

PROGRESS REPORTS

2004



FISH DIVISION
Oregon Department of Fish and Wildlife

Green Sturgeon Population Characteristics in Oregon

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ANNUAL PROGRESS REPORT

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Prepared by: Ruth A. Farr
J. Chris Kern

Oregon Department of Fish and Wildlife
17330 Southeast Evelyn Street
Clackamas, OR 97015

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Report A: Green Sturgeon Population Characteristics in Oregon

Ruth A. Farr – Oregon Department of Fish and Wildlife

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ABSTRACT

During May through July 2004, we used gill nets, snorkeling, smallmouth bass *Micropterus dolomieu* stomach contents, and an underwater video camera to attempt to capture or observe adult and sub-adult green sturgeon *Acipenser medirostris* and white sturgeon *Acipenser transmontanus* in the Umpqua River and Coos River, Oregon. We set 58 static gill nets for an average 1.0 h and captured no green sturgeon and one individual white sturgeon (119 cm fork length (FL)). We deployed two seine nets for an average 0.2 h and captured no sturgeon. We deployed an underwater camera 13 times for 0.1–1.5 h and observed no sturgeon. We angled eight times for 1.7 – 2.5 h to sample smallmouth bass stomachs and observed no sturgeon. We snorkeled eight times during daylight and at night and observed no sturgeon. The unmarked white sturgeon was tagged with spaghetti and passive integrated transponder (PIT) tags.

Field staff from Oregon Department of Fish and Wildlife's Gold Beach office sampled green sturgeon in the Rogue River. They set nine static gill nets for an average 0.8 h and captured eight individual green sturgeon (155-188 cm FL). All unmarked sturgeon were tagged with spaghetti tags and PIT tags. Of these, one was recaptured once. Four fish were tagged with radio, sonic, and depth-recording tags. Three fish were tagged with sonic tags and one was tagged with a satellite tag. Two adult green sturgeon (180-185 cm FL), and eight juvenile green sturgeon (13-35 cm total length) were captured during beach-seine sampling.

INTRODUCTION

Relatively little is known about the biology and life history of green sturgeon *Acipenser medirostris* and there is widespread concern and uncertainty regarding their status. 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. They are classified as “rare” in Canada, but have no special status in Washington or Oregon. In June 2001, green sturgeon were petitioned for listing under the Endangered Species Act (EPIC 2001), and in December 2001, the National Marine Fisheries Service (now National Oceanic and Atmospheric Administration Fisheries – NOAA Fisheries) initiated a status review to determine if action was warranted (Federal Register 2001). NOAA Fisheries decided that action was not warranted under the Endangered Species Act in June of 2002 (Adams et al. 2002). The Environmental Protection Information Center and the Center for Biological Diversity sued in April 2003 claiming the decision was arbitrary. The District Court for Northern California ordered NOAA Fisheries to reconsider their finding that green sturgeon do not merit Endangered Species Protection in March 2004.

The harvest of green sturgeon in Oregon has 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.

In 1999, the Oregon Department of Fish and Wildlife (ODFW) 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 documents field activities performed on the Umpqua and Coos Rivers, during spring and summer 2004 as we attempted to document presence outside of known green sturgeon spawning populations. We also report on green sturgeon catches by Wildlife Conservation Society (WCS) from work to monitor adult sturgeon movement and by ODFW's Gold Beach office, during salmonid monitoring in the Rogue River (Krohn 2004).

METHODS

Sampling Areas

We conducted field work on two Oregon river systems, the upper Umpqua and Coos (including the bay and the Millicoma, a tributary). In addition, WCS and ODFW Gold Beach conducted sampling on the lower Rogue River.

The Umpqua River Basin is located in Douglas County in southwestern Oregon and flows from the Cascade Mountain crest to the Pacific Ocean at Reedsport, Oregon. The North and South Umpqua rivers and their tributaries combine to form the main stem Umpqua River northwest of Roseburg, Oregon. The drainages of the North and South Umpqua rivers together make up about two-thirds of the greater basin drainage. The main stem Umpqua River flows in a northwesterly direction to the ocean. Together, the three rivers form one of the longest coastal basins in Oregon. The estuary of the Umpqua River has a large seawater wedge that extends inland 45 rkms (Johnson et al. 1994). Field sampling for green sturgeon and white sturgeon *A. transmontanus* was conducted in July 2004, using the underwater camera, snorkeling, smallmouth bass *Micropterus dolomieu*, stomach contents, and beach seines between rkm 154 and 180 (Figure 1). We targeted juvenile sturgeon in habitat similar to that in which a juvenile green sturgeon had been recovered from a smallmouth bass stomach (Farr and Rien 2002).

The Coos River is located in Coos County in southwestern Oregon. The Coos River enters the Pacific Ocean at Coos Bay, Oregon. Major tributaries include the Millicoma River and the Williams River. Gill-net sampling for green sturgeon and white sturgeon was conducted in May and June 2004, in Coos Bay between rkm 14 and 24, in Isthmus Slough, Millicoma River between rkm 0 and 5, and the South Coos River between rkm 0 and 11 (Figure 2). We also used the underwater camera in the Millicoma River. We gillnetted in Isthmus Slough in areas that green sturgeon had been noted from historical sampling data obtained from the ODFW Charleston office (Farr and Rien 2002).

The Rogue River is located in Curry County in southwest Oregon. It enters the Pacific Ocean at Gold Beach, Oregon. Field sampling for green sturgeon and white sturgeon was conducted in June and October 2004, with gill nets and seines between rkm 8 and 14 (Figure 3).

Sampling Gear

Large-Mesh Experimental Gill nets

In May and June 2004, we sampled Coos Bay, Isthmus Slough, the Coos River and the Millicoma River. We deployed 57 gill nets in tidally influenced water (Table 1 and 2) to capture sub-adult and adult sturgeon. Nets were fished in suitable areas for up to 1.1 h. In June and October, field staff from ODFW's Gold Beach office deployed nine gill nets in the Rogue River. Nets were fished in suitable areas for up to 1.4 h. All nets were 3.0 m deep and 61.0 m long and were constructed of 23.5-cm stretched-measure multi-strand monofilament.

Experimental Gill net

In July we set 1 gill net in the Umpqua River for 0.5 h.

Underwater Video Camera

We sampled the Millicoma River in June 2004, and the Umpqua River in July 2004. We deployed an underwater video camera (Table 1) to document juvenile sturgeon and to record habitat associated with juvenile sturgeon. We used an Atlantis AUW-525C Video Camera System attached to a Sony DCR-TRV240 Digital Camcorder¹. The camera was suspended from the boat and held at position just off the bottom while the boat drifted with the current or tide.

Angling

We angled in the Umpqua river in July 2004 for smallmouth bass to examine stomach contents for presence of juvenile sturgeon (Table 1 and 2). We used spinning gear with lures or earthworms. We angled in the late afternoon to shortly after dark. Stomachs were pumped immediately on most fish >19 cm FL and all fish were released. Stomach contents were identified to order and recorded. No stomach contents were preserved.

Snorkeling

We snorkeled in the Umpqua River in July 2004 to attempt to observe juvenile sturgeon. Snorkeling took place in approximately 5 m or less of depth in the evening before dark. Usually we teamed one person snorkeling in shallower water and one person following in the boat using the underwater video camera in deeper water. Generally floats were downstream at or slightly faster than the current velocity.

Beach Seine

In July 2004 we deployed 2 seine nets in the Umpqua River (Table 1 and 2) to capture juvenile sturgeon. Seines were used at suitable sites where gradient and flow allowed. The seine was 45.7 m long and 2.4 m deep and constructed of 4.8-mm nylon mesh, with a weighted line at the bottom and a floating line at the top.

Fish Processing

We identified fish to family and to species if possible. We measured fork length (FL) for sturgeon and smallmouth bass. We examined all fish for tags and marks. Sturgeon were tagged with both a passive integrated transponder (PIT) tag and an external spaghetti tag. The second left lateral scute was removed to indicate the fish was implanted with a PIT tag (Rien et al. 1994) and the eleventh right lateral scute was removed to indicate that the fish was handled in 2004. Tissue samples were taken from the pectoral fins and stored in ethyl alcohol for subsequent genetic analyses. No pectoral fin-spine sections were collected for age analysis during our regular sampling.

¹ The use of trade names does not constitute endorsement by the Oregon Department of Fish and Wildlife.

Table 1. 2004 schedule of effort for gears by water body and week (date shown is the Monday starting the week). A dash (--) indicates no effort.

	Water Body		
	Coos System	Umpqua	Rogue
Gillnet	7/17 (14)	7/26 (1)	6/2 (7)
Week (sets)	5/24 (21) 6/21 (22)		10/4 (2)
Seine	--	7/19 (2)	--
Week (sets)			
Camera	6/21 (0:30:32)	7/19 (4:57:06)	--
Week (h:mm:ss)		7/26 (2:47:20)	
Angling	--	7/26 (16:40)	--
Week (h:mm)			

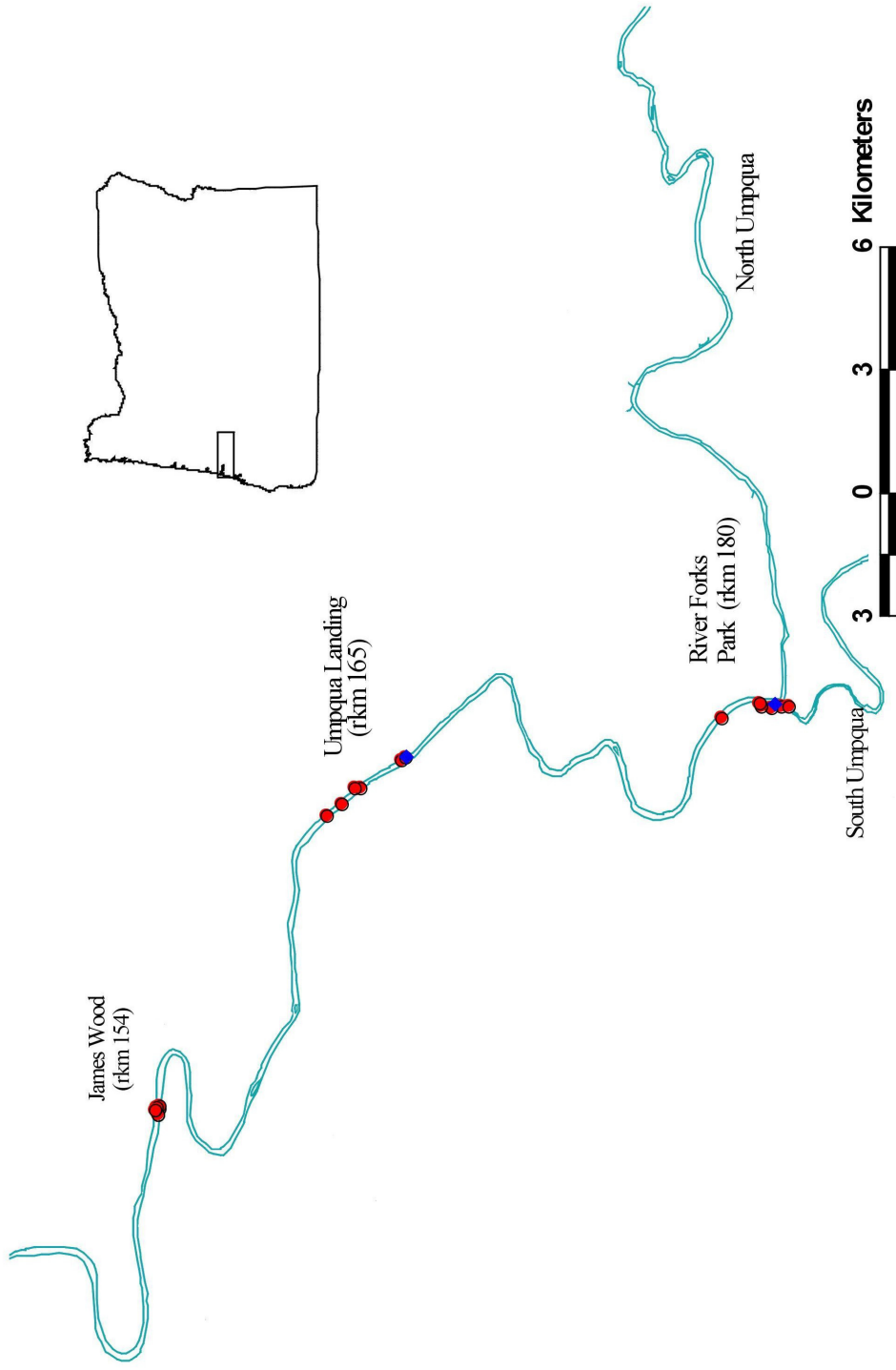


Figure 1. Umpqua River Basin, Oregon. Diamonds are seine set locations. Circles are underwater camera set locations.

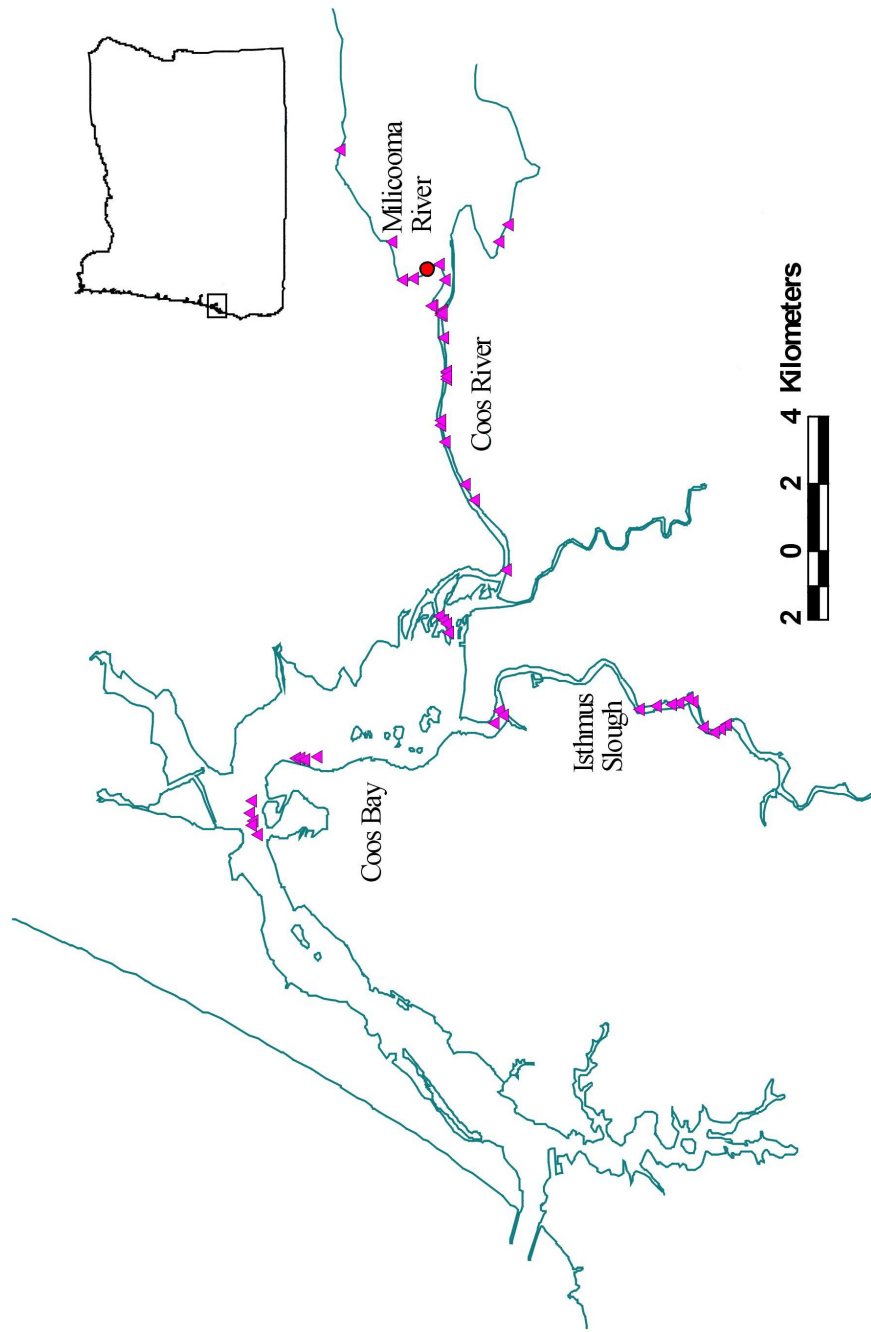


Figure 2. Coos River, Oregon. Triangles are gill-net set locations. Circle is underwater camera set location.

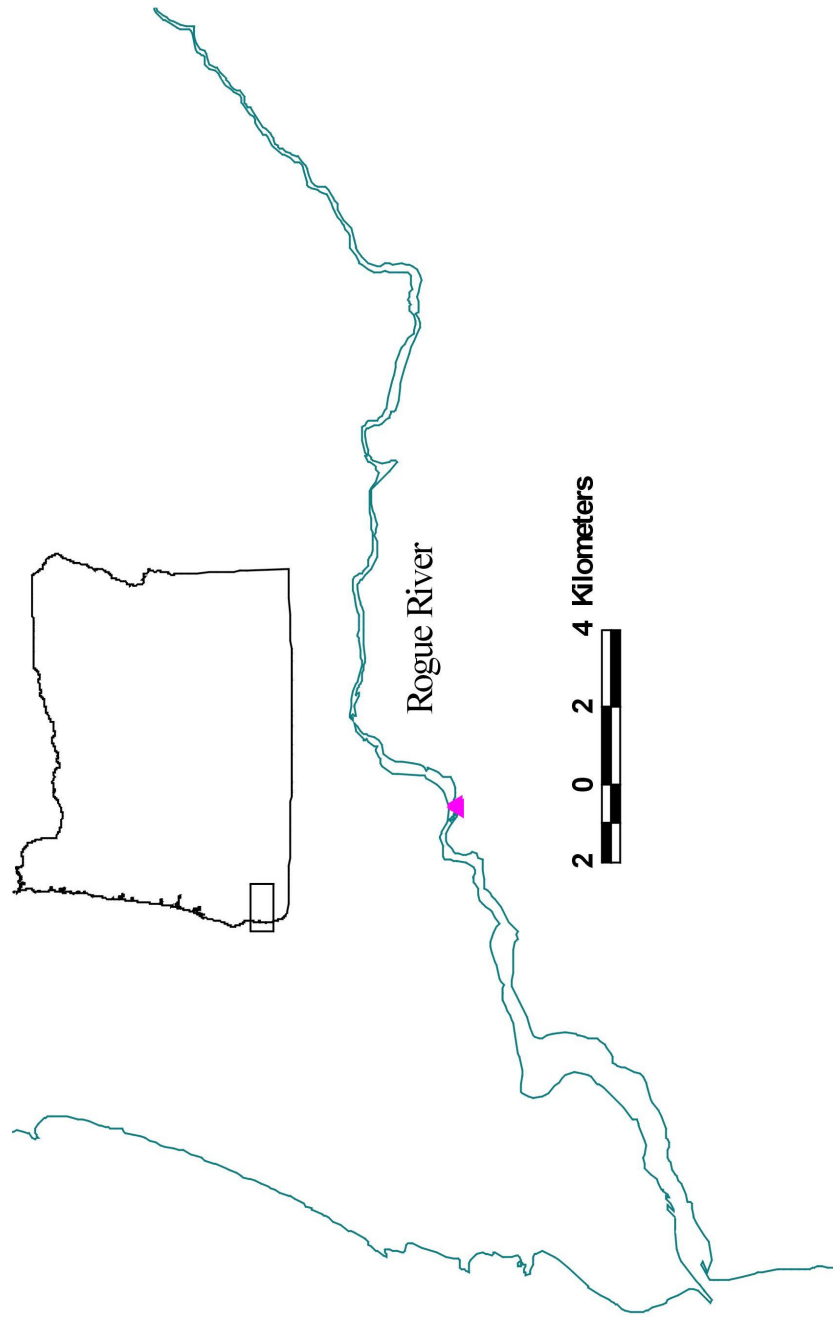


Figure 3. Rogue River, Oregon. Triangles are gill-net set locations.

Table 2. Effort (hours) by gear and water body, 2004.

Gear	Water Body	Effort					
		Sets	Hours	Mean	Minimum	Maximum	STD
Gill net							
Coos System							
	Millicoma Rive	8	8.22	1.03	1.00	1.13	0.05
	S. Coos River	23	22.57	0.98	0.38	1.07	0.13
	Coos Bay	16	16.07	1.00	1.00	1.03	0.01
	Isthmus Slough	10	10.03	1.00	1.00	1.02	0.01
	Umpqua River	1	0.50	0.50	0.50	0.50	--
	Rogue River	9	7.48	0.83	0.25	1.42	0.39
Angling							
	Umpqua	8	16.80	2.10	1.70	2.50	0.33
Seine							
	Umpqua River	2	0.47	0.23	0.22	0.25	0.02

RESULTS

Field Sampling

We did not capture or observe any sturgeon in the Umpqua River (Table 3). We captured no green sturgeon and one adult white sturgeon using gill nets in the Coos system.

We captured 33 smallmouth bass using hook and line (Table 4) and pumped the stomachs of 11 fish.

In the Rogue River, Gold Beach field staff (ODFW) captured eight individual adult green sturgeon using gill nets (Table 3). They recaptured one green sturgeon four months later at the same location. It had not grown. Two adult and eight juvenile green sturgeon were captured by ODFW in seine nets during salmonid monitoring.

Table 3. Catch by gear and water body, 2004. A dash (--) indicates no fishing effort. Numbers in parentheses are mortalities.

Gear Species	Water Body		
	Coos River	Umpqua River	Rogue River ¹
Gill net			
Green sturgeon	0	0	9
White sturgeon	1	0	0
Largescale sucker	0	8	
Striped bass	1	0	
Seine			
Northern pikeminnow	--	55 (3)	--
Redside shiner	--	99 (6)	--
Smallmouth bass	--	5	--
Largescale sucker	--	1	--
Angling			
Smallmouth bass	--	33 (2)	--

¹ No report of bycatch.

Table 4. Summary of smallmouth bass stomach contents, Umpqua River, July 2004.

Location	Number Caught	Length range (cm FL)	Stomachs Pumped	Individual FL and contents
James Wood Ramp River Kilometer 154	16	13 - 21	3	14 cm ^a 2+ Crayfish
				21 cm 1 Bullhead
				21 cm Nymphs
Umpqua Landing Ramp River Kilometer 165	4	15 - 36	2	20 cm Crayfish parts
				36 cm Nymphs
				36 cm 1 Bullhead
River Forks Ramp River Kilometer 179	13	15 - 34	6	20 cm Nymphs
				20 cm Worms
				20 cm Nymphs
				22 cm Crayfish parts
				34 cm Rock
				21 cm Nymphs
21 cm 2 Whole crayfish				
				Nymphs
				Rock

^aWe pumped this < 20 cm FL fish because of it's distended abdomen.

Table 5. Summary of green sturgeon tissue samples collected by ODFW staff for genetic assay, 2000 - 2004.

Year Location	Green Sturgeon		Intermediate ^a
	Adult and Sub-adult	Juvenile	Adult
2000			
Coos Bay, OR	1		
Pacific Ocean off Newport, OR	4		
Rogue River, OR	66	10	
Tillamook Bay, OR	6		
Umpqua River, OR	106		
Yaquina Bay, OR	11		
2001			
Coos Bay, OR	8		
Lower Columbia River, OR	160		
Rogue River, OR	49	5	
Umpqua River, OR	20		
Yaquina Bay, OR	5		1
2002			
Coos Bay, OR	2		
Rogue River, OR	96		
Umpqua River, OR	57		
Yaquina Bay, OR	8		
2003			
Coos Bay, OR	1		
Rogue River, OR	36	1	
Tillamook Bay, OR	3		
Umpqua River, OR	31		
2004			
Rogue River, OR	10	6	
Sum	680	22	1
Minimum Total Length (mm)	380	130	1,060
Maximum Total Length (mm)	2,250	335	1,060

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

DISCUSSION

This year's field sampling was directed at replicating past catches in the Coos River system of adult and sub-adult green sturgeon and documenting juvenile green sturgeon in the upper Umpqua River. We scheduled field work to coincide with expected juvenile movement calculated from juvenile green sturgeon catches in salmonid monitoring on the Rogue River. We did not capture any adult, sub-adult, or juvenile green sturgeon outside of the Rogue River system. We have not captured green sturgeon in the Coos system during two years of sampling. Anglers we have spoken to confirm that green sturgeon are not as abundant as years ago, although they say that white sturgeon are now more abundant.

The underwater camera continues to show promise as a tool to locate and observe juvenile sturgeon. We used it in daylight and at night. We were able to identify many fish and invertebrate species that ranged widely in size. We used the camera in conjunction with snorkeling and discovered it was much more effective than snorkeling at night, so we discontinued snorkeling at night and just used the camera. Snorkeling was as effective as the camera in daylight for inspecting the river bed and identifying fish and invertebrate species although it lost its effectiveness in water over 5 meters deep.

Plans for Next Year

Field sampling plans for 2005 will transition to young-of-year sampling in the lower Columbia River (see Report B this report). We will use gill nets to attempt to index sturgeon recruitment below Bonneville Dam. We will submit a completion report for the green sturgeon work to date that will include an appendix of historic data retrieved from ODFW files along with anecdotal information collected from newspapers, guides, and anglers on the presence of green sturgeon. It will also include an updated table of green sturgeon commercial, sport, and tribal harvest for Washington, Oregon, and California. The ODFW Gold Beach office will conduct limited gillnetting to attempt to capture adult green sturgeon for sonic tag implantation by the Wildlife Conservation Society (WCS). The WCS will be working under a separate contract to monitor adult movements in the Rogue River.

ACKNOWLEDGEMENTS

Michele Hughes, Chris Kern, and Tom Rien of ODFW's Clackamas office assisted with sampling. Steven West of Washington Department of Fish and Wildlife assisted with sampling. Blaire Krohn, and staff of ODFW's Gold Beach Field office and James Simino assisted by gillnetting, tagging, and collecting DNA samples from the Rogue River.

Dan Erickson, with the WCS, radio tagged fish, collected samples, and tracked potential spawning fish using telemetry in the Rouge River.

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**Report B: Indexing recruitment of juvenile white sturgeon in the
lower Columbia River, Oregon**

J. Chris Kern – Oregon Department of Fish and Wildlife

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Introduction

Expansion of catch-and-release fisheries for over-legal sized white sturgeon downstream of Bonneville Dam on the lower Columbia River has highlighted the importance of understanding and monitoring juvenile recruitment. Trends in juvenile recruitment over time and the relationship between recruitment and abundance of over-legal sized white sturgeon are critical information needs for managing this fishery. Research conducted from 1987 through 1991 described egg and larval distribution in this section of river and demonstrated that spawning occurred in all years sampled (McCabe and Tracy 1994). However, monitoring of egg and larvae only documented the occurrence of spawning. It could not characterize relative success of spawning. White sturgeon year-class strength is typically set at the young-of-year (YOY) life stage. These fish are 9 to 12 inches long in the fall and vulnerable to capture with small mesh (2-inch) gill nets (Burner et al 2000).

The objectives of this study are to:

- 1) Describe trends in annual white sturgeon YOY recruitment in the lower Columbia River and relate indices of recruitment to broodstock abundance, and fishery and habitat conditions.
- 2) Use existing white sturgeon mark/recapture information to generate an estimate of annual survival and abundance in the lower Columbia River.

In the fall of 2004, we initiated a program of annual monitoring of YOY recruitment downstream from Bonneville Dam using methodologies and gear similar to those now used in reservoirs of the Columbia and Snake rivers (Burner et al 2000). Using small-mesh gill nets deployed at designated sites, we will determine catch-per-effort and the proportion of sets capturing white sturgeon to allow inter-annual comparison of densities of YOY and juvenile fish. This methodology is not suitable to estimate abundance, and this index will be most useful as long-term monitoring to describe trends and relationships. We conducted pilot sampling in 2004 to determine index fishing sites for future efforts and to verify that methods used to index YOY recruitment in Columbia and Snake River reservoirs can be applied to the free-flowing Columbia River below Bonneville Dam, hereafter referred to as the lower Columbia River.

Methods

The lower Columbia River study area is approximately 145.5 river miles long and is bounded upstream by Bonneville Dam and downstream by the Pacific Ocean (Figure 1). Trawl surveys to capture YOY white sturgeon (McCabe and Tracy 1994) captured YOY fish from about RM 30.0 up to about RM 140, so we focused on this area in our surveys.

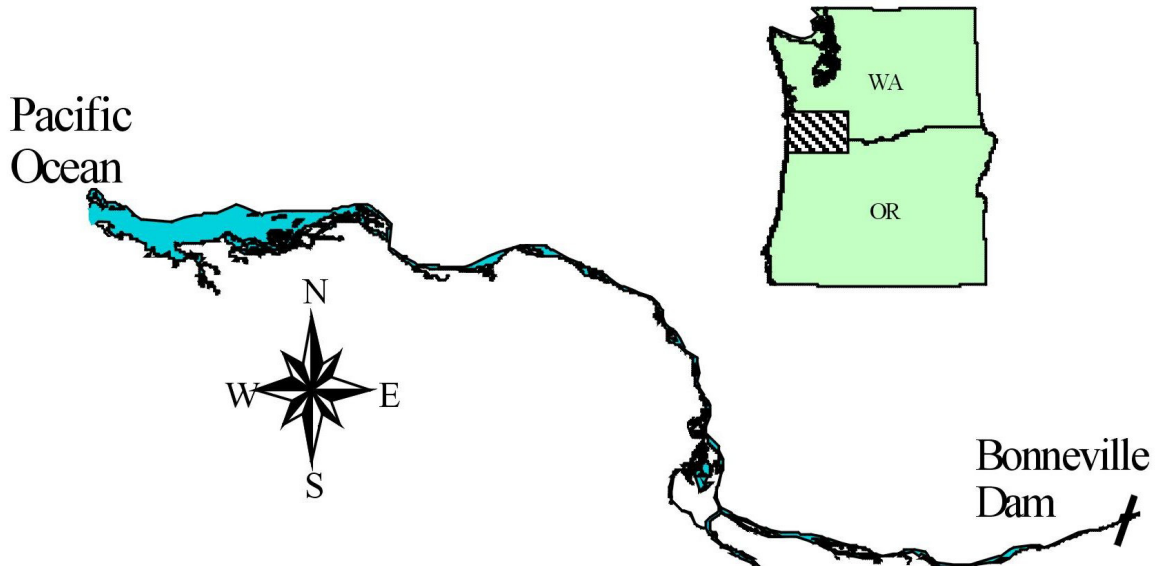


Figure 1. Lower Columbia River study area.

The amount of effort we were able to expend was limited by staff time, boat availability, and funding. In order to sample as many of the approximately 100 river miles as possible, we broke the section into four subsections of approximately 25 river miles each. We fished each subsection for one week. Methods for indexing YOY in Columbia and Snake River reservoirs typically involve fishing multiple overnight sets at the same site during the week (Burner et al 2000), however, because we needed to cover such a large area in this first phase of sample design, we fished one overnight set at each site, moving the nets to new sites each day. Our sampling protocol was to fish sections of river approximately seven river miles in length each day, selecting six sampling sites within each seven-mile section. We decided on six sets per day based upon our estimates of time required to pull gear, work fish, move to a new site, and reset gear during a workday. We generally deployed nets parallel to the shoreline to prevent problems with debris and tidal flows. We collected global positioning system (GPS) data at all sites to allow re-sampling of the same sites in the future. We fished nets overnight for less than 24 h at each site.

Because our contract was not in place, we were unable to begin sampling until late-August, and needed to complete sampling before September 30, the end of the contract period. During this period, fall chinook and coho salmon runs were beginning to peak, increasing the potential for us to capture ESA-listed salmonids in our gear. We began sampling on August 30 and fished through September 9. During the week of September 6-10, we captured three adult salmonids (two unmarked Chinook and one marked coho) that had died in the gill net. This exceeded our authorized take by NOAA Fisheries for the contract period covered in this report. Following the start of the 2005 contract period, we were able to complete our pilot sampling. Sampling resumed and was completed during the week of October 4 – 8, with the assistance of a second boat and crew from Washington Department of Fish and Wildlife.

We identified all fish to species, with the exception of sculpins, which were identified as Cottids spp. We measured white sturgeon to the nearest mm fork length, and collected pectoral fin spine sections from all white sturgeon captured to verify age as YOY or older than YOY. We did not apply any marks to captured fish. We returned all fish to the river, with the exception of three adult salmonids that expired in gillnets. These fish were kept for visual identification and reporting to NOAA Fisheries and later discarded.

We calculated catch-per-effort and the proportion of positive sets for all sites sampled. Sampling effort was measured in number of overnight sets. We also calculated proportion of positive efforts – the proportion of sets that captured at least one white sturgeon. This parameter, referred to as E_p , may be a better measure of relative densities of small numbers of fish than catch-per-effort (Counihan et al 1999), and is the parameter most often used in comparing catches of YOY white sturgeon among years in Columbia and Snake River reservoirs. We calculated catch-per-unit-effort (CPUE) and E_p for both YOY white sturgeon, and for all white sturgeon captured (YOY and > YOY).

Finally, we selected sites for future sampling using the results of this years' pilot study. We will keep the level of effort expended this year similar in the future. One crew will conduct four weeks of sampling, (or two crews and two weeks of sampling). We will continue to sample the same four subsections of the lower Columbia River (Table 1). Each site will be sampled with small-mesh gillnets overnight each day between Monday and Friday for one week, resulting in four overnight efforts at each selected site. Some of the sites sampled this year were deemed unsuitable for long-term use as index sites due to snags, safety considerations, or conflicts with other fishers. These sites were removed from consideration as permanent sites. Neither catches nor catch-rates of sturgeon were considered as criteria for elimination or retention of sites for random selection. Among the suitable sites, we numbered sites within each section from 1 – n beginning with the lowermost site and ending at the uppermost site. We then used a random number generator (<http://www.randomizer.org/form.htm>) set to randomly select six numbers from 1 to n without repetition. Sites corresponding to the six randomly selected numbers were designated as index sites. We then numbered the unselected sites in each section from 1 – n and repeated the process to select two additional sites in each section that may be fished in the event that we have overestimated the effort required to sample the primary six sites.

Results

We captured a total of 336 white sturgeon (Table 1). Although we have not completed aging as of the time of this writing, no white sturgeon greater than 250 mm fork length was assigned an age younger than age-1. Until the remaining samples are assigned ages, we are classifying all fish ≤ 250 mm as YOY, and all fish over 250 mm as older than YOY. Under these criteria, we have identified 101 of 336 white sturgeon captured as YOY.

Table 1. Young-of-year gill-net effort and catch of white sturgeon from the lower Columbia River, August – October, 2004.

Parameter	River miles				
	30.8-56.0	56.1-81.0	91.1-106.0	106.1-131.4	All
Gill net sets	17	21	21	19	78
Total Hours	357.4	436.7	481.6	423.6	1,699.2
Hours per set	21.0	20.8	22.9	22.3	21.8
Mean distance between sets (miles)	1.5	1.2	1.2	1.4	1.3
White sturgeon catch (all)	39	106	106	85	336
White sturgeon catch (YOY)	24	60	12	5	101
White sturgeon / set (all)	2.29	5.05	5.05	4.47	4.31
White sturgeon / set (YOY)	1.41	2.86	0.57	0.26	1.29
Sets w/ >0 sturgeon – E _p (all)	47%	86%	81%	95%	78%
Sets w/ >0 sturgeon – E _p (YOY)	35%	76%	33%	26%	44%

Of the 235 white sturgeon sampled that were >250 mm FL, none were larger than the current 42-inch total length (96 cm FL) minimum size for sport harvest (Figure 2). The largest fish captured was 954 mm fork length (approx. 41.5 inches total length). Of 336 white sturgeon captured, 90% (300) were returned to the river alive and unharmed. Thirty-six, mostly <250 mm white sturgeon, did not survive capture, and were returned to the river dead after sampling. Although we did not distinguish in data collection between white sturgeon that were dead at capture and those that died during processing, crews noted that most sturgeon mortalities were dead at capture.

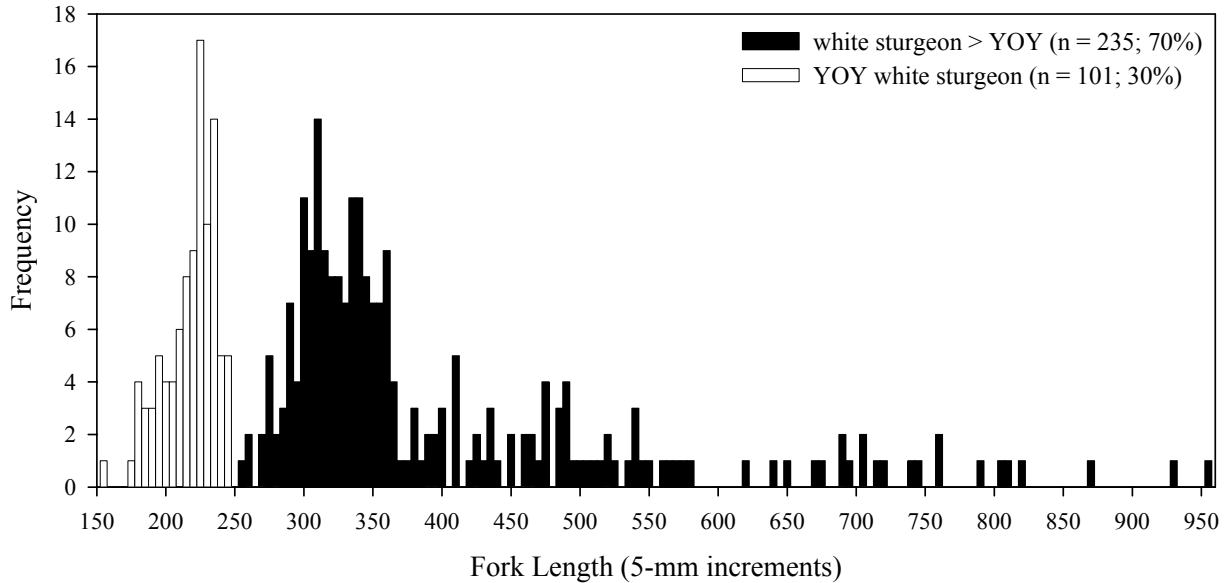


Figure 2. Length frequency distribution of white sturgeon captured during YOY index sampling, 2004.

Catch-per-unit-effort for all sites combined was 4.31 white sturgeon; for YOY white sturgeon (≤ 250 mm FL) CPUE was 1.29 fish (Table 1). We captured white sturgeon in 78% of the sets, and captured YOY white sturgeon in 44% of the sets. Catch rates for both YOY white sturgeon, and all sizes of white sturgeon were highest in the section between river miles 56.1 and 81.0. Total catch of YOY white sturgeon was more than twice as high in this section than in any other section. Total catch and CPUE of YOY white sturgeon were lowest in the uppermost section sampled, while total catch and CPUE of all sizes of white sturgeon were lowest in the lowermost section sampled. Overall, the two lowermost sections (river miles 30.8—56.0 and river miles 56.1—81.0) had the highest total catch and CPUE of YOY white sturgeon.

We captured substantial numbers of non-target resident fish species (3,562 fish; Table 2). The most abundant of these was peamouth *Mylocheilus caurinus* (3,100 fish). The majority (91%) of the peamouth we captured were dead at capture, possibly due to high water temperatures ranging from 17 to 22 C (Table 3). The next most common non-target species captured was Northern pikeminnow *Ptycocheilus oregonensis*, with 270 captured. About 30% of captured Northern pikeminnow survived capture and were returned to the river unharmed. Some American shad *Alosa sapidissima* were also captured (46), mostly juveniles. However, these fish generally did not survive capture either. About 70% of fish of other species were also dead when captured (approximately 120 individual fish).

We encountered several listed and non-listed salmonid species during our sampling (Table 2). During the week of September 7th – 9th, we captured two unmarked adult Chinook salmon and one unmarked adult coho salmon. All three of these fish were dead at capture. One adipose-clipped adult steelhead was also captured during that week, but was released unharmed. These captures exceeded our take permit from NOAA Fisheries and we were forced to curtail sampling.

Following resumption of sampling during the week of October 11th – 15th, we captured one adipose-clipped adult coho salmon (dead at capture), two unmarked juvenile steelhead (dead at capture), and one steelhead of unknown stage and origin that was released unharmed.

Table 2. Bycatch of non-target species captured during lower Columbia River white sturgeon YOY index sampling, 2004.

Species	Release Condition		Total
	Alive	Dead	
American shad <i>Alosa sapidissima</i>	1	45	46
brown bullhead <i>Ameiurus nebulosus</i>	1	0	1
Chinook salmon <i>Oncorhynchus tshawytscha</i>	0	2 ^a	2
chiselmouth <i>Acrocheilus alutaceus</i>	6	6	12
coho salmon <i>Oncorhynchus kisutch</i>	0	1 ^b , 1 ^a	2
Cottidae	7	12	19
crayfish (unidentified)	4	0	4
largescale sucker <i>Catostomus macrocheilus</i>	5	14	19
Northern pikeminnow <i>Ptycocheilus oregonensis</i>	71	199	270
peamouth <i>Mylocheilus caurinus</i>	280	2,838	3,118
pumpkinseed sunfish <i>Lepomis gibbosus</i>	2	3	5
smallmouth bass <i>Micropterus dolomieu</i>	2	3	5
starry flounder <i>Platichthys stellatus</i>	21	11	32
steelhead <i>Oncorhynchus mykiss</i>	1 ^c , 1 ^d	2 ^e	4
walleye <i>Sander vitreus</i>	0	1	1
white crappie <i>Pomoxis annularis</i>	2	1	3
yellow perch <i>Perca flavescens</i>	4	16	20
Total	408	3,155	3,563

^a unmarked adult (mortality); ^b adipose-clipped adult (mortality); ^c adipose-clipped adult (unharmed); ^d unknown stage/origin (unharmed); ^e unmarked juvenile (mortality).

Table 3. Water temperatures (degrees C) during YOY index sampling, 2004.

Date	Mean Temperature (C)
08/31	22
09/01	22
09/02	22
09/03	22
09/04	22
09/08	21
09/09	21
10/12	17
10/13	18
10/14	17
10/15	18
10/16	17

Discussion

As of the time of this writing, we have only aged approximately half of the samples we collected. In the final analysis of this year, and in all future years, all fish will be aged and YOY age assignment will be determined by aging of all fish, not by extrapolation from size. Because of contract deadlines and delays in conducting our sampling, we simply did not have time to complete this analysis prior to development of the annual report. The remaining age assignments of samples collected in 2004 will be discussed in the annual report for 2005 work.

We captured YOY white sturgeon in all sections and over 40% of the efforts. In years with densities similar to or greater than this year's, CPUE will probably provide the best comparison among years. However, because we do not know the relative YOY density in this year versus future years, we will continue to include E_p as a parameter in YOY indexing in the lower Columbia River. If future YOY densities are substantially lower, the comparison of E_p among years may become more appropriate.

In establishing the sampling protocol for future indexing, we calculated the relative power of estimates of YOY CPUE versus the number of samples collected to determine what level of effort we should expend, and what results would be reasonable to expect from the level of effort we will likely be able to expend. Using methods outlined by Eckblad 1991, we calculated the relative accuracy of estimates at varying levels of effort and statistical significance based on the mean, sample size, and variances of YOY CPUE from our preliminary results. Using these methods, we estimated that the level of effort expended during the pilot study (78 samples) would allow us to detect approximately a 24% difference in mean CPUE among years at a confidence level of $\alpha = 0.10$. If we wanted to raise that confidence to $\alpha = 0.05$, we would need to collect approximately 129 or more samples to detect a 24% difference in mean CPUE among years (Table 4). At $\alpha = 0.15$, around 50 samples could be collected for the same precision. Figure 3 illustrates the relationship between number of samples and precision at each of these confidence levels based on the variances of YOY CPUE results from pilot sampling. The flattest portions of the curves shown represent the areas where small increases in sampling effort yield the greatest increase in precision. In most cases, increasing effort beyond levels associated with the flat sections yields very little improvement in precision for a large expenditure of effort. Realistically, we would be unable to expend enough effort to detect inter-annual differences in YOY CPUE of less than about 15% without huge increases in cost and effort.

This analysis suggests that we should continue to expend a similar amount of effort in future years (~80 samples) and expect to be able, on average, to detect approximately 20% change in CPUE of YOY white sturgeon (at $\alpha = 0.10$). We may be able to dedicate slightly more effort in future years. In 2004, a significant amount of time was required to conduct our pilot methodology of moving nets to different sites each day. In future years, nets will be fished in the same locations repeatedly so some sampling time that was lost to moving gear to new locations may be dedicated to fishing more nets in future years. However, our new methods will also require more travel time between sites each fishing day. We have pre-selected additional sites to sample if 2005 sampling activities take less time per day to conduct than we estimate. If these sites are added in 2005, our intent is that they will become permanent sampling sites for future years as well.

Table 4. Summary of precision versus sampling effort at three levels of confidence based on means and variances of 2004 samples.

Precision	Number of samples needed for $\alpha =$		
	0.05	0.10	0.15
0.05	2,920	1,773	1,159
0.06	2,028	1,231	806
0.07	1,491	905	592
0.08	1,142	693	454
0.09	902	548	359
0.10	731	444	291
0.11	605	367	240
0.12	508	309	202
0.13	433	263	172
0.14	374	227	149
0.15	326	198	130
0.16	287	174	114
0.17	254	155	101
0.18	227	138	90
0.19	204	124	81
0.20	184	112	73
0.21	167	102	67
0.22	153	93	61
0.23	140	85	56
0.24	129	78	51
0.25	119	72	47
0.26	110	67	44
0.27	102	62	41
0.28	95	58	38
0.29	89	54	36
0.30	83	51	33

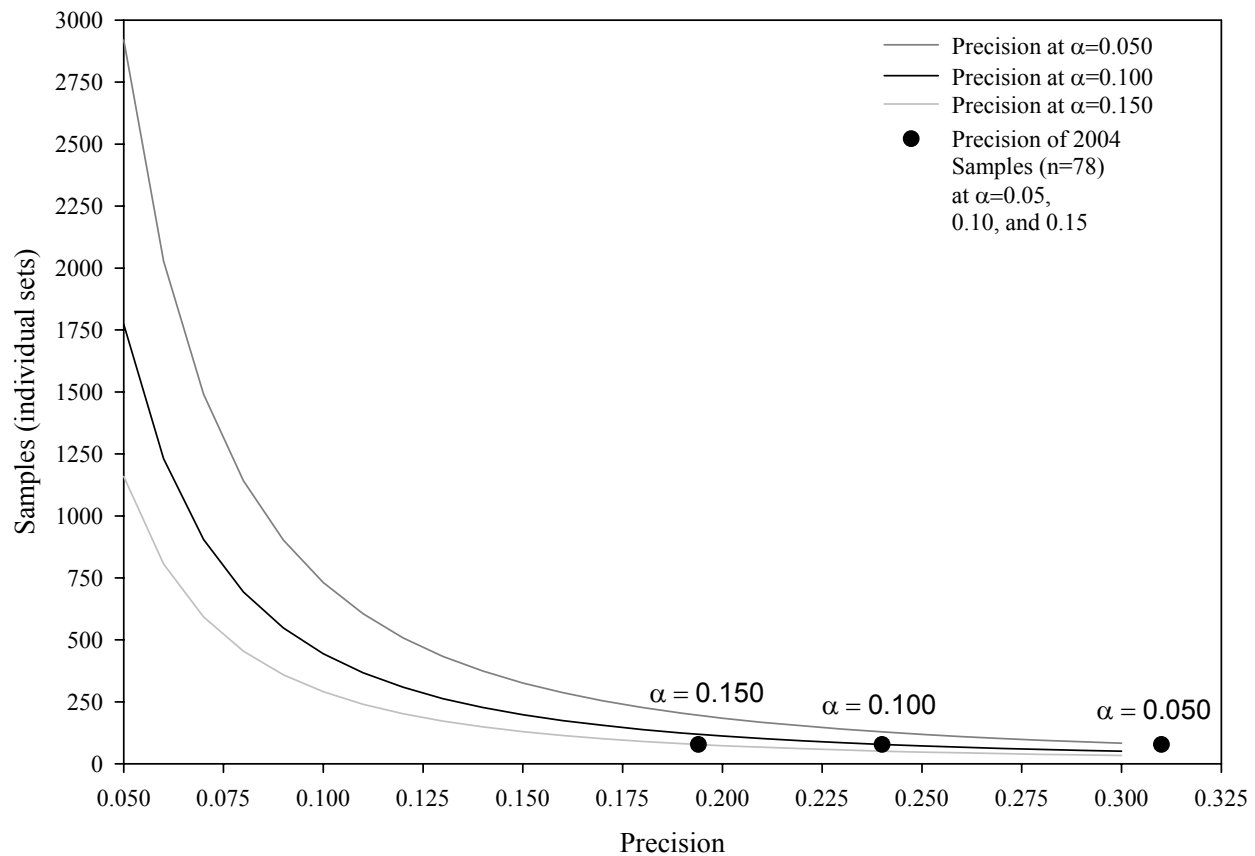


Figure 3. Relative precision of YOY CPUE estimates at increasing sampling effort. For example, a precision of 0.200 enables detection of $\geq 20\%$ difference in YOY CPUE's (at $\alpha = x$ confidence).

Sampling in 2004 resulted in a large amount of bycatch of non-target resident fish species, and a high percentage of that bycatch was killed. We suspect that this high bycatch, especially of peamouth, may be related to relatively warm water temperatures during the sampling period, which may also have contributed to the high mortality. Peamouth are quite common as bycatch in similar studies in Columbia and Snake River reservoirs, and mortality for captured peamouth tends to be quite high in those reservoirs (Appendix Table A-7 in Kern et al 2001). However, our 2004 bycatch and mortality were high even by those standards. In 2005, we hope to conduct sampling during the winter months, which may help to reduce non-target bycatch and mortality. We will also be sampling in the fall of 2005, but will try to avoid sampling during peak salmon runs. Because of the overlapping nature of salmonid runs in the lower Columbia River this will be difficult. Our results from 2004 show relatively low catches of salmonids considering that we were operating small mesh gillnets during peak run times. Our selection of off-channel sites to avoid river traffic and anglers probably also helped us avoid salmonid concentrations to some extent.

In previous studies using small mesh gillnets for YOY white sturgeon indexing, we have experienced very little mortality of white sturgeon. However, catches of small white sturgeon in these areas are relatively rare altogether. Regardless, 10% mortality is much higher than we have experienced using identical gears in other areas (Appendix Table A-7 in Kern et al 2001). Water temperatures during 2004 sampling were higher than we generally see during YOY indexing in Columbia and Snake River reservoirs, which probably contributed to higher mortality rates. In future years, we would prefer to schedule YOY indexing surveys in the lower Columbia River during times of lower water temperatures.

We intended to estimate annual survival and abundance of white sturgeon in the lower Columbia River using tag return data and the program MARK. Our past attempts to use this powerful tool have led us to believe there is a relatively steep learning curve necessary to fully utilize the program. The program developers offer workshops on a semi-annual basis, however, because of delays in finalizing the contract for this project, we were unable to meet the deadline to register for the MARK program workshop in 2004. There has been no announcement of whether or not there will be a workshop in 2005.

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**3406 Cherry Ave. NE
Salem, Oregon 97303**