

LAKE ROOSEVELT WHITE STURGEON RECOVERY PROJECT

ANNUAL PROGRESS REPORT

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ABSTRACT

This report summarizes catch data collected from white sturgeon *Acipenser transmontanus* in Lake Roosevelt during limited setlining and gill netting activities in the fall of 2003, and documents progress toward development of a U.S. white sturgeon conservation aquaculture program for Lake Roosevelt. From 27-30 October, 42 overnight small mesh gill net sets were made between Marcus and Northport, WA for a total catch of 15 juvenile white sturgeon (275-488 mm FL). All sturgeon captured were of Canadian hatchery origin. These fish had been previously released as sub-yearlings into the Canadian portion (Keenleyside Reach) of the Transboundary Reach of the Columbia River during 2002 and 2003. Most sturgeon (n=14) were caught in the most upstream area sampled (Northport) in low velocity eddy areas. Five fish exhibited pectoral fin deformities (curled or stunted). Growth rates were less than for juvenile sturgeon captured in the Keenleyside Reach but condition factor was similar. Condition factor was also similar to that observed in juvenile sturgeon (ages 1-8) captured in the unimpounded Columbia River below Bonneville Dam between 1987-92. From 10-14 November, 28 overnight setline sets were made in the Roosevelt Reach between the confluence of the Spokane River and Marcus Island for a total catch of 17 white sturgeon (94-213 cm FL). Catch was greatest in the most upstream areas sampled, a distribution similar to that observed during a WDFW setline survey in Lake Roosevelt in 1998. The mean W_r index of 110% for fish captured this year was higher than the mean W_r of 91% for fish captured in 1998. Excellent fish condition hindered surgical examination of gonads as lipid deposits made the ventral body wall very thick and difficult to penetrate with available otoscope specula. Acoustic tags (Vemco model V16 coded pingers, 69 kHz, 48-month life expectancy) were internally applied to 15 fish for subsequent telemetry investigations of seasonal and reproductively motivated movements. In August 2003, three Vemco VR2 fixed station acoustic receivers, supplied by the UCWSRI Transboundary Telemetry Project, were deployed in the vicinities of Kettle Falls Bridge, Marcus Island, and Northport, WA. Data downloaded from these receivers through December 2003 confirmed the findings of a previous telemetry study that the Marcus area is an important overwintering habitat for white sturgeon. On 18 February 2004, juvenile white sturgeon (n=2,000) were transported from Kootenay Sturgeon Hatchery in British Columbia to WDFW Columbia Basin Hatchery (CBH) in Moses Lake, WA. Fish were reared at CBH to approximately 30 g and individually outfitted with PIT tags and scute marked. On 11 May 2004, fish were released into Lake Roosevelt in the vicinities of Kettle Falls Bridge, North Gorge, and Northport.

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INTRODUCTION

Background

Various white sturgeon studies conducted in the Transboundary Reach of the Columbia River (i.e. Grand Coulee Dam in the U.S. to Keenleyside Dam in Canada) since 1990 have shown that natural recruitment of white sturgeon is absent in most years and minimal in others. Younger age-classes are either lacking or poorly represented despite documented spawning at the confluence of the Columbia and the Pend d'Oreille rivers during monitoring activities performed since 1993 (Golder Associates Ltd. 2002).

Recruitment failure in the transboundary reach white sturgeon population was first documented during the early 1990's in the Canadian portion of the Transboundary Reach (hereafter termed the Keenleyside Reach) (Hildebrand and English 1991; R.L.&L. 1994; Hildebrand et al. 1999). These findings were corroborated in the U.S. section of the reach (hereafter termed the Roosevelt Reach) in 1998 during a cooperative setline survey by the Washington Department of Fish and Wildlife (WDFW), Oregon Department of Fish and Wildlife (ODFW), and the Spokane Tribe of Indians (STOI) that sampled an aged white sturgeon population (Devore et al. 2000). In the same year, a trawl survey by the U.S. Geological Survey (USGS) (Kappenman et al. 2000) in the upper stretches of the Roosevelt Reach failed to capture white sturgeon YOY or juveniles. More recent sturgeon studies in the Keenleyside Reach (Golder Associates Ltd. 2002, 2003b, 2004; Arndt 2003) and Roosevelt Reach (Lee and Underwood 2002; Lee and Pavlik 2003) show a continuation of failed recruitment in the transboundary population through failure to catch significant numbers of juvenile sturgeon.

Upper Columbia white sturgeon (i.e. all white sturgeon populations found upstream from Grand Coulee Dam) are currently subject to a recovery plan (the Upper White Sturgeon Recovery Plan [UCWSRP]) initiated in Canada and completed with involvement by U.S. federal, state and tribal parties (UCWSRI 2002). The Lake Roosevelt White Sturgeon Recovery Project (LRWSRP) operates within the framework of the UCWSRP as part of a cooperative transboundary recovery effort.

2003 Activities

The LRWSRP is funded by the Bonneville Power Administration (BPA; Project 199502700). This annual report describes first year progress by WDFW on the LRWSRP for the period 1 April 2004 through 31 March 2005. Although the reporting period began in January, project personnel were not hired until October. Activities during the reporting period were focused upon establishing a field office and purchasing project field-sampling equipment and supplies. However, some preliminary field sampling was performed using boats and equipment borrowed from existing BPA funded white sturgeon projects 1986-50. This report summarizes white sturgeon catch data obtained

during setlining and gill netting activities, and documents progress toward development of a U.S. white sturgeon conservation aquaculture program for the Roosevelt Reach.

Gill netting objectives were to capture white sturgeon produced by the Canadian Upper Columbia White Sturgeon Recovery Initiative (UCWSRI) hatchery project in order to quantify juvenile habitat preferences, movements, distribution, survival and growth in individuals dispersing downstream into the Roosevelt Reach. The primary objective of setlining was to capture and acoustic tag white sturgeon for subsequent telemetry investigations of fish movements within the transboundary reach.

The LRWSRP aims to follow the lead of Canadian researchers in developing a white sturgeon conservation aquaculture program to preserve the remaining demographic and genetic diversity of the transboundary population and rebuild the natural age-class structure. Canadian aquaculture activities commenced in 2001 and approximately 8,700 and 12,000 sub-yearling fish were released into the Keenleyside Reach in 2002 and 2003, respectively. The objective of the initial phase of the U.S. aquaculture program development was the establishment of an interim aquaculture operation to meet the UCWSRP goal of an immediate program in the U.S.

METHODS

Small-mesh gill netting

Juvenile white sturgeon were captured with small mesh benthic gill net gear (5.1 cm stretch measure, 30.5 m long by 1.8 m deep) used by the STOI during Lake Roosevelt Fisheries Evaluation Project (LRFEP) juvenile sturgeon sampling in Lake Roosevelt in the fall of 2001 and 2002 (Lee and Underwood 2002, Lee and Pavlik 2003). Sampling was conducted 27-30 October, 2003 between Kettle Falls Bridge (river kilometer [rkm] 1,133 as measured upstream from the mouth of the Columbia River) and Northport (rkm 1,183). Sampling sites were clustered around the vicinities of Marcus, North Gorge, and Northport (Figure 2). Fourteen sets were made in each of these three areas for a total of 42 overnight sets during the sampling period. Set depth, set and retrieval times, water temperature and GPS coordinates were recorded at each sampling site. General flow observations were recorded for most sampling sites. During the sampling period, Grand Coulee Dam forebay water elevation was at approximately full pool (393 m above mean sea level).

In the Marcus and North Gorge areas individual sampling locations replicated those sampled during 2001 and 2002 LRFEP juvenile white sturgeon sampling efforts. In the Northport area, where the Columbia River exhibits more riverine characteristics than downstream sampling locations, previous LRFEP juvenile white sturgeon gill netting effort was distributed among a variety of velocity habitats. This year, concerns over the effects of water velocity on the effectiveness of sampling gear led to one vessel selecting sampling sites that generally approximated the locations of previous sampling efforts but that were characterized by low water velocities (i.e. eddy areas).

Sturgeon and bycatch were placed in a live well until the net was fully retrieved. All captured sturgeon were examined for lateral scute marks and scanned for Passive Integrated Transponder (PIT) tags. Sturgeon were measured for fork length (FL), total length (TL), snout length, and head length to the nearest millimeter and weighed to the nearest 5g with a Pesola spring scale. External abnormalities such as deformed fins were recorded. All bycatch species were enumerated and measured for TL to the nearest mm.

Absolute growth was estimated for FL (mm d^{-1}) and weight (g d^{-1}). Fish condition was assessed from the Fulton type formula: $K = (W/FL^3) * 10^5$ where K = fish condition, W = fish weight (g), and FL = fork length (mm). This formula was used by Miller and Beckman (1993) to compare juvenile (ages 1-8) white sturgeon condition among three lower Columbia River impoundments and the unimpounded lower river below Bonneville Dam. This method was preferred over using Beamesderfer's (1993) standard weight equation to determine relative weight based on his recommendation that such analyses be restricted to lengths of 60 cm or more to "avoid effects of errors in weighing small fish and of developmental changes in body form from juveniles to adults".

Statistical comparisons of growth parameters were not possible due to the small sample size of fish collected this year.

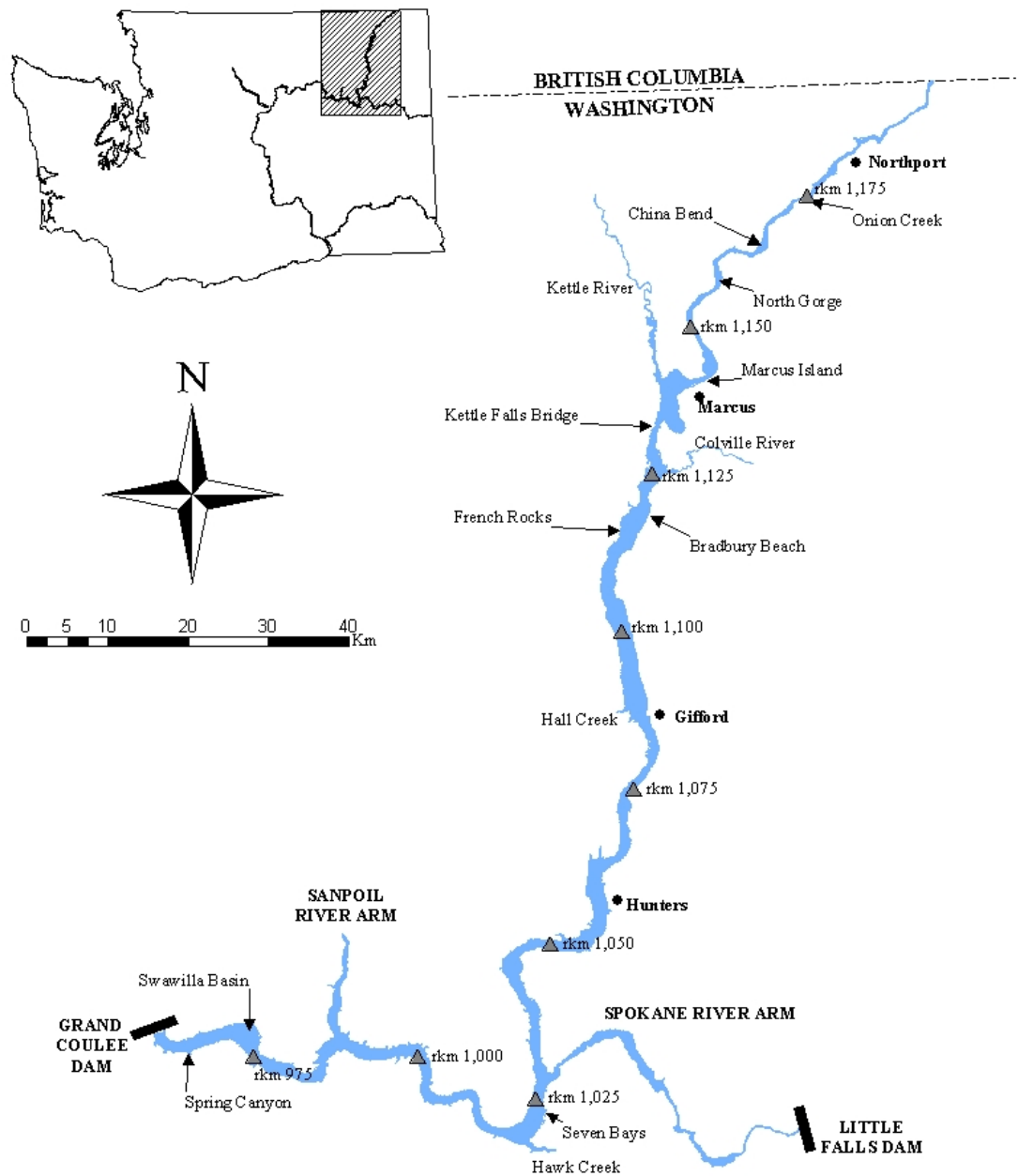


Figure 1. The Roosevelt Reach of the Columbia River. Triangles indicate river kilometers (rkm) as measured upstream from the mouth of the Columbia River.

Setline Sampling

White sturgeon were captured using standard setline gear and sampling methods developed and used since 1987 by ODFW on the mid-Columbia River reservoirs (Rien et al. 1993) and during WDFW sturgeon sampling in Lake Roosevelt in 1998 (Devore et al. 2000).

Sampling was conducted 10-14 November 2003 from the confluence of the Spokane River (rkm 1,028) upstream to Marcus Island (rkm 1,140; Figure 3). Effort was distributed throughout the area with specific sampling sites chosen according to the previous experience of staff in setlining for white sturgeon and with reference to catch data obtained during WDFW setline sampling in 1998. Set depth, set and retrieval times, and GPS coordinates were recorded at each set location.

Captured sturgeon were placed in an onboard live well or tied alongside the boat until the setline was fully retrieved. All captured sturgeon were examined for previously applied tags, tag scars, pectoral fin section scars, and lateral scute marks. Sturgeon were measured for FL and TL to the nearest centimeter and weighed to the nearest kilogram. PIT (134.2 kHz ISO) tags were injected dorsally immediately behind the bony plates of the head. The second left lateral scute was removed to indicate the presence of this tag (Rien et al. 1994). Existing external tags found on fish recaptured from previous sampling efforts were removed. Pectoral fin-ray sections were removed from 16 sturgeon for future age analysis (Rien and Beamesderfer 1994). Thumbnail size clips of soft tissue were taken from the pectoral fins of 10 fish and stored in 99% ethanol for future genetic analysis.

Sex and maturity were determined by examining the gonads of fish via surgical biopsy. Surgical procedures were similar to those reported by Beamesderfer et al. (1989). Stage of reproductive maturity was assessed in the field according to criteria given by Conte et al. (1988). Body wall thickness hindered observations of gonads through the incision due to the good condition of the fish and limited length of otoscope specula. In addition, many fish were found to have excessive fluid within the body cavity that obscured direct observation of the gonad further. Consequently, the determination of sex and stage of maturity for most fish was made based on grab samples collected with ovarian biopsy forceps. Gonad and blood plasma samples were collected for ongoing white sturgeon sex and maturation studies by Department of Fisheries and Wildlife staff at Oregon State University (OSU) (Webb et al. 2001, Webb et al. 2002).

Paired samples of fork length and weight were used to calculate a non-linear least squares regression of the form $W = aFL^b$. Fish condition was assessed utilizing Beamesderfer's (1993) standard weight equation for white sturgeon to derive relative weights (W_r). Mean W_r from sampling in 2003 was compared (t-test) to that obtained during WDFW's sampling effort in Lake Roosevelt in 1998 (DeVore et al. 2000).

Acoustic Tagging and Telemetry

Following surgical procedures and examination of gonads, acoustic tags (Vemco model V16 coded pingers, 69 kHz, 48-month life expectancy) were internally applied to a sub-sample of fish for subsequent telemetry investigations of movement behavior.

During August 2003, three Vemco VR2 fixed station acoustic receivers, supplied by the Canadian UCWSRI telemetry project, were deployed in the vicinities of Kettle Falls Bridge (KF; 07 August; rkm 1,133), Marcus Island (MI; 20 August; rkm 1,140), and Northport, WA (NP; 20 August; rkm 1,183) (Figure 4). Data from these receivers was downloaded to a laptop computer in October and December.

Interim Aquaculture Program

In 2003, the initial objective of the interim aquaculture effort was to establish a failsafe facility to raise Canadian hatchery juveniles. The WDFW Colville Hatchery was chosen for this purpose due to its close proximity to the transboundary reach. Equipment was purchased to rear 2,000 Canadian juveniles (one family group) at the Colville Hatchery. The production capacity was limited to 2,000 fish because we did not want to expend substantial amounts of capital funds modifying a hatchery prior to the completion of the feasibility study. Purchases included two round rearing tanks with belt feeders, a juvenile fish transport tank and fish food.

Prior to the transfer of juvenile white sturgeon from Canada, the UCWSRT expressed concerns about the water temperature at Colville Hatchery (11°C/51-52°F). Juvenile white sturgeon reared at the Kootenay Sturgeon Hatchery (KSH) did not exhibit significant growth when reared in water temperatures of 11°C (Ron Ek, KSH, pers. comm.). Consequently, the UCWSRT would not support transferring fish to Colville Hatchery unless the water was heated. In order to get the interim U.S. project started, the WDFW Columbia Basin Hatchery (CBH) in Moses Lake, WA was selected as an alternative due to the high costs associated with installing and operating a water heating system at the Colville Hatchery. Water temperature at CBH is 14-15°C (58-59°C), which is optimal for juvenile white sturgeon growth (Ron Ek, KSH, personal communication).

On 18 February 2004, there were 2,000 juvenile white sturgeon transferred from the KSH to the CBH. All of the fish were from Family #6 of brood year (BY) 2003. At CBH, juvenile sturgeon were reared in round fiberglass tanks at a water temperature of 14°C (58°F) and were fed Biomoist 2.0 and 2.5. On 20-21 April 2004, all of the sturgeon that had reached 30 g were tagged with a Passive Integrated Transponder (PIT) tag and were secondarily marked by removal of the first and fifth left lateral scutes to indicate brood year.

On 11 May 2004, all fish that had been tagged and scute marked were measured (FL), weighed, checked for tag retention, and examined for external deformities of the

pectoral fins, caudal fin, operculum, missing dorsal scutes, and asymmetrical head development. Twenty individuals with less than half of a pectoral fin were culled. Fish were divided into three groups and released in the vicinities of Kettle Falls Bridge, North Gorge, and Northport on 12 May 2004 (Figure 4). The fish stocked in the vicinities of Kettle Falls Bridge and North Gorge were transported by boat from the Kettle Falls Marina and released into the main river channel. The fish released at Northport were planted directly from the liberation truck at the city boat launch.

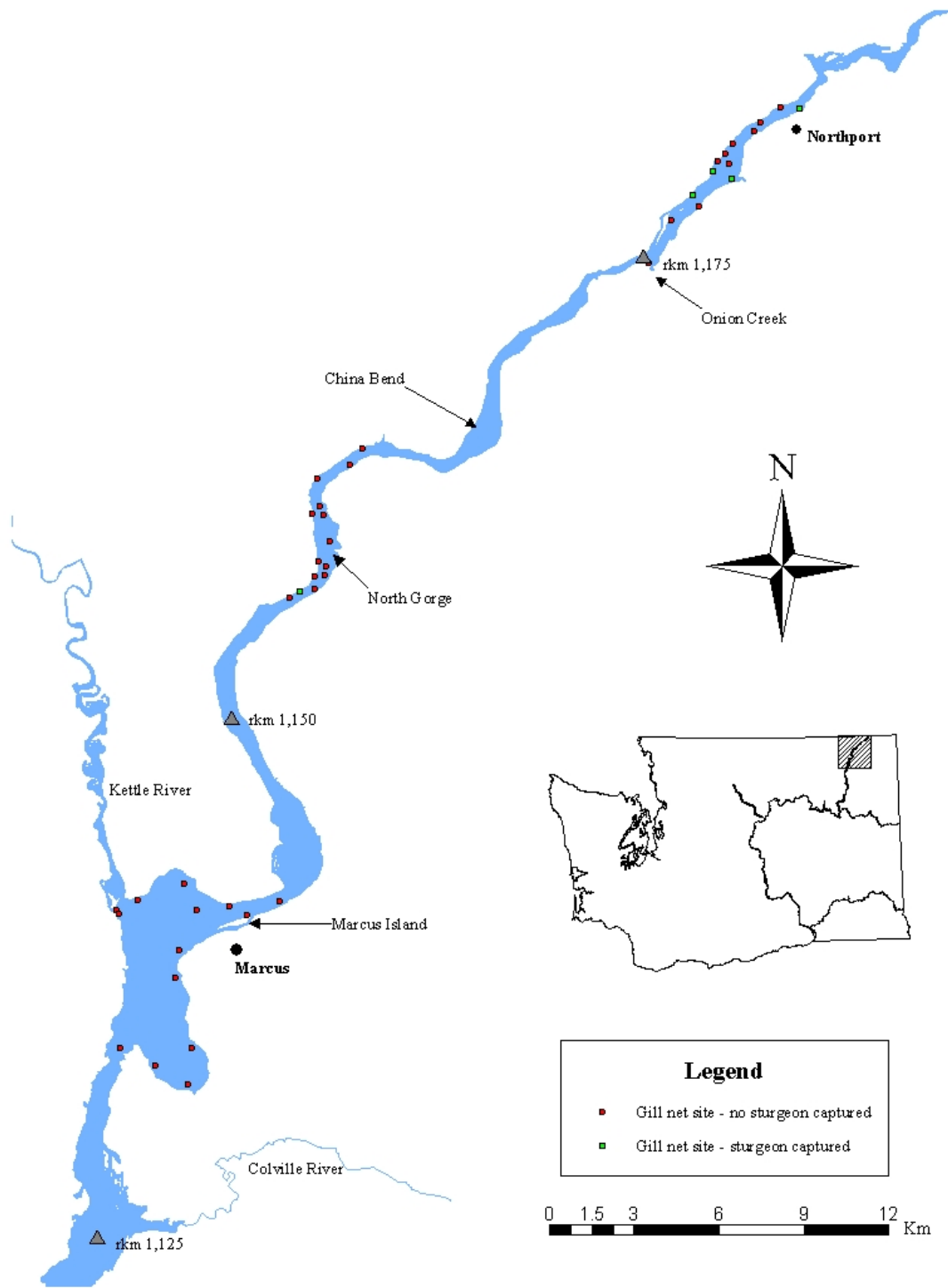


Figure 2. Study area and locations of overnight small-mesh gill net sets made during white sturgeon sampling in Lake Roosevelt, October 2003.

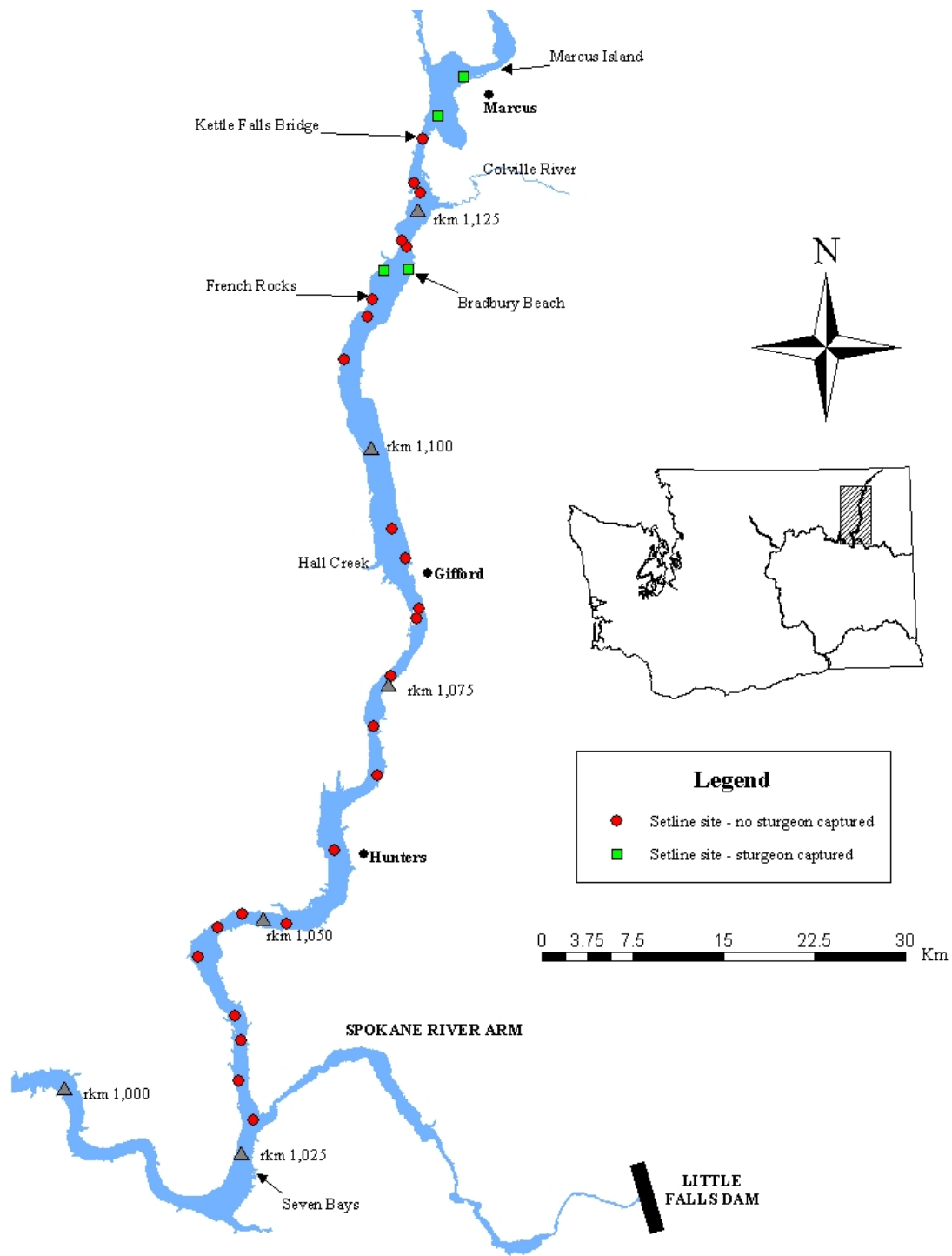


Figure 3. Study area and locations of overnight setline sets made during white sturgeon sampling activities in Lake Roosevelt, November 2003.

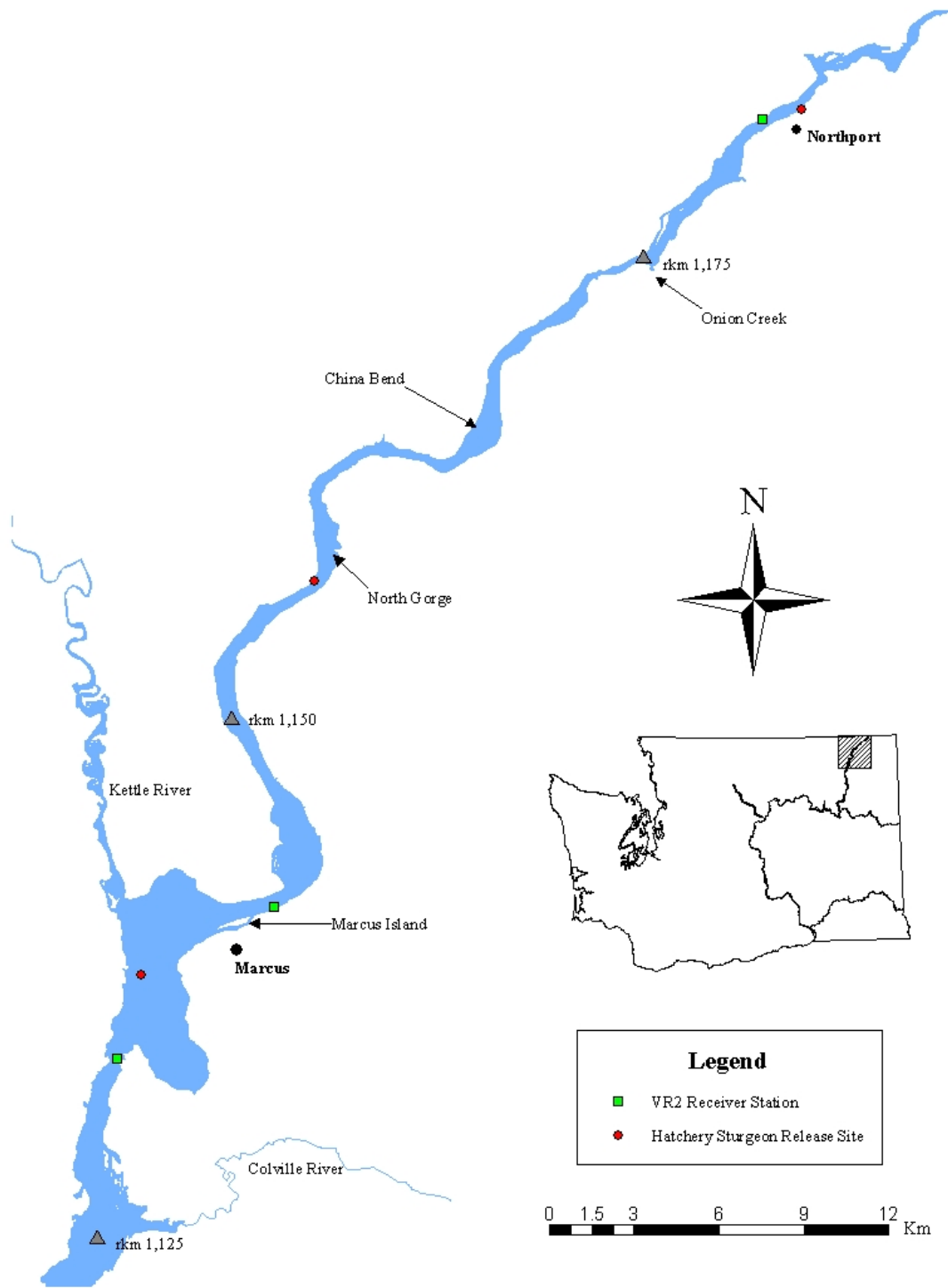


Figure 4. Release locations of hatchery reared sub yearling white sturgeon in upper Lake Roosevelt, May 2003, and locations of VR2 fixed station acoustic receiver stations. River kilometers (RKM) as measured upstream from the mouth of the Columbia River.

RESULTS

Small mesh gill netting

Effort and catch

A total of 42 overnight sets were made during the sampling period for a total catch of 15 juvenile white sturgeon. Individual set times ranged from 18.4 – 25.3 hours (mean = 21.6 hours) (Table 1). Total gill net effort was 905.4 hours. Five of the total 42 sets caught sturgeon. For sets that caught sturgeon, the maximum number captured in a single set was five and the minimum was one. Water temperature during the sampling effort averaged 11.7 °C.

All sturgeon were alive at capture and release. Based on scute mark patterns and presence of PIT tags, all sturgeon captured were of Canadian hatchery origin. A PIT tag was not present, or was inoperative, in one juvenile deemed to be a 2003 hatchery release (2002 brood year) based on scute removal pattern. Ten sturgeon were from hatchery releases in 2003 (2002 brood year) and five sturgeon were from releases in 2002 (2001 brood year) (Figure 5). Three (30%) of the 2002 brood year fish, and two (40%) of the 2001 brood year fish exhibited pectoral fin deformities (curled or stunted). In total, 141 fish were captured incidentally by gill net sampling. Gill net catch species composition is given in Appendix A.

Distribution

Most sturgeon (14) were caught near Northport (Table 1). One sturgeon was caught near North Gorge. All sturgeon were captured in sets made in low water velocity locations (i.e. eddy areas). Sampling depths ranged from 2.4-21.9 m (mean = 14.3 m) while depths for sets that caught juvenile white sturgeon ranged from 7.0-16.6 m (mean = 9.8 m).

Length and weight

All fish captured in the Roosevelt Reach had grown (FL and weight) since time of release (Table 2). However, mean FL of 2002 BY fish (i.e. at large for approximately 5 months) caught in the Roosevelt Reach was 82% of similar aged Keenleyside Reach fish. Mean weight was only 55% of that seen in Keenleyside Reach fish (Table 2). Mean FL of 2001 BY fish caught in the Roosevelt Reach was 95% of Keenleyside Reach fish. Mean weight was 81% of that observed in fish from the Keenleyside Reach (Table 2).

Growth and condition

Mean daily growth (FL, mm d⁻¹) since release for 2002 BY fish captured in the Roosevelt Reach was 70% of BY 2002 fish captured in the Keenleyside Reach. Mean daily growth (weight, g d⁻¹) was only 50% of that observed in the Keenleyside Reach (Table 2). Mean daily growth (FL) since release for 2001 BY fish captured in the Roosevelt Reach was 89% of 2001 BY fish captured in the Keenleyside Reach. Mean daily growth (weight) was 77% of that observed in the Keenleyside Reach (Table 2).

Mean condition factor had decreased between release and recapture, however fish condition at recapture was similar in both reaches and close to that observed in juveniles

(ages 1-8) captured in the unimpounded Columbia river below Bonneville Dam (Table 3) (Miller and Beckman 1993).

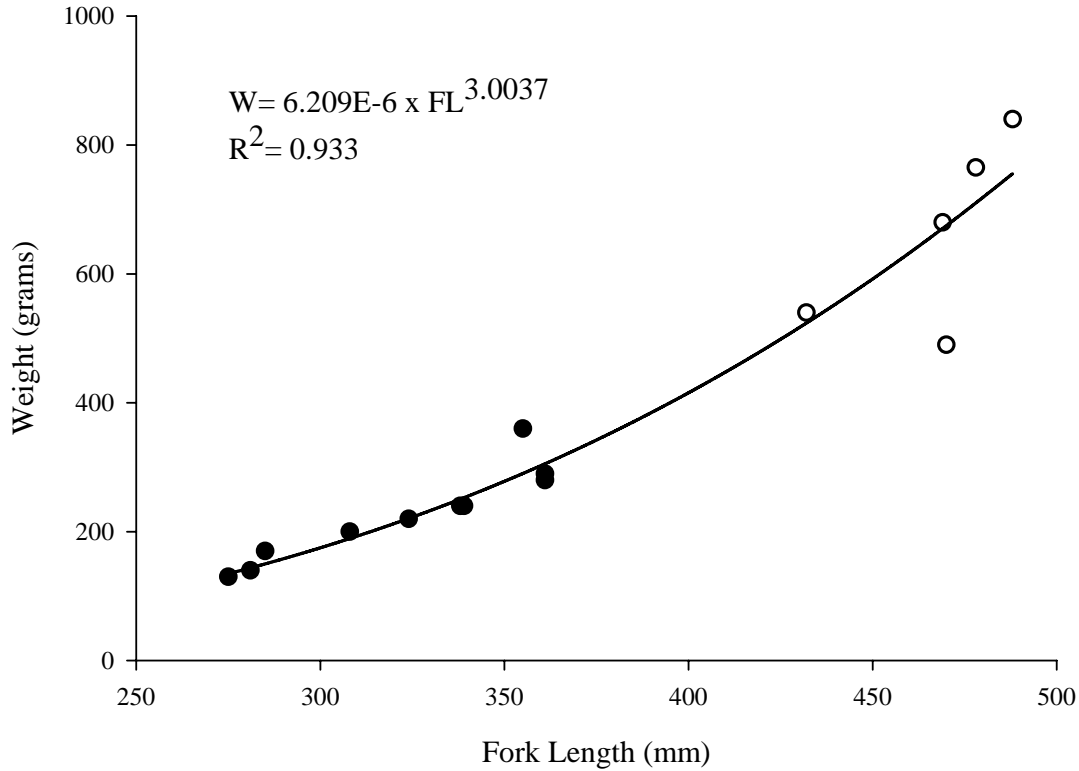


Figure 5. Length-weight relationship of hatchery origin white sturgeon captured with small mesh gill nets in the Roosevelt reach of the Columbia River, October 2003. Filled circles denote 2002 BY fish, and open circles 2001 BY fish.

Table 1. Small-mesh gill net sampling effort and white sturgeon catch during juvenile sampling activities in the Roosevelt reach of the Columbia River, October 2003.

Date (set/pull)	Location	Number of overnight sets	Total effort (hours)	White Sturgeon Catch	Catch per net hour
Oct 10/11	Marcus	14	322.1	0	0.000
Oct 11/12	North Gorge	14	305.0	1	0.003
Oct 12/13	Northport	14	278.3	14	0.050
Total		42	905.4	15	0.017

Table 2. Growth summary of hatchery reared juvenile white sturgeon captured in the Keenleyside Reach (KR) and Roosevelt Reach (RR) of the Columbia River, fall 2003. Data for the Keenleyside Reach was provided by Golder Associates Ltd.

Area	Brood Year	N	Time at large (d)	FL (mm)				Weight (g)				
				Release	Capture	Growth	Growth rate (mm d ⁻¹)	Release	Capture	Growth	Growth rate (mm d ⁻¹)	
KR	2001	54	Mean	503.37	205.0	484.9	279.9	0.56	66.2	759.0	692.8	1.38
			Range	430-555	140-290	409-583	194-414	0.39-0.76	20-59	418-1454	379-1418	0.72-2.85
			SD	40.42	34.76	39.52	44.72	0.07	31.86	219.36	209.43	0.43
RR	2001	4	Mean	531.00	197.5	462.3	264.8	0.50	54.9	618.8	563.9	1.06
			Range	531-531	190-210	432-478	242-279	0.46-0.53	44-65	490-765	425-705	0.80-1.32
			SD	0	9.57	20.56	15.90	0.03	9.42	126.38	129.13	0.24
KR	2002	27	Mean	163.41	209.9	393.1	183.2	1.13	69.9	410.3	340.4	2.10
			Range	123-192	160-278	323-468	143-237	0.87-1.62	26-141	205-710	163-605	1.04-3.43
			SD	21.09	25.17	41.27	28.69	0.20	26.21	153.93	136.15	0.81
RR	2002	10	Mean	161.80	197.3	322.7	125.4	0.79	59.3	227.0	167.7	1.05
			Range	112-171	158-235	275-361	70-171	0.41-1.13	27-100	130-360	65-260	0.38-1.60
			SD	17.92	22.15	33.55	33.72	0.23	19.65	71.34	63.37	0.39

Table 3. Condition factor for hatchery produced white sturgeon collected in the transboundary reach (Keenleyside Reach and Roosevelt Reach) of the Columbia River, fall 2003. Data from juveniles (ages 1-8) captured in the mid-Columbia reservoirs and the unimpounded lower Columbia River 1987-1991 provided for comparison (Miller and Beckman 1993).

rea	N		Condition factor ^b		
			Release	Capture	Change
Keenleyside Reach ^a	81	Mean	0.73	0.65	-0.08
		Range	0.48-1.16	0.50-0.85	-0.52-0.11
		SD	0.11	0.07	0.10
Roosevelt Reach	14	Mean	0.74	0.65	-0.09
		Range	0.64-0.90	0.47-0.80	-0.34-0.05
		SD	0.07	0.08	0.11
Lower Columbia River	6460	Mean	-	0.66	-
		Range	-	0.41-1.19	-
		SD	-	0.07	-
Bonneville Reservoir	2132	Mean	-	0.71	-
		Range	-	0.36-1.04	-
		SD	-	0.07	-
The Dalles Reservoir	1247	Mean	-	0.71	-
		Range	-	0.44-1.07	-
		SD	-	0.07	-
John Day Reservoir	73	Mean	-	0.70	-
		Range	-	0.54-0.82	-
		SD	-	0.05	-

^a Data provided by Golder Associates Ltd.

^b $C=(W/FL^3)*10^5$

Population Status

Setlining effort and catch

A total of 28 overnight setline sets were made during the period 10-14 November 2003 for a total catch of 17 white sturgeon and no bycatch (Table 4). Four of the 28 sets caught sturgeon. For sets that caught sturgeon, the maximum number caught in a set was nine and the minimum was one. Set times ranged from 16.7 – 23.9 hours (mean = 21.0 hours). Set depths ranged from 16.8 - >73.1 m (maximum limit of depth sounder on research vessel). The average depth of sets where white sturgeon were captured was 30.8 m. Water temperature progressively declined during the sampling period from 12.8 – 7.8 °C (mean = 10.0 °C).

Distribution

Sturgeon were captured between rkm's 1,116 (vicinity of Bradbury Beach) and 1,139 (Marcus Island, the furthest upstream sampling location). Average sturgeon catch per set in this area was 1.9 this year, and 2.2 in 1998 (Devore et al. 2000). No sturgeon were captured further downstream than rkm 1,116 despite sampling at locations where previous studies had successfully captured sturgeon (e.g. Gifford; rkm 1,086) (Brannon and Setter 1992; Devore et al. 2000).

Table 4. Setline sampling effort and white sturgeon catch from WDFW sampling activities on Lake Roosevelt during November 2003.

Date (set/pull)	Location (rkm) ^a	Number of sets	Total effort (hours)	White Sturgeon Catch	CPUE (catch per overnight set)
Nov 10/11	1,026-1,048	8	181.6	0	0.00
Nov 11/12	1,057-1,089	8	161.2	0	0.00
Nov 12/13	1,106-1,121	8	174.6	7	0.88
Nov 13/14	1,122-1,137	4	69.8	10	2.50
Total		28	587.2	17	0.61

^a River kilometers, as measured from the mouth of the Columbia River.

Length and weight

White sturgeon lengths ranged from 94-213 cm FL (mean = 171 cm) and weights ranged from 6-89 kg (mean = 54 kg). Paired samples of fork length and weight were sufficient to calculate a power regression equation of the form $W = (3.0 \times 10^{-6}) \times FL^{3.2219}$ (Figure 6). The W_r values ranged from 0.89 to 1.40 (mean = 1.10). The mean W_r of 1.10 for 17 fish weighed this year was significantly greater than the mean W_r of 0.91 (range 0.66-1.30) for 196 fish weighed in 1998 (t-test, df=211, $P < 0.0001$; Figure 7).

Recaptures

Two sturgeon were recaptures from previous studies. Both recaptures were taken on the same setline at rkm 1,134 in the Marcus vicinity. The first recapture was initially tagged 17 August 1998 at rkm 1,131 during WDFW's setline sampling survey (Devore et al. 2000). The FL's and weights for this fish at tagging/recapture were 141/168 cm FL and 23/46 kg. Average annual growth (FL) for this fish was 5.4 cm yr⁻¹ for the period 1998-2003. The W_r for this fish was 0.95 in 1998 and 1.11 in 2003.

The second recapture was initially tagged 28 March 1993 in Waneta eddy (approx. rkm 1,199) and subsequently recaptured 27 April 1994, also in Waneta eddy (RL&L 1997). The FL's and weights for this fish at tagging/recapture/recapture were 150/149/199 cm FL and 26/27/66 kg. Average annual growth (FL) for this fish was 5.6 cm yr⁻¹ for the period 1994-2003. The W_r for this fish was 0.88 in 1993 and 0.90 this year.

The recapture of only one individual tagged by WDFW in 1998 precluded the calculation of a statistically meaningful population estimate for the area of study based on this tag group.

Sex and maturity

Fourteen fish (8 females, 6 males) were assigned sex and stage of maturity based on field examination of gonads (Table 5). Due to difficulties in directly observing the gonads of some fish the sex and maturity assignments reported here are deemed preliminary and require histological confirmation based on collected samples.

Of the females, five were judged to be in non-reproductive or pre-vitellogenic stages, one was early vitellogenic and two were spent. Of the males: one was maturing, three were mature/late reproductive, and two were spent. It was assumed spent fish spawned in 2003. Two fish classified as juveniles based on length (94 cm and 104 cm FL) were not examined for sex. Sex and stage of maturity were not assessed for one adult as the posterior intestine was accidentally cut during the process of surgical incision. This fish was immediately sutured and released.

Acoustic tagging

Acoustic tags were internally applied to 15 white sturgeon (104 – 213 cm FL) captured at four locations between rkm's 1,116 and 1,139 (Table 5). None of these individuals were females expected to spawn in 2004.

Movements

Signals from all but one (code 82) tagged fish were recorded by fixed station receivers in the study area (Figure 8). Telemetry data indicated that most fish exhibited a general movement upstream from initial tagging sites toward the MI receiver from mid-November through mid-December (Figure 8). Most fish appeared to remain in the Marcus vicinity through March 2004. Signal receptions gradually diminished over the study period indicating increasing quiescence of fish in response to the onset of winter and decreasing water temperatures.

Acoustic signals from three fish tagged by Canadian researchers in Waneta Eddy (located just upstream from the US-Canada border at the confluence of the Columbia and Pend-Oreille Rivers) during June 2003 were also detected within the study area (Golder Associates 2003a) (Figure 8c).

Code 60 was captured June 13 and determined to be a ripe female at the time of tagging. Canadian telemetry data shows this fish remained in Waneta eddy until mid-July. Signals from this fish were first recorded at the KF receiver on September 12. This fish migrated downstream from Waneta eddy to the Marcus area sometime between mid-July and early August before receivers were deployed in the US.

Code 65 was captured June 26 and was determined to be a developing male at the time of tagging. Canadian researchers were not able to relocate this fish subsequent to tagging. Acoustic signals from this fish were initially recorded at the KF receiver August 5. This fish probably migrated downstream to the Marcus area soon after being tagged.

Code 66 was captured June 26 and was determined to be a late-vitellogenic female at the time of tagging. This fish remained in the lower section of the Keenleyside reach until late August when it moved upstream to the eddy just below Hugh Keenleyside Dam (HLK). At some point after this the fish began a downstream migration to the Marcus area. This fish was recorded at the NP receiver between 2:00am and 3:00am, 14 September after which it moved rapidly downstream and was picked up by the MI receiver at 11:35am, 15 September. This represents a downstream movement of approximately 55 km in 20.5 hours. After arriving in the Marcus vicinity, all three of Canadian tagged fish exhibited movement behavior similar to those of fish tagged locally (Figure 8).

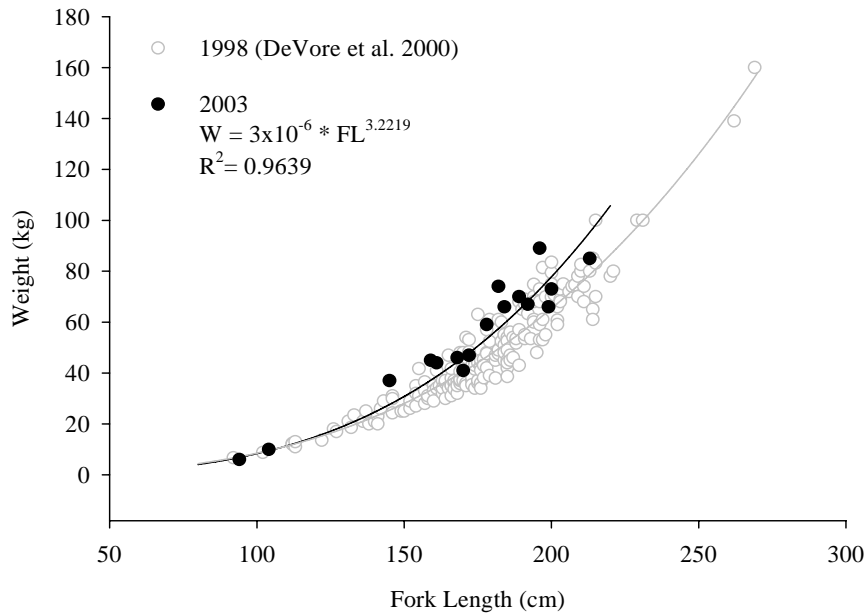


Figure 6. Length-weight relationship for white sturgeon captured in Lake Roosevelt during WDFW setline sampling activities in 1998 (n=196) and 2003 (n=17).

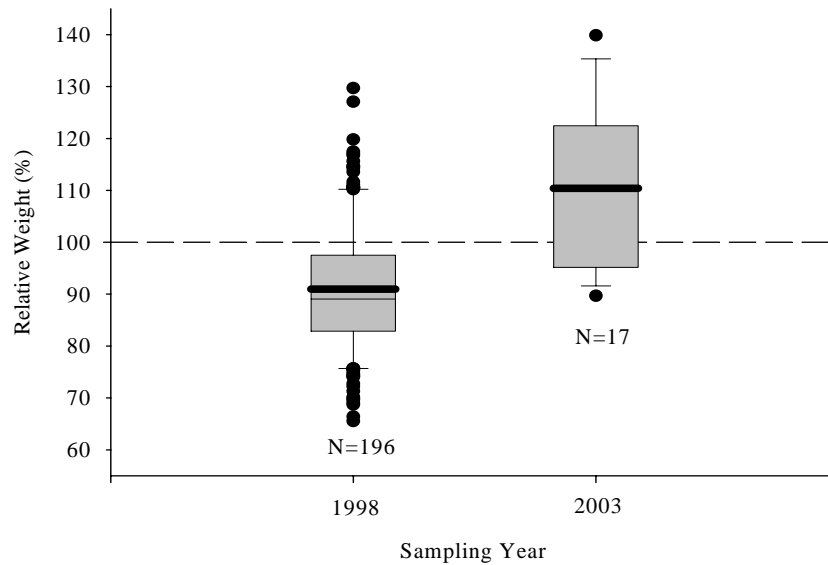


Figure 7. Box plot comparison of relative weights, W_r , for white sturgeon captured in Lake Roosevelt during WDFW setline sampling activities in 1998 and 2003. The box boundaries indicate the 25th and 75th percentiles and lines within the box mark the median (light) and mean (heavy). Bars indicate the 90th and 10th percentiles. Shaded circles denote outliers.

Table 5. Sex, stage of maturity (based on field examination), and acoustic tag codes implanted in white sturgeon captured by setline in Lake Roosevelt, November 2003.

Date	Approximate capture/release location (rkm) ^a	Fork Length (cm)	Sex	Stage of maturity code (Conte et al. 1988)	Acoustic tag code (Vemco V16, 69 kHz)
11/13/03	1,116	161	F	11	74
		184	F	12	75
		182	M	04	76
11/13/03	1,118	104	Unknown	98	67
		200	F	16	82
		196	M	04	83
		178	F	11	84
11/14/03	1,134	168 ^b	F	12	68
		172	M	02	69
		199 ^c	F	16	70
		170	M	06	72
		145	M	04	73
		189	M	06	78
		192	F	12	79
		94	Unknown	98	-
159 ^d	Unknown	97	-		
11/14/03	1,139	213	F	13	77

^a River kilometers, as measured upstream from the mouth of the Columbia River

^b Originally tagged in the Roosevelt Reach in 1998. External spaghetti tag was removed.

^c Originally tagged in Canada in 1993. External T-anchor tag was removed.

^d The posterior intestinal tract of this fish was accidentally cut during the process of surgical incision. Sex and stage of maturity were not assessed.

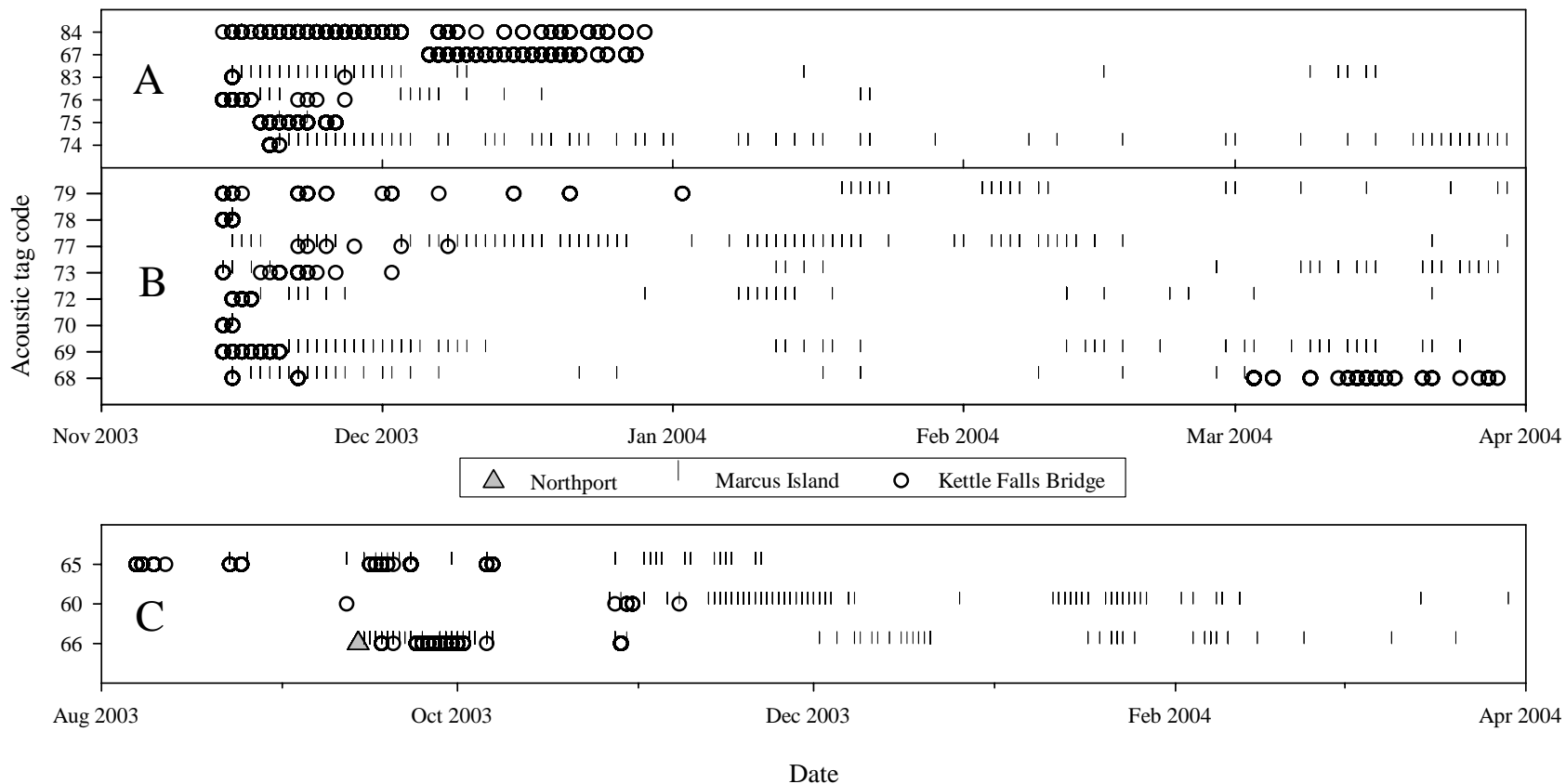


Figure 8. Acoustic signal receptions recorded at three fixed telemetry stations in the Roosevelt Reach of the Columbia River from white sturgeon tagged in the fall, 2003. Data are grouped according to tagging date and location: 13 November, rkm 1,114-1,116 (A); 14 November, rkm 1,129-1,135 (B); 13 June (code 60) and 26 June (codes 65 and 66), Waneta Eddy, British Columbia (C).

Interim Aquaculture Program

There were 1,841 hatchery reared juvenile sturgeon released at three locations in the Roosevelt Reach, of which 534 (29.0%) had deformities (Table 6). Twenty individuals with less than half of a pectoral fin were culled. We examined 1,810 fish for PIT tags and found 38 individuals without tags (97.9% tag retention). Thirty-two fish that were too small for marking in April were scute marked and PIT tagged on 11 May. The mean FL of sturgeon at release was 23.3 cm (sd = 2.5; n = 1,842) and mean weight was 96.6 g (sd = 29.3; n = 1,841) (Table 6).

Table 6. Summary of hatchery produced juvenile white sturgeon release groups planted in to the Roosevelt Reach on 12 May 2004.

Release Location	rkm ^a	n	FL (cm)			Weight (g)			Deformities
			Mean	SD	Range	Mean	SD	Range	
Kettle Falls	1,135	634 ^b	24.3	1.8	15.4-28.9	109.1 ^b	24.2	30.2-199.0	197 (31.1%)
North Gorge	1,155	608	23.5	2.4	11.9-28.8	97.1	28.4	20.9-176.5	153 (25.2%)
Northport	1,183	600	22.0	2.7	14.6-27.9	82.7	29.0	22.0-164.8	184 (30.7%)
Total	-	1,842 ^b	23.3	2.5	11.9-28.9	96.6 ^b	29.3	20.9-199.0	534 (29.0%)

^aRiver kilometers from the mouth of the Columbia River.

^bSample sizes for weights were Kettle Falls = 633 and Total = 1,841.

DISCUSSION

Hatchery juveniles

Distribution

Captures of hatchery reared juvenile sturgeon in the Roosevelt Reach during LRFEP fish assemblage sampling and directed sturgeon sampling in 2002 (Lee and Pavlik 2003, Appendix B) and this year demonstrate that fish released in Canada are dispersing into the upper Roosevelt Reach at least as far downstream as the Marcus area.

The increase in the number of hatchery sturgeon caught in the vicinity of Northport during directed sturgeon sampling this year (14 sturgeon) compared to 2002 (one sturgeon) despite similar gill netting effort may be partly attributable to greater fish abundance in the area following downstream dispersal of fish after two years of releases in Canada. However, it is likely that differences in choice of sampling locations between 2002 and this year played a significant role. In 2002, seven of the 15 net sets made in the Northport area were fished in high water velocity locations (Lee and Pavlik 2003). The gear employed in the sampling effort is of very light construction and likely only fishes effectively under limited flow conditions. This year most sets were made in eddy or backwater areas (i.e. nets were generally fished more effectively), which resulted in increased catch. Additionally, it is likely that sturgeon seek these eddy and backwater areas for velocity refugia (Golder Associates Ltd 2004 *in prep*) leading to the increased catch in 2003.

Growth and condition

Although the small numbers of fish captured this year in the Roosevelt Reach preclude statistical comparisons of growth and condition parameters among groups, some basic trends are apparent. BY 2002 sturgeon captured in the Roosevelt Reach showed markedly lower rates of growth (for both FL and W) than their counterparts captured in Canada. Lower growth rates may be attributed to increased energy expenditure resulting from movement from release sites downstream in to the U.S. Golder Associates Ltd (2004 *in prep*) noted that growth rates of fish captured in the Transboundary Reach in 2003 were generally reduced in fish that were captured >25 km from their release locations.

Forage base may also be greater in the Keenleyside Reach than in the upper sections of the Roosevelt Reach. The Keenleyside Reach receives substantial tributary input from the Kootenay and Pend Oreille Rivers (via Brilliant and Waneta Dams, respectively) as well as from upstream through Keenleyside Dam. Golder Associates Ltd. (2004 *in prep*) found that juvenile sturgeon collected in the Keenleyside Reach fed almost exclusively on the freshwater shrimp, *Mysis relicta*. Mysids entrain into the Keenleyside Reach through Keenleyside, Brilliant, and Waneta Dams and likely provide a relatively abundant source of food. Recent fertilization experiments have increased the productivity of Arrow Lake Reservoir (formed by Keenleyside Dam) and Mysid entrainment through Keenleyside Dam is probably significant. Interestingly, Golder Associates (2004 *in prep*) found that growth of hatchery fish was faster for individuals released and subsequently caught in the area immediately below the dam. The degree of

transport of entrained organisms into the U.S. is unknown but it seems probable that abundance decreases downstream and possibly results in reduced forage suitable for juvenile sturgeon.

Despite reduced growth rates, the mean condition of hatchery fish captured in the Roosevelt Reach in 2003 was similar to that of fish captured in the Keenleyside Reach. Fish captured in both reaches showed a slight decrease in mean condition between release and recapture but condition factor at recapture was similar to that observed in juvenile fish (ages 1-8) captured in the unimpounded reach of the Columbia River below Bonneville Dam (Miller and Beckman 1993). Interestingly, total benthic invertebrate densities reported for the Columbia River below Bonneville dam (McCabe et al. 1993) were similar to those reported for the reservoir portions of the Roosevelt Reach (Beckman et al. 1985).

Population Status

Natural Recruitment

Despite sampling in habitats actively utilized by white sturgeon (as evidenced by recaptures of hatchery origin fish) no YOY or wild juveniles were captured this year demonstrating a continuation of poor/failed recruitment in the transboundary reach population.

Distribution

Sampling effort during this study was too sparse to provide a definitive description of sturgeon distribution within the Roosevelt Reach. However, sturgeon catch data and acoustic telemetry observations from previous sturgeon studies performed in the Roosevelt Reach suggest that habitat preferred by sturgeon is largely confined to the upper half of the Reach and is apparently optimal in the Marcus area.

During the summer of 1998, WFDW deployed 927 overnight setlines (including 151, 45, and 14 sets in the Spokane, San Poil and Kettle river arms respectively) and 43 overnight gill net sets between Grand Coulee dam and the U.S.-Canada border. Effort was evenly distributed throughout the reach on a per lineal river mile (statute) basis. There were 204 sturgeon were captured (201 by setlines and 3 by gill nets). The furthest downstream capture occurred at rkm 1,043 (approximately 83 km upstream of Grand Coulee Dam). However, only nine sturgeon (4% of total catch) were captured between this point and Gifford (rkm 1,086; approximately 126 km upstream from Grand Coulee Dam) (Figure 1). So, 96% of the total sturgeon catch was taken in the upper 112 km of the Roosevelt Reach. The greatest catch rates were observed between French Rocks (rkm 1,113) and Marcus Island (rkm 1,139) (Figure 9).

A similar distribution was observed by Brannon and Setter (1992) who captured 159 sturgeon with setlines between Gifford and the U.S.-Canada border during late spring and summer 1988-1990. The majority (124 or 78%) of sturgeon were captured between the mouth of the Colville River (rkm 1,125) and the Marcus area (Figure 1). Only seven (4% of total catch) fish were captured at sampling locations further downstream. Brannon and Setter (1992) acoustic tagged 16 sturgeon (123-264 cm, length type not

specified) to study seasonal movement patterns. Sturgeon were tagged at three locations that represented different habitat types found in the Roosevelt Reach: upper reservoir habitat (Gifford); the reservoir/riverine interface (Marcus); and riverine habitat (China Bend). Subsequent tracking identified nine high use areas between Gifford and Northport. However, the majority of usage (55%) occurred in the Marcus area. During the course of the study: all fish tagged at China Bend moved downstream to the Marcus area; all fish tagged at Gifford moved upstream to the Marcus area; and all fish tagged at Marcus generally remained there. No fish were observed to travel downstream of Gifford.

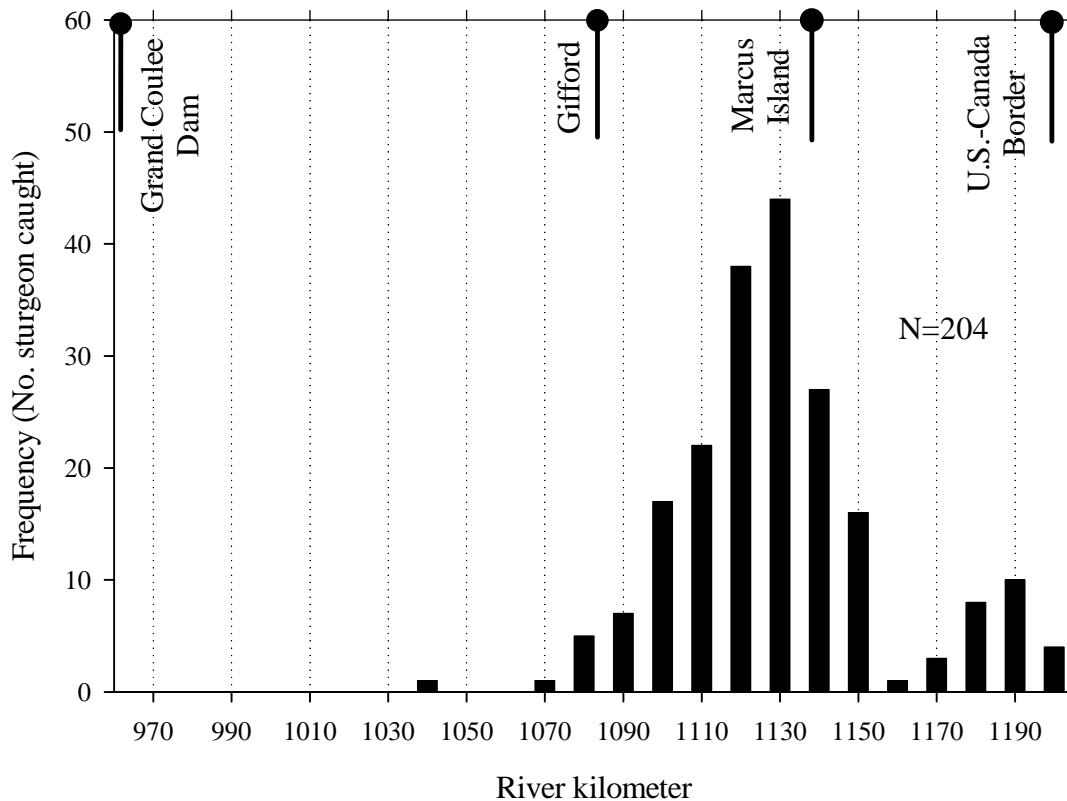


Figure 9. Catch distribution of white sturgeon in the Roosevelt Reach of the Columbia River during WDFW setlining and gill netting activities, summer 1998.

Brannon and Setter (1992) and Beckman et al. (1985) noted that the Marcus area is located toward the lower end of the river/reservoir interface and is characterized by a wide expanse of water forming a large basin that results in the first significant reduction in water velocity within the Roosevelt Reach. Allochthonous material from both upstream and the Kettle River settles out in this area as the movement of inflowing water subsides. The density and taxonomic composition of benthic organisms is heavily dependent upon habitat and detrital input (Beckman et al. 1985). Since sturgeons are principally benthic omnivores they require habitats that encourage proliferation of benthic invertebrates. Catch data and acoustic telemetry observations suggest the Marcus

area provides such suitable habitat. Additionally, the low velocity regime in this area would allow sturgeon to optimize energetic benefits.

Although limited in scope, benthic invertebrate surveys in the main stem of the Roosevelt Reach have demonstrated a progressive downstream reduction in both organism abundance and taxonomic diversity (Griffith et al. 1993, Beckman et al. 1985). Beckman et al. (1985) sampled for benthic invertebrates at three main stem locations (confluence of Colville River, Gifford, San Poil arm confluence) (Figure 1) in the Roosevelt Reach. They estimated mean densities of benthic organisms to be 9,352/m² at the Colville River confluence (just a few km downstream from the Marcus area), 6,302 m² at Gifford, and 3,241/m² at the San Poil arm confluence. They speculated that numbers of benthic organisms and taxa were reduced downstream as the effects of the watershed input were lessened. Limited allochthonous input and lack of vegetation around the perimeter of the reservoir (due to extreme water level fluctuations during annual springtime reservoir drafting for flood control) restricts habitat diversity and food base of benthos in the lower reservoir. Reductions in sturgeon catch progressively downstream from Marcus during WDFW's 1998 survey may be a reflection of decreasing benthic productivity (Figure 9). By comparison, catch data from various studies performed in the impoundments of the mid-Columbia and lower-Snake rivers (Rien et al. 1997; North et al. 1998, North et al. 1999; Kern et al. 2001; Kern et al. 2002) show that sturgeon are found distributed throughout the full extent of each reservoir. These reservoirs are "run of the river" operations and are not subject to the extreme annual fluctuations in water level characteristic of the Roosevelt Reach resulting from flood control operations of Grand Coulee Dam. Consequently, their littoral zones are generally well vegetated with submergent plants that provide a source of autochthonous nutrient input and suitable habitat for benthic production. For example, Sprague et al. (1993) estimated benthic invertebrate densities of up to 31,833/m² during May and 38,519/m² during September in 1988 in the Dalles reservoir - numbers significantly greater than reported for the Roosevelt Reach.

Additional insight into sturgeon distribution in the Roosevelt Reach comes from catch data from various fish assemblage studies performed annually by STOI and WDFW. Between 1998 and 2002, there were 18 wild white sturgeon were captured in the Roosevelt Reach with small mesh gill nets during these studies (unpublished data; details provided in Appendix B). Similar to the results of the sturgeon studies described previously, the majority of these sturgeon (15) were captured upstream of the Gifford area. However, the remaining three individuals were captured in the lower third of the Reach. Two fish were caught near Spring Canyon, just upstream from Grand Coulee Dam (Figure 1), and the other was caught approximately 8 km below the mouth of the Spokane River Arm opposite the mouth of Hawk Creek (Figure 1). All three fish were small juveniles (350, 438, and 475 mm TL) and caught in October of 1998 (i.e. immediately subsequent to WDFW's sturgeon stock assessment that year). Fish of this length do not recruit well to setline gear and would not have been detected during stock assessment activities that same year. The WDFW also fished small mesh gill nets in this area; however, effort was sparse. Given the extremely high spring flows and resulting low water retention times of 1997, it could be postulated that the presence of these

individuals in the lower portions of the Reach is attributable to downstream entrainment rather than via volitional movements or migration.

Unfortunately, only one of these fish was measured for both length (TL) and weight. Converting the TL of this individual to FL using a factor of 0.8313 (derived from a linear regression of paired TL and FL data from similar sized BY 2001 hatchery juveniles captured in the Transboundary Reach in 2003; $n = 58$, $r^2 = 0.906$) allows a K_{FL} calculation of 0.74 for this fish. This condition factor was similar to the mean value of hatchery-reared fish at time of their release and therefore may suggest productive feeding areas exist in the lower portions of the Roosevelt Reach. Interestingly, during the summer of 2003 (i.e. just prior to setline sampling this year) recreational anglers sighted several (actual numbers were not reported) large sturgeon basking at the surface at the confluence of the Spokane River Arm and at Swawilla Basin, just upstream from Grand Coulee Dam (Chris Donley, WDFW district biologist, pers. comm. 2004). These areas correspond quite closely with juvenile capture locations indicating that foraging habitat within the lower Roosevelt Reach may be localized around the mouth of the Spokane River Arm and in the area immediately upstream of Grand Coulee Dam. Further setlining work needs to be performed in the lower Roosevelt Reach to investigate the nature and extent of sturgeon usage of this area.

Movements

Despite deliberately sampling in areas (e.g. Gifford; rkm 1,086) where sturgeon had been previously caught by WDFW (Devore et al. 2000) and Brannon and Setter (1992), no fish were captured further downstream than rkm 1,116 this year. Limited acoustic telemetry data collected this year showed sturgeon generally moved upstream from tagging sites to the Marcus area during November and December. This is consistent with the findings of Brannon and Setter (1992) who also observed a general upstream migration in the winter months. Perhaps the lack of catch in the Gifford area this year can be attributed to sampling timing i.e. most fish utilizing the Gifford area during the summer months had moved upstream to overwintering locations prior to sampling in mid-November.

Brannon and Setter (1992) suggested the Marcus area could be an important area for recovery of post-spawn adults. This appears to be the case as four fish collected in the vicinity of Marcus this year were classified as spent (2 females, 2 males) based upon surgical examination of gonads. Additionally, two late-reproductive females acoustic tagged by Canadian researchers at Waneta (the only known spawning area in the transboundary reach at the confluence of the Columbia and Pend Oreille Rivers, rkm 1,199) in June migrated down to the Marcus area during the late summer, presumably after spawning. Two other post-spawners radio tagged by Canadian researchers in the early 1990's were also observed to move downstream in to the U.S. (RL&L 1994). Whether or not these post-spawn fish are normally resident in the Roosevelt Reach is unknown. If it is assumed that these fish are usually resident in the U.S. then it would appear that the reproductively active stocks in the Roosevelt and Keenleyside reaches are mixing.

Further insight into sturgeon movements and seasonal distribution within the Transboundary Reach will become apparent through data collected from the newly established transboundary acoustic telemetry array as well as more intensive setline surveys in the future.

Fish Condition

The mean FL of 171 cm for sturgeon captured with setlines this year was similar to the mean of 177 cm (n=204) observed from setline sampling in Lake Roosevelt by WDFW in 1998 (Devore et al. 2000). The average W_r of 1.10 for white sturgeon captured during this study was similar to 1.12 reported for the population inhabiting the unimpounded section of the Columbia River below Bonneville Dam by Beamesderfer et al. (1995). The W_r of 0.91 estimated for the population from sampling performed by WDFW in 1998 was the lowest recorded for any Columbia River population to date (Devore et al. 2000). Kern et al. (2002) reported statistically significant increases in W_r of the white sturgeon population in John Day reservoir between two successive sampling passes during the summer of 2000. Similarly, the disparity in sturgeon condition observed in Lake Roosevelt between 1998 and 2003 may be related to seasonal differences in sampling timing: sampling in 1998 was performed during the period July - September while sampling this year occurred in November when fish condition was likely to be at its peak.

The high spring flows and reservoir level fluctuations of 1996 and 1997 may have influenced the condition of sturgeon in 1998. The exceptionally high spring freshet of 1997 may have caused scouring of productive feeding areas, prevented sturgeon from accessing feeding grounds for an extended period of time, entrained sturgeon downstream to less productive areas, or temporarily reduced productivity of food resources important for sturgeon in the Roosevelt Reach. Operations of hydroelectric and flood control facilities during periods of high reservoir discharges and extreme reservoir elevation manipulations adversely impact the reproduction of fish and benthos, and increase recruitment and entrainment of nutrients, fish, and other biota (Beckman et al. 1985, Cole and Deitner 1991, Stark 2001). For example, the extensive back-to-back reservoir drawdowns and associated low water retention times during 1996 and 1997 resulted in an entrainment level of Lake Roosevelt rainbow trout and kokanee populations through Grand Coulee Dam more acute (95-99% for rainbow trout tagged at Kettle Falls and Seven Bays, respectively) than previously observed (Spotts et al. 2000). It seems likely that the detrimental influence of dam operations on the biological community during high flow years directly impacts the sturgeon population. The poor condition of sturgeon observed in 1998, may thus have been related to the vestigial impacts of reservoir operations on the biota during the previous two years.

Historically, effluent discharges in the Keenleyside Reach from the Cominco fertilizer plant, Celgar pulp mill, and municipal sewage artificially increased nutrient levels in the Transboundary Reach. However, over approximately the last 10-15 years, industrial and municipal effluent discharges into the Transboundary Reach have been substantially reduced (UCWSRI 2002). As discussed in the previous section, the sturgeon population in the Roosevelt Reach is likely highly reliant upon allochthonous

nutrient and detrital input to stimulate benthic productivity. Reductions in nutrient input from upstream areas have probably lessened the biological productivity of the Roosevelt Reach and this perhaps provides an alternative explanation for the poor condition of sturgeon observed in 1998.

In 1999, a five-year fertilization experiment was initiated on Arrow Lakes Reservoir (the impoundment above Keenleyside Dam) in response to dramatic declines in kokanee production. After only three years of fertilization, phytoplankton, zooplankton, and mysid densities increased from pre-fertilization levels and the kokanee populations had responded with improvements to in-lake abundance, escapement, spawner size, and fecundity. It is possible that fertilization operations have affected the productivity of the Transboundary Reach through downstream entrainment of nutrients and/or organisms and may have led to the improved condition of sturgeon seen in the Roosevelt Reach in 2003.

PLANS FOR 2004

More intensive gill netting efforts will be performed over a larger area (Gifford to the US/Canadian border) in 2004 to attempt to detect the natural recruitment signal as well as characterize downstream dispersal, growth, habitat, and dietary preferences of Canadian and U.S. reared hatchery fish. In addition to increasing sampling effort, small mesh gill net configurations used for YOY recruitment indexing in the mid-Columbia and lower-Snake Rivers by ODFW and WDFW that perform more efficiently in low to moderate flow situations than gear used to date will be employed.

Setlining for adults will be performed from Gifford to the US-Canadian border where, based on studies to date, the majority of adult fish in Lake Roosevelt are concentrated. Sampling will be performed late-April through May during maximum reservoir drawdown that may act to concentrate fish in certain areas and thereby improve catch rates. Sampling during this timeframe also coincides with broodstock collection efforts by Canadian researchers in the reach of the Columbia river between the border and HLK Dam. Pooled data from these efforts may allow the calculation of a robust population estimate for the transboundary reach based on recaptures of fish tagged in previous studies. Sampling will be performed systematically in a single pass that will allow comparisons of catch rate and various population parameters (sex, stage of maturity, growth, condition factor etc.) between study area sections.

Reproductively mature fish collected during adult sampling efforts will be outfitted with radio and acoustic tags and tracked to assess spawning activity in the US section of the transboundary reach. Artificial substrates will be deployed to collect eggs in suspected spawning areas. Additional fixed telemetry stations will be deployed in Lake Roosevelt to increase knowledge of white sturgeon movements.

Factors limiting recruitment in the US will be assessed by pilot sampling for spawning activity, the nature and extent of larval dispersal, and the potential for predation on eggs and larvae.

In 2004, juvenile rearing operations will continue to be conducted at CBH. The source of BY 2004 fish will either be eggs or juvenile fish transferred from British Columbia. Juveniles (BY 2004) will be PIT tagged, scute marked, and released in the U.S. portion of the transboundary reach in the Spring 2005. We will also examine the feasibility of collecting broodstock in the U.S. in 2004, either for future transfers to British Columbia to increase the genetic pool for their operations or for egg collection in the U.S.

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APPENDIX A. Species composition of catch from juvenile gill net sampling in Lake Roosevelt, 2003.

Species	Northport	North Gorge	Marcus	Total
White sturgeon (<i>Acipenser transmontanus</i>)	14	1	-	15
Walleye (<i>Sander vitreum</i>)	10	15	43	68
Yellow perch (<i>Perca flavescens</i>)	4	1	2	7
Smallmouth bass (<i>Micropterus dolomieu</i>)	1	-	3	4
Longnose sucker (<i>Catostomus catostomus</i>)	2	3	4	9
Largescale sucker (<i>Catostomus macrocheilus</i>)	2	-	1	3
Bridgelip sucker (<i>Catostomus columbianus</i>)	3	-	-	3
Northern Pikeminnow (<i>Ptychocheilus oregonensis</i>)	4	3	4	11
Peamouth chub (<i>Mylocheilus caurinus</i>)	-	-	2	2
Mountain whitefish (<i>Prosopium williamsoni</i>)	-	-	3	3
Lake whitefish (<i>Coregonus clupeaformis</i>)	1	-	22	23
Rainbow trout (<i>Oncorhynchus mykiss</i>)	3	-	-	3
Kokanee (<i>Oncorhynchus nerka</i>)	-	-	1	1
Burbot (<i>Lota lota</i>)	-	-	4	4
Total	44	23	89	156

APPENDIX B. Captures of wild and hatchery produced sturgeon in small mesh gill nets during various studies in the Roosevelt Reach of the Columbia River 1998-2003. A (-) indicates unavailable data.

Date	Capture Location	Lat. N	Lon. W	Depth (m)	Fish origin	FL (mm)	TL (mm)	Weight (g)	PIT @ capture
15-May-1998 ^a	Hall Creek	-	-	-	Wild	-	1,575	-	-
16-May-1998	Colville River	-	-	-	Wild	-	1,194	-	-
7-Jul-1998 ^a	Sherman Creek	-	-	-	Wild	-	1,118	-	-
12-Oct-1998 ^a	Spring Canyon	-	-	-	Wild	-	350	-	-
12-Oct-1998 ^a	Spring Canyon	-	-	-	Wild	-	438	-	-
15-Oct-1998 ^b	Sherman Ck	48.546	118.142	42	Wild	-	2,138	-	-
27-Oct-1998 ^b	Seven Bays	47.842	118.369	37	Wild	-	475	460	-
4-Oct-1999 ^a	Evans	-	-	-	Wild	-	632	2250	-
27-Jun-2000 ^b	Sherman Ck	-	-	38	Wild	-	650	-	-
27-Jun-2000 ^b	Sherman Ck	-	-	38	Wild	-	700	-	-
12-Jul-2000 ^a	Hall Creek	-	-	-	Wild	-	652	-	-
4-Oct-2000 ^a	Hall Creek	-	-	-	Wild	-	760	2,200	-
16-Oct-2001 ^a	Hall Creek	-	-	-	Wild	-	583	1,000	-
10-Jul-2002 ^a	Colville River	-	-	-	Wild	-	821	3,000	-
2-Oct-2002 ^c	Kettle R. Bridge	48.674	118.116	21.6	Wild	620	710	2,000	-
2-Oct-2002 ^c	Marcus	48.673	118.113	13.7	Wild	548	632	1,400	-
2-Oct-2002 ^c	Marcus	48.676	118.102	21.6	Wild	527	626	1,300	-
2-Oct-2002 ^c	Marcus	48.982	118.084	17.7	Wild	570	654	1,750	-
30-Sep-2002 ^c	Onion Creek	48.875	117.846	9.1	Hatchery	254	320	-	985120013044494
1-Oct-2002 ^c	Northgorge	48.800	118.008	19.2	Hatchery	218	257	70	985120013008085
15-Oct-2002 ^a	Kettle Falls	-	-	-	Hatchery	-	436	350	985120014091710

^a STOI fish assemblage surveys ^b WDFW limnetic fish surveys ^c STOI sturgeon survey