April 2001

WHITE STURGEON MITIGATION AND RESTORATION IN THE COLUMBIA AND SNAKE RIVERS UPSTREAM FROM BONNEVILLE DAM

APRIL 1999 - MARCH 2000

Annual Progress Report

DOE/BP-63584-14

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WHITE STURGEON MITIGATION AND RESTORATION IN THE COLUMBIA AND SNAKE RIVERS UPSTREAM FROM BONNEVILLE DAM.

ANNUAL PROGRESS REPORT

APRIL 1999 - MARCH 2000

Edited by:

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In Cooperation With:

Washington Department of Fish and Wildlife
U.S. Geological Survey Biological Resources Division
Columbia River Inter-Tribal Fish Commission
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EXECUTIVE SUMMARY

We report on our progress from April 1999 through March 2000 on determining the effects of mitigative measures on productivity of white sturgeon populations in the Columbia River downstream from McNary Dam, and on determining the status and habitat requirements of white sturgeon populations in the Columbia and Snake rivers upstream from McNary Dam. The study is a cooperative effort by the Oregon Department of Fish and Wildlife (ODFW; Report A), Washington Department of Fish and Wildlife (WDFW; Report B), U.S. Geological Survey Biological Resources Division (USGS; Report C), Columbia River Inter-Tribal Fish Commission (CRITFC; Report D), and the U.S. Fish and Wildlife Service (USFWS; Report E).

This is a multi-year study with many objectives requiring more than one year to complete. Therefore, findings from a given year may be part of more significant findings yet to be reported. Highlights of results of our work from April 1999 through March 2000 are:

Report A

(1) ODFW and CRITFC staff marked 6,143 white sturgeon in Bonneville Reservoir for mark/recapture population estimates. This high number of marked fish resulted in a more precise abundance estimate than was possible in previous efforts.

(2) Abundance of white sturgeon over 54 cm fork length in Bonneville Reservoir was estimated to be 128,548 fish, approximately 50,000 more fish than estimated in 1989 and 1994. Estimates based on size class indicated abundances of 10,991 fish from 96-109 cm, 3,083 fish from 109-137 cm, and 1,000 fish over 137 cm.

(3) Relative weights of white sturgeon from Bonneville Reservoir in 1999 were significantly lower than in 1994, when the reservoir was last sampled.

(4) In late 1999 we transplanted 4,248 white sturgeon (30-90 cm fork length) from below Bonneville Dam to The Dalles (77) and John Day (4,171) reservoirs.

(5) As in previous years, while sampling for young-of-the-year white sturgeon, catch per effort and proportion of positive net sets were highest in downstream reservoirs, and decreased progressively moving upstream.

Report B

(1) We sampled the1999 recreational fishery between Bonneville and McNary dams (Zone 6 management unit) to estimate white sturgeon harvest. We estimated that 1,236, 694, and 422 white sturgeon were harvested from Bonneville, The Dalles, and John Day reservoirs respectively. Managers used our projections of estimated harvest to close the retention season in Bonneville Reservoir on April 17th and on June 12th in The Dalles. The season in John Day Reservoir remained open year-round.

(2) A new active management strategy that relied on our in-season harvest estimates and projections successfully eliminated the reoccurring white sturgeon over-harvest in Zone 6 recreational fisheries. Recreational harvest averaged 97%(Bonneville), 103%(The Dalles),

and 85% (John Day) of the Sturgeon Management Task Force's (SMTF) annual harvest guidelines since 1995. Prior to pro-active in-season management (1991-1994), sport harvest averaged 158% (Bonneville), 163% (The Dalles), and 169% (John Day) of the respective guidelines. The 1991-1999 average for Zone 6 sport and commercial fisheries is 114% (Bonneville), 113% (The Dalles), and 98% (John Day) of the combined sport and commercial guidelines.

(3) Harvest per angler trip declined for the fourth consecutive year in Bonneville Reservoir. Harvest per angler trip in The Dalles Reservoir declined from the 1998 level but was still greater than any year since guidelines were established in 1991. Harvest per angler trip in John Day Reservoir declined for the second consecutive year following 1997's eleven-fold increase in the guideline.

Report C

(1) In an ongoing telemetry study, only two of seven adult male white sturgeon moved into known spawning areas, suggesting that periodicity of spawning among males may be greater than one year.

(2) Bottom trawling for juvenile white sturgeon in September and October revealed that recruitment to young of the year occurred in Bonneville, The Dalles, and John Day reservoirs. River discharges and water temperatures during 1999 were favorable for spawning downstream from McNary, John Day, the Dalles, and Bonneville dams.

(3) Study designs for laboratory experiments investigating predation on larval and juvenile white sturgeon were completed. Experiments will begin in 2000.

Report D

(1) Techniques were developed for capturing, holding and spawning white sturgeon from Columbia River reservoirs above McNary dam. A total of 212 white sturgeon were captured in 130 setline sets during 19 days of fishing. Nine sexually mature white sturgeon were taken for broodstock trials. Gametes from both male and female white sturgeon were collected. Timing of male and female gamete production did not coincide, subsequently fertilization was not possible. Trials indicate that cool water temperatures at the holding facility interrupted the natural sexual maturation of female broodstock and prevented successful artificial spawning. Development of a holding facility that utilizes natural Columbia River water is underway.

(2) Mark/tagging operations used for monitoring the abundance of white sturgeon in Zone Six were completed in Bonneville Reservoir. We captured 3537 white sturgeon in 601 gillnets sets from 11 November, 1998 through 13 January, 1999. A total of 3,298 white sturgeon were marked with the 8th right scute removal pattern, 2,645 of these white sturgeon were pit tagged.

Report E

(1) Wild maturing white sturgeon were successfully captured, held through the spawning season, then released back to the site of origin.

(2) Although not in synchronous spawning, viable gametes were collected from both male and female white sturgeon.

(3) By changing adult holding protocol and increasing the number of males per female white sturgeon, a viable spawning is expected in 2000.

WHITE STURGEON MITIGATION AND RESTORATION IN THE COLUMBIA AND SNAKE RIVERS UPSTREAM FROM BONNEVILLE DAM

ANNUAL PROGRESS REPORT

APRIL 1999 - MARCH 2000

Report A

Evaluate the success of developing and implementing a management plan for enhancing production of white sturgeon in reservoirs between Bonneville and McNary dams

This report includes: An update of abundance, life history parameters, and population dynamics of white sturgeon in Bonneville Reservoir, results of transplant supplementation in The Dalles and John Day reservoirs, and a summary of gill-net effort and catch targeting young-of-year white sturgeon in Columbia and Snake River reservoirs.

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ABSTRACT

This report summarizes data collected from April 1999 through March 2000 to update life history parameters and population dynamics of white sturgeon *Acipenser transmontanus* in Bonneville Reservoir, document young-of-year recruitment of white sturgeon in three Columbia River and two Snake River reservoirs, and continue transplant supplementation of juvenile white sturgeon from the lower Columbia River below Bonneville Dam to The Dalles and John Day reservoirs.

Sampling to estimate white sturgeon abundance was coordinated with staff of the Columbia River Inter-Tribal Fish Commission (CRITFC) who contracted with commercial fishers to capture and mark white sturgeon in Bonneville Reservoir in December 1998 and January 1999. Staff from Oregon Department of Fish and Wildlife (ODFW) set 729 setlines from 3 May through 30 August 1999, and captured 7,377 white sturgeon. White sturgeon were distributed throughout Bonneville Reservoir, but catch rates were highest in the lower portions of the reservoir. Recaptured fish were most often caught near the site of marking, however, marked fish moved an average of 0.66 km downstream between marking and subsequent recapture. Combined effort by CRITFC and ODFW resulted in 6,143 white sturgeon being marked with passive integrated transponder (PIT) tags between December 1998 and August 1999. Using multiple mark-recapture estimates, we estimated the total population of white sturgeon in Bonneville Reservoir in 1999 to be 128,548 fish. A large data set of marks and recaptures of fish of various sizes allowed us to use a more robust method to estimate population abundance in 1999 than has previously been possible. This estimate is much higher than estimates from 1989 and 1994 that each indicated a population size of approximately 50,000 individuals. The majority of this population growth is comprised of individuals below 107 cm fork length, with no discernable difference in abundance of oversize white sturgeon between 1989, 1994, and 1999 estimates.

We assessed recruitment of young-of-year (YOY) white sturgeon using standardized gill nets and fishing locations in The Dalles, John Day, McNary, Ice Harbor, and Little Goose reservoirs. Sampling efforts were coordinated with similar surveys conducted using trawl gear by the United States Geological Service to facilitate comparison of the two methods. Catch rates of YOY white sturgeon were relatively high in The Dalles Reservoir with a mean catch of 8.14 YOY sturgeon per net set, but declined as sampling progressed upstream, with a low of 0.03 YOY white sturgeon per net set in Ice Harbor Reservoir.

Transplant supplementation (trawl-and-haul) continued in 1999 with transplant of juvenile white sturgeon from below Bonneville Dam to The Dalles and John Day reservoirs. Using trawl gear, a total of 4,728 mostly juvenile white sturgeon were captured below Bonneville Dam by the National Marine Fisheries Service. The majority of transplants were made to John Day Reservoir, with 4,171 of the total 4,248 white sturgeon moved being transplanted to this reservoir. All transplanted fish were marked by scute removal to identify the year of their capture, however, none of these fish were PIT-tagged.

INTRODUCTION

This report summarizes work performed by the Oregon Department of Fish and Wildlife (ODFW) during the period April 1999 through March 2000 in accordance with tasks outlined in the Bonneville Power Administration funded Project 86-50 Performance Work Statement. During this period we participated in three distinct efforts to assess or restore productivity of white sturgeon *Acipenser transmontanus* in the Columbia River upstream from Bonneville Dam (Figure 1): 1) During May through September 1999 we assessed abundance and productivity measures of white sturgeon in Bonneville Reservoir. 2) During October and November 1999, we coordinated an effort to transplant juvenile white sturgeon from the Columbia River downstream of Bonneville Dam to The Dalles and John Day reservoirs. 3) During October and November 1999, we participated in assessing recruitment of young-of-year (YOY) white sturgeon in The Dalles, John Day, and McNary reservoirs in the Columbia River, and Ice Harbor and Little Goose reservoirs in the Snake River.

METHODS

Stock Assessment

We sampled for white sturgeon in Bonneville Reservoir from early May through late August to estimate population statistics. The reservoir was divided into eight sections, each about 9.5 km long (Figure 1). The boat-restricted zone (BRZ) immediately downstream from The Dalles Dam was not sampled due to turbulent water and restricted access associated with dam spill. Past sampling has shown white sturgeon catch rates are typically highest in the BRZ's of Columbia River dams (North et al. 1993a). We distributed setline sampling effort equally among and within the eight sections to obtain a representative sample of the population. We divided the field season into four 4-5 week sampling periods and sampled all sections during each period (Table 1).

We used setlines as our primary sampling gear because they are less size selective and less damaging to sturgeon than other gears and provide suitable catch rates for our objectives (Elliott and Beamesderfer 1990). Setlines were equipped with 12/0, 14/0, and 16/0 hooks with individual lines containing 13 hooks each of two sizes and 14 hooks of the remaining size, which was chosen randomly for each line. Setlines were fished overnight for an average of 23.8 hours, and all lines were baited with pickled squid *Loligo* spp., which yields higher catch rates than baits used in the past (North et al. 1998). Gill nets, described by Rien et al. (1991), were also used in an attempt to increase our catch of white sturgeon <80 cm FL. All gill nets were fished for 1-hour intervals.

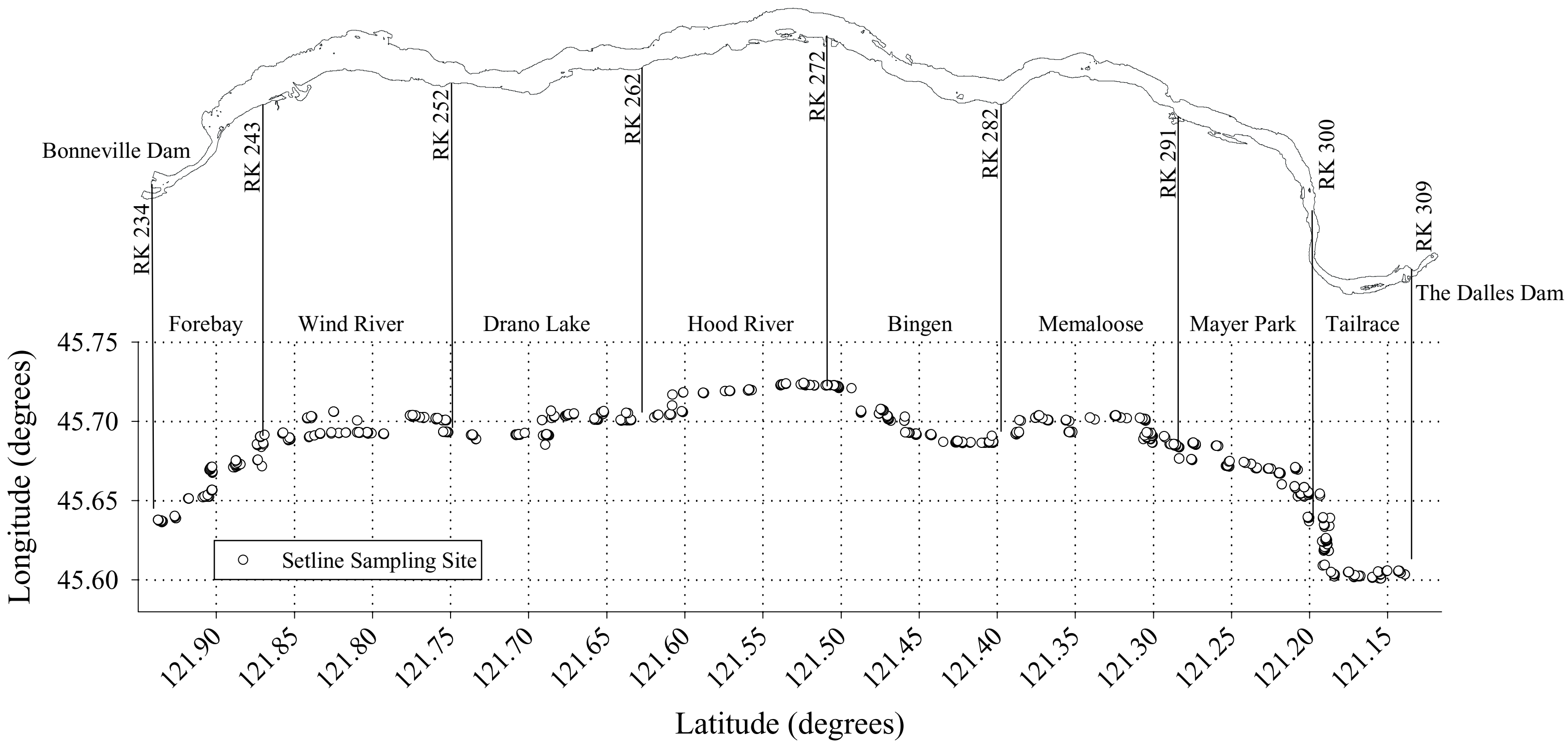

Figure 1. Setline sampling sections in the Columbia River, Bonneville Reservoir, 1999. Scale is approximate (RK = river kilometer).

Table 1. Sampling effort (number of setline sets) for white sturgeon in Bonneville Reservoir by week and sampling section, May through August 1999. A "--" indicates sampling was not conducted.

	Sampling Section								
Week	1	2	3	4	5	6	7	8	Total
May 3	--	--	--	--	18	20	--	--	38
May 10	--	--	20	20	--	--	--	--	40
May 17	--	--	--	--	--	--	23	21	44
May 24	18	18	--	--	--	--	--	--	36
May 31	--	--	--	--	--	--	--	--	0
June 7	--	--	--	--	22	22	--	--	44
June 14	--	--	16	15	--	--	--	--	31
June 21	--	--	--	--	--	--	24	22	46
June 28	24	24	--	--	--	--	--	--	48
July 5	--	--	--	--	--	--	--	--	0
July 12	--	--	--	--	24	24	--	--	48
July 19	--	--	24	22	--	--	--	--	46
July 26	--	--	--	--	--	--	24	24	48
August 2	24	24	--	--	--	--	--	--	48
August 9	--	--	--	--	25	21	--	--	46
August 16	--	--	27	28	--	--	--	--	55
August 23	--	--	--	--	--	--	30	27	57
August 30	27	27	--	--	--	--	--	--	54
Total	93	93	87	85	89	87	101	94	729

We measured fork length (cm), and looked for tags, tag scars, fin marks, and scute marks on all white sturgeon captured. All measurements herein are fork length unless otherwise indicated. We removed a pectoral fin-spine section for aging and weighed a subsample of the catch (up to 30 fish per 20-cm length interval). Due to concerns about relative weight and condition of fish sampled early in the season, we weighed an additional 30 fish per 20-cm interval beginning on 9 August. Most white sturgeon were tagged with a 125-MHz passive integrated transponder (PIT) tag. The second left lateral scute was removed to identify PIT-tagged fish (Rien et al. 1994). No white sturgeon were externally tagged. Existing external tags detected on fish recaptured from previous sampling were removed. The eighth left lateral scute was removed as a secondary mark to indicate the fish was captured in 1999. Recaptures were weighed to calculate growth rate.

We surgically examined the gonads of most white sturgeon larger than 140 cm to determine sex and stage of maturity. Procedures were similar to those reported by Beamesderfer et al. (1989). A small sample (<1 g) of the gonad was removed from examined fish using biopsy forceps. We verified field sex identification in the laboratory by microscopic examination and classified maturation stage of females according to criteria in North et al. (1993b) that is modified slightly from Chapman (1989).

We injected surgically examined white sturgeon with oxytetracycline (OTC). Fish smaller than 140 cm were not injected, primarily to prevent human consumption via legally harvested sturgeon. We injected 100 mg/mL OTC into the red muscle under the dorsal scutes immediately posterior to the head at a rate of 25 mg per kg of body weight (McFarlane and Beamish 1987). The second right lateral scute was removed from OTC-injected fish for identification.

Age of white sturgeon was estimated from thin cross-sections of pectoral fin-spines following procedures outlined in Beamesderfer et al. (1989). Each fin-spine section was aged twice each by two experienced staff, and up to 20 fish for each 20-cm length interval were aged. An age-length frequency distribution was developed from these age assignments and added to a database of existing length-at-age information. We derived a Von Bertalanffy age and growth equation using age-at-length data and SAS (PROC GLM) two-way ANOVA.

Paired samples of fork length and weight were used to calculate a length-weight regression to estimate weight of fish with known fork length and unknown weight. Relative weights (W_r) were calculated to assess the relative condition of white sturgeon larger than 70 cm fork length. We used ANOVA and a Tukey's studentized range test (SAS 1988) to test for significant differences in relative weights of fish examined in Bonneville Reservoir during three collection periods: April – September 1994, 3 May – 9 August 1999, and 9 August – 30 August 1999.

We collected 1-cm^2 pieces of pectoral fin from 398 white sturgeon (Appendix Table A-1) for DNA analyses. Samples were placed in lysis buffer and transferred to the University of Idaho for analysis by a separate, BPA-funded project. We also collected 24 plasma samples in conjunction with gonad samples to test blood steroid sexing methodology being developed at Oregon State University. Unfortunately, a freezer breakdown resulted in two of the DNA samples and all 24 of the plasma samples being destroyed.

Recoveries of marks from previous years were used to determine movement patterns among reservoirs. For fish marked with only a PIT tag, or with a PIT tag and external tag, only the PIT tag information was used to track the fish. For fish with external tags only, external tag information was used. Recaptured fish with known mark histories were grouped according to the year and reservoir they were originally marked in. In cases of multiple captures within 1999, only the first capture was used to determine movement among reservoirs.

In past years, fish abundance has been estimated using a Schnabel multiple mark and recapture estimator (Ricker 1975) for fish in the 70–166 cm size class (Beamesderfer et al. 1995). After an abundance estimate for fish 70–166 cm was made, estimates for fish below and above this size class were made based on their relative proportion in the catch, adjusted for relative vulnerability of each size to capture by setline as estimated from recapture rates of marked fish. In 1999, larger numbers of fish were captured and marked, allowing a more robust estimate of abundance by a different method. Initial abundance estimates were calculated for fish in the 54 – 95 cm and 96 – 109 cm size classes because differences in catchability between these size classes have been documented in previous study years. These estimates were summed and the abundance of fish larger than 109 cm was estimated based on catch length frequency data. Fish below 54-cm fork length were not included in abundance estimates. This method did not rely on calculations of gear vulnerability, eliminating a potential source of bias. However, as this method requires large numbers of marks and recaptures, we will probably only be able to use it infrequently in the future.

Trawl and Haul Supplementation

From 13 October to 11 November 1999, we transplanted juvenile sturgeon captured in the Columbia River downstream from Bonneville Dam into The Dalles and John Day reservoirs to supplement these populations (Figure 2). Equipment and techniques for fish collection and transportation were nearly identical to work conducted in previous years (Burner et al. 1999). Trawling was conducted by staff of the National Marine Fisheries Service (NMFS), who also provided the trawling vessel and gear. Fish processing and transportation were conducted primarily by ODFW staff with assistance from many volunteers.

Although most fish transported were between 35 and 90 cm fork length, some smaller fish were transported on days when catches were low. We measured a sample of about 100 fish each day to estimate the length frequency of captured fish. All transported fish had their eighth left lateral scute removed for identification. Fish were transported in a 13,000-liter ODFW fish liberation truck, except on the first day of transport, when only a 10,500-liter truck was available. Only one load of fish was transplanted into The Dalles Reservoir, at Celilo Park (RK 325) in Oregon. In John Day Reservoir, all fish were transplanted on the Oregon side of the Columbia at the Arlington Boat Ramp (RK 390), a boat ramp near Three Mile Canyon (RK 414), the Boardman Boat Ramp (RK 434), or the Irrigon Boat Ramp (RK 455).

Young-of-Year Indexing

During October and November of 1999, we sampled three Columbia River reservoirs and two Snake River reservoirs to determine YOY white sturgeon recruitment relative to previous years sampled. Gill nets were used to collect white sturgeon and sampling methodology was similar to past years (Burner et al. 1999). To facilitate comparisons between two methods, gill net sampling was done immediately following sampling by U.S. Geological Survey (USGS) using trawl gear. On the Columbia River, we sampled The Dalles, John Day, and McNary reservoirs, and on the Snake River we sampled Ice Harbor and Little Goose reservoirs. Nets were 91.4 m long and 3.7 m deep and were constructed of 5.1-cm stretched measure multifilament nylon webbing. Nets were set in standardized locations (Parsley et al. 1999) to allow comparisons of relative catch with previous years, and with USGS trawl data. Nets were fished on the river bottom overnight for 21.5 h to 23.1 h. Each overnight set was classified as a single effort. We classified white sturgeon as YOY, based on length frequency distribution. We calculated mean catch per unit effort (CPUE) and proportion of positive efforts for white sturgeon.

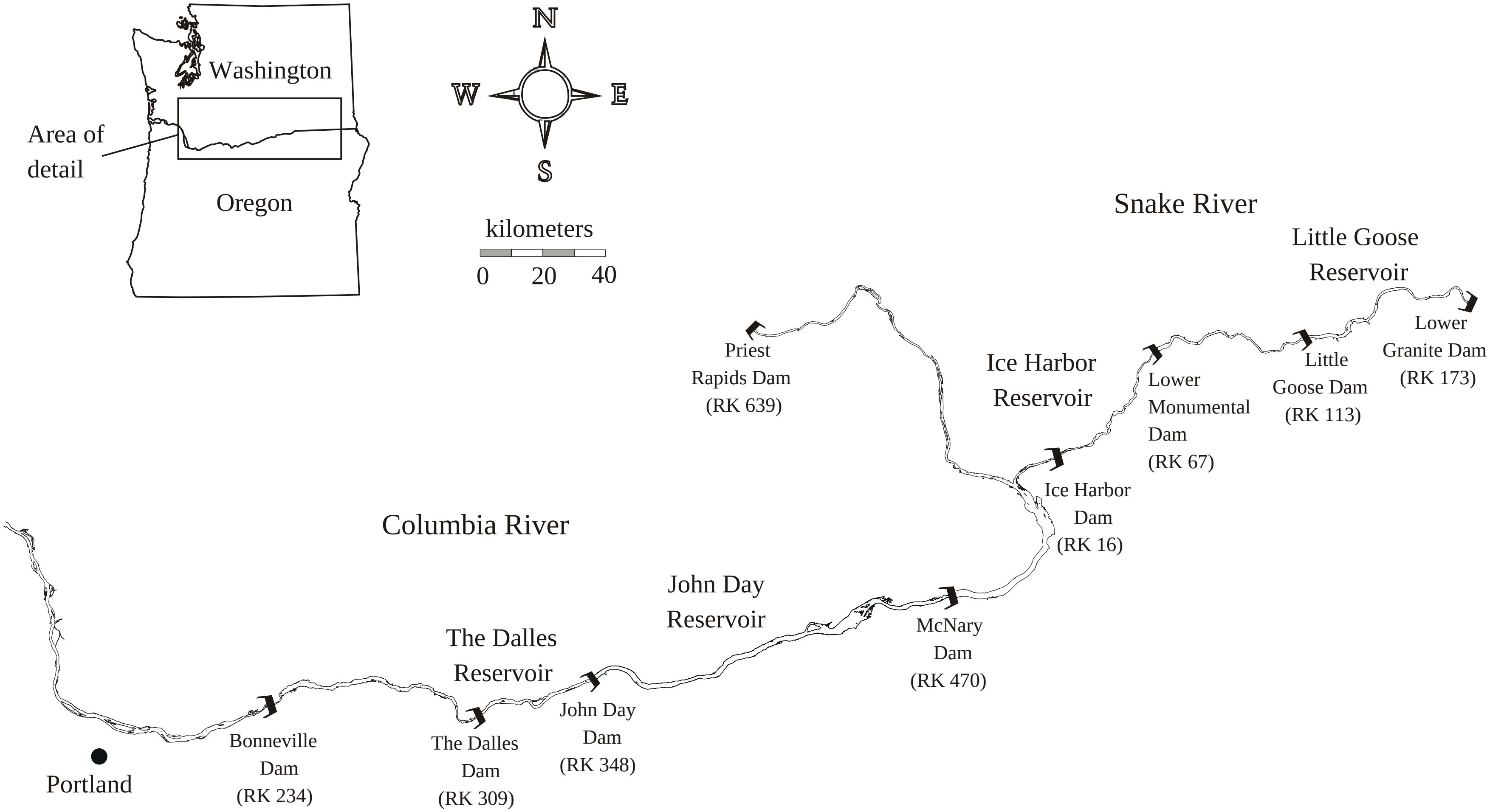

Figure 2. The Columbia River upstream to Priest Rapids Dam and the Snake River upstream to Lower Granite Dam. The scale is approximate. RK = river kilometer.

RESULTS

Stock Assessment

Catch

We caught a total of 7,377 white sturgeon during sampling activities in Bonneville Reservoir from 3 May to 30 August 1999 (Table 2). Setline catch consisted of 88.3% sublegal size (<96 cm), 10.9% legal size (96–137 cm), and 0.6% ‘oversize’ (>137 cm) fish (Figure 3).

Distribution and Movement

We captured white sturgeon throughout Bonneville reservoir, but catches were highest in the three lowermost sections. Catch rates averaged 11.7 fish per setline-day in sections 1–3, and 9.1 fish per setline-day in sections 4–8 (Table 3). The majority of recaptured fish were caught in the same section they were tagged in, with 87% recovered within 10 km of the original marking location (Table 4). The average movement of recaptured fish was 0.66 km downstream from where they were originally marked. Since 1987, only 4 marked white sturgeon have been verified as being captured in a reservoir upstream of the original marking location, 123 have been captured in the reservoir immediately downstream, and 9 have been captured two reservoirs downstream (Table 5, Appendix Tables A-2 to A-5). However, the majority (3,347, or 96%) of sturgeon recaptured have been recaptured within the reservoir they were originally marked in.

Age and Growth

We assigned ages to 181 white sturgeon captured from Bonneville Reservoir in 1999. These data, combined with previously collected age data (Table 6), were used to estimate parameters of a Von Bertalanffy growth equation (Figure 4).

Relative weights of white sturgeon sampled in Bonneville Reservoir in 1999 were significantly lower than in 1994, when the reservoir was last sampled for stock assessment. Mean relative weight in 1999 was 88%, compared to 106% in 1994. Relative weights for fish sampled before and after 9 August 1999 (see **Methods**) were not significantly different from each other, but each was significantly lower than was observed in 1994 ($\rho = 0.05$, d.f. = 2,446).

Table 2. Catches of white sturgeon with setlines in Bonneville Reservoir by week and sampling section, May through August 1999. A "--" indicates sampling was not conducted.

	Sampling Section								
Week	1	2	3	4	5	6	7	8	Total
May 3	--	--	--	--	98	137	--	--	235
May 10	--	--	130	142	--	--	--	--	272
May 17	--	--	--	--	--	--	113	110	223
May 24	107	160	--	--	--	--	--	--	267
May 31	--	--	--	--	--	--	--	--	0
June 7	--	--	--	--	188	166	--	--	354
June 14	--	--	277	163	--	--	--	--	440
June 21	--	--	--	--	--	--	178	264	442
June 28	301	317	--	--	--	--	--	--	618
July 5	--	--	--	--	--	--	--	--	0
July 12	--	--	--	--	271	261	--	--	532
July 19	--	--	275	260	--	--	--	--	535
July 26	--	--	--	--	--	--	266	302	568
August 2	377	388	--	--	--	--	--	--	765
August 9	--	--	--	--	299	233	--	--	532
August 16	--	--	390	259	--	--	--	--	649
August 23	--	--	--	--	--	--	219	213	432
August 30	184	329	--	--	--	--	--	--	513
Total	969	1,194	1,072	824	856	797	776	889	7,377

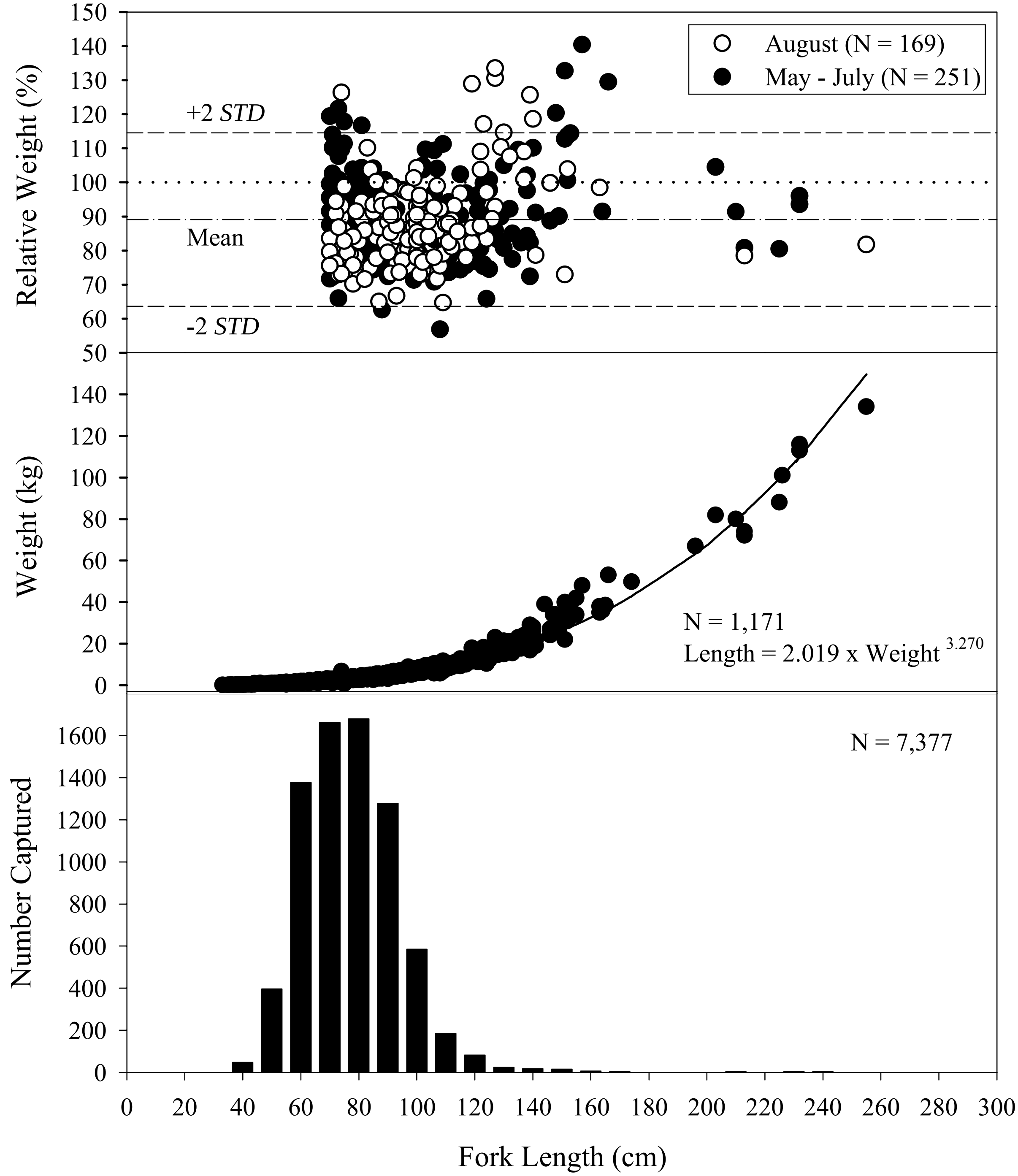

Figure 3. Relative weight, length-weight relationship, and length frequency of white sturgeon caught on ODFW setlines, Bonneville Reservoir 1999.

Table 3. Catch of white sturgeon per setline day in Bonneville Reservoir by month and sampling section, May through August 1999.

	Sampling Section								
Month	1	2	3	4	5	6	7	8	Total
May	5.9	8.9	6.5	7.1	5.4	6.9	4.9	5.2	6.3
June	13.3	13.3	17.3	10.9	8.5	7.5	7.4	12.0	10.9
July	11.1	13.0	11.5	11.8	11.3	10.9	11.1	12.6	11.6
August	11.0	14.1	14.4	9.3	12.0	11.1	7.3	7.9	11.1
Total	10.4	12.8	12.3	9.7	9.6	9.2	7.7	9.5	10.1

Table 4. Numbers of white sturgeon (all lengths) PIT-tagged and recaptured by agency and location in Bonneville Reservoir, May through August 1999.

Tagging Agency	Number	Recapture Location								
Tagging Location	tagged	1	2	3	4	5	6	7	8	Total
CRITFC										
Forebay (1)	70	6	1	0	0	0	1	0	0	8
Wind River (2)	441	6	19	7	2	0	2	0	2	38
Drano Lake (3)	477	6	4	23	1	0	0	0	2	36
Hood River (4)	525	1	2	1	34	2	0	0	1	41
Bingen (5)	123	0	0	0	2	2	1	0	0	5
Memaloose (6)	992	2	2	3	1	0	176	6	4	194
Mayer Park (7)	17	0	0	0	0	0	0	0	0	0
Tailrace (8)	0	0	0	0	0	0	0	0	0	0
Total	2,645	21	28	34	40	4	180	6	9	322
ODFW										
Forebay (1)	681	20	2	0	0	0	0	0	0	22
Wind River (2)	747	4	13	0	0	1	0	0	0	18
Drano Lake (3)	578	5	2	11	1	0	0	1	0	20
Hood River (4)	428	0	0	0	8	2	0	1	0	11
Bingen (5)	396	2	1	1	2	18	2	0	0	26
Memaloose (6)	234	1	1	0	0	0	11	0	0	13
Mayer Park (7)	162	0	0	0	1	1	1	7	0	10
Tailrace (8)	272	0	1	0	0	1	0	0	9	11
Total	3,498	32	20	12	12	23	14	9	9	131

Table 5. Summary of within and out-of-reservoir recaptures of marked white sturgeon within the Columbia Basin, 1987-1999. “Up” refers to sturgeon captured upstream of the reservoir they were marked in (no fish were recaptured more than one reservoir upstream). “Down 1” refers to sturgeon recaptured one reservoir downstream of where they were originally marked, “Down 2” refers to fish recaptured two reservoirs downstream, etc. Numbers of recaptures are cumulative from date of release until the end of 1999 sampling (refer to Appendix Tables A-2 to A-5).

		Recapture Location					
Reservoir	Release year	Up	Within	Down 1	Down 2	Down 3	Down 4
McNary	1993	--	22	3	2	0	0
	1995	--	30	3	0	0	0
	Total	--	52	6	2	0	0
	Percent	--	86.67	10.00	3.33	0	0
John Day	1989	0	6	1	0	0	--
	1990	0	117	12	1	0	--
	1991	0	16	0	0	0	--
	1996	0	364	9	3	0	--
	Total	0	503	22	4	0	--
	Percent	0	95.09	4.16	0.76	0	--
The Dalles	1987	1	198	4	1	--	--
	1988	0	232	24	1	--	--
	1989	1	36	0	0	--	--
	1991	1	68	0	0	--	--
	1993	0	0	1	1	--	--
	1994	0	419	10	0	--	--
	1995	0	448	12	0	--	--
	1997	0	268	11	0	--	--
	Total	3	1,669	62	3	--	--
	Percent	0.17	96.09	3.57	0.17	--	--
Bonneville	1988	0	70	4	--	--	--
	1989	0	336	17	--	--	--
	1991	1	126	12	--	--	--
	1993	0	0	0	--	--	--
	1994	0	138	0	--	--	--
	1999	0	453	0	--	--	--
	Total	1	1,123	33	--	--	--
	Percent	0.09	97.06	2.85	--	--	--

Table 6. Age and length frequency distribution of white sturgeon 30-109 cm fork length collected in Bonneville Reservoir, 1989, 1994, and 1999.

	Fork Length (cm)												
Age (yr)	20-39	40-59	60-79	80-99	100-119	120-139	140-159	160-179	180-199	>199	MEAN	STD	N
1	1										33.0		1
2	10										35.0	2.8	10
3	30	5									37.2	3.9	35
4	13	20	3								44.6	8.7	36
5	7	38	1								47.4	7.5	46
6	6	29	8								51.7	9.6	43
7	1	26	13	1							57.1	9.7	41
8		19	10	1							57.8	10.2	30
9	1	15	13	6							63.9	12.6	35
10	2	4	11	5	1						72.2	18.3	23
11		10	11	6	5	1					75.9	19.4	33
12		4	13	14	4	1					83.6	18.1	36
13		1	6	7	12	2					93.8	19.2	28
14		3	3	8	13	3					96.3	20.9	30
15			8	11	18	12	1				103.9	19.1	50
16		1	5	12	23	12	1				104.9	20.3	54
17		1	6	14	26	20	5				108.6	20.5	72
18			4	13	19	19	1				109.6	18.7	56
19			2	6	14	17	4				114.0	18.1	43
20			3	11	13	13	8	1			114.0	24.2	49
21			1	10	10	12	6	1			118.9	26.4	41
22			4	2	10	14	5	1			118.6	21.6	36
23					7	4	7	3			134.0	19.8	21
24				1	6	9	2	2			128.9	19.9	20
25			1		8	6	3	2	1	1	132.4	30.5	22
26				1	3	7	3	1	2	1	139.9	32.1	18
27					1	5	5		1	1	146.4	26.8	13
28				3		5	8	1	1	1	139.8	30.5	19
29				2	4	3	3	2		2	142.4	43.1	16
>29				1	4	12	3	2	10	26	185.6	49.1	58
ALL	71	176	126	135	201	177	65	16	15	33	98.1	43.3	1,015

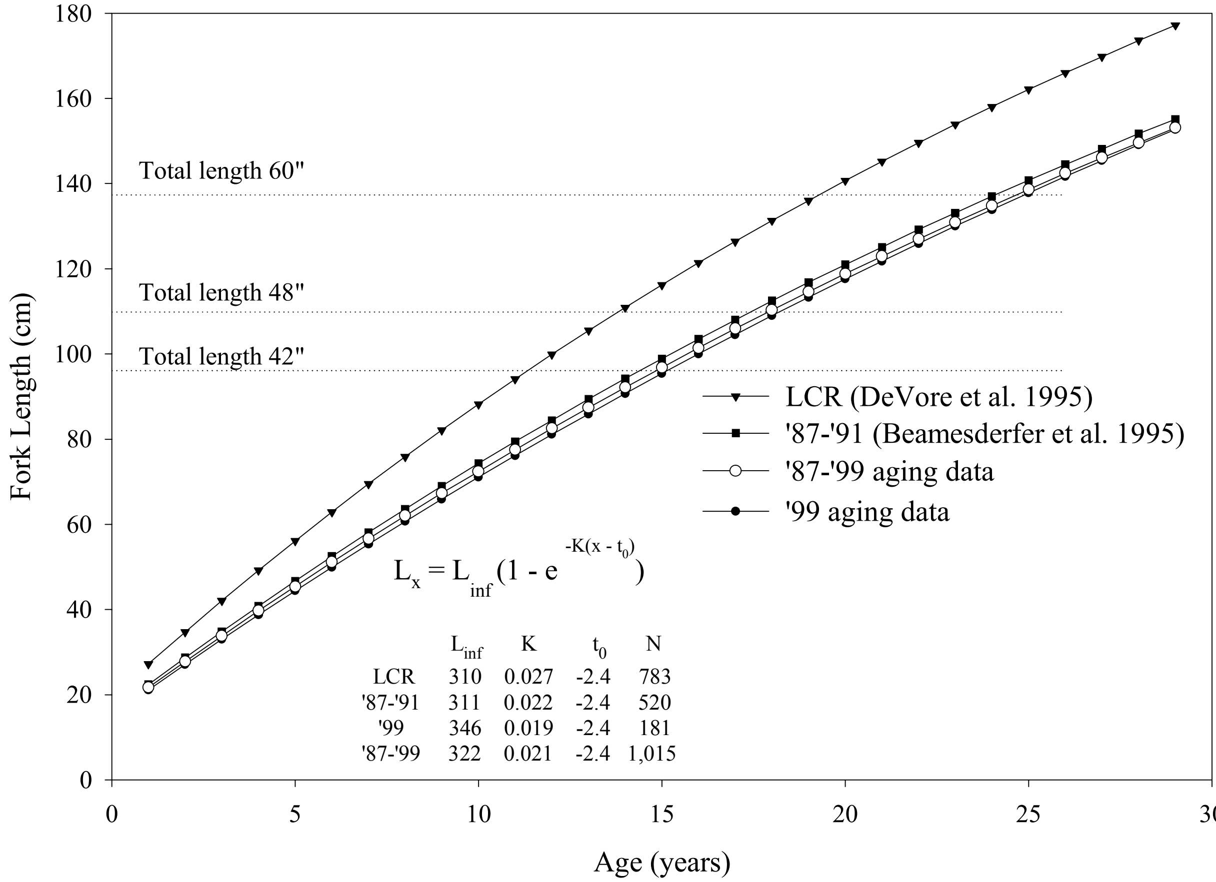

Figure 4. Comparison of von Bertalannfy growth curves for Bonneville Reservoir and the Lower Columbia River (LCR), 1999 and 1987 – 1999.

Abundance Estimates

From December 1998 through August 1999, 6,143 white sturgeon of various sizes were marked by CRITFC and ODFW (Table 4). Approximately 78% of these marks were applied to white sturgeon from 54–95 cm fork length, another 16% were applied to fish in the 96–109 cm range, and the remaining marks were applied to fish over 110-cm fork length. We recaptured fish in the 54–95 cm, 96–109 cm, and 110–137 cm size classes, though numbers of recaptures in the latter group were too low (6) to include in mark-recapture calculations. Utilizing a Schnabel multiple mark-recapture model (Ricker 1975), we estimated the abundance of 54–95 cm and 96–109 cm white sturgeon to be 113,474 and 10,991 fish respectively (Table 7). Estimated abundance of white sturgeon larger than these size classes totaled 4,083 fish. The total estimated population of white sturgeon >54 cm fork length in Bonneville Reservoir in 1999 was 128,548 fish.

Table 7. Abundance of white sturgeon in Bonneville Reservoir in 1989, 1994, and 1999 based on mark/recapture estimates. A "--" indicates no estimate generated for this interval.

	Sampling Year		
	1989	1994	1999
Total Abundance	51,400	52,000	128,548
	95% Confidence Interval		
70-166 cm	27,500-45,400	24,800-66,000	--
54-95 cm	--	--	99,900-128,900
96-109 cm	--	--	8,400-14,400
	Abundance by Fork Length		
54-81 cm	32,900	31,300	
54-95 cm	--	--	113,474
82-109 cm	16,700	18,300	--
96-109 cm	--	--	10,991
110-137 cm	--	--	3,083
110-166 cm	1,200	1,500	--
138-166 cm	--	--	580
166+ cm	600	900	420
Fish per hectare	6.1	6.2	15.3
Kg per hectare	30.0	--	66.4

Trawl and Haul Supplementation

The NMFS caught 4,728 white sturgeon in 132 trawl tows for an average of 35.8 fish per tow (Table 8). Mean trawl duration was 12.3 minutes at an average depth of 18 m. White sturgeon of various sizes were captured, although fish of the target size group of 35–90-cm fork length dominated the catch (99.3%; Figure 5). Incidental catches of other fish species are shown in Appendix Table A-6.

Of the 4,248 white sturgeon transported in 1999, the majority (4,171) were transplanted into John Day Reservoir (Table 9). The remaining 77 fish were transplanted into The Dalles Reservoir at Celilo Falls Park. Of the fish transplanted into John Day Reservoir, 40% were released at the Boardman boat ramp, 29% near Irrigon Hatchery, 23% at the Arlington boat ramp, and 8% at Threemile Canyon (Table 10). No mortalities occurred during capture and processing and only 4 mortalities were observed at release, all due to physical injury in a single incident when the transport tank gate valve had to be shut early. Mean fork length of transplanted fish estimated from a subsample of 1,387 fish was 46 cm (Figure 5). Daily transport densities ranged from 0.0028 kg/L to 0.0363 kg/L. Dissolved oxygen levels in the transport vehicle were nearly always at or above saturation and fish condition during and after transport generally appeared to be excellent.

Table 8. Effort and catch of juvenile and sub-adult white sturgeon collected for Trawl and Haul supplementation from the Columbia River downstream of Bonneville Dam during October and November 1993-1999.

Year, agency	Sampling days	Number of trawls	Total catch[a]	Mean catch	Mean trawl time (min)	Mean fishing depth (m)
1993						
NMFS[b]	3	19	564	29.7	10.0	18.6
USGS[c]	3	14	358	25.6	14.0	--
1994						
NMFS[b]	15	59	3,428	58.1	9.9	19.5
USGS[c]	5	22	365	16.6	10.0	--
1995						
NMFS[b]	12	102	5,974	58.6	10.4	20.3
1998						
NMFS[b]	14	118	10,362	87.8	8.6	17.8
1999						
NMFS[b]	14	132	4,728	35.8	12.3	18.0

[a] Approximate number since some white sturgeon were not counted and immediately released at the capture site when tow catches were very large.
[b] National Marine Fisheries Service.
[c] U. S. Geological Survey

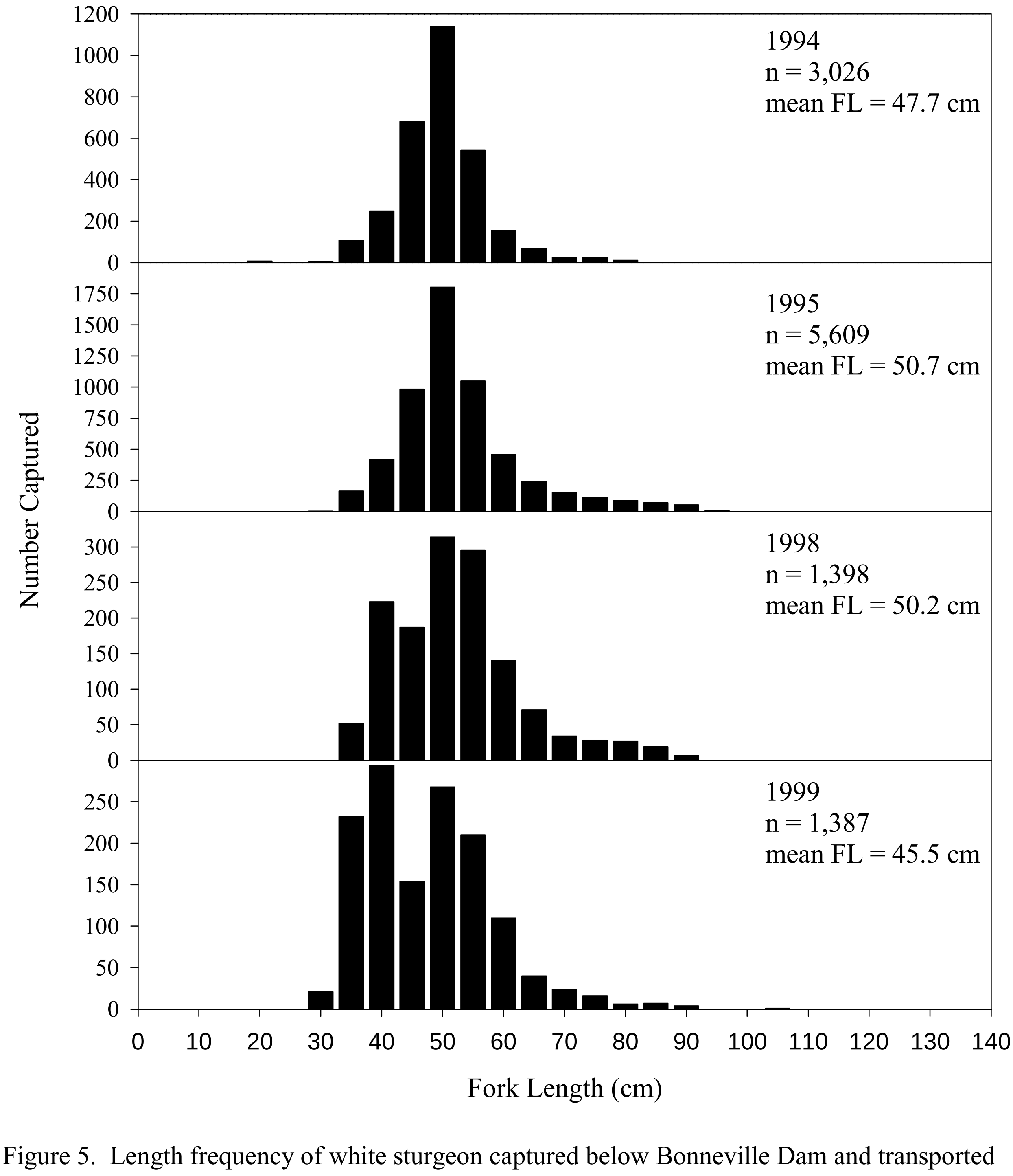

Figure 5. Length frequency of white sturgeon captured below Bonneville Dam and transported to The Dalles and John Day reservoirs, fall 1994 – 1999.

Table 9. Number of white sturgeon transported from below Bonneville Dam to The Dalles and John Day reservoirs from 1994 – 1999.

Year	Release Reservoir: The Dalles	Release Reservoir: John Day	Total
1994	2,935	--	2,935
1995	5,611	--	5,611
1998	3,257	5,534	8,791
1999	77	4,167	4,244
Total	11,880	9,701	21,581

Table 10. Trawl and Haul fish transport data, 13 October – 11 November 1999.

Date	Number of fish loaded	Number of fish released	Time in tanker	Release location	Release site temperature (°C)	Transport temperature (min/max °C)	Transport dissolved oxygen (ppm) (min/max)	Transport volume (liters)	Average fish weight (kg)[a]	Loading density (kg/L)
10/13	436	436	10:05	Boardman	16.1	-- /15.5	--	10,600	0.863	0.0355
10/14	477	477	10:03	Irrigon	16.1	-- /15.0	21.1/35.5	13,247	1.008	0.0363
10/18	199	196	9:15	Boardman	15.5	-- /14.4	11.5/22.0	13,247	0.970	0.0146
10/19	164	164	9:45	Irrigon	14.4	-- /14.4	12.0/23.0	13,247	0.644	0.0080
10/20	155	155	9:46	Boardman	14.4	12.7/13.9	11.0/14.1	13,247	0.775	0.0091
10/21	106	106	6:40	Irrigon	13.8	-- /13.8	10.0/17.0	13,247	0.600	0.0048
10/25	243	242	7:10	Irrigon	13.8	-- /13.8	10.2/12.5	13,247	0.638	0.0117
10/26	513	513	8:40	Boardman	13.8	12.7/13.3	10.3/15.2	13,247	0.564	0.0218
10/27	77	77	8:35	Celilo	13.3	12.7/12.7	13.2/13.9	13,247	0.478	0.0028
10/28	375	375	9:00	Boardman	12.7	11.1/12.2	1.4/8.6	13,247	0.742	0.0210
11/08	203	203	4:25	Irrigon	11.1	-- /10.6	--	13,247	0.727	0.0111
11/09	321	321	7:20	3 Mile Cyn	11.1	-- /11.1	7.5/11.1	13,247	0.835	0.0202
11/10	636	636	7:25	Arlington	10.6	-- /11.1	8.0/14.0	13,247	0.648	0.0311
11/11	343	343	8:07	Arlington	10.6	-- /10.6	8.2/13.0	13,247	0.643	0.0167
Total	4,248	4,244								

[a] Average weight per fish calculated from fork lengths of daily subsamples of measured fish and estimated weight calculated from a length/weight regression (r^2=0.9542) developed for juvenile sturgeon from previous Trawl and Haul sampling (1993-1997).

Young-of-Year Indexing

Catch data from YOY sampling in the five reservoirs studied is shown in Table 11. Based on length frequency, we considered white sturgeon less than 32-cm fork length to be YOY in all reservoirs except The Dalles, where white sturgeon less than 30-cm fork length were considered YOY (Figure 6). In The Dalles Reservoir, 86% of gill net sets captured white sturgeon, and 67% captured YOY. A total of 686 white sturgeon of all sizes were caught with 274 of these classified as YOY. Mean catch of YOY white sturgeon per set was 7.61. In John Day Reservoir, 39% of sets resulted in capture of sturgeon of all sizes, and 22% resulted in capture of YOY sturgeon. Catch of YOY sturgeon was similarly low, with a total of only 82 white sturgeon captured and only 18 of these classified as YOY. Mean catch of YOY sturgeon in John Day Reservoir was only 0.39 fish/set. Catch of sturgeon in McNary Reservoir was even lower, with an average of 21% of sets resulting in capture of sturgeon and only 8% capturing YOY sturgeon. Total catch of sturgeon of all sizes was 23, with only 6 YOY fish caught. Catch rate was 0.08 YOY sturgeon per set. Catches in the two Snake River reservoirs were similar to McNary Reservoir, with mean catches of 0.03 and 0.14 YOY sturgeon per set respectively in Ice Harbor and Little Goose reservoirs. Very few sets in these reservoirs caught sturgeon (22% and 28%) at all and only a small fraction caught YOY sturgeon (3% and 8%). Incidental catches of other fish species are shown in Appendix Table A-7.

DISCUSSION

Stock Assessment

The population abundance estimate for white sturgeon from Bonneville Reservoir in 1999 was 128,548 fish, compared to only 52,000 fish in 1994 (Table 7). Estimated abundance in 1989 was similar to 1994. Most of the increase from 1994 to 1999 occurred in the sublegal (less than 107 cm) size class (Appendix Figure A-1). The legal-sized population increased from 8,600 to 16,800 fish. If sufficient numbers of these size classes remain unharvested, these increases should eventually lead to increased numbers of mature, reproductive fish.

The 1999 estimate indicates relatively little change in the abundance of broodstock-sized white sturgeon in Bonneville Reservoir, despite changes in harvest regulations intended to enhance this component of the population (Table 81 in ODFW and WDFW 2000). The reduction in estimates of ‘oversize’ fish from 1994 to 1999 (Table 7) is likely due to our inability to sample the Boat Restricted Zones in Bonneville Reservoir in 1999. This resulted in a low sample size for this size class, which required abundance estimates to be made based on length frequency data, and not actual mark-recapture techniques. We are uncertain about the robustness of the estimate because it is based upon catch length frequency of a size class that past work has indicated is less vulnerable to setlines than smaller size classes. In addition, comparisons between estimates are complicated by a change in setline baits used in 1994 (Pacific lamprey) and 1999 (pickled squid).

Table 11. Young-of-year sampling gill-net effort and catch of white sturgeon in Columbia and Snake River reaches during October – November 1999.

River Reach / Parameter	Reservoir Quarter 1	2	3	4	All
The Dalles Reservoir					
Gill Net Sets	6	9	15	6	36
Total Hours	136.3	206.0	348.4	140.6	831.3
White Sturgeon Catch (all sizes)	93	344	200	49	686
White Sturgeon Catch (FL<30 cm)	64	191	12	7	274
White Sturgeon / Set	15.50	38.22	13.33	8.17	19.06
White Sturgeon (FL<30 cm)/Set	10.67	21.22	0.80	1.17	7.61
Sets with >0 white sturgeon (all sizes)	100%	100%	80%	67%	86%
Sets with >0 white sturgeon (FL<30 cm)	100%	100%	33%	67%	67%
John Day Reservoir					
Gill Net Sets	9	10	12	10	41
Total Hours	203.9	220.8	276.3	217.8	918.8
White Sturgeon Catch (all sizes)	0	1	43	38	82
White Sturgeon Catch (FL<32 cm)	0	1	15	2	18
White Sturgeon / Set	0.00	0.10	3.58	3.80	2.00
White Sturgeon (FL<32 cm)/Set	0.00	0.10	1.25	0.20	0.39
Sets with >0 white sturgeon (all sizes)	0%	10%	83%	50%	39%
Sets with >0 white sturgeon (FL<32 cm)	0%	10%	50%	20%	22%
McNary Reservoir/Hanford Reach					
Gill Net Sets	27	42	5	6	80
Total Hours	617.4	945.9	103.1	130.3	1796.7
White Sturgeon Catch (all sizes)	13	9	0	1	23
White Sturgeon Catch (FL<32 cm)	3	2	0	1	6
White Sturgeon / Set	0.48	0.21	0.00	0.17	0.29
White Sturgeon (FL<32 cm)/Set	0.11	0.05	0.00	0.17	0.08
Sets with >0 white sturgeon (all sizes)	33%	17%	0%	17%	21%
Sets with >0 white sturgeon (FL<32 cm)	11%	5%	0%	17%	8%
Ice Harbor Reservoir					
Gill Net Sets	9	9	9	9	36
Total Hours	199.6	201.2	205.8	195.0	801.7
White Sturgeon Catch (all sizes)	1	1	0	6	8
White Sturgeon Catch (FL<32 cm)	1	0	0	0	1
White Sturgeon / Set	0.11	0.11	0.00	0.67	0.22
White Sturgeon (FL<32 cm)/Set	0.11	0.00	0.00	0.00	0.03
Sets with >0 white sturgeon (all sizes)	11%	11%	0%	67%	22%
Sets with >0 white sturgeon (FL<32 cm)	11%	0%	0%	0%	3%
Little Goose Reservoir					
Gill Net Sets	9	9	9	9	36
Total Hours	195.7	194.7	189.0	192.9	772.3
White Sturgeon Catch (all sizes)	0	3	1	60	64
White Sturgeon Catch (FL<32 cm)	0	0	0	5	5
White Sturgeon / Set	0.00	0.33	0.11	6.67	1.78
White Sturgeon (FL<32 cm)/Set	0.00	0.00	0.00	0.56	0.14
Sets with >0 white sturgeon (all sizes)	0%	22%	11%	78%	28%
Sets with >0 white sturgeon (FL<32 cm)	0%	0%	0%	33%	8%

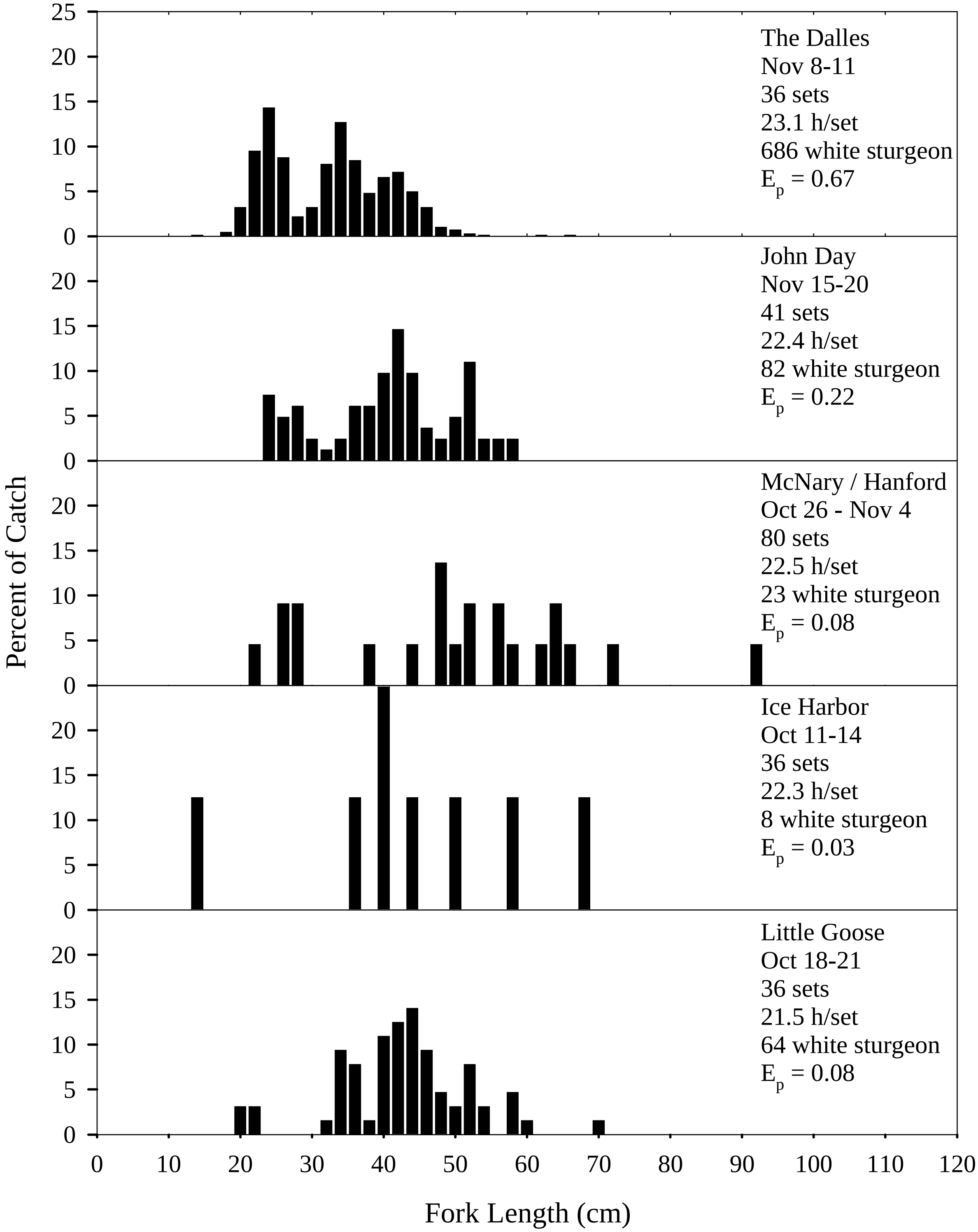

Figure 6. Length frequencies of white sturgeon captured during YOY gillnet surveys, Fall 1999.

Relative weight of white sturgeon sampled in 1999 (88%) was significantly lower than in 1994 (106%). This reduction in relative weight may indicate that some density dependent mechanisms are at work in the population. These factors could seriously limit the productivity of Bonneville Reservoir (Beamesderfer et al. 1995). Potential actions that may address these mechanisms would largely focus on reducing the abundance of smaller white sturgeon in the reservoir. One alternative would be to transplant young fish from Bonneville Reservoir to other, more productive reservoirs with low recruitment. However, this option would be logistically complex due to difficulty in capturing juvenile fish in this reservoir. In addition, to attain any benefit from such transplants, growth increases would have to outweigh potential mortality associated with transplantation. Another option would be increased harvest of small fish within Bonneville Reservoir. Increasing harvest of small fish would be difficult from an enforcement perspective, since river reaches upstream and downstream of Bonneville Reservoir would continue to be under current regulations that do not allow such harvest. Perhaps a better option would be to restore some of the white sturgeon population's ability to volitionally migrate between reservoirs. Re-establishment of effective passage at The Dalles Dam might allow high-density populations to spread upstream to low density areas. One possible alternative would be to activate the fish lift at The Dalles Dam, which was shown to be effective in passing white sturgeon in the past (Warren and Beckman 1993). Alternatively, low recruitment in the reservoir in recent years may reduce the population size sufficiently to overcome any density-dependent effects.

Trawl and Haul Supplementation

As in previous years, supplementation of white sturgeon from below Bonneville Reservoir to The Dalles and John Day reservoirs appears to be largely limited by our ability to capture fish. We have yet to maximize available transport capacity of the liberation trucks. In 1999, transplant efforts focused almost entirely on supplementation of the John Day Reservoir population. Due to concerns about high densities of young white sturgeon in The Dalles Reservoir, we will probably continue to supplement the John Day population at a higher rate than the population in The Dalles Reservoir. Stock assessment sampling planned for 2001 in John Day Reservoir will allow us to assess the status of transplants to this reservoir over the last several years. Although very little mortality has been observed during handling and transport, we have received reports of dead scute-marked white sturgeon at release sites following releases of trawl-and-haul fish. This indicates some amount of delayed mortality is occurring, but the magnitude of this mortality is unknown at this time.

Young-of-Year Indexing

As indicated by catch rates during YOY sampling, recruitment was relatively high in The Dalles Reservoir, but declined steadily as sampling progressed upriver (Table 11). This pattern has also been observed in previous years, indicating a consistently low level of recruitment in upper river reservoirs relative to lower river reservoirs (Rien et al. 1991, North et al. 1998). This information corroborates other findings (DeVore et al. 1999) that indicate low abundances of mature, reproductive adults in the upper reservoirs, and that white sturgeon populations in these reservoirs are recruitment limited.

PLANS FOR NEXT YEAR

We do not plan to conduct any stock assessment sampling in 2000. The next stock assessment survey will be conducted in John Day Reservoir in 2001.

Prior to and including 1999, methods for capturing juvenile white sturgeon for trawl-and-haul supplementation have been relatively consistent and have resulted in the transplant of up to 5,600 fish annually into each reservoir. However, beginning in 2000, we will be contracting with a private commercial trawler to collect juvenile white sturgeon. Due to the use of new personnel, this may result in lower catches as the fishers refine collection methods. However, for consistency, we will employ trawl nets of the same design and measurements as have been used in previous years.

We will continue YOY indexing using gill nets to collect white sturgeon. The USGS will continue to utilize trawl methods for collecting YOY white sturgeon, and will compare the two methods. In the fall of 2000, we will again conduct YOY gill net sampling in The Dalles, John Day, McNary, Ice Harbor, and Little Goose reservoirs.

We will also assist Washington Department of Fish and Wildlife personnel with creel sampling in order to assess harvest rates of white sturgeon in Bonneville, The Dalles, and John Day reservoirs.

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APPENDICES

Appendix Table A-1. Biological samples collected for laboratory work from Bonneville Reservoir, 1999[a].

Size Class (cm fork length)	Number of DNA Samples	Number of Plasma Samples
20-39	9	0
40-59	79	0
60-79	72	0
80-99	73	0
100-109	65	0
120-139	57	0
140-159	23	14
160-179	6	2
180-199	2	0
200-219	4	3
220-239	6	4
240-259	2	1
260-279	0	0
Total	398	24

[a] All plasma and two DNA samples were destroyed during a freezer breakdown.

Appendix Table A-2. Summary of white sturgeon marked in McNary Reservoir and recaptured within McNary and in other reservoirs.

		Released in McNary	
		1993	1995
	Number marked	156	787
Recaptured in McNary	1993	6	--
	1994	4	--
	1995	7	13
	1996	2	10
	1997	3	7
Recaptured in John Day	1993	2	--
	1994	1	--
	1995		
	1996		2
	1997		1
Recaptured in The Dalles	1993		--
	1994		--
	1995		
	1996		
	1997	2	
Recaptured in Bonneville	none to date		

Appendix Table A-3. Summary of white sturgeon marked in John Day Reservoir and recaptured within John Day and in other reservoirs.

		Released in John Day			
		1989	1990	1991	1996
	Number marked	21	516	85	4,111
Recaptured in McNary (upstream reservoir)	none to date				
Recaptured in John Day	1989		--	--	--
	1990	3	35	--	--
	1991		29		--
	1992		7	1	--
	1993	1	2		--
	1994		4	1	--
	1995		2	1	--
	1996	2	38	12	238
	1997			1	126
	1998				
	1999				
Recaptured in The Dalles	1989		--	--	--
	1990			--	--
	1991	1	1		--
	1992				--
	1993		1		--
	1994		3		--
	1995				--
	1996				
	1997		7		9
	1998				
	1999				
Recaptured in Bonneville	1989		--	--	--
	1990			--	--
	1991		1		--
	1992				--
	1993				--
	1994				--
	1995				--
	1996				
	1997				
	1998				
	1999				3

Appendix Table A-4. Summary of white sturgeon marked in The Dalles Reservoir and recaptured within The Dalles and in other reservoirs.

		Released in The Dalles							
		1987	1988	1989	1991	1993	1994	1995	1997
Number marked during regular sampling		837	1,248	147	379	--	1,312	--	5,797
Number marked during other sampling[a,b]		--	--	--	--	7[a]	2,935[b]	5,611[b]	--
Total number marked		837	1,248	147	379	7	4,247	5,611	5,797
Recaptured in McNary (upstream reservoir)	none to date								
Recaptured in John Day (upstream reservoir)	1987	1	--	--	--	--	--	--	--
	1988			--	--	--	--	--	--
	1989				--	--	--	--	--
	1990				--	--	--	--	--
	1991					--	--	--	--
	1992				1	--	--	--	--
	1993						--	--	--
	1994							--	--
	1995								--
	1996			1					--
	1997								
	1998								
	1999								
Recaptured in The Dalles	1987	69	--	--	--	--	--	--	--
	1988	86	115	--	--	--	--	--	--
	1989	16	58	3	--	--	--	--	--
	1990	6	15	1	--	--	--	--	--
	1991	13	24	4	7	--	--	--	--
	1992	3	7	1	5	--	--	--	--
	1993	1	7	1	9		--	--	--
	1994	3	6	6	15		30	--	--
	1995						3		--
	1996				1		1		--
	1997	1	17	20	31		385	448	268
	1998								
	1999								
Recaptured in Bonneville	1987		--	--	--	--	--	--	--
	1988			--	--	--	--	--	--
	1989		4		--	--	--	--	--
	1990	2	1		--	--	--	--	--
	1991	1	14			--	--	--	--
	1992		1			--	--	--	--
	1993	1	2				--	--	--
	1994		1					--	--
	1995								--
	1996					1			--
	1997								
	1998								
	1999		1				10[c]	12[c]	11

(Continued)

Appendix Table A-4 (Continued)

		Released in The Dalles							
		1987	1988	1989	1991	1993	1994	1995	1997
Number marked during regular sampling		837	1,248	147	379	--	1,312	--	5,797
Number marked during other sampling[a,b]		--	--	--	--	7[a]	2,935[b]	5,611[b]	--
Total number marked		837	1,248	147	379	7	4,247	5,611	5,797
Recaptured in Lower Columbia River	1987	1	--	--	--	--	--	--	--
	1988			--	--	--	--	--	--
	1989				--	--	--	--	--
	1990				--	--	--	--	--
	1991					--	--	--	--
	1993					1	--	--	--
	1994		1					--	--
	1995								--
	1996								--
	1997								
	1998								
	1999								

[a] Sturgeon marked during radio tagging experiments.
[b] Sturgeon marked as part of Trawl and Haul Program. Fish were captured in the Lower Columbia River, marked, and transported to The Dalles Reservoir in the fall of 1994 and 1995.
[c] Some recaptures (7 from 1994 and all 12 from 1995 markings) were originally marked as part of the Trawl and Haul program, released into The Dalles Reservoir, and recaptured in Bonneville Reservoir in 1999.

Appendix Table A-5. Summary of white sturgeon marked in Bonneville Reservoir and recaptured within Bonneville and in other reservoirs.

		Released in Bonneville					
		1988	1989	1991	1993	1994	1999
Number marked during regular sampling		341	2,131	1,141	--	2,332	6,267
Number marked during other sampling activities[a]		--	--	--	8[a]	--	--
Total number marked		341	2,131	1,141	8	2,332	6,267
Recaptured in McNary (upstream reservoir)	none to date						
Recaptured in John Day (upstream reservoir)	none to date						
Recaptured in The Dalles (upstream reservoir)	1988		--	--	--	--	--
	1989			--	--	--	--
	1990			--	--	--	--
	1991				--	--	--
	1992				--	--	--
	1993					--	--
	1994						--
	1995						--
	1996			1			--
	1997						--
	1998						--
	1999						
Recaptured in Bonneville	1988	2	--	--	--	--	--
	1989	44	91	--	--	--	--
	1990	5	46	--	--	--	--
	1991	11	89	33	--	--	--
	1992		19	23	--	--	--
	1993	2	12	13		--	--
	1994	4	37	36		21	--
	1995	1	7	4		11	--
	1996		9	5		12	--
	1997	1	7	4		4	--
	1998						--
	1999		19	8		90	453
Recaptured in Lower Columbia River	1988		--	--	--	--	--
	1989	4	4	--	--	--	--
	1990		1	--	--	--	--
	1991		7	2	--	--	--
	1992		3	1	--	--	--
	1993		1	5		--	--
	1994			1			--
	1995			2			--
	1996		1	1			--
	1997						--
	1998						--
	1999						

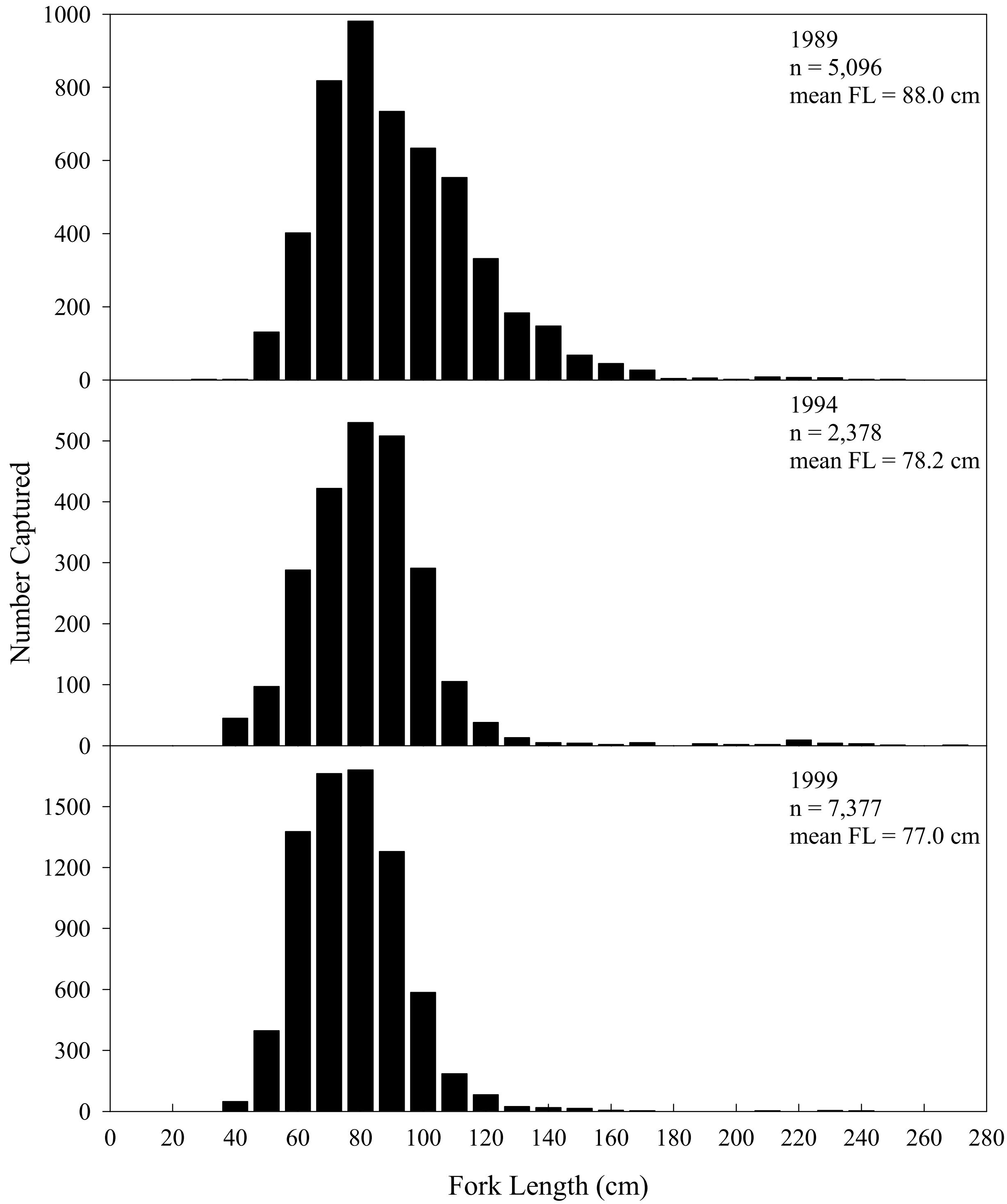
[a] Sturgeon marked during radio tagging experiments.

Appendix Table A-6. Total catch (including bycatch) by NMFS during Trawl-and-haul white sturgeon collection below Bonneville Dam, October and November 1999.

	Date														
	10/13	10/14	10/18	10/19	10/20	10/21	10/25	10/26	10/27	10/28	11/8	11/9	11/10	11/11	Total
Sturgeon	451	533	212	169	188	121	208	594	92	476	209	367	664	428	4,712
N. pikeminnow	71	11	17	17	24	45	15	28	11	39	14	27	21	12	352
Peamouth	42	18	62	57	160	254	90	125	23	84	91	157	102	77	1,342
Lg. scale sucker	11	18	28	48	53	89	62	67	38	144	32	82	100	81	853
American shad	29		13	5	106	214	125	267	5	18	19	94	94	96	1,085
Prickly sculpin		4	2	5	10	9	16	14	3	40	12	24	7	13	159
Sandroller		4	3	18	14	199	30	31	11	83	36	69	45	31	574
Leopard dace			3	2	9	3	3	1	1	11			2	2	37
Redside shiner						1				3		1			5
Starry flounder										1	1	5			7
Sm. bass												1			1
Unid. Catfish							1			2					3
Yellow perch										1		1			2
Crayfish						1									1
Walleye						1	1								2
Mt. whitefish									1						1
Unid. crappie										2					2
Chiselmouth										1					1

Appendix Table A-7. Species composition of catches from young-of-year gill net samples, 1999. Codes for disposition of fish are: 1 = alive and released, 2 = killed during handling, 3 = dead or dying at capture.

Species	The Dalles				John Day				McNary				Ice Harbor				Little Goose				Total			
Disposition	1	2	3	All	1	2	3	All	1	2	3	All	1	2	3	All	1	2	3	All	1	2	3	All
American shad					2	7	6	15		3		3			11	11					2	10	17	29
Bluegill					1			1													1	0	0	1
Bullhead													1			1					1	0	0	1
Bridgelip sucker	15		6	21	39	1	3	43	67		17	84	171		45	216	54		16	70	346	1	87	434
Channel catfish					91			91	139			139	344		6	350	320	26	7	353	894	26	13	933
Chinook salmon											2	2			2	2	3		3	6	3	0	7	10
Chislemouth	1			1	11		3	14	386		74	460	26		5	31	4		1	5	428	0	83	511
Coho salmon			1	1																	0	0	1	1
Carp					2			2	6			6					1	2		3	9	2	0	11
Crappie	2			2							6	6	55		55	110	68		61	129	125	0	122	247
Largescale sucker	21	1	2	24	23		13	36	161		12	173	113		74	187	98		24	122	416	1	125	542
N. pikeminnow	16	8	13	37	3	9	45	57	6	71	62	139	9	37	24	70	12	110	10	132	46	235	154	435
Peamouth	34		15	49	10	2	5	17	139		53	192	162		205	367	215		277	492	560	2	555	1,117
Pumpkinseed																	1			1	1	0	0	1
Redside shiner									13		19	32									13	0	19	32
Smallmouth bass	1			1					2			2									3	0	0	3
Sculpin	2		2	4	1	1	1	3	15	2		17									18	3	3	24
Sandroller															1	1					0	0	1	1
Walleye	2			2					1		2	3									3	0	2	5
Whitefish									2		5	7					1			1	3	0	5	8
White sturgeon	679		7	686	82			82	23			23	8			8	64			64	856	0	7	863
Yellow perch	13	2		15	46		44	90	308		240	548	25		26	51	7		2	9	399	2	312	713
Total	786	11	46	843	311	20	120	451	1,268	76	492	1,836	914	37	454	1,405	848	138	401	1,387	4,127	282	1,513	5,922



Appendix Figure A-1. Length-frequencies of white sturgeon captured with setlines in Bonneville Reservoir, 1989, 1994, and 1999.

WHITE STURGEON MITIGATION AND RESTORATION IN THE COLUMBIA AND SNAKE RIVERS UPSTREAM FROM BONNEVILLE DAM

ANNUAL PROGRESS REPORT

APRIL 1999 – MARCH 2000

Report B

Evaluate the success of developing and implementing a management plan for white sturgeon in reservoirs between Bonneville and McNary dams in enhancing production

and

Describe the life history and population dynamics of subadult and adult white sturgeon upstream of McNary Dam and downstream from Bonneville Dam

This report includes: A survey of the 1999 sport and commercial fisheries for white sturgeon between Bonneville and McNary dams.

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March 2001

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ACKNOWLEDGMENTS

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ABSTRACT

The Washington and Oregon Departments of Fish and Wildlife conducted a census of the 1999 sport fisheries on the Columbia River from Bonneville Dam upstream to McNary Dam to estimate white sturgeon *Acipenser transmontanus* harvest. The sport fishery was closed to the retention of sturgeon in Bonneville Reservoir on April 17 and on June 12 in The Dalles Reservoir when harvest was projected to reach respective harvest guidelines. The harvest guideline was not attained in John Day Reservoir and the retention fishery remained open year-round. An estimated 1,236, 694, and 422 white sturgeon were harvested in 1999 sport fisheries in Bonneville, The Dalles, and John Day reservoirs, respectively.

Treaty Indian commercial fishers landed 1,280 white sturgeon from Bonneville Reservoir, 1,051 from The Dalles Reservoir, and 760 from John Day Reservoir during gill net and setline fisheries. The Columbia River Inter-Tribal Fish Commission and the Yakama Indian Nation estimated an additional 244 fish were harvested during 1999 subsistence fisheries.

INTRODUCTION

This annual report describes work completed by the Washington Department of Fish and Wildlife (WDFW) as part of the Bonneville Power Administration white sturgeon *Acipenser transmontanus* research project 86-50. The WDFW is responsible for portions of tasks related to Objective 1: to experimentally implement and evaluate the success of selected measures to protect and enhance white sturgeon populations and mitigate for effects of the hydropower system on the productivity of white sturgeon in the Columbia River downstream from McNary Dam. These tasks include surveying the sport fishery between Bonneville and McNary dams to estimate annual white sturgeon harvest and to evaluate management plans intended to regulate sturgeon fisheries at optimum sustainable exploitation rates.

The WDFW also shares responsibility for tasks relating to Objective 3: to monitor and evaluate actions to mitigate for lost white sturgeon production due to development, operation, and configuration of the hydropower system. We worked with staff from the Columbia River Inter-Tribal Fish Commission (CRITFC) and the Yakama Indian Nation to capture broodstock white sturgeon from Wanapum and McNary reservoirs for experimental artificial propagation studies (see CRITFC Report E). We worked with the U.S. Geological Survey (USGS) staff to capture white sturgeon in The Dalles Reservoir for telemetry studies (see USGS Report C). We worked with staff from the Oregon Department of Fish and Wildlife (ODFW) to sample for white sturgeon in Bonneville Reservoir from May through August to estimate population statistics (see ODFW Report A) and we sampled with gillnets in Columbia and Snake River reservoirs to index recruitment of white sturgeon young-of-year (see ODFW Report A).

METHODS

Sport Fishery Census

The 1999 sport fishery survey was conducted in Bonneville and The Dalles reservoirs, and that portion of the John Day Reservoir downstream from McNary Dam to Arlington, Oregon (river kilometer (rkm) 390) (Figure 1). Methods were similar to those used since 1995 (James et al. 1996) and relied on angling pressure distribution data collected during surveys of Bonneville Reservoir from 1988-1990, The Dalles Reservoir from 1987-1989, and John Day Reservoir from 1989-1991 (Hale and James 1993). Sampling was conducted by two full-time creel samplers hired by ODFW, three full-time samplers hired by WDFW, and one staff member from the WDFW Southwest Regional office.

The survey was limited to legal angling hours for sturgeon (one hour before sunrise to one hour after sunset). Therefore, estimates of angling effort and harvest for steelhead *Oncorhynchus mykiss*, walleye *Stizostedion vitreum*, smallmouth and largemouth bass *Micropterus dolomieui* and *M. salmoides*, and northern pikeminnow *Ptychocheilus oregonensis*, which are harvested at night in Washington, are considered minimum estimates.

Angling effort (angler hours) was estimated by counting anglers within representative index areas and expanding those counts to the entire reservoir using 1987-1991 aerial counts of angling

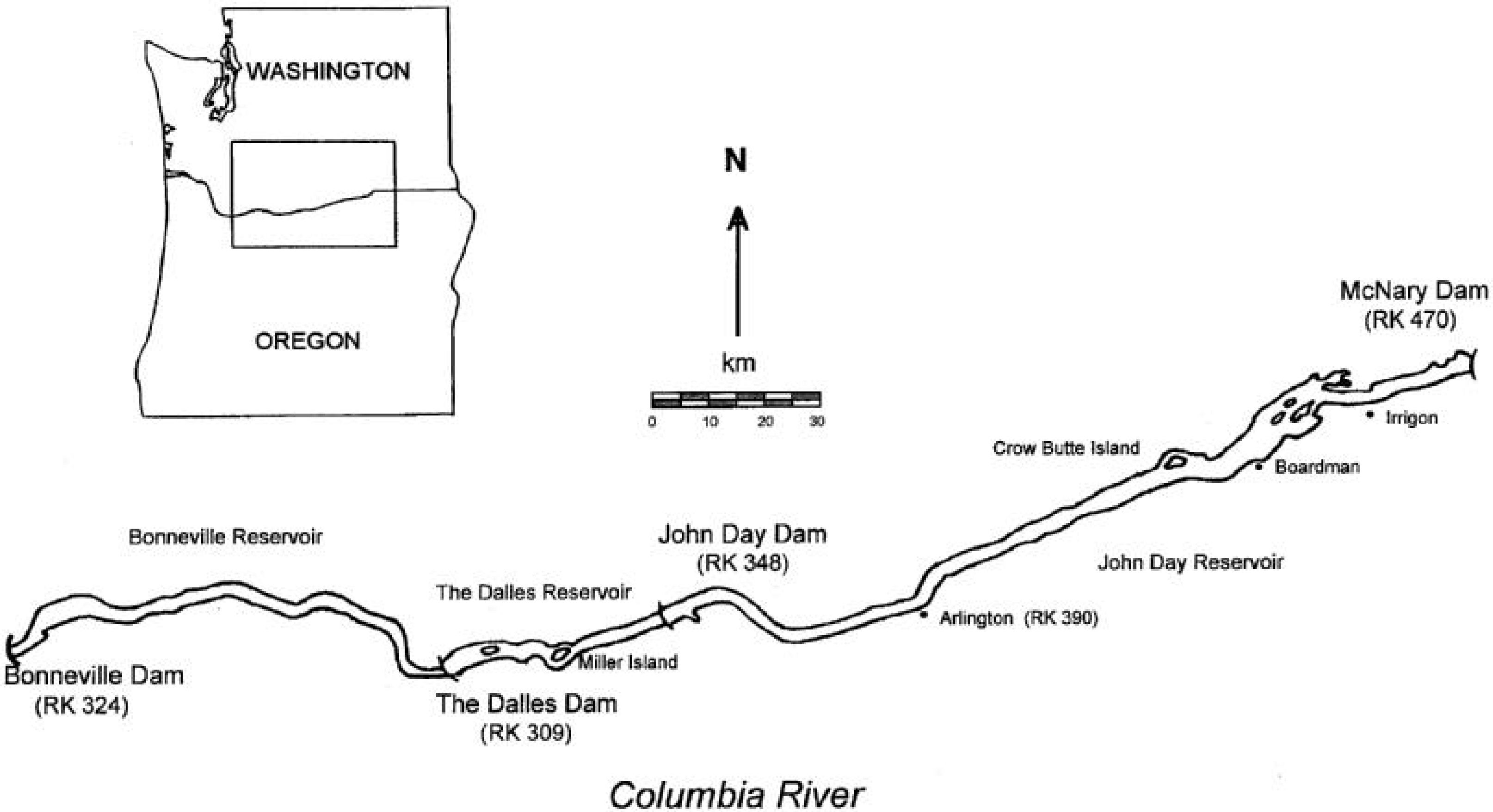

Figure 1. Location of the 1999 recreational fishery census on the Columbia River: Bonneville and The Dalles reservoirs and from Arlington upstream to McNary Dam on John Day Reservoir.

pressure within and outside of index areas. Indices of angler pressure were established at popular fishing locations and vantage points in each reservoir. These index areas were the same as those used since 1995. Counts were made of all bank anglers and sport fishing boats within each index area. Average numbers of anglers per boat were determined from angler interviews. Angling pressure within index areas was counted once a day between 1000 and 1300 hours. The proportion of the day's total angling effort represented by the count was calculated from average daily angling pressure distributions derived from prior years' data when systematic counts were made throughout the day. Index to non-index angling pressure distribution patterns were obtained from prior aerial survey data.

Catch per effort data were collected by interviewing anglers and examining catches. Samplers interviewed anglers at bank fishing sites and boat ramps to determine angler type (target species) and catch per hour of effort for each species in the creel. Samplers collected data from both incomplete and complete angler trips. Interview data collected included angling method (bank or boat), target species, hours fished, number of anglers in the party, fishing location, state of residence, species, number of fish caught, number released, fork length (FL) of all retained fish, and mark sample data for white sturgeon, salmonids, and walleye. Samplers did not differentiate between smallmouth and largemouth bass. Anglers participating in walleye and bass tournaments were not sampled; however, summaries of catch and effort provided by tournament operators were used.

Harvest estimates for boat anglers were calculated by multiplying the observed catch per hour for boat anglers within a reservoir subsection by the total estimated effort for boat anglers for that subsection. White sturgeon harvest by bank anglers was calculated in a different manner. The one fish daily bag limit, enacted in 1991 for The Dalles and John Day reservoirs and in April 1996 for Bonneville Reservoir, made it more likely that successful bank anglers would leave the river before we could interview them, thus biasing our estimate of harvest per hour of bank angling effort. Boat angler catch per hour of effort was not biased by the one fish daily bag limit since we only interviewed boat anglers after they had completed their trip. Therefore, we calculated reservoir specific ratios of boat angler harvest per unit effort (CPUE) vs. bank angler CPUE for years prior to one fish bag limits (1993-95 for Bonneville Reservoir, 1988-89 for The Dalles Reservoir, and 1989-90 for John Day Reservoir). The 1999 boat angler CPUE was used to adjust 1999 bank angling CPUE such that boat CPUE vs. bank CPUE matched the pre-one fish daily limit ratio.

Harvest estimates were derived for each angling method (bank/boat), reservoir subsection, and weekend/weekday type to account for differential catch and sampling rates. Harvest and angling effort estimates were derived weekly and reported monthly.

Treaty Indian Commercial and Subsistence Harvest

Numbers of white sturgeon harvested in Zone 6 treaty Indian commercial fisheries were estimated from poundages reported on fish receiving tickets for each gear type. Poundages of white sturgeon were converted to numbers of fish by dividing by an average fish weight obtained during random biological sampling of treaty Indian commercial landings by field crews. Landings by reservoir were estimated from the catch area reported on fish receiving tickets. The legal size slot for treaty Indian commercial fisheries was 122-152 cm (48-60 in) total length (TL).

The Columbia River Inter-Tribal Fish Commission (CRITFC) and the Yakama Indian Nation (YIN) provided estimates of treaty Indian subsistence harvest. Fishers were interviewed at fishing sites to obtain catch and effort information used to estimate white sturgeon harvest.

RESULTS

Sport Fishery Census

Bonneville Reservoir

The 1999 retention season for white sturgeon in Bonneville Reservoir opened January 1 and was scheduled to run through June 30. We began our survey January 1 and continued through April 16. State fishery managers closed the fishery to retention of white sturgeon on April 17 based on our projection that harvest would reach the 1,520 fish guideline by that date.

Anglers fished an estimated 53,329 hours (9,533 trips) in Bonneville Reservoir from January 1 through April 16 (Table 1). Angling effort for sturgeon comprised 90% (8,608 trips) of the total estimated effort. The estimated number of angler trips by species targeted were as follows: 54 (1%) for anadromous salmonids, 0 (0%) for American shad *Alosa sapidissima*, 702(7%) for walleye, 118 (1%) for bass, 0 (0%) for northern pikeminnow, 51 (1%) for other resident fish, and 0 (0%) for anglers participating in tournaments.

Anglers harvested an estimated 1,236 white sturgeon during 8,608 trips for sturgeon between January 1 and April 16, a 24% decrease in harvest and 13% decrease in angler trips from the 1998 retention period (Table 2). The fishery for white sturgeon encompassed the entire reservoir although most of the harvest occurred downstream of Hood River, Oregon (Rkm 271). Harvest per angler trip peaked in March at 0.18 fish per trip and averaged 0.08 fish per trip for bank anglers and 0.22 fish per trip for boat anglers during the retention fishery (Table 3). The 2,307 sturgeon anglers interviewed accounted for 20% of the estimated bank effort (angler hours) and 16% of the estimated boat effort for sturgeon (Table 4).

Anglers released 13% of the total legal-size catch from January 1 through April 16 (Table 4), due in part to the daily bag limit regulation which allowed retention of only one fish 107-152 cm (42 - 60 in) TL. The percentage sublegal (< 107 cm, < 42 in) TL, legal (107-152 cm, 42-60 in, both kept and released) TL, and oversize (> 152 cm, > 60 in) TL white sturgeon in the January 1 through April 16 reported catch was 88.4%, 11.5%, and 0.1%, respectively (Table 4). The length distribution of the sampled harvest is presented in Table 5. Average harvest per trip decreased for the fourth year in a row (Table 6).

Table 1. Combined Washington and Oregon sport fishery angling effort estimates for Bonneville Reservoir, January 1 through April 16, 1999; The Dalles Reservoir, January 1 through June 11, 1999; and John Day Reservoir, January 1 through December 31, 1999.

Species Method	Bonneville Hours	Bonneville Trips	The Dalles Hours	The Dalles Trips	John Day Hours	John Day Trips
Sturgeon						
Bank	25,317	4,724	46,810	5,396	36,776	6,542
Boat	22,499	3,884	10,677	1,804	56,058	10,110
Total	47,816	8,608	57,487	7,200	92,834	16,652
Salmonid						
Bank	201	54	1,006	169	10,904	2,674
Boat	0	0	1,250	231	7,678	1,574
Total	201	54	2,256	400	18,582	4,248
Shad						
Bank	0	0	822	176	356	95
Boat	0	0	0	0	87	29
Total	0	0	822	176	443	124
Walleye						
Bank	94	30	343	80	200	43
Boat	2,718	672	16,853	2,778	48,846	8,814
Total	2,812	702	17,196	2,858	49,046	8,857
Bass						
Bank	30	13	1,550	470	1,175	276
Boat	328	105	844	138	22,740	4,658
Total	358	118	2,394	608	23,915	4,934
Northern Pikeminnow						
Bank	0	0	7,046	655	210	52
Boat	0	0	3,666	574	639	106
Total	0	0	10,712	1,229	849	158
Other						
Bank	142	51	1,345	251	5,960	1,250
Boat	0	0	791	165	5,842	1,507
Total	142	51	2,136	416	11,802	2,757
Tournament (Boat)	0	0	144	16	3,757	446
Combined Total						
Bank	25,784	4,872	58,922	7,197	55,581	10,932
Boat	25,545	4,661	34,225	5,706	145,647	27,244
Total	51,329	9,533	93,147	12,903	201,228	38,176

Table 2. Washington and Oregon sport fishery harvest, and catch and release estimates for Bonneville Reservoir, January 1 through April 16, 1999; The Dalles Reservoir, January 1 through June 11, 1999; and John Day Reservoir, January 1 through December 31, 1999.

Species	Bonneville	The Dalles	John Day
White Sturgeon [a]			
Legals kept	1,236	694	422
Sublegals released	11,038	7,918	10,752
Legals released	187	127	92
Oversize released	15	170	591
Total	12,476	8,909	11,857
Chinook salmon [b]			
Adults kept	0	0	42
Jacks kept	0	0	75
Total	0	0	117
Released	0	0	10
Coho salmon [b]			
Adults kept	0	0	40
Jacks kept	0	0	11
Total	0	0	51
Steelhead [b]			
Kept	0	109	587
Released	0	2	458
American shad			
Kept	0	491	250
Released	0	827	111
Walleye			
Kept	183	871	1,177
Released	61	1,050	765
Bass			
Kept	0	1,179	808
Released	0	2,009	3,599
Northern Pikeminnow	0	4,702	621
Other resident fish	0	0	926

[a] *White sturgeon retention allowed January 1 through April 16 in Bonneville Reservoir, January 1 through June 11 in The Dalles Reservoir, and January 1 through December 31 in John Day Reservoir.*

[b] *Closed to chinook and coho retention January 1 - July 31, steelhead retention April 1 - June 15.*

Table 3. Estimates of sport fishery angler trips for white sturgeon, white sturgeon harvest, and harvest per angler trip (CPUE) for Bonneville Reservoir, January 1 through April 16, 1999; The Dalles Reservoir, January 1 through June 11, 1999; and John Day Reservoir, January 1 through December 31, 1999.

Month	Bonneville			The Dalles			John Day		
Method	Trips	CPUE	Harvest	Trips	CPUE	Harvest	Trips	CPUE	Harvest
January [b]									
Bank	1,294	0.05	66	684	0.08	57	488	0.01	4
Boat	1,085	0.21	223	261	0.30	78	313	0.01	2
Total	2,379	0.12	289	945	0.14	135	801	0.01	6
February [b]									
Bank	1,048	0.04	41	617	0.01	4	469	< 0.01	1
Boat	770	0.17	31	273	0.04	11	319	0.01	2
Total	1,818	0.09	172	890	0.02	15	788	< 0.01	3
March [b]									
Bank	1,829	0.13	234	944	0.02	23	631	< 0.01	2
Boat	1,569	0.25	395	254	0.09	22	831	0.01	5
Total	3,398	0.18	629	1,198	0.04	45	1,462	< 0.01	7
April [b]									
Bank	553	0.10	56	844	0.05	42	523	< 0.01	1
Boat	460	0.20	90	334	0.15	49	959	< 0.01	2
Total	1,013	0.14	146	1,178	0.08	91	1,482	< 0.01	3
May									
Bank	--	--	--	1,854	0.14	261	610	0.01	8
Boat	--	--	--	663	0.11	72	733	0.04	26
Total	--	--	--	2,517	0.13	333	1,343	0.03	34
June									
Bank	--	--	--	453	0.17	75	868	0.01	8
Boat	--	--	--	19	0.00	0	942	< 0.01	4
Total	--	--	--	472	0.16	75	1,810	0.01	12
July									
Bank	--	--	--	--	--	--	1,238	0.03	31
Boat	--	--	--	--	--	--	1,887	0.03	59
Total	--	--	--	--	--	--	3,125	0.03	90

continued

Table 3. Continued.

Month / Method	Bonneville Trips	Bonneville CPUE	Bonneville Harvest	The Dalles Trips	The Dalles CPUE	The Dalles Harvest	John Day Trips	John Day CPUE	John Day Harvest
August									
Bank	--	--	--	--	--	--	697	0.04	25
Boat	--	--	--	--	--	--	787	0.07	54
Total	--	--	--	--	--	--	1,484	0.05	79
September									
Bank	--	--	--	--	--	--	522	0.05	24
Boat	--	--	--	--	--	--	749	0.15	115
Total	--	--	--	--	--	--	1,271	0.11	139
October									
Bank	--	--	--	--	--	--	176	0.01	1
Boat	--	--	--	--	--	--	1,870	0.02	32
Total	--	--	--	--	--	--	2,046	0.02	33
November [b]									
Bank	--	--	--	--	--	--	140	0.02	3
Boat	--	--	--	--	--	--	173	0.03	5
Total	--	--	--	--	--	--	313	0.03	8
December [b]									
Bank	--	--	--	--	--	--	180	0.02	3
Boat	--	--	--	--	--	--	547	0.01	5
Total	--	--	--	--	--	--	727	0.01	8
Combined [a]									
Bank	4,724	0.08	397	5,396	0.09	462	6,542	0.02	111
Boat	3,884	0.22	839	1,804	0.13	232	10,110	0.03	311
Total	8,608	0.14	1,326	7,200	0.10	694	16,652	0.03	422

[a] *Harvest per angler trip was calculated for the period when retention was allowed.*

[b] *Creel samplers did not observe any insample kept fish from John Day Reservoir during January-April, November, and December. Estimates were based on out-of-sample angler reports.*

Table 4. Numbers of sturgeon anglers interviewed and numbers of white sturgeon kept and released reported during sampling of sport fisheries in Bonneville Reservoir, January 1 through April 16, 1999; The Dalles Reservoir, January 1 through June 11, 1999; and John Day Reservoir, January 1 through December 31, 1999.

Reservoir Method/Month	Anglers checked	Hours fished	Sublegal released	Legal released	Legal kept	Oversize released
Bonneville						
Bank						
January	426	1,201	160	3	11	0
February	407	1,075	64	3	7	0
March	654	2,020	386	5	40	0
April	184	641	106	0	10	0
Bank total	1,671	4,937	716	11	68	0
Boat						
January	147	818	351	9	30	0
February	158	913	242	4	29	2
March	229	1,354	561	7	70	1
April	102	498	217	4	40	0
Boat total	636	3,583	1,371	24	169	3
Combined total	2,307	8,520	2,087	35	237	3
The Dalles						
Bank						
January	310	1,117	118	0	16	4
February	260	1,201	32	0	1	0
March	334	1,485	109	0	5	1
April	388	1,887	153	0	11	0
May	340	1,698	301	2	28	6
June	146	746	138	0	3	6
Bank total	1,778	8,104	851	2	74	17
Boat						
January	27	98	20	8	7	1
February	49	275	15	0	1	1
March	46	323	40	0	4	2
April	55	303	90	0	8	2
May	35	234	76	2	4	1
June	2	13	14	0	0	0
Boat total	214	1,246	255	10	24	7
Combined total	1,992	9,350	1,106	12	98	24

Continued

Table 4. Continued

Reservoir Method/Month	Anglers checked	Hours fished	Sublegal released	Legal released	Legal kept	Oversize released
John Day						
Bank						
January	183	526	34	0	0	1
February	197	515	14	0	0	0
March	216	697	38	0	0	1
April	157	454	19	0	0	1
May	323	1,075	40	0	1	2
June	455	1,511	90	0	4	19
July	475	1,989	93	0	8	7
August	273	938	42	0	5	0
September	113	458	14	0	0	2
October	25	70	2	0	0	0
November	20	34	2	0	0	0
December	30	89	2	0	0	0
Bank total	2,467	8,356	390	0	18	33
Boat						
January	118	598	60	0	0	3
February	131	548	44	0	0	4
March	150	722	67	0	0	2
April	153	821	96	1	0	12
May	174	1,004	123	0	4	17
June	218	1,303	254	1	1	11
July	233	1,297	313	0	14	10
August	265	1,451	267	6	18	12
September	143	877	241	5	22	5
October	47	274	74	1	3	3
November	26	132	27	2	0	3
December	10	47	8	0	0	1
Boat total	1,668	9,074	1,574	16	62	83
Combined total	4,135	17,430	1,964	16	80	116

Table 5. Length frequencies of harvested white sturgeon measured during sampling of sport fisheries in Bonneville Reservoir, January 1 through April 16, 1999; The Dalles Reservoir, January 1 through June 11, 1999; and John Day Reservoir, January 1 through December 31, 1999.

Fork length (cm)	Bonneville	The Dalles	John Day	Fork length (cm)	Bonneville	The Dalles	John Day
90				130	3	2	1
91				131			
92	3			132		1	1
93	2			133			
94	7			134		1	1
95	5			135	1		
96	7			136		2	1
97	8			137	1	1	1
98	8			138			1
99	29			139			1
101	16		1	140			
101	13		1	141			1
102	11			142	1	1	
100	9			143			
104	15	1		144			
105	4			145			
106	10		3	146			
107	10	2		147			
108	5	4	1	148			
109	6	3	1	149			
110	6	7	9	150			
111	3	4	6	151			
112	7	5	6	152			
113	1	6	6	153			
114	2	5	4	154			
115	8	6	3	155			
116	4	6	4	156			
117	1	7	1	157			
118	1	1	5	158			
119	2	5	6	159			
120	1	8	4	160			
121	1		2	161			
122	1	3	2	162			
123	2	2	2	163			
124	3	4	2	164			
125	2	5		165			
126	1	4	1	166			
127	2	1	2	167			
128		1	2				
129	1	2	3	Total	223	99	85

Table 6. Estimated angling effort, harvest, and harvest per angler trip (CPUE) of white sturgeon from Bonneville, The Dalles, and John Day reservoirs, 1989 through 1999.

Reservoir		Bank anglers			Boat anglers		
Year	Period	Trips	Harvest	CPUE	Trips	Harvest	CPUE
Bonneville (95-138 cm fork length interval)							
1989	Mar-Oct	8,028	1,316	0.164	5,792	1,099	0.190
1990	Mar-Oct	7,213	719	0.100	7,349	1,055	0.144
1991	[a]						
1992	[a]						
1993	Mar-Oct	7,599	678	0.089	6,747	736	0.109
1994	Mar-Oct	7,821	1,024	0.131	5,329	1,089	0.204
1995	Feb-Apr	2,541	456	0.180	1,750	857	0.490
1996	Jan-Mar	3,341	823	0.246	1,735	463	0.267
1997 [b]	Jan-Apr 4	5,093	808	0.159	2,535	632	0.249
1998	Jan-Apr 19	4,913	358	0.073	4,990	1,214	0.243
1999	Jan-Apr 16	4,724	371	0.078	3,884	782	0.201
The Dalles (110-138 cm fork length interval)							
1989	Mar-Oct	3,659	119	0.033	1,760	99	0.056
1990	[a]						
1991 [b]	[a]						
1992	[a]						
1993	Mar-Oct	2,058	46	0.023	1,902	61	0.032
1994	Mar-Oct	3,124	75	0.024	1,863	68	0.037
1995	Mar-May	957	28	0.029	510	18	0.035
1996	Mar-Apr	655	21	0.031	251	29	0.115
1997	Jan-May 4	2,278	119	0.052	538	16	0.030
1998	Jan-Jun 7	4,102	455	0.111	1,319	296	0.225
1999	Jan-Jun 11	5,396	381	0.071	1,804	192	0.106
John Day (110-138 cm fork length interval)							
1989	May-Jul	3,572	22	0.006	3,401	34	0.010
1990	Mar-Dec	3,806	33	0.009	3,063	82	0.027
1991 [b]	Apr-Sep	1,977	36	0.018	2,463	73	0.030
1992	[a]						
1993	Mar-Oct	3,208	56	0.018	4,466	111	0.025
1994	Mar-Oct	3,221	42	0.013	6,860	164	0.024
1995	Mar-May	1,891	12	0.006	2,407	30	0.013
1996	Mar-Apr	1,524	17	0.011	1,396	27	0.020
1997	Feb-Aug	4,780	166	0.035	5,968	287	0.048
1998	Jan-Oct 5,531	161	0.029	8,540	371	0.043	
1999	Jan-Dec6,542	80	0.012	10,110	224	0.022	

[a] *Little or no sampling.*

[b] *Initiation of one fish daily bag limit.*

The Dalles Reservoir

The 1999 retention season for white sturgeon in The Dalles Reservoir opened January 1 and was scheduled to close June 30. We began our survey on January 1 and continued sampling through June 11. State fishery managers closed the fishery to retention of white sturgeon on June 12 based on our projection that harvest would reach the guideline by that date.

Anglers fished an estimated 93,147 hours (12,903 trips) in The Dalles Reservoir from January 1 through June 11 (Table 1). Angling effort for white sturgeon comprised 56% (7,200 trips) of the total estimated effort. The number of angler trips estimated by target species were as follows: 400 (3%) for anadromous salmonids, 176 (1%) for American shad, 2,858 (22%) for walleye, 608 (5%) for bass, 1,229 (10%) for northern pikeminnow, 416 (3%) for other resident fish, and 16 (< 1%) for anglers participating in tournaments.

Anglers harvested an estimated 694 white sturgeon during 7,200 trips for sturgeon between January 1 and June 11 (Table 2). The primary sport fishery for white sturgeon extended from the John Day Dam tailrace downstream to Miller Island (Rkm 327). More white sturgeon anglers fished from the bank than from boats. Harvest per trip averaged 0.09 for bank anglers and 0.13 for boat anglers targeting sturgeon during the retention fishery (Table 3). The 1,992 white sturgeon anglers interviewed accounted for 32% of the estimated bank effort (angler hours) and 6% of the estimated boat effort for white sturgeon (Table 4).

The percentage sublegal (< 122 cm, < 48 in) TL, legal (122-152 cm, 48-60 in) TL, and oversize (> 152 cm, > 60 in) TL white sturgeon in the January through June sampled catch was 89%, 9%, and 2%, respectively (Table 4). The length distribution of the sampled harvest is presented in Table 5. Harvest per trip of 110-138 cm FL (48-60 in TL) fish declined for the first time since 1993 (Table 6).

John Day Reservoir

We began our survey of the 1999 sport fishery in John Day Reservoir on January 1 and continued sampling it through December 31. The harvest guideline was not attained and the retention fishery remained open year-round.

Anglers fished an estimated 201,228 hours (38,176 trips) in John Day Reservoir during 1999 (Table 1). Angling effort for white sturgeon comprised 44% (16,652 trips) of the total estimated effort. The number of angler trips estimated by target species were as follows: 4,248 (11%) for anadromous salmonids, 124 (< 1%) for American shad, 8,857 (23%) for walleye, 4,934 (13%) for bass, 158 (< 1%) for northern pikeminnow, 2,757 (7%) for other resident fish, and 446 (1%) for tournament anglers.

Anglers harvested an estimated 422 white sturgeon during 16,652 trips for sturgeon in 1999 (Table 2). Anglers concentrated their effort for sturgeon from McNary Dam downstream past Irrigon, Oregon (Rkm 449). Effort for white sturgeon was greatest in July (Table 3).

Harvest per trip averaged 0.02 for bank anglers and 0.03 for boat anglers during the retention fishery (Table 3). The 4,135 sturgeon anglers interviewed accounted for 23% of the estimated bank effort (angler hours) and 16% of the estimated boat effort for white sturgeon (Table 4).

The percentage sublegal (< 122 cm, < 48 in) TL, legal (122-152 cm, 48-60 in) TL, and oversize (> 152 cm, > 60 in) TL white sturgeon in the reported catch was 91%, 4%, and 5%, respectively (Table 4). The length distribution of the sampled harvest is presented in Table 5. Harvest per trip of 110-138 cm FL (48-60 in TL) fish declined for the second consecutive year (Table 6).

Treaty Indian Commercial and Subsistence Harvest

The 1999 treaty Indian commercial harvest estimates for Zone 6 were 1,280 white sturgeon from Bonneville Reservoir, 1,051 white sturgeon from The Dalles Reservoir, and 770 white sturgeon from John Day Reservoir (Table 7). Most of the harvest (1,706 fish) was landed in the winter gill net fishery (February 1 - March 20) with 1,183 fish harvested in the spring setline fishery (April 1 - July 31), 51 fish harvested in the January setline fishery (January 1-31), and 151 fish landed in the fall setline fishery (October 11 – December 31). The treaty Indian Zone 6 subsistence white sturgeon harvest estimated by CRITFC and the Yakama Indian Nation was 244 fish from all three reservoirs (Table 7).

DISCUSSION

Zone 6 Sturgeon Harvest Management

Harvest management of Zone 6 white sturgeon fisheries during 1999 was coordinated through the Sturgeon Management Task Force (SMTF), consisting of representatives from WDFW, ODFW, and the Columbia River treaty Indian tribes. The SMTF recommended 1999 harvest guidelines of 1,520 sport and 1,300 commercial white sturgeon from Bonneville Reservoir, 600-800 sport and 1,000-1,200 commercial from The Dalles Reservoir, and 560 sport and 1,160 commercial from John Day Reservoir.

White sturgeon sport harvest exceeded SMTF guidelines from 1991 through 1994 (Table 7). Beginning in 1995, managers were more successful at keeping harvest within guidelines by adopting in-season retention fishery closures based on weekly projections of harvest. Harvest again exceeded the sport guidelines in 1998 when unexpected late season increases in catch rate occurred. Managers relied on more conservative interpretations of our harvest projections in 1999 to insure that sport guidelines were not exceeded. Once closure dates were set, harvest fell short of these projections due to late season declines in angling pressure and catch rates.

The active management strategy relying on our in-season harvest estimates and projections successfully eliminated the reoccurring white sturgeon overharvest in Zone 6 sport fisheries. Since 1995, sport harvest has averaged 97%, 103%, and 85% of the SMTF's annual harvest guidelines for Bonneville, The Dalles, and John Day reservoirs respectively (Table 7). Prior to pro-active in-season management (1991-1994), sport harvest averaged 158%, 163%, and 169% in

Table 7. Sturgeon Management Task Force (SMTF) harvest guidelines and estimated harvest of white sturgeon from Bonneville, The Dalles, and John Day reservoirs, 1991 through 1999.

Fishery	Bonneville		The Dalles		John Day		Unspecified	
Year	Guideline	Harvest	Guideline	Harvest	Guideline	Harvest	Harvest	Total
Sport								
1991	1,350	2,270	100	199	100	150	0	2,619
1992	1,350	1,717	100	139	100	147	0	2,003
1993	1,350	2,307	100	158	100	144	0	2,609
1994	1,350	2,223	100	154	100	234	0	2,611
1995	1,350	1,370	100	50	100	53	0	1,473
1996	1,350	1,353	100	80	100	62	0	1,495
1997	1,520	1,463	200	178	560	464	0	2,105
1998	1,520	1,626	600-800	857	560	593	0	3,076
1999	1,520	1,236	600-800	694	560	422	0	2,352
Indian commercial								
1991	1,250	999	300	457	100	39	0	1,495
1992	1,250	1,146	300	431	100	23	0	1,600
1993	1,250	1,415	300	579	100	12	0	2,006
1994	1,250	1,176	300	309	100	117	0	1,602
1995	1,250	1,421	300	312	100	308	0	2,041
1996	1,250	1,005	300	230	100	360	0	1,595
1997	1,300	1,852	400	498	1,160	1,260	0	3,610
1998	1,300	1,462	1,000-1,200	1,108	1,160	1,100	0	3,670
1999	1,300	1,280	1,000-1,200	1,051	1,160	760	0	3,091
Combined fisheries								
1991	2,600	3,269	400	656	200	189	0	4,114
1992	2,600	2,863	400	570	200	170	0	3,603
1993	2,600	3,722	400	737	200	156	0	4,615
1994	2,600	3,399	400	463	200	351	0	4,213
1995	2,600	2,791	400	362	200	361	0	3,514
1996	2,600	2,358	400	310	200	422	0	3,090
1997	2,820	3,315	600	676	1,720	1,724	0	5,715
1998	2,820	3,088	1,800	1,965	1,720	1,693	0	6,746
1999	2,820	2,516	1,800	1,745	1,720	1,182	0	5,443

continued

Table 7. Continued.

Fishery	Bonneville		The Dalles		John Day		Unspecified	
Year	Guideline	Harvest	Guideline	Harvest	Guideline	Harvest	Harvest	Total
Indian subsistence [a]								
1991		[b]		[b]		[b]	[b]	[b]
1992		89		[b]		[b]	119	208
1993		146		31		30	56	263
1994		290		197		163	0	650
1995		570		260		320	0	1,150
1996		260		120		110	0	490
1997		130		40		63	0	233
1998		109		86		45	0	240
1999		90		116		28	0	244

[a] *The SMTF did not establish harvest guidelines for the subsistence fishery, however, the expected annual subsistence harvest was 300 white sturgeon for 1994 through 1999.*
[b] *Not available.*

Bonneville, The Dalles, and John Day reservoirs respectively. Since 1991, harvest has averaged 114%, 113%, and 98% of the combined sport and commercial harvest guidelines for Bonneville, The Dalles, and John Day reservoirs respectively.

Conservative harvest management strategies based on optimum sustainable (OSY) harvest rates, coupled with trawl and haul stocking efforts in The Dalles and John Day reservoirs, have been successfully used by managers to rebuild Zone 6 white sturgeon abundance. This has been born out in the results of recent stock assessments in each reservoir (North et al. 1998, North et al. 1999, Burner et al.- Report A). Zone 6 fisheries have benefited with greater harvest guidelines. The trend in increased abundance should have translated to increased catch of legal size fish per unit effort (angler trip) (CPUE). However, while CPUE improved in The Dalles Reservoir in 1997 and 1998, it declined in 1999 (Table 6). CPUE has declined for the past two years in John Day Reservoir and it has declined in Bonneville Reservoir since 1995.

Harvest per trip in all three reservoirs should be closely monitored to insure that harvest does not reverse the trend in increased legal-size white sturgeon abundance. The optimum sustainable harvest rates and corresponding harvest guidelines used for Zone 6 sturgeon fishery management are designed to maintain harvest at levels that increase legal-size abundance to a theoretical carrying capacity. If CPUE does not continue to increase, abundance estimates and harvest rates should be reexamined to determine appropriate harvest guidelines. Any problem attributable to harvest should not impact the abundance of sublegal fish and the latest stock assessments indicate that this segment remains healthy for each population.

PLANS FOR NEXT YEAR

We will continue to monitor Zone 6 sport and treaty Indian commercial fisheries in 2000. We plan to conduct young-of-year (YOY) white sturgeon recruitment indexing using small mesh gill nets in Little Goose and Ice Harbor reservoirs on the Snake River and in McNary, John Day, and The Dalles reservoirs on the Columbia River. We will also assist CRITFC in capturing mature white sturgeon in the Columbia River upstream from McNary Dam to provide broodstock for a planned experimental artificial propagation effort.

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WHITE STURGEON MITIGATION AND RESTORATION IN THE COLUMBIA AND SNAKE RIVERS UPSTREAM FROM BONNEVILLE DAM

ANNUAL PROGRESS REPORT

APRIL 1999 – MARCH 2000

Report C

Describe reproduction and early life history characteristics of white sturgeon populations in the Columbia River between Bonneville and Priest Rapids dams

and

Define habitat requirements for spawning and rearing white sturgeon and quantify the extent of habitat available in the Columbia River between Bonneville and Priest Rapids dams

This report includes: Progress updates on investigations on spawning and rearing habitat and recruitment to young-of-the-year in various Columbia and Snake River reservoirs.

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ABSTRACT

During 1 April 1999 through 31 March 2000 the U.S. Geological Survey (USGS) worked on nine tasks. Three are ongoing activities related to the development of long-term data sets, four are studies of moderate duration in which the majority of the field or laboratory work has already been completed, and two were activities that began during this reporting period.

Seven male white sturgeon were tracked during April, May, June, and July to investigate pre-spawn and spawning movements and behavior associated with dam operations at John Day Dam. Two fish moved into the suspected spawning area but the remaining five fish either moved downstream or remained near the release location.

Physical conditions were favorable for spawning during 1999 and fall bottom trawling revealed that recruitment of young-of-the-year white sturgeon occurred in Bonneville, The Dalles, and John Day reservoirs. The Oregon Department of Fish and Wildlife provided gillnet catch data from The Dalles and John Day reservoirs in an ongoing comparison of indices of abundance derived from the two gears.

Analyses continued on several tasks, including quantifying habitat for spawning and rearing white sturgeon in McNary Reservoir, describing the effects of proposed reservoir drawdowns on productivity of white sturgeon, and assessing the effects of water temperature on the development of white sturgeon eggs.

Preliminary study designs for two laboratory experiments investigating predation on larval and older white sturgeon were completed. These experiments will begin in 2000.

INTRODUCTION

This annual report describes progress of the U.S. Geological Survey, Western Fisheries Research Center, Columbia River Research Laboratory on the Bonneville Power Administration funded Project 86-50 – White Sturgeon Restoration and Enhancement in the Columbia and Snake Rivers Upstream from Bonneville Dam. The reporting period for this report (1 April 1999 through 31 March 2000) overlaps the contracting periods outlined in statements of work for fiscal years 1999 and 2000, therefore this report covers tasks that were listed in both statements of work.

The multi-agency project has four common objectives. Those objectives are to:

1) Develop and implement mitigation actions that do not involve changes to hydrosystem operation and configuration.
2) Mitigate for effects of hydrosystem operation and configuration by developing and recommending actions that involve changes to hydrosystem operation and configuration to optimize physical habitat conditions for white sturgeon production.

3) Monitor and evaluate actions to mitigate for lost white sturgeon production due to development, operation, and configuration of the hydrosystem.
4) Assess losses to white sturgeon production due to development, operation, and configuration of the hydrosystem.

During this reporting period the U.S. Geological Survey worked on nine tasks related to the four objectives stated above. Those tasks and the objective addressed were to:

1) Describe the habitat use and movements of juvenile and adult white sturgeon in the Columbia River between Priest Rapids and McNary dams and downstream from Ice Harbor Dam on the Snake River. This includes working with the USFWS (Report D) to quantify spawning and rearing habitat for white sturgeon in McNary Reservoir – Objective 4.

2) Use trawls to determine if recruitment of white sturgeon to young-of-the-year (YOY) occurred in Bonneville, The Dalles, and John Day reservoirs – Objective 3.

3) Compare catches of YOY from gill nets and trawls to index the abundance of YOY white sturgeon in The Dalles and John Day reservoirs – Objective 3.

4) Assess the effects of water temperature on the development of white sturgeon eggs obtained from feral white sturgeon in the Columbia River Basin – Objective 2.

5) Estimate the availability of spawning habitat for white sturgeon downstream from Bonneville, The Dalles, John Day, and McNary dams – Objective 2.

6) Describe the potential effect of reservoir drawdowns on white sturgeon productivity in John Day, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite reservoirs – Objective 2.

7) Use telemetry to monitor the behavior of pre-spawn and spawning white sturgeon in the tailrace of John Day Dam in relation to dam operations – Objective 2.

8) Conduct laboratory trials to determine the size at which white sturgeon are no longer vulnerable to predation – Objective 1.

9) Test the hypothesis that predation on larval and age-0 white sturgeon is not affected by turbidity – Objective 4.

These tasks are in various stages of completion. Tasks 2, 3, and 5 are ongoing activities related to the development of long-term data sets. Tasks 1, 4, 6, and 7 are studies of moderate duration in which the majority of the field or laboratory work has already been completed and final analyses are ongoing. Tasks

8 and 9 are studies that began during this reporting period. Activities conducted on these tasks were primarily study design and purchasing necessary for experiments that will be conducted during the next reporting period.

METHODS

Quantify Spawning and Rearing Habitat for White Sturgeon in McNary Reservoir

Investigations of the seasonal habitat use and movements of Columbia and Snake River juvenile and adult white sturgeon in McNary Reservoir began in 1996 as part of a larger effort to quantify spawning and rearing habitat in this reach. Kappenman (2000) explains how habitat suitability index curves were developed from telemetry derived habitat use data and how substrate maps of the study area were derived. During 1999 we were to work with the USFWS (Report D) to integrate results from their assessment of flow effects on spawning habitat in the free-flowing Hanford Reach and downstream from Ice Harbor Dam with our assessment of the availability of rearing habitat in the remainder of the McNary Reservoir.

Young-of-the-Year Indexing

We sampled for juvenile white sturgeon with a 6.2 m high-rise bottom trawl (Palmer et al. 1988) to determine if recruitment to YOY occurred in Bonneville, The Dalles, and John Day reservoirs. The previously designed sampling program calls for conducting a total of 66 tows at 11 sites in Bonneville Reservoir (6 replicates per site), 24 tows at 12 sites in The Dalles Reservoir (2 replicates per site), and 38 tows at 19 sites in John Day Reservoir (2 replicates per site). Sample sites were designated with a code indicating statute river mile and relative position across the river channel. The last digit of the site designation represents position in the channel, with 0 and 5 designating backwater areas and 1 through 4 designating ¼ channel width increments from left to right facing upstream. Digits preceding the last number represent river miles to the nearest 0.1-mile from the mouth of the Columbia or Snake rivers. For example, a site coded as 34753 indicates that the location is near river mile 347.5 and in the third quadrant of the river from the left bank (looking upstream).

Trawling was conducted in an upstream direction and each tow was typically 10 minutes in duration. We estimated the distance fished during each tow with a Rockwell PLGR+ Global Positioning System (GPS) receiver using the Precise Positioning Service[1] and determined the area fished by multiplying the distance by 4.4 m; the estimated fishing width of our bottom trawl. We also used the GPS to navigate the trawling vessel and to maintain a speed-over-ground of approximately 3 km/h during each tow.

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[1]Precise Positioning Service (PPS) is available to the military and certain Federal civilian agencies. This service differs from the Standard Positioning Service available to civilian users. The GPS receiver incorporates the Wide Area GPS Enhancement (WAGE) system and can achieve less than 4 m error in horizontal positioning autonomously in real-time without the need for broadcast variables or post-processing. The WAGE also provides position error estimates to indicate the quality of the data.

All fish captured were enumerated and released. Generally, all fish were measured with the exception of American shad. When catch of an individual species was high, a subsample of 50 individuals was measured. We measured the total length (TL) on all fish and fork length (FL) on fish with forked caudal fins to the nearest mm. Weights were obtained only from white sturgeon. Generally, young-of-the-year white sturgeon were weighed to the nearest 1 g, and larger juveniles were weighed to the nearest 5 or 10 g.

Catch-per-unit-effort (μ_{cpue}) of white sturgeon was expressed as the number of fish caught per 2,500 m^2. The proportion of positive tows (*Ep*) for YOY white sturgeon was calculated as the ratio of tows where at least one YOY was captured to the total number of tows conducted.

Comparison of Gill Nets and Bottom Trawls to Index Recruitment to Young-of-the-Year

The USGS is collaborating with the Oregon Department of Fish and Wildlife (ODFW) and Washington Department of Fish and Wildlife (WDFW) to determine if indices of recruitment developed from catches of young-of-the-year white sturgeon from 51-mm stretched mesh gillnets follow trends similar to those developed from catches in bottom trawls. Sampling with bottom trawls to index the recruitment of young-of-the-year white sturgeon is an effective method to index recruitment (Counihan et al. 1999a) but is restricted to areas with suitable bottom topography, and requires specialized boats and boat operator experience. Counihan et al.1999a described two indices that can be used to assess the relative abundance of young-of-the-year white sturgeon from highly skewed trawling data; the proportion of positive trawl tows (i.e. the ratio of the number of trawl tows with at least one young-of-the-year white sturgeon to the total number of tows conducted) and mean catch per unit of effort. Comparisons between gears will be made from sampling with both gears in The Dalles and John Day Reservoirs. The USGS has an ongoing sampling program in each of these reservoirs, and in 1999 the ODFW began sampling with gillnets at fixed sites in these reservoirs (Figures 1 and 2). The ODFW conducted sampling in The Dalles and John Day reservoirs (Report A) and entered, proofed, and summarized the catch data from that sampling.

The statistical design for this comparison calls for sampling with each gear during October or November at fixed locations. Generally, in each reservoir sampling with gillnets is conducted after sampling is done with the bottom trawl. Young of the year are discerned from older white sturgeon through length frequency analysis, and two indices of abundance are derived for each gear and reservoir. The proportion of positive efforts (Ep; Uphoff 1993) is the number of efforts with at least one young-of-the-year white sturgeon to the total number of efforts conducted. The arithmetic mean of catch per unit effort (CPUE) is the mean of untransformed CPUE data. For the bottom trawl data, mean CPUE is presented as the number of young-of-the-year white sturgeon per 2,500 m^2 of riverbed sampled. For the gillnet data, mean CPUE is presented as the number of young of the year per overnight set. Correlation analysis will be used to compare indices of abundance of young of the year between gears for each reservoir.

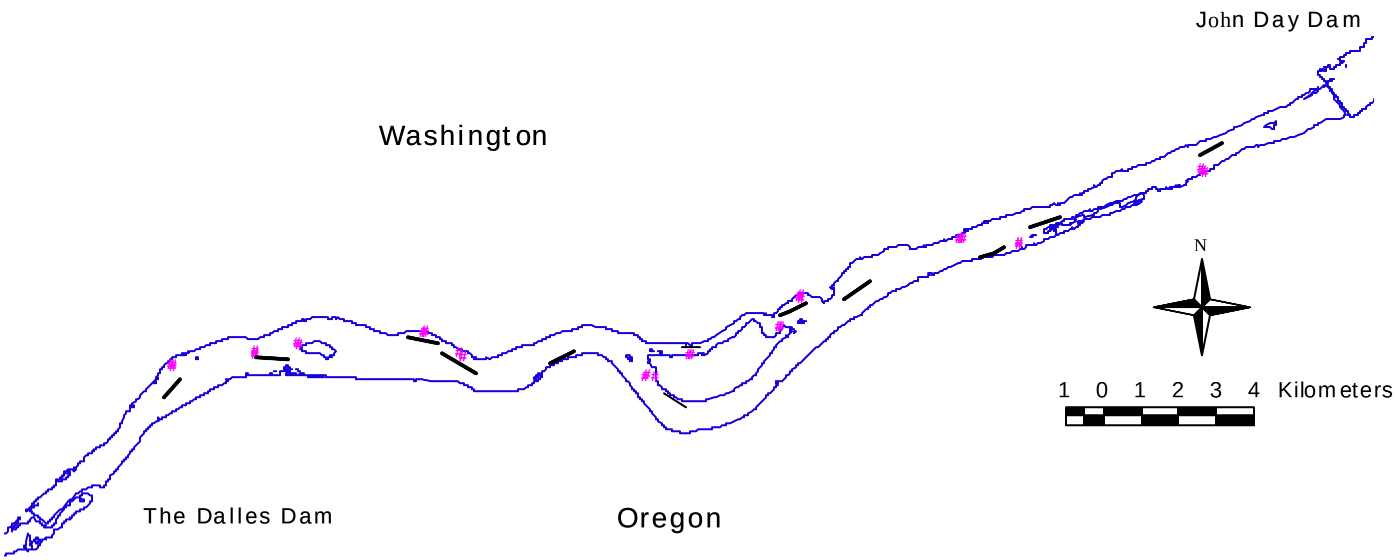

Figure 1. Locations in The Dalles Reservoir where gillnets were fished in 1999 to index the recruitment of young-of-the-year white sturgeon. Dots indicate the location of the end of the gillnet that was closest to the shore. Lines indicate bottom trawl sites.

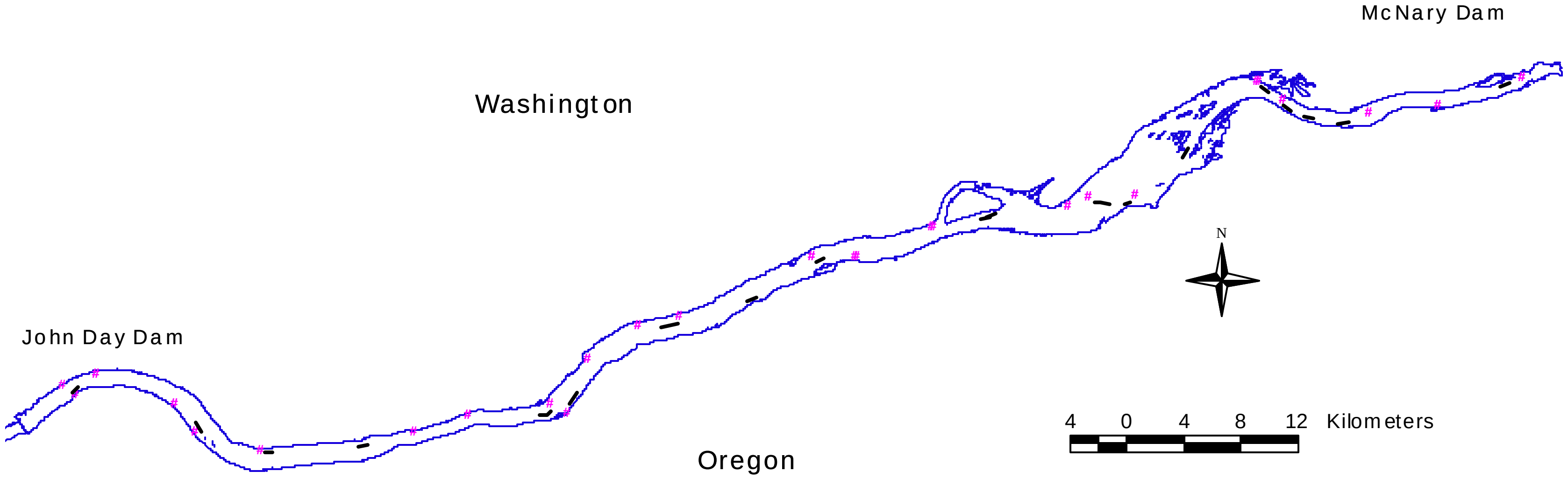

Figure 2. Locations in John Day Reservoir where gillnets and bottom trawls were fished in 1999 to index the abundance of young-of-the-year white sturgeon. Dots indicate the location of the end of the gillnet closest to the shore. Lines indicate bottom trawl sites.

Assess Effects of Water Temperature on the Development of White Sturgeon Eggs

Laboratory studies were conducted in 1997 and 1998 to investigate relations between water temperature and timing of the development of white sturgeon eggs from three river systems. Counihan et al. (1999b) and Kappenman et al. (2000) described the experiments and methods used in this study. No experiments were conducted during this reporting period; we worked on data analysis and preparation of a manuscript describing the results of the experiments.

Availability of Spawning Habitat

Parsley and Beckman (1994) presented the results of hydraulic simulations of the physical habitat downstream of McNary, John Day, The Dalles, and Bonneville dams in response to river discharges. The methods, models, and results from that paper were used with river discharges and water temperatures that occurred during 1999 as inputs to create a daily index of white sturgeon spawning habitat for these four known spawning areas. Mean daily river discharges and water temperatures that occurred at the dams during April through July were obtained from the Data Access in Real Time (DART) web page (http://www.cqs.washington.edu/dart/).

Effects of Proposed Reservoir Drawdowns on the Productivity of White Sturgeon

As described in our 1998 annual report (Kappenman et al. 2000) we are using cartographic modeling to estimate the spatial distribution of habitats suitable for spawning and rearing white sturgeon under natural and impounded river conditions. Estimates of white sturgeon spawning and rearing habitat under natural and impounded conditions are being made for the impounded portions of the lower Snake River reservoirs downstream from Hells Canyon Dam and for John Day Reservoir.

In general, our approach is to use previously modeled data that describes the physical environment (water depths and mean water column velocities) at current operating conditions and during pre-impoundment conditions. Methods describing the acquisition of the modeled physical data are provided in our annual report from last year (Kappenman 2000). Univariate criteria curves describing the suitability of habitats for spawning (Figure 3) were provided by Parsley and Beckman (1994). Univariate criteria curves for rearing (Figure 4) were developed from the frequency-of-use data presented and analyses presented in Kappenman (2000). For this analysis these curves were generalized into three suitability categories – not suitable, suitable, and optimal habitats (Figures 5 and 6).

Information on riverbed substrates for the Columbia and Snake rivers is generally lacking, particularly for pre-impoundment conditions. However, in the absence of substrate data, water velocity can be used as a surrogate for expected riverbed sediments. Hjulstrom (reported in Gordon et al. 1992) developed a set of curves that relate velocity to particle size. The curves can be used for general estimates

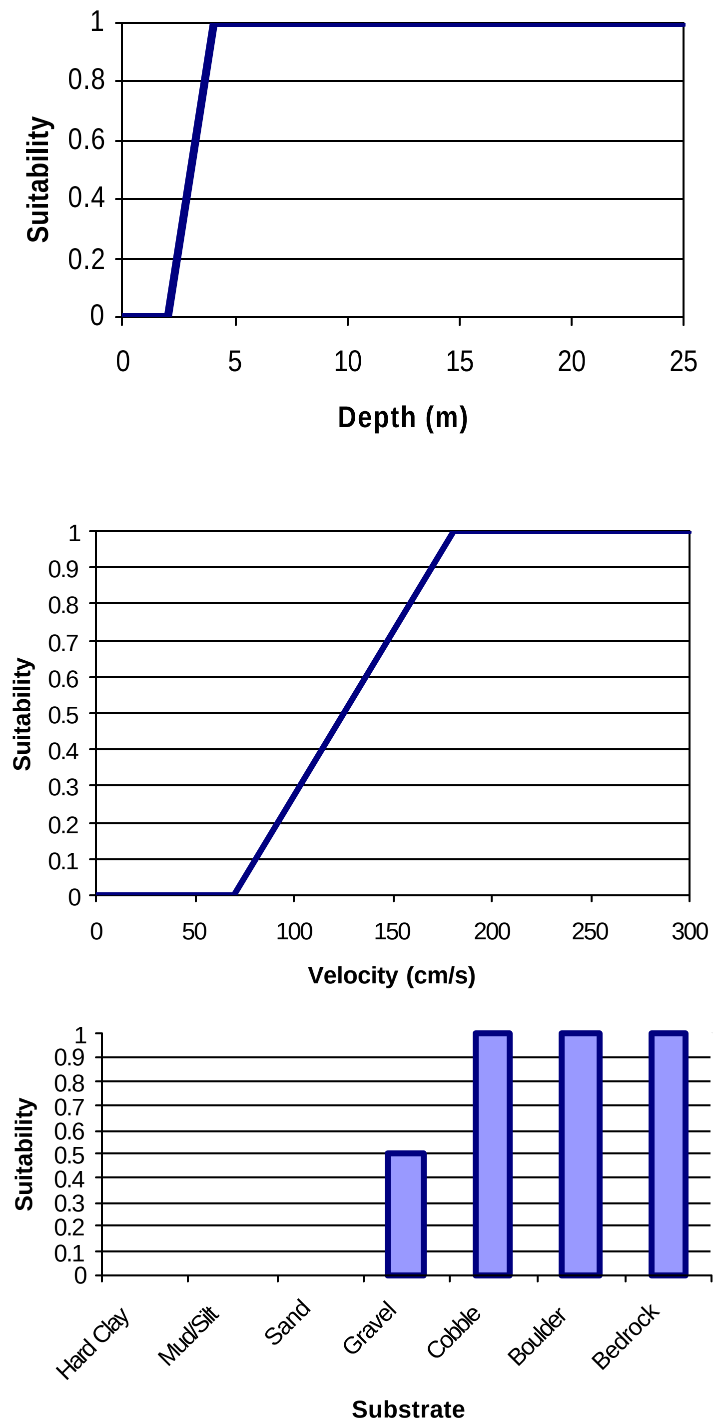

Figure 3. Univariate suitability index curves for white sturgeon spawning (from Parsley and Beckman (1994)).

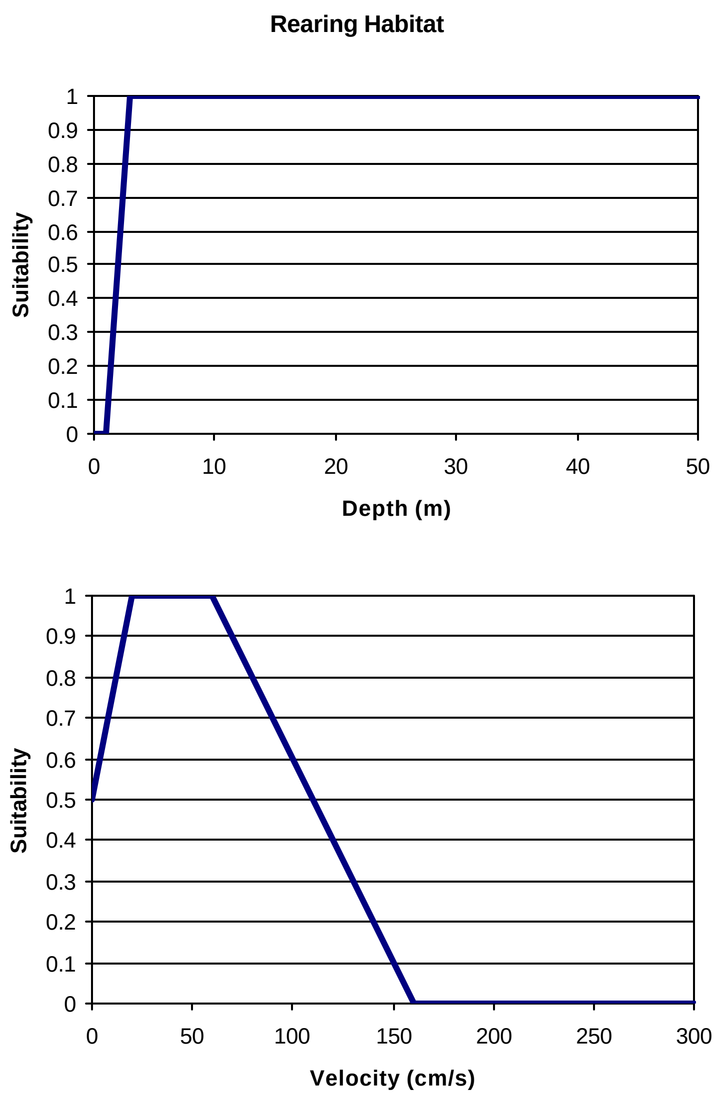

Figure 4. Univariate suitability index curves for white sturgeon rearing developed from information provided in Kappenman et al. (1999). White sturgeon did not select for or against different substrates; therefore, all substrate types were assigned a suitability of 1.0.

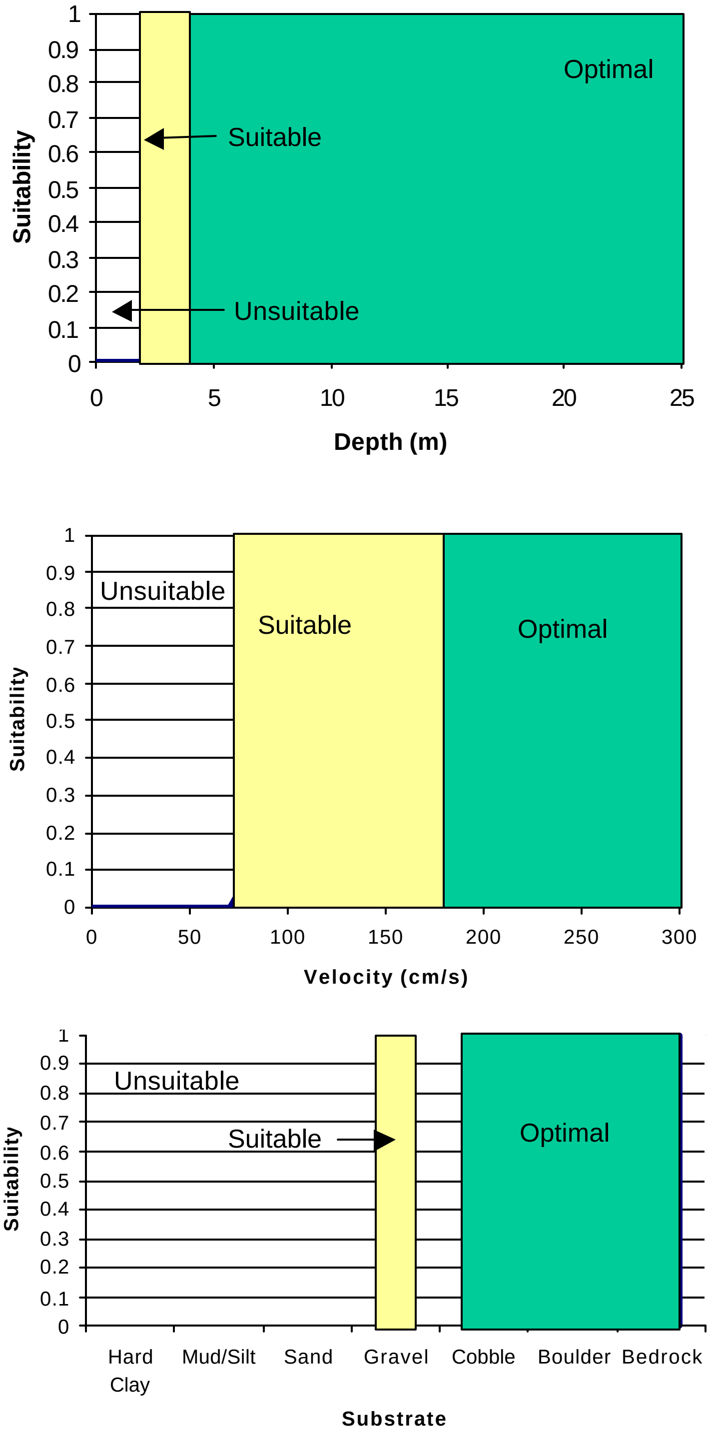

Figure 5. Suitable, optimal, and unsuitable white sturgeon spawning habitat categories developed from univariate suitability index curves.

Rearing Habitat

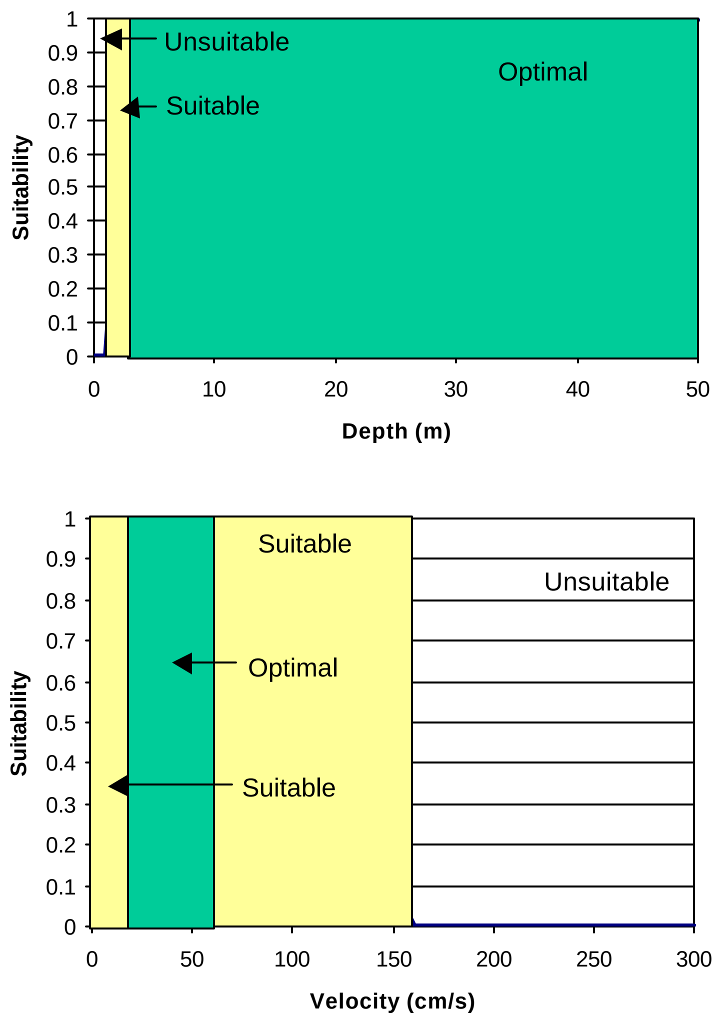

Figure 6. Suitable, optimal, and unsuitable white sturgeon rearing habitat categories developed from univariate suitability index curves. Kappenman et al. (2000) reported that rearing white sturgeon did not select for or against different substrates. Therefore, all substrate types are considered to be optimal for rearing.

of sediment entrainment (Gordon et al. 1992), and can be used to estimate what sediments may be expected if the river velocity is known. Thus, in the absence of riverbed substrate data, we are using modeled river velocities as a surrogate for riverbed substrates.

Movements and Behavior of Pre-Spawn and Spawning White Sturgeon

The USGS continued a telemetry study investigating the movements and behavior of pre-spawn and spawning white sturgeon in The Dalles Reservoir that began in 1998. The study plan called for weekly searches in The Dalles Reservoir for seven previously transmittered male white sturgeon (Kappenman 2000) during the spring until water temperatures exceeded 10°C. When water temperatures were between 10°C and 18°C we conducted daily searches, excluding weekends, of the John Day Dam Tailrace and attempted to get locations of fish downstream from the tailrace by returning to the fish's last known location. Because this study was intended to investigate movements of pre-spawning and spawning fish in relation to discharge operations at John Day Dam, we placed more emphasis on locating fish in the John Day Dam tailrace versus the rest of The Dalles reservoir. Spawning by white sturgeon has been documented between river km 342.8 and 346 (Miller et al. 1991), and habitat suitable for spawning is influenced by discharge at the dam (Parsley and Beckman 1994).

We implemented two search strategies in The Dalles Reservoir; continuous listening and pre-established listening stations spaced at 0.5 km intervals. Continuous listening was required immediately downstream from John Day Dam because complex channel structure and high ambient noise from operations at the dam limited reception distance of the acoustic transmitters. Therefore, the area downstream of the John Day Dam boat restricted zone between river km 347.6 and 345.5 was searched from a boat along both the Washington and Oregon shorelines by either powering or drifting downstream while continuously listening for acoustic transmitters on 72, 73, and 74 kHz frequencies. At the same time, a radio receiver scanned for radio transmitters on frequencies 149.200, 149.210, and 149.220 MHz.

We searched the remainder of The Dalles Reservoir downstream from river km 345.5 by motoring to predetermined listening stations. The boat was stopped at each listening station and the directional hydrophone was deployed and rotated 360 degrees, pausing for several seconds in each of the four 90 degree quadrants. After listening in all four quadrants, the acoustic receiver was set to the next frequency and the process was repeated until all transmitter frequencies were scanned. When a transmitter was detected, the boat was maneuvered until the signal was equal in all four directions, indicating that we were directly above the fish. At each fish location the latitude and longitude were recorded using a GPS, the approximate river mile was recorded and the depth was measured using a fathometer.

Setlining was conducted during January and February 2000 to capture and attach transmitters to additional sexually mature or maturing white sturgeon. The methodologies used while setlining, including handling of the fish and determining sex and state of maturity, were similar to those described by DeVore et al. (in press). Surgeries to determine the sex and state of maturation were performed only on fish $\geq$ 153 cm total length.

Radio and sonic transmitters were attached externally. A multi-stranded stainless steel wire was passed through two holes on either end of the radio transmitter and then through the musculature ventral to the dorsal fin of the fish. The tag ends of the wire were then passed through holes on the sonic transmitter and through three American Fishing Wire #4 double barrel compression sleeves. The tag ends were pulled tight and the compression sleeves compressed securing the transmitter. The tag ends of the wire were trimmed and the attachment area was bathed with a solution of nitrofurazone to reduce infections. Transmitters were verified to be functioning and the fish were released near where they were captured.

A wireless hydrophone system was deployed in March 2000 to remotely monitor movements of transmittered fish in and out of the known spawning area during the year 2000 spawning season. Each wireless hydrophone detects acoustic signals and relays them via VHF transmission to a land-based receiver station. Two hydrophones were deployed; one at river km 343.8 and one at river km 345.2. The remote VHF data logging station was positioned on the dredge spoil island at river km 346.5 (Figure 7). This configuration enabled us to determine direction of fish movement (upstream or downstream) as well as when fish entered or left the area. Testing in March of 2000 showed that acoustic signals were consistently received approximately 150 m upstream and downstream from the wireless hydrophones and each hydrophone provided coverage from shoreline to shoreline. Thus, we had fairly high confidence that the wireless hydrophone system would detect movements of fish into and out of the spawning area during the upcoming spawning season.

The performances of the Lotek SRX_400 with W5 firmware and a Sonotronics USR_91 telemetry receiver were compared to determine which receiver would be used to search for telemetred fish during the 2000 spawning period. Lotek and Sonotronics transmitters were attached to an anchored buoy at river km 345.5 and submerged approximately 2-3 meters below the waters surface. A boat equipped with both receiver types drifted downstream from the transmitters while the listener periodically recorded if the acoustic signals could be audibly heard from each receiver.

RESULTS

Quantifying Spawning and Rearing Habitat in McNary Reservoir

The USGS made no progress on this task during this reporting period. Due to circumstances beyond our control, the USFWS was unable to conduct work on this collaborative task. Efforts to complete this work will continue in 2000.

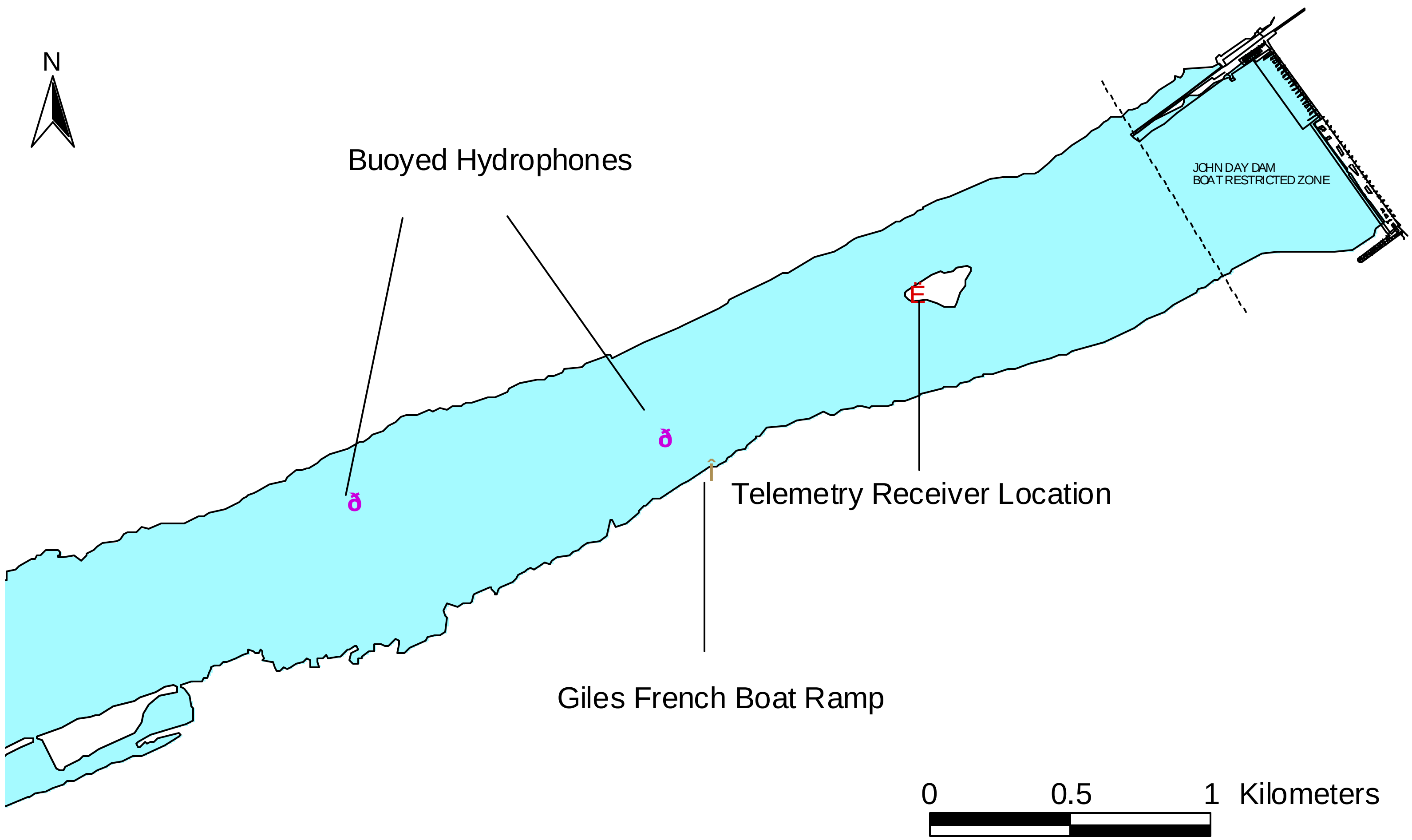

Figure 7. Placement of the Wireless Hydrophone System downstream from John Day Dam.

Young-of-the-Year Indexing

The bottom-trawl sampling program was completed as scheduled during 1999. We fished the bottom trawl on 13 d from 13 September to 1 October in Bonneville Reservoir, on 6 d from 18 October to 28 October in The Dalles Reservoir, and on 5 d from 27 October to 9 November in John Day Reservoir. Down time due to equipment problems or damaged trawls was not significant this year. Weather conditions were favorable and there were no weather-related delays to the sampling. Strong easterly winds can sometimes preclude sampling at sites in the western end of Bonneville Reservoir near Stevenson, whereas strong westerly winds can sometimes preclude sampling at nearly all sites in all reservoirs. No nets were lost while sampling this year, but one net did become snagged on the river bed in approximately 10 m of water at site 20244 in The Dalles Reservoir. We were unable to free the net by pulling with the boat so the trawl warps were cut, leaving the net on the riverbed. However, USGS scuba divers recovered the net the following week.

Bonneville Reservoir

Recruitment of young-of-the-year white sturgeon occurred in Bonneville Reservoir in 1999. We captured 205 juvenile white sturgeon with the high-rise trawl during our sampling of Bonneville Reservoir, 111 (54%) of these were YOY. Young-of-the-year white sturgeon were captured at 10 of the 11 sites (Table 1). Young-of-the-year white sturgeon were easily distinguished from older fish by length frequency analysis (Figure 8). The YOY ranged in length from 76 to 234 mm TL and weighed 2.3 to 53 g. The mean length of YOY captured was 166.5 mm TL and mean weight was 23.1 g. Older juvenile white sturgeon were captured at all 11 sites trawled. The older juvenile white sturgeon measured 294 mm to 1,346 mm FL and weighed 110 to 3,380 g.

The CPUE for combined effort for each of the 11 sites sampled with the bottom trawl in Bonneville Reservoir ranged from 0.0 to 4.39 YOY per 2,500 m^2 and from 0.19 to 9.95 fish per 2,500m^2 for all white sturgeon caught (Table 1). The mean CPUE for individual tows was 1.94 YOY per 2,500 m^2 (SE = 0.28) and 3.55 fish per 2,500m^2 (SE = 0.5) for all juvenile white sturgeon. The proportion of positive tows for YOY white sturgeon during 1999 for Bonneville Reservoir was 0.61.

The Dalles Reservoir

Recruitment to YOY also occurred in The Dalles Reservoir in 1999. We captured 70 juvenile white sturgeon with the bottom trawl during sampling in The Dalles Reservoir; 18 (26%) of these were YOY. Young-of-the-year white sturgeon were captured at 4 of the 12 sites (Table 2).

YOY white sturgeon ranged in length from 212 to 299 mm TL (Figure 8) and weighed 39.5 to 120 g. The mean length of YOY captured was 257.2 mm TL and the mean weight was 76.5 g. Older white sturgeon were captured at 8 of the 12 sites trawled. The older juvenile white sturgeon measured 300 to 710 mm FL and weighed 185 to 1,550 g.

Table 1. Characteristics of bottom trawling conducted to index recruitment of white sturgeon in Bonneville Reservoir during 13 September to 1 October 1999. Young of the year (YOY) white sturgeon were differentiated by length frequency analysis.

			Number of white sturgeon collected		White sturgeon catch/2500 m^2	
Site	Number of trawl tows	Total area sampled (ha)	All ages	YOY	All ages	YOY
15052	6	1.265	11	11	2.17	2.17
15734	6	1.051	14	9	3.33	2.14
15951	6	1.344	18	16	3.35	2.98
16522	6	1.320	4	4	0.76	0.76
16851	6	1.299	22	22	4.24	2.24
17063	6	1.378	26	14	4.72	2.54
17374	6	1.309	29	23	5.54	4.39
17652	6	1.210	10	2	2.07	0.41
17911	6	1.304	17	5	3.26	0.96
18351	6	1.331	53	5	9.95	0.94
18523	6	1.328	1	0	0.19	0
Totals	66	14.347	205	111		

Table 2. Characteristics of bottom trawling conducted to index recruitment of white sturgeon in The Dalles Reservoir during 19 October to 28 October 1999. Young of the year (YOY) white sturgeon were differentiated by length frequency analysis.

			Number of white sturgeon collected		White sturgeon catch/2500 m^2	
Site	Number of trawl tows	Total area sampled (ha)	All ages	YOY	All ages	YOY
19463	2	0.457	6	1	3.28	0.55
19683	2	0.466	19	12	10.19	6.44
19981	2	0.425	36	3	21.18	1.76
20012	2	0.451	3	2	1.66	1.11
20244	2	0.465	0	0	0	0
20432	2	0.423	1	0	0.59	0
20451	2	0.435	1	0	0.57	0
20651	2	0.454	0	0	0	0
20752	2	0.436	1	0	0.57	0
21014	2	0.475	0	0	0	0
21103	2	0.447	0	0	0	0
21412	2	0.430	3	0	1.74	0
Totals	24	5.364	70	18		

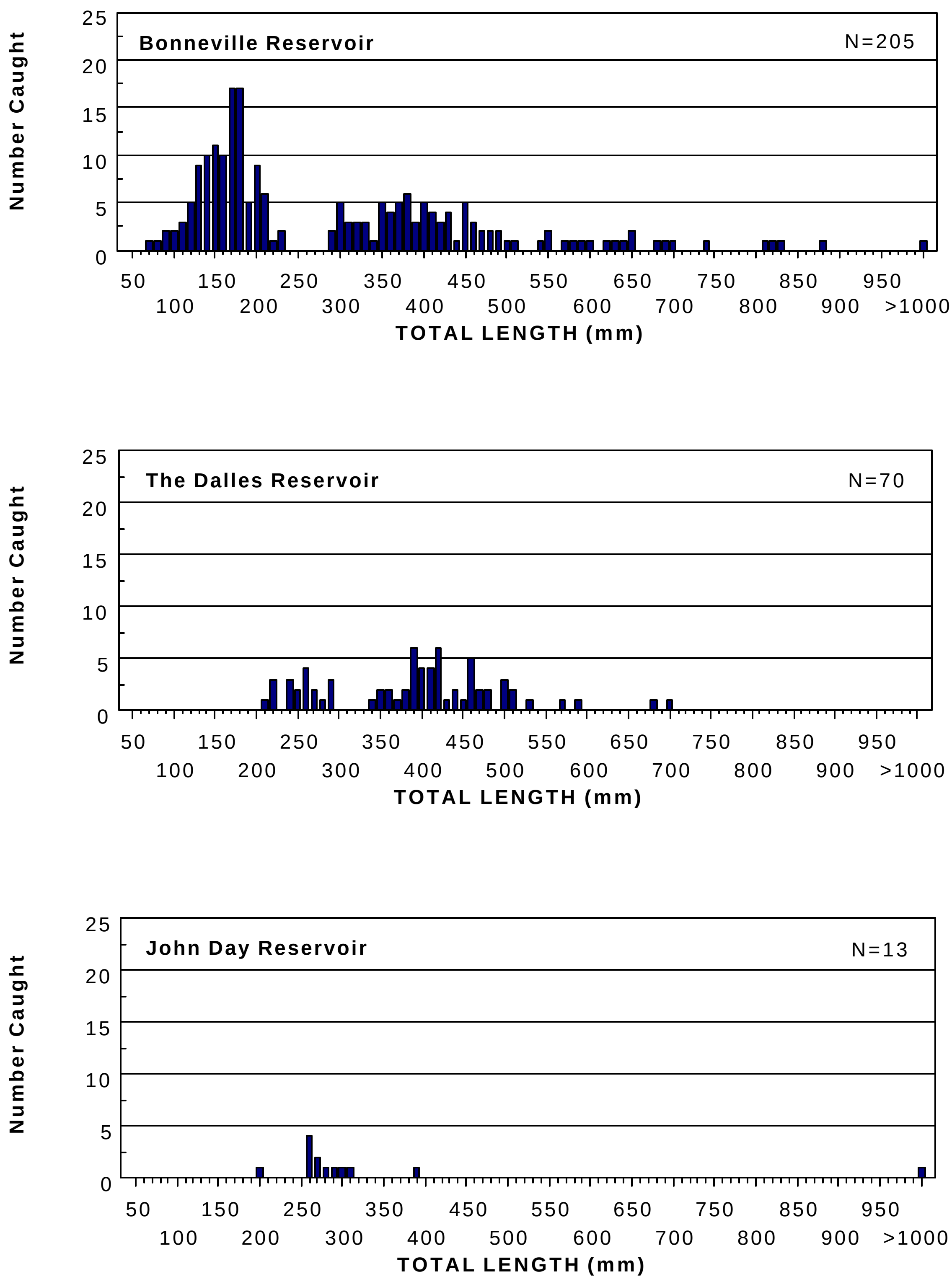

Figure 8. Length frequency distribution of juvenile white sturgeon captured during fall bottom trawling in Bonneville, The Dalles, and John Day reservoirs in 1999.

The CPUE for combined effort for each of the 12 sites sampled with the bottom trawl in The Dalles Reservoir ranged from 0 to 6.4 YOY per 2,500 m^2 and from 0 to 21.2 fish per 2,500 m^2 for all white sturgeon caught (Table 2). The mean CPUE for the 24 completed tows was 0.82 YOY per 2,500 m^2 (SE = 0.38) and 3.31 fish per 2,500 m^2 (SE = 1.3) for all juvenile white sturgeon. The proportion of positive tows for YOY white sturgeon during 1999 for The Dalles Reservoir was 0.25.

John Day Reservoir

We captured 13 juvenile white sturgeon with the bottom trawl during our sampling of John Day Reservoir. However, 11 (85%) were YOY indicating that recruitment occurred in 1999. Young-of-the-year white sturgeon were captured at 3 of the 19 sites (Table 3).

The YOY ranged in length from 201 to 313 mm TL (Figure 8) and weighed 40.5 to 125 g. The mean length of YOY captured was 273 mm and mean weight was 94.2 g. The 2 older juvenile white sturgeon measured 345 and 900 mm FL respectively.

The CPUE for combined effort for each of the 19 sites sampled with the bottom trawl in John Day Reservoir ranged from 0 to 3.5 YOY per 2,500 m^2 and from 0 to 3.5 fish per 2,500 m^2 for all white sturgeon caught (Table 3). The mean CPUE for the 38 completed tows was 0.3 YOY per 2,500 m^2 (SE = 0.16) and 0.38 fish per 2,500 m^2 (SE = 0.17) for all juvenile white sturgeon. The proportion of positive tows for YOY white sturgeon during 1999 for John Day Reservoir was 0.13.

Comparison of Gill Nets and Bottom Trawls to Index Recruitment to Young of the Year

Sampling during 1999 by ODFW and USGS provided the first year of data to be used for comparing indices of abundance derived from gillnet and bottom trawl catches. In The Dalles Reservoir, the ODFW (Report A) sampled 12 fixed sites with gillnets three times each for a total of 36 gillnet efforts while the USGS, as described above, sampled 12 fixed sites with bottom trawls two times each for a total of 24 tows. In John Day Reservoir, ODFW 41 scheduled gillnet efforts. The USGS sampled 19 fixed sites two times each for a total of 38 trawl tows. Indices of abundance were calculated (Table 4) but additional data points are needed for correlation analysis.

Table 3. Characteristics of bottom trawling conducted to index recruitment of white sturgeon in John Day Reservoir during 27 October to 9 November 1999. Young of the year (YOY) white sturgeon were differentiated by length frequency analysis.

Site	Number of trawl tows	Total area sampled (ha)	Number of white sturgeon collected		White sturgeon catch/2500 m^2	
			All ages	YOY	All ages	YOY
21924	2	0.423	0	0	0	0
22533	2	0.459	0	0	0	0
22931	2	0.433	0	0	0	0
23352	2	0.462	0	0	0	0
24173	2	0.453	1	1	0.55	0.55
24324	2	0.462	0	0	0	0
24822	2	0.456	0	0	0	0
25283	2	0.519	0	0	0	0
25623	2	0.439	0	0	0	0
26382	2	0.455	5	4	2.75	2.20
26422	2	0.431	6	6	3.48	3.48
26803	2	0.438	0	0	0	0
27054	2	0.447	1	0	0.56	0
27384	2	0.438	0	0	0	0
27851	2	0.432	0	0	0	0
27974	2	0.447	0	0	0	0
28074	2	0.427	0	0	0	0
28184	2	0.464	0	0	0	0
28972	2	0.432	0	0	0	0
Totals	38	8.515	13	11		

Table 4. Indices of young-of-the-year white sturgeon abundance for 1999 derived from gillnet and bottom trawling sampling data. E*p* represents the proportion of positive efforts (those efforts with at least one young-of-the-year white sturgeon) and CPUE is the arithmetic mean of untransformed CPUE data. Gillnet catch information was obtained from ODFW (Report A).

		Gillnet	Bottom Trawl
The Dalles Reservoir			
	E*p*	0.67	0.25
	CPUE	7.61	0.82
John Day Reservoir			
	E*p*	0.22	0.13
	CPUE	0.39	0.30

The Relation of the Timing of White Sturgeon Egg Development to Water Temperature

A manuscript describing the results from these experiments is in preparation.

Availability of Habitat

Bonneville, The Dalles, John Day, and McNary Dam Tailraces

River discharge and water temperatures that occurred during April through July 1999 provided conditions that were favorable for spawning by white sturgeon downstream from Bonneville, The Dalles, John Day, and McNary dams. The river hydrograph (Figure 9) shows that daily discharge rose during the latter part of April, declined slightly during May before rising sharply during the last week in May and peaking in early June. Daily discharge then gradually declined throughout June and July. Water temperatures, which determine the time period when spawning will occur, rose to optimal levels for spawning by white sturgeon on or about 22 May (Figure 10) and exceeded optimum levels on or about 15 June. Thus the temperature suitability of the habitat for spawning indicates that optimal spawning temperatures occurred for just less than 4 weeks. As a result of the hydrograph and temperature regime that occurred in 1999, our monthly estimates of the index of spawning habitat showed that the availability of habitat for spawning peaked in June and the estimates were much higher for this month than historical estimates dating back to 1985 (Figure 11). Annual indices for 1999 were higher than the long-term average for each spawning area (Figure 12).

McNary Reservoir

The USGS statement of work called for this task to be completed in collaboration with the USFWS

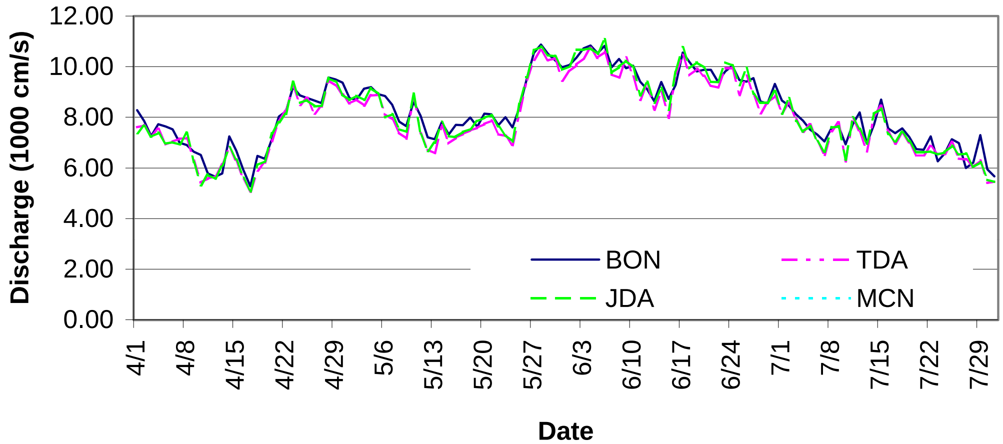

Figure 9. River discharges at Bonneville (BON), The Dalles (TDA), John Day (JDA), and McNary (MCN) dams during 1999. Data were obtained from the DART website (http:\\www.cqs.washington.edu\dart\).

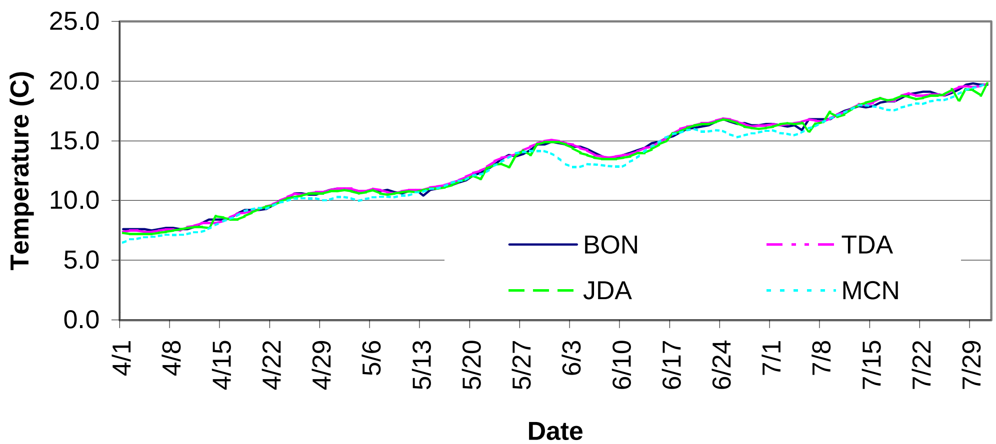

Figure 10. Water temperatures at Bonneville (BON), The Dalles (TDA), John Day (JDA), and McNary (MCN) dams during 1999. Data were obtained from the DART website (http:\\www.cqs.washington.edu\dart\).

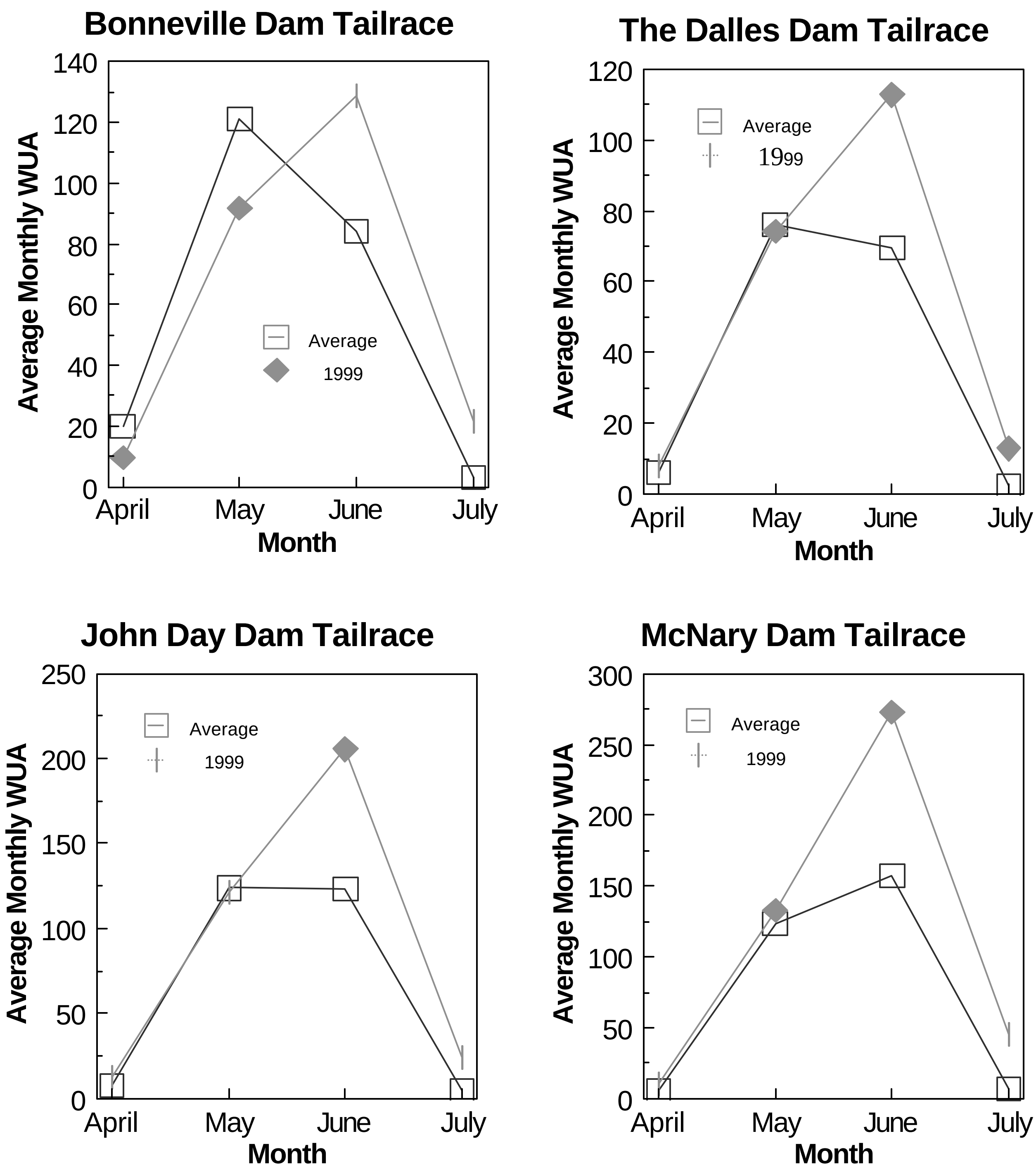

Figure 11. Mean monthly indices of spawning habitat (temperature conditioned weighted usable area (WUA)) for white sturgeon during 1999 and the average for 1985 through 1998 for the four spawning areas that have been modeled.

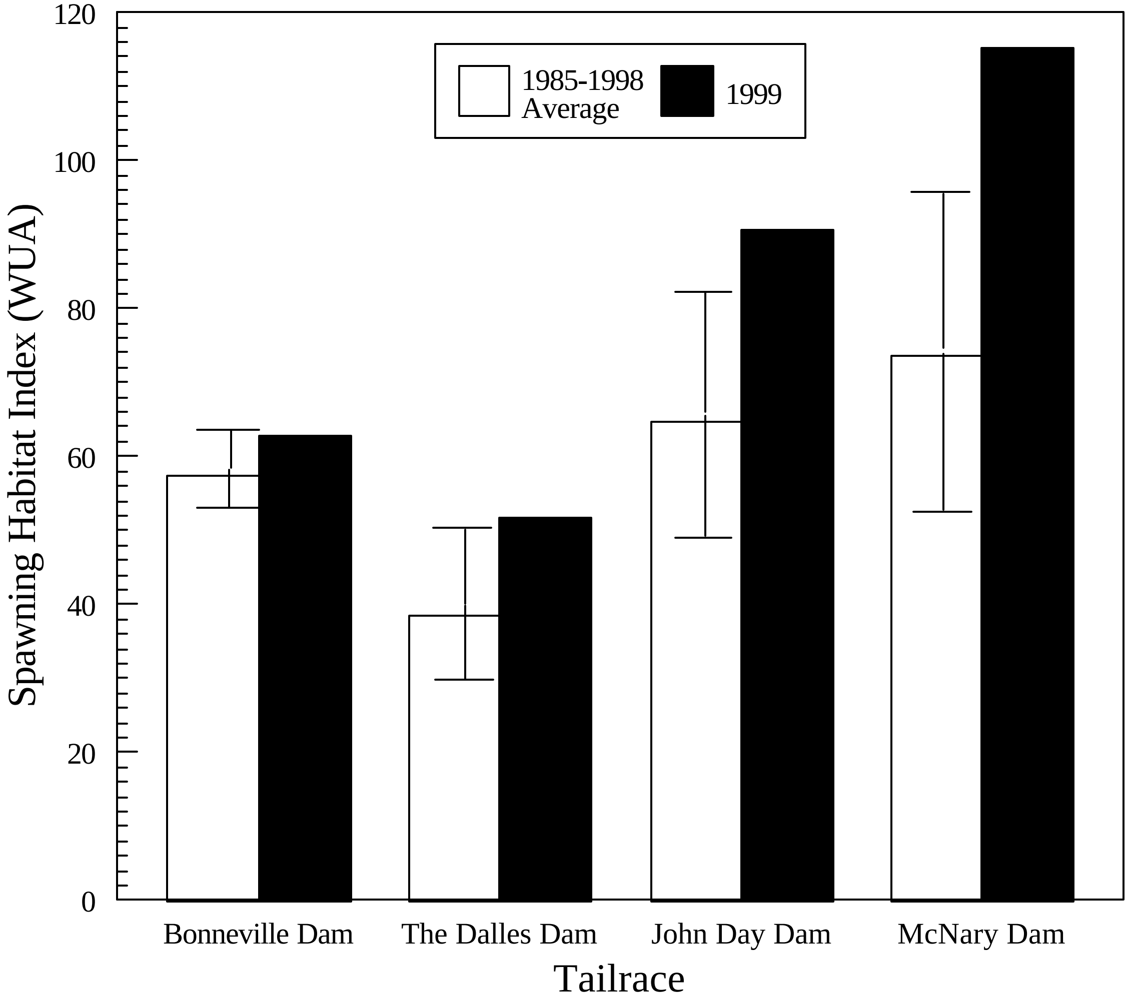

Figure 12. Annual mean composite index of spawning habitat (temperature conditioned weighted usable area (WUA)) for white sturgeon for each of the four dam tailraces that have been modeled (Parsley and Beckman 1994). Shown are the indices for 1999 and the average for 1985 through 1998. The vertical lines within the bars for the averages depict one standard deviation.

(Report D). No work was performed on this task.

Effects of Proposed Reservoir Drawdowns on the Productivity of White Sturgeon

The results of this analysis are not available at the time of this writing. We will report the results from this analysis in our annual report for activities during 2000.

Movements and Behavior of Pre-Spawn and Spawning White Sturgeon

The seven transmittered fish were located 247 times via mobile tracking during 4 April through 15 July 1999 (Figures 13 - 19; Appendixes C1-C7). No transmittered fish were detected with the wireless hydrophone system, which was operational during one month (March 2000) of this reporting period. Most of the fish were detected with the acoustic telemetry gear rather than the radio telemetry gear, primarily because fish depth often impeded radio signal transmission. We also found that turbulent water caused by operations at John Day Dam often reduced acoustic signal reception between the boat restricted zone at river km 347.6 downstream to approximately river km 345.5. Thus, we adopted the continuous search method in this area. Though acoustic signal reception was reduced at times, this searching technique should have increased the likelihood of detecting fish that moved into this area.

Two of seven transmittered male white sturgeon moved upstream to the tailrace area during the suspected spawning period. Fish with coded transmitters 72.247 (Figure 14) and 74.448 (Figure 18) moved into or near the John Day Dam tailrace on 17 June 1999 and 6 July 1999 respectively. Both fish remained in the tailrace area until telemetry ceased on 15 July 1999. Of the remaining five fish, two fish remained near their original release location near Miller Island (Figures 13 and 17) and three fish moved downstream to Browns Island (Figures 11, 12, and 15) during the spawning period.

On 26 May 1999 we deployed six artificial substrates (McCabe and Beckman 1990) just downstream from where fish with transmitters 72.247 and 74.448 had been relocated several times (Figures 14 and 18). The substrates were checked for white sturgeon eggs at least once per week between 1 June 1999 and July 15 1999. No white sturgeon eggs were found, thus we cannot verify that these fish were in this area for spawning.

Additional setlining was conducted during the winter of 1999 to capture additional mature white sturgeon. A total of 182 setline efforts (Figure 20) resulted in catches of 302 white sturgeon. Acoustic and radio transmitters were attached to 5 mature males and 3 maturing females that ranged in fork length from 1,430 mm to 2,310 mm (Table 5). No anadromous salmonids were captured.

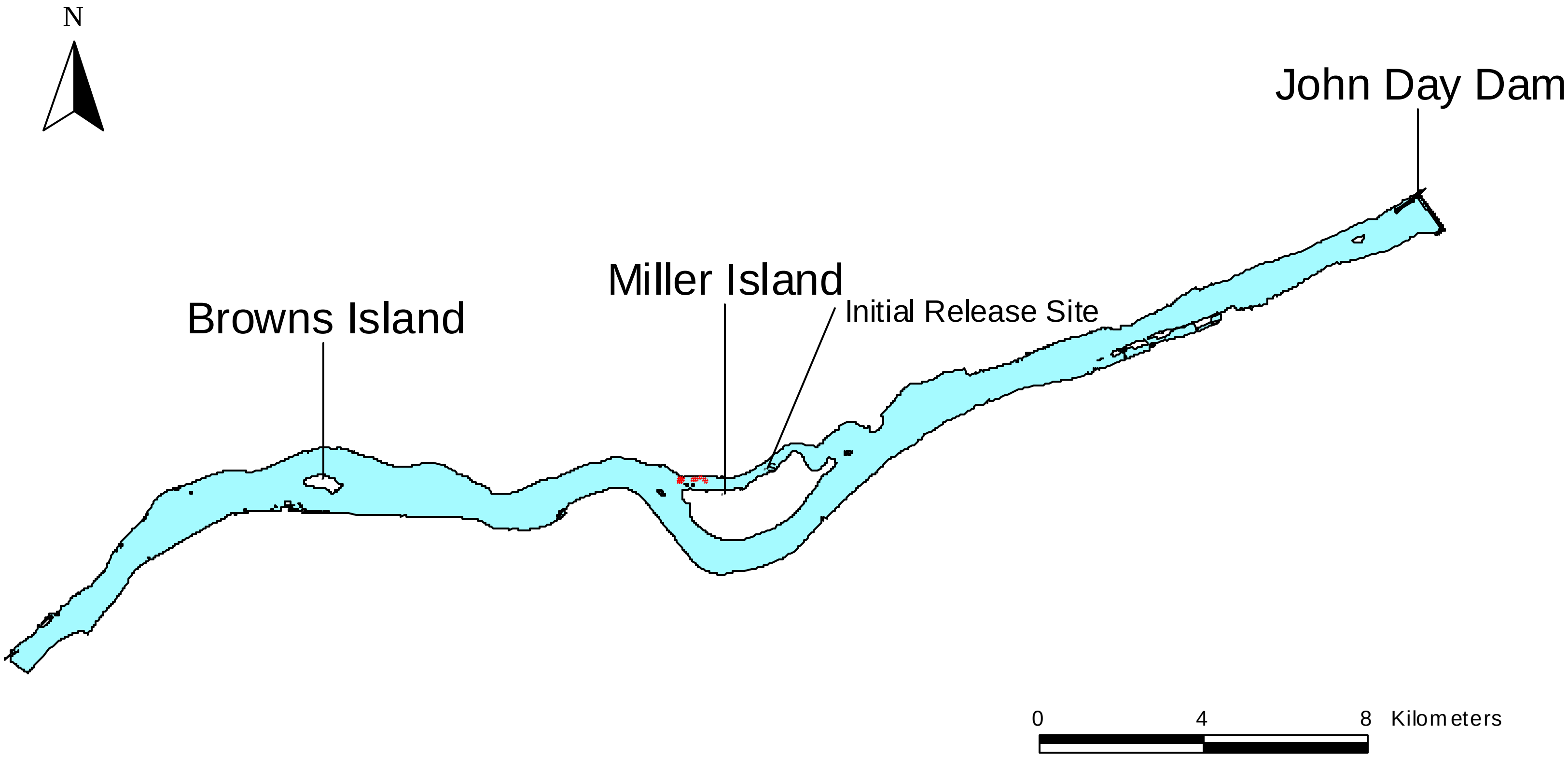

Figure 13. Release location and subsequent movements of a white sturgeon tagged with acoustic transmitter 72.238. This sturgeon was relocated 41 times. (Appendix C-1)

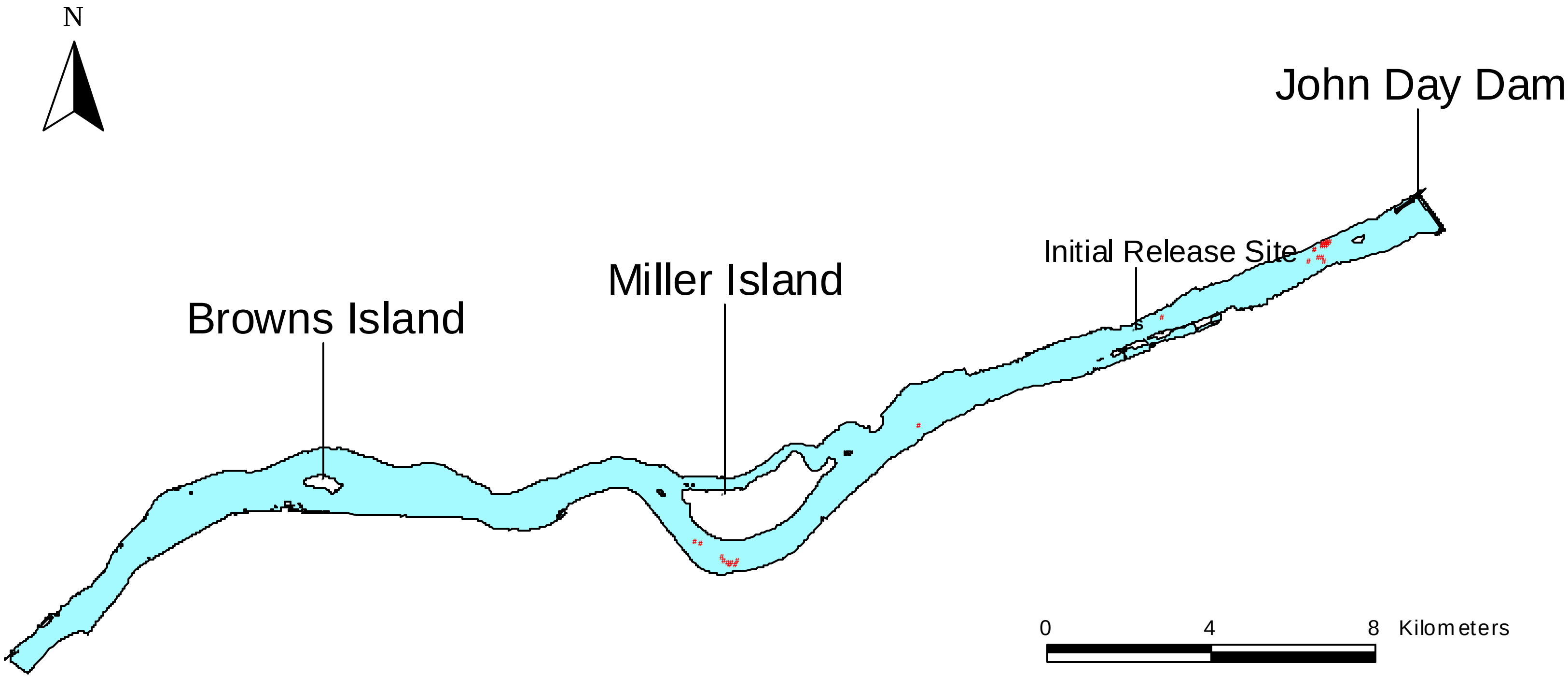

Figure 14. Release location and subsequent movements of a white sturgeon tagged with acoustic transmitter 72.247. This sturgeon was relocated 29 times. (Appendix C-2)

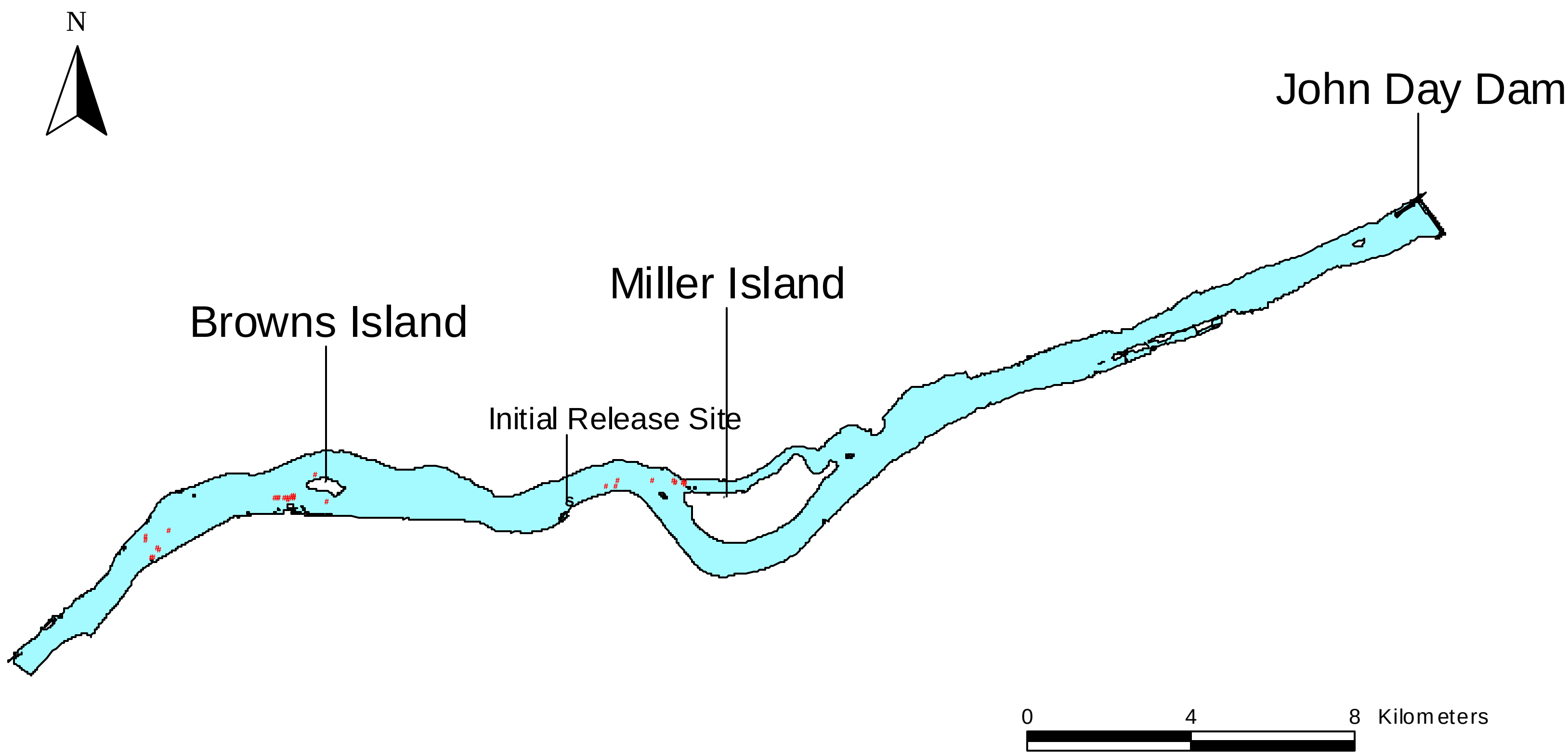

Figure 15. Release location and subsequent movements of a white sturgeon tagged with acoustic transmitter 73.338. This sturgeon was relocated 34 times. (Appendix C-3)

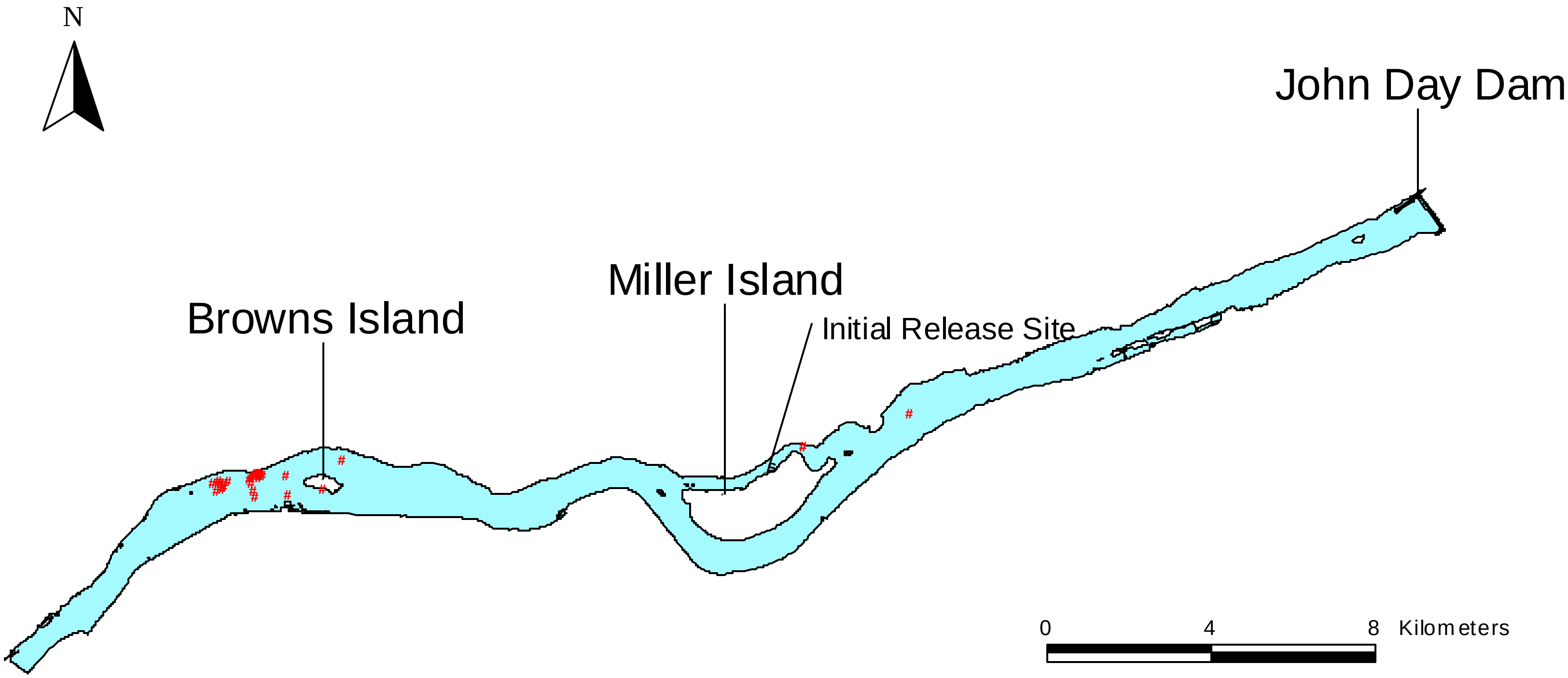

Figure 16. Release location and subsequent movements of a white sturgeon tagged with acoustic transmitter 73.347. This sturgeon was relocated 35 times. (Appendix C-4)

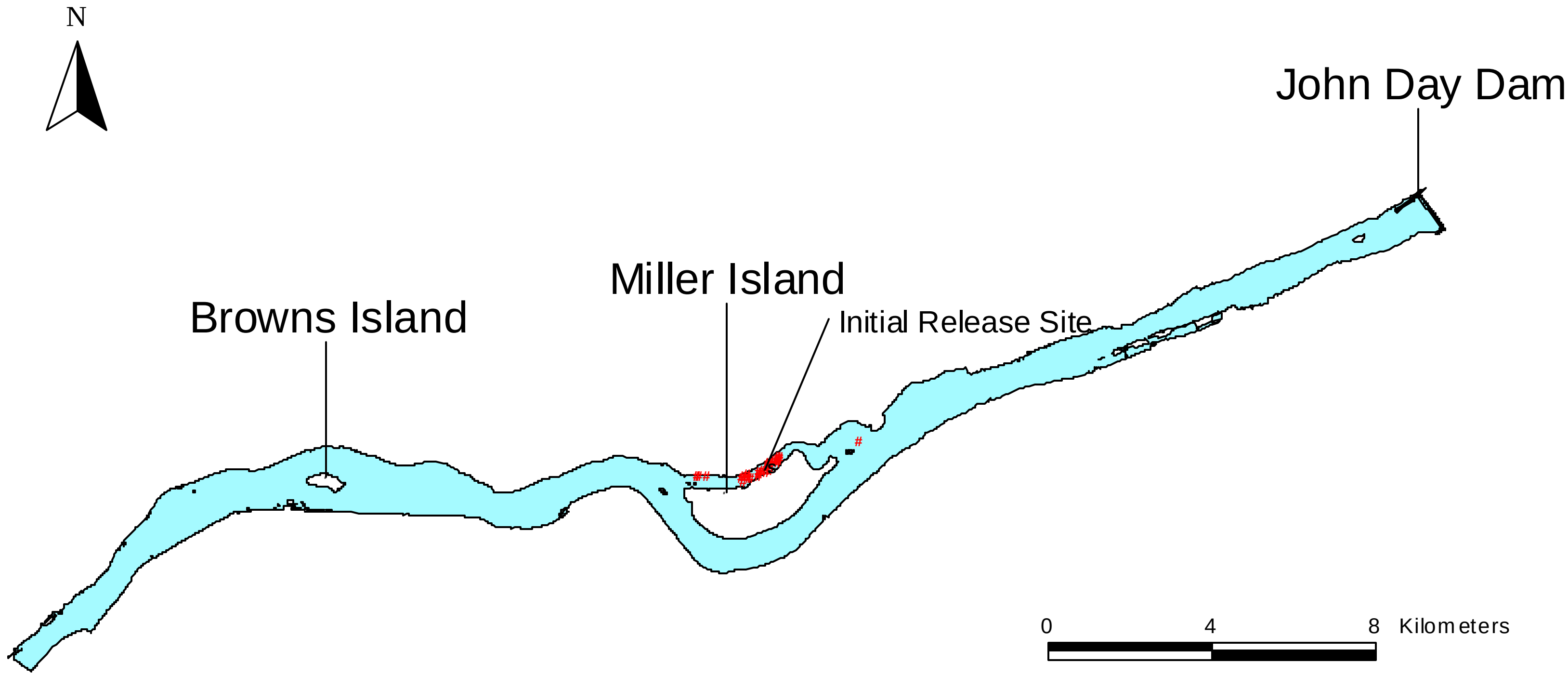

Figure 17. Release location and subsequent movements of a white sturgeon tagged with acoustic transmitter 73.356. This sturgeon was relocated 39 times. (Appendix C-5)

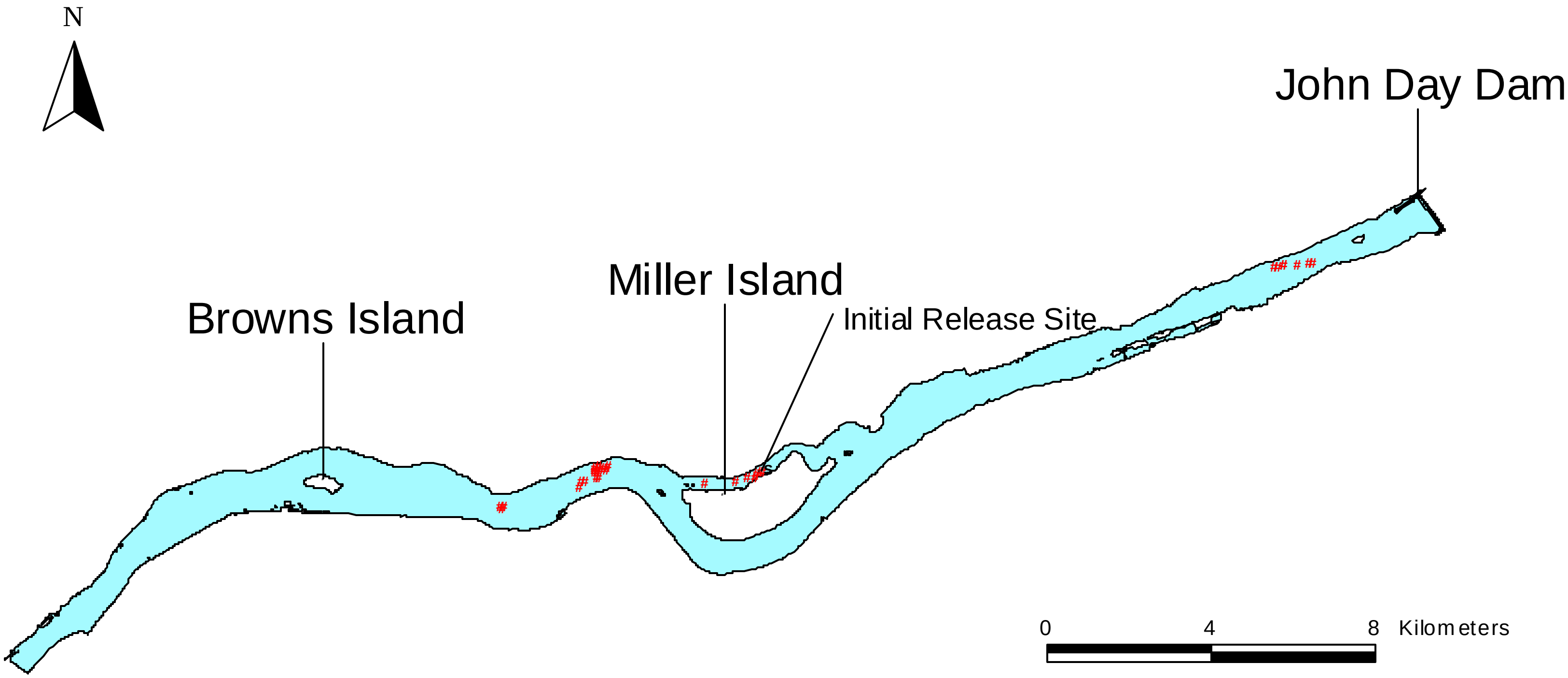

Figure 18. Release location and subsequent movements of a white sturgeon tagged with acoustic transmitter 74.448. This sturgeon was relocated 32 times. (Appendix C-6)

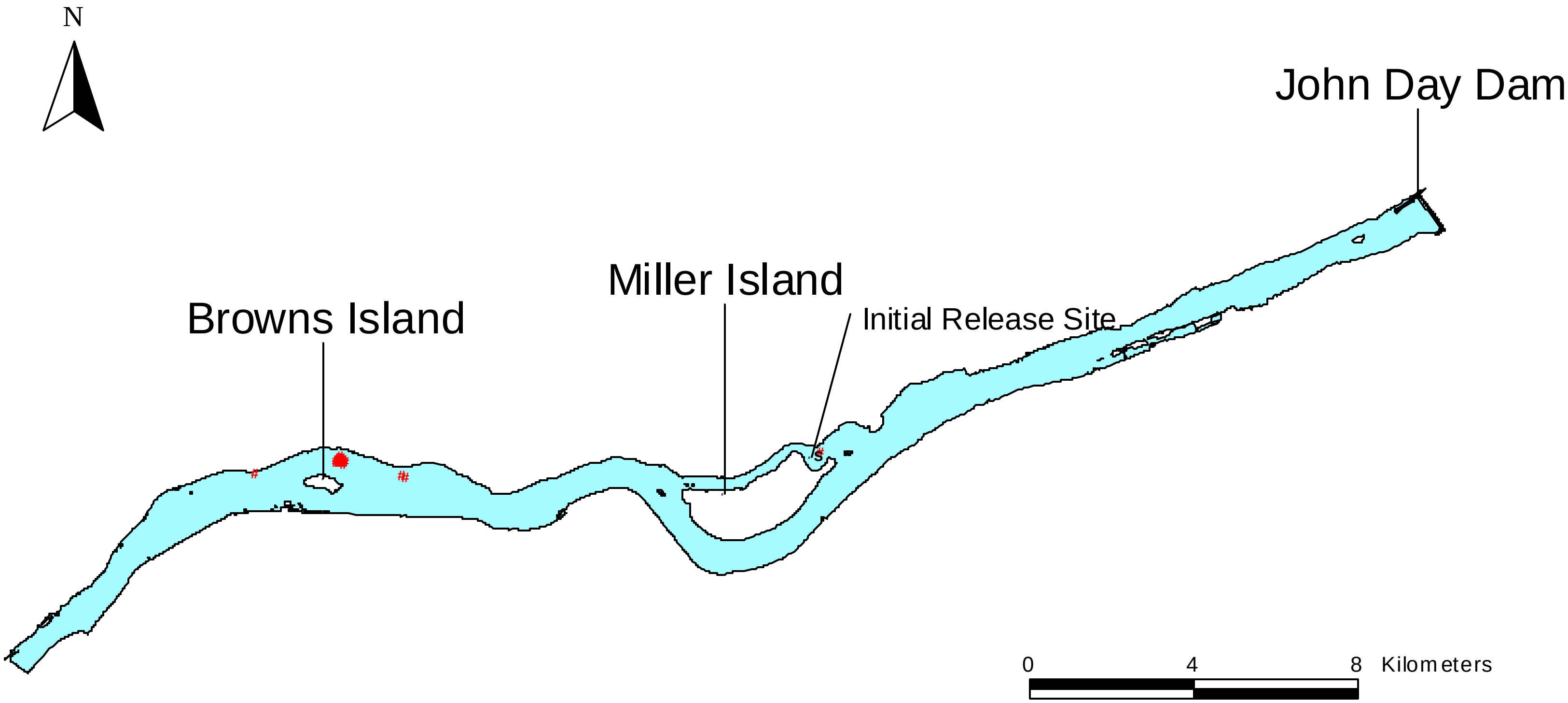

Figure 19. Release location and subsequent movements of a white sturgeon tagged with acoustic transmitter 74.466. This sturgeon was relocated 36 times. (Appendix C-7)

Table 5. Characteristics of white sturgeon fitted with sonic transmitters (Lotek model CAFT32) and radio transmitters (Lotek model CFRT-7DXT) during February 2000.

Transmitter Code		Date Captured			FL	TL	Location where captured[c]	
Acoustic[a]	Radio[b]	YY	MM	DD	(mm)	(mm)	Latitude	Longitude
76.8/50	149.200/20	2000	02	15	1455	1600	45 39.215	121 00.761
76.8/62	149.210/28	2000	02	09	1840	2110	45 38.277	120 55.112
76.8/73	149.220/32	2000	02	15	2221	2435	45 38.383	120 55.205
76.8/74	149.200/24	2000	02	16	1670	1832	45 38.288	120 55.104
76.8/98	149.210/25	2000	02	16	1430	1620	45 40.174	120 50.945
76.8/110	149.220/34	2000	02	25	1660	1815	45 38.329	120 54.772
76.8/143	149.220/30	2000	02	25	1565	1750	45 38.285	120 54.594
76.8/156	149.210/29	2000	02	16	2310	2500	45 39.011	121 01.852

[a]Digits preceding the slash are the frequency in kHz. Digits after the slash indicate the code used to identify individual transmitters.
[b]Digits preceding the slash are the frequency in mHz. Digits after the slash indicate the code used to identify individual transmitters.
[c]Locations (latitude and longitude) were recorded in WGS84 datum.

Tests showed that the reception distance of acoustic signals was greater with the Sonotronics acoustic receiver than with the Lotek radio receiver equipped with a sonic upconverter. The acoustic signal was lost with the Lotek receiver approximately 853 meters downstream from the transmitters, whereas acoustic signals could be heard with the Sonotronics receiver up to 1.6 km downstream from the transmitters. Thus, searches during the 2000 spawning season will be made using the Sonotronics equipment.

DISCUSSION

During this reporting period (April 1, 1999 through March 31, 2000) the USGS worked on nine tasks, each having distinct goals and products. Field sampling was necessary for two tasks (YOY indexing and monitoring the movements and behavior of pre-spawning and spawning white sturgeon in The Dalles Reservoir). Activities on the remaining tasks included the continued analysis of previously collected field or laboratory data (habitat use and movements of juvenile white sturgeon, effects of water temperature on the development of white sturgeon eggs) and incorporating annual data into new summaries (comparisons of catches of YOY from gill nets and bottom trawls, availability of spawning habitat). Substantial progress was also made to assess the potential effect of reservoir drawdowns on white sturgeon productivity and preparations are well underway for conducting laboratory experiments to investigate predation on early life stages of white sturgeon.

Conducting a study to investigate movements and behavior of pre-spawning and spawning white sturgeon proved problematic from several standpoints. It was difficult to capture mature female fish, and only two of the seven male white sturgeon tracked in 1999 moved into the suspected spawning area. This was somewhat surprising and suggests that adult male white sturgeon do not necessarily spawn each year. The wireless hydrophone system that was deployed will enable us to remotely monitor white sturgeon movements into and out of the area in 2000. However, this system will only detect the eight fish captured in 1999 and outfitted with Lotek acoustic transmitters.

The bottom trawling for juvenile white sturgeon revealed that recruitment to young of year occurred in Bonneville, McNary, and The Dalles reservoirs. However, the young of year captured during 1999 were generally shorter than young of year captured during other years. Relatively cooler water temperatures that occurred throughout the summer may have resulted in slower growth rates and thus smaller fish in September and October when the trawling occurred.

Snagging the trawl on the bottom is an unpredictable occurrence and can result in damaged or lost nets. Down time related to repairing damaged trawls caused by snags has been minimized by carrying an additional net on the boat to replace trawls that get damaged beyond immediate repair. Sampling with bottom trawls requires specialized vessels and crew expertise, and trawls cannot be fished in many areas with rugged bottom topography or snags. Gill nets can be fished in a broader range of riverine conditions than bottom trawls, and do not require highly specialized boats and crews. Thus, gill nets may be a more desirable gear to use for indexing recruitment. To discern if trends in recruitment can be detected using this gear, several years of catch data during years of variable recruitment will be necessary. Thus, it is imperative that the sampling strategies described to allow this comparison are adhered to. Eventually, the analyses will determine if trends can be derived from gill net data and whether the trends correlate with trends derived from trawling data. If so, sampling strategies could be implemented that use gill nets rather than bottom trawls.

Plans for 2000

During 2000, the USGS will continue several tasks begun in previous years, including indexing the recruitment of white sturgeon to YOY in the Bonneville, The Dalles, and John Day reservoirs, and assessing the potential effects of reservoir water level manipulations on the productivity of white sturgeon. We will continue with the analyses and preparation of manuscripts for studies completed during 1998 and 1999. In particular, we will complete our analyses of data collected to describe the habitat use and movements of white sturgeon in the McNary Reservoir, our analysis of the timing of the development of white sturgeon embryos, our analysis of the effects of proposed reservoir drawdowns on the productivity of white sturgeon populations, and our study using biotelemetry to monitor the movements of adult white sturgeon prior to and during the spawning period.

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APPENDIX C-1

Movements of a white sturgeon tagged with acoustic transmitter 72.238 and radio transmitter 149.200/22. The North American Datum of 1927 was used for all recorded positions. The positions were reported in state plane coordinates, Washington South Zone. River km designations were taken from NOAA navigation charts.

	Geographic coordinates		
Date	Northing	Easting	River km
4-April-1999	118090.23	1892344.10	328.80
13-April-1999	118139.70	1892162.24	328.80
14-April-1999	118095.89	1892171.92	328.80
19-April-1999	118097.92	1892201.62	328.80
27-April-1999	118116.10	1892047.70	328.64
5-May-1999	118105.50	1893008.26	329.28
10-May-1999	118248.90	1892676.45	329.12
17-May-1999	118012.92	1893198.05	329.12
24-May-1999	118117.13	1891342.41	328.47
26-May-1999	118083.69	1891200.58	328.47
27-May-1999	118142.24	1890987.51	328.47
28-May-1999	118100.32	1891024.11	328.47
1-June-1999	118031.52	1891077.16	328.31
2-June-1999	118025.28	1891016.65	328.31
3-June-1999	118044.84	1891001.44	328.31
4-June-1999	118140.34	1891149.97	328.31
7-June-1999	118176.92	1891040.74	328.47
8-June-1999	118202.68	1891086.04	328.47
10-June-1999	118157.15	1890995.19	328.47
11-June-1999	118007.43	1891168.45	328.47
14-June-1999	118178.37	1891109.97	328.47
15-June-1999	118195.51	1891036.78	328.47
16-June-1999	118123.90	1891067.43	328.47
17-June-1999	118180.73	1891071.86	328.47
18-June-1999	118126.28	1891012.16	328.47
21-June-1999	118200.54	1891069.71	328.47
23-June-1999	118161.54	1891081.04	328.31
24-June-1999	118170.18	1891046.33	328.47
25-June-1999	118157.87	1891085.08	328.47
26-June-1999	118189.51	1890952.20	328.47
29-June-1999	118077.65	1891076.16	328.47
30-June-1999	118183.63	1891007.58	328.47
1-July-1999	118160.15	1890986.05	328.31
2-July-1999	118164.66	1891109.87	328.31
6-July-1999	118173.81	1890955.75	328.31
7-July-1999	118117.67	1890993.57	328.31
8-July-1999	118117.82	1891080.06	328.31
9-July-1999	118113.39	1891055.15	328.31

	Geographic coordinates		
Date	Northing	Easting	River km
12-July-1999	118176.64	1890984.76	328.31
13-July-1999	118067.51	1891056.00	328.31
15-July-1999	118134.72	1891035.58	328.31

APPENDIX C-2

Movements of a white sturgeon tagged with acoustic transmitter 72.247 and radio transmitter 149.210/27. The North American Datum of 1927 was used for all recorded positions. The positions were reported to state plane coordinates, Washington South Zones. River km designations were taken from NOAA navigation charts.

	Geographic coordinates		
Date	Northing	Easting	River km
4-April-1999	113013.72	1892735.28	329.95
14-April-1999	111653.35	1894453.87	329.97
19-April-1999	111708.37	1895581.08	330.29
19-April-1999	111429.66	1895516.42	329.91
27-April-1999	111501.47	1895066.72	330.78
5-May-1999	111554.97	1894871.20	329.97
10-May-1999	111921.59	1894407.22	329.33
17-May-1999	113278.76	1892215.40	329.15
24-May-1999	111354.36	1895003.69	329.81
26-May-1999	122415.23	1910195.10	334.80
27-May-1999	131112.02	1929536.75	341.19
17-June-1999	137000.57	1942703.60	346.18
18-June-1999	136593.88	1941835.70	346.18
21-June-1999	137000.95	1942452.95	346.18
22-June-1999	136550.66	1941825.74	346.02
23-June-1999	136759.36	1942379.47	346.02
24-June-1999	136991.42	1942585.52	346.02
25-June-1999	136904.97	1942390.46	346.02
26-June-1999	137125.43	1942959.26	346.02
29-June-1999	137076.16	1942729.65	346.02
30-June-1999	137082.34	1942890.13	346.18
1-July-1999	137021.08	1942721.88	346.18
6-July-1999	135569.47	1941345.23	345.23
7-July-1999	135864.05	1942084.04	345.23
8-July-1999	136945.48	1942557.82	345.69
9-July-1999	136834.83	1942754.97	345.69
12-July-1999	136977.22	1942858.05	345.69
13-July-1999	135676.44	1942562.77	345.74
15-July-1999	135838.88	1942431.35	345.74

APPENDIX C-3

Movements of a white sturgeon tagged with acoustic transmitter 73.338 and radio transmitter 149.200/21. The North American Datum of 1927 was used for all recorded positions. The positions were reported in state plane coordinates, Washington South Zone. River km designations were taken from NOAA navigation charts.

	Geographic coordinates		
Date	Northing	Easting	River km
4-April-1999	118360.84	1885816.17	325.95
14-April-1999	118025.55	1891277.29	328.47
19-April-1999	118154.11	1891320.41	328.47
27-April-1999	118229.76	1890284.13	328.15
5-May-1999	118125.56	1891070.82	329.44
10-May-1999	118150.54	1891144.40	328.47
17-May-1999	118121.24	1890570.87	328.47
24-May-1999	118177.94	1890497.35	328.47
26-May-1999	118340.54	1888592.42	327.67
27-May-1999	117795.29	1885730.70	325.80
28-May-1999	117772.39	1884944.37	325.80
2-June-1999	116684.80	1862621.02	318.69
7-June-1999	117011.91	1859916.79	317.58
8-June-1999	116954.81	1859816.44	317.58
10-June-1999	116973.75	1860013.07	317.58
11-June-1999	116908.97	1859936.15	317.58
14-June-1999	117051.04	1859769.34	317.40
15-June-1999	116950.66	1858387.37	317.10
16-June-1999	116877.69	1858491.46	317.10
17-June-1999	116868.70	1859175.60	317.10
18-June-1999	116844.20	1859310.08	317.10
21-June-1999	116975.17	1858687.84	317.24
23-June-1999	116977.91	1858640.88	317.24
24-June-1999	116886.42	1859399.94	317.42
25-June-1999	116815.87	1859497.30	317.42
29-June-1999	112084.12	1848525.67	313.07
30-June-1999	112102.82	1848554.88	313.07
1-July-1999	112107.35	1848694.86	313.07
6-July-1999	114328.79	1849928.08	313.86
7-July-1999	112811.86	1849123.46	313.23
8-July-1999	112862.85	1848990.80	313.38
9-July-1999	118713.70	1861702.47	318.51
13-July-1999	113771.60	1848036.79	313.36
15-July-1999	113513.63	1848119.69	313.36

APPENDIX C-4

Movements of a white sturgeon tagged with acoustic transmitter 73.347 and radio transmitter 149.200/21. The North American Datum of 1927 was used for all recorded positions. The positions were reported in state plane coordinates, Washington South Zone. River km designations were taken from NOAA navigation charts.

	Geographic Coordinates		
Date	Northing	Easting	River km
4-April-1999	118332.55	1859327.54	317.39
27-April-1999	123263.94	1909215.54	333.80
4-May-1999	120691.61	1900695.45	331.69
5-May-1999	120681.78	1900668.37	331.69
11-May-1999	117185.06	1854254.80	315.78
17-May-1999	117132.59	1853831.80	315.76
24-May-1999	117787.75	1854739.85	316.26
26-May-1999	117737.92	1854348.95	316.26
27-May-1999	117647.45	1854322.80	316.26
28-May-1999	117637.22	1854053.38	316.26
2-June-1999	117362.71	1854318.31	315.92
7-June-1999	117910.76	1853928.08	315.92
8-June-1999	117808.49	1853989.82	315.92
10-June-1999	117691.67	1853982.65	315.92
11-June-1999	117705.22	1853443.12	315.92
14-June-1999	117176.57	1862181.27	318.38
15-June-1999	116788.42	1859411.46	317.58
17-June-1999	116665.98	1856858.87	316.44
18-June-1999	117112.28	1856687.93	316.42
21-June-1999	117749.75	1856540.74	316.74
23-June-1999	118017.00	1856337.95	316.74
24-June-1999	118208.11	1856514.06	316.73
25-June-1999	118344.10	1856830.96	316.73
26-June-1999	119564.39	1863838.59	316.74
29-June-1999	118149.36	1857202.28	316.89
30-June-1999	118416.07	1857115.92	316.89
1-July-1999	118458.40	1856901.12	316.89
2-July-1999	118339.55	1856743.26	316.89
6-July-1999	118365.11	1857334.02	316.89
7-July-1999	118266.70	1857429.89	316.89
8-July-1999	118311.01	1857320.80	316.89
9-July-1999	118437.69	1857157.14	316.89
12-July-1999	118470.93	1857273.37	316.89
13-July-1999	118396.45	1857048.44	316.89
15-July-1999	118331.95	1856842.81	316.89

APPENDIX C-5

Movements of a white sturgeon tagged with acoustic transmitter 73.356 and radio transmitter 149.220/31. The North American Datum of 1927 was used for all recorded positions. The positions were reported in state plane coordinates, Washington South Zone. River km designations were taken from NOAA navigation charts.

	Geographic coordinates		
Date	Northing	Easting	River km
4-April-1999	118640.19	1897329.35	330.41
13-April-1999	119182.96	1897759.09	330.73
14-April-1999	119026.55	1897854.31	330.73
19-April-1999	119071.68	1897771.28	330.24
27-April-1999	118986.43	1897782.76	330.24
5-May-1999	118080.73	1892007.41	329.28
7-May-1999	118082.71	1892242.77	328.96
10-May-1999	118136.03	1892057.80	328.96
24-May-1999	119765.31	1898757.94	331.03
26-May-1999	119552.11	1898602.93	331.05
27-May-1999	119741.78	1898602.23	331.05
28-May-1999	119372.11	1898400.58	331.05
1-June-1999	119358.47	1898551.71	331.05
2-June-1999	119566.92	1898616.38	331.05
3-June-1999	119387.39	1898155.63	331.05
4-June-1999	118123.15	1896954.37	330.41
7-June-1999	118086.24	1896141.53	329.92
8-June-1999	117965.60	1896212.69	329.92
10-June-1999	117758.46	1895770.92	329.78
11-June-1999	117956.43	1896385.93	329.78
14-June-1999	118437.86	1896982.66	329.78
15-June-1999	118386.52	1897067.88	329.78
16-June-1999	118412.51	1897084.51	329.78
17-June-1999	118933.51	1897783.59	330.26
18-June-1999	119289.80	1898496.18	330.73
21-June-1999	118629.18	1897845.80	330.41
23-June-1999	118043.02	1895600.42	329.92
24-June-1999	118171.74	1895811.01	329.92
25-June-1999	118257.81	1896142.52	329.92
26-June-1999	118980.67	1897732.26	330.73
29-June-1999	119203.67	1898083.82	330.73
30-June-1999	119064.64	1897864.66	330.73
1-July-1999	119038.76	1897833.71	330.73
2-July-1999	118833.70	1897576.77	330.73
6-July-1999	118519.08	1897609.39	330.42
7-July-1999	119368.47	1898197.88	331.05
8-July-1999	119262.56	1897983.73	331.05

Date	Geographic coordinates		River km
	Northing	Easting	
9-July-1999	119137.91	1897718.40	330.57
12-July-1999	118093.88	1892896.95	328.80
15-July-1999	120962.46	1905001.46	333.16

APPENDIX C-6

Movements of a white sturgeon tagged with acoustic transmitter 74.448 and radio transmitter 149.220/33. The North American Datum of 1927 was used for all recorded positions. The positions were reported in state plane coordinates, Washington South Zone. River km designations were taken from NOAA navigation charts.

	Geographic coordinates		
Date	Northing	Easting	River km
4-April-1999	117404.86	1882747.65	325.14
14-April-1999	117816.45	1883201.34	325.29
19-April-1999	118761.45	1884560.81	325.92
27-April-1999	119147.35	1885107.04	325.26
5-May-1999	117836.60	1883009.43	325.92
10-May-1999	118790.56	1884044.58	325.75
17-May-1999	118921.37	1884837.88	325.90
24-May-1999	118190.55	1884244.60	325.92
26-May-1999	118208.43	1884332.63	325.92
27-May-1999	118696.72	1884936.02	325.59
28-May-1999	119015.76	1884288.71	325.59
2-June-1999	118407.15	1896920.44	330.41
3-June-1999	118136.71	1896814.64	330.41
7-June-1999	118695.26	1884389.92	326.24
8-June-1999	118653.18	1884098.23	326.24
10-June-1999	118892.90	1884099.92	326.24
11-June-1999	118637.77	1884177.60	326.24
14-June-1999	117709.84	1892897.49	329.29
15-June-1999	117849.54	1895259.70	329.46
23-June-1999	115864.08	1876740.66	323.52
24-June-1999	115733.19	1876587.12	323.52
25-June-1999	115762.23	1876400.34	323.52
26-June-1999	118080.25	1896298.75	329.92
29-June-1999	118621.88	1897473.00	330.24
30-June-1999	118628.33	1897317.30	330.41
6-July-1999	134993.60	1938437.44	344.57
7-July-1999	135081.57	1939101.44	344.73
8-July-1999	134943.84	1938680.38	344.74
9-July-1999	135082.28	1939131.31	344.74
12-July-1999	135063.73	1940245.14	344.92
13-July-1999	135318.40	1941470.94	345.24
15-July-1999	135337.39	1941114.47	345.24

APPENDIX C-7

Movements of a white sturgeon tagged with acoustic transmitter 74.446 and radio transmitter 149.200/23. The North American Datum of 1927 was used for all recorded positions. The positions were reported in state plane coordinates, Washington South Zone. River km designations were taken from NOAA navigation charts.

	Geographic coordinates		
Date	Northing	Easting	River km
4-April-1999	120194.76	1902129.47	332.18
14-April-1999	118162.81	1868841.76	320.44
19-April-1999	118298.18	1868545.18	319.96
27-April-1999	119408.52	1863839.94	318.83
5-May-1999	119409.63	1863493.47	318.66
10-May-1999	119428.79	1863689.00	318.66
17-May-1999	119270.06	1863898.20	318.66
24-May-1999	119267.67	1864003.97	318.83
26-May-1999	119408.13	1863853.59	318.83
27-May-1999	119601.20	1863539.75	318.83
28-May-1999	119505.60	1863757.82	318.83
2-June-1999	119450.80	1863961.00	318.83
7-June-1999	119334.17	1863703.49	318.67
8-June-1999	119412.20	1863796.92	318.67
10-June-1999	119449.23	1864096.62	318.67
11-June-1999	119524.66	1863883.78	318.67
14-June-1999	119753.07	1863509.43	318.67
15-June-1999	119851.37	1863641.41	318.67
17-June-1999	119677.87	1863607.73	319.48
18-June-1999	119556.83	1863516.41	319.00
21-June-1999	119641.32	1863484.71	318.66
23-June-1999	119612.54	1863501.86	318.66
24-June-1999	119668.75	1863710.52	318.66
25-June-1999	119550.00	1863820.10	318.82
26-June-1999	118400.34	1856922.42	318.66
29-June-1999	119583.91	1863755.87	318.66
30-June-1999	119659.73	1863717.90	318.66
1-July-1999	119713.29	1863800.24	318.82
2-July-1999	119603.84	1863774.54	318.82
6-July-1999	119512.42	1863407.59	318.66
7-July-1999	119451.04	1863398.35	318.66
8-July-1999	119437.63	1863450.29	318.66
9-July-1999	119353.63	1863544.47	318.98
12-July-1999	119446.35	1863698.22	319.00
13-July-1999	119508.82	1863676.06	318.83
15-July-1999	119612.03	1863836.35	318.83

WHITE STURGEON MITIGATION AND RESTORATION IN THE COLUMBIA AND SNAKE RIVERS UPSTREAM FROM BONNEVILLE DAM

ANNUAL PROGRESS REPORT

APRIL 1999 – MARCH 2000

REPORT D

Evaluate the success of developing and implementing a management plan for enhancing production of white sturgeon in reservoirs between Bonneville and McNary dams.

This report includes: The results of efforts to capture and mark white sturgeon in Bonneville Reservoir for population abundance estimates and a summary of activities and plans to develop and implement artificial propagation techniques and protocols for experimental propagation of white sturgeon.

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CONTENTS

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We offer our appreciation and thanks to Cecil James, Yakama fishery technicians Chuck Gardee, James Kiona, and Alvin McConnville, and commercial fishermen Robert Brigham, Bobby Begay, Butch Lumley and their crew members for their efforts in conducting the mark and recapture operations in Bonneville Reservoir. We also thank Washington Department of Fish and Wildlife technicians John Hone and Robert Morgan, and US Fish and Wildlife Service biologists John Holmes and Jeff Poole for their work and assistance with the experimental white sturgeon supplementation project.

ABSTRACT

We made significant progress to develop and implement techniques for capturing, holding, and spawning white sturgeon in 1999 - 2000. During 19 days of setline fishing from 15 March, 1999 to 21 April, 1999 we captured a total of 212 white sturgeon in 130 sets. We successfully captured and transported nine sexually mature white sturgeon, three females and six males, from Wanapum and McNary reservoirs to holding facilities at Abernathy National Fish Technology Center. At Abernathy both male and female white sturgeon were successfully held in captivity and induced to spawn. Viable gametes from both sexes were collected. Timing of male and female gamete production did not coincide, subsequently fertilization was not possible. Mark and tagging operations for Bonneville Reservoir resulted in marking 3298 white sturgeon with the 8^{th} right scute removal pattern and pit tagging 2645 of these white sturgeon. A total of 3537 white sturgeon were captured in 601 gillnet sets from 11 November, 1998 through 13 January, 1999.

INTRODUCTION

In this report we describe work completed by Columbia River Inter-Tribal Fish Commission (CRITFC) staff, under subcontract with Oregon Department of Fish and Wildlife (ODFW), from 1 April, 1999 through 31 March, 2000, performed to meet objectives of Bonneville Power Administration (BPA) tasks outlined under project 86-50. The two primary tasks of CRITFC during this period were:

- To develop and implement artificial propagation techniques for white sturgeon. The offspring of this artificial propagation will be used for experimental releases in specific Columbia River Basin impoundments. This research is being performed to develop techniques that will mitigate for lost productivity where development and operation of hydrosystem has reduced natural production of white sturgeon. Specific goals for this task for 1999 – 2000 were: 1) to cooperatively develop, evaluate, and implement a plan to introduce hatchery reared white sturgeon in Columbia River reaches, 2) satisfy appropriate National Environmental Protection Agency (NEPA) requirements for release of hatchery reared white sturgeon, 3) prepare Abernathy National Fish Technology Center for holding and spawning of adult white sturgeon and culture of juvenile white sturgeon, and 4) collect, hold and spawn white sturgeon broodstock.

- Monitor the status of white sturgeon populations between Bonneville and Priest Rapids dams in the Columbia River. Specific goals for this task for 1999 – 2000 were: 1) to capture and mark/tag approximately 3000 white sturgeon in Bonneville Reservoir, 2) provide assistance to cooperating agencies to conduct gill net sampling for young-of-year (YOY) in The Dalles and John Day reservoirs, and 3) provide assistance to cooperating agencies with transplanting juvenile sturgeon from areas downstream of Bonneville Dam and releasing them in John Day or The Dalles reservoirs.

The first task involves the collection and spawning of wild white sturgeon to produce juvenile white sturgeon for release into selected reservoirs to evaluate supplementation as a recovery and mitigation tool for depressed/declining white sturgeon populations. Within this report we describe the methods, efforts, and results of white sturgeon collection performed by CRITFC with cooperation and assistance from Washington Department of Fish and Wildlife (WDFW). Preparation of the Abernathy facility for white sturgeon broodstock holding and spawning were cooperatively undertaken by CRITFC and U.S. Fish and Wildlife Service staff and are described by Holmes (section F, this report). Satisfaction of NEPA requirements were limited in scope because no white sturgeon production occurred and will be addressed as we develop methods that allow successful spawning and rearing of white sturgeon to juvenile size and approach an actual release date.

The second task involves the cooperative monitoring of Zone 6 white sturgeon fisheries between CRITFC, Yakima Indian Nation (YIN), WDFW, and ODFW. This work builds on successful efforts in John Day Reservoir in 1996, (Parker 1998) and in

The Dalles Reservoir in 1997 (North et al. 1998; 1999) to increase the number of marks-at-large white sturgeon with the intent of increasing the precision of population estimates performed by ODFW in these reservoirs. The success of those efforts lead to expanding this cooperative marking project to Bonneville Reservoir to provide an abundance estimate with an expected precision of ± 15 percent. The results of this estimate will be reported by ODFW in this report. The ODFW will also report trawl and haul efforts and WDFW will report YOY gill net surveys as CRITFC's responsibility with those projects involved only assistance with field work.

METHODS

Artificial Propagation Research

Broodstock Collection

A joint crew from CRITFC and Washington Department of Fish and Wildlife (WDFW) fished for white sturgeon broodstock in McNary and Wanapum reservoirs in the Columbia River (Figure 1) from 15 March, 1999 through 21 April, 1999. White sturgeon were caught using setlines fished overnight. Each setline was made up of 182.88 m of nylon mainline and was equipped with 40 detachable gangions snapped on approximately every 5.22 m. Gangions were 46 cm long and attached to circle halibut hooks in sizes 10/0, 12/0, and 14/0. Near even number of each size hooks were deployed, with 14 of one hook size and 13 of the other two sizes. Hooks were baited with pickled squid (*Loligo spp.*) and only rebaited when bait was missing. Each end of the line was held on the river bottom with an anchor. Anchors varied in weight and style, but most weighed approximately 14 to 17 kg. A large inflated buoy (i.e. 60 cm diameter) was attached to each anchor and the end of the setline to mark the location of each end of the line. A numbered smaller buoy (i.e. 30 cm diameter) was attached to one of the two marker buoys for individual identification. Setlines were generally pulled by hand, although the anchors were generally retrieved with a hydraulic winch.

Captured white sturgeon were immediately placed in a live well or if too large for the live well (greater than 213 cm) placed on the deck with water flushed through gills via an electric pump or tied along side the boat. After running a set line all captured white sturgeon were measured to fork and total length (cm), examined for tags, tag scars, missing scutes, past sexing scars, pectoral fin scars, and missing barbels. White sturgeon with missing scutes or tag scars were scanned with an Avid[1] passive integrated transponder (PIT) tag detector. Large fish likely of sexual maturity and stressed fish were examined first. We determined sex and staged gonad maturity of fish ≥ 152 cm. Determination of sex and maturity was made first by trying to strip eggs or milt from the vent, then if manual stripping failed to produce gametes, a surgical examination was performed using an otoscope inserted through a 2-3 cm ventral incision. Classification of maturation was based on a histological assessment of oocyte development (Chapman 1989) and methods described by Welch and Beamesderfer (1993). During the surgical examination, fish were placed ventral side up and held in place with sandbags while gills

[1] Use of trade names does not imply endorsement by CRITFC.

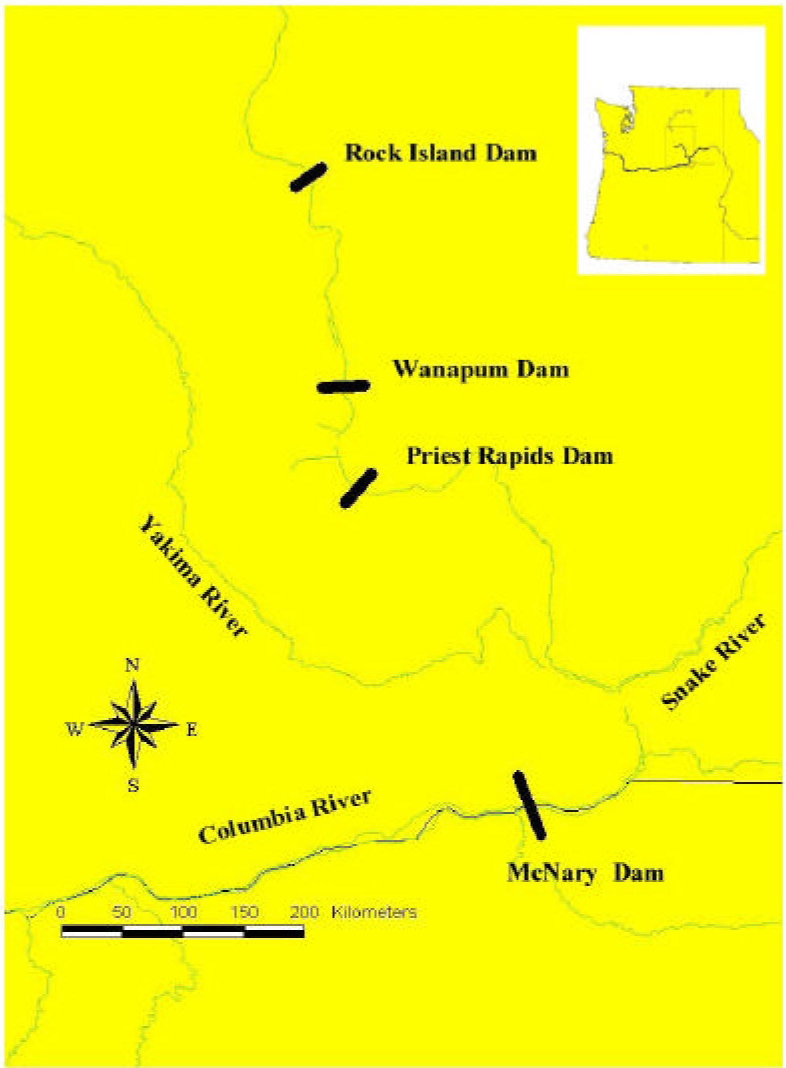

Figure 1. The Columbia River, depicting our white sturgeon broodstock collection areas in McNary and Wanapum reservoirs.

were continuously flushed with water using an electric pump. The incision was closed with two to four stitches. White sturgeon that were assessed to have potential as broodstock were immediately placed into a specialized transport tank and held on fresh river water until the fishing week's end. All other white sturgeon were immediately released into their respective reservoir. At week's end potential broodstock were transported to Abernathy National Fish Technology Center and held in 3 m diameter tanks (Holmes, this report).

Bonneville Capture, Mark and Pit Tagging

Columbia River Inter-Tribal Fish Commission captured, marked, and tagged white sturgeon in Bonneville Reservoir in order to perform population monitoring. The capture, mark, and pit tag operation for Bonneville Reservoir (Table 1) was performed for seven weekly fishing periods from 11 November, 1998 through 13 January, 1999. We sampled the area from about statute river mile 149 to 186 (Figure 2). We divided the sampling area into four sections 14.4 to 16.1 km long in an effort to systematically sample the entire reservoir (Figures 3-6). Areas restricted from commercial white sturgeon fishing were observed and thus incorporated into our sampling strategy. All crews began sampling in section one and moved upriver one section each week for the first four weeks. During the last three weeks of sampling, fishers were allowed to fish freely throughout the four sections. We employed this strategy in an effort to mark fish throughout the entire reservoir and also to reduce the possibility of recapturing newly marked fish. A fishing week usually began on Monday and ran through Friday. Nets were checked and reset each day, with Monday being the first set day of the week and Friday being the last pull day of the week, except when limited by severe weather or mechanical problems. Fishing operations were also adjusted to accommodate seasonal holidays - during the weeks of Christmas and New Years nets were set on Monday and pulled on Thursday.

Three Yakima Indian Nation fishery (YIN) technicians and three commercial fishermen with crew performed all sampling operations. Each contract fisher was required to provide three crew members to perform all marking, measuring, and tagging of white sturgeon along with any other requested data collections. Columbia River Inter-Tribal Fish Commission biologists and YIN technicians were responsible for training fishers with measuring techniques, identifying marked fish, and tag application procedures. Fishery technicians recorded all data while fishers worked up the catch according to established protocol.

Fishing was performed from commercial fishing vessels with commercial diver gillnets. Commercial vessels consisted of two 8 m bow pickers and one 5.5 m open boat. The length of nets fished ranged from 76 to 122 m and mesh size was either 20.3 or 25.4 cm stretched mesh. A variety of materials were used for anchors and floats. Fishers were paid a daily boat lease rate of $100.00 per day and $12.00 for each captured and processed white sturgeon recorded on the data sheets. Because fishers were rewarded on a catch rate basis they were motivated to search out areas they felt would be productive fishing sites within the pre-described boundaries. Each fisher was typically able to run 10

Table 1. Summary of Columbia River Inter-Tribal Fish Commission sampling effort showing the number of gill net sets for white sturgeon in Bonneville Reservoir from 30 November, 1998 through 14 January, 1999 by week and sampling section.

	Section	1	2	3	4	
Week	Dates					Total
1	11/30 – 12/4	62	1[1]	-	-	63
2	12/7 – 12/11	-	118	-	-	118
3	12/14 – 12/18	-	-	90	1[1]	91
4	12/20 – 12/23	-	-	-	57	57
5	12/27 – 12/30	-	-	-	76	76
6	1/ 4 – 1/8	23	15	2	72	112
7	1/12 – 1/14	26	35		23	84
Total		111	169	92	229	601

[1] Two sets took place outside of locations we had originally specified in our strategic sampling plan

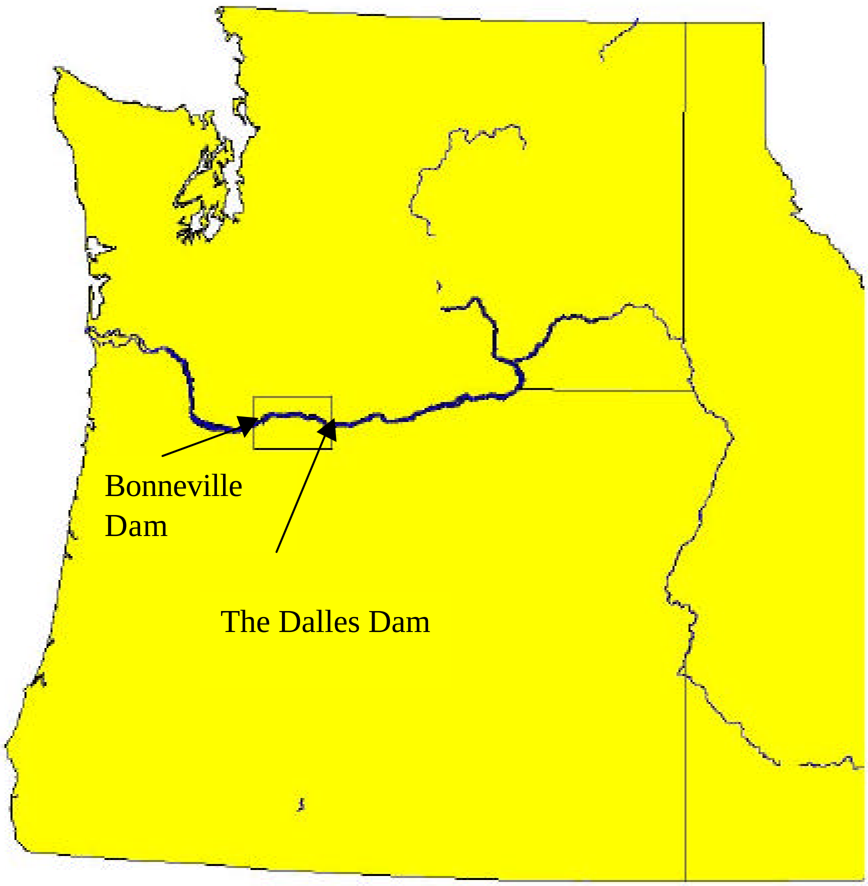

Figure 2. The Columbia River Basin, area within box represents Bonneville Reservoir statute river mile 149 to 186, where mark/tagging operations were performed.

Target is UTM 10 593994E 5064028N - **CARSON** quad

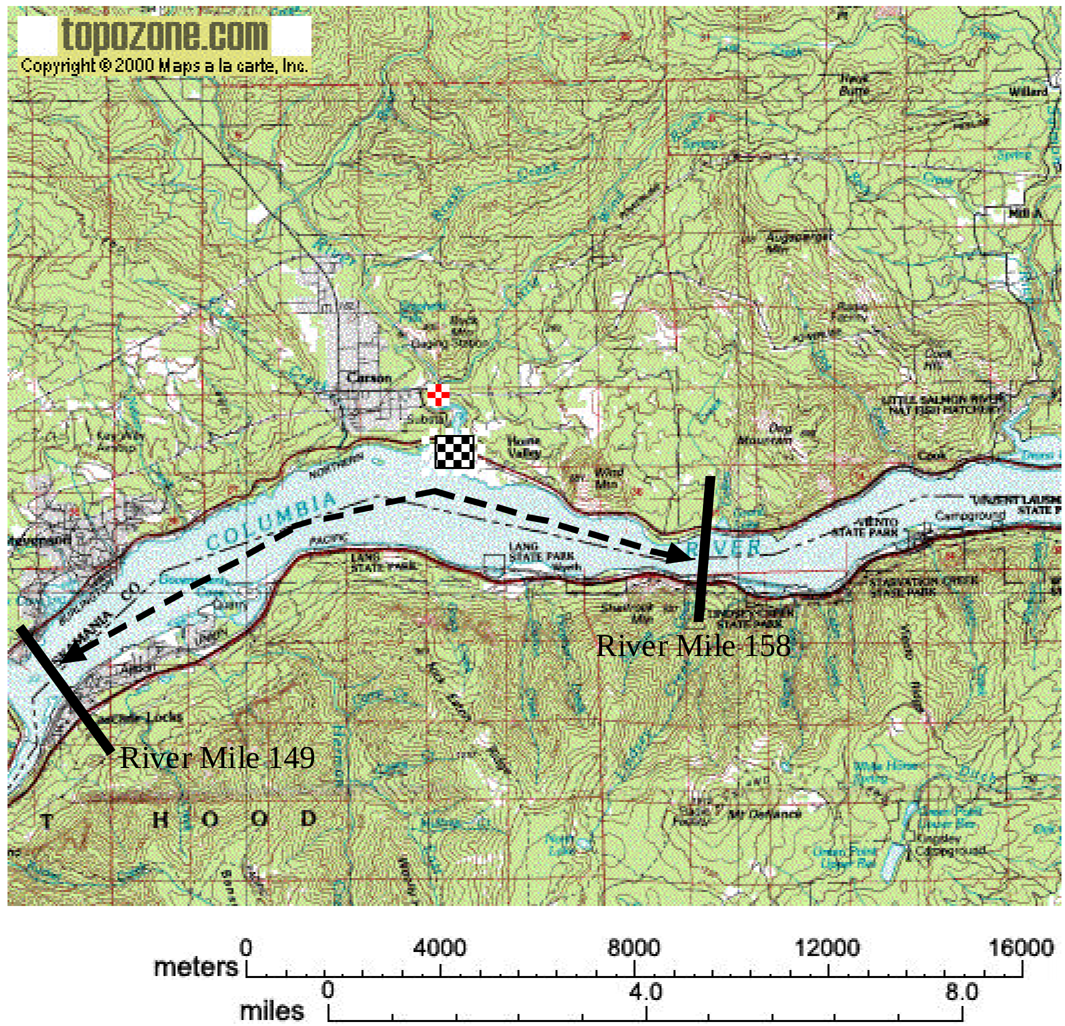

Figure 3. Map depicts a section of Bonneville Reservoir in the Columbia River, area between black lines represents section one of our white sturgeon gill net sampling area from river mile 149 to river mile 158, checkered box represents area closed to sampling.

Map center is UTM 10 605536E 5062725N - **MT DEFIANCE** quad

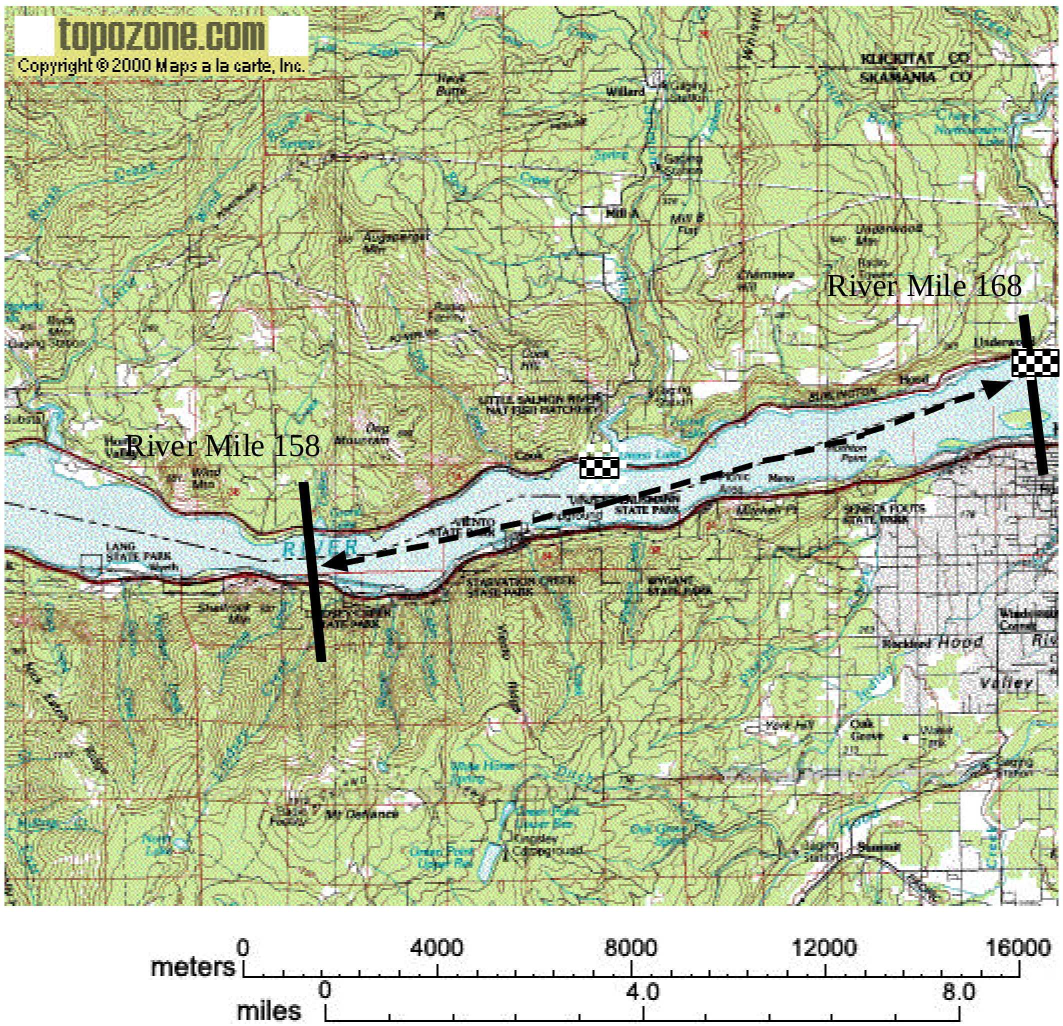

Figure 4. Map depicts a section of Bonneville Reservoir in the Columbia River, area between black lines represents section two of our white sturgeon gillnet sampling area from river mile 158 to river mile168, checkerd boxes represents areas closed to samplng.

Target is UTM 10 621794E 5062733N - **WHITE SALMON** quad

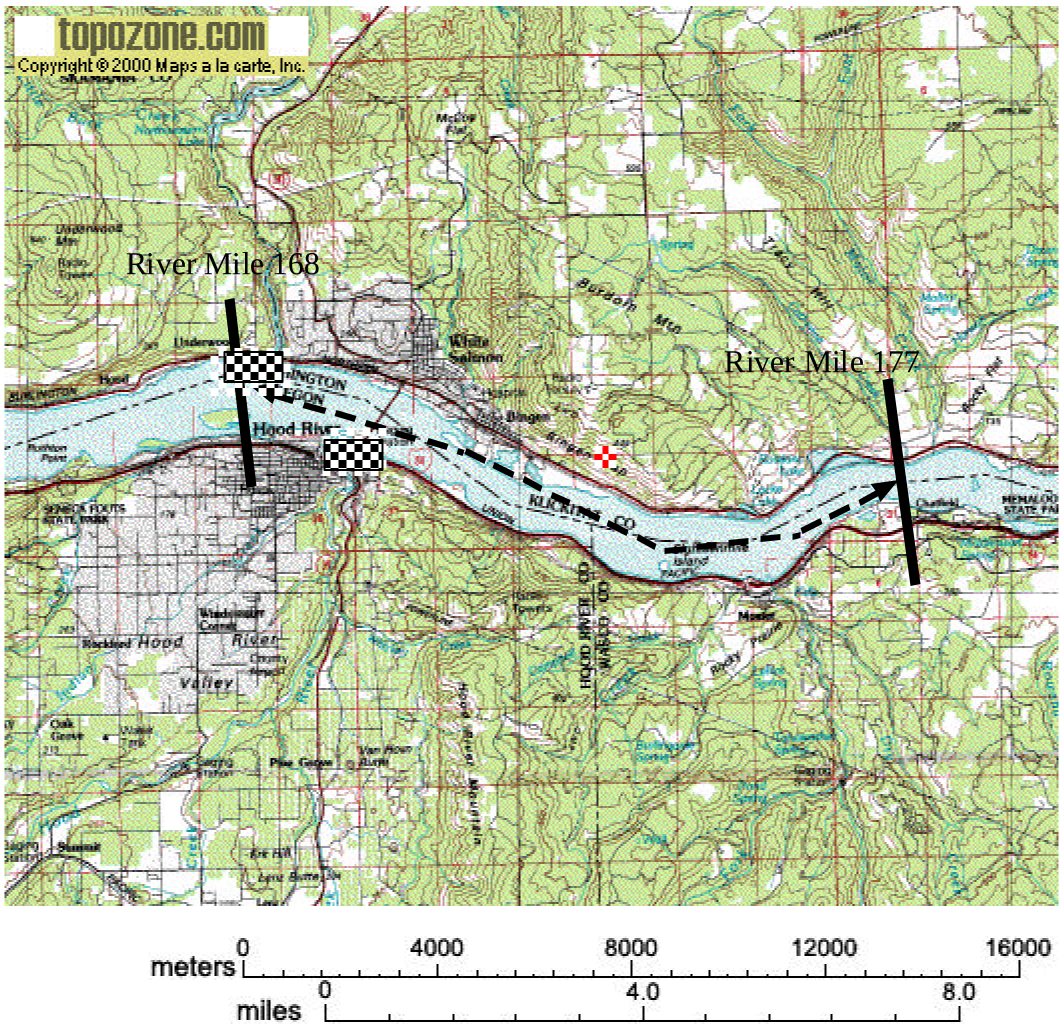

Figure 5. Map depicts a section of Bonneville Reservoir in the Columbia River, area between black lines represents section three of our white sturgeon gillnet sampling area from river mile 168 to river mile 177, checkered boxes represents areas closed to sampling.

Target is UTM 10 635325E 5061590N - **LYLE** quad

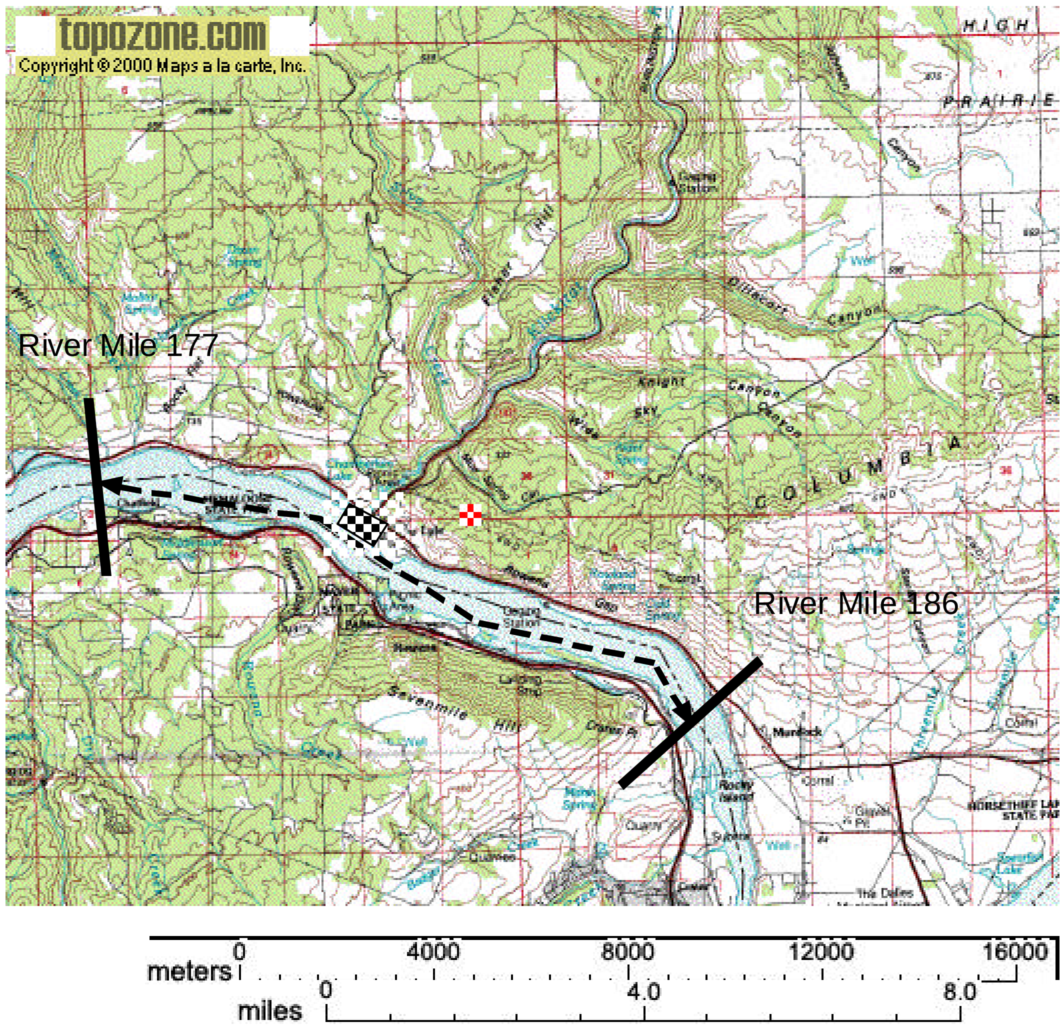

Figure 6. Map depicts a section of Bonneville Reservoir in the Columbia River, area between black lines represents section four of our white sturgeon gillnet sampling area from river mile 177 to river mile 186, checkered box represents area closed to sampling.

– 15 nets per day working daylight hours. The number of nets fished each day depended on catch rates and fisher crew efficiency.

The standard operating procedure for processing white sturgeon collected with a gill net was as follows. White sturgeon were brought on board and removed from the gillnet. All white sturgeon were examined for tags, tag scars, missing scutes, pectoral fin scars, and missing barbels. White sturgeon with missing scutes or tag scars were scanned with an Avid[1] passive integrated transponder (PIT) tag detector. All white sturgeon were measured to the nearest cm fork length and the 8th right side scute was removed to indicate year of capture was 1998. We did not weigh fish. Fish less than 70 cm were then released. In most cases, if the fork length was equal to or greater than 70 cm and the fish did not possess a pit tag, an Avid 125 MHz pit tag was injected into the musculature beneath the armor posterior of the head, near the dorsal midline. The second left lateral scute was also removed in order to identify a PIT-tagged fish (Rein et al. 1994). We used a biomark[1] MK5 general-purpose implanter with standard 12 gauge needles to inject pit tags. All pit tag numbers found upon examination or applied were recorded with biological information corresponding to the fish and later entered into a database maintained by ODFW. Once processed all fish were released.

RESULTS

Artificial Propagation Research

We collected nine white sturgeon for broodstock trials, three females, which were 205, 200, and 175 cm in fork length, weighing 76, 65, and 41 kg, respectively, and 6 males, ranging from 137 to 163 cm in fork length and weighing between 22 and 31 kg. We captured a total of 212 white sturgeon in 130 sets in 19 days of fishing during a six-week fishing period from 15 March, 1999 to 21 April, 1999 (Table 2). Sizes of white sturgeon captured ranged from 63 to 235 cm fork length. We performed 92 surgical examinations on fish suspected of sexual maturity to determine sex and maturity, revealing a total of 35 females and 57 males. We fished Wanapum Reservoir from statute river mile 416.1 to 437.9 from 15 March, 1999 through 18 March, 1999 capturing only three female white sturgeon in a total of 28 sets. Of the three captured, one was a mature female (205 cm in fork length) with black eggs and was kept for brood stock. All other fishing took place in McNary Reservoir from statute river mile 296.0 to 314.4.

All white sturgeon captured and not taken as broodstock were released in good condition into their respective reservoirs. All white sturgeon taken for broodstock in 1999 were returned in good condition to McNary Reservoir except for the female captured in Wanapum Reservoir which was held at Abernathy facility for potential spawning in 2000. Incidental catch consisted of a few channel catfish (*Ictalurus punctatus*) that were released unharmed and one northern pikeminnow (*Ptychocheilus oregonensis*) that was sacrificed.

[1] Use of trade names does not imply endorsement by CRITFC.

Table 2. Summary of Columbia River Inter-Tribal Fish Commission white sturgeon broodstock capture efforts showing number of days fished, number of sets, number of white sturgeon captured, and number of broodstock kept for the fishing period from 15 March, 1999 to 21 April, 1999 in McNary and Wanapum reservoirs.

Reservoir	McNary		Wanapum	
Days fished	15		4	
Number of Sets	102		28	
White sturgeon captured	209		3	
Broodstock kept	Males 6	Females 2	Males 0	Females 1

Bonneville Capture, Mark and Pit Tagging

Effort and White Sturgeon Catch

A total of 3537 white sturgeon were captured in 601 gillnet sets. We marked 3298 of these fish with the 8th right scute removal pattern described in the methods section. Of the 3537 captured, 644 were less than 70 cm (approximately 18 percent), 2891 (approximately 82 percent) were 70 cm or greater, and two fish were mistakenly released before they could be measured. We applied pit tags to 2645 white sturgeon, with 2644 of these tags applied to white sturgeon equal to or greater than 70 cm. One fish measuring 67 cm was mistakenly pit tagged. Twice pit tags were mistakenly applied to fish that already possessed a pit tag. White sturgeon captured ranged in fork length from 19 to 245 cm, with a mean length of 85.8 cm (Table 3). Seventy nine percent (2785) of white sturgeon captured were less than 100 cm (Figure 7).

The total white sturgeon catch consisted of 3433 commercial sublegal size (less than 48 inches or 121.92 cm), 87 commercial legal size (between 48 inches and 60 inches or 121.92 cm and 152. 4 cm) and 15 over legal size (greater than 60 inches or 152.4 cm). A total of 2880 white sturgeon between 70 and 166 cm, the size range used in the past by ODFW to estimate population abundance, were captured by CRITFC.

Distribution, Marking, and Mark Recovery

We captured white sturgeon from all four sampling sections throughout Bonneville Reservoir (Table 4). Section four, the section nearest The Dalles Dam, had the highest number of fish caught with a total of 1664 white sturgeon in 229 sets. This accounted for forty seven percent of the total catch from thirty eight percent of the total sets. Sampling section two was next highest with 786 fish caught in 169 sets accounting for twenty two percent of the catch from twenty eight percent of the sets. Sections three and section one had similar catch numbers with 559 (16%) white sturgeon caught in 111 (18%) sets, and 528 (15%) white sturgeon caught in 92 (15%) sets, respectively.

The total mean white sturgeon catch per set for all sets combined was 5.89. The highest mean catch rate per set by week was 7.91, and occurred in week five when fishers were allowed to fish anywhere within the four sections and chose to place all of those sets within section four. The lowest mean catch per set by week was 3.89 and occurred in week four when fishers were mandated to fish in section four. A possible explanation for this anomaly is that, as fishers gained knowledge of where fish were congregated in this section, catch rate increased. Also, it should be understood that changes in environmental factors that effect activities such as movement and feeding patterns of white sturgeon may also have lead to an increase in catch. Abundance estimates for Bonneville Reservoir and tag retention rates for fish tagged by CRITFC and recaptured by ODFW are reported by Kern et al. (section A, this report).

Table 3. Columbia River Inter-Tribal Fish Commission catches of white sturgeon in Bonneville Reservoir from 11 November, 1998 through 13 January, 2000 by fork length interval and sampling section.

Fork Interval	Sampling Section				
	1	2	3	4	Total
16-25	0	0	6	4	10
26-35	1	5	11	32	49
36-45	3	36	6	63	108
46-55	3	22	3	37	65
56-65	4	13	6	159	182
66-75	12	24	36	409	481
76-85	43	129	93	387	652
86-95	134	219	190	297	840
96-105	169	224	120	169	682
106-115	115	67	36	58	276
116-125	47	31	12	20	110
126-135	14	5	3	17	39
136-145	7	4	3	4	18
146-155	5	2	1	2	10
156-165	1	0	0	1	2
166-175	0	1	1	1	3
176-185	0	0	1	1	2
186-195	0	0	0	1	1
196-205	0	0	0	0	1
206-215	0	0	0	0	0
216-225	0	2	0	0	2
226-236	0	0	0	1	0
236-245	0	0	0	0	1
246-255	0	1	0	0	1
Total	558	785	528	1664	3535

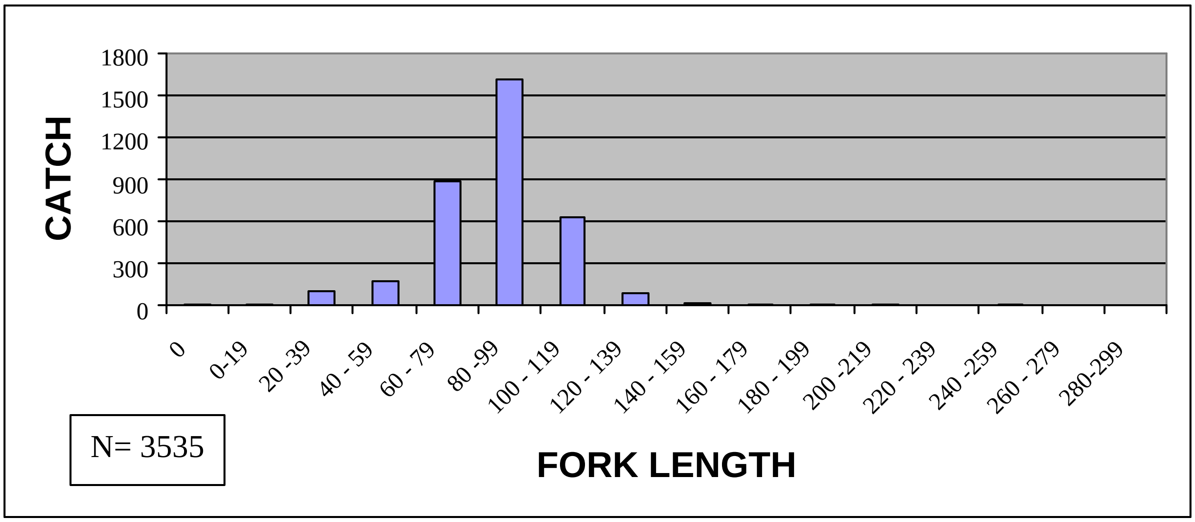

Figure 7. Length frequencies of white sturgeon caught with gill nets by Columbia River Inter-Tribal Fish Commission in Bonneville Reservoir, from 11 November, 1998 through 13 January, 2000.

Table 4. Columbia River Inter-Tribal Fish Commission catches of white sturgeon with gill nets in Bonneville Reservoir from 30 November, 1998 through 14 January, 1999 by sampling section and week, including number of sets and mean catch of sturgeon per set.

Week	Sampling Section				N Sets	Mean Catch Per Set	Total
	1	2	3	4			
1	425	2	-	-	63	6.78	427
2	-	557	-	-	118	4.72	557
3	-	-	512	3	91	5.66	515
4	-	-	-	222	57	3.89	222
5	-	-	-	601	76	7.91	601
6	73	81	16	598	112	6.86	768
7	61	146	-	240	84	5.32	447
Total	559	786	528	1664	601	5.89	3537

Disposition of White Sturgeon Captured

Of the 3537 white sturgeon captured and handled in Bonneville Reservoir all were released alive.

DISCUSSION

Artificial Propagation Research

We successfully captured, transported, held and induced spawning in wild Columbia River white sturgeon. Our lack of success to fertilize eggs and produce offspring understates the many successes of this first effort to develop artificial propagation techniques for the experimental supplementation of white sturgeon. The development of the entire process involved in propagating Columbia River wild white sturgeon and the ultimate success of rearing white sturgeon to a releasable age group will no doubt occur through a series of trial and error. Our development of techniques to capture broodstock proved successful and building on this experience, should allow for increased efficiency and the possibility of higher catch rates in the upcoming years of operations, thus increasing our chances of success. Our success with developing techniques to produce gametes from both male and female white sturgeon, albeit at different spawning times, described by Holmes (section F, this report) will be valuable in future work. Our experience holding captive broodstock at the Abernathy holding facility indicates that static cool water temperatures interrupted the natural sexual maturation of female white sturgeon broodstock and prevented successful artificial spawning. We feel that developing a spawning station at McNary Dam that utilizes natural Columbia River water, and thus reduces stress from transportation and allows for natural changes in water temperature will increase our chances of successful spawning. Also, we intend to investigate the possibility of purchasing newly hatched fry, spawned from wild lower Columbia River white sturgeon broodstock, should we fail to produce juvenile white sturgeon from broodstock above McNary Dam.

Bonneville Capture, Mark and Pit Tagging

The effort in Bonneville Reservoir marks the first attempt by CRITFC to mark/tag white sturgeon in Bonneville Reservoir and the third year of the multi-agency tag and recapture population abundance estimate for the Zone 6 white sturgeon fishery. The utilization of experienced commercial fisherman to capture white sturgeon with gillnets, exploiting white sturgeon’s tendency to congregate during the late winter, has been proven a cost-effective sampling strategy for this project in all three reservoirs. Using this method of capturing white sturgeon for marking/tagging operations we were able to capture 3537 white sturgeon. Of these 3537 white sturgeon captured, we applied 8th right scute removal marks to 3298 and pit tags to 2645, slightly under our goal of 3000 applied pit tags. One explanation for this short coming is that some fishers had less experience fishing in Bonneville Reservoir than others which may have resulted in lower catches and more potential problem sets (i.e. snags, and lost nets). For example, the fisher and crew with the most experience fishing in Bonneville Reservoir captured 1680 white sturgeon, compared to the least experienced fisher and crew in Bonneville Reservoir who caught 702 white sturgeon. None-the-less, the 3298 marked fish along with the 2645 pit tagged fish are a significant contribution to the number of marked fish for population estimates and should increase statistical confidence limits. It is interesting to note the high proportion of sublegal commercial size fish captured (97%) compared to legal commercial size and oversize white sturgeon captured (3%) in the mark/tagging operation. These numbers suggest that the intensity of the commercial and sport fishery combined with lower condition factors (Kern, this report) appear to allow little escapement to the oversize class and even into the commercial size class.

We expect that we will have more productive and efficient fishing operations in the future if we are able to retain experienced fishers, or provide new fishers with information concerning where the best fishing locations might be. We are hoping that in upcoming mark/tagging operations we will be able to provide Global Positioning Systems (GPS) to our technicians and keep a record of fishing locations and maintain a data base that reflect catch rates and sampling effort throughout the reservoirs. We feel that use of GPS will increase our fishing productivity by allowing us to pass productive fishing location information onto fisherman and also help to easily locate nets on foggy days and avoid the potential mistake of running the same net twice. Also we feel this information could provide insight in determining white sturgeon late winter habitat use areas, and may be useful input to instream flow models.

Since this cooperative management effort began for Zone 6, the number of marked white sturgeon used in population estimates in John Day, The Dalles and Bonneville reservoirs has increased significantly. The increased number of marked fish is a product of the most comprehensive sampling effort ever performed on these reservoirs and has produced estimates with tighter confidence limits. The Bonneville total abundance populations estimate for 1999 was 128,548 (pers. Comm. Chris Kern) a two and one half-fold increase over population estimates that were performed in 1989 and 1994. This increase is less than the six fold increase seen between the 1997 and 1994 estimates in The Dalles Reservoir and the nearly seven fold increase that occurred in John Day Reservoir between 1996 and 1990, but still remains a significant increase over past estimates. The factors that lead to these significant increases in each reservoir's population estimate are still not fully understood. Further repetition of these efforts, if they provide similar results, should explain the cause of the substantial increases in population estimates for reservoirs above Bonneville Dam, though it seems possible as North et al. (1999) suggests, that white sturgeon have historically been underestimated in these reservoirs in the past. Accurate population estimates are critical to managing for the optimal sustained yield harvest model that has been in effect since 1997. It is with keen interest that we look toward future population estimates to provide this much needed information.

PLANS FOR UPCOMING YEARS

Broodstock spawning operations for the spring 2000 along with all other completed activities will be reported in the Annual Report for period April 2000 through March 2001. We will be performing mark/tagging operations in John Day Reservoir beginning in late November 2000 and ending in early February 2001. We hope to pit tag approximately 3000 white sturgeon and plan to apply scute marks to all fish caught during this effort. We plan to make several changes concerning our artificial spawning operations in 2001. We will establish a holding and spawning facility at McNary Dam Fish Facility scheduled for completion in March 2001 and plan to hold and spawn fish there during the 2001 broodstock collection season, then transport the fertilized eggs to Abernathy Fish Technology Center.

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WHITE STURGEON MITIGATION AND RESTORATION IN THE COLUMBIA AND SNAKE RIVERS UPSTREAM FROM BONNEVILLE DAM

ANNUAL PROGRESS REPORT

APRIL 1999 – MARCH 2000

REPORT E

Develop artificial propagation techniques and protocols in preparation for supplementation of selected white sturgeon populations.

This report includes: Work to (1) establish a temporary facility to be used for holding and spawning wild white sturgeon, incubating and hatching eggs, and rearing resulting juveniles, and (2) procedures and results of the 1999 spawning season.

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CONTENTS

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This project was the result of many people lending their support via their hard work and/or their expertise, their assistance was greatly appreciated. Jeff Poole, Abernathy Fish Technology Center (AFTC), played a major role in the construction of the temporary facility and in the activities involving the wild adult sturgeons. Yakama Indian Nation fisheries technicians Chuck Gardee and Donella Miller, and Mike Wakeland with Columbia River Inter-Tribal Fish Commission (CRITFC) helped with the construction of the temporary facility. Blaine Parker, CRITFC, was instrumental in assisting with facility design, procurement of building materials and supplies, and assisting with activities involving the wild adult sturgeons. A special thanks to Joel Van Eenennaam and Serge Doroshov, University of Califomia, Davis, for sharing their knowledge and assessing oocyte samples. And special thanks to Jack Siple and Sue Ireland, Kootenai Tribe of Idaho, for assisting in developing our facility and spawning protocol.

ABSTRACT

A total of nine wild maturing white sturgeon, 3 females and 6 males, were successfully captured, held through the spawning season, and then released back to the site of origin. One male was induced to spawn in early June. One female was induced to spawn in late August. While this did not result in a successful spawning and subsequent juvenile production, it did identify areas to be addressed. The temperature of the facility water, creek water, fluctuated widely, with potential negative impacts on spawning timing. Increasing the number of available males, 5 or 6 to each female, should also increase the probability of synchronous spawning. By changing the current protocol to address these issues we believe that a viable spawning can be achieved.

INTRODUCTION

This annual report describes work completed by the U.S. Fish and Wildlife Service, Abernathy Fish Technology Center (AFTC) as part of the Bonneville Power Administration white sturgeon *Acipenser transmontanus* research project 86-50. The AFTC is responsible for portions of tasks related to Objective 1: develop, recommend, and implement actions that do not involve changes to hydrosystem operation and configuration to mitigate for lost white sturgeon productivity in impoundments where development and operations of the hydrosystem has reduced production. These tasks include hold and spawn wild white sturgeon to produce age-specific cohorts and evaluate the feasibility of using artificial propagation as a mitigation tool.

METHODS

Temporary Facility

A temporary facility (Figure 1.) was constructed at AFTC, Longview, WA to hold wild adult white sturgeon for final maturation and spawning. This facility, in addition to pre-existing rearing tanks and raceways at AFTC, would also be utilized in rearing juvenile sturgeon. Sixteen fiberglass tanks, 3.05 m in diameter and 1.22 m in depth, were installed on a pre-existing concrete slab. Tanks were supported on a sand platform, 9.15 m by 36.60 m, with a sand depth of 0.86 m. The sand was held in place with timber and steel supported walls that were bolted to the concrete slab. Each tank was supplied with two water sources, Abernathy Creek water (5.0 - 13.0ºC) and well water (12.5 ºC), to allow for potential water temperature control. Tanks designated to hold adult sturgeon were fitted with perforated plywood covers to provide a more natural darkened environment, prevent sturgeon from exiting the tank, and to act as security against human activity.

Figure 1. Construction of Abernathy FTC temporary sturgeon facility

The spawning, hatching, and early rearing section of the temporary facility was housed in a pre-existing building. A custom-built fiberglass tank and plywood cover, 0.89 m x 3.05 m with 0.61 m depth, was installed to hold pre-ovulating sturgeon. Twelve McDonald type hatching jars were plumbed in pre-existing fiberglass troughs, which allowed division of eggs from the fertilization of a single female with multiple males.

Sturgeon Procedures

Pre-spawning

Nine adult sturgeon were captured and transported to AFTC in March and April 1999 described by Kappenman and Parker (in press), and held in covered 3.05 m diameter tanks supplied with creek water. Figure 2 shows daily high and low creek temperatures for this period. Females were housed one sturgeon per tank, and males two sturgeon per tank. Water depth was 0.91 m with a flow rate of 45.3 lpm. As a food source adult sturgeon tanks were stocked with juvenile salmonids, which were added periodically to maintain a constant food supply. In May the water source was transitioned to the warmer well water (12.5 °C) to assist in maturation. One female captured in the Wanapum Reservoir was not expected to mature in 1999 and was held for spawning in 2000. Two females and six males were captured in the McNary Reservoir and via surgical examination were expected to spawn in 1999.

The only observed health problem with the adult sturgeon was a external fungal infection on a single female, which became noticeable six weeks after the sturgeon arrived at AFTC. The infection was successfully treated with four consecutive days of salt baths. Treatment involved one hour per day baths at 7ppt NaCl for the first day, and at 15ppt for the remaining three days.

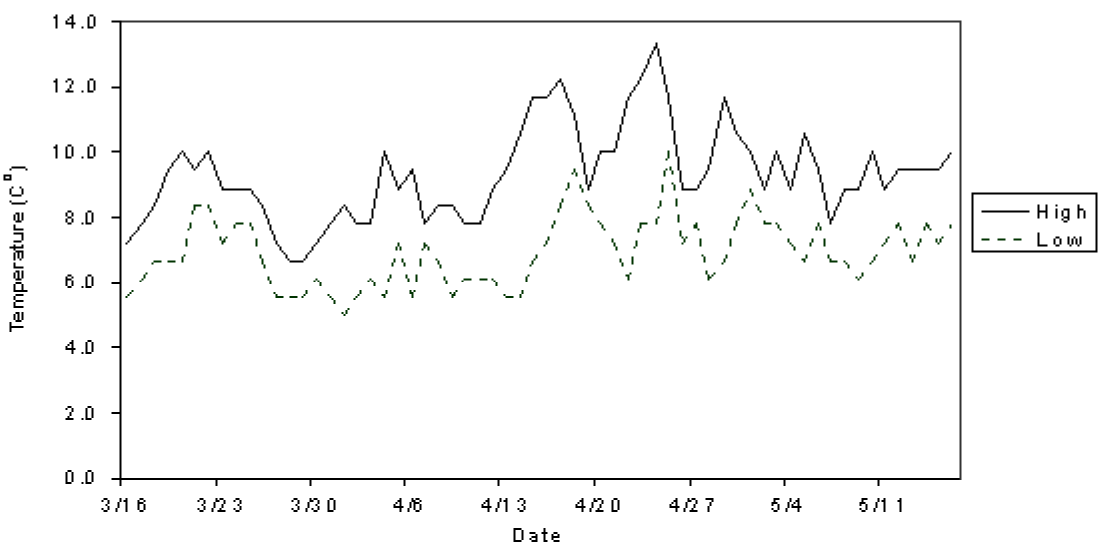

Figure 2. 1999 Abernathy Creek temperature profile.

Spawning

Oocyte sampling procedures closely followed those described by Conte et al. (1988). Oocytes were periodically collected from female sturgeon to determine maturation stage by examination of nucleus/germinal vesicle (GV) position. To facilitate this procedure, holding tank water depths were reduced to 0.3 m. Since reduced water depth increased the sturgeon's activity level, handling of the fish was delayed until activity level returned to a resting state. Once the female sturgeon was in the stretcher, she was positioned ventral side up with her head in the stretcher's built-in hood. The stretcher was raised, elevating the tail bringing the abdomen above the water while keeping the head submerged. Thus, the female remained calm, allowing the minor surgery and oocyte sampling to occur without use of anesthesia. A small incision was made approximately midway between the pectoral and pelvic fins, and midway between the center-ventral line and the ventral scutes. To allow the entry of a 4.0 mm internal diameter tygon tubing with the tip cut at a 45^{o} to ease entry. A sample of approximately 60 oocytes was removed by aspiration and placed in a small vial containing 100-200 ml of 16 ^{o}C Ringer's Solution. The incision was sutured using 2 to 3 mattress stitches and a veterinary tissue sealant was applied. The female was then released from the stretcher never having been removed from the water.

Once oocytes were determined to be mature by GV position, a progesterone assay was used to confirm that the female was ready to spawn. Protocol followed Conte et al. (1988), except for the use of Ringer's Solution instead of Leibovitz incubation medium, and a decrease in assay incubation time from 16 h instead of 24 h.

Spawning induction in both males and females was accomplished with exogenous hormone injection, using [D-Ala^{6}, Des-Gly^{10}]-LH-RH Ethylamide (Peninsula Laboratories, Inc., San Carlos, CA), hereafter referred to as LHRH. The hormone dose was based on the sturgeon's weight taken at the time of capture. Females were given two injections: an initializing dose of 2 ug/Kg body weight; and a second resolving dose, of 18 ug/Kg, 12 hours later. Ovulation is expected to occur 20 to 40 hours after the resolving injection. Males received a single injection of 10 ug/Kg, with harvest of sperm (milt) occurring approximately 20 hours postinjection.

Timing of male injections, and subsequent milt harvest, was set to occur prior to the spawning of the female to insure an adequate supply of viable sperm. Once viable sperm was collected, the initializing dose was given to the female. Males received their LHRH injection in the holding tanks, similar to the procedure used for females. Tagging the adults at the time of capture with passive integrated transponder (PIT) tags allowed for positive identification of sturgeon and their corresponding LHRH injection dose. Milt was extracted as cited in Conte et al. (1988) and stored in ziplock bags filled with oxygen gas. Ziplock bags were stored over ice, with no direct contact with ice, in a closed cooler. Oxygen was replaced every 24 h and milt agitated three times during the day. Sperm viability was to be checked as cited in Conte et al. (1988) prior to fertilizing eggs.

For spawning purposes, the female sturgeon was transported from its holding tank to the spawning tank via stretcher. After the female had adjusted to the smaller spawning tank the initializing injection was given underwater. Twelve hours later the female received the resolving dose injection. At 20 hours after the resolving injection, hourly monitoring for signs of ovulation began. When hundreds of eggs were observed, they egg were harvested.

When harvesting eggs, the non-anesthetized female was placed in the stretcher, as in oocyte sampling, but elevated out of the water with the stretcher supported by a wooden rack to prevent premature contact of eggs with water. Water flow to the gill cavity of the sturgeon was supplied via a soft tipped hose placed in the mouth cavity. With care not to allow the eggs contact with water, the genital opening area was first dried with paper towels, then gentle pressure was applied with fingertips anterior to the genital opening to release eggs. Using a large plastic spoon, eggs were collected in small batches and transferred to a plastic bowl to await fertilization (Figure 3.). A total of 30,000-60,000 eggs of the sturgeon's total egg production were needed. When egg harvest was completed the female was returned to the spawning tank and eventually the holding tank for recovery.

Figure 3. White sturgeon egg collection

RESULTS

Nine wild adult white sturgeon were successfully captured and transported to AFTC (Table 1). Feeding on live salmonids was confirmed in one adult. Dr. Alfred Caudle, University of Georgia, visited AFTC to test ultra-sound as a tool for determining the sex of sturgeon, and identified a salmonid in the digestive tract. The only disease problem to occur with the adults was an external fungal infection in one female, which was successfully treated with salt baths.

The female sturgeon (PIT# -5058), captured in McNary Reservoir in April, was sampled for oocytes on May 4th to determine stage of oocyte maturation. The migration of the GV towards the animal pole of the oocyte indicated continued maturation. It was decided to conduct a progesterone assay in two weeks. On May 20th oocytes were sampled and the progesterone assay indicated a GV breakdown in 80% of the eggs sampled. After conferring with staff at U.C. Davis it was decided to initiate spawning in early June.

Table 1. Wild adult white sturgeon *Acipenser transmontanus* transported to Abernathy Fish Technology Center in 1999.

Arrival Date	Capture Location	Sex	PIT Tag	Weight Kg	Length cm
03/19/99	Wanapum Reservoir	F	024540779	76	205
03/25/99	McNary Reservoir	M	115776631A	22	137
03/25/99	McNary Reservoir	M	116168630A	31	163
03/25/99	McNary Reservoir	M	115612611A	23	141
04/15/99	McNary Reservoir	F	024535058	41	175
04/15/99	McNary Reservoir	F	115552747A	65	200
04/22/99	McNary Reservoir	M	116251385A	-	154
04/22/99	McNary Reservoir	M	024544296	26	149
04/22/99	McNary Reservoir	M	115724643A	-	154

On June 1st four males were injected with LHRH and 20 hours post-injection milt collections were initiated. Viable milt was collected from one male. Although milt was not opaque, it contained active sperm when examined (Figure 4).

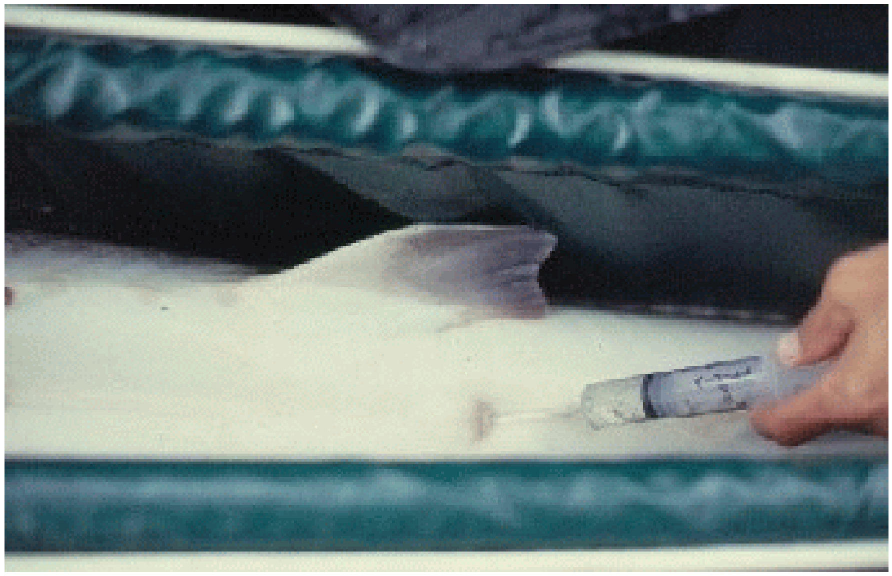

Figure 4. White sturgeon milt collection

With successful spawning of a male, the female was given the initial LHRH injection on June 2nd at 8:00 PM, followed by the resolving LHRH injection on the 3rd at 8:00 AM. After 60 hours of monitoring, no ovulation occurred. Eggs were surgically sampled on the 7th of June and sent to U.C. Davis for examination. It was decided that the sturgeon's eggs were not mature enough for the LHRH injections to cause ovulation and that the GV migration should be monitored by U.C. Davis in the second female sturgeon. This would allow better determination of when oocyte maturation occurs.

The female sturgeon (PIT# -747A), captured in McNary Reservoir in April, was sampled for determination of oocyte maturation on May 4th. Migration of the GV indicated continued maturation, and sampling and progesterone assay was scheduled in two weeks. The progesterone assay on May 20th showed no GV breakdown. In consulting with U.C. Davis it was decided to run another progesterone assay in late June. Results of the June 21st progesterone assay again showed no GV breakdown. The next progesterone assay occurred on August 2nd, and although we were not able to identify GV breakdown, U.C. Davis determined that GV breakdown had occurred in all eggs and that migration had progressed to the optimal level. It was recommended that spawning should occur in the next 2-3 weeks.

On August 22nd all six males were injected with appropriate dosages of LHRH. Attempts to collect milt on the 23rd were unsuccessful. The female (PIT#) was given the initial dose of LHRH on the 22nd at 8:00 PM, with the resolving dose on the 23rd at 8:00 AM. Approximately 32 hours post-resolving injection, the female began releasing eggs. To allow for better ovulation to occur, 3 hours were allowed to pass prior to harvesting eggs. In 30 minutes approximately 30,000-36,000 eggs were collected.

DISCUSSION

Although synchronous spawning did not occur, collection of male and female gametes was successfully achieved. To determine possible reasons for non-synchronous spawning researchers at U.C. Davis and the Kootenai Tribe of Idaho were consulted. It was determined that our protocol of transferring adults from creek water (5.0-13.0 C°) to well water (12.5 C°) should be changed. It was believed the female sturgeon were transferred too late causing a delayed spawning season. Male sturgeons were transferred too early causing spawning to occur prior to female maturation. Another observation made was that the low number of males restricted the potential of pairing spawning males with spawning females. To address these issues in project year 2000: A) captured female sturgeon will be placed directly on the well water source; and B) we plan to have 5 to 6 males for each female.

Our limited experience in determining the stage of maturation of the oocyte resulted in making a false determination and attempting to spawn our first female sturgeon prior to optimum conditions. Therefore in project year 2000 all oocyte samples will be sent to U.C. Davis to confirm maturation stage to assist in determining spawning schedule.

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