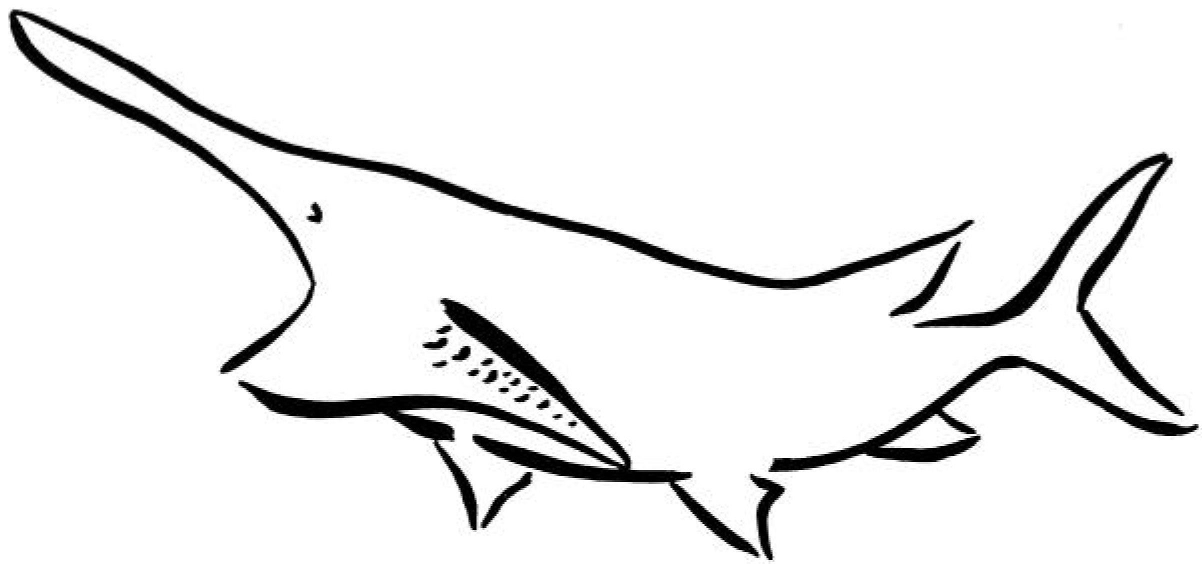
Paddlefish in the lower Missouri River sub-basin:

South Dakota, Nebraska, Iowa, Kansas and Missouri



Lower Missouri River Paddlefish Management Team

December 30, 2005

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EXECUTIVE SUMMARY

Status of Paddlefish in the lower Missouri River sub-basin

- *Missouri*
    - Missouri River - the population has declined in the Missouri River.
    - Tributaries - state-wide the status is considered stable because of a stocking program in the reservoirs.
- *Kansas*
    - Missouri River - the population status in the Missouri River is unknown.
    - Tributaries - the population is considered to be increasing due to stocking in reservoirs.
- *Iowa*
    - Missouri River - the population status in the channelized Missouri River bordering Nebraska is unknown.
    - Tributaries - the population is considered to be declining.
- *Nebraska*
    - Missouri River - larval and juvenile paddlefish have been collected from all reached of the main channel of the Missouri River. The population in the Missouri River and Lewis and Clark Lake above Gavins Point Dam is considered stable. The population is considered stable in the Missouri River below Gavins Point Dam. The status of the population in the channelized stretch of the Missouri River from Sioux City to the Kansas border is unknown.
    - Tributaries - No spawning populations of paddlefish are known to occur in tributaries to the Missouri. Small numbers of paddlefish can be found in the lower reaches of the Platte and Elkhorn Rivers.
- *South Dakota*
    - Missouri River - Paddlefish have been documented throughout the Missouri River in South Dakota. Populations exist in the mainstem reservoirs as well as in the natural river reaches. Paddlefish populations in Lakes Oahe and Sharpe are comprised predominately of large adults, remnant of those “trapped” in the reservoirs after impoundment, and are considered to be declining as older individuals are lost to natural causes. The population in Lake Francis Case is considered stable and may be increasing, largely due to annual fingerling stockings. The population in the Missouri River below Fort Randall Dam and in Lewis and Clark Lake is considered stable. Reproduction has been documented in the “unchannelized” reach of the Missouri River between Fort Randall Dam and Gavins Point Dam. The population below Gavins Point Dam is considered stable and supports a successful recreational fishery managed jointly by the states of Nebraska and South Dakota.
    - Tributaries - no spawning populations of paddlefish are known to occur in tributaries of the Missouri River in South Dakota. Paddlefish have been

documented, by both biologists and anglers, using the lower reaches of some tributaries during periods of high flows.

Recommendations

- Continue and expand the MICRA paddlefish project
- Increase sampling throughout the lower Missouri River sub-basin
- Develop standardized sampling methods
- Recognize and/or create spawning habitat
- Collect and monitor recreational harvest data
- Evaluate the population status of paddlefish in the lower Missouri River sub-basin on a regular basis
- Monitor the spread of aquatic nuisance species and their effects on paddlefish populations
- Support contaminant analysis of paddlefish from across the lower Missouri River sub-basin

Table of Contents

LIST OF TABLES

LIST OF FIGURES

MISSISSIPPI INTERSTATE COOPERATIVE RESOURCE ASSOCIATION (MICRA)

The Mississippi Interstate Cooperative Resource Association (MICRA) is an organization made up of the 28 Mississippi River basin states that coordinates efforts to improve management of interjurisdictional fisheries. Uncertainty about the status of paddlefish populations in North America prompted MICRA to initiate a multi-state and multi-agency paddlefish research effort in March 1995. This project examines paddlefish habitat use, distribution, movement, extent of harvest, and population status in the Mississippi River basin. Since the project began in 1995, 22 states have participated by collecting biological information and/or by tagging wild and all stocked paddlefish.

PADDLEFISH STATUS

United States and International

Paddlefish (*Polyodon spathula)* are listed by The World Conservation Union (IUCN) as a Vulnerable species (IUCN 2004) but are not listed as threatened or endangered under the Endangered Species Act (ESA). The IUCN designation (VU A3de) projects “A population size reduction of ≥ 30%, suspected to be met within three generations, caused by: 1) actual or potential levels of exploitation and 2) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites” (IUCN 2004). One other species of paddlefish (*Psephurus gladius)* exists in the Yangtze River of China and is listed by IUCN as critically endangered due primarily to overfishing (IUCN 2004).

North American paddlefish were historically abundant throughout major rivers in the Mississippi and Gulf Coast basins and existed in some of the Great Lakes during the early 1900's (Carlson and Bonislawsky 1981). Figure 1 depicts historic paddlefish distribution.

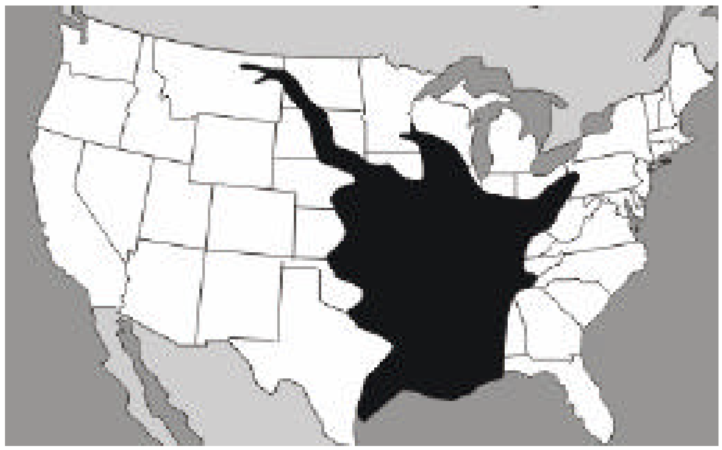

Figure 1. Historic distribution of paddlefish in the Mississippi River drainage.

Surveys completed by biologists in 26 states during 1996 showed that populations were believed to be increasing in 4 states, stable in 10 states, decreasing in 5 states, extirpated in 4 states, and in 3 states the population status was unknown or biologists were not in agreement (Graham 1997). Paddlefish have been extirpated from peripheral areas of their historical range including Lake Huron and Lake Helen in Canada, Pennsylvania, New York, North Carolina, and Maryland.

Robust sub-populations of paddlefish now only exist in fragmented stretches of river which are usually central to their historic range. Previous reviews of MICRA data have indicated that range-wide, paddlefish populations are stable but certain sub-populations such as the Ohio River sub-basin may be experiencing unsustainable levels of commercial harvest (Henley et al. 2001).

INTRODUCTION

STUDY AREA

The Missouri River flows 2,341 miles from its headwaters in Montana to its confluence with the Mississippi River at St. Louis, Missouri. The Missouri River drainage basin is the largest in the United States and covers approximately 529,350 square miles within 10 states. The Pick-Sloan Plan of the early 1940's initiated the construction of six mainstem dams upstream of Yankton, South Dakota primarily for flood control and hydro-electric generation. To facilitate commercial navigation and to provide flood control, the River and Harbor Act of 1945 authorized the channelization of 735 miles of river from the confluence with the Mississippi River to Sioux City, Iowa (Baumel and Van Der Kamp 2003; Sparrowe 1986). Today, about one third of the Missouri River is channelized, one third is pooled in reservoirs and one third remains in a semi-natural state, with sandbars, backwater areas, braided chutes and islands. The U.S. Army Corps of Engineers projected 5 million tons of commercial barge traffic per year by 1980 but the intended level of usage has never been met (Baumel and Van Der Kamp 2003). The amount of corn, wheat, and soybeans shipped on the Missouri River from Missouri, Kansas, Iowa and Nebraska is less than one-quarter of one percent of the total production from those states (Babcock and Anderson 1999). The combined impacts of channelization and dam construction have had far reaching impacts on the ecology of the Missouri River, with arguably less than anticipated economic and social benefits. Changes in river conditions that have been shown to impact native fish species include but are not limited to a reduction in shallow, slow water habitat, altered seasonal flows, and changes in sediment loads and composition. The Missouri River sub-basin described in this report encompasses the Missouri River and its drainage within the states of Missouri, Kansas, Iowa, Nebraska, and South Dakota (Figure 2).

Figure 2. Missouri River drainage basin and sub-basin outlined in red.

Threats to Paddlefish within the lower Missouri River sub-basin

Paddlefish are native to the Missouri River and many of its large tributaries. Channelization, dam construction and elimination of backwater areas have caused a decline in paddlefish numbers (Unkenholtz 1986). Most notably, six mainstem dams in the Missouri River have impacted spawning habitat, recruitment, migration ability and high spring flows that initiate reproduction. Purkett (1961) found that increased water flows were a trigger that stimulated paddlefish spawning, although photoperiod and water temperatures were also important. If there is not sufficient water flow during the spawning period, paddlefish will not spawn successfully or will reabsorb their eggs.

Paddlefish are capable of migrating great distances through river systems when barriers are not present (Russell 1986). These movements are sometimes apparently at random but most are associated with changes in flow or temperature; the most dramatic migration is linked to spawning behavior. Although requirements for successful spawning areas are well known, exact locations in many river reaches have not been identified (Carlson and Bonislawsky 1981). Purkett (1961) observed paddlefish spawning over inundated gravel bars in late March to late June as water temperatures reach the mid 50's. Since alteration of the river channel and construction of dams, shallow gravel areas have been either dredged out or flooded (Unkenholtz 1986). Benthic trawl samples from the old Missouri River channel in Lewis and Clark Lake have revealed high annual variability in catch of young of the year (YOY) paddlefish but reproduction has been documented most years since 1965 (Mestl 2003). Female paddlefish do not spawn until they are ten to twelve years of age (Russell 1986) and under ideal environmental conditions spawn every two years. These factors contribute to the low numbers of paddlefish throughout the Missouri River system.

Paddlefish populations are easily overexploited by commercial means because their behavior makes it easy for commercial fishers to catch large numbers quickly and low recruitment and slow growth rates make it difficult to withstand heavy fishing pressure (Pasch and Alexander 1986). It has been suggested by Larkin (1978) that younger fish may have less viable eggs than older, larger fish, which are targeted by commercial activities. Although commercial fishing has been discontinued in all states along the Missouri River since 1986, poaching has increased because of the caviar trade and recreational harvest is permitted by every state in the sub-basin. The ability of paddlefish to travel long distances creates the potential for inter-state and inter-basin fishery competition.

Reporting of commercial harvest in the Missouri River was infrequent during most of the late 1800's and early 1900's and records from different agencies are inconsistent. Carlson and Bonislawski (1981) report a peak harvest of 58,000 kg in the Missouri River during 1894 but during the last 50 years commercial harvest has averaged approximately 4000 kg per year until 1985 (Zuerlein 1988). Years of over-harvest of sturgeon in traditional fisheries, mainly the Caspian Sea, have driven stocks to such low numbers that caviar brokers have started to utilize paddlefish roe as a lower cost substitute. Beluga sturgeon caviar retails on the Internet for $110 per ounce while domestic paddlefish caviar retails for $20 per ounce.

In addition to alterations on the river and their effects on paddlefish movement and reproduction and the increasing illegal harvest connected to the caviar trade, several exotic species are also threatening paddlefish populations in the Missouri River. Bighead carp *(Hypophthalmichthys nobilis)* were first reported in the Missouri River in the mid-1990's and have extended their range throughout the middle and lower Missouri River and its major tributaries in several years. Shrank et al. (2001) noted that bighead carp larvae in 1997 were extremely high in abundance in the lower Missouri River relative to those in other studies on larval fish. In the past several years, bighead carp were the most abundant species sampled at the mouth of the Big Sioux River using drifting trammel nets (Lannie Miller, Personal Communication). Bighead carp compete with native planktivores such as paddlefish and data suggests that they may have the ability to negatively affect growth rates of paddlefish (Schrank and Guy 2003). Silver carp (*Hypophthalmichthys molitrix)* have recently entered the Missouri River and are rapidly expanding their range. It has similar feeding behavior and will only add to the competition for plankton in the river. Zebra mussels (*Dreissena polymorpha)* have been collected in the Missouri River south of Sioux City, Iowa while zebra mussel veligers have been documented upstream of Lewis and Clark Lake. Only one adult and several veligers have been found, but this mussel multiplies rapidly and forms large colonies that feed on the same organisms that paddlefish eat and require to thrive.

Classification of Paddlefish

All states (Missouri, Kansas, Iowa, Nebraska, and South Dakota) in the Missouri River sub-basin classify and manage paddlefish as a sport species and currently do not permit commercial harvest from the Missouri River or its tributaries. However, Missouri permits commercial harvest in the Mississippi River and lower St. Francis River (Hesse and Carreiro 1997).

Paddlefish Fishing Regulations within the lower Missouri River sub-basin

Missouri

Paddlefish are harvested during a 45-day snagging season that runs March 15 through April 30. There is a statewide 24-inch minimum eye to fork length limit, except on Lake of the Ozarks, Table Rock Lake and Harry S Truman Lake and their tributaries where the minimum length 34-inches eye to fork (body length). The current daily and possession limit is two and four fish respectively.

Numerous regulations have been implemented over the years to both protect and enhance the quality of this fishery. A chronological listing of statewide and specific lake regulations used to manage paddlefish in Missouri can be found in Table 1 in the Appendix. For the most up-to-date Missouri Wildlife Code and complete listing of all paddlefish regulations, please visit http://www.sos.mo.gov/adrules/csr/current/3csr/3csr.asp

Iowa

Fishing is restricted on the Missouri and Big Sioux Rivers and 200 yards upstream from any of their confluences. On open waters within the state there is no minimum length, the daily bag limit is two, possession is four and there is a year round snagging season. Snagging is also restricted below the Saylorville dam, 5 in 1 dam, C Street Roller dam, Coralville dam, Lake Rathbun dam, Ottumwa dam, and at the spillway below Spirit Lake. A chronological listing of statewide and specific lake regulations used to manage paddlefish in Iowa can be found in Table 3 in the Appendix. Visit the Iowa Department of Natural Resources' Website for more information http://www.iowadnr.com/fish/regulations/paddle.htm

Kansas

Paddlefish may only be taken on designated waters. There is a paddlefish season on the Neosho River below the Chetopa dam, Marais des Cygnes River below Osawatomie Dam, Walnut River below the Tunnel Mill Dam at Winfield, and the Browning Oxbow Lake of the Missouri River or other areas posted by the Kansas Department of Wildlife and Parks. All legal sized paddlefish must be kept and checked in at a state designated area. There is a 34 inch eye to fork length limit on the Neosho River and the Marais des Cygnes River, daily bag limits of one or two, possession is up to six and the snagging season runs from March 15 to May 15. Paddlefish may be snagged with one or two single or treble hooks. Visit the Kansas Department of Wildlife and Parks website for more information *http://www.kdwp.state.ks.us*

Nebraska and South Dakota

Paddlefish may only be taken on designated waters. The Missouri River upstream from Fort Randall Dam, the Missouri River upstream from Gavins Point Dam which forms the border between Nebraska and South Dakota and the Missouri River downstream from the mouth of the Big Sioux River which forms the border between Nebraska and Iowa are closed to paddlefish angling. Currently fishing is permitted only on the Missouri River from Gavins Point Dam downstream to the mouth of the Big Sioux River where Nebraska and South Dakota jointly manage a recreational fishery for paddlefish. The paddlefish archery season opens on the second Saturday of July and runs for 30 days. A total of 550 archery permits are issued jointly by Nebraska and South Dakota and each angler can have a maximum of two permits. The paddlefish snagging season runs from October 1 to October 30. A total of 2,800 permits are issued jointly by Nebraska and South Dakota and each angler may have a maximum of two permits. During the snagging season there is a protected slot limit of 35 to 45 inches and catch and release is allowed. Only one treble hook, 0.5 inches or less from tip to shank is permitted. A chronological listing of statewide and specific lake regulations used to manage paddlefish in Nebraska can be found in Table 2 in the Appendix. For more information visit the Nebraska Game and Parks Commission's Website at *http://www.ngpc.state.ne.us*

A chronological listing of statewide and specific lake regulations used to manage paddlefish in South Dakota can be found in Table 4 in the Appendix. For more information, visit the South Dakota Department of Game, Fish and Parks website at http://www.sdgfp.info

MICRA PADDLEFISH STUDY

In 1995 the Mississippi Cooperative Resource Association initiated a long-term multi-state, multi-jurisdictional paddlefish study to assess the condition of paddlefish stocks throughout the Mississippi River Basin. The Missouri Department of Conservation, the U.S. Fish and Wildlife Service, the Kansas Department of Wildlife and Parks, the Nebraska Game and Parks Commission, the Iowa Department of Natural Resources and the South Dakota Department of Game, Fish and Parks have participated in this study in the lower Missouri River sub-basin.

Methods

Since 1995 paddlefish have been tagged, sampled and stocked in the Lower Missouri River sub-basin according to procedures outlined in the 1995 National Paddlefish Research Report developed by MICRA (MICRA 1995). Startup funding was obtained from the International Association of Fish and Wildlife Agencies by MICRA to provide participating agencies with tagging equipment, tag detection equipment, tags and paper supplies (data sheets, recovery tags, etc). Due to the limited availability of funds since then, MICRA was only able to provide limited support to the participating agencies for field studies (mostly in the way of tags, data sheets, etc.).

The MICRA Paddlefish and Sturgeon Sub-committee developed sampling and data recording protocols (Oven 1995, Oven and Fiss 1996 and Grady and Conover 1998). Due to the wide variety of gears being used and the equally wide variety of habitats and conditions being sampled these protocols were made very flexible to allow biologists to accurately describe their particular samples and sample conditions. Standard data sheets, developed by the MICRA paddlefish and sturgeon sub-committee and were used to record all data. These data sheets along with any recovered tags were forwarded to a centralized location for tag reading and data entry.

Each sampling trip was given a unique Project Identifier. This project identifier tied together all data sheets and tags. The *COLLECTION SHEET* contained information on the sample location including river, pool, river mile, habitat stratum, date, time, gps location, substrate and structure information, water elevations, Secchi disk readings, water temperature, conductivity and miscellaneous comments. The *SAMPLE EFFORT DATA* sheet contained information on net type, net description, set time, pull time, depth and water velocity. The *PADDLEFISH MEASUREMENT SHEET* contained information for each paddlefish sampled including, fish number, net number, eye to fork length (cm), weight (kg), sex, injury code, previously tagged, tagged and released.

Coded wire tags (Northwest Marine Technology Inc.) were implanted in standardized locations on the rostrum of hatchery released and wild paddlefish caught by biologists. Rostrums were scanned to identify previously implanted tags. Previously implanted tags were removed from recaptured fish and new tags were implanted if the fish was released. A procedure was developed whereby continuously numbered coded wire tags could be used to identify individual fish. The process involved injecting a tag into a silicon strip on the *PADDLEFISH MEASUREMENT SHEET*, then injecting a tag into the paddlefish and finally injecting a second silicon strip on the *PADDLEFISH MEASUREMENT SHEET*. These two reference tags were recovered at the tag reading facility and read. The tag numbers on these two reference tags in theory bracketed the tag number on the tag injected into the paddlefish allowing identification of individual fish. This was a unique application of the coded wire technology and allowed the use of a relatively cheap tag in a large scale tagging program. Coded wire tags were also used by all participating states for all hatchery stocked fish since the implementation of the project but these are batch tags. Tags with a single batch identifier which only allows information to be tracked back to a stocking event. Batch tags were used until 1998. We found too many human errors, such as practice wire inserted in fish and folks using the same batch code numbers across years and sites. All hatchery fish have been tagged with sequential wire since then. Data was entered and stored into a single database maintained by the U.S. Fish and Wildlife Service.

Additional information presented in this report was collated from state and federal agency stocking records, commercial harvest data, recreational harvest data, and other state and federal paddlefish publications, reports and professional opinion. Biologists have also recovered tags from paddlefish rostrums collected from commercial and sport anglers. In 2001 the creel clerks for the Missouri Department of Conservation began checking harvested paddlefish for coded wire tags on three reservoirs (Lake of the

Ozarks, Table Rock Lake and Harry S Truman Lake). Rostrums from tagged fish were removed.

Since 1995 the Nebraska Game and Parks Commission and the South Dakota Department of Game, Fish and Parks have issued rostrum tags to all anglers participating in their jointly managed paddlefish archery and snagging seasons. Anglers who harvested a paddlefish were asked to remove the rostrum, attach their rostrum tag to the rostrum and drop the rostrum off at designated drop locations. These rostrums were collected periodically throughout both the archery and snagging seasons and were examined for coded wire tags. In addition, information was collected on the date and location that the rostrum was collected. Although not required, anglers often supplied additional information included length of the paddlefish harvested, harvest location, harvest date and angler information.

Results

Effort and Catch

From 1995 to 2003 the Missouri Department of Conservation, the Kansas Department of Wildlife and Parks, the Nebraska Game and Parks Commission, the Iowa Department of Natural Resources, the South Dakota Department of Game, Fish and Parks and the U.S. Fish and Wildlife Service conducted 221 paddlefish sampling projects (trips) in the lower Missouri River sub-basin (Table 1). During these sampling trips the participating agencies sampled 6,421 paddlefish using over 40 different sampling gears or methods. The large number of sampling gears used was the result of lack of financial resources to assist agencies with the cost of standardizing sampling gear. Agencies used equipment they already possessed and continued using the same equipment they had used in the past for standardization. Paddlefish were sampled for multiple purposes including brood stock collection and tagging. Samples were obtained from a variety of habitats both riverine and reservoir, under a variety of conditions which necessitated the use of specific gears. Although at this time no effort had been made to standardize gears used in the lower Missouri River sub-basin over half (57.6%) of the effort expended and the majority (84.7%) of the paddlefish came from a small subset of the different gears used (3 or 3.5 inch mesh floating or drifting multifilament gill and trammel nets) (Table 1).

Table 1. Total effort (number of net sets or samples) and number of paddlefish collected by gear type from the lower Missouri River sub-basin from 1995 through 2003.

Net	Netting	Type	Hobbled	Mesh (inches)	Nets / Samples	Paddlefish
Gill net	Multi	Floating	No	3	120	1999
				3.5	35	253
				4	2	3
				5	12	190
			Yes	3	14	358
				3.5	31	656
				5	6	38
		Drifting	No	Unknown	3	0
				3	4	2
				3.5	5	279
				4	2	8
				4.25	2	8
				5	2	4
		Sinking	No	1.5	23	4
				2	26	2
				3	41	131
				3.5	1	1
				4	28	17
				5	6	1
				6	2	0
				11.5	1	0
			Yes	Unknown	10	1
	Mono	Floating	No	3	4	20
				4	45	25
		Drifting		3	8	1
				4	6	0
		Sinking		3	4	1
				4	74	42
		Both		3	1	0
				4	2	0
Trammel net	Multi	Floating	No	3	268	1739
				3.5	17	19
		Drifting		3.5	54	135
		Sinking		3.5	3	11
		Both		3.5	23	33
		Unknown		3.5	1	6
Unknown				Unknown	17	86
				1.5	1	1
				3	1	6
				4	1	8
Snagging					41	245
Electrofishing					4	88
Total					951	6421

Effort (number of sampling trips) and total catch were consistent from 1995 to 2003 but effort and catch were highest during the first several years of sampling (Figure

3).   Effort (number of sampling trips) and total catch were inconsistent between months but were highest during spring and early summer (Figure 4).

Frequent sampling of the Gavins Point Dam tailwater resulted in nearly 49% of all effort (number of sampling trips) and over 83% of total catch coming from tailwater habitat (Table 2). Modest effort was expended and few paddlefish were collected in other habitat strata (Figure 5). Increased sampling effort in other habitat strata would better define the role and significance of tailwater habitat.

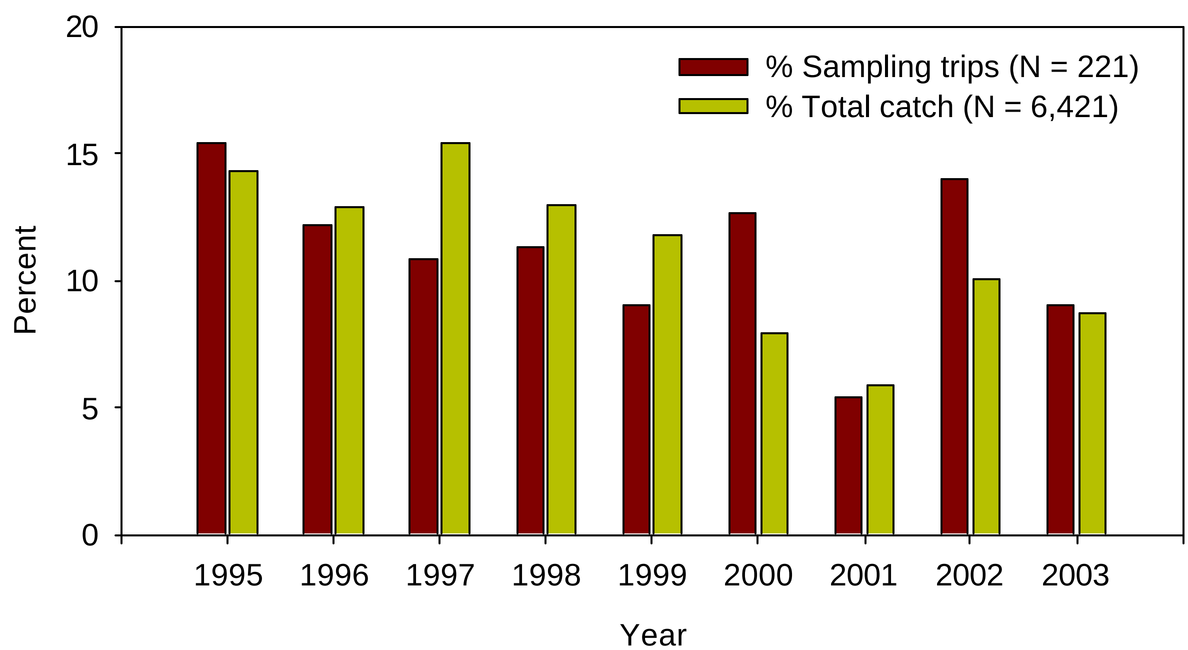

Figure 3. Percent of paddlefish sampling trips and total catch by year from the lower Missouri River sub-basin from 1995 through 2003.

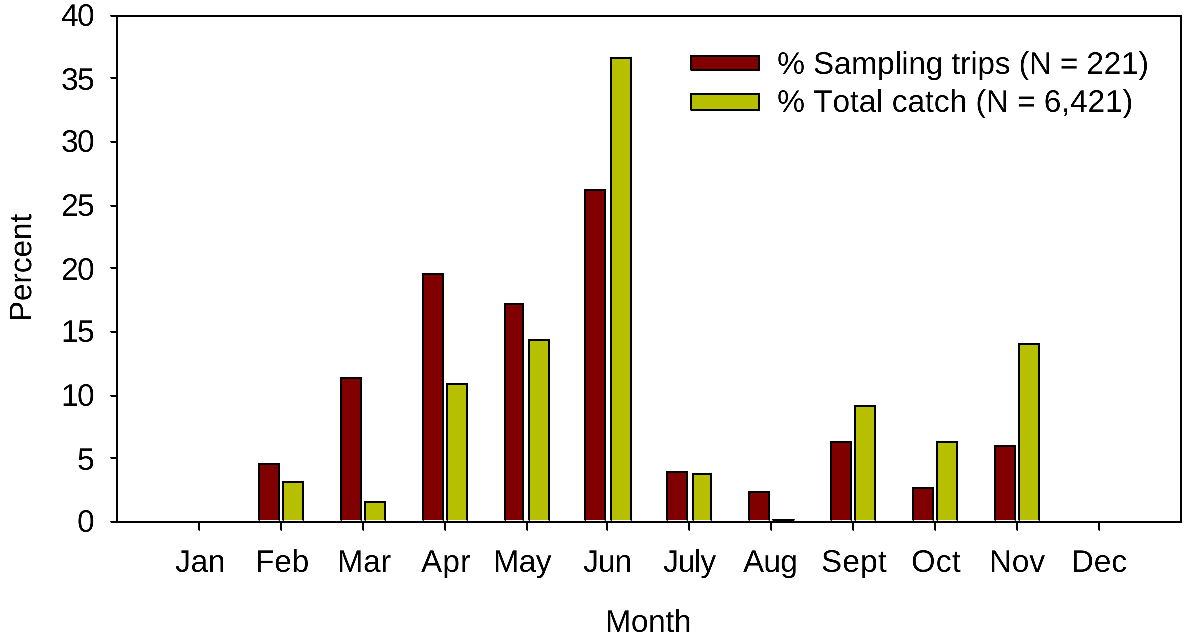

Figure 4. Percent of paddlefish sampling trips and total catch by month from the lower Missouri River sub-basin from 1995 through 2003.

Table 2. Percent of paddlefish sampling trips and total catch by location from the lower Missouri River sub-basin from 1995 through 2003.

Site	Upper River Mile	Lower River Mile	Percent of Trips	Percent of Paddlefish
	Missouri River			
Lake Francis Case	955		3.7	1.5
Fort Randall Dam Tailwater	880		0.5	0.1
Upper Unchannelized	840	842	3.2	1.3
Gavins Point Dam Tailwater	811		48.9	83.3
Lower Unchannelized	802	786	6.8	3.3
Upper Channelized	718	683	3.6	1.6
Lower Channelized	281	21	20.9	1.6
	Other Basin Rivers			
Big Sioux River			4.5	3.0
Blue River			1.0	2.0
Osage River			6.8	2.3
Total			221	6,421

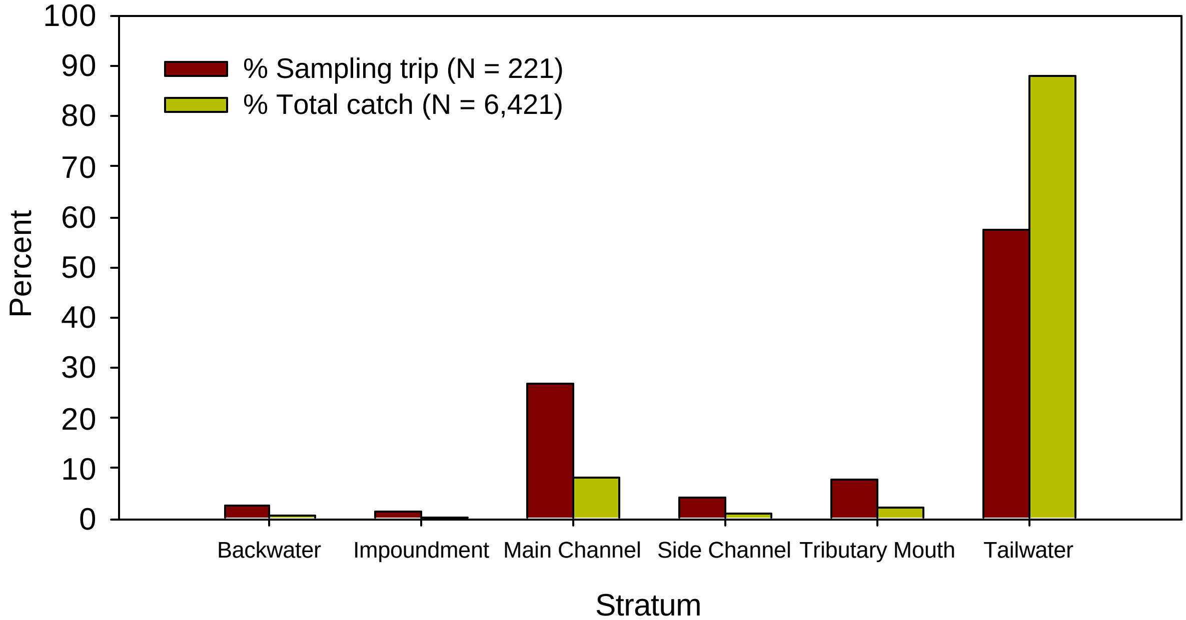

Figure 5. Percent of paddlefish sampling trips and total catch by habitat strata from the lower Missouri River sub-basin from 1995 through 2003.

Length frequency distributions were compared by location, gear type and mesh sizes for all paddlefish sampled. Because low numbers of paddlefish sampled at other locations precluded the ability to look at combinations of these factors for locations other than the Gavins Point tailwater, each of these factors were analyzed separately.

Length frequency distributions using all paddlefish sampled by location are presented in Figure 6. These distributions were compared using the SAS PROC NPAR1WAY procedure with the edf (empirical distribution function) which runs a Kolmogorov-Smirnov test comparing the cumulative length distributions between groups (P of Ksa < 0.05). Most of the distributions were considered significantly different from each other (Table 3), the exceptions were the Gavins Point Dam tailwater and the Lower Channelized Missouri River, the Lower Unchannelized Missouri River and the

Lower Channelized Missouri River and the Big Sioux River and the Blue River. This meant that either the length distributions of paddlefish were different between almost all locations or that these differences were the result of other factors such as gear type, mesh, season, etc.

A comparison was made of length frequency distributions of paddlefish sampled by location between the following net types; multifilament floating gill nets, multifilament floating trammel nets, multifilament hobbled floating gill nets, multifilament drifting gill nets, multifilament sinking gill nets, monofilament sinking gill nets, monofilament floating gill nets and multifilament hobbled sinking gill nets. Only net types that had more than 20 fish were used in the analysis; multifilament floating gill nets, multifilament floating trammel nets, multifilament hobbled floating gill nets and multifilament sinking gill nets. The length frequency of paddlefish sampled with multifilament sinking gill nets was significantly different (P of Ksa < 0.05) from all other net types.

Catches from multifilament floating gill nets, multifilament floating trammel nets and multifilament hobbled floating gill nets were combined and compared to length frequency distributions between different mesh sizes. There were significant differences (P of Ksa < 0.05) between the length frequency of paddlefish sampled by location with 3”, 3.5”, 4” and 5” mesh nets. Too few paddlefish were sampled by the 1.5” (n=4), 2” (n=2), 4.25” (n=8), 6” (n=0) or 11” (n=0) mesh nets for analysis. The length frequency of paddlefish sampled with different mesh sizes was significantly different (P of Ksa < 0.05) from all other net types.

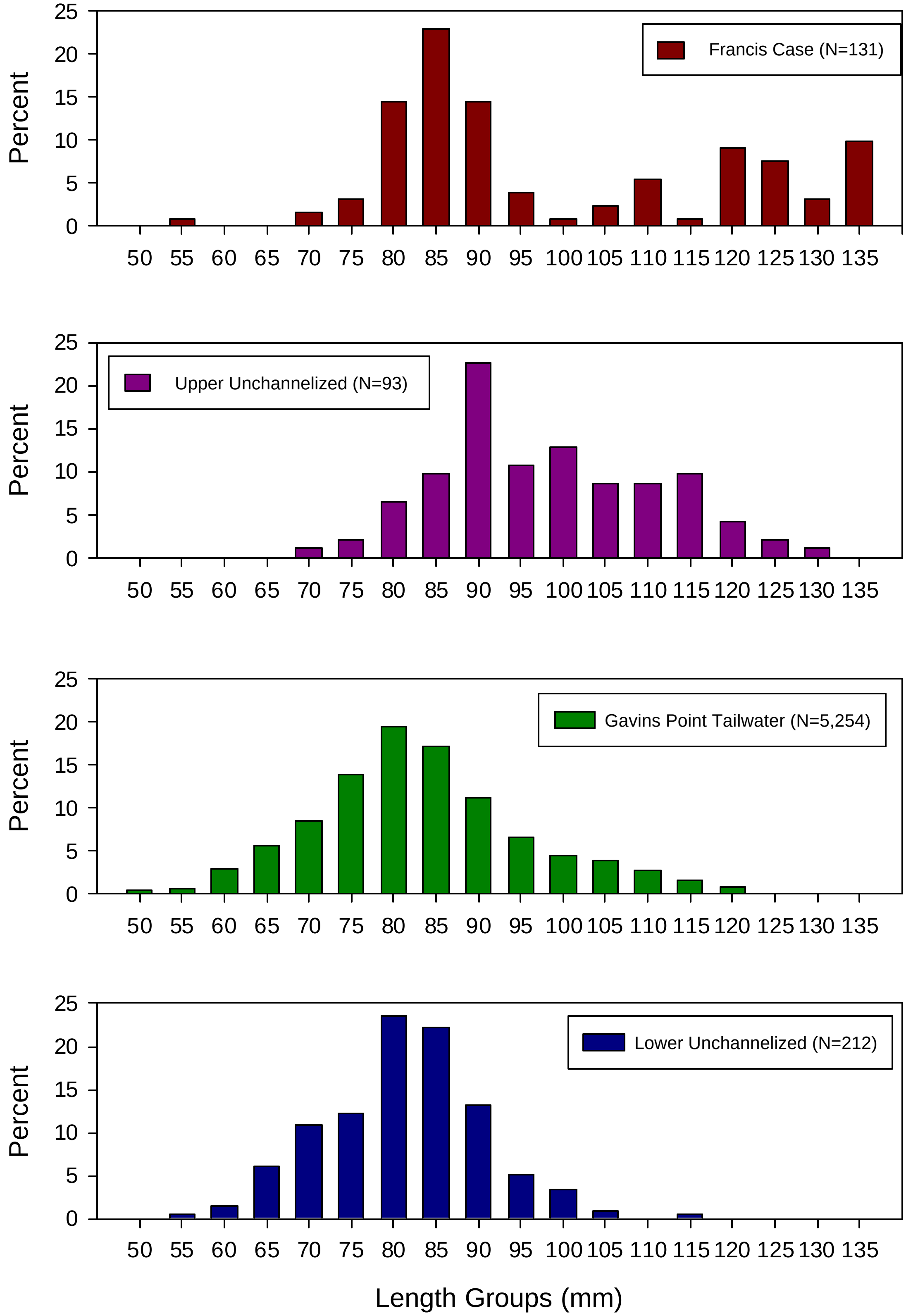

Figure 6. Length frequency distribution of paddlefish sampled by location from the lower Missouri River sub-basin from 2003 through 2003.

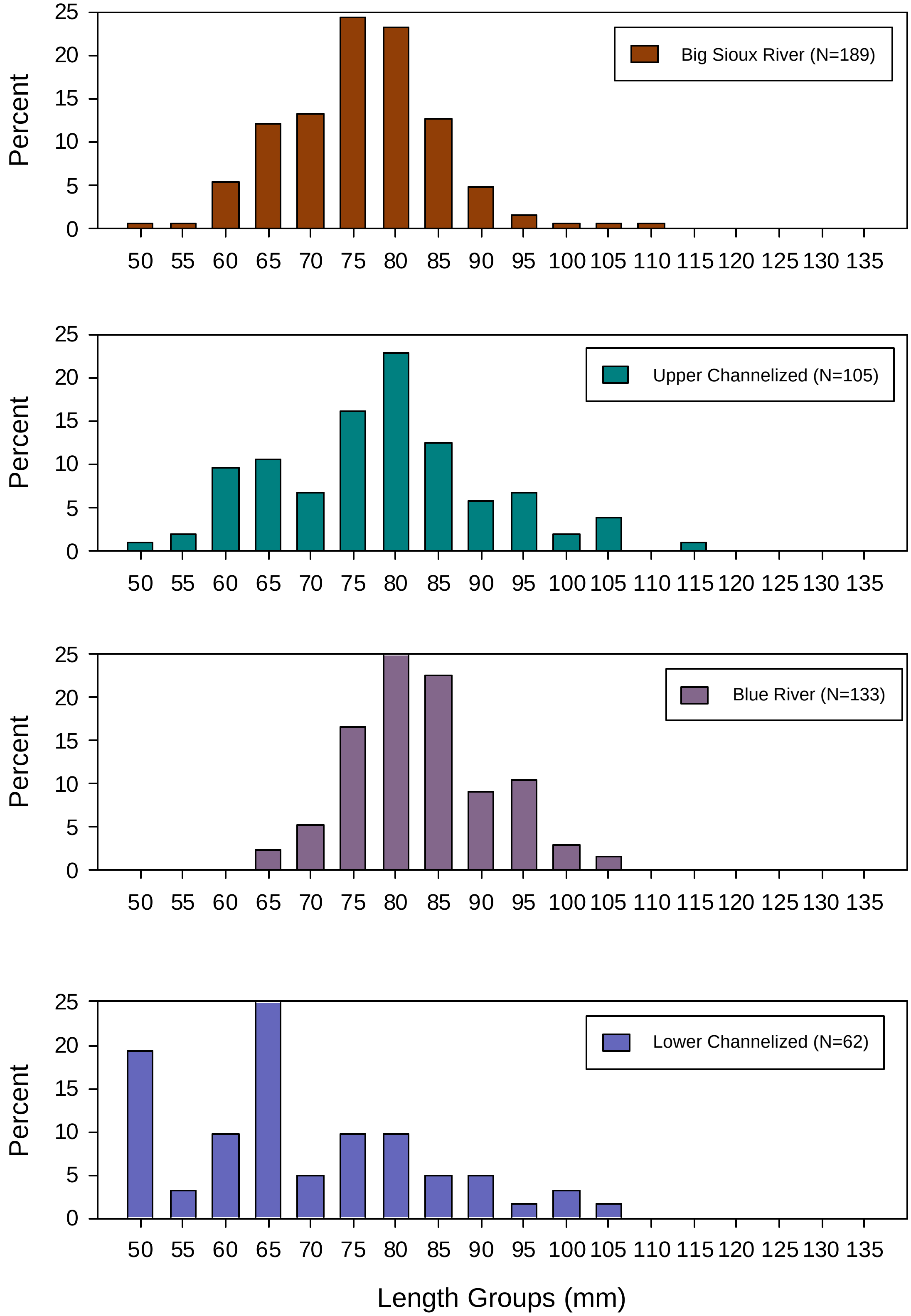

Figure 6. Continued.

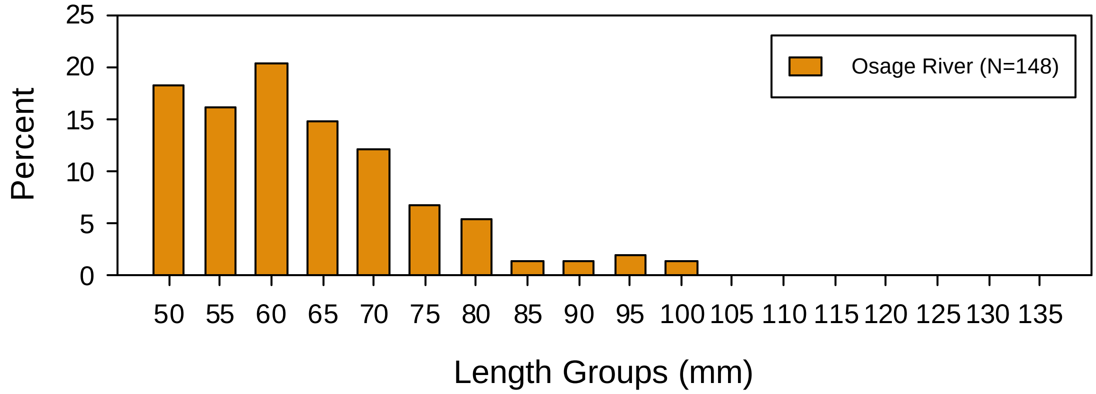

Figure 6. Continued.

Table 3. Kolmogorov-Smirnov test results for length frequency differences for all paddlefish sampled by location from lower Missouri River sub-basin from 1995-2003.

	Upper Unchannelized Missouri River	Gavins Point Tailwater	Lower Unchannelized Missouri River	Big Sioux River	Upper Channelized Missouri River	Blue River	Lower Chanelized Missouri River	Osage River
Lake Francis Case	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Upper Unchannelized Missouri River		< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Gavins Point Tailwater			< 0.05	< 0.05	< 0.05	< 0.05	N.S.	< 0.05
Lower Unchanelized Missouri River				< 0.05	< 0.05	< 0.05	N.S.	< 0.05
Big Sioux River					< 0.05	N.S.	< 0.05	< 0.05
Upper Channelized Missouri River						< 0.05	< 0.05	< 0.05
Blue River							< 0.05	< 0.05
Lower Chanelized Missouri River								< 0.05

Catch Per Unit Effort (CPUE)

Catch per unit of effort for gill and trammel nets was standardized at the number of fish sampled per hour per 4,000 square feet of netting. Because over half of the net types were fished less than 10 times each, the nets were combined the nets into three categories; floating gill nets, trammel nets and sinking gill nets. Catch per unit of effort by net type, location and mesh size is presented in Table 4. Catch ranged from 0 paddlefish per hour for several different net types and locations up to 198.0 paddlefish per hour for 3 inch mesh trammel nets fished at the Gavins Point Dam tailwater. No single net type or mesh size was fished at all locations. Catch per unit of effort by net type, location and year is presented in Table 5. Catch ranged from 0 paddlefish per hour for several different net types and locations up to 305.0 paddlefish per hour for trammel nets fished at the Gavins Point Dam tailwater. Gill nets were fished at the Gavins Point Dam tailwater in all years.

Table 4. Catch per unit of effort (number of fish per hour per 4,000 square feet of net) by net type, mesh and location from the lower Missouri River sub-basin from 1995 through 2003.

		Mesh Size									
Net Type	**Location**	1.5”	2”	3”	3.5”	4”	4.25”	5”	6”	11.5”	Mean CPUE
Gill Net	Lake Francis Case					2.7	2.7	2.5			2.6
	Upper Unchannelized				40.5	13.8		35.6			30.0
	Gavins Point Tailwater			36.7	18.5	0.6		29.5			21.3
	Lower Unchannelized			115.3	3.6						59.5
	Lower Channelized			0.3		0.0					0.2
	Osage River					12.3					12.3
Trammel Net	Upper Unchannelized			25.5							25.5
	Gavins Point Tailwater			198.0	3.7						100.9
	Lower Unchannelized			149.5							149.5
	Upper Channelized				0.8						0.8
	Big Sioux River				50.2						50.2
Sinking Gill Net	Gavins Point Tailwater			22.8	3.3						13.1
	Lower Channelized	0.2	0.1	0.7		0.4				0.0	0.3
	Osage River			0.0		2.7		1.4	0.0		1.0
Mean CPUE		0.2	0.1	61.0	17.2	4.6	2.7	17.2	0.0	0.0	

Table 5. Catch per unit of effort (number of fish per hour per 4,000 square feet of net) by net type, location and year from the lower Missouri River sub-basin from 1995 through 2003.

Net Type	Location	1995	1996	1997	1998	1999	2000	2001	2002	2003	Mean CPUE
Gill Net	Lake Francis Case		1.2		1.5	1.3	2.7	4.3			2.5
	Upper Unchannelized		61.5	0.0					9.8		34.7
	Gavins Point Tailwater	13.6	31.4	18.1	19.8	28.2	5.7	14.9	29.1	111.4	31.4
	Lower Unchannelized		5.3				57.8			288.0	117.0
	Lower Channelized				0.0		0.3				0.2
	Osage River	12.3									12.3
	Mean CPUE	12.9	27.2	16.3	16.1	23.7	19.5	11.4	25.7	119.5	30.2
Trammel Net	Upper Unchannelized		25.5								25.5
	Gavins Point Tailwater	87.9	149.2	300.5	115.7	193.7					195.3
	Lower Unchannelized			89.8	185.8				137.0		149.5
	Upper Channelized			0.9		0.0					0.8
	Big Sioux River				23.3	12.6	148.5		46.7	6.7	50.2
	Mean CPUE	87.9	128.0	210.2	110.5	138.2	148.5		98.3	6.7	116.0
Sinking Gill Net	Gavins Point Tailwater	23.4	16.9		23.0						21.3
	Lower Channelized	1.2					0.0	1.1	1.1	0.2	0.4
	Osage River	2.6		0.0							2.4
	Mean CPUE	3.7	16.9	0.0	23.0		0.0	1.1	1.1	0.2	5.8

Gavins Point Dam tailwater Analysis

This analysis will be limited to paddlefish sampled from the Gavins Point Dam Tailwater from 1995 to 2003 using 3” mesh gill and trammel nets. Comparison of the length frequency distributions of paddlefish sampled by the different 3” mesh net types used determined that multifilament sinking gill nets were statistically different (P of Ksa < 0.05) from multifilament floating gill nets, multifilament floating trammel nets, multifilament hobbled floating gill nets and monofilament floating gill nets and were subsequently dropped from the analysis. This left 4,773 paddlefish in the analysis (Table 6). The mean length of paddlefish collected by year ranged from 793 mm in 1995 to 828 mm in 2000. We then compared the length frequency distributions between years. In Table 6 the colored boxes represent years that the length frequency distributions were not statistically different from each other (P of Ksa < 0.05). The length frequency distributions are presented in Figure 7. A simple plot between mean length and year (Figure 8) revealed that the mean length of the paddlefish has been increasing.

Table 6. Catch per unit of effort (number of fish per hour per 4,000 square feet of net) by net type, location and year from the lower Missouri River sub-basin from 1995 through 2003.

Year	Number	Mean length	Std.	Min length	Max length	1995	1996	1997	1998	1999	2000	2001	2002	2003
1995	591	793	132.93	475	1160									
1996	692	820	134.94	478	1190									
1997	918	807	134.13	470	1290									
1998	586	810	131.37	525	1296									
1999	450	817	129.44	428	1310									
2000	244	828	115.72	525	1186									
2001	328	821	119.23	470	1290									
2002	475	817	108.01	510	1277									
2003	489	824	94.99	525	1152									
Total		4,773												

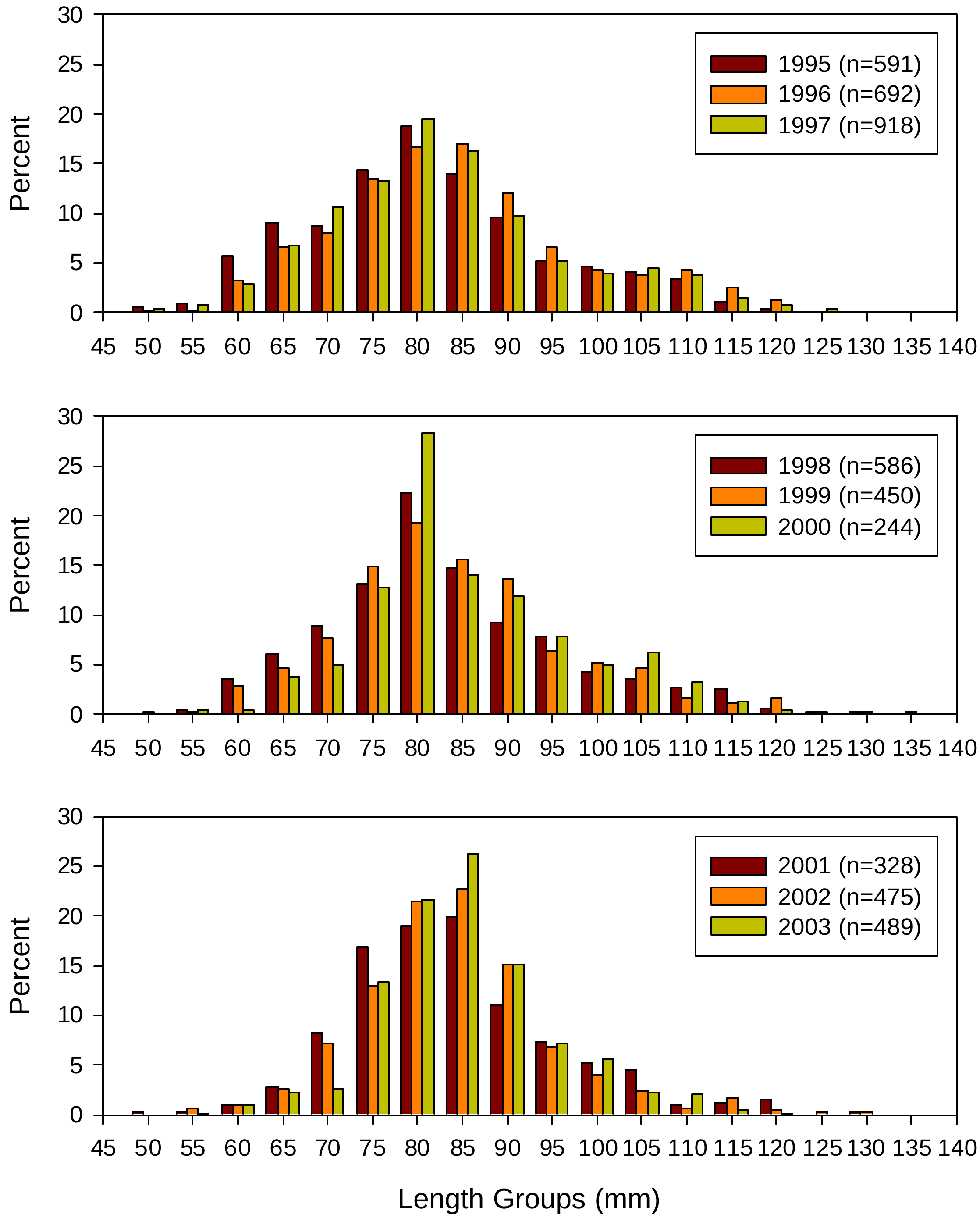

Figure 7. Length frequency distribution of paddlefish sampled by year from the Gavins Point Dam tailwater from 1995 through 2003.

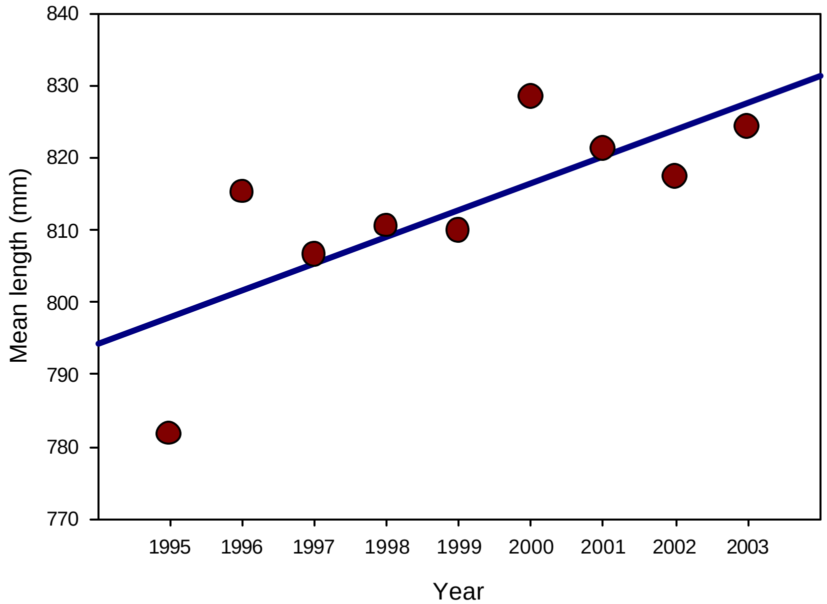

Figure 8. Plot of length by year for paddlefish collected from the Gavins Point Dam tailwater with 3” mesh nets from the lower Missouri River sub-basin from 1995 through 2003.

Length frequencies between seasons were compared (Spring: March – May, Summer: June – August and Fall: September – November). An increase in the proportion of small fish (less than 700 mm) sampled during spring supports the movement of mature fish away from Gavins Point Dam tailwater during spring (Figure 9). Length frequencies plotted by season progressively increased from spring through fall.

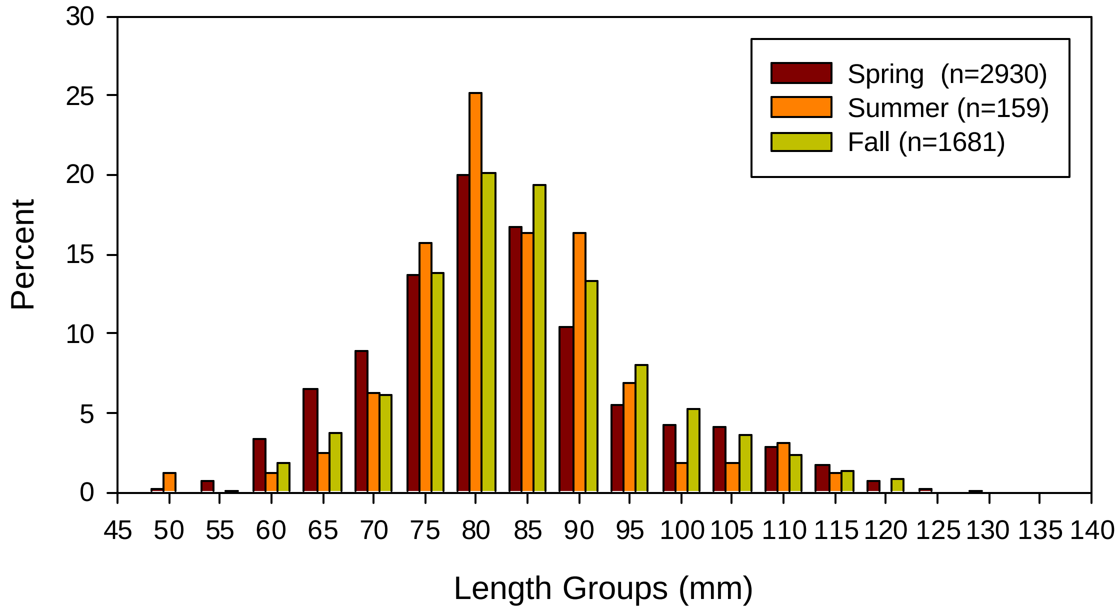

Figure 9. Length frequency distribution by season (Spring: March – May, Summer: June – August and Fall: September – November) of paddlefish collected from the Gavins Point Dam tailwater with 3" mesh nets from the lower Missouri River sub-basin from 1995 through 2003.

Length-Weight Relationships and Relative Weights (Wr)

Length–Weight (L-W) relationships were calculated by fitting EFL (mm) and weight (W) (kg) to the power function W = a EFL^ ^{b}. Where *a* is the y axis intercept and *b* is the slope of the length-weight relationship and isometry coefficient. Lengths and weights from all mesh sizes of floating and drifting multifilament gillnets and trammel nets were pooled by season (spring Mar-May, summer Jun-Aug, fall Sept-Nov, winter Dec-Feb) and fish caught by all gear types were pooled by five locations within the Missouri River sub-basin. Floating and drifting multifilament gillnets and trammel nets were used to compare seasonal L-W relationships because those gear types showed similar length frequency distributions which indicated minimal differences in gear selectivity. Fish caught by all gear types were pooled together by location because sampling gears were not standardized between agencies or locations.

Relative weights (Wr) were calculated using the Ws equation developed for both sexes of paddlefish by Brown and Murphy (1993). In this Ws equation a = -5.027 and b = 3.092. Relative weights were calculated by season, year, and habitat strata using fish caught by all mesh sizes of floating and drifting multifilament gillnets and trammel nets.

Length-weight relationships

Length-weight relationships were variable between seasons (spring, summer, fall, winter) (Table 7) (Figure 10). Negative allometric (b < 3.00) growth was observed during most seasons except for spring but combined seasons resulted in positive allometric growth: W = 1.12 E-08 EFL^ $^{3.02}$. The high isometry coefficient (3.28) in spring is likely impacted by the presence of gravid females and the low isometry coefficient in the winter (2.52) may be attributed to cold water temperatures slowing metabolism and reduced productivity in the river during this time.

Table 7. Length-Weight relationships by season for paddlefish collected from the lower Missouri River sub-basin from 1995 to 2003.

Season	N	a	b	r^2
Mar-May	1009	1.89 E-09	3.28	0.86
Jun-Aug	1542	3.57E-08	2.86	0.81
Sept-Nov	1746	1.34 E-08	2.99	0.82
Dec-Feb	137	2.87E-07	2.52	0.77
Combined	4452	1.12 E-08	3.02	0.82

L-W relationships varied between the five locations and combined resulted in positive allometric growth: W = 6.81 E-09 $^{\wedge 3.10}$ (Table 8) (Figure 10). Paddlefish collected from the Big Blue River (3.53) and those from above Gavins Point Dam (3.74) exhibited high b values while those from the Big Sioux River (2.55) had the lowest. Paddlefish smaller than 850 mm had similar L-W relationships regardless of location but variability increased as fish grew larger. Different proportions of mature fish between locations are likely to impact L-W relationships.

Table 8. Length-Weight relationship by location for paddlefish collected from the lower Missouri River sub-basin from 1995 to 2003.

Location	N	a	b	r^2
Missouri River sub-basin	6230	6.81 E-09	3.10	0.81
Above Gavins Point	98	1.02 E-10	3.74	0.90
Gavins Point	5207	1.15 E -08	3.02	0.83
Big Sioux	189	2.30 E-07	2.55	0.81
Big Blue	84	4.80 E-01	3.53	0.72
Osage	148	4.35E-01	3.50	0.96

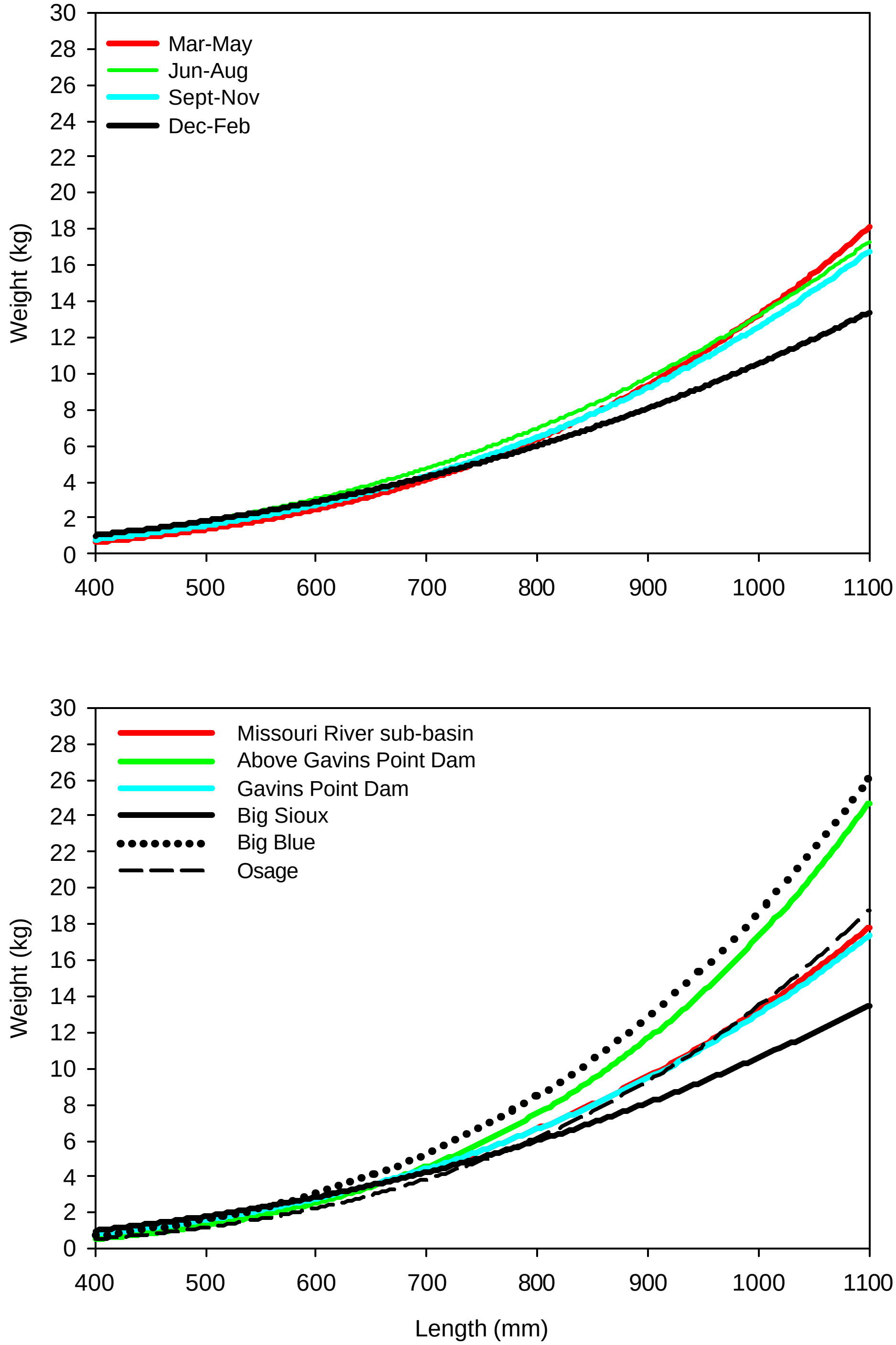

Figure 10. Length-Weight relationships by season and location for paddlefish collected from the lower Missouri River sub-basin from 1995 to 2003.

Relative Weight (Wr)

Mean relative weight (Wr) was greatest during the summer (78.64 ± 14.30) and lowest during the winter (70.28 ± 11.51) (Figure 11). Relative weights during the spring and summer exhibited the widest range of Wr values from 37.48 to 255.43. Mean relative weight (Wr) by year was consistent ranging from 70 to 75 but 2001 (86.28± 17.30) and 2002 (79.52±13.83) were unusually high for the Missouri River sub-basin (Figure 12). Paddlefish captured from impoundments in South Dakota primarily from Lake Francis Case produced the greatest mean Wr value (94.73 ± 20.61) compared to other habitat strata (Figure 13). High Wr values from impoundments may be caused by the reduced energy demands required to live in a lentic, compared to lotic environment. The 37 paddlefish collected from river confluences also resulted in high Wr values (93.60±16.01), while fish from the channelized river had the lowest values (69.24 ± 9.43).

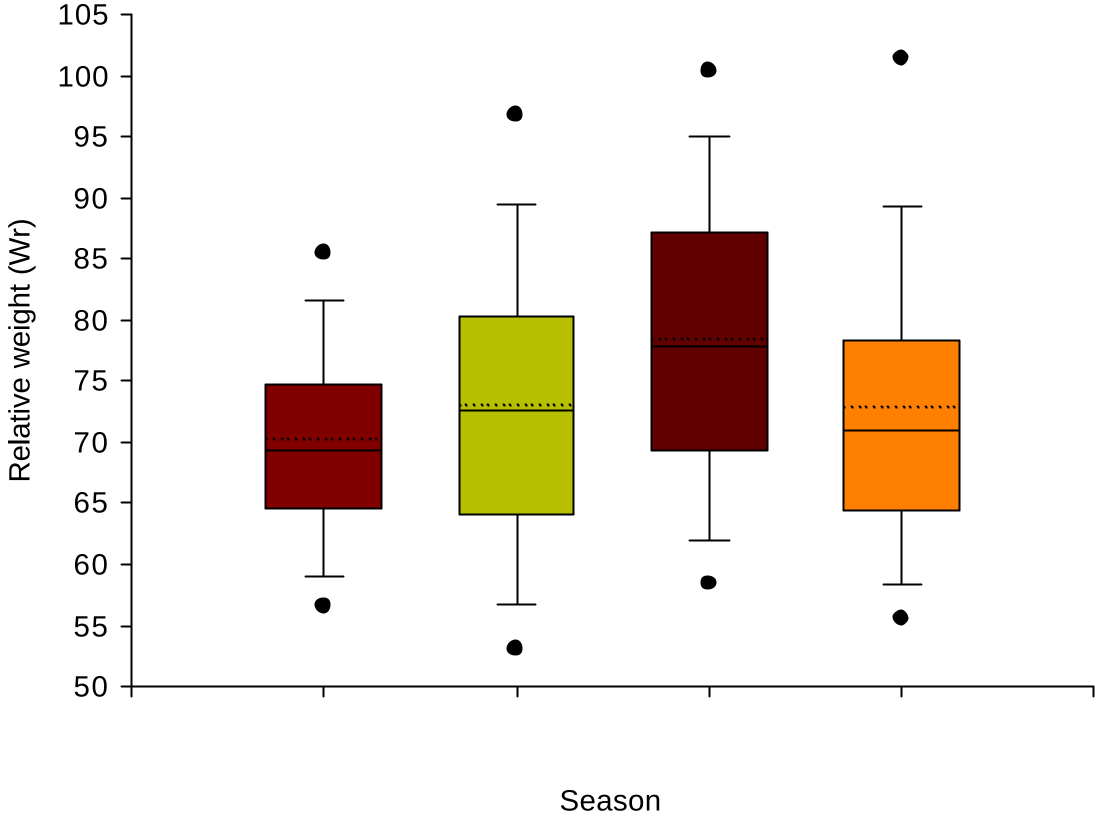

Figure 11. Box plot of relative weight (Wr) by season for paddlefish caught by floating and drifting gillnets and trammel nets collected from the lower Missouri River sub-basin from 1995 to 2003.

[Box is middle 50% of data, dotted line = mean, solid line = median, and dots = 5% and 95% confidence limit]

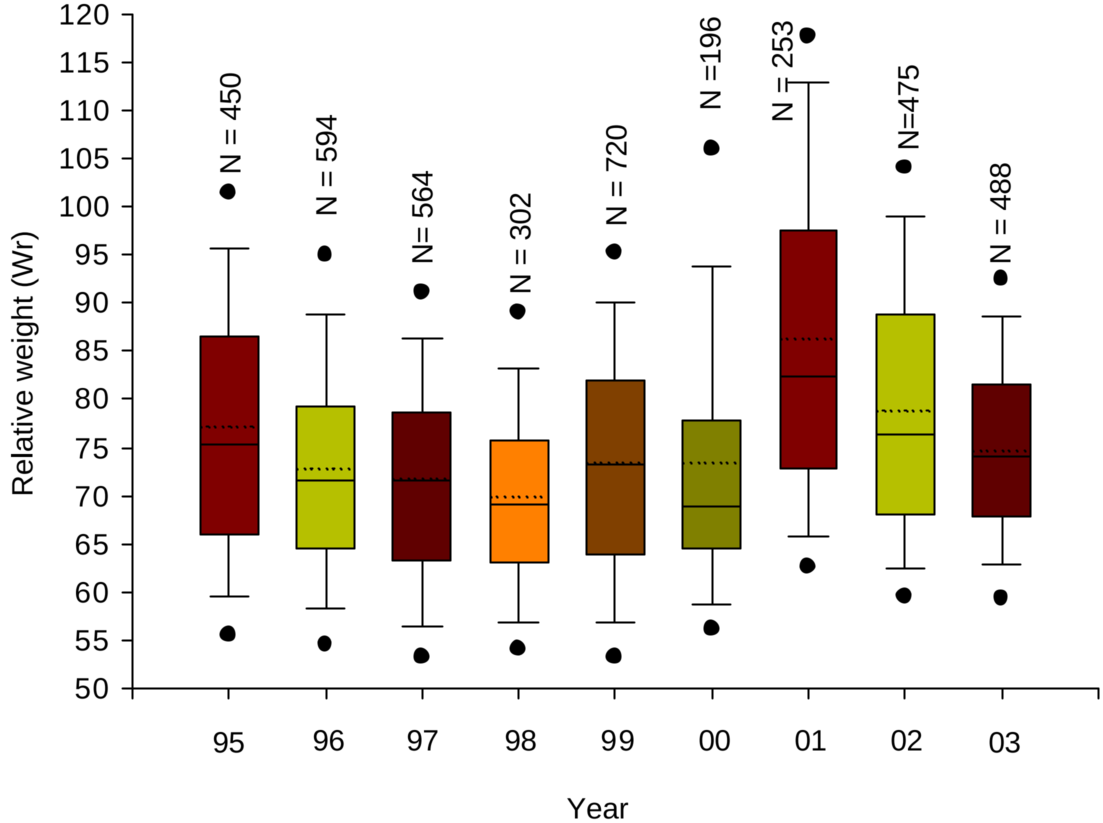

Figure 12. Box plot of relative weight (Wr) by year for paddlefish caught by floating and drifting gillnets and trammel nets at Gavins Point Dam tailwater from 1995 to 2003.

[Box is middle 50% of data, Dotted line = mean, Solid line = median, and dots = 5% and 95% confidence limit.]

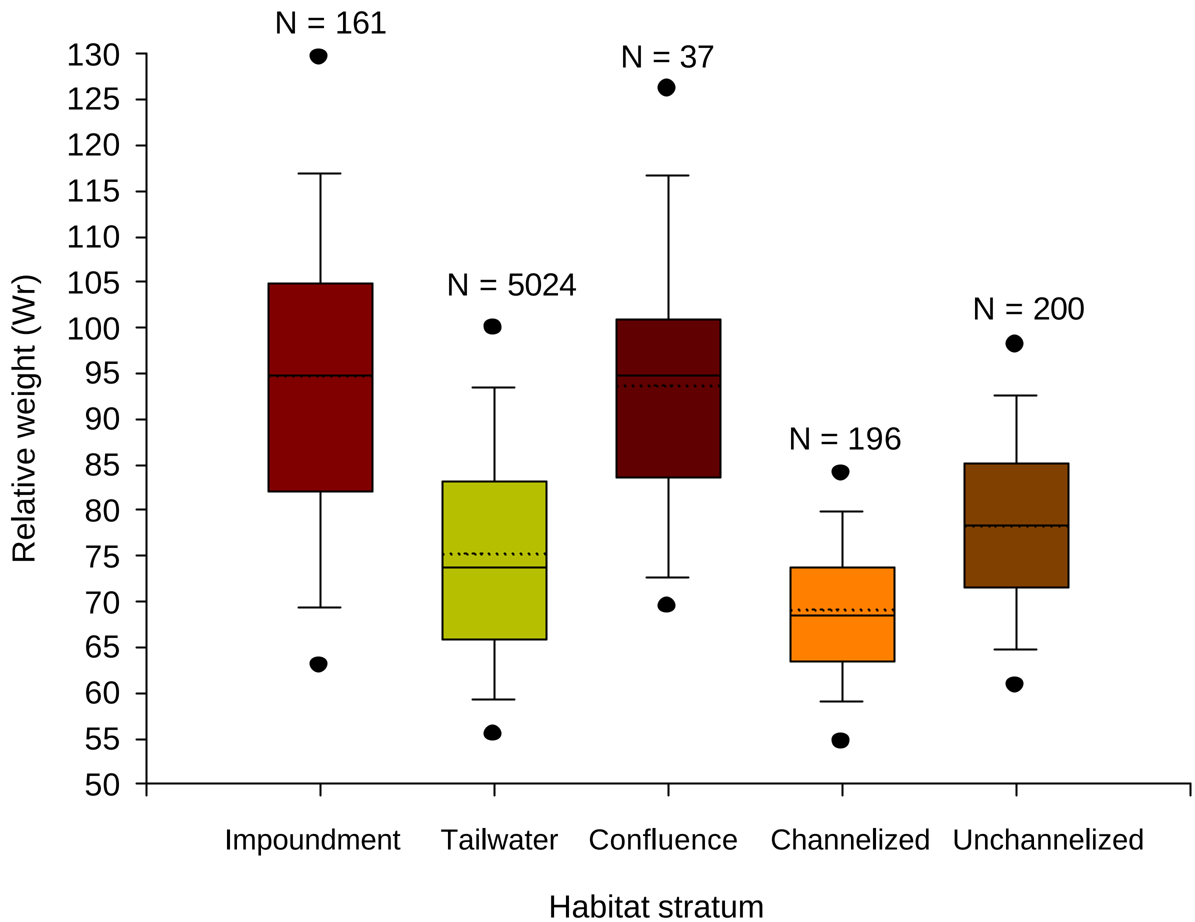

Figure 13. Box plot of relative weight (Wr) by habitat strata for paddlefish caught by floating and drifting gillnets and trammel nets from the lower Missouri River sub-basin from 1995 to 2003.

[Box is middle 50% of data, Dotted line = mean, Solid line = median, and dots = 5% and 95% confidence]

RSD

RSD values were based on minimum lengths of 410 mm (stock), 660 mm (quality), 840 mm (preferred), 1040 mm (memorable), and 1300 mm (trophy) (Gabelhouse 1984). Values were calculated by year for fish collected with three inch floating gillnets. As a result of different gear types used by different agencies, no comparison was made between locations. A total of 1891 paddlefish were collected by three inch floating gillnets and approximately 98% (1846/1891) were from the tailwaters below Gavins Point Dam. When interpreting RSD values it must be considered that three inch floating gillnets (and most sampling methods) appear to be biased toward sampling large individuals. Every year from 1995 to 2003, 100% of the paddlefish captured were greater than stock size (410 mm), and no trophy (1300 mm) fish were sampled (Table 9). The proportion of individuals in most size classes remained steady during the nine year sampling period. The Preferred size class exhibited the greatest, but still modest annual variability in RSD values.

Table 9. RSD values by year for paddlefish collected with three inch floating gillnets for paddlefish collected from the lower Missouri River sub-basin from 1995 to 2003.

Year	1995	1999	1998	1999	2000	2001	2002	2003
(N)	259	57	71	89	211	253	453	498
RSD-Q	69	95	77	92	94	97	94	96
RSD-P	19	58	23	38	36	41	36	38
RSD-M	2	16	3	6	5	6	4	3
RSD-T	0	0	0	0	0	0	0	0

Population Estimates

Population size estimates were calculated using the Schumacher-Eschmeyer Population estimator for multiple census counts. This estimator provides relatively robust population estimates under the assumptions that there is random interspersion of marked fish into the general population and there is equal catchability of all fish within each sampling period, including both marked and unmarked fish (not necessarily among sampling periods). The population size estimate (N) is calculated as (from Schneider 1998):

$$N = \frac{\sum_{d=1}^{n} C_d M_d^2}{\sum_{d=1}^{n} R_d M_d},$$

Where:

N =population estimate in numbers of fish;
$C_d = U_d + R_d$ = total number of fish caught during date d;
U_d = number of unmarked fish caught during date d;
R_d = number of recaptures during date d (of the type of mark under consideration);
M_d = number of marked fish available for recapture at **start** of date d;
d = sample number (usually date), ranging from first (d_1) to last (d_n).

Population size estimates were calculated for the reach of unchannelized Missouri River forming the border between Nebraska and South Dakota from Gavins Point Dam tailwater to of Big Sioux River confluence. From 1995 through 2003 biologists sampled nearly 5,000 paddlefish in this reach and biologists examined over 8,700 paddlefish snagged by anglers in this reach (Table 10). The numbers of marked paddlefish in the population, the number of paddlefish checked for tags and the number of tags recovered and used for population size estimates for biologist sampled fish and angler snagged fish are presented in Table 10.

Table 10. Numbers of marked (Md), checked (Cd) and recaptured (Rd) paddlefish used for population estimates from unchannelized Missouri River bordering Nebraska and South Dakota from Gavins Point Dam tailwater to the Big Sioux River confluence from 1995 to 2003.

Year	Netting			Snagging – No Growth			Snagging - Growth		
	M_d	C_d	R_d	M_d	C_d	R_d	M_d	C_d	R_d
1995	0	518	0	627	2092	24	581	2092	24
1996	603	703	13	1440	1725	40	1112	1725	40
1997	1400	957	17	2340	726	24	1746	726	24
1998	2309	392	7	2748	843	25	2147	843	25
1999	2715	727	21	3630	924	7	2516	924	7
2000	3620	339	8	3982	464	8	2573	464	8
2001	3965	232	5	4190	733	21	2500	733	21
2002	4161	669	22	4808	354	14	2665	354	14
2003	4779	407	26	5373	851	32	2655	851	32
Total		4944			8712			8712	

Population size estimates for biologist sampled paddlefish adjusted for various rates of tag loss, natural mortality and emigration are presented in Table 11. Estimates ranged from over 104,000 paddlefish when tag loss, natural mortality and emigration were estimated at 0% to almost 38,000 paddlefish when tag loss was estimated at 20%, natural mortality at 10% and emigration at 3%. Although estimates, the values for tag loss, natural mortality and emigration are within expected ranges.

Table 11. Population size estimates for biologist sampled paddlefish with various rates of tag loss, natural mortality and emigration from the unchannelized Missouri River bordering Nebraska and South Dakota from Gavins Point Dam tailwater to of Big Sioux River confluence for the period 1995-2003.

Tag loss	Natural mortality	Emigration	N	SE
0%	0%	0%	104353	38996
5%	0%	0%	86829	32533
10%	0%	0%	72720	27382
20%	0%	0%	52007	19909
0%	3%	0%	93383	34942
5%	5%	0%	73356	27613
10%	7.50%	0%	57837	22003
20%	10%	0%	40412	15756
0%	3%	3%	84030	31507
5%	5%	3%	66812	25240
10%	7.50%	3%	53291	20370
20%	10%	3%	37818	14825

Population size estimates for angler snagged paddlefish adjusted for various rates of tag loss, natural mortality and emigration are presented in Table 12. Because paddlefish that are from 35 to 45 inches eye to fork length are protected during the snagging season and must be released, we calculated population size estimates using the raw snagging data and then by estimating a standard growth rate of 1 inch per year and adjusted the number of tags available in harvestable sized fish (Table 10).

Estimates ranged from over 137,000 paddlefish when tag loss, natural mortality and emigration were estimated at 0% and no growth adjustment was used to almost 65,000 paddlefish when tag loss was estimated at 20%, natural mortality at 10% and emigration at 3% for both the raw data and when the growth adjustment was used.

Table 12. Population size estimates for angler snagged paddlefish with various rates of tag loss, natural mortality and emigration from the unchannelized Missouri River bordering Nebraska and South Dakota from Gavins Point Dam tailwater to the Big Sioux River confluence for the period 1995-2003.

Tag loss	Natural mortality	Emigration	No Growth Adjustment		Growth Adjustment	
			N	SE	N	SE
0%	0%	0%	137270	54194	84349	32874
5%	0%	0%	117388	45894	80987	31509
10%	0%	0%	101738	39498	77639	30151
20%	0%	0%	79496	30622	70986	27461
0%	3%	0%	124771	48955	82331	32054
5%	5%	0%	102436	39780	77806	30218
10%	7.50%	0%	85653	33075	73141	28331
20%	10%	0%	67549	26064	65715	25341
0%	3%	3%	114256	44604	80377	31261
5%	5%	3%	95296	36906	75998	29486
10%	7.50%	3%	80844	31188	71484	27662
20%	10%	3%	64943	25076	64302	24774

The Schumacher-Eschmeyer approach is a relatively coarse first step in assessing paddlefish population dynamics in the Missouri River where gear, fish distribution, and catchability biases greatly influence the resulting estimates. Therefore, the estimates and associated confidence limits presented here provide only an approximation of the number of paddlefish in the Missouri River below Gavins Point Dam. Future analyses will focus on using more refined population size estimation techniques (e.g., MARK).

Paddlefish Stocking in the lower Missouri River sub-basin

The construction and subsequent operation of six mainstem Missouri River dams altered flow and temperature regimes as well as degraded paddlefish spawning habitat. As a result, sharp declines in paddlefish stocks, due to a combination of over-harvest and decreased reproduction and recruitment, were observed in many paddlefish populations in the lower Missouri River. While reproducing populations still exist in the semi-natural river stretches below Ft. Randall and Gavins Point Dams, many paddlefish populations in the lower Missouri River are supplemented with stocking.

Since the early 1970's, over 6,800,000 hatchery reared paddlefish have been stocked into the lower Missouri River (Figure 14). A majority of stockings are used to supplement populations in large mainstem (Lewis and Clark Lake and Lake Francis Case) or large tributary reservoirs (Tuttle Creek, Truman Lake and Lake of the Ozarks) that show little or no signs of reproduction or recruitment. These stocks have provided benefits in river segments outside the reservoirs due to entrainment. The reductions in overall numbers of fish stocked on an annual basis in recent years is a result of shifting from fry stocks to large fingerling stockings to reduce the effects of predation. Over 379,000 paddlefish have been stocked in the lower Missouri River sub-basin since initiation of the MICRA paddlefish project in 1995 (Table 13). These fish were all tagged with coded wire tags as per MICRA protocol.

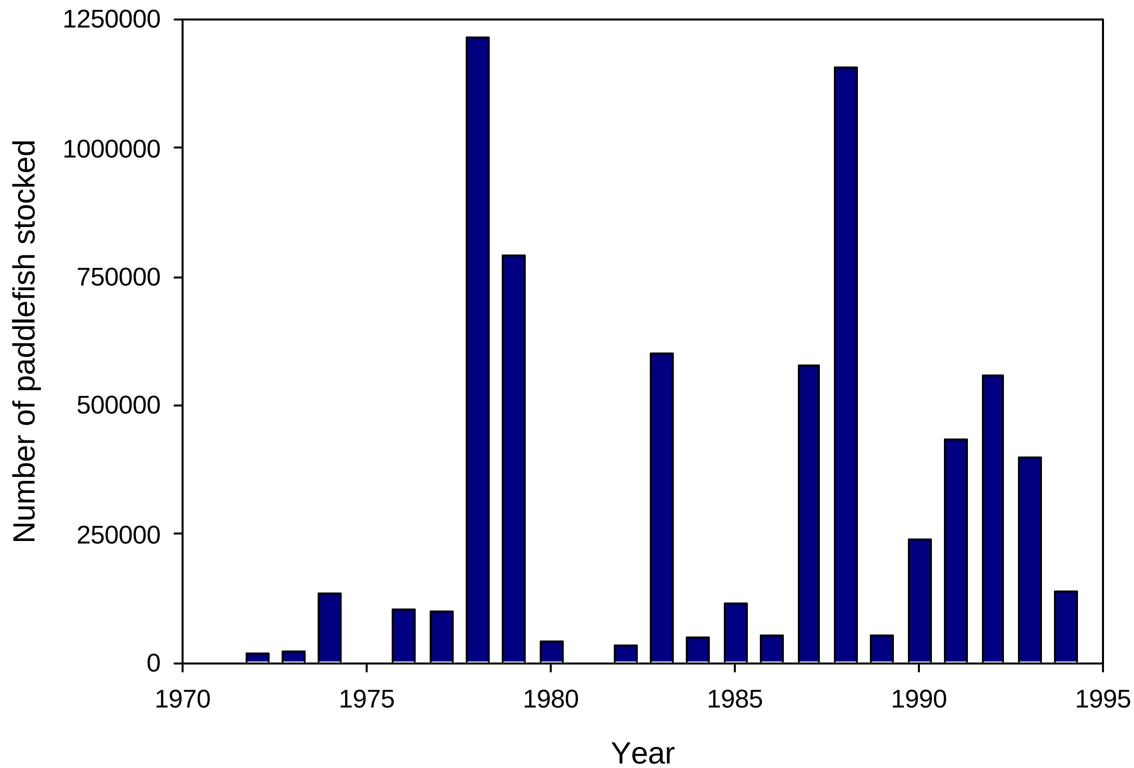

Figure 14. Number of paddlefish stocked in the lower Missouri River sub-basin from 1972 through 1994.

The majority of the paddlefish stocked since the MICRA project started were stocked into mainstem reservoirs on the Missouri River; Lewis and Clark Lake and Lake Francis Case or in large tributary reservoirs; Tuttle Creek, Truman Lake and Lake of the Ozarks.

Participating agencies have recovered over 860 stocked paddlefish (Table 14). The majority of these paddlefish were recovered in the Gavins Point Dam tailwater either by biologists or sport anglers. Over 57% of the recaptures were paddlefish that were stocked into Lewis and Clark Lake and passed through Gavins Point Dam.

Thirteen percent of the paddlefish recaptured were stocked into Lake Francis Case and were recovered from the Gavins Point Dam tailwater meaning the paddlefish had passed through both Fort Randall and Gavins Point Dams. One of these stocked fish was recovered in the Republican River in Kansas. Over 20% of the recaptured fish were stocked into Tuttle Creek Reservoir in Kansas and individuals were recovered from the Blue, Smokey Hill and Republican Rivers in Kansas and a large number (156 fish) were recovered at the Gavins Point Dam tailwater. Paddlefish stocked into Lake of the Ozarks in Missouri have been recaptured in the Bagnell Dam and Gavins Point Dam tailwaters. Paddlefish stocked into Harry S. Truman Lake in Missouri have been recaptured in Lake of the Ozarks.

Table 13. Paddlefish fingerlings stocking in the lower Missouri River sub-basin from 1988 through 2003.

State / Location	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2003	Total
Missouri																
Osage River Truman Lake	26700	16403	29576	5987[1]	4471[1]	39522[1]	29001[1]	11927	9335	3906	18605	20267	9694	66620	14740	306754
Osage River Lake of the Ozarks	25994	17452	10129	5895	2760	10028	10180	6830	7972	1738	18974	21203	8190	63881	15253	226479
Kansas																
Blue River Blue River Boat Ramp								87								87
Blue River Tuttle Creek Reservoir							6460	5470								11930
Neosho River John Redmond Res.													100			100
South Dakota																
Missouri River Lake Francis Case				21460	24272	23315	21394	28934	12436	13821	13271	32646	2702	538	21089	215878
Missouri River Lewis and Clark Lake	22212	18364	19385	24690	21419											106070
Total	74906	52219	59090	58032	52922	72865	67035	53248	29743	19465	50850	74116	20686	131039	51082	867298

[1] Paddlefish fry also stocked.

Table 14. Recovery of stocked paddlefish from lower Missouri River sub-basin from 1995 to 2003.

Stocking State River Location	Truman Reservoir	Lake of the Ozarks	Bagnell Dam	Blue River	Tuttle Creek Reservoir	Republican River Milford	Smokey Hill River	Lake Francis Case	Fort Randall Tailwater	Gavins Point Tailwater	Total
Missouri											
Osage River Truman Lake	5		1								6
Osage River Lake of the Ozarks		1	15							3	19
Kansas											
Blue River Blue River Boat Ramp										1	1
Blue River Tuttle Creek Reservoir				2	6	6	1			156	174
South Dakota											
Missouri River Lake Francis Case						1		52	2	115	170
South Dakota / Nebraska											
Missouri River Lewis and Clark Lake									3	495	498
Total	5	1	16	2	6	7	1	52	5	770	868

Paddlefish Movement

Movement information from tagged paddlefish in the lower Missouri River sub-basin is limited by the small percentage of fish that were tagged in and sampled from locations other than the Gavins Point Dam tailwater (Table 15). Most wild paddlefish were recaptured in the same location that they were tagged. This does not necessarily mean that they did not travel to other locations but just that they were tagged and subsequently recaptured in the same location. Many stocked fish have been shown to move long distances from their stocking site and even though the numbers of recaptured wild paddlefish are small there is some indication that wild paddlefish are also moving.

No paddlefish tagged outside the lower Missouri River sub-basin were subsequently recaptured in the sub-basin (Table 15). Over 45 percent of the wild paddlefish that were tagged in the lower Missouri River sub-basin and recaptured in a different location were harvested by commercial fishermen on the Mississippi or Kaskaskia Rivers in Illinois and Missouri.

Table 15. Recovery of wild tagged paddlefish that moved from or within the lower Missouri River sub-basin from 1995 to 2003.

Tagging location	Basin	River mile	Capture location	Basin	River mile or State	Number	Recapture type
Niobrara	Missouri	840	Gavins	Missouri	811	2	Sport
Gavins	Missouri	811	Big Sioux	Missouri	714	5	Biologist
Gavins	Missouri		Bagnell Dam	Missouri	Missouri	1	Sport
Gavins	Missouri		Kaskaskia	Mississippi	Illinois	3	Commercial
Gavins	Missouri		Mississippi	Mississippi	Illinois	3	Commercial
Gavins	Missouri		Mississippi	Mississippi	Missouri	1	Commercial
Gavins	Missouri		Des Moines	Mississippi	Iowa	1	Biologist
James	Missouri	801	Gavins	Missouri	811	1	Sport
Big Sioux	Missouri	714	Gavins	Missouri	811	2	Sport
Herman	Missouri	98	Gavins	Missouri	811	1	Biologist
Bagnell Dam	Missouri		Mississippi	Mississippi	Missouri	1	Commercial
Bagnell Dam	Missouri		Kaskaskia	Mississippi	Illinois	2	Commercial
Osage River	Missouri		Mississippi	Mississippi	Illinois	1	Commercial

Paddlefish Harvest

Commercial Harvest

Paddlefish were harvested commercially in the Missouri River from the late 1800’s until 1986. Commercial harvest in the Missouri River is currently prohibited by all states in the sub-basin but poaching is a serious concern (Hesse and Carreiro 1997). Records show that approximately 50 metric tons were harvested per year from the Missouri River before 1900 (Carlson and Bonislawski 1981). Historic records were based on voluntary reports from commercial fishermen and are likely to underestimate total catch. After consistent reports of catch exceeding 40 metric tons per year, paddlefish harvest dropped to about 15 metric tons by 1922 and to around 5 metric tons per year until the late 1950’s Figure 15). Harvest peaked again to an all time high of 55,700 kg during 1960 when harvest permits were granted in Lake Oahe and Lake Francis Case in South Dakota. Harvest in South Dakota rapidly declined over the next

10 years and by 1970 total harvest from the sub-basin was 4439 kg. Total reported commercial harvest from 1970 to 1985 stabilized and usually ranged from 4000 to 6000 kg per year until 1985 (Zuerlein 1988).

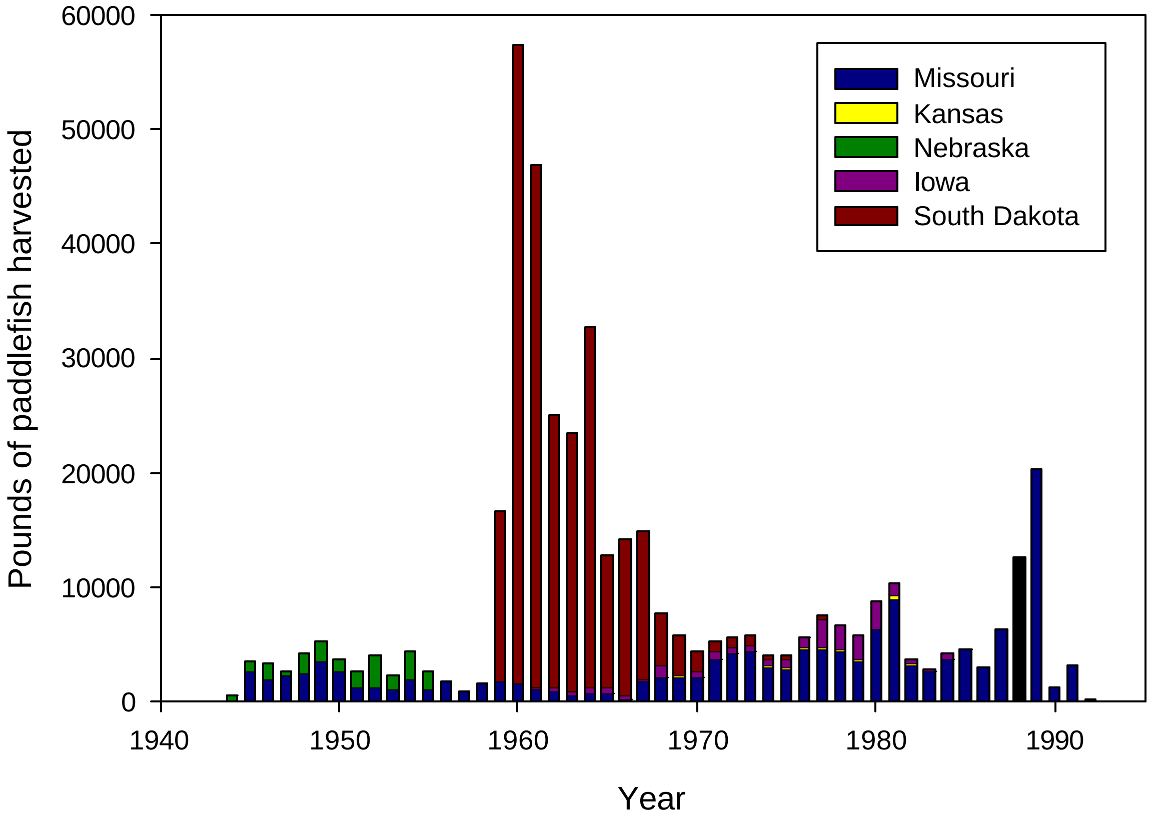

Figure 15. Commercial harvest of paddlefish in the Missouri River sub-basin since 1944.

Sport Harvest

Recreational harvest of paddlefish is allowed by every state of the sub-basin. In South Dakota alone, paddlefish anglers annually spent between an estimated 9,700 and 17,000 hours pursuing paddlefish during the 1997-2001 period (Stone and Sorensen 2002). Season dates and lengths, along with harvest quotas and restrictions vary among states and are shown in the Appendix. Total catch estimates from recent reports, excluding Iowa, exceeds 100,000 kg per year (Hesse and Carreiro 1997). Total reported catch of 75,000 kg in the state of Missouri alone, far exceeds the peak reported commercial harvest of 55,700 kg for the entire Missouri River. Nebraska and South Dakota jointly manage paddlefish archery and snagging seasons on the Unchannelized Missouri River from the Gavins Point Dam tailwater to the Big Sioux River confluence. Both have 30 day seasons and an established harvest quota managed by issuing a limited number of permits; 100 paddlefish and 550 permits for the archery season and 1,600 paddlefish and 2,800 permits for the snagging season. All anglers are encouraged to submit rostrums from harvested paddlefish at drop-off locations. A postage paid response card issued with each permit allows the states to estimate total use and harvest for each season. Estimated paddlefish harvest has ranged from 44 to 138 paddlefish for the archery season from 1995 to 2003 and from 725 to 2,092 paddlefish for the snagging season from 1995 to 2005 (Table 16).

A simple population estimate was calculated by using the ratio of the number of paddlefish tagged in the proceeding year and the number of these tags recovered during the following snagging season (Table 17). The functional population size ranged from 14,040 in 1995 to 83,259 in 1997 with a mean of 46,240 paddlefish.

Table 16. Sport harvest of paddlefish during the archery and snagging seasons on the Unchannelized Missouri River from the Gavins Point Dam tailwater to the Big Sioux River confluence from 1995 through 2003.

	Archery Harvest	Snagging Harvest	Total
1995	44	2,092	2,136
1996	100	1,725	1,825
1997	88	947	1,035
1998	120	1,114	1,234
1999	82	1,310	1,392
2000	133	943	1,076
2001	138	1,030	1,168
2002	98	725	823
2003	130	1,212	1,342
Total	933	11,098	12,031
Mean	104	1,233	1,337

Table 17. Number of fish tagged in the previous year, number of tags recaptured during the snagging season, percent exploitation and estimated functional population size on the Unchannelized Missouri River from the Gavins Point Dam tailwater to the Big Sioux River confluence from 1995 through 2003.

Year	Fish tagged	Recaptures	% Exploitation	Functional population size
1995	627	28	4.47%	14040
1996	851	24	2.82%	30175
1997	957	11	1.15%	83259
1998	446	5	1.12%	39783
1999	936	0	0.00%	n.a.
2000	370	0	0.00%	n.a.
2001	232	2	0.86%	26912
2002	669	6	0.90%	74594
2003	620	7	1.13%	54914
Mean	634	9.2	1.38%	46240

Young-of-the-year monitoring

Young-of-the-year paddlefish have been sampled most years by North Central Reservoir Investigation (NCRI), the South Dakota Department of Game, Fish and Parks (SDGFP), the University of South Dakota (USD) and the Nebraska Game and Parks Commission (NGPC) since 1965 from Lewis and Clark Lake using a 23' otter trawl (Figure 16). The abundance of young-of-the-year paddlefish has fluctuated over the years and most recently the numbers are down perhaps as a result of the severe drought the basin has been enduring.

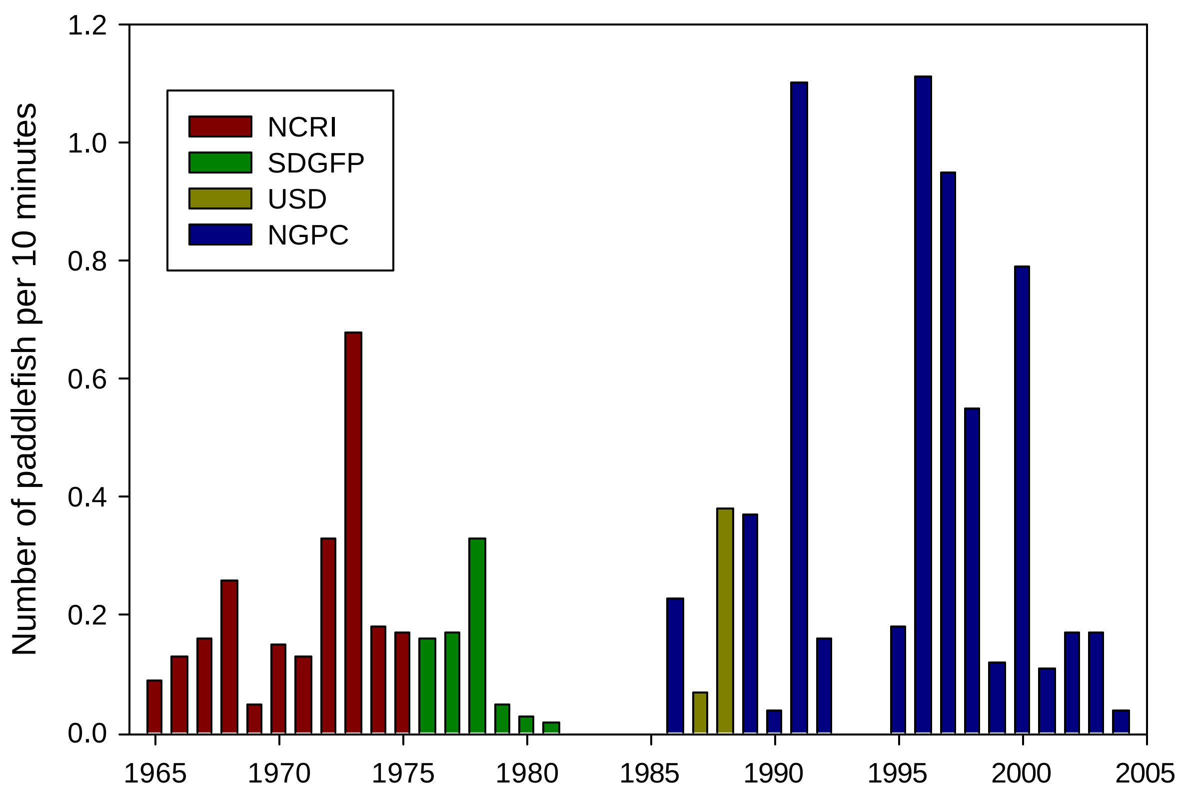

Figure 16. Number of paddlefish sampled per 10 minutes using an otter trawl in Lewis and Clark Lake from 1965 to 2004.

Contaminant Monitoring

As paddlefish are harvested and consumed by recreational anglers in the Missouri River sub-basin, contaminants may pose a threat to both humans and fish. Paddlefish frequently live longer than 20 years and thus have the potential to accumulate higher levels of contaminants than other short-lived fish species in the region. Their longevity and their planktivorous feeding habits may also contribute to elevated concentrations of contaminants compared to other fish species. The US Fish and Wildlife Service Contaminants Program published reports on natural and anthropogenic contaminants in paddlefish from the Missouri River near Blair, Nebraska (approx. 22 miles north of Omaha) and at the confluence with the Yellowstone River in North Dakota, near Williston (Allan and Wilson 1991; Welsh 1992). A total of six fish were collected, four from North Dakota and two from Nebraska and tissues were analyzed for concentrations of over 23 elements and 11 compounds.

Of primary concern to fish and people in the Missouri River sub-basin are compounds and elements used for agricultural purposes. Polychlorinated biphenly (PCB) compounds were banned in 1979 but concentrations still remain in the environment and can accumulate in fish tissues such as eggs, organs, and muscle. Aroclor is the most common generic name for PCB's in the United States. Other potentially dangerous agricultural chemicals such as Atrizine are legal and are currently used and applied in vast amounts across the Missouri River sub-basin. Trace elements such as zinc, arsenic, selenium, copper and lead may also pose a threat to fish and human health in the Missouri River sub-basin (Allan and Wilson 1991). Some of the aforementioned chemicals are carcinogens, lethal at extremely low concentrations, and others can have profound affects on the immune, endocrine, reproductive, and nervous systems of living organisms including humans and fish.

Analysis of muscle tissue from two paddlefish from the Missouri River near Blair, Nebraska in 1988 identified high concentrations of PCB (Aroclor1254) and total cyclodiene (i.e. chlordane, aldrin) as well as DDT suggesting recent inputs into the system (Table 18). The National Academy of Sciences and National Academy of Engineering (NAS and NAE) recommended in 1974 that whole-body wet weight concentrations of cylclodiene compounds should not exceed 0.1 µg/g for fish and environmental health (Allan and Wilson 1991). One out of the two paddlefish tested exceeded the NAS and NAE threshold by nearly five times. Chlordane is a member of the cyclodiene family and the U.S. Food and Drug Administration (FDA) established 0.3 µg/g unsafe for human consumption. One out of the two paddlefish tested exceed the FDA threshold. Concentrations of Aroclor1254 in both paddlefish were nearly double the 1980 EPA recommendation of 0.4 µg/g.

Table 18. Concentrations (µg/g wet weight) of contaminants it muscle tissue of paddlefish collected from the Missouri River near Blair, Nebraska in 1988 (Allan and Wilson 1988).

Species	Number	Total DDT	Aroclor 1254	Total Chlordane	Aldrin	Total Cyclodiene
Paddlefish	1	0.08	0.82	0.36	0.14	0.52
Paddlefish	1	0.06	0.75	0.05	0.01	0.06

Analysis of organs and eggs from four paddlefish in the Missouri River near the confluence with the Yellowstone River revealed unhealthy concentrations of arsenic, copper, and selenium and the concentration of most elements were higher in paddlefish than previous reports for other fish species (Table 19) (Welsh 1992). Comparisons made with element concentrations in organs of pallid sturgeon which are also large, long-lived and a native fish of the Missouri River, identify elevated concentrations in paddlefish. However, none of the 23 elements tested exceeded toxicity thresholds for the species or exceed levels that have been shown to influence reproduction.

Table 19. Concentrations (ppm, dry weight) of elements in the liver, kidney, and eggs of paddlefish from the Missouri River confluence with the Yellowstone River and comparison with pallid sturgeon samples collected in Lake Oahe, North Dakota (Welsh 1992).

Contaminant	Tissue	Paddlefish	Pallid sturgeon
Arsenic	Liver	7.77	0.53
	Kidney	1.54	0.44
	Eggs	0.75	0.4
Copper	Liver	135.4	5.17
	Kidney	5.16	3.56
	Eggs	4.72	3.65
Selenium	Liver	11.65	3.96
	Kidney	3.94	1.98
	Eggs	2.17	2.39

Results must be taken with caution and regarded as preliminary (Welsh 1992). Reports were from paddlefish collected during 1988 and 1991 and thus may not reflect current contaminant levels. Additionally, the small sample size of six paddlefish combined from both studies is not enough to test for statistical significance and the scientific methods of each study were designed to provide groundwork for future studies and did not focus on paddlefish.

STATUS OF PADDLEFISH IN THE LOWER MISSOURI RIVER SUB-BASIN

Most states in the Missouri River sub-basin consider paddlefish populations stable although the range of paddlefish has decreased in many smaller rivers such as the Platte and Loup Rivers in Nebraska (Hesse and Carreiro 1997). Paddlefish have been stocked in several sub-basin reservoirs in South Dakota, Kansas and Missouri.

Missouri

Missouri River

Paddlefish are native to the Mississippi, Missouri and Osage River basins in Missouri. Substantial paddlefish populations occur in the Mississippi, Missouri, Osage and Black Rivers. The population has declined in the Missouri River but state-wide the status is considered stable because of a persistent stocking program in and around reservoirs (Hesse and Carreiero 1996). Much is known about the reservoir paddlefish populations but knowledge about riverine paddlefish populations is limited. Paddlefish frequent several of the larger tributaries to the Missouri and Mississippi rivers, but other than the Osage River there are no other important fisheries. Natural spawning areas and food might be important limiting factors in keeping most river populations regulated at relatively low levels.

Tributaries

The Osage River - Lake of the Ozarks paddlefish population supports the largest snag fishery in Missouri and one of the largest in the United States. Construction of Harry S Truman Dam on the Osage River near Warsaw in 1977 blocked spawning migrations out of Lake of the Ozarks and inundated spawning areas, threatening this excellent fishery. Historically, paddlefish migrated out of Lake of the Ozarks during the spring to spawn over clean gravel in flowing water of the Osage River during spring rises (Russell 1986). Paddlefish were harvested during a special two-month snagging season (March 15-May 15) as they concentrated in deep pools prior to the spawning run and later near the spawning areas. The average annual spring harvest was about 3,600 fish weighing approximately 115,000 pounds. This fishery and the spawning areas were described in detail by Purkett (1961 and 1963). Russell et al. (1980) concluded that the loss of spawning areas would result in a decline in this paddlefish population and fishery without special management. They recommended that hatchery-produced paddlefish fingerlings be stocked to maintain the population and fishery in Lake of the Ozarks and to develop a population and fishery in Harry S Truman Lake. In the early 1970's a paddlefish population and fishery was established in Table Rock Lake by stocking hatchery-produced fingerlings (Graham 1986). And in 1978 the MO Department of Conservation began stocking hatchery produced fingerlings to establish and maintain the paddlefish population in Harry S Truman Lake. This population developed rapidly and fishing was permitted in 1990 under statewide regulations. Today the paddlefish populations in Lake of the Ozarks, Harry S Truman lake and Table Rock Lake are maintained by annual stockings of hatchery produced fingerlings and restrictive harvest regulations. The Missouri Paddlefish Plan calls for stocking all three reservoirs annually. The plan calls for stocking Table Rock Lake with 3,000 paddlefish fingerlings annually and a pulse stocking of up to 6,000 fish every three years. And stocking Lake of the Ozarks and Harry S Truman Lake with 15,000 paddlefish fingerlings each annually and a pulse stocking of up to 30,000 fish every three years.

There has been no documented natural reproduction in the reservoirs. To monitor and evaluate the reservoir paddlefish populations standardized roving creel surveys are being conducted.

Small paddlefish are commonly found in the lower stretches of many rivers, particularly those that drain directly into the Missouri and Mississippi rivers. We suspect that most of these paddlefish are immature and move up these smaller streams during periods of high flow. Streams that routinely have paddlefish are the Chariton, Grand, Lamine, Osage, Moreau and Gasconade rivers that empty into the Missouri River. Other than the Osage River there are no other important fisheries. However, the occasional paddlefish may be caught in other streams by anglers fishing for other species. Paddlefish larvae have been collected in the Lamine and Missouri rivers and Auzvasse Creek (Hesse and Carreiro 1996).

Kansas

Missouri River

The population status in the Missouri River is unknown

Tributaries

Paddlefish fisheries in Kansas are dependant on stocking and natural reproduction in other states. The largest fishery occurs at Chetopa Dam on the Neosho River from paddlefish migrating out of Grand Lake, OK. A small fishery exists at Osawatomie Dam on the Marais des Cygnes River from fish stocked into Truman Reservoir by the Missouri Department of Conservation. These populations are considered to be stable due to stocking in reservoirs. A collaborative effort to stock Kaw Reservoir, OK on the Arkansas River was undertaken by the Kansas Department of Wildlife and Parks and the Oklahoma Department of Conservation. As yet, limited results have been realized from those efforts. Stocking at Tuttle Creek Reservoir on the Blue River has not produced the desired results. Most of the recaptures from those stocks have been from the Blue River below Tuttle Creek Dam and from the tailwater of Gavins Point Dam. Paddlefish are occasionally observed at Bowersock Dam on the Kansas River at Lawrence and at Clinton Dam on the Wakarusa River, a tributary to the Kansas River. Eggs and larvae have not been collected but juveniles have been sampled from the Smokey Hill, Blue, Marais des Cygne and Neosho rivers (Hesse and Carreiero 1996).

Iowa

Missouri River

The population status in the channelized Missouri River bordering Nebraska is unknown (Hesse and Carreiro 1996).

Tributaries

The population is considered to be declining (Hesse and Carreiro 1996).

Nebraska

Missouri River

Larval and juvenile paddlefish have been collected from the main channel of the Missouri River (Hesse and Mestl 1984, 1988, 1991 and 1992). The population in the Missouri River and Lewis and Clark Lake above Gavins Point Dam is considered stable. Since 1965, young-of-the-year have regularly been sampled from Lewis and Clark Lake and this recruitment is believed to contribute to paddlefish populations downstream of Gavins Point Dam (Mestl 2003). The population is considered stable in the Missouri River below Gavins Point Dam (Hesse and Carreiro 1996). This has been supported by the results of this study. The mean size of paddlefish in this reach is increasing while maintaining a successful recreational fishery. The status of the population in the channelized stretch of the Missouri River from Sioux City to the Kansas border is unknown.

Tributaries

No known spawning populations of paddlefish are known to occur in tributaries to the Missouri. Small numbers of paddlefish can be found in the lower reaches of the Platte and Elkhorn Rivers.

South Dakota

Missouri River

Paddlefish have been documented throughout the Missouri River in South Dakota. Populations exist in mainstem reservoirs as well as natural river reaches. Hatchery reared paddlefish have been used to supplement a declining population upstream from Gavins Point Dam (Hesse and Carriero 1996). However, the status of paddlefish in South Dakota differs from one river reach to the next.

Paddlefish populations in Lakes Oahe and Sharpe are comprised predominately of large adult fish, remnants of those "trapped" in the reservoirs after impoundment, and are considered to be declining as older individuals are lost to natural causes. The population in Lake Francis Case is considered stable and may be increasing, largely due to annual fingerling stockings. Degradation of spawning habitat is a limiting factor in all mainstem reservoirs. The population in the Missouri River below Fort Randall Dam and in Lewis and Clark Lake is considered stable. Although reproduction has not been recently documented in Lakes Oahe, Sharpe or Francis Case, reproduction has been documented in the unchannelized reach of the Missouri River between Fort Randall Dam and Gavins Point Dam. Young-of-the-year paddlefish have regularly been sampled in Lewis and Clark Lake since 1965 (Mestl 2003). The population below Gavins Point Dam is considered stable (Hesse and Carreiro 1996) and supports a successful recreational fishery managed jointly by the states of Nebraska and South Dakota.

Tributaries

No known spawning populations of paddlefish are known to occur in tributaries of the Missouri River in South Dakota. Paddlefish have been documented, by both biologists and anglers, using the lower reaches of some tributaries during periods of high flows.

RECOMMENDATIONS

- Continue and expand the MICRA paddlefish project
    - The MICRA paddlefish project provides a solid supporting structure for paddlefish studies in the lower Missouri River sub-basin and will provide the best means to evaluate the status of paddlefish at the sub-basin level. Although the evidence is limited, we have documented movement from the lower Missouri River sub-basin into the middle Mississippi River sub-basin and all but one of these paddlefish were harvested by commercial fishermen. This supports the contention that paddlefish are indeed an interjurisdictional fish and to accurately evaluate basin wide population status the MICRA paddlefish project is a necessity.
- Increase sampling throughout the lower Missouri River sub-basin
    - Increased sampling outside the Gavins Point Dam area is necessary to make rational judgments about the Missouri River sub-basin population. Sampling areas to focus on include; unchannelized Missouri River above Lewis and Clark Lake, channelized river bordering Iowa and Nebraska, the Missouri River in Missouri, and mainstem Missouri River reservoirs. We recommend a goal of sampling and tagging100 paddlefish from each of these areas each year.
- Develop standardized sampling methods: gears, seasons, etc.
    - Standardizing sampling gears would improve the accuracy of population assessments and facilitate more robust comparisons between years and

regions. Floating trammel nets, gill nets and hobbled gillnets are recommended because each has similar size selectivity. Three inch mesh is recommended to increase the range of sizes collected

- Recognize and/or create spawning habitat
  - The loss of paddlefish spawning habitat has led to the decline of paddlefish numbers in the lower Missouri River. Alterations in water temperature and flow regimes have contributed to declines in paddlefish stocks in the lower Missouri River. Stocking hatchery reared paddlefish is a short term solution. Without restoring spawning habitat, paddlefish populations are continually in jeopardy. States are encouraged to identify and work to restore or create areas suitable for successful paddlefish spawning.
- *Collect and monitor recreational harvest data*
  - Sub-basin-wide recreational harvest is not kept on an annual basis. Combined records of recreational harvest by state would allow for a better assessment of exploitation rates and interpretation of coded wire tag returns. States are encouraged to record and submit annual harvest information to MICRA.
- Evaluate the population status of paddlefish in the lower Missouri River sub-basin on a regular basis.
  - With the continued threats to paddlefish populations as a source of caviar and with the many habitat and flow modifications occurring in the lower Missouri River sub-basin it is important for the biologists of the sub-basin

to get together on a regular basis and evaluate the status of the paddlefish population. We recommend updating this report every five years.

- Monitor the spread of aquatic nuisance species and their effects on paddlefish populations
    - Aquatic nuisance species such as Asian carp species and zebra mussels continue to expand their ranges and compete with paddlefish for limited food resources. It is important for biologists to monitor and attempt to reduce the effects that this invasion has on paddlefish populations in the lower Missouri River sub-basin.
- Support contaminant analysis of paddlefish from across the lower Missouri River sub-basin.
    - The few paddlefish sampled for contaminants in the lower Missouri River sub-basin in 1988 raised concerns because paddlefish frequently live longer than 20 years and thus have the potential to accumulate higher levels of contaminants than other short-lived fish species in the region.

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ANNOTATED BILIOGRAPHY

We reviewed many published and unpublished paddlefish studies for the Lower Missouri River and identified reports that contained information on the following subjects.

1) Drift netting
2) Trawling
3) Gill netting
4) Seining
5) Aircraft observation
6) Radio telemetry
7) Tagging
8) Tag returns
9) Snagging
10) Fishing pressure
11) Catch rates
12) Harvest rates
13) Total annual survival rates
14) Population estimates
15) Master angler awards
16) Length weight regressions
17) Total and body length regressions

18) Eye to fork length gill raker regressions

19) Dentary bone length regressions

20) Length at age

21) Stocking

22) Genetics studies

Drift netting

a) 1974 - No young of the year paddlefish were collected in 8, .25 or .5 hour (dependent on sediment buildup in net) plankton net samples on the White River on June 12 and 13 (Kallemeyn, L. W. 1974).

b) 1974 - No young of the year paddlefish were collected in 4 plankton net samples near the mouth of Bow Creek (Kallemeyn, L. W. 1974).

c) 1974 - No young of the year paddlefish were collected in 6 plankton net samples from below Ft. Randall Dam (Kallemeyn, L. W. 1974).

d) 1975 - A total of 18 paddlefish larvae were collected in 100, 0.5 hour plankton net samples. Larval paddlefish were collected at all stations between Fort Randall Dam and Springfield, South Dakota (Kallemeyn, L. W. 1975).

e) 1975-1981 - The total mean density of larval paddlefish collected from the Missouri River with plankton nets was 0.29 larvae/1000 m^3 (SD = 0.25) (Hesse, L. W. *et al* 1990).

f) 1976 - No larval paddlefish were collected in 8, 0.5 hour plankton net samples between Gavins Point Dam and Jim River Island (Unkenholz, D. G. 1976).

g) 1976 - A total of 6 paddlefish larvae were collected in 108, 0.5 hour plankton net samples below Fort Randall Dam. No fry were collected from the tailwater (Unkenholz, D. G. 1976).

h) 1977 - A total of 8 larval paddlefish were collected in 78, 0.5 hour plankton net samples below Fort Randall Dam (Unkenholz, D. G. 1977).

i) 1979 - A total of 14 larval paddlefish were collected in 16, .5 hour plankton net samples from four stations downstream of Fort Randall Dam. Length and weight was measured (Unkenholz D. G. 1980, 80-3).

j) 1980 - No larval paddlefish were collected in 105, 0.5 hour plankton net samples (Unkenholz, D. G. 1981).

k) 1981 - One larval paddlefish was collected in 54, 0.5 hour plankton net samples from below Fort Randall Dam to Lewis and Clark Lake (Unkenholz, D. G. 1982).

2) <u>Trawling</u>

a) 1970-1974 - A total of 448 paddlefish were collected in weekly 40, 10 minute trawls from Lewis and Clark Lake during June - Aug (Ruelle & Hudson, 1977).

b) 1974 - Paddlefish were collected at two stations from the old river channel of the Lewis and Clark Lake (Kallemeyn, L. W. 1974).

c) 1975 - Sixty eight young-of-year paddlefish were collected in 42, 10 minute trawl samples (cpue of 1.62 per 10 minutes) from the old river channel off the mouths of Wiegand and Miller Creeks in Lewis and Clark Lake (Kallemeyn, L. W. 1975).

d) 1976 - A total of 66 young of the year paddlefish were collected in 45, 10 minute trawl samples (cpue of 1.47 per 10 minutes) from Lewis and Clark Lake (Unkenholz, D. G. 1976).

e) 1977 - A total of 55 young of the year paddlefish were collected in 40, 10 minute trawl hauls (cpue of 1.38 per 10 minutes) from Lewis and Clark Lake (Unkenholz, D. G. 1977).

f) 1979 - A total of 13 young of the year paddlefish were collected in 28, weekly 10 minute otter trawl samples (cpue of .46 per 10 minutes) from the old river channel near the mouths of Wiegand and Miller Creeks in Lewis and Clark Lake (Unkenholz, D. G. 1980, 80-3).

g) 1980 - Ten young-of-year paddlefish were collected in 40, 10 minute trawl samples (cpue of 0.25 per 10 minutes) from the old river channel off the mouths of Wiegand and Miller Creeks in Lewis and Clark Lake (Unkenholz, D. G. 1981).

h) 1981 - A total of 9 young of the year paddlefish were collected in 44, 10 minute trawl samples (cpue of 0.20 per 10 minutes) from the old river channel of the mouths of Wiegand and Miller Creeks in Lewis and Clark Lake (Unkenholz, D. G. 1982).

i) 1989 - A total of 25 young of the year paddlefish were collected in a 67 minute otter trawl (cpue of 0.37 per minute) from Lewis and Clark Lake (Hesse, L. W. *et al* 1990).

j) 1995- A total of 26 young of the year paddlefish were collected in a 147 minute otter trawl (cpue of 0.18 per minute) from Lewis and Clark Lake (Mestl G. 1996).

k) 1996- A total of 177 young of the year paddlefish were collected in a 160 minute otter trawl (cpue of 1.11 per minute) from Lewis and Clark Lake (Mestl G. 1997).

l) 1997- A total of 200 young of the year paddlefish were collected in a 210 minute otter trawl (cpue of 0.95 per minute) from Lewis and Clark Lake (Mestl G. 1998).

m) 1998- A total of 125 young of the year paddlefish were collected in a 229 minute otter trawl (cpue of 0.55 per minute) from Lewis and Clark Lake (Mestl G. 1999).

n) 1999- A total of 28 young of the year paddlefish were collected in a 237 minute otter trawl (cpue of 0.12 per minute) from Lewis and Clark Lake (Mestl G. 2000).

o) 2000- A total of 212 young of the year paddlefish were collected in a 270 minute otter trawl (cpue of 0.79 per minute) from Lewis and Clark Lake (Mestl G. 2001).

p) 2001- A total of 28 young of the year paddlefish were collected in a 262 minute otter trawl (cpue of 0.11 per minute) from Lewis and Clark Lake (Mestl G. 2002).

q) 2002- A total of 56 young of the year paddlefish were collected in a 330 minute otter trawl (cpue of 0.17 per minute) from Lewis and Clark Lake (Mestl G. 2003).

r) 2003- A total of 56 young of the year paddlefish were collected in a 330 minute otter trawl (cpue of 0.17 per minute) from Lewis and Clark Lake (Mestl G. 2004).

3) <u>Gill netting</u>

a) 1974 - A total of 30 paddlefish were captured in three overnight gill net sets with hourly checks below Ft. Randall Dam (Kallemeyn, L. W. 1974).

b) 1974 - One paddlefish was captured in six overnight gillnet sets from Fort Randall Dam tailwater (Kallemeyn, L. W. 1975, R-10).

c) 1974 - A total of three paddlefish were captured in nine overnight gillnet sets from Lewis and Clark Lake in August (Kallemeyn, L. W. 1975, R-10).

d) 1975 - A total of two paddlefish were captured in by-weekly gill netting in the Fort Randall tailwater from December, 1974 through March, 1975 (Kallemeyn, L. W. 1975).

e) 1975 - A total of 24 paddlefish were captured in five nights of gill netting in the Fort Randall tailwater from May through August (Kallemeyn, L. W. 1975).

f) 1975 - No paddlefish were collected in nine overnight gill net sets in Lewis and Clark Lake during the week of September 22-25 (Kallemeyn, L. W. 1975).

g) 1975-1976 - A total of 458 paddlefish were captured in gill nets. Fish were weighted and measured with 184 dentary bones collected (Rosen & Hales 1980).

h) 1975-1976 - Adult paddlefish were captured in gill nets from a section of the Missouri River between Yankton, SD and Ponca, NE at least once a mouth starting in August (Rosen & Hales 1981).

i) 1976 - A total of 455 paddlefish were captured in seven overnight gill nets from Yankton, SD to Ponca, NE (Rosen, R. A 1976).

j) 1976 - A total of 73 paddlefish were captured in gill nets from below Gavins Point Dam (Unkenholz, D. G. 1976).

k) 1976 - A total of 470 paddlefish were captured in gill nets from below Gavins Point Dam between June-Aug (Rosen, R.A. *et al* 1982).

l) 1979 - A total of 52 paddlefish were captured in gill nets ran every 15 to 30 minutes in the Fort Randall Dam tailwater area (Unkenholz, D. G. 1980, 80-3).

m) 1979 - A total of 327 paddlefish were sampled using gill nets in the river downstream of Gavins Point Dam in sand bar pools (Unkenholz, D. G. 1980).

n) 1980 - Eighteen paddlefish were sampled using gill nets in the Fort Randall tailwaters. Two of the fish were previously tagged in Lake Francis Case and two that were previously tagged in the Fort Randall Tailwater (Unkenholz, D. G. 1981).

o) 1981 - No adult paddlefish were captured from 3 weeks of gilling net in Fort Randall Dam tailwaters.

4) Seining

a) 1974 - No young of the year paddlefish were collected in several seine hauls on the White River (Kallemeyn L. W. 1974).

b) 1974 - One paddlefish was captured in 5 seine hauls made in the Fort Randall Dam tailwater (Kallemeyn, L. W. 1975, R-10).

5) Aircraft Observation

a) 1974 - The largest concentration of paddlefish observed from Ponca to Gavins Point Dam was in the area 2 to 3 miles downstream from the Mouth of the James River (Kallemeyn, L. W. 1974).

b) 1974 - No paddlefish were observed from the upstream end of Lewis and Clark Lake to Ft. Randall Dam in July (Kallemeyn, L. W. 1974).

6) Radio telemetry

a) 1979 - Radio telemetry failed due to high water conductivity (Unkenholz, D. G. 1980, 80-3).

b) 1980 - Twelve paddlefish were tagged with radio transmitters in 1980 (Unkenholz, D. G. 1981).

c) 1981- Eighteen paddlefish were tagged with radio transmitters and released near the old townsite of Niobrara (Unkenholz, D. G. 1982).

7) Tagging

a) 1969 - A total of 116 paddlefish were tagged in Lake Francis Case (Friberg, D. V. 1974).

b) 1970 - A total of 153 paddlefish were tagged in Lake Francis Case (Friberg, D. V. 1974).

c) 1972-1973 - A total of 325 paddlefish were tagged in the tailwaters of Gavins Point Dam (Kallemeyn L. W. 1974).

d) 1972-1977 - A total of 727 paddlefish were tagged in the free-flowing river below Gavins Point Dam. A total of 112 paddlefish were tagged from the channelized portion below Gavins Point Dam (Rosen, R. A. *et al* 1982).

e) 1974 - A total of 24 paddlefish in June and 6 paddlefish in July were tagged in the spillway below Ft. Randall Dam (Kallemeyn, L. W. 1974).

f) 1976 - A total of 191 paddlefish were tagged from June-Nov between Yankton, SD and Ponca, NE (Rosen, R. A. 1976).

g) 1978 - A total of 89 paddlefish were tagged below Gavins Point Dam (Unkenholz, D. G 1979).

h) 1979 - A total of 327 paddlefish were tagged in the river downstream of Gavins Point Dam (Unkenholz, D. G. 1980).

i) 1979 - A total of 52 paddlefish were tagged in the Fort Randall Dam tailwater area (Unkenholz, D. G. 1980, 80-3).

j) 1980 - A total of 253 paddlefish were tagged from below Gavins Point Dam (Unkenholz, D. G. 1981, 81-2).

8) Tag returns

a) 1972-1973 - Nineteen tags were returned from the tailwaters of Gavins Point Dam (Friberg, D. V. 1974).

b) 1973 - The accumulative percent recovered for fish tagged in Lake Francis Case in 1969 was 28.2 and in 1970 was 27.3 (Friberg, D. V. 1974).

c) 1976 - Anglers returned 15 jaw tags between Yankton, SD and Ponca, NE (Rosen, R. A. 1976).

d) 1978 - Anglers returned 5 tags during the 1977-1978 snagging season (Unkenholz, D. G. 1979).

e) 1979 - Anglers returned 30 tags during the 1978-1979 snagging season (Unkenholz, D. G. 1980).

f) 1979 - Anglers returned 9 tags from the tailwaters of Fort Randall Dam in April (Unkenholz, D. G 1980, 80-3).

g) 1980 - Anglers returned 32 tags for paddlefish tagged below Gavins Point Dam (Unkenholz, D. G. 1981, 81-2).

h) 1980 - Anglers returned 3 tags from paddlefish tagged at the Fort Randall Dam tailwater. Two of the paddlefish were caught in the Fort Randall Dam tailwater and one in the Gavins Point Dam tailwater (Unkenholz, D. G. 1981).

i) 1981 - Anglers returned 2 tags from paddlefish tagged at the Fort Randall Dam (Unkenholz, D. G. 1982).

	Tag Returns Below Gavins Point Dam(% returned)										
Year of tagging	# tagged	72-73	73-74	74-75	75-76	76-77	77-78	78-79	79-80	80-81	
1972	327	23(14)	12	2	5	8	0	2	3	0	
1973	14	-	1(7)	0	2	0	0	1	0	0	
1975	248	-	-	-	15(6)	7	1	3	1	2	
1976	125	-	-	-	-	10(8)	3	13	1	4	
1977	89	-	-	-	-	-	1(1)	4	2	4	Unkenholz 1979
1978	327	-	-	-	-	-	--	7(6.9)	4	5	Unkenholz 1980
1979	322	-	-	-	-	-	--	-	24(7.4)	21	Unkenholz 1981, 81-2
1980	253	-	-	-	-	-	-	-	-	25(9.9)	Unkenholz 1982, 82-9

	Tag Returns Below Fort Randall Dam or Lewis and Clark Lake (% returned)									
Year of tagging	# tagged	1974	1975	1976	1977	1978	1979	1980	1981	
1973	9	2(22)	0	0	0	0	0	0	0	
1974	32	-	2(6)	0	3	0	0	0	0	
1975	39	-	-	1(3)	2	1	2	1	0	
1976	8	-	-	-	0	0	0	0	0	
1978	6	-	-	-	-	1(17)	1	0	0	
1979	52	-	-	-	-	-	9(17.3)	2	1	
1980	14	-	-	-	-	-	-	0	1	
1981	18	-	-	-	-	-	-	-	0	Unkenholz 1982

9) Snagging

a) 1972-1973 - Fifty seven paddlefish were measured, weighed and dentary bones collected (Boehmer, R. J. 1973).

b) 1975 - Lengths and weights were collected from 15 paddlefish harvested by anglers (Kallemeyn, L. W. 1975).

c) 1976 - A total of 18 paddlefish were collected between Yankton, SD and Ponca, NE in the winter months (Rosen, R. A. 1976).

1989 - A total of 19 paddlefish were collected from the Yellowstone River at Intake, Montana (Holloway *et al.* 1991).

10) <u>Fishing Pressure</u>

a) 1972-1973 - The tailwaters of Gavins Point Dam experienced the greatest pressure: 3 times that in the unchannelized river and 4 times in the channelized section (Groen, C. L. & J. C. Schmulbach 1978).

b) 1973 - Gavins Point Dam in the fall season experienced the greatest angling pressure: 33,866 man hours (Groen, C. L 1973).

c) 1987 - Ninety percent of the snagging pressure in November occurred in Gavins Point Dam tailwaters (Stone, C. 1987).

11) <u>Catch rates</u>

a) 1973 - The catch rate for paddlefish below Gavins Point Dam was 0.20 fish/hour in December of the 1973 snagging season (Kallemeyn, L. W. 1975, R-10).

b) 1986 - The catch rate for paddlefish below the Gavins Point Dam was 0.28 fish/hour in November of the 1986 snagging season (Stone, C 1987).

c) 1989-1990 - The catch rate for paddlefish between Lewis and Clark Lake and the Big Sioux River was 0.25 for the first four days of the 1989 snagging season and 0.29 for the first four days of the 1990 season (Hesse, L. W. *et al* 1990).

12) Harvest rates

a) 1972 - The expected harvest rate from Big Bend Dam tailwaters of 2000 adult paddlefish was not reached by anglers in May - June (Friberg, D. V. 1973).

b) 1973 - The expected harvest rate from Big Bend Dam tailwaters of 2000 adult paddlefish was not reached by anglers in May - June (Friberg, D. V. 1974).

c) 1972-1973 - The mean take of anglers in the 1972-73 snagging season below Gavins Point Dam was .32 paddlefish per hour (Groen, C. L. & J. C. Schmulback 1978).

d) 1976 - The harvest rate from below Gavins Point Dam was estimated at 5-10% of the population (Unkenholz, D. G. 1976).

e) 1979 - The harvest rate was estimated at 6.9% of the total population (Unkenholz, D. G. 1980).

f) 1979 - The harvest rate was estimated at 17.3% from the Fort Randall Dam tailwaters (Unkenholz, D. G. 1980, 80-3).

g) 1980 - The harvest rate was estimated at 7.4% from below the Gavins Point Dam for the 1979-80 snagging season (Unkenholz, D. G. 1981, 81-2).

13) Total annual survival rates

a) 1972-1977 - The total annual survival rate of paddlefish from Gavins Point Dam was estimated as .82 (Rosen, R. A. *et al* 1982).

b) 1979 - The total annual survival rate of paddlefish from the Missouri River below Gavins Point Dam was estimated as 0.81 for 1978-1979 (Unkenholz, D. G. 1980).

c) 1979 - The total annual survival rate of paddlefish from the Fort Randall Dam tailwaters was estimated as .86 (Unkenholz, D. G. 1980, 80-3).

d) 1980 - The total annual survival rate of paddlefish from below the Gavins Point Dam was estimated as .83 (Unkenholz, D. G. 1981, 81-2)

14) Population estimates - Peterson method

a) 1972 - The estimated population from the Gavins Point Dam area was projected at 70,270 based on total harvest and tag returns (Friberg, D. V. 1974).

b) 1973 - The estimated population for Lake Francis Case was projected at 20,940 fish (SE = 2,016 fish) (Friberg, D. V. 1974).

c) 1975 - The estimated paddlefish population for Lake Francis Case was projected at (Kallemeyn, L. W. 1975, R-10):

i) 1971: 21,000 fish

ii) 1972: 16,175 fish

iii) 1973: 20, 940 fish

iv) 1974: 21,159 fish

15) Master angler awards

a) 1972-1973 - The average weight of paddlefish harvested from Gavins Point Dam tailwaters was 17.3 pounds between October and April (Friberg, D. V. 1974).

b) 1980 - Anglers harvested 50 proud angler paddlefish (fish over 50 pounds) during 1980 (Unkenholz, D. G. 1981).

c) 1981 - Anglers harvested 6 proud angler paddlefish (Unkenholz, D. G. 1982).

16) <u>Length weight regressions</u>

a) 1972-1973 - Gavins Point Dam tailwater, snagged paddlefish, weight = -5.7600 + 3.4903 * length, r = 0.93, P < 0.01 (Boehmer, R. J. 1973).

b) 1972-1977 - The length weight relationship did not differ (P > .05) between paddlefish sexes from Gavins Point Dam (Rosen, R. A. *et al* 1982).

c) 1979-1980 - Below Gavins Point Dam, gill netted paddlefish, Log weight = -2.0772 + 3.1091 * Log length (Unkenholz, D. G. 1981, 81-2).

d) 1976 - Between Yankton, SD and Ponca, NE, paddlefish, Log weight = -3.86 + 2.66 * Log length (P< .01) (Rosen, R. A. 1976).

17) <u>Total and body length regressions</u>

a) 1972 - Lake Oahe, paddlefish (Ruelle & Hudson 1977):

   i) Adult females: total length = 198.10 + 1.299 * body length, P <.05

   ii) Adult males: total length = 236.89 + 1.235 * body length, P <.05

   iii) Combined: total length = 200.67 + 1.286 * body length, P <.05

18) <u>Eye to fork length gill raker regressions</u>

a) _1975-1976 - Missouri River between Yankton, SD and Ponca, NE, paddlefish (Rosen & Hales, 1981)

   i) Gill raker width = $6.8x10^{-4}$ * length - 0.044

   ii) Mean interraker distance = $3.4x10^{-5}$ * length + 0.035

19) <u>Dentary bone length regressions</u>

a) 1973 - Gavins Point Dam, paddlefish, fork length = 0.19 + 0.0427 * jaw diameter, r = .84, P<.01 (Boehmer, R. J. 1973, Ages).

20) Length at age

		Age Class																					
Year	N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
1972-1973	52				651 (4)	704 (7)	760 (7)	803 (5)	845 (2)	921 (8)	906 (9)	1035(4)		1041 (1)	1080 (2)	1118(1)	965 (1)						A
1978-1979	103	366 (12)	414 (3)	576 (14)	669 (15)	678 (14)	737 (10)	761 (14)	1009 (7)	768 (8)		917 (3)	932 (2)		1710 (1)								B
1979	19										990.6 (1)	889 (1)	1092.2 (1)	1104.9 (1)	1155.7 (2)	1143 (1)	1016 (1)	1119.2 (4)		1149.4 (2)	1168.4 (1)	1136.6 (4)	C
1976 (EFL)	50			503 (6)	510 (3)	677 (6)	714 (3)	729 (3)	702 (4)	758 (9)	771 (9)	857 (1)	860 (2)	829 (3)	857 (1)								D
1979-1980	40	300 (1)	436 (5)	493 (6)	577 (9)	637 (6)	715 (9)	710 (2)	685 (1)	745 (1)		938 (2)	1115 (2)	875 (1)	1100 (1)								E
1987 (EFL)	87		437	537	593	682	737	700	804	822	865	860	793	882	851	1090							F
1988 (EFL)	378		463	546	654	722	753	761	772	748	890	1005	1004	893		894							F
1989 (EFL)	575	391	476	578	649	754	782	837	815	826	903	1037	1042	1059		1170							F

21) <u>Stocking</u>

a) 1972 - Eleven paddlefish captured below Big Bend Dam were used for propagation at Gavins Point National Hatchery. Failed to rear any paddlefish fry (Friberg, D. V. 1973).

b) 1973 - Twenty-one paddlefish captured below Big Bend Dam were used for propagation at Gavins Point National Hatchery. Failed to rear any paddlefish fry (Friberg, D. V. 1974).

c) 1973 - Seventeen paddlefish captured at Big Ben Dam tailwaters were used for propagation at Gavins Point National Fish Hatchery. A total of 21,600 fry were stocked in Lake Francis Case. A total of 440 paddlefish were released into Lake Francis Case (Kallemeyn, L. W. 1974).

d) 1975 - Fourteen paddlefish captured at the Big Bend tailwater that used for propagation at Gavins Point National Fish Hatchery were released into Lewis and Clark Lake (Kallemeyn, L. W. 1975).

e) 1976 - A total of fourteen paddlefish were captured at the Big Bend tailwater to be used for propagation at Gavins Point National Fish Hatchery. A total of 41,000 fry were stocked in Lake Francis Case (Unkenholz, D. G. 1976)

1977 - A total of twenty paddlefish were captured in Lake Francis Case near the mouth of the White River to be used for propagation at Gavins Point National Fish Hatchery (Unkenholz, D. G. 1977).

22) <u>Genetics studies</u>

a) 1995 - A total of 23 fin clippings were taken from paddlefish collected from the tailwaters of Gavins Point Dam in order to examine mtDNA heterozygosity in a single population (Bromley *et al.* 1996).

APPENDIX I

History of Paddlefish Regulations by State

Table 1. Chronological listing of statewide and specific regulations used to manage paddlefish in Missouri.

Year	Regulations	Location
Pre-1978	March 15 – May 15 and October 1 – December 31 snagging season, with two (2) fish daily and in possession.	Statewide
1978	3.5 mile no snagging zone below Harry S Truman Dam.	Lake of the Ozarks
1979	Shorten spring snagging season (March 15 – April 30).	Lake of the Ozarks
1979	Prohibited snagging on Harry S Truman Lake and its tributaries.	Harry S Truman Lake
1983	No possession of paddlefish in Harry S Truman Dam tailwaters.	Lake of the Ozarks
1983	No possession of paddlefish on Harry S Truman Lake and its tributaries.	Harry S Truman Lake
1987	24-inch (body length) length limit.	Lake of the Ozarks
1990	24-inch (body length) length limit.	Statewide
1990	Paddlefish parts (including eggs) may not be used as bait.	Statewide
1990	Paddlefish eggs may not be transported or sold.	Statewide
1990	Eliminated fall snagging season (October 1 – December 31).	Statewide
1990	Eliminated commercial harvest of paddlefish on the Missouri River.	Missouri River
1990	Permitted snagging on Harry S Truman Lake and its tributaries.	Harry S Truman Lake
1997	Eliminated possession of paddlefish from Lake Springfield Dam downstream to highway 160 bridge.	Table Rock Lake
2000	34-inch (body length) length limit on Lake of the Ozarks, Table Rock Lake, Harry S Truman Lake and their tributaries.	Lake of the Ozarks, Table Rock Lake , Harry S Truman Lake
2000	On Lake of the Ozarks and its tributaries, Osage River below U.S. Highway 54 and Harry S Truman Lake and its tributaries, no person shall continue to snag, snare or grab for any species after taking a daily limit of two (2) paddlefish.	Osage River, Lake of the Ozarks, Harry S Truman Lake
2000	Possession limit twice daily limit; extracted paddlefish eggs may not be possessed on the water or banks and may not be transported.	Statewide

Table 2. Chronological listing of statewide and specific regulations used to manage paddlefish in Nebraska.

Year	Regulations	Location
1957	No Limit	Statewide
1958	Bag limit 2, possession limit 4, season length July 1 - February 28	Statewide
1964	Season length November 1 - April 1	Statewide
1966	Season length October 1 - April 30	Statewide
1974	Possession limit 2, all paddlefish caught must be kept, paddlefish may only be field dressed	Statewide
1976	Tailwater area open from November 1 - March 31 Missouri River open from October 1 - April 30	Missouri River
1978	Snagging is prohibited after limit of paddlefish is reached	Missouri River
1983	Missouri River above Gavins Point Dam open November 1 - April 30 Missouri River below Gavins Point Dam open November 1 - March 31	Missouri River
1985	Missouri River above Gavins Point Dam season length 181 days, Missouri River from Gavins Point Dam to South Sioux City open from November 1 - March 31, Missouri River from South Sioux City to Kansas border from April 1 - May 15 and October 1 - October 31. Paddlefish may only be snagged from sunrise to sunset	Missouri River
1986	Missouri River above Gavins Point Dam season length 181 days, Missouri River from Gavins Point Dam to mouth of Big Sioux River open from November 1 - March 31, closed Missouri River below South Sioux City to archery fishing	Missouri River
1987	Snagging season shortened to 30 days opens on November 1, archery season shortened to 31 days opens on July 31, Missouri River above Gavins Point Dam closed to snagging	Missouri River
1988	Snagging season 30 days , archery season 31 days	Missouri River
1989	1,600 fish quota implemented, season opened October 15 and closed on November 15 (31 day season), bag limit 1, possession limit 1, limit of 1 hook	Missouri River
1991	Closed stilling basin, wall and tailrace	Missouri River
1992	Archery season opens on second Saturday and runs for 9 days, the A 35 to 45 inch protected slot implemented, snagging season opens on October 10 and runs for 30 days or until 1,600 fish quota reached, hook size of 1/2" gap implemented, Missouri River	Missouri River

Year	Regulations	Location
1992	All waters of the state closed to snagging except the reach on the Missouri River from Gavins Point Dam to the mouth of the Big Sioux	State wide
1997	Archery season extended from 9 to 16 days	Missouri River
1998	Free paddlefish required to harvest a paddlefish for both archery and snagging, snagging season to run from October 1 through October 30, legal hours are 7:00 a.m. to 7:00 p.m., all harvested paddlefish must be tagged immediately with harvest tag, bag limit equal to number of tags that each angler possesses	Missouri River
2000	Anglers must be 12 years old apply for a paddlefish archery or snagging tags	Missouri River
2003	There is a $5.00 application fee for archery and snagging permits	Missouri River
2004	The stilling basin was reopening for boat anglers during the snagging season	Missouri River
2005	Archery season lengthened to 30 days	Missouri River

Table 3. Chronological listing of statewide and specific regulations used to manage paddlefish on the Missouri River in Iowa.

	Sport Anglers				Commercial Anglers			
Year	**Open Season**	**Daily Limit**	**Possession**	**Minimum Wt. (lb)**	**Open Season**	**Daily Limit**	**Possession**	**Minimum Wt. (lb)**
1920-49	No information				Continuous	none	none	none
1950-63	Continuous	15	30	5	Continuous	none	none	none
1964-69	Continuous	2	4	5	Continuous	none	none	none
1970-73	Continuous	2	4	none	Continuous	none	none	none
1974	**Legalized snagging**				Continuous	none	none	none
1974-85	15 Nov to Feb 28	2	4	none	Continuous	none	none	none
1986-05	**Closed snagging**				**Closed commercial fishing**			

Table 4. Chronological listing of statewide and specific regulations used to manage paddlefish on the Missouri River in South Dakota.

Years	Season length	Daily limit	Possession limit	Special Conditions
		Below Big Bend Dam		
1963 - 1965	Nov. 15 - Jan	2	4	
1966 - 1967	Jan - Dec	4	4	
1968 - 1970	Jan - Dec	2	4	
1971	Jan - Dec	1	1	
1972 - 1973	Jan - Dec	1	1	Harvest quota of 2000 fish implemented
1974 - 1982	Jan - Dec	1	1	
1983 - 1986	Jan - Dec	1	1	Repealed harvest quota
1987 - 2005	none			season closed
		Below Fort Randall Dam		
Prior to 1957	none			Illegal harvest occurred
1957 - 1958	Jan - Dec	2	4	Legislature legalized snagging
1958 - 1959	Nov. 15 - Feb	2	4	
1959 - 1965	Nov. 15 - Jan	2	4	
1966 - 1967	Jan - Dec	4	4	
1968 - 1969	Jan - Dec	2	4	
1970 - 1971	Jan - Dec	1	1	
1972 - 1973	Jan - Dec	1	1	
1974 - 1982	Jan - Dec	1	1	
1983 - 1986	Jan - Dec	1	1	
1987 - 2005	none			season closed
		Below Gavins Point Dam		
Archery				
1957- 1969	Jan - Dec	2	4	
1970 - 1986	Jan - Dec	2	2	
1987 - 1988	Jun 1 - Jul 30	2	2	
1989 - 1991	Jul 1 - Jul 31	1	1	
1992 - 1996	9 days beginning 2nd Sat. in Jul.	1	1	

Years	Season length	Daily limit	Possession limit	Special Conditions
1997	9 days beginning 2nd Sat. in Jul.	1	1	Limited entry fishery with 200 tags/permits issued by lottery
1998 - 1999	16 days beginning 2nd Sat. in Jul.	1	1	Limited entry fishery with 200 tags/permits issued by lottery
2000 - 2004	16 days beginning 2nd Sat. in Jul.	1	1	Limited entry fishery with 275 tags/permits issued by lottery
2005	30 days beginning 2nd Sat. in Jul.	1	equal to number of tags held	Limited entry fishery with 275 tags/permits issued by lottery
Snagging				
1957 - 1969	Jan - Dec	2	4	
1970 - 1973	Jan - Dec	1	1	
1974 - 1982	Oct - Apr	2	2	
1983 - 1986	Nov - Mar	2	2	
1987 - 1988	Nov	2	2	
1989 - 1991	Oct 15 - Nov 15 max.	1	1	30 day season or until a harvest quota of 1,600 fish is reached
1992	30 days beginning 2nd Sat. in Oct.	1	1	30 day season or until a harvest quota of 1,600 fish is reached
1993 - 1996	30 days beginning 2nd Sat. in Oct.	1	1	Protected slot limit of 35" - 45" EF added, harvest quota in effect
1997 - 1999	Oct. 1 - Oct. 30	1	1	Limited entry fishery with 1,050 tags/permits issued by lottery
2000 - 2005	Oct. 1 - Oct. 30	1	1	Limited entry fishery with 1,400 tags/permits issued by lottery