FISHERY RESEARCH

KOOTENAI RIVER WHITE STURGEON SPAWNING AND RECRUITMENT EVALUATION

ANNUAL PROGRESS REPORT
May 1, 2006 — April 30, 2007

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By

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ABSTRACT

The objective of this research is to determine the environmental requirements for successful spawning and recruitment of the Kootenai River white sturgeon *Acipenser transmontanus* population. Annual tasks include monitoring and evaluating the response of various life stages of Kootenai River white sturgeon to mitigation flows supplied by the United States Army Corps of Engineers (USACE). On May 21, Libby reservoir inflows peaked at 2180 m^3/s (77,000 ft^3/s) and the reservoir filled to elevation 743 m (2437 feet), 7 meters from full. On June 17, the reservoir was near full, inflow was being monitored hourly, and spill increased to 877 m^3/s (31,000 ft^3/s) for a total outflow from the dam of 1557 m^3/s (55,000 ft^3/s). Libby elevation was above normal full reservoir elevation, or 750 m (2459 feet), for approximately 34 hours. By June 20, inflows and river stage levels began to recede, and spill levels were reduced and spill ended on June 27. Sampling for adult Kootenai River white sturgeon in 2006 began in February and continued into June. One hundred forty-four adult white sturgeon were captured with 5,630 hours of angling and set-lining effort. During adult sampling, 11 late vitellogenic females were taken to the Kootenai Tribe of Idaho (KTOI), but only seven of the 11 females met the specifications to induce ovulation. These seven females were spawned between June 3 and June 28, and 563,880 of the eggs were released at one of five sites between rkms 250.8 and 274.5 as part of the experimental egg release. Twenty-nine tagged adult white sturgeon exhibited a spawning migration in 2006. Forty-one percent (12) of the migrating adult white sturgeon moved upstream as far as rkm 243.5 (Ambush Rock), and 31 percent moved above Ambush Rock to near the Hwy. 95 bridge in Bonners Ferry. Additionally, five (four females and one male) moved above Bonners Ferry into the braided reach to rkm 246.8, and two of these (both females) were recorded as far upstream as rkm 248.6. Eight spawning white sturgeon were recorded in the Vemco Radio Acoustic Positioning (VRAP) array between April 28 and June 10. A total of 526 positions were recorded for these individuals. Sampling for white sturgeon eggs with artificial substrate mats began May 8. We sampled 1195 mat days and collected 665 white sturgeon eggs, mostly near Shortys Island. Sampling for larval white sturgeon began June 3, primarily above Bonners Ferry below the egg release sites in an attempt to document any recruitment that might have occurred from the egg release experiment. We collected 4980 larval fish but did not collect any white sturgeon larvae or embryos. Juvenile white sturgeon sampling began August 1 and continued through September 20. A total of 325 hours of gillnetting effort captured 210 juvenile hatchery white sturgeon and 4 wild juvenile white sturgeon. Each of the wild juvenile white sturgeon was from a different age class.

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INTRODUCTION

The Kootenai River white sturgeon population is comprised mainly of old-aged adults, and significant recruitment has not occurred since the 1970s. Although the specific causes of recruitment failure remain unclear, years of study suggest that mortality occurs between embryo and larval stages. Over a decade of artificial substrate mat sampling has indicated that from nine to 20 spawning events occur annually, and many viable embryos are produced (Paragamian and Wakkinen 2002). Most of the post-Libby Dam spawning events have been documented in areas where substrate conditions appear to be unsuitable for egg incubation and larval rearing (Paragamian et al. 2001), and no larvae and very few wild juveniles have been collected despite years of intensive sampling. Hatchery-reared juveniles (as young as 9 months of age at release) consistently exhibit successful growth and second year survival rates exceed 90% (Ireland et al. 2002). Research to date suggests that egg and/or larval suffocation, predation, and/or other mortality factors associated with these early life stages contribute to persistent recruitment failure. Since 1991, Libby Dam has released spring flows intended to benefit Kootenai River white sturgeon (hereafter white sturgeon) spawning by increasing discharge and river stage.

OBJECTIVE

Our study objective was to determine environmental requirements for successful spawning and recruitment of Kootenai River white sturgeon *Acipenser transmontanus*. The main tasks of this program are to monitor the response of all life stages of Kootenai River white sturgeon to mitigative flows from Libby dam provided by the United States Army Corps of Engineers (USACE).

STUDY SITE

The Kootenai River originates in Kootenay National Park, British Columbia (BC), Canada. The river flows south into Montana and turns northwest at Jennings, near the site of Libby Dam, at river kilometer (rkm) 352.4 (Figure 1). Kootenai Falls, 42 rkm downstream of Libby Dam, may be an impassable barrier to Kootenai River white sturgeon. As the river flows through the northeast corner of Idaho, there is a gradient transition at Bonners Ferry. Upstream from Bonners Ferry, the channel has an average gradient of 0.6 m/km, and the velocities are often higher than 0.8 m/s. Downstream from Bonners Ferry, the river slows to velocities typically less than 0.4 m/s, the average gradient is 0.02 m/km, and the channel deepens as the river meanders north through the Kootenai River Valley. The river returns to BC at rkm 170.0 and enters the South Arm of Kootenay Lake at rkm 120.0. The river leaves the lake through the West Arm of Kootenay Lake and flows to its confluence with the Columbia River at Castlegar, BC. A natural barrier at Bonnington Falls (now a series of four dams) has isolated the Kootenai River 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). Regulation of the Kootenai River following the construction of Libby Dam in 1974 changed the natural hydrograph of the river. Spring flows were reduced by about a third, and flows during winter are now three to four times higher (Figures 2 and 3).

METHODS

Water Levels

Kootenai River discharge and water temperature data at Bonners Ferry were obtained from the United States Army Corps of Engineers (USACE). In coordination with Unites States Fish and Wildlife Service (USFWS), state, and tribal biologists, USACE proposed a stacked flow operation for the Kootenai River in 2006. The USFWS concurred that the proposed operation was consistent with the 2006 Biological opinion (USFWS 2006) in a letter dated May 5, 2006. The plan was to provide 704 m^3/s for up to two weeks with the objective of timing the start of these releases to coincide with a peak in local runoff freshet below Libby Dam. The USACE also stated that it would not intentionally exceed elevation 538 meters (1764 feet) (flood stage) at Bonners Ferry. The USACE signed a Record of Consultation and Statement of Decision on May 8, 2006 advising the USFWS of the USACE intent to operate Libby Dam in accordance with the USFWS 2006 Biological Opinion (USFWS 2006). The USACE then coordinated with the USFWS and biologists on the Kootenai River White Sturgeon Recovery Team for the recommended start time for the stacked flow operation. Reservoir Control Center monitored the Bonners Ferry water temperatures and local inflows daily to inform the timing for the stacked flow operation and, based on available information, considered increasing the flow above 112 m^3/s on May 8 to capture water from the local flow.

Adult White Sturgeon Sampling

Adult white sturgeon were collected by angling or setlines from February 26 through June 13 and from September to October 2006, following the methods of Paragamian et al. (1996). From February through April, most of the sampling occurred in the staging areas at rkm 205 and 215. These areas are backwater habitats and have depths in excess of 20 meters and low current velocities (<0.05 m/s). Later in the spring, areas further upstream closer to the spawning locations were sampled more frequently (near rkm 229). Fall sampling occurred in the spring staging areas and near the Kootenai River delta at rkm 120. We biopsied adult sturgeon to determine sex and level of maturity. Male and female white sturgeon expected to spawn in 2006 or later were tagged with Vemco model V16 sonic transmitters and released (see telemetry section). Adult female white sturgeon expected to spawn in 2006 were transported to the Kootenai Tribe of Idaho Hatchery (KTOI) for Hatchery production. Gametes from ripe male white sturgeon were collected in the field by extraction through the urogenital opening with a syringe. Gametes were placed in a Ziploc bag, transported to the KTOI Hatchery, and stored in a refrigerator. White sturgeon sperm is viable for only 48 hours after extraction, so we did not collect male gametes until a female was initially induced to ovulate.

Experimental Egg Release

The focus of the experimental egg release in 2006 was to document conditions and locations suitable for hatching. Female white sturgeon expected to spawn in 2006 were transported to the KTOI Hatchery, and a sample of their eggs was used for an experimental egg release study. Eggs were sampled periodically by KTOI Hatchery personnel to check progression of the polarity index and germinal vesicle breakdown to determine when spawning would occur. When the eggs were ripe, two hormone injections were administered 24-hours apart to induce ovulation. The number of eggs spawned per female was determined by enumerating a small volume of eggs in a beaker, then extrapolating this ratio to the entire volume released from each female. Spawned eggs were then placed into 2 L plastic buckets with sealed lids. The buckets

were placed into coolers and partly submerged in hatchery water to assure ambient temperatures were maintained. A control group from each release (totaling approximately 2200 de-adhesed fertilized eggs) was placed into Macdonald jars at the KTOI Hatchery to estimate fertilization success and to provide a benchmark for hatching in the river (Rust et al. 2007).

Fertilization took place at the release sites. After the spawn was completed, the eggs and sperm were transported by boat upriver to one of five predetermined release sites. Release sites were selected that resembled spawning and rearing conditions (substrate size and water velocity) of other successfully recruiting white sturgeon populations (Parsley and Beckman 1994). Three of the five sites were new for the 2006 egg release (Rust et al. 2007). These new sites were all side channel areas and were selected because sampling in the main channel was not effective during high summer discharge and velocities in 2006. Additionally, these new sites increased the probability of documenting successful hatching because the volume of water in these side channels was lower compared to the main river channel (Figure 4). Upon arrival to each site, water temperatures in the coolers were tempered with river water to ensure no shock would occur to the eggs and sperm. Sperm from at least two males (to create multiple families) was mixed with 2 liters of water in a large stainless steel bowl to initiate motility. The mixture was then added to the egg buckets and stirred with a feather for 2-3 minutes until the eggs began to adhere to the feather. The eggs were broadcast across the thalweg immediately upstream of the site. Current velocity, water depth, and temperature were recorded at each release site at the time of release. Thermographs were deployed near each site to provide information on dispersal timing of hatchlings, embryos, or larvae as described by Richmond and Kynard (1995).

Adult White Sturgeon Telemetry

Monitoring daily and seasonal movements of Kootenai River white sturgeon throughout the Kootenai River/Lake system continues to be a high priority of this investigation. Beginning in 2003 and continuing into 2006, we deployed an array of passive Vemco model VR2 sonic receivers from Kootenai Lake, British Columbia upstream to near the Montana border in Idaho (Figure 4). We selected sites based on river morphology, and deployed receivers in areas where fish pass through but do not usually hold for long periods to avoid redundant data collection. Most sites were below river bends or along straight stretches that allow for good signal reception but are reasonably free of drifting debris and out of potential vandals' sight. Each receiver was tethered to a float to keep the hydrophone off the substrate, then anchored to a cement block and chained to the riverbank. This array allows continuous monitoring of sturgeon movements within the Kootenai river system and into Kootenai Lake.

To determine the feasibility of a large-scale habitat enhancement project aimed at improving egg incubation and larval rearing habitat, a pilot study is proposed near Shortys Island (rkm 230.8) and construction is scheduled to begin in summer 2006. The main purpose of this pilot study is to test physical processes including sedimentation rate and subsidence. This pilot study proposal includes placing large diameter boulders and cobble near Shortys Island (rkm 230.8) (Figure 5) on the substrate in a 1,600 square meter area. United States Geological Survey - Idaho Water Science Center (Tacoma, Washington), will monitor physical processes.

Through a contract with United States Geological Survey (USGS) - Biological Resources Division, a Vemco Radio Acoustic Positioning (VRAP) system was deployed within the Shortys Island spawning reach (Figures 5) to determine adult white sturgeon movements within the area where habitat enhancement is planned. Three buoy moorings were established at Shortys Island, and the lineal distance between the moorings and the base station was approximately 6.4

km (4 miles). The moorings were located adjacent to the area where the pilot study is expected to occur. The mooring for the primary buoy was located outside of the main current flow and was fixed with two anchors, one upstream and one downstream, to reduce buoy movement. The other two moorings were located in the current and needed only one anchor each. This VRAP system measures real-time, detailed position information from acoustic transmitters using a series of three buoys and a two-way radio link to a base station. The VRAP system is typically able to furnish position information with a resolution in the range of 1 to 2 meters within the buoy triangle. Receivers on the buoys collect transmitter detections from the tagged animal, information about these detections is dispatched by radio to a base station, and a position is calculated and displayed in real-time. Depending on the transmitter type selected, temperature and depth data can also be collected. This system will collect movement data from tagged adult white sturgeon during the spawning period prior to the construction phase. Preconstruction phase movements will be compared to post-construction phase movements in subsequent years to determine if spawning adult white sturgeon are selecting for this new habitat.

Artificial Substrate Mat Sampling

Artificial substrate mats were used to document white sturgeon spawning in the Kootenai River (McCabe and Beckman 1990). Mats were deployed between rkm 229.6 and 246.6 with most of the sampling occurring at Shortys Island and near Bonners Ferry. Effort was concentrated near Shortys Island because most of the post-Libby Dam spawning occurs here (Paragamian et al. 2002) and sampling near this area provides an index to the initiation of spawning each year. The Bonners Ferry area marks the beginning of the transition zone from sand substrates to gravel and cobble, and we sampled intensively in this reach to document any spawning on rocky substrates. Mats were checked every other day and all eggs were removed from the mats each time they were encountered. Eggs were stored in formalin and brought back to the field station. All eggs were staged by viewing at 120X under a dissecting microscope to estimate spawn date by the methods described by Beer (1981).

Larval White Sturgeon Sampling

Larval sturgeon have never been collected in the Kootenai River in D-ring or conical ½-meter plankton nets. In 2006, the majority of the larval sampling occurred near the Caboose Creek side channel in an attempt to collect any drifting embryos or larvae resulting from the experimental egg release. Sampling occurred from June 3 to August 15 between rkm 150.8 and 270.3 and increased in intensity when hatchery control eggs began to hatch at 13°C (slightly warmer than ambient river water). Effort intensified when hatchery control larvae had absorbed their yolk sacs, as any larvae hiding in the rock substrates within the release sites may become vulnerable to drift when they begin exogenous feeding. When conditions allowed, tows were conducted directly below (within one rkm) the release sites. The standard sampling method consisted of passively towing two benthic D-rings and two conical ½-meter nets, one of which was placed near mid column and the other on the surface. Lead weights ranging from 2.7-9.1 kg were attached to nets to achieve desired depths. A diver's watch was attached to the mid column nets to record specific depth within the water column. A General Oceanics model 2030R flow meter was attached to the mouth of each net to record rotor revolutions, which was used along with net diameter and sampling time to give the total volume of water sampled. Sampling occurred at all hours within a 24-hour period. In addition to the standard boat sampling, later in the season after river discharge decreased, conical 1-meter nets and D-ring nets were anchored with 100 kg cement blocks in shallow water and were fished overnight unattended.

Juvenile White Sturgeon Sampling

The objectives of this sampling are to determine trends in the age, growth, size, condition, and mortality rates of hatchery reared and wild juvenile white sturgeon in the Kootenai River. We used weighted multifilament gill nets with 2.5, 3.8, 5.1, 6.4, 7.6, and 10.2 cm stretch mesh to sample juvenile and young-of-the-year (YOY) sturgeon in August and September 2006 and followed the methodology of Paragamian et al. (1996). We sampled 10 different sites between rkm 190.0 and 244.5. Gill nets were set during the daytime and checked every hour to eliminate mortality of sampled fish, and all fish were released alive. From 1992 to 2004, prior to release, each fish was PIT (passive integrated transponder) tagged and a pattern of scutes removed, which provides a unique mark for each brood year. In 2005 and 2006, most (92%) of the released juvenile white sturgeon were not PIT tagged, although scutes were removed from each fish released (see Appendix 3). We recorded fork and total length, weight, PIT tag numbers, fish condition, and scute removal patterns for each sampled fish. Pectoral fin ray sections were removed from all wild juvenile white sturgeon for age determination.

RESULTS

Water Levels

Record temperatures, rapid snow melt, and significant rain events contributed to flooding in Kootenai Valley in June 2006. The May 8 forecast for Libby Dam showed inflow of about 708 m^3/s (25,000 ft^3/s) by May 18 and indicated a statistical 75% confidence that inflow would be less than 1,416 m^3/s (50,000 ft^3/s) through June. As the May final forecast was 98.9% of normal, USACE reservoir control planned to shape Libby outflows to provide the stacked flow operation in accordance with the objectives of the USFWS Biological Opinion (USFWS 2006) and the refill objectives for summer salmon flow augmentation (USACE 2006). By May 18, inflows to the Libby reservoir were increasing to 1,784 m^3/s (63,000 ft^3/s), and the stage at Bonners Ferry was slightly above 537 m (1762 feet). With the prediction of flows approaching flood stage, reports of increased snow pack melting and runoff in tributaries to the Kootenai River, and a verbal request from Boundary County, the USACE deployed an emergency response flood team to assess the threat of local flooding. By May 20, the inflow to Libby Reservoir was in excess of 1,982 m^3/s (70,000 ft^3/s), which was more than double what was forecast earlier in the week (USACE 2006). The reservoir was filling quickly and maintaining higher outflow was recommended to keep space available in the reservoir for the remainder of the runoff season. On May 21, Libby Reservoir inflows peaked at 2,180 m^3/s (77,000 ft^3/s) and the reservoir filled to elevation 743 m (2437 feet), 7 meters from full. By June 7, the inflow to Libby reservoir remained in excess of 1,133 m^3/s (40,000 ft^3/s), and the reservoir had filled to above elevation 749 m (2454 feet), within 2 meters from full with about 24,660 ham (hectare meters) (200,000 acre ft) of space available (USACE 2006). Inflow to the Libby Reservoir continued to increase because of thunderstorm activity in the basin upstream of Libby. On June 17, the reservoir was near full, inflow was being monitored hourly, and spill increased to 877 m^3/s (31,000 ft^3/s) for a total outflow from the dam of 1,557 m^3/s (55,000 ft^3/s). Libby elevation was above normal full reservoir elevation, or 750 m (2459 feet), for approximately 34 hours. The maximum elevation was about 6 cm above full. Emergency management actions continued throughout this period. River stage at Bonners Ferry peaked at elevation 539 m (1766.6 feet) on June 18. By June 20, inflows and river stage levels began to recede, and spill levels were reduced slowly to minimize sloughing of levee embankments downstream (USACE 2006). Spill ended on June 27. The observed inflows to Libby Dam in June were 1,121 m^3/s (39,612 ft^3/s), 108% of normal.

Adult White Sturgeon Sampling

Between February 27 and October 24, 2006, we expended a total of 5,630 h to capture 59 adult white sturgeon by angling and 105 adult white sturgeon with setlines. Twenty of the angled adults were caught in the fall, for which there was no effort recorded. One adult white sturgeon was collected by gillnet during juvenile white sturgeon sampling. The adult sturgeon catch per unit effort (CPUE) was 0.14 fish per rod h for angling and 0.02 fish per setline h for setlines (Table 1). One hundred sixteen (80%) of the 145 adult white sturgeon collected were recaptures from previous years (Table 1). Thirty-one adult white sturgeon were biopsied by IDFG during adult sampling; 23 were females, five were males, and sex could not be determined from three individuals. Twenty of the 23 females biopsied were stage F4 (mature eggs), one was stage F1 (immature eggs), and stage could not be determined for the remaining two females. Three of the biopsied males were stage M9 (flowing milt), and specific stage could not be determined from two males. KTOI Hatchery personnel also captured and biopsied adult white sturgeon for their propagation operations; Lewandowski (2006) provides adult capture information.

Experimental Egg Release

Eleven of the 20 late vitellogenic females were taken to the KTOI Hatchery. The other nine were tagged for telemetry studies (next section). In cooperation with KTOI Hatchery, sperm was extracted from 15 ripe males during the spawning season and motility was estimated for each male prior to the spawn by KTOI Hatchery personnel. Female polarity indices and germinal vesicle breakdown were calculated for each female during the spawning season, and only seven of the 11 females met the specifications to induce ovulation (Lewandowski 2006). Spawning at the KTOI Hatchery took place from June 3 through June 28, 2006. A total of 563,880 eggs were collected from the seven females, and the eggs were released at one of five sites between rkm 250.8 and 274.5 (Table 2). The controls in the hatchery all had hatching success above 70% (Lewandowski 2006).

The average velocity reading for the release sites was 1.1 m/s, and temperature averaged 12.3°C at the time the eggs were released (Table 2). The discharge measured at the Leonia gage (USGS) during the period ranged from 736 to 1359 m^3/s and averaged 957 m^3/s (Table 2).

Adult White Sturgeon Telemetry

Adult white sturgeon movements were analyzed after downloading location data from stationary Vemco VR2 sonic receivers located at 56 locations from rkm 18.0, near the mouth of the Lardeau River in Kootenay Lake, BC, upstream to rkm 275.5, just below the Montana border (Figure 4). Twenty adult white sturgeon were tagged with Vemco sonic transmitters in spring 2006, four were tagged in fall 2005 that were expected to spawn in 2006, and 25 adult white sturgeon had active Vemco sonic transmitters from previous years (Table 3) or were not expected to spawn in spring 2006. Ten of the adult white sturgeon tagged in spring 2006 were fitted with Vemco pressure sensor tags so depth could be determined as fish entered the VRAP array. To date, 56 adult sturgeon have been tagged with Vemco sonic transmitters (Table 3).

Twenty-nine tagged adult white sturgeon (15 females) were in spawning condition and exhibited a spawning migration. This is defined as fish observed in spawning condition in 2006 or expected to be in spawning condition based on previous biopsies, which moved upstream to at least the lower end of the spawning reach (rkm 228.0). Twenty-seven (93% - 14 females) of the migrating adults moved upstream as far as rkm 235.2 and 23 (79% - 11 females) were

recorded at rkm 239, just below Deep Creek. Twelve (41% - 6 females) of the migrating adults went upstream as far as rkm 243.5 (Ambush Rock), and 31 percent (9) went above Ambush Rock to near the Hwy. 95 bridge in Bonners Ferry. Additionally, five (four females) went above Bonners Ferry into the braided reach to rkm 246.8, and two of these (both females) were recorded as far upstream as rkm 248.6. This is the farthest upstream any tagged white sturgeon has been recorded since IDFG began telemetry studies in 1991.

Appendix 1 shows the temperature and discharge conditions during the movement histories of eight female adult white sturgeon that exhibited a spawning migration in 2006. Some of these individuals were tagged in previous years.

The USGS assisted IDFG in setting up the VRAP system during April 2006. The base station and VHF antenna were set up at the IDFG field station located on the USFWS Kootenai National Wildlife Refuge. Performance of the VRAP system was evaluated and training of IDFG field crews in maintenance and operation occurred between April 19 and April 27. The study officially started on April 27 and the first sturgeon position was obtained at 9:18 am on April 28. The VRAP buoys were removed from the water on May 15 because of the potential of loss or damage due to forecasted high water and associated floating debris. The buoys were placed back on the moorings on May 25. Forecasted high water again resulted in removal of the buoys on June 10. They were placed back in the river on June 26 and remained in the river until July 13, when the study ended.

A total of 8,441 valid positions were resolved for 22 sturgeon during the deployment (range of 3-3,995 positions per individual). We selected a subset of locations that were within a radius of 125 m from the centroid of the three buoys because this area encompassed the proposed pilot study area. This reduced the dataset to 4,646 positions for the 22 sturgeon (range 2-2,296 positions per individual). Selecting only female sturgeon expected to spawn during 2006 (maturity stage F-4) resulted in 526 positions for eight fish (range 2-320 positions; Table 4; Figure 7) between April 28 and June 10. Results from this baseline effort suggest most of the locations occurred on the edge of the deeper (>10 m) water adjacent to the thalweg in the center of the river (Figure 7), and adult sturgeon are currently not extensively using the area earmarked for habitat enhancement.

Artificial Substrate Mat Sampling

We deployed substrate mats at six different geographic river sections within the traditional post-Libby dam spawning reach (rkm 229.6–246.6) and sampled 1195 mat days between May 8 and July 5, 2006. Six hundred sixty-five eggs were collected from three sections in 2006, and on May 26, 589 eggs were collected from a single mat at rkm 229.5 (Shortys Island). This is the most eggs ever collected from a single mat during substrate mat monitoring on the Kootenai River. While most of the eggs were collected in the middle Shortys Island reach (rkm 229.6-231.5), spawning was documented throughout the spawning reach (Table 5). Three hundred sixty-six of the 665 were staged with at least 55 percent of the eggs being viable (Table 6). Egg development ranged from stage 12 to stage 26 (less than 1 hr to 95 hrs old) (Table 6). Based on the ages of the viable eggs, we estimate that white sturgeon spawned during at least 12 days in 2006.

Larval White Sturgeon Sampling

We sampled for white sturgeon embryos and larvae between June 3 and August 15, 2006 (Table 7). We spent a total of 1289 hours sampling at six sites between rkm 150.8 and

270.3 (Table 7). The majority of the sampling occurred near the Caboose Creek side channel (Table 2; Table 7) in an attempt to capture embryos or larvae from the experimental egg release. Because the volume of water was lower and the depth shallower compared to the main river channel, we thought our chances of collecting larval white sturgeon were greatest in this location. Subsequently, sampling effort was highest at this site. No larval white sturgeon were captured in 2006, but nearly 5,000 non-target larval and juvenile fish were collected in 2006. Most of the 5,000 larval fish were collected at night near the Caboose Creek side channel (Table 7), and most belonged to the Catostomidae family.

Juvenile White Sturgeon Sampling

Beginning in 1990 and continuing to the present, the KTOI hatchery has released over 121,000 juvenile white sturgeon. We sampled for juvenile white sturgeon with gillnets between August and September 2006. We sampled 10 sites and captured 210 hatchery reared juvenile white sturgeon and four wild juvenile white sturgeon with 325 h of effort (Table 1). The Ferry Island area had the highest catch with 26.6 percent of the individuals and the highest catch rate at 1.66 fish per net hour (Table 8). The catch was well distributed among the 10 sites, and juvenile white sturgeon were collected in five of the six mesh sizes (Table 9). One hundred nineteen of the individuals were collected in the 2.5 cm gillnets, but the highest catch rates were in the 10.2 cm nets (Table 8 and 9). The average fork and total length of the hatchery reared juvenile white sturgeon was 35.6 cm FL and 41.5 cm TL (n = 209 and 210, respectively), and weight of juvenile sturgeon averaged 0.35 kg (n = 197) (Table 10). Appendix 2 lists the details on sizes and numbers and recapture rates of tagged and/or measured hatchery juvenile white sturgeon released in the Kootenai River since 1990. Appendix 3 provides the numbers of untagged and/or not measured juvenile hatchery releases through March 31, 2007. Appendix 4 provides the specific growth parameters of hatchery-released juveniles captured in 2006.

Four wild juvenile white sturgeon were captured while gill netting in 2006. The total length of these four individuals ranged from 43.0 to 65.1 cm, and weights ranged from 0.32 to 1.14 kg (Table 11). Two of the individuals were collected in the 2.54 cm stretch nets, and all were collected at different sites. Four different year classes were represented (Table 11). Appendix 5 shows the year class assignments from a sample of the wild juvenile white sturgeon collected between 1957 and 2006 that could be aged. Appendix 6 shows the number of wild juvenile white sturgeon collected annually from 1977 to 2006.

DISCUSSION

We examined white sturgeon spawning events during the years 1994 through 2000 and compared them to daily average flow and daily average temperature at Bonners Ferry for each event (Paragamian and Wakkinen 2002). We found white sturgeon often spawned during decreasing flows and that the number of events each year ranged from as few as nine to as many as 20, with the number of days during the spawning period ranging from 17 to 31 days. The most consistent year of Kootenai River white sturgeon spawning was 1996 when spawning was detected during 18 of 19 days; flow ranged from 891 to 1,259 m^3/s (31,465-44,461 ft^3/s) and averaged about 1,131 m^3/s (~40,000 ft^3/s) for the first 11 events before there was a day of undocumented spawning. Average daily temperature during spawning ranged from 7.5 to 14°C (45.5-57.2°F), with the highest probability of spawning (48%) at the 9.5-9.9°C (49.1-49.9°F) range (Paragamian and Wakkinen 2002). However, despite our improved understanding of spawning events there has been little success at measuring recruitment of young white

sturgeon from mitigated flow years and with the available data the present level of recovery is still unknown (Paragamian and Wakkinen 2002; Paragamian et al. 2002).

Flow was also an important variable affecting sturgeon spawning. Average daily flow for spawning events ranged from 141 to 1,265 m^3/s (4,979-44,673 ft^3/s), but most (63%) spawning took place above 630 m^3/s (22,248 ft^3/s) (Paragamian and Wakkinen 2002). Our analysis suggests flows for optimum white sturgeon spawning in the Kootenai River should be held above 630 m^3/s (22,248 ft^3/s), an ideal temperature range of 9.5 to 12°C (49.1-53.6°F), and a duration of 42 d, which is based on recommendations in the Kootenai River White Sturgeon Recovery Plan (USFWS 1999). As previously noted the most consistent spawning took place at an average of about 1,131 m^3/s (40,000 ft^3/s). However, of the two variables, temperature is the most difficult to control.

None of the migrating adult sturgeon that moved into the braided reach stayed continuously for more than one week, and all moved up before May 27, just after the first peak in the hydrograph of 1,500 m^3/s (see fish 6, 9, 10, and 267 in Appendix 1). None of the migrating adults appeared to respond to the second peak in the hydrograph (Appendix 1), even though these discharge and stage conditions are the highest since Libby Dam began operations in 1974 and may have more closely resembled the historic conditions that occurred when sturgeon were successfully recruiting. This record post Libby dam discharge (near 2,000 m^3/s) may not be necessary to stimulate movement into the braided reach or the second peak may have occurred too late in the spawning season, after most of the spawning was complete. Normally, as Libby Dam discharge increases each spring, water temperatures decrease because the large volume of water in the reservoir remains colder than in the river, which can warm considerably before reaching Bonners Ferry. Even though Kootenai River white sturgeon spawn at water temperatures as low as 8°C, rapidly reduced water temperatures can cause females to stop spawning and move downstream out of spawning areas (Paragamian et. al 2002). In 2006, selective withdrawal gates were placed in the forebay of Libby Reservoir to release the warmest water available in the reservoir and to maintain more stable water temperatures released for spawning sturgeon (Greg Hoffman, USACE at Libby Dam, personal communication). This created conditions whereby water temperatures at Bonners Ferry were rising while discharge was increasing. Most of the spawning adult sturgeon that moved upstream and above the Bonners Ferry area into the braided reach in 2006 moved during a narrow period between May 17 and May 24. It is unknown if the physical conditions of 2006 were responsible for providing a successful year class of wild sturgeon, and we will not know the results until these potential recruits are vulnerable to our gill nets in three or four years. However, in 2006, most of the spawning sturgeon moved rapidly upstream as water temperatures steadily (relatively) increased to 9°C and discharge increased to 1,500 m^3/s. These conditions should be provided whenever possible.

As mentioned previously, 79% of the migrating adults moved upstream to the Deep Creek area (rkm 239), yet only 41% moved further upstream to rkm 243.5, just below Ambush Rock. This area of the Kootenai River is a transition zone from the meander reach, comprised of sand and silt substrates with reduced water velocities, to the braided reach, comprised of increased velocities and coarser substrates. It is unknown what physicochemical conditions in this 4.5-kilometer transition zone preclude further upstream sturgeon migration. One of the current objectives of this telemetry research is to better understand the conditions under which migrating sturgeon move to, and possibly upstream of, Bonners Ferry where spawning substrates and larval rearing conditions more closely resemble those of successfully recruiting white sturgeon populations. Understanding these conditions may provide the opportunity to manipulate dam operations to maximize the upstream extent of and numbers of spawning

sturgeon. More detailed telemetry analysis coupled with hydrological studies may provide the answers to why many adults stop near Deep Creek.

The Vemco VRAP system proved to be a useful tool for determining movements of adult sturgeon in a specific reach of the Kootenai River. This 2006 study is a pretreatment evaluation to determine if adult sturgeon are currently using the area earmarked for habitat enhancement. The VRAP array will be redeployed in the same location during April 2007 to monitor sturgeon movements after the construction of the Shortys Island pilot study, to determine if spawning adult sturgeon will occupy and possibly spawn of this new structure.

The record high post-Libby dam discharges in 2006 made main river larval sampling difficult, and eggs were released in three new locations for the 2006 experimental egg release. In 2005, all eggs were released in the main river channel because sampling conditions (discharge and flow) were more favorable and substrate and flow conditions were optimal. In 2006, a new site was added in a side channel near Crossport (rkm 255.7), and side channels near two of the 2005 sites (near rkm 250.8 and 270.3) were selected because flow was reduced and sampling efficiencies were higher in these areas. No larval white sturgeon were collected in 2006; however, nearly 5,000 nontarget larval fish were collected. The substrate and flow conditions of the selected release sites may not be suitable for egg development and hatching even though they closely resemble sites in other rivers where sturgeon successfully develop and hatch. It is also possible that the conditions are suitable for egg development but too few eggs were released to have a reasonable chance of collecting any drifting free embryos or larvae.

Artificial substrate mats have been used successfully for many years to document the spatial and temporal distribution of white sturgeon spawning events. Although much information has been gained from this research, including spawning site selection and the extent of the spawning reach, sampling effort was not been uniform. From 2004 through 2006, substrate mats have been used more as an index to determine the beginning of the spawning season and comparatively few mats were deployed. To date, substrate mat sampling has been biased by unequal sampling effort and sampling at specific locations where sturgeon were known to spawn. A statistically based random sampling study design may provide a more accurate understanding of the extent and duration of white sturgeon spawning in the Kootenai River.

RECOMMENDATIONS

1. As soon as water temperature reaches 7°C after April 1, provide flows of 425 m^3/s at Bonners Ferry with stable or increasing temperature to initiate and maintain spawning migration of Kootenai River white sturgeon.

2. Provide minimum flows of 630 m^3/s for 42 d (as prescribed for spawning and rearing in the Kootenai River White Sturgeon Recovery Plan) at Bonners Ferry once water temperatures of 8-10°C are reached to stimulate spawning and optimize egg/larval survival of Kootenai River white sturgeon.

3. Use Vemco VRAP system to determine adult use and potential spawning on the Shortys Island pilot study rock structure (near rkm 231).

4. Use a stratified random sampling design to determine spatial and temporal trends in the distribution of white sturgeon spawning events and to determine if white sturgeon spawn on the proposed pilot study structure.

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Table 1. Sampling effort and number of adult and juvenile white sturgeon caught by the Idaho Department of Fish and Game alone or with Kootenai Tribe of Idaho or British Columbia Ministry of the Environment personnel, in the Kootenai River, Idaho, February 27, 2006 to October 24, 2006.

	Hours of effort	Number of juvenile sturgeon caught (No. of recaptures)	Number of adult sturgeon caught (No. of recaptures)	Juvenile CPUE (fish/h)	Adult CPUE (fish/h)
Gillnet	325.0	214 (144)	1(1)	0.66	0.003
Angling	292.0[a]	1 (1)	39 (30)[b]	0.003	0.13
Setline	5,337.5[c]	2 (2)	105 (85)	0.0004	0.02
Total	5,954.5	217 (147)	145 (116)		

[a] Includes 12 hours angling effort by BCE staff for IDFG and three adult captures (2 recaptures) on May 2, 2006.
[b] There were an additional 20 adults captured (13 recaptures) during angling effort by IDFG and BCE staff from September 28–October 24, 2006. Complete effort hours were not recorded.
[c] Based on 24-hour sets.

Table 2. Egg release site specifications and water quality parameters from the egg release experiment, Kootenai River, Idaho, 2006.

Site Name	River kilometer	Date	Eggs released	Release number	Mean velocity (m/s)	Water Temp °C	Leonia Discharge (m^3/s)
Crossport*	255.7	4 - Jun	88,000	1	0.9	9.0	927
Cow Creek*	250.8	7 - Jun	48,675	2	0.7	11.0	879
		10 - Jun	63,825	3	0.9	11.0	1,359
		13 - Jun	122,100	4	1.0	14.0	1,274
Hemlock Bar	262.5	26 - Jun	80,000	5	0.8	14.0	991
Caboose Creek*	270.3	27 - Jun	55,500	6	0.8	11.0	736
		28 - Jun	47,690	8	0.9	14.0	750
Boulder Creek	274.5	27 - Jun	58,090	7	2.1	14.0	736
		Total	563,880				

* Side channel

Table 3. Vital statistics from Kootenai River adult white sturgeon marked with Vemco sonic tags as part of a telemetry study, Kootenai River, Idaho, 2003-2006.

Tag year	Sex/Development stage	Release date	Release rkm	Fish #	Fork length (cm)	Total length (cm)	Weight (kg)	Vemco code
2003	F-2	8/26/03	119.0	2117	173.0	195.5	37.8	52
2003	na	9/8/03	19.0	1471	181.0	205.0	45.0	51
2004	F-3[a]	9/7/04	121.0	22212	204.0	229.0	78.8	259
2004	M-8	9/7/04	121.0	22214	179.5	203.0	48.6	261
2004	M	9/7/04	121.0	1791	141.0	163.0	22.5	264
2004	na	9/7/04	121.0	1792	138.0	164.0	26.0	265
2004	F-3	9/8/04	121.0	22211	186.0	213.0	56.3	260
2004	M-8	9/8/04	121.0	22210	169.0	191.0	38.3	262
2004	M-8	9/8/04	121.0	22222	182.0	204.0	45.9	263
2004	M-8	9/8/04	121.0	690	168.5	190.0	38.3	266
2004	M-8	10/4/04	119.0	22213	195.5	220.0	54.9	257
2005	F-4	3/10/05	204.0	53853	170.0	197.0	41.0	275
2005	F-2	3/16/05	215.0	53855	215.0	241.0	na	277
2005	F-4	3/29/05	215.0	53872	165.0	191.0	48.0	274
2005	F-3	3/29/05	215.0	53871	182.0	209.0	47.0	276
2005	F-3	4/12/05	215.0	53863	182.0	200.0	59.0	273
2005	F-4	4/26/05	215.0	947	142.0	162.0	26.0	272
2005	F-4[b]	4/28/05	226.5	958	189.0	220.0	58.0	280
2005	F-1	5/18/05	230.7	348	161.0	184.0	na	278
2005	M-8	6/08/05	229.0	906	166.0	191.0	35.0	281
2005	M-8	6/08/05	229.0	330	179.0	206.0	43.0	279
2005	M-8	6/08/05	229.0	53894	189.0	217.0	70.0	271
2005	F-4[c]	6/28/05	243.0	2117	170.0	196.0	40.0	52
2005	M-7	9/26/05	215.0	406	168.0	192.0	43.0	50
2005	F-4[b]	9/26/05	215.0	345	164.0	189.0	52.0	269
2005	F-4[b]	9/26/05	215.0	535	177.0	204.0	57.0	270
2005	F-4	9/27/05	215.0	1578	178.0	200.0	40.0	267
2005	U[d]	9/27/05	215.0	804	105.0	132.0	14.0	87
2005	F-4	9/27/05	215.0	1795	185.0	208.0	54.0	268
2005	M-7	9/27/05	215.0	1794	197.0	224.0	63.0	258
2006	F-4	3/23/06	207.0	1824	166.0	189.0	36.9	9
2006	F-1	3/28/06	190.0	202	185.0	212.0	48.6	292
2006	M	3/28/06	185.0	939	147.0	171.0	21.2	294
2006	M	3/28/06	185.0	65	167.0	193.0	27.9	290
2006	F-4[b]	3/30/06	215.0	1305	158.0	182.0	36.9	3
2006	F-4[b]	4/4/06	205.0	22218	169.0	195.0	37.2	10
2006	M-8	4/4/06	187.5	86	161.0	195.0	33.3	7
2006	M-8	4/6/06	215.0	139	175.0	202.0	43.5	1
2006	F-4[b]	4/10/06	205.0	1828	185.0	215.0	56.0	6
2006	F-4[b]	4/13/06	215.0	1833	196.0	228.0	65.0	8
2006	F-4[b]	4/19/06	215.0	1837	194.0	223.0	65.9	4
2006	F-4[b]	4/25/06	215.0	1840	186.0	217.0	53.3	288
2006	M-8	4/26/06	204.0	987	151.0	174.0	25.5	291
2006	M-8	5/4/06	229.0	2230	214.0	243.0	54.2	2
2006	M-8	5/4/06	229.0	1842	155.0	179.0	30.5	295
2006	F-4[d]	5/4/06	229.0	22212	208.0	236.0		293
2006	F-4	5/9/06	229.0	2227	170.0	190.0	37.2	287
2006	M-8	6/1/06	235.5	679	155.0	177.0	27.3	5
2006	M-9	6/6/06	229.0	1847	167.0	187.0	40.3	286

Table 3. Continued.

Tag year	Sex/Development stage	Release date	Release rkm	Fish #	Fork length (cm)	Total length (cm)	Weight (kg)	Vemco code
2006	M-9	6/7/06	229.0	7917	145.0	165.0	23.3	289
2006	F3	10/5/06	215.0	57035	172.0	194.0	42.75	296
2006	F3	10/5/06	215.0	57033	179.0	210.0	48.15	298
2006	F3	10/8/06	215.0	57034	182.0	205.0	54.0	301
2006	F4	10/24/06	215.0	1854	185.0	213.0	60.0	297

[a] This fish was re-tagged with Vemco 293 in May 2006, no mention of old Vemco 259
[b] F-1 eggs present
[c] Fish recaptured; no mention of sonic tag
[d] Unknown sex/ development; 3-year tag

Table 4. Number of positions of female white sturgeon expected to spawn in 2006 that were within a 125 m radius of the centroid of the VRAP buoy array, Kootenai River, 2006.

Transmitter ID	Number of detections
3	56
4	69
6	38
10	25
267	2
270	320
287	13
288	3
Total	526

Table 5. Location (rkm), depth (m), effort, and white sturgeon egg catch by standard artificial substrate mats, Kootenai River, Idaho, 2006.

Geographical description	River location (rkm)	Depth range (m)	Total mat days[a]	Number white sturgeon eggs
Middle Shortys Island	229.6-231.5	3.0-15.2	248.4	659
Upper Shortys Island	231.6-233.4	7.3	3.6	0
Myrtle Creek	233.5-234.7	5.5-16.5	83.7	0
Refuge	234.8-237.5	6.4-24.1	181.1	1
Deep Creek	237.6-240.5	4.3-14.6	56.5	0
US Hwy 95	244.7-246.6	1.8-11.9	621.9	5
All sections	229.6-246.6	1.8-24.1	1195.3	665

[a] One mat day is one 24 hour set.

Table 6. Stages of white sturgeon eggs captured by artificial substrate mats, Kootenai River, Idaho, 2006.

Buoy no. start	End °C	End rkm2	Date pull	End time	Total eggs	Egg stage									Staging results unknown	Notes	Spawn date
						12	15	16	17	18	23	26	Dead	Other			
						4											5/26/06
							18										5/26/06
								290									5/25/06
0	9.0	229.5	5/26/06	13:43	589				45						36		5/25/06
										1							5/25/06
													115				—
														80		broken	—
														2		Fungus/broken	—
0	11.0	229.6	6/2/06	15:30	6							3			1		5/28/06
107	10.0	236.3	6/2/06	14:30	1			1							—		6/2/06
92	10.6	230.3	6/5/06	15:12	62										62	missing?	
92	11.1	230.1	6/9/06	9:30	2						2				—		6/6/06
998	14.4	245.5	6/28/06	11:53	2			2									6/27/06
200	14.4	245.5	6/28/06	11:40	3								1	2	—	fungus, broken	—
				Total collected:	665												
				Total staged:	566	4	18	293	45	1	2	3	116	84			
				Staging results unknown:											99		

Table 7. Summary of 2006 white sturgeon larval sampling effort and volume sampled by gear type and location, Kootenai River, Idaho.

Gear Type	Location (river kilometer)	Sampling dates	Catch	No. sites	Effort (hours)		Volume (m^3) sampled	
					Mean (SD)	Total	Mean (SD)	Total
Surface and mid-column	150.8	6/7	0	2	0.56 (0.01)	1.12	330.68 (44.03)	661.36
	230.0	8/7	0	1	27.12	27.12	1436.21	1436.21
	244.5	6/21,6/28,6/29, 7/31	1	14	5.19 (9.35)	72.62	850.84 (225.13)	11911.74
	246.0	6/30	0	2	1.72 (0.42)	3.43	762.33 (205.09)	1524.66
	255.7	6/3	0	3	13.52 (0.04)	40.55	3546.0 (2849.22)	10638.0
	270.3	8/15	22	3	24.23 (0.05)	72.68	4143.73 (1395.5)	12431.2
Benthic D-ring	150.8	6/7	0	1	0.58	0.58	7.01	7.01
	230.0	8/7	0	2	27.1 (0)	54.2	1121.19 (120.99)	2242.37
	244.5	6/28,6/29,7/31	6	13	3.66 (7.16)	47.53	743.68 (511.04)	9667.84
	246.0	6/30	6	4	1.63 (0.31)	6.53	915.91 (188.75)	3663.66
	250.6	6/15,6/21	0	22	1.99 (1.16)	43.82	277.28 (430.73)	5822.97
	270.3	7/5-7/7,7/10-7/12,7/17,7/19, 7/24-7/26,7/31,8/7	4945	154	5.97 (5.95)	919.12	2626.15 (1276.19)	401801.2
Combined	All	6/3-8/15	4980	221	5.83 (6.85)	1289.3	2108.71 (1474.88)	461808.22

Table 8. Idaho Department of Fish and Game juvenile white sturgeon gill net sampling effort by sampling location for August through September 2006.

River Kilometer	Number of sets	Hours of effort	Number of adults captured	Number of juveniles captured	Sturgeon catch per unit of effort
190.0	56	57.9	0	38	0.6567
192.0	38	37.7	0	10	0.2655
193.0	15	15.1	0	9	0.5967
204.0	33	34.9	1	57	1.6611
215.0	37	41.1	5	40	0.9728
215.5	5	4.6	0	2	0.438
225.0	56	55.8	0	28	0.5019
229.0	12	12.2	0	3	0.2459
234.5	3	2.1	0	0	0
244.5	61	63.8	0	27	0.4234

Table 9. Idaho Department of Fish and Game juvenile white sturgeon gill net sampling effort by mesh size for August through September 2006.

Gillnet mesh size (cm)	Number of sets	Hours of effort	Number of adults captured	Number of juveniles captured	Sturgeon catch per unit of effort*
2.5 stretch	160	166.7	0	119	0.71
3.8 stretch	21	21.9	0	13	0.59
5 stretch	74	77.1	0	40	0.52
6.4 stretch	7	5.1	0	0	0
7.6 stretch	32	31.4	1	15	0.51
10.2 stretch	19	19.9	0	25	1.26
Unknown	3	2.8	0	2	0.71

* Catch per effort in fish per hour

Table 10. Summary statistics of recaptured juvenile hatchery white sturgeon (N=210) from 2006 gill net sampling, Kootenai River, Idaho.

	Statistic	FL (cm)	TL (cm)	WT (kg)
Recaptures N = 210	Average	35.6	41.5	0.35
	Standard deviation	11.6	13.6	0.34
	Minimum	18.5	21.1	0.02
	Maximum	72.5	84.8	1.49

Table 11. Wild juvenile white sturgeon captured in gillnets in 2006, Kootenai River, Idaho.

Date	Capture rkm	Fork length (cm)	Total length (cm)	Weight (kg)	Mesh size (cm)	Age
8/1	215	50.4	59.2	0.88	2.5	8
8/3		55.1	64.5	1.01		9
8/8	192	37.3	43.0	0.32	2.5	5
8/9	190	55.4	65.1	1.14	5.1	7

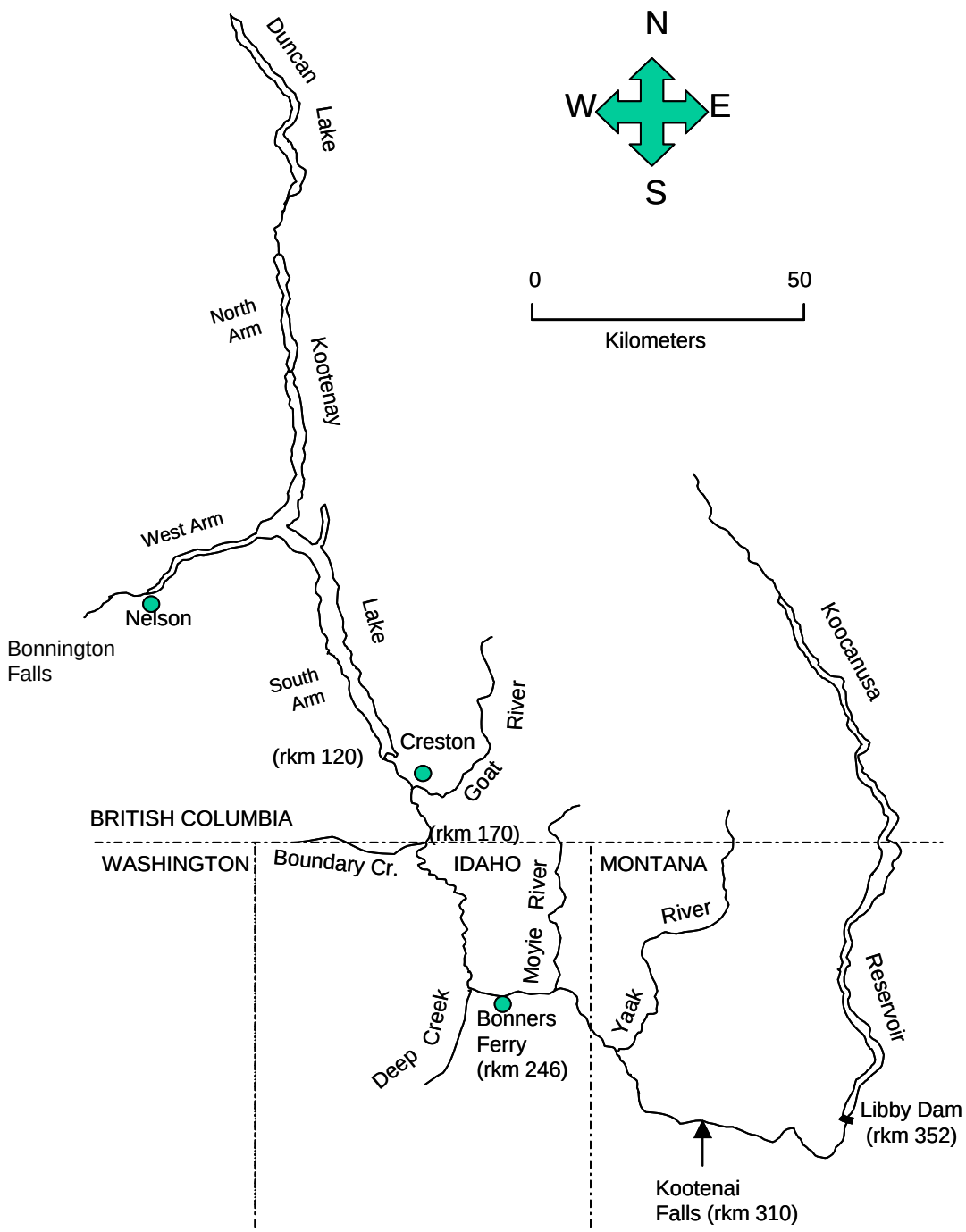

Figure 1. Location of the Kootenai River, Kootenay Lake, Lake Koocanusa, and major tributaries. The river distances from the northernmost reach of Kootenay Lake are in river kilometers (rkm) and are indicated at important access points.

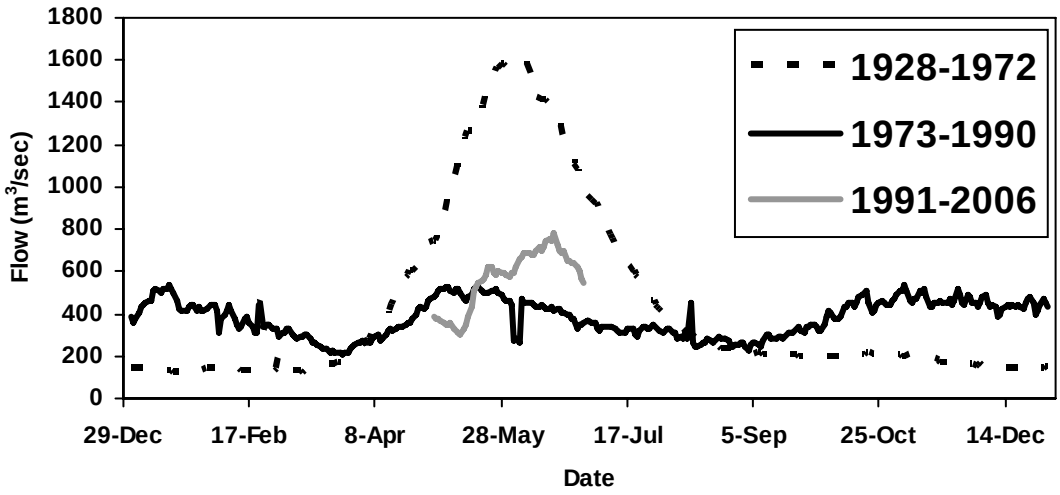

Figure 2. Mean daily flow patterns in the Kootenai River at Bonners Ferry, Idaho from 1928-1972 (pre-Libby Dam), 1973-1990 (post-Libby Dam) and 1991-2006 (post-Libby Dam with augmented flows, May 1 through June 30).

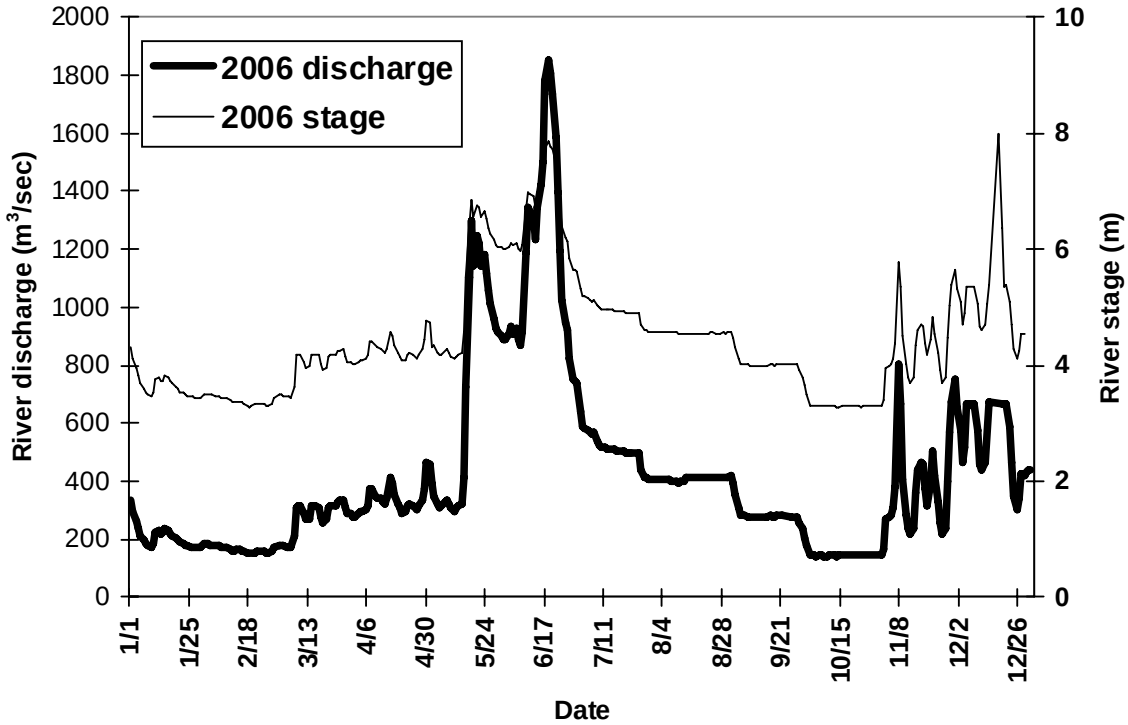

Figure 3. Mean daily discharge (m^3/sec) and stage (meters) for Kootenai River at Bonners Ferry, Idaho, 2006.

Figure 4. Embryo release site near Caboose Creek side channel (rkm 270.3), Kootenai River, Idaho, 2006.

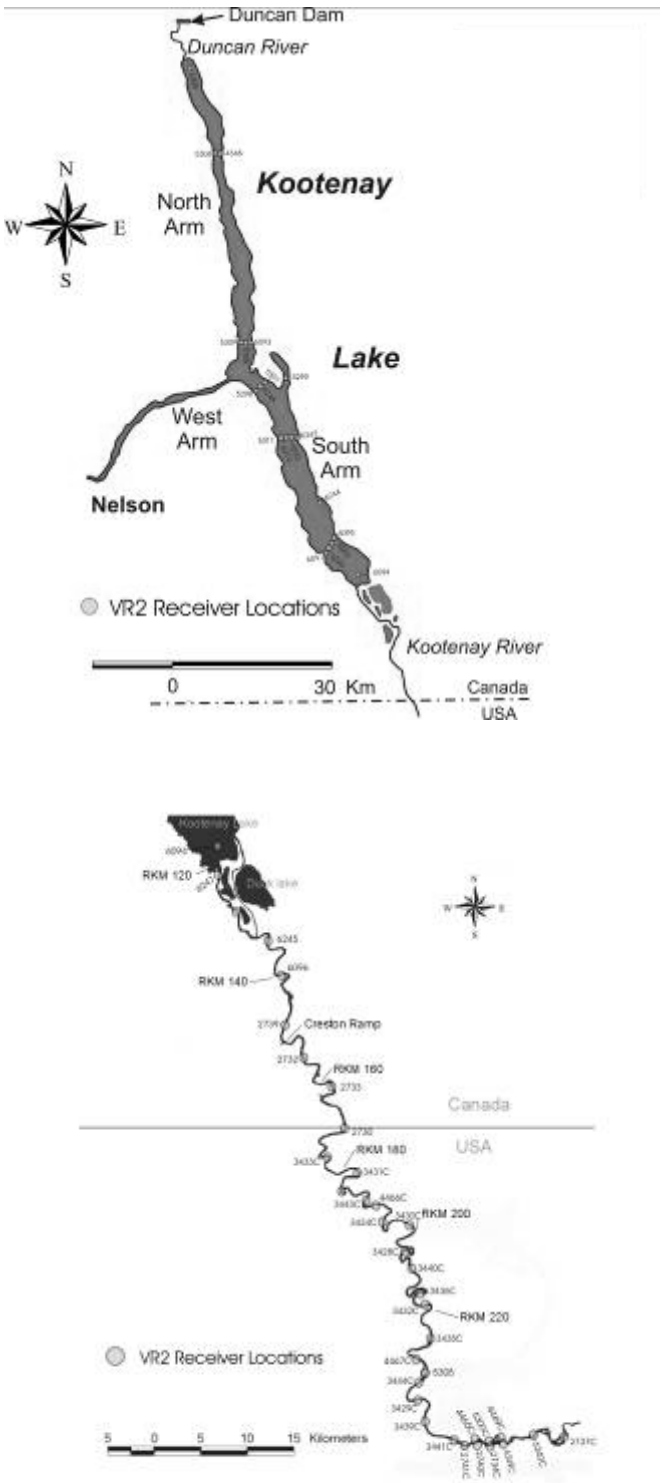

Figure 5. Location of Vemco VR2 receivers in Kootenai River/Lake system, Idaho and British Columbia, Canada, 2006.

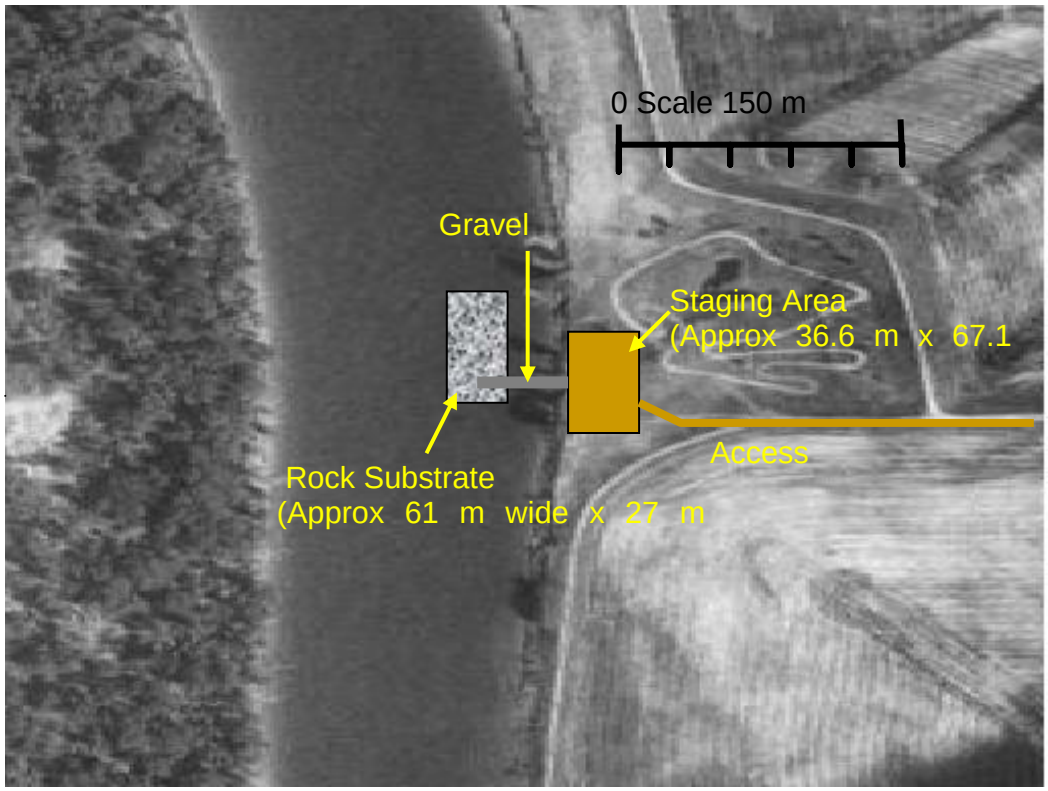

Figure 6. Shortys Island Pilot study area, Kootenai River, Idaho, 2006.

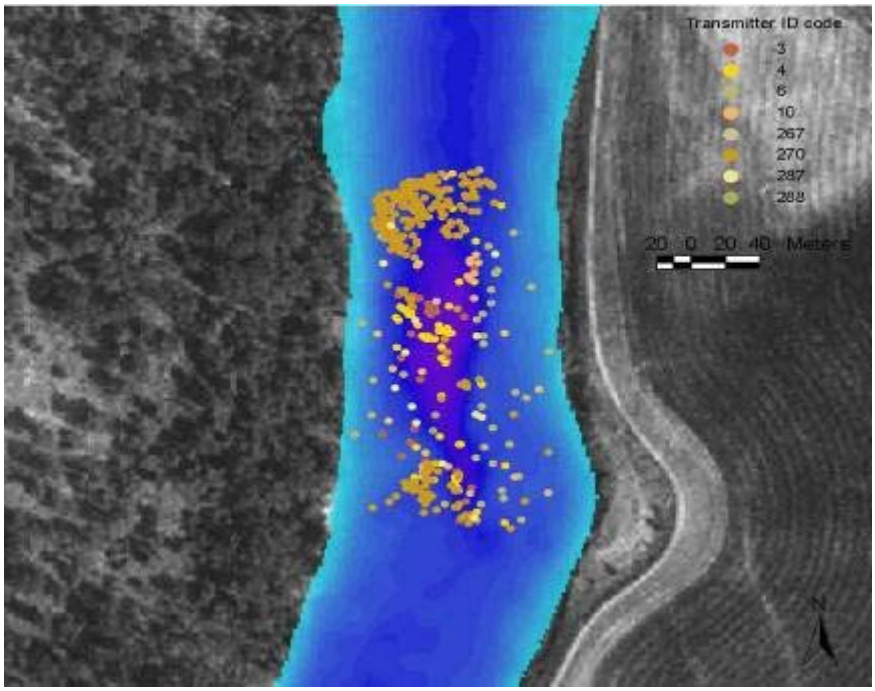

Figure 7. Positions of eight female white sturgeon expected to spawn in 2006 (N = 526). Only locations within 125 m of the centroid of the VRAP buoy array are shown.

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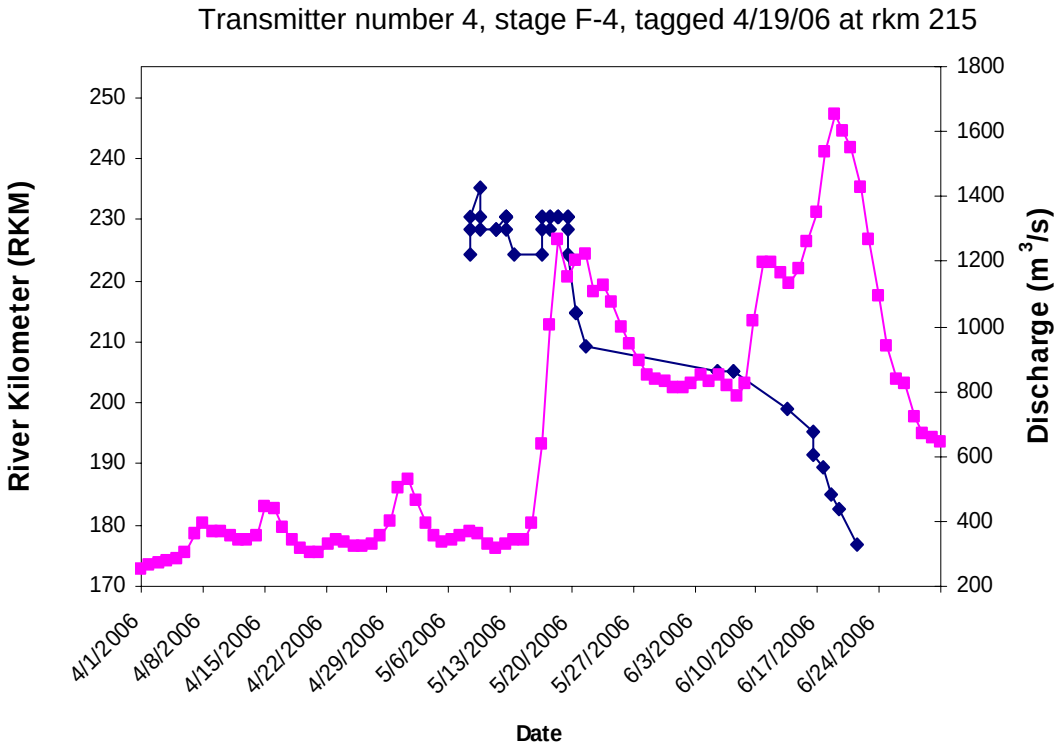
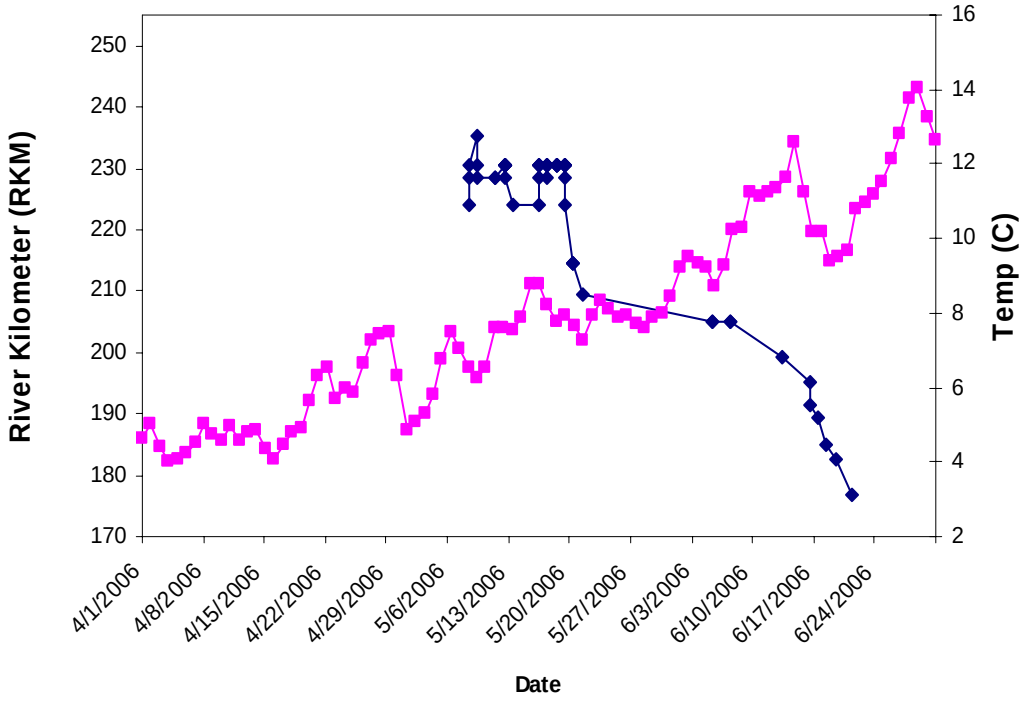
APPENDICES

Appendix 1. Migration of eight female white sturgeon, all of which are believed to have spawned in the Kootenai River, Idaho, 2006. Black lines denote fish movements.





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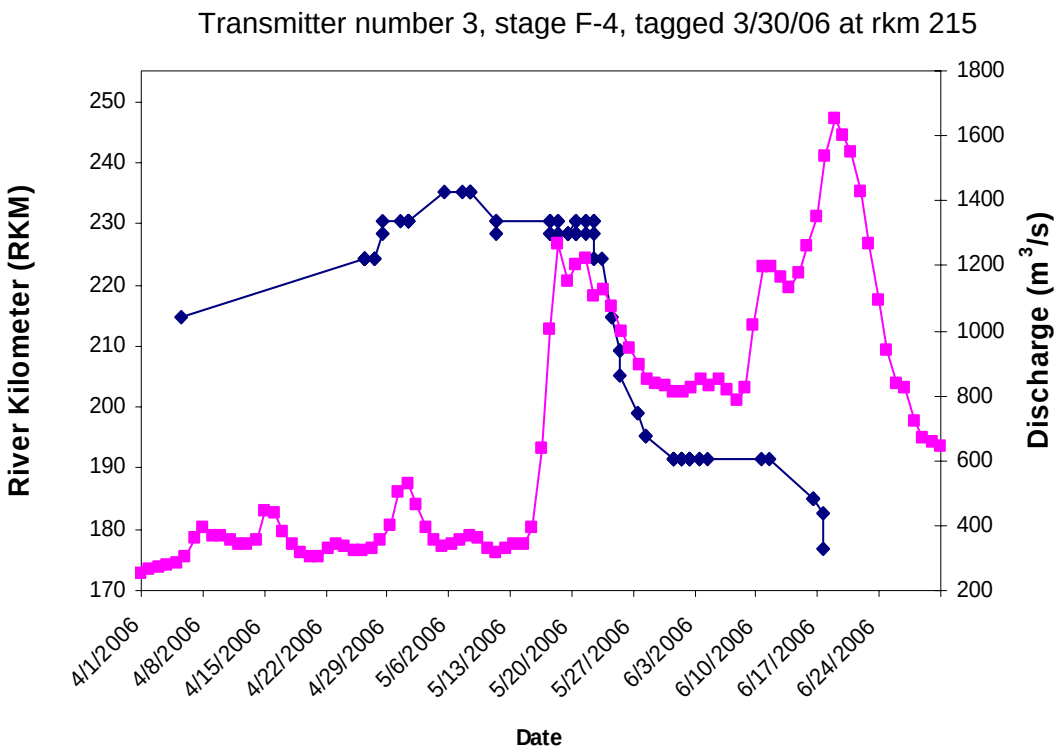
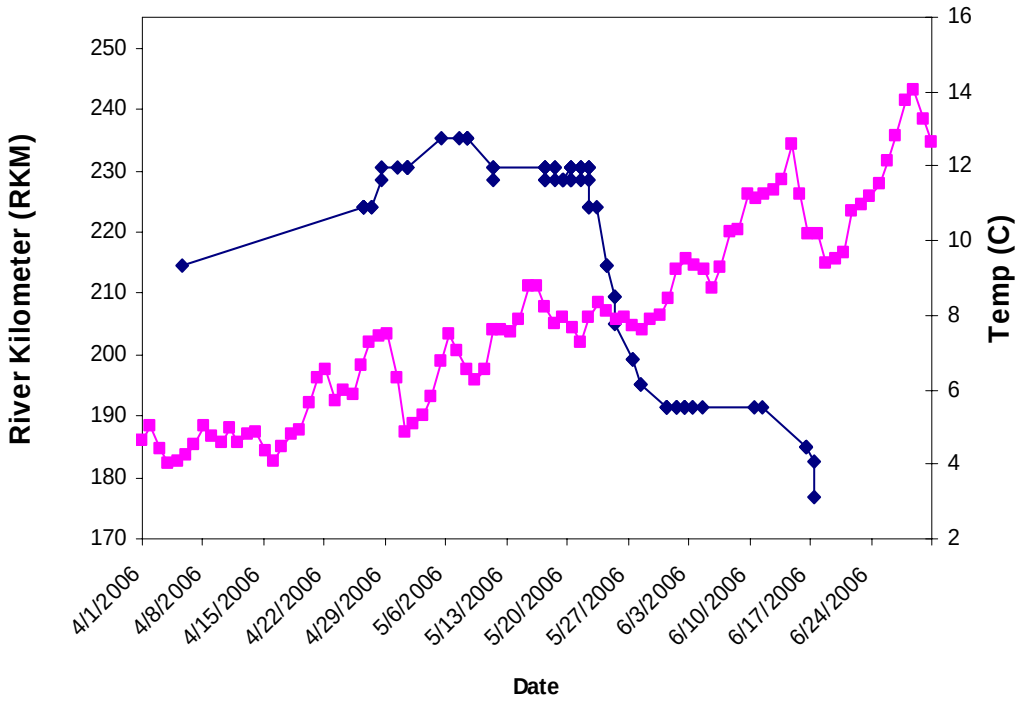
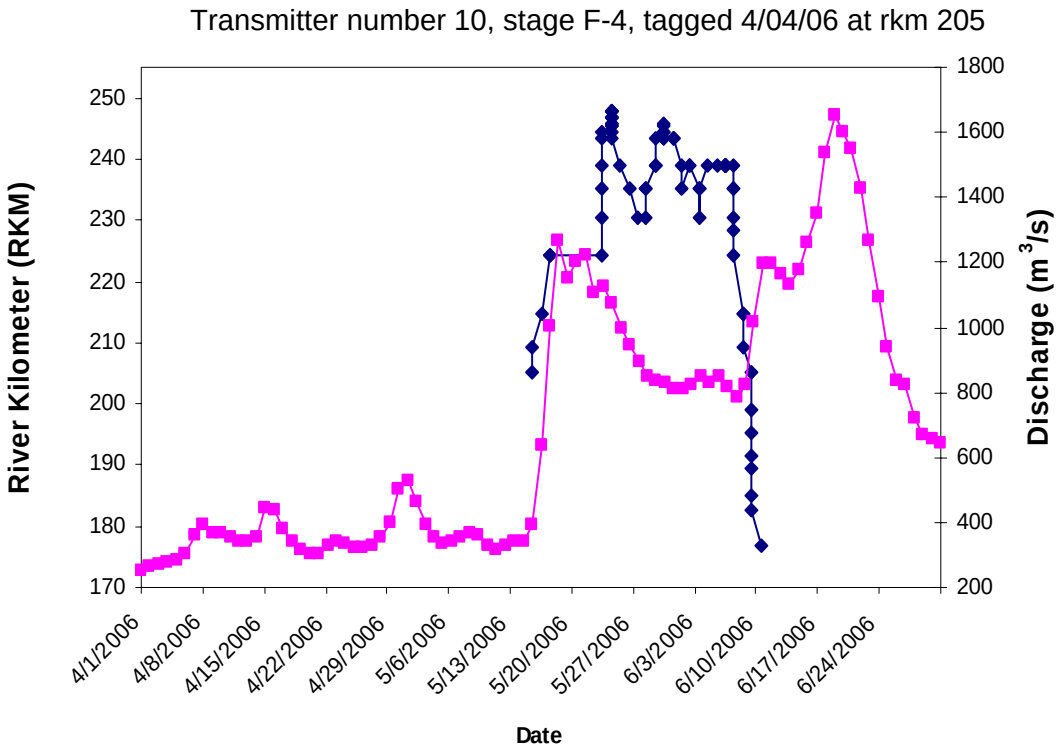
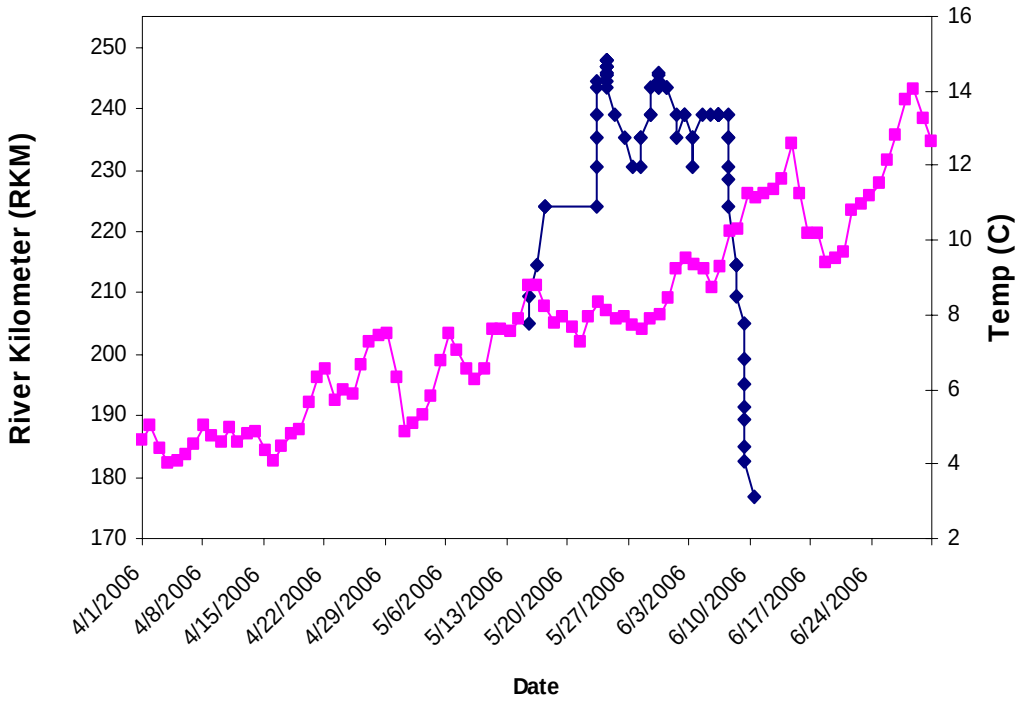




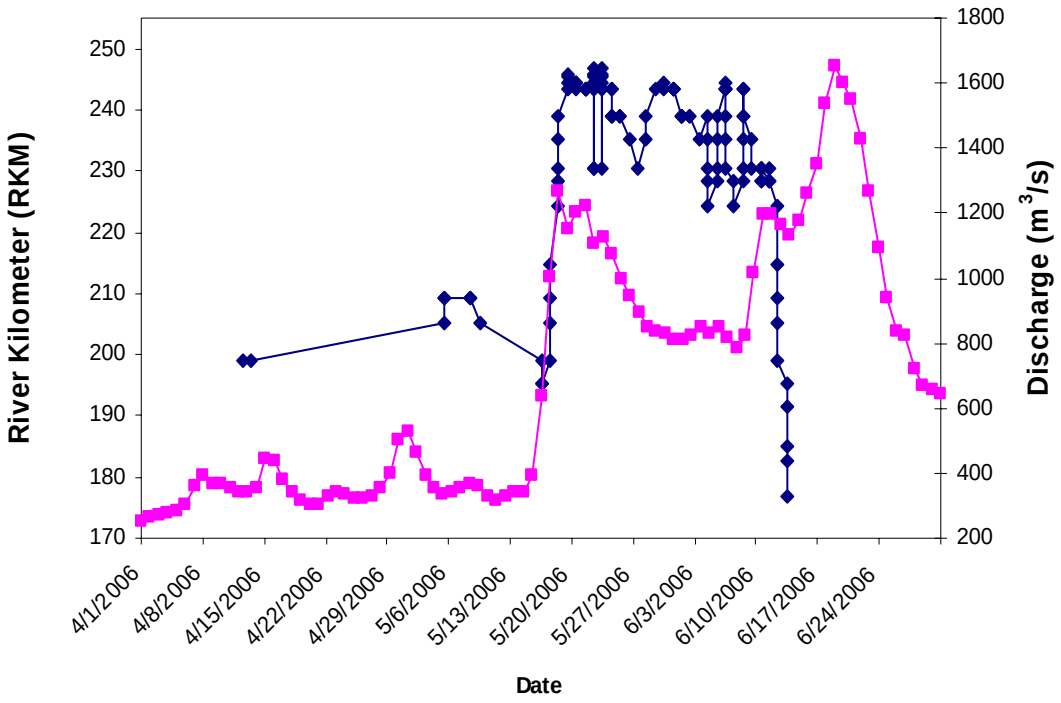
Appendix 1. Continued.

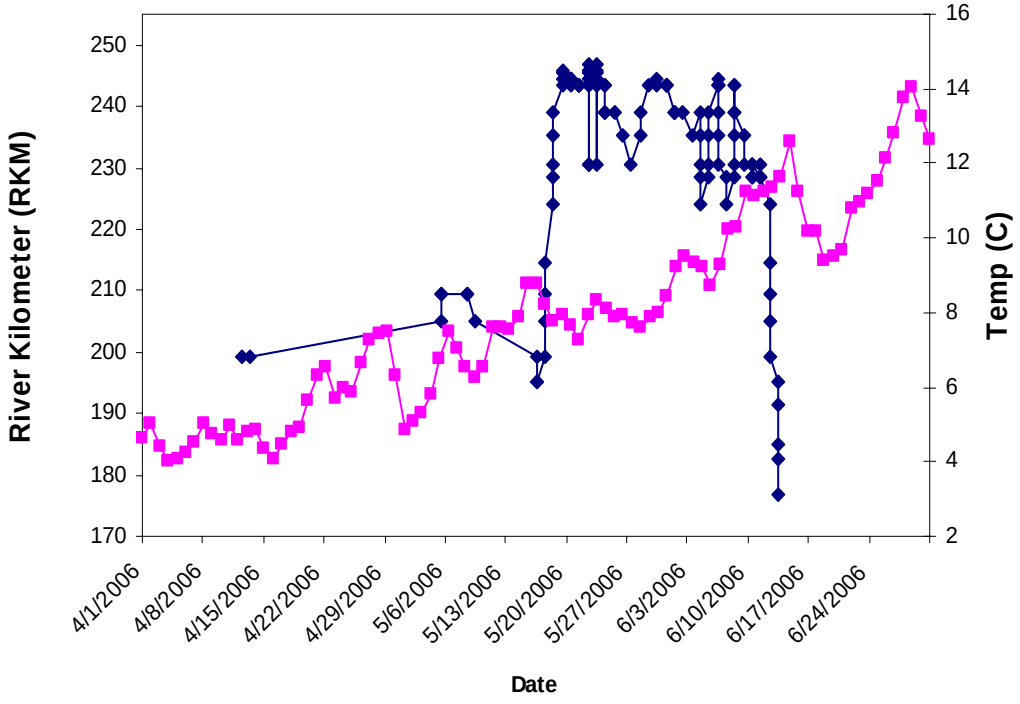




Appendix 1. Continued.

Transmitter number 6, stage F-4, tagged 4/10/06 at rkm 205





Appendix 1. Continued.

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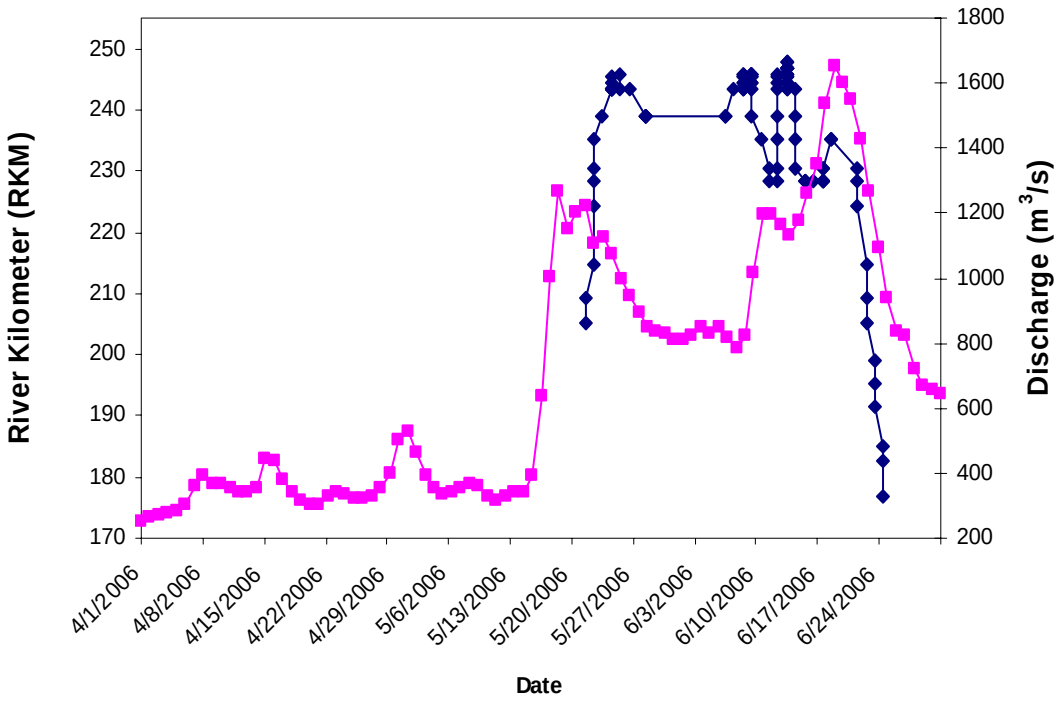
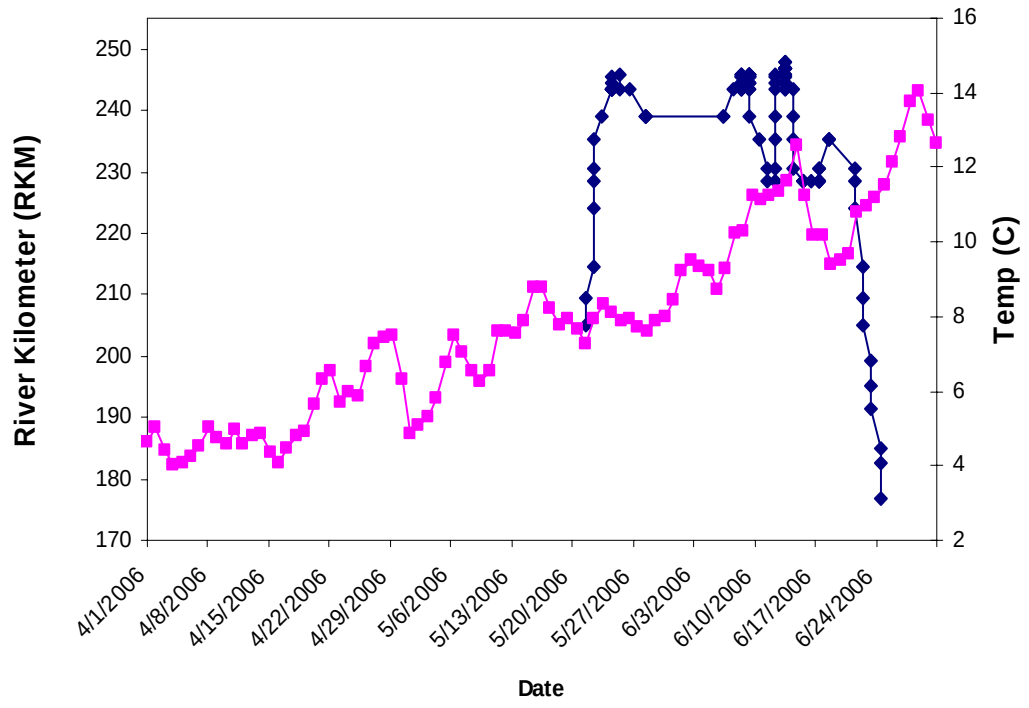
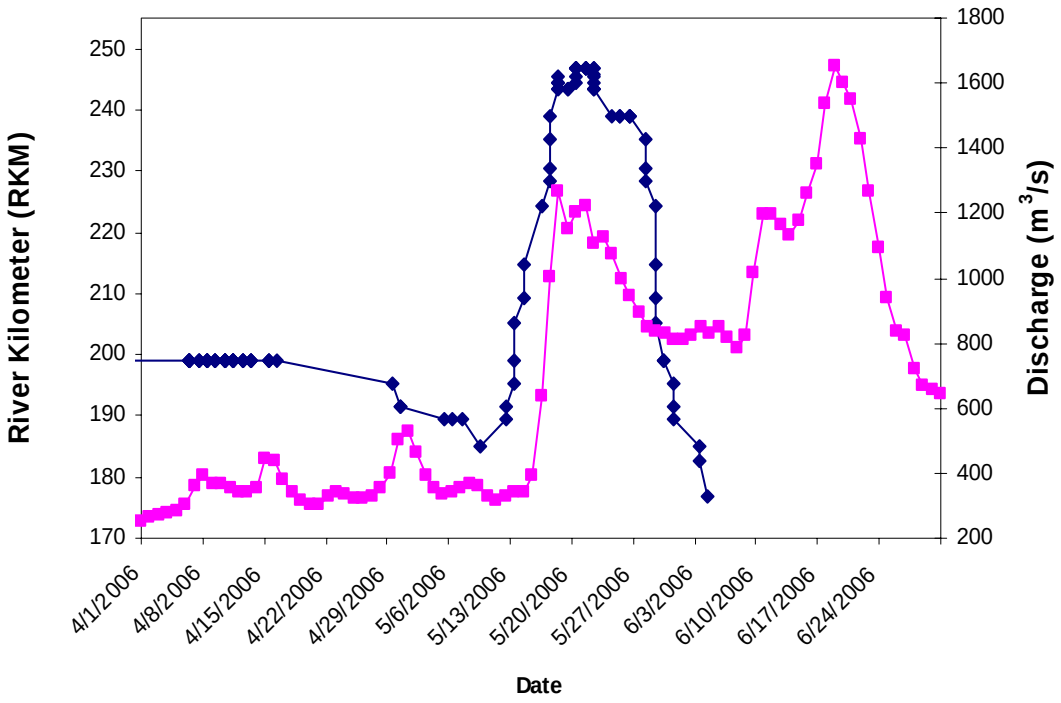
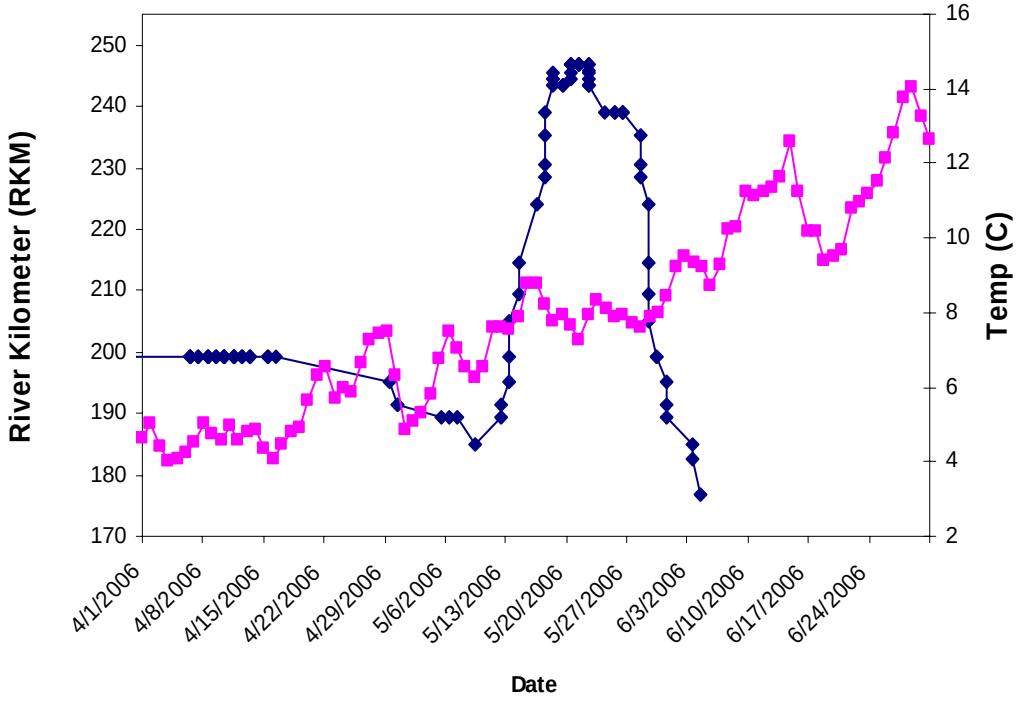




Appendix 1. Continued.

Transmitter number 267, stage F-4, tagged 9/27/05 at rkm 215





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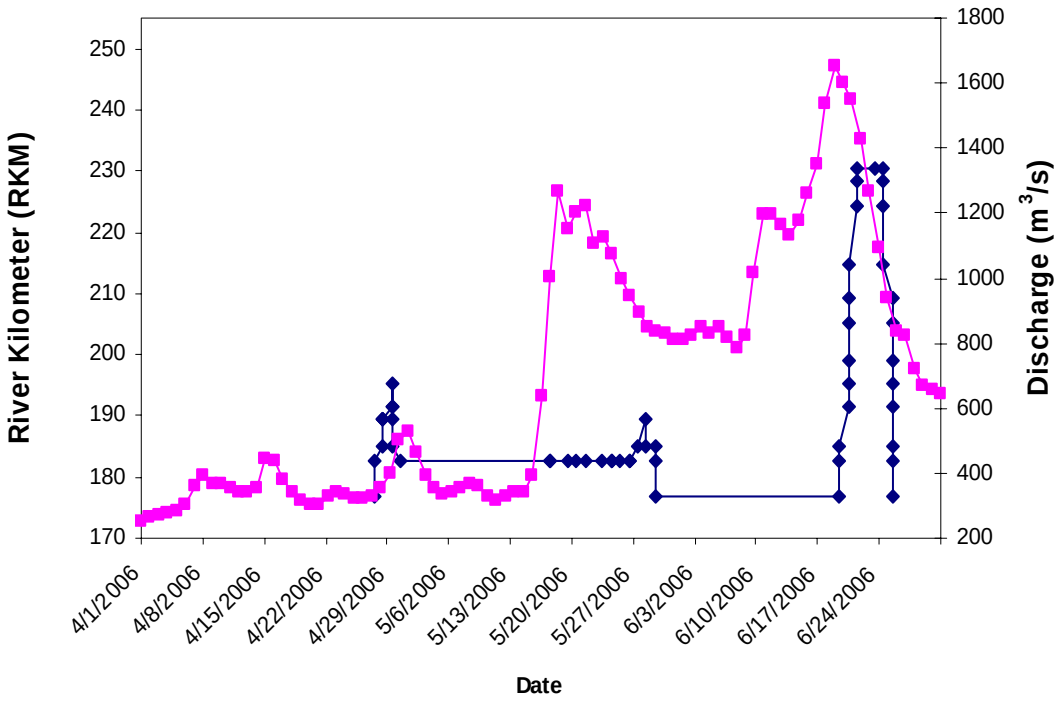

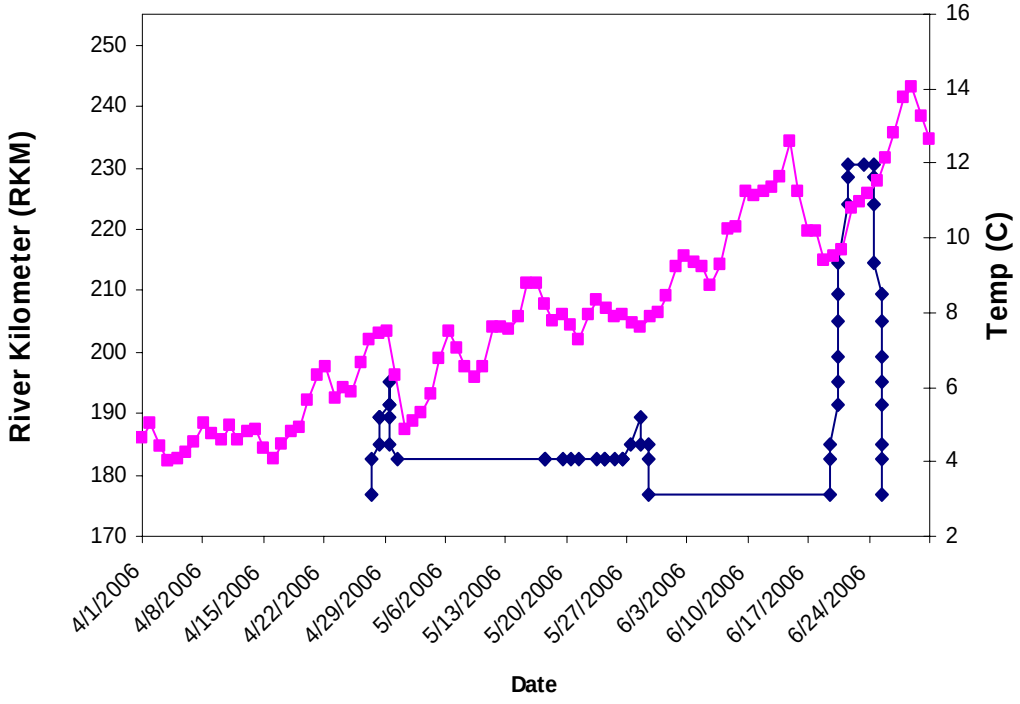

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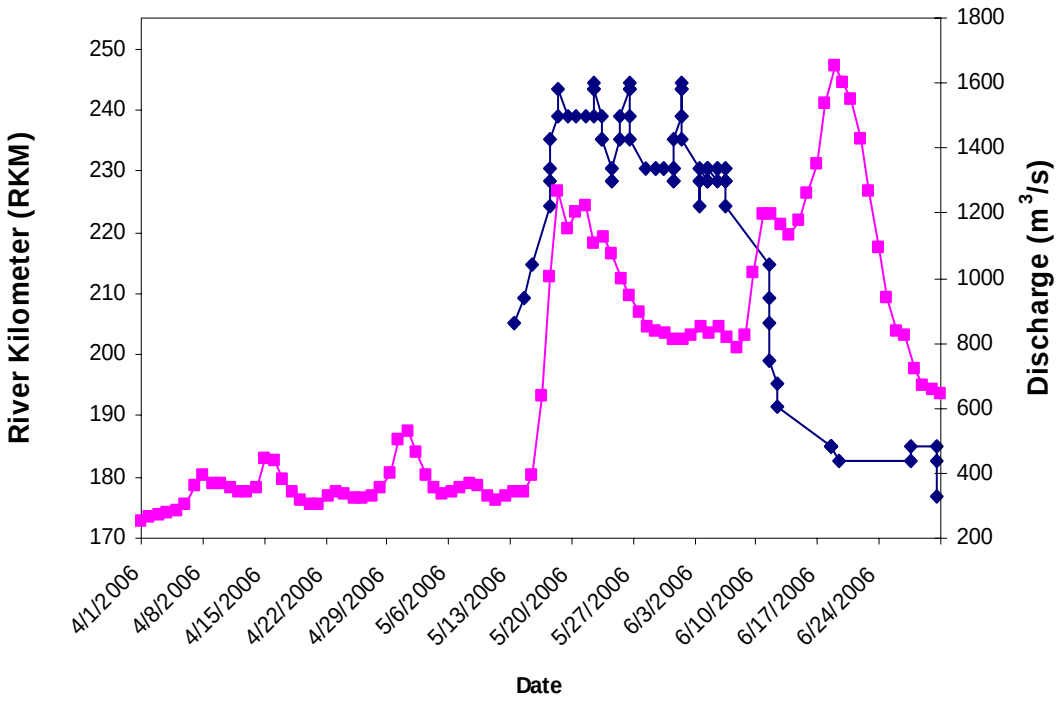
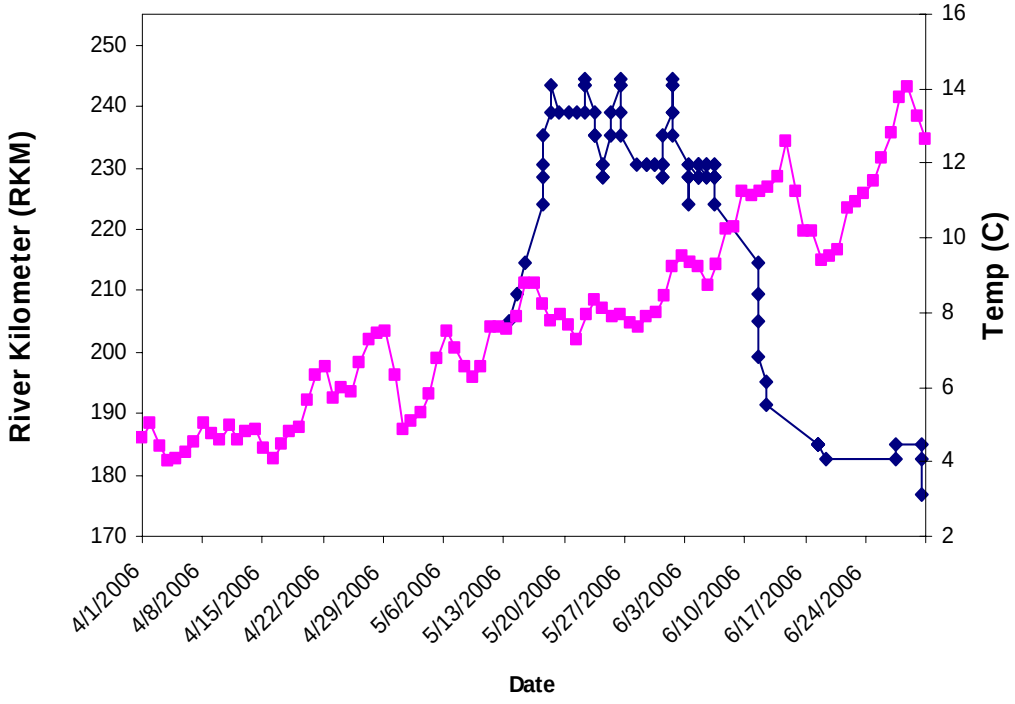




Appendix. 2 Numbers and recapture rates of hatchery produced juvenile sturgeon (progeny of wild brood stock) released into the Kootenai River and Kootenay Lake in Idaho, Montana and British Columbia between 1990 and 2006 (from Kootenai Tribe of Idaho and Idaho Department of Fish and Game Annual Reports 1990-2006). This table includes tagged and/or measured fish only.

Year class	Hatchery facility[a]	Release number	Mean total length (mm) at release (S.D.)	Mean weight (g) at release (S.D.)	Release season & year	Number recaptures	Percent of all recaptures
1990	KTOI	14	456.9 (53.0)	320.8 (112.3)	Summer 1992	10	0.34%
1991	KTOI	104	254.7 (17.3)	66.1 (13.1)	Summer 1992	115	3.91%
1992	KTOI	123	482.6 (113.0)	549.3 (482.9)	Fall 1994	111	3.78%
1995	KTOI	0	—	—	?[b]	41	1.40%
1995	KTOI	1,075	228.5 (27.0)	47.3 (16.6)	Spring 1997	450	15.32%
1995	KTOI	884	343.6 (43.7)	148.0 (64.0)	Fall 1997	424	14.43%
1995	KTOI	97	410.7 (68.2)	288.5 (137.8)	Summer 1998	58	1.97%
1995	KTOI	25	581.5 (40.5)	863.3 (197.9)	Summer 1999	13	0.44%
1998	KTOI	309	260.1 (41.9)	79.0 (44.4)	Fall 1999	50	1.70%
1999	KTOI	828	256.1 (22.2)	70.6 (18.2)	Fall 2000	132	4.49%
1999	KH	1,358	248.1 (32.9)	67.2 (27.6)		329	11.20%
1999	KTOI	491	284.3 (54.4)	107.6 (60.1)	Spring 2001	33	1.12%
1999	KH	1,583	306.5 (40.4)	55.9 (39.5)		459	15.62%
1999	KT	0	—	—	?[b]	3	0.10%
1999	—	0	—	—	?[b]	46	1.57%
2000	KTOI	2,286	244.0 (38.9)	64.2 (31.0)	Fall 2001	80	2.72%
2000	KH	1,654	240.0 (23.2)	57.7 (16.4)		117	3.98%
2000	KH	2,209	283.1 (28.7)	99.3 (30.2)	Spring 2002	6	0.20%
2000	KH	30	365.4 (14.0)	195.3 (19.9)	Summer 2002	0	0.00%
2000	KTOI	214	409.4 (53.5)	294.1 (109.8)	Fall 2002	26	0.88%
2000	KTOI[c]	908	334.2 (36.9)	192.9 (62.7)	Jan. 2003	73	2.48%
2000	KTOI[d]	10	557.7 (28.4)	87.6 (18.4)	Feb. 2004	0	0.00%
2000	—	0	—	—	?[b]	23	0.78%
2001	KTOI	2,672	200.1 (37.9)	33.0 (15.6)	Fall 2002	65	2.21%
2001	KH	4,469	227.4 (24.2)	51.6 (16.6)		2	0.07%
2001	KH	1,715	257.1 (26.4)	71.8 (24.2)	April 2003	4	0.14%
2001	—	0	—	—	?[b]	2	0.07%
2002	KH	5,864	217.3 (25.2)	41.3 (14.2)	May 2003	7	0.24%
2002	KTOI	856	214.0 (43.8)	41.9 (22.6)	Oct. 2003	0	0.00%
2002	KTOI[e]	550			Nov. 2003	NRD	—
2002	KTOI	3,852	215.4 (37.3)	43.4 (20.0)	Late wtr. 2003	3	0.10%
2002	KTOI	3,663	214.2 (54.8)	43.1 (27.2)	Late wtr.'03-early wtr. '04	6	0.20%
2002	—	0	—	—	?[b]	14	0.48%
2003	KH	9,020	222.8 (25.7)	48.9 (24.4)	Spring 2004	331	11.27%
2003	KH[f]	19	229.5 (26.7)	51.9 (18.5)	Sept. 2004	0	0.00%
2003	KTOI	3,519	226.9(46.3)	55.4(31.6)	Late wtr. 2004	2	0.07%
2003	—	0	—	—	?[b]	13	0.44%
2004	KH[g]	2,038	196.2(27.7)[h]	57.4(33.0)	Spring 2005	7	0.24%
2004	—	0			?[b]	53	1.80%
2005	KH[i]	14	298.6(14.1)	174.2(27.8)	Spring 2006	0	0.00%
2005	KH[g]	1,765	197.8(24.5)[h]	54.2(22.4)		93	3.17%
2005	KTOI[i]	8	551.9(110.2)	475.6(175.8)	Summer 2006	0	0.00%
2005	KTOI[j]	510	151.0(39.0)	26.8(19.9)	Fall 2006	0	0.00%
2005	—	0			?[b]	2	0.07%

Appendix 2. Continued.

Year class	Hatchery facility[a]	Release number	Mean total length (mm) at release (S.D.)	Mean weight (g) at release (S.D.)	Release season & year	Number recaptures	Percent of all recaptures
2006	KH[g,k]	600	148.8(10.8)[h]	22.9(5.4)	Fall 2006	2	0.07%
?[b]	KT	0	—	—	—	3	0.10%
?[b]	—	0	—	—	—	106	3.61%
Total		**55,336**	—	—	—	**635**	**5.31%**

[a] Hatchery facility refers to the rearing hatchery: Kootenai Tribal Hatchery in Idaho (KTOI) or Kootenay Hatchery in British Columbia (KH).
[b] Year class determined by scute removal; fish had shed PIT or PIT was not matched in database to determine stock year.
[c] Eleven fish held over for later upriver release with transmitters.
[d] These fish were released upriver (rkm 306.5) with sonic and radio tags.
[e] No measurements available; exact number not known, approximate is 550; NRD (number recaptured cannot be determined).
[f] These fish were first taken to Kokanee Creek Provincial Park, then released in September 2004.
[g] Additional fish were released with no measurements taken or PIT added (see Appendix 3).
[h] Value given is mean fork length (mm).
[i] These fish were released upriver (285.6, 299.0 and 258.7) with Vemco sonic tags.
[j] There were 200 fish held over at KTOI hatchery for Biopar study.
[k] These fish did not have a PIT tag added and were all given fish # 999.
[l] White sturgeon had no PIT; year class could not be determined by scute removals.

Appendix 3. Juvenile hatchery releases with no tag added or measurements taken through March 31 2007: combined hatcheries.

Year class	Hatchery facility[a]	Release number	Release season and year
2004	KTOI	3,000	Fall 2004
2004	KTOI	1,275	Late wtr. ’04-early wtr. ‘05
2004	KTOI	17,723	Spring 2005
2004	KH	3,440	Spring 2005
2004	KTOI	8,637	Summer 2005
2005	KTOI	6,200	Fall 2005
2005	KTOI	3,947	Spring 2006
2005	KH	13,665	Spring 2006
2006	KH	6,900	Fall 2006
2006	KTOI	1,425	Spring 2007
Total		66,212	

[a] Hatchery facility refers to the rearing hatchery: Kootenai Tribal Hatchery in Idaho (KTOI) or Kootenay Hatchery in British Columbia (KH).

Appendix 4. Year class, number captured, capture locations, fork length (cm), total length (cm), and weight (kg) of hatchery released juvenile sturgeon captured with gill net from Kootenai River, Idaho, 2006.

Year class	Number captured	Capture rkm	Fork length (cm)	Total length (cm)	Weight (kg)
1990	1	120.0	76.5	88.0	3.00
	3	205.0	61.0-81.4	74.0-95.0	1.75-2.70
	2	215.4	55.4-66.2	66.2-78.1	1.86
	1	215.6	65.2	76.0	2.00
	1	215.7	69.0	82.0	2.25
	1	225.1	65.8	77.0	1.95
	1	Unknown	66.5	76.1	1.95
1991	1	118.0	95.0	110.5	5.65
	3	119.0	73.0-85.0	85.5-98.0	1.10-4.50
	1	119.5	75.0	88.5	—
	4	120.0	63.0-102.5	73.5-118.5	1.60-6.65
	3	121.0	67.0-76.5	77.2-92.0	2.10-3.85
	1	134.0	82.0	94.5	4.1
	1	190.0	70.0	83.0	2.20
	1	192.0	35.1	40.8	0.16
	1	203.4	56.0	64.0	1.05
	4	203.5	52.0-72.0	61.0-83.0	0.95-2.70
	1	204.5	64.0	76.0	—
	1	204.7	60.0	68.8	1.36
	23	205.0	26.5-84.0	30.5-100.0	0.11-3.60
	1	205.4	51.0	60.0	1.10
	4	205.5	47.0-76.0	56.0-89.1	0.69-3.10
	5	215.0	40.0-53.0	47.0-62.0	0.14-0.70
	1	215.3	47.0	56.0	0.70
	1	215.4	64.2	75.4	2.15
	17	215.5	46.0-74.0	54.0-85.1	0.21-2.85
	8	215.6	41.0-57.0	48.0-66.2	0.43-1.80
	4	215.7	39.0-61.0	46.0-72.0	1.05-1.60
	3	216.0	44.0-53.0	51.0-61.0	0.50-0.88
	1	217.1	33.0	42.0	0.49
	1	224.6	48.0	58.0	0.65
	1	224.7	46.0	55.0	0.70
	2	224.9	42.0-73.5	50.0-84.8	0.45-2.80
	10	225.0	38.0-60.5	45.0-70.0	0.40-1.65
	3	225.1	39.0-49.6	46.0-58.0	0.40-0.78
	2	225.5	50.0-52.0	55.0-61.0	1.90-1.95
	1	227.0	36.0	43.0	0.52
1992	3	118.0	80.0-97.5	95.0-110.0	3.4-5.95
	4	119.0	61.0-102.0	69.0-118.0	1.20-5.50
	1	120.0	70.5	80.5	2.20
	1	121.0	77.0	92.0	3.19
	1	123.0	78.0	90.5	3.3
	1	134.0	77.1	90.5	2.95
	1	161.0	67.3	77.5	2.10
	1	174.3	56.0	62.0	1.06
	1	182.5	51.5	59.0	0.78
	1	190.3	61.2	71.0	1.53
	1	190.4	73.0	86.0	4.25
	1	203.4	74.0	85.0	5.20
	4	203.5	52.0-66.0	62.0-75.0	1.55-1.90
	1	204.0	59.0	69.5	1.50
	1	204.3	64.5	75.0	1.77
	1	204.7	65.8	75.6	1.60

Appendix 4. Continued.

Year class	Number captured	Capture rkm	Fork length (cm)	Total length (cm)	Weight (kg)
1992. Continued.	17	205.0	49.0-68.6	58.0-79.2	2.00
	1	205.3	50.0	90.0	1.80
	2	205.4	62.0-65.3	75.0-75.2	1.83
	6	205.5	49.0-69.0	57.0-79.1	0.20-3.50
	1	205.6	54.0	64.0	—
	1	208.0	70.4	79.4	1.90
	1	210.5	66.3	75.6	1.80
	1	215.0	50.0	59.0	0.70
	2	215.1	59.0-67.90	67.5-81.0	1.11-2.10
	1	215.3	58.0	66.5	1.20
	11	215.5	50.2-72.5	57.9-83.5	0.11-2.13
	8	215.6	45.0-62.0	52.0-75.0	0.48-2.40
	6	215.7	42.0-66.0	49.0-77.0	1.05-2.30
	1	215.8	57.0	65.0	1.08
	1	215.9	63.0	75.0	1.35
	2	216.0	49.0-67.5	56.0-78.6	0.70-1.78
	2	217.1	30.0-36.0	35.0-44.0	0.35-0.51
	1	224.5	56.5	66.5	1.16
	2	224.9	50.0-69.5	61.0-80.5	1.30-1.68
	5	225.0	31.0-55.0	37.0-65.0	0.35-1.10
	5	225.1	47.0-62.0	56.0-73.0	0.60-1.30
	1	227.0	66.0	80.0	1.70
	1	227.4	59.1	62.0	1.00
	1	227.8	42.0	49.0	0.90
	1	229.0	46.0	55.0	0.55
1995	5	118.0	63.1-74.0	72.6-84.6	1.8-3.05
	3	119.0	49.0-58.0	56.5-67.1	0.70-1.27
	11	120.0	56.5-86.9	65.5-99.0	0.83-3.90
	16	121.0	43.9-74.0	50.0-85.5	0.53-2.20
	4	123.0	65.2-75.0	70.1-85.7	1.30-2.60
	3	130.0	38.0-49.5	43.9-57.4	0.46-0.73
	3	134.0	49.0-70.5	57.0-81.3	0.73-2.4
	1	137.0	50.9	59.2	0.76
	1	141.0	53.8	60.4	0.83
	1	144.3	39.8	45.3	0.38
	2	144.5	29.0-45.5	33.5-52.0	0.14-0.56
	4	145.0	42.5-61.0	50.0-70.5	0.50-1.40
	1	157.0	54.1	62.6	0.99
	1	157.5	33.2	37.3	0.18
	2	161.0	45.6	51.8	0.44
	1	163.0	49.1	56.9	0.73
	1	174.5	52.4	60.7	0.77
	1	176.0	33.9	40.0	0.20
	4	176.3	24.7-49.3	40.0-58.1	0.15-0.68
	4	176.4	42.5-51.0	50.0-59.0	0.42-0.71
	2	176.5	39.3-44.1	46.2-53.0	0.33-0.48
	2	177.3	37.9-45.0	43.7-52.0	0.28-0.49
	1	184.9	44.2	51.0	0.31
	1	185.0	39.1	43.3	0.33
	1	189.9	51.5	59.5	0.74
	18	190.0	31.0-62.0	36.0-72.3	0.15-1.41
	4	190.1	36.8-54.0	43.9-63.5	0.28-0.87
	2	190.3	27.2-48.5	31.7-56.0	0.15-0.63
	1	190.4	43.0	50.5	0.47
	1	191.9	35.7	41.3	0.20
	2	192.0	34.7-61.4	38.2-71.8	0.18-1.49
	1	192.1	36.1	42.0	0.25
	3	195.7	35.5-50.0	42.0-57.0	0.24-0.65

Appendix 4. Continued.

Year class	Number captured	Capture rkm	Fork length (cm)	Total length (cm)	Weight (kg)
1995.	2	195.8	47.5-49.0	55.5-57.0	0.64-1.34
Continued.	1	195.9	43.0	50.5	0.42
	1	203.3	39.3	45.5	0.34
	2	203.4	33.2-37.0	38.5-42.9	0.25-0.36
	7	203.5	36.5-49.8	42.5-57.5	0.28-0.60
	6	204.0	37.9-61.0	43.5-70.0	0.27-1.39
	1	204.1	39.0	45.0	0.35
	1	204.3	44.0	51.0	0.35
	3	204.7	43.0-54.3	49.8-63.6	0.43-1.00
	5	204.8	35.4-50.3	41.2-58.4	0.26-0.67
	7	204.9	35.2-48.0	41.2-55.2	0.20-0.62
	159	205.0	30.8-69.1	35.0-81.1	0.13-2.30
	3	205.3	38.0-50.0	44.0-51.0	0.30-0.76
	10	205.4	36.0-50.5	42.2-58.5	0.28-0.78
	33	205.5	26.0-62.1	31.0-71.8	0.08-1.50
	2	213.2	51.4-58.1	60.2-67.0	0.85-1.17
	1	213.5	58.6	67.6	1.13
	32	215.0	33.1-67.3	37.8-77.6	0.10-0.18
	9	215.1	36.1-49.5	41.1-58.2	0.25-0.69
	6	215.2	25.0-47.0	30.0-55.5	0.05-0.55
	23	215.4	31.2-49.0	36.5-56.4	0.20-0.75
	149	215.5	25.5-64.8	29.1-74.0	0.06-1.32
	41	215.6	30.0-48.9	34.2-56.8	0.13-0.60
	61	215.7	25.0-54.8	29.0-63.8	0.05-0.93
	9	215.8	25.0-50.2	30.0-58.4	0.08-0.68
	2	216.0	40.5-45.6	47.3-52.5	0.39-0.53
	4	219.0	22.0-58.4	25.3-67.4	0.10-1.18
	2	219.8	28.7-33.5	33.5-39.0	0.13-0.25
	1	220.0	32.5	38.0	0.24
	4	222.0	25.9-30.5	30.0-35.0	0.20-0.30
	1	222.7	33.0	38.2	0.20
	1	224.0	61.2	70.9	1.32
	1	224.5	39.0	45.4	0.34
	2	224.6	29.4-35.0	33.0-42.0	0.15-0.19
	12	224.7	31.4-50.9	36.0-58.7	0.18-0.95
	16	224.8	31.9-50.1	36.2-59.3	0.18-0.76
	24	224.9	30.4-64.0	34.2-74.0	0.15-1.70
	105	225.0	21.0-65.9	24.0-75.6	0.05-1.49
	33	225.1	28.0-55.4	32.0-64.2	0.09-1.20
	2	225.2	24.0-27.0	28.0-32.0	0.05
	1	225.4	37.1	43.0	0.20
	1	226.1	45.3	52.3	0.53
	5	227.0	29.5-51.0	33.5-61.0	0.10-1.00
	3	227.2	33.0-35.0	38.0-40.5	0.20
	6	227.3	30.0-34.5	34.5-39.0	0.10-0.20
	11	227.4	22.7-41.4	33.0-48.6	0.10-0.45
	2	227.8	48.3-51.5	54.8-60.2	0.65-0.78
	1	229.7	46.3	53.5	0.55
	2	229.8	39.9-42.3	46.6-50.1	0.35-0.38
	1	230.5	51.5	60.3	0.75
	2	230.8	29.0-36.3	35.0-41.3	0.13-0.25
	3	230.9	27.9-47.5	32.3-55.0	0.13-0.68
	1	234.3	33.2	37.0	—
	2	234.4	25.0-37.0	29.0-42.0	0.09-0.20
	5	234.5	224.0-52.0	27.0-60.2	0.06-0.83
	1	244.0	56.8	66.2	0.98

Appendix 4. Continued.

Year class	Number captured	Capture rkm	Fork length (cm)	Total length (cm)	Weight (kg)
1995.	1	244.4	33.8	43.4	—
Continued.	1	244.5	48.2	56.6	0.65
	1	244.6	31.5	36.6	0.13
	6	Unknown	45.5-55.5	52.2-65.3	0.56-1.13
1998	1	145.0	28.5	31.1	0.13
	1	204.0	38.4	44.4	0.28
	9	205.0	30.0-41.5	35.0-47.5	0.13-0.42
	1	213.2	35.5	41.5	0.24
	1	213.5	37.7	43.2	0.28
	4	215.0	36.1-50.8	52.0-66.7	0.51-1.22
	6	215.5	22.6-46.6	26.7-52.5	0.08-0.34
	1	215.7	33.2	38.7	0.20
	1	224.0	32.5	38.7	0.20
	1	224.8	36.0	41.7	0.30
	6	224.9	30.0-51.0	35.1-60.2	0.12-0.83
	6	225.0	27.0-38.5	31.6-44.6	0.06-0.36
	2	225.1	27.7-27.8	32.0-32.4	0.10-0.14
	1	226.1	36.1	41.8	0.28
	1	227.4	25.7	30.5	0.07
	1	227.8	28.4	33.1	0.13
	2	229.8	22.5-25.6	26.4-30.2	0.06-0.10
	1	230.0	54.0	63.7	1.1
	2	230.9	23.5-25.0	28.0-29.5	0.07-0.08
	1	244.5	40.7	47.4	0.35
1999	55	118.0	42.3-74.0	49.5-86.6	0.47-3.25
	2	119.0	—	39.0-45.2	0.24-0.38
	44	120.0	29.1-62.5	33.9-72.0	0.16-1.54
	33	121.0	29.5-65.0	34.0-75.5	0.17-1.95
	12	123.0	32.1-59.6	37.5-69.5	0.19-1.28
	14	130.0	27.6-48.3	31.8-55.8	0.12-0.62
	9	134.0	31.3-40.5	36.5-47.0	0.17-0.38
	4	137.0	28.3-45.0	33.4-57.0	0.14-.70
	8	145.0	26.5-46.0	31.1-53.1	0.11-0.55
	3	150.0	37.5-41.5	43.6-48.2	0.35-0.45
	5	157.0	31.2-35.0	36.9-40.0	0.19-0.27
	14	161.0	27.4-47.0	31.9-55.2	0.13-0.72
	2	163.0	29.0	33.7	0.15
	7	165.0	27.2-36.5	31.0-42.8	0.14-0.27
	2	167.0	32.1-32.7	37.1-38.1	0.16-0.20
	31	174.5	24.1-33.4	28.3-38.9	0.04-0.20
	1	176.1	35.7	42.4	0.25
	1	176.4	26.5	30.5	0.10
	2	176.5	24.5-29.0	28.5-33.6	0.07-0.14
	1	176.9	31.3	36.3	0.17
	5	182.0	30.1-38.5	35.6-44.5	0.15-0.29
	1	189.9	29.0	34.0	0.13
	39	190.0	23.0-47.3	26.5-55.0	0.06-0.63
	2	190.1	27.0-29.0	31.0-33.0	0.10-0.14
	2	190.2	23.5-31.0	28.0-36.0	0.07-0.15
	8	190.3	27.0-41.5	31.1-49.1	0.10-0.36
	5	190.4	27.0-36.0	31.0-41.5	0.10-0.20
	4	192.0	28.5-35.5	33.0-41.4	0.15-0.24
	4	195.7	22.3-32.0	25.9-37.0	0.08-0.20
	12	195.8	24.5-36.0	28.6-42.0	0.07-0.31
	14	195.9	22.5-33.5	26.5-39.2	0.04-0.68
	6	196.0	25.5-33.5	30.0-38.5	0.05-0.23

Appendix 4. Continued.

Year class	Number captured	Capture rkm	Fork length (cm)	Total length (cm)	Weight (kg)
1999. Continued.	1	203.5	27.5	32.1	0.12
	12	204.0	30.5-51.5	35.6-59.7	0.15-86
	3	204.7	26.3-31.7	29.8-38.0	0.11-0.21
	1	204.8	29.0	34.0	0.12
	4	204.9	27.6-32.4	32.0-37.9	0.11-0.19
	217	205.0	19.5-57.5	28.5-66.5	0.05-0.88
	1	205.3	28.0	32.0	0.10
	1	205.4	24.0	29.3	0.05
	49	205.5	25.6-51.5	29.1-60.0	0.11-0.88
	12	207.0	34.4-45.5	40.1-53.0	—
	7	208.0	27.1-35.1	31.4-41.5	0.12-0.23
	4	213.2	29.6-40.6	33.6-47.3	0.15-0.35
	1	213.5	31.0	36.1	0.18
	63	215.0	34.5-51.1	39.6-59.6	0.23-0.80
	83	215.5	20.9-44.5	31.5-52.6	0.14-0.50
	1	216.0	28.9	33.6	0.11
	1	219.0	51.4	59.0	0.70
	1	219.5	36.0	41.2	0.30
	6	224.7	22.6-30.0	24.9-34.9	0.05-0.15
	8	224.8	25.0-27.4	28.5-32.2	0.08-0.12
	14	224.9	26.9-43.5	30.9-50.7	0.10-0.67
	35	225.0	23.2-51.9	26.1-60.4	0.07-0.82
	1	225.1	26.5	30.7	0.12
	3	230.0	27.0-44.0	32.0-51.2	0.10-0.47
	4	230.9	25.0-27.5	29.0-32.0	0.10-0.14
	2	231.0	25.5-285	30.0-33.5	0.10-0.14
	1	244.0	42.3	49.3	0.47
	4	244.5	27.5-37.1	30.5-43.2	0.11-0.28
	91	Unknown	19.0-39.0	22.0-44.2	0.05-0.90
2000	1	76.0	25.6	31.0	0.11
	19	118.0	36.9-67.0	42.1-77.7	0.29-1.65
	16	120.0	26.3-60.3	30.9-69.3	0.12-1.44
	13	121.0	26.4-51.1	30.4-56.8	0.12-0.75
	7	123.0	29.5-50.1	34.3-57.9	0.14-0.90
	11	130.0	25.1-42.4	29.3-49.3	0.09-0.39
	2	134.0	36.5-42.5	42.5-49.2	0.25-0.48
	1	137.0	28.2	32.6	0.11
	3	141.0	30.8-39.0	34.8-46.0	0.14-0.31
	4	145.0	31.1-33.0	33.2-38.3	0.15-0.24
	2	150.0	29.3-33.5	34.0-39.0	0.19-0.21
	4	157.0	23.5-27.8	27.0-31.9	0.09-0.11
	9	161.0	21.8-33.4	24.5-39.0	0.07-0.24
	3	163.0	25.5-29.0	29.6-33.5	0.13-0.14
	9	165.0	26.0-31.0	29.7-35.6	0.09-0.17
	4	167.0	27.2-35.5	31.4-41.5	0.10-0.26
	2	182.0	29.2-29.4	33.5-34.7	0.13-0.15
	5	190.0	26.1-44.5	30.6-51.7	0.09-0.57
	2	190.3	25.5-29.0	30.9-33.6	0.09-0.14
	2	192.0	30.0	35.0	0.14-0.16
	5	195.8	26.5-34.2	32.3-40.2	0.11-0.27
	1	204.0	37.0	43.1	0.03
	69	205.0	21.0-43.1	26.2-50.0	0.05-0.75
	26	205.5	24.1-42.7	28.0-49.2	0.08-0.42
	2	207.0	33.6-37.3	38.5-42.6	—
	2	208.0	25.6-32.0	30.0-37.5	0.10-0.19
	1	210.0	34.2	40.4	0.25

Appendix 4. Continued.

Year class	Number captured	Capture rkm	Fork length (cm)	Total length (cm)	Weight (kg)
2000. Continued.	10	213.2	26.0-35.3	30.2-41.1	0.10-0.29
	4	213.5	28.0-32.5	32.0-38.6	0.12-0.19
	20	215.0	30.2-44.5	33.8-52.8	0.14-0.62
	25	215.5	25.1-37.7	27.3-44.0	0.09-0.30
	1	219.0	38.7	45.4	0.37
	6	224.0	29.6-38.0	34.3-44.0	0.15-0.31
	9	224.9	32.2-39.0	37.7-45.5	0.23-0.44
	22	225.0	26.1-43.0	30.5-50.0	0.09-0.55
	1	227.8	24.3	27.8	0.09
	1	230.5	32.9	37.5	0.21
	3	Unknown	28.0-32.2	32.4-38.0	0.12-0.18
2001	4	118.0	36.6-64.1	43.0-73.4	0.27-1.95
	2	120.0	52.0-54.0	60.5-62.0	0.89
	1	121.0	51.5	59.0	0.61
	2	123.0	26.2-33.6	31.3-38.8	0.09-0.20
	1	161.0	18.9	21.9	0.04
	2	190.0	31.5-40.8	36.6-47.9	0.19-0.36
	1	192.0	34.9	39.4	0.22
	2	195.8	21.9	25.2	0.06
	3	204.0	35.5-38.0	41.8-44.2	0.25-0.30
	10	205.0	25.0-39.4	28.2-45.2	0.08-0.24
	3	205.5	23.6-29.1	27.2-33.7	0.08-0.13
	1	207.0	35.3	41.3	—
	1	213.2	23.0	26.5	0.07
	1	213.5	24.5	28.9	0.09
	18	215.0	28.9-40.4	30.9-46.2	0.14-0.35
	7	215.5	21.2-29.3	24.4-33.8	0.05-0.15
	2	224.0	22.9-26.1	26.6-30.4	0.07-0.09
	3	224.9	22.3-29.0	25.8-33.2	0.06-0.20
	9	225.0	18.2-36.0	20.6-42.5	0.04-0.27
	1	228.5	22.7	26.6	0.06
2002	2	118.0	51.5-53.0	61.0-62.8	0.89-1.10
	2	120.0	26.0-35.5	30.1-40.9	0.10-0.26
	1	121.0	37.4	43.0	0.31
	2	123.0	26.0-53.5	30.1-62.8	0.08-0.88
	2	130.0	22.0-30.4	25.7-35.6	0.07-0.15
	1	134.0	24.0	27.9	0.09
	1	137.0	26.4	30.6	0.10
	4	145.0	20.8-23.4	24.1-27.1	0.05-0.08
	4	161.0	24.1-57.2	27.8-67.0	0.07-1.14
	2	163.0	19.0-21.9	22.2-25.2	0.030.06
	3	165.0	22.2-23.6	26.1-27.3	0.05-0.07
	2	167.0	15.0-21.0	17.6-24.0	0.03-0.05
	1	190.0	29.3	33.5	0.14
	1	205.0	27.5	31.6	0.11
	2	205.5	27.7	31.4	0.10-0.13
2003	4	118.0	33.8-36.0	39.0-42.0	0.21-0.27
	4	120.0	30.0-39.0	35.0-45.2	0.16-0.45
	10	121.0	21.0-41.0	24.8-48.4	0.08-0.38
	5	123.0	22.5-32.7	26.1-37.0	0.06-0.19
	22	130.0	20.2-40.2	23.4-47.2	0.04-0.37
	26	134.0	19.5-41.5	23.0-48.3	0.05-0.38
	13	137.0	21.3-25.0	24.6-29.5	0.04-0.09
	15	141.0	18.0-33.0	21.5-39.0	0.03-0.21
	58	145.0	19.0-38.0	22.1-44.0	0.04-0.35
	35	150.0	17.8-30.0	20.8-35.6	0.03-0.18
	4	157.0	20.6-26.0	24.1-29.8	0.07-0.10

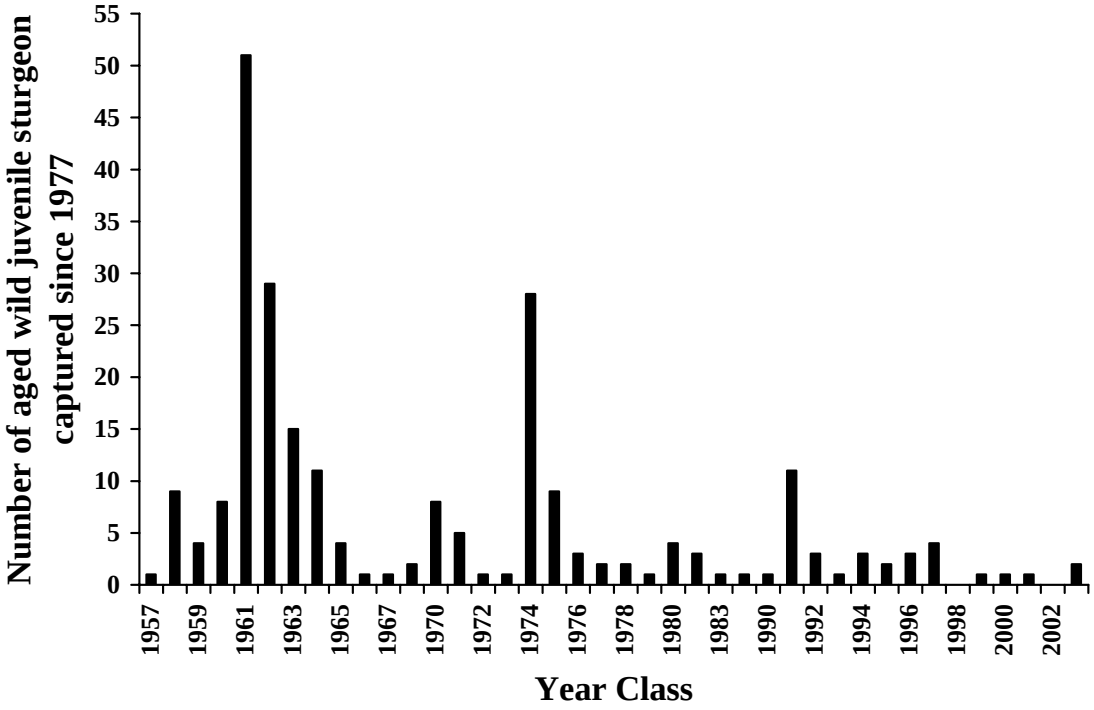
Appendix 4. Continued.

Year class	Number captured	Capture rkm	Fork length (cm)	Total length (cm)	Weight (kg)
2003. Continued.	51	161.0	19.5-32.0	22.8-37.5	0.04-0.17
	12	163.0	20.7-33.5	23.8-32.1	0.04-0.11
	18	165.0	20.7-33.5	24.0-40.0	0.05-0.24
	7	167.0	14.9-32.0	17.1-37.8	0.02-0.18
	15	190.0	28.0-41.4	32.7-49.0	0.13-0.45
	3	192.0	25.8-27.2	29.6-31.7	0.09-0.11
	4	204	31.0-35.7	36.1-41.5	0.02-0.22
	16	205.0	23.5-38.5	27.2-45.2	0.08-0.34
	22	215.0	22.5-42.4	26.5-50.0	0.07-0.47
	4	225.0	25.8-34.0	29.7-38.5	0.11-0.24
	1	230.0	31.2	36.8	0.18
2004	1	118.0	27.9	32.1	0.11
	1	123.0	28.0	32.1	0.12
	7	130.0	23.6-36.0	27.5-42.7	0.08-0.26
	1	134.0	23.8	28.4	0.07
	5	141.0	20.5-21.5	23.1-25.3	0.04-0.06
	11	145.0	19.0-29.1	22.0-34.1	0.02-0.14
	4	150.0	17.8-31.0	21.0-35.1	0.04-0.15
	2	157.0	25.5-28.0	29.6-30.5	0.08-0.12
	5	161.0	24.0-29.2	27.9-34.2	0.07-0.14
	2	165.0	28.0-30.0	32.6-35.2	0.11-0.15
	1	167.0	29.0	33.4	0.12
	1	190.0	32.1	37.3	0.13
	2	204.0	25.9-30.0	30.0-33.5	0.09-0.12
	5	205.0	23.0-25.6	25.0-39.8	0.07-0.10
	1	215.0	35.5	41.9	0.25
	3	225.0	25.6-30.8	26.0-36.4	0.06-0.17
	5	244.0	21.5-24.7	25.3-28.7	0.06-0.09
	3	244.5	25.4-28.7	29.9-33.6	0.09-0.14
2005	2	120.0	23.1-25.4	27.3-29.5	0.06-0.08
	4	130.0	23.3-24.8	26.8-29.6	0.06-0.17
	1	134.0	22.6	26.5	0.06
	4	137.0	25.9-28.0	30.0-33.2	0.07-0.12
	10	141.0	20.5-26.5	24.0-30.9	0.04-0.10
	16	145.0	19.5-27.1	23.2-31.8	0.04-0.11
	1	157.0	25.5	30.7	0.09
	6	161.0	21.3-26.9	22.9-31.1	0.05-0.10
	2	163.0	20.9-24.1	24.5-28.8	0.04-0.09
	5	165.0	23.0-27.6	27.0-33.0	0.06-0.11
	3	190.0	20.8-27.8	23.2-32.1	0.05-0.09
	3	192.0	22.6-24.3	26.9-27.6	0.06-0.08
	9	204.0	19.5-25.5	22.6-29.2	0.03-0.08
	1	205.0	20.5	23.7	0.05
	1	215.0	28.6	33.2	0.12
	3	225.0	20.0-22.7	24.3-26.0	0.06-0.07
	3	229.0	25.1-28.6	29.5-33.0	0.08-0.13
	20	244.5	18.5-26.5	21.1-40.9	0.03-0.23
2006	1	130.0	23.6	27.9	0.07
	1	145.0	22.0	25.5	0.04
Unknown year class	4	118.0	44.5-60.0	51.5-69.2	0.52-1.80
	2	120.0	41.5-52.6	47.9-48.0	0.35-0.42
	4	121.0	24.5-76.0	28.5-91.0	0.08-3.25
	3	130.0	18.0-40.0	21.8-46.1	0.03-0.35
	4	145.0	19.5-38.3	22.8-44.7	0.04-0.30
	1	150.0	30.1	34.9	0.19
	6	161.0	22.1-31.8	25.9-36.5	0.07-0.18

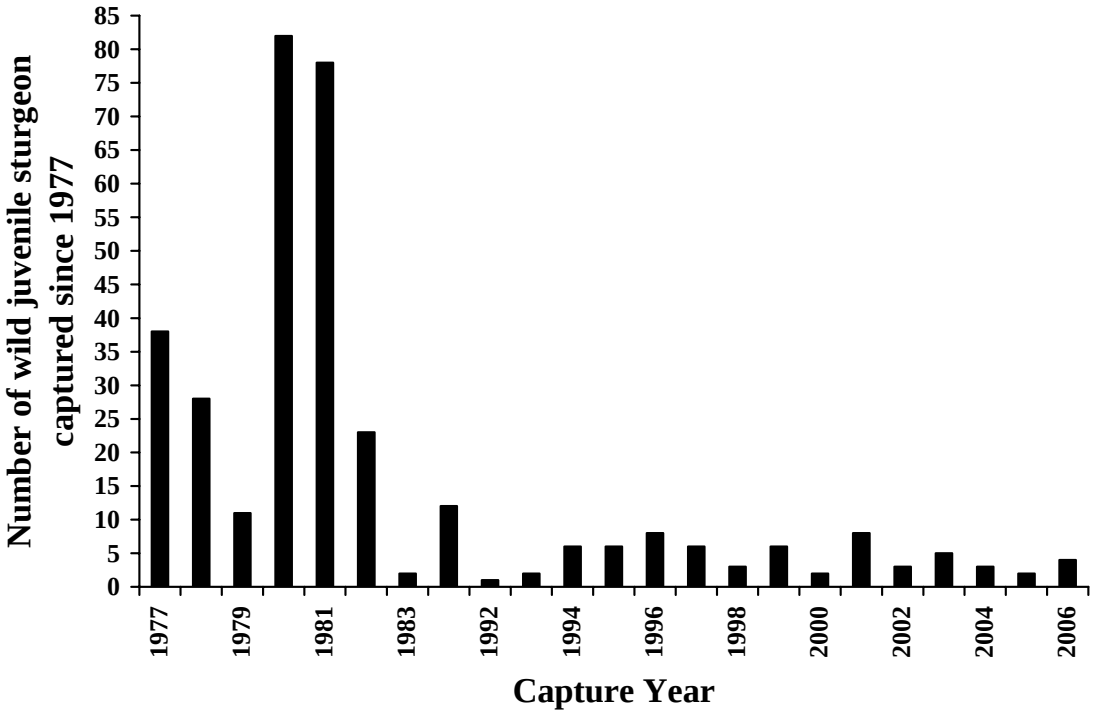
Appendix 4. Continued.

Year class	Number captured	Capture rkm	Fork length (cm)	Total length (cm)	Weight (kg)
Unknown year class. Continued.	2	163.0	18.5-25.6	21.0-29.6	0.03-0.07
	5	165.0	16.8-25.0	19.0-29.2	0.03-0.08
	2	167.0	15.4-15.8	17.8-18.3	0.02
	6	190.0	20.5-29.6	24.7-34.1	0.07-0.20
	4	192.0	21.4-33.0	24.6-38.8	0.06-0.20
	1	195.8	34.2	38.0	0.20
	4	204.0	21.2-72.5	25.0-84.8	0.05-0.56
	20	205.0	15.4-74.0	17.2-87.0	0.01-2.80
	6	205.5	33.4-35.0	38.1-40.7	0.16-0.33
	4	207.0	26.8-56.3	31.8-65.1	0.08
	5	215.0	26.4-43.7	30.4-51.2	0.09-0.46
	1	215.4	61.0	72.0	1.10
	10	215.5	21.8-51.0	24.7-58.3	0.07-0.90
	2	219.5	30.9-33.0	35.5-36.7	0.20-0.23
	3	224.9	30.0-36.1	34.6-40.7	0.13-0.26
	7	225.0	23.1-37.2	26.7-44.0	0.07-0.50
	1	230.0	30.0	35.0	0.13
	3	244.5	19.1-21.2	22.0-24.6	0.04-0.05
	1	Unknown	24.0	27.2	0.08
Total	3252				

Appendix 5. Number of aged wild juvenile white sturgeon captured by year class in the Kootenai River, Idaho, since 1977.



Appendix 6. Number of wild juvenile white sturgeon captured in the Kootenai River, Idaho, since 1977.



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