A Management Plan for Paddlefish In Missouri

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EXECUTIVE SUMMARY

This plan summarizes the current status of paddlefish management in Missouri and recommends objectives for managing paddlefish populations in reservoirs and rivers for the l0-year period, 1992-2001. Efforts during that period will focus on maintaining fisheries in Lake of the Ozarks, Harry S Truman Lake and Table Rock Lake at current levels and learning more about populations in rivers.

Paddlefish are common in the Mississippi, Missouri, and Osage rivers in Missouri, but major sport fisheries only occur in Lake of the Ozarks, Harry S Truman Lake and Table Rock Lake. These fisheries are maintained by annual fingerling stockings because of the lack of natural reproduction. Fisheries in Harry S Truman and Table Rock lakes were developed by stocking hatchery-produced fingerlings. The Mississippi and Missouri rivers and the Osage River below Bagnell Dam support fisheries but fish are generally small. Paddlefish can be taken commercially from the Mississippi and lower St. Francis rivers but they are not an important commercial product.

Spawning habitat has been seriously degraded in most areas in Missouri. We believe that the best management technique for maintaining existing sport fisheries in reservoirs is to stock hatchery-produced fingerlings. Sport harvest in reservoirs should be monitored to ensure that current regulations are effective in preventing overharvest and for determining replacement stocking rates. Level of sport harvest in the Missouri and Mississippi rivers and Osage River below Bagnell Dam should be determined and commercial harvests in the Mississippi River should be monitored to aid in paddlefish management. Regulations for reservoirs and rivers should be reviewed periodically to ensure that paddlefish populations are managed properly. Informational programs should be developed to increase public awareness of paddlefish.

This long-range plan will be directed by the following goal statement and objectives:

Goal Statement: Manage paddlefish statewide as trophy sport fisheries

- Objective I. Maintain existing fisheries
- Objective II. Prohibit illegal harvests
- Objective III. Manage riverine populations
- Objective IV. Public awareness

FOREWORD

This plan for managing the paddlefish resource in Missouri was the result of a team effort utilizing the wide array of expertise available within Fisheries Division. Though many people provided input and guidance, the team specifically charged with development of the plan was composed of the following Fisheries Division staff:

Kim Graham	Chairman
Joe Dillard	Committee Member
Ron Dent	Committee Member
Jerry Hamilton	Committee Member
Gordon Farabee	Committee Member

This plan incorporates the major modifications in our paddlefish management program since the late 1970s and outlines long-range (1992-2001) management direction for paddlefish in Missouri. It will be revised annually and implementation will be directed by annual operational plans that consider current priorities and availability of funds and manpower. This plan will be updated or modified as needed in five years (1997).

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INTRODUCTION

Paddlefish (Polyodon spathula) were once abundant throughout the Mississippi River Basin, adjacent Gulf drainages, and some even resided in the Great Lakes (Carlson and Bonislawsky 1981). Since the turn of the century, significant declines in major paddlefish stocks have occurred in the Mississippi, Missouri, Ohio and Red rivers (Gengerke 1986), the relic population has been lost from the Great Lakes and paddlefish are now found in only a portion of their former range (Fig.1).

Habitat destruction and river alteration were the most obvious changes affecting the abundance of paddlefish. Construction of dams on mainstem streams has had severe impacts. Dams eliminated traditional spawning sites, interrupted natural spawning migrations, altered water flow regimes, dewatered streams and eliminated backwaters that were important as nursery and feeding areas. To a lesser degree, industrial pollution, poaching (eggs to be used as caviar), and over-exploitation by commercial and sport fishermen have adversely affected paddlefish populations.

In Missouri, substantial populations occur in the Mississippi, Missouri, and Osage rivers but the only sport fisheries of significance are in Lake of the Ozarks, Table Rock Lake, and Harry S Truman Lake. Unfortunately, because of lack of natural reproduction, these fisheries must be maintained by stocking hatchery-produced fingerlings (10-12 inches total length).

This plan summarizes current knowledge about paddlefish and their management and recommends objectives for management during the 10-year period, 1992-2001. Estimated costs and personnel commitments are described to aid budget decisions, assist fishery managers in integrating paddlefish needs into lake management plans and river basin plans, and assist hatchery personnel in annual production planning. Graham (1988) provided a detailed historical account of Missouri's major paddlefish sport fisheries and discussed several management options for maintaining fisheries.

STATUS OF PADDLEFISH POPULATIONS AND FISHERIES

Statewide. 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 blocked spawning migrations out of Lake of the Ozark since 1977, threatening that excellent fishery. Traditionally, paddlefish migrated out of Lake of the Ozarks during the spring to spawn over clean gravel in flowing water of the Osage River during 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, 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. A paddlefish population and fishery was established in Table Rock Lake by stocking hatchery-produced fingerlings (Graham 1986).

Our knowledge about paddlefish in other rivers of Missouri is limited. Paddlefish populations in the Missouri and Mississippi rivers are believed to be small and the population in the Mississippi River supports a limited commercial fishery. Paddlefish frequent several of the larger tributaries to the Missouri and Mississippi rivers but there are no important fisheries. Natural spawning areas and food might be important limiting factors in keeping most river populations regulated at relatively low levels.

Lake of the Ozarks. After the construction of Harry S Truman Dam and the resultant loss of spawning areas, it was necessary to stock fingerling paddlefish. Since 1982, about 16,000 fingerlings were stocked annually (except 1985 when no fish were stocked) (fable 1). The estimated harvest during the period 1978-1986 was about 3,000 fish per year, then decreased slightly to about 2,000 fish anually since 1986 (Graham 1988). This reduction may have been caused in part by the illegal harvest of adult paddlefish for caviar. Since 1986, 20 to 25 percent of the paddlefish harvested weighed 50 pounds or more. A major paddlefish egg poaching operation was broken up in the late
1980s and individuals arrested admitted killing many mature paddlefish for their roe. Although exact figures will never be known, we suspect that hundreds of mature paddlefish were killed each year for several years. These were mature paddlefish on spawning runs out of Lake of the Ozarks that would ordinarily be susceptible to sport fishermen.

Paddlefish harvests were regulated by a 6O-day spring season (March 15 -May 15) and a 92-day fall season (October 1 -December 31) with 2 fish daily and in possession. When Harry S Truman Lake was impounded in the late 1970s and natural reproduction no longer occurred, paddlefish management required annual stockings of fingerlings and more restrictive regulations. Regulation changes to protect the adult paddlefish population in Lake of the Ozarks began in 1978, and by 1990 eleven different regulations were implemented to aid in paddlefish management (fable 2). Current statewide paddlefish regulations involve a March 15 -April 30 season, 2 fish daily and in possession, and a 24- inch (body length) length limit. Illegal poaching of paddlefish for their eggs resulted in regulations (1990) prohibiting the sale and transportation of eggs and the use of eggs as bait. More detailed information regarding paddlefish regulations can be found in Graham (1988).

Table Rock Lake. The paddlefish population in Table Rock Lake was established by stocking about 83,000 fingerlings (2/acre) over a 6-year period (1972-1977) (fable 1).

Fishermen began harvesting paddlefish at Table Rock Lake in the early 1980s when the males started reaching sexual maturity and moved into the upper reaches of the James River Arm. The first year of significant harvest was 1983. The numbers harvested were not measured, but Conservation Agents estimated that about 2,000 paddlefish were harvested during the March 15 -May 15 season. Harvest was measured from 1984 to 1990, and the population supports a modest fishery (fable 3). During the period, 1984-1990, 20 to 56 percent of the harvested paddlefish weighed 50 pounds or more.

Missouri's first arrest for illegal harvest of paddlefish for caviar was made at Table Rock Lake in 1986. Apparently, significant numbers of paddlefish were harvested illegally during the late 1980s, and, as in Lake of the Ozarks, exact figures will never be known.

Table 1. Number of paddlefish fry and fingerlings (10-12 inches total length) stocked into Lake of the Ozarks, Harry S. Truman Lake, and Table Rock Lake, 1972-1990.

Year	Lake of the Ozarks	Harry S Truman Lake	Table Rock Lake
1972			400,000 fry*
1972			11,779
1973			25,326
1974			37,718
1975			5,171
1976			264,594 fry*
1976			1,872
1977			2,293
1978		4,367,795 fry*	
1978		180,000	
1979		623,700 fry*	
1979		147,740	
1980		42,816	
1982	15,381	17,811	
1983	9,717	11,438	
1984	26.854	21,876	22,985
1986	4,935	5,103	
1987	11,434	11,154	15,506
1988	25,994	26,700	21,750
1989	17,452	16,403	12,106
1990	10,129	29,576	9,998

* Fry stockings were made because they were excess to fingerling production needs.

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

Year	Regulations	Location
Pre-1978	March 15 – May 15 and October 1 – December 31 snagging season, with 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 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 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	Missouri River

Table 3. Estimated number and average size of paddlefish harvested from Table Rock Lake, 1984-1990.

	1984	1985	1986	1987	1988	1989	1990
Number Harvested	968	1504	843	476	594	497	345
Average size (lbs.)	41	47	47	49	50	50	51

Paddlefish were not stocked from 1978 through 1983 so we could determine whether paddlefish would reproduce naturally. In 1983, some paddlefish spawned in the James River but rapidly receding water levels prevented the eggs from hatching. We did not document survival of naturally spawned paddlefish in 1983, and have not found eggs since that date, although paddlefish occasionally move upstream in the James River during spring floods. Stockings were resumed in 1984. Fish stocked since 1984 are not yet mature and have not entered the harvest. They should enter the harvest in 1992 or 1993. Although the harvest was not measured in 1991, an estimated 200 paddlefish were harvested (personal communication, 1991, Bill Anderson, Fisheries Management Biologist, Missouri Department of Conservation, Springfield, Missouri). He believed that the Department of Health, Level ill chlordane advisory (no consumption) was responsible for the reduced harvest. Because of chlordane contamination, no paddlefish will be stocked in Table Rock Lake until 1996. The problem will be reevaluated at that time.

Harry S Truman Lake. A paddlefish population has been established in Harry S Truman Lake by annual stockings of hatchery-produced fingerlings (fable 1). The population developed rapidly and fishing was permitted in 1990 under statewide regulations of 2 fish per day, 2 fish in possession, a 45-day season (March 15 -April 30), and a 24-inch length limit (fable 2). Because of high water during the 1990 snagging season, harvest was restricted to the Osage and Marais des Cygnes rivers. For the year, an estimated 5,400 anglers caught 2,400 paddlefish, averaging 36 pounds. Twenty-five percent of the paddlefish harvested in 1990 weighed 50 pounds or more. Potential spawning sites in tributary streams are limited and this population and fishery will have to be maintained by stocking hatchery-produced fingerlings.

Missouri, Mississippi, St. Francis, and Osage Rivers. Paddlefish are in the Missouri and Mississippi rivers, however there are no significant sport fisheries. Some paddlefish are snagged in the Missouri River in spring near the mouths of the Lamine and Moreau rivers. Few paddlefish are caught and most are small, weighing 5-20 pounds. Sport fisheries on the Mississippi River are limited to primarily two areas; below Lock and Dam 24 and 25, near Clarksville and Winfield, Missouri, respectively. These fisheries are also small. Paddlefish are generally larger in the Mississippi River but most of those harvested weigh less than 35-40 pounds.

Paddlefish may be harvested commercially from the Mississippi and lower St. Francis rivers. Commercial harvest of paddlefish was prohibited on the Missouri River beginning in 1990. Prior to the regulation change, the reported commercial harvest of paddlefish on the Missouri River was 10,000-15,000 pounds annually (personal communication, 1991, John Robinson, Fisheries Research Biologist, Missouri Department of Conservation, Columbia, Missouri). The Mississippi River commercial harvest was higher but averaged only about 30,000-40,000 pounds annually. Many paddlefish taken commercially in recent years were utilized for caviar production. Commercial harvest of paddlefish from the lower St. Francis River is extremely low. The harvest since 1975

ranged from 10 to 100 pounds annually.

Our knowledge regarding paddlefish populations in Missouri's big rivers is limited. We know very .little about population dynamics, size and age structure, growth, and reproduction. Surprisingly, no spawning sites have been identified except in the Osage River, Missouri (Purkett 1961, Russell et al. 1980).

The harvest of paddlefish in most other streams is small and success largely depends upon upstream movement of fish during rising water. The Tailwater fishery in the Osage River below Bagnell Dam (impounds Lake of the Ozarks) is a good example of the relationship between flows and harvest. In spring seasons when large amounts of water were released, the harvest was high, and during years of low water the harvest was insignificant (Hanson 1976). Creel census records indicate that harvests during some years exceeded 7,000 paddlefish during the 6O-day spring snagging season but few fish exceeded 20 pounds (Hanson 1976). The 24-inch length limit implemented in 1990 will severely restrict harvest in this tailwater.

Small Rivers. 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, Moreau and Gasconade rivers that empty into the Missouri River; the Cuivre, Salt, South, North, Fabius, Wyaconda, Fox, and Meramec rivers that drain to the Mississippi; and the Current River that flows into the Black River. There is a small sport fishery on the lower Meramec River but few paddlefish are caught and they are usually small. There are no other known sport fisheries but an occasional paddlefish may be caught in other streams by anglers fishing for other species.

THREATS TO PADDLEFISH IN MISSOURI

Paddlefish are big-river inhabitants, and require precise flows, temperatures and substrate for growth and reproduction. Water resource projects such as dredging, flow modification, and dam and reservoir construction have altered most of the original paddlefish habitat in the United States (Sparrowe 1986). In Missouri, these same threats, as well as biological problems such as habitat destruction, illegal fishing for caviar production and pesticides has caused serious problems for paddlefish.

Habitat Destruction. Habitat destruction and alteration are the most obvious changes affecting the abundance of paddlefish. The construction of dams on mainstem streams (example-Harry S Truman Dam on the Osage River) has had the most impact. Dams eliminated ancestral spawning areas, interrupted natural spawning migrations, altered water flow regimes, dewatered streams, and eliminated backwaters that were important as nursery and feeding areas. Unfortunately the effects of most of these habitat alterations are irreversible.

Illegal Fishing. The increasing demand for paddlefish eggs for caviar has resulted in increased exploitation of many paddlefish populations. Caviar made from paddlefish eggs is an excellent substitute for sturgeon caviar and the retail price is routinely about $300 per pound. Large female paddlefish have 8 pounds or more of eggs that, after processing, may bring $30 to $90 per pound, resulting in a potential value of $250 to $700 per fish. Since the mid-1980s, paddlefish were taken illegally in increased numbers in large-mesh gill nets from Lake of the Ozarks, Table Rock Lake and Harry S Truman Lake. In most cases, large numbers of male paddlefish were also killed because the poachers cannot tell whether a fish has eggs until they cut it open. Because a 6O-pound female usually contains about 8 pounds of caviar-grade eggs after they have been separated from the ovarian tissue, it would be possible, under ideal conditions, for a poacher to catch enough paddlefish in one night's work to gross $5,000-$15,000.

Although several arrests have been made since 1986 for the illegal capture of paddlefish and the resultant sale of their eggs, this will likely continue to be a serious problem because of the large amount of money involved. Continued enforcement will be required because of these poaching problems. Illegal paddlefish harvest could easily exceed annual legal sport harvest.

Pesticide Levels. Another problem currently facing paddlefish management in Missouri is the high level of chlordane in the flesh of fish from certain waters. On April 30, 1990, the Missouri Department of Health issued a Level m (recommend no consumption) advisory on paddlefish and paddlefish eggs from Lake of the Ozarks and Table Rock Lake. More than one-half of the paddlefish tissue samples collected from these two lakes had chlordane levels that exceeded the Food and Drug Administration's action level of 300 parts per billion (Ppb). Chlordane is a suspected carcinogen known to cause chronic liver damage and may cause immune and nervous system damage. While there is no immediate health risk from eating chlordane-contaminated fish, there may be long-term risks. The sale and use of chlordane was banned in 1988. Its presence in the environment will gradually diminish but health officials warn that the effects of this chemical may persist for years.

Although the paddlefish harvest from Table Rock Lake was not measured in 1991, we believe the reduced catch (an estimated 200 paddlefish) resulted from the Level m chlordane advisory.

MANAGEMENT EMPHASIS

Paddlefish management for the next 10 years will focus on maintaining fisheries in Lake of the Ozarks, Harry S Truman Lake and Table Rock Lake at current levels and learning more about paddlefish populations in rivers. Maintaining the "status quo" will provide adequate opportunities for anglers and will not increase demands upon our hatchery system. Paddlefish will not be managed in ponds or small lakes because these

impoundments will not support the numbers of fish needed to provide fisheries.

Although additional reservoir fisheries are not planned at this time and the Mark Twain Lake Management Plan does not include paddlefish, future revisions of this plan should consider creation of a fishery in Mark Twain Lake. This would provide the only sport fishery in the northern portion of the state. The lake is large enough to provide a substantial annual harvest (2,000-3,000 fish per year), and paddlefish would likely concentrate near tributary streams and be accessible to fishermen during the spring snagging season. Most tributary streams entering Mark Twain Lake have adequate gravel areas, but the streams are small and it is doubtful that natural reproduction will occur. The population would probably have to be maintained with hatchery-produced fish.

GOAL STATEMENT

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The goal of the paddlefish management program in Missouri is to manage paddlefish statewide as trophy sport fisheries. A trophy sport fishery is defined as one where the average weight of harvested paddlefish is 30 pounds or more and at least 20% of harvested paddlefish weigh 50 pounds or more. Achievement of this goal will require coordinated effort of all sections (Administration, Research, Management and Hatcheries) of Fisheries Division to protect important habitats, to maintain populations and fisheries and to increase public awareness and appreciation for paddlefish, and of Protection Division to enforce regulations for this valuable fisheries resource.

OBJECTIVE I. **During the period 1992-2001, manage paddlefish populations in Lake of the Ozarks, Harry S Truman Lake, and Table Rock Lake to provide average annual harvests of 3,000 fish and average weights not less than 30 pounds.**

Strategy A. Monitor the harvest of the three reservoir fisheries every three years.

Task 1. Develop a standardized creel survey methodology for determining annual harvests for all fisheries by 1992.

Task 2. Determine year-class composition of the paddlefish harvest by collecting and aging dentary bones every three years in conjunction with creel survey.

Strategy B. Determine whether adjustments are needed in annual replacement stocking rates for the three reservoir fisheries.

Task 1. Calculate annual stocking rates based upon harvest and population structure.

Task 2. Develop a marking and tagging program to monitor survival and growth of year classes.

Strategy C. Produce 10- to 12-inch paddlefish for supplemental stockings in the three reservoirs.

Task 1. Request numbers of paddlefish desired annually for the three reservoirs.

Task 2. Collect wild broodstock annually and collect sufficient numbers of eggs to produce requested fingerlings.

Task 3. Refine culture and rearing techniques to reduce costs to $.50 or less per stocked paddlefish.

Strategy D. Review and/or modify existing paddlefish regulations as needed to ensure desired population structure and harvest.

Task 1. Evaluate harvest and exploitation rates in relation to management objectives for each reservoir.

Strategy E. Monitor chlordane levels and other appropriate contaminants annually in each reservoir.

Perspective on Maintenance of Existing Fisheries. When paddlefish spawning sites are inundated by reservoirs, paddlefish populations and fisheries decline rapidly. Only recently have fishery managers and culturists had the knowledge and technology to produce large numbers of paddlefish fingerlings to supplement existing populations or develop new ones. In Missouri, we have done both.

Since the impoundment of Harry S Truman Lake, we have maintained an excellent fishery in Lake of the Ozarks and sustained it with supplemental stockings of fingerlings to offset the lack of natural reproduction. At both Table Rock and Harry S Truman lakes, paddlefish populations and fisheries,were developed by stocking fingerlings. Strict regulation of the harvest has been required to achieve management objectives and protect the populations from overexploitation.

Paddlefish populations and fisheries at Lake of the Ozarks, Harry S Truman Lake and Table Rock Lake are currently maintained by annual stockings of 10,000 fingerlings into each lake. These fish should be 10-12 inches total length to minimize predation. Population structure should be monitored and creel survey information should be used

to determine whether stocking rates and harvest regulations require adjustment.

Based on current production, 30,000 fingerlings can be reared in 4.5 acres of water. Experiments currently underway that combine artificial diets and heavily fertilized ponds may reduce the acreage needed. Regardless, a continual commitment of hatchery facilities is needed to rear paddlefish and maintain fisheries. Our hatchery personnel have demonstrated over the past 15 years that they can produce the numbers and sizes of paddlefish needed to maintain existing populations. Production costs for 30,000 fingerling paddlefish are about $19,000 annually (Table 4).

Table 4. Personnel time and itemized production costs for rearing 30,000 fingerling paddlefish in 1990.

Section/Person	Item	Effort	Costs
Management/Hatcheries	Collect broodstock 2 people	5 days	$980.00
Hatcheries	Hatch, rear and stock fish 3 people, 10 days; 2 people, 68 days	166 days	$10,570.00
Pathologist	Disease identification and treatment 1 person, 3 days	3 days	$380.00
Administration	Overhead $21/hr., 5 days	5 days	$840.00
Hatcheries	Operations, equipment and supplies		$6,340.00
		TOTAL	$19,110.00

Perspective on Developing New Populations. Paddlefish populations capable of supporting a fishery can be developed by stocking hatchery-produced fingerlings. The Table Rock Lake population was developed by stocking about 83,000 fingerlings, about 2 fish per acre, over a 6-year period (fable 1). Paddlefish populations can likely be established by stocking fingerlings where habitat is suitable. If additional reservoir paddlefish populations are desired, the highest priority should be given to reservoirs with tributaries capable of providing conditions for natural reproduction. This would eliminate the expense of maintenance stocking. Considerations should be given to streams with large expanses of clean gravel and high spring flows necessary for reproduction (Russell 1986). Large streams sustain rises longer and are most likely to provide conditions necessary for spawning, hatching, and dispersal of fry. If natural reproduction does not occur, hatchery-produced fingerlings would be required to maintain the fishery. This commitment would have to be balanced against other management needs for fish from hatcheries. Special considerations should be given to determining the potential risk of high pesticide levels before establishing paddlefish

populations in new waters. The cheapest way to establish paddlefish would be to stock fry, however, little is known about the success of stocking them. Our attempts at stocking fry in Table Rock Lake in 1972 and 1976 (table 1) were apparently unsuccessful. Fry should only be stocked in new lakes lacking significant numbers of predators. In waters with abundant predators, fingerlings 10 to 12 inches in total length should be stocked to ensure adequate survival. Production costs vary, but 10- to 12-inch paddlefish can generally be reared for about 60 cents each.

Current stocking rates are based on the assumption that 10- to 12-inch fingerlings have excellent survival during the first year after stocking. Mortality after the first year is believed to be low. Based on the size and age composition of paddlefish in Table Rock Lake where we stocked the entire population, survival of fingerlings is high. We used several techniques to mark small paddlefish for survival estimates but none were acceptable. Young paddlefish were extremely sensitive to handling and most marking techniques tested (latex injections, tattoos, freeze branding, various sizes and shapes of rostrum punches, and fin clips) were either temporary or caused excessive mortality. Additional methods of marking paddlefish should be evaluated to enhance identification of year classes and to evaluate survival. Terramycin and binary-coded wire tags have been used successfully to mark other species and may prove useful for long-term marking of paddlefish.

An important consideration when developing new paddlefish populations is to determine where the fisheries will likely occur. Fisheries will usually develop in the headwaters of reservoirs, in deep pools of tributary streams or near the confluence of other tributary streams. Fisheries will usually develop when the fish begin to reach sexual maturity, usually within 8-10 years.

Most reservoirs in Missouri will support paddlefish populations. Mark Twain Lake (18,600 acres) and Stockton Lake (24,900 acres) are capable of supporting paddlefish populations and fisheries. Both lakes are fed by tributary streams that contain gravel, and although both have major tributary streams that carry large volumes of water during floods, there is some question whether the streams are large enough to meet the spawning requirements of paddlefish. Regardless, paddlefish would concentrate near the confluence of these streams each spring and sport fisheries could be developed. Mark Twain Lake may be more desirable than Stockton Lake for paddlefish because it would provide a paddlefish fishery in northern reservoirs; however, pesticide levels should be determined as safe before stocking.

OBJECTIVE II. Eliminate illegal harvest or paddlefish by sporting and commercial methods by 1993.

Strategy A. Ensure sportfishermen compliance with paddlefish regulations.

Task 1. Conduct annual meetings with Protection Division to discuss enforcement efforts for each reservoir.

Task 2. Work closely with Public Affairs and Protection divisions to prepare news releases prior to sport season to inform the public about paddlefish regulations and their importance.

Strategy B. Prevent illegal commercialization of paddlefish.

Task 1. Assist Protection Division in selecting sites for group patrols from October to March on three major paddlefish reservoirs to deter poaching.

OBJECTIVE III. Manage paddlefish populations in the Missouri and Mississippi rivers and their major tributaries to achieve optimum harvest levels by 2001.

Strategy A. Assess the status of paddlefish in the Missouri and Mississippi rivers and their major tributaries by 1996.

Task 1. Develop standardized sampling methods and sample periods by 1994.

Task 2. Develop marking and tagging programs by 1994 and determine movement and exploitation rates where fisheries occur by 1998.

Task 3. Locate major spawning areas in Missouri's rivers by 2001.

Strategy B. Determine whether present sport fishing and/or commercial fishing regulations are effective for managing riverine paddlefish populations for the period 1992-2001.

Task 1. Monitor commercial harvest of paddlefish annually in Mississippi and lower St. Francis rivers and determine sport fishing harvest for Missouri and Mississippi rivers and Osage River below Bagnell Dam.

Task 2. Determine size and age structure of commercially harvested paddlefish by 1995 and subsequently at 5-year intervals.

Task 3. Establish cooperative studies and agreements with states sharing commercially harvested waters to monitor harvests and work toward standardized regulations with border states by 1995.

Task 4. Use standardized creel surveys to monitor sport harvest at selected sites on Missouri and Mississippi rivers and Osage river below Bagnell Dam by 1995 and subsequently at 3-year intervals.

Task 5. Determine size and age structure of paddlefish harvested by sport methods in Missouri and Mississippi rivers and Osage River below Bagnell Dam by 1995 and subsequently at 3-year intervals.

Strategy C. Determine contaminant levels in riverine paddlefish populations every 5 years.

Perspective on Riverine Population Assessment. Our knowledge of paddlefish populations in Missouri's streams and rivers is limited. Substantial populations occur only in the Mississippi, Missouri, and Osage rivers and the only sport fishery of significance is in the Osage River immediately below Bagnell Dam. We know very little about movement of paddlefish in these rivers. Paddlefish occur in smaller tributary rivers (Gasconade, Meramec, Lamine, and Moreau rivers) and some support limited fisheries, but we suspect that most of the paddlefish caught in these rivers are immature and originate from the big rivers.

Tagging programs should be developed to learn more about the movement of paddlefish in these rivers. Paddlefish could be easily captured in the Osage River below Bagnell Dam or at concentration areas in selected small streams.

Paddlefish may spawn in the Missouri and Mississippi rivers but no spawning areas have been located in Missouri. Paddlefish fry have been collected in the Lamine River which suggests tributary streams may be important recruitment sites for the big rivers besides serving as feeding areas for small paddlefish (Brown 1989). It is suspected that paddlefish may spawn along rock wing dikes or in areas where flow is satisfactory for egg attachment and development.

Creel surveys should be used to measure the sport harvest at selected sites, and commercial harvest statistics should be utilized for monitoring the commercial harvest from the Mississippi and lower St. Francis rivers. Current regulations developed for reservoir fisheries should be evaluated for their application in managing river populations.

OBJECTIVE IV. Increase the levels or awareness and appreciation or paddlefish so that 20 percent or all Missouri citizens appreciate and have increased knowledge about them by 1997.

Strategy A. Develop informational programs for use at the Missouri State Fair, and Missouri Department of Conservation regional service centers and nature centers by 1995.

Task 1. Prepare video depicting paddlefish life history, importance as a trophy sport fish, methods of catching, and problems facing paddlefish populations by 1995.

Task 2. Prepare a pamphlet describing life history, statewide range, management, regulations, problem areas, methods for catching, how to properly clean and recipes for preparing for the table by 1995.

Task 3. Provide mounted specimens or replicas for key Missouri Department of Conservation installations by 1994.

Task 4. Prepare Conservationist articles annually and/or use other news media methods to promote paddlefish as a trophy sport fish and discuss key regulation changes or environmental problems associated with the species for the period 1992-2001.

Task 5. Recommend paddlefish as the official state fish.

Strategy B. Survey Missouri citizens in 1993 and 1997 to measure baseline levels of awareness and appreciation and to evaluate success.

Perspective on Public Awareness. Fisheries Division and the Missouri Department of Conservation have a great and continuing need to inform the general public about key sport fish such as paddlefish. Although public awareness and appreciation of paddlefish have not been measured, there is little doubt that current levels are far below 20 percent. Public awareness can be improved and public support for regulations can be increased through better dialog with the public. Current issues such as poaching paddlefish and chlordane contamination can be communicated more effectively with innovative methods of public awareness.

IMPLEMENTATION SCHEDULE							
Objective	Strategy	Task	Work Description	Section/Division	Annual Person-Days (PM & Temp. Labor)	Schedule	Annual Salary & Operating Costs
I.	A.	1.	Develop standardized creel survey	Management/Admin	5	1992	$700
		2.	Collect age/growth information and measure sport harvest (creel census)	Management	60*	1992-2001	$5,000
I.	B.	1.	Determine stocking rates	Management	2	1992-2001	$300
		2.	Develop reservoir tagging program for fingerlings	Management	1	1992	$500
	C.	1.	Request fingerlings annually	Management	1	1992-2001-	$300
		2,3.	Produce fingerlings/refine culture techniques	Hatcheries	180	1992-2001	$19,000
	D.	1.	Monitor harvest rates	Management	50	1992-2001	$7,500
	E.		Monitor pesticide levels	Admin/Management	6	1992-2001	$6,250
II.	A.	1,2.	Protect paddlefish populations	Protection	250-400	1992-2001	$32,500-$50,000
	B.	1.	Select sites for group patrol	Res/Protection	1	1992-2000	$300
III.	A.	1.	Develop sample methodology	Res/Management	5	1994-2001	$500
		2.	Develop river tagging program	Res/Management	2	1994-2001	$500
		3.	Locate spawning areas	Management	20	1995-2001	$4,575
	B.	1.	Collect commercial statistics	Research	10***	1995-2001	$1,100
		2.	Analyze commercial statistics	Research	10*****	1995-2001	$1,100
		3.	Establish cooperative studies	Res/Management	5	1995-2001	$1,200
		4.	Measure sport harvest (creel census)	Management	40*	1995-2001	$3,000

		5.	Determine age/size structure	Management	10*	1995-2001	$1,000
	C.		Monitor pesticide levels	Admin/Management	6**	1992-2001	$6,250
IV.	A.	1.	Develop video for education	Admin/Management	5	1992-1995	$2,000
		2.	Develop pamphlet for education	Admin/Management	15	1992-1995	$2,000
		3.	Mounted specimens	Management	5	1992-1994	$1,000
		4.	Promote paddlefish/news media	Admin/Management	5	1992-2001	$600
		5.	Recommend paddlefish as state fish	Admin/Management	2	1993	$300
	B.		Survey awareness/evaluate success	Administration	10	1993 & 1997	$1,500

* Performed every three years
** Performed every five years
*** Includes commercial harvest statistics for all species

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