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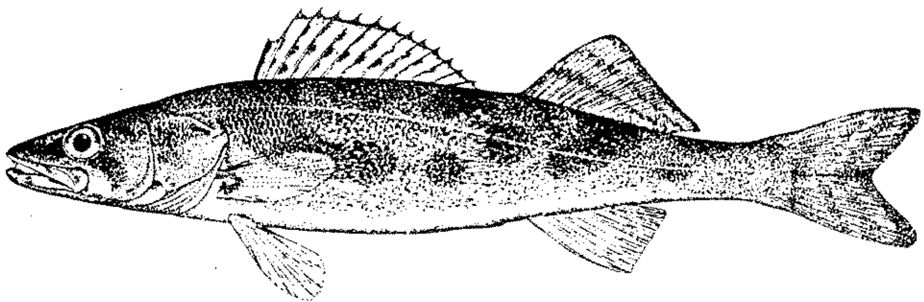
STATUS OF SAUGER IN MONTANA



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I. Introduction

The purpose of this report is to review the status of sauger, a native fish of Montana. Sauger, a close relative of the nonnative walleye, is one of the most widely distributed among North American fishes, found throughout central and eastern North America from northern Canada to Alabama and westward to the upper Missouri River drainage (Scott and Crossman 1973). Early fish surveys found sauger common in large rivers and major tributaries throughout the upper Missouri River drainage (Everman and Cox 1894). In fact, despite their widespread occurrence in North America, the species was first described from a collection made during the Lewis and Clark expedition in the early 1800s at the Missouri River near the Marias River (Moring 1996). Historically, sauger in Montana occurred in 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).

Sauger support important sport fisheries in Montana and elsewhere, the species having a flesh quality as good if not superior to that of its walleye cousin (Priegel 1983). Sauger fisheries are particularly popular in winter and spring when sauger tend to congregate below reservoir tailwaters (Nelson and Walburg 1977; Hesse 1994; Pegg et al. 1996). In Montana, reservoir and diversion dam tailwaters (e.g., Intake near Glendive and Cartersville near Forsyth), and the mouths of important spawning tributaries (e.g., Powder, Tongue, and Marias rivers) have supported popular spring sport fisheries for sauger in the Missouri and Yellowstone rivers.

The first intensive sampling efforts in the lower Missouri and Yellowstone rivers conducted in the 1960s and 1970s found sauger abundant and widespread in eastern Montana. For example, in the Missouri River drainage, 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 207-mile section of the Missouri River between Fort Peck Reservoir and Morony Dam. In the Yellowstone drainage, Peterman and Haddix (1975) estimated a population of 2,024 sauger, comprising 70% of the sport fish catch, in a 1-mile section of the Yellowstone River, and other workers noted large spawning congregations of sauger in the lower Tongue and Powder rivers (Elser et al. 1977; Rehwinkle 1978).

Over the past decade, biologists have noted what appeared to be widespread declines in sauger in both the Missouri and Yellowstone drainages. Penkal (1981) was the first to draw attention to a decline in the spawning run in the lower Tongue River during periods of river dewatering below the Tongue River reservoir. Stewart (1992a-1998a reports) observed a marked decline in young-of-year (YOY) and adult sauger in the lower Yellowstone River beginning in the early 1990s, estimating that sauger numbers were only 4-14% of the numbers observed in the 1980s. In the middle Missouri and Marias rivers, sauger numbers in the 1990s were a small fraction of that observed in the 1980s (Penkal 1990; Hill et al. 1995, 1996, 1998; Gardner 1998a). Though sauger declines were originally thought to be due to the severe drought in the late 1980s (Gardner 1998b) and associated wide fluctuations in reservoir flow releases during spring spawning (Penkal 1981, 1990), the lack of rebound in sauger abundance despite improved flow conditions in the 1990s planted a seed of concern over the status of sauger in the state. Evidence for significant sauger declines was also accumulating from many other portions of its native range including Nebraska (Hesse 1994), the Great Lakes (Rawson and Schell 1978), and one of its major strongholds, the Tennessee River system (Pegg et al. 1996). Angler overharvest, water flow fluctuations, migration barriers, and loss of spawning habitat have been implicated in the declines of sauger in other regions (Hesse 1994; Pegg et al. 1997).

An initial status review of sauger in Montana was presented at the American Fisheries Society annual meeting in 1998 by Bill Gardner, a Montana Fish, Wildlife, and Parks (FWP) fishery biologist with a long history of experience with the Missouri and Yellowstone rivers in eastern Montana. This review (Gardner 1998a) found evidence of substantial declines in sauger distribution and abundance in Montana over the past 20 years. Concern over the status of sauger in Montana spurred the development of this report, a detailed review and synthesis of current and historical information on the population status of sauger. Specific questions addressed in this report are:

How widespread is the decline in sauger in Montana?

What are the possible reasons for the decline? Specifically, what are the potential roles of river flows and reservoir water levels, loss of habitat, hybridization with walleye, interactions with other species, and overharvest?

What is the status of sauger in surrounding regions?

What management options might be available to protect and bolster remaining populations of this native fish and the sport fishery it supports?

To answer these questions, this report reviews life history information about sauger, summarizes population trend information for the sauger in Montana and surrounding areas, and considers what factors could be causing sauger declines. Finally, the report offers suggestions for needed research and monitoring, and discusses specific management options that could be used to protect and enhance sauger populations in the state.

II. Review of Sauger Life History

Sauger (*Stizostedion canadense*), members of the perch (Percid) family, closely resemble walleyes (*S. vitreum vitreum*). Sauger are distinguished from walleye by the presence of cheek scales and rows of distinct black spots on the first dorsal; the absence of a dark splotch on the posterior base of the first dorsal fin; and the absence of a white lower lobe the caudal fin (Scott and Crossman 1973; Holton and Johnson 1996). The two species occupy a very similar native range in North America but differ in that sauger occur farther southward in the lower Mississippi drainage, and walleye occur farther northward in Canada (Scott and Crossman 1973). In the upper Missouri drainage, sauger extended farther up the mainstem Missouri and were distributed farther westward into in the major tributaries, inhabiting eastern Montana, Wyoming, and western Nebraska, whereas walleye were historically absent from these areas. As noted above, in Montana, sauger are a native species occurring in the Missouri River drainage below Great Falls, and in the Yellowstone River drainage below the Clarks

Fork. Walleye are not native to Montana, but their distribution now almost entirely overlaps that of sauger (Holton and Johnson 1996).

The biology of sauger is not nearly as well known as that of walleye (Scott and Crossman 1973). Only about 10-20% of the 3,100 references listed in a 1988 bibliography on walleye and sauger deal with sauger (Ebbers et al. 1988). Available information does suggest, however, that compared to walleye and other percids like yellow perch, sauger have more restricted spawning and rearing habitat requirements; move over much greater distances; and are more sensitive to habitat alteration.

A. Spawning and rearing habitat

Sauger and walleye differ in their habitat requirements and generally exhibit little food or habitat overlap even in areas where they coexist (Swenson 1977; Rawson and Schell 1978). Though both species are nearly completely piscivorous as juveniles and adults, sauger tend to eat more benthically oriented prey than walleye (Swenson 1977). Sauger are most abundant in large, turbid rivers and large, shallow, turbid lakes. Walleye are less tolerant of highly turbid conditions, but are found over a wider range of habitat conditions (e.g., clearer lakes, reservoirs) than sauger (Scott and Crossman 1973). Indeed, turbidity appears to be an important delineator of habitat suitability for sauger (Doan 1941 cited in Schlick 1978; Nelson and Walburg 1977; Nelson 1978; Crance 1988). Due to highly developed light-sensitive eyes, saugers do poorly in waters where turbidities exceed 1 m secchi depth (Crance 1988). As a result, sauger abundance often declines following impoundment as water clarity increases following reservoir filling. In four mainstem Missouri River reservoirs in South Dakota (Oahe, Francis Case, Sharpe, and Lewis and Clark lakes), sauger abundance declined in the first three reservoirs from 4 to <1 fish per gillnet set as water clarity increased to 1.5-3.5 m secchi depth in the 10 years following dam closure (Nelson and Walburg 1977). In contrast, sauger abundance remained high (4 fish per net) in Lewis and Clark Lake, a shallow lake with an average secchi depth of 0.5 m and more riverine-like conditions (low water residence time). In two Manitoba lakes, sauger were rare in the one with a secchi depth of 1.49 m but abundant in the other having a secchi depth of 0.55 m (Nelson 1978). In Fort Peck and other Missouri River reservoirs, sauger tend to concentrate in turbid headwaters whereas walleye are found over a wider area (Nelson 1968; Wiedenheft 1990). In Lake Erie, walleye were associated with rocky reefs offshore whereas sauger were generally found in shallow, turbid shoreline areas (Rawson and Scholl 1978). In a current large-scale study of Missouri River fishes, sauger and walleye were most abundant at turbidities of 10-50 JTU, however sauger were rare <10 NTU and common at 50-100 NTU, whereas walleye exhibited a reverse pattern of abundance (Young et al. 1997).

Like walleye, sauger are spring spawners, broadcasting their eggs over rocky substrates. Spawning takes place in April and May and generally lasts about two weeks, with peak spawning occurring over a short 1-week period (Nelson 1968; Elser et al. 1977; Penkal 1992). Spawning typically occurs over temperature ranges of 50-58 °F (10-14 °C) (Penkal 1992). Males arrive on the spawning grounds first, followed by the females which leave very soon after spawning (Nelson 1968; Berg 1981; Penkal 1992). Spawning depth ranges from 1-6 feet (Nelson 1968; Graham and Penkal 1978). Eggs fall into gravel or boulder crevices and hatch in 21 days at 47 °F and 9-14 days at 55 °F.

After hatching, larvae swim up into the water column and are carried by the current over long distances. Nelson (1968) first captured larvae in Lewis and Clark Reservoir, 37 miles downstream, one week after first sampling them at the spawning grounds. Priegel (1970 cited in Penkal 1992) determined that sauger are susceptible to downstream drift for 10-12 days, prior to horizontal swimming ability becomes functional. In the middle Missouri River, Gardner and Berg (1982) found YOY sauger 130 miles below the spawning grounds in the Marias River. Larval sauger hatched in the lower Tongue River are thought to drift downstream to above or into Lake Sakakawea (Garrison Reservoir, North Dakota)(Penkal 1992) a distance of about 120-200 miles. I estimated how far larval sauger can drift from the spawning grounds by assuming a current velocity of 1 foot/sec (30 cm/sec) and a drift period of 1 week, both conservative estimates (Nelson 1968). The calculation yields a minimum estimated drift distance for larval sauger of 115 miles.

Spawning often appears to be concentrated in a relatively few sites (Nelson 1968, 1969; Gardner and Stewart 1987; St. John 1990; Hesse 1994; but see Siegwarth et al. 1993). For example, much of the sauger recruitment in the Missouri River above Fort Peck Reservoir and perhaps in the reservoir itself, is derived from fish spawning in the lower Marias River (Berg 1981; Gardner and Berg 1982). Similarly, the lower Yellowstone sauger population may be recruited almost exclusively by spawning in the lower Tongue and Powder rivers, and below the Intake diversion (Penkal 1992). In the lower Missouri below Fort Peck Reservoir, Gardner and Stewart (1987) found sauger spawning was concentrated in a half-dozen rocky reef areas that had unique geomorphic features associated with rocky cliffs. In contrast, walleye appear to be much less eclectic in their choice of spawning areas. In the Yellowstone River below Intake, walleye were found spawning on gravel bars throughout the lower river (Penkal 1992).

Sauger spawn almost exclusively in large tributaries or the mainstem reaches of large rivers (Hackney and Holbrook 1978; Nelson 1978; Rawson and Scholl 1978). Curiously, reports of sauger spawning on wave-washed rocky shorelines or reefs in a lake or reservoir, areas favored by walleye, are rare (Priegel 1983; Jeffrey 1995). Why these areas are not utilized for spawning is not known. In Tennessee, only reservoirs with large rivers flowing into them contained sauger populations (Hackney and Holbrook 1978). In upper Mississippi River tailwater areas, sauger and walleye are found in the same river reaches, but utilize different channel habitat types before, during, and after spawning (Siegwarth et al. 1993). Sauger were observed to move from sidechannel border habitats during the day, to spawn on rocky areas in the main channel at night. Walleye inhabited backwater lakes during the day, and moved into a tributary river to spawn at night.

Despite overlapping distribution and similar spawning habitat requirements, natural hybridization between walleye and sauger is relatively rare under normal circumstances (Billington et al. 1988; White and Schell 1995). As noted, sauger tend to spawn in different locations than walleye, and where they do spawn together, sauger tend to spawn later than walleye. Hybrids can be readily produced and yield reproducing individuals (Malison et al. 1990), but the maintenance of unique genetic markers in each species point to a lack of inbreeding historically, indicating the presence of some natural (unknown) isolating mechanisms (Billington et al. 1988; White and Schell 1995). However, natural isolating mechanisms may break down under certain circumstances. Rates of hybridization between sauger and walleye are higher in reservoirs where both species reproduce and spawning habitat may be limited (Nelson and Walburg 1977; Ward and Berry 1985; Van Zee et al. 1996). Concern over hybridization is rising due to widespread stocking of the sauger x walleye hybrid, saugeye. Since saugeye are not sterile and readily form backcrosses with either parental species (Fiss et al. 1997), stocking of saugeye has raised the issue of hybrid reproduction and the consequences to stock integrity of pure sauger and walleye stocks (White and Schell 1995). Hybridization is of special concern when sauger populations are at low levels. Regier et al. (1969 cited in Johnston 1977) speculated that the near extinction of the sauger stock in Lake Erie was hastened due to its absorption into the walleye gene pool following a period of low abundance. Due to the now wide distribution of nonnative walleye, hybridization of sauger with walleye is a concern in Montana and numerous samples have been taken to assess degree of hybridization with walleye. This information will be presented and discussed in detail in the following section "Reasons for Decline."

YOY saugers are captured along shallow shoreline areas in reservoirs (Wiedenheft 1990; Van Zee 1996), but little is known about seasonal habitat use at the juvenile and adult stages. In rivers, YOY sauger are found in backwaters, sidechannels, main channel pools, and other types of slow flowing habitats the first summer then shift to main channel riffles in the fall (Gardner and Berg 1982; Gardner and Stewart 1987; Hesse 1994). YOY saugers less than 50 mm feed on zooplankton and aquatic insects and switch almost exclusively to fish at sizes >150 mm (Nelson 1968; Wahl and Nielsen 1985).

It is important to note that, historically, sauger in Montana were the most common and abundant top predator in the Missouri and Yellowstone rivers and major tributaries. Following reservoir construction and introduction of nonnative walleye, smallmouth bass, and northern pike, other species now occupy this same sauger feeding niche. Though, as noted above, feeding and habitat niches of walleye and sauger typically do not overlap in their native range, competion between sauger and introduced piscivores is a factor that should be considered when determining factors affecting their distribution and abundance.

B. Migratory tendency

Sauger are recognized as the most highly migratory species among percids (Collette et al. 1977). Historically, sauger migrated long distances from mainstem rivers to spawn near the headwaters of large tributaries. Their highly migratory nature was evidenced by large concentrations that formed in the spring below newly constructed dams in the 1950s (Nelson 1968; Hesse 1994). An example of the magnitude of this migration is shown by the estimated 73,542 sauger that were harvested in one winter and spring below Lewis and Clark dam soon after its closure (Hesse 1994). Spawning migrations by sauger tend to be farther upstream and over a much greater river distance than walleyes. In Tennessee River reservoirs, walleye tend to spawn in rocky shoals just above the reservoir headwaters whereas sauger spawn much farther upriver near reservoir tailwaters (St. John 1990; Stodola 1992).

Several studies have documented sauger migration from reservoirs in late fall to overwinter in the river and near tailwaters, and rapid return downstream in the spring after spawning (Nelson 1968; St. John 1990). A typical pattern is thought to be that exhibited by sauger in Lewis and Clark Reservoir, South Dakota, where most sauger moved out of the reservior in the fall and winter and concentrated in the river and tailwaters. After completion of spawning in the spring, fish then returned to the reservoir (Nelson 1968). Tag return information from sauger in the lower Yellowstone and Missouri rivers have revealed complex, long distance (150 mile) movements (Gardner and Stewart 1987; Penkal 1992). In a recent study in the South Saskatchewan River drainage, Alberta, radiotagged sauger moved over much greater distances than sympatric walleye (Patalas et al. 1998). Median distance moved from December-July was 90 miles for sauger (range 6-230 miles) and 27 miles for walleye (<1-195 miles). One sauger moved 90 miles downstream to spawn and then returned to near its original location within a 3-month period.

C. Response to habitat alteration

Sauger are considered the most sensitive among large percids (walleye, yellow perch) to environmental perturbation (Leach et al. 1977). In Lake Erie, sauger was the first of the percids to decline, well before walleye and yellow perch (Rawson and Scholl 1978). By the early 1970s, sauger had approached extinction in the lake, whereas at the turn of the century they were one of the most abundant species in the lake, supporting a large commercial fishery (Rawson and Scholl 1978). Their long spawning migrations and requirement for tributary spawning appear to be the lynchpin in the sauger life history. In the Great Lakes, spawning tributaries were the first to show the ill effects of sedimentation; in other regions, tributaries are the first to have dams or water diversions that block spawning migrations. Indeed, the most dramatic declines in sauger in the Tennessee Valley have been in tributary reservoirs, where once abundant sauger stocks are now much reduced or absent (Hackney and Holbrook 1978; Stodola 1992). Loss of tributary populations of sauger appears common in areas where they were once abundant (e.g., North Platte River in Wyoming, Baxter and Simon 1970; Niobrara River, Nebraska, Hesse 1994; major tributaries to the Tennessee River, Hackney and Holbrook 1978; Stodola 1992).

Several aspects of their life history appear to make sauger populations especially prone to large and rapid collapses and sometimes slow or no recovery. Because of their migratory propensity and need for access to spawning tributaries, sauger concentrate in large numbers below dams throughout the winter and spring where they are highly vulnerable to angling (St. John 1990; Hesse 1994; Pegg et al. 1996). Declines of >95% in sauger populations occurred in the Missouri River, Nebraska, due to a combination of migratory blockages, channelization, and high exploitation during winter-spring congregations below dams (Hesse 1994). Declines of similar magnitude have been observed in a number of reservoirs in the Tennessee River Valley where sauger were formerly very abundant (Pegg et al. 1996). For example, the Watts Bar Reservoir, Tennessee, fishery declined from a peak harvest of 23,214 fish in 1978 to a low of 791 fish in 1982 with little recovery since that time period (St. John 1990).

Other factors that influence sauger population abundance are turbidity, channelization, and water level fluctuations. The requirement of sauger for turbid water was detailed above. Hesse (1994) noted that sauger use a variety of main channel and off channel habitats in large rivers and documented large declines in sauger following channelization of the mainstem Missouri River in Nebraska. Several studies have illustrated the importance of water levels during spring spawning. Nelson (1968) investigated the effects of water fluctuations on the Missouri River sauger population below Fort Randall dam. He found a significant negative correlation between water level fluctuations and year-class strength. In particular, sharp water level changes (> 3 feet) over sauger spawning bars during the spawning and incubation period led to poor reproductive success. Futhermore, the loss of recruitment was reflected as weak sauger year-class strength during the following years. Cessation of spawning activity also has been observed during periods of rapid flow fluctuations (Penkal 1992; Stodola 1992). Positive relationships between spring discharge and sauger year class strength have also been reported for Tennessee populations (Fischbach 1998).

III. Historical and Current Distribution and Abundance in Montana

To compare historical and current distribution and abundance of sauger, I first divided the native range of sauger in eastern Montana into four major drainages: middle Missouri River; lower Missouri River; middle Yellowstone River; and lower Yellowstone River. Following an analysis of past and present sauger distribution and abundance by drainage, maps of current distribution were compared to historical distribution to illustrate where sauger are still common and where they are now rare or absent and to estimate how significant sauger declines have been statewide.

A. Middle Missouri

The middle Missouri system consists of the 207-mile mainstem Missouri River section from Morony Dam near Great Falls, to the headwaters of Fort Peck Reservoir, and several major tributaries, the Marias, Judith, Teton, and Musselshell rivers. The mainstem section encompasses the Wild and Scenic portion of the Missouri River, the last major free-flowing section of this river. The Lewis and Clark expedition collected sauger in the mainstem Missouri in the early 1800s, but there was little fish distribution information obtained until the 1970s. Large rivers are notoriously difficult to sample, and it wasn't until the refinement of electrofishing at that time that allowed extensive sampling of the Missouri and Yellowstone rivers (Peterman and Haddix 1975). Since the mid 1970s there has been a number of studies that allow assessment of trends in sauger populations particularly on the mainstem and Marias Rivers.

A.1. Mainstem Middle Missouri

A good record of sauger abundance exists for the river section between Morony Dam and the mouth of the Marias River. The 5.3-7.9 mile-long Portage Coulee section below Morony Dam has been electrofished in the fall (late August-early September) for 13 of the last 20 years (1978-98), with a nearly complete time series since 1988. These data have been reported in Berg (1981), Penkal (1990), and in annual DJ reports (Hill et al. 1989, 1990, 1995, 1996, 1998; Liknes and Hill 1992, 1994; Liknes et al. 1989, 1993, 1994). Hill et al. (1998) provide a summary of electrofishing catch statistics in this section from 1978-98.

Sauger abundance shows marked changes over this time period. In 1978-81 sampling, sauger catch per hour ranged from 14.6-40.0, averaging 25.9 sauger per hour of electrofishing (Figure 1). For example, in 1979, 120 sauger were caught in 3 hours of sampling. Following a 7-year gap in sampling, sauger catch rate has been below 15 fish per hour since 1988. In the last six years of annual sampling (1993-1998), sauger catch rate has dropeed well below this level, averaging 2.2 fish per hour, a 90% decrease in average catch rate from the 1978-81 period. In 1997, only 9 sauger were caught in 8.2 hours of electrofishing. The last year that appreciable numbers of sauger were caught was 1990 (Hill et al 1998).

Inspection of abundance patterns of other sport fishes over this same time period (rainbow trout, brown trout, mountain whitefish, walleye, smallmouth bass) indicates that the decline of sauger is real and not an artifact of declining overall catch of all fishes. Other sport fishes show high year-to-year variation (Hill et al. 1998), but no other species shows a comparable decline in abundance. Since 1988, sauger composition of the catch has shown a steady decline (Figure 1), from the most abundant sport fish (44-70% from 1988-90) to being one of the rarer sport fishes sampled (<9% of the catch 1994-97; smallmouth bass omitted from the calculation). Over this same time period, other species have increased, most notably smallmouth bass and walleye. Smallmouth bass stocking in this section of the Missouri began in 1994, and this species has dominated the catch of sport fishes during electrofishing sampling since 1996 (10.5 fish per hour; Hill et al. 1998). Walleye have also shown a steady rise in abundance in this section of the Missouri (Figure 3). Walleye catch rate has risen from 0.2 in 1978-81, to about 5 fish per hour since 1993, a greater than 10-fold increase. Since 1988, walleye percent of total sport fish catch has risen steadily from about 10 to 20% (smallmouth bass omitted). While the reason for the sauger decline is unknown, an increase in smallmouth bass or walleye abundance does not appear to be a major factor since sauger declines were most marked in the late 1980s-early 90s period when both smallmouth bass and walleye abundance was still low.

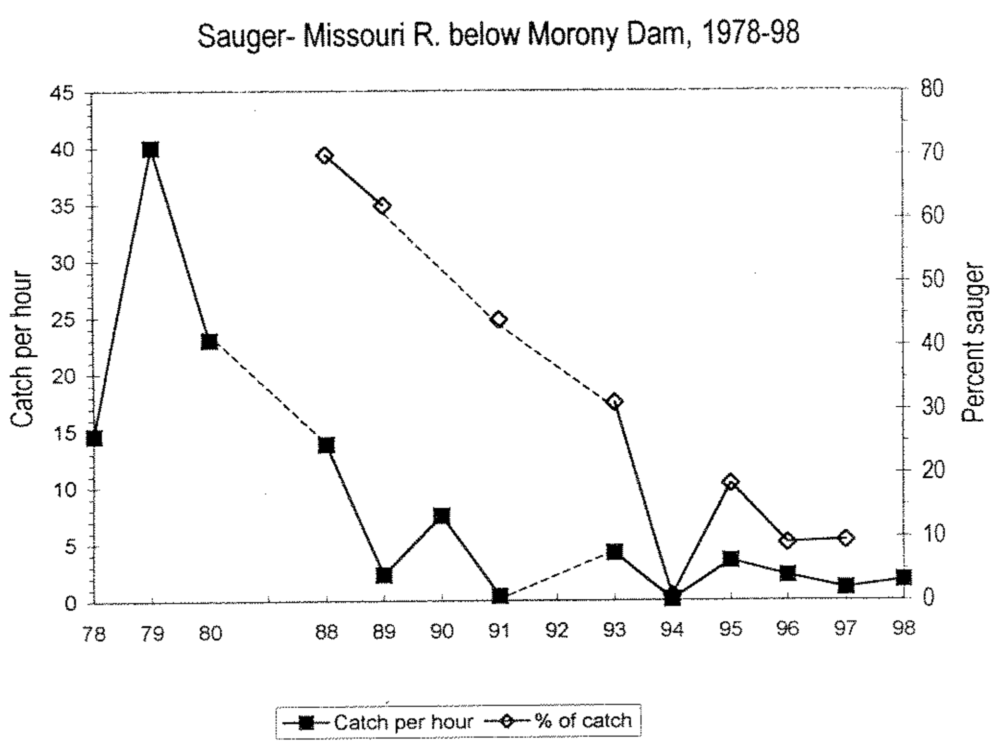

Figure 1. Sauger catch per hour of electrofishing and sauger percent of total catch in middle Missouri River below Morony Dam, 1978-98.

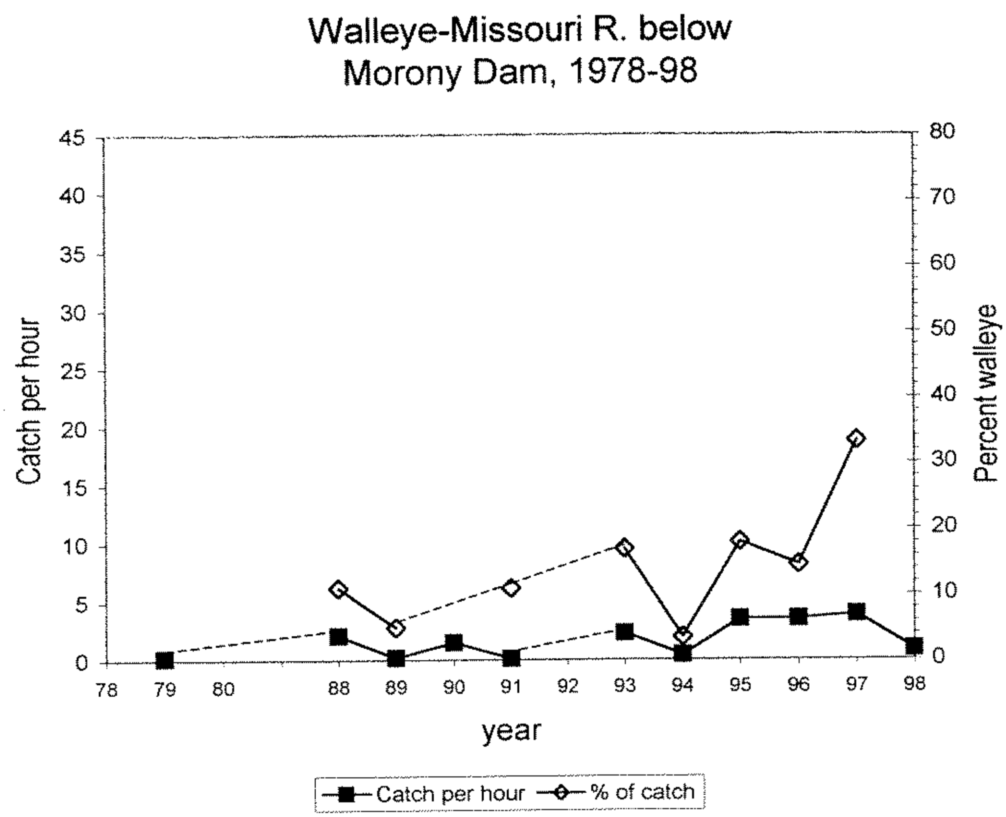

Figure 2. Walleye catch per hour of electrofishing and percent of total catch in middle Missouri River below Morony Dam, 1978-98.

Could overexploitation have contributed to the sauger decline? Anglers do target sauger in this river section, averaging about 7,000 angler days per year (S. Leathe, FWP, Great Falls, 1999 pers. comm.). No creel census data are available, but voluntary tag returns from fish tagged during annual electrofishing surveys do not show a clear indication of a high level of exploitation coincident with the sauger decline. For example, exploitation rate based on tag returns was 3.9% (11 of 284 tagged) in 1988-90 during the beginning of the marked decline in sauger abundance (FWP, Region 4-Great Falls, data records). Unfortunately, numbers of fish tagged and tags returned was very low during 1991-94, a period when high exploitation would have been expected if overharvest was occurring. Other data supports the idea that overexploitation was not the root cause for the decline. Mean length of sauger caught during the fall electrofishing surveys has increased from about 14 inches in the late 1970s to 15.5 inches the last six years (Figure 3). If overexploitation were or had occurred, a reduction, rather than an increase in sauger length would have been expected. There is also no clear evidence for recruitment failure as a cause of the decline. Though no direct YOY sampling data is available, the increase in mean length has not been met by an increase or a narrowing in the range of lengths of sauger captured; this range has remained similar (~12-19 inches) despite the large decrease in abundance. Thus the decrease in abundance the past decade cannot be readily attributed to an increase in mortality of a particular size group. It should be noted, however, that estimated exploitation in recent years (1995-97) has increased to 11.4% (4 of 35), a level that may impede sauger recovery, particularly if unreported harvest is high, a factor that has led to underestimation of exploitation levels in other sauger populations (Pegg et al. 1996).

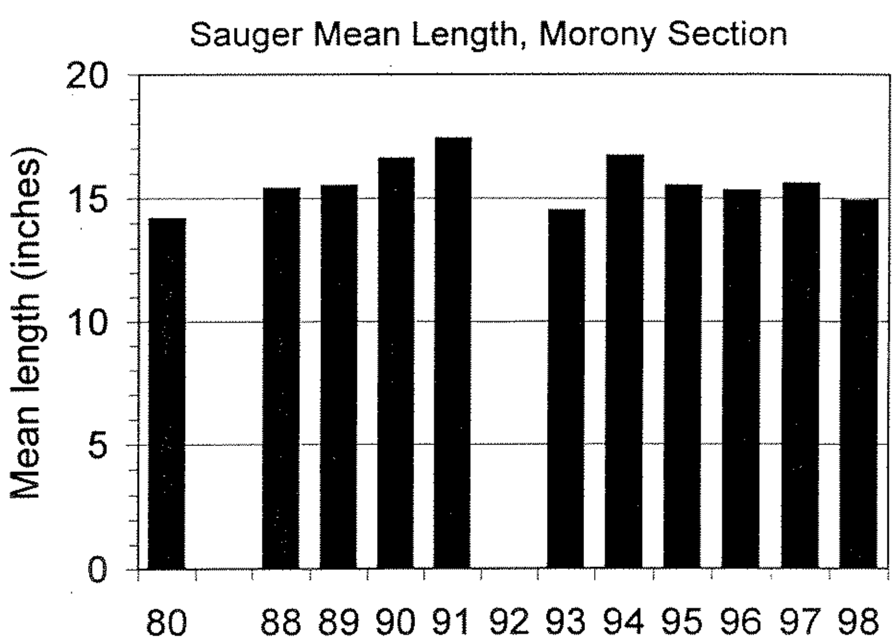

Figure 3. Mean lengths of sauger electroshocked in middle Missouri River below Morony Dam.

What about unsuitable river flows? Penkal (1990) speculated that a combination of low water years and excessive daily discharge fluctuations was responsible for the decline in sauger populations he observed in the 1988-90 period in the mainstem Missouri River below Morony dam. Previous studies have documented that sauger year-class strength is poor during years of low or highly fluctuating flows (Nelson 1968). Penkal (1990) found that average annual discharge below Morony dam was below average from 1984-89, the years 1987-89 the three lowest flow years on record over the 13-year period 1977-89. Gardner and Berg (1992) found YOY sauger closely tied to sidechannels in the mid Missouri mainstem, and determined that 5,400 cfs was necessary to prevent dewatering of sidechannels.

To assess if river flows in the 1990s may have contributed to continued low sauger abundance, I calculated the average annual discharge of the Missouri River at Virgelle during spring and summer (May-September) from 1958 to 1998 (Figure 4). These results show that flow conditions have been below the 41-year average of 9,950 cfs in

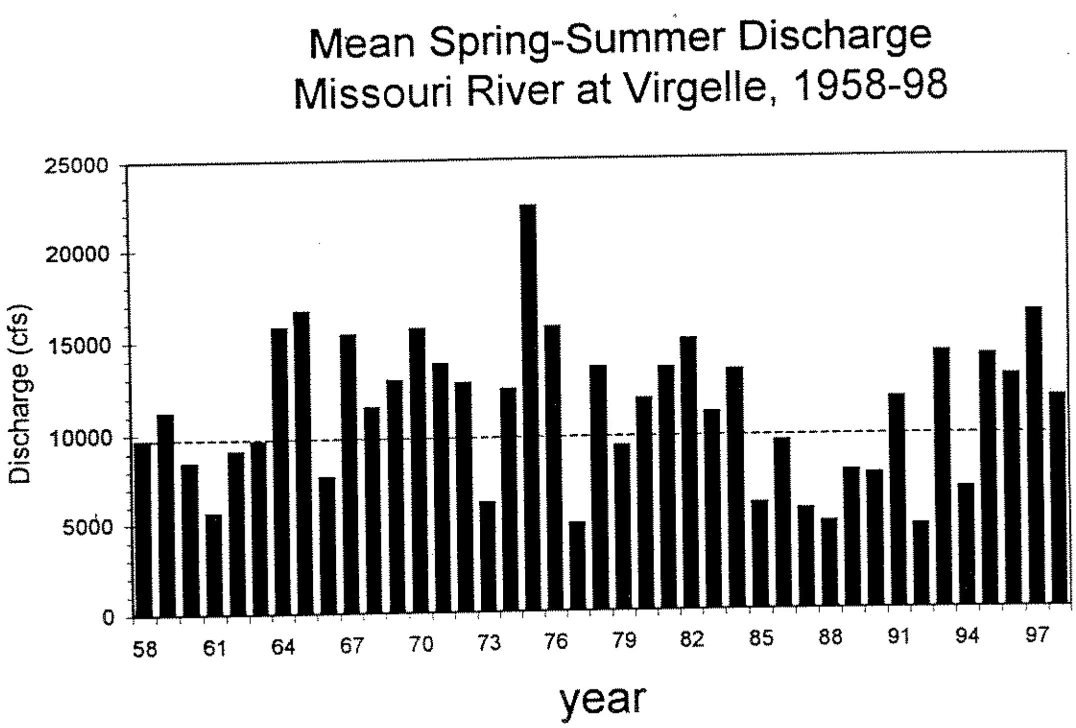

Figure 4. Mean spring-summer (May 1 – September 30) discharge of the middle Missouri River at Virgelle, 1958-98. 41-year average shown as dashed line.

7 of the last 14 years, particularly in the period of 1985-1994 when 7 of 10 years were below the long term average. Average discharge in 1988 and 1992 was the lowest over this 41-year record, and summer flows fell well below the 5,400 cfs deemed necessary to prevent dewatering of sidechannels. As noted, the decline in sauger populations in the mainstem Missouri below Morony Dam coincided with these low flow conditions. However, flows have been well above average in the last four years (1995-98) but sauger numbers have remained low.

To assess if there is a lag response between flows and sauger population response, I compared sauger numbers below Morony Dam with spring-summer flows in the previous 3 and 4 years for the 13-year record of sauger catch data, since these are likely the dominant age classes of of fish captured below Morony during electrofishing surveys. There was no association between sauger catch rate and flows 3 years previous ($r = 0.27$, $P=0.38$). However, the relationship between sauger catch rate and flows 4 years previous was highly significant {$r = 0.87$, $P < 0.001$; catch rate = (0.002)flow – 12.19}. This relationship supports Penkal's (1990) contention that sauger abundance is correlated with flows, and that improved flow conditions should result in higher sauger abundance. However, it also supports the contention stated above that sauger abundance in recent years is not responding as positively to increased flows as expected. Sauger catch rates in 1995 and 1997, corresponding to high flow years, 1991 (11,671 cfs) and 1993 (14,109 cfs)(circled on Figure 5), are well below expected. Respective observed and predicted catch rates based on the catch rate-flow regression relationship are 3.5 and 11.1 for flow year 1991, and 1.1 and 16.0 for flow year 1993. The observed catch rates average 80% below expected values. These results imply that some factor other than flow is limiting sauger abundance in recent years. The series of flows >10,000 cfs since 1995 (Figure 4) should provide a critical test in the next few years of whether sauger populations will rebound under good flow conditions.

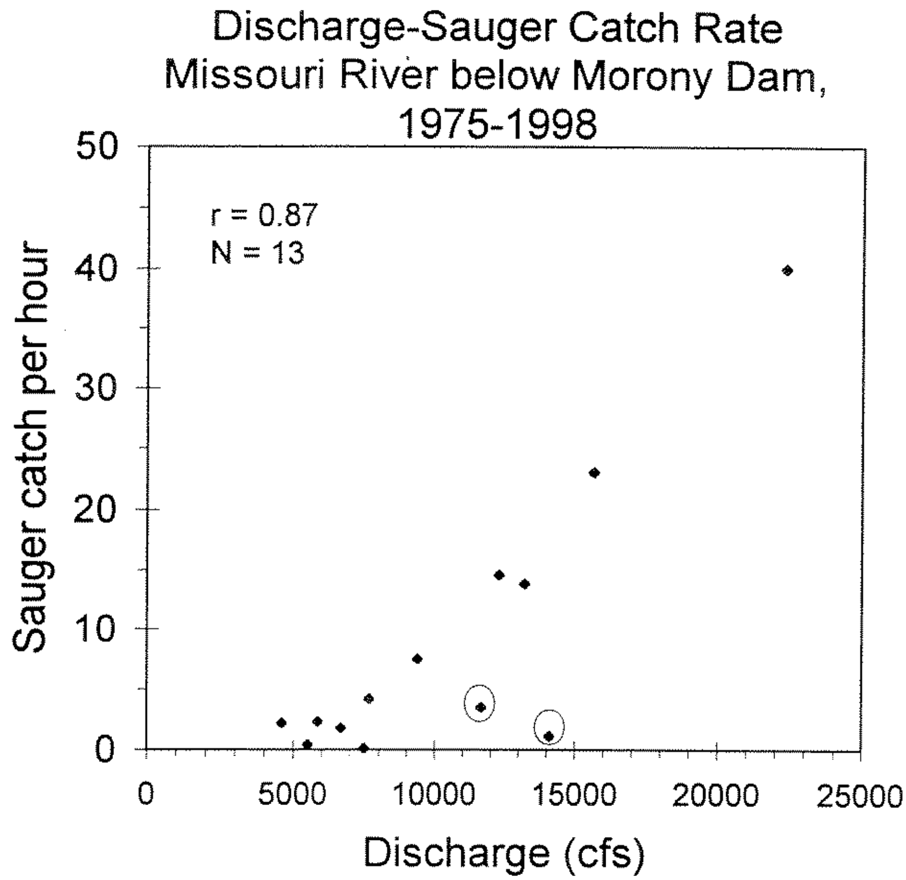

Figure 5. Relationship between mean spring-summer discharge (cfs) of the Missouri River at Virgelle and sauger catch rate below Morony Dam 4 years later.

A number of other studies conducted in the 1970s and 1980s provided additional information about sauger abundance and distribution in the mainstem. In one of the most extensive inventories to date on sauger and on large river ecology, Berg (1981) conducted a fishery inventory between Morony Dam and Fort Peck Reservoir and the lower reaches of the Marias, Teton, and Judith rivers from 1975-80. Sauger were one of the most abundant and widely distributed fish species, occurring at all 11 sampling stations from Morony dam to Fort Peck Reservoir (Figure 6). Of the 9,835 fish captured by electrofishing, sauger comprised 2,916 or 29.6% of the total catch. Highest sauger densities occurred at the four sampling stations above the Marias River (Loma Ferry-Morony Dam; Figure 6). Sauger comprised 41% of the total catch and averaged 11.0 fish per hour above, and 17% of the total catch and 2.1 fish per hour below, the Marias River confluence. Sauger were most abundant below Morony Dam, where they comprised 53% (N = 664) of all fish captured at a catch rate of 20.1 per hour. In contrast, walleye were rare throughout the mainstem Missouri; they were absent from 4 of 11 stations and a total of only 42 were captured (0.4% of total catch). Sauger mean length ranged from 11.9 inches at Robinson Bridge to 15.1 inches at Stafford Ferry. Overall, the mean length of sauger was 13.4 inches; fish ≥20 inches were captured at most stations.

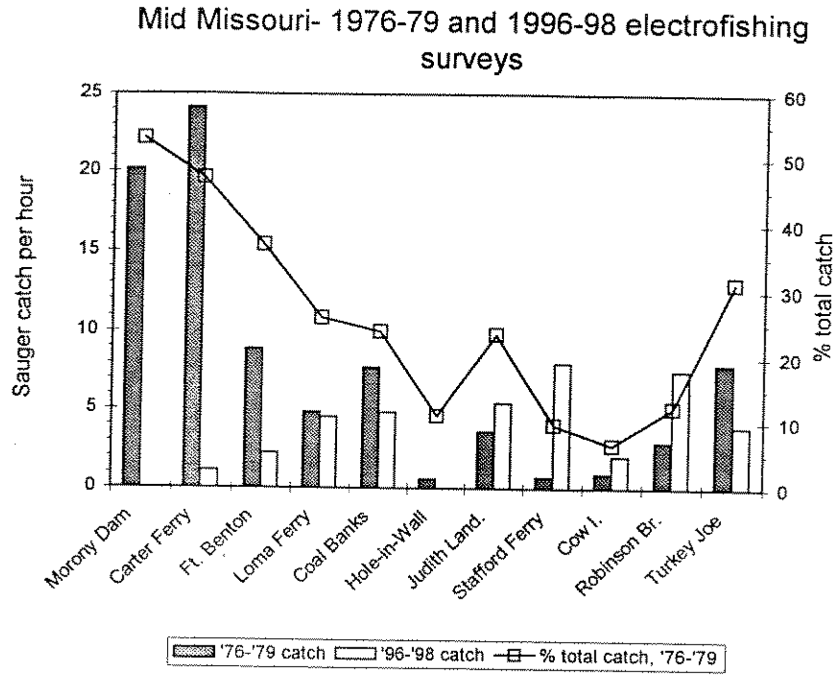

Figure 6. Mean electrofishing catch rates of sauger and percent of total catch in the middle Missouri River, 1976-79 (Gardner and Berg 1982) and 1996-98 (L. Bergstedt, pers. comm.).

Sauger exhibit a pronounced spawning migration from sections below Marias River confluence into the area between Fort Benton and Morony Dam (Berg 1981). Spawning occurred from mid April to late May, peak spawning occurring the first two weeks of May as mean water temperature rose above 53 °F. Though timing of walleye and sauger spawning overlapped, peak spawning of walleye occurred in late April, two weeks prior to peak sauger spawning. Sauger spawning movement into the upper portion of the river occurred during early spring. Catch rate for sauger at Morony Dam increased from 0.2 per hour in late March to 12.0 per hour during the spawning period in May. The catch rate continued to increase through the summer to 28.8 sauger per hour in August, and then decreased to 9.5 in October, indicating many of the fish had moved back downstream. Catch rates of sauger at the Carter Ferry and Fort Benton stations showed a similar seasonal movement pattern (Berg 1981). Large numbers of ripe fish during spawning and high catch rates of sauger from spring-summer in the

Fort Benton-Morony Dam section indicated that this reach of the middle Missouri was critical sauger habitat. Abundance of sauger forage fishes (longnose dace, suckers, shorthead redhorse) was also highest in this section of the river.

Tag return information from 168 of 3,950 tagged sauger revealed extensive and complicated seasonal migrations throughout the 277-mile mid Missouri section. Berg (1981) identified two distinct patterns:

1. Seasonal spawning and feeding migration from areas downstream to upstream involving movements of over 120 miles. Several fish tagged in the headwaters of Fort Peck Reservoir were collected above Fort Benton in the spring and summer. A large proportion of the sauger population in the middle Missouri exhibits a seasonal migration pattern of utilizing upriver areas in spring and summer, and downriver areas in fall and winter.

2. Spawning migration of sauger from the mainstem Missouri River into the lower Marias, Teton, and Judith rivers. These tributaries are used primarily for spawning and fish move back to the mainstem by June. Tag return data also revealed that sauger that spawn in the lower Marias River come from as far as 48 miles upstream and 146 miles downstream of the Marias River.

Angler exploitation of sauger was low during this period based on a tag return rate of 1.5% (58 of 3,950 tagged).

In a continuation of Berg's study from 1975-79, Gardner and Berg (1982) conducted an extensive inventory of YOY sauger distribution and abundance from 1979-83 in the middle Missouri River mainstem in the same 11 sampling stations from Morony Dam to Fort Peck headwaters used by Berg (1981) to quantify adult fish abudance. A main aim of the study was to assess instream flow requirements for spawning and rearing of sauger and other fishes in this mainstem section.

YOY sauger were found throughout the mainstem below the Marias River confluence, but were most abundant (70%) in a 28-mile reach of the lower mainstem in the Cow

Island and Robinson Bridge sections during July-September (Figure 7). YOY sauger were most abundant in side channels followed by main channel pools; habitat types that were common in these lowermost reaches of the mainstem Missouri, but relatively rare upstream. Side channels also proved to be the chief rearing areas for the principal forage species consumed by sauger, namely flathead chub and western silvery minnow.

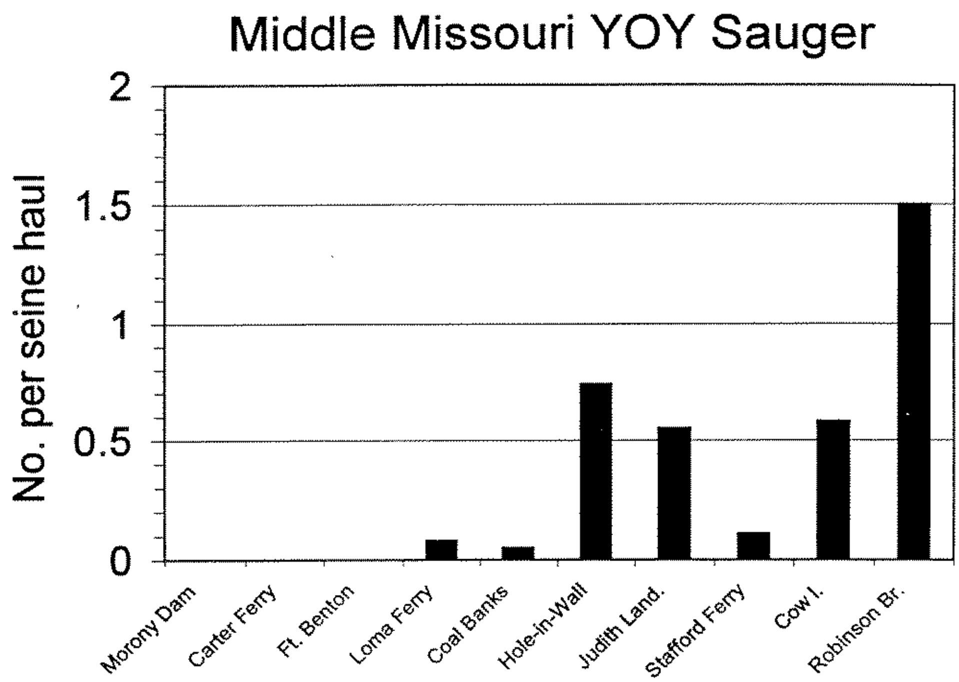

Figure 7. YOY sauger abundance in various sections of the middle Missouri River, late 1970s (from Gardner and Berg 1982).

Sauger distribution responded to differences in flow changes between years. During the high flow years of 1980-81, few YOY sauger were found in sections were they had been abundant in 1979, an average flow year. Sampling was then extended downstream to the Turkey Joe section and the delta region of the headwaters of Fort Peck Reservoir. An average of 2.5 YOY sauger per seine haul were captured in this area, indicating that it provided significant rearing habitat. These data suggested that, in high water years, it is likely that many larval sauger drift into the reservoir, whereas in normal water years, larvae are carried into sidechannels in the lower river reaches. How these difference in water year influence year class strength are unknown.

However, the data do suggest that sidechannels must receive adequate flow for sauger rearing to obtain adequate recruitment into the population. Gardner and Berg (1982) determined that a Missouri River discharge of 5,400 cfs at Virgelle during June-August was necessary to prevent dewatering of sidechannels.

YOY sauger underwent a noticeable shift in distribution and habitat preferences in the fall. In October, sauger shifted from side channel pools to main channel riffles. At this time, the principal food items for sauger shifted to fishes associated with swift current such as stonecats. The results showed that sauger feed extensively in riffle areas and also verifies the significance of side channels and other peripheral habitat areas as essential food producing areas for sauger.

In 1985, Drewes and Gilge (1986) sampled the mainstem Missouri River near Virgelle to examine the possible fishery effects of constructing a canal to divert Missouri River water from the Virgelle Ferry area on the Missouri River to the Big Sandy and Milk rivers. A 10-mile section of river from Six Mile Coulee to Alkali Creek (~Coal Banks section of Berg 1981 and Gardner and Berg 1982, Figures 6 and 7) was electrofished every two weeks from mid April to early August, 1985. This area had been identified by Berg (1981) as one of the most important spawning areas for fishes in the middle Missouri River, lying about 15 miles below the Marias River, a major spawning tributary (Gardner and Berg 1982). Sauger and shovelnose sturgeon were the most abundant sport fishes collected during electrofishing surveys. Overall catch rate for sauger was 3.7 fish per hour, nearly identical to the catch rate of 3.6 per hour measured by Berg (1981) in this same section in the late 1970s. Sauger catch rate peaked in the spring spawning period (6.0 per hour) and declined post spawning (2.0 per hour), as fish moved into this area for spawning, and then upstream above the Marias River confluence for summer rearing (Berg 1981). Mean length of sauger was 13.4 inches. Sauger were found throughout the study section, but large numbers were collected along the steep cliffs just downstream of Virgelle Ferry in April and May, indicating that this area is an important spawning location and habitat type for sauger. YOY sauger were absent from beach seining collections. Gardner and Berg (1982) found few YOY sauger in the Coals Banks reach due a lack of sidechannel habitat. Moreover, in 1985, the sidechannels that did occur in this area were mostly dewatered due to extremely low summer flows (<5,000 cfs in July; Drewes and Gilge 1985).

To assess possible changes in mainstem sauger abundance in this reach over the past 20 years, I compared electrofishing catch rates of sauger in some of Berg's (1981) and Gardner and Berg's (1982) sampling stations that overlap with current sampling of mid Missouri River fish assemblages by Bill Gardner, FWP biologist, and Lee Bergstedt, a graduate student at Montana State University.

Gardner (1997, 1998, pers. comm.) conducted electrofishing surveys in upper river sections in the Carter Ferry, Fort Benton, Loma Ferry, and Coal Banks sections during fall 1996-98. Overall, catch rates in the upper river were considerably lower than fall surveys conducted by Berg (1981) in 1976-79, averaging 70% fewer fish (Figure 6). Bergstedt (1999 pers. comm.) conducted electrofishing surveys in the mainstem below Fort Benton from 1996-98 in the vicinity of the five stations above Fort Peck Reservoir (Judith Landing to Turkey Joe; Figure 6) as part of the current Missouri River benthic fishes study (Young et al. 1998). Average catch rates for sauger in these sections, in contrast, were similar to those reported by Berg (1981) (Figure 6). Average catch rates by site and by years in the lower river were generally similar during the three years of sampling (Table 1). These data suggest that the upper river population density has declined whereas the lower river population density is similar to that determined in earlier surveys.

Table 1. Catch rates (number per hour) for sauger in the middle Missouri River 1996-98 at sites within or near the sampling stations of Berg (1981). ns= not sampled (from L. Bergstedt, pers. comm).

	1996	1997	1998	Average
Judith Landing	4.8	4.5	6.5	5.4
Stafford Ferry	8.0	ns	ns	8.0
Cow Island	4.0	0.0	ns	2.0
Robinson Br.	5.9	6.0	9.4	7.5
Turkey Joe	4.0	3.4	4.4	3.9
Average	5.3	3.5	6.8	5.4

These recent data do not show the marked declines in sauger abundance observed in the upper mainstem below Morony Dam (described above) and in the lower Marias River (described below).

A. 2. Belt Creek

Posewitz (1962a) documented a significant sauger spawning run as far as 31 miles up Belt Creek, a tributary to the Missouri River located several miles below Morony Dam. Penkal (1990) conducted limited electrofishing surveys in fall 1990 in lower Belt Creek and found no resident sauger. It is unknown if sauger continue to use this stream for spawning.

A. 3. Marias River

Studies in the 1960s (Posewitz 1962a, 1963) and 1970s (Berg 1981) confirmed the lower Marias River as an important sauger spawning area. Berg (1981) electroshocked a 2.4 mile section of the lower Marias near its confluence over a four-year period (1976-79) and collected 41-236 adult sauger per year during the period of late April to early July. Given the abundance of ripe sauger in the lower Marias and the small portion of area sampled, it was felt that this section of the Marias represents only a small proportion of the total sauger spawning habitat available below Tiber Dam. Posewitz (1963) observed sauger movements of up to 52 miles upstream in the Marias River. From April 3 to June 11,1962, Posewitz (1962a) captured 384 sauger, 54% of the total catch of 711 fish comprising 14 species, in fish traps placed in various locations in the 75-mile reach between Tiber Dam and the mouth. These results support Berg's (1981) contention that sauger spawned throughout the length of the Marias River below Tiber Dam.

The spawning run at the Marias River confluence with the Missouri River has been monitored intermittently in a four-mile reach since Berg's (1981) initial sampling in the late 1970s. The size of the spring sauger run in this area has dropped substantially in the last 20 years. In 1979-82, a period of good sauger abundance as noted above, sauger catch rate was 18.2-39.2 per hour (Figure 8). Paralleling the decline observed in the mid Missouri below Morony Dam, sauger catch rate declined to an average of 14.0 fish per hour during the low water years of the late 1980s (Gardner 1998b). In 1996-97, sauger catch averaged 3.6 per hour, a 75% decline from the reduced spawning runs of the late 1980s. In April 1999, sauger catch was 3.0 fish per hour based on 5.4 hours of sampling over 3 days from April 9 to May 18 (B. Gardner pers. comm.); walleye catch rate was 9.4 fish per hour during the same period. Larval sampling in 1996 and 1997 showed that the Marias River confluence is still a critical sauger spawning area (Gardner 1998b), but numbers of spawners appears much reduced.

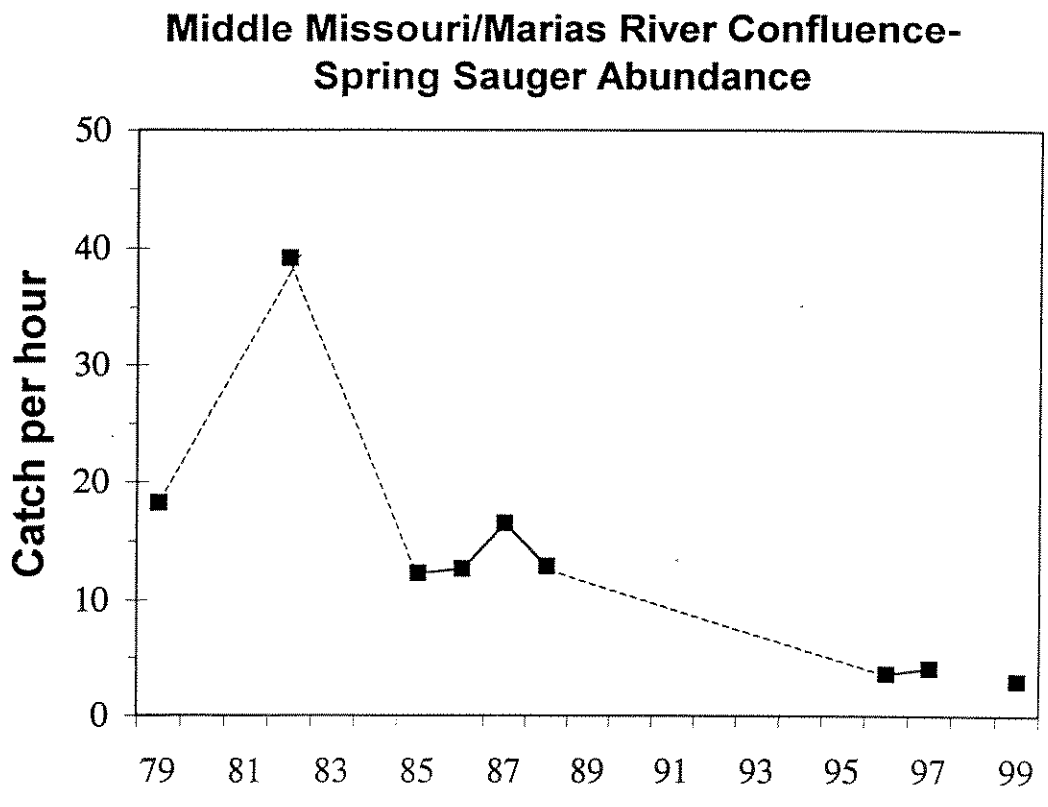

Figure 8. Sauger catch rate in the lower Marias River during spring spawning, 1979-99.

Why the Marias River spawning run has declined so markedly is unclear. However, the decline is significant since it is likely the most important spawning run in the entire middle Missouri system (Berg 1981). As noted, timing of the initial decline coincided with system-wide drought and associated sauger decline below Morony Dam. Tiber

Dam releases changed in 1994 resulting in higher and cooler spring flows which could have altered the seasonal cues that trigger sauger spawning migration. However, Gardner (1998b) reasoned that dam release changes are unlikely to have caused the decline since sauger spawning runs began declining several years earlier. Moreover, the recommended minimum springtime flow in the lower Marias during sauger spawning and incubation (500 cfs from April 20-June 7; Anon. 1998) has been met since 1988. Depressed water temperature during the spring and summer could be another factor. However, April and May temperatures in the lower 30 miles of river are comparable to upper Marias and mid Missouri River temperatures, and still well within preferred spawning temperatures (Gardner 1997, 1998b).

Resident sauger also occurred in the lower Marias River and historically were the most common sport fish and comprised the bulk of the sport fishery. Sauger and other resident fishes were surveyed by Gardner and Berg (1982) in five sections of the river in fall 1979. The lower Marias River is characterized by a narrow floodplain confined by steep badlands topography, and very little side channel development. Sauger abundance increased downstream. Sauger catch increased from 4.1 fish per hour or 8.8% of the total fish caught by electrofishing at Tiber Dam, to 32.2 fish per hour or 68% of the total fish caught in the Collins section near the mouth (Figure 9). The high abundance of sauger in the fall (October), particularly in the lower 35 miles of the lower Marias, signified that it supported a resident as well as an influx of spawning fish from the mainstem. A number of YOY sauger were collected in the lower two sections indicating some juvenile rearing occurs in this tributary too.

Gardner (1997, 1998b) re-sampled parts of three of the five sections of the lower Marias River from April-July 1996 and 1997. Overall, sauger catch rates were considerably lower than that observed by Gardner and Berg (1982) in 1979 (Figure 9). Possible limitations of this comparison are the different time of sampling (fall in 1979 vs. spring-early summer in 1997-98) and the fact that the sections sampled were not the same length as the earlier survey. However, spring-summer densities, partially reflective of an influx of spawning fish, would be expected to be higher than fall densities, suggesting that the resident population may even be lower in the lower Marias than the recent catch values indicate.

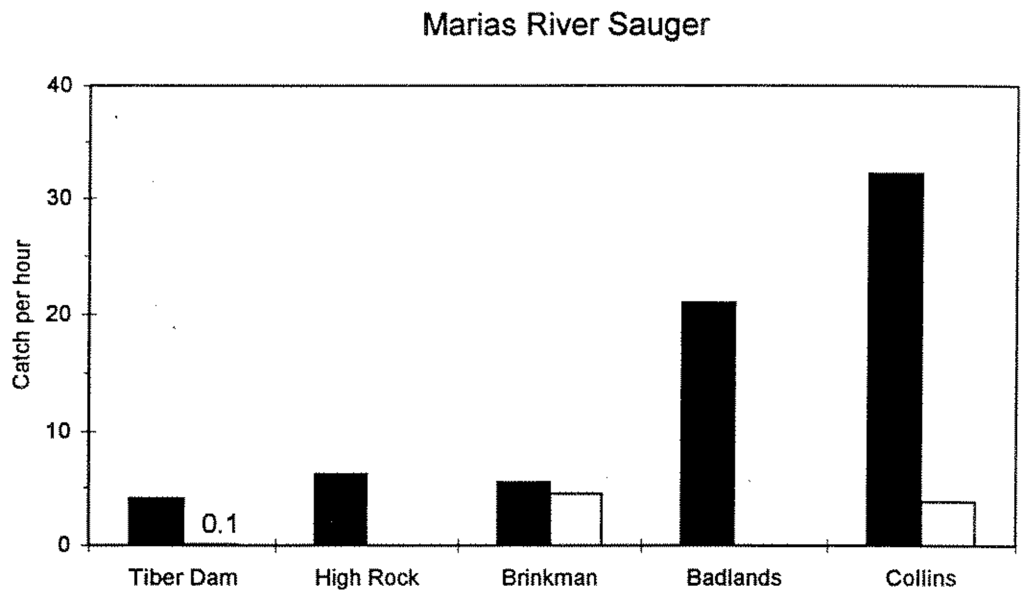

Figure 9. Electrofishing catch rates of sauger in various sections of the Marias River below Tiber Dam, 1979 and 1996-98 (data from Berg 1981 and Gardner 1997, 1998b).

Sauger were once common in the upper river above what is now Tiber Reservoir (Posewitz 1962b). Tiber Dam was constructed on the Marias River in 1950s. A large scale chemical treatment of the upper river prior to closing the dam resulted in extirpation of sauger and goldeye in the upper Marias River. Posewitz (1962b) found no sauger above the reservoir during a 1961 survey of the upper river, and recommended reintroduction of sauger to the upper river. No sauger have been collected in Tiber Reservoir during annual gill net surveys in ensuing years (S. Leathe, FWP, Great Falls, pers. comm.). A survey of the river above the reservoir was conducted in late June 1993, when spawning sauger would most likely have been present. No sauger were collected in a nine-mile section near Cut Bank, MT, nor in a 4 mile section about 10 miles upstream from the reservoir (Liknes and Hill 1994). Walleye were common in both sections and it is believed that the upper river supports both a migrant and resident population of walleye. FWP is considering reintroducing sauger above the reservoir, but there is concern about the potential for hybridization with the substantial walleye spawning run into the river from Tiber Reservoir and with possible competition for limited forage in the reservoir with walleye and northern pike (Anon. 1997; S. Leathe pers. comm.).

A. 4. Teton River

The Teton River is a large tributary river that joins the Marias River near the confluence with the Missouri River near Fort Benton. Berg (1981) found considerable use of the lower Teton River by spawning sauger during surveys in late April 1977 and early May 1979, capturing an average of 6.3 sauger per mile near the mouth. Numbers of spawning fish were considerably less abundant than found in the lower Marias River. Gardner and Berg (1982) sampled resident fish populations in a 75-mile reach from Shannon Bridge to the confluence with the Marias during fall 1979. The reach was divided into a 6-mile-long upper section (Bootlegger, ~70 miles from the mouth) and a 23-mile-long lower section near the mouth (Wood). Sauger were the most common sport fish in both sections. In the upper section, sauger catch was 3.5 per hour, and 4.8% (25 of 517) of the total catch. In the lower section, sauger catch was 2.5 per hour and 5.5% (28 of 509) of the total catch. Sauger were large, averaging 400 mm in length, and no YOY sauger were found in either section, indicating large fish were likely seasonal migrants.

Historically, the Teton River likely supported a good resident and spawning population of sauger given the favorable forage and habitat conditions present when flows are adequate. There has been limited sampling on the Teton River since 1979, but several lines of evidence suggest that resident sauger are now very rare in the entire river (B. Gardner pers. comm.): sauger have been absent from angler catches; they were absent from the Woods section when it was re-sampled in 1997 (Gardner 1998b) whereas they were common in this same reach in 1979; and no sauger larvae were present in larval sampling in 1996 or 1997 (Gardner 1998b). The five irrigation storage reservoirs on the river restrict access and dewatering is a chronic problem (Berg 1981). Much of the river was severely dewatered during the mid 1980s drought, and major dewatering of the lower river is estimated to occur in five of 10 years (Gardner pers. comm.). Adequate minimum flows would likely enable the sauger to reside as year-round residents (Gardner and Berg 1982). It is uncertain why the lower river appears to no longer support a spawning run of sauger, since spring flows, temperature, and turbidity would seem to favor sauger use, and other native fishes like blue sucker still spawn there (Gardner pers. comm.).

A. 5. Judith River

The Judith River is the second largest tributary of the middle Missouri River. Berg (1981) electroshocked a "significant number" of spawning sauger in the lower Judith River in May 1979, but did not report actual numbers. Resident fish populations were surveyed in a 19-mile reach of the lower Judith between Anderson Bridge and the confluence with Missouri by Gardner and Berg (1982). The lower Judith River is characterized by a well developed, moderately confined floodplain, and substrate comprised of small cobble and gravel. A significant feature of the system is the presence of spring creeks which augment the flow. A 3-mile-long upper reach (Anderson) and a 3.9-mile-long lower reach (PN ranch) were electrofished in fall 1979. Resident sauger were moderately abundant in both reaches, averaging 3.4 fish per hour or 8% (26 of 325) of the total catch. A number of YOY sauger were collected in the lower reach indicating that spawning and rearing occurs in the lower Judith River. The Judith River appears to have good habitat for sauger (riffles with gravel/rubble substrate, deep pools, abundant forage, and adequate river flows). There have been no recent surveys so a comparison of past and recent sauger abundance is not possible. The Judith River is one of the lesser known river systems in the state, and a baseline fisheries inventory is needed to assess use by sauger and other species (Anon. 1997).

A. 6. Musselshell River

High turbidity and low conductivity limit the effectiveness of electrofishing on this river hence little population data is available. Wiedenheft (1980) surveyed eleven 2.5-mile sections over 220 miles of the Musselshell River in summer 1979 and found sauger the most abundant sport fish in the river below the town of Musselshell. Of the 66 sport fish captured (smallmouth bass, channel catfish, northern pike), 76% (50) were sauger.

Sauger were absent from the river above the town of Musselshell, and electroshocking above and below the Musselshell water diversion revealed that the structure blocked upstream movement.

No data is available on current status of the sauger population. Historically, the Musselshell likely supported a good population of spawning and resident sauger. Anglers are known to target a sauger spawning run up the Musselshell in the spring when they congregate below the Musselshell diversion dam. However, where sauger spawn in this system, the impacts of restricted movement from diversion dams, and how the population has fared in recent years is unknown. Status of walleye use of the river is also unknown, but it is possible that sauger using the river are reproductively isolated from walleye (K. Frazer and M. Vaughn, FWP, Billings, 1999 pers. comm.). Chronic dewatering of the lower Mussellshell likely limits its suitability as habitat for spawning and resident sauger, channel catfish, and smallmouth bass (Anon. 1997).

B. Lower Missouri

The lower Missouri system consists of the 183-mile mainstem Missouri River section from Fort Peck Dam to the North Dakota border, the ~162-mile-long Fort Peck Reservoir, a major tributary-the Milk River, and several moderate-sized tributaries: the Poplar and Redwater rivers, and Big Muddy and Little Porcupine creeks. Fort Peck Reservoir has a long fish sampling record for following trends in sauger abundance. The lower mainstem and the lower reaches of the major tributaries were sampled in the late 1970s-early 1980s by Gardner and Stewart (1987), but data are scarce from that time until the mid 1990s when another round of more intensive fish sampling began. Large sections of the Milk River and its rather sizable tributaries remain poorly known.

B. 1. Fort Peck Reservoir

A good record of sauger population data exists for Fort Peck Reservoir. Trap netting for walleye spawners has occurred annually each spring since 1980. Beach seining of shoreline areas, numbering 133-195 seine hauls per year, has occurred annually in late August-early September since 1981. Reservoir-wide gillnetting at 26 stations has occurred almost annually during mid-summer since the early 1980s. Reservoir-wide creel surveys were conducted in 1990 and 1997. The data are available in annual DJ reports (e.g., Wiedenheft 1990); the 1998 report (Brunsing 1998) lists a data summary of beach seine data for all species from 1981-1997.

Sauger YOY abundance in beach seine surveys averaged 0.4 fish per seine haul from 1981-86 (Figure 10). Catch dropped sharply in 1987-89 to 0.05 per haul. Poor catches of YOY northern pike and yellow perch also occurred at this time, and Wiedenheft (1990) attributed low recruitment of these three species to very low river and reservoir water levels. Water levels have risen steadily since the early 1990s, especially in 1993, and northern pike and yellow perch recruitment has rebounded accordingly as shoreline vegetation has become inundated (Brunsing 1998). In contrast, sauger YOY abundance has remained low, averaging 0.1 fish per haul, a 75% average decrease from the 1980s.

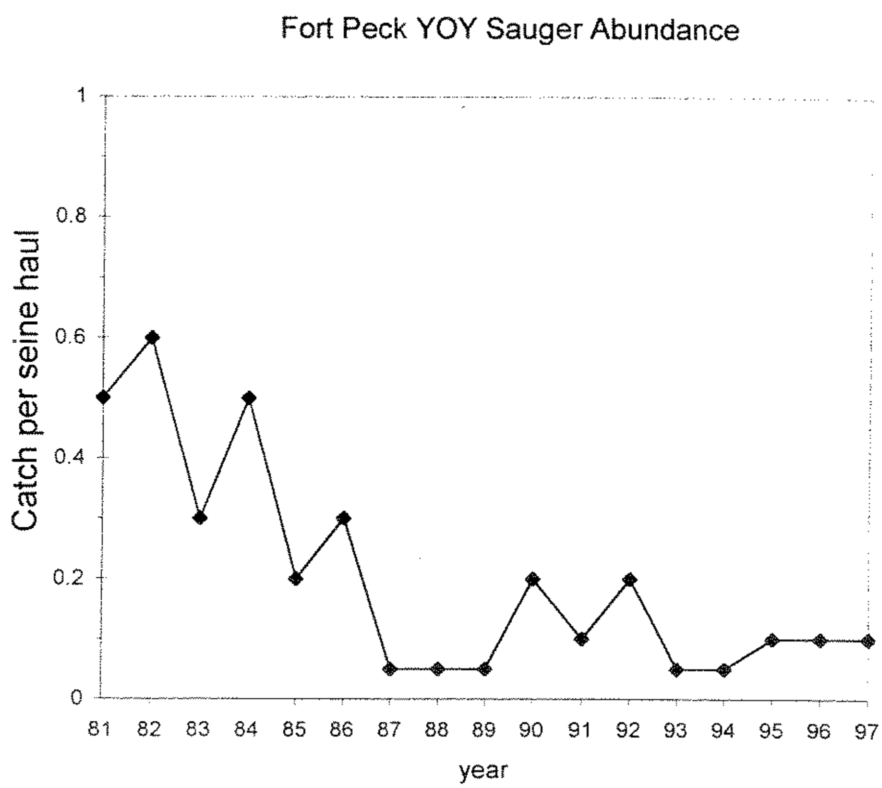

Figure 10. Catch rates of YOY sauger in Fort Peck Reservoir, 1981-97.

Gillnet catches of sauger generally mirror the decline in YOY abundance (Figure 11). Sauger abundance has shown a steady decline from 4.4 fish per net in 1982 (Needham and Gilge 1983) and 3 fish per net in 1987 (Wiedenheft 1989) to <1 fish per net since 1994. Percent of total gill net catch has shown a similar decline, decreasing from 9% to 2% over this same time period. In contrast, other species like northern pike, walleye, and yellow perch, have shown marked increases in abundance over the past decade (Brunsing 1994-97).

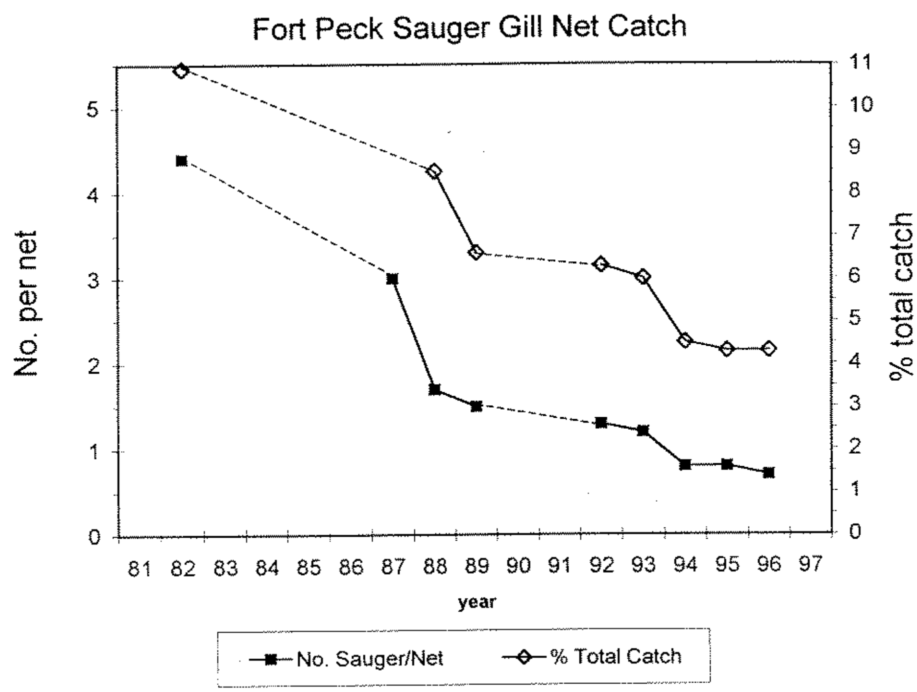

Figure 11. Number of sauger caught per gill net set, Fort Peck Reservoir 1982-96.

The number of sauger caught by anglers also decreased from 1990 to 1997. An estimated 3,128 sauger were harvested in the summer 1990 creel survey, or 12% of the total catch. In 1997, only 917 sauger were harvested, representing 2.6% of the total catch. Reservoir-wide, the sauger catch rate declined by 75%, from 0.023 to 0.005 fish per hour. Angler harvest data therefore appear to mirror the decline of sauger observed in YOY and gill net sampling.

It is important to note that Fort Peck sauger are larger than most sauger populations that average 13 inches and about a pound or less. The average size of sauger harvested in 1990 was 20.3 inches and 2.8 pounds, and 18 inches and 2.2 pounds in 1997. The size of these fish suggests that sauger could be managed as a trophy fishery in Fort Peck Reservoir. It is curious, though, as why sauger growth and abundance has not responded dramatically to improved forage availability since the late 1980s as have other piscivores in the lake. After cisco introduction, walleye growth rates and length-at-age has risen dramatically (Brunsing 1998). Other piscivores like northern pike and chinook salmon also feed heavily on cisco and have shown a similar marked increase in size and abundance. Saugers do feed on cisco (Brunsing 1998), but to a lesser degree than other piscivores (2.5% of sauger stomachs vs. 9.5-44% in other species), and improved forage appears to have had little impact on abundance or growth of sauger.

Sauger are most abundant in the more turbid and riverine-like Missouri Arm in the upper reservoir. Greater than 90% of sauger captured in beach seine hauls, and >78% of those captured in gill nets, occurred in the Missouri Arm of the reservoir. Very few sauger have been caught during spring trap netting in the Big Dry Arm of the reservoir in contrast to walleye which are very abundant (e.g., 4,000 in 1997; Brunsing 1998; B. Wiedenheft, FWP, Glasgow, 1999 pers. comm.). In the 1997 creel surveys, sauger catch rate was considerably higher in the Missouri Arm (0.012 fish/hr) than in other areas of the reservoir (0.001-0.007 fish/hr).

In summary, adult abundance and YOY recruitment of sauger declined sharply in the late 1980s during drought years, and unlike other species, has shown little evidence of rebounding despite higher river flows and reservoir water levels over the past six years. Sauger size also has not responded to a greatly improvied forage base compared to other piscivores.

B. 2. Mainstem Lower Missouri

Gardner and Stewart (1987) conducted a 5-year study of the 183-mile section of the lower Missouri between Fort Peck Dam and the Montana-North Dakota border from

1979-1983. Cold, clear water release from Fort Peck Reservoir was found to influence the river for many miles downstream. Two major tributaries, the Milk and Poplar rivers, contribute to restoring some of the prairie river characteristics by increasing both water temperatures and turbidities to more natural levels. For example, turbidities are typically <7 JTU in the 10-mile section between the dam and the Milk River confluence but increase to >50 JTU below the Milk River (Gardner and Stewart 1987). As noted in the life history section, sauger are rare at turbidities <10 JTU.

Gardner and Stewart (1987) determined fish distribution and abundance in 8 sections of the mainstem and several tributaries from 1979-83. Sauger were common to abundant in all 8 reaches of the mainstem except for the section below Fort Peck dam, and most abundant (7.8 fish per hour via electrofishing) in the Nickels Ferry reach near the confluence of the Milk River (Figure 12). Sauger were the most common sportfish, comprising 69% (3,612) of the 5,206 sportfishes captured (shovelnose sturgeon, northern pike, burbot, sauger, walleye). A mark-recapture population estimate of sauger in the Nickels Ferry reach just below the Milk River confluence yielded 2,028 sauger per mile (1,314-2,985 95% CI) in summer-fall 1982. Population estimates in other reaches were attempted but deemed unreliable due to the low number of recaptures.

Sauger were much more abundant than walleye by about a 10:1 ratio. A total of 300 walleye were captured in the 5 years of the study, comprising 2-14% of the sport fish catch, compared to 61-85% for sauger. The average catch rate for sauger in all sections and years combined was 4.3 fish per hour, about 7 times greater than shovelnose sturgeon, the next most common sport fish. Average of mean lengths of sauger captured at all stations was 14.75 inches, ranging from a high of 17.5 inches mean length at Ft. Peck dam to a low of 13.8 inches mean length in the Wolf Point reach. Length range of all fish was from 4.8 to 29.6 inches, the largest fish tipping the scales at 6.7 pounds.

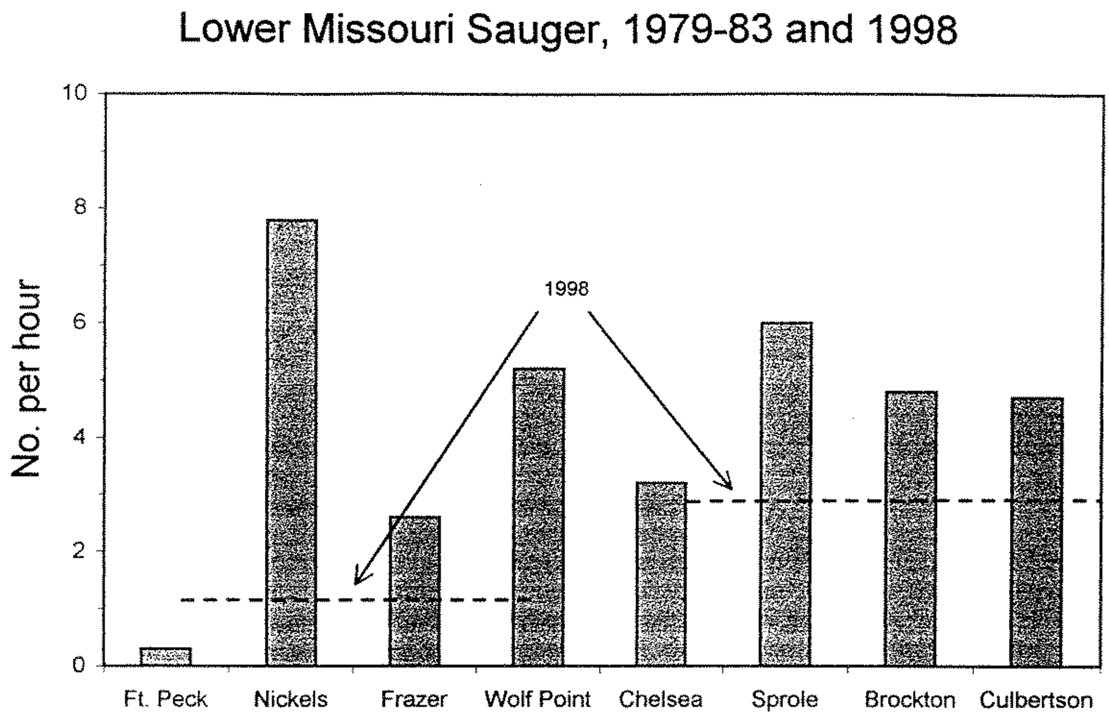

Figure 12. Electrofishing catch rates of sauger in various sections of the lower Missouri River, 1979-83 (from Gardner and Stewart 1987). Catch rates in 1998 shown as dotted line (Ruggles and Fuller, 1999 pers. comm.).

Sauger spawning over the entire 184 mile mainstem reach was primarily concentrated in two areas--the turbid, warmer Milk River confluence area, and about 14 separate locations below the Highway 13 bridge (Chelsea section above the Poplar River confluence)—totaling about 5 river miles (Gardner and Stewart 1987). Concentrations of sauger in spawning condition were noted in these areas in the spring. In the Chelsea section, Gardner and Stewart (1987) found spawning sauger concentrated in rocky reef areas, a unique geomorphic feature in the river created by erosion of hard sandstone cliffs (Figure 13). Spawning was limited to about 8 sites in the river having these unique features.

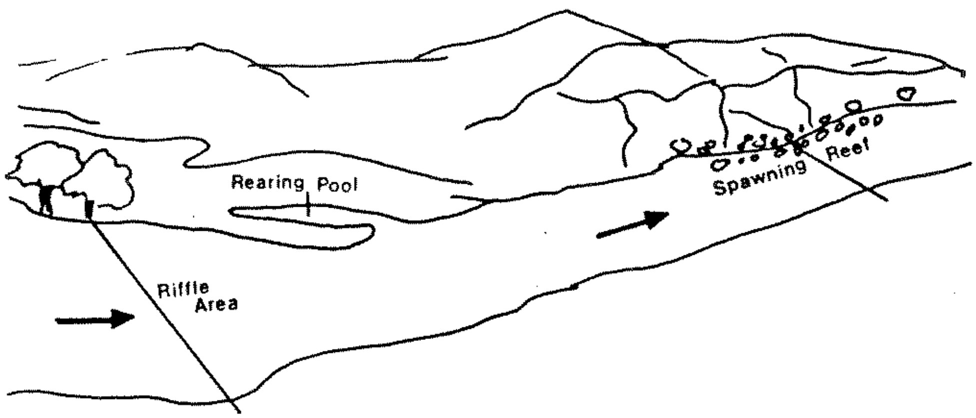

Figure 13. Diagram of rocky reefs and rearing pools used by sauger for spawning and rearing, lower Missouri River (from Gardner and Stewart 1987).

Gardner and Stewart (1987) recommended instream flows of 11,497 at the Wolf Point and Culbertson USGS stream gauging stations from May 11 to June 30 in order to maintain adequate spawning and incubation flows in these important and likely limiting spawning habitats. Inspection of spring (May 1-June 30) flows in the lower Missouri River at Wolf Point for the 50-year period, 1949-98, revealed that spring flows have been well below both the long-term average (~10,000) and the recommended spawning and incubation flow of 11,497 in most years since the mid 1980s (Figure 14). In the 13-year period, 1987-98, spring flows exceeded the recommended flow in only 3 years; flows were well below this value (6-8,000 cfs) for 7 consecutive years from 1987-93.

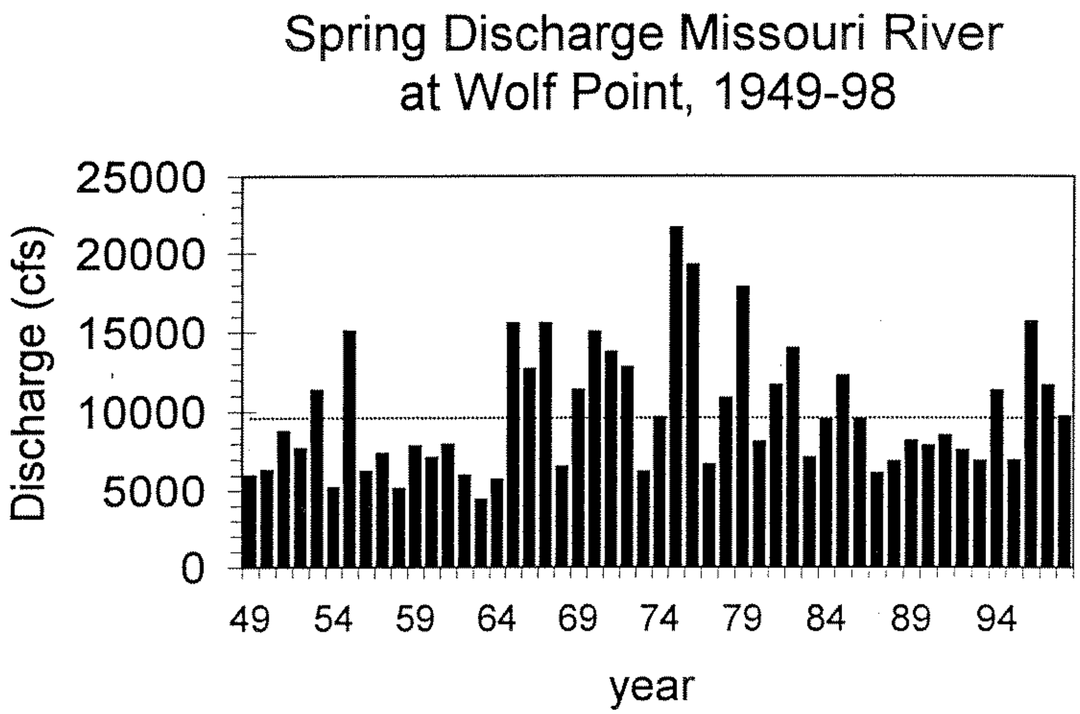

Figure 14. Mean spring (May 1-June 30) discharge of the lower Missouri River at Wolf Point, 1949-98.

Though records are insufficient to allow statistical comparison, available data suggests a positive relationship between spring flows and abundance of spawning sauger in the lower Milk River and the confluence. Gardner and Stewart (1987) reported high variation in spawner abundance between years. In spring 1982, when spring discharge averaged 13,979 cfs, sauger spawner abundance was ~12 times higher than the previous two years of lower flows (Table 1). Stewart (1981a) found few sauger or other species overwintering in the mainstem, and speculated a large warmwater pulse from tributary streams triggered movement from overwintering sites. Where sauger overwinter is unknown, but Stewart (1981a) and Gardner and Stewart (1987) speculated that higher spring flows triggered increased sauger migration out of Lake Sakakawea. Sauger may switch spawning to below Fort Peck dam in years when reservoir discharge is high relative to Milk River discharge (Clancey 1989). Abundance of larval fishes also peaked during high flow years, further indicating that reproduction appeared tied to spring flow conditions. Recent data appear to support such a sauger-discharge link. In 1996, a high flow year (Figure 14), 76 sauger were gill netted during early May in the lower Milk, one of the the larger catches made in recent years (J. Liebelt, FWP, Fort Peck, unpub. data).

Table 1. Catch rates of sauger electroshocked in the Missouri River, spring 1980-82 (from Gardner and Stewart 1987), and spring (May-June) discharge (cfs).

Year	N	Fish/hour	Total hours	Discharge
1980	59	1.0	60	8,103
1981	46	0.8	64	11,636
1982	558	12.8	44	13,979

Gardner and Stewart (1987) found YOY sauger were the most abundant sportfish rearing in the study area. The majority were sampled in the lower 80 miles of the study area between the Poplar River confluence and the North Dakota border (Figure 15). The pattern of YOY density was similar to that observed in the middle Missouri (about 1.5 fish per seine haul; Gardner and Berg 1982), though the sidechannel habitat favored by YOY sauger in the mid Missouri was relatively rare in the lower Missouri. YOY were most abundant in deep off-channel pools formed by lateral sand bars. YOY sauger were generally absent from pools <1.5 feet deep and from areas with noticeable river current.

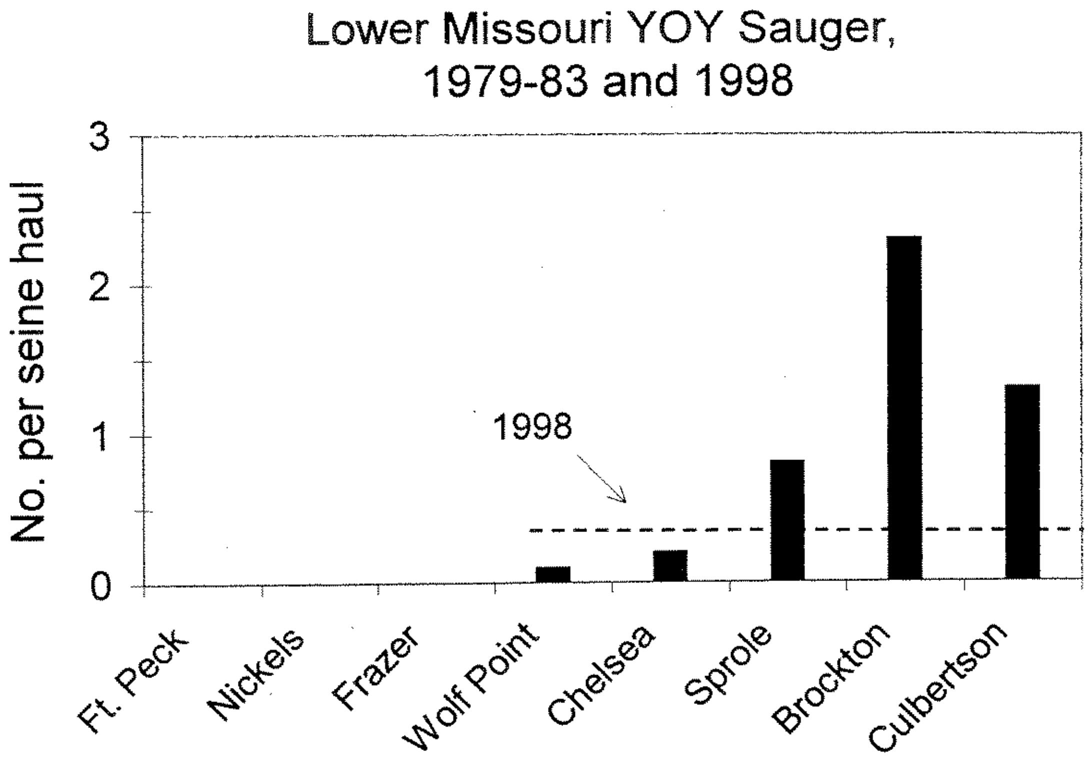

Figure 15. Abundance of YOY sauger in various sections of the lower Missouri River, 1979-83 (Gardner and Stewart 1987) and 1998 (Ruggles and Fuller, pers. comm.).

Sauger exhibit extensive movements in the lower Missouri and Lake Sakakawea system. Gardner and Stewart (1987) tagged 4,530 sauger during their study, one of the more intensive tagging studies of sauger reported. A total of 362 or 8% of tagged sauger were recovered. Sauger were highly mobile, exhibiting a median movement distance of about 10 miles, but extremely long distance movement of up to 420 miles in 121 days was recorded. Sauger tagged in the lower Missouri River mainstem were recaptured throughout the 150-mile-long Lake Sakakawea and in the lower Yellowstone River. The median and range of movements shown by sauger were similar in magnitude to those documented by Berg (1981) in the middle Missouri River

The general seasonal movement pattern was summarized as follows:

1. Sauger remain in the Milk River confluence section in spring and early summer during spawning and post spawning through mid summer. As the Milk river turbid plume subsides in mid summer, sauger disperse, many of moving them upriver to

feed on rainbow smelt in the tailwater area of Fort Peck Dam.

2. Nine percent of tags were recovered in Lake Sakakawea. This movement was variable and likely related to river flow conditions and spawning and foraging activities. No tagged fish exhibited this movement in 1979 and 1980 when spring runoff was low. Conversely, movement between the river and reservoir was common during 1980 and 81, years of normal spring run off conditions, which suggests that high river flows trigger spawning migrations out of Lake Sakakawea into the upper and middle reaches of the Missouri River mainstem. Rainbow smelt migrations upriver may also trigger sauger to move upriver out of the reservoir (see also Stewart 1981a).

3. The majority of fish recaptured in Lake Sakakawea were recovered in the upper third of the reservoir.

Angler exploitation of sauger during the study was estimated to be 2.8% based on tag returns.

There is a significant gap in sauger abundance information in the lower Missouri River mainstem since Gardner and Stewart's (1987) study in the early 1980s. Some sauger have been captured from 1994-98 in the lower Missouri mainstem during annual sampling for pallid sturgeon using drifting trammel and gill nets (Tews 1994; Liebelt 1996), but the data series are not long enough to determine trends.

Recent sampling in the lower Missouri as part of the Missouri River benthic fish sampling project, however, suggests sauger numbers are about 50% lower than in the early 1980s. Electrofishing catch rates in the Milk River confluence to Wolf Point section were 1.5 sauger per hour in 1998 compared to an average of 5.2 per hour in 1979-83 sampling (Figure 12)(M. Ruggles and D. Fuller, FWP, Fort Peck, 1999 pers. comm.). The Wolf Point to Yellowstone River confluence yielded 2.4 sauger per hour in 1998, compared to 4.7 per hour in 1979-83. YOY sauger in particular were less common, yielding an average of 0.08 sauger per seine haul (5 fish in 60 seine hauls) compared to an average of 0.9 fish per seine haul in 1979-83 (63 fish in 68 seine hauls)(Figure 15).

B. 3. Milk River

The Milk River is a large drainage that extends from the Missouri River just below Fort Peck northwestward into Canada. Historically, this river likely supported an abundant migratory and resident population of sauger. Its high turbidity and presence of gravel substrates for spawning characterize high quality habitat for sauger and a large spawning run of sauger from the Missouri up the Milk River was probably common. Sauger were collected in the Milk River during early fish surveys in the state (Evermann and Cox 1894). There are now seven major water diversions on the Milk River in Montana beginning with the Vandalia dam 117 miles from the mouth. The Dodson and Havre water diversion dams are known barriers to channel catfish and carp, respectively, but all seven diversion dams are likely impassable to migratory fish such as sauger since all have 10-40 foot drops (K. Gilge, FWP, Havre, 1999 pers. comm.).

There is some historical data on sauger abundance in the lower Milk River below the lowermost dam, Vandalia. The lower Milk River is about 100 feet wide, has low gradient, and gravelly riffles are spaced about 1-2 miles apart interspersed with long pools 6-8 feet deep during the summer, features conducive to providing good sauger habitat. Gardner and Stewart (1987) sampled the lower 60 miles of the Milk River in 1979-84 using a variety of gears in three sections: near the mouth, and 23 and 60 miles upstream. Sauger were common to abundant at each of the three sites, gill net sets averaging 2.4 sauger per net. Electrofishing occurred in spring-early summer and was confined to the lower 5 miles of the river. Sauger averaged 10.2 fish per hour whereas other sport fish occurred in low numbers. Overall, 918 sauger were captured in 4 years of sampling, comprising 91% of the catch of 1,024 sport fish (Gardner and Stewart 1987). In contrast, 54 walleye (5.4% of the total sport fish catch) were captured, yielding a sauger:walleye ratio of 17:1. Large numbers of spawning sauger were found in the lower reach of the Milk near the confluence with the Missouri River and this reach is thought to support a large majority of the total spawning activity of sauger throughout the lower Missouri River (Gardner and Stewart 1987). In 1980, a total of 285 sauger were captured in one week in early May in a 2-mile stretch near the confluence (4 days of sampling=71 fish per day). Very few fish tagged were recaptured during this period, attesting to the high use of this area for spawning by sauger. This lower section is also used heavily by sauger throughout the summer. In summer 1980 {mid June(post spawning)-early September}, 395 sauger were captured in 6 days of electrofishing for a capture rate of 66 fish per day in this same section of the lower Milk River. In contrast, only 16 walleye were caught. Use of the lower Milk River for spawning and rearing was highly variable, depending upon flow conditions (Stewart 1981a). Highest catch occurred in 1980, a high flow year. Spring-summer catch rates were lower in lower flow years (1979=14.5 fish per day; 1981=24 fish per day; 1982=19.1 fish per day).

There is a gap in data from the Milk River since the mid 1980s. However, there has been some recent sampling of the lower Milk River from the mouth to Vandalia dam as part of the Missouri River benthic sampling study (M. Ruggles, D. Fuller, and J. Liebelt, FWP, Fort Peck, 1999 pers. comm.). Gill net catches in the lower Milk have ranged from a high of 115 in 1996, but 1997 catches yielded only 2 sauger. Sauger:walleye ratio has also changed from >10:1 in the 1980s to 2-3:1 in recent years. No sauger were captured by electrofishing this reach in 1998, and only one was captured in a gill net (~0.3 fish per net set assuming 16 hour net sets). In contrast, Gardner and Stewart (1987) reported catch rates of 2.4 sauger per gill net set. The data suggest that the Milk River sauger decline is mirroring the apparent decline in sauger in the lower Missouri River mainstem.

There is a lack of data on the Milk River upstream of Vandalia dam. Available data suggest that sauger are uncommon throughout much of this rather extensive river section. In 1998, no sauger were caught among the 652 fishes collected during the benthic fish survey in the ~80-mile reach between Vandalia and Dotson dams. No sauger have been recorded in Nelson Reservoir (Gilge pers. comm.), an offriver reservoir located near to the Milk River mainstem.

Based on angler reports, sauger may still be common between the Havre and Dotson diversion dams though little sampling has been done in this area (Gilge pers. comm.). The section between Fresno Reservoir and the Havre diversion dam is characterized by steep banks, shifting sand and silt substrate, and limited boat access. This reach has not been sampled extensively in the past, but sauger were listed as 'common' based on spot collections in the 1960s to 1980s (Drewes and Gilge 1985). Several large gravel/rubble riffles below the dam likely provide the major suitable spawning areas for sauger in this section of the Milk River. Low flows in early spring, when Fresno Reservoir is filling, often dewaters available spawning substrate and likely limits the potential for successful spawning (Drewes and Gilge 1986).

Drewes and Gilge (1986) sampled the lower 50 miles of Big Sandy Creek, a major tributary to the mid Milk River, from Box Elder, MT, to its junction with the Milk River near Havre, MT, in 1985 using electrofishing, larval fish sampling, and beach seining. No sauger were captured in the upper 48 miles of the stream. Due to low water levels, the stream was dominated by slow moving, vegetated pools, and as a result white sucker, cyprinids, and northern pike comprised nearly all the catch. YOY sauger were common in the lower 1.8 miles near the mouth. This section was characterized by a pool: riffle configuration and a diversity of habitat types including dense aquatic vegetation and bank cover, backwaters, and a deep mid stream channel. This habitat type is rare in the mid Milk River, and this section is likely a critical nursery area for sauger and other species (Drewes and Gilge 1986).

Sauger are only occasionally caught in Fresno Reservoir (3 from 1992-1998; Gilge pers. comm.), and no YOY sauger have ever been caught in annual beach seining in the reservoir from 1965-1997 (Gilge and Liebelt 1998). Little sampling in the upper Milk River above Fresno Reservoir has been done so sauger status is uncertain (Gilge pers. comm.). There are no reports of declines in sauger in the upper Milk River in Canada (see status in Alberta below).

At this time available data from the Milk River suggests that the sauger population is now much reduced over much of its length, and its distribution now highly fragmented due to numerous migration barriers.

B. 4. Other tributary streams

Gardner and Stewart (1987) found sauger common in the lower reaches of four other tributaries to the lower Missouri: Little Porcupine Creek, Redwater River, Poplar River, and Big Muddy Creek. Sauger electrofishing catch rates ranged from 1.0-4.0 per hour, comprising 20% of the total catch (110 of 535). Needham and Gilge (1982) found no sauger in Beaver Creek, a 200-mile-long tributary to the Milk River near Havre. The historical use of this tributary by sauger is unknown. There is no recent data to evaluate current sauger status in these tributary streams.

C. Middle Yellowstone

The middle Yellowstone system consists of the 160-mile long mainstem section between the Bighorn River upstream to the town of Big Timber, and one major tributary historically used by sauger, the Bighorn River. This section is a transition zone between coldwater and warmwater fishes (Haddix and Estes 1976).

C. 1. Mainstem Middle Yellowstone

Historically, resident and spawning sauger were likely common in the mainstem middle Yellowstone River to what is now Billings (Brown 1971), and may have occurred up the turbid Clarks Fork (Holton and Johnson 1996); sauger have been collected upstream as far as Big Timber (Swedberg 1984). However, they are now uncommon above the Bighorn River confluence. The Huntley diversion dam near Billings apparently acts a barrier to upstream movement, as Swedberg (1985) found no sauger above this dam, and there have been no reports in recent years of anglers catching sauger upstream from the diversion. Electrofishing surveys between Huntley diversion and the Bighorn River confluence have yielded very few sauger in recent years (Poore 1990; K. Frazer and M. Vaughn, unpub. data, 1990-94). Haddix and Estes (1976) noted that the mouth of the Bighorn River was a popular and productive area for sauger angling in the 1970s, but sauger numbers now appear much lower (K. Frazer and M. Vaughn, FWP, Billings, 1998 pers. comm.). Although historic abundance data are lacking, the combination of Cartersville diversion near Forsyth (Penkal 1992; Stewart 1990a, 1998a) and the Rancher diversion just downstream from the Bighorn River confluence (Stewart 1988), coupled with the reduced sediment yield and sauger recruitment in the Bighorn River due to Bighorn Dam (Frazer and Vaughn, pers. comm.), have likely played a prominent role in the large reduction in sauger densities in the middle Yellowstone.

C. 2. Bighorn River

The Bighorn River extends 128 miles from its mouth to the Wyoming state line. While historic distribution of sauger is unknown, it likely supported an abundant resident and spawning population of sauger given its turbid, warmwater characteristics prior to the completion of Bighorn Reservoir, and the fact that sauger in the Bighorn drainage extend well into Wyoming over a distance of 250 miles from its junction with the Yellowstone River.

Bighorn dam, located at about river mile 80, was completed in 1965. Bishop (1967) sampled two 1-mile sections in the lower Bighorn River below the dam in fall 1965 soon after completion of the dam. Sauger were moderately abundant, averaging 3.5 sauger per mile and ranging from 3 to 18% of the total catch. Other species collected (goldeye, shorthead redhorse, river carpsucker, flathead chub) where characteristic of the warmwater river fish assemblage of which sauger are typically found.

Very few sauger have been captured in electrofishing surveys above and below Manning dam, located 4 miles from the mouth of the Bighorn River, from 1990-96 (Frazer and Vaughn, pers. comm.). In the past, sauger have concentrated in good numbers in the spring in the lower mile of the Bighorn (Stewart 1987a), but this concentration in recent years is much reduced, with only one sauger collected in spring 1996 and none in spring 1999 (Frazer and Vaughn, pers. comm.). Anglers targeting saugers in this area and below Rancher and Huntley diversions in the spring have quit fishing due to poor catches (ibid).

Several factors have likely led to the sauger decline. First, habitat change as a result of the Bighorn dam have caused significant alterations in the suitability of the lower Bighorn as sauger habitat. Coldwater release from the reservoir persists about 40 miles downstream before conversion to warmwater characteristics near Hardin, as does the much reduced sediment yield and assoicated turbidity (Frazer, pers. comm.). Using aerial photos, Martin (1977 cited in Rehwinkel 1978) documented significant reductions in the number of island and lateral gravel bars after dam closure, habitat types likely important for sauger spawning and rearing habitat. Dampening of spring peak flows may also have resulted in the loss of the trigger for upstream migration for sauger in some years.

Diversion dams have also played a role. As noted below in the lower Yellowstone River section of this report, the Rancher diversion dam just downstream from the mouth appears to be a partial barrier. Manning diversion dam also restricts fish passage (Anon. 1997). Improved fish passage over Cartersville, Rancher, and Manning diversions is needed to improve the sauger population (Anon. 1997).

Bighorn Reservoir is managed primarily as a walleye fishery, but fair populations of sauger exist, particularly in the upper reservoir (Kreuger et al. 1997). Low sampling efficiency in this steep-sided reservoir make evaluation of trends in sauger numbers tenuous, and sauger status is uncertain. Good numbers of sauger were captured in the upper, more turbid reservoir section in the late 1980s (N = 121, electrofishing at Horseshoe Bend in 1988), but relatively few have been caught electrofishing or gillnetting in various parts of the Montana portion of the reservoir in the 1990s, though most sampling has been concentrated in the lower quarter of the reservoir where water clarity is greatest (Frazer and Vaughn, pers. comm.).

For the status of sauger in the upper Bighorn Reservoir and River in Wyoming, see the section "Status of Sauger in Surrounding Regions."

D. Lower Yellowstone

The lower Yellowstone system consists of the 295-mile mainstem Yellowstone River section from the Bighorn River to the North Dakota border, and two major tributaries—the Tongue and Powder rivers. Three major cross-channel low head diversion dams--Intake (river mile 71), Cartersville (river mile 230), and Rancher (river mile 295)—act as partial or at times complete barriers to upstream movement of sauger and other fishes and influences their longitudinal distribution and abundance.

D. 1. Mainstem Lower Yellowstone

Nearly annual sampling of sauger in the lower Yellowstone River since the mid 1970s provides a wealth of data on sauger abundance, size, and movement patterns over the past 25 years. Peterman and Haddix (1975), Haddix and Estes (1976), and Penkal (1992) sampled the river from 1973-79 using electrofishing, gill nets, and bag seines. Stewart conducted annual electrofishing surveys in various river reaches from 1985-98, and reported these findings in annual DJ reports (Stewart 1986a-98a). Summaries of sauger data collected from 1987-97 are summarized in Stewart (1997a, 1998a).

Saugers were very abundant in the 1970s, particularly below diversion dams in the spring. A multiple mark-recapture population abundance estimate obtained by weekly electrofishing a 1-mile section below the Cartersville diversion dam near Forsyth, Montana, in spring 1974 yielded 2,024 sauger per mile (1,564-2,867 80% CI). Sauger comprised 70% of the sport fish catch and walleye 3%. Large concentrations of walleye and sauger were found below the lowermost diversion dam at Intake. Electroshocking below Intake in spring 1975 yielded 714 sauger and 389 walleye, for a sauger:walleye ratio of 1.8:1.

Fall electrofishing in five sections of the lower Yellowstone from 1977-1998 allow comparison of sauger abundance trends over the past 20 years (Table 2). The five sections are: Upper Forsyth (above Cartersville diversion), Lower Forsyth (below Cartersville diversion), Miles City (above and below the Tongue River confluence), Fallon (above and below the Powder River confluence), and Lower Intake (below the Intake diversion). Sampling occurred over about 1-5 miles in each section. Because electrofishing data were reported in different formats as number caught per mile (Penkal 1992), number per hour (Stewart 1986a-92a), and number caught per day (Stewart 1993a-98a), data were converted to catch per hour to allow trend analysis. Catch per mile data were converted to catch per hour based on an average of 1.2 hours per mile for electrofishing both sides of a river (B. Gardner, FWP, Lewistown, unpub. data). Catch per day data were converted to catch per hour based on Stewart's (1994) estimate of a day of electrofishing as 4 hours pre-1994, and 2 hours post-1994 (V. Riggs and Brad Schmitz, FWP, Miles City, pers. comm.).

Table 2. Fall sauger abundance (catch per hour of electrofishing) at five sampling reaches in the lower Yellowstone River, 1977-98 (sources listed in text).

	Reach				
	Upper Forsyth	Lower Forsyth	Miles City	Fallon	Lower Intake
1977	1.4	5.7		6.7	9.3
1978	1.7	14.0		13.1	8.6
1979	3.3	12.4		12.9	10.2
1985			6.8		29.8
1987		4.6			
1988		7.3			
1990		6.3	2.0		
1992		1.0	0.7	1.6	
1993		0.4	0.2	2.7	4.3
1994		0.5	0.3	1.2	2.8
1995		3.5	1.2	3.4	6.6
1996		1.0	1.8	0.5	1.6
1997		1.5	0.6	1.5	5.0
1998		1.7	6.3	6.0	15.2

Sauger abundance has declined substantially since the late 1980s throughout all sections of the lower Yellowstone River below the Cartersville diversion dam at Forsyth. In the 1970s and 1980s, fall sauger abundance averaged about 12 fish per hour (Figure 16). Sauger abundance dropped sharply beginning in 1987, and since 1990 has averaged about 2 fish per hour, an 83% 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 1986a, 1998a). An exception to this pattern is the catch rate in fall 1998, when the sauger abundance averaged 9.2 sauger per hour. Above the Cartersville dam, sauger density abundance has remained at similar, low levels since the late 1970s due to restricted passage above the dam (Stewart 1998).

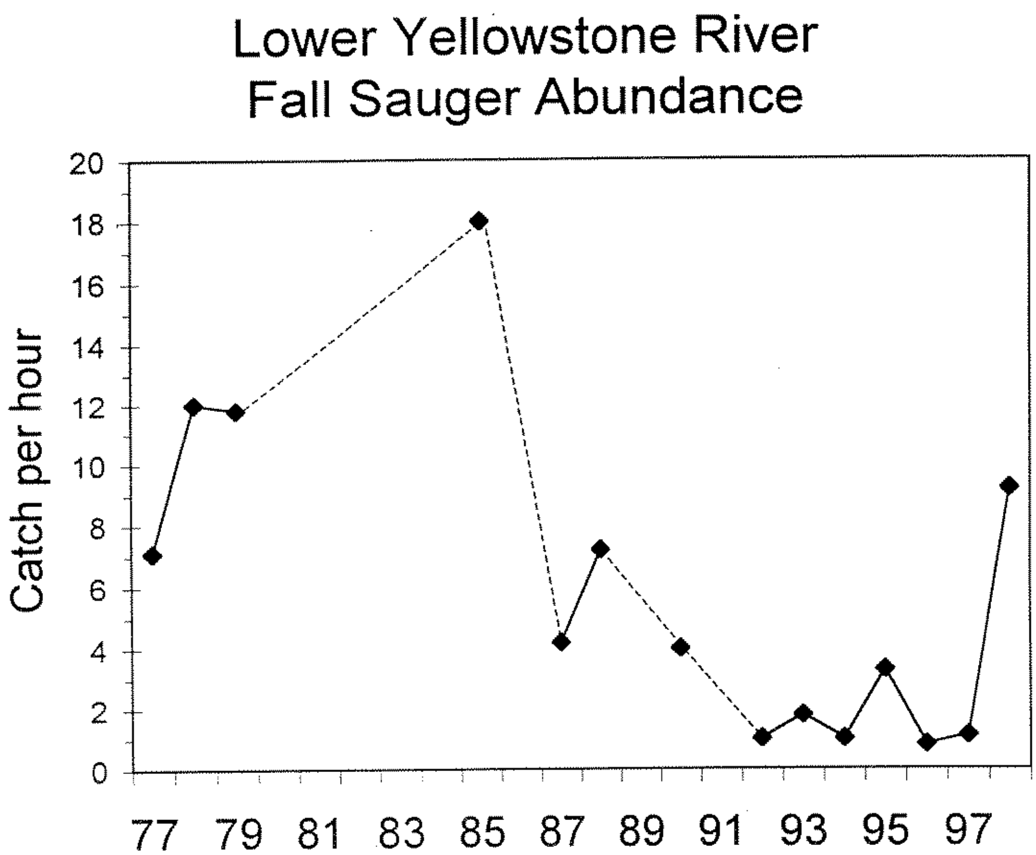

Figure 16. Mean electrofishing catch rate of sauger below Cartersville diversion (Forsyth), lower Yellowstone River, 1977-98 (see text for data sources).

The role of angler harvest in the sauger decline is unclear. Creel census data are lacking, but about the time of the initial decline, anglers were expressing concern for overharvest (Stewart 1990a). Stewart (1992a) noted that anglers were becoming more sophisticated and efficient at harvesting sauger and angler harvest may be an issue. In contrast, a long time series of voluntary tag returns on tagged fish suggests low exploitation rates. In the late 1970s, a total of 11,499 sauger were tagged and only 425 were recaptured by anglers, yielding a annual harvest rate of <1% (Penkal 1992).

Angler harvest increased in recent years to an average of 5.1% from 1985-95. Stewart (1998:3) speculated that "Even if actual harvest rate is 2-3 times higher than tag return rate, catch rates are probably not excessive." However, the size structure of the population has shifted significantly to smaller fish in recent years (Figure 17). While the shift to smaller fish in part reflects the influx of a strong year class in 1994 described below, the results also show a significant decrease in the numbers of larger fish in the population. In 1985, sauger >16 inches comprised 48% of the fish sampled and the overall mean length was 14.9 inches (Stewart 1986a). In the years 1994-96, only 16% were >16 inches and the mean length was 11.9 inches, about 3 inches shorter. The cause of this decline is unknown, but overharvest is one possibility. Fish >16 inches were common in Lake Sakakawea at this time, so failure of these large fish to move up the Yellowstone is another possible explanation (Stewart 1997a). Sauger captured in 1998 in the lower Yellowstone during the benthic fish survey showed a continued trend to smaller fish, the 50 fish caught averaging 10.5 inches and only 12% of the fish were >16 inches (J. Liebelt, FWP, Fort Peck, unpub. data). The average length of the 60 sauger captured below Intake in the fall 1998 electrofishing survey was 12.65 inches and the range 6.8 – 20.9 inhces (V. Riggs and B. Schmitz, pers. comm.).

Whatever the role harvest has played in the sauger decline, angler catch rates are much reduced (Anon. 1997). B. Gardner (pers. comm.) noted that an electrofishing catch rate of about 10 fish per hour supports a good sauger fishery; at catch rates below 5 fish per hour, angler catch rates are correspondingly poor. Sauger catch rates in the lower Yellowstone have been below the 5 fish per hour level since the late 1980s in most years. Excessive catches and possible implementation of a sauger size regulation have been identified as important management issues on the lower Yellowstone (Anon. 1997).

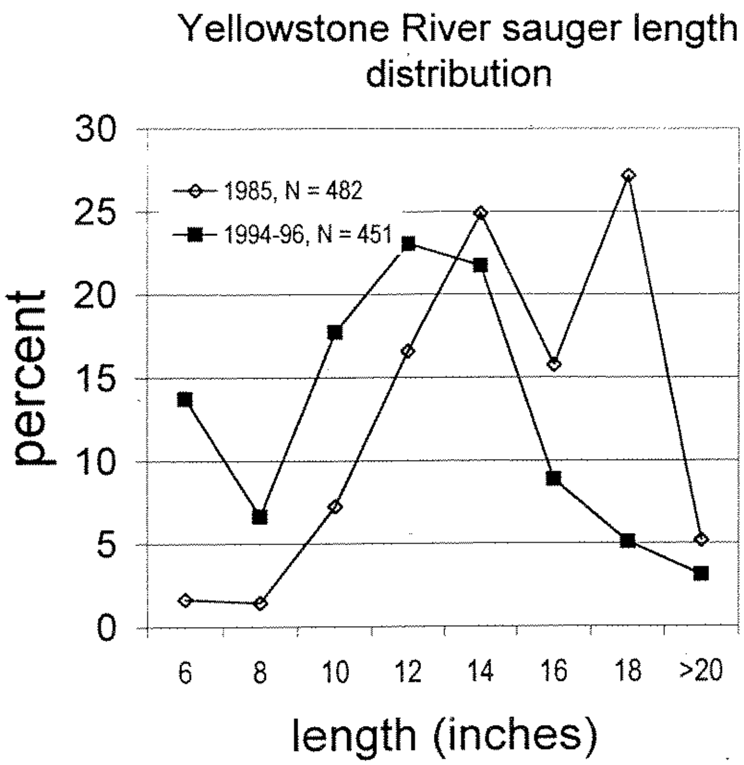

Figure 17. Length distribution of sauger electrofished in the lower Yellowstone River, 1985 and 1994-96 (data sources listed in text). N = sample size.

What has been the role of river flows in the sauger decline? Average spring-summer (May-September) flows in the lower Yellowstone at the border near Sidney were well below average from 1987-90 (Figure 18) when the sauger decline began. However, flows since 1991 have been above average in 5 of the last 8 years. Similar to the pattern observed elsewhere in Montana, then, improved flow conditions in the lower Yellowstone mainstem have not been met by a measurable increase in the sauger population.

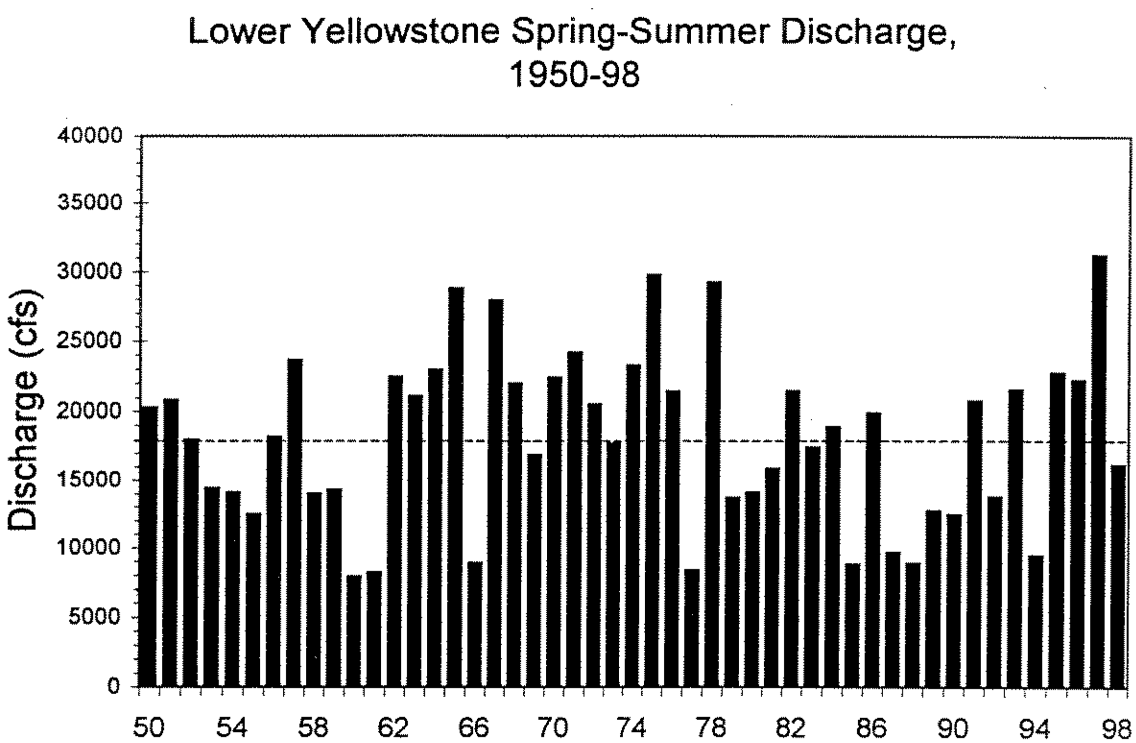

Figure 18. Spring-summer (May 1-September 30) discharge in the lower Yellowstone River at Sidney, MT, 1950-98.

YOY sauger abundance in the lower Yellowstone below Intake shows high annual variation but a general decline since the mid to late 1980s with the exception of good catches in 1994 and 1995 (Stewart 1998). Penkal (1992) and Stewart (1998a) speculated that the Yellowstone River sauger population is dependent on upstream movement of YOY upstream from Lake Sakakawea. Few YOY sauger are caught except in backwaters in the lowermost reaches of the Yellowstone below Intake. Most sauger larvae are thought to drift into Lake Sakakawea from main spawning grounds in the Tongue and Powder rivers, with YOY fish gradually making their way back upstream in late summer and fall, as shown by an increasing size of sauger with increasing distance from Sakakawea (Penkal 1992). YOY recruitment appears to be positively related to Lake Sakakawea water levels (Stewart 1996a). Rising water levels in Lake Sakakawea beginning in 1993 could have led to better survival and hence increased YOY abundance of sauger in 1994 and 1995. However, YOY sauger abundance has been low since 1995 despite higher reservoir water levels. In addition, the strong 1994 and 1995 year classes have not led to the anticipated increase in adult recruitment (Figures 16, 17). Stewart (1998a:3) concluded that "Why these fish fail to return to the river in some years ... needs to be investigated."

An extensive tagging study in the late 1970s revealed that sauger in the lower Yellowstone, as do those in the Missouri system, exhibit long distance seasonal migrations, with 100-mile movements common (Penkal 1992). During spring months (March-May), the majority of adult fish migrate to the lower Tongue and Powder rivers to spawn. This pattern of movement was well illustrated by the fact that very few fish are caught in the mainstem during April and May. Penkal (1992) electroshocked only 2 mature fish in a 52-mile section of the mainstem from Forsyth to Miles City during early May when sauger were abundant in the Tongue and Powder rivers. Many fish appear to stage near the mouths of both spawning tributaries prior to moving upstream to spawn (Penkal 1992). Spring population estimates in a 4.8-mile section near the Tongue River mouth in the years 1978-80 and 1985 ranged from 1,042 to 1,981 sauger or 217 to 413 per mile. A repeat of these spring population estimates would provide another good indicator of population status in the Yellowstone system.

The only other spawning in the lower Yellowstone that has been documented is in a few sites in the lower Yellowstone below Intake diversion. Penkal (1992) reported that a gravel bar below Intake was often occupied by sauger and large numbers of walleye in the spring. Spring sampling below Intake has not been conducted in recent years so how large the sauger run in this area is now is not known but angler catch appears much reduced from past years. Spawning distribution of sauger in the Yellowstone River system parallels that observed in the Missouri River system whereby spawning appears confined to only a few sites within a very large area, suggesting that sauger are highly selective in spawning habitat selection. Walleye, in contrast, were found spawning in numerous sites below Intake (Penkal 1992).

Sauger appear to travel long distances to spawn in the Tongue and Powder rivers, as fish from as far upstream as the Huntley diversion dam near Billings and as far downstream as the lower Missouri have been recaptured near or within these two spawning tributaries (Penkal 1992). Though no tagged fish from the Yellowstone were reported in Lake Sakakawea, movements between Lake Sakakawea, the lower Missouri, and the mainstem Yellowstone are thought to be common (Penkal 1992; Stewart 1997). For example, one fish tagged in the lower Missouri was recaptured 4 months later in the Yellowstone River near Miles City, a distance of 276 miles (Penkal 1992).

Sauger density and size structure varies substantially along the lower Yellowstone mainstem. Density tends to decrease, and size increases with distance upstream (Penkal 1992). Part of this difference can be attributed to the above mentioned movement of YOY sauger upstream from Lake Sakakawea and the lowermost reaches of the lower Yellowstone as they grow. However, the three diversion dams on the lower Yellowstone also have a large effect on sauger abundance and size structure. Sauger tend to concentrate below Intake, the lowermost diversion dam, in the spring during the upstream spawning migration, but movements of tagged adults indicate that it is not a major barrier to movement at least during high flows (Penkal 1992). Walleye, in contrast, do not move above this diversion in appreciable numbers (Penkal 1992). However, the low numbers of YOY sauger caught above this structure (Penkal 1992; Stewart 1998a), suggests that it may greatly reduce or eliminate movement particularly at lower flows (Penkal 1992). YOY sauger begin to show up below Intake diversion in the late summer-fall. Flows <5,000 are common at this time particularly during below average flow years (e.g., 1988, 1994; Figure 18).

Recent evidence suggests that many juvenile fish may get diverted into the Intake water diversion canal at this time, particularly during low flow years when a greater percentage of total river flow is diverted into the canal (S. Heibert, Bureau of Reclamation, Denver, pers. comm.). Heibert has documented large numbers of sauger swept into this canal, especially during August, when an estimated 10,000 sauger per month pass into the canal. The ultimate fate of these fish is unknown, but mortality is likely high, and plans are underway to design a fish bypass system. Upstream blockage coupled with offriver loss of juvenile sauger at Intake may have exacerbated the decline of sauger during the 1980s drought, and may also help explain why the sauger population has not increased in recent years despite several years of more favorable flows and water levels, and stronger YOY year classes, in the lower river and in Lake Sakakawea (see Stewart 1996a-98a, and Lake Sakakawea sauger status discussed in "Status of Sauger in Surrounding Regions").

Cartersville diversion at Forsyth is a major impediment to sauger movement upstream. Sauger densities below the Cartersville diversion are about 3-10 times higher than above the dam (Penkal 1992; Stewart 1988a, 1990a). For example, in fall 1989, Stewart (1990a) collected 60 sauger in 25 days of sampling above the dam compared to 621 fish in 26 days of sampling below the dam, a 10-fold difference. Fish above the dam were also significantly larger (17.4 vs. 15.5 inches average length), signifying only large fish could negotiate the structure. No fish <10 inches were collected. Long distance movements upstream by fish that do pass over the dam (Stewart 1989a) suggests that the dam limits access to many miles of otherwise suitable sauger habitat. The dam is also a migratory barrier to shovelnose sturgeon (Stewart 1990a).

How significant Rancher diversion dam, located 2 miles below the mouth of the Bighorn River, is as a barrier to upstream movement by sauger is not known. Sauger movement over the dam has been documented (Stewart 1988a), but densities above and below the dam are low and therefore few fish below the structure have been tagged, and only one has been recaptured above the dam. Stewart (1987a) did capture 22 sauger in the lower 0.5 miles of the Bighorn River above the dam in fall 1986, suggesting that the Rancher diversion is not as severe an impediment to upstream movement as the Cartersville diversion.

What about competition with walleye and smallmouth bass as a factor in the sauger decline? A large number of walleye run up from Lake Sakakawea to spawn below Intake (Penkal 1992), but few walleye remain in the river as residents, and most return to Sakakawea soon after spawning. Even in recent years of low sauger numbers, sauger were much more abundant than walleye during fall electrofishing surveys (Stewart 1997a). Walleye made up less than 5% of the total spawning run in the lower Tongue and Powder rivers in the late 1970s; whether they now utilize these areas more as sauger have declined and walleye populations have increased is unknown, but would be worth exploring, particularly with regards to assessing hybridization potential between sauger and walleye.

Penkal (1992) found very few walleye YOY in the lower Yellowstone, suggesting that competition between YOY sauger and walleye can probably be ruled out as a factor in the decline of sauger. The potential for YOY competition between walleye and sauger rearing in Lake Sakakawea is a possibility since the larvae of both species probably drift into the reservoir after hatching. The production of good year classes of sauger in the mid 1990s during high walleye abundance in Sakakawea (G. Power, North Dakota Game and Fish Department, Bismarck, 1999 pers. comm.), however, would argue against strong competitive interactions between the two species in the reservoir.

Smallmouth bass numbers, though, have increased substantially in the lower Yellowstone during the past decade. In the 1970s, few smallmouth bass were captured in the mainstem (Penkal 1992). By fall 1992, smallmouth bass were about 3 times more abundant than sauger, comprising 47 vs. 15% of the total number of fish electroshocked in the Forsyth-Miles City section of the river (Stewart 1993a). However, smallmouth bass numbers have declined in the mainstem in recent years, to a level equal to or below sauger (Stewart 1998a). The increase in smallmouth bass several years after the initial decline in sauger, and their decline in recent years while sauger numbers have remained low, suggests that the sauger decline cannot be linked to an increase in smallmouth bass, nor does it appear at this time that smallmouth bass are expanding into the "sauger niche" in the lower Yellowstone River.

D. 2. Powder River

The Powder River is a large prairie stream that is characterized by high turbidities, little pool development, and shifting sand substrate. The most comprehensive survey of the system was conducted in 1975-77 by Rehwinkel (1978), with additional data collected in 1978-79 by A. Elser and reported in Penkal (1992). Rehwinkel (1978) collected resident fishes in 7 sections from the mouth to the Wyoming border, a distance of 210 miles, in summer-fall, 1975-76. Sport fishes were rare throughout the entire system, and only 1 sauger was captured, comprising 0.04% of the total catch of 2,523 fishes. No sauger were found in two major tributaries, Mizpah Creek and Little Powder River.

Sampling in the spring, however, revealed that the lower Powder is an important spawning area for sauger. Considerable numbers of mature male and female sauger were electrofished in the lower 10 miles of the river from late March-early May. This lower section is characterized by a shallow braided channel with slow to moderate current, numerous rock and shelf rock ledges, and sand-small gravel substrate. Spawning congregations of shovelnose sturgeon also occur in this section (Backes et al. 1992). Walleye spawning in this section appeared to be rare, as Rehwinkel (1978) and Penkal (1992) did not report any walleye captured during spring electrofishing.

A total of 620 sauger were captured during spring sampling in 1976-80, 87% of which were mature. Few mature sauger were captured in the mainstem Yellowstone at this time, emphasizing the importance of the lower Powder as a spawning site for sauger. Annual variation in the sauger spawning run was high, varying from 12-292 sauger captured, depending in part on intensity of sampling (Penkal 1992). Biweekly surveys conducted from mid April-early May, 1976, captured 0.6-13.8 sauger per mile, averaging 5.6 sauger per mile.

Sauger entered the lower Powder in late March as temperatures rose above 38 ^{o}F (2.8 ^{o}C)(Rehwinkel 1978). Spawning occurred during the moderate discharge period between the early runoff peak in March and the late runoff peak in late May-June. Sauger age ranged from 2-8 years, with 4 and 5-year-old fish comprising the bulk of the spawning run. Few fish remained in the river once water temperatures increased above 16 C.

Over 500 sauger were tagged in the lower Powder from 1976-79, but only 20 fish were recaptured (Rehwinkel 1978; Penkal 1992). Recaptured fish showed long distance movement, however, ranging from Forsyth to Intake on the mainstem Yellowstone, a distance of ~90 miles upstream and downstream, respectively, from the Powder River confluence. Three fish tagged in the lower Powder also were captured the same spring in the upper Powder near the Wyoming border, a distance of 194 miles upstream.

No fish sampling occurred in the Powder River from 1979 to 1997. Angler catch rates are reportedly still good at the mouth of the Powder (B. Schmitz and V. Riggs, pers.

comm.). Limited sampling in April 1999 found 20 sauger and 0 walleye in 2 days of electrofishing (total 2.9 hrs or 6.9 sauger per hour; B. Gardner, pers. comm.). Ryan Trenka, a Montana State University graduate student, electrofished the lower 44-mile section from Mizpah Creek to the mouth in spring-summer 1997-98. Only 1 sauger was collected in May 1998.

For the status of sauger in the upper Powder River in Wyoming, see the section "Status of Sauger in Surrounding Regions."

D. 3. Tongue River

The Tongue River flows 203 miles southward from the Yellowstone River near Miles City, Montana, to the Wyoming border. There are five dams along the river, from the T and Y water diversion dam 20.4 miles from the mouth, to the Tongue River dam near the Wyoming border. Tongue River Reservoir, completed in 1940, covers 3,500 acres; the upper Tongue River above the reservoir extends another 60 miles into Wyoming. Water diversion dams and Tongue River reservoir operation have a major influence on abundance and distribution of sauger and other fishes in this system (Elser et al. 1977; Penkal 1992).

Elser et al. (1977) conducted a fisheries inventory in the 1970s along the entire length of the lower Tongue from the mouth to the Tongue River dam. Resident sauger were found from the mouth to Brewsters water diversion dam (river mile 150), but were rare above the T and Y dam. From the T and Y dam to Brewster's dam, a distance of 137 miles, only 7 sauger were collected, comprising about 1% of the total catch and averaging 0.6 sauger per mile. Below T and Y dam, however, sauger were abundant, comprising 13.1% of the total electrofishing catch during fall sampling. Walleye were not found above T and Y dam, and only in low numbers (0.6 fish per mile) below the dam. These data suggest that the T and Y dam is a major barrier to upstream movement by sauger and walleye.

Spawning sauger were very abundant in the lower river section. In spring 1976, 1,004 sauger were collected (Elser et al. 1977). A multiple mark-recapture population estimate in a 6.8 mile reach yielded 3,796 sauger (3,249-4,564 95%CI), or 558 fish per mile (Table 3). Saugers ranged in age from 3-9 years, with ages 4-6 comprising the bulk (75%) of the spawners. Saugers averaged 14.9 inches in length and 0.97 pounds.

Table 3. Number of sauger per mile collected during the spring (April-May) spawning run, lower Tongue River from mouth to T and Y diversion dam (from Elser et al. 1977; Penkal 1992; Stewart 1992a, 1993a; Trenka 1999 pers. comm.; Gardner 1999 pers. comm.). The population estimate per mile was based on actual measurement in 1976 (Elser et al. 1977). Other years were determined by assuming that catch rate was about 5% of actual population, based on the 1976 estimate.

Year	Number per mile	Population estimate per mile
1976	28.8	558
1977	21.6	432
1978	26.4	528
1979	24.0	480
1980	6.6	132
1991	"very few"	
1992	0.2	4
1997	0	
1999	5.7	115

More detailed sampling and analyses of the sauger spawning run were conducted in 1979-80 and reported in Penkal (1992). Ripe males and females were collected in the lower Tongue from the last week of March to the first week of May. Sauger first entered the Tongue at temperatures of 10-12 °C, and peak spawning occurred at 13-14 °C. Males and females were generally caught together with concentrations evident at two locations: near the mouth at river mile 0-4, and at river mile 10-13; numbers were lowest from river mile 13 –19 (Penkal 1992).

Additional historical data point to the high use of the lower Tongue as a major spawning site for sauger. At the time there was a high number of of sexually mature fish in the lower Tongue, few mature sauger were collected in the mainstem Yellowstone River (Penkal 1992). The much reduced numbers of sauger using the lower Tongue in the fall (Elser et al. 1977), further illustrate the relatively rapid movement in and out of this system by spawning fish. Additionally, based on tag return rates, it was estimated that at least 50% of the spawning sauger returned to spawn in the lower Tongue in subsequent years. Sauger from throughout the lower Yellowstone River utilized the lower Tongue for spawning as tagged sauger were recovered throughout the lower Yellowstone River from Forsyth to Intake (Elser et al. 1977; Penkal 1992).

Though data are lacking on the size of the sauger spawning run since 1980, available data suggests that the sauger use of the lower Tongue has decreased markedly over the past 18 years. Stewart (1992a, 1993a) electrofished the lower 10 miles of the Tongue River for several days during prime spawning time (April-early May) in 1991 and 1992 and collected "very few fish" in one year, and only 2 in the other (Table 3). No sauger were sampled from T and Y dam to the mouth in May 1997 (R. Trenka, Montana State University, 1999 pers. comm.). In April 1999, B. Gardner (pers. comm.) collected 20 sauger in 2.9 hours of electroshocking during two days of sampling. This corresponded to 5.7 sauger per mile, based on the assumption of an electrofishing rate of 1.2 miles of river sampled per hour.

Though the exact reasons for the decline are unknown, low and erratic flow conditions in the lower Tongue due to a combination of low runoff and changing reservoir flow releases have likely had a significant effect on spawner abundance and spawning success. As in the Powder River, sauger spawn in the lower Tongue River in the moderate flow period after peak lowland runoff and before peak mountain snowpack runoff (Penkal 1992). Elser et al. (1977) calculated a desired passage and spawning flow level of 525 cfs from April for successful sauger reproduction. During the good spawning years of 1976-79 (Table 3), daily average flows ranged from 370-720 cfs and were generally above 440 cfs (Figure 18). In 1980, the spawning run was much reduced, only 25% of that observed in the previous four years, and successful reproduction, as measured by the number of sauger larvae collected at the mouth, was estimated at 30% less than previous years. Flows in April 1980 ranged from 94 to 404 cfs and were higher than 300 cfs for only 3 days. Flows <300 cfs were accompanied by a sharp drop in numbers of sauger in the lower Tongue, suggesting the higher flows are needed to maintain continued sauger use or movement into the lower Tongue

River, and prevent egg dessication. A close relationship between discharge and sauger spawning success have noted by previous investigators (Nelson 1968; Walburg 1972).

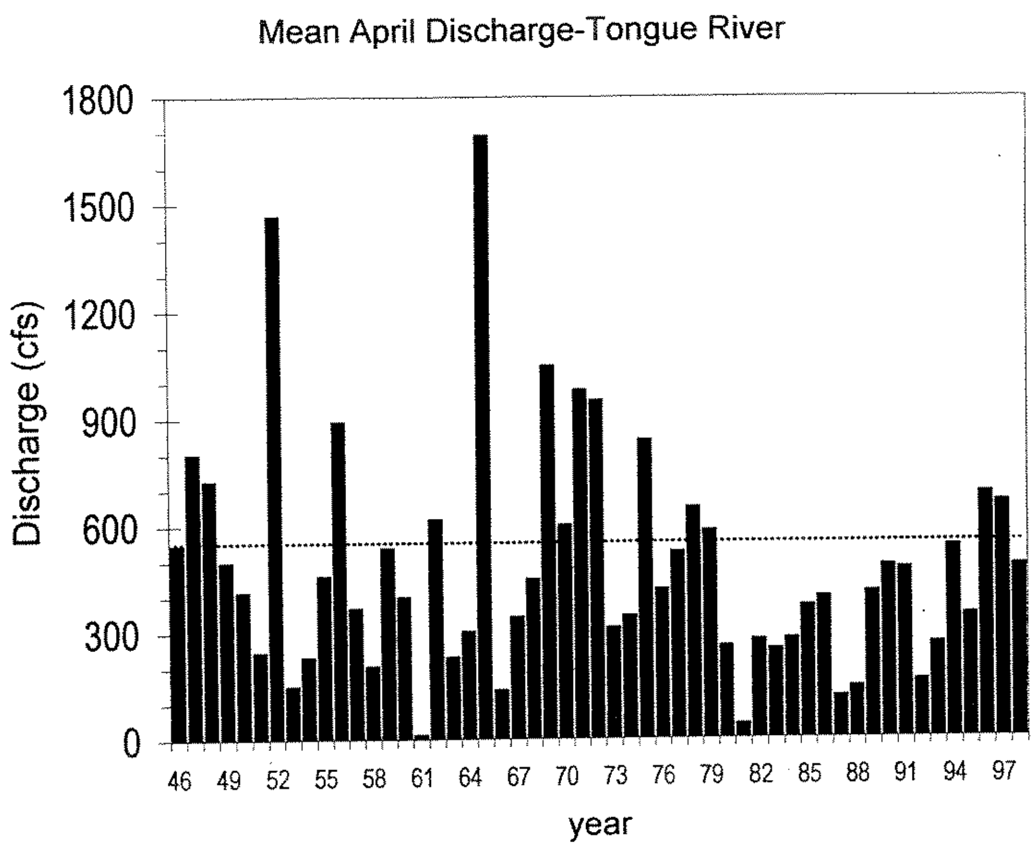

Figure 18. Mean April discharge, Tongue River near mouth, 1946-98.

The pattern of mean April discharge at the Tongue River mouth from 1946-98 clearly shows that flow conditions during spawning have been poor for most years since 1980 (Figure 18). For the 19-year period, 1980-98, flows met or exceeded the recommended flow of 525 cfs in only 5 years. In addition, in 9 years daily flows were less than the minimum of 300 cfs for >15 days in April (Figure 19). A lack of data do not permit a statistical analysis of a sauger abundance-flow relationship in the lower Tongue, but the sauger abundance and reproduction decline during a low flow year in 1980 as reported by Penkal (1992), suggests such a linkage exists. It is noteworthy that, similar to the sauger populations in Fort Peck Reservoir and in the lower and middle Missouri Rivers, recent improvements in flow conditions in the lower Tongue since 1995 have resulted in little or limited rebound in the sauger spawning run.

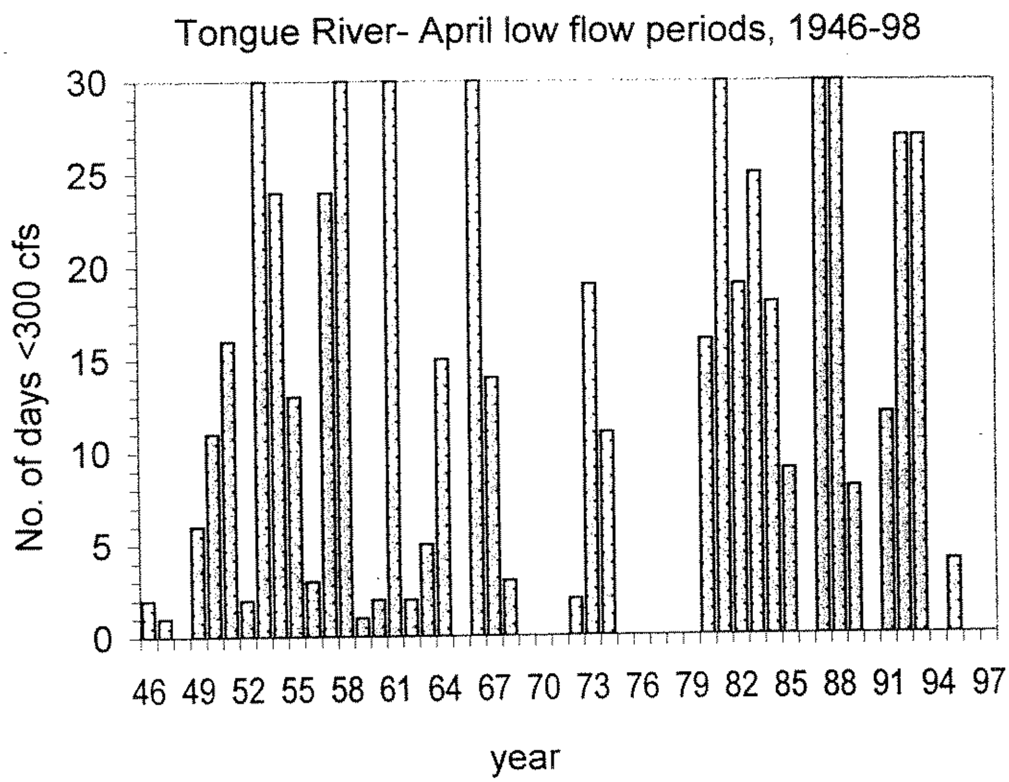

Figure 19. Number of days in April with discharge <300 cfs, Tongue River near mouth, 1946-98.

The upper Tongue River likely supported a good population of resident and migratory sauger prior to the construction of the Tongue River Reservoir. In a 1938 report of fish populations in the Tongue River near the Montana-Wyoming state line, Eugene E. Bjorn noted that sand pike (sauger) were thought to quite common in this section of the river (B. McDowell, Wyoming Game and Fish Department, Sheridan, 1999 pers. comm.). Since 1963, the reservoir has been managed as a warmwater fishery, mostly for northern pike, walleye, and crappie. Sauger were absent from annual gillnet surveys in the reservoir from 1964-1973. Sauger have been consistently captured in the reservoir albeit at low numbers since 1973. The reservoir was chemically treated in 1957 to remove undesirable fish species, and Elser et al. (1977) noted that it is thought that the current sauger population in the reservoir may have resulted from a reintroduction of sauger in the upper Tongue River above the reservoir in 1967 by Wyoming Game and Fish personnel.

Elser et al. (1977) sampled the reservoir intensively from 1973-76. Sauger were common but abundance was low, averaging about 1.0 sauger per net in gillnet surveys. Walleye:sauger ratio was about 2:1, walleye comprising about 4% and sauger ~2% of the total gillnet catch. Most sauger were found in the more turbid upper reservoir. Angler exploitation was low (2.0% or 6 tag returns on 302 sauger tagged) compared to 5.3% for walleye.

Riggs (1978) conducted an age and growth study of walleye and sauger in the reservoir in the 1970s. He also investigated potential spawning in the river in a 2-mile river section above the reservoir. He found fairly good numbers of sauger in the reservoir, collecting 546 sauger and 640 walleye using a variety of gears over a 2-year period. Sauger exhibited good growth in the reservoir compared to other Montana waters, and fish up to 23.3 inches in length and weighing 5.9 pounds were captured. Walleye used the river just upstream from the reservoir for spawning, but spawning locations of sauger could not be determined.

Sauger populations in the 1980s remained low and stable, with < 1 fish per net, comprising about 1% of the total fish catch, captured during summer gillnet surveys of the reservoir (Stewart 1986a-1989a). However, no sauger have been caught in the reservoir since 1990 (Stewart 1991a-96a). No YOY sauger have been captured during annual shoreline seining since at least 1985. In contrast, adult and YOY walleye catch rates have been good since 1990.

For the status of sauger in the upper Tongue River in Wyoming, see the section "Status of Sauger in Surrounding Regions."

D. 4. Other tributaries

Morris et al. (1981) sampled for presence/absence of sauger and other fishes in 45 small tributaries to the lower Yellowstone below the Tongue River confluence. Sauger use of these small tribs was uncommon, with only 5 or 11% of streams containing sauger. Where present, sauger only occurred in close proximity to the mainstem Yellowstone River.

E. 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. Three of the larger tributaries, Box Elder, Little Beaver, and Beaver creeks, were surveyed in Montana portions of the creeks, 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) show sauger as being present in Beaver Creek and Box Elder Creek. However, based on the above surveys it appears that sauger 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 sauger for spawning and rearing, as Guzevich (1993) and Elser et al. (1980) found walleye to be moderately abundant in large permanent pools in Little Beaver Creek, including YOY fish, suggesting that habitat requirements were probably suitable for sauger in historic times.

F. SUMMARY: Historical and Current Status of Sauger in Montana

To compare historic with current distribution statewide for sauger, I prepared maps to represent best available information on where sauger are still thought to be common and where they are now rare or absent. Historic information on sauger distribution was based on fish distribution maps (Holton and Johnson 1996) and fishery surveys conducted during the 1970s (e.g., Berg 1981). Current distribution was based on the Montana River Information System (MRIS; http://nris.state.mt.us). MRIS characterizes abundance and distribution for fish species statewide for each individual hydrologic unit based on sample data and expert opinion of district fishery biologists. The sauger database, consisting of 423 hydrologic units, was current as of December

1998. This information was augmented with recent survey information. The resulting distribution maps are shown in Figure 20.

The maps were also used to compare area or stream miles historically and currently occupied by resident sauger (Bill Gardner pers. comm.). Resident sauger are those that use a river year-round. This analysis is shown in Table 4. Overall, 53% or 1,070 miles of the estimated 2,015 stream miles that historically supported sauger no longer support resident sauger. As in other parts of their native range, loss of sauger habitat has been particularly acute in tributary drainages. An estimated 77% of tributary stream miles (881 of 1,148) no longer support resident sauger compared to 22% of mainstem stream miles (189 of 867). In addition, as substantiated in the above sections, sauger numbers are low in much of the remaining stream miles where the species is present. Sauger status still appears to be fair to good in the following areas: the middle Missouri below the Marias River confluence (160 miles); the upper 25% of Fort Peck Reservoir (41 miles); the lower Missouri mainstem (153 miles); and the lower Yellowstone mainstem below Cartersville diversion (237 miles). These areas total 591 stream miles, or 21% of the presumed historic distribution in Montana, where sauger can still be considered common.

Montana Sauger Distribution

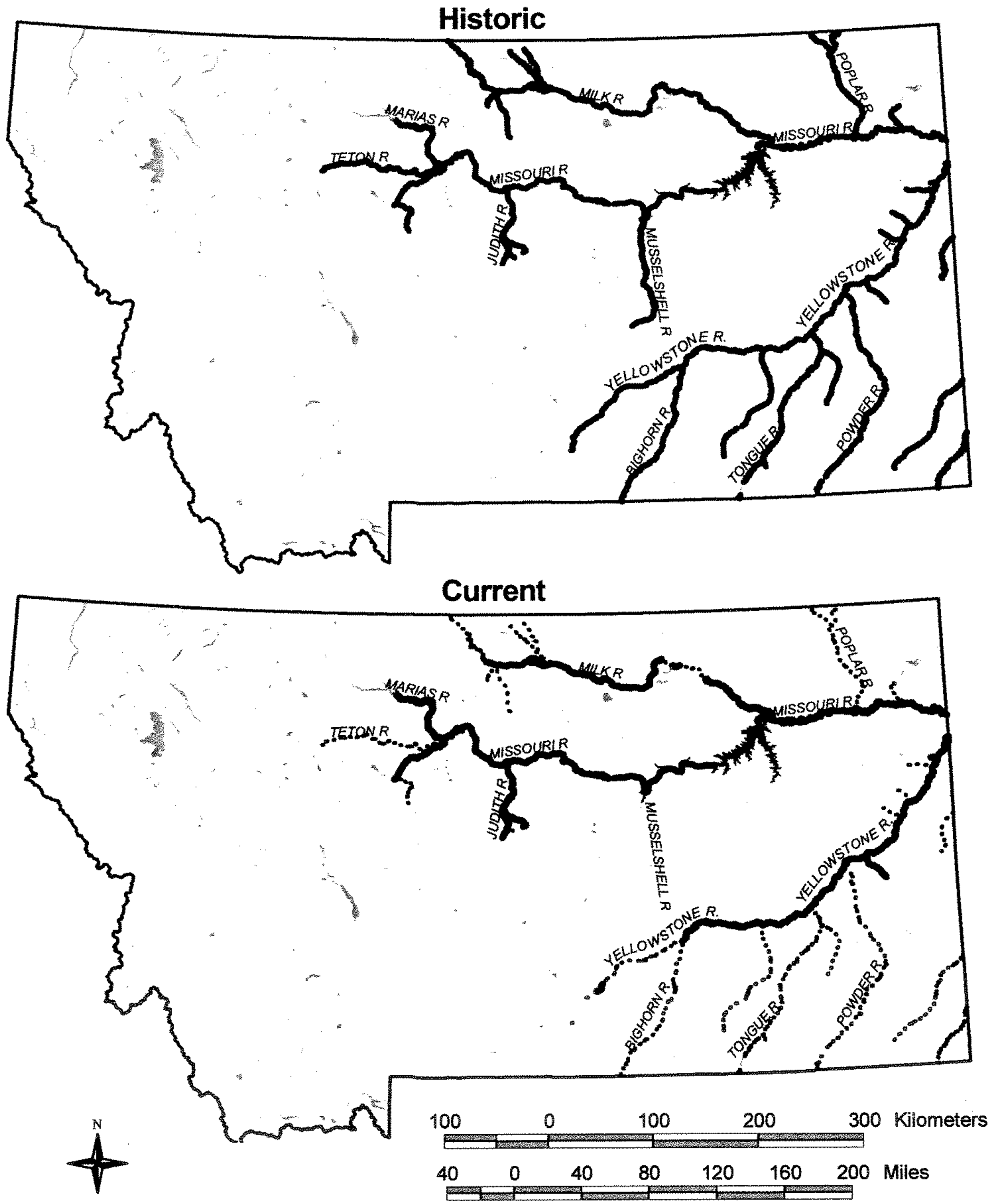

Table 4. Historic vs. current stream miles occupied by resident sauger in Montana (after B. Gardner, pers. comm.).

Drainage/Stream	Historic miles	Current miles	Percent loss
Middle Missouri	207	207	0
Marias	170	60	65
Teton	50	0	100
Judith	53	53 (?)	0
Musselshell	75	0 (?)	100
Lower Missouri*	315	234	0
Milk	452	150	67
Middle Yellowstone	50	0	100
Bighorn	128	4	97
Lower Yellowstone	295	237	20
Rosebud	?	?	
Tongue	150	0	100
Powder	?	?	?
Little Missouri			
Beaver	50	0	100
L. Beaver	20	0	100
Box Elder	?	?	?
Total stream miles occupied	2015	945	53

*including Fort Peck Reservoir, 162 miles long. Assumed upper half of reservoir is typically occupied by sauger.

IV. Reasons for decline

A. River flows and reservoir water levels

There is a clear association between low river flows and 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—middle Missouri River (Figure 1), Marias River (Figure 8), Fort Peck Reservoir (Figures 10, 11), lower Yellowstone River (Figure 16), and Lake Sakakawea (Figures 20 and 21)—declined substantially during a 3-4 year drought. Montana sauger population responses mirrored that observed in other sauger populations, namely that: 1. river flows and reservoir water levels are positively related to sauger abundance (Nelson 1968); and 2. sauger populations tend to exhibit region-wide trends (Hackney and Holbrook 1978; Pitlo 1992; Lyons and Welke 1996).

Though sauger in a few areas of the state, as noted above, appear to be holding their own, it is curious why sauger in most areas have shown no evidence of recovery despite much improved river flows and reservoir water levels in most areas (excluding the Tongue River) the past 4-5 years. Considerable year-to-year fluctuations in recruitment typify sauger and other percid population dynamics (Nelson 1969; Hackney and Holbrook 1978; Lyons and Welke 1996). But what is unique is the lack of evidence for recruitment over much of the state for the past decade. At this point, sauger in Montana appear to be following the pattern observed in sauger populations in Nebraska (Hesse 1994) and Tennessee (St. John 1990; Pegg et al. 1997) of a rapid decline in numbers followed by little or no recovery to densities required to sustain a desirable fishery. Why such a response has occurred in Montana is difficult to ascertain. Although there has been some habitat degradation and loss over this time period, much of the habitat conditions sauger encounter today (e.g., water diversion structures, dams), for the most part have not changed dramatically over the past 20 or more years.

Why the rather marked and sudden statewide decline, then, despite improved flows? One possibility is that the populations will recover but there is a lag response (e.g., see discussion on middle Missouri River). However, for the Yellowstone system at least, flows have not improved in the lower Tongue River. The long string of poor spring flow conditions over the past 15 years may have adversely affected the entire Yellowstone sauger population if, as the data suggest, this was the prime spawning area in the entire system. A similar loss of an important spawning tributary in Tennessee due to dam construction was thought to be responsible for the decline of sauger in the entire upper Tennessee River population (St. John 1990).

Another possibility is that recovery may be unlikely under current conditions. Sauger, like other species with complex migration patterns, may be more susceptible than less migratory species to habitat loss and loss of migratory corridors and ensuing fragmentation of habitats. The common pattern of extirpation of sauger from large tributary streams throughout its range (St.John 1990; this report), speaks well to the sensitivity of the species to such fragmentation. Because of large-scale connectivity among populations, a large disturbance, in this case drought, can result in large scale population declines in highly migratory species. Migratory barriers and water diversion canals, which did not dramatically influence the populations when population levels were high, then act to impede recovery and keep numbers low.

B. *Habitat loss*

There was no apparent habitat loss that could account for the regional decline in sauger. Tiber, Tongue River, and Bighorn dams, and Cartersville and Vandalia diversion dams, have blocked or impeded migratory access to large areas of the historical range of sauger in Montana. Similarly, the Intake water diversion canal, recently shown to entrain large numbers of sauger, has been in operation for decades. Thus at first glance it is difficult to point to these migratory blockages and canal diversions as the main reason for the recent sauger decline as these structures were in place during the 1970s and 1980s when sauger were abundant and widespread throughout the Yellowstone and Missouri drainages. However, these structures are probably impeding recovery directly by causing high mortality and preventing access to suitable habitat, and indirectly by increasing the vulnerability of remaining fish to exploitation.

Hesse (1994) attributed channelization as an important factor in the decline of sauger in the mainstem Missouri River in Nebraska. However, much of channel complexity in the Missouri and Yellowstone rivers remains intact, so it is unlikely channel changes caused the sauger decline. In the middle Missouri, however, dewatering of sidechannels used as rearing habitat for YOY sauger as a result of power peaking operations at Morony Dam (Penkal 1990), could be an important factor affecting year-class strength.

C. Hybridization with walleye

As noted in section Ia, despite overlapping distribution and similar spawning habitat requirements, natural hybridization between walleye and sauger is relatively low under normal circumstances due to different spawning times and spawning locations and probable reproductive isolating mechanisms (Billington et al. 1988; Siegwarth et al. 1993; White and Schell 1995). Rates of hybridization increase where both species reproduce and spawning habitat may be limited, for example in reservoirs (Nelson and Walburg 1977; Van Zee et al. 1996), and especially where the sauger x walleye hybrid, saugeye, are stocked (Fiss et al. 1997). Hybridization may increase, too, when sauger populations fall to low levels. Since sauger x walleye hybrids readily breed and do not appear to have reduced survival, there is rising concern over the stock integrity of saugers (White and Schell 1995; Billington et al. 1996; Fiss et al. 1996; Leary and Allendorf 1997). Though saugeye are not stocked in Montana and nearby regions, the high overlap between spawning walleye and sauger populations coupled with low density of sauger and expanding walleye populations, raise concerns over sauger stock integrity in the state.

Visual identification of true hybrids is often unreliable (Flammang and Willis 1993; Ward and Berry 1995; Van Zee et al. 1996); for example, 16% of fish from Lewis and Clark Lake, South Dakota, were incorrectly identified using external traits (Van Zee et al. 1996), and none of 15 electrophoretically-determined hybrids from Fort Peck Reservoir were visually identified as such (Leary and Allendorf 1997). However, hybrids can be readily determined electrophoretically by comparing the frequency of four different protein coding nuclei (Billington et al. 1990). I 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 5). Overall, sauger hybridization rates in Fort Peck, the middle Missouri River, and the lower Yellowstone River are similar to other Missouri River reservoirs (Sakakawea, Lewis and Clark), averaging about 10%. Rates of hybridization are well below that reported from waters where saugeye have been stocked (74%; Fiss et al. 1997).

Table 5. Proportion of sauger x walleye hybrids in Montana and surrounding regions. N is the total number of *Stizostedion* screened.

Location	Date	N	No. of hybrids (%)	Source
Middle Missouri R.	1996	14	0 (0)	Billington et al.1997
	1999	109	5 (4.5)	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

Kreuger et al. (1997) found no hybridization in the Bighorn River and Boysen and the upper Bighorn reservoirs, Wyoming, and attributed this to a low walleye reproduction in these systems. Walleye also have low repoductive success in Fort Peck Reservoir, but a hybridization level for *Stizostedion* of about 6.5-9.5% (Table 5). Leary and Allendorf (1997) concluded that use of misidentified sauger or sauger x walleye hybrids during artificial propogation (walleye are trapped in Fort Peck for spawn taking operations each spring), was likely the source of the hybridization in combination with natural hybridization.

In summary, present information suggests that hybridization levels are similar to those observed in other systems where walleye and sauger coexist without supplemental stocking of saugeye, and there is no evidence that hybridization caused the sauger decline. Whether hybridization rates will increase is uncertain. In some systems, like Lewis and Clark Reservoir, South Dakota, sauger and walleye have coexisted for many years and both reproduce in the same area and spawning habitat is limited yet the hybridization remains about 10% and substantial loss of stock integrity of sauger has not yet been observed. Other than stocking of saugeye (Fiss et al. 1997), it is difficult to predict what factors will magnify hybridization, thus it is difficult to target practices that may lessen or enhance risk. Given this uncertainty, continued monitoring is necessary, as well as close genetic screening of walleye or sauger broodstock used in artificial propogation (Ward 1992; Leary and Allendorf 1997; Billington 1998). Suspension of walleye stocking into known sauger spawning areas (e.g., Tongue River) would also be a desirable precaution.

D. Interactions with other species

There is no evidence for direct competition of sauger with other coexisting top predators, namely walleye and smallmouth bass. As noted, walleye and sauger tend to occupy different habitats where they do coexist. Similarly, smallmouth bass would likely not do well in the turbid conditions favored by sauger. Rather, habitat alterations that favor walleye or smallmouth bass, or increased predation on young sauger from increased abundance of piscivorous fishes, likely play a larger role in species replacement than direct competition. Sauger do not do well in waters of moderate to high transparency, and reductions in turbidity have been shown to shift species dominance to walleye (e.g., Missouri River reservoirs, Nelson and Walburg 1977; section Ia and c above). Such reductions in turbidity as a result of reservoir influence have occurred in the Bighorn and Tongue rivers, the middle Yellowstone River below Bighorn River, and the upper half of the Marias River below Tiber Dam. The Tongue River, for example, is now quite clear during the summer months (R. Trenka, MSU, pers. comm.) and smallmouth bass are the dominant sport fish. This shift in conditions in these former tributary strongholds has likely significantly reduced their suitability as habitat for resident sauger, and favors species that prefer clearer waters.

It is important to note, too, that walleye numbers are increasing in some areas where sauger were formerly abundant. Walleye are now much more common in the lower Missouri (i.e., Milk River confluence) and middle Missouri (below Morony Dam) rivers than they were in the past. It is unknown if these higher numbers merely reflect the higher populations of walleye in Fort Peck and Sakakawea reservoirs, or represent an actual shift in the replacement of resident sauger by walleye.

E. Overharvest

The role of overharvest remains equivocal. Several factors suggest that exploitation rates are low. First, exploitation rates as derived from voluntary tag returns by anglers of fish tagged during electrofishing and subsequently recovered all suggest that sauger exploitation is low, below 10%, in both the Yellowstone and Missouri systems. Also, many sauger waters in the state receive light angling pressure due to their remoteness and large size. Other factors that could be indicative of high exploitation rates also have other possible explanations. For example, the very low numbers of larger sauger in the lower Yellowstone in the 1990s, despite their presence in Lake Sakakawea (see next section), suggests that size structure changes could also be the result of the failure of these larger sauger to move upstream (for some unknown reason).

In addition to the above size structure changes, however, several factors argue for the idea that overharvest may be a problem. First, because of their propensity to concentrate in high numbers in specific locales in the winter and spring, a propensity that has been augmented by impedence of movement by dams and water diversion structures, the potential for overharvest of sauger is real and has been well documented in the literature. Anglers in Montana do seasonally target sauger below diversion dams and in spawning tributaries, but again, without detailed creel information it is unknown how significant the harvest rates are. Second, reliance on voluntary tag returns is problematic because of the very significant potential for underreporting in sauger harvest estimates (Pegg et al. 1996). A nonreporting level of 30%-- a level not uncommon in voluntary tag return studies (Pegg et al. 1996; Maceina et al. 1998)— would inflate exploitation rates of sauger near 40%, a level that could have significantly reduced the sauger population when coupled with the effects of low river flows.

V. Status of Sauger in Surrounding Regions

Alberta: Sauger is a locally important sportfish in the upper Milk River in Alberta. Little information on their distribution and abundance is available, but there is no evidence to date for a large decline in the population (T. Clayton, Alberta Conservation Association, Lethbridge, 1999 pers. comm.). In a set line and seining survey of the drainage in 1987 (RL&L Environmental Services 1987), sauger comprised about 0.4% of the catch (76 of 16,733 fishes captured), a percentage similar to that found in a 1969 survey (Willock 1969). An electrofishing survey in the mid 1990s of the South Saskatchewan River basin (Hudson Bay drainage), the next drainage north from the Milk River, found sauger to be widely distributed and in good numbers throughout the basin, comprising 11.8% of the 2,559 sportfish captured, catch rates varying from 0.36 to 6 fish per hour (Patalas et al. 1997).

North Dakota: There are two primary sauger populations in the state, the Missouri River system- Lake Sakakawea and the short river reach above Sakakawea to the Montana-North Dakota border, and Lake Oahe; and the Red River (Hudson Bay drainage)(G. Power, North Dakota Game and Fish Department, Bismarck, 1999 pers. comm.). The sauger population in Lake Sakakawea, located downriver from the lower Missouri-lower Yellowstone confluence, shows wide fluctuations in abundance. Abundance was very high in the mid 1980s; in 1988, for example, sauger comprised 460 of 600 fish (77%) caught during summer gill netting surveys. Sauger numbers declined sharply during the drought years from 1988-92 (Figure 20). This down cycle corresponds to the timing of the low water years and associated decline in the sauger populations in Fort Peck Reservoir (Figure 10), and the middle Missouri (Figure 1) , and lower Yellowstone (Figure 16) rivers. However, unlike the latter systems, the population has shown recovery as reservoir water levels have increased in recent years, and has stabilized at a reasonably healthy level, though walleye are now much more abundant than sauger (G. Power, pers. comm.). Catches of YOY sauger in fall gill net sets further indicate good reproduction in most years since the mid 1980s, with 4 of the last 5 years exceeding the long-term median (Figure 21). As noted above, this contrasts with the apparent continued low recruitment of YOY sauger in both the lower Missouri and lower Yellowstone systems. Sauger harvest has reflected this population trend, peaking at 59,739 sauger harvested in 1988, and declining by about 90% to 5,591 in 1997; however, the spring recreational harvest increased markedly in 1998. Despite widely varying abundance, the average size of sauger caught has remained at about 17 inches and 1.6 pounds (G. Power, pers. comm.). North Dakota is preparing a comprehensive review of walleye status in the Missouri River system this year, and is planning a similar review for sauger next year.

CATCH RATE OF ADULT SAUGER IN LAKE SAKAKAWEA, 1962-1998

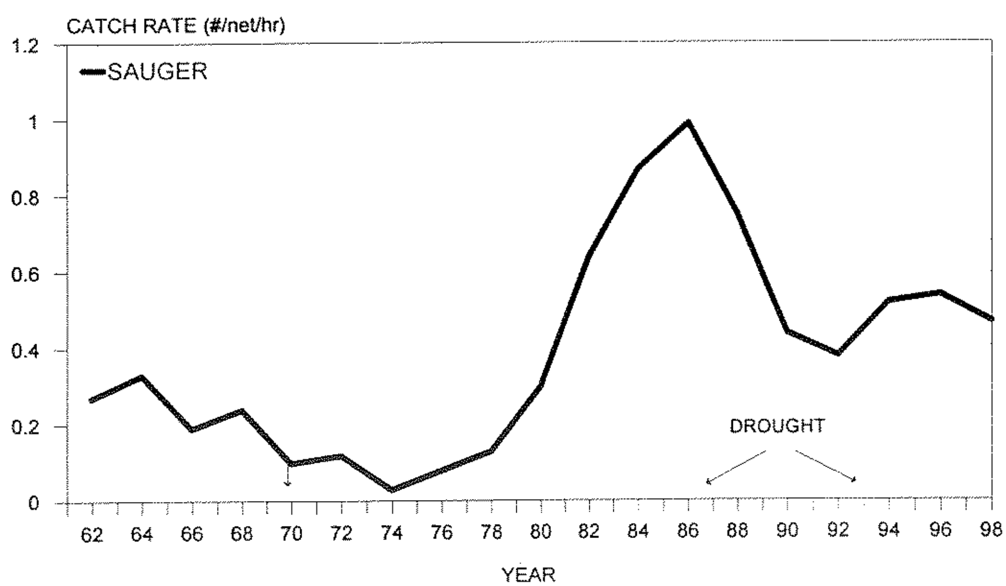

Figure 21. Catch rate of adult sauger in gill nets, Lake Sakakawea 1962-98.

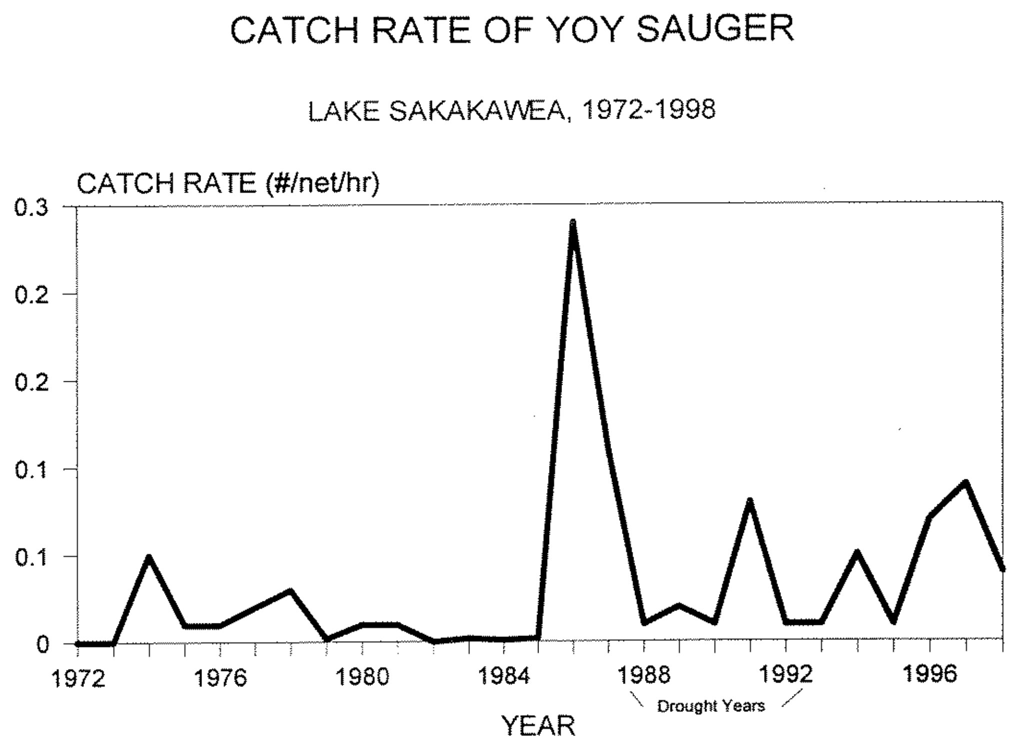

Figure 22. Catch rate of YOY sauger in Lake Sakakawea, 1972-98 (figure from G. Power, North Dakota Game and Fish, Bismarck, unpub. data, with permission).

South Dakota: Of the mainstem Missouri reservoirs in South Dakota, sauger are most abundant in the Lewis and Clark Lake, a turbid reservoir with a high water exchange rate (Nelson 1968; Walburg 1971; Van Zee 1996). Van Zee (1996) assessed YOY sauger abundance from 1985-94 and found a sharp drop in abundance in the late 1980s to mid 1990s. Natural recruitment has been good to fair in recent years (Wickstrom 1998).

Fish assemblages in three major tributaries to the Missouri River in western South Dakota—Belle Fourche (Doorenbos 1998), Cheyenne (Hampton 1998), and Moreau (Loomis 1997) rivers, were recently surveyed to assess fish distribution and abundance in these poorly known systems. Sauger were rare (<0.25% among >3,000 fishes captured in each drainage) or absent in all three of these large drainages. Although the historic abundance of sauger in these systems is unknown, the habitat characteristics present in these prairie rivers (moderate to high turbidity, some deep pools and gravelly riffles) would seem to provide suitable conditions for both resident and migratory sauger from the mainstem Missouri or the present-day Lake Oahe. In addition, the surveys found channel catfish common to abundant, a species that typically co-occurs with sauger (e.g., the lower Yellowstone River). The habitat conditions and fish assemblage structure of the three drainages therefore suggests that sauger were probably common throughout these systems in the past. Use of these tributaries for spawning cannot be ruled out since streams were sampled in the summer, but presence of irrigation diversion dams along each of the streams likely restricts any spawning movements.

Wyoming: Sauger were once common in the North Platte River in southeastern Wyoming, but are now extinct (Baxter and Simon 1970). As noted, historic sauger distribution extended into Wyoming from Montana in the upper Powder, Tongue, and Bighorn rivers. Although the present status of sauger in the upper Powder in Wyoming is unknown (B. McDowell, Wyoming Game and Fish Department, Sheridan, 1999 pers. comm.), sauger were probably never abundant due to unsuitable habitat conditions of shifting sand substrate and a lack of pools (W. Hubert, University of Wyoming, 1999 pers. comm.). Rehwinkel (1977) captured a few sauger in spring 1976 near the Montana-Wyoming border which were presumably migrants from the Yellowstone, entailing a migration of 194 miles. Reports of "good catches" of sauger by anglers in the spring below the Clear Creek diversion dam, a tributary that joins the Powder River near the Montana border, provide further support for the notion that some sauger spawn from the Yellowstone spawn in the upper Powder, and sauger distribution may have extended upstream even further in the drainage. Presently, data are lacking on how much of the Powder is occupied and at what population levels (B. McDowell, pers. comm.).

As noted, historic accounts suggest that sauger were abundant in the upper Tongue River in Wyoming prior to the construction of the Tongue River dam, but may have disappeared or declined to very low numbers after its completion in the 1950s. Following a purported reintroduction in Wyoming in the late 1960s (Elser et al. 1977), sauger now occur in low numbers below the Ranchester diversion dam downstream to the Tongue River reservoir (B. McDowell, pers. comm.). Angler reports of relatively good catches of sauger in the spring below this dam suggests that the presence of a sauger spawning run, but the magnitude of this run and where these fish come from is unknown.

The major remaining population in the state of Wyoming is the upper Bighorn/ Wind River drainage. Sauger are found in Boysen and Bighorn reservoirs and in 80-mile reach of the Bighorn River between the two reservoirs. Relatively little is known about the status of sauger in the system, but a comprehensive study of their distribution throughout the system began in 1999 (M. Welker, Wyoming Game and Fish Department, Cody, 1999 pers. comm.). While some sauger are river residents, most sauger in the river below Boysen Reservoir are seasonal migrants that move upstream from Bighorn Reservoir to spawn. However, there are a number of water diversion structures in the river between Bighorn Reservoir and the town of Worland, about 50 miles upstream, that likely impede upstream movement of sauger (Kreuger 1996). The spring sauger spawning run is large enough to support a sauger fishing tournament in Worland in April (Kreuger 1996). Both Boysen and the upper Bighorn reservoirs support low to moderate populations of sauger. Krueger et al. (1997) reported catch rates of about 8 fish per gill net set in Boysen Reservoir, and about 5 fish per gill net set in Bighorn Reservoir. Interestingly, gill net catch rates are much lower in the summer than in the spring and fall in both reservoirs (Kreuger et al. 1997), but the exact whereabouts of sauger during the summer is unknown (M. Welker, pers. comm.). Walleye are stocked into both reservoirs, and are much more abundant than sauger in Boysen Reservoir, averaging about 30 fish per gill net set. Low relative weight and relative stock density (size structure) of the Boysen Reservoir sauger was attributed to lower turbidity providing less suitable light conditions, cooler temperatures, greater mean depth, and competition with walleye for food (Kreuger et al. 1997).

In summary, sauger status in surrounding regions is similar to that of Montana in that 1. sauger appear to be much reduced or absent from tributary drainages (e.g., western South Dakota, Tongue and North Platte rivers in Wyoming) where they were likely historically common, and 2. where sauger do persist, their status in some areas is often uncertain due to limited information about this highly migratory and relatively poorly understood species. Unlike the Missouri and Yellowstone river systems in Montana, the Lake Sakakawea sauger appear to be rebounding since the late 1980s low water years. This population increase has not been manifested by increased sauger densities in the lower Yellowstone and lower Missouri systems. The recent spike in the Sakakawea sauger population will provide a further test of a link in the next couple of years.

VI. Conclusions and Recommendations

A. *Current status of sauger:* Sauger in Montana persist in about half of the estimated 2,015 stream miles that historically supported this species and are now common in only about 21% of its former range. Losses have been particularly acute in tributary drainages where an estimated 77% of tributary stream miles no longer support resident sauger compared to 22% of mainstem stream miles. Significant reductions have occurred statewide over the past 20 years, and resulted in significantly reduced angler harvests. Status of sauger in surrounding regions appears stable in some areas (Alberta, Lake Sakakawea in North Dakota), but is much reduced or uncertain in other areas (western South Dakota, Wyoming).

B. *Reasons for decline:* The statewide drought in the late 1980s appeared to trigger the marked decline in sauger in large portions of the Missouri and Yellowstone drainages. Despite improved flows since the mid 1990s there has been little evidence for recovery in most areas. It is difficult to attribute the decline to habitat loss since much of the major habitat alterations that affect sauger, namely migratory barriers in the form of dams and water diversion structures and canals, were in place before the decline began. It is hypothesized, however, that barriers to migration of this highly migratory species, in association with seasonally high harvest pressure during spring spawning runs, may be preventing population rebound in spite of improved flows. It does not appear that hybridization with walleye is abnormally high nor increasing at this point in time. Evidence was lacking for displacement of sauger by walleye or smallmouth bass, but altered temperature and water clarity conditions in some primary spawning tributaries (Tongue River, Marias River) may over time shift the balance in favor of other species.

C. *Information gaps:* A general lack of basic information on sauger distribution and habitat requirements makes development of management policies difficult (Pegg et al. 1997). Tagging studies in both the Yellowstone and Missouri systems indicate sauger are highly migratory and that there appear to be two spatially large and distinct populations in the state: the middle Missouri population, bounded by the mainstem middle Missouri and its major tributaries and including Fort Peck Reservoir; and the Yellowstone population, comprised of the mainstem middle and lower Yellowstone, lower Missouri, and major tributaries, and Lake Sakakawea (Garrison Reservoir) in North Dakota. Movement data suggest that sauger freely move throughout each of these areas encompassing a very large geographic area that crosses interjurisdictional boundaries both within and outside of Montana. How habitat conditions in one area affects the whole population remains unknown, but current information indicates the need for each population to be managed as a whole, interconnected unit. Some important questions are: where do sauger from each reservoir spawn? How does reservoir water level influence upriver recruitment? What are the seasonal habitat requirements and movements of YOY sauger occupying reservoirs? Mainstem rivers? Answers to these questions would shed light on reasons why sauger have decreased and point to management actions for population enhancement.

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 and seasonal movement patterns. A large scale study on the contribution of each of these reservoirs to upriver sauger stocks would be especially informative. Radiotracking of walleye and sauger during spawning (e.g., below Intake, lower Marias and Milk rivers) would also provide additional information about potential hybridization at spawning sites as well as sites where sauger are spawning. The low numbers of sauger in some main spawning tributaries (e.g., the Tongue River) begs the question if sauger are spawning in other locations. Such information would be especially useful for designing stocking and habitat management practices to supplement low sauger densities.

D. Management actions to protect and enhance sauger

1. Improved fish passage and water flows- FWP plans, outlined the in the recent report "Warmwater Fisheries Management Plan, 1997-2006" (Anon. 1997), for improved fish passage at Cartersville diversion and other diversions dams, and for reduction of fish entrainment at the Intake water diversion canal, are excellent steps for promoting sauger recovery. These actions should improve access to many former historic miles of sauger habitat and reduce high mortality of juvenile sauger moving upstream from the lower Yellowstone River and Lake Sakakawea.

   Improved flows in the lower Tongue River and other former sauger habitats (e.g., the lower Teton River) should also be a key objective for sauger recovery (Anon. 1997). Better information on the role of Morony Dam releases on YOY habitat in the Missouri River above Fort Peck is also needed.

2. Angling regulations- Minimum length limits of 14-15 inches and bag limits have been successfully implemented in some sauger waters to prevent recruitment and growth overfishing and improve the size structure of the population (Pegg et al. 1996; Fischbach 1998; Maceina et al. 1998). The poor size structure in the lower Yellowstone River, in particular, suggests that implementation of a minimum length limit should be considered. However, implementation of angling regulations to protect sauger is problematic given that current regulations in Montana do not separate walleye and sauger but treat them together with a joint statewide bag limit of 5 walleye and sauger per day. Such a regulation was implemented because anglers often have difficulty telling them apart. Thus any regulation would require a considerable education effort. Because sauger are most subject to overharvest during a relatively short time window when they are concentrated during spawning migration and on the spawning grounds, implementation of restricted angling areas and spawning refugia may be a more effective way to control harvest (Pegg et al. 1997).

   A creel survey in selected high use sites during the spring (e.g., below Intake and

Cartersville diversion dams, below the Powder mouth on the Yellowstone) is suggested in order to better quantify current harvest rates, and also to provide a better benchmark with which to judge future improvement or decline.

3. Supplemental stocking- Stocking has been used successfully to supplement natural recruitment of sauger for both rivers (Heidinger and Brooks 1998) and lakes (Rawson and Scholl 1978; Stodola 1992) though the literature on the subject is not extensive (Heidinger and Brooks 1998 for review). Currently, sauger stocking is being considered for the lower Yellowstone to supplement the depressed sauger numbers and improve angling for this recreationally important species in southeastern Montana; the upper Marias River above Tiber Reservoir to restore sauger to an area from which it was extirpated; and to Morony Reservoir to supplement depressed recruitment in the middle Missouri mainstem (Anon. 1997).

   Several practices should be implemented prior to stocking. Secchi depth readings should be taken as a simple way to evaluate of the suitability of the site as sauger habitat. The literature indicates that secchi depths > 1 m represent poor habitat suitability for sauger and the likelihood of stocking success will be low under these conditions. The greatest risk in stocking is the risk of increasing hybridization rates since a few hybrids artificially propogated can produce many thousands of fry and fingerlings containing foreign alleles (Ward and Berry 1995; Billington 1998). Thus careful genetic screening of broodstock is an important precaution (Ward and Berry 1985; Billington et al. 1996). Finally, marking of sauger fry with oxytetracycline prior to stocking is recommended so that stocking success and extent of movements of fish after stocking can be assessed (Heidinger and Brooks 1998).

4. Spawning habitat enhancement- Given the propensity for sauger to spawn in just a few rocky shoals or cobble-boulder fields (see lower Missouri section above), it is possible that sauger spawning and hatching success could be improved by habitat enhancement of spawning areas. This recommendation is speculative since no studies in the literature mentioned spawning habitat improvement for sauger. Could, for example, the loss of sauger habitat in some areas (e.g., the lower Tongue River), be offset by augmenting limited habitat in other known spawning

areas (e.g., the Powder River)? Trial testing of spawning habitat enhancement would be informative, too, as it would indicate if and how quickly sauger would learn to spawn in new locales.

5. Monitoring- Continued monitoring of sauger abundance in sites that have historic population data is key to tracking population trends. Because of their concentration in a relatively few areas in the spring, sampling below diversion dams and in known spawning areas is probably the most efficient and effective way to track population status over a large area. Several key spawning areas that have not been sampled intensively in the spring for many years, e.g., the lower Milk River, lower Tongue, lower Powder, lower Missouri 'bluff habitats,' and Musselshell rivers- should be re-sampled to better assess spawner abundance and assess larger scale population trends. Repetition of population estimates done in the past on the lower Milk, lower Tongue, and the lower Yellowstone, would further clarify how significant the sauger decline has been. Finally, surveying little known areas (e.g., the Judith River) would help further delineate where sauger persist.

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