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EFFECTS OF MITIGATIVE MEASURES ON PRODUCTIVITY OF WHITE STURGEON POPULATIONS IN THE COLUMBIA RIVER DOWNSTREAH FROM HCNARY DAM, AND STATUS AND HABITAT REQUIREMENTS OF WHITE STURGEON POPULATIONS IN THE COLUMBIA AND SNAKE RIVERS UPSTREAM FROM HCNARY DAM

Annual Progress Report
April 1992 - March 1993

Edited by

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Oregon Department of Fish and Wildlife

Cooperators

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U.S. Fish and Wildlife Service
National Marine Fisheries Service

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Project No. 86-50
Contract No. DE-AI79-86BP63584

DECEMBER1993

CONTENTS

EXECUTIVE SUMMARY

We report on our progress from April 1992 – March 1993 in research on white sturgeon in the lower Columbia River. The study began in July 1986 and progress through 1992 was summarized in a comprehensive report in 2 volumes (Beamesderfer and Nigro 1993a, 1993b).

This report details activities during the first year of Phase II of this sturgeon research. In Phase I, we assessed the status and habitat requirements of the white sturgeon populations in the Columbia River downstream from McNary Dam. Phase II will examine the effects on white sturgeon productivity of mitigative measures recommended in Phase I. The status and habitat requirements of white sturgeon populations upstream from McNary Dam will also be examined in Phase II.

The study is a cooperative effort by the Oregon Department of Fish and Wildlife, Washington Department of Fisheries, U.S. Fish and Wildlife Service, and National Marine Fisheries Service. Work during the past year has focused on: 1) analysis of results of limited sampling conducted in 1992, 2) submission of Phase I results to the peer-review literature to ensure widespread dissemination, clarity of presentation, and credibility of findings, and 3) preparations for additional field work in 1993. In report sections A to D, each agency reports 1992 results if applicable and the current status of manuscripts. Results of field work conducted in 1993 will be reported in the 1994 annual report.

LITERATURE CITED

Beamesderfer, R. C., and A. A. Nigro, editors. 1993a. Status and habitat requirements of the white sturgeon populations in the Columbia River downstream from McNary Dam, volume 1. Final Report (Contract DE-AI79-86BP63584) to Bonneville Power Administration, Portland, Oregon.

Beamesderfer, R. C., and A. A. Nigro, editors. 1993b. Status and habitat requirements of the white sturgeon populations in the Columbia River downstream from McNary Dam, volume 2. Final Report (Contract DE-AI79-86BP63584) to Bonneville Power Administration, Portland, Oregon.

REPORT A

1. Evaluate growth, mortality, and contributions to fisheries of juvenile white sturgeon transplanted from areas between the estuary and The Dalles Dam to areas in The Dalles and John Day reservoirs.
2. Assess quantity and quality of habitat available for use by subadult and adult white sturgeon downstream from HcNary Dam.
3. Describe the life history and population dynamics of subadult and adult white sturgeon in HcNary Reservoir and downstream from HcNary Dam.

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This report describes work completed by Oregon Department of Fish and Wildlife during April 1992 – March 1993, including publication of the results of Phase I of this research from 1986 to 1992 and plans for field work during April 1993 – September 1993.

Nine chapters of the Phase I Final Report were targeted for publication. Two of the articles have been published in peer review journals, two are in press, and two have been accepted for publication with revision. One article was published as an ODFW information report and two are still in progress (Table 1).

In addition, the following work was completed to address 3 objectives of Phase II of this research project:

Objective 1. *Evaluate growth, mortality, and contributions to fisheries of juvenile white sturgeon transplanted from areas between the estuary and The Dalles Dam to areas in The Dalles and John Day reservoirs.*

We summarized trawl catch data provided by National Marine Fisheries Service, and U.S. Fish and Wildlife Service to assess the impact of October trawling on endangered salmonids. We examined the probability of detecting significant differences in growth and survival among transported and control fish populations. We assessed the impact of removing juvenile white sturgeon on fisheries and brood stock recruitment below Bonneville Dam. In October 1993, we intend to collect and transport a small number of juvenile white sturgeon to determine catch rates and to identify potential problems with fish handling. We will use this information to prepare a detailed proposal for testing the feasibility of supplementation with transplanted fish.

Objective 2. *Assess quantity and quality of habitat available for use by subadult and adult white sturgeon downstream from McNary Dam.*

To assess availability of subadult and adult white sturgeon habitat below McNary Dam, we needed to measure habitat parameters of areas used by radiotagged fish. During April – September 1993 we will radio tag and monitor white sturgeon in Bonneville and The Dalles pools to assess the feasibility of radio tracking white sturgeon and determine the level of effort necessary to obtain adequate habitat data. This year's field sampling plans are described in detail in the appendix.

Objective 3. *Describe the life history and population dynamics of subadult and adult white sturgeon in McNary Reservoir and downstream from Bonneville Dam.*

In McNary Reservoir we will use similar gear and procedures to our previous work to capture, measure, weigh, mark, and tag white sturgeon to that used in phase I work. Our primary goals in this year's field work are to collect pectoral spines for age analysis, examine gonad samples to assess sex and stage of maturity, and obtain data on catch rates and size structure of the population to plan a comprehensive tagging program for 1994 field work above McNary Dam. Details of this years field work are provided in the appendix.

Table 1. Titles and progress for ODFW final report products (1987-1992).

Distribution and movements of white sturgeon in three lower Columbia River Reservoirs. North, J.A., R. C. Beamesderfer, and T. A. Rien. 1993. *Northwest Science* **67:105-111.**
Dynamics and potential production of white sturgeon populations in three Columbia River reservoirs. Beamesderfer, R. C., and T. A. Rien. In progress for *Transactions of the American Fisheries Society.*
Effects of impoundment and harvest strategy on potential production of white sturgeon in the lower Columbia River. Beamesderfer, R. C., and ? In progress for *North American Journal of Fisheries Management.*
Comparison of efficiency and selectivity of three gears used to sample white sturgeon in a Columbia River Reservoir. Elliott, J. C., and R. C. Beamesderfer. 1990. *California Fish and Game* **76:174-190.**
Retention, recognition, and effects on survival of several tags and marks on white sturgeon. Rien, T. A., R. C. Beamesderfer, and C. A. Foster. In revision for *California Fish and Game.*
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MOCPOP 2.0: A flexible system for simulation of age-structured populations and stock related functions. Beamesderfer, R. C. 1991. Oregon Department of Fish and Wildlife Information Report 91-4.

APPENDIX

1993 Sampling Plan

CONTENTS

INTRODUCTION

In 1986, the Bonneville Power Administration (BPA) funded a 6-year study of white sturgeon in the Columbia River below McNary Dam. The study addressed objectives of a research program implementation plan developed in response to the 1987 Fish and Wildlife Program measure 903(e)(l). Cooperative research was conducted on sturgeon populations below McNary dam by Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fisheries (WDF), U.S. Fish and Wildlife Service (USFWS), and National Marine Fisheries Service (NMFS). This research to determine the impact of development and operation of the hydropower system on sturgeon populations below McNary Dam was essentially completed in 1992. Cooperators found development of the Columbia River Basin hydroelectric system has created impoundments that severely restrict movement of white sturgeon, and degraded spawning and rearing habitat. In 1993, BPA extended funding for continued sturgeon research in this study area and above McNary Dam. The overall objectives of this research are:

1. Experimentally implement and evaluate success of selected measures to protect and enhance populations and mitigate for effects of the hydropower system on productivity of white sturgeon in the Columbia River downstream from McNary Dam.

2. Continue to examine and develop promising new measures to protect and enhance populations and mitigate for effects of the hydropower system on productivity of white sturgeon in the Columbia River downstream from McNary Dam.

3. Evaluate the need and identify potential measures for protecting and enhancing populations and mitigating for effects of the hydropower system on productivity of white sturgeon in the Columbia and Snake rivers upstream from McNary Dam.

Research in this area will be conducted over a five-year period but initial work will focus on McNary Reservoir. Given funding constraints, we will focus our efforts in the current (FY 93) performance period on addressing objectives 1 and 3, although some effort will focus on feasibility work under objective 2. This sampling plan outlines the approach of ODFW for 1993 field sampling upstream from McNary Dam and is intended to serve as a reference by field personnel.

PROJECT APPROACH AND OBJECTIVES

Our approach is to compare sturgeon populations in reservoirs above Bonneville Dam with those in the unimpounded reach below Bonneville Dam, which is as representative of historical conditions where sturgeon had access to the ocean as is now possible. Differences between impounded and unimpounded areas will be attributed to dam construction and operation.

This year our field operations will focus on: 1. The feasibility of implementing protection, enhancement, and mitigation measures between Bonneville and McNary dams and 2. Reconnaissance sampling in McNary Reservoir to design the approach to determining the status of the white sturgeon population and address the quality and quantity of available habitat.

We (ODFW-Research) are addressing the following tasks in 1993 as identified in the project proposal:

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

   Action: Assist ODFW-Management and WDF with surveys of sport and commercial sturgeon fisheries.

2. Evaluate growth, mortality, and contributions to fisheries of juvenile white sturgeon transplanted from areas downstream from The Dalles Dam to areas in The Dalles and John Day reservoirs.

   Action: Develop a plan for collecting, transporting, releasing, and evaluating survival, growth, and fishery contributions.

3. Assess quantity and quality of habitat available for use by subadult and adult white sturgeon downstream from McNary Dam.

   Action: Conduct pilot sampling to confirm feasibility and identify sample rates required to assess habitat.

4. Describe the life history and population dynamics of subadult and adult white sturgeon in McNary Reservoir and downstream from Bonneville Dam.

   Action: Conduct pilot sampling in McNary Reservoir to confirm feasibility and identify sample rates required to assess life history and population dynamics.

In this sampling plan we will address the field sampling design for tasks 3 (adult and subadult habitat availability below McNary Dam) and 4 (population dynamics above McNary Dam).

SAMPLING METHODS

Population Dynamics above McNary Dam

Sampling Areas

We have divided McNary Reservoir into eight, approximately 14-mile sections (Figure 1, Table 1). Sampling will occur during four, nine day periods during June and July (Table 2). During each period, we will sample two consecutive sections with equal setline and gill net effort in each section. Each sampling period will include two travel days, one set day, and six days for checking lines and gill net sampling (Table 3). We will utilize motels in either Umatilla or the Tri-cities area for overnight accommodations during our sampling trips.

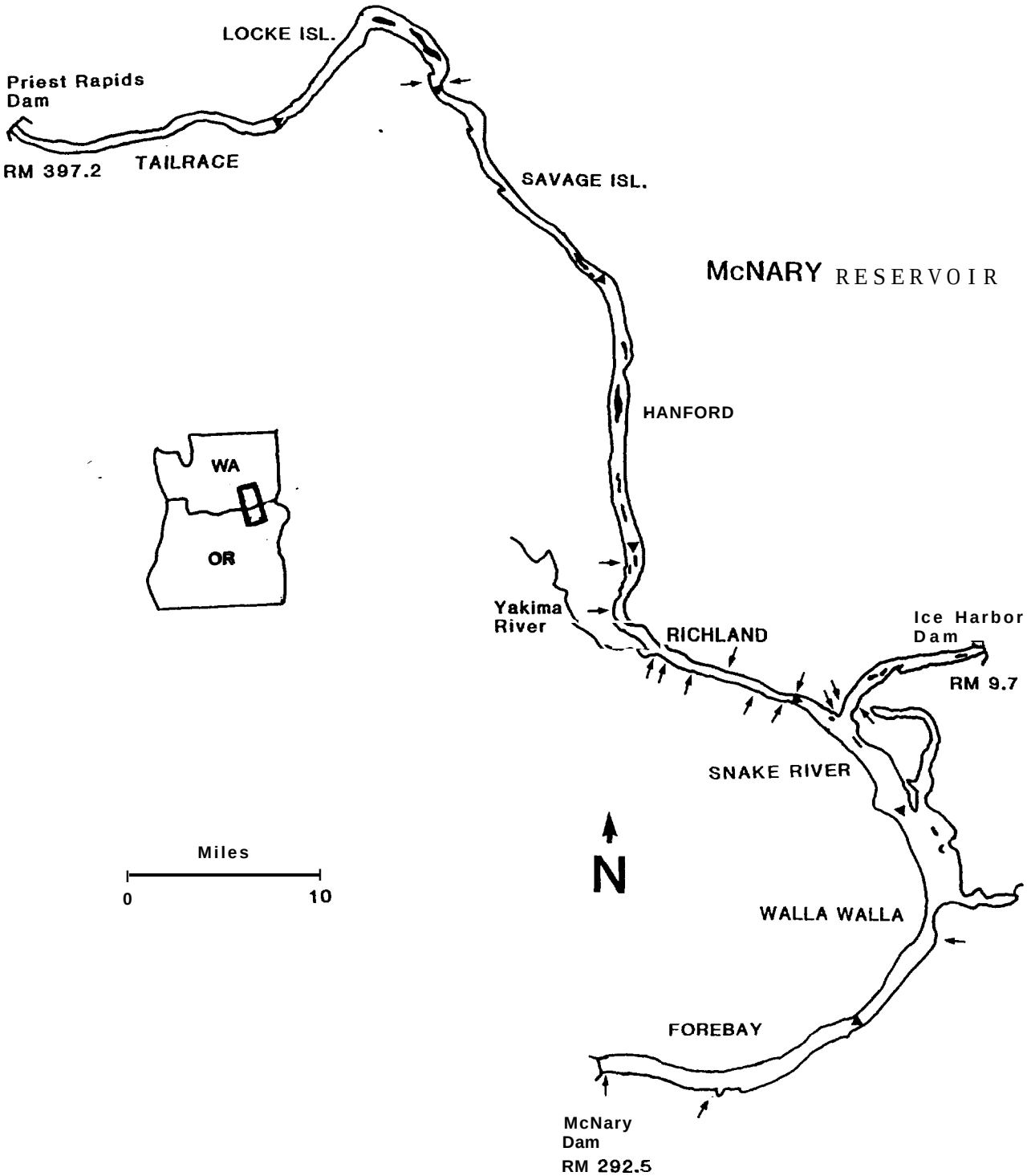


Figure 1. Columbia River from McNary to Priest Rapids Dams and the Snake River from Ice Harbor Dam to the Columbia River confluence. Sampling area boundaries are indicated by ▲'s. Boat ramps are indicated by an arrow.

Table 1. Description of McNary Reservoir sampling areas.

Section	River Miles Lower	Upper	Length	Ramps[a]
1. Forebay	292.5	306.9	14.5	McNary Dam Boat Ramp (292.5)
2. Walla Walla	307.0	321.9	15.0	Port Kelley (312.3)
3. Snake River (CR)	322.0	9.7	6.0	Sacajawea State Park (325.0)
Snake River (SR)	1.0	341.9	8.7	Hood Park (2.1)
4. Richland	328.0	[illegible]	14.0	Clover Island (328.9)
5. Hanford	342.0	355.9	14.0	Snyder Road Boat Ramp (340.5)
6. Savage Isl.	356.0	369.9	14.0	East White Bluffs (369.8)
7. Locke Isl.	370.0	383.9	14.0	East White Bluffs (369.8)
8. Tailrace	384.0	397.2	13.2	Vernita Bridge Ramp (387.9)

[a] Possible alternative ramps:
Hat Rock State Park (298.7), Pasco Yacht Basin (328.0), South Columbia Park (330.1), Riverview (331.5), Columbia Park (332.8), Columbia Avenue Boat Ramps (334.2 and 334.4), Sham-na-pum Golf Course (336.7), and Ringold Area Ramp (353.?)

Table 2. Sampling schedule for McNary Reservoir, June-July, 1993. See Table 1 for section descriptions.

Dates	Days	Reservoir Section 1	2	3	4	5	6	7	8
Jun 7-15	(Mon-Tue)	X	X						
Jun 21-29	(Mon-Tue)					X	X		
Jul 6-14	(Tue-Wed)			X	X				
Jul 20-28	(Tue-Wed)							X	X

Table 3. Proposed daily activities for McNary Reservoir sturgeon sampling, June-July, 1993.

Sampling Day	Activities
Day 1	Travel to sampling area and boat/gear preparation
Day 2	Set 8 lines and set/check 2 gill nets (Section A)
Day 3	Check/reset 8 lines and set/check 2 gill nets (Section A)
Day 4	Check/reset 8 lines and set/check 2 gill nets (Section A)
Day 5	Check/pull 8 lines and reset in adjoining section (Section A & B)
Day 6	Check/reset 8 lines and set/check 3 gill nets (Section B)
Day 7	Check/reset 8 lines and set/check 3 gill nets (Section B)
Day 8	Check/pull 8 lines and makeup any remaining gill nets (Section B)
Day 9	Travel to Clackamas and boat/gear preparation

Sampling Gears

We initially evaluated setlines, gill nets and angling as potential capture methods and are now primarily using setlines as they provide the greatest catch rates, represent the widest range of fish sizes, select almost exclusively for sturgeon, and seldom harm fish. Lines are evenly distributed throughout each sampling section. In McNary Reservoir we will set at least eight lines per day.

Setlines measure 183-m long (600 ft) and consist of a 6 mm (0.25 inch) soft lay nylon mainline with 40 circle halibut hook lines attached every 4.6 m (15 ft). Hook lines measure 0.7 m (2 ft) and consist of a 6 mm mainline snap with 4/0 swivel attached by a hog ring and gangion line tied between the swivel and hook. Hook sizes are 12/0, 14/0, and 16/0. Thirteen hooks of two sizes and 14 hooks of the third size will be placed on each line. The size with 14 hooks will be randomly chosen. Hooks are baited with pieces of lamprey.

Setlines are deployed parallel to river flow. Depth of the set is determined and float lines of the appropriate length are selected. An anchor and float line with a buoy attached are connected to the end of the mainline. The float is tossed and the anchor is lowered overboard as one person pays out the mainline while the other attaches pre-baited hook lines at marks on the mainline every 15 ft. When the first anchor reaches bottom, the third crew member backs the boat in the direction of the current or the wind (whichever is stronger) matching pace with the line setters to keep the line straight, but to avoid dragging the anchor. A second anchor and float line/buoy are attached to the downstream end of the mainline and lowered to the bottom.

Setlines are retrieved from the downstream float. The buoy/float line is snagged and hooked to the hydraulic assembly through the snatch block. The control lever is depressed to begin retrieving the line which is coiled into a bucket. The boat operator moves the boat forward as the anchor and main line are lifted off the bottom, lessening the force needed to pull the line. Whenever possible use the boat to do the work and reduce the strain on personnel and the hydraulic assembly. When the anchor comes up, it is lowered to the deck by reversing the control lever. The anchor is then removed and the carabiner attaching the main and float lines is lifted over the snatch block and repositioned on the hauler. Always make sure the mainline is attached to something so it is not dropped overboard. Again depress the control lever to retrieve the mainline, and remove hook lines before they reach the snatch block. The second anchor and float line are then retrieved.

Although we will utilize setlines as our primary sampling gear, we may use bottom gill nets to sample smaller sturgeon in the Columbia River upstream of its confluence with the Snake River. The gill nets are 45.6 m long x 2.4 m deep (150 ft x 8 ft). Each half has three panels of 3.2 cm, 4.4 cm, and 5.1 cm bar mesh monofilament nylon. We fish nets during daylight for approximately 1 hour in areas of sturgeon concentrations.

Gill nets are deployed from the bow of the boat. Attach an anchor and float line/buoy to the loop in the net bridle. Toss the float and line overboard and lower the anchor and net to the river bottom at the upstream end of the site. Back downstream slowly, untangling the net as it pulls from the

container. Attach an anchor and float line to the other bridle. Lower the anchor overboard and stretch the net straight. Attach a float to the end of this float line and toss overboard. This is the start time.

Retrieving the net is conducted reverse of the set sequence. Stop time is recorded when the first float is retrieved. Remove all fish from the net as it is retrieved and hold in the live well until the net is removed from the water. More incidental species are encountered while sampling with gill nets than with setlines.

Fish Handling

All fish cleared from a gill net should be kept onboard until the net is removed from the water to avoid re-tangling in the net. Process any incidental captured salmonids, walleye or bass first. These fish are vulnerable to handling and should be returned to the water as soon as possible. Incidental species commonly caught on setlines such as carp, catfish, and suckers need only to be counted and should be released while the line is being retrieved.

Examine each fish for tags, tag scars, or marks. The species most likely to be tagged or marked are bass, squawfish, walleye, salmon, and steelhead. Record the disposition, fork length, total length, fin clips, tag type, color and number, and collect scales (>10) from each recaptured fish. Salmonids should be released immediately unless they are tagged, in which case, try to collect total length, scales, tag number and type, and species unless this handling will jeopardize the survival of the fish. Collect scales, weights, and measurements (TL and FL) from all squawfish. Squawfish scales (>10) are removed from the left side of the fish in the area just above the lateral line and along an imaginary line from the posterior insertion of the dorsal fin to the anal fin (remove scales from the right side if it is obvious that scales have previously been removed from the left side). Collect total length, fork length, weight (dead fish only) and scales (>10) from all bass and walleye captured. Walleye and bass scales are collected from the area under the tip of the left pectoral fin. Scales are placed in a scale envelope on which all pertinent data is recorded. Record data for each individual bass, walleye, and squawfish on separate lines of the data sheet. Record the disposition and total number of other species for which no biological or tag related data is collected. All fish, except untagged squawfish, must be returned to the water regardless of disposition.

Sturgeon are placed in the live well as they are removed from the setline. Hooks may be left in the fish and later removed while processing. Large fish may have to be tied alongside the boat, and if many fish are caught, they may be worked up before the entire line is retrieved. It is important to minimize the length of time fish are onboard and out of the water. Process the stressed and oversized fish first. Two crew members work up the fish while the third records data.

Fish are processed as follows:

1. Examine the fish for tags, tag scars, tattoos, fin marks, barbel clips, and lateral scute marks.

2. Measure fork length and total length to the nearest cm.

3. Remove the 5th lateral scute from the right side as a secondary mark and the 2nd lateral scute from the right side if the fish is to be injected with oxytetracycline (FL < 80 cm and FL ≥ 140 cm). The 2nd lateral scute from the left side will be removed for fish to be tagged with passive integrated transponder (PIT) tags.

4. Inject tetracycline into muscle tissue under the first dorsal scute posterior to the head. Refer to the dosage chart **onboard** the boat for the proper amount to use for the length of the fish. Distribute large doses by injecting portions underneath several **scutes.**

5. Apply a single spaghetti tag at the anterior base of the dorsal fin of fish with fork lengths of 65 to 79 cm. Destroy and discard the second tag of the same number in sequence on the roll of tags. Apply one spaghetti tag at the anterior base and one Peterson disk dangler tag at the posterior base of the dorsal fin of fish with fork lengths 80 cm and greater (some fish may receive an additional anchor tag). When one spaghetti tag and one disk tag are to be used, ensure both tags are legible and have the same number. Clip each spaghetti tag from the roll approximately 6 mm from the last character. Insert a tagging needle into the unnumbered end of the spaghetti tag. Apply spaghetti tags by piercing the skin approximately 1.5 cm below the dorsal fin anterior origin and thread the needle and tag laterally through the body. The needle is pulled from the tag and both ends are gathered and tied in an "overhand" knot, leaving a 2-5 cm loop between knot and body and the numbered portion of the tag trailing behind the knot.

   Disk tags are applied using a double-needle applicator. Insert the applicator through the dorsal fin in the posterior position and insert both disk tag wires into the hollow needles of the applicator. The applicator is briskly removed from the fin and the wires are tightly wrapped close to the skin surface with at least four twists. Trim any excess wire.

   We may also apply intramuscular anchor tags to a portion of the sturgeon catch (FL > 80 cm). The position of application will be reviewed and discussed prior to field operations.

6. Remove a section of the right pectoral fin ray from all fish (Figure 2). A section is removed from the left fin when the right fin is deformed or the fish is a recapture that was not originally sampled within the previous 2 months based on tag numbers. In 1993, we will not take a pectoral fin ray sample from recaptured fish.

   From live fish, a piece of the leading pectoral fin ray is removed by first making two cuts with a hacksaw blade. The first cut is made within 6 mm of the articulation (knuckle) of the fin, and the second approximately 1.5 cm distal to the first cut. Avoid deep cuts which sever the fin artery. The fin ray section is then twisted free with a pliers or separated with the tip of a knife. The sample is placed into a scale envelope with the appropriate date, reservoir, river mile,

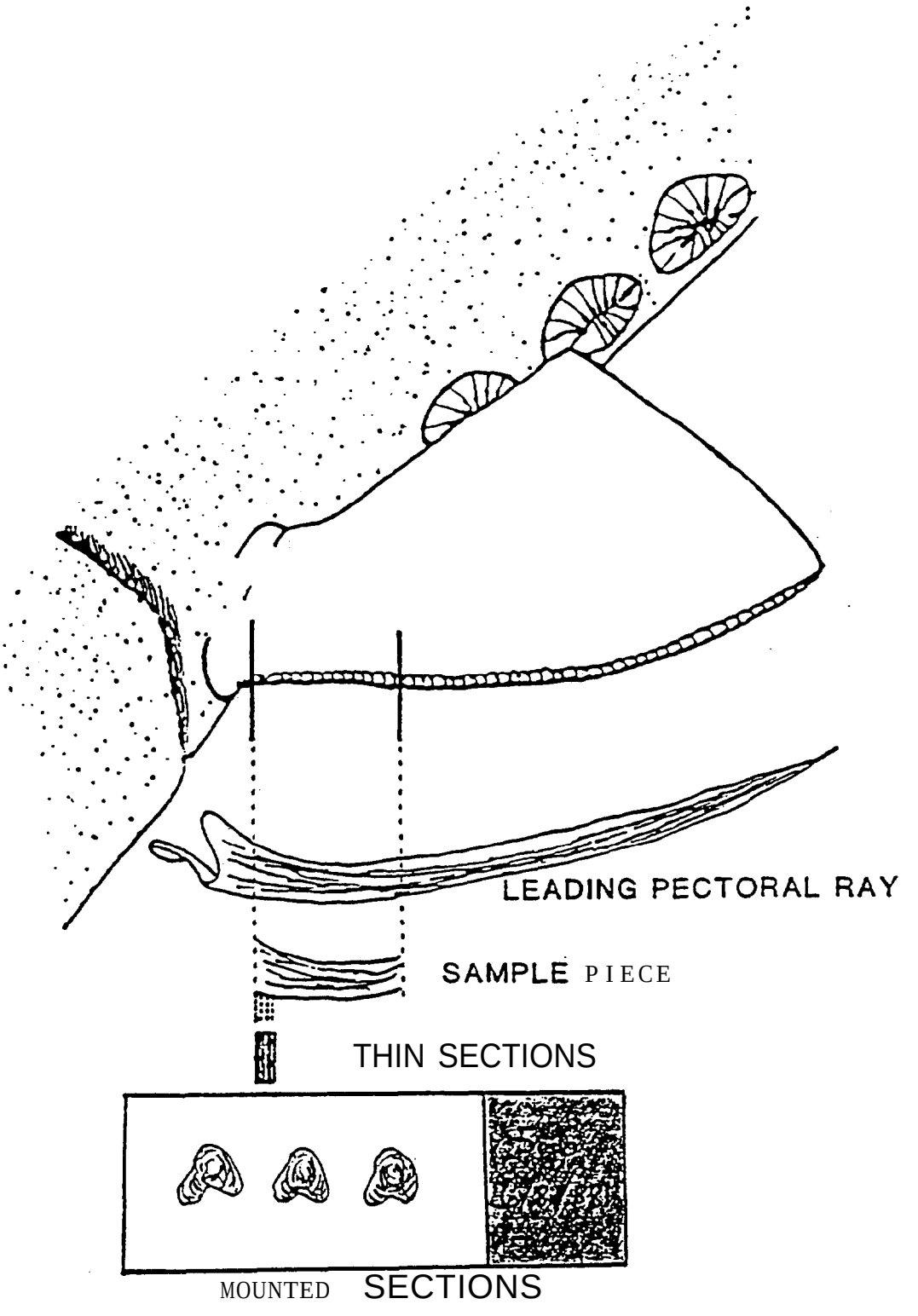


Figure 2. Location of samples of pectoral fin rays of white sturgeon collected for age analysis.

sample number, line number, fork length, and collectors initials. Write "recap" on the envelope if the fish is a recapture.

From dead fish, the whole leading pectoral fin ray including the knuckle is removed from one or both sides of the fish. The leading ray is separated from the fin by running a knife along the inner edge of the ray from tip to base. Bend the ray forward until the knuckle pops free from the socket and then cut the ray free at its base. Trim excess rays and flesh, label as above, store in a plastic bag, and freeze.

7. Surgically sample the gonads of fish with fork lengths ≥ 140 cm unless sex and maturity can be determined from eggs or milt stripped from the vent. Refer to Appendix B for surgical methods. Make sure to record observations of the condition of the gonad in the remarks section of the data sheet. Do not gonad sample recaptured sturgeon ≥ 140 cm FL if a surgery scar is already present.

8. For female and unknown sex sturgeon mortalities, the whole fish should be retained and worked up later on shore. These fish should be kept as cool as possible and out of direct sunlight. After returning to the field office, remove and preserve a sample of the gonad. Samples of developing or ripe females should come from three locations of the egg mass and have a total weight of at least 100 g. Weigh the entire gonad as well as the sample and record weights under remarks on the data sheet. Place samples in a plastic bag along with an identification tag listing the date, reservoir, river mile, sample number, line number, fork length, gonad weight, and sample weight. Add **formalin** to fix the sample.

9. Weigh all fish to the nearest 0.1 kg. Smaller fish can be weighed with a tubular scale and entered on the data sheet. Place large fish in a sling and hang from the large dial scale attached to the boom arm. Make sure the scale is zeroed with the sling in place or else be sure to subtract the sling weight. Record the fish weight in the remarks section. Upon returning to the office, convert to the appropriate units and transfer to the weight column.

10. Ensure fish are in good condition and actively swimming and all procedures have been completed for each fork length interval before releasing the fish (Table 4). Hold fish overboard or in the live well until they can maintain themselves upright and are gilling regularly. Sacrifice any fish that are doubtful and collect gonad information as if the fish was dead at capture. Be sure and change data codes to reflect the new disposition of the fish.

Surgical Procedure

The following procedure can be done **onboard** a boat, or on land. After capture, the fish is held in the live well or along side the boat until the necessary equipment and surgical items are laid out. Once this is done the fish is transferred to a hooded stretcher and positioned ventral side up. The hood is flooded and continually flushed with fresh water to aerate the gills. The remainder of the fish is covered with wet burlap to keep the fish cool and the skin moist. Care should be taken to keep all surgical instruments and

Table 4. Summary of fish handling procedures by fork length interval for McNary Reservoir, 1993.

Procedure	Fork Length (cm) 1-64	65-79	80-155	156+
Total length	Yes	Yes	Yes	Yes
Fork length	Yes	Yes	Yes	Yes
Weigh	Yes	Yes	Yes	Yes
Fin sample	Yes	Yes	Yes	Yes
Scutes:				
5th right	Yes	Yes	Yes	Yes
2nd right	Yes	Yes	No	Yes
OTC injection	Yes	Yes	No	Yes
Tags:				
Spaghetti	No	Yes	Yes	Yes
Disk	No	No	Yes	Yes
Anchor	No	No	Possible	Possible
Surgery	No	No	No	No
Blood	No	No	No	No
	0-28	28-35	35-67	68+
	Total Length (inches)			

hands sterile to avoid contamination of the incision during the surgical process. Hands should be washed with Betadyne.

Disinfect the abdominal area, three lateral scutes anterior to the pectoral fin, by swabbing with cotton soaked in zephiran chloride. Using a scalpel, make a 1.0 to 1.5 cm incision just off the mid-line through the ventral body wall being careful not to cut any internal organs. Advanced and mature female gonads will be quite large and often readily seen through the incision. If the gonad is not visible, insert the speculum of the otoscope into the opening to examine the condition of the gonads. It may be necessary to enlarge the incision to 2.0 to 2.5 cm. Gonads that are immature or in early maturation stages are not as large. The gonads are located along the dorsal and ventral sides of the body cavity. In order to observe the gonad, it may be necessary to raise the tail end of the fish to drain body cavity fluid toward the head.

Once the gonad is identified, a small sample up to 5.0 mm in size is removed with the use of tissue forceps. The gonad sample is then placed in a small vial and preserved with 10% formalin. On the vial, record the corresponding sample number, line number, and date from the data sheet. Comments on gonad condition and the surgical process are recorded in the remarks column on the back of the data sheet.
The incision is closed by using a half circle, reverse cutting edge needle, size CP-2 swedged with polydioxanone suture (PDS). When the body wall is thick (> 0.5 centimeters) a vertical mattress stitch is used (Figure 3). If the body wall is thinner, a simple stitch can be used. The sutures should be no more than 1 cm apart. They should pull the edges together but not too tight. This will prevent cutting by the sutures due to swelling which occurs during the healing process. The incision is then swabbed with zephiran chloride and allowed to dry. A surgical adhesive (Nexaband or Vetbond) is applied over the incision and sutures to protect the area for a short period of time. The fish is released and the instruments are cleaned with alcohol and stored in the Nolvosan solution.

Data Recording

Physical Sampling Information. - This data uniquely describes each setline set and is found at the top of the data sheet. Most of this information is completed when the line is first set.

1. Page__ of __. Most pages will be 1 of 1 unless more than 20 fish are captured.

2. Personnel. Initials of sampling crew.

3. Section. Reservoir and sampling section.

4. Site description. A detailed description of set location so it could be found by someone else.

5. Comments. Weather, problems, general observations, etc.

6. Sample Number. Each set will have a unique sample number l,...,n.

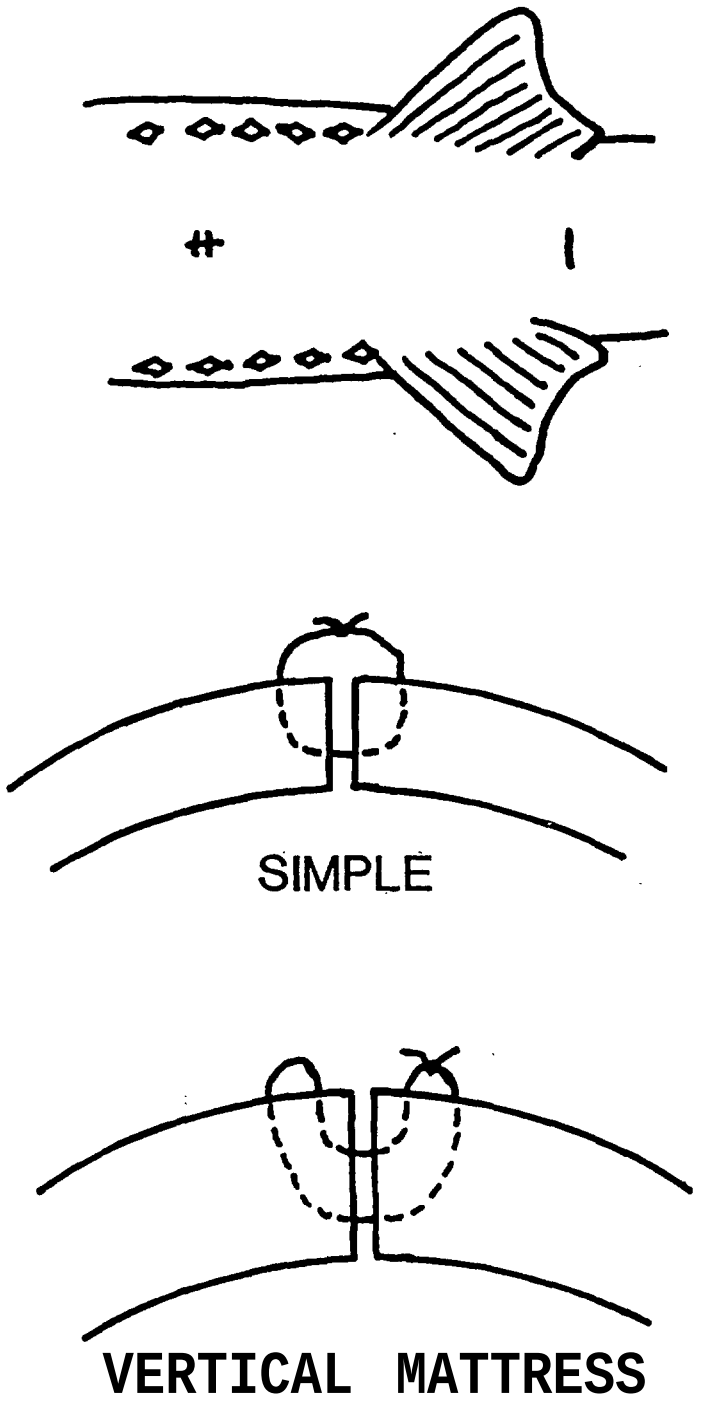


Figure 3. Stitches used to close surgical incisions in the abdominal wall of white sturgeon.

7. Gear. S=setline, G=gill net.

8. Reservoir. Reservoir code. B = Bonneville, D = The Dalles
J = John Day, M = McNary

9. Location. A five digit code: the first 4 digits are river mile to the nearest 0.1 (Appendix C). The last digit describes location relative to shore:
   1 = within 1/4 mile of WA shore
   2 = 1/4 mile from WA shore to midpoint of river
   3 = midpoint of river to 1/4 mile from OR shore
   4 = within 1/4 mile of OR shore
   If the reservoir is less than one mile wide, use codings 1 and 4 only.

10. Year. This year is 93.

11. Set Date. Month and day. June 18 is 0618 for instance.

12. Start Time. Military time. 3:30 AM is 0330, 3:30 PM is 1530.

13. Pull Date. Record like set date.

14. Pull Time. Record like start time.

15. Set depth. Minimum and maximum depth to the nearest foot observed between ends of setline.

16. Temperature. Recorded in Celsius to the nearest degree.

Biological Sampling Information. - This data is recorded for each fish. Up to 20 fish may be included on one data sheet.

17. Line Number. Each fish is recorded on a separate line except incidental species such as carp, suckers, and catfish. Lines are already numbered unless you catch 10 or more fish in which case you need to enter the first digit. If you continue onto a second page, the first digit for the first 9 fish will be a 2, etc.

18. Fork Length. To the nearest cm.

19. Total Length. To the nearest cm.

20. Weight. To the nearest 0.1 kg. Weights measured in pounds (large fish) should be recorded in the remarks section and later converted and recorded in the weight column.

21. Sex. M = male, F = female, 0 = no exam, U = unknown. Don't guess. Sex can only be distinguished from examination of gonads or sex products.

22. Disposition.
   1 = Alive at capture and released.
   2 = Alive at capture but kept and sacrificed.
   3 = Dead or in poor condition at capture.

23. Oxytetracycline. 0 = not injected, 1 = injected.

24. Gonad. 0 = no surgery performed, N = surgery performed but no gonad sample collected, Y = surgery performed and gonad sample collected. Record as performed (Y) on dead fish from which gonad samples are taken.

25. Blood. 0 = not sampled, 1 = sampled.

26. At Capture/Applied. Marks and tags present at capture/marks and tags applied after capture.

Marks.

Pect. 0 = none
L = left pectoral ray sampled
R = right pectoral ray sampled

Scute. The numeric position of anterior lateral scutes missing at capture or removed. Enter the **scute** position in the appropriate column on the data sheet. Two spaces are provided for both left and right scutes missing at capture or applied. Do not re-scute a recaptured fish unless oxytetracycline will be injected and the fish will have at least one good pectoral fin ray when it is recaptured the third time.

Tags.

Ant. 0 = never tagged or not applied
L = tag lost, scar visible
S = spaghetti tag present or applied
d = disk tag present or applied

Post. o = never tagged or not applied
L = tag lost, scar visible
S = spaghetti tag present or applied
d = disk tag present or applied

PIT tag 0 = none present or applied
1 = passive integrated transponder tag present or applied

Other A=anchor, R-radio. Radio tag frequencies for tags applied are recorded on the reverse side of the data sheet with the corresponding line number

27. PIT/Spaghetti/Disk Tag Number. The tag coding sequence of PIT tags or the reservoir prefix and number of spaghetti, disk, and anchor tags on fish at capture or applied. For example: **7F71310** for PIT tags and JD50347 for spaghetti, disk, and anchor tags. Record the tag characters and numbers in the appropriate columns. Leave or replace spaghetti and disk tags from recaptured fish according to the following:

Do not retag
Single or both tags in fair/good condition

Single tag in poor condition with no migration
Both tags present but in poor condition (swollen or migrated)

Retag
Single or both tags missing at capture
Single tag in poor condition and migrated
One tag lost and one tag swollen and migrated

28. Morphometry Measures. Head and snout lengths to the nearest mm. Snout length is measured (with calipers) in a straight line from the midline tip of the snout to the anterior orbital of the eye. Head length is measured in a straight line from the midline tip of the snout to the posterior edge of the operculum at its dorsal articulation with the cranium. Both measurements should be taken on the left side of the fish unless some deformity exists that would bias either measurement. Do not record measurements if the snout is obviously deformed.

29. Incidental Catch. The species code and number collected. Codings for commonly encountered species are located on the bottom of the data sheet. Record each species of fish on separate lines and within any species, separate lines are used for each fish for which data other than disposition, number, and species are collected. The species coding for sturgeon does not need to be recorded.

30. Remarks. 0 = no remarks, 1 = remarks recorded on back of sheet. Be sure to record the corresponding line number on the back of the sheet. The remarks section is used to record anything out of the ordinary. On all recaptures, write out which marks and tags are present at capture, and which are applied. On all surgery fish, describe the condition of the gonads or the outcome of the surgery i.e. "unable to locate gonad, no blood taken". For surgery fish, clearly indicate if a gonad sample is taken. Record whole gonad and sub-sample weights from mortalities. Record large fish weights and indicate if the weight includes the sling.

EXAMPLE (Figure 4 - Data sheet)

On the second day of the field season, you check a line set in the McNary Forebay and catch six sturgeon. Five of the six are untagged with lengths of 50, 73, 97, 139, and 182 cm FL. The 6th fish (FL 109 cm) is a recapture with a posterior disk tag in poor condition that reads "JD50630 ODFW CLACKAMAS, OR 97015") a tag scar in the anterior position, the 4th scute on the left side missing, and a deformed leading ray on the left pectoral fin and a fin ray scar on the right pectoral fin. The incidental catch includes four carp, two channel catfish, and three squawfish. One squawfish is a recapture with a posterior white spaghetti tag (# 40117), and a lower caudal lobe clip.

Handle fish and record data as follows: The carp and catfish are counted and released as the line is retrieved. The untagged squawfish can be killed and set aside or placed in the live well with the tagged squawfish and handled after the sturgeon. Work up the large sturgeon first to minimize stress. The 182 cm FL fish gets the full treatment because it is $\geq$ 140 cm FL. This includes tetracycline injection, surgery, blood sample, right fin ray sample,

5th right and 2nd right scutes removed, one spaghetti tag, one disk tag, possibly an anchor tag, weight, and measure (FL and TL).

The 50 cm FL fish is injected with tetracycline, weighed, measured, a section of the right fin ray is removed, and the 2nd and 5th right scutes are removed because it is < 65 cm FL. The 73 cm FL fish receives tetracycline, a fin ray sample, weight, measurement, scute marks and a single spaghetti tag because its between 65 and 79 cm FL. The 97 cm FL fish is fin ray sampled, weighed, measured, 5th right scute removed, one spaghetti tag and one disk tag, and possibly one anchor tag applied because it is between 80 and 139 cm FL. The 139 cm FL fish is measured, weighed, right pectoral fin sampled, the 5th right scute removed, and tagged with spaghetti, disk, and possibly one anchor tag since it is between 80 and 139 cm FL.

For the recaptured sturgeon, all marks at capture are recorded. No additional scute marks are applied. The original tag is removed and replaced with two same-numbered tags because one tag is missing at capture and the other tag is in poor condition. The fish is measured and weighed. No fin ray sample will be taken because one fin ray is deformed and the other has already been taken. No oxytetracycline will be applied.

The tagged squawfish is measured for fork and total length, weighed, record tag type, color (as a prefix) and number, scale sampled, and fin clip and disposition recorded.

FIGURE 7.

ODFW WHITE STURGEON RESEARCH DATA SHEET

Personnel TR, RF, JN

Section McMary - Foreboay

Site Description 150 yds off WA shore, straight across from Hat Rock State Park

Comments 1 hr wind, warm

SAMP. NO.	GEAR	LOCATION			YEAR	SET DATE		START TIME		PULL DATE		PULL TIME		SET DEPTH		TEMP °C
		S	MILE	¼		MO	DAY	HR	MIN	MO	DAY	HR	MIN	MIN	MAX	
0011	SM	29	8	7	1993	06	07	10	20	06	08	09	42	75	82	10

LINE NUMBER	LENGTH FORK (cm)	LENGTH TOTAL (cm)	WEIGHT (kg)	SEX	DISPOSITION	OXY & BLOOD	GONAD	PECT	AT CAPTURE: LATERAL SCUTE SCARS L	AT CAPTURE: LATERAL SCUTE SCARS R	AT CAPTURE: ANT	AT CAPTURE: POST	AT CAPTURE: OTHER	AT CAPTURE: PIT/SPAGHETTI/DISK TAG NUMBER	APPLIED: PECT	APPLIED: LATERAL SCUTES REMOVED L	APPLIED: LATERAL SCUTES REMOVED R	APPLIED: ANT	APPLIED: POST	APPLIED: OTHER	APPLIED: PIT/SPAGHETTI/DISK TAG NUMBER	MORPHOMETRY MEASURES (mm) HEAD	MORPHOMETRY MEASURES (mm) SNOUT	INCIDENTAL CATCH: SPP.	INCIDENTAL CATCH: COUNT	REMARKS
1																								CP	4	0
2																								CC	2	0
3					2																			SQ	2	0
4	1812	2011	54.98	F	1	Y	1								R	a	5	S	d	A	JD 1010101037	1168				1
5	510	517	1.900	1	1	0	0								R	a	s					1218	151			0
6	1713	812	2.960	1	1	0	0								R	2	5	S			JD 1010101	1516	1616			0
7	917	1018	1.697	0	1	0	0	0							R		5	S	S	A	JD 1 1010102	1714	1717			0
8	1319	1513	2.295	0	1	0	0	0							R		5	S	S	A	JD 1 1010013	2129	1011			0
9	1019	1212	1.698	0	1	0	0	0	R	4		L	d		JD 1501613 10			S	d		JD 1 1010014	2101	1914			1
10	316	319	.94	U	1							S			W 1401 1 11	17								SQ	1	L
11																										
12																										
13																										
14																										
15																										
16																										
17														I I I III												
18																					I I I III					
19																										
20																										

SEX: 1=MALE, 2=FEMALE, 0=NO EXAM, U=UNKNOWN

DISPOSITION: 1=ALIVE & RELEASED, 2=KEPT/SACRIFICED, 3=DEAD

OXY & BLOOD: 0=NO, 1=YES

GONAD: 0=NO SURGERY, N=NO SAMPLE, Y=SAMPLE KEPT

PECT TAGS (ANT/POST): 0=NONE, L=LEFT, R=RIGHT

PIT TAG: 0=NONE, L=LOST, S=SPAG., d=DISK

OTHER TAGS: 0=NONE, 1=PRESENT

INCIDENTAL SPP.: A=ANCHOR, R=RADIO; SQ WA SB LB CC CP BSU CSU PM SS ST CH SH

FIGURE 4. (Continued)

SAMPLE NUMBER: 001

LINE	TRANSMIT FREQUENCY	REMARKS
4		- Surgery - At Capture: No marks, Applied, R pect, 2nd & 5th R scutes, Ant. Spag., Post dish, Anchor JD 10000, Got sample of ripe eggs, good
		blood sample. Surgery went well, Fish not stressed. Took wt + length, weight w/o sling = 121 lb's, Took morphometry
9		- Recap: At capture: Ant. tag scar, Post dish tag in poor condition. # JD 50630 4th L scute missing, R pect sample, L pect
		deformed Applied: No pect. No scutes, removed old tag and applied Spag. Ant and Dish post., No oxy, took
		length, wt., Morphometry. No anchor tag applied.
10		- Recapture: At capture: Post. white spag tag # 40117 (good condition), lower lobe caudal fin clip Applied TL & FL,
		scales from right side, weighed, released.

Field Equipment Checklist

Boat

Radio	Spark plugs	Flares	Scrub brush
Fathometer	Spare propeller	First aid kit	Wash bucket
Tool box	Charged batteries	Life ring	Knife
Flashlight	Fuel	Horn	2 anchors
Paddles	Outboard oil	Fire extinguisher	Boat hook
Maps			

Setlines

Set day.

- Leather and Cotton gloves
- 10 lines (2 trash cans full)
- 20 floats
- 20 anchors
- Cooler with freshly baited hooks
- Bucket of 50 ft float lines
- Bucket of 75 ft float lines
- Bucket of 100 ft float lines
- At least 40 carabiners

Subsequent days.

- Leather and Cotton gloves
- 2 spare lines
- 2 spare floats
- 3 spare anchors
- Cooler with new bait
- Spare 50 ft float lines
- Spare 75 ft float lines
- Spare 100 ft float lines
- Spare carabiners
- Spare gangions
- Hook sharpener
- Spare bait

Fish Processing

Data Sheets	Measuring board	Measuring tape	Calipers
Weighing scales	Hack saw	Scale envelopes	Locking pliers
Knife	Diagonal cutters	Hooded Sling	Burlap
Tetracycline	Filled OTC syringes	OTC Dosage chart	Cooler

Disk tags & applicator
Anchor tags & applicator
Spaghetti tags & tagging needles

Surgery

Scalpels	Spare blades	Cotton balls	Sutures
Tissue forceps			
Hemostats	Scissors	Otoscope (charged)	Speculums
Arthroscope	Light source	Fiber optic cable	
Zephiran Chloride	Nolvasan Adhesive	Betadyne	Alcohol
Formalin	1.5 ml tubes		

Personal

Coveralls	Rain jacket	Life vest	Lunch
Warm clothes	Rain pants	Sun glasses	Sunscreen
Uniform shirt & hat	Boots	Water	

Adult and Subadult Habitat Availability Below McNary Dam

In cooperation with ODFW's Predator Control Evaluation (also funded by BPA), northern squawfish and white sturgeon will be monitored by a Predator Control crew on a White Sturgeon project boat. We will capture white sturgeon in early April using setlines for attachment of radio transmitters. We will be working in Bonneville and The Dalles reservoirs and will concentrate effort where catch per unit effort (CPUE) has been highest in previous early season work. These areas, coincidentally, will spread the effort throughout the reservoirs. If we fail to capture the needed number of fish within a week in each reservoir, we will concentrate sampling in tailraces of the dams (where CPUE is typically very high).

Radio Tag Application

Telemetry transmitters (48-50 Mhz) will be attached to 20 white sturgeon (10 in each reservoir). Within each reservoir, two fish <40 in. total length (TL), four fish 40 - 60 in. TL, and four fish >60 in. TL will be radio tagged. Sturgeon will be monitored by airplane, by boat, and possibly by car May 3 - September 23. Upon relocation of a radio-tagged fish water velocity and depth will be measured, and substrate type will be classified.

The radio transmitters will be attached to the dorsum of half of the sturgeon we tag and surgically implanted in remaining fish. The procedure for dorsal attachment of transmitters is to sterilize instruments and transmitter attachment wires using chlorhexidine diacetate before each use. Two large gauge hypodermic needles are inserted through a pad of neoprene fabric, into the fatty tissue along the dorsum posterior to the point of maximum girth and beneath the dorsal spine ridge. The needles are then inserted through second pad of neoprene. The stainless steel attachment wires of the transmitter are threaded through the inserted needles, the needles are removed, and the wires are twisted snugly to the pad (Figure 5).

Surgically implanted tags are placed in the abdominal cavity of the fish. The transmitter lies on the internal ventral surface of the abdominal cavity and the antenna protrudes through a small incision anterior to the tag. Sterile procedures, incisions and suturing techniques are described in the procedures for biopsy of fish above McNary Dam. Tags will not be placed in ripe females. The procedure for implant requires two incisions just off the abdominal midline and anterior of the pelvic fins. The incisions are spaced 1.25 transmitter lengths apart. The anterior incision is made large enough to insert the transmitter, the posterior incision is just large enough to accommodate the diameter of plastic tubing. Tubing is inserted in the large incision and out the small incision. The transmitter antenna is threaded into the anterior tubing end, the transmitter is inserted through the large incision, and the tubing is pulled through the small incision. The incisions are sutured closed; the antenna is stabilized within the suture loop for the small incision.

Radio Tracking

Airplane flights will be made about every other week on Mondays. These flights will provide preliminary location data used to establish areas that will monitored by boat in the intervening time. The crew will work four, 10-

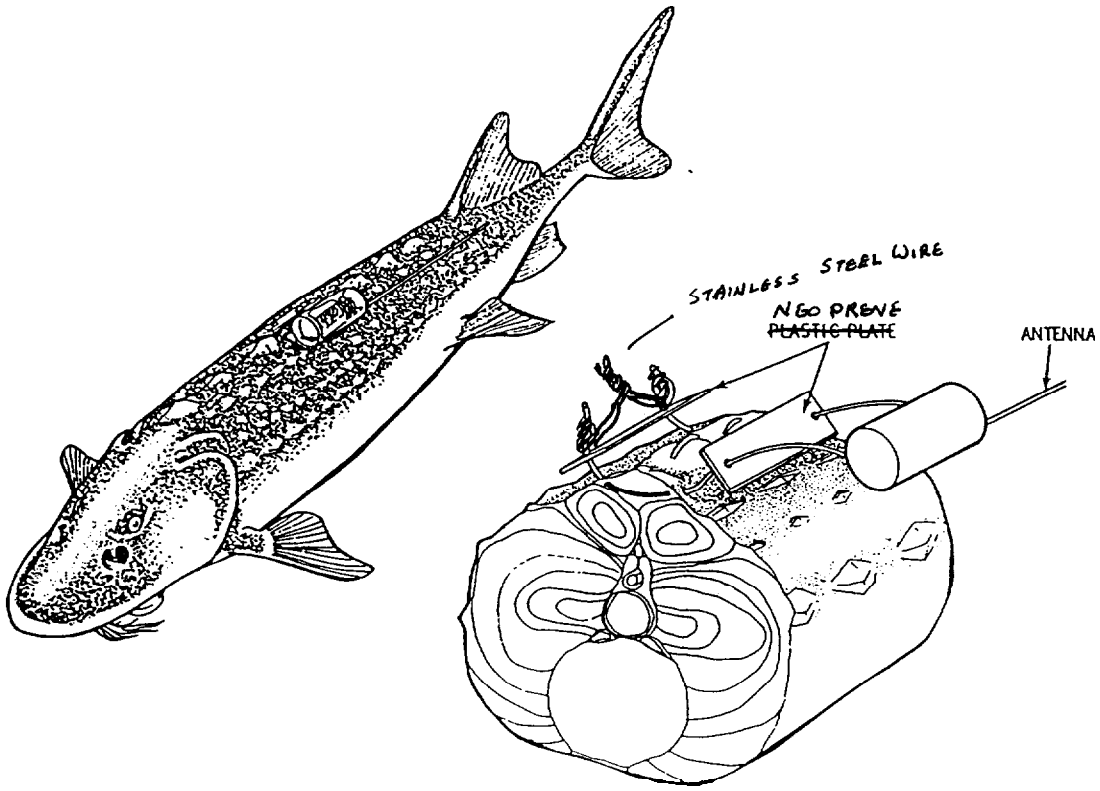


Figure 5. Attachment of external radio transmitter to white sturgeon.

hour days per week: two days in Bonneville pool and two days in The Dalles pool. Using locations from flights the crew will start monitoring in areas where fish were last found. If possible the crew will also monitor by vehicle in the weeks when no flight occurs or if the fish can't be found in a timely manner later in a flight week. During the sampling season we will monitor diel sturgeon movements in The Dalles pool: two days in May and two days in September.

Each reservoir is divided into two monitoring sections (an east and west half). One section is monitored each day. The general sampling pattern in eastern *(western)* halves is to: Launch at the ramp closest to the furthest downstream *(upstream)* fish location as determined by the flights and proceed to that location. Work in a zigzag pattern between one shore (Oregon or Washington) and mid-channel. When the shift is half over or at the furthest upstream *(downstream)* fish location within a section, return to the starting point working the other shore to mid-channel zigzag pattern. In western halves transpose the words *upstream* and *downstream* in the pattern description. Adjustments to the monitoring procedure may be made by project supervisors to maximize the number of tags located or improve distribution of monitoring.

To locate a radio tag use an omnidirectional or yagi antenna, and set the RF (radio frequency) gain of the receiver to maximum. After finding a fish switch to the hand held loop antenna, and turn the RF gain down. Using peak and null signals continue moving toward the fish while turning the RF gain down until you are confident you are over the fish. At this point fill out the data sheet and mark the position on the maps in pencil and fill out the data sheet.

Habitat Data Collection

Habitat data (water depth, water velocity, and substrate type) will be collected as time allows. Measure depth from the fathometer. Measure water velocity at one-third, two-thirds and just off the substrate. For example, if the depth is 60 feet, measure velocity at 20, 40, and 59 ft. Collect a substrate sample using a ponar dredge deployed by hand and retrieved with a hydraulic winch. Categorize the substrate according to the particle size: silt/mud, sand, gravel, etc.

Data Recording (Figure 6 - Data Sheet)

1. Date: YY=Year (93) MM=Month (Ol=January) DD=Day (03=the 3rd).

2. Pool: the pool you are working in (02=Bonneville pool, 03=The Dalles pool).

3. Gear: the vehicle or vessel you are using to find the fish (A-airplane, B=boat, C=car/truck, H=helicopter).

4. Sample number: unique sequential number for each data sheet starting with 0001. Each sheet will have a new number all season. (0001, 0002, 0003, etc.)

5. Personnel: the initials or names of the crew. The person filling out the data sheet puts their name/initials first.

6. Pool: write out the name of the pool you are working in. This is a double check for verification.

7. Species: the species of fish that frequency was assigned to. STG=white sturgeon, SQ=Northern squawfish (check the list of frequency assignments in the data book).

8. Time: time of the day in military time (8:23 AM=0823, 1:13 PM=13:13)

9. Frequency: the frequency of the fish you found as read off the receiver.

10. River mile: as determined from your maps, to the nearest tenth. (124.7)

11. Map number: the number in the upper middle of the map that coordinates with the location of the fish.

12. Distance to: when you find the fish, take a measurement (in meters) with the range finder to both shores. Box A is to the Oregon shore, box B is to the Washington shore. If the distance is greater than 1,000m, enter 9999 in the box.

13. Distance : if a day marker, range marker or navigation buoy is within 1,000 m of the fish location take a third reading with the range finder to the marker. Box A is for the color of the marker (R=red, G=green, O=orange, B=black). Box B is for the number that is on the marker. Box C is to put if you are downstream (D) or upstream (U) of the marker. Box D is to put the actual distance (in meters) to the marker.

14. Depth: the depth in feet as measured with the fathometer.

When tracking sturgeon and taking habitat data flip the data sheet over to enter the remaining habitat data. The comment section is also on the back. (see instruction number 19).

15. Sample #: transfer sample number from the front of the data sheet.

16. Line #: enter the line number corresponding to the line number on the front of the data sheet. For instance if the data is for a fish on line 6 on the front, put 6 in the line number box for each line corresponding to that fish.

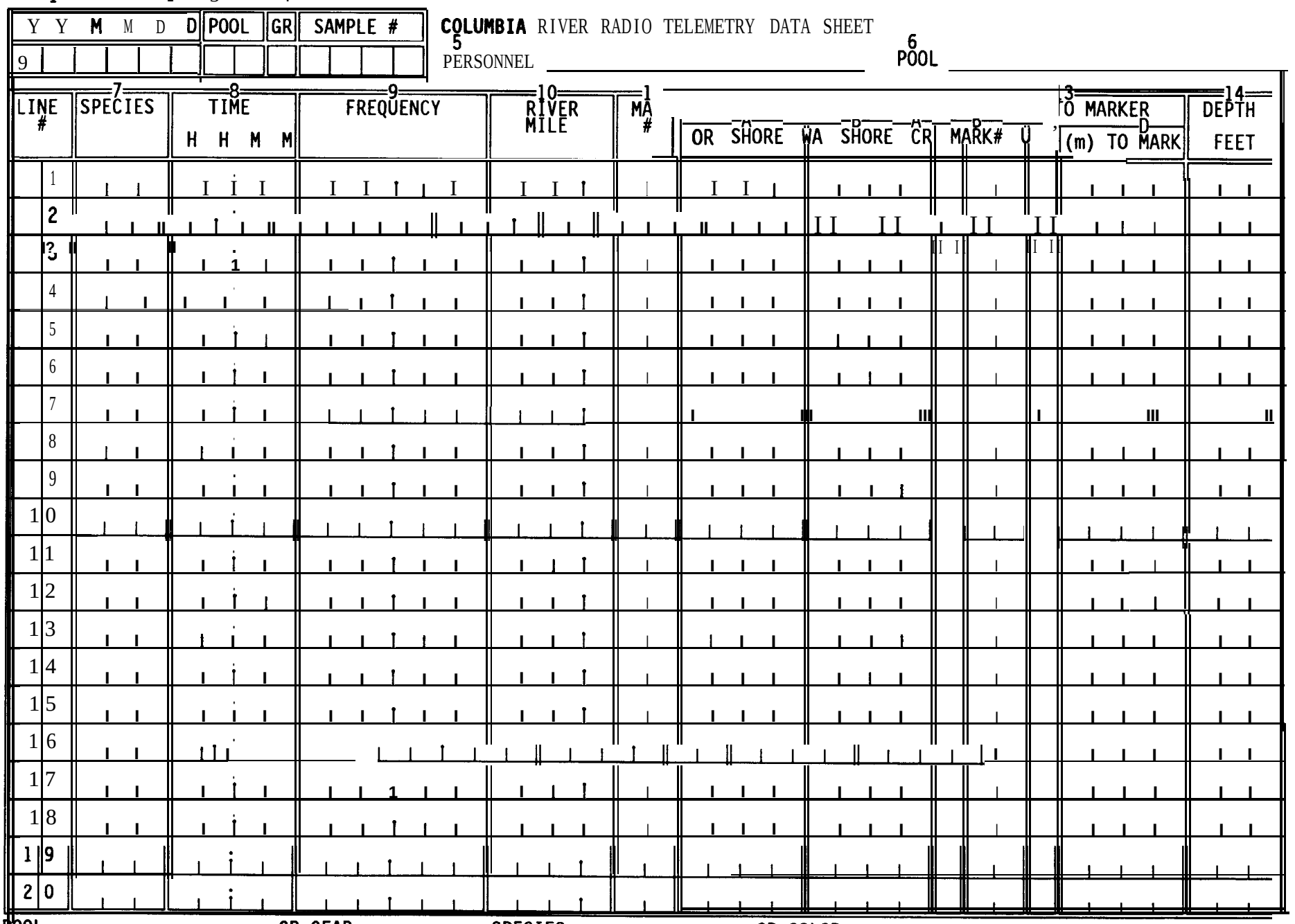
17. Ponar: visual determination of the preponderance of the ponar grab. Do three grabs. Enter the code for the first grab in column 1, second grab in column two and third grab in column three. For instance, the first grab is mostly sand - enter 2 in the first column, the second grab is mostly gravel - enter 3 in the second column, the third grab is mostly sand - enter 2 in the third column. If a sample comes up empty and you are sure it hit the bottom you should suspect a bedrock substrate and you would enter it as a 6.

18. Velocity: the velocity as determined by the velocity meter (specific instructions when available) Take three measurements. One at 1/3 of the

depth (box A), one at 2/3 of the depth (box B), and one just off the bottom (box C).

19. Comments: This is to note ANYTHING unusual. Comments that would help with analysis or answer any questions about the data are written here. USE THIS SPACE! If you need more than one line for a fish, put the line number for that fish at the beginning of every line you have comments written for that fish.

Figure 6.



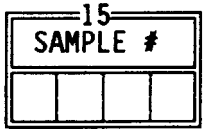
POOL
02=BONNEVILLE
03=THE DALLES

GR=GEAR
A=PLANE
B=BOAT
C=CAR

SPECIES
SQF=SQUAWFISH
STG=STURGEON

CR=COLOR
R=RED B=BLACK
G=GREEN
O=ORANGE

Figure 6 (continued).



16 LINE # 7	17 PONAR 1 2 3	18 VELOCITY A 1/3	B 2/3	C SUB	19 COMMENTS
33					

PONAR
1=SILT/MUD
2=SAND
3=GRAVEL-TO BASEBALL SIZE
4=COBBLE-BASEBALL-BOWLING BALL
5=BOULDER-LARGER THAN BOWLING BALL
6=BEDROCK
7=DETRITUS

REPORT B

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

2. Describe the life history and population dynamics of subadult and adult white sturgeon in McNary Reservoir and downstream from Bonneville Dam.

Prepared by:

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Brad James
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Washington Department of Fisheries

ACKNOWLEDGEMENTS

We would like to thank Wendy Brown of the Oregon Department of Fish and Wildlife (ODFW) for conducting a significant portion of the recreational fishery sampling in Zone 6. The Columbia River biological staff from the Washington Department of Fisheries and ODFW collected data from the treaty commercial fisheries. We thank Chuck Tracy for editing this report.

Abstract.- Primary responsibilities for WDF during 1992 BPA research efforts were sampling treaty commercial fisheries as they occurred between Bonneville and McNary dams (Zone 6), sampling recreational fisheries in Zone 6, estimating harvest in commercial and recreational fisheries, preparing manuscripts containing Phase 1 research results for journal publication, and developing sampling plans for 1993.

Treaty commercial harvest of white sturgeon fell within the Sturgeon Management Task Force (SMTF) guideline of 1,650 for all three reservoirs combined, however the reservoir specific harvest guideline was exceeded for The Dalles Reservoir. There were about 1,600 white sturgeon landed in Zone 6 by treaty commercial fishermen. Landings by reservoir with the reservoir specific SMTF harvest guidelines (in parentheses) were as follows: 1,146 (1,250) in Bonneville Reservoir, 434 (300) in The Dalles Reservoir, and 23 (100) in John Day Reservoir. Recreational harvest estimates also fell within SMTF mandated guidelines, although harvest in The Dalles Reservoir slightly exceeded the guideline for that reservoir. A total of 1,070 white sturgeon were estimated harvested by recreational anglers in 1992. Harvest estimates by reservoir with the reservoir specific SMTF harvest guidelines (in parentheses) were as follows: 870 (1,350) in Bonneville Reservoir, 110 (100) in The Dalles Reservoir, and 90 (100) in John Day Reservoir.

All manuscripts included in volumes I and II of "Status and habitat requirements of the white sturgeon populations in the Columbia River downstream from McNary Dam" have either been submitted for publication in selected journals or are soon to be submitted.

Sampling plans for 1993 are similar to those of 1992 where all Zone 6 commercial and recreational fisheries were sampled. Based on these sampling efforts and research results from Phase 1, a Zone 6 sturgeon management plan will be submitted to SMTF members for consideration in November 1993. This management plan will provide recommendations designed to conduct Zone 6 fisheries in a manner to achieve optimal sustainable yield.

INTRODUCTION

The Washington Department of Fisheries (WDF) is responsible for tasks associated with Objective 1 of Goal 1 and Objective 2 of Goal 3 outlined in the 1993 FFY Performance Work Statement of BPA Project 86-50. Objective 1 of Goal 1 is to "evaluate the success of annually developing and implementing a management plan for white sturgeon in reservoirs between Bonneville and McNary dams". Objective 2 of Goal 3 is to "describe the life history and population dynamics of subadult and adult white sturgeon in McNary Reservoir and downstream from Bonneville Dam". Our progress in accomplishing these objectives associated with Phase 2 in the BPA sturgeon research project as well as concluding Phase 1 research objectives are discussed herein.

A significant conclusion from the first phase of research on the status of Columbia River white sturgeon populations was that construction and operation of dams had functionally isolated white sturgeon in impoundments and decreased their relative production potential by altering critical habitats. Cumulative impacts to these impounded populations included overexploitation, a result partially attributed to decreased population production potential. White sturgeon fisheries in two of the reservoirs, John Day and The Dalles, have recently declined and continued high exploitation risks severe stock depletion.

One recommendation from Phase 1 research was that future harvest management strategies be tailored to the unique attributes of each impounded population to help offset the adverse effects of hydroelectric system operation on production (Beamesderfer and Rien 1993). Task 1.3 of Objective 1, Goal 1 of the current phase of work, describes the development and evaluation of annual management plans that closely monitor and regulate sturgeon fisheries to maintain exploitation at optimum sustainable rates.

Management of Columbia River white sturgeon fisheries during 1992 was coordinated through the Sturgeon Management Task Force (SMTF), consisting of representatives from WDF, the Oregon Department of Fish and Wildlife (ODFW), and the Columbia River treaty tribes. The SMTF recommended harvest guidelines specific to each fishery and reservoir for 1992 (ODFW and WDF 1993).

A limited creel survey was conducted during 1992 to estimate white sturgeon recreational harvest in Bonneville, The Dalles, and John Day reservoirs. In addition, tribal commercial harvest was monitored through a WDF funded research program. The results will be used to help develop reservoir specific recreational and commercial fishery management plans for review by the SMTF prior to implementation in 1994.

This annual report describes our activities from October 1992 through March 1993 and contains the following sections:

1) Results of sampling 1992 recreational and tribal commercial fisheries between Bonneville and McNary dams,
2) A brief summary of status towards publication of prior research results,
3) A description of 1993 sampling plans.

METHODS

Recreational Fishery Survey

Funding was not available in 1992 to conduct the full scale angler surveys carried out from 1987-1991 (Hale and James 1993). However, we collected a small amount of angling effort and catch per effort data from recreational fisheries in Bonneville, The Dalles, and John Day reservoirs (Figures 1 and 2). This data was compared to similar information collected during previous surveys to derive 1992 harvest estimates.

The Dalles and Bonneville reservoir recreational fisheries were sampled about nine days a month from April-October 1992 while the fishery in John Day Reservoir was sampled up to four days a month from May-October 1992. One sampler was hired by the ODFW, Columbia River Management, Clackamas, to conduct field sampling in each reservoir. WDF biological staff from the Columbia River regional office in Battle Ground supplemented this creel censusing effort.

Index areas for angler effort counts were established at popular fishing locations and vantage points in each reservoir. These were the same indices used in the 1987-1991 surveys (Hale and James 1993). Angling effort was counted only within area indices and was counted at least once during the day every time a sampler censused a reservoir recreational fishery.

Samplers interviewed anglers at bank fishing sites and boat ramps to determine angler type (target species) and catch per hour of effort (CPUE) for each species in the creel. Additional data collected was the same as during earlier surveys (Hale and James 1993).

The daily average number of bank anglers and recreational fishing boats counted within index areas, by three hour period, and stratified by weekend'and weekday, was derived for six week periods for each reservoir in 1992. These average counts were compared to similarly stratified index count data from previous surveys to estimate 1992 total angling effort relative to previous years' angling effort estimates.

Angling effort for white sturgeon was derived by applying the proportion of all anglers interviewed who were targeting sturgeon to the estimate of total angling effort. The 1992 proportion of sturgeon angling effort was compared to previous

years' proportions. This ratio, combined with the ratio of index counts between years, was used to adjust prior years' white sturgeon angling effort estimates to estimate 1992 white sturgeon angling effort.

White sturgeon harvest estimates were extrapolated from 1987-1991 estimates by adjusting for changes in angling effort and CPUE between years. The angling effort adjustment consisted of the 1992 sturgeon effort estimate divided by the previous year's sturgeon effort estimate. The CPUE adjustment consisted of the 1992 average sturgeon catch per hour of angling effort divided by the previous years (1987-1991) average catch per hour of angling effort. Two harvest estimates, each based on a previous year's estimate, were calculated for each reservoir, then averaged for the final estimate. Bonneville Reservoir estimates were extrapolated from 1989 and 1990 survey data, The Dalles Reservoir estimates from 1988 and 1989 data, and John Day Reservoir estimates from 1990 and 1991 data.

Tribal Commercial and Subsistence Harvest

Numbers of white sturgeon harvested in Columbia River tribal commercial fisheries were estimated from poundage reported on fish receiving tickets for each gear type. Poundages were converted to numbers of fish by applying an average weight per fish obtained during random biological sampling by field crews. Average weights and the conversion of numbers from pounds of fish were calculated by statistical week. Landings by reservoir were estimated from the catch area reported on fish receiving tickets. The legal size slot for tribal commercial fisheries between Bonneville and McNary dams was 48 to 72 inches in 1992.

Treaty fishermen may take white sturgeon for subsistence purposes by commercial gear during commercial seasons and by hook-and-line year round. Accounting of subsistence harvest is a tribal responsibility. Estimates of treaty subsistence harvests for 1992 were obtained by monitoring some fishermen during commercial seasons and by interviewing treaty anglers at certain locations. These estimates were provided to the Technical Advisory Committee of the Columbia River Compact and are contained in this report.

RESULTS

Recreational Fishery 'Survey

Bonneville Reservoir

Washington and Oregon anglers fished an estimated 139,670 hours (23,390 trips) in Bonneville Reservoir from April-October (Table 1). Angling effort for sturgeon comprised 37% (8,550 trips) of the total estimated effort.

Anglers harvested an estimated 870 white sturgeon from April through October (Table 1). The average harvest per hour of angling effort was 0.015 for bank anglers and 0.024 boat anglers. The ratio of sublegal (<40 in, <102 cm TL) to legal (40-60 in, 102-153 cm TL, Washington; 40-72 in, 102-183 cm TL, Oregon) to oversize (>60 in, >153 cm TL, Washington; >72 in, >183 cm TL, Oregon) sturgeon in the sampled catch was 213:20:1 (Table 2). Approximately 3% of the estimated bank effort and 2% of the estimated boat effort for sturgeon was represented by the 542 sturgeon anglers interviewed.

The Dalles Reservoir

Washington and Oregon anglers fished an estimated 90,690 hours (15,710 trips) in The Dalles Reservoir from April-October (Table 1). Angling effort for sturgeon comprised 16% (2,590 trips) of the total estimated effort.

Anglers harvested an estimated 110 white sturgeon during the sample period (Table 1). The average harvest per hour of angling effort was 0.005 (bank) and 0.005 (boat). The ratio of sublegal (< 48 in., 122 cm TL) to legal (48-60 in., 122-153 cm TL, Washington; 48-66 in., 102-168 cm TL, Oregon) to oversize (>60 in., >153 cm TL, Washington; >66 in., >168 cm TL , Oregon) sturgeon in the sampled catch was 67:2:1 (Table 2). Approximately 7% of the estimated bank effort and 5% of the estimated boat effort for sturgeon was represented by the 298 sturgeon anglers interviewed.

John Day Reservoir

Washington and Oregon anglers fished an estimated 134,610 hours (25,090 trips) in John Day Reservoir from May-October (Table 1). Angling effort for sturgeon comprised 11% (2,740 trips) of the total estimated effort.

Anglers harvested an estimated 90 white sturgeon during the sample period (Table 1). The average harvest per hour of angling effort was 0.002 (bank) and 0.010 (boat). The ratio of sublegal (<48 in, <122 cm TL) to legal (48-60 in, 122-153 cm TL, Washington; 48-66 in, 122-168 cm TL, Oregon) to oversize (>60 in, >153 cm TL, Washington; >66 in, >168 cm TL, Oregon) sturgeon in the reported catch was 45:2:1 (Table 2). Approximately 2% of the estimated bank effort and 4% of the estimated boat effort for sturgeon was represented by the 166 sturgeon anglers interviewed.

Tribal Commercial and Subsistence Harvest

Bonneville Reservoir

An estimated 1,146 white sturgeon were harvested from Bonneville Reservoir during 1992 tribal commercial fisheries Table 3). The majority of this harvest, 945 fish, came from target sturgeon setline fisheries. The remainder was harvested as incidental catch during the winter salmonid setnet fishery. Sale of white sturgeon during the fall setnet fishery was not allowed. The SMTF tribal commercial harvest guideline for Bonneville Reservoir was 1,250 fish.

The reported tribal subsistence harvest for all three reservoirs was 208 white sturgeon, 89 of which came from Bonneville Reservoir (Table 3). The location of harvest of the remaining fish was not reported.

The Dalles Reservoir

An estimated 434 white sturgeon were harvested from The Dalles Reservoir during 1992 by tribal commercial fisheries (Table 3). Most of these fish (407) came from the winter salmonid setnet fishery. Twenty-seven fish were harvested during the winter setline fishery. Setlining was not allowed in The Dalles Reservoir after March 5. Sale of white sturgeon during the fall setnet fishery was not allowed. The 1992 tribal commercial harvest exceeded the SMTF guideline of 300 fish for The Dalles Reservoir.

John Day Reservoir

Only 23 white sturgeon were harvested from John Day Reservoir during 1992 tribal commercial fisheries (Table 3). Five of these fish came from the winter setline fishery and the other 18 came from the winter salmonid setnet fishery. The John Day reservoir was closed to setlining after April 30 and white sturgeon were not allowed for sale during the fall setnet fishery. The SMTF commercial harvest guideline for John Day Reservoir was 100 fish for 1992.

Progress on Publishing Research Results

Results obtained during Phase 1 of the BPA funded sturgeon research project 86-50 have been drafted in manuscripts for selected journals. "Length at age relationships for white sturgeon in the Columbia River downstream from Bonneville Dam" by Tracy and Wall has been submitted to Transactions of the American Fisheries Society. "Spawning characteristics and early life history of white sturgeon Acipenser *transmontanus* in the lower Columbia River" by McCabe and Tracy has been submitted to Fishery Bulletin. "Migration and distribution of white sturgeon in the Columbia River downstream from Bonneville Dam and in adjacent marine areas" by DeVore and Grimes is nearly ready for submission

to Transactions of the American Fisheries Society. "Dynamics and potential production of white sturgeon in the Columbia River downstream from Bonneville Dam" by DeVore et al. is ready for submission to the North American Journal of Fisheries Management but is awaiting the drafting of two other manuscripts ("Optimal harvest strategies for Columbia River white sturgeon populations" by DeVore et al. and @'Comparisons of population dynamics and potential production of impounded and unimpounded white sturgeon populations in the Columbia River" by Beamesderfer et al.) for submission as a special sturgeon supplement package. "Recreational and commercial fisheries in the Columbia River between Bonneville and McNary dams, 1987-1991" by Hale and James is ready for publication as a WDF Progress Report.

1993 Sampling Plans

The reservoir recreational and treaty commercial fisheries between Bonneville and McNary dams will be sampled in conjunction with ODFW Columbia River Management staff. Recreational fisheries will be sampled from March through October with ODFW having primary responsibility for sampling The Dalles and John Day reservoirs and WDF primarily sampling the Bonneville Reservoir fishery. Sampling methodology will be the same as that described for 1992 in this report. Harvest and effort estimates will be subjected to the same limitations described in this report due to the lack of dedicated funds necessary for a more complete sampling effort.

Treaty commercial fisheries will be sampled as they occur during 1992. Biological and mark sampling of landings will be targeted for a 20% sample rate. Harvest will be estimated from average weights by species from our sampling efforts applied to the total poundage by species as recorded on Washington and Oregon fish receiving tickets.

A Zone 6 sturgeon management plan will be prepared for the Sturgeon Management Task Force by November 1993. Based on research and fishery sampling results obtained during Phase 1 of BPA sturgeon research efforts, this management plan will present recommendations for conducting 1994 commercial, treaty subsistence, and recreational fisheries. The overriding consideration for recommendations concerning Zone 6 sturgeon harvest will be exploitation at optimal sustainable yield as determined from population simulation modeling. Other recommendations will be solicited from state and tribal harvest managers and included in the Zone 6 sturgeon management plan.

DISCUSSION

Recreational fishery sampling effort was insufficient to estimate harvest using the statistically sound method of applying observed catch rates to estimated angling effort. We did not have the personnel to conduct the flight and dawn to dusk effort counts needed to accurately measure angling effort nor did we have the ability to collect enough effort and CPUE data to **stratify** the analysis by reservoir subarea and **time period.** Therefore, we chose to relate index **area** effort counts and CPUE to similar data collected in previous years with reliable harvest estimates, then extrapolate those estimates to generate 1992 harvest estimates. Considering the importance of restricting harvest to optimal sustainable yield levels and the necessity of closely monitoring fisheries to assure that populations are not overexploited, it is recommended that future sampling efforts be conducted to achieve at least a 20% sample rate.

There was some bias in the areas selected for interviewing anglers during 1992, with some locations being sampled more often than others. Ramps with sport reward stations (associated with the BPA funded northern squawfish predator control program) were sampled less often than other ramps. As a result, angling effort for northern squawfish was underrepresented in our sample. By underestimating effort for some species, we may have overestimated effort and harvest for white sturgeon. We were not able to determine the accuracy and precision of our estimates at the level of sampling employed during 1992. Still, we feel our estimates reasonably approximate white sturgeon harvest levels for the 1992 survey period given the inadequate sampling presence.

The results of the 1992 angler survey confirmed that the recreational fishery regulations in effect for 1992 (Table 4) were adequate to restrict harvest to the levels recommended by the SMTF (ODFW and WDF 1993). White sturgeon harvests in The Dalles and John Day reservoirs were similar to 1990 and 1991 levels and were close to the SMTF guideline of 100 fish each. White sturgeon harvest from Bonneville Reservoir was down from previous years and was below the 1,350 fish guideline for 1992.

Managers were able to restrict 1992 tribal commercial fishery harvest to a level below that recommended by the SMTF for all three reservoirs combined (1,650 fish), although commercial harvest exceeded that recommended for The Dalles Reservoir.

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Table 1. Combined Oregon and Washington recreational fishery angling effort and white sturgeon harvest estimates for Bonneville (April-October), The Dalles (April-October), and John Day (May-October) reservoirs, 1992.

Reservoir, Fishery	Total hours fished	Sturgeon effort		Harvest per hour	Fish harvest	SMTF guideline
		Hours	Trips			
Bonneville						
Bank	94,390	31,460	5,340	0.015	470	
Boat	45,280	16,540	3,210	0.024	400	
Total	139,670	48,000	8,550	0.018	870	1,350
The Dalles						
Bank	38,140	14,840	1,500	0.005	80	
Boat	52,550	6,400	1,090	0.005	30	
Total	90,690	21,240	2,590	0.005	110	100
John Day						
Bank	59,970	14,600	1,760	0.002	30	
Boat	74,640	5,920	980	0.010	60	
Total	134,610	20,520	2,740	0.004	90	100

Table 2. Numbers of white sturgeon anglers interviewed and numbers of white sturgeon observed, by size group, during sampling of recreational fisheries in Bonneville, The Dalles, and John Day reservoirs, 1992.

Reservoir, Month	Anglers checked	Sublegal	Legal released	Legal kept	Oversize
Bonneville					
April	39	18	0	0	0
May	109	79	0	5	0
June	130	96	1	13	2
July	104	93	0	9	0
August	69	60	0	3	0
September	46	48	0	2	0
October	45	32	0	7	0
Total	542	426	1	39	2
The Dalles					
April	10	1	0	0	0
May	63	15	0	0	0
June	70	56	0	3	4
July	54	34	0	2	0
August	34	44	1	1	0
September	38	32	0	0	0
October	29	84	0	1	0
Total	298	266	1	7	4
John Day					
May	9	3	0	2	0
June	28	2	0	0	0
July	34	4	0	0	0
August	38	26	0	0	1
September	17	28	0	0	0
October	40	26	0	2	1
Total	166	89	0	4	2

Table 3. Estimated harvest of white sturgeon by tribal commercial and subsistence fisheries from Bonneville, The Dalles, and John Day reservoirs during 1992.

Fishery, Period	Bonneville	The Dalles	John Day	Total
Setline				
1 Jan - 5 Mar	296	27	0	323
1 Apr - 30Apr	200	-- a/	5	205
1 Jul - 31 Jul	279	-- a/	-- b/	279
26 Oct - 30 Nov	170	-- a/	-- b/	170
Total	945	27	5	977
Setnet				
1 Feb - 5 Mar c/	201	407	18	626
Commercial total	1,146	434	23	1,603
SMTF Guidelines d/	1,250	300	100	1,650
Subsistence	89 e/	e/	e/	208

a/ The Dalles Reservoir was closed to seline fishing after 5 March.
b/ John Day Reservoir was closed to setline fishing after 30 April.
c/ The setnet fishery was closed to the sale of white sturgeon after 5 March.
d/ The SMTF guidelines apply only to commercial harvest.
e/ Subsistence harvest also included 119 fish from unspecified reservoirs.

Table 4. History of recreational sturgeon fishery regulations for the Columbia River between Bonneville and McNary dam, 1987-1992.

Year	Daily bag limit	Size limit	Other
1987	2	36" minimum 72" maximum	No gaffing of sturgeon in Washington Sturgeoncatch recordand 30 fish annual limit required of Oregon anglers since 1986.
1988	2	40" minimum 72" maximum	Sturgeon catch record requiredof Washington anglers.
1989	2	40" minimum 72" maximum	15 fish annual limit in Washington.
1990	2	40" minimum 72" maximum	15 fish annual limit in Oregon. No gaffing of sturgeon in Oregon. Single pint barbless hooks.
1991	2	40" minimum 72" maximum	Bag limit changed to 1 fish less than 48" and 1 fish greater than or equal to 48".
	1	48" minimum 66" maximum	Effective April 16, 1991 for waters upstream of The Dalles Dam.
1992	2	40" minimum 60" maximum	Effective April 16, 1992 in Washington for waters downstream of The Dalles Dam.
	1	48" minimum 60" maximum	Effective April 16, 1992 in Washington for waters upstream of The Dalles Dam.

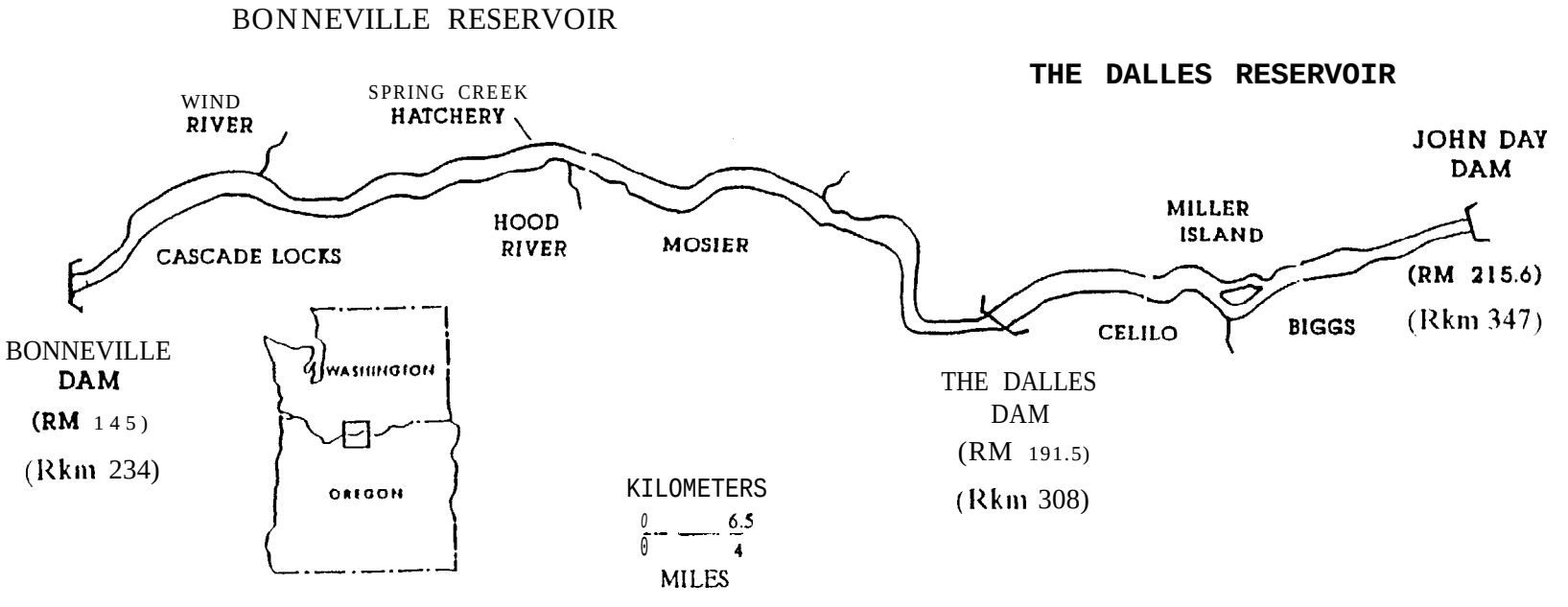

Figure 1. Location of Bonneville and The Dalles reservoirs on the Columbia River.

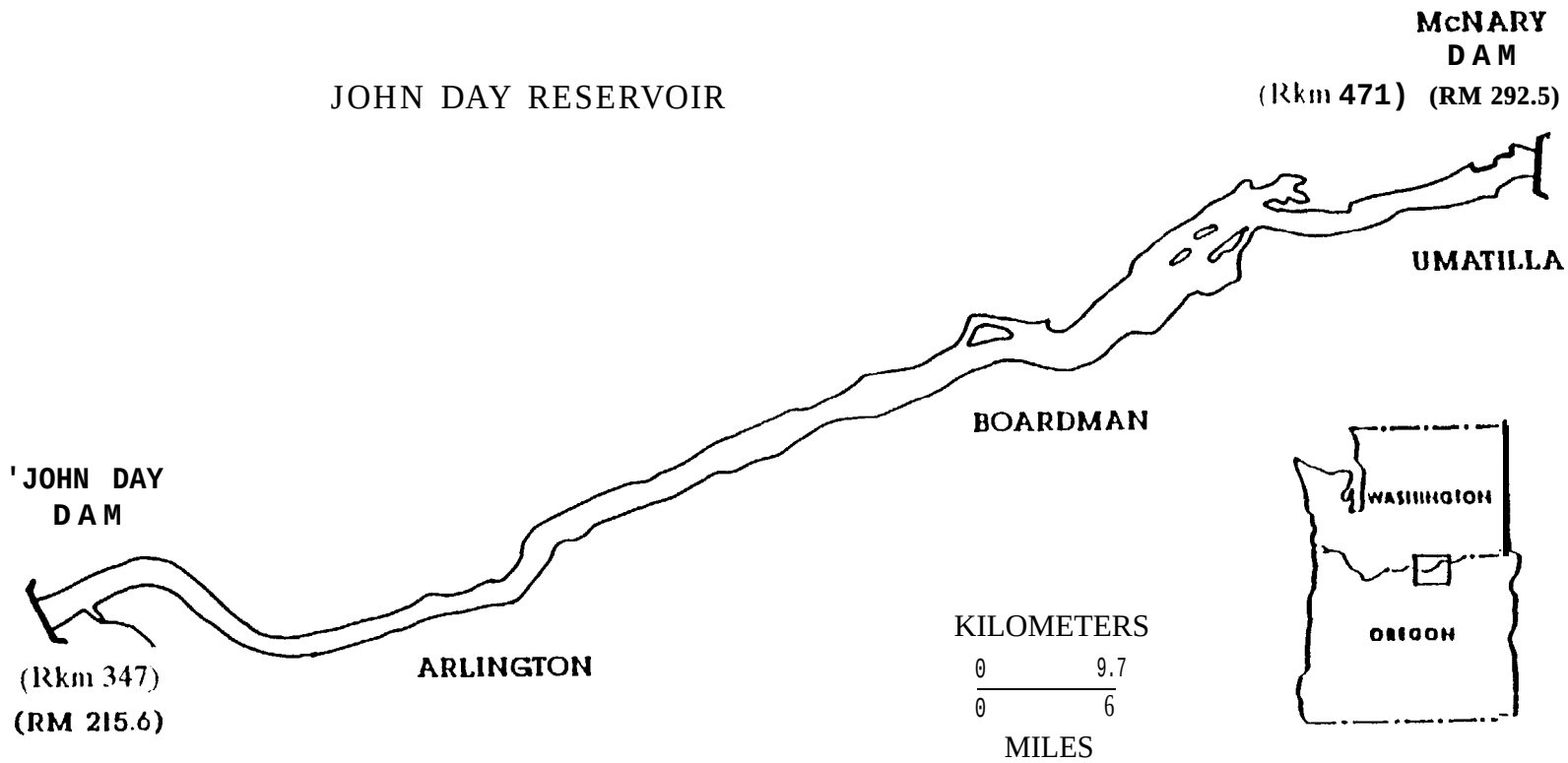

Figure 2. Location of John Day Reservoir on the Columbia River.

Report C

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

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

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Introduction

This report describes U.S. Fish and Wildlife Service activities conducted as part of the white sturgeon *Acipenser transmontanus* study from October 1, 1992 to March 31, 1993 and outlines activities planned for fiscal year 1993 after March 31. The U.S. Fish and Wildlife Service is responsible for tasks related to objectives one and three of the study. Objective one is to describe reproduction and early life history characteristics of white sturgeon populations in the Columbia River between Bonneville and Priest Rapids dams on the Columbia River and downstream from Ice Harbor Dam on the Snake River. Objective three is to define habitat requirements for spawning and rearing of white sturgeon and quantify the extent of habitat available in the same areas covered in objective one. All reported and planned activities relate to objectives one and three.

Activities conducted from October 1, 1992 to March 31, 1993

1) Final versions of 12 manuscripts were completed and submitted for the phase I final report (Table 1).

2) Eight manuscripts were submitted to journals. Of these manuscripts one has been published, three have been accepted for publication, and four are currently being reviewed. One other manuscript is being prepared for submission.

3) Maps and remotely sensed imagery were acquired for McNary Pool and the Hanford reach of the Columbia River and were used to prepare plans for field collections.

4) A reconnaissance trip was made to McNary Pool and the Hanford reach to become familiar with those areas where field work will be conducted.

5) We purchased and helped design a 24 foot trawling vessel for the study.

6) We acquired work and safety equipment needed to outfit the new trawling vessel.

7) We analyzed data from phase I of this study to determine which sites in Bonneville, The Dalles, and John Day pools had the greatest catch per unit effort (CPUE) values for white sturgeon eggs, larvae, young-of-the-year (YOY), and older juveniles. These sites will be used to further assess spawning and recruitment of white sturgeon in those three pools.

8) We organized a technical session for the 1993 American Fisheries Society national meetings to be held in Portland, Oregon, in September, 1993. The session is entitled: Biology and management of North American sturgeons.

Activities planned for April 1, 1993 to September 30, 1993

Field season preparation

Safety and work equipment will be installed in the new trawling vessel and sea trials will be conducted. A 21 foot vessel which will be used to deploy plankton nets and associated equipment will be readied for field use.

Estimation of spawning and recruitment of white sturgeon in Bonneville, The Dalles, and John Day pools

Sampling for white sturgeon eggs and larvae will begin in early May and probably will end in late July. Weekly sampling will be done with plankton nets at the three sites in each pool that had the greatest CPUE for eggs during phase I of this study.

Sampling for YOY white sturgeon in the three pools will begin in early August and continue through the end of September. Bi-weekly sampling will be done with high-rise trawls at the six sites in each pool that had the greatest CPUE for YOY white sturgeon during phase I of this study. Plankton nets and high-rise trawls will be fished using the same techniques as during phase I of this study (Palmer et al. 1988; Parsley et al. 1989; Duke et al. 1990; and Miller et al. 1991).

Exploratory sampling of eggs, larvae, YOY, and older juveniles in McNary Pool and the Hanford reach.

Sampling for white sturgeon eggs, larvae, YOY, and older juveniles in McNary Pool will be done primarily to establish standard sites to be used throughout phase II of this study, although physical information indicating habitat-use (water temperature, velocity, and depth) will be collected with each effort. Substrate mapping of McNary Pool may be initiated but not completed, in 1993.

Sampling for white sturgeon eggs and larvae will begin in early May and probably will end in late July. Weekly sampling will be done in the Ice Harbor Dam tailrace, on the Snake River, with plankton nets and in the Priest Rapids Dam tailrace, on the Columbia River (including the Hanford reach), with beam trawls.

Sampling for YOY and older juvenile white sturgeon will begin in early August and continue through September. Bi-weekly sampling will be done throughout McNary Pool upstream to Ice Harbor Dam and Priest Rapids Dam using high-rise trawls. Plankton nets, beam trawls, and high-rise trawls will be fished using the same techniques as during phase I of this study (Palmer et al. 1988; Parsley et al. 1989; Duke et al. 1990; and Miller et al. 1991).

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REPORT D

1. Description of reproduction and early life history characteristics of white sturgeon populations in the Columbia River downstream from Bonneville Dam.

2. Definition of habitat requirements for spawning and rearing of white sturgeon and quantification of extent of habitat available in the Columbia River downstream from Bonneville Dam.

3. Experimentally implement and evaluate success of selected measures to protect and enhance populations and mitigate for effects of the hydropower system on productivity of white sturgeon in the Columbia River downstream from McNary Dam.

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ABSTRACT

From March 1992 to March 1993, the National Marine Fisheries Service (NMFS) completed its responsibility under the first phase (1986-1992) of the White Sturgeon (*Acipenser transmontanus*) Study. Seven reports that were authored or co-authored by NMFS biologists were completed and included in Volume I or II of the Final Report of Research for the White Sturgeon Study (July 1986-September 1992). Six of the reports have been submitted to professional journals; three have been published or accepted for publication.

A work statement for the first year of the second phase (1992-1997) of the White Sturgeon Study was prepared and submitted to the Oregon Department of Fish and Wildlife and the Bonneville Power Administration (BPA), and the proposed research for 1993 was funded by BPA.

The 12.2-m research vessel that will be used in 1993 was prepared for field sampling. Also, artificial substrate systems, which will be used to collect white sturgeon eggs, were constructed, and sampling supplies for 1993 were procured.

INTRODUCTION

This annual report describes work completed during parts of two phases of the White Sturgeon *(Acipenser transmontanus)* Study. Under an agreement with the Oregon Department of Fish and Wildlife (ODFW), the National Marine Fisheries Service (NMFS) is responsible for segments of two objectives in the first phase (1986-1992) of the White Sturgeon Study. The first objective is to describe reproduction and early life history of white sturgeon populations, and the second is to define habitat requirements for all life stages of white sturgeon and to quantify available habitat.

In the second phase (1992-1997) of the White Sturgeon Study, NMFS is responsible for part of one objective: to experimentally implement and evaluate the success of selected measures to protect and enhance populations and mitigate for effects of the hydropower system on productivity of white sturgeon in the Columbia River downstream from McNary Dam. NMFS research has been and will be conducted in the Columbia River downstream from Bonneville Dam. This reach of the river is free flowing and will be used as a "control" area to evaluate the success of measures to protect and enhance white sturgeon populations in the impoundments upstream from Bonneville Dam. In the first phase of the White Sturgeon Study, this reach of the river was also used as a control against which habitat availability and use in the reach of the river between Bonneville and McNary dams were compared.

This report describes progress on NMFS studies from March 1992 to March 1993. The status of various manuscripts resulting from data collected during the first phase of the White Sturgeon Study will be discussed. Field sampling was not conducted in 1992; consequently, this report does not present new data, but describes research proposed for 1993, in accordance with NMFS's work statement.

METHODS

In April 1993, NMFS and the Washington Department of Fisheries (WDF) will begin a cooperative sampling effort for white sturgeon eggs and larvae in the Columbia River downstream from Bonneville Dam. White sturgeon egg and larval sampling will be conducted between Bonneville Dam and River Mile (RM) 120 biweekly or weekly (during the spawning period) through at least part of July. A D-ring plankton net will be used to collect white sturgeon eggs and larvae. This net is 0.8 m wide at the bottom of its mouth opening and is constructed of 7.9-mesh/cm nylon netting (Kreitman 1983). Depending upon the water velocity, two to six lead weights (4.5 or 9.1 kg each) will be attached to the net frame to hold the net on the river bottom. A digital flow-meter (General Oceanics Model 2030) will be suspended in the mouth of the net to estimate the water volume

[1] *Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.*

sampled. Typically, two plankton nets will be fished simultaneously for about 30 minutes from an anchored 12.2-m research vessel. When water velocities are extremely high, only one plankton net will be fished.

Artificial substrates will also be used to collect white sturgeon eggs (McCabe and Beckman 1990). The substrates consist of 76 x 91-cm sections of latex-coated animal hair that are secured to an angle-iron frame. Two short sections of cable are used to attach the frame to an anchor, which holds the substrate and frame in place on the bottom. A buoy line is attached to the anchor to allow retrieval of the substrate, frame, and anchor. Artificial substrates will generally be retrieved and examined for eggs weekly.

After collection, white sturgeon eggs and larvae will be fixed in a buffered solution of approximately 4% formaldehyde and transferred to WDF. As in past years, egg and larval stages will be determined by WDF based on descriptions developed by Beer (1981). Timing of egg deposition will be estimated using an equation developed by Wang et al. (1985); the water temperature at the time of egg collection will be used in the equation.

To estimate the success of young-of-the-year white sturgeon recruitment in 1993, NMFS will sample previously established trawling stations in the Columbia River downstream from Bonneville Dam in September. Bottom trawling will be conducted in the river between RM 28 and 132 using a 7.9-m (headrope length) semiballoon shrimp trawl, identical to that used from 1987 to 1991 to collect juvenile white sturgeon. Mesh size in the trawl is 38 mm (stretched measure) in the body with a 10-mm mesh liner inserted in the cod end of the net. The distance the net fishes during each sampling effort will be estimated using a radar range-finder. Then, using the distance fished during a trawling effort and the estimated fishing width of the net (5.3 m), the area fished for each effort will be determined. Densities of juvenile white sturgeon will be calculated and expressed as number/hectare (10,000 m^2).

Selected physical parameters will be measured in conjunction with the biological sampling--depth (m) (minimum and maximum); bottom-water temperature (°C); bottom-water turbidity (NTU); and water velocities at 20% of the total depth, 80% of the total depth, and about 0.6 m above the bottom. By averaging the water velocities measured at 20% and 80% of the total depth, a mean water-column velocity can be calculated. Water velocities will be measured only during egg and larval sampling with plankton nets. Depth will be measured with electronic depth sounders, and velocity with a current meter attached to a 45.4-kg lead weight. Turbidity will be determined using a Hach Model 2100A Turbidimeter.

Data collected during the 1993 field season will be entered into computer files and eventually transferred to the Bonneville Power Administration. Throughout the field season, NMFS will remain in close communication with the U.S. Fish and Wildlife Service, which will be conducting similar white sturgeon research in the impoundments upstream from Bonneville Dam.

RESULTS

Work on seven white sturgeon reports authored or co-authored by NMFS biologists was completed during the period covered by this annual report. These reports were included in Volume I or II of the Final Report of Research for the White Sturgeon Study (July 1986-September 1992). Six of the reports have been submitted to professional journals; three have been published or accepted for publication.

The NMFS also prepared a data-set documentation section for the Final Report of Research for the White Sturgeon Study. This section describes the types of data collected by NMFS from 1987 through 1991 and lists the data formats and codes used in the computer data files. Copies of all computer data files were provided to ODFW.

The 12.2-m research vessel that will be used in 1993 was prepared for field sampling. Preparation included installation of a new sampling boom, repair of rusted areas on the hull, and general maintenance.

Other activities during the reporting period included construction of artificial substrate systems and procurement of sampling supplies for 1993.

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