KOOTENAI RIVER WHITE STURGEON INVESTIGATIONS AND EXPERIMENTAL CULTURE

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ABSTRACT

Setline and angling techniques were used to sample 64 white sturgeon Acioenser transmontanus from the Kootenai River in 1992. Of those sampled, 15 were recaptures from previous years of this study. A total of 429 white sturgeon were captured from March 1989 through September 1992. Fork lengths of white sturgeon in the total sample ranged from 88 to 274 cm. Our data indicated there was a complete lack of recruitment of juveniles into the population which was estimated in 1990 at 880 individuals with a 95% confidence interval of 638 to 1,211. Annual mortality of white sturgeon from 1982 to 1991 was 0.0374. Approximately 80% of the population was more than 20 years old and was reproductively mature.

An ongoing sonic telemetry study revealed long distance movements among adults. Sturgeon regularly moved across the British Columbia-Idaho border. Sturgeon used deep holes in the river or migrated to Kootenay Lake during late fall. During spring and early summer, reproductively mature sturgeon moved from 15 to 110 kilometers upriver and congregated within 15 kilometers downriver from Bonners Ferry in areas of elevated water velocity. This behavior coincided with increasing discharge and water temperatures.

Wemonitored movements of five reproductively mature female white sturgeon. The fish responded to increasing then decreasing flows by moving upriver then downriver, respectively. All five fish quickly moved to Kootenai Lake when flows dropped suddenly from higher than 20 kcfs to less than 10 kcfs. One fish was recaptured and was reabsorbing eggs.

Trawling and sampling with mats of artificial substrate failed to capture white sturgeon eggs or larvae in 1992.

One hundred and four age 1 and 14 age 2 hatchery-reared Kootenai white sturgeon were released into the Idaho section of the river in 1992. Telemetry of six of the larger juveniles showed general downriver movement from September into November.

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TEXT

INTRODUCTION

The population of white sturgeon aCIPENSER transmontanus in the Idaho section of the Kootenai River was first surveyed in 1979 through 1982 (Partridge 1983). Recruitment of juvenile sturgeon to the population appeared to be insufficient to sustain the harvest of adult fish, forcing a closure on harvest beginning in 1984.

When this study began, our knowledge regarding habitat requirements of white sturgeon and our understanding of environmental influence on distribution, movement, spawning, and juvenile survival was insufficient to allow us to determine how development and management of the Kootenai River has impacted this species.

This project was authorized by the Northwest Power Planning Council (1987) in an effort to identify environmental factors limiting the white sturgeon population in the Kootenai River and to recommend effective management actions to restore the wild population. The Kootenai Indian Tribe of Idaho is developing an experimental white sturgeon culture facility on the Kootenai River to help evaluate the reproductive potential of the wild population and to explore the feasibility of supplementation. In November of 1988, the Idaho Department of Fish and Game (IDFG) and Kootenai Tribe began working cooperatively to meet the goal of restoring this population.

DESCRIPTION OF STUDY AREA

Geography

The Kootenai River originates in Kootenay National Park, British Columbia. The river flows south into Montana and turns northwest at Jennings, the site of Libby Dam, at river kilometer (rkm) 352.4 (Figure 1). Kootenai Falls, 50 km below Libby Dam, presents an impassable barrier to sturgeon. As the river flows through the northeast corner of Idaho, a definite reach change occurs at Bonners Ferry. Upstream from town, the river has an average gradient of 0.6 m/km, with velocities higher than 0.8 m/s. Downstream from Bonners Ferry, the river slows to an average gradient of 0.02 m/km, deepens, and meanders through the Kootenai Valley back into British Columbia and into the southern arm of Kootenay Lake. The river leaves the lake through the western arm to a confluence with the Columbia River at Castlegar. A natural barrier at Bonnington Falls (and now a series of four dams) has isolated the Kootenai white sturgeon from other populations in the Columbia River basin for approximately 10,000 years (Northcote 1973). The basin drains an area of 49,987 km^2 (Bonde and Bush 1975).

Development

Spring floods were common prior to commencement of operation of Libby Dam in 1972. The U.S. Army Corps of Engineers constructed Libby Dam to provide flood control and hydropower generation as part of the Bonneville Power Administration (BPA) network. Dam operation drastically alters natural flow levels by storing water during spring runoff, discharging power peaking flows during late summer and fall, and increasing the flows throughout winter. Corra Linn Dam raises the mean level of Kootenay Lake 2.4 m, influencing the river level to Bonners Ferry.

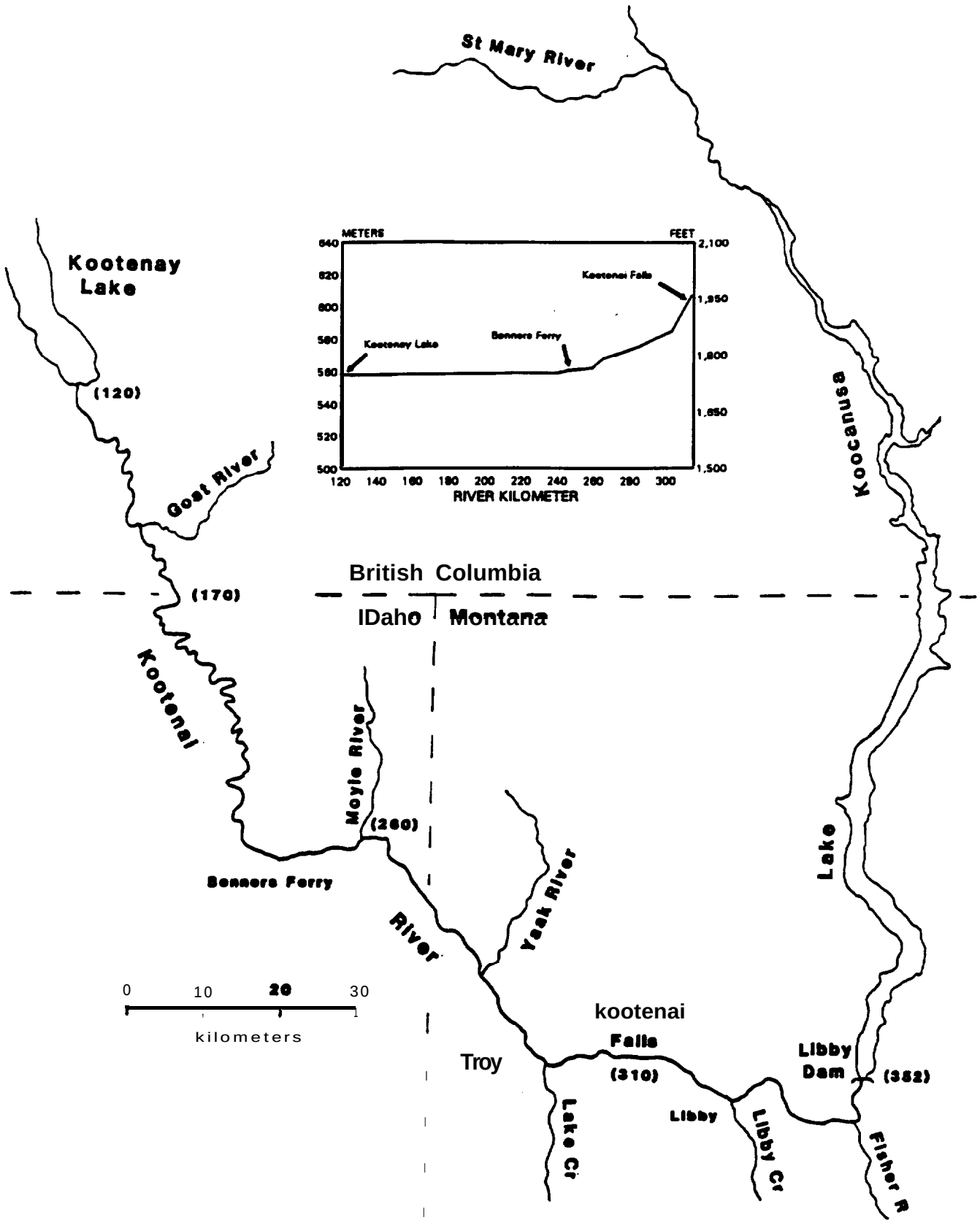


Figure 1. Map of the Kootenai River with a schematic of river gradient. Study area was from southern Kootenay Lake upriver to Kootenai Falls.

To protect agricultural land between Bonners Ferry and Kootenay Lake, the riverbanks have been diked extensively since the 19208, effectively removing most backwater and slough areas from the river system.

Contaminants

Prior to construction of Libby Dam, most point source pollution in the Kootenai River drainage came from a mine and fertilizer plant upriver on the St. Mary River (Bonde and Bush 1975). The ASARKO mine (copper and silver) on Lake Creek near Troy, Montana is the only current mining operation in the drainage below the dam. The closed Snowshoe Mine on Snowshoe Creek (tributary to Libby Creek) was reclaimed in 1989 to prevent water quality problems.

Sturgeon Fishery

Idaho

Harvest of white sturgeon from the Kootenai River has been regulated in Idaho since 1944 when commercial fishing was prohibited. Increasingly restrictive statewide harvest limits and length restrictions were imposed over the years (Table 1). From 1944 through the mid-1970s' 10 to 20 fish were harvested per year; an estimated 43 to 50 white sturgeon per year were harvested from 1979 through 1982. Partridge (1983) conducted the first and only prior investigation of fisheries resources on the lower Kootenai River from 1979 through 1982. He found that only 13% of his sample of white sturgeon were younger than age 15 and smaller than 92 cm total length, the legal size for harvest. The IDFG terminated harvest of white sturgeon in 1984 based on Partridge's (1983) conclusion of low juvenile abundance.

Montana

Montana did not restrict harvest of white sturgeon prior to 1972 (Table 1). Montana Department of Fish, Wildlife, and Parks restricted harvest to two fish/year with a slot regulation of 102 to 183 cm total length for the next six years. Anglers legally harvested 5 to 18 white sturgeon annually during that period. Montana closed the fishery completely in 1979 (Graham 1981). Montana officials have declared white sturgeon a "species of special concern" due to the very small number (an estimated 5 fish) residing in the river in 1979.

British Columbia

White sturgeon harvest has been restricted in British Columbia since 1952 (Table 1). From 1974 through 1989, anglers in B.C. were allowed to harvest one white sturgeon per year with a minimum length restriction of 1 m. Beginning in 1989 setlining for white sturgeon was prohibited, which limited the method of harvest to angling. All white sturgeon harvest was prohibited in the Kootenai River beginning in 1990. Prior to this closure, 5 to 18 fish were harvested annually, and illegal harvest may have increased that estimate by 50% (Andrusak 1980). Since 1977, the British Columbia Ministry of Environment tagged 180 white sturgeon at the mouth of the Kootenai River where it enters the south arm of the lake. Several of those fish were recaptured in Idaho (Andrusak 1980).

Table 1. A history of fishing regulations for white sturgeon in the Kootenei River.

Year	Sturgeon fishing regulations		
	I deho	Montana	British Columbia
1944	2 in possesion; no yearly limit; no commercial harvest		
1948	1 setline; 1 in possession		
1949	1 setline; 1 in possession; 76 cm minimun sire		
1952			setlines permitted; 1 per day; 92 cm minimun size
1955	1 setline; 1 in possession; 102 cm minimum size		
1957	1 setline; 2 per year; 1 in possession; 102 cm minimun size	setlines permitted for ling only	
1960	1 setline; 2 per year; 1 in possession; 92 - 183 cm length restriction		
1968		setline permitted for sturgeon February 15 through June 30	
1973		6 setlines uith 6 hooks per line permitted February 15 through June 30; 2 per year; 102 - 183 cm length restriction	
1975		no setlines permitted; 2 per year; 102 - 183 cm Length restriction	
1978			100 cm minimun size
1979	2 per year; 1 in possession; 92 - 183 cm length restriction; permit required	closed	
1981			1 per year; 100 cm minimun size
1982			Sturgeon declared a game fish
1983	setlines prohibited; season: July 1 through December 31; 1 per year; 92 - 183 cm length restriction		
1984	catch and release only; open all year		
1989			setlines prohibited
1990			catch and release only

TABLE-I

GOAL

To restore wild sturgeon populations to historic levels in the Kootenai River to maintain the catch and release fishery.

OBJECTIVES

1. Assess the status of white sturgeon in the Kootenai River between Kootenay Lake and Kootenai Falls with regard to distribution, population size, reproduction, and recruitment.

2. Describe weekly and seasonal movements of white sturgeon and describe the use frequency of physical habitat parameters, including depth, focal point velocity, temperature, and turbidity.

3. Determine gamete viability by experimental culture of white sturgeon from the Kootenai River.

4. Test experimental culture as a means of recruiting white sturgeon to the population.

5. Determine effects of pollutants on white sturgeon reproduction by measuring levels of contaminants in white sturgeon ova and offspring and in river sediments.

6. Determine if Kootenai River white sturgeon are genetically different from other white sturgeon stocks by electrophoretic analysis.

Cur activities in 1992 focused on Objectives 1, 2, and 4. The Kootenai Tribe continued culture activities, and addressed Objectives 3 and 4 (Siple 1993). We reported our efforts to achieve the other objectives in Apperson and Anders (1990 and 1991) and Apperson (1993).

METHODS

Population Status

Adult and Sub-adult Sturgeon Sampling

Detailedmethods for capture, handling, marking, and collecting habitat use information on sub-adult and adult white sturgeon are provided in Apperson and Anders (1990).

White Sturgeon Egg and Larvae Sampling

We used mats of filter material (latex-coated animal hair) bolted to angle iron frames (62 x 75 cm) in an attempt to collect white sturgeon eggs, and thereby document spawning activity (McCabe and Beckman 1990). We deployed the mats in the river from May 30 through July 12, 1991 and from May 15 through June 30, 1992. Mats were set out in groups of three to five from rkm 226 to 259 in

water deeper than 3 m, anchored with one or two 10-kg cement weights. Researchers checked the mats every 2 to 13 days for white sturgeon eggs.

Trawls sampled the river drift for white sturgeon eggs and larvae during June of 1990, 1991, and 1992. Trawls were of two types: a beam trawl net (2.7 m x 0.5 m, 1.59 mm knotless mesh) and a D-ring plankton net (0.78 m maximum width x 0.54 m high, 1.59 mm knotless mesh). We held the nets stationary on the substrate for 5 to 20 minutes per sample. Detailed methodology and gear specifications are given by Parsley et al. (1989).

Habitat Utilization and Seasonal Movement

During 1991 and 1992, we used telemetry to monitor reproductively mature white sturgeon. We tracked fish weekly from mid-April through July to identify timing of spawning-related movement, timing of spawning, and habitats used for spawning. During 1992, we attached new transmitters to wild white sturgeon that were expected to spawn within three years. All ultrasonic transmitters placed on adult white sturgeon during 1991 and 1992 were Sonotronics model ST-71-3 (65 mm x 18 mm; 8 g) equipped with 50-month batteries and a detection limit of up to one km.

During September through November 1992, we obtained habitat use and movement data on juvenile white sturgeon by attaching 40-day ultrasonic transmitters to six age 2 hatchery-reared Kootenai white sturgeon (Sonotronics model MT-91-2; 40 mm x 9 mm; 3 g). Transmitters were attached by the method described for adult white sturgeon (Apperson and Anders 1990). Six juvenile white sturgeon were stocked into the river on August 26 and monitored weekly to biweekly until all transmitters ceased to function. Water depth, mean water column and focal velocities, water temperature, river location, distance from river bank, and cover were recorded each time we located one of these fish.

RESULTS

Population Structure

Population Estimate and Abundance

We used sample data from 1989 and 1990 to estimate the number of white sturgeon in the Kootenai River at 880 individuals, with a 95% confidence interval of 638 to 1,211 (Apperson and Anders 1991). This translates to an average abundance of 7 white sturgeon per km between Bonners Ferry and Kootenay Lake, with an associated confidence interval of 5 to 10 white sturgeon.

Crews captured 429 individual white sturgeon from March 1989 through September 1992. Catch per unit of effort of sampling is summarized by year, river section, and gear type in Appendix A. All but two fish were marked with Floy tags and all white sturgeon sampled after June 9, 1989 received Passive Integrated Transponder (PIT) tags. Crews recaptured 68 white sturgeon, of which 7 were recaptured more than once. Floy tags were lost from 16 white sturgeon (7 of those were lost during the year of tagging), but PIT tags were secure in all recaptured fish. With one exception, all white sturgeon were captured between rkm 244.5 (1 rkm downstream from the Highway 95 bridge at Bonners Ferry) and the extreme southern arm of Kootenay Lake at rkm 120. In May 1989, one white sturgeon (105 cm fork length) was caught in Montana at rkm 310.5 (2 rkm below Kootenai Falls). Using data from initial capture, fork length of white sturgeon

in the sample ranged from 88 cm to 274 cm, with a mean of 150 cm (Figure 2). A weight-length relationship developed from 223 measurements was weight = (1.016×10^{-6}) fork $length^{3.394}$ (Figure 3).

General Movement and Habitat Use of Adult White Sturseon

From June 1989 through October 1992, ultrasonic transmitters were attached to 38 adult white sturgeon that were captured throughout the Kootenai River downriver from Bonners Ferry (Appendix B). Analyses of seasonal habitat use and movement patterns of white sturgeon tracked through 1991 are reported by Apperson and Anders (1991) and Apperson (1992). In 1992, we only tracked white sturgeon to describe spawning-related movement (see RESULTS section on spawning-related movement).

Reproductive Potential

Maturity

From 1989 through 1992, a total of 339 white sturgeon were surgically examined to determine sex and stage of maturity. Twenty-six white sturgeon were surgically examined multiple times, with surgeries no less than one year apart. Nineteen males were identified by milt extraction without surgery. Of those surgically examined, 80% were positively sexed (Table 2). Refinement of our technique was partly responsible for the decrease in proportion of unsexable white sturgeon from 1989 to 1991. Also, a factor was our disproportionate sampling during April through June of 1990, 1991, and 1992 in sections of river where reproductive fish concentrated. White sturgeon sampled and released with and without surgical examination were recaptured at rates of 17% and 14%, respectively.

Lengths of white sturgeon at various reproductive stages are presented in Figure 4. The smallest ripe female in our sample was 135 cm fork length, and two females smaller than 130 cm fork length were judged to be spent. White sturgeon of this size range in the Kootenai River are 19 to 29 years old. The smallest reproductive male was 115 cm fork length and 23 years old.

Seven female white sturgeon examined for sexual maturity in multiple years of the study suggests a reproductive cycle of three to four years (Table 3). Reexamination of six males suggests a reproductive cycle of one to two years.

Wild Spawning

Trawlins-A single D-ring plankton net sampled for a total of 765 minutes in 1992, exceeding trawl efforts in 1990 and 1991 by three times (Figure 5). Samples in 1992 were collected on June 2, 4, 11, 18, and 25 at river depths of 2.1 to 9.8 m and surface velocities of 0.12 to 1.68 m/s. Water temperatures were 12°C to 17.5°C. No white sturgeon eggs or larvae were collected.

Artificial Substrate Sampling-Mats of artificial substrate sampled a total of 21,000 hours in 1992 as compared to 2,300 hours in 1991 (Figure 6). We sampled most intensively at rkm 245.8 (immediately downriver from bridges at Bonners Ferry) where fertilized white sturgeon eggs were recovered in 1991.

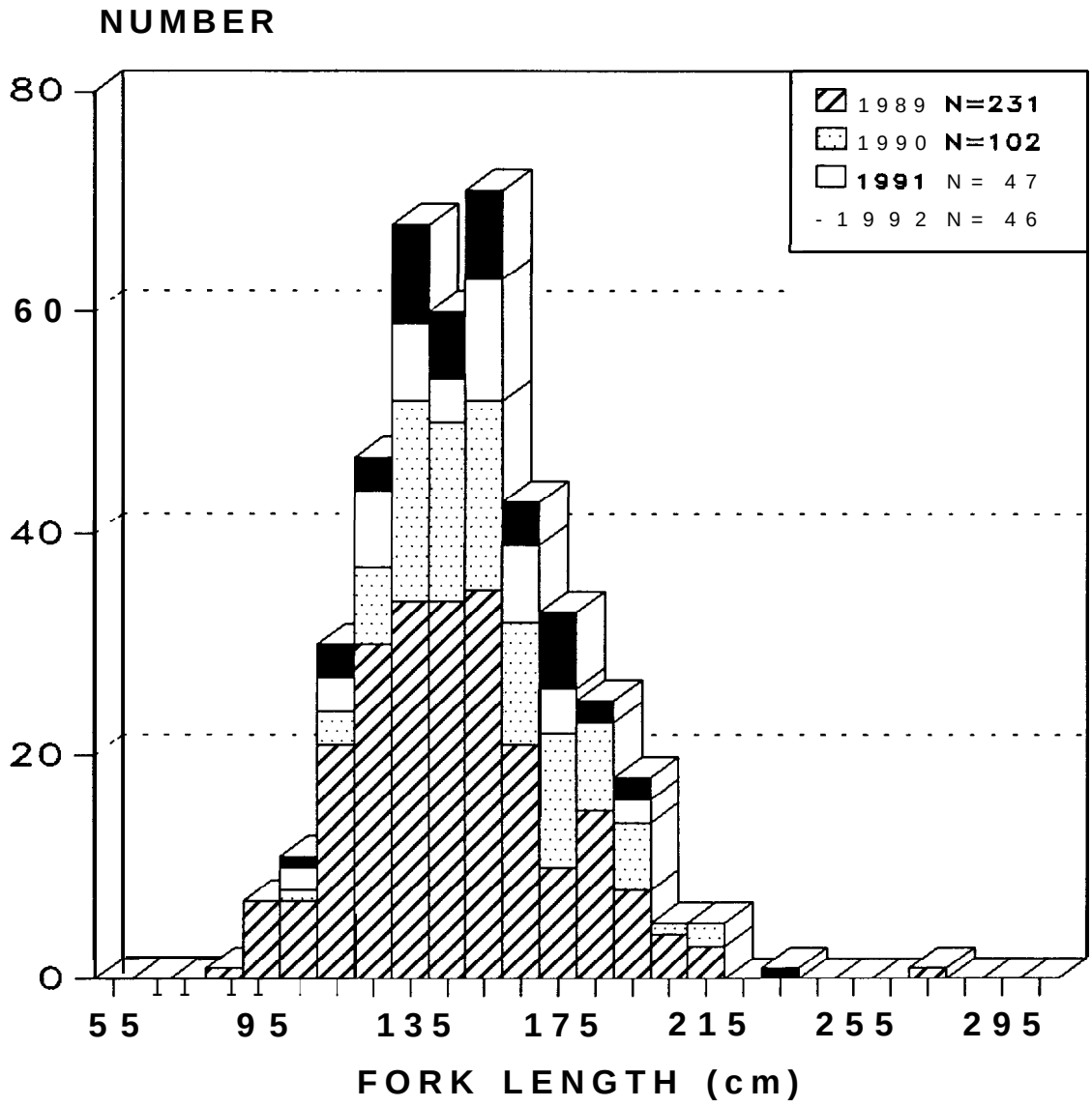


Figure 2. Lengths, at first capture, of white sturgeon sampled from the Kootenai River, 1989 through 1992.

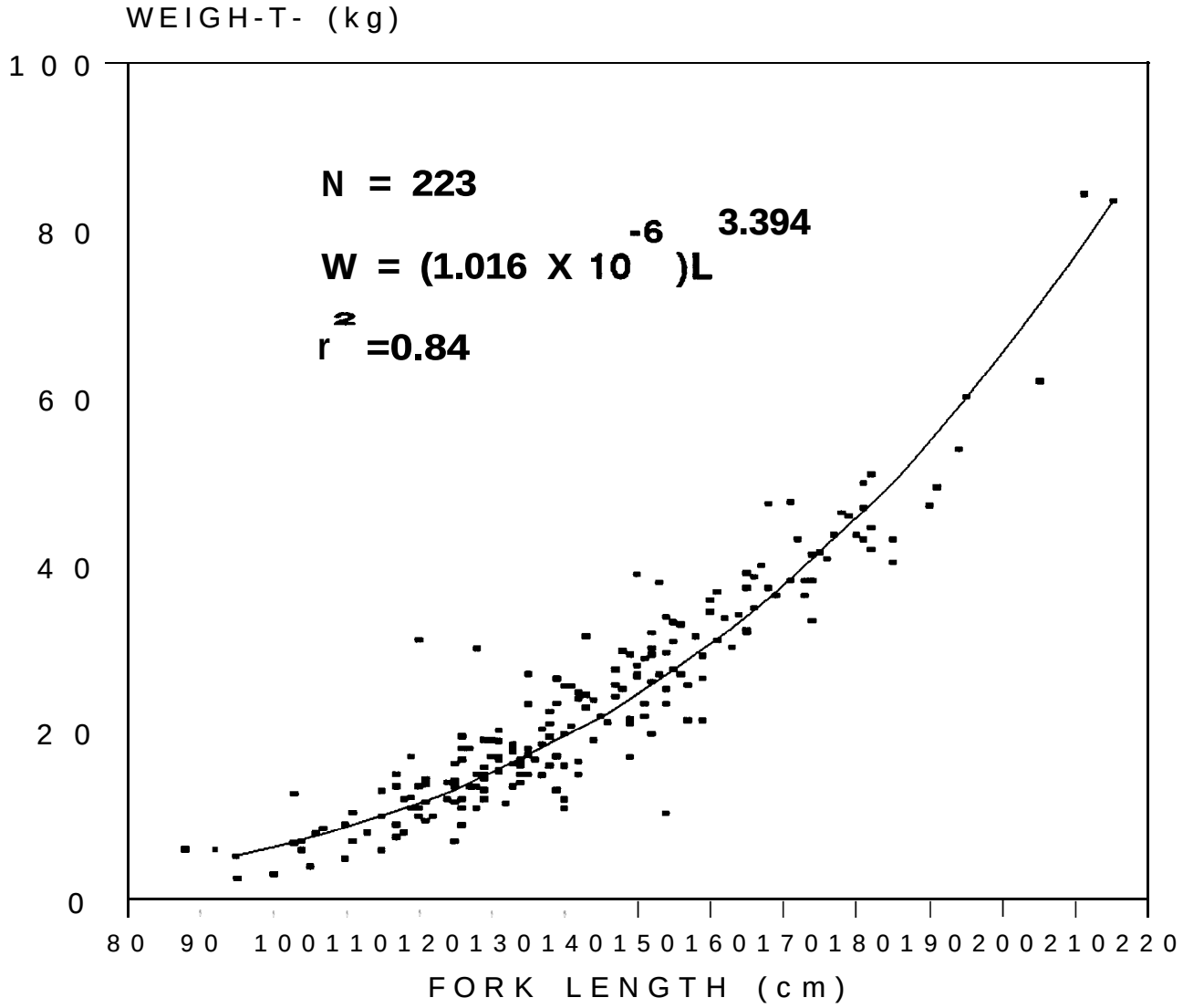
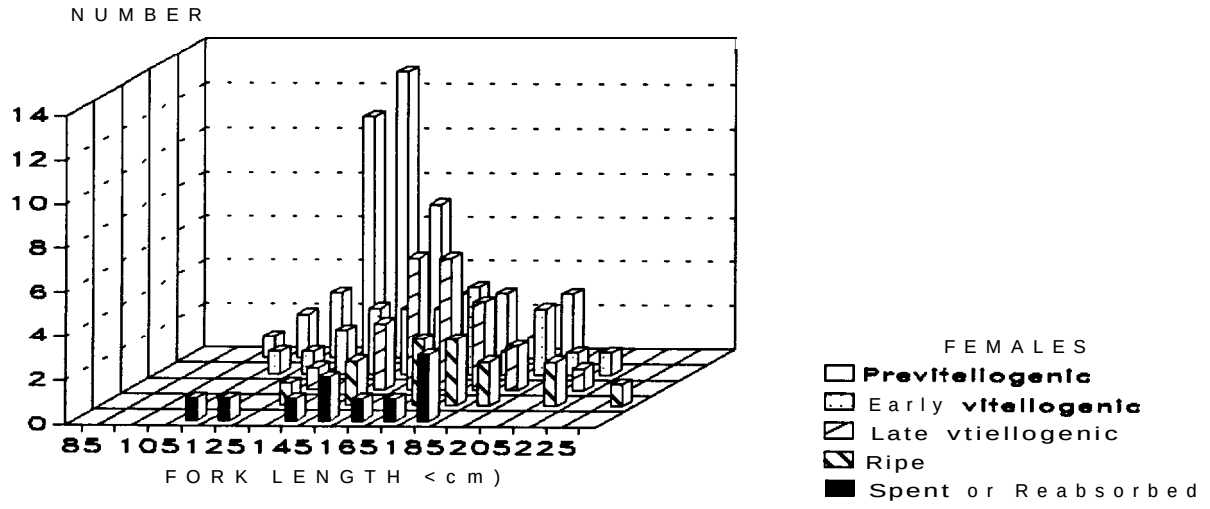


Figure 3. Weight-length relationship for white sturgeon sampled from the Kootenai River, 1989 through 1991.

Table 2. Sexual development of white sturgeon sampled in the Kootenei River, 1989 through 1992.

Categories of sexual development			Percent (number) of sample by year			
Category	Sex	Description of development	1989	1990	1991	1992
0	unknom	gonad undifferentiated or not seen	32 (58)	14 (15)	6 (3)	2 (1)
1	Female	Previtellogenic: no visual signs of vitellogenesis; eggs present but have average diameter <0.5 mm	14 (25)	12 (13)	8 (4)	12 (5)
2	Female	Early vitellogenic: eggs are cream to gray; average diameter 0.6 to 2.1 mm	7 (12)	7 (8)	4 (2)	2 (1)
3	Female	Late vitellogenic: eggs are pigmented and attached to ovarian tissue; average diameter 2.2 to 2.9 mm	6 (10)	5 (5)	8 (4)	9 (4)
4	Female	Ripe: eggs are fully pigmented and detached from ovarian tissue; average diameter 3.0 to 3.4 mm	2 (3)	5 (5)	4 (2)	9 (4)
5	Female	Spent: gonads are flaccid and contain some residual fully pigmented eggs	3 (5)	1 (1)	2 (1)	0
6	Female	Previtellogenic with attritic oocytes: eggs present but have an average diameter <O.5 mn; dark pigmented tissue present that may be reabsorbed eggs	2 (3)	0	0	0
R	Female	Reabsorbing eggs	0	0	0	2 (1)
7	Hale	Non-reproductive: testes uith translucent smokey pigmentation	3 (6)	27 (30)	29 (15)	26 (11)
8	Male	Reproductive: testes white with folds and lobes	32 (58)	28 (31)	18 (9)	16 (7)
9	Male	Ripe: milt flowing; large uhite Lobular testes	0	3 (3)	14 (7)	21 (9)
S	Hale	Spent: testes flaccid; some residue of milt	0	0	8 (4)	0



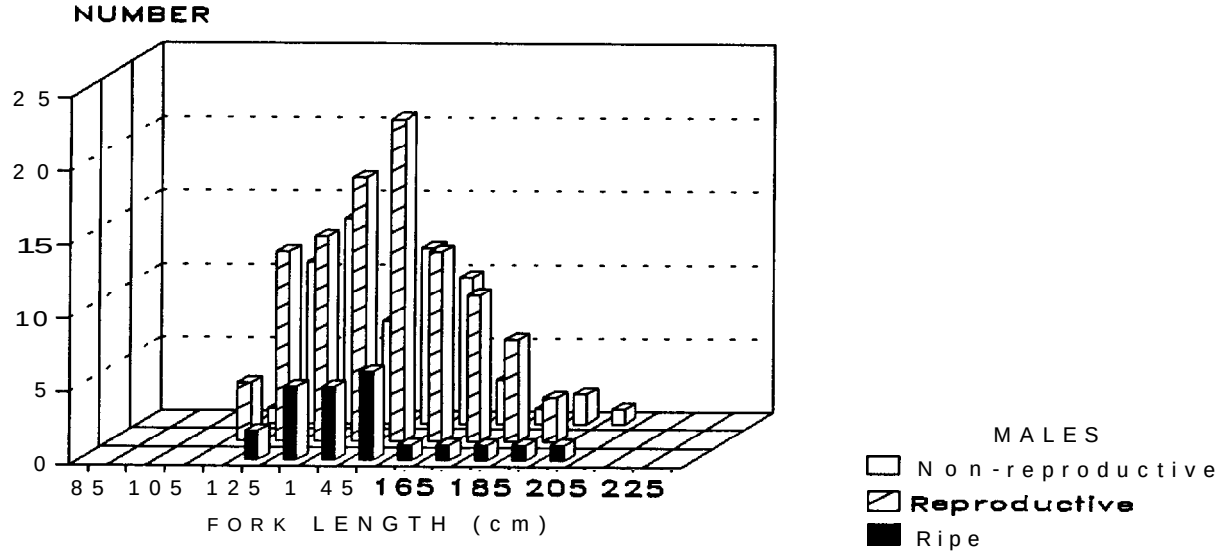


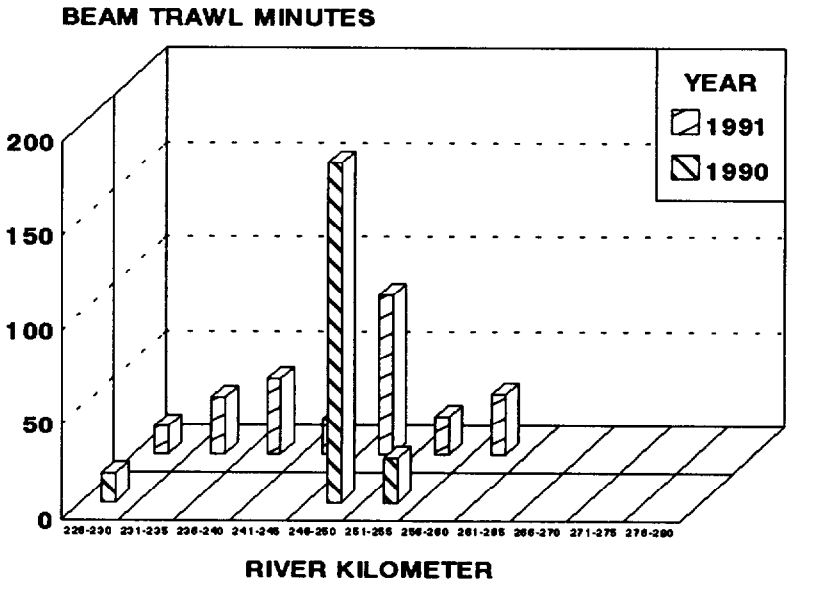
Figure 4. Length frequencies of white sturgeon, by reproductive stage, sampled from the Kootenai River, 1989 through 1992.

Table 3. A progression of the reproductive condition of female white sturgeon in the Kootenei River, 1989 through 1992, based on observations of recaptured fish.

PIT tag number	Fish number from database	Reproductive stage by season of year"						
		1989		IWO		1991	1992	
		Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
7F7F12113D	36	2					5	1	
7F7F402041	78	3		4					
7F7Fl2071C	141		4					1	
7F7FOE1341	150		3		5				
7F7F 137C25	155		3				1		
7F7Fl21602	202		1		2				
7F7E45691 F	378						3		R

'stage definition:

1 = previtellogenic
2 = early vitellogenic
3 = late vitellogenic
4= ripe
5 = spent
6 = previtellogenic with attritic oocytes
R = reabsorbing oocytes



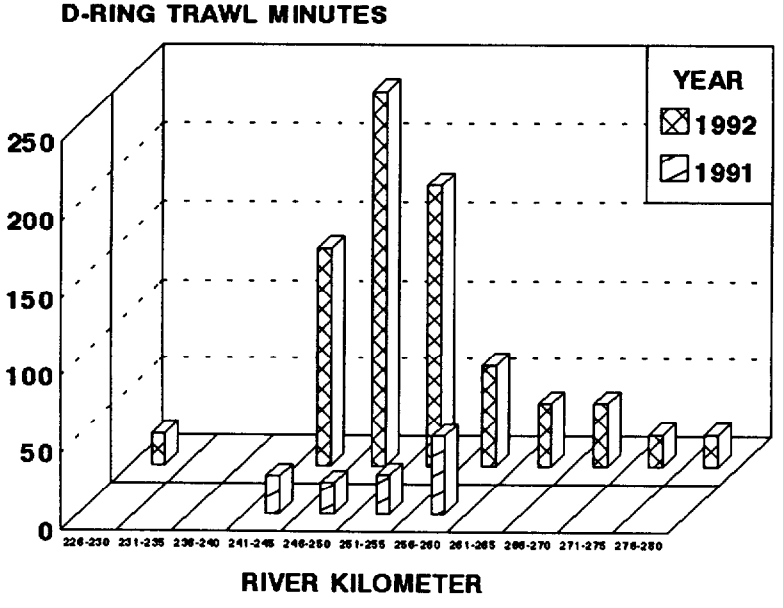


Figure 5. Sampling effort for white sturgeon eggs and larval white sturgeon with trawls, Kootenai River, 1990 through 1992.

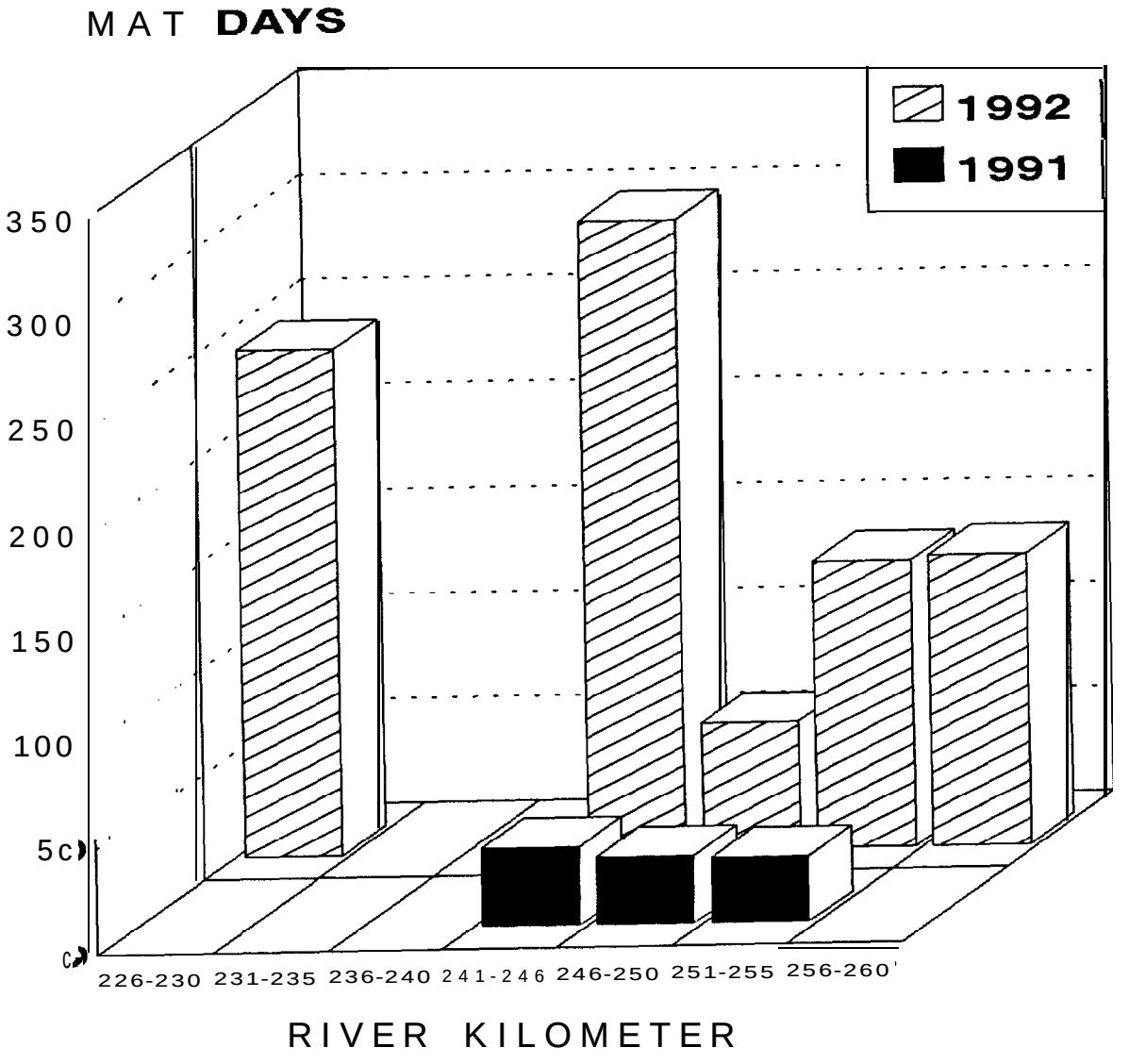


Figure 6. Sampling effort for white sturgeon eggs with mats of artificial substrate, 1991 and 1992, Kootenai River. One mat day + one mat sampling for 24 hours.

Sample depths ranged from 2.1 m to 9.8 m. Substrate mats collected no white sturgeon eggs in 1992.

Spawning Related Movement

During April through May 1992, five female white sturgeon with sonic transmitters exhibited spawning-related behavior of moving from 40 to 120 km upriver and congregating between rkm 230 (Shorty's Island) and rkm 240 (Deep Creek) from May 11 through May 20 (Figure 7; Appendix C). During that time, the five fish were found in 3- to 8-m deep water, with mean river column velocities of 0.3 to 0.4 m/s (0.8 to 2.3 f/s). All five fish were expected to spawn in 1992 based on their reproductive stage when they were tagged. Despite weekly efforts, four of the five fish were not located again until June 21 in the southern arm of Kootenay Lake. One female (fish number 324) was located twice during that period, moving toward the lake. These females may have moved upriver into faster water near Bonners Ferry, where they would be undetectable with sonic receivers, before making the migration to Kootenay Lake. We recaptured one female (fish number 378) in July to find her reabsorbing eggs. Two male white sturgeon that were reproductive in 1991 did not exhibit spawning behavior in 1992 (Appendices B and C). Three female white sturgeon, expected to spawn in 1993, were tagged with sonic transmitters during 1992.

Supplementation

White Sturgeon Stocked in 1992

Hatchery personnel released 104 age 1 and 14 age 2 Kootenai white sturgeon into the Kootenai River on August 26, 1992 (Figure 8). All fish were PIT-tagged and the second left lateral scute removed for identification. We stocked equal numbers of fish at two locations*, rkm 204 (5 km upriver from the Copeland Bridge) and rkm 243 (2 km downriver from the Highway 95 bridge at Bonners Ferry). We captured no juvenile white sturgeon despite 1,265 setline hours of effort in the stocking locations during the week after their release.

Habitat Utilization and Movement of Hatchery-reared White Sturgeon

The six juvenile white sturgeon with transmitters moved both upstream and downstream from their release points (Figure 9). We located one transmitter (#964, frequency 69) only once, the day after its release. Transmitter X1055 was not located after August 31, 1992. These small transmitters were not coded, and three transmitters (1081, 1171, 1071) fluctuated in frequency enough that making a distinction between them became difficult once the locations of the three juveniles overlapped. One of these three transmitters remained at the same location several days in a row. An unsuccessful attempt was made to recover the transmitter from the river bottom.

Transmitter #1114 was located August 27 through November 23, 1992. This is the only fish who's movements can be tracked for the entire sampling period. Transmitter X1114 was released at Smith Island (rkm 205) and moved generally downstream (68.2 km) over the next four weeks. From September 17 to October 13 (week 4 to week 8), the fish moved back upstream 54.8 km. It returned 43 km back downstream by November 4 (week 11), where it remained within the same 2-km area for three more weeks until batteries on the transmitter probably expired. We found transmitter #1114 at a mean depth of approximately 12 m (range 5.1 - 16.4

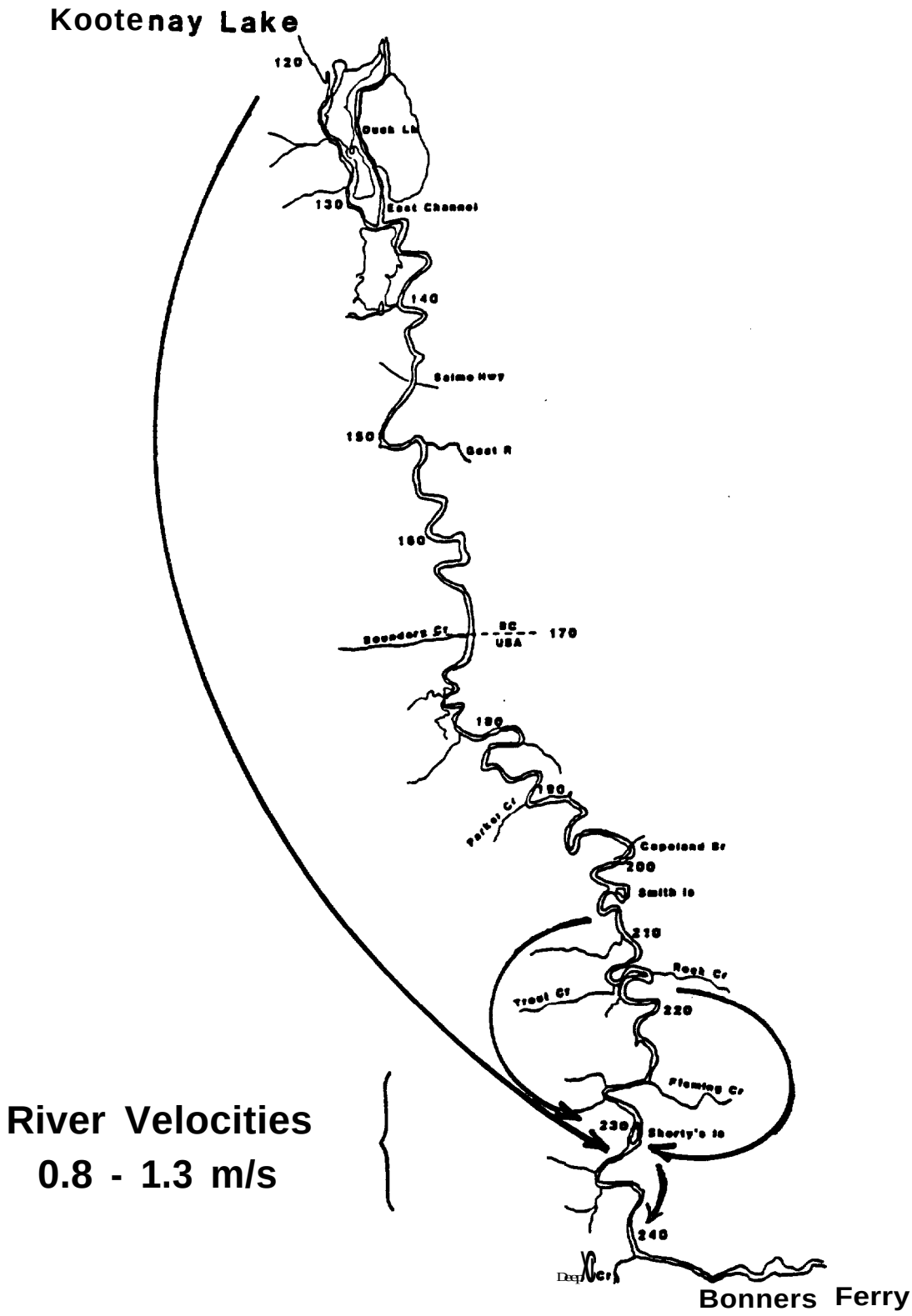


Figure 7. Observed spring migrations of reproductively mature female white sturgeon in the Kootenai River, 1992.

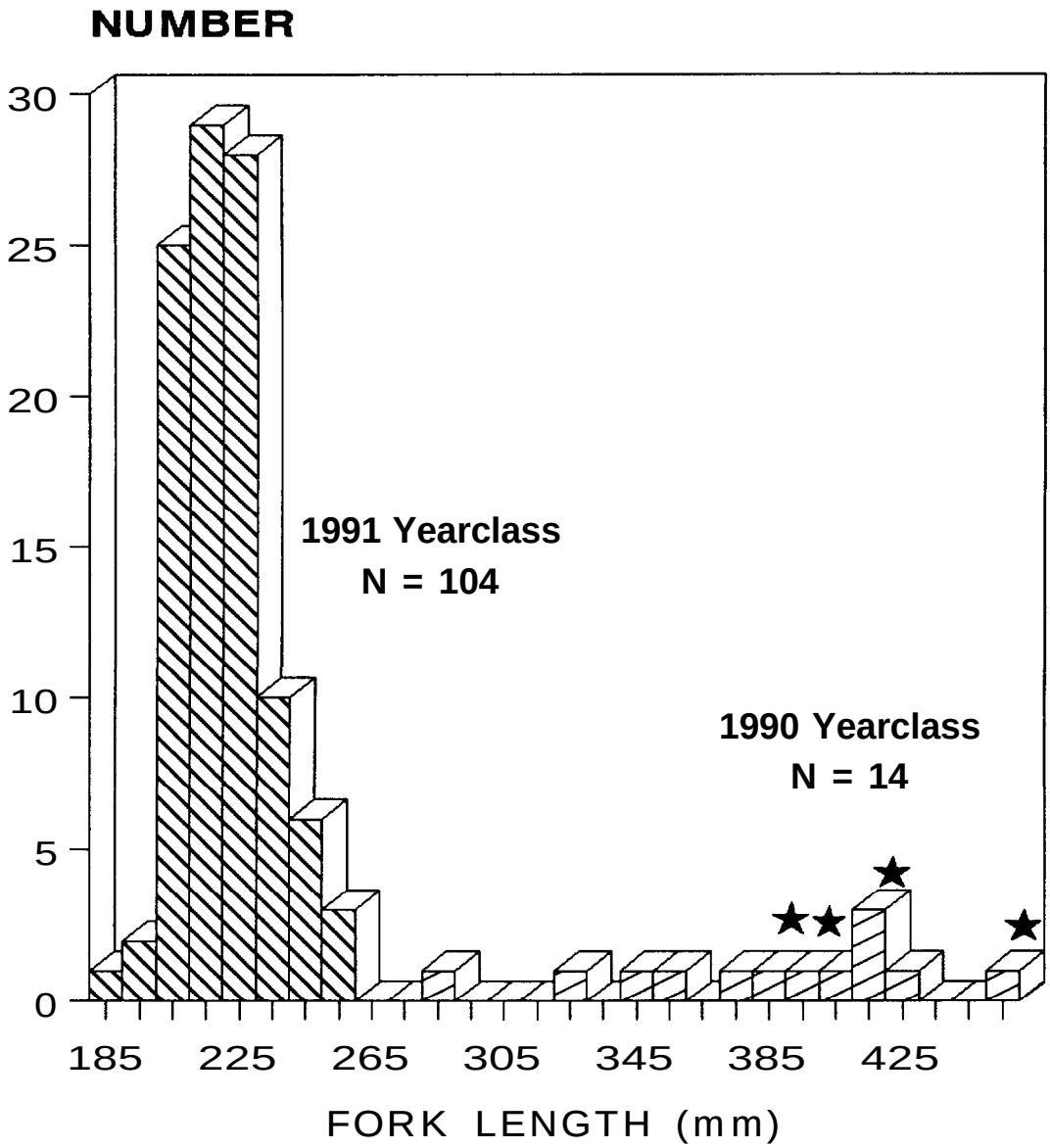


Figure 8. Lengths of hatchery-reared white sturgeon stocked into the Kootenai River in 1992. Stars identify lengths of six white sturgeon released with ultrasonic transmitters.

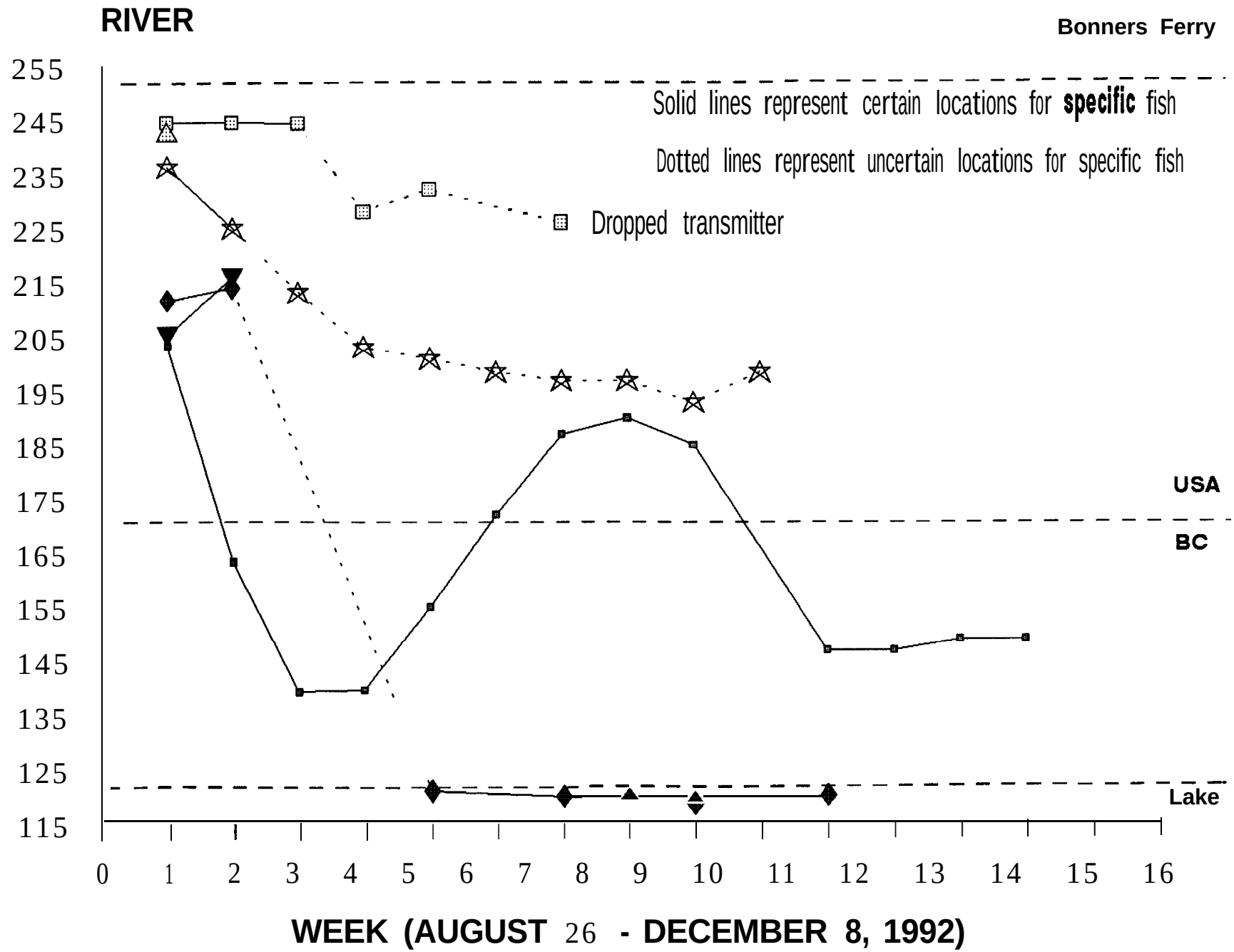


Figure 9. Movements of six age 2 hatchery-reared white sturgeon after release in the Kootenai River, 1992.

m), mean water temperature of 12.1°C, mean bottom velocity of 0.08 m/s (range 0.0 - 0.5 m/s), and mean surface velocity of 0.88 m/s (range 0.05 - 1.9 m/s).

DISCUSSION

Population Structure and Reproductive Potential

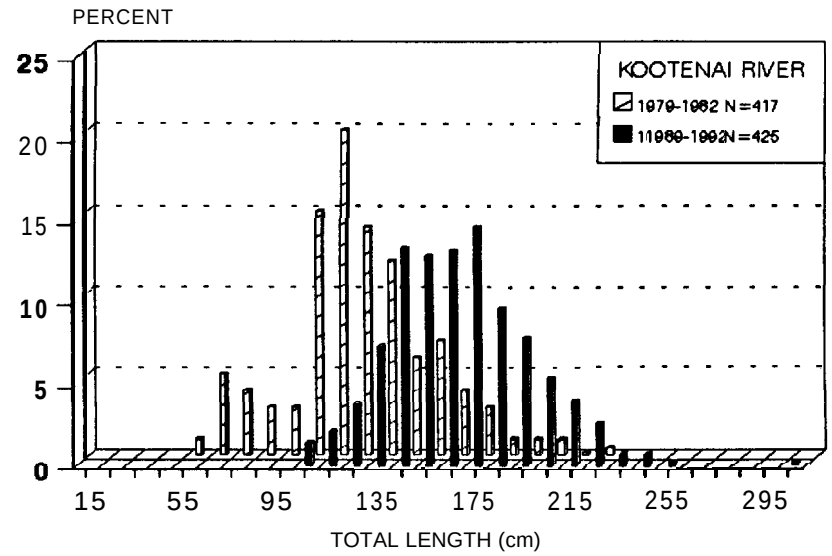
The pattern of the past and present length frequencies of white sturgeon in the Kootenai River are very similar, but a 40-cm shift toward larger fish was noted (Figure l0a). Lengths of 417 white sturgeon sampled from the Kootenai River in 1980 through 1982 ranged from 50 cm total length to 224 cm total length, with a mean total length of 122 cm (Partridge 1983). It appears from this and from growth rate data that the same individuals sampled 10 to 12 years ago have grown, with virtually no recruitment of juveniles into the population (Apperson 1993). Our sample of 426 white sturgeon collected since 1989 included only 8 fish that were younger than the 1972 year class (Apperson and Anders 1990). Estimated ages of these fish by five analysts varied by zero to two years. We believe that our sample accurately represented the population. Partridge (1983) observed a relatively strong year class of sturgeon produced in 1974. One to five of the sturgeon in our sample may have been of the 1974 year class. Recruitment of white sturgeon to setline gear was evaluated by the Oregon Department of Fish and Wildlife in the lower Columbia River (Beamsderfer et al. 1989). Gear identical to ours fully recruited white sturgeon >90 cm fork length and did catch fish as small as 50 cm with all hook sizes (Figure 10b).

A comparison of population estimates made in 1982 (Partridge 1983) and in 1990 (Apperson and Anders 1991) show a decline in number of fish from 1,194 (with a 95% confidence interval of 907 to 1,503) to 880 (with a 95% confidence interval of 638 to 1,211), indicating an overall annual mortality rate of 0.0374 for adult white sturgeon. The average abundance of five to ten white sturgeon/rkm in the Kootenai River is comparable to the eight white sturgeon/rkm of similar-sized fish found in the middle Snake River (Cochnauer 1983). However, in addition to adults, juveniles (60 to 91.5 cm total length) were found in the middle Snake River at an average abundance of 18 white sturgeon/r-km. Similarly, in Hells Canyon of the Snake River, 5 white sturgeon/rkm were found that were >91.5 cm total length, and 20 white sturgeon/rkm were found that were 46 to 91.5 cm total length (Lukens 1984).

Approximately 80% of the Kootenai River population is over 20 years old and is reproductively mature. Five passes with setlines through the study area produced a sample of white sturgeon with a 1:l sex ratio (Apperson and Anders 1991). Approximately 7% of the female white sturgeon and 30% of the male white sturgeon in that sample were reproductive. We used that sample and our population estimate to estimate that 22 to 42 females and 96 to 182 males may attempt to spawn each year. However, if our population estimate and sex ratio estimate are accurate, female white sturgeon in the Kootenai River should be on a 14-year spawning cycle. Examinations of recaptured fish indicate a 3- to 4-year cycle for females. The female reproductive cycle can be as short as 2 years under intensive culture conditions (Joel Van Eenennaam, University of California at Davis, personal communication). We suggest that either there are more males than females in the Kootenai population or that our sampling techniques do not recruit reproductive females representative of the population. Our sampling during May and June of 1991 and 1992 in areas where reproductive white sturgeon congregate supports that notion; with three to six reproductive males captured for every reproductive female captured.

We do not know what minimum spawning population is required to sustain the Kootenai white sturgeon population, or at what age individual reproductive

A



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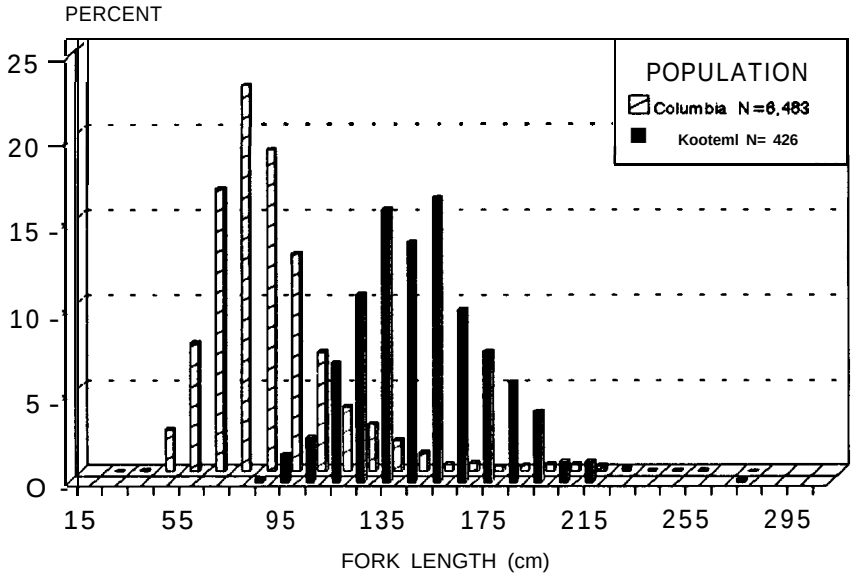


Figure 10. A) Comparisons of past (Partridge 1983) and current length frequencies of white sturgeon in the Kootenai River. B) Comparison of current length frequencies of white sturgeon sampled by setline and angling in the Kootenai River and by setline in the lower Columbia River (Beamsderfer et al. 1990).

potential declines. We can estimate that, with zero recruitment, the number of Kootenai River white sturgeon may decline to less than 500 individuals within 15 years. To estimate survival further would be misleading because we expect survival rate of an aging population to decline. It is imperative that recruitment of juvenile sturgeon occurs during the next ten years to ensure maintenance of the population.

Effects of Sampling Techniques on Survival and Behavior

We have had 515 captures of white sturgeon during this study (Appendix A). Setlines captured 415 white sturgeon, and angling captured 100 white sturgeon. Of the 68 individuals that were recaptured, 60 were initially captured by setline, and only 8 were initially captured by angling. This suggests that setline-captured fish may have higher survival. However, during 1992 angling captured the majority of white sturgeon (45 versus 11 captured with setline). We cannot make a valid comparison of relative survival of white sturgeon captured by the two methods until all fish can redistribute to have an equal chance of being recaptured. Part or all of 3% of the setline sets (13 of 415 sets) from 1989 through 1992 were not retrieved because of entanglement with submerged debris. We do not know if any of those lines captured white sturgeon.

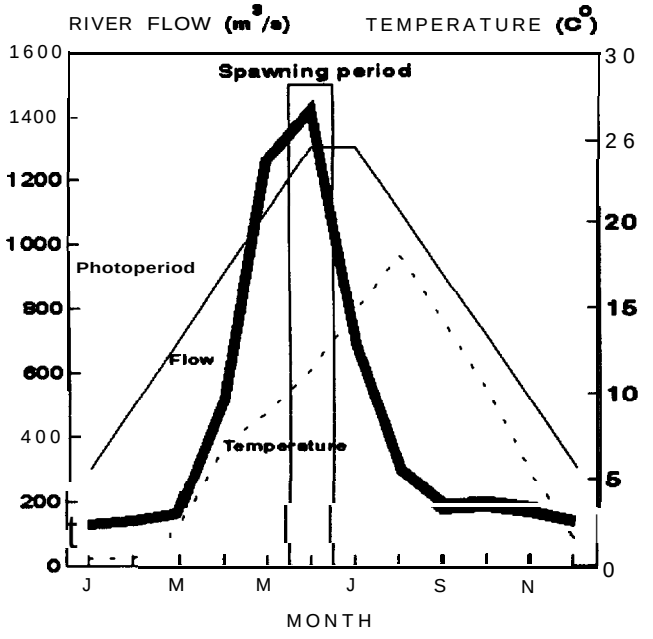
The River Environment and White Sturgeon Spawning

Typically, the operation of Libby Dam drastically alters seasonaldownriver discharge by storing natural spring runoff, providing more constant flows throughout the year, and providing late summer power peaking flows (Figure 11). Spring discharge in the lower river in 1992 and in 1989 was fairly typical for the post-Libby Dam period, with discharge declining just as ideal temperatures were reached for white sturgeon spawning (13°C to 16°C) (Figure 12). In 1992, river discharge and temperature increased together from early April through mid-May when flow suddenly declined from 600 m^3/s to 300 m^3/s, and temperature increased to 12°C. Flows did increase again, remaining above 500 m^3/s for twelve days, but water temperatures fluctuated between 8°C and 13°C. This was the time period that the four female white sturgeon with transmitters and in spawning condition could not be found in the river downstream from Bonners Ferry. After June 7, flow declined rapidly to less than 225 m^3/s through July. River temperature exceeded 17°C by July 1.

Increasing and high flows coincided with increasing temperature through June in both 1990 and 1991. Migration and staging of reproductive white sturgeon was associated with those conditions in both years. Physical habitat for spawning of white sturgeon has been described for the lower Columbia River as having: mean column velocity >0.8 m/s; bottom velocity >0.5 m/s; depth >4 m; temperature >10°C and <18°C; and substrate of sand or larger particles (Parsley et al., in press). Sturgeon in the lower Columbia River key into increasing velocities with increasing temperature for spawning. In 1991, increasing flow coincided with increasing temperature through June, with a sudden peak of discharge in early July. A few fertilized white sturgeon eggs were recovered from the Kootenai in early July 1991 in habitat in the lower end of the depth and velocity ranges described above (Apperson 1993). On the average, water temperatures during the spawning period have not been altered dramatically by the operation of Libby Dam (Figure ll), but when flow declines rapidly during June and July, temperatures can rise rapidly to exceed lethal limits for incubating eggs of white sturgeon.

A river discharge model is being developed by Montana Department of Fish, Wildlife, and Parks. Preliminary data indicates that spawning habitat for white

PRE-DAM



POST-DAM

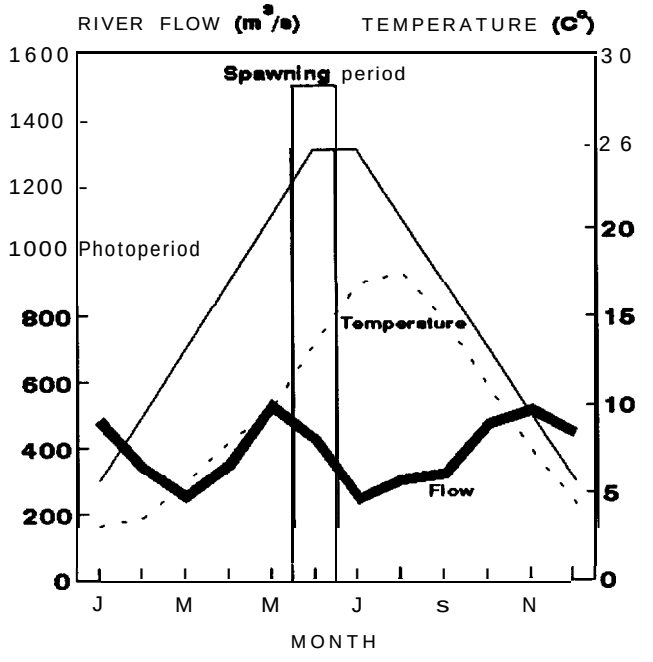


Figure 11. Mean monthly flow, water temperature, and relative photoperiod in the Kootenai River at Porthill, Idaho before and after the operation of Libby Dam.

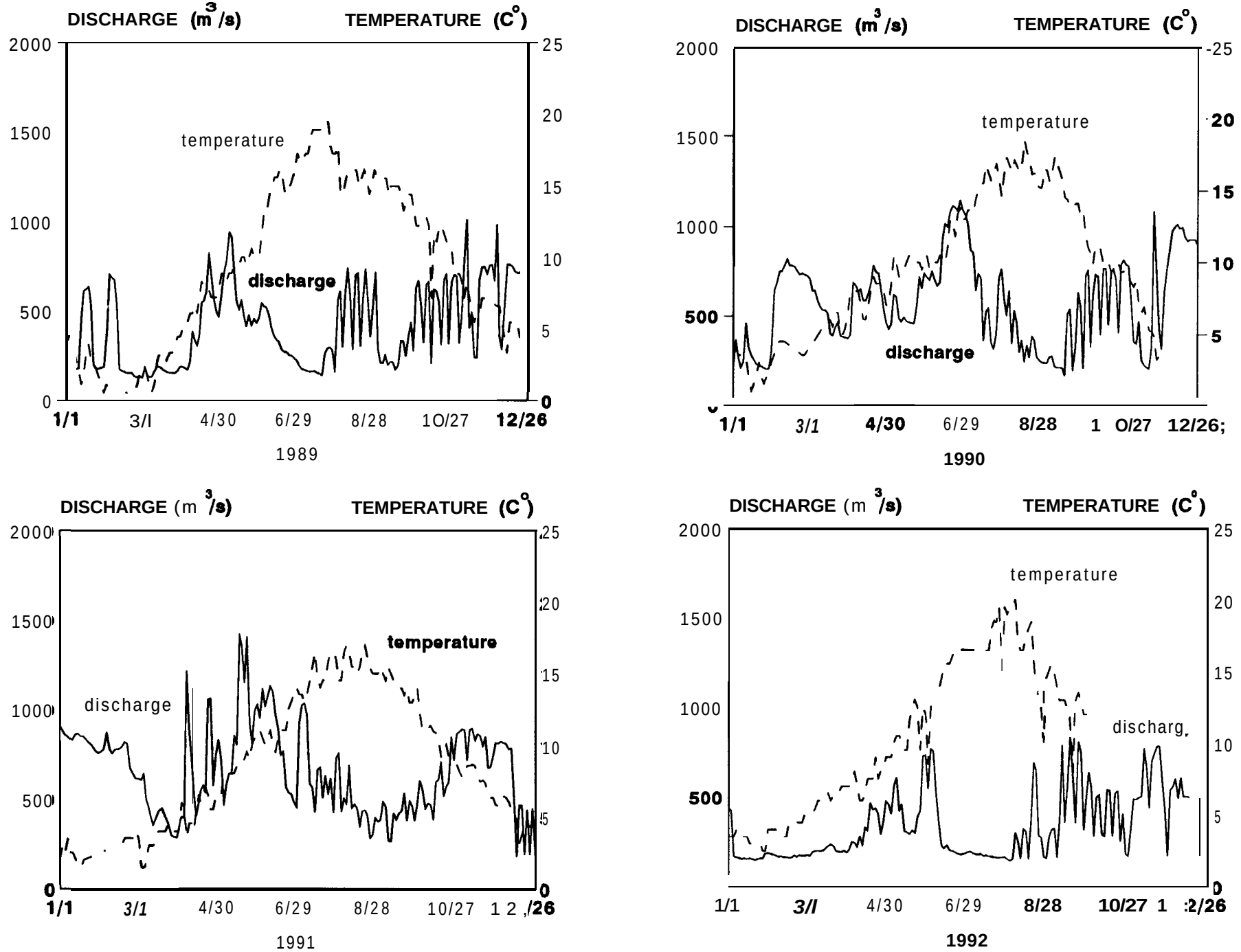


Figure 12. Mean daily discharge and minimum daily temperature of the Kootenai River at Porthill, Idaho, 1989 through 1992.

sturgeon downriver from the Moyie River is negligible at less than 700 m^3/s (23 kcfa) (Don Skaar, Montana Department of Fish, Wildlife, and Parks, personal communication). Wetted perimeter is lost rapidly as flow declines below 330 m^3/s (11 kcfs), possibly hindering upriver migration of spawners and causing desiccation of embryos. Flows in 1974, the only year since Libby Dam that appreciable sturgeon production occurred, exceeded 1,000 m^3/s (35 kcfs) during most of the spawning season. We believe a manipulation of the regulated discharge through Libby Dam to approximate more natural spring flows would enhance sturgeon reproduction and recruitment in the Kootenai River.

RECOMMENDATIONS

1. Take immediate steps to provide habitat for wild sturgeon spawners and their progeny with natural spring and summer flows. Treat any flows less than natural as experimental and evaluate enhancement of spawning success, embryo survival, and, ultimately, juvenile recruitment relative to various flow patterns.

2. Radio and sonic telemetry used together would allow more efficient tracking and habitat use evaluation of spawning white sturgeon as fish move into spawning habitat. We recommend use of both types of transmitters on each adult fish.

3. Continue to collect information to improve estimates of reproductive potential. Track reproductive cycles of white sturgeon by re-examining recaptured fish.

4. Develop techniques to sample juvenile white sturgeon in the Kootenai River to document recruitment to the population as soon as possible after flows are provided for enhancement of spawning and recruitment.

5. Cease use of floy tags since PIT tags are more reliable and less intrusive to the fish.

ACKNOWLEDGEMENTS

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LITERATURE CITED

Andrusak, H. 1980. Kootenay River white sturgeon. British Columbia Ministry of Environment, Nelson, B.C., Canada.

Apperson, K.A. and P.J. Anders. 1990. Kootenai River white sturgeon investigations and experimental culture. Idaho Department of Fish and Game. Annual Progress Report. Project 88-65, Bonneville Power Administration, Portland, Oregon.

Apperson, K.A. and P.J. Anders. 1991. Kootenai River white sturgeon investigations and experimental culture. Idaho Department of Fish and Game. Annual Progress Report. Project 88-65, Bonneville Power Administration, Portland, Oregon.

Apperson, K.A. 1993. Kootenai River white sturgeon investigations and experimental culture. Idaho Department of Fish and Game. Annual Progress Report. Project 88-65, Bonneville Power Administration, Portland, Oregon.

Beamsderfer, R-C., J-C. Elliot, and C.A. Foster. 1989. Report A in A.A. Nigro, editor. Status and habitat requirements of white sturgeon populations in the Columbia River downstream from McNary Dam. Annual progress report to Bonneville Power Administration, Portland, Oregon.

Bonde, T.H. and R.M. Bush. 1975. Kootenai River water quality investigations, Libby Dam preimpoundment study 1967 - 1972. U.S. Army Corps of Engineers.

Cochnauer, T.G. 1983. Abundance, distribution, growth and management of white sturgeon Acioenser transmontanus in the middle Snake River, Idaho. Ph.D. Dissertation, University of Idaho, Moscow.

Graham, P. 1981. Status of white sturgeon in the Kootenai River. Montana Department of Fish, Wildlife, and Parks, Kalispell. Unpublished report.

Lukens, J.R. 1984. Hells Canyon white sturgeon investigations. Idaho Department of Fish and Game. Job Performance Report, Project F-73-R-B, Subproject IV, Study II, Boise.

McCabe, G.T. Jr. and L.G. Beckman. 1990. Use of an artificial substrate to collect white sturgeon eggs. California Fish and Game 76(4):248-250.

Northcote, T.C. 1973. Some impacts of man on Kootenay Lake and its salmonids. Great Lakes Fishery Commission, Technical Report Number 2, Ann Arbor, Michigan.

Northwest Power Planning Council. 1987. Columbia River Basin fish and wildlife program. 850 S.W. Broadway, Suite 1100, Portland, Oregon 97205.

Parsley, M.J., L.G. Beckman, and G.T. McCabe, Jr. In press. Spawning and rearing habitat use by white sturgeon in the Columbia River downstream from McNary Dam. Transactions of the American Fisheries Society.

Parsley, M.J., S.D. Duke, T.J. Underwood, and L.G. Beckman. 1989. Report C In A.A. Nigro, editor. Status and habitat requirements of white sturgeon populations in the Columbia River downstream from McNary Dam. Report to Bonneville Power Administration (Project 86-50), Portland, Oregon.

Partridge, F. 1983. Kootenai River fisheries investigations. Idaho Department Fish and Game. Job completion report. Project F-73-R-5, Subproject IV, Study VI, Boise.

Siple, J.T. 1993. Kootenai River white sturgeon culture. In Resident Fish Hatcheries Annual Report, January 1, 1992 to December 31, 1992. Idaho Department of Fish and Game, Boise.

A P P E N D I C E S

Appendix A. Capture of uhite sturgeon, Kootenai River, 1989 through 1992.

Year	River section	Gear type					
		Large setlines		Small setlines[b]		Angling	
		Setline hours	Number of sturgeon captures	Setline hours	Number of sturgeon captures	Rod hours	Number of sturgeon captures
1989	British Columbia	4,803	53	545	0	23	9
1989	Idaho (lower river)"	8,095	173	675	2	90	15
1989	Idaho (upper river)[d]	690	0	0	0	6	0
1989	Montana	1,487	2	0	0	1	0
IWO	British Columbia	3,515	47	247	0	56	6
IWO	Idaho (lower river)	8,630	83	279	0	54	0
IWO	Idaho (upper river)	67	0	0	0	0	0
1990	Montana	0	0	0	0	0	0
1991	British Columbia	145	10	47	0	10	3
1991	Idaho (lower river)	2,574	31	0	0	209	13
1991	Idaho (upper river)	0	0	0	0	0	0
1991	Montana	0	0	0	0	0	0
1992	British COlumbia	138	3	0	0	57	9
1992	Idaho (lower river)	756	8	509	3	435	45
1992	Idaho (upper river)	0	0	0	0	0	0
1992	Montana	0	0	0	0	0	0
TOTAL		30.900	410	2,302	5	941	100

"large setline = six hooks, two each of 12/0, 14/0, and 16/0

[b]small setline = ten hooks, size 10/0

[c]downriver from Bonners Ferry

[d]upriver from Bonners Ferry

Appendix B. White sturgeon tagged uith ultrasonic transmitters in the Kootenai River, 1989 through 1992.

Fish number (from database)	PIT tag number (Floy tag number)	Sonic code	Sex (stage)' when first tagged	Initial capture		Last location (with working transmitter)	
				Date	River km	Date	River km
35	7F7F440A7D (01500)	249[b]	M(8)	5/17/89	237.7	11/07/90	215.9
36	7F7Fl2113D (01596)	258"	F(2)	S/17/89	234.5	10/07/91	236.3
37	(01044)	276	M(8)	S/17/89	234.5	10/10/90	215.5
60	(01067)	267	F(1)	5/31/89	225.1	10/11/90	120.0
67	(01074)	294	M(8)	6/07/89	203.6	09/17/90	215.5
75	(01087)	285	M(8)	6/09/89	199.5	07/24/90	140.0
80	7F7F12171F (01665)	339[d]	F(2)	6/13/89	192.0	09/31/89	120.0
83	7F7Fl218lF (01095)	357[e]	M(8)	6114189	193.1	11/07/90	192.2
84	7F7Fl21431 (01096)	2228'	F(5)	6/14/89	193.1	11/06/90	212.5
86	7F7F12OElB (01098)	366[g]	M(8)	6/14/89	191.0	04/25/90	211.2
88	7F7Fl20601 (01100)	348	M(8)	6/14/89	190.0	10/25/90	215.5
105	7F7FOE315A (01118)	384	Unknom	6/23/89	154.2	06/21/90	230.0
103	7F7FOElB51 (01116)	2255'	F(2)	6/22/89	163.0	10/30/90	120.0
134	7F7FOE4946 (01147)	2246'	F(4)	6/28/89	140.0	11/06/90	209.7
135	7F7F12113A (01148)	456	M(8)	6/28/89	138.7	10/30/90	120.0
155	7F7F137C25 (01169)	465[h]	F(3)	7/20/89	205.5	10/30/90	120.0

'refer to Table 4 for definitions of reproductive stages for sturgeon

[b]transmitter removed 4/29/92, upon recapture

"replaced with transmitter #366 on 9/7/90 at rkm 232.6

[d]recaptured on 9/03/92; transmitter missing

*not moved since 7/18/89; suspect fish lost transmitter

'two-year transmitter

[g]taken to netpan on 4/25/90; released without transmitter on 7/17/90

[h]fish recaptured and transmitter removed on 8/29/91 at rkm 225.1

163	7F7F121011 (01177)	375	F(3)	7/20/89	213.2	11/07/90	216.2
189	7F7FOE2F2C (01204)	2264'	F(2)	8/31/89	228.7	04/11/91	228.6
191	7F7F121166 (01206)	2237'	F(6)	9/06/89	216.0	04/19/9I	215.5
206	7F7F12175B (01221)	447	M(8)	9/26/89	215.2	04/10/91	120.0
231	7F7F137750 (01246)	88	F(3)	4/11/90	225.0	06/02/91	120.0
255	7F7F403075 (01291)	1057	M(9)	5/30/90	230.0	06/26/91	174.0
78	7F7F402041 (01090)	555'	F(4)	6/29/90	204.0	04/25/91	115.0
260	7F7F40325A (01296)	97*	F(3)	6/24/90	204.0	05/07/91	120.0
324	7F7F4433OE (01565)	2273	F(2)	9/26/90	129.8	10/07/91	224.7
238	7F7F427E51	2327	F(4)	11/01/9	213.5	06/29/91	120.0
335	7F7E643750 (01587)	284	M(8)	04/03/9 1	225.1	09/12/91	120.0
349	7F7E45682B (01578)	248	M(9)	06/01/9 1	240.5	10/07/91	120.0
363	7F7E644413 (01593)	347	F(3)	07/11/9 1	231.0	IO/D1/91	209.6
345	7F7F453646 (01494)	266'	F(5)	08/11/9 1	241.0	09/12/91	120.0
370	7F7E45642C (01615)	2435	F(2-3)	08/27/9 1	121.0	10/07/91	210.5
366	7F7E6C2111 (01598)	293	F(2)	08/27/9 1	121.0	09/12/91	120.0
378	7F7E45691F (01622)	338	F(3)	IO/24/9 1	225.1	10/24/91	225.1
381	7F7E3FSEOO (01625)	876'	F(3)	10/25/9 1	215.5	10/25/91	225.1
387	7F7F44350E (01505)	465	F(3)	04/28/9 2	215.5	II/IO/92	207.8
403	7F7F441F42 (01692)	257	F(3)	05/20/9 2	230.9	10/26/92	114.5
426	7F7E457124 (01667)	249	F(3)	09/01/9	216.0	11/10/92	215.2

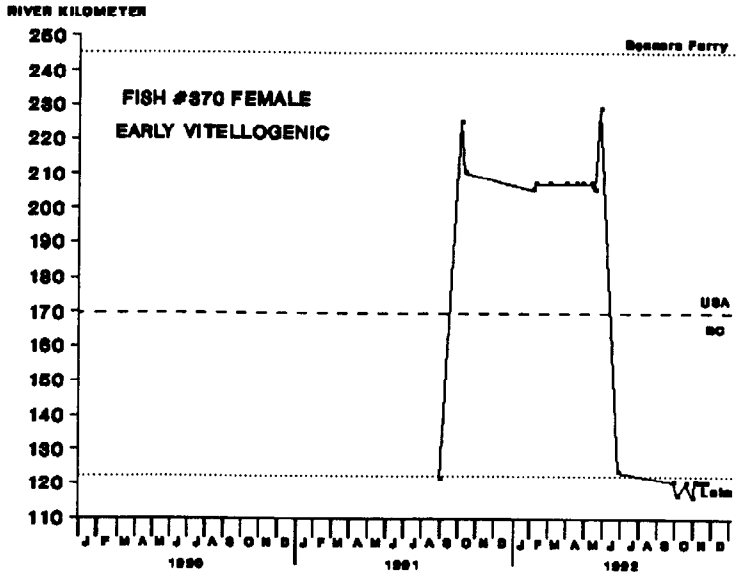
'transmitter not coded

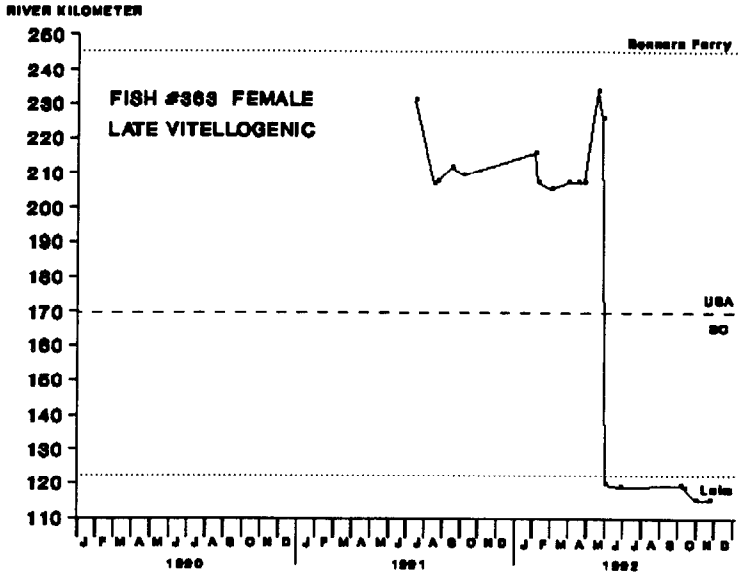
'fish did not move since 9/18/90; suspect she died; was held in netpen from 6/8 - 6/29/90

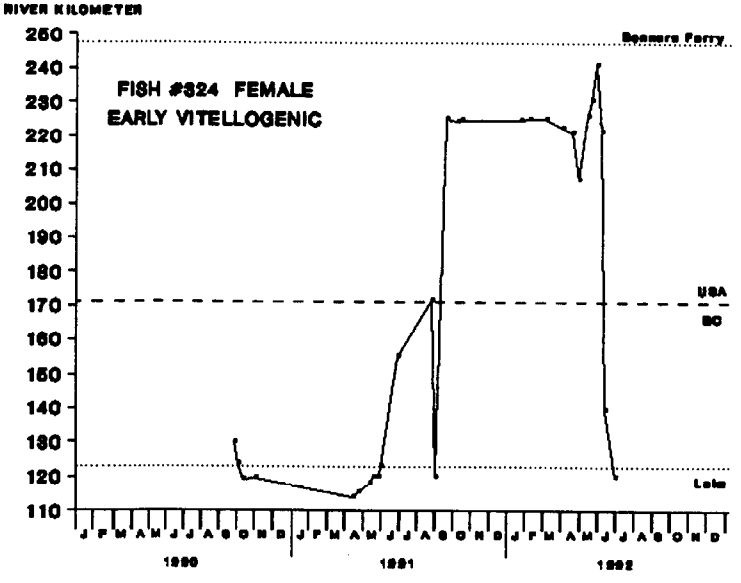
*released from netpen; originally captured at rkm 231.3 on 6/3/90

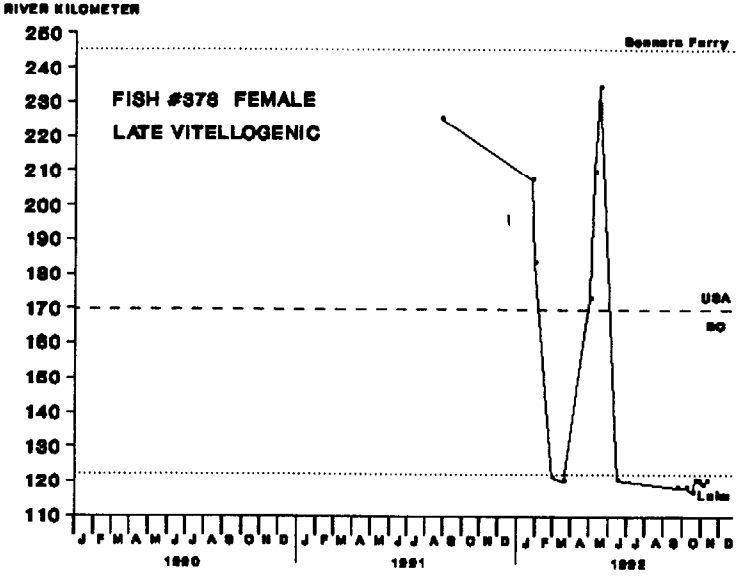
'released from hatchery, 1991 brood fish

Appendix C. Movements in 1992 of white sturgeon tagged with ultrasonic transmitters, Kootenai River. Fish number refers to identification in database. Reproductive stage is stage at time of tagging.









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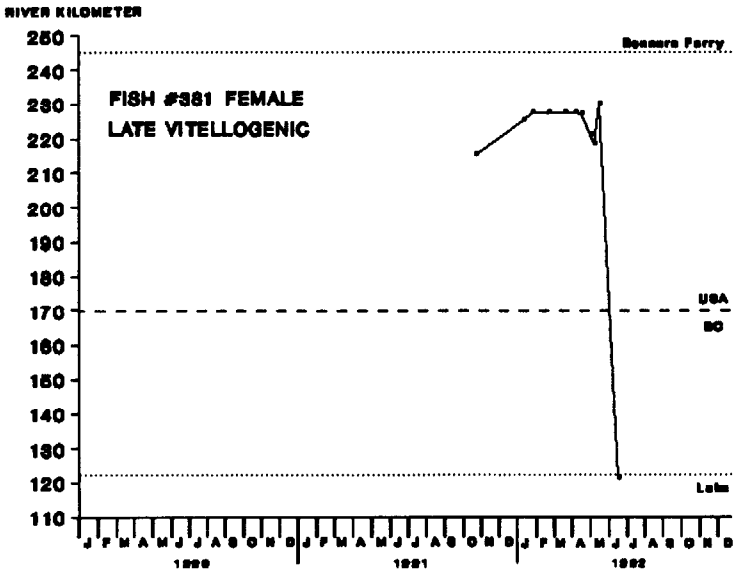

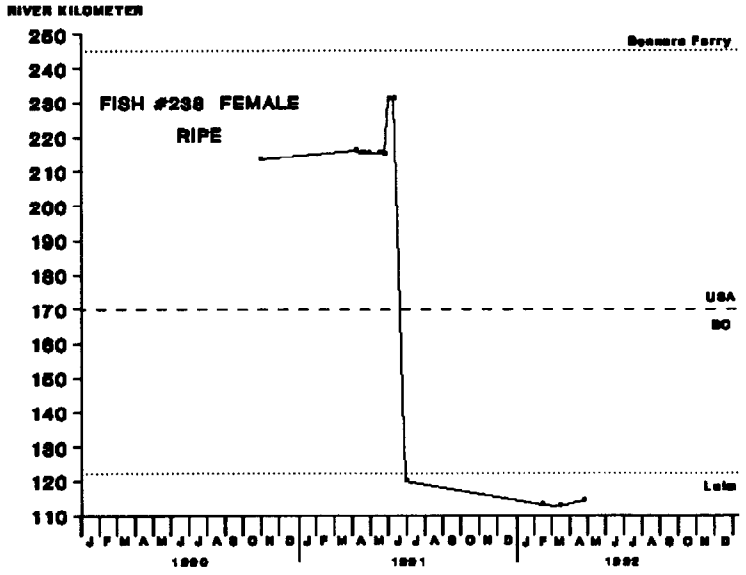

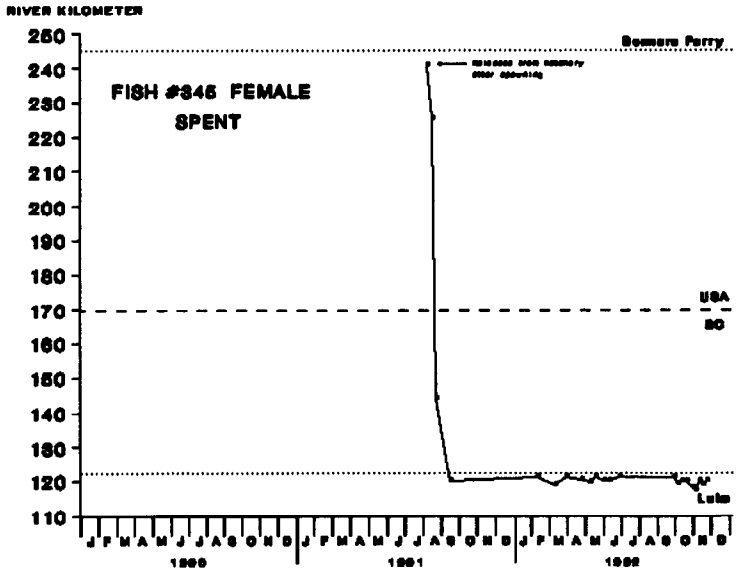

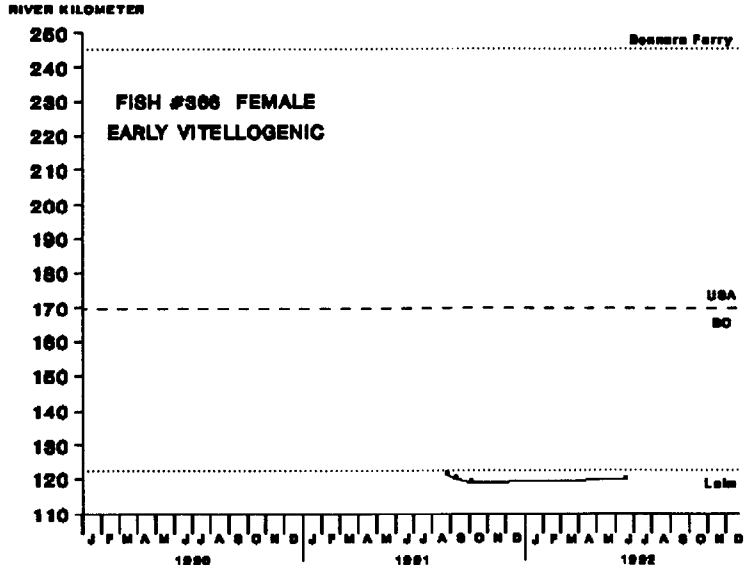

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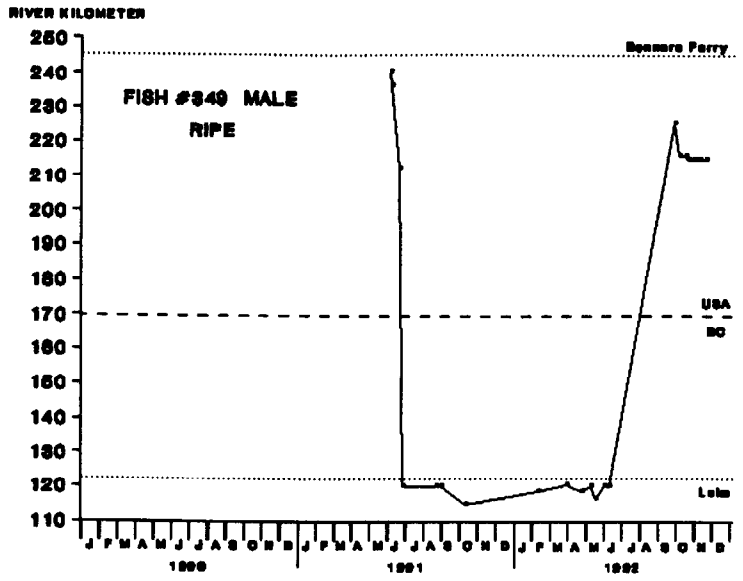

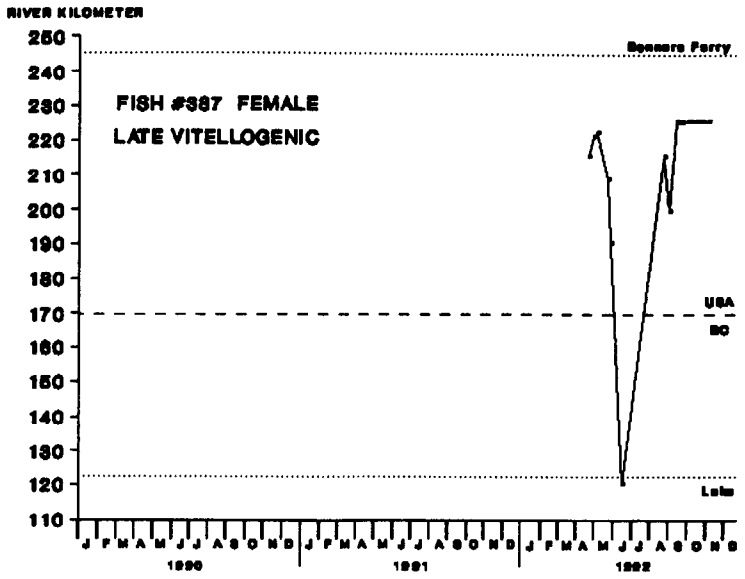

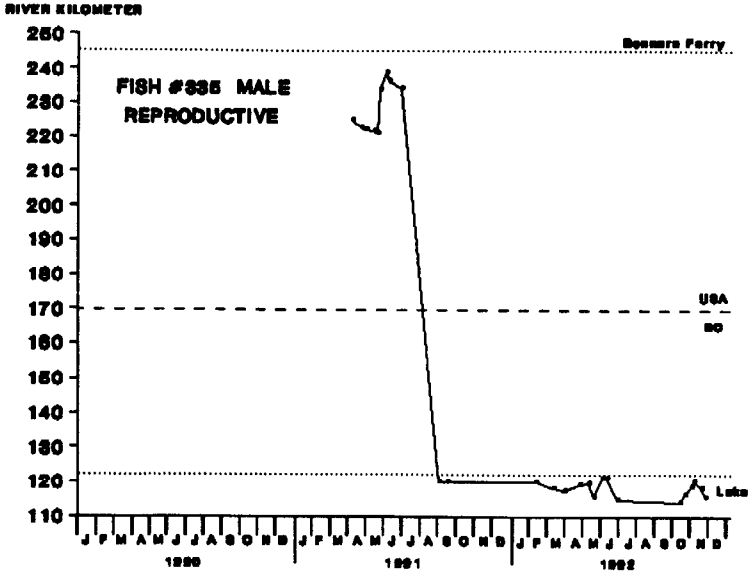

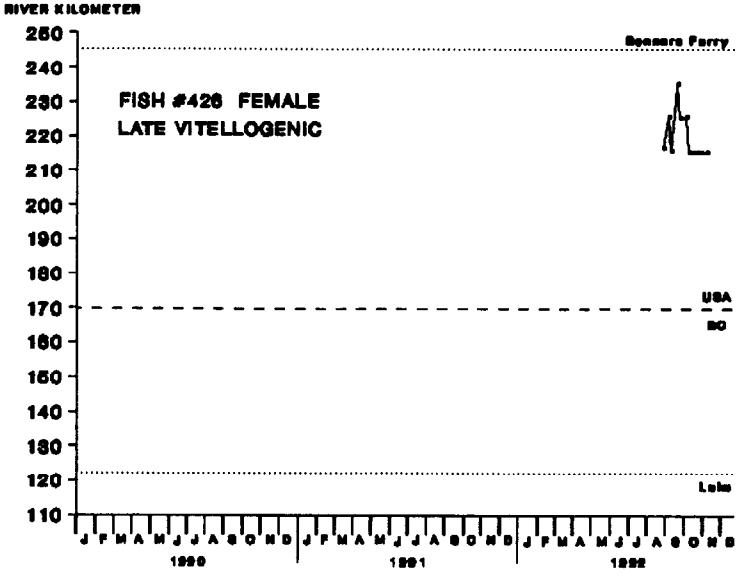

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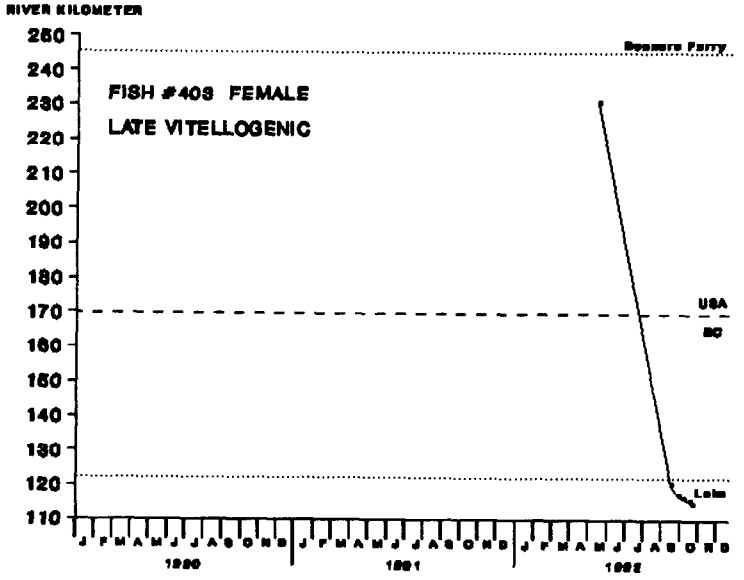

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