)[2] Carlson et al. 1985	1:23 (4.3%) Killgore 2004
178 Year 2001 Kapusinski 2003		1:387 (0.26%) Doyle and Starostka 2003		1:647 (0.15%) Grady et al. 2001 1996-2000 Cumulative	
166 Year 2002 Kapusinski 2003					
151 (89-236) (95% Confidence) Year 2003 Kapusinski 2003					

[1] Ratio on Middle Mississippi River is to shovelnose sturgeon only
[2] Ratio is to all river sturgeon (shovelnose, lake, pallid, hybrid)

A more detailed picture of the current status and population trends is revealed by examining the available field data. Table I.4 summarizes the current range and population data available for the pallid sturgeon. All pallid sturgeon catch records, including those gleaned from the literature, are catalogued in a Service database maintained in Bismarck, North Dakota. The database contains 1,214 records of pallid sturgeon captured from 1920 to 2002, and includes individuals captured more than once. Some river reaches are more easily sampled than others, and some have been sampled more heavily for brood stock collections, research, assessment and monitoring. This may account for the relatively few records (historic and present) in the Missouri River below Gavins Point Dam and the Middle Mississippi River. According to the database, reports of the most frequent catches on the Missouri River occur from between Ft. Peck Dam in Montana and the headwaters of Lake Sakakawea in North Dakota and in the reservoir reaches between Garrison Dam and Gavins Point Dam. However, the majority of catches from between Oahe Dam and Gavins Point Dam occurred prior to 1970. Other frequent records occur between Sioux City, Iowa, and the confluence with the Mississippi River, and from the confluence with the Missouri River to Cairo, Illinois on the Mississippi River.

Table I.4: Summary of Pallid Sturgeon Range and Population

Basin	Location	Population/Status	Citation
Upper Missouri River	Above Fort Peck Dam in Montana (Recovery - priority management area #1[RPMA #1])	50-100 adults	Duffy et al. (1996) Mark and recapture data.
Upper Missouri River	Garrison Dam in North Dakota and Fort Peck Dam, which also includes the Yellowstone River (RPMA#2).	200-300 adults	Duffy et al. (1996) Mark and recapture data.
Upper Missouri River	RPMA#1	30 – 50 adults	Kapuscinski 2003
Upper Missouri River	RPMA#2	89 - 236 adults	Kapuscinski 2003
Upper Missouri River	RPMA#2 at the confluence of the Yellowstone and Missouri Rivers	23 captured	Krentz 2000
Upper Missouri River	RPMA#2 April 2000 at the confluence of the Missouri and Yellowstone Rivers	17 adults captured in 2000. Eight were untagged. Three were recaptured hatchery reared pallid sturgeon.	Yerk and Baxter (2001)
Upper Missouri River	RPMA #2 11 of the 15 were captured during spring at the confluence of the Missouri and Yellowstone Rivers	15 adults captured. Three were untagged.	Kapuscinski and Baxter (2003)
Middle Missouri River (river segments 4 to 9)	Between the headwaters of Oahe Reservoir in North Dakota and Garrison Dam	Sport anglers have reported up to five pallid sturgeon catches per year. However, no catches have been reported since 2002	USFWS 2004
Middle Missouri River (river segments 4 to 9)	Riverine reach above Gavins Point Dam to the Fort Randall Dam	Occasional catches reported, suggesting that perhaps as many as 25 to 50 fish remain in each of these areas. No catches of adults have been reported since 1992.	USFWS 2004
Middle Missouri River (river segments 4 to 9)	Between Oahe Dam and the Big Bend Dam above the headwaters of Lake Sharpe	50 to 100 fish No catches have been reported since 2001.	Krentz, USFWS, pers. comm. 2003
Lower Missouri River (river segments 10 to 15)	Below Gavins Point Dam and in the channelized river adjacent to Nebraska	one pallid sturgeon	Mestl 2001 Trawl data.
Lower Missouri River (river segments 10 to 15)	Goose Island	one pallid sturgeon	Mestl 2001 Trawl data.
Lower Missouri River (river segments 10 to	Not specified	Of the 9 pallid sturgeon collected between 1996-	Grady et al. 2001

Basin	Location	Population/Status	Citation
15)		2000, 7 were presumed to be of wild origin, while 2 were hatchery stocked fish.	
Lower Missouri River (river segments 10 to 15)	Highway 19 bridge replacement at Hermann, Missouri	Columbia Missouri Fishery Resources Office (CMFRO) collected 3 pallid sturgeon and 14 hybrids from January 2000 through March 2001.	Milligan 2002
Lower Missouri River (river segments 10 to 15)	Sampled 6 reaches along 200 river miles in 2002	Columbia Missouri Fishery Resources Office (CMFRO) collected 12 pallid sturgeon and 12 pallid/shovelnose hybrids. 5 of the pallid sturgeon were classified as juveniles. While 4 of these fish were from recent stocking of hatchery reared fish, one was presumed to be wild.	Doyle and Starostka 2003
Middle Mississippi River (Upper Mississippi River miles 196.0 to 0.0)	Throughout the MMR	41 pallid sturgeon Collected from May 2002 to May 2003. The total was up to 58 by March 2004. It is conservatively estimated that approximately 60 percent of these pallid sturgeon are MoDOC hatchery reared fish released in 1994 and 1997	USACE 2003a Jack Killgore, USACE, pers. comm. 2004 Dave Herzog, MoDOC, pers. comm. 2003
Middle Mississippi River (Upper Mississippi River miles 196.0 to 0.0)	Not Specified	Of the 12 pallid sturgeon collected between 1996 and 2000, 1 was considered a wild origin fish and 11 were considered hatchery stocked fish.	Grady et al. 2001
Middle Mississippi River (Upper Mississippi River miles 196.0 to 0.0)	Chain of Rocks area (river miles 189.0 to 185.0)	9 pallid sturgeon	Rob Maher, IDNR, pers. comm. 2003
Middle Mississippi River (Upper Mississippi River miles 196.0 to 0.0)	Chain of Rocks area	7 pallid sturgeon This includes one female thought to have black eggs.	Jim Garvey, SIUC, pers. comm. 2004
Lower Mississippi River	Not specified	11 pallid sturgeon	Hartfield et al. (2002)

Basin	Location	Population/Status	Citation
and Atchafalaya River		In 2001.	
Lower Mississippi River and Atchafalaya River	Near Vicksburg, Mississippi	5 pallid sturgeon one hybrid in 2003.	Hartfield et al. 2004). Trawling data.
Lower Mississippi River and Atchafalaya River	Old River Control Structure at the junction of the Mississippi and Atchafalaya Rivers in Louisiana	In late 2000 and early 2001, biologists collected a total of 83 pallid sturgeon and 109 hybrid sturgeon	Reed 2002
Lower Mississippi River and Atchafalaya River	Not specified	11 were pallid sturgeon and 20 hybrids from 2002 -2004	Reed 2002
Lower Mississippi River and Atchafalaya River	Lower Mississippi River	115 pallid sturgeon collected between 2000 and 2004	Killgore 2004

Upper Missouri River - The pallid sturgeon sub-population in this river reach is aging and declining in status. The population is estimated at 151 individuals with 95% confidence intervals of 89 to 236 individuals (Kapuscinski 2003). This number is down from an estimated 166 individuals in 2002 and 178 individuals in 2001. Kapuscinski (2003) estimates that this population of wild pallid sturgeon will be extinct by 2018 based on trend data collected for the period 1991-2003. The Service has interpreted Kapuscinski's conclusion of extinction to mean that this sub-population would be extirpated by 2018. It should be noted that Kapusinski (2003) compensated for certain assumptions that are necessary for a valid outcome from the original method used to estimate population size (Schnable mark-recapture). Incorporating these into the analysis to address the mortality assumption resulted in a slightly lower abundance estimate than the estimate obtained from the original analysis.

Lower Missouri River - Recent records of the pallid sturgeon in the Lower Missouri River from Gavins Point Dam (river mile 811.1) to the mouth of the Platte River (river mile 595.5) are rare. According to the Service's pallid sturgeon database, a total of 20 pallid sturgeon have been reported in this reach. Eight of these fish were reported for the unchannelized reach from Gavins Point Dam to Ponca, Nebraska (river mile 753.0). Thirteen of these records were reported prior to 1990. Seven pallid sturgeon have been reported since listing of the species in 1990.

According to Doyle and Starostka (2003) pallid sturgeon continue to decline at a rapid rate. Within the 200 river miles they sampled, the ratio of pallid sturgeon compared to all river sturgeon decreased from 1:311 (0.32%) in the 1996-2000 MICRA study to 1:387 (0.26%) in 2002. It should be noted, however, that the sampling effort in 2002 does not reflect the same sampling effort or gear utilized during the MICRA study which was completed over a period of five years.

I.3 LITERATURE CITED

Armstrong, D., B. Stevens, and J. Hoeman. 1982. Distribution and abundance of Dungeness crab and *Crangon* shrimp, and dredged-related mortality of invertebrates and fish in Grays Harbor, Washington. Technical Report. School of Fisheries, Univ. of Washington, Washington Dept. of Fisheries, and U.S. Army Corps of Engineers, Seattle District.

Buell, J. 1992. Fish entrainment monitoring of the Western-Pacific Dredge *R.W. Lofgren* during operations outside the preferred work period. Prepared for the Western-Pacific Dredging Company by Buell and Associates, Inc., Portland, OR.

Cada, G.F. 1990. A review of studies relating to the effects of propeller-type turbine passage on fish early life stages. North American J. of Fisheries Management. 10:418-426.

Carlson, D.M., W.L. Pflieger, L. Trial, and P.S. Haverland. 1985. Distribution, biology, and hybridization of *Scaphirhynchus albus* and *S. platorynchus* in the Missouri and Mississippi Rivers. Environmental Biology of Fishes. 14(1):51-59.

Coffey, M., J. Harshbarger, K. Phillips, C. Berg., and T. Gross. 2000. Middle Mississippi River Sturgeon Preliminary Contaminants Investigation. Final Report. U.S. Fish and Wildlife Service, Rock Island, Illinois.

Coffey, M. 2001. Screening Level Contaminants Risk Assessment for the Federally Listed Endangered Pallid Sturgeon in the Middle Mississippi River. Final Draft Report. U.S. Fish and Wildlife Service, Rock Island, Illinois.

Constant, G.C., W.E. Kelso, D.A. Rutherford, and C.F. Bryan. 1997. Habitat, movement and reproductive status of pallid sturgeon (*Scaphirhynchus albus*) in the Mississippi and Atchafalaya Rivers. Report prepared for the U.S. Army Corps of Engineers, New Orleans District, New Orleans, Louisiana.

Doyle, W., and A. Starostka. 2003. 2002 Annual Report for the Lower Missouri River Monitoring and Population Assessment Project. Report prepared for the U.S. Army Corps of Engineers, Northwest Division. U.S. Fish and Wildlife Service, Columbia Missouri Fisheries Resources Office. January 2003. 38pp.

Duffy, W.G., C.R. Berry and K.D. Keenlyne. 1996. Biology of the pallid sturgeon with an annotated bibliography through 1994. Cooperative Fish and Wildlife Research Unit, Technical Bulletin 5. South Dakota State University, Brookings.

Gardner, B., 2003. 2003 Pallid Sturgeon Research and Recovery Efforts in the Upper Missouri River. Montana Fish, Wildlife, and Parks, Lewistown, Montana. 2003 Upper Basin Pallid Sturgeon Workgroup Project Summaries.

Gerrity, P.C., C.S. Guy, and W.M. Gardner. 2003. Habitat Use, Movements, Growth, and Food Habits of Hatchery-Reared Juvenile Pallid Sturgeon and Indigenous Juvenile Shovelnose Sturgeon in the Missouri River above Fort Peck Reservoir, Montana. 2003 Upper Basin Pallid Sturgeon Workgroup Project Summaries. Montana State Univ. – Bozeman, Montana Fish, Wildlife and Parks.

Grady, J.M., J. Milligan, C. Gemming, D. Herzog, G. Mestl and R.J. Sheehan. 2001. Pallid and Shovelnose Sturgeons in the Lower Missouri and Middle Mississippi Rivers. Final Report for MICRA.

Gutreuter, S., J.M. Dettmers, and D.H. Wahl. 2003. Estimating Mortality Rates of Adult Fish From Entrainment Through the Propellers of River Towboats. Trans. American Fisheries Society. 132:646-661.

Harshbarger, J.C., M.J. Coffey, and M.Y. Young. 2000. Intersexes in Mississippi River Shovelnose Sturgeon sampled below St. Louis, Missouri. Marine Env. Research. 50:247-250.

Hartfield, P., D. Drennen, T. Slack, and R. Nassar. 2002. Sturgeon Survey in the Lower Mississippi River. In. R. Wilson, ed., Pallid Sturgeon Recovery Update, Issue No. 12.

Hartfield, P., D. Drennen, and T. Slack. 2004. Trawl Collections from the Mississippi River in the Vicinity of Vicksburg, MS. In. R. Wilson. ed., Pallid Sturgeon Recovery Update, Issue No. 14.

Herzog, D. 2002. Open River Field Station Report for January 2002. Missouri Department of Conservation, Fisheries Research, Assessment and Monitoring Section, Open River Field Station, Cape Girardeau, Missouri.

Jennings, D.P. 1988. Bighead carp (*Hypophthalmicthys nobilis*): a biological synopsis. U.S. Fish and Wildlife Service, Biological Report. 88(29). 35pp.

Kapuscinski, K. 2003. Population Abundance Estimation of Wild Pallid Sturgeon in Recovery-priority Management Area #2 of the Missouri and Yellowstone Rivers, 1991-2003. Draft Report. Montana Fish, Wildlife & Parks. November 6, 2003.

Kapuscinski, K.L., and M.W. Baxter. 2003. Lower Missouri and Yellowstone Rivers Pallid Sturgeon Study, 2002 Report. Submitted to Western Area Power Administration. Montana Fish, Wildlife and Parks, Fort Peck, Montana.

Keenlyne, K.D. 1989. A report on the pallid sturgeon. U.S. Fish and Wildlife Service, Pierre, South Dakota. 20 pp.

Keenlyne, K.D., L.K. Graham, and B.C. Reed. 1994. Hybridization between the pallid and shovelnose sturgeons. Proc. South Dakota Academy of Science. 73:59-66.

Killgore, K.J., S.T. Maynord, M.D. Chan, and R.P. Morgan II. 2001. Evaluation of Propeller-Induced Mortality on Early Life Stages of Selected Fish Species. North American J. of Fisheries Management. 21:947-955.

Killgore, K.J. 2004. U.S. Army Corps of Engineers Research and Development Center, Waterways Experiment Station. In. R. Wilson, ed., Pallid Sturgeon Recovery Update, Issue No. 14.

Krentz, S. 2000. 2000 Summary Report of work conducted by the Missouri River FWMAO on Missouri-Yellowstone River's Pallid Sturgeon. U.S. Fish and Wildlife Service, Missouri River FWMAO, Bismarck, North Dakota.

Laird, C.A., and L.M. Page. 1996. Non-native fishes inhabiting the streams and lakes of Illinois. Illinois Natural History Survey Bulletin. 35(1):1-51.

Larson, K., and C. Moehl. 1990. Fish entrainment by dredges in Grays Harbor, Washington. In. Effects of dredging on anadromous Pacific Coast fishes. C.A. Simenstad, ed., Washington Sea Grant Program, Univ. of Washington, Seattle. Pp. 102-12.

Lin, Z. 1991. Pond fisheries in China. Pearl River Fisheries Institute of the Chinese Academy of Sciences. Pergamon Press. Elmsford, New York. 10-14pp.

Mestl, G.E. 2001. 2000 Missouri River Ecology. Dingell-Johnson/Wallop-Breaux Project Report by the Nebraska Game and Parks Commission. F-75-R-18. September 2001.

Milligan, J. 2002. Hermann Bridge Replacement Study Report. Report by the U.S. Fish and Wildlife Service, Columbia Missouri Fisheries Resources Office to the Missouri River Natural Resources Committee, 16th Annual Proceedings.

Papoulias, D.M., M.L. Wildhaber, and A.J. DeLonay. 2003. Fact Sheet Preliminary Data Summary: Abnormal Hermaphroditism in Shovelnose Sturgeon from the Missouri River. USGS, Columbia Environmental Research Center, Columbia, Missouri.

Papoulias, D.M., and D. Tillitt. 2004. USGS Columbia Environmental Research Center Research Activities – Contaminants. In. R. Wilson, ed., Pallid Sturgeon Recovery Update, Issue No. 14.

Pflieger, W.L. 1997. The fishes of Missouri. Missouri Dept. of Conservation, Jefferson City, Missouri. 372pp.

Reed, B., 2002. Louisiana Pallid Sturgeon Activities 2001. In. R. Wilson, ed., Pallid Sturgeon Recovery Update, Issue No. 12.

Reine, K., and D. Clarke. 1998. Entrainment by hydraulic dredges – A review of potential impacts. Technical Note DOER-E1. U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Ruelle, R., and K.D. Keenlyne. 1994. The suitability of shovelnose sturgeon as a pallid sturgeon surrogate. Contaminant Information Bulletin. SD-ES-94-03. U.S. Fish and Wildlife Service, Pierre, South Dakota.

Tranah, G.J., H.L. Kincaid, C.C. Krueger, D.E. Campton, and B. May. 2001. Reproductive Isolation in Sympatric Populations of Pallid and Shovelnose Sturgeon. North American J. of Fisheries Management. 21:367-373.

U.S. Army Corps of Engineers. 1999. Tier I Biological Assessment for Operation and Maintenance of the Upper Mississippi River Navigation Project within the St. Paul, Rock Island, and St. Louis Districts.

U.S. Army Corps of Engineers. 2003a. Implementation of the Biological Opinion, Annual Progress Report. September 2003. U.S. Army Corps of Engineers, St. Louis District.

U.S. Fish and Wildlife Service. 1993. Pallid sturgeon recovery plan. U.S. Fish and Wildlife Service, Bismarck, North Dakota. 55 pp.

U.S. Fish and Wildlife Service. 2000. Final Biological Opinion for the Operation and Maintenance of the 9-Foot Navigation Channel on the Upper Mississippi River System. Prepared by Region 3, U.S. Fish and Wildlife Service, Fort Snelling, Minnesota. 240 pp.

U.S. Fish and Wildlife Service 2003. Amendment to the 2000 Biological Opinion on the Operation of the Missouri River Main Stem Reservoir System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System. Dated 12/16/2003

U.S. Fish and Wildlife Service 2004. Final Biological Opinion for the Upper Mississippi River-Illinois Waterway System Navigation Feasibility Study. U.S. Fish and Wildlife Service Rock Island Field Office, Rock Island, Illinois Marion Suboffice, Marion, Illinois Twin Cities Field Office, Bloomington, Minnesota August 2004

Van Eenennaam, J.P., and S.I. Doroshov. 1998. J. Fish Biol. 53:624-637.

Williamson, D. F. 2003. Caviar and Conservation: Status, Management and Trade of North American Sturgeon and Paddlefish. TRAFFIC North America. Washington D.C.: World Wildlife Fund.

Yerk, D.B., and M.W. Baxter. 2001. Lower Missouri and Yellowstone Rivers Pallid Sturgeon Study, 2000 Report. Report submitted to Western Area Power Administration. Montana Fish, Wildlife and Parks, Fort Peck, Montana.

PERSONAL COMMUNICATION

Chapman, Duane, pers. comm. 2003. U.S. Geological Survey, Columbia Environmental Research Center, Columbia, Missouri.

Garvey, Jim, pers. comm. 2004. Fisheries and Illinois Aquaculture Center, Southern Illinois University, Carbondale, Illinois.

Gemming, Craig, pers. comm. 2003. Missouri Department of Conservation, Jefferson City, Missouri.

Herzog, David, pers. comm. 2003. Missouri Department of Conservation, Cape Girardeau, Missouri.

Jacobson, Robb, pers. comm.. 2003. U.S. Geological Survey, Columbia Environmental Research Center, Columbia, Missouri.

Killgore, Jack, pers. comm. 2004. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi.

Krentz, Steve, pers. comm. 2003. U.S. Fish and Wildlife Service, Missouri River FWMAO, Bismarck, North Dakota.

Maher, Rob, pers. comm.. 2003. Illinois Department of Natural Resources.