Status of Sauger in Montana

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Abstract

Though abundant throughout the Yellowstone and Missouri River drainages in eastern Montana prior to the 1990s, recent survey data suggest that native sauger (*Stizostedion canadense*) have declined throughout the state. We compared historical and recent survey information to assess the extent of the decline, examine possible reasons for the decline, and suggest management options for protecting and bolstering remaining populations. Sauger declined state-wide in concert with the drought in the late 1980s in several locations including the Missouri River, Fort Peck Reservoir, and Yellowstone River. Despite improved flows since the mid-1990s, there was little rebound in sauger numbers in most locales. Of special concern are the substantial declines in spawning runs of sauger in several key spawning tributaries (Marias, Milk, and Tongue rivers). Estimated range of sauger in 1999 was 1570 km, a 53 percent decline from their historical range. Decline of this highly migratory species was more extensive in tributaries (75%) because of loss of migration routes caused by damming and dewatering. The roles of hybridization with walleye (*Stizostedion vitreum vitreum)*, interactions with abundant nonnative piscivores (walleye and smallmouth bass *Micropterus dolomieu*), and angler harvest in the sauger decline are uncertain. Better information is needed on movement patterns, spawning ecology, fish passage problems, and angler harvest to develop management actions for sauger recovery.

Key words: fishery management, Montana fishes, sauger, *Stizostedion canadense*, Missouri River, Yellowstone River.

Introduction

Sauger (*Stizostedion canadense*), a percid fish closely related to walleye (*S. vitreum vitreum*), is one of the most widely distributed of North American fishes, occupying large, turbid rivers and lakes throughout central and eastern North America from northern Canada to Alabama, and westward to the upper Missouri River drainage (Scott and Crossman 1973). The species was first described during the Lewis and Clark expedition in the early 1800s from the Missouri River near the mouth of the Marias River, Montana (Moring 1996). Historical distribution in Montana was the Missouri River and its major tributaries below Great Falls, and the Yellowstone River and its major tributaries below and including the Clarks Fork (Brown 1971, Holton and Johnson 1996). Both Missouri and Yellowstone river populations have supported popular sport fisheries.

The first intensive sampling efforts conducted in the Missouri River below Morony Dam and the Yellowstone River below the mouth of the Tongue River in the 1960s and 1970s found sauger abundant and widespread in eastern Montana. Posewitz (1963) captured large numbers of sauger spawning in the Marias River in the early 1960s, and Berg (1981) and Gardner and Berg (1982) found sauger common-to-abundant in the lower Marias, Judith, and Teton rivers and in the Missouri River between Great Falls and Fort Peck Reservoir. Large spawning congregations of sauger also were noted in the lower Tongue and Powder rivers in the Yellowstone drainage (Elser et al. 1977, Rehwinkle 1978).

Apparently widespread declines of sauger in both the Yellowstone and

Missouri drainages were reported in the early 1990s. Penkal (1992) described a decline in the spawning run in the lower Tongue River, and Stewart (1992) reported a >85 percent decline in age-0 and adult sauger in the lower Yellowstone River from the 1980s to the 1990s. Declines of similar magnitude also were observed in the Missouri (upstream from Ft. Peck Reservoir) and Marias rivers (Penkal 1990, Gardner 1998, Hill et al. 1998). Though severe drought in the late 1980s was thought to have triggered the sauger decline (Penkal 1990), an apparent lack of rebound in sauger abundance despite improved flow conditions in the mid-1990s raised concern over the status of sauger in the state (Gardner 1998, Stewart 1998). Population collapses have occurred in other parts of the native range of sauger including Nebraska (Hesse 1994), the Great Lakes (Rawson and Schell 1978), and the Tennessee River system (Pegg et al. 1996, 1997). High exploitation, water flow fluctuations, migration barriers, hybridization with walleye, and loss of spawning habitat were implicated in these declines (Hesse 1994, Pegg et al. 1997).

Concern over the status of sauger in Montana provided the impetus for this synthesis of historical and current information on its distribution and abundance. Our objectives were to summarize available information about this little-known species, compare past and present abundance and distribution data to assess the extent of a sauger decline, examine possible reasons for documented declines, and suggest management options for protecting and bolstering remaining populations of this native fish and the sport fisheries they support.

Methods

We assessed the status of sauger in five main areas corresponding to their historical range in Montana: the Missouri River and tributaries upstream of Fort Peck Reservoir, Fort Peck Reservoir, the Missouri River from Fort Peck Dam downstream to the North Dakota border, the Yellowstone River and a major tributary, the Bighorn River, and the Yellowstone River and tributaries from the North Dakota border to the mouth of the Bighorn River (Fig. 1).

We obtained data on sauger abundance and distribution from published and unpublished fishery survey reports and from

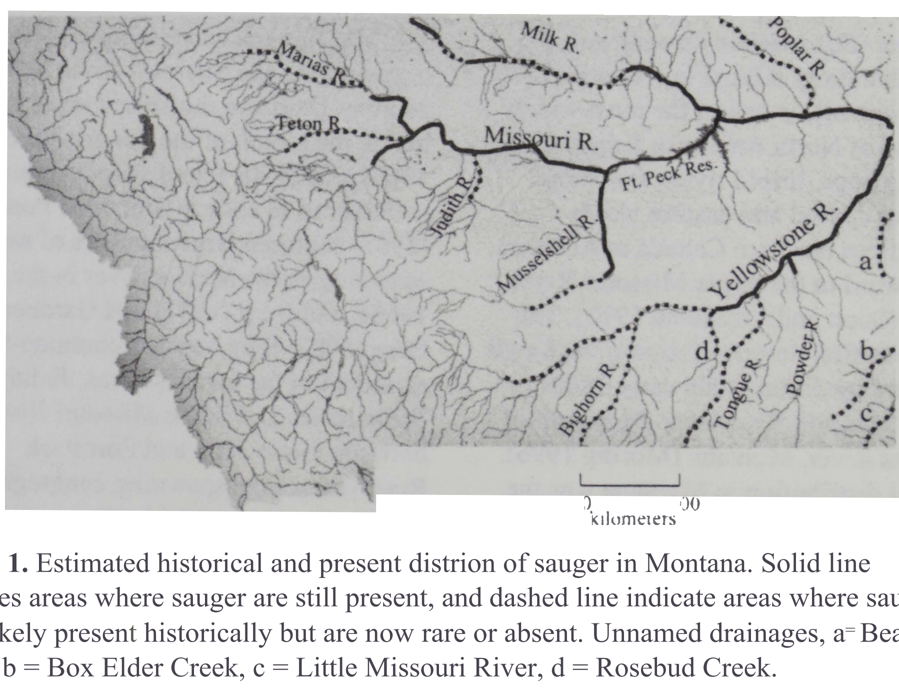

Figure 1. Estimated historical and present distrion of sauger in Montana. Solid line indicates areas where sauger are still present, and dashed line indicate areas where sauger were likely present historically but are now rare or absent. Unnamed drainages, a= Beaver Creek, b = Box Elder Creek, c = Little Missouri River, d = Rosebud Creek.

unpublished data provided by biologists contacted throughout the state. Abundance data were summarized as number caught/hr or km of electrofishing or number caught/net based on gill net or seine haul population surveys. If several areas were sampled in the same river section, data from all sections were averaged (McMahon 1999). Though such effort data do not provide actual abundance estimates, they can nevertheless provide insight into population trends when collected over time using standardized sampling schemes (Ney 1993). Much of the data on sauger abundance trends used here were collected over periods of at least 9 years using a consistent sampling protocol. We evaluated possible associations between sauger abundance and river discharge using simple linear correlation based on U.S. Geological Survey discharge records for the Missouri and Yellowstone rivers *(www.montana.usgs.gov)*.

We assessed overall status of sauger by comparing estimated historical with present distribution. Historical information was based on published range maps (Brown 1971, Holton and Johnson 1996), initial extensive surveys conducted in the 1970s (e.g., Berg 1981), and historical descriptions of habitat conditions relative to sauger habitat requirements. We excluded some streams from the analysis where sauger are now rare or absent but where historical information on their distribution was lacking (Poplar River and Beaver Creek in the Missouri drainage, Little Missouri River, Box Elder Creek, and Rosebud Creek in the Yellowstone drainage). Present-day range was based on the fish collection database by Montana Fish, Wildlife, and Parks (FWP) *(www.nris.state.mt.us)*, and on expert opinion from FWP biologists.

Past and Present Distribution in Montana

Missouri River Upstream of Fort Peck Reservoir

Mainstem.—Sauger abundance has been monitored since the 1970s for the river section between Morony Dam, near Great Falls, and the mouth of the Marias River (Fig. 1). In 1978-1980, sauger catch averaged 25.9 fish per hour of electrofishing (Fig. 2). In 1979, for example, 120 sauger were caught in 3 hours of sampling (Penkal 1990). Following a 7-

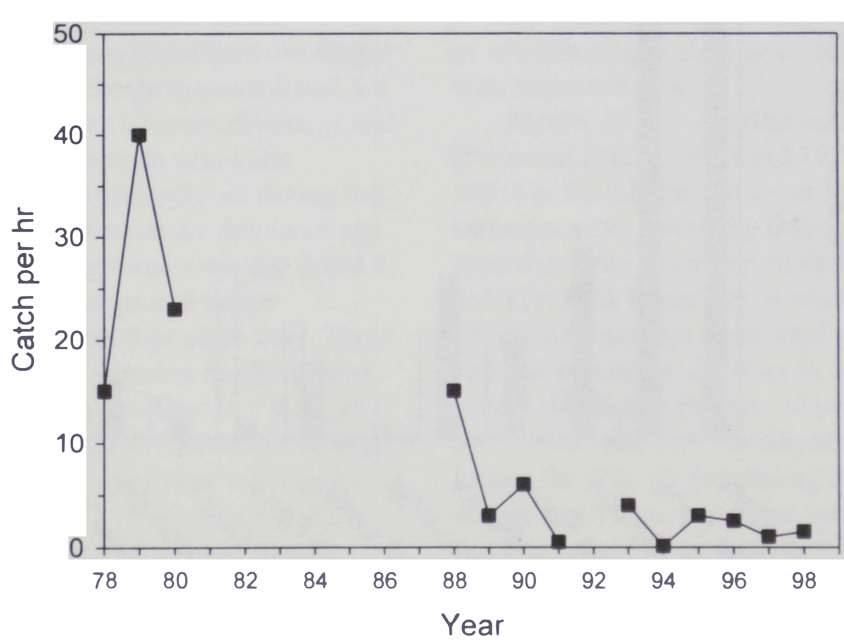

Figure 2. Electrofishing catch rate of sauger, Morony Dam to Marias River sampling section, Missouri River, 1978-1998.

yr gap in sampling, sauger catch rate was <6 fish/hr in 1989-1998. In the 1993-1998 period sauger catch averaged 2.2 fish/hr, a 90 percent decrease in average catch rate from the 1978-1981 period. In 1997 only nine sauger were caught in 8.2 hours of electrofishing (Hill et al. 1998). Abundance patterns of other sport fishes (rainbow trout *Oncorhynchus mykiss*, brown trout *Salmo trutta*, mountain whitefish *Prosopium williamsoni*, walleye, smallmouth bass *Micropterus dolomieu*) show high year-to-year variation (Hill et al. 1998), but none exhibit a comparable decline, and some (smallmouth bass, walleye) increased over this period. Sauger were the most abundant sport fish in the late 1980s (65% of total sport fish catch) but were one of the rarer sport fishes sampled (<9% of the catch) during the 1994-1997 sampling.

More extensive surveys of the mainstem Missouri between Morony Dam and the headwaters of Fort Peck Reservoir conducted in the 1970s found sauger one of the most abundant and widely distributed fish species (Berg 1981; Fig. 3). Of the 9835 fish captured by electrofishing, 2916 were sauger or 29.6 percent of the total catch. Catch rate in recent surveys (Fig. 3) has declined considerably in the upper river, averaging 70 percent fewer sauger than surveys during the 1970s (Gardner 1997, 1998, L. Bergstedt, Montana State University, personal communication). In contrast sauger abundance in the lower river was mostly higher than earlier surveys.

Previous studies have documented a positive correlation between discharge and sauger year-class strength (Nelson 1968, Fischbach 1998). Average daily discharge for the spring-summer period in the Missouri River at Virgelle from 1958 to 1998 indicated that discharge was below the 41-year average of 311 m^3/s in 7 of the last 14 years, particularly during the period of 1985-1994 when 7 of 10 years were below the long term average (Fig. 4). Discharge in 1988 and 1992 was the lowest over this 41-yr period. Summer flows in these years were below the 153 m^3/s minimum flow deemed necessary to prevent dewatering of Missouri River sidechannels, a key rearing

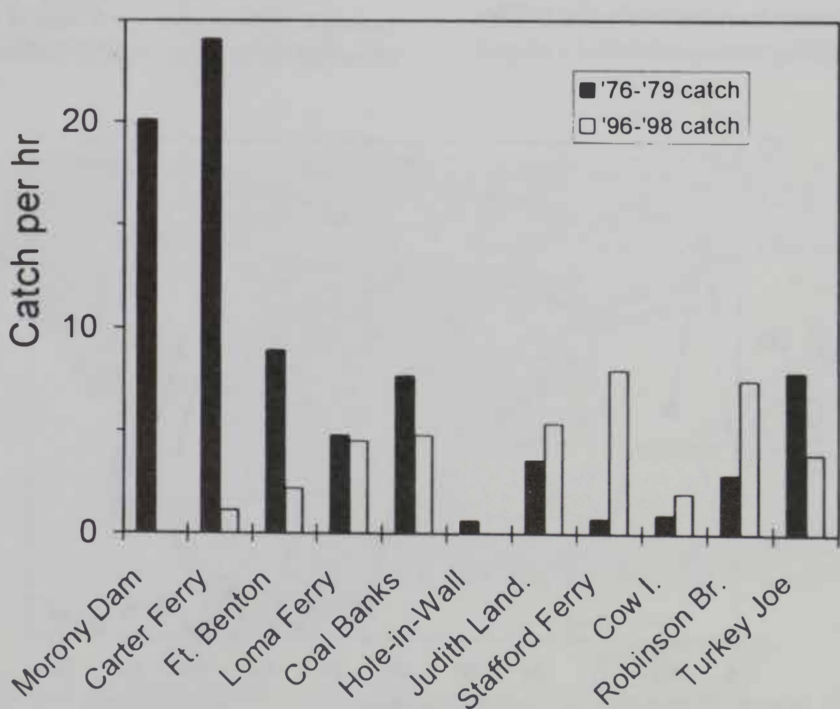

Figure 3. Comparison of mean electrofishing catch rates for sauger in sampling sections of the Missouri River from Morony Dam to the headwaters of Fort Peck Reservoir, 1976-1979, and 1996-1998.

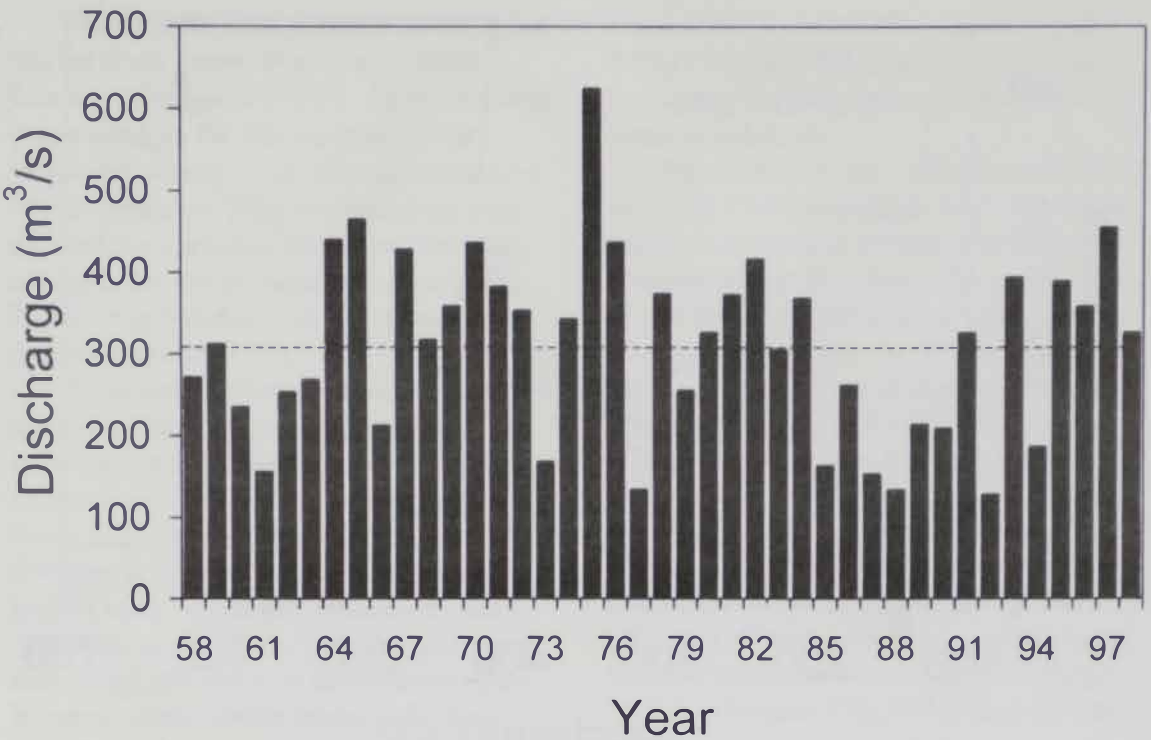

Figure 4. Mean spring-summer (1 May-30 September) discharge of the Missouri River at Virgelle, 1958-1998. Forty-one year average shown as dashed line.

habitat for age-0 sauger (Gardner and Berg 1982). The decline in sauger catch therefore coincided with the initiation of drought in the late 1980s (Penkal 1990); however, flows have been well above average since 1995 but sauger abundance has remained low.

To examine the relation between sauger abundance and discharge in more detail, we tested for a lag effect between discharge and sauger catch rate because year-class strength in fishes is typically set during the first year of life. Because the dominant age classes of sauger captured were age 3 and 4, we compared discharge and sauger recruitment three and four years later. There was no association between discharge and sauger catch three years later ($r = 0.27$, $P = 0.38$), but the correlation between discharge and sauger catch 4 years later was highly significant ($r = 0.87$, $P < 0.001$; Fig. 5), indicating that higher discharge should result in higher sauger abundance. However, sauger catch rates in recent years apparently have not responded to increased flows. Sauger catch rates in 1995 and 1997, corresponding to high flow years 1991 (mean daily discharge, 330 m^3/s) and 1993 (400 m^3/s), respectively, were 80 percent below the value predicted by the regression equation, suggesting additional factors were involved in continued low numbers. A series of flows >280 m^3/s since 1995 should provide a critical test in the next few years of whether sauger abundance will rebound with improved flows.

Marias River.—Studies in the 1960s (Posewitz 1962a, 1963) and 1970s (Berg 1981) indicated that the lower Marias River serves as a key spawning area for sauger from the entire mainstem Missouri River and Fort Peck Reservoir. However, intermittent surveys conducted since 1978 showed substantial declines in the spring sauger run during the past 20 years. In 1979-1982, catch rate averaged about 30 sauger /hr (Fig. 6). Paralleling the decline in sauger catch observed in the mainstem reach below Morony Dam, catch rate declined by about 50 percent to an average of 14.0 sauger/hr during the low water years of the late 1980s (Gardner 1998). In 1996-1999, sauger catch averaged about 3 fish/hr, a further 75 percent decline.

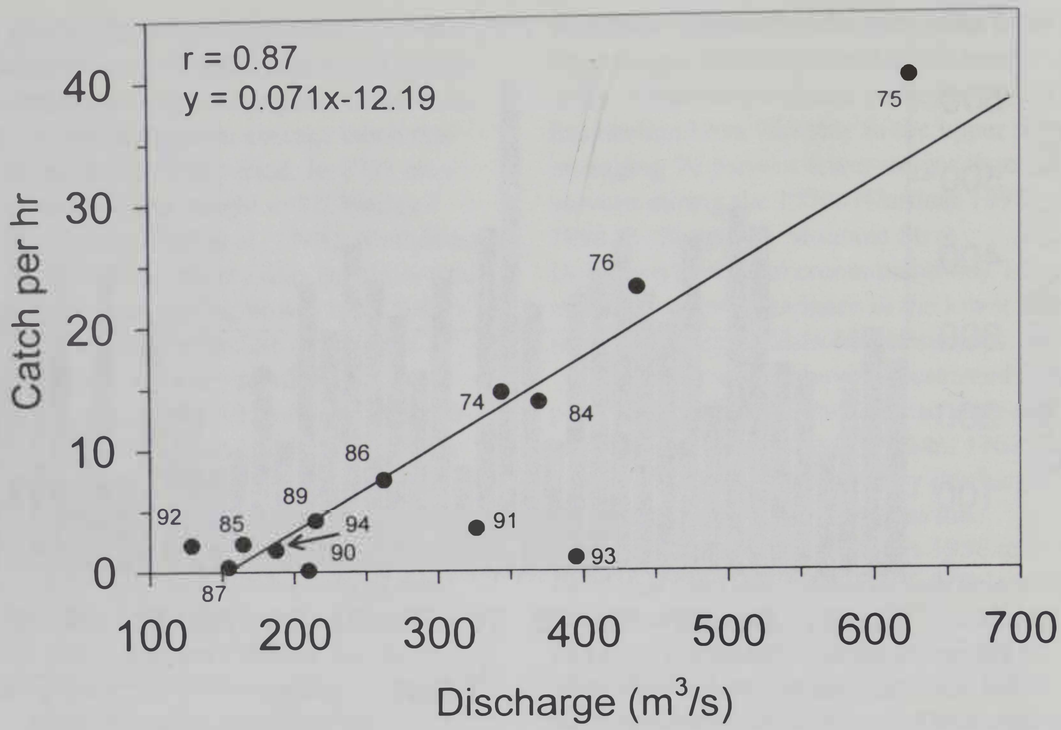

Figure 5. Relationship between mean spring-summer discharge of the Missouri River at Virgelle and sauger catch rate below Morony Dam four years later.

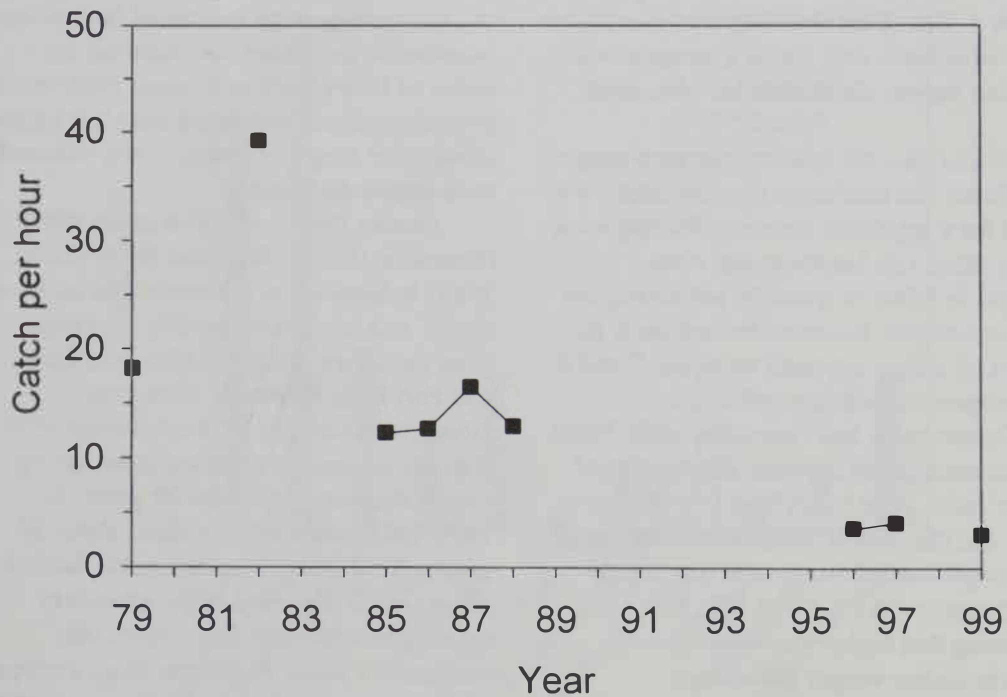

Figure 6. Electrofishing catch rate of sauger in the lower Marias River sampling section during the April-May spring spawning period, 1979-1999.

Sauger were once common in the upper Marias River above what is now Tiber Reservoir (Posewitz 1962b). Tiber Dam was constructed on the Marias River in the 1950s, and a large-scale chemical treatment of the upper river prior to closing the dam resulted in extirpation of sauger above the reservoir. No sauger were collected in this 100-km reach during early 1990s surveys (Liknes and Hill 1994).

Teton River.—Sauger were common in the lower Teton River during spring spawning surveys conducted in the late 1970s (Berg 1981) and in a survey of the lower 120 km conducted during fall 1979 (Gardner and Berg 1982). There has been limited sampling on the Teton River since 1979, but several lines of evidence suggest that sauger are now rare in the entire river. In recent years (1997), sauger have been absent from angler catches, and they were absent from the lower river section in 1997 unlike the 1979 survey which found them common (Gardner 1998). Irrigation demand severely dewaters most portions of the lower Teton River (Berg 1981, Gardner 1998).

Judith River.—Berg (1981) electroshocked a "significant number" of spawning sauger in the lower Judith River in May 1979. Sauger were common during a fish survey conducted by Gardner and Berg (1982) in fall 1979, but no surveys have been conducted since and current status is unknown.

Musselshell River.—Wiedenheft (1980) surveyed 11 4-km sections over 350 km of the river in summer 1979 and found sauger common below the town of Musselshell but absent above a local water diversion dam. No data are available on current status of the sauger population as high turbidity and low conductivity limit electrofishing effectiveness. Anglers target a sauger spawning run up the Musselshell River in the spring when they congregate below the Musselshell diversion dam, but where and how many sauger spawn in this system are unknown. Chronic dewatering of the lower Musselshell limits its suitability as sauger habitat (Montana Fish, Wildlife, and Parks 1997).

Fort Peck Reservoir

Sauger abundance in Fort Peck Reservoir has been monitored since 1980 via a nearly-annual series of extensive shoreline seine hauls and gill netting. Sauger age-0 abundance in beach seine surveys averaged 0.4 fish/seine haul from 1981 to 1986 but dropped sharply in the late 1980s coincident with low water levels (Brunsing 1998; Fig. 7). Water levels have

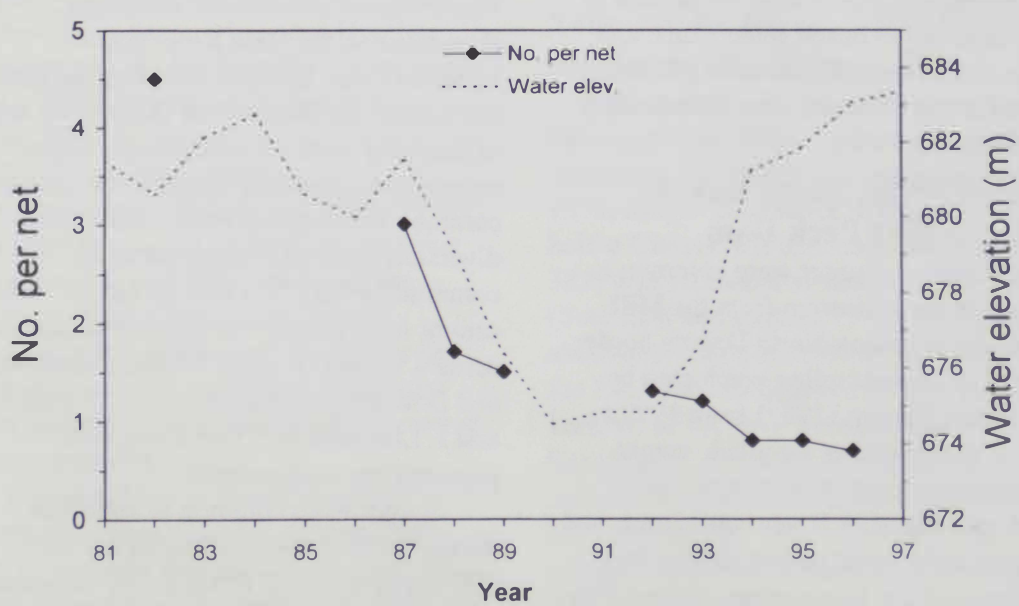

Figure 7. Number of sauger caught per gill net and water level elevation in Fort Peck Reservoir, 1981-1996.

risen steadily since the early 1990s, but abundance has remained low, averaging 0.1 fish/haul, a 75 percent average decrease from the 1980s.

Gillnet catches of sauger mirrored the decline in age-0 abundance (Fig. 7). Adult sauger abundance declined steadily from 3-4.4 fish/net in the 1980s (Needham and Gilge 1983, Wiedenheft 1989) to <1.0 fish/net since 1994. In contrast, northern pike (*Esox lucius*), walleye, and yellow perch (*Perca flavescens*) have shown marked increases in abundance over the past decade (Brunsing 1998). The number of sauger caught by anglers also decreased from 1990 to 1997. An estimated 3128 sauger were harvested in the summer 1990 creel survey, or 12 percent of the total catch. In 1997, 917 sauger were harvested, representing 2.6 percent of the total catch. The reservoir-wide angler catch rate of sauger declined by 75 percent, from 0.023 to 0.005 fish/hr. Average size of sauger harvested was similar in each year (50 cm and 1.2 kg), in contrast to other piscivores (walleye, northern pike) that have increased significantly in abundance and growth since the early 1990s following introduction of cisco (*Coregonus artedi*) (Brunsing 1998).

Sauger are most abundant in the more turbid and riverine-like Missouri Arm in the upper reservoir. Greater than 90 percent of sauger captured in beach seine hauls, and >78 percent of those captured in gill nets, occurred in the Missouri Arm (Wiedenheft 1990, Brunsing 1998).

Missouri River, North Dakota Border to Fort Peck Dam

Mainstem.—Sauger were common to abundant in the mainstem from the Milk River to the Montana-North Dakota border during extensive sampling conducted by Gardner and Stewart (1987) from 1979 to 1983. Of eight reaches sampled, sauger were most abundant in the warm, turbid section near the Milk River confluence, and rare in the cold, clear section below Fort Peck Dam. Of the five species of sport fish collected (shovelnose sturgeon *Scaphirhynchus platorynchus*, northern pike, burbot *Lota lota*, walleye, and sauger), sauger were the most abundant, comprising 69 percent or 3612 of the total 5206 sportfishes captured. Only limited sampling has been done since, but more recent surveys suggested that sauger numbers are about 50 percent lower than in the early 1980s. Electrofishing catch rates in the section from the Milk River confluence to Wolf Point were 1.5 sauger/hr in 1998 compared to an average of 5.2 /hr in 1979-1983 sampling (M. Ruggles and D. Fuller, FWP, Fort Peck, MT, personal communication). The section from Wolf Point to the Yellowstone River confluence yielded 2.4 sauger/hr in 1998, compared to 4.7/hr in 1979-1983.

Milk River.—The Milk River is a large tributary that extends from the Missouri River just below Fort Peck Dam northwestward into Canada. Its high turbidity, deep pools, and gravelly riffles characterize high quality habitat for sauger, and historically it likely supported an abundant resident population (Gardner and Stewart 1987). Seven major water diversions now occur on the Milk River beginning with the Vandalia Dam 187 km from the mouth, and all are considered migratory barriers to sauger (K. Gilge, FWP, Havre, MT, personal communication). There is little information on sauger abundance in the Milk River above Vandalia Dam. Limited sampling suggests that sauger are uncommon throughout much of this long river section, though angler reports indicated they may still be locally common between the Havre and Dodson diversion dams (K. Gilge, personal communication). In 1998, no sauger were caught from among the 652 fishes captured using a variety of gears between Vandalia and Dodson dams (M. Ruggles, D. Fuller, and J. Liebelt, FWP, Fort Peck, MT, personal communication).

Sauger were common to abundant during 1979-1984 sampling in the lower 100 km of the Milk River below Vandalia Dam (Gardner and Stewart 1987). Gill net catch averaged 2.4 sauger/net, and spring electrofishing yielded 10.2 sauger/hr. Overall, 918 sauger or 91 percent of the total catch of 1024 sport fish, were captured in 4 years of sampling. Large numbers of spawning sauger were found near the mouth; this reach is thought to support the majority of total spawning activity of sauger from the Missouri River between Fort Peck Dam and Lake Sakakawea in North Dakota (Gardner and Stewart 1987). Sampling has been limited since the 1980s, but gill netting and electrofishing surveys conducted in 1998 suggest sauger may be less abundant than in the past. Catch rates of sauger in 1998 averaged 0.3 sauger/gill net, and no sauger were caught during electrofishing surveys (M. Ruggles, D. Fuller, and J. Liebelt, personal communication).

Yellowstone River Upstream of the Bighorn River

Mainstem.—Historically, sauger were likely common in the Yellowstone River upstream to what is now Billings (Brown 1971) and have been collected as far upstream as the town of Big Timber (Swedberg 1984). They also may have occurred historically in the turbid Clarks Fork tributary (Holton and Johnson 1996). However, they are now uncommon above the Bighorn River confluence (Fig. 1). The Huntley diversion dam near Billings is a migratory barrier (Swedberg 1985), and electrofishing surveys between Huntley diversion and the Bighorn River confluence have yielded few sauger in recent years (Poore 1990, K. Frazer and M. Vaughn, FWP, Billings, MT, personal communication). Haddix and Estes (1976) noted that the mouth of the Bighorn River was a popular and productive area for sauger angling in the 1970s. Sauger numbers in the 1990s were thought to be much lower in this reach based on many fewer anglers (Frazer and Vaughn, personal communication).

Bighorn River.—Given its turbid, warmwater characteristics, sauger likely were historically abundant in the Bighorn River. Sauger were moderately abundant in the lower Bighorn River prior to completion of the Bighorn Dam (river km 128) in 1965, averaging 5.6 fish/km and ranging from 3 to 18 percent of the total catch (Bishop 1967). Sauger were rare during the 1990s; periodic electrofishing surveys from 1991 to 1996 yielded few sauger (<0.4 fish/km) (K. Frazer and M. Vaughn, personal communication). In the past sauger concentrated in good numbers during spring in the lower 2 km of the Bighorn (Stewart 1987), but more recently, concentration in this reach was much reduced with only one sauger electrofished in spring 1996 and none in spring 1999 (Frazer and Vaughn, personal communication). Rancher diversion dam just below the mouth of the Bighorn River, and Manning diversion dam 6.5 km upstream of the mouth, likely restrict movement (Montana Fish, Wildlife and Parks 1997), and reservoir release of colder, clearer water has reduced habitat suitability for sauger throughout the lower Bighorn River.

Sauger are moderately abundant in the upper, more turbid portion of Bighorn Reservoir (Kreuger et al. 1997) and relatively rare elsewhere (Frazer and Vaughn, personal communication). Sauger migrate out of the reservoir 80 km upstream to spawn in the Bighorn River in Wyoming, the last remaining sauger population in that state (Kreuger et al. 1997).

Yellowstone River, North Dakota Border to the Bighorn River

Mainstem.—Sauger were abundant throughout the Yellowstone River during surveys in the 1970s. For example, in spring 1974, sauger abundance in the river section below Cartersville diversion dam (river km 383) was estimated at 1265 fish per km (Peterman and Haddix 1975). However, abundance has declined substantially since the late 1980s throughout all five urvey sections of the river between the Cartersville diversion dam at the town of Forsyth and the Intake diversion dam (river km 118). In the 1970s and 1980s, fall sauger abundance averaged about 12 fish/hr (Fig. 8). Sauger abundance dropped harply beginning in 1987, and since 1990 ha

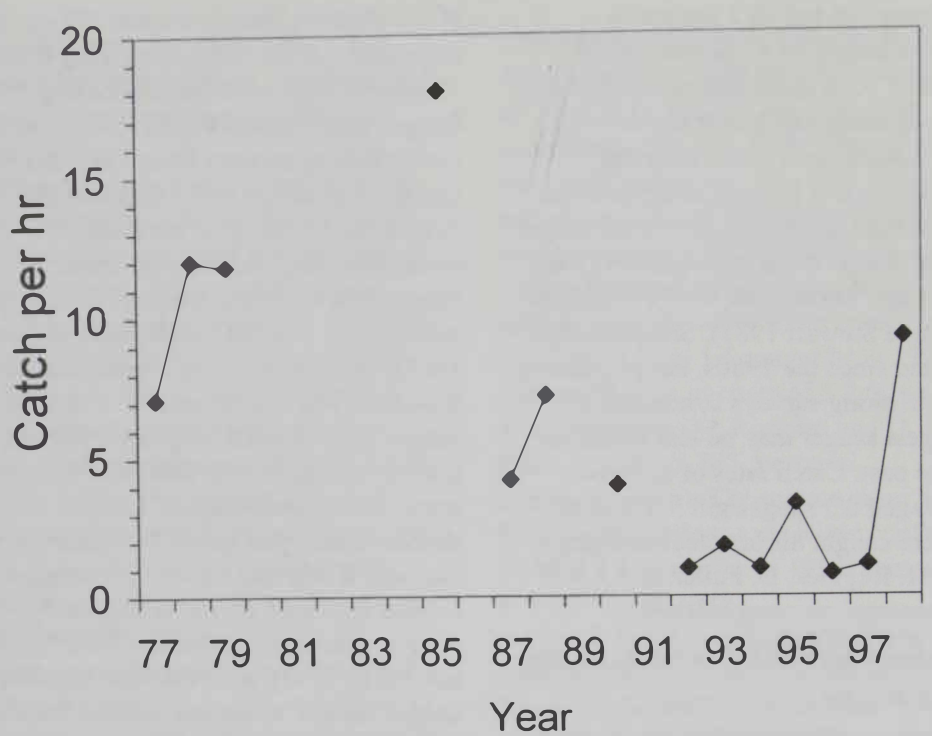

Figure 8. Mean electrofishing catch rates of sauger in the lower Yellowstone River, 1977-1998.

averaged about 2 fish/hr, an 83 percent drop in average abundance. An illustration of the decline is shown by a catch of 358 sauger in 3 days of sampling below Intake in fall 1985, and only 20 sauger in 2 days of sampling the same section in fall 1997 (Stewart 1998). An exception to this pattern is the catch rate in fall 1998, when the sauger abundance averaged 9.2 sauger/hr. Above the Cartersville Dam, sauger abundance has remained at low levels (~10% of downstream abundance) due to restricted passage (Stewart 1998).

Initiation of sharp declines in sauger abundance in the Yellowstone River coincided with low water levels. Average spring-summer discharge of the Yellowstone River at Sidney from 1987-1990 was well below the 48-year average of 506 m^3/s when the sauger decline began (Fig. 9). Sauger catch rate was positively correlated with spring-summer discharge 3 years earlier ($r = 0.52$, $P = 0.058$; Fig. 10). Sauger catch was lower than expected in the early 1990s, but there was some evidence for a positive response to higher discharge in 1995 (Fig. 10).

Spawning for the entire Yellowstone River may be confined to two tributaries, the Powder and Tongue rivers. Penkal (1992) electroshocked only two mature sauger in a 83-km section of the mainstem from Miles City to Forsyth during early May when sauger were abundant in the Tongue and Powder rivers. The only other documented spawning in the lower Yellowstone was at a few sites below Intake diversion (Penkal 1992). Walleye, in contrast, spawn in numerous locations below Intake (Penkal 1992).

Sauger larvae drift downstream from the Tongue and Powder River spawning grounds to rear in the lower mainstem and in Lake Sakakawea, and gradually move upstream in late summer and fall (Penkal 1992). Age-0 abundance in the lower Yellowstone varies widely but appears positively associated with Lake Sakakawea water levels (Stewart 1996a). However, age-0 abundance has been low since 1995 despite higher discharge and reservoir water levels (Stewart 1998). Recent evidence

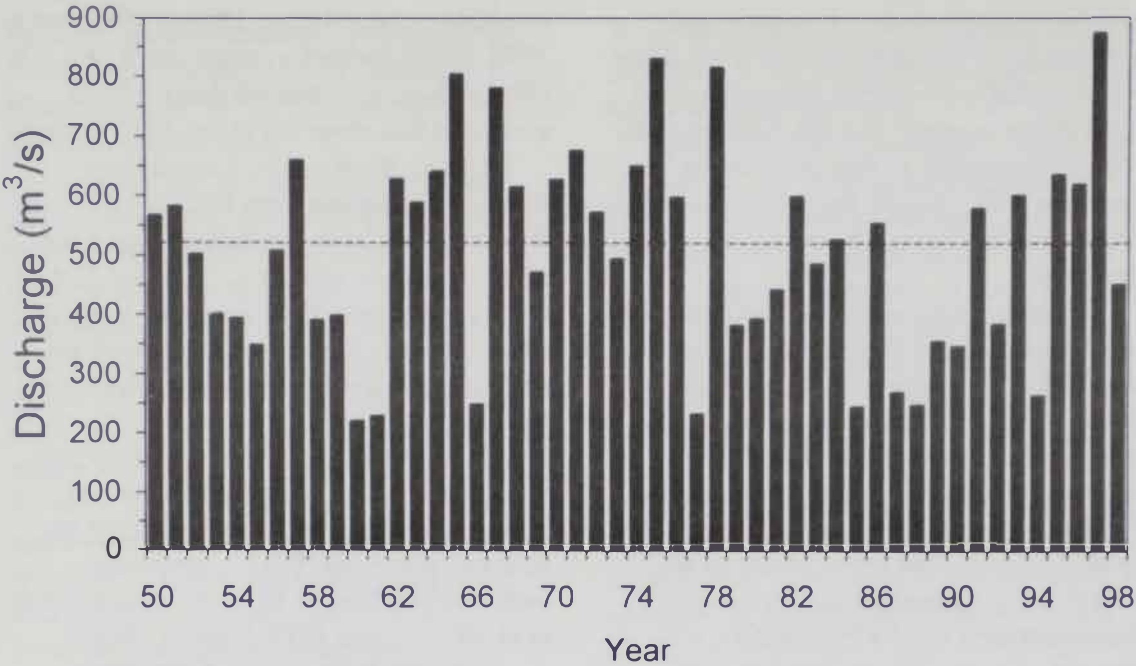

Figure 9. Mean spring-summer (1 May-30 September) discharge of the lower Yellowstone River at Sidney, 1950-1998. Thirty-nine year average shown as dashed line.

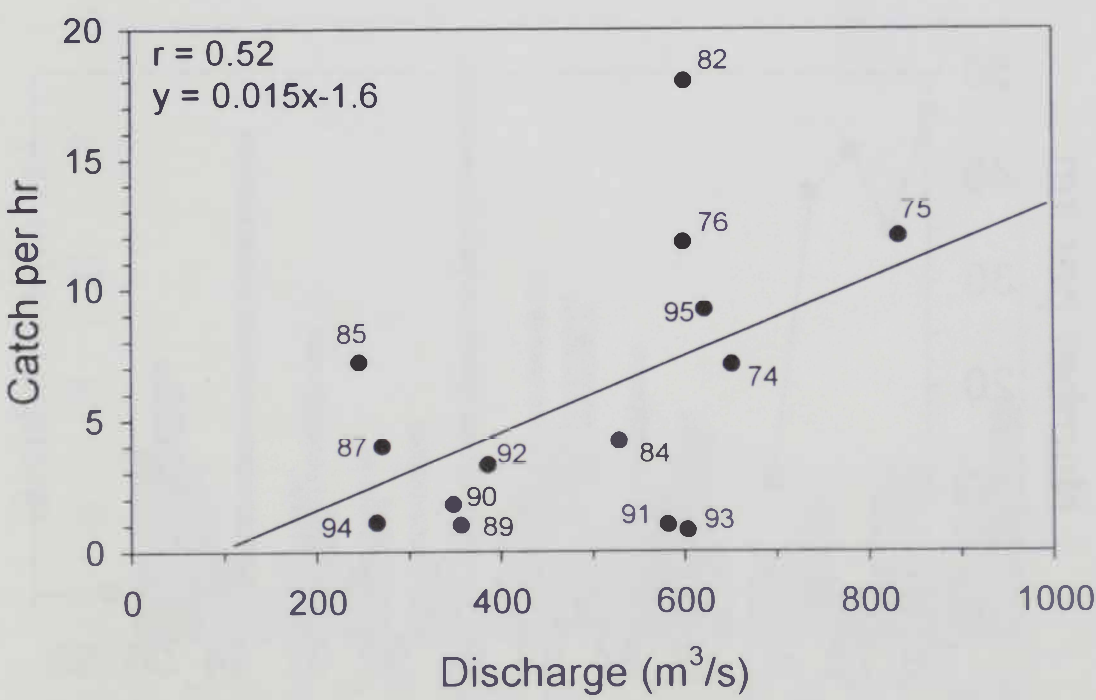

Figure 10. Relationship between mean spring-summer discharge of the Yellowstone River at Sidney and average sauger catch rate in the lower Yellowstone River three years later.

suggests that thousands of juvenile and adult sauger in the lower Yellowstone River are entrained in the Intake water diversion canal in late summer and fall (Hiebert et al. 2000), presumably as they are moving upstream. The ultimate fate of entrained fish is unknown but we would expect significant mortality.

Powder River.—The Powder River is a large prairie stream that is characterized by high turbidities, little pool development, and shifting sand substrate. Surveys conducted in the 1970s indicated sauger were historically uncommon throughout the 336-km drainage in Montana (Rehwinkel 1978). However, the lower 16 km of the river is a key spawning area for sauger. During spring 1976-1979 sampling, 620 sauger or 5.6/hr, were captured during electrofishing surveys in this section; many fish caught were mature (Rehwinkel 1978, Penkal 1992). Fish tagged during spawning were recovered throughout the lower 150 km of the lower Yellowstone mainstem indicating that long-distance movement to spawning grounds was common. No sampling occurred from 1979 to 1997, but a 1998 survey yielded a sauger catch of 6.9/hr (W. Gardner, unpublished data), a level similar to that observed in the 1970 surveys.

Tongue River.—The Tongue River flows 325 km north from the Montana-Wyoming border to the Yellowstone River near Miles City, Montana. There are five dams on the river, from the T and Y water diversion dam, 33 km from the mouth, to the Tongue River Dam near the Wyoming border. The upper river extends another 100 km above the Tongue River Reservoir into Wyoming. Sauger likely were abundant historically throughout the system but are now rare above the T and Y diversion, including the Tongue River Reservoir (Elser et al. 1977, Riggs 1978, Stewart 1996b).

The river below T and Y diversion supported a strong spawning run of sauger, averaging about 40 fish/km during spring electrofishing surveys conducted in the 1970s (Fig. 11; Elser et al. 1977, Penkal 1992). Though there is a gap in data from 1981-1991, surveys since 1991 indicate the sauger spawning run has declined markedly

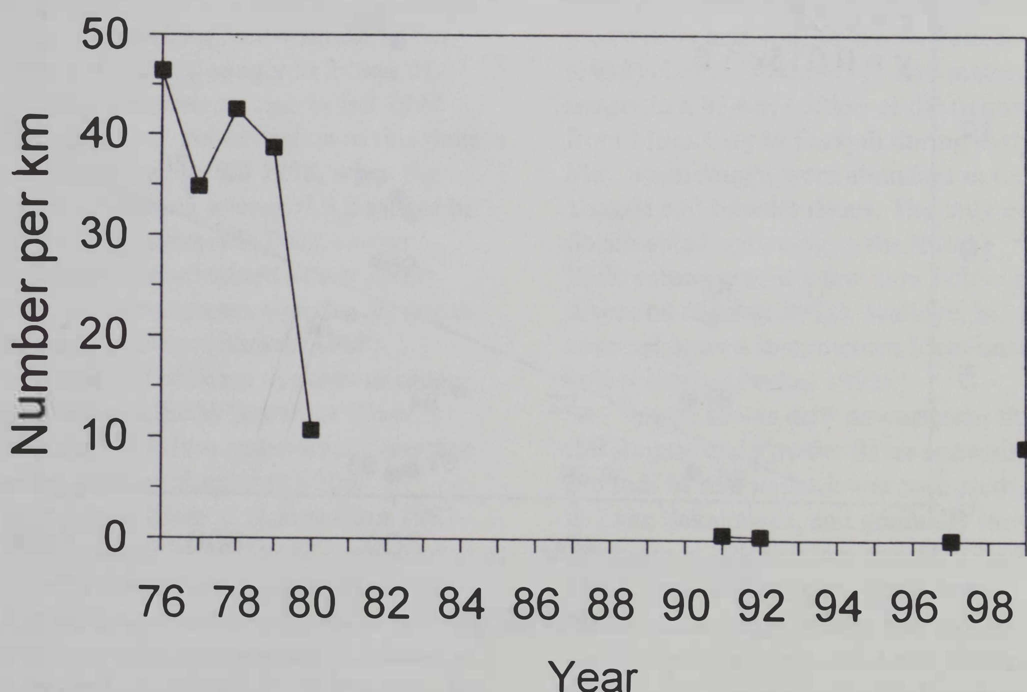

Figure 11. Spring electrofishing catch of sauger below T and Y diversion dam, lower Tongue River, 1976-1999.

from historical abundance, averaging < 5 fish/km or 90 percent fewer fish than observed in the 1970s (Stewart 1993, Gardner, unpub. data).

Chronically low spring water levels likely have had a significant effect on spawner abundance and perhaps reproductive success. Elser et al. (1977) calculated a desired passage and spawning flow level of 15 m^3/s during April for successful sauger reproduction, and Penkal (1992) observed a precipitous decline in sauger spawning when flows dropped below 8.5 m^3/s. During the high spawning run years of 1976-1979, April discharge was typically >12 m^3/s. However, since 1980 average April discharge has met or exceeded the recommended flow of 15 m^3/s in only 5 years (Fig. 12). In addition, daily flows in 9 years were <8.5 m^3/s for >15 days (McMahon 1999). Discharge levels in some recent years have approached those of the late 1970s, but a rebound in the spawning run has not been observed. Whether other spawning areas have been colonized as the run in the Tongue River has declined is unknown.

Little Missouri Drainage.—The Little Missouri River system, located in the far southeastern corner of the state, drains northward into Lake Sakakawea in North Dakota. Montana portions of three of the larger tributaries, Box Elder, Little Beaver, and Beaver creeks, were surveyed in the late 1970s (Elser et al. 1980) and early 1990s (Barfoot 1993, Guzevich 1993). Sauger were conspicuously absent from among the 25 species found in Little Beaver and Beaver creeks, but were present in Box Elder Creek. Holton and Johnson (1996) reported the presence of sauger in Beaver Creek and Box Elder Creek. However, based on the above surveys sauger apparently are now absent from Beaver Creek. Box Elder Creek has not been sampled in recent years, so the status of sauger in that system is unknown. It is likely that these tributaries were used by

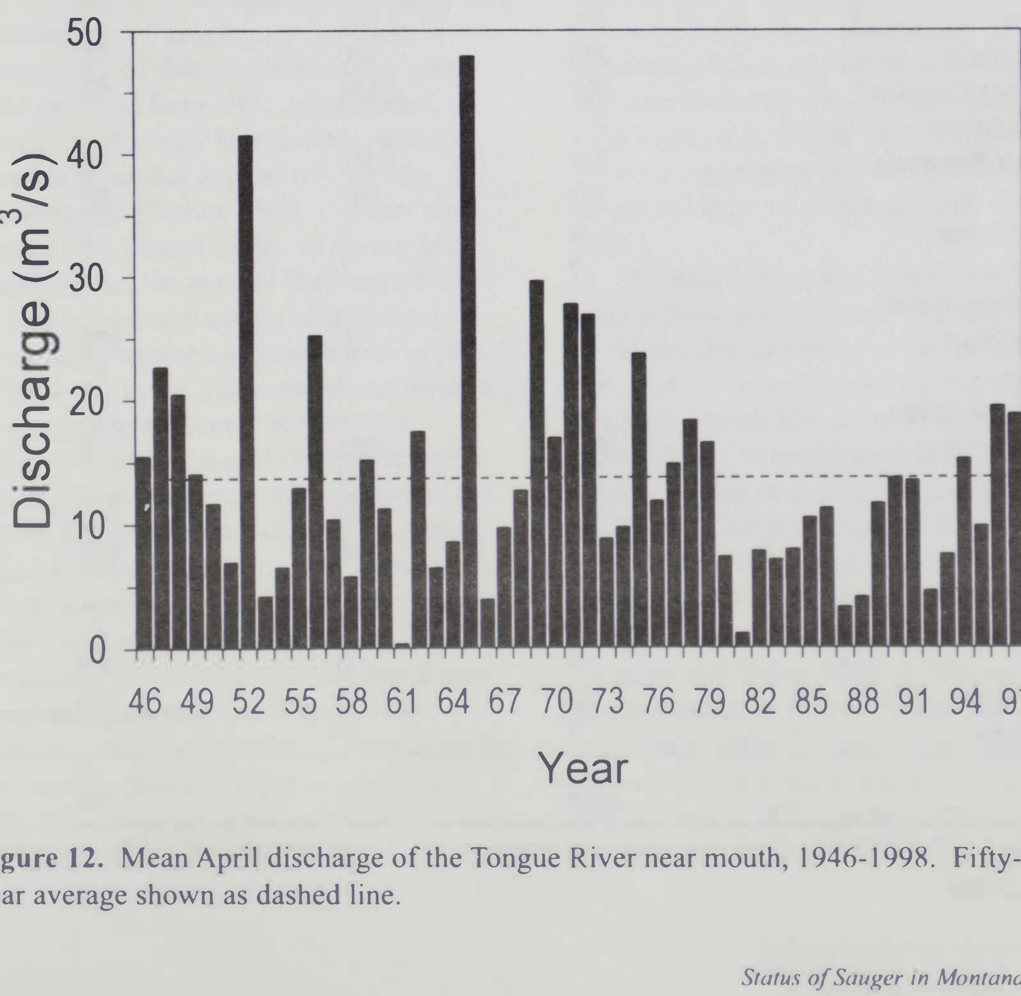

Figure 12. Mean April discharge of the Tongue River near mouth, 1946-1998. Fifty-three year average shown as dashed line.

sauger for spawning and rearing, as Guzevich (1993) and Elser et al. (1980) found walleye moderately abundant in large permanent pools in Little Beaver Creek, including age-0 fish, suggesting that habitat requirements were probably suitable for sauger in the past.

Present Status of Sauger in Montana

Historically, sauger likely occupied at least 3376 km of riverine habitat in Montana (Table 1). Present-day range is estimated at 1570 km, a 53 percent decline, though status is uncertain over some of their range. Decline has been much more extensive in tributaries; of the estimated historical occupancy of 1896 km, only 479 km are known to currently support sauger, a 75 percent reduction. In contrast, we estimate range reduction in mainstem rivers at 22 percent (1395 to 1091 km). Sauger remain common in four locales but apparently at lower than historical levels: Missouri mainstem between the Marias River and Fort Peck Reservoir (256 km); upper 25 percent of Fort Peck Reservoir (66 km); Missouri mainstem below Fort Peck Reservoir (246 km); and the lower Yellowstone mainstem below Cartersville diversion (381 km), comprising 949 km or 28 percent of the historical range.

Table 1. Historical vs. present-day range of sauger in Montana by major drainage. Range reported as kilometers of river occupied.

Drainage/River	Historical	Present (1999)	Percent loss
Missouri above Fort Peck Reservoir	333	333	0
Marias	274	96	65
Teton	80	0	100
Judith	85	?	
Musselshell	240	120	50
Fort Peck Reservoir*	261	131	50
Missouri below Fort Peck Reservoir	246	246	0
Milk	727	241	67
Beaver Creek	?	?	
Poplar	?	?	
Yellowstone above Bighorn River	80	0	100
Bighorn	206	6	97
Yellowstone below Bighorn River	475	381	20
Rosebud	?	?	
Tongue	241	0	100
Powder	16	16	100
Little Missouri			
Little Missouri	?	?	
Beaver	80	0	100
L. Beaver	32	0	100
Box Elder	?	?	
Total	3376	1570	53

*including Fort Peck Reservoir, 261 km long. We assumed that sauger typically occupy the upper half of the reservoir.

Discussion

Causes of the Decline

River Flows and Reservoir Water Levels.—A clear association occurred between low river flows and low reservoir water levels and the timing of the marked sauger decline throughout Montana in the late 1980s. All major sauger populations for which there is adequate trend data—Missouri River below Morony Dam, Marias River, Fort Peck Reservoir, and the lower Yellowstone River—declined substantially during a 3-4 year drought. This state-wide decline mirrored patterns observed in other sauger populations where abundance was positively correlated with river flows and reservoir water levels (Nelson 1968, Fischbach 1998). Populations also tended to exhibit region-wide trends in abundance (Lyons and Welke 1996). Species that exhibit high interpopulation synchrony in abundance are more susceptible to regional-scale environmental disturbance (Dunning et al. 1992), and we believe that sauger in Montana conform to such a pattern.

Reduced, or fluctuating, flow may lead to stranding of sauger eggs (Nelson 1968), dewatering of side channel rearing areas (Gardner and Berg 1982), diminished transport of sauger larvae downstream to rearing areas that may be 60-300 km downstream (Nelson 1968, Gardner and Berg 1982, Penkal 1992), or poorer prey recruitment (Nelson and Walburg 1977). It is perplexing why sauger abundance has generally remained so low despite improved river flows in the Yellowstone and Missouri rivers and water levels in Fort Peck Reservoir since the mid 1990s. Though there is some evidence for recovery of the lower Yellowstone population, there has been a lack of recovery in the Missouri River population, despite above-average flows in 6 of the last 8 years from 1991-98, and in the Fort Peck Reservoir population, despite high water levels since 1994. Concern over their declining abundance led to classification of sauger as a Montana "species of special concern" (Hunter 1994) in 2000 (Graham 2000).

Migratory barriers/habitat loss.—Dams and water diversion structures have blocked or impeded migratory access to large areas of the historical range of sauger in Montana, and have undoubtedly served as the primary cause for their significant range reduction, especially in tributaries. Their highly migratory nature, coupled with their apparent propensity to spawn in only a few areas, make them particularly susceptible. For example, the loss of an important spawning tributary to damming resulted in a decline of sauger in the entire upper Tennessee River system (St. John 1990). Similar declines following fragmentation of fish populations as a result of damming of tributaries also have been documented for other species (Luttrell et al. 1999). The role of migratory barriers in the recent decline in sauger is unclear. Most of the migratory barriers were in place during the 1970s and 1980s when sauger were abundant and widespread throughout the Yellowstone and Missouri drainages. However, these structures may impede recovery by causing direct mortality, e.g., entrainment in the Intake water diversion canal, by increasing vulnerability of remaining fish to exploitation because of a concentration effect during spawning migration, (e.g., Hesse 1994, Pegg et al. 1996), or by preventing recolonization from neighboring populations (Luttrell et al. 1999).

Channelization and subsequent loss of river side-channels was an important factor in the decline of sauger in the mainstem Missouri River in ebraska (Hesse 1994). Channel complexity in the Missouri and Yellowstone rivers remains largely intact, so channel changes and associated habitat loss likely have not been a major factor in the recent decline. Chronic dewatering of several major tributaries in Montana where sauger were historically abundant (Teton, Tongue, and Musselshell rivers), however, has undoubtedly played a significant role, especially in the Tongue River, one of apparently only two main spawning areas for the entire Yellowstone population (Penkal 1992). In the middle Missouri, dewatering of sidechannels used as rearing habitat for age-0 sauger as a result of power peaking operations at Morony Dam (Penkal 1990), could be an important factor affecting year-class strength, particularly during low flow years.

Hybridization with Walleye.—Walleye and sauger can readily hybridize and produce fertile offspring, but hybridization is rare under natural circumstances despite their overlapping distribution and similar spawning habitat requirements (Billington et al. 1988, White and Schell 1995). However, hybridization rates and loss of stock integrity may become significant when sauger populations fall to low levels, spawning habitat is limited, or when sauger x walleye hybrids (saugeye) are stocked (White and Schell 1995, Van Zee et al. 1996, Fiss et al. 1997).

We compiled hybridization data from Montana and nearby regions to assess if hybridization rates have increased and to compare Montana hybridization rates to other locales (Table 2). Overall, sauger hybridization rates in Fort Peck Reservoir, the middle Missouri River, and the lower Yellowstone River are similar to other Missouri River reservoirs (Lakes Sakakawea and Lewis and Clark), averaging about 10 percent. Rates of hybridization are well below that reported from waters where saugeye have been stocked (~74%; Fiss et al. 1997) and there is no indication thus far of an increase associated with the sauger decline.

Whether hybridization rates will increase in the future is uncertain. In some systems, e.g., Lewis and Clark Reservoir, South Dakota, sauger and walleye have coexisted for many years, spawning in the same limited habitat; yet hybridization levels remain about 10 percent, and substantial loss of stock integrity has not been observed. Other than stocking of saugeye (Fiss et al. 1997), predicting what factors will magnify hybridization and, thus, targeting practices that may lessen or enhance risk are difficult. Given this uncertainty, continued monitoring is necessary, as well as close genetic screening of walleye or sauger broodstock used in artificial propagation (Ward 1992, Leary and Allendorf 1997, Billington 1998).

Species interactions.—Historically, sauger were the most common top predator in the Missouri and Yellowstone Rivers and major tributaries in eastern Montana. Two nonnative piscivores, walleye and smallmouth bass, now co-occur with sauger over much of the sauger's historical range in the state (Holton and Johnson 1996). Smallmouth bass are now the dominant top predator in the Tongue and upper Missouri rivers. Smallmouth bass and walleye are now abundant in the upper Missouri River below Morony Dam (Hill et al. 1998). Decline of sauger cannot be directly related to the expansion of these two species because the most marked decrease occurred when both smallmouth bass and walleye abundances were still low. Direct

Table 2. Proportion of sauger x walleye hybrids in Montana and surrounding regions. *N* is the total number of *Stizostedion* tested.

Location	Date	*N*	No. of hybrids (%)	Source
Middle Missouri R.	1996	14	0 (0)	Billington et al. 1997
	1999	109	5 (4.5)	N. Billington unpub. data
Fort Peck L.	1997	50	3 (6.0)	Billington 1998
Fort Peck L.	1995	158	15 (9.5)	Leary and Allendorf 1997
Lower Yellowstone R.	1995	48	7 (14.6)	Leary and Allendorf 1997
Lower Missouri R.	1996	85	4 (4.7)	Leary 1998
Lewis and Clark L., SD	1995	50	5 (10)	Van Zee et al. 1996
Bighorn L. and R., WY	1995	164	0 (0)	Kreuger et al. 1997
Boysen L., WY	1995	98	0 (0)	Kreuger et al. 1997
Lake Sakakawea, ND	1991	279	28 (10)	Ward 1992

competition among sauger and smallmouth bass and walleye is unlikely given dissimilar habitat preferences (e.g., Nelson and Walburg 1977, Rawson and Scholl 1978). However, changing habitat conditions could shift the balance in favor of these other species. Increases in water clarity as a result of damming and altered spring flows favor both walleye and smallmouth bass (Nelson and Walburg 1977). We hypothesize that while species interactions have not directly caused sauger declines, expanding populations of other piscivores could impede recovery through predation on juvenile sauger (Zimmerman 1999).

Overexploitation.—Overfishing has been implicated in sauger declines in other regions (Hesse 1994, Pegg et al. 1996, Maceina et al. 1998). High exploitation rates probably were not a significant factor leading to the state-wide sauger decline in Montana, however, because of low angler density from the remoteness and large size of eastern Montana waters. Tag return data from the Missouri and Yellowstone rivers indicate low (<10%) exploitation rates (Berg 1981, Gardner and Stewart 1987, Stewart 1998). However, actual exploitation rates could be higher if harvest is concentrated when sauger are aggregated in high densities in restricted areas during winter and early spring (Hesse 1994, Pegg et al. 1996). Though creel census data are lacking from most areas, quality of the popular sauger fishery in eastern Montana has also declined considerably over the past decade based on anecdotal angler reports and documented reductions in fish size on the lower Yellowstone River (Stewart 1998). The harvest limit of sauger in the upper Missouri River upstream of the Judith River confluence was reduced from 5 fish to 1 fish in 1999 because of the low density in this reach (Fig. 5). More extensive creel data are needed to better quantify harvest rates, provide a benchmark for judging future change in fishery quality, and suggest if and what type of angling regulation changes could bolster the fishery.

Conclusions

Sauger persist in about half, and remain common in only about 28 percent, of the estimated 3376 river-kilometers of their historical range in Montana. Losses have been particularly acute in tributaries where an estimated 75 percent of the former range no longer supports sauger compared to 22 percent of mainstem waters. Although much of the range reduction likely occurred over the past 80 years as a result of construction of migratory barriers and chronic dewatering of some tributaries, state-wide drought in the late 1980s appeared to trigger a marked decline in sauger in large portions of the Missouri and Yellowstone drainages. Despite improved flows since the mid-1990s, evidence of recovery was minimal in most areas. Attributing the recent decline to habitat loss is difficult because many of the major habitat alterations that affected sauger, namely migratory barriers in the form of dams and water diversion structures and canals, were in place before the decline began. However, barriers to migration of this highly migratory species may be impeding recovery by entrainment in irrigation canals, by increasing their vulnerability to exploitation, and by reducing recolonization from neighboring populations. On the other hand, hybridization with walleye apparently is not abnormally high nor increasing at this point in time. Evidence was lacking for displacement of sauger by nonnative walleye or smallmouth bass, but over time reduced turbidity may shift the balance in favor of these species.

A general lack of basic information on sauger ecology in Montana and other portions of its range makes development of management policies difficult (Pegg et al. 1997). Tagging studies in both the Yellowstone and Missouri systems indicate that sauger are highly migratory, moving throughout a very large area that crosses jurisdictional boundaries both within and outside of Montana. How habitat conditions in one area affect the population as a whole remains unknown. Radiotracking and tag recovery studies (e.g., Pegg et al. 1997), though logistically daunting over such a large area, would help refine important habitat types, seasonal movement patterns, and exploitation rates, and perhaps identify heretofore unknown spawning locales.

Improved fish passage at key diversions dams, improved minimum flows in the Tongue River during spawning and other historical habitats like the Teton River, and reduction of entrainment at the Intake water diversion canal would help promote sauger recovery (Montana Fish, Wildlife and Parks 1997). These actions should improve access to many kilometers of historical sauger habitat and reduce high mortality of juvenile sauger moving upstream from the lower Yellowstone River and Lake Sakakawea in North Dakota. Habitat enhancement of current spawning areas also could help offset the loss of historical spawning grounds.

Continued monitoring of sauger abundance in sites that have historical population data is key to tracking population trends. Survey of little known areas (Milk, Teton, Judith,and Musselshell rivers) also is needed to further clarify population status and define where sauger persist.

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