KOOTENAl RIVER WHITE STURGEON STUDIES

Report A: Natural Spawning of White Sturgeon in the Kootenai River

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Report B: Experimental Culture

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Report C: Kootenai River Tributary Kokanee Spawning Ground Survey

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Prepared for:
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P.O. Box 3621
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KOOTENAI RIVER WHITE STURGEON STUDIES

NATURAL SPAWNING OF THE WHITE STURGEON IN THE KOOTENAI RIVER

Annual Report of Research FY 1993
Report A

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ABSTRACT

This report evaluates natural spawning of white sturgeon in the Kootenai River before, during and after the 1993 augmented discharge period. To determine how altering the operation of Libby Dam may improve conditions for natural spawning of white sturgeon in the Kootenai River, discharge from Libby Dam (with no power peaking or load following) was increased to produce 20 kcfs (+ 2 kcfs) discharge at Bonners Ferry, Idaho, for a 14 day period from June 2 to June 16.

Three types of gear were used to sample naturally produced white sturgeon eggs from the Kootenai River: artificial substrate mats, D-ring plankton nets, and a beam trawl net. The latter two types of gear were also used to sample white sturgeon larvae.

Objectives of this research were to: 1) determine if white sturgeon spawned in the Kootenai River during 1993; and 2) collect baseline biological data including timing, location, and habitat requirements of white sturgeon spawning in the Kootenai River in order to formulate and implement future flow regimes as effective recovery measures for white sturgeon.

While sampling is not expected to collect a majority of white sturgeon eggs or larvae produced in a river, the fact that over 41,000 hours of sampling (combined gear) collected only 3 white sturgeon eggs and no larvae suggests that spawning conditions during 1993 were inadequate to benefit this population.

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INTRODUCTION

Recruitment of white sturgeon ***(Acipenser transmontanus)*** in the Kootenai River (Idaho, Montana, and British Columbia (B.C.)) has been virtually non-existent since 1974, when the operation of Libby Dam began altering the annual hydrograph (Figure 1). Hydrograph alteration appears to be a prominent factor in the white sturgeon population decline in the Kootenai River (Anders 1991, Apperson and Anders 1991, 1990). Physical, chemical, and biological changes in the Kootenai River during the past 20 years may also have contributed to this lack of recruitment through various mechanisms. Since 1974, undocumented white sturgeon spawning may have occurred followed by the lack of recruitment; however, insufficient effort has targeted juveniles during this time. Research is ongoing to determine causes of this lack of recruitment and to develop and implement recovery measures.

White sturgeon in the Kootenai River are reported to have been geographically isolated between the west arm of Kootenay Lake (Bonnington Falls, B.C.) and Kootenai Falls (Montana) (Figure 2) for the last 10,000 years since the retreat of the past glacial period (Wisconsin) (Northcote 1973). Genetic research conducted to date suggests a reduced heterozygosity for the Kootenai River white sturgeon population relative to Snake and Columbia river populations of white sturgeon, and that white sturgeon in the Kootenai River constitute a distinct stock within the species (Setter 1988).

After nearly 20 years with virtually no recruitment, the Kootenai River population of white sturgeon was petitioned for listing as threatened or endangered under the Endangered Species Act (June 11, 1992). On July 7, 1993, the species was proposed to list as endangered in the Federal Register. No listing decision has occurred at this time (February, 1994).

To determine how altering the operation of Libby Dam may improve conditions for natural spawning of white sturgeon in the Kootenai River, discharge from Libby Dam (with no load following or power peaking) was increased to produce 20 kcfs (± 2 kcfs) discharge at Bonners Ferry, Idaho, for a 14 day period from June 2 to June 16 (Figure 3). This report evaluates natural spawning of white sturgeon in the Kootenai River before, during and after the 1993 augmented discharge period.

Objectives:

Objectives of this research were to:

1) Determine if white sturgeon spawned in the Kootenai River during 1993.

2) Collect baseline biological data including timing, location, and habitat requirements of white sturgeon spawning in the Kootenai River in order to formulate and implement effective recovery measures.

STUDY AREA

From headwaters located in southeastern British Columbia (B.C.), the Kootenai River flows south into northwestern Montana, west into Idaho, then back north into Kootenay Lake, B.C. (Figure 2) and out the west arm of the lake eventually joining the Columbia River at Castlegar, B.C. The Kootenai River is the second largest Columbia River tributary in terms of runoff volume and the third largest in terms of watershed area (36,000 square km) (Knudson 1993).

Immediately downstream from Libby Dam the Kootenai River flows through a single channel into Idaho winding through a narrow steep-sided canyon; in this section, Kootenai Falls is thought to be an upstream migration barrier for sturgeon. From Kootenai Falls, downstream into Idaho the river consists of predominantly long runs, with locally, uniformly sized substrate ranging from large rocks to gravel (Partridge 1983). This river section contains several deep pools lined by bedrock. Further downstream the river widens into a braided channel and gravel bar reach, then meanders northward through the Purcell Trench emptying into Kootenay Lake. This meandering section is characterized by very low gradient and water velocity, with deep pools (> 30 m). For further physical information about the study area see Knudson (1993) and Anders (1991).

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METHODS

Sampling design - Sampling sites in the Kootenai River were chosen to collect white sturgeon eggs and larvae from the drift downstream from suspected spawning habitat. Location of suspected spawning habitat was based on two criteria: Instream Flow Incremental Methodology (IFIM) model predictions; and 2) locations of late vitellogenic male and female white sturgeon tagged with radio and/or sonic transmitters.

1) Instream Flow Incremental Methodology model predictions: Since white sturgeon spawning habitat criteria are not yet established for the Kootenai River, published criteria from the Columbia River populations were used in the IFIM model at 20 kcfs to locate suspected spawning habitat in the Kootenai River. White sturgeon spawning habitat criteria in the Columbia River used in the IFIM model were: 1) mean water column velocity >0.5 mps, 2) gravel or larger substrate, and 3) water depth > 3 m (Parsley et al 1993). Based on IFIM model output using 20 kcfs as the discharge value, habitat in the Kootenai River meeting these three criteria was located from rkm 260-267.

2) Locations of late-vitellogenic white sturgeon tagged with sonic and radio transmitters: Tracking late vitellogenic males and females could identify white sturgeon spawning habitat in the Kootenai River. Location and intensity of sampling was affected by the collection of sturgeon eggs or larvae. Sampling intensified in areas where white sturgeon eggs were collected.

Naturally produced white sturgeon eggs and larvae were sampled in three reaches of the Kootenai River: Reach 1: Shorty's Island (rkm 227.5-234.51, Reach 2: Ambush Rock (rkm 245.0-245.81, and Reach 3: upstream from the Highway 95 bridge (rkm 245.8-267).

Sampling gear - Three types of gear were used to sample naturally spawned white sturgeon eggs from the Kootenai River: artificial substrate mats, D-ring plankton nets, and a beam trawl net. The latter two types of gear were also used to sample white sturgeon larvae. Since white sturgeon eggs and larvae are demersal, all three types of gear were fished in a stationary position on the substrate.

Artificial ***substrate mats*** - Artificial substrate mats constructed of a latex coated animal hair furnace filter secured within a 62 X 75 cm angle iron frames (McCabe & Beckman 1990) were used to sample white sturgeon eggs in the Kootenai River from May 18 to July 7, 1993. Mats were anchored to the substrate and marked with a fluorescent buoy within the three river reaches (rkm **227.5-258.6).** Mats were removed from the river and inspected for white sturgeon eggs every 4 to 5 days.

D-Ring plankton nets - During plankton nets (1.59 mm knotless nylon mesh attached to a "D" shaped stainless steel frame (0.76 m wide X 0.54 m high)) were used to sample the drift for white sturgeon eggs and larvae. Two to four 10 lb. lead cannonballs **were** attached to the corners of the frame to hold it upright in a stationary position on the substrate. Two D-ring nets were usually fished simultaneously. A sample consisted of fishing one D-ring net for 15 minutes, however, nets were fished for 5 to 30 minutes depending on the amount of organic debris in the drift. Since river elevation at Bonners Ferry dropped 3 to 4 feet after the augmented discharge period ended, site locations were altered to continue sampling the thalweg while adhering to previously described sampling site selection criteria.

Beam Trawl Net - A 3 X 1 m weighted aluminum frame beam trawl net (3.18 mm net liner mesh) was also used to sample white sturgeon eggs and larvae from May 26 to June 29. For a more detailed description of this gear see Palmer et al. (1988). Sampling duration varied from 3 and 30 minutes per set depending on the amount of debris in the drift.

Due to the inability of the propeller powered trawler to navigate shallow waters upstream. from Bonners Ferry, all beam trawl samples were collected only in river reaches one and two. Sampling was conducted at depths between 1.4 and 15.2 m.

***Sample* preservation *and* analysis -** Depending on the volume of material collected by the various gear types, samples were stored in either glass vials, quart or l/2 gallon jars, and preserved in 10%, unbuffered formalin tinted with Rose Bengal stain in the field. Samples were later sorted in the laboratory. Embryonic stages of white sturgeon eggs and development of larvae in the samples were determined using a dissection microscope and embryological criteria developed by Beer (1981). Larval fish other than white sturgeon were identified to family and reported as incidental catch.

White sturgeon spawning dates and times ($\pm$ 4 hr.) were back-calculated from all viable white sturgeon eggs in the samples using an exponential function (Wang et al. 1985) knowing water temperature and embryonic development (Beer 1981). Newly spawned white sturgeon eggs (in the water column < 4 hr., changing pigmentation stage, Beer 1981) were also used to estimate the dates and times of spawning. Dead white sturgeon eggs could not be used to predict date or time of spawning.

RESULTS

River discharge - During June, before the augmented discharge period, river discharge at Bonners Ferry (including 4 kcfs from Libby Dam) peaked at 23,517 cfs on May 15. After May 15; river discharge decreased until May 30 when additional discharge from Libby Dam resulted in slightly over 14 kcfs at Bonners Ferry (Figure 2). Increased Libby Dam discharge from June 1 to June 16 provided a 18,962-20,127 cfs discharge at Bonners Ferry (Figure 3). On June 16 the augmented discharge period ended, river surface elevation dropped 3 to 4 feet, and discharge values measured at Bonners Ferry fell to less than 10 kcfs.

River rater temperature - River water temperature increased from May through June, ranging from 7 to 17" C (Figure 3). Water temperatures did not exceed 15" C until mid to late June, thereby providing near optimal water temperatures for spawning during the historic natural spawning period.

White sturgeon egg catch - In 1993, three naturally spawned white sturgeon eggs were collected from the Kootenai River during the augmented discharge period, two from artificial substrate mats, and one in a D-ring net (Table 1). Of the two eggs collected from artificial substrate mats (June 10, and June 15, rkm 245) one had reached the early neurulation stage (73 hours old, spawned at 1300 hours (± 4 hr.) on June 7). The second egg was collected approximately 4 hours (± 4 hr.) after being spawned on June 15 at 0700 hours. This egg had not reached the changing pigmentation stage, therefore we could determine whether it was fertilized. Since the first egg collected on June 7 was 73 hours old, and the second egg collected on June 15 was less than 5 hours old, these two eggs were assumed to be from two different females.

The third white sturgeon egg collected in 1993 was collected in a D-ring net on June 10. Since the egg was dead when collected, we could not determine when it was spawned.

White sturgeon larvae catch - No white sturgeon larvae were collected from the Kootenai River during 1993.

Incidental catch - From all gear types combined, samples contained 20 non-sturgeon fish eggs and 15 larval fish (Cyprinidae and Catastomidae spp.). Non-sturgeon fish eggs were not identified taxonomically.

Sampling distribution and frequency - Over 41,000 hours of sampling occurred during 1993 providing a total of 823 samples: 354 from artificial substrate mats, 245 from D-Ring plankton nets, and 224 from the beam trawl (Table 1). With all gear combined, 124 and twenty-two samples were collected in river reach one, 426 in river reach two, and 275 in river reach three.

DISCUSSION

Natural spawning of white sturgeon - Collection of three white sturgeon eggs (one of which was fertilized) from two different females approximates the minimum amount of data needed to conclude that white sturgeon spawned in the Kootenai River during 1993. While white sturgeon spawning cannot be quantified using egg and larval collections due to inherently high variability (Miller and Beckman 1993; Mike Parsley, National Biological Survey, personal communication) collection of three white sturgeon eggs and no larvae suggests that the 1993 discharge augmentation (20 kcfs for 14 days) was insufficient to reduce or eliminate the threat of extinction for this population. The following evidence supports this conclusion.

Using the 1990 white sturgeon population estimate (n=880) (Apperson and Anders 1991) less 3.7 % annual mortality since then (1994 pop. estimate=756) a 50/50 sex ratio, and 7% of the females expected to spawn in a given year (Apperson 1992) 26 female white sturgeon could be expected to spawn during 1994. Fecundity estimates from female white sturgeon from the Kootenai River spawned in the Kootenai Experimental Aquaculture facility between 1991 and 1993 ranged from 60,000 to 150,000 eggs per female (John Siple, Idaho Department of fish and Game, personal communication). Assuming an average fecundity of 100,000 eggs per female and 26 females estimated to spawn in 1994, an estimated 2,600,OOO eggs could been produced given optimal river conditions for spawning.

While the accuracy of these population parameter estimates may be low, the previous calculations suggest that spawning conditions during 1993 were insufficient to realize the reproductive potential of the population in the Kootenai River.

Conversely, since only 4 of 62 adult white sturgeon sampled during broodstock collection during the spring of 1993 were females, collected in an area used extensively by late vitellogenic fish, perhaps stock limitation may have confounded attempts to define spawning habitat criteria for white sturgeon in the Kootenai River.

RECOMMENDATIONS

1. On the basis of research results, future adaptive river management designed to reestablish natural spawning by white sturgeon in the Kootenai River should include a longer period of augmented discharge (3-4 weeks), with higher minimum discharge levels maintained before and after this period.

2. Since virtually no white sturgeon recruitment has occurred in the Kootenai River during the past 20 years, future adaptive river management should be designed to create conditions capable of providing recruitment as well as natural reproduction of white sturgeon.

3. Due to a current lack of defensible data, the success of adaptive river management as the only mechanism to reestablish white sturgeon spawning, successful recruitment, and life cycle completion in the Kootenai River should not be assumed at this time.

4. While the success of using adaptive river management to reestablish spawning and recruitment cannot be guaranteed, all involved fisheries agencies should cooperatively and systematically test various river operation scenarios with the goal of reestablishing natural spawning and recruitment of white sturgeon in the Kootenai River.

5. Since virtually no recruitment has occurred during the past 20 years, and the success of adaptive river management alone to restore this population cannot be guaranteed, multi-faceted recovery efforts including field research, augmented discharge scenarios, and genetically sound aquaculture

techniques should be implemented to maintain the population's existing genetic diversity.

6. The overall goal of preservation and restoration of the white sturgeon population in the Kootenai River must remain a higher priority than the contributing research objectives. For example, for the past three years multiple family year classes have been produced using proven aquaculture techniques. However, experimentation designed to reestablish natural reproduction and recruitment was supported at the expense of currently needed conservation aquaculture measures. Recovery activities should be addressed simultaneously for the benefit of the population.

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Table 1. Distribution and frequency of white sturgeon egg and larval sampling before, during and after the 1993 augmented discharge period in the Kootenai River.

Gear type	River reach	Number of samples	Total sampling time (hours)
Substrate mats	1	86	9,083
	2	116	14,516
	3	152	17,998
		354	41,597
D-Ring nets	1	0	0
	2	122	34.8
	3	123	30.0
		245	64.8
Beam Trawl nets	1	36	8.6
	2	188	44.4
	3	0	0
		224	53.0
		823	41,714

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Table 2. Distribution of white sturgeon eggs and larvae sampling with D-ring plankton nets during the 1993 natural spawning test on the Kootenai River.

Site #	Site location (rkm)	Total Sampling time (hr.)	Number of samples	Sample* items
O-A	ambush rock	0.84	3	
o-1	245.6	11.25	42	1 wst egg
o-2	245.6	9.75	35	
o-3	245.8	10.25	36	
o-4	245.8	2.7	6	
1-K	246.0	0.5	2	
1-G	246.8	12.75	46	4 wst eggshells
l-l	247.0	2.35	10	
l-2	248.0	1.2	5	
l-3	248.6	0.3	3	
l-4	249.6	1.76	8	
2-l	253.1	0.45	3	
2-2	253.2	2.0	8	
2-3	253.4	1.45	10	
2-4	255.9	1.58	6	
3-l	258.5	1.17	5	
3-2	258.6	0.5	2	
4-l	265.5	2.17	8	
4-2	267.0	2.25	7	1 wst eggshell
		64.78	**245**	

*wst=white sturgeon

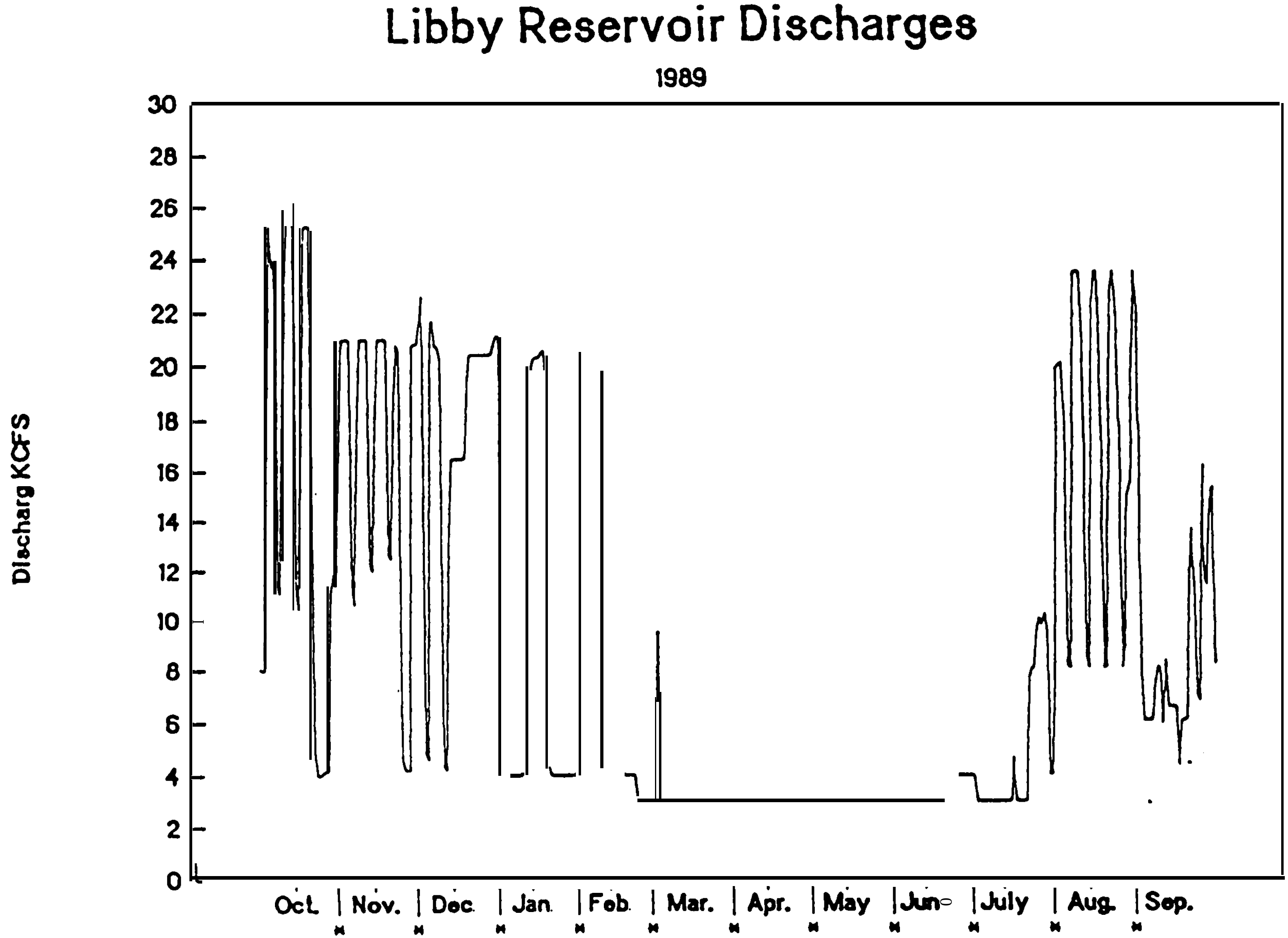


Figure An example of the altered post-dam Kootenai River hydrograph.

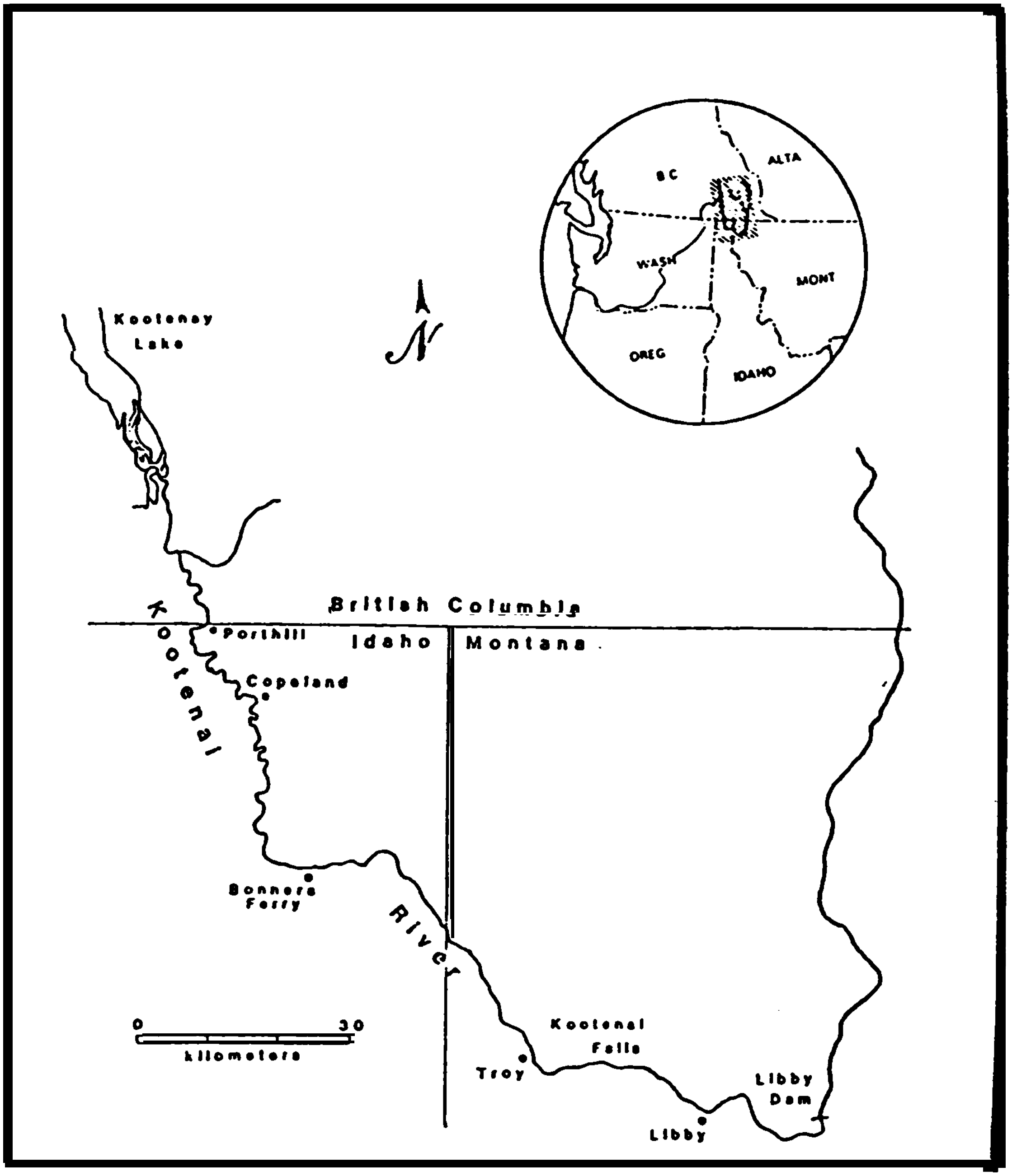
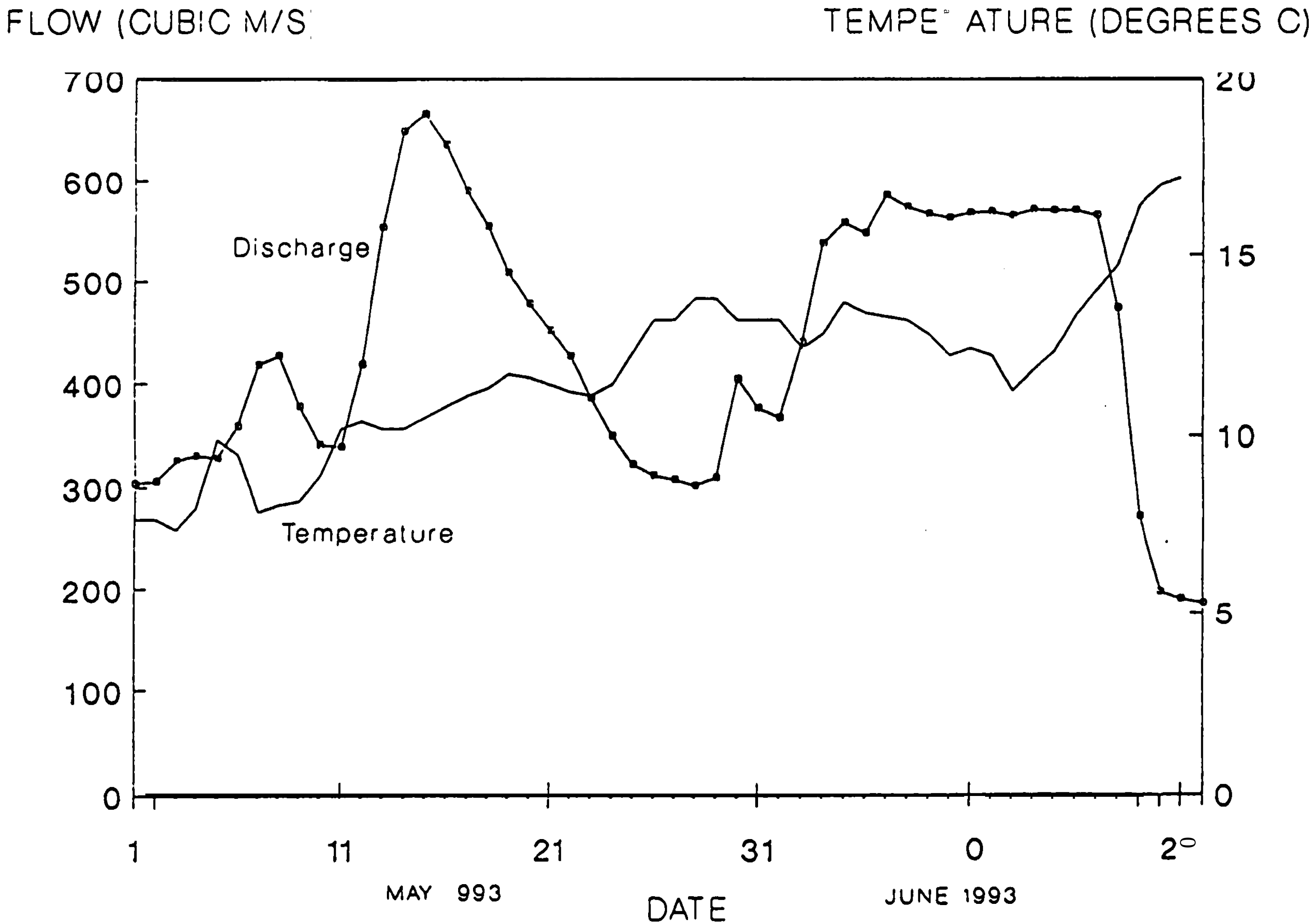


Figure 2. Map of the Kootenai River system. White sturgeon are found downstream from Kootenai Falls, and primarily downstream from Bonners Ferry, Idaho.

Figure 3. Temperature and calculated discharge of he Kootenai River at Bonners Ferry, Idaho for May to June 21, 993



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KOOTENAI RIVER WHITE STURGEON STUDIES

EXPERIMENTAL CULTURE

Annual Hatchery Report FY 1993
Report B

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INTRODUCTION

The Kootenai Experimental White Sturgeon ***(Acipenser transmontanus)*** Aquaculture Facility is located in Boundary County, Idaho, approximately three miles west of Bonners Ferry, in extreme northeast Idaho (Figure 1). Construction of the facility was completed in the spring of 1991, as a resident fish mitigation measure under the Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program [Section 900 (g) (1) 1987 (H) ; Action Plan, section 1403 (7.5)]. Funding for this facility was provided by Bonneville Power Administration (BPA) under the auspices of the Northwest Power Planning and Conservation Act (P.L. 96-501,1980).

Staffing at the facility includes an Idaho Fish and Game (IDFG) facility manager and three permanent Kootenai tribal personnel. This facility produces one and two year old white sturgeon for laboratory and field research including experimental releases into the Kootenai River. This research facility was established for experimental rearing of Kootenai River White Sturgeon as part of a BPA project evaluating White Sturgeon in the Kootenai River. The facility will release one and two year old sturgeon during the spring to fall period as directed to meet research objectives. Representative numbers of fish > 70 cm TL (Total Length) will be PIT tagged, marked with a scute removal pattern and fitted with radio and sonic transmitters to be tracked after release into the river during 1994.

WATER SUPPLY

The facility has two water supply systems, Kootenai River water and Bonners Ferry city water. A new double primary pump system was designed for the facility (Figures 2,3), and installed during the first week of May. The intake system contains two electric 7.5 hp submersible pumps, each in a separate 8" diameter steel pipe. One pump runs for 24 hours before the system automatically switches to the second pump for 24 hours. A third pump (portable gas 8 hp) was also purchased for further water reliability, in the event that both primary electrical pumps fail at the same time, or in case of generator failure during a power outage. This gas powered pump can deliver up to 190 gpm depending on river elevation.

Kootenai River water is pumped into a head-box at approximately 947 l/min. and is distributed for egg incubation, juvenile rearing, adult holding and recovery of female spawners. The gravity fed city water is first dechlorinated through two activated charcoal canisters. Then the water goes through a column packed with aeration media [shot shell wads] and then into a head-box for distribution.

The Kootenai River water temperature varies by season from a low of 1° C in the winter and as warm as 20" C in the summer. The city water temperature also varies seasonally. Following spawning in 1993, city water temperatures in the facility ranged from 13-16" C (Table 1).

An electric water heater can be used for city and river water in the winter, increasing the water temperature to 17" C in three rearing tanks. A heat pump (chiller) was installed in June to chill river water. This chiller was used for incubation and early larval rearing. However, this chiller has a limited capacity: heating for chilling 3-4 gpm or 2 rearing tanks using a recirculation system.

FACILITY DESIGN

The Kootenai Experimental Facility is a metal pole building, 17.8 m long and 12.5 m wide, housing rearing ponds, an office, laboratory space, and a backup diesel generator. Rearing ponds consist of : two rectangular tanks 3.66 m in length by 0.36 m wide by 0.45 m high; one rectangular tank 3.66 m in length by 0.56 m wide by 0.30 m high; one rectangular tank 3.09 m in length by 0.37 m wide by 0.47 m high; ten rectangular tanks 1.20 m in length by 0.60 m wide by 0.40 m high; three rectangular tanks 1.20 m in length by 0.45 m wide by 0.57 m high; three circular tanks 3.06 m in diameter by 1.53 m high and three 1.53 m diameter circular tanks and 1.22 m high.

PRODUCTION

INCUBATION AND EARLY FRY REARING

On June 26 at 1700 hours, twelve hours post fertilization, random egg samples were taken from the bottom, middle and top of the MacDonald jars from each water source. We then recorded number of eggs sampled. and their embryonic stage under a dissecting microscope (Table 3 a-c).

Water flow was increased 48 hours post fertilization, to roll the eggs and reduce fungus infection and clumping. Ambient city water temperature was approximately 15" C, with better survival to hatch (Table 4). Hatching began 4.5-5 days post fertilization on Kootenai River water and heated city water. On city, ambient river, and chilled river water hatching began **7** days post fertilization, and lasted up to 3 days.

The late hatching larvae in all water sources showed a high incidence of deformity, mainly in the form of crooked backs which rendered the post yolk sac fry unable to feed. For a more detailed description of these deformities, see Siple and Aitken 1991. Total hatching produced 14,217 larvae on ambient city water, heated city water produced 527 larvae and 1,264 were produced on Kootenai River water; chilled river water jars produced 937 larvae (Table 5). Larvae were allowed to swim out of the MacDonald jars directly into emergence tanks or rectangular rearing tanks.

Larvae hatched in ambient city water were split up, weighed and moved to respective rectangular rearing tanks. All larvae hatched in heated and ambient city water males were switched over to ambient river water on July 21. Feed initiation began 10 days post hatch. The larvae were not actively feeding at first, but the exposure to feed seemed to help stimulate feeding in the larvae in time.

SURVIVAL

Hatching

As in past years at the facility, a certain percentage of post yolk-sac larvae never began to feed on processed feed. This is represented by mortality between July and August (Table 5).

Hatching success was substantially higher for eggs collected by hand stripping (mean 30.4% hatch, range 9.2-40.8%) than for eggs collected by cesarian surgery (mean 7.1% hatch, range 3.9-11.4%) (Table 5). The low percent hatch of eggs surgically collected may be largely explained by the following two factors:

1) Blood and white eggs (already dead) were found in the ovarian fluid at the onset of and throughout the surgical process. No blood or white eggs were seen in ovarian fluid expressed during the earlier hand stripping. Blood in the ovarian fluid may have resulted from the fish's unusual movement in the stretcher. However, in past years, blood has been observed in ovarian fluid during surgery with fish that were not previously hand stripped, and did not exhibit any motion in the stretcher.

2) Eggs collected by cesarian surgery were the last lots to be transferred into MacDonald hatching jars. Therefore, egg loss may have also been due to anoxia or clumping to a greater extent than seen with eggs transferred to jars previously.

Fry

The highest monthly fry mortality occurred between July and August (Table 5) when larvae must begin exogenous feeding on processed feed. In addition to egg mortality before hatching, the onset of exogenous feeding constitutes another critical period for survival.

Fingerlings

No major mortality episodes occurred with fish from the 1993 broodyear. However, small numbers of fingerlings routinely died throughout the 1993 rearing period beginning in early fall. The cause or causes of chronic mortality are not understood. No evidence of bacterial gill disease or WSIV (White Sturgeon Iridovirus) was observed with fish from the 1993 broodyear.

However, measuring condition factors of dead and live fish may provide some insight into this low level chronic mortality. .

1992 BROODYEAR

In January 1993, approximately 1600 age 1 (1992 broodyear) fish were held in the facility. Due to multiple and finally terminal pump failure at the facility on February 18, all but four of these fish were moved to the Sandpoint Hatchery. On May 28, 450 of these fish were brought back to the Kootenai facility (Figure 4) Percent monthly survival of these fish ranged from 89 to 100%.

FISH HEALTH

1993 Broodyear

No major mortality episodes occurred during 1993. There are no evidence of, bacterial gill disease or WSIV. To further investigate the nature and treatment of WSIV 1,204 fish from the 1993 broodyear were transported to a research facility at Clear Springs (Buhl, ID.). Only one fish was killed during the unloading process at Clear Springs.

The following report of fish health from the Eagle Fish Health Laboratory (IDFG) was reported for the Kootenai Facility in 1993: Fish health at the Kootenai Facility was excellent in 1993. Two minor outbreaks- of bacterial gill disease occured in the BY92 fish and were controlled with salt baths at 3% concentration. No visits were made by Eagle Laboratory pathologists in 1993, but routine contact was maintained over the telephone. Recommendations for 1994 include:

1) Cooperate with Eagle and Clear Springs Laboratories in testing for white sturgeon iridovirus.

2) Notify pathologists when adult broodstock are to be captured so that disease samples may be collected from the wild population.

1992 Broodyear

Health of fish from the 1992 broodyear was also very good during 1993. Monthly survival ranged from 89-100%, with the exception of one rearing tank in which a mild infection of bacterial gill disease caused the loss of 294 fish between July 21 and September 6.

FISH TRANSFERS

During the third week of February, all but four of the 1992 broodyear fish were moved to the Sandpoint Hatchery following terminal pump failure on February 18 (See power/pump failure section of report). On May 28, 450 fish from the 1992 broodyear (21 fish/lb. average TL 6.5") were returned to the Kootenai Experimental Facility following proven success of the new water intake system (See new construction section of this report). On December 13, 40 fish from the 1992 broodyear and 199 fish from the 1993 broodyear were transferred from the Kootenai Experimental White Sturgeon Facility to Sandpoint State Hatchery. On December 21, 1,204, 1993 broodyear fish were transferred to Clear Springs research labs to investigate the effects of rearing density on white sturgeon iridovirus.

BROODSTOCK CAPTURE

From April through June of 1993, 66 white sturgeon were captured from the Kootenai River by angling between Rock Creek and Ambush Rock (Table 2). Of the 66 fish captured only 4 (6.6%) were females (Table 2). Captured fish were placed upside down in a stretcher suspended across the boat gunwales, with river water added as needed. Fish were then sexed in the field either by making a 1 cm abdominal incision and viewing gonadal tissue with a veterinarian otoscope or by inserting a flexible plastic tube and extracting developing oocytes (eggs) by suction. Once the sex and stage of sexual maturation were determined, fish were either brought to the facility by boat or truck, or released back into the river.

Of the 66 fish captured, 16 sexually mature fish (4 females and 12 males) were transported to the facility; no more than three females and six males were held at one time in the facility during 1993. All fish captured were checked for the presence of PIT and Floy tags. Fish captured without a PIT tag were PIT tagged on the right lateral surface below the dorsal fin. During broodstock collection fish captured were weighed (kg), measured (TL cm), and marked with the removal of the second left lateral scute (Table 2).

STAGING BROODSTOCK

On June 19, 1993, eggs from three female white sturgeon held in the facility were tested for GVBD with the following results:

Female (PIT tag #)	Control(n=lO eggs)	% GVBD (n=lO eggs)
3775A	flattened GV	100
3552E	rounded GV	70
	8 rounded	
	2 flattened	
2705A	rounded GV	80
	10 rounded	
	0 flattened	

On June 25,1993, sperm samples from five male white sturgeon were tested for motility with the following results:

Males PIT #	Sperm motility (min.)	Sperm sample volume (ml) 6/24	6/25
5360	no sperm visible	-	
5079	> 2 minutes	8	30
5326	> 2 minutes	30	70
7856	no sperm visible		
0863	no sperm visible		

For a detailed description of male and female broodstock staging criteria and techniques, see Siple (1992).

SPAWNING PROCEDURES

One female white sturgeon (PIT tag #3775A) was spawned with two males (PIT tag # 5079, 5326) in the Kootenai Experimental Facility in 1993. The female was captured on May 17 and transported to the facility where she was staged with an egg diameter of 3.2-

3.3 mm and a GV position of stage 4. A progesterone assay was performed on the eggs on June 3, with only 60% exhibiting GVBD. On June 19, the female was staged again with more favorable results. The eggs had a diameter of 3.5 mm and the GV position was stage 5 with 100% of 10 eggs exhibiting GVBD. It appeared that this fish could be induced to ovulate.

Hormone injections to induce spawning began on June 23. The female was injected with a primary dose of 10% of a 0.1 mg/kg body weight dose of luteinizing hormone releasing hormone analogue (LHRHa) at 2000 hours. Twelve hours later, she was given a resolving dose of 90% of the 0.1 mg/kg body weight LHRHa. Prior to the induction injections she was placed by stretcher into a 1.0 X .67 X 3.0 meter covered fiberglass spawning tank. This spawning tank allowed the fish to be injected under water which reduces stress and handling. This also makes for easier observation while waiting for ovulation.

Sperm from two males (PIT tag # 5079, 5326) was checked for motility at 0030 hours on June 25. Thirty-eight ml of sperm was collected from male #5079 and 100 ml was collected from male # 5326. A sperm sample from each male was checked by microscope for motility and time of death. Remaining sperm was placed in ziplock plastic bags with pure oxygen and stored in a refrigerator. Care was taken to keep the tubing, syringe and surface area of the fish dry when collecting sperm.

Ovulation was expected between 24 to 48 hours post resolving injection on June 24. Twenty to 30 dark eggs were observed approximately 37 hours post resolving dose injection, near the bottom of the spawning tank. This was a good sign as viable eggs stick to the bottom of the tank. We continued to observe her until 0200 hours on June 26. At this time several hundred eggs were observed clumped and stuck to the bottom of the spawning tank.

EGG REMOVAL TECHNIQUES

Hand stripping

On June 26, at approximately 0310 hours egg removal began by hand stripping. The hand stripping technique involves massaging the ventral side of the fish while holding the ventral side up in a stretcher. Massaging the eggs out of the body cavity was done by applying pressure with the ball of the hand on the ventral midline of the fish and gently moving the hand posteriorly on the midline from approximately one foot anterior of the oviduct to the oviduct. During the first 40 minutes of hand stripping 51,690 eggs were collected (Table 4). However, the one female that was spawned this year had deformed ovaries which may have contributed to the success of hand stripping. Rather than the ovaries being parallel to the fish's midline, the ovaries resembled a letter X, crossing the midline. Regardless of this abnormality, the success of hand stripping indicates that cesarian surgery may become obsolete at the facility in the future.

Cesarian surgery

On June 26, at 0334 hours cesarian surgery began. In 1993, 34,620 eggs were removed by cesarian surgery (Table 4). The ventral side was disinfected with 4% nitrofurazone. A 10 cm incision was made along the midline to expose the egg mass, then the eggs were gently removed with a disinfected plastic spoon from the body cavity. The eggs were placed into nine stainless steel bowls to await fertilization. This process took approximately 60 minutes. Three, 10 g egg samples were collected and counted later to determine fecundity. The female was thoroughly disinfected with 4% nitrofurazone and the incision was closed with Ethicon's PDSII violet monofilament (polydioxanone) suture swedged to a reverse cutting CP-1 curved, surgical needle. A continuous suture of both the inside and outside body cavity wall was used. She was placed back into the holding tank at 0500 hours. After 24 hours she was checked and then transferred to the recovery tank.

Egg fertilization and processing began at 0500 hours. The coelomic fluid was removed from the eggs. A 10 ml sperm sample was poured into a bowl of 2,000 ml of water. This mixture was then stirred and added to the eggs and gently stirred with feathers until the eggs began to stick to the feathers, approximately two minutes later. This process was performed with sperm from each male and for each of the three water experiments, for a total of nine samples that were kept separate. The bowls were drained off and a de-adhesive solution of Fullers Earth (diatomaceous earth) was mixed with water, and set in flowing water for tempering, then has added to the eggs. Again eggs were gently stirred until they were no longer adhesive. Constant monitoring of the egg temperature was done so when the egg mixture increased more than 5" C it was poured off and new tempered mix was added. This process lasted 75 minutes. The eggs were thoroughly rinsed to remove excess material and placed into 24 MacDonald jars, 18 on ambient city water, 2 on heated city water, 2 on ambient river water, and 2 on chilled river water.

Egg densities per MacDonald jar were established as follows:

Jar number	Number of eggs per jar	Total number of eggs
1-12	2,865	34,380
13-16	2,925	11,716
17-22	5,730	34,380
23,24	2,925	5,850
	Total egg take	86,326

Flow was set at 3.79 l/min/jar. This flow rate kept the eggs suspended but not rolling. The difference between the initial and subsequent egg take estimates (0.06%) was caused by error inherent to extrapolating egg numbers from volumetric measurements.

NEW CONSTRUCTION

During Fiscal Year 1993, the following improvements were made at the Kootenai Facility:

1) Entire fish rearing area was insulated
2) Wood stove installed in fish rearing area
3) Water heater/chiller unit purchased and installed
4) Self contained on-site living facility (29' travel trailer)
5) Small portable transport/holding tank purchased
6) The facility water intake pumphouse received a heater and was insulated

PUBLIC RELATIONS

More than 500 people visited the Kootenai Experimental Facility during 1993. Approximately 90 groups of people toured the facility. These groups, usually numbering 1 to 5 people, visited the facility from Idaho, Montana, Washington, Oregon, Alaska, South Dakota, Iowa, Pennsylvania, Massachusetts, Florida, and British Columbia, Canada. Approximately 10 additional groups visited the facility from schools in Idaho and Montana.

RECOMMENDATIONS

Research

1) Increase capacity to control water temperatures in the facility to improve survival at critical life stages.

2) Incubate, hatch and rear eggs, larvae, and fingerlings on ambient river water to assess potential survival of naturally produced early life stages of white sturgeon in the river. Additional eggsI larvae and juveniles will be reared in thermally altered river water.

3) Further refine hand stripping techniques using females with normally developed ovaries.

4) Investigate the feasibility of discontinuing cesarian surgery for egg collection in favor of hand stripping.

5) Except for during major fish loss episodes, document the condition factors of live and dead fish in the facility to better understand chronic low mortality seen at the facility.

Production

Broodstock:

1) Broodstock collected should be transported to the facility as soon as possible to reduce stress.

2) Fish should be checked regularly to determine degree of maturation.

3) At least three females should be at the facility one month prior to spawning.

4) One spawning female should be old enough to have spawned naturally at least once before in it's life.

Spawning:

1) Have a male to female ratio of 3:l.

2) Keep eggs sorted by the male's number from incubation through stocking or until overcrowding becomes a problem.

3) Transfer a portion of the larvae and fingerlings to Sandpoint State Hatchery to hatch and rear on heated spring water not to exceed 10° C.

4) Attempt to spawn a female 142-172 cm TL and one >213 cm TL to compare contaminant levels in eggs from each fish.

Incubation:

1) **Do not** use water warmer than 16" C for incubation.

Facility design

Due to the following pump and power failures at the Facility during 1993, a facility site with thermally correct reliable gravity flow water source would be beneficial.

Date	Power failure	Pump failure
l/4		X
2/11		X
2/12		X
2/17		X (terminal failure)
2/18		
8/l	X	
8/12	X	
8/29	X	
10/20	X	
12/16	X	
12/17	X	
12/29	X	
Total	7	4

LITERATURE CITED

Northwest Power Planning Council Columbia River Basin Fish and Wildlife Program. 1987.

Siple, J. 1992. Kootenai River Fisheries Investigations and Experimental Culture. Annual Hatchery Report. BPA Project No. 88-65.

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The Kootenai Tribe Fisheries Program also thanks the Bonneville Power Administration for funding this research and facility.

APPENDIX

Table 1. Daily water temperatures of all water sources in the Kootenai Experimental Facility for the 1993 broodyear fish. Two temperature values for each date represent temperature at 8 AM and-4 PM.

DATE	HEATED CITY	AMBIENT CITY	RIVER	CHILLED RIVER
06-26-93*	18	15	15	15
06-27-93	18	15	1 4	15
06-28-93	18.5	15	14	15
06-29-93	19	14	15	14
06-30-93	18/18	14/14	14/13	14/14

*spawned fish

DATE	HEATED CITY	AMBIENT CITY	RIVER	CHILLED RIVER
07-01-93	18	14	14	13/13
07-02-93	19/19	13/13	15/14	14/14
07-03-93	18/18	14/14	14/15	14/14
07-04-93	18/19	14/14	15/16	14/15
07-05-93	18/20	13/14	15/16	14/15
07-06-93	18/19	14/15	15/16	14/14
07-07-93	19/19	14/15	15/16	14/14
07-08-93	19/19	14/15	14/16	14/14
07-09-93	19/19	14/15	14/16	14/14
07-10-93	19/19	14/15	14/16	14/14
07-11-93	18/19	14/15	16/17	14/15
07-12-93	18/19	14/14	15/15	14/14
07-13-93	17/18	14/15	14/16	14/14
07-14-93	18/19	14/15	14/16	14/15
07-15-93	18/19	14/15	14/16	14/15
07-16-93	18/19	14/15	14/16	14/15
07-17-93	18/18	14/14	15/15	14/14
07-18-93	18/19	14/15	14/16	14/14
07-19-93	18/18	14/15	14/15	14/14
07-20-93	18/19	14/16	15/15	14/15
07-21-93	18/19	a	15/15	14/15
07-22-93	19/19		16/15	14/15
07-23-93	19/19		16/15	14/15
07-24-93	19/19		16/15	14/15
07-25-93	19/19		16/16	14/14
07-26-93	20/20		16/16	14/15
07-27-93	19		16	14
07-28-93	19/20		16/17	15/16
07-29-93	19/20		17/17	15/16
07-30-93	19/20		17/17	15/16
07-31-93	19/20		17/17	15/16

a=All tanks using ambient city water were switched over to river water on 7/21.

DATE	HEATED CITY	AMBIENT CITY	RIVER	CHILLED RIVER
08-01-93	19/20		17/17	15/16
08-02-93	19/20		17	15/16
08-03-93	19/20		16/17	15/16
08-04-93	19/20		16/17	15/16
08-05-93	19/20		17/18	15/16
08-06-93	19/20		17/18	16/16
08-07-93	19/20		17/18	16/16
08-08-93	19/20		17/18	17/16
08-09-93	19/20		18/18	14/17
08-10-93	19/19		17/18	14/17
08-11-93	19		17/18	14
08-12-93	19/21		17/18	14/16.5
08-13-93	18/18		17/19	15/16
08-14-93	16/18		17/19	14/16
08-15-93	17/18		17/19	15/16
08-16-93	20/19		17/17	15/15
08-17-93	20/21		16/16	14/14
08-18-93	21		15	14
08-19-93	19/18		16/17	14/16
08-20-93	17/18		18/18	14/16
08-21-93	18/18		17/17	14/15
08-22-93	17/18		16/16	14/15
08-23-93	18/19		14/14	14/14
08-24-93	18/18		13/14	13/14
08-25-93				
08-26-93				
08-27-93	18		15	14/14
08-28-93	20/19		13/14	19/15
08-29-93	18/18		13/14	14/14
08-30-93	18/19		13/14	13/14
08-31-93	19/19		13/14	13/14
09-01-93				
09-02-93				
09-03-93				
09-04-93				
09-05-93	18/19		15/16	15/15
09-06-93	18/19		15/16	14/14
09-07-93	19/19		15/16	15/14
09-08-93	18/19		15/16	14/14
09-09-93	18/19		14/16	14/14
09-10-93	18/20		14/15	13/14
09-11-93	19/18		14/14	14/14
09-12-93	18/19		13/13	14/14
09-13-93	18/19		13/14	14/14
09-14-93	18/19		13/17	14/15
09-15-93	18/19		13/13	14/15
09-16-93	19/19		12/13	14/15

DATE	HEATED CITY	AMBIENT CITY	RIVER	CHILLED RIVER
09-17-93	18/19		13/14	14/15
09-18-93	18/19		13/14	14/15
09-19-93	19/19		13/13	14/14
09-20-93	19/19		13/13	14/14
09-21-93	19		13	14
09-22-93				
09-23-93	20/20		12/13	14/14
09-24-93	20/20		13/13	14/14
09-25-93	14/21		12/13	13/14
09-26-93	21/21		12/13	13/14
09-27-93	20/21		13/13	14/14
09-28-93	21/21		13/13	14/14
09-29-93	20/21		13/14	14/14
09-30-93	21/21		13/14	14/14
10-01-93	19		13	14
10-02-93	18			14
10-03-93	18/19		13/13	14/14
10-04-93	19		13	14/14
10-05-93	18/19		13/14	14/14
10-06-93	18/19		13/13	14/14
10-07-93	18/18		13	13
10-08-93				
10-09-93	17/18		11/13	11/14
10-10-93	18/19		12/12	12/14
10-11-93	17/18		11/12	12/13
10-12-93	18/18		12/12	13/14
10-13-93	17/18		12/12	14/14
10-14-93	17/18		12/12	14/14
10-15-93	17/18		12/12	14/14
10-16-93	17/17		12/12	12/13
10-17-93	17/17		12/12	12/14
10-18-93	17/17		12/12	13/13
10-19-93	17/13		11/12	12/13
10-20-93	14		12/11	12/12
10-21-93	15/16		11/12	11/12
10-22-93	15/16		11/11	12/13
10-23-93	17/17		11/12	12/13
10-24-93	16/16		11/12	11/13
10-25-93	16/16		11/12	11/12
10-26-93	14/13		12/12	12/13
10-27-93	13/13		11/12	12/13
10-28-93	12/12		12/12	12/13
10-29-93	11/11		12/12	12/13
10-30-93	heated water turned off		12/12	11/11
10-31-93			11/11	12/12

DATE	CHILLED RIVER	RIVER
11-1	11	12
11-2	11	12
11-3	11	12
11-4	10	11
11-5	10	11
11-6	10	11
11-7	10	11
11-8	9	10
11-9	9	10
11-10	9	10
11-11		
11-12	9	10
11-13		
11-14		
11-15	10	10
11-16	10	10
11-17	10	10
11-18	10	10
11-19	9	9
11-20	9	9
11-21	9	9
11-22	9	9
11-23	9	9
11-24	9	8
11-25	8	8
11-26	8	8
11-27	8	8
11-28	8	8
11-29	9	9
11-30		
12-1		
12-2		
12-3		
12-4		
12-5		
12-6		
12-7		
12-8	8	9
12-9	9	9
12-10	9	9
12-11	7	7
12-12	9	9
12-13	8	8
12-14	8	8
12-15	8	8
12-16	8	8
12-17	8	8
12-18	8	8
12-19	8	8
12-20	8	8
12-21	8	8

DATE	CHILLED RIVER	RIVER
12-22	8	8
12-23	8	8
12-24	7	8
12-25	7	7
12-26	7	7
12-27	7	7
12-28	7	7
12-29	7	7
12-30	7	8
12-31	8	8

Table 2. Catch data for adult white sturgeon captured in the Kootenai River during 1993.

DATE	SEX	LOCATION	TIME	WEIGHT	LENGTH	DEPTH	PIT TAG #	FLOY TAG #
05-10-93	UN	ROCK CREEK	1245	----	142 CM	32 FEET	7F7F43572C	------
05-10-93	UN	ROCK CREEK	1450	----	229 CM	32 FEET	7F7F44524b	------
05-11-93	M	ROCK CREEK	1250	14.0 KG	136 CM	35 FEET	7F7F427F2a	------
05-11-93	M	SHORTY'S ISLAND	1640	17.0-24 KG	145 CM	35 FEET	7F7F426A34	------
05-13-93	M	SHORTY'S ISLAND	1140	53.0 KG	183 CM	-----	7F7F443223	------
05-13-93	M	-----	-----	19.0 KG	155 CM	- -	----------	00737
05-13-93	FE	SHORTY'S ISLAND	1900	51.0 KG	220 CM	36 FEET	7F7F43552E	------
05-13-93	M	SHORTY'S ISLAND	1400	----	136 CM	36 FEET	7F7F427A4D	------
05-14-93	M	SHORTY'S ISLAND	1221	---	-----	36 FEET	UNREADABLE	555 (SONIC)
05-15-93	M	SHORTY'S ISLAND	1456	15.0 KG	146 CM	36 FEET	7F7F117F46	01554
05-15-93	M	SHORTY'S ISLAND	1545	28.0 KG	167 CM	35 FEET	7F7F457949	------
05-15-93	M	SHORTY'S ISLAND	1737	15.0 KG	140 CM	35 FEET	7F7F426B49	------
05-16-93	UN	SHORTY'S ISLAND	1719	11.4 KG	126 CM	31 FEET	7F7F427123	------
05-16-93	UN	SHORTY'S ISLAND	1735	11.0 KG	132 CM	31 FEET	7F7F444420	01053
05-16-93	M	-----	es---	17.0 KG	149 CM	-----	7F7F12181F	------
05-16-93	M	SHORTY'S ISLAND	1751	21.0 KG	157 CM	31 FEET	7F7F644338	------
05-17-93	M	SHORTY'S ISLAND	1000	21.0 KG	159 CM	33 FEET	7F7F12113P	01596
05-17-93	M	CAUGHT ON 5-15-93	1424	---	----	-----	7F7F117F46	------
05-17-93	UN	-------	1119	----	----	-----	--------	------
05-17-93	M	SHORTY'S ISLAND	1600	18.0 KG	155 CM	31 FEET	7F7F426012	------
05-17-93	FE	SHORTY'S ISLAND	1700	70.0 KG	214 CM	31 FEET	7F7F43775A	------
05-17-93	UN	SHORTY'S ISLAND	1500	36.0 KG	192 CM	31 FEET	7F7F426826	------
05-16-93	M	CAUGHT ON 5-15-93		15.0 KG	146 CM		7F7F117F46	01554
05-13-93	M	SHORTY'S ISLAND	1004	45.0 KG	191 CM	-----	7F7E365326	------
05-13-93	M	SHORTY'S ISLAND	1740	33.5 KG	172 CM	-----	7F7F441E79	------
05-16-93	UN	SHORTY'S ISLAND	1010	-9 KG	130 CM	-----	7F7F402F5B	------
05-16-93	M	SHORTY'S ISLAND	1130	53.0 KG	210 CM	36 FEET	7F7F425F1F	------
05-18-93	FE	SHORTY'S ISLAND	1210	53.0 KG	199 CM	31 FEET	7F7F427916	RELEASED 5-28-93

DATE	SEX	LOCATION	TIME	WEIGHT	LENGTH	DEPTH	PIT TAG #	FLOY TAG #
05-22-93	FE	UPPER SHORTY'S	1149	26.0 KG	170 CM	40 FEET	7F7F42705A	------
05-22-93	UN	SHORTY'S ISLAND	1123	7.0 KG	110 CM	40 FEET	7F7E357439	------
05-23-93	M	SHORTY'S ISLAND	1025	27.0 KG	175 CM	31 FEET	7F7F430B08	------
05-23-93	M	SHORTY'S ISLAND	0957	30.0 KG	175 CM	31 FEET	7F7F4277DE	------
05-23-93	M	SHORTY'S ISLAND	1630	24.0 KG	160 CM	31 FEET	7F7F44104D	------
05-23-93	M	SHORTY'S ISLAND	1700	17.0 KG	145 CM	31 FEET	7F7F436A3E	------
05-23-93	UN	SHORTY'S ISLAND	1645	7.5 KG	115 CM	-----	7F7F431D70	------
06-04-93	M	AMBUSH ROCK	1120	----	172 CM	-----	7F7F443F16	------
06-04-93	M	AMBUSH ROCK	1250	----	215 CM	-----	7F7F007039	01589
06-07-93	M	AMBUSH ROCK	1430	11.0 KG	125 CM	-----	7F7F437E56	MORTALITY
06-11-93	M	SHORTY'S ISLAND	1500	30.0 KG	185 CM	31 FEET	7F7F0E5942	------
06-11-93	M	SHORTY'S ISLAND	1409	32.5 KG	177 CM	31 FEET	7F7F435360	2 + -
06-14-93	M	SHORTY'S ISLAND	1150	10.5 KG	129 CM	31 FEET	7F7F43723D	------
06-14-93	M	SHORTY'S ISLAND	123 1	15.5 KG	144 CM	31 FEET	7F7F443E36	01492
06-14-93	M	SHORTY'S ISLAND	1300	21.5 KG	238 CM	31 FEET	7F7F436A22	------
06-14-93	M	SHORTY'S ISLAND	1430	18.5 KG	155 CM	31 FEET	7F7F427559	2+----
06-14-93	M	SHORTY'S ISLAND	1600	51.0 KG	215 CM	-----	7F7F44057F	------
06-14-93	M	SHORTY'S ISLAND	1618	----	-----	31 FEET	7F7E357439	------
06-14-93	M	SHORTY'S ISLAND	1631	18.5 KG	152 CM	31 FEET	7F7F3D5079	------
06-15-93	M	SHORTY'S ISLAND	0957	38.0 KG	184 CM	31 FEET	7F7F444F54	------
06-15-93	M	SHORTY'S ISLAND	1050	24.5 KG	169 CM	31 FEET	7F7F3D5124	------
06-15-93	M	SHORTY'S ISLAND	1100	33.5 KG	182 CM	31 FEET	7F7F441E5E	------
06-15-93	M	SHORTY'S ISLAND	1215	27.0 KG	169 CM	31 FEET	7F7F12170E	------
06-15-93	M	SHORTY'S ISLAND	1220	- - -	216 CM	31 FEET	7F7F43786F	------
06-15-93	M	SHORTY'S ISLAND	13 10	12.0 KG	140 CM	31 FEET	7F7F443E1A	------
06-15-93	M	SHORTY'S ISLAND	1505	30.0 KG	166 CM	31 FEET	7F7F435103	------
06-15-93	M	SHORTY'S ISLAND	1510	32.0 KG	181 CM	31 FEET	7F7E12052A	------
06-15-93	M	SHORTY'S ISLAND	1605	- -	-----	31 FEET	7F7F435631	------

DATE	SEX	LOCATION	TIME	WEIGHT	LENGTH	DEPTH	PIT TAG #	FLOY TAG #
05-13-93	M	SHORTY'S ISLAND	1004	45.0 KG	191 CM	-----	7F7E365326	------
05-13-93	M	SHORTY'S ISLAND	1740	33.5 KG	172 MC	-----	7F7F441E79	-------
05-13-93	M	SHORTY'S ISLAND	1140	19.0 KG	155 CM	-----	———	00737
06-11-93	M	SHORTY'S ISLAND	1206	22.0 KG	160 CM	31 FEET	7F7F440863	01063
06-11-93	M	SHORTY'S ISLAND	1206	----	159 CM	31 FEET	7F7F436A54	------

Table 3a. Embryonic development of white sturgeon eggs hatched on heated city water at the Kootenai Experimental Facility, 12-120 hours post-fertilization.

WHOTE STURGEON EMBRYONIC STAGES (heated city water)

HOURS	JAR #	# EGGS	EARLY CLEAVAGE	ADVANCED CLEAVAGE	LATE CLEAVAGE	EARLY GASTRULATION	GASTRULATION	YOLK PLUG	EARLY NEURALATION	NEURAL TUBE	LATE NEURALATION	# DEAD
12	13	33	3	1	16							13
25	14	37				21	15					1
50	13	68						4	54			10
74	14	41									28	13
98	13	73									50	23
120	NO COUNT:	STARTED HATCHING BETNEEN 1700 HOUR8 AND 2000 HOUR8										

Table 3b. Embryonic development of white sturgeon eggs hatched on city water at the Kootenai Experimental Facility, 12-120 hours post-fertilization.

WHITE STURGEON EMBRYONIC STAGES (City water)

HOURS	JAR #	# EGGS	EARLY CLEAVAGE	ADVANCED CLEAVAGE	LATE CLEAVAGE	EARLY GASTRULATION	GASTRULATION	YOLK PLUG	EARLY NEURALATION	NEURAL TUBE	LATE NEURALATION	# DEAD
12	1	41	17	18								6
12	7	31	29	1								1
25	18	42			25	17						0
25	21	33			18	15						
50	2	47						early 25				22
50	6	49						early 2				47
74	19	34							28			6
74	22	52							5			47
74	3	30							13			17
74	9	105							7			98
98	4	33									17	16
98	10	66									6	60
98	17	42									18	24
98	20	34									5	29
120	5	71									45	26
120	11	31									1	30
120	18	50									25	25
120	21	43									3	40

Table 3c. Embryonic development of white sturgeon eggs hatched on river and chilled river water at the Kootenai Experimental Facility, 12-120 hours post-fertilization.

WHITE STURGEON EMBRYONIC STAGES

HOURS	JAR #	# EGGS	EARLY CLEAVAGE	ADVANCED CLEAVAGE	LATE CLEAVAGE	EARLY GASTRULATION	GASTRULATION	YOLK PLUG	EARLY NEURALATION	NEURAL TUBE	LATE NEURALATION	# DEAD
River water												
12	15	40	10	6	17							7
25	16	31			25	6						0
50	15	52						6	25			21
74	16	33								23		10
98	15	44									20	24
122	16	62									31	31
Chilled river water												
12	23	35	15	15								5
25	24	43			18	15						10
50	23	83						(early)33				50
74	24	42							11			31
98	23	76									36	40
122	44										17	27

Table 4. Hatching success of hand stripped and surgically removed white sturgeon eggs at the Kootenai Hatchery, 1993.

Tank No.	No. of eggs before hatch	Number hatched	Percent hatched
		Hand stripped eggs	
1	5,730	2,154	38.6
2	5,730	1,778	31.0
3	5,730	2,166	37.8
7	5,730	1,264	22.1
8	5,730	527	9.2
9	5,730	2,336	40.8
10	5,730	2,224	38.8
11	5,730	2,339	40.8
15	5,850	937	16.0
Total	51,690	15,725	30.4%
		Surgically removed eggs	
4	5,730	214	7.5
5	5,730	326	11.4
6	5,730	219	7.7
12	5,730	179	6.3
13	5,850	167	5.7
14	5,850	115	3.9
Total	34,620	1,220	7.1*

* See text for explanation of low percent hatch

Table 5. Hatch and survival data for 1993 broodyear in the Kootenai Experimental Facility. Tank numbers 15-18 did not receive fish until August or September.

	Water source	Tank number	Number hatched	July	Number of fish surviving* Aug	Sept	Oct	Nov	Dec
1	city	1 H	2,154	1,635	136	43	38	200	187
2	"	2 H	1,778	1,267	283	85	80	59	56
3	"	3 H	2,166	1,697	821	713	708	693	688
4	"	4 C	214	120	75	24	23	441	419
5	"	5 C	326	127	88	21	14	418	415
6	"	6 C	219	189	111	83	78	59	42
7	"	9 H	2,336	1,886	1,072	941	207	37	36
	"	10 H	2,224	1,916	1,186	1,072	475	22	20
8	"	11 H	2,339	1,928	1,219	1,145	436	13	4
9	"	12 C	179	146	100	93	90	87	82
10	"	13 C	167	151	78	42	37	31	27
11	"	14 C	115	108	59	41	37	32	27
12	chilled river	15 H	937	767	665	301	266	211	198
13	heated city	8 H	527	502	431	177	30	17	8
14	river	7 H	1,264	487	230	78	38	36	35
15	"	16 H				301	293	245	230
16	"	17 H			1,061	923	917	907	905
17	"	18 H			97	75	68	67	66
18	"	19 H				375	374	372	372

*=increases and large decreases in # of fish surviving in a given tank is due to fish transfers among tanks to maintain optimum rearing densities
H=eggs collected by hand stripping
C=eggs collected by cesarian surgery

Figure 1. Location of the Kootenai Experimental White Sturgeon Facility.

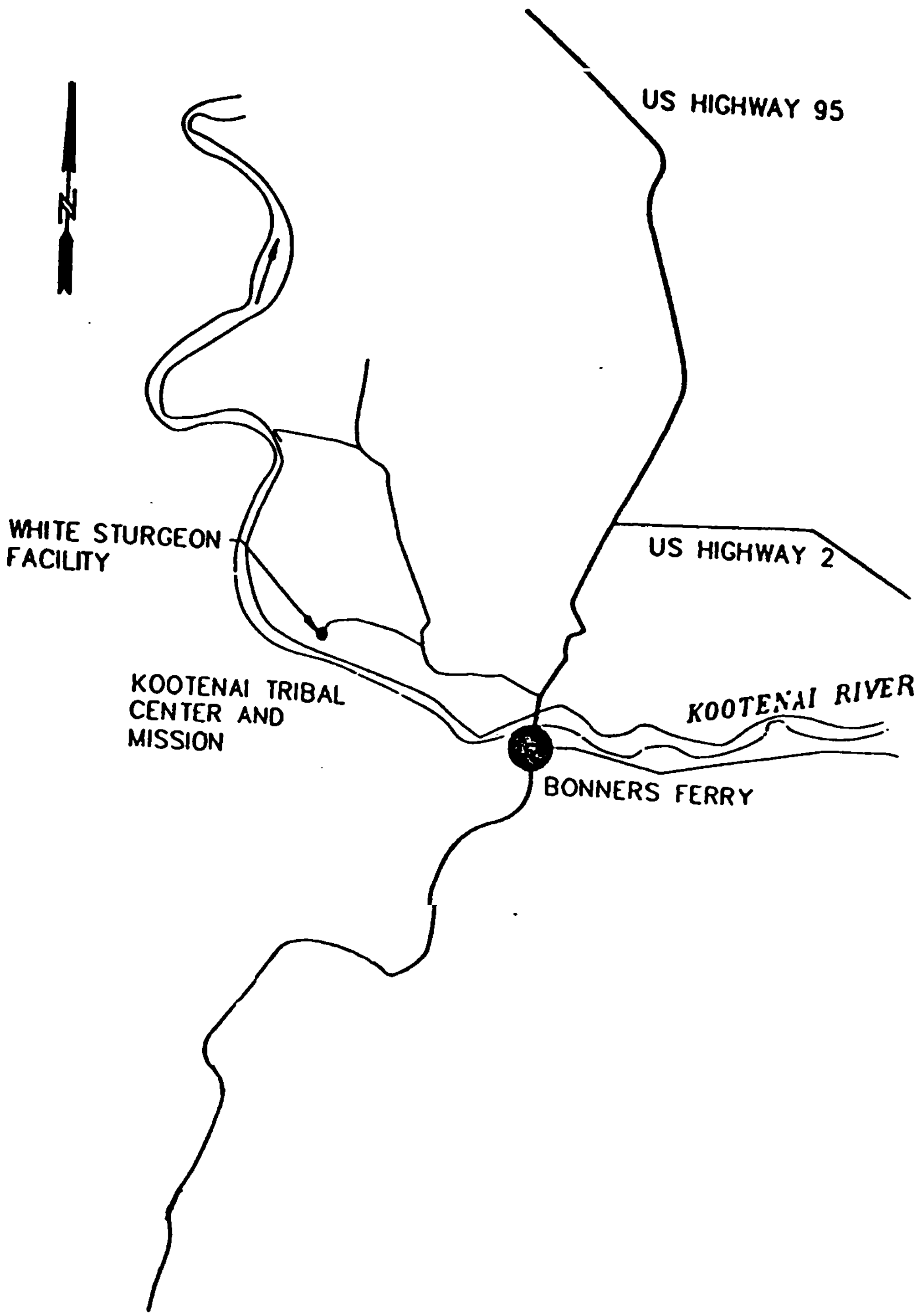


Figure 2. Top view of newly installed river water intake system for the Kootenai Experimental Facility.

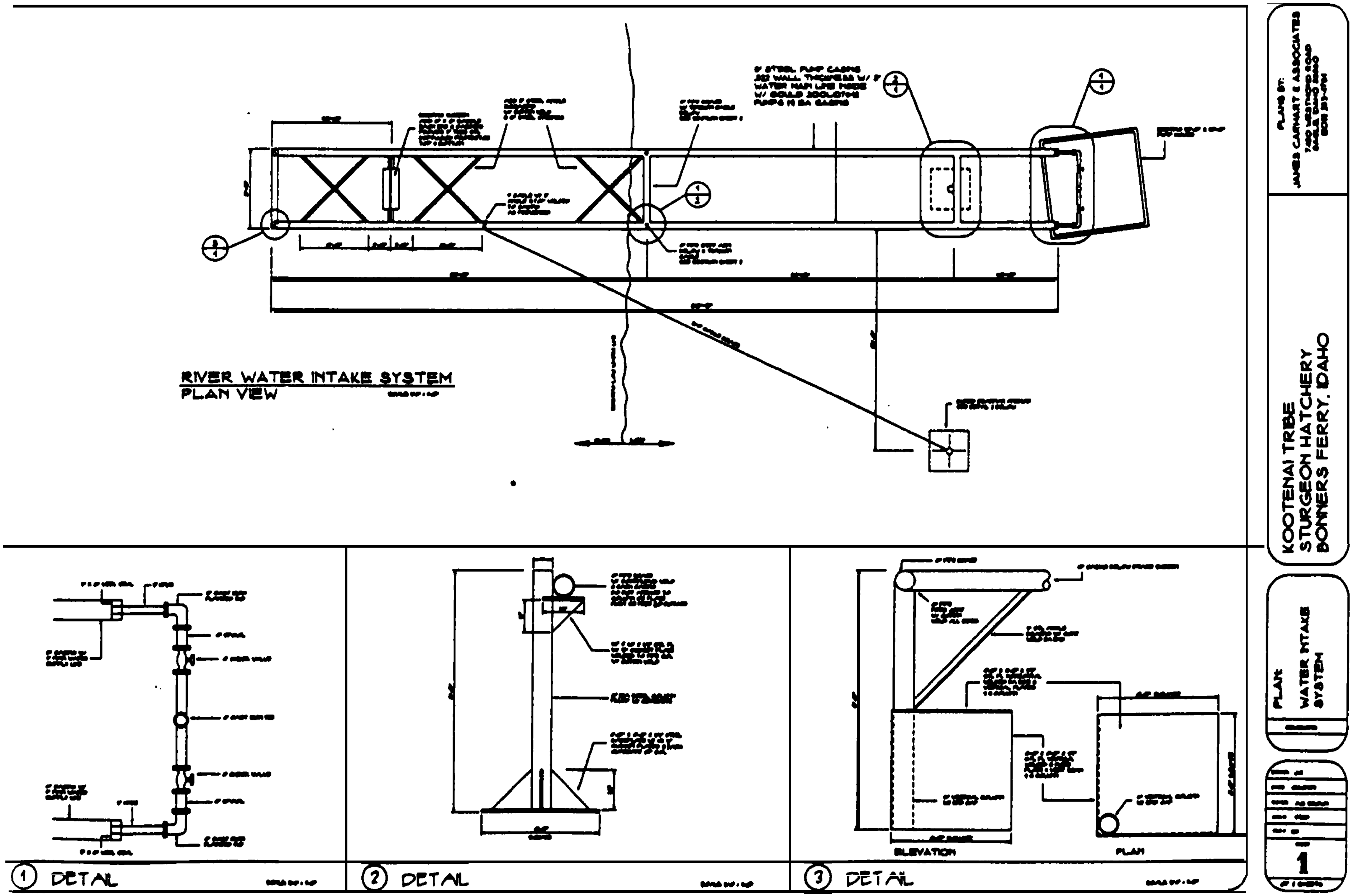
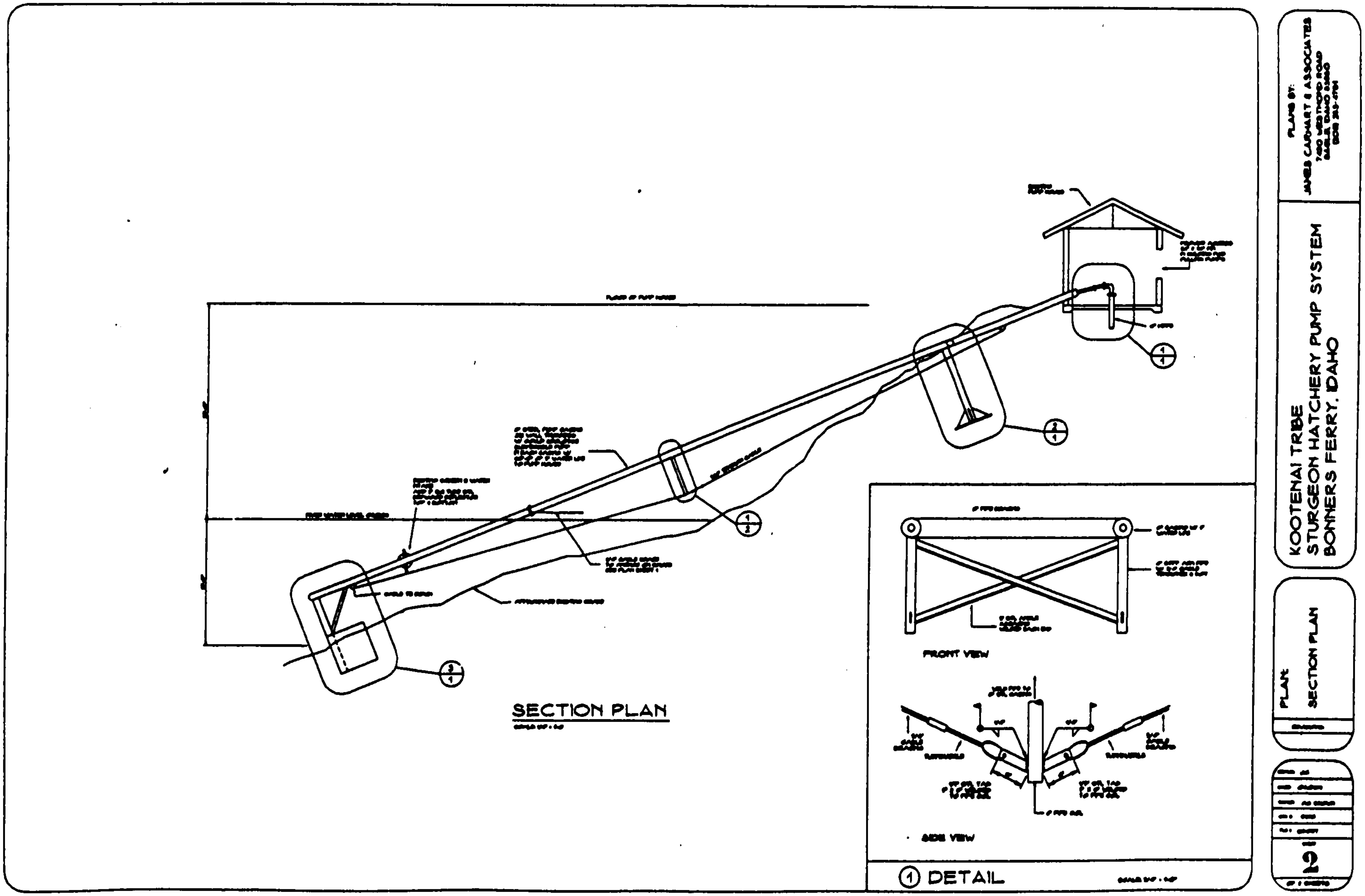
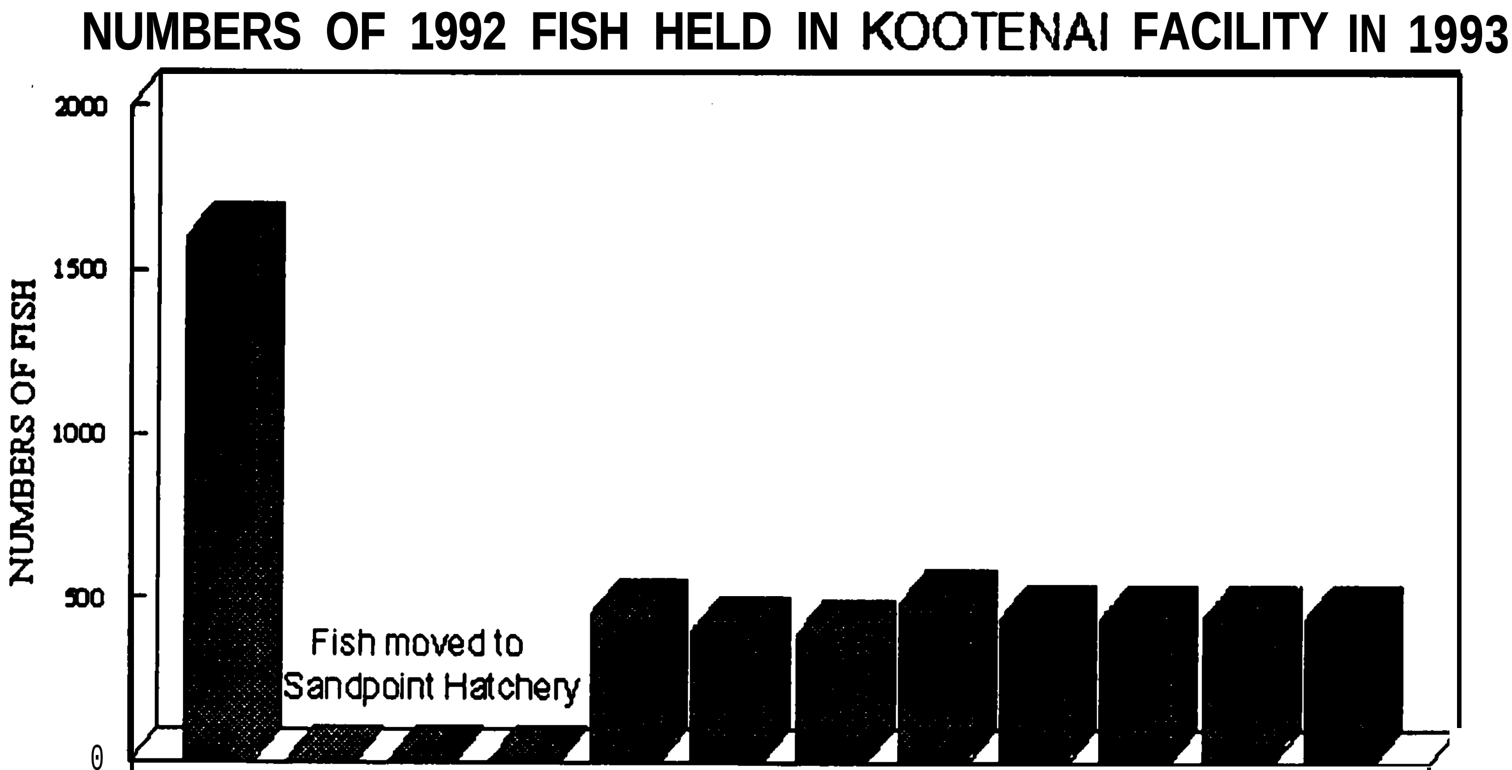


Figure 3. Side view of newly installed river water intake system at the Kootenai Experimental Facility.





J	F	M	A	M	J	J	A	S	O	N	D
1600	4	4	4	454	403	393	489	441	441	441	441

Figure 4. White sturgeon from the 1992 broodyear held in the facility during 1993.

KOOTENAI RIVER FISHERIES STUDIES

KOOTENAI RIVER TRIBUTARY KOKANEE SPAWNING GROUND SURVEY

Annual Report of Research FY 1993
Report C

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ABSTRACT

Kokanee salmon (Oncorhynchus nerka) runs in the lower Kootenai River tributaries in Idaho have experienced a profound population decline during the past several decades. Kokanee that historically spawned in lower Kootenai River tributaries in Idaho inhabited the South Arm of Kootenay Lake in British Columbia. During 1993, five lower Kootenai River tributaries in Idaho that historically supported kokanee spawning runs were surveyed to document current reproductive status of South Arm stock kokanee.

In the Northwest Power Planning Council's (NPPC) Columbia Basin Fish and Wildlife Program (NPPC 1987), and in the most recent NPPC Annual Report (NPPC 1993), the Council "calls on the Kootenai Tribe of Idaho to assess all fish stocks in the Idaho portion of the Kootenai River (including kokanee) and to identify fishery enhancement opportunities.

To document numbers of spawning South Arm kokanee in five lower Kootenai River tributaries (Boundary, Long Canyon, Parker, Trout and Myrtle creeks) spawning kokanee, redds, and spawned out carcasses were counted. The sex of observed kokanee was also observed and recorded. Eighty-two live kokanee, 64 redds, and three kokanee carcasses were counted in lower Kootenai River tributaries from August 26 to September 5, 1993. This population crash illustrates the need for an objective assessment of kokanee enhancement or recovery opportunities.

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INTRODUCTION

Recently much attention has been paid to the decline of the white sturgeon population in the Kootenai River system in Idaho, Montana, and British Columbia (Giorgi 1993; Apperson 1992; Apperson and Anders 1991, 1990; Anders 1991; Uehara and Scholz 1986). However, historic kokanee ***(Oncorhynchus nerka)*** runs in the lower Kootenai River in Idaho have experienced a simultaneous and profound population decline (Ashley and Thompson 1993; Partridge 1983). Kokanee that historically spawned in lower Kootenai River tributaries in Idaho inhabited the South Arm of Kootenay Lake in British Columbia (Figure 1), and are reported to be a different stock from West and North Arm Kootenay Lake stocks (Vernon 1957). While the population of South Arm stock kokanee was declining, simultaneous limnological changes were occurring in Kootenay Lake, British Columbia.

Kootenay Lake has experienced a series of perturbations during the past 50 years resulting in the collapse of South Arm kokanee stocks, and a dramatic decrease in the abundance of North Arm stocks (Ashley and Thompson 1993). Environmental perturbations include construction and operation of hydropower dams, reductions in nutrient loading and production, and increases in Mysis shrimp numbers (Ashley and Thompson 1993). These authors suggested that enhancement of Gerrard rainbow trout ***(Oncorhynchus*** mykiss), a kokanee predator, may have also contributed to the decline of kokanee in Kootenay Lake. While Partridge (19831 reported that kokanee spawning runs in Kootenai River tributaries in Idaho have decreased during past decades due to stream channelization and increased fine sediment loads, habitat degradation was never quantified. Other than simultaneous occurrences, no correlation between habitat degradation and the kokanee population decline has been established.

Three important research questions exist concerning needed future management of kokanee in the Kootenai River system: 1) is spawning habitat in Kootenai River tributaries in Idaho limiting?; 2) if the number of adult kokanee were adequate to seed historic spawning streams in Idaho, would current in-lake survival allow re-establishment of a sustainable population? and 3) are recent decreases in nutrient availability prohibitive to kokanee re-establishment? Ongoing limnological research in the Kootenai River and Kootenay Lake may provide some insight into these issues.

During the past two years the North Arm of Kootenay Lake has been experimentally fertilized. Numbers and condition of spawning kokanee in tributaries to the North Arm of Kootenay Lake

Meadow Creek and Lardeau River collectively) have increased from 225,000 to 800,000 during the past 3 years (Les Fleck, personal communication, B.C. Ministry of Environment). The abundance of large bodied cladocerans, a kokanee food source, has also increased in the lake during the past two years. North Arm kokanee travel extensively throughout the lake, including into the South Arm, where increased numbers have been recently documented using Sonar techniques (Jay Hammond, Les Fleck, personal communication, B.C. Ministry of Environment). Whether remaining South Arm stock kokanee exhibit similar movements to utilize newly available food resources in the North Arm is currently unknown, but possible. While this increase in productivity coincides with experimental lake fertilization, conclusions about whether increased numbers and condition of kokanee and increased cladoceran abundance are due to fertilization are currently premature.

In the Northwest Power Planning Council's (NPPC) Columbia Basin Fish and Wildlife Program (1987), and in the most recent NPPC Annual Report (1993), the NPPC "calls on the Kootenai Tribe of Idaho to assess all fish stocks in the Idaho portion of the Kootenai River (including kokanee) and to identify fishery enhancement opportunities".

In 1993, five lower Kootenai River tributaries in Idaho that historically supported kokanee spawning runs were surveyed to document current reproductive status of South Arm stock kokanee. This report provides results from that 1993 survey, and preliminary recommendations for future kokanee research and management in the Kootenai River system.

METHODS

To document numbers of spawning South Arm kokanee in five lower Kootenai River tributaries (Boundary, Long Canyon, Parker, Trout and Myrtle creeks, (Figure 1), spawning kokanee, redds, and spawned out kokanee carcasses were counted. The sex of observed kokanee was also observed and recorded. These five streams, in which kokanee historically spawned, were surveyed up to four times between August 26 and October 5, 1993.

RESULTS

Eighty-two live kokanee, 64 redds, and three kokanee carcasses were counted in lower Kootenai River tributaries from August 26 to September 5, 1993 (Table 1). Of the 82 live kokanee counted, 57 were males and 25 were females. All kokanee (live and dead) were observed only in Long Canyon and Parker creeks. Of the 64 kokanee redds observed, 54 were seen in Parker Creek and nine in Long Canyon Creek (Table 1).

All live and dead kokanee and redds were observed between August 26 and September 28, with the exception of one redd seen in Trout Creek on October 4. The three kokanee carcasses were observed in Parker Creek, two on August 31 and one on September 8.

DISCUSSION

The small number of spawning kokanee (n=82) and kokanee redds (n=64) observed during 1993 in streams that historically supported large numbers of spawners are direct results of the decline of South Arm stock kokanee in the Kootenai River system. During 1988 the numbers of kokanee observed during spawning ground surveys using similar techniques in these same streams were two to three orders of magnitude greater (Table 2). This population crash illustrates the need for an objective assessment of kokanee enhancement or recovery opportunities, followed by appropriate research and management.

During recent years, kokanee entrainment through Libby Dam near Libby, Montana (Figure 1) has produced a kokanee population downstream from the dam (Don Skaar, Montana Department of Game Fish and Parks, personal communication, 1994). Entrainment may be a confounding factor in assessing trends of various kokanee stocks that spawn in the Kootenai River or its tributaries. These fish (Okanogon stock) are not native Kootenay Lake stocks, and whether they are migrating downstream into the lower Kootenai River or into Kootenay Lake is currently unknown.

Poor in-lake survival and negative effects of reduced productivity (Woods 1982; Daley et al. 1981) on various trophic levels in the Kootenai River system have been proposed as evidence not to assess the feasibility of recovering or enhancing dwindling kokanee stocks. However, consistent with Northwest Power Planning Council directives since 1987, objective research, including field applications, is needed to determine the feasibility of research and management needed for successful kokanee restoration or re-establishment in the Kootenai River system.

RECOMMENDATIONS

1. Initiate negotiations with the British Columbia Ministry of Environment, Idaho Department of Fish and Game, and the Montana Department of Fish, Wildlife and Parks regarding cooperative international research and management approaches addressing the current problem of low kokanee abundance in the Kootenai River system.

2. Determine whether the South Arm stock of kokanee is functionally extinct, then evaluate feasibility of appropriate research and management alternatives.

3. Assess kokanee spawning habitat suitability in Kootenai River tributaries in Idaho by comparing these areas to habitat in other Kootenai River basin habitat where kokanee are currently spawning annually, and where stocks are currently increasing in size.

4. Improve estimates of remaining South Arm stock kokanee during 1994 by installing weir traps in lower Kootenai River tributaries known to currently support remnant spawning runs documented in this report.

5) Future kokanee spawning ground surveys should occur from late July through September.

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NWPPC, P & W PROGRAM 1987 -

VEXNON, 1957

WOODS, 1982

DALEY, ET. AL. 1981

Table 1. Results from the 1993 spawning ground survey in five lower Kootenai River tributaries in Idaho, August 26-October 4, 1993.

Date	Creek	Live kokanee Males	Females	Redds	Carcasses
8/26	Canyon	1	0	0	0
9/7	Canyon	11	6	0	0
9/9	Canyon	0	0	9	0
9/29	Canyon	0	0	0	0
8/31	Parker	34	13	0	2
9/8	'Parker	11	6	38	1
9/28	Parker	0	0	16	0
8/30	Trout	0	0	0	0
10/4	Trout	0	0	1	0
9/1	Boundary	0	0	0	0
9/16	Boundary	0	0	0	0
10/4	Myrtle	0	0	0	0
Totals		57	25	64	3

* Long Canyon Creek listed as Canyon

Table 2. Number of kokanee observed in lower Kootenai River tributaries in Idaho, during 1981 (data from Partridge, 1983)

Date	Streams surveyed Parker Cr.	Long Canyon Cr.	Boundary Cr.
7/15	0	0	0
8/10	90	125	22
8/18	120	210	140
8/24	300	580	520
8/30	260	980	640
9/6	105	760	470
9/14	0	87	80

	875	2,742	1,872

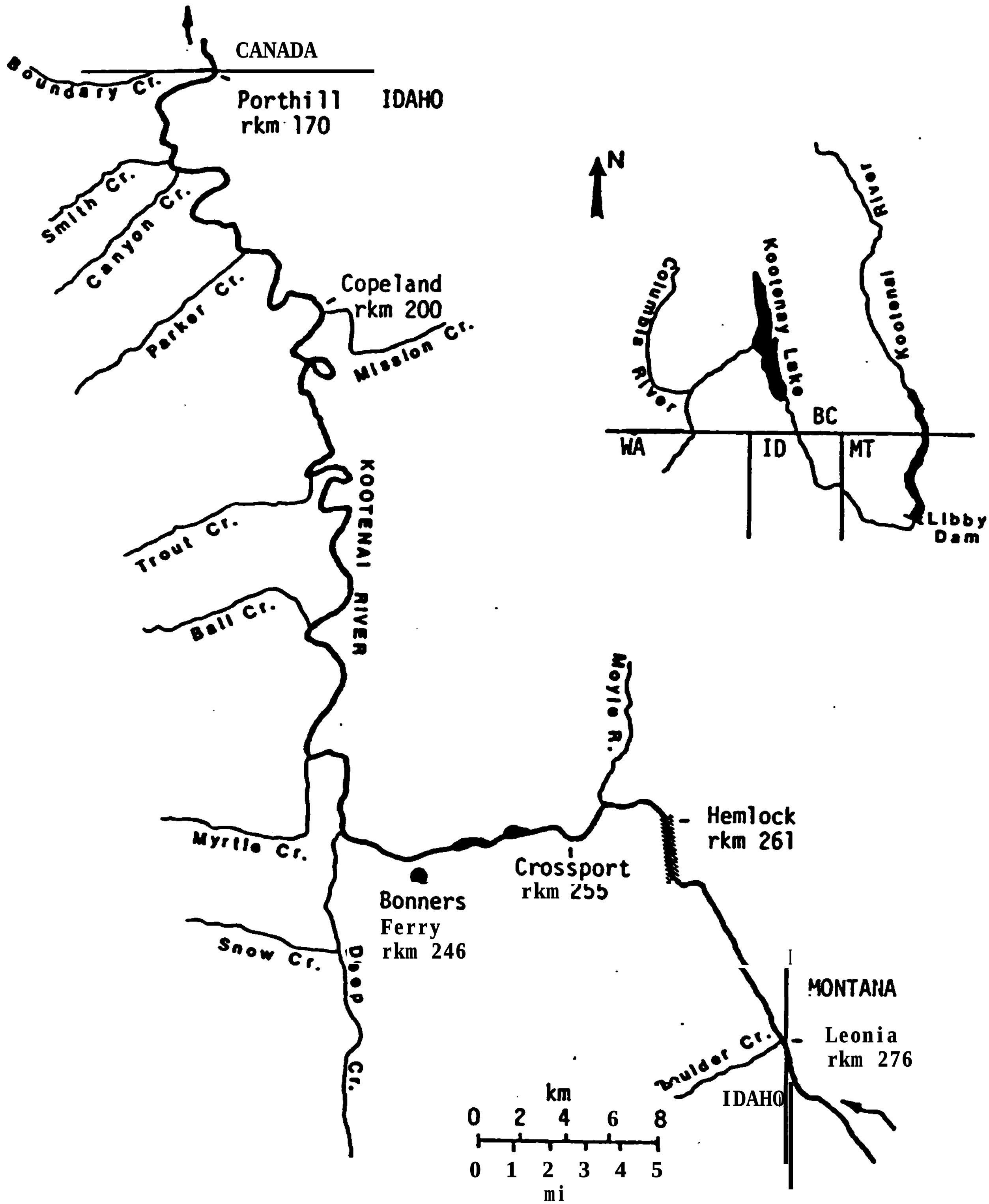

Figure 1. Location of the Kootenai River and major tributaries in the Idaho Panhandle with river distances in kilometers of major access points. (From Partridge, 1983)