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ABSTRACT

During March through September, 2001, a variety of fishing gears were used to attempt to capture adult, juvenile, larvae, and eggs of green sturgeon *Acipenser medirostris* and white sturgeon *Acipenser transmontanus* in the Rogue River, Oregon. We set 118 gill nets for an average 59 minutes and captured 43 individual green sturgeon (138-201 cm fork length, FL). Wildlife Conservation Society (WCS) staff used angling to capture two adult green sturgeon (145-166 cm FL) and one adult white sturgeon (184 cm FL). Most adult sturgeons were tagged with spaghetti and passive integrated transponder tags and 15 adult green sturgeon and one adult white sturgeon were radio tagged at capture by WCS staff. Fishing effort by staff (gill nets and beach seines) occurred between river kilometers (RKM) 1.8 and 39.4. Effort was distributed between two index areas (RKM 1.8 and 14.2) and areas that allowed gears to be fished based on river conditions. Beach seining conducted in an unrelated study captured three juvenile green sturgeon, three adult green sturgeon (15 –193 cm FL), and one adult white sturgeon (201 cm FL) in 675 sets fished mid July through October at RKM 12.9.

No eggs or larvae of green or white sturgeon were collected during five sets for a total of 19 d of egg substrates, 32 D-ring plankton net sets of 28 minutes duration, or three sets of mop-head substrates for a total of 89 h. These gears were difficult to fish with our small vessel in areas that seemed suitable for spawning. No eggs or larvae of green or white sturgeon were collected during 16 d of screw trap operation for a total of 372.4 h.

Data on morphological and meristic characteristics, and lavage and bioscope examination results collected from three green sturgeon captured in the 2001 Columbia River commercial gill net fishery are summarized as an appendix.

INTRODUCTION

Relatively little is known about the biology and life history of green sturgeon *Acipenser medirostris* and there is widespread concern and uncertainty regarding its status. Green sturgeon have recently been petitioned for listing as threatened under the Endangered Species Act by The Center for Biological Diversity, Environmental Protection Information Center, and WaterKeepers Northern California (EPIC 2001). Green sturgeon are classified as a species of special concern by the U. S. Fish and Wildlife Service and California Department of Fish and Game and as "rare" in Canada, but have no special status in Washington or Oregon. In June 2001, green sturgeon were petitioned for listing (EPIC 2001), and in December 2001, the National Marine Fisheries Service initiated a status review to determine if action is warranted (Federal Register 2001). The green sturgeon and Russian Sakahlin sturgeon *Acipenser mikadoi* (either a closely related species or a stock of green sturgeon) are the focus of a joint project by Russian and Oregon Department of Fish and Wildlife (ODFW) biologists due to declines in abundance and spawning distribution.

The harvest of green sturgeon in Oregon has, until recently, been managed without the benefit of a comprehensive statewide investigation of population status. Most green sturgeon harvest occurs in the lower Columbia River, Oregon and Washington, and in Willapa Bay and Gray's Harbor, Washington. Sport harvest averaged almost 400 fish annually during 1986-1998 (San Francisco Bay to Gray's Harbor) whereas commercial and tribal harvests averaged almost 4,000 fish (Table 1).

In 1999, the Oregon Department of Fish and Wildlife initiated a multi-year project to increase the understanding of green sturgeon population characteristics, distribution, and status in Oregon. The specific objectives of the project are to:

1. Summarize and analyze existing information on green sturgeon.

2. Describe characteristics of adult populations in the Columbia, Umpqua, and Rogue rivers.

3. Describe spawning and recruitment in the Umpqua and Rogue rivers.

This report serves to document current progress toward these objectives**.** Emphasis is placed upon field activities performed on the Rogue River during spring/summer 2001**.** Currently, the Rogue River is the only system in Oregon known to support green sturgeon spawning (Wang 1986; Moyle et al. 1995) based primarily on incidental capture of juveniles during salmonid monitoring studies.

METHODS

Rogue River 2001 Field Sampling

The Rogue River is located in southwest Oregon and flows 346 kilometers from its headwaters near Crater Lake to the Pacific Ocean at Gold Beach (Figure 1). Field sampling for adult and juvenile green and white sturgeon *Acipenser transmontanus* was conducted from early

March through late August, 2001 in the lower 40 km of the Rogue River from Gold Beach to Copper Canyon (Tables 2 and 3).

Adult Sampling

Large-Mesh Experimental Gillnets:

From March through August 2001, we deployed 118 gill nets between the Highway 101 bridge (RKM 1.7) and Little Canyon (RKM 35.4). Nets were fished an average of 0.99 h/set (Table 4) during daylight hours. All nets were 3.0-m deep. Nets were constructed using 23.5-cm stretched-measure of multi-strand monofilament in 30.4-m and 61.0-m lengths. The nets were both statically fished in suitable areas of deep, slow moving water for up to 1.5 h and drifted through areas of higher currents for up to 10 minutes.

Two index sites were established. Two gill nets were fished each week from March through the first week of July in the tidal index area at RKM 1.8. Nets were set periodically (weekly) and were generally fished on the high slack tide. Two gill nets were fished periodically (approximately monthly) from April through August at the non-tidal index area at RKM 14.2. Additional nets set at these sites within a month were not counted in the index.

Beach Seine:

From July through October 2001, we deployed 18 beach seines between Ferry Hole (RKM 8.5) and Copper Canyon (RKM 39.6) using a net 47.2-m long by 5.7-m deep by 0.01-cm square mesh, during daylight hours. Nets were fished for about 10 minutes (Table 5). In an unrelated study, 675 sets (45 sets/week for 15 weeks) were completed by Gold Beach District staff (ODFW) at Huntley Park (RKM 13.2) with a 141.7-m long by 5.7-m deep beach seine with 0.01-cm square mesh net (Weber 2001).

Fish Processing:

Each sturgeon captured was measured to the nearest 1 cm (fork length, FL and total length) and examined for tags and marks. Most sturgeons were tagged with both a passive integrated transponder (PIT) tag and an external spaghetti tag. The second left lateral scute was removed from each fish implanted with a PIT tag (Rien et al. 1994). The ninth left scute was removed to indicate that the fish was handled in 2001. Pectoral fin-spine sections were collected from six fish for age analyses. Unlike white sturgeon, green sturgeon are prone to prolonged bleeding when fin spines are removed so not every fish was sampled. Tissue samples were taken from the pectoral fins and stored in ethyl alcohol for subsequent genetic analyses. After processing, thirteen fish were handed off to Wildlife Conservation Society (WCS) staff for radio tag implanting. When a radio tag was surgically implanted, a determination of sex and maturity (ripe or not ripe) was made. In addition, 3 fish (including one recaptured radio tagged fish) were fitted with satellite archival pop-off tags by WCS.

Table 1. Harvest of green sturgeon in California, Oregon, and Washington commercial and sport fisheries.[1] Harvest estimates were provided by State and Tribal fisheries managers at a green sturgeon workshop in Weitchpec, California, 22-23 March 2000. Harvest numbers in Oregon fisheries have been updated based on current estimates.

			Columbia River							Washington				San Fran. Bay	
	Oregon Coastal		OR and WA		Willapa Bay		Grays Harbor/Chehalis River			Ocean	Klamath River			Sac./S. Joaquin R.	
Year	Sport	Trawl	Sport	Comm.	Sport	Comm.	Sport	Comm.	Tribal	Trawl	Yurok	Hoopa	Sport	Sport	Total
1985	N/A	726	533	1,600	NA	1,289	NA	236	5	359	351	10	Few	Few	5,109 +
1986	153	190	407	6,000	NA	921	NA	635	3	123	421	30	Few	Few	8,883 +
1987	170	124	228	4,900	NA	877	NA	781	5	65	171	20	Few	Few	7,341 +
1988	258	120	141	3,300	1	1,599	4	610	1	37	212	20	Few	Few	6,303
1989	202	210	84	1,700	4	465	12	872	2	128	268	30	Few	Few	3,977
1990	157	143	86	2,200	2	954	4	743	9	61	242	20	Few	Few	4,621
1991	366	242	22	3,190	0	922	0	1,530	3	16	312	13	Few	Few	6,616
1992	197	94	73	2,160	0	1,002	0	740	3	2	212	3	Closed	Few	4,486
1993	293	250	15	2,220	32	320	112	545	3	2	417	10	Closed	Few	4,219
1994	160	154	132	240	13	300	25	39	22	1	293	14	Closed	Few	1,393
1995	78	29	21	390	12	302	92	559	185	2	131	2	Closed	Few	1,803
1996	210	182	63	610	24	129	71	290	153	1	119	17	Closed	Few	1,869
1997	158	400	41	1,614	4	16	117	316	197	5	306	7	Closed	Few	3,181
1998	103	77	73	894	12	65	29	25	53	0	335	10	Closed	Few	1,676
1999	73	21	93	967[2]	NA	9	NA	14	56	3	184	27	Closed	Few	1,447 +
2000	15[3]	12	32	861	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	920 +
2001	NA	17	50	264[4]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	331 +
Averages															
1985-1989	196	274	279	3,500	3	1,030	8	627	3	142	285	22	N/A	N/A	6,323 +
1990-1994	235	176	66	2,002	9	700	28	719	8	16	295	12	N/A	N/A	4,267
1995-1999	124	142	58	895	13	104	77	241	129	2	215	13	N/A	N/A	1,995 +
1985-1999	184	197	134	2,132	9	611	42	529	47	54	265	16	N/A	N/A	4,195 +

[1] Catch estimates are generally not good indicators of abundance or population status trends because of changes in management practices over time. Most green sturgeon catch occurs incidentally to other species and is subject to fishery constraints associated with abundance and allocation issues for the target species.

[2] 1999 Columbia River commercial harvest was previously reported as 1,362. The final estimate is 967 (from Oregon and Washington landing data).

[3] 2000 Coastal estuary data entry is not complete and has not yet been expanded to account for non-reporting bias.

[4] 2001 Columbia River commercial harvest is Oregon landings only. Washington landings were not included.

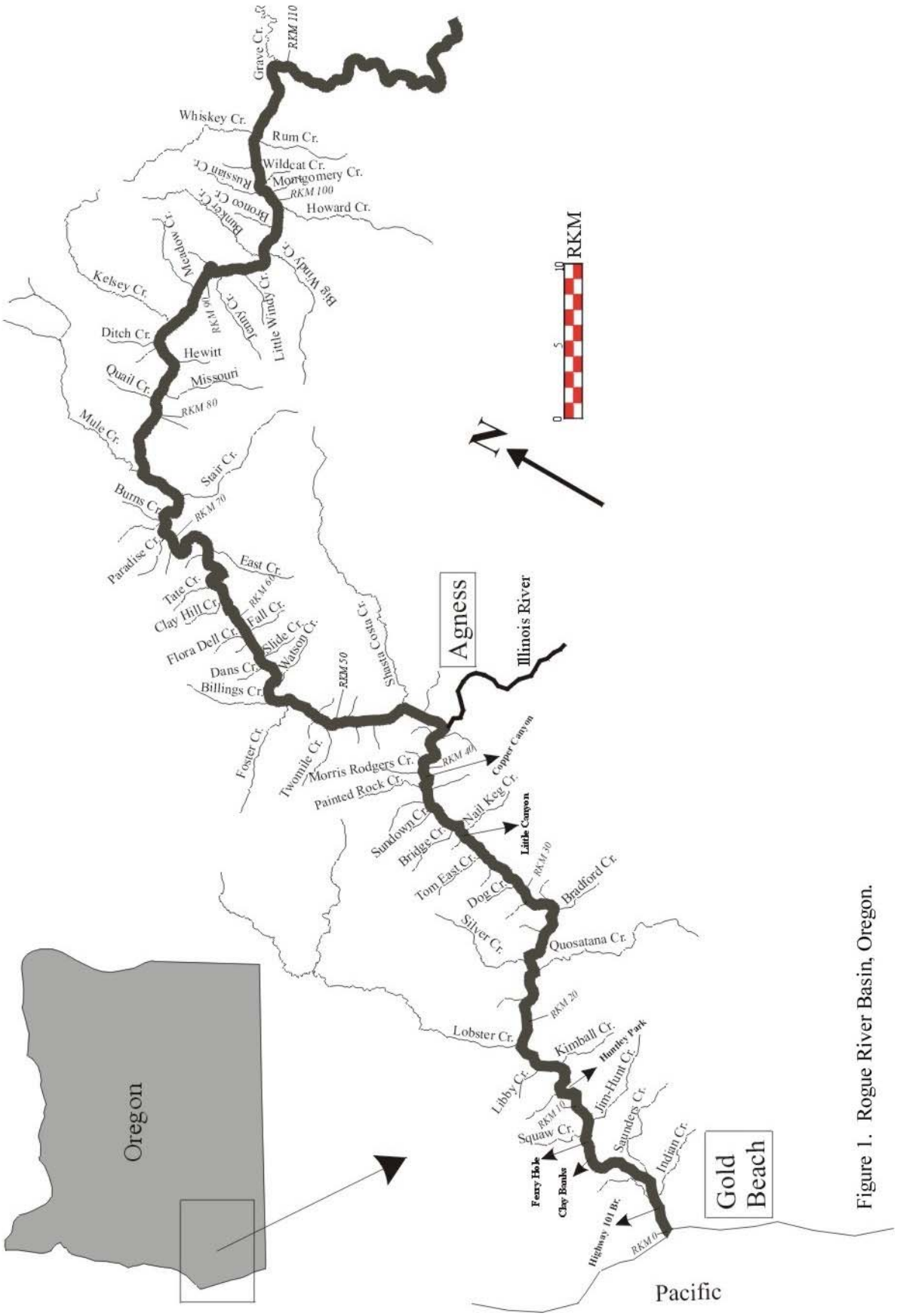

Figure 1. Rogue River Basin, Oregon.

Table 2. Effort and (catch) for all gears by week, Rogue River, Oregon, 2001. All catch is green sturgeon unless noted. To clarify trends, this table is not zero-filled.

		Gear						
Period	Week	Angling Efforts[a]	Egg Frame Days	Mop Head Days	Gill Net Sets	Beach Seine Sets	D-ring Sets	Screwtrap Days
1	11-Mar				13 (5)			
	18-Mar				3 (0)			
	25-Mar				2 (1)			
	1-Apr				2 (0)			
2	8-Apr				15 (10)			
	15-Apr				3 (0)			
	22-Apr				6 (1)			
3	29-Apr		4 (0)		18 (0)			
	6-May				2 (0)			
	13-May		4 (0)		6 (4)			
4	20-May			1 (0)	10 (5)		5 (0)	
	27-May	[a] (1)[b]	11 (0)		2 (0)			
	3-Jun				2 (0)			
	10-Jun				2 (0)			
	17-Jun				2 (0)			
5	24-Jun				6 (9)			2 (0)
	1-Jul				2 (0)			1 (0)
	8-Jul				2 (0)			4 (0)
	15-Jul					50 (4)[c]		4 (0)
6	22-Jul			2 (0)	4 (1)	50 (0)	10 (0)	3 (0)
	29-Jul				3 (0)	49 (1)		2 (0)
	5-Aug				3 (2)	45 (1)		
	12-Aug				4 (1)	45 (0)		
7	19-Aug			1 (0)	5 (0)	49 (0)	17 (0)	
	26-Aug					45 (0)		
	2-Sep					45 (0)		
8	16-Sep					45 (0)		
	23-Sep					45 (0)		
	30-Sep					45 (0)		
	7-Oct					45 (0)		
	14-Oct				1 (9)	45 (0)		
	21-Oct	[a] (2)				45 (0)		
	28-Oct					45 (0)		
	Totals	[a] (3)	19 (0)	4 (0)	118 (48)	693 (6)	32 (0)	16 (0)

[a] Angling effort not documented.

[b] White sturgeon

[c] Includes one white sturgeon

Table 3. Catch per unit effort of green sturgeon for all gears by river kilometer (RKM), Rogue River, Oregon, 2001. Angling is not included, as effort was not documented. To clarify trends, this table is not zero-filled.

	Gear					
RKM	Egg Frame	Mop Head	Gill Net	Beach Seine	D-ring	Screwtrap
0.0 - 5.0			0.12			
5.1 - 10.0			0.00	0.00		
10.1 - 15.0			0.57	0.01	0.00	0.00
15.1 - 20.0	0.00		6.00		0.00	
20.1 - 25.0		0.00	0.00	0.00	0.00	
25.1 - 30.0				0.00	0.00	
30.1 -35.0		0.00			0.00	
35.1 - 40.0	0.00		0.00	0.00	0.00	
40.1 - 45.0	0.00					
0.0 - 45.1	0.00	0.00	0.41	0.01	0.00	0.00

Egg and Larval Sampling

Egg Frame Substrates:

During April - May, 2001, WCS set out five substrates for an average of 91.05 h between RKM 17.9 and 40.9 (Table 5). Sampling sites were immediately downstream of high velocity riffles where green sturgeon were suspected to spawn, and at locations occupied by previously radio-tagged sturgeon. Substrates were anchored mid-channel. The anchor was attached to a weighted rope that was tied off on shore. Upon retrieval, substrates were closely examined for the presence of eggs. Egg substrates were 0.70-m^2 frames of angle iron that encased a sheet of latex-coated animal hair filter material. This gear has been used successfully in the Columbia (McCabe and Beckman 1990) and Sacramento (Schaffter 1997) rivers to collect white sturgeon eggs. On the assumption that the eggs of green sturgeon exhibit similar characteristics we fabricated several substrates according to specifications outlined by McCabe and Beckman (1990).

Plankton Nets:

During May - August, 2001, we set 32 D-shaped plankton nets for an average of 0.33 h between RKM 13.7 and 39.4 (Table 4) to capture sturgeon eggs and larvae. The net frame was 0.8 m wide at the base and 0.5-m deep. Netting was 7.9 mesh/cm marquisette fabric. Lead weights were attached to the base of the frame to hold the net on the river bottom. We deployed the net from an anchored boat immediately downstream of high velocity riffles where we believed green sturgeon could spawn or where larvae might be “funneled” and transported by the current.

Table 4. Effort (h) and catch by sampling week for angling, gill nets, and d-rings used to capture adults, larvae, and eggs of green and white sturgeon, Rogue River, Oregon, 2001.

Gear		Effort		Catch	
Week	Sets	Total	STD	Green Sturgeon	White Sturgeon
Angling[a]				*Sturgeon >10 cm FL*	
May 27	1			0	1
October 14	1			2	0
	2			2	1
Gill Nets				*Sturgeon >10 cm FL*	
March 11	13	12.63	0.05	5	0
March 18	3	2.50	0.29	0	0
March 25	2	2.00	0.00	1	0
April 1	2	2.00	0.00	0	0
April 8	15	15.65	0.14	10	0
April 15	3	3.00	0.00	0	0
April 22	6	6.00	0.00	1	0
April 29	18	17.43	0.11	0	0
May 6	2	2.00	0.00	0	0
May 13	6	5.17	0.34	4	0
May 20	10	10.40	0.13	5	0
May 27	2	2.00	0.00	0	0
June 3	2	2.00	0.00	0	0
June 10	2	2.00	0.00	0	0
June 17	2	2.00	0.00	0	0
June 24	6	6.02	0.02	9	0
July 1	2	1.50	0.35	0	0
July 8	2	2.00	0.00	0	0
July 22	4	4.20	0.08	1	0
July 29	3	3.55	0.32	0	0
August 5	3	3.00	0.00	2	0
August 12	4	4.00	0.00	1	0
August 19	5	5.00	0.00	0	0
October 14	1	0.60	-	9	0
	118	116.65	0.14	48[b]	0
D-Ring Egg and Larvae Nets				*Eggs and Larvae*	
May 20	5	1.33	0.15	0	0
July 22	10	3.35	0.20	0	0
August 19	17	5.80	0.05	0	0
	32	10.48	0.13	0	0

[a] Angling was conducted by Wildlife Conservation Society staff. Effort was not tracked.

[b] Includes 43 individual fish. Five of these were recaptured once.

Table 5. Effort (h) and catch by sampling week for beach seine, screw trap and substrates used to capture green and white sturgeon and their eggs, Rogue River, Oregon, 2001.

Gear		Effort		Catch	
Week	Sets	Total	STD	Green Sturgeon	White Sturgeon
Beach Seine[a]				*Sturgeon >10 cm FL*	
July 1	50			4	0
July 8	50			0	0
July 15	49			1	1
July 22	45			1	0
July 29	45			0	0
August 5	49			0	0
August 12	45			0	0
August 19	45			0	0
August 26	45			0	0
September 2	45			0	0
September 16	45			0	0
September 23	45			0	0
September 30	45			0	0
October 7	45			0	0
October 14	45			0	0
	693			6	1
Screw Trap				*Larvae*	
June 24	2	44.22	1.33	0	0
July 1	1	26.50	-	0	0
July 8	4	93.83	4.27	0	0
July 15	4	90.83	1.91	0	0
July 22	3	70.42	6.88	0	0
July 29	2	46.58	3.12	0	0
	16	372.38	3.53	0	0
Mop-Head Substrate				*Eggs*	
May 20	1	18.65	7.27	0	0
July 22	1	45.00	14.74	0	0
August 19	1	25.50	2.06	0	0
	3	89.15	13.67	0	0
Egg Frame Substrates				*Eggs*	
April 29	2	96.00	0.00	0	0
May 13	2	95.23	0.02	0	0
May 27	1	264.00		0	0
	5	455.23	96.68	0	0

[a] Beach seine sets are standardized to about 10 minutes each.

We also set in deep holes with little current where larvae might rest. The majority of the sets were done after sunset. The duration of deployment was contingent upon sediment and debris load. Upon retrieval, the contents of the collection cup were emptied into a white plastic tray and were examined for eggs and larvae.

Mop Head Substrate:

During May – August 2001, we set three mop head substrates (Van Eenennaam et al. 2001) for an average of 29.72 h between RKM 24.8 and 33.6 (Table 5) to capture sturgeon eggs. Substrates were constructed of five standard size mop heads attached to snap hooks with hog rings. Substrates were spaced out on 23.6 – 35.4-m of rope depending on the width and length of the area sampled. Weights were spaced along the rope to keep it on the bottom. Mop heads were collected into a 19-l bucket and examined individually for eggs.

Screw Trap:

A standard 2.4-m rotary screw trap was anchored at the head of the glide behind the island at Kimball Bend (RKM 14.2) for an average of 23.27 h a day (Table 5). Site selection was based on river traffic problems as opposed to potential catch.

Other Activities

Two experienced readers estimated ages for 120 green sturgeon collected from the Rogue River and Oregon coastal estuaries during 2000-2001. Using techniques developed for white sturgeon (Rien and Beamesderfer 1994; Brennan and Cailliet 1989), we counted annular rings in pectoral-fin spine sections. These were combined with older data sets (unpublished) of ages from experienced readers including 31 green sturgeon from 1949-1953, 26 green sturgeon from 1982, and 84 green sturgeon from 1988. We also aged 135 green sturgeon (without length measurements) collected from the Columbia River in 2001.

Separate Von Bertalanffy equations ($FL = L_{\infty} \times (1-e^{-k \times (age - t_0)})$) that described size at age for green sturgeon were fit with a nonlinear regression (SAS Institute 1988 a and b) by males, females, and all fish. The Von Bertalanffy parameter t_0 was standardized at the mean value for fish aged.

We sampled three green sturgeon caught near Astoria, Oregon in the August 2001 Columbia River commercial gill-net fishery. They were sampled for sex, maturity, age, and morphometric and meristic characteristics (Appendix). The digestive tracts from the fish were frozen and will be examined later to determine food items.

The 4th International Sturgeon Symposium was held in Oshkosh, Wisconsin, 8-12 July 2001. We presented a poster entitled "Morphometric measurements and meristic count comparisons for North American and Asian forms of green sturgeon *Acipencer medirostris*" and made an oral presentation entitled "Green Sturgeon *Acipenser medirostris* Fisheries in the Eastern Pacific: Are Harvest Rates Sustainable?" which synthesized current knowledge of population characteristics to describe potential production of green sturgeon and relate it to current Columbia River harvest.

Three ripe egg samples collected when implanting radio tags were sent to the University of California at Davis by WCS to measure the germinal vesicle position to determine the oocyte polarization index (PI). Two of these samples were collected in 2001 and one sample was collected in 2000.

RESULTS

Fifty-one unmarked green sturgeon (15-201 cm FL) were captured (Tables 4 and 5). We recaptured five of these over the study period. Forty-three of the unmarked sturgeon were tagged with spaghetti tags and 38 were tagged with PIT tags. All PIT tagged fish were marked by removing the second left lateral scute anterior from the opercle. In addition, we marked 37 of these fish by removing the ninth left lateral scute anterior from the opercle. Eight fish caught by Gold Beach District staff and WCS were not marked. We collected six pectoral-spine samples for age determination. We collected DNA tissue samples from all previously unmarked fish. Fifteen of the fish were radio-tagged for tracking by WCS staff. We collected two of the smallest green sturgeon (15-17 cm FL) for stomach analysis.

Two individual white sturgeon (184 – 201 cm FL) were caught, one angling and one in a beach seine (Tables 4 and 5). Neither of these were recaptured in the study period. We spaghetti-tagged both of these fish. One was injected with a PIT tag and marked by removing the second and ninth left lateral scute anterior from the opercle. The other was radio-tagged for tracking by WCS staff. Two DNA tissue samples and no pectoral spine samples were collected from white sturgeon.

In 17 weeks of index sampling at RKM 1.8 (34 gill nets) we captured four green sturgeon (Figure 2). In 26 additional sets at and near this index site three more green sturgeon were captured. After the week of 1 July 2001, we discontinued gillnetting at this site due to increasing salmonid bycatch.

Monthly sampling at Kimball Bend (RKM 8.8) produced more fish than the site near the mouth. In six months of index sampling (12 gill nets) we captured 11 green sturgeon (Figure 2). In 27 additional gill net sets, we caught 18 more green sturgeon. Despite the repetitive sampling at this one site, recaptures were relatively rare -- only 4 among the 29 fish caught.

We did not capture any eggs or larvae using D-ring plankton nets, a screw trap, or with artificial substrates. We discontinued the use of the screw trap after several instances of vandalism.

We assigned ages to 120 green sturgeon (15-202 cm FL) (Tables 6-8). Growth curves were generated for male, female, and all fish aged. In addition, a growth curve was generated for fish aged by us exclusively (Figure 4). We also aged 135 green sturgeon without length measurements collected from the Columbia River in 2001. These have been forwarded to ODFW's Genetics Program with matching DNA samples. All DNA is being analyzed by Dr. Michael Lynch, Indiana University, Bloominton, Indiana, under a separately funded project. All DNA samples collected to date are shared with genetics programs at University of California, Davis, and at the U. S. Fish and Wildlife Service laboratory in Ashland, Oregon (Table 9).

Two ripe egg samples were collected while implanting radio tags. These were sent with one sample from 2000 to the University of California at Davis (UC Davis). The samples were determined to have mean egg diameters from 4.44 mm – 4.45mm and mean PI's of 0.034 – 0.039.

DISCUSSION

This year's field sampling was directed at describing characteristics of the adult population, spawning, and recruitment of green sturgeon in the Rogue River. Weekly and monthly gill-net sampling near the mouth and at Kimball Bend was intended to be minimally disruptive to fish that were radio tagged and monitored by WCS and to allow us to document seasonal use patterns.

The gill-net site at RKM 1.8 was chosen to allow capture of fish just entering the Rogue River. These fish could be radio tagged and their movements monitored throughout their freshwater residency by WCS. Preliminary sampling in March to select an appropriate site for weekly indexing showed this site had promise. However, over the field season, only four green sturgeon were captured and two of those were caught in the first week. We had to discontinue gillnetting at this site in July due to salmonid bycatch. Also, debris and weeds washed out by daily water level fluctuations intended to enhance salmonid migration and survival in this low water year reduced the effectiveness of the gear by "filling" the nets with debris. Thus indexing at this location did not reveal the seasonal timing of green sturgeon entry into the Rogue River.

At the second gill-net site (RKM 8.8) catches declined through the season but the site was generally used by some green sturgeon. Recaptures of spaghetti-tagged fish showed some green sturgeon spent extended periods using this small area of the river. In the fall, many of the radio-tagged fish were located in this area shortly before they emigrated from the system.

Monitoring of radio-tagged fish was completed by WCS staff. Most movement of radio-tagged fish was prior to 1 June. Once fish distributed in the system they tended to hold in the same areas from summer through fall. When the water temperature fell to about 10 C and flows started to increase, fish began to move downstream. All radio-tagged green sturgeon had left the system by the end of December. This behavior was consistent with observations in 2000 (personal communication, Dan Erickson, WCS).

Fish that were classified as ripe by WCS exhibited the majority of the movement in the river system. Three of these fish moved upstream beyond RKM 37. The fourth fish shed its radio tag at RKM 17. With the exception of one fish tagged at RKM 1.8, fish that were classified as not ripe exhibited little movement. Over ten days this fish moved upstream to RKM 33 and spent at least 30 d moving between RKMs 27 and 39. In early May, it moved downstream to hold near RKM 15 (personal communication, Dan Erickson, WCS).

Juvenile green sturgeon captured in beach seines over the last several decades are strong evidence that spawning occurs fairly regularly in the Rogue River (Rien et al. 2000). This year, three green sturgeon (15, 17, and 20 cm FL) were collected in July and August and we aged two of them as 0 years.

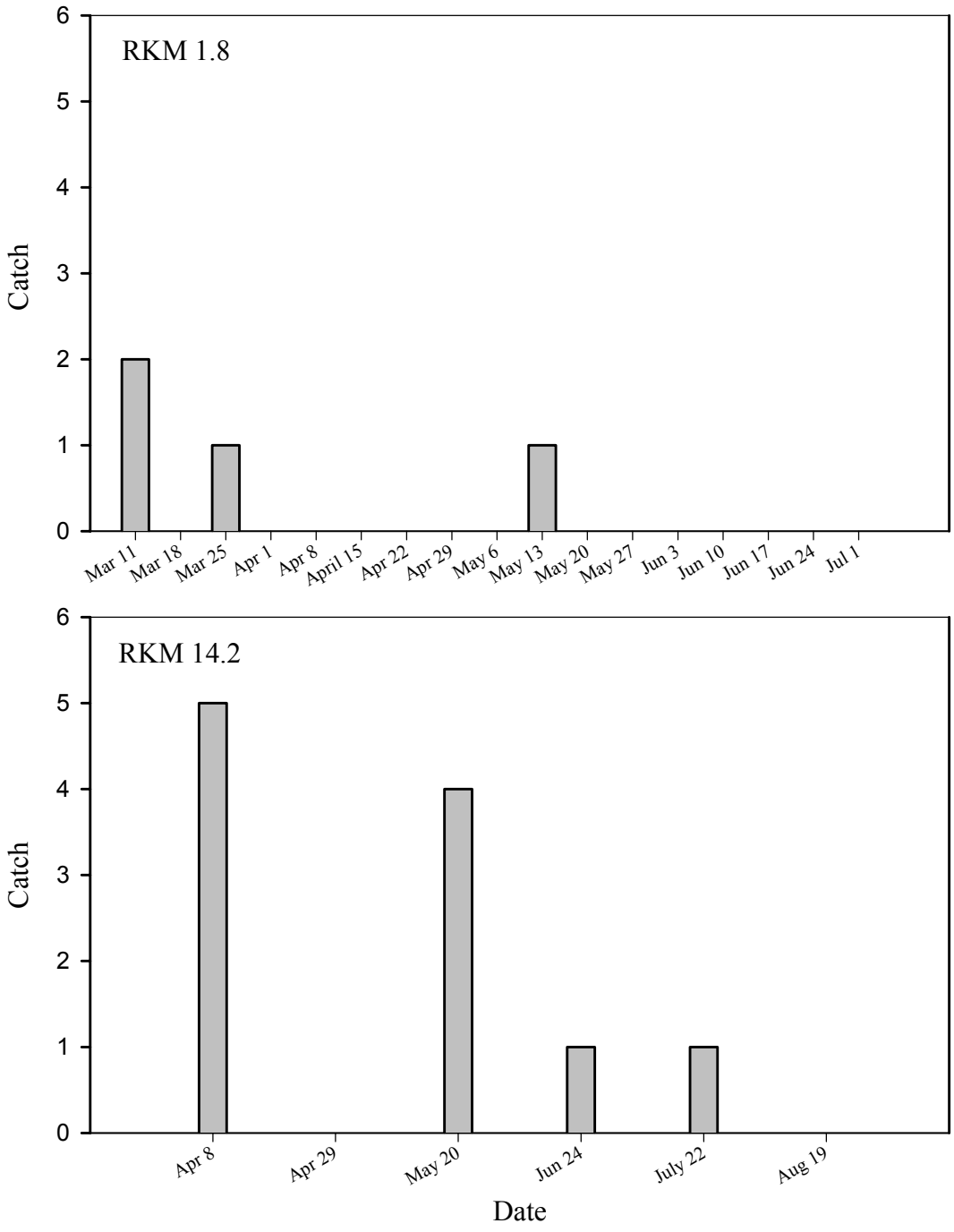

Figure 2. Index area catches of green sturgeon, Rogue River, Oregon, 2001. Sampling (two gill-net sets/date) was conducted on each date represented.

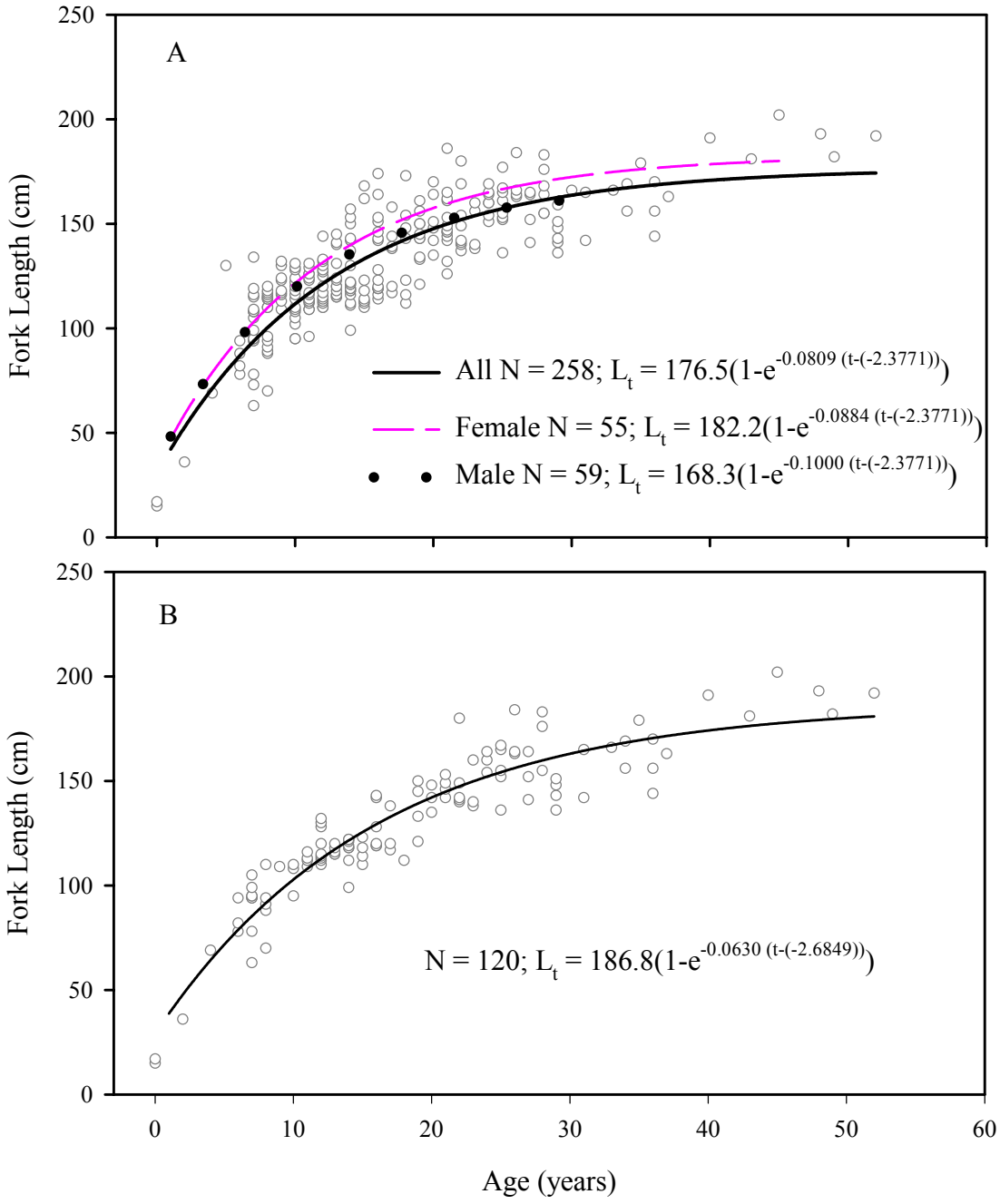

Figure 3. Von Bertalanffy growth curves for green sturgeon. (A) All aged fish (B) fish aged by ODFW. t = age (years); where L_t = FL (cm) at age t.

Table 6. Age frequency distribution for green sturgeon <220-cm FL collected from Puget Sound, Columbia River, Yaquina Bay, Winchester Bay, Coos Bay, and Rogue River, 1949 – 2001. To clarify trends, this table is not zero-filled.

	Fork length interval (cm)													
Age	0-19	20-39	40-59	60-79	80-99	100-119	120-139	140-159	160-179	180-199	200-219	Mean length	STD	N
0	2											16.0	1.4	2
1														0
2		1										36.0		1
3														0
4				1								69.0		1
5														0
6				1	3							85.5	7.0	4
7				3	5	4						94.0	15.6	12
8				1	5	8	1					104.3	15.1	15
9						8	3					116.9	6.5	11
10					2	8	4					112.7	11.7	14
11					1	9	10					118.5	9.1	20
12						7	7					120.2	8.4	14
13						6	5	4				127.8	13.0	15
14					1	5	6	3				124.7	13.2	15
15						5	5	2				127.3	15.7	12
16						6	2	3	2			131.6	20.0	13
17						2	2	3	1			138.4	19.2	8
18						2	1		1			128.8	23.9	4
19							3	9	1			144.0	10.4	13
20							1	4	2			151.0	12.4	7
21							2	7	2	1		151.7	16.4	12
22								5	3	1		155.3	13.7	9
23							1	1	1			146.0	12.2	3
24								3	3			158.0	4.7	6
25							1	4	6			159.5	11.5	11
26									3	1		169.0	10.0	4
27								2	1			152.3	11.5	3
28								2	2	1		167.0	12.5	5
29							1	3	1			148.8	11.2	5
30								1				141.0		1
>30								4	8	5	1	171.3	16.8	18
All ages	2	1	0	6	17	70	55	60	37	9	1	131.6	28.2	258

Table 7. Age frequency distribution for male green sturgeon <220-cm FL collected from Puget Sound, Columbia River, Yaquina Bay, Winchester Bay, Coos Bay, and Rogue River, 1949 – 2001. To clarify trends, this table is not zero-filled.

	Fork length interval (cm)													
Age	0-19	20-39	40-59	60-79	80-99	100-119	120-139	140-159	160-179	180-199	200-219	Mean length	STD	N
0														0
1														0
2														0
3														0
4														0
5														0
6														0
7														0
8					1	2	1					111.0	14.9	4
9							1					131.0		1
10						4	3					117.1	11.4	7
11					1	4	4					117.2	10.5	9
12						1	2					122.0	5.6	3
13						1	1	3				139.4	13.2	5
14							2	2				136.8	12.6	4
15							2	1				144.3	11	3
16								1				142.0		1
17						1		1	1			144.7	26.4	3
18														0
19								5	1			149.8	7.5	6
20								2	2			158.0	11.2	4
21								1				150.0		1
22									1			162.0		1
23														0
24									1			160.0		1
25							1	1	1			152.0	16.5	3
26														0
27														0
28								1				155.0		1
29														0
30								1				141.0		1
>30									1			165.0		1
All ages	0	0	0	0	2	13	17	19	8	0	0	135.4	19.6	59

Table 8. Age frequency distribution for female green sturgeon <220-cm FL collected from Puget Sound, Columbia River, Yaquina Bay, Winchester Bay, Coos Bay, and Rogue River, 1949 – 2001. To clarify trends, this table is not zero-filled.

	Fork length interval (cm)													
Age	0-19	20-39	40-59	60-79	80-99	100-119	120-139	140-159	160-179	180-199	200-219	Mean length	STD	N
0														0
1														0
2														0
3														0
4														0
5														0
6														0
7						3						110.7	4.6	3
8						5						114.2	2.9	5
9						7	2					116.2	4.5	9
10					1	1	1					110.3	16	3
11							6					126.0	3.8	6
12							1					133.0		1
13							1	1				136.5	6.4	2
14														0
15							2	1				135.0	14.4	3
16						1			2			149.7	33.9	3
17								2				149.0	7.1	2
18									1			164.0		1
19								1				147.0		1
20														0
21								1	2			163.3	8.7	3
22									2			165.0	0	2
23														0
24								1				159.0		1
25									3			169.0	8	3
26									2			164.5	0.7	2
27														0
28									1			166.0		1
29									1			166.0		1
30														0
>30									2		1	178.0	20.9	3
All ages	0	0	0	0	1	17	13	7	16	0	1	137.9	24.8	55

Table 9. Sumary of green sturgeon tissue samples collected by ODFW staff for genetic assay , February 2000 - February 2002.

Year	Green Sturgeon		Intermediate[a]
Location	Adult	Juvenile	Adult
2000			
Coos Bay, OR	1		
Pacific Ocean off Newport, OR	4		
Rogue River, OR	65	10	
Tillamook Bay, OR	6		
Winchester Bay, OR	106		
Yaquina Bay, OR	11		
2001			
Coos Bay, OR	8		
Lower Columbia River, OR	160		
Winchester Bay, OR	20		
Yaquina Bay, OR	5		1
Sum	386	10	1
Minimum Total Length (mm)	380	135	1060
Maximum Total Length (mm)	2250	330	1060

[a.] This fish (most likely a green sturgeon) had morphological and meristic characteristics intermediate between white and green sturgeon.

This indicates that spawning occurred in the Rogue River in 2001. Still, we were not able to directly document sturgeon spawning or spawning sites through collection of eggs or larvae using artificial substrates, plankton nets, or screw traps. The year 2001 was among the lowest flow years on record for the Rogue River (Figure 5), which probably reduced spawning success.

Egg frame substrates probably have the most promise to capture eggs in the future in the Rogue River. They can be left for long periods of time without monitoring and have been effective at catching white sturgeon eggs in the Columbia River (McCabe and Beckman 1990 ; Schaffter 1997). Green sturgeon fingerings are a relatively common bycatch of screw traps in the Klamath River system (personal communication, James Craig, U. S. Fish and Wildlife Service, Arcata); however, a narrow channel, heavy recreational and commercial boat use, and vandalism on the Rogue River prevented us from positioning the trap at optimum sites.

We were able to interpret ages of 120 green sturgeon from pectoral fin-spine sections. Age determinations were made based on criteria developed for white sturgeon, but we urge caution in applying these results. There has been no work to verify that translucent rings in pectoral fin spines of green sturgeon are formed every year and only once each year. Under-aging is a documented problem in white sturgeon (Rien and Beamesderfer 1994) and we have noted that green sturgeon are more difficult to age than white sturgeon. Some of the challenging characteristics we have observed include: 1) low or poor contrast between opaque and translucent zones (fin spines were variously described by readers as cloudy or shadowy), 2) readers had difficulty defining the first annulus due to multiple proximate marks near the origin, 3) white sturgeon fin spines are larger for a given aged fish, which makes separating or distinguishing annuli easier, and 4) secondary fin rays were frequently included in the spine section of older fish, which made tracing individual annuli difficult and contributed to reader uncertainty.

Work is needed to validate and verify the fin-spine method of age determination in green sturgeon. Similar to work done on white sturgeon (Brennan and Cailliet 1989), multiple age structures could be obtained and examined to ensure annuli are formed consistently among various structures. Regardless of the utility of alternate age structures, fin-spines are likely the only structure that can be taken from living fish. Oxytetracycline injection and comparison of ages after extended periods of time at large have been used to verify ages in long-lived fishes (Beamish and Chilton 1982, Rien and Beamesderfer 1994). The rarity of recaptures and relative brevity of research studies will make age verification in wild green sturgeon particularly difficult. Coordination and cooperation among research and management groups working with green sturgeon will be needed to obtain age structures from recaptured fish.

The egg diameters (4.44 mm – 4.45mm) and PI's (0.034 – 0.039) of the ripe egg samples that were sent to UC Davis by WCS were compared to Klamath River ripe females. The Klamath samples had a mean egg diameter of 4.32 and a mean PI of 0.042 obtained from 42 fish. As a morphologic criterion of oocyte ripeness (Dettlaff et al. 1993), a PI of less than 0.10 is used as a guideline for spawning induction in hatchery practices. Based on this criteria, the females from the Rogue River were in spawning condition and likely were in a spawning region of the river or close to one (personal communication, Joel Van Eenennaam, UC Davis).

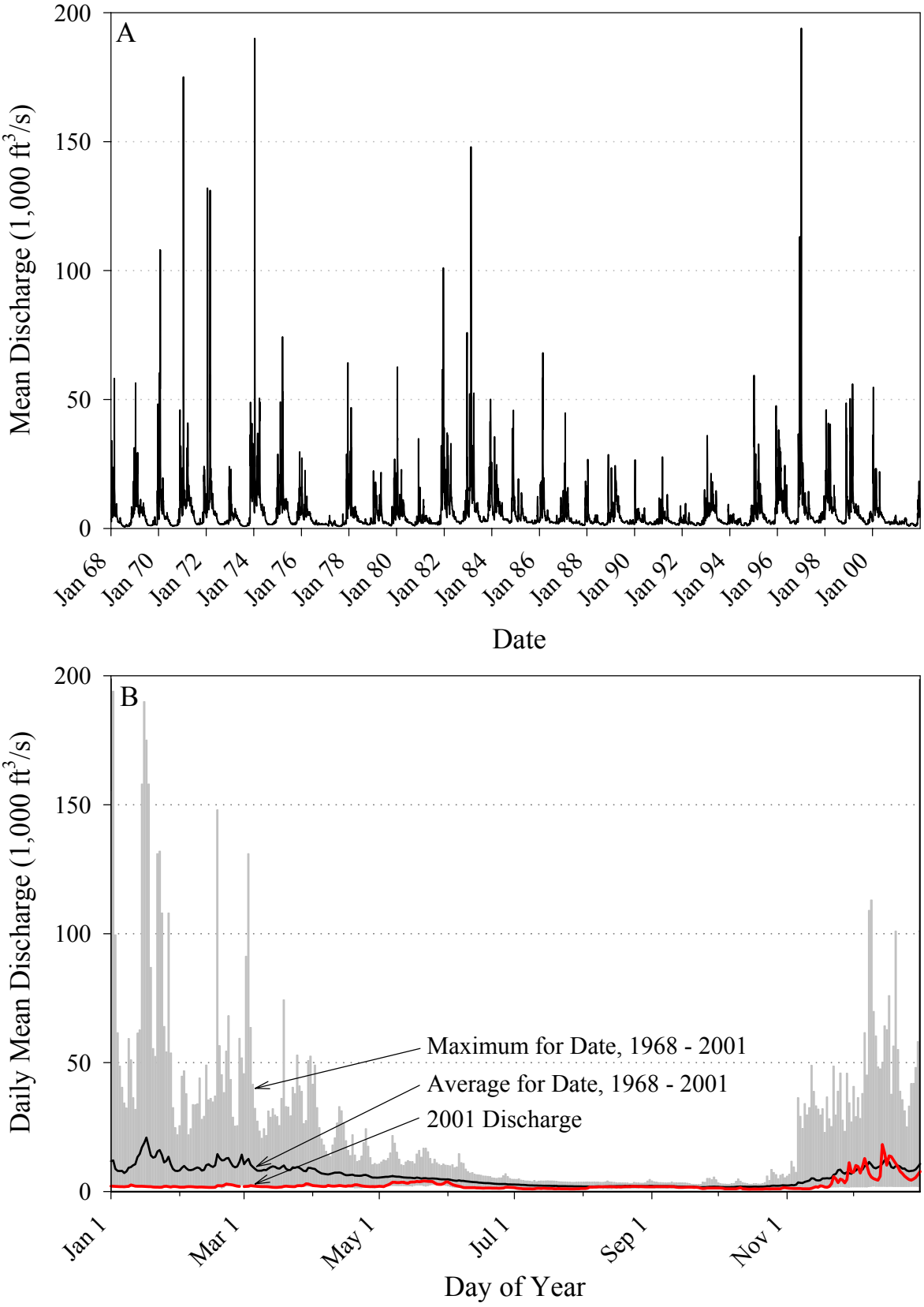

Figure 5. Rogue River discharge near Agness, Oregon, 1968-1999. A) Mean by date. B) 2001 daily mean discharge and the average and maximum daily means by day of year. Source: U. S. Geologic Survey (http://water.usgs.gov/usa/nwis/sw).

Plans for next year

Field sampling plans for 2002 will emphasize gillnetting in the Rogue River at specific sites to collect fish for radio telemetry by WCS. The WCS will be working under a separate contract to monitor adult movements and attempt to capture eggs. We will also initiate Umpqua River sampling for green sturgeon to describe characteristics of adult populations and to identify spawning and recruitment. We will use gill nets as far upstream as practical to attempt to capture adult sturgeon. We will also use gear designed to capture sturgeon eggs and larvae.

A determination of the threatened/endangered status of green sturgeon is scheduled for June 2002 (Federal Register 2001). We expect that some staff time will be needed to coordinate with and provide information to the National Marine Fisheries Service and other interested parties.

ACKNOWLEDGEMENTS

Russ Stauff, John Weber, and Mark Dilenge of ODFW's Gold Beach Field office were generous with their time and with their knowledge of the Rogue River and its fisheries. Wendy Martin with ODFW's Columbia River Investigations program volunteered to help us with field sampling. Steve King and Dave Ward with ODFW's Fish Division supported efforts to investigate green sturgeon status and helped us with study design.

Kevleen Melcher and Tom Neill with ODFW's Columbia River Management section conducted estuary sampling, obtained fish from the commercial fishery for us, and supplied pectoral-spine samples for ageing.

Dan Erickson, with WCS, worked as a full partner on this study. He conducted angling, radio tagged fish, collected samples, and helped us locate potential spawning fish through radio telemetry.

Alexander Bajkov (an ODFW Employee in the 1950's) aged green sturgeon collected 1949-1953. We also wish to thank Craig Foster and Lisa Burner of ODFW and Mike Wall of Washington Department of Fish and Wildlife who aged fish collected in the 1980's.

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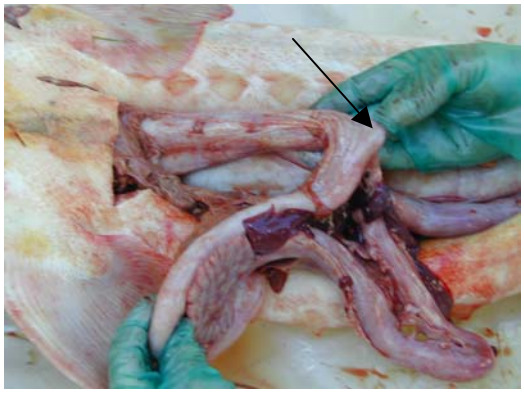
APPENDIX

We received three commercially harvested green sturgeon through Columbia River Management on 6 August 2001. They were stored in a walk-in cooler until 7 August 2001.

Lavage

We attempted to use a lavage to collect stomach contents (Haley 1998). We constructed a lavage using a hand-operated bilge pump, 0.30-cm reinforced plastic tubing, 0.20-cm aquarium tubing, and a hypodermic case. The reinforced tubing was connected to the bilge pump and a ~1 cm end piece of the hypodermic case was drilled in 5 places and attached to the end of the tubing to provide a rounded tip for the hose and to provide side exits for the water. The pump was fed from a 19-liter bucket filled with water.

We placed the first fish on its back on a table and inserted the lavage into the mouth of the fish. As the tube was slowly guided into the alimentary canal, the pump was used to provide water for lubrication. When resistance was encountered that didn't appear to be passable, we stopped the advance and opened the fish to examine its placement and effect. The tube only progressed as far as the first bend in the alimentary canal. (Appendix Figure 1) With the fish opened, we were able to advance the tubing another 2-3 cm. This would not be possible on a live fish. We found that the air bladder was half-filled with water and distended. As we pumped more water, the air bladder continued to fill. We tried it with the smaller diameter tubing and again were stopped at the first bend and again just filled the air bladder with water. We then tried the same procedure with the second fish and achieved the same results. We did not use the procedure on the third fish as it had failed on the first 2. It seems highly unlikely that we could evacuate and collect the entire stomach contents of a live fish without harming the animal.



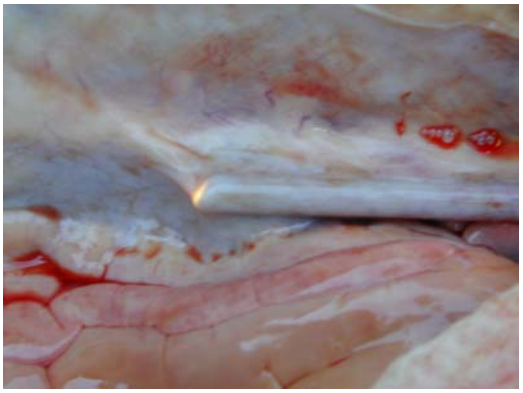
Appendix Figure 1. Lavage placement.

Bioscope

We attempted to use a bioscope to sex the sturgeon (Kynard and Kieffer 2001). We used a 4mm x 170 mm 40 degree angle arthroscope with a small, mag-lite flashlight attached as a light source. We inserted the scope into the genital pore and advanced the scope 100-150 mm into the genital canal (Appendix Figures 2 and 3). On the first two fish, we were unable to distinguish

any gonadal tissue. It was blurry and white. Occasionally we would see a small blood vessel. When these two fish were opened, they were determined to be immature males. With the third fish, we thought we might have seen granular tissue that may have been immature eggs. The canal was darker and reddish. When we opened the fish, it was determined to be a very gravid male. We may have been influenced by the girth of the fish, as it was much plumper than the first two. With practice, we can see this as a good tool for finding ripening and ripe females. It is fast and easy to do.

Appendix Figure 2. Bioscope placement.



Appendix Figure 3. Close up of bioscope.

Gonadosomatic Index (GSI)

We determined the GSI for the third fish as the quotient of gonad weight and total weight GSI=5.10 kg gonad/28.87 kg total weight x 100% = 17.67%.

Morphometrics

To attempt to develop a correction factor for previous measurements of snout-to-barbels and snout-to-mouth, we measured these on all three fish. First, the fish was measured from the center of the closed mouth and again from the mouth ridge edge in front of the mouth. These were measured using calipers and the caliper opening measured in mm using a ruler. Scute counts were done on the left side of the fish. Dorsal scute counts are from the first moveable scute posterior of the head to the dorsal fin. Lateral scute counts are from the first moveable scute posterior of the head to where the scutes angled up into the caudal fin. Ventral scute counts are from the first scute posterior of the pectoral fin to the pelvic fin. Dorsal fin ray counts are from the base of the fin prior to any ray splits and includes all rays. Anal fin ray counts are from the base of the fin prior to any ray splits and includes all rays (Appendix table 1).

Appendix Table 1. Ages, sex and measurements of three green sturgeon collected from the Columbia River, Oregon, August 2001.

Measurement or count	Fish #1	Fish #2	Fish #3
Total length	160 cm	157 cm	175 cm
Fork length	145 cm	141 cm	160 cm
Closed mouth to center of middle barbels	94 mm	85 mm	91 mm
Closed mouth to end of snout	160 mm	134 mm	154 mm
Front of mouth to center of middle barbels	67 mm	56 mm	67 mm
Front of mouth to end of snout	132 mm	108 mm	126 mm
Dorsal scute count	10	11	9
Lateral scute count	30	27	27
Ventral scute count	8	9	8
Dorsal fin ray count	35	34	32
Anal fin ray count	23	25	22
Age	17	18	27
Sex	Male	Male	Male

Ageing

A leading pectoral fin-spine section was taken from each fish, labeled, and dried. Using techniques developed for white sturgeon (Rien and Beamesderfer 1994; Brennan and Cailliet 1989), we counted annular rings in pectoral-fin spine sections. They were aged at 17, 18 and 27 years old (Appendix Table 1).

Stomach Samples

The stomachs from a section at about the air bladder insertion to the vent were removed and placed in 1-gallon resealable freezer bags, labeled, and frozen. These have not been examined to date.

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