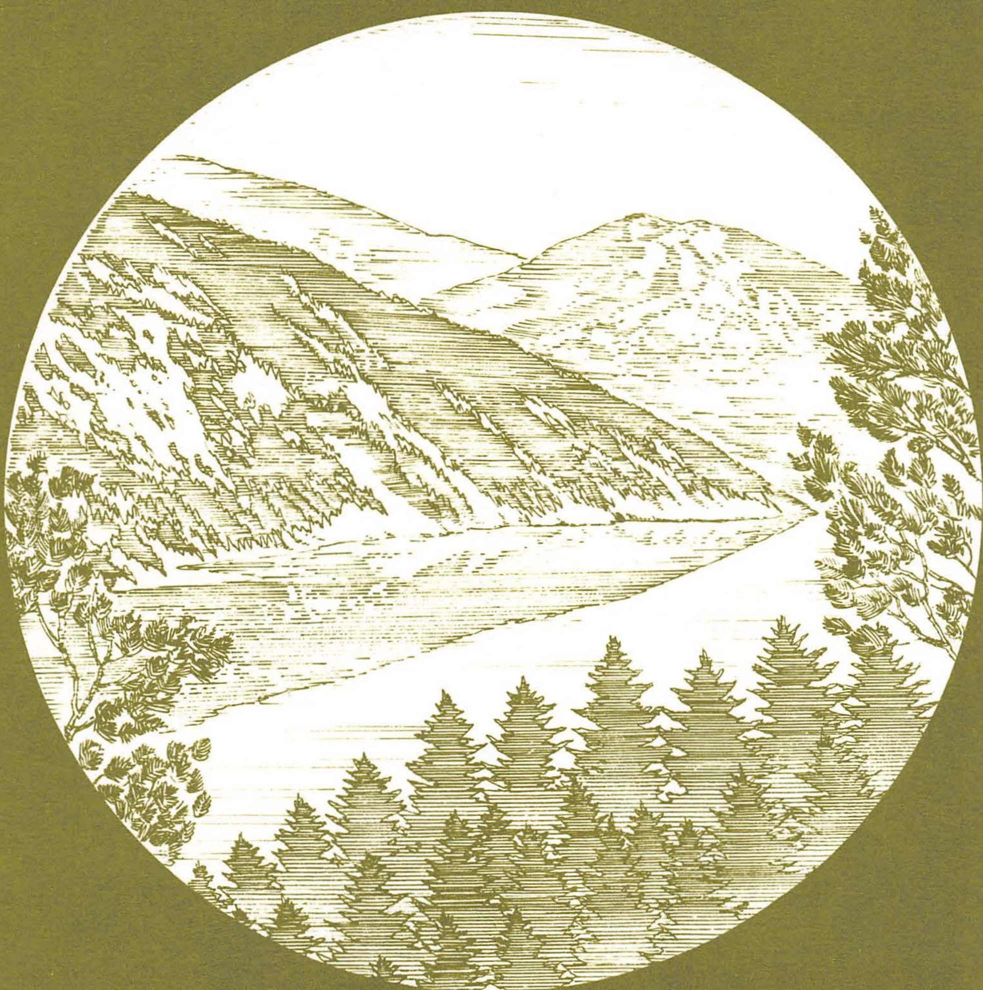
Status and Habitat Requirements of White Sturgeon Populations in the Columbia River Downstream from McNary Dam

U.S. Department of Energy
Bonneville Power Administration
Division of Fish & Wildlife

Oregon Department of Fish and Wildlife
Washington Department of Fisheries
U.S. Fish and Wildlife Service
National Marine Fisheries Service

June 1987

McCabe & McConnell



Annual Progress Report

This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views in this report are the author's and do not necessarily represent the views of BPA.

For copies of this report, write:

Bonneville Power Administration
Division of Fish and Wildlife
Public Information Officer - PJ
P.O. Box 3621
Portland, OR 97208

STATUS AND HABITAT REQUIREMENTS OF WHITE STURGEON POPULATIONS IN THE COLUMBIA RIVER DOWNSTREAM FROM MCNARY DAM

Annual Progress Report

July 1986 - March 1987

Prepared By

Oregon Department of Fish and Wildlife
P.O. Box 59
Portland, Oregon 97207

Washington Department of Fisheries
115 General Administration Building
Olympia, Washington 98504

U.S. Fish and Wildlife Service
500 NE Multnomah, Suite 1692
Portland, Oregon 97232

National Marine Fisheries Service
847 NE 19th Avenue, Suite 350
Portland, Oregon 97232

Funded By

Fred Holm, Project Manager
U.S. Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife
P.O. Box 3621
Portland, Oregon 97208
Project 86-50
Contract No. DE-A179-86BP63584

June 1987

CONTENTS

EXECUTIVE SUMMARY

Measure 804(e)(8) of the Northwest Power Planning Council (NPPC) Fish and Wildlife Program states that Bonneville Power Administration (BPA) "shall fund research to determine the impacts of development and operation of the hydroelectric power system on sturgeon in the Columbia River Basin..." In June 1985, BPA sponsored a workshop to define and list in priority order research needs in the basin (Fickeisen 1985a)[1]. In December 1985, BPA submitted a research program implementation plan (Fickeisen 1985b)[2] to the NPPC. The purpose of the plan is to provide guidance for conducting research necessary to address four objectives identified by regional fishery interests for protecting, mitigating and enhancing white sturgeon populations in the Columbia River basin. The plan's objectives are:

1. Assess the current status of Columbia River basin white sturgeon stocks.
2. Provide the basis to evaluate the need for protection, mitigation and enhancement of white sturgeon in the Columbia River system.
3. Provide information that can be used to evaluate potential methods of protection, mitigation and enhancement of existing stocks.
4. Provide tools to assess the effectiveness of protection, mitigation and enhancement efforts.

---

[1] Fickeisen, D.H. 1985a. White sturgeon work plan. Bonneville Power Administration, Final Report, Portland, Oregon.

[2] Fickeisen, D.H. 1985b. White sturgeon research program implementation plan Bonneville Power Administration, Final Report, Portland, Oregon.

In July 1986, BPA funded a cooperative study by the Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fisheries (WDF), U.S. Fish and Wildlife Service (FWS), and National Marine Fisheries Service (NMFS) to determine the status and habitat requirements of white sturgeon populations in the Columbia River downstream from McNary Dam. The study has four objectives, each corresponding to the objectives of the research program implementation plan. The study objectives are:

1. Describe reproduction and early life history characteristics of white sturgeon populations.
2. Describe the life history and population dynamics of subadult and adult white sturgeon.
3. Define habitat requirements for spawning and rearing of white sturgeon and quantify extent of habitat available.
4. Evaluate the need and identify potential methods for protecting, mitigating, and enhancing white sturgeon populations.

The study is scheduled to continue through September 1992 and focuses on white sturgeon in the area between Bonneville and McNary dams.

BPA contracted with ODFW to conduct the study. ODFW subsequently entered into cooperative agreements with WDF, FWS and NMFS to conduct certain portions of the study. ODFW will address Study Objective 2 in the pools between Bonneville and McNary dams and Study Objective 4. WDF will address Study Objective 2 in the area downstream of Bonneville Dam, will assist ODFW with Study Objective 2 between Bonneville and McNary dams and will assist NMFS with Study Objective 1. FWS and NMFS will address Study Objectives 1 and 3, FWS in the pools between Bonneville and McNary dams and NMFS in the area downstream of Bonneville Dam.

In the area below Bonneville Dam, WDF, ODFW and NMFS are funding work under Study Objectives 1 and 2 and BPA is funding work under Study Objective 3. Data collected on white sturgeon populations below Bonneville Dam will serve as a control against which data collected on white sturgeon populations between Bonneville and McNary dams will be compared. Our assumption is that the status of and habitat use by populations below Bonneville Dam approximate the predam situation between Bonneville and McNary dams. We recognize that, because of no predam data, our study will be unable to definitively determine the effects that development and operation of the federal hydropower system have had on white sturgeon in the Columbia River basin. However, this study will provide the basis for determining if and how the populations differ. That question must be answered before the agencies, tribes, NPPC and BPA can begin discussing why white sturgeon populations differ and what portion of the differences should be attributed to the dams.

This summary has been prepared by ODFW and highlights results presented in individual annual reports prepared by ODFW (Appendix A), WDF (Appendix B), FWS (Appendix C), and NMFS (Appendix D). The reports cover the period July 1986 through March 1987. The content of each individual report is the sole responsibility of the agency that prepared the report. The reports describe progress made in preparing for the first field season. Results of field sampling, some of which began in January 1987, will be reported in the next annual reports.

Before work could begin on the project, ODFW had to negotiate subcontracts with WDF, FWS, and NMFS. ODFW signed a cooperative agreement with WDF in January 1987 and agreed to pay preaward costs retroactive to 1 September 1986. ODFW signed a cooperative agreement with NMFS in September 1986 and with FWS in December 1986. Terms and conditions of each agreement were the same as those contained in the interagency agreement between ODFW and BPA.

ODFW and WDF met in November and December 1986 and agreed on methods to collect and analyze data for estimating growth, survival, recruitment, harvest and abundance of white sturgeon populations below and above Bonneville Dam. WDF began state-funded sampling of subadult and adult white sturgeon below Bonneville Dam in April 1987 using drift gillnets and hook and line. ODFW began sampling in April 1987 above Bonneville Dam using stationary gillnets, setlines, and hook and line. As proposed, work above Bonneville Dam in 1987 is being conducted only in The Dalles pool. ODFW also plans to sample dewatered turbine draft tubes at John Day Dam for stranded white sturgeon. State-funded sampling of the commercial fisheries below and above Bonneville Dam occurred from January through March 1987 and identified a potential problem in distinguishing fish harvested from The Dalles pool. Buyers were not segregating fish by the pool where they were caught. Efforts are underway to resolve this problem. The state-funded survey of sport anglers below Bonneville Dam began in February 1987. The sport angler survey in The Dalles pool will begin in June 1987.

Approaches for modeling white sturgeon populations were identified. Some preliminary analyses were conducted to identify data to which the models were particularly sensitive. Two modeling approaches appear useful to integrate estimates of population parameters and describe and compare stock characteristics; a population simulator similar to that used by Cochnauer (1983) and the Ricker (1975) equilibrium yield model (See References in Appendix A). The equilibrium yield model appears most sensitive to estimates of natural mortality, whereas the population simulator may be most sensitive to reproductive potential and survival from egg to recruit.

We anticipate that growth can be estimated precisely and compared among stocks. Estimates of mortality and abundance will depend on sample sizes and how well sample age structures approximate population age structures. A potential problem exists with estimates of reproductive potential and spawning periodicity. Most samples of dead fish will come from the fisheries. However, most mature fish will be larger than the legal maximum length limit. To collect enough samples, we may need to perform biopsies on fish collected with our sampling gear.

WDF, NMFS and FWS met in January 1987 to determine how their approaches to sampling white sturgeon eggs, larvae, and juveniles will be coordinated and integrated. NMFS is assisting WDF with state-funded sampling of eggs and larvae that began in March 1987. Initial efforts by WDF and NMFS are in the area immediately downstream from Bonneville Dam, but will later be more widely distributed among established index sites. NMFS and FWS are evaluating various gear to sample white sturgeon eggs, larvae, and juveniles. Each are using different gear in 1987 so that together a wide array of gear will be tested. NMFS and FWS also met in January 1987 to define physical and chemical parameters that will be used to characterize habitat. Water temperature, depth, velocity, turbidity, and substrate type are being recorded wherever sampling for white sturgeon occurs. Stomachs of juvenile white sturgeon that do not survive sampling are being preserved to examine diets and identify important food items.

Finally, ODFW, WDF, FWS, and NMFS met in February 1987 and agreed upon common codes and formats for entering data into files on the BPA mainframe computer. Each agency has, or is, in the process of gaining access to the BPA computer. Data collected during past studies of white sturgeon in the Columbia River downstream of McNary Dam are being compiled by WDF and NMFS and will be entered into computer files under the common format.

APPENDIX A

1. Description of the life history and population dynamics of subadult and adult white sturgeon in the Columbia River between Bonneville and McNary dams.

2. Evaluation of the need and identification of potential methods for protecting, mitigating and enhancing white sturgeon populations in the Columbia River downstream of McNary Dam.

Prepared By:

Bruce E. Rieman
John C. Elliott
Anthony A. Nigro

Research and Development Section
Oregon Department of Fish and Wildlife
Portland, OR

CONTENTS

ACKNOWLEDGMENTS

We thank Fred Holm of the Bonneville Power Administration and Charles Willis of the Oregon Department of Fish and Wildlife for their assistance with administration of funds. Douglas Engle was responsible for much of the work in gear development and review of methods on determining reproduction potential. Steven King of the Oregon Department of Fish and Wildlife and Gayle Kreitman of the Washington Department of Fisheries were helpful with selection of gear and preparation of the sampling plan.

ABSTRACT

We reviewed methods and gear for sampling and marking white sturgeon *Acipenser transmontanus*. We selected setlines and gillnets as our primary gear; sport and commercial catch surveys and entrapment in turbine draft tubes as our secondary gear; and a combination of tags, tattoos, and clips as our marking procedure. We began work to evaluate these methods. We identified population characteristics to be described and made preliminary analysis of available data using a population simulation model and the Ricker equilibrium yield model.

The sampling and marking procedures may have some limitations that could result in bias or poor precision in results. Work during the first year was designed to identify and minimize those limitations. Data on population characteristics of growth, mortality, and reproductive potential are limited. Models are sensitive to mortality and reproductive potential. The development of extensive data on these characteristics will be important in this study.

INTRODUCTION

ODFW is responsible for Study Objective 2 (Describe the life history and dynamics of white sturgeon populations between Bonneville and McNary dams) and Study Objective 4 (Evaluate the need and identify potential methods for protecting, mitigating and enhancing white sturgeon populations). Our approach is to describe key population characteristics including individual growth, mortality, reproductive potential, and size of populations above and below Bonneville Dam. We will compare estimates to identify important differences in stocks. We will use simple population models to interpret and describe the importance of observed differences to the ultimate productivity of each population. The project began in the fall of 1986.

Consistent with BPA's research plan, the first year of study was devoted to exploratory work. Specific objectives for our first field season were to:

1. Develop sampling methods to provide accurate representation of the population with the least cost.

2. Develop marking methods that will allow long-term identification of fish.

3. Obtain preliminary data on the population characteristics of interest.

4. Review and develop appropriate population models in cooperation with the Washington Department of Fisheries.

Most of our work has been in reviewing, selecting, designing, purchasing, and constructing sampling equipment. We have also refined sampling plans and methods of analysis necessary to meet the objectives for our first field season. At the time of this report we had just begun field work in The Dalles pool. This report summarizes work we have done in preparation for the field season and for analysis of preliminary data.

METHODS

Sampling

To meet the objectives of the study we must collect, mark, and release live fish in good condition. Sturgeon have been sampled by a variety of methods that we reviewed as part of our project planning. We developed our sampling methods based on discussions with commercial fishermen, on an agency test fishing program and on systems described in the literature. We selected two primary methods, setlines and large mesh gillnets, and two secondary methods, entrapment in turbine draft tubes and surveys of sport and commercial fisheries for sampling white sturgeon during the first field year.

Primary Methods

Setlines that we selected have a 600-ft mainline of 1/4-inch diameter nylon, with 40-hook lines or gangions equally spaced along the mainline. Gangions are approximately 1-m long and are 150-lb test braided nylon. Swivels are used to attach the gangions to the mainline and to the hook. We chose circle hooks ranging from size nine (10/0) to size three (16/0). We plan to fish lines with hooks of one size and in "experimental" arrangements of alternating hook sizes.

Our plan for fishing setlines will allow us to describe the relative catch per unit of effort (CPUE) on a temporal and spatial scale and to identify more productive locations for maximizing catch. We partitioned the reservoir into three areas of equal size. Sampling is scheduled for 1 week in each area in every 5-week sampling period from April through September. We plan to fish approximately 30% of the lines at the same sites in each area during each period. The remaining lines will be set randomly to insure sampling representative of the area. We plan to fish lines continuously throughout each week. Tending frequency will be based on CPUE, bait loss, and injury rates of landed fish. We anticipate tending lines at least twice daily.

The gillnets we selected are 150-ft long and consist of six, equal-length, alternating panels of 2-in, 3.2-in and 4.5-in bar mesh. The net panels are constructed from multifilament and cable nylon. We made each panel 15-ft deep but we spaced 10-ft slacker lines at 12.5-ft intervals for the length of the net. Leadlines overweigh float lines along the entire length of the net.

We plan to fish gillnets during the 4th week of each 5-week sampling period. Nets will be fished in each of the three sampling areas for 1 or 2 days, fishing day and night as conditions permit. Nets will be tended hourly and moved after each tending within a sampling area. Fishing with gillnets will result in incidental catches of fish other than white sturgeon including adult salmon (Oncorhynchus spp.) and steelhead (Salmo gairdneri). We reviewed our sampling plans with management staff in Washington and Oregon and established guidelines to minimize incidental catches of adult salmonids.

Secondary Methods

We know that white sturgeon can become trapped in draft tubes within John Day Dam during turbine shutdowns. The number of fish trapped and the potential for sampling fish under those conditions has not been documented. Although dam operations are designed to minimize trapping of fish, this may still be an opportunity to collect large numbers of fish with little effort. For that reason, we plan to enter draft tubes during scheduled turbine shutdowns and estimate the number of white sturgeon present. We will also subjectively evaluate the potential for collecting, handling, and removing fish under the existing conditions. Draft tube sampling will depend upon assistance from the U.S. Army Corps of Engineers (USACE). We have made initial inquiries and requests with the USACE in this regard.

We will also sample harvested white sturgeon through programs designed to estimate sport and commercial catch. WDF will sample sport anglers on a routine basis. The Columbia River Management Program of ODFW will continue an established program of sampling commercial harvest through fish buyers. We have established a data recording system in cooperation with both agencies to insure that we will have ready access to available data.

Marking

Estimates of population size, mortality, exploitation and movement require that we recognize previously sampled fish. Sturgeon have been marked using several methods, but retention and recognition of marks has not been consistent. We reviewed established marking techniques and selected a combination of methods to be tested during the first year of study.

Population Parameters

We identified estimates of growth, population size, mortality, and reproductive potential as primary data needs for this project. The approach and method for each was outlined in the project proposal and work statement. Estimates of each depend upon data generated during sampling. We have done no further work with methods for growth, population size, and mortality estimates since the project began. We did review available literature and contact recognized authorities to refine the methodology for reproductive potential. We also reviewed commercial catch records to establish sample sizes we are likely to get through currently planned sampling.

We plan to sample the ovaries of all female white sturgeon encountered in the sport and commercial catch. We have established four stages of maturity based on the stage of egg development. Each fish will be classified as immature (no egg development), maturing (development beginning), mature (eggs 2-3 mm with some pigment, spawning anticipated within 1 year), ripe (eggs 3-4 mm, black, spawning anticipated within 2 months). We will preserve samples from each ovary in formalin or Bouin's solution for later comparison with samples of known maturity in an attempt to confirm or revise criteria for the classification scheme. We will estimate fecundity of all mature and ripe fish by weighing the entire egg mass and subsampling to estimate mean weight of individual eggs. We will retain the entire egg mass whenever possible to estimate the proportion of total mass made up by ovarian tissue other than eggs.

Modeling

Simple population models will be used to integrate estimates of population parameters and to describe and compare characteristics of separate stocks. We constructed a preliminary version of a population simulator similar to that used by Cochnauer (1983) for his evaluation of white sturgeon populations in Idaho. The model is an age-structured Leslie type matrix and incorporates an age specific function for reproductive potential. We used existing data from white sturgeon below Bonneville Dam, and from the literature or we assumed values for estimates of parameters in the model. We ran several simulations of the model to familiarize ourselves with its characteristics and identify limitations in available data.

We also adapted the Ricker equilibrium yield model (Ricker 1975) as a spreadsheet program capable of handling 50 year classes of a single recruited cohort, similar to the approach of Semakula and Larkin (1968). We used our preliminary estimates of population parameters to describe anticipated yield per recruit for varying levels of exploitation as familiarization with this model.

RESULTS AND DISCUSSION

Sampling

We have completed the bidding, purchasing and construction of our setline and gillnet fishing systems. We have just begun trial sampling, but we have no sampling results to present here.

We are confident that these gear will provide reasonable sample numbers, but we also recognize several sampling limitations. Setlines and gillnets have been used effectively in commercial fisheries for sampling white sturgeon. However, setlines may result in physical damage of some fish. Gillnets, if tended frequently, should cause limited damage, but may result in a substantial, incidental catch of other fish. We are particularly concerned about incidental catch and mortalities of adult salmonids. We also know that both gear will be size selective (Threader and Brousseau 1986) and may result in biased representation of population size and age structure.

We adopted use of circle hooks and swivels on the gangion to minimize damage to fish on setlines. We also plan to tend lines at least twice daily and more frequently if necessary to minimize injury. To minimize injury to white sturgeon and salmonids in gillnets we will tend the nets on an hourly basis and will not fish at all during periods of peak migration of adult salmon and steelhead. We adopted an experimental approach in hook and mesh size to minimize size selection in sampling. Selectivity will still occur, however, and we anticipate that we may have a particular problem obtaining a representative sample of larger size classes of fish. We can document gear selectivity by comparing catch size structure among our primary and secondary gears and through actual estimates of vulnerability based on recapture of marked fish.

Marking

Our needs for marking white sturgeon require that we and that anglers are able to identify any fish previously captured in our own sampling. For our own identification marks could be obscure as long as retention approaches 100 % or is easily quantified. Marks also should be identifiable without killing fish. For mark recognition by anglers, a very obvious mark (and preferably one prompting a response) is necessary. The retention of marks for angler recognition does not have to be 100 %, but must be quantifiable.

Methods used for marking sturgeon in biological studies include tags (Cochnauer et al. 1985), silver nitrate (personal communication with Fred Partridge, Idaho Department of Fish and Game, Boise, Idaho), fin ray removals (Cochnauer et al. 1985) and barbel removal (personal communication with Robert Pipkin, University of California, Davis, California). Retention of fin and barbel marks appears to approach 100 %. Tags, tattoos, and silver nitrate markings have shown mixed results. Mark retention and legibility appear to be problems (personal communications with Steven King, Oregon Department of Fish and Wildlife, Clackamas, Oregon; Gayle Kreitman, Washington Department of Fisheries, Battleground, Washington; and Fred Partridge, Idaho Department of Fish and Game, Boise, Idaho) and may be variable depending on environmental conditions (personal communication with James Lukens, Idaho Department of Fish and Game, Idaho Falls, Idaho). Loss can also be restricted to a low rate by use of multiple marks (personal communication with Steven King, Oregon Department of Fish and Wildlife, Clackamas, Oregon).

We chose to mark all sampled fish that are in good condition by clipping a single barbel and by removing a segment of a pectoral fin ray. In addition, we plan to mark all fish longer than minimum legal harvest size (90 cm) with two "spaghetti" type tags and a tattoo. Each tag and tattoo will have its own number. One tag will be inserted through the body just below the anterior margin of the dorsal fin. The other tag will be inserted through the body just below the posterior margin of the dorsal fin. The tattoo will be placed on the ventral surface. We selected a spaghetti-type tag because anglers are familiar with it, and because past results suggest it provides reasonable retention, particularly if two tags are used. We chose a ventral surface tattoo based on success in some habitats in Idaho.

We can document tag and tattoo retention from recognition of fin and barbel clips and tagging scars on recaptured fish. We are using four sturgeon in circular tanks at the Clackamas, Oregon, laboratory to evaluate regeneration of clipped barbels and fins and determine location of tattoos for best retention. We are also evaluating the usefulness of fin and barbel clips by documenting occurrence of "natural" marks that could confuse results.

Population Parameters

Sampling during the first field year of the project was planned primarily to develop methods and identify limitations that will be likely in future estimates of growth, reproductive potential, mortality, and population size. Some potential limitations are evident at this time.

We anticipate that we will be able to generate precise estimates of growth and useful comparisons of growth with other stocks. Aging techniques are well developed and consistency among projects should not be a problem. Some bias in estimates of individual age and growth may result from reading fin ray sections taken at various distances away from the body articulation (Threader and Brousseau 1986). We will document the potential bias by reading multiple sections. We will correct age estimates as necessary. We will standardize techniques to minimize any error.

Accurate estimates of mortality and of population size will be particularly dependent upon sample size, accurate representations of population age structure, and mark retention and recognition. Descriptions of gear efficiency gear selectivity, and mark retention will be used to develop a sampling program that will maximize the precision and minimize bias in our estimates within budget constraints. At this time we do not know what limitations we will have in the data. Although sampling problems have been documented in other sturgeon work, the influence of sampling bias on population parameter estimates has not been explored.

The components of reproductive potential, fecundity and the proportion of the population spawning at a given age or size, have been approximated in some work (Cochnauer 1983; Lukens 1985; file memo dated 26 January 1987 by Steven King, Oregon Department of Fish and Wildlife, Clackamas, Oregon). Data are few, however, and the accuracy of available estimates is unknown. We anticipated collecting much of our information through samples taken in surveys of the commercial and sport fisheries. That data will be limited for two reasons. First, sample sizes available through the commercial buyers cannot be easily stratified by where fish were caught. Although samples from above Bonneville Dam will likely number several hundred fish, less than 10% may be identified as from The Dalles pool, our population of greatest interest. Second, Columbia River white sturgeon begin to mature at approximately 50 inches in length, and the bulk of the reproducing population may be fish larger than the maximum legal size limit of 72 inches. We will not be able to sample a large part of the mature fish through the commercial or sport fisheries. We believe we can increase our sample size and size range for maturity data through biopsy of live fish in the field. Biopsy to determine maturity is currently used in sturgeon culture (University of California manuscript report [undated] to U.S. Fish and Wildlife Service; personal communication with Serge Doroshov, University of California, Davis, California). The technique is relatively simple and could be adapted to the field.

Modeling

We used data from other white sturgeon populations to approximate growth (Hess 1984), natural mortality (Semakula and Larkin 1968), and fecundity (Lukens 1985) for our preliminary analysis with the population models. We assumed values for age of maturity, reproductive frequency, and survival from egg to recruit. Our analyses were useful primarily as familiarization with the models and the available data. We found that the equilibrium yield model is particularly sensitive to estimates of natural mortality (Semakula and Larkin 1968, Gulland 1983).

The population simulator is dependent upon assumptions of survival from egg to recruit and reproductive potential, and could be particularly responsive to compensation in those parameters. Analyses of this sort are limited. Semakula and Larkin (1968) and Threader and Brousseau (1986) provide the only equilibrium yield analyses of sturgeon we have found. Cochnauer (1983) and Lukens (1985) provide the only attempts of population simulation. The available information suggests that white sturgeon can support only limited exploitation, but all of these analyses relied on approximations or major assumptions regarding natural mortality and reproductive potential. More extensive data on these two population characteristics will be especially important for our goals and for further understanding of white sturgeon biology in general.

REFERENCES

Cochnauer, T.G., J.R. Lukens and F. Partridge. 1985 Status of white sturgeon, Acipenser transmontanus, in Idaho. Pages 127-133 in F.P. Binkowski and S.I. Doroshov, editors. North American Sturgeons. W. Junk, The Hague, Netherlands.

Cochnauer, T.G. 1983. Abundance, distribution, growth and management of white sturgeon (Acipenser transmontanus) in the middle Snake River, Idaho. Doctoral dissertation. University of Idaho, Moscow, Idaho.

Fickeisen, D.H. 1985. White sturgeon research program implementation plan. Bonneville Power Administration, Pacific Northwest Laboratory report for Contract DE-A179-85BP22209, Portland, Oregon.

Gulland, J.A. 1983. Fish stock assessment: A manual of basic methods. John Wiley and Sons, New York.

Hess, S.S. 1984. Age and growth of white sturgeon in the lower Columbia River, 1980-1983. Oregon Department of Fish and Wildlife, Informational Report, Portland, Oregon.

Lukens, J.R. 1985. Hells Canyon white sturgeon investigations. Idaho Department of Fish and Game, Job Performance Report F-73-R-7, Boise, Idaho.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Fisheries Research Board of Canada Bulletin 191.

Semakula, S.N. and P.A. Larkin. 1968. Age, growth, food and yield of the white sturgeon (Acipenser transmontanus) of the Fraser River, British Columbia. Journal of the Fisheries Research Board of Canada 25:2589-2602.

Threader, R.W. and C.S. Brousseau. 1986. Biology and management of the lake sturgeon in Moose River, Ontario. North American Journal of Fisheries Management 6:383-390.

APPENDIX B

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

2. Description of the life history and population dynamics of subadult and adult white sturgeon in the Columbia River downstream from Bonneville Dam.

3. Description of the white sturgeon sport fishery in the Columbia River between Bonneville and McNary dams.

Prepared By:

Gayle Kreitman
Brad James

Harvest Management Division
Columbia River Laboratory
Washington Department of Fisheries
Battle Ground, Washington 98604

CONTENTS

ACKNOWLEDGMENTS

We would like to thank the Washington Department of Fisheries (WDF) staff at Battle Ground and the Oregon Department of Fish and Wildlife (ODFW) Columbia River Management staff at Clackamas for their field sampling and data collection during the commercial and recreational fisheries below McNary Dam.

Additional thanks go to Steve King of ODFW for assistance with the angler survey design for The Dalles reservoir; to Sam Hess of ODFW for his expertise and assistance in preparing and aging pectoral fin ray sections; and, to Ray Beamesderfer of ODFW for assistance with population dynamics modeling.

Final thanks go the National Marine Fisheries Service (NMFS) for their assistance and equipment during larval sampling activities below Bonneville Dam.

ABSTRACT

First year activities were primarily preparatory in nature. Participating agencies coordinated planning activities to ensure compatible sampling strategies and products between existing, state-funded WDF programs below Bonneville Dam and this project.

References on white sturgeon, Acipenser transmontanus, life history and population dynamics were compiled through computer searches of the general literature, and by contacting other reseach or management entities. Review and summarization of existing data for its applicability to modeling white sturgeon population dynamics commenced. Data base formats and codes were formulated for use in a common computer data base. Analysis of existing program data downstream from Bonneville Dam identified the need for additional data on growth, natural mortality, reproduction potential, and age structure.

Totals of 179 white sturgeon from above, and 511 from below Bonneville Dam were sampled during commercial fisheries for mark, biological profiling, and harvest data. Preparations were made for the June and July 1987 angler survey in The Dalles reservoir. Sampling downstream from Bonneville Dam for sturgeon eggs and larvae commenced 18 March 1987. No eggs or larvae were observed at that time.

References on population dynamics modeling methodology were compiled and reviewed. Optimal methods for modeling white sturgeon population dynamics were explored.

INTRODUCTION

WDF is examining the stock status and population characteristics of white sturgeon below Bonneville Dam under existing, state-funded projects (Kreitman 1984, 1985, 1986). This includes sampling the recreational and commercial fisheries for mark, biological profiling, and harvest data, preparing and examining pectoral fin rays previously collected for age determination, conducting egg and larval sampling activities below Bonneville Dam with the cooperation of NMFS, and tagging white sturgeon to determine population abundance, growth, survival, and migration. In addition, under this BPA-funded study, WDF is examining the white sturgeon recreational fishery between Bonneville and McNary dams.

While data on Columbia River white sturgeon has been collected through other programs, analysis of that data has begun only recently. Additionally, efforts have begun to fill data gaps identified in existing programs through review of the literature (Lane 1985; Fickeisen 1986) and evaluation of population dynamics modeling approaches.

The complete extent of white sturgeon spawning throughout the year and river must still be identified. Information regarding spawning success and survival rates to age at recruitment is also missing. Improved collection-sampling techniques and equipment are required in order to sample sufficient numbers of eggs, larvae, young-of-the-year, and juvenile white sturgeon prior to answering these questions.

Abundance, population dynamics, and migration data below Bonneville Dam exits, but has not been completely analyzed. Available data includes information regarding exploitation-fishing mortality rates, fecundity, age at maturation, sex ratios, and age:length:weight relationships. A major data limitation is the lack of sufficient information available for white sturgeon less than the legal minimum sport length of 36 inches or over the legal maximum sport and commercial length of 72 inches. Little data exists on the extent of movement to and from the ocean.

This annual report, detailing activities through 31 March, is for the contract period from 1 September 1986 to 30 June 1987.

Study objectives addressed during this contract period were:

1. Describe reproduction and early life history characteristics of white sturgeon populations.
2. Describe the life history and population dynamics of subadult and adult white sturgeon.
3. Define habitat requirements for spawning and rearing of white sturgeon and quantify extent of habitat available.

METHODS AND MATERIALS

Many first year tasks required multiagency coordination. Cooperative planning sessions established a link with BPA's mainframe computer, a common data base format with required components, and a sampling plan. Additional coordination ensured compatible sampling strategies and schedules between WDF state-funded programs below Bonneville Dam and this project.

Collection of information on existing white sturgeon data, and on potential white sturgeon population dynamics modeling approaches occurred through literature searches and by contact with other sturgeon and modeling experts. Review of data for applicability to this project and evaluation of modeling approaches were done.

Spawning

A separate WDF program to assess reproduction below Bonneville Dam (Kreitman 1984, 1985, 1986) was coordinated with NMFS's early life history sampling to provide flexibility and an increased assurance of sampling success. WDF personnel sampled for eggs and larvae with 0.5 meter plankton nets and an epibenthic sled from a 40-ft, steel-hulled NMFS vessel. Twice-monthly sampling was scheduled in an area up to five miles directly below Bonneville Dam from March through June. In May and June, additional semimonthly egg and larval sampling was scheduled in conjunction with NMFS's young-of-the-year sampling activities at selected sites farther downstream.

Commercial Fishery Sampling

Commercial fishery sampling for mark, biological profiling, and harvest data was conducted under state-funded programs during the large-mesh sturgeon gillnet fishery below Bonneville Dam, the winter salmon gillnet fisheries below McNary Dam, and the setline fishery above Bonneville Dam. At least 20% of the catch was randomly sampled. Biological data collected included pectoral fin rays for aging, total and fork lengths, weight, sex, and maturity. All fish were examined for marks from previous tagging studies in Bonneville (Malm 1981) and John Day (personal communication with Thomas Macy, U.S. Fish and Wildlife Service, Vancouver, Washington) reservoirs, and below Bonneville Dam (Kreitman 1984, 1985, 1986).

The leading rays of pectoral fins collected below Bonneville Dam were dried, sectioned with a jeweler's saw, and mounted in preparation for aging.

Recreational Fishery Sampling

Angler survey methodology was established to sample the The Dalles reservoir sturgeon recreational fishery from 1 June through 31 July 1987 for mark recovery, biological profiling data, and information regarding catch and effort (sport harvest). Biological data collected will be fork and total lengths, weight, sex, age, and maturity.

Sport harvest for the two months will be derived from estimates of total angler effort obtained through angler counts and catch rates determined from angler interviews. Effort will be estimated from both weekend and weekday aerial counts of boat and bank anglers along the entire reservoir. One weekend day per week and three weekdays per month will be randomly chosen for midmorning flights to provide a total of 14 aerial counts for the two month survey. Weekends will be defined as Saturdays, Sundays, and holidays. Simultaneous to each flight, ground effort counts every three hours within an index section of the reservoir extending about 10 miles downstream from John Day Dam will be made. The index section bounds will be refined prior to the start of the survey. Index counts will begin within three hours of sunrise, continue until sunset, and consist of counts of bank rods to determine bank effort and counts of boat trailers to determine boat angler effort. When samplers are in the field on nonflight days, a single index count will be made to account for variation in effort between days.

Flight counts will be used to describe the distribution of angler effort through the entire reservoir, and index counts will describe distribution of effort throughout the day. Daily total effort will be calculated as the area under the curve of index section effort by time, which will be derived from the continous index counts, expanded by the "instantaneous" count of total effort made from the air. Effort units used will be angler-hours.

Samplers will interview anglers at bank fishing sites and boat ramps to determine angler type and catch per hour of effort for each species in the catch. The white sturgeon catch will be sampled for mark and biological information. Interviews will take place between effort counts and on nonflight days.

Both effort and catch sampling data will be stratified by bank and boat angler types, as well as weekday and weekend effort to account for differences in catch rates. Total removal of marked white sturgeon for each period will be estimated by multiplying catch of marked white sturgeon per hour of effort for each angler type by total effort for each angler type calculated for that period.

RESULTS AND DISCUSSION

Existing Data

Information from existing sturgeon programs from WDF, the University of Washington (UW), the University of California at Davis (UCD), Canada, the Idaho Department of Fish and Game (IDFG), USFWS, and the California Department of Fish and Game (CDFG) was obtained for review and summarization. Data base formats and required components, including parameter-variable codes, were identified, but not finalized.

Summaries of the existing data in the form of at least two products will be forthcoming in the next contract period. The first product will be the compilation of an extensive sturgeon bibliography-reference, including selected abstracts. The second product will be a summary reference table of existing white sturgeon data.

Reproduction and Early Life History

Sampling commenced 18 March below Bonneville Dam. No eggs or larvae were observed at that time.

Subadult and Adult White Sturgeon

Collection and Marking Techniques

Coordination with ODFW occurred to ensure similiar data collection results for the tagging portion of this project in The Dalles reservoir and WDF's tagging efforts below Bonneville Dam under another project (Kreitman 1984, 1985, 1986). WDF continued to analyze existing tag recovery data to determine tag shed and size specific differences in catchability.

Commercial Fishery Sampling

The commercial fisheries below McNary Dam that occurred January through March 1987 were sampled for mark, biological profiling, and catch data. Although no marked white sturgeon were available from The Dalles reservoir, marked fish existed from earlier USFWS studies in Bonneville (Malm 1981) and John Day (personal communciation with Thomas Macy, U.S. Fish and Wildlife Service, Vancouver, Washington) reservoirs, and WDF studies below Bonneville (Kreitman 1984, 1985, 1986).

Totals of 179 white sturgeon from above Bonneville Dam, and 511 from below the dam were sampled. Data was formatted for entry onto computer files for analysis.

A potential problem was identified in distinquishing the particular reservoir from which sturgeon were commercially caught. Buyers purchased fish caught from all three reservoirs, and these fish were frequently combined prior to being made available to the sampler. Consequently, although total harvest by reservoir could be determined from landing tickets, individual fish sampled could infrequently be traced to a particular reservoir. A potential solution to the problem is to have individual fishermen mark their catch. Fishermen, particularly from The Dalles reservoir, will be contacted regarding their assistance with this problem.

Recreational Fishery Sampling

The angler survey above Bonneville Dam was scheduled for June, therefore, no data were collected at the time of this report. Tag drop sites in The Dalles, Goldendale, and Rufus, and survey procedures were established.

Below Bonneville Dam, the angler survey started in February. Collection of mark, biological profiling, catch, and effort data from the below Bonneville Dam recreational fishery occurred under a separate project.

Population Dynamics Model

The literature was searched and population dynamics modeling approaches were identified. Evaluation of those approaches began prior to selection. Criteria for evaluation included the approach's value in describing white sturgeon population dynamics, and on how well it met agency data collection limitations. Definition and refinement of model objectives and scope were concurrently examined. Criteria to define model components and variables were preliminarily established.

REFERENCES

Fickeisen, D. H. 1986. White sturgeon bibliography. Final report for Bonneville Power Administration, Contract DE-AI-84BP22209. Portland, Oregon.

Lane, E. D. 1985. A bibliography on the white sturgeon, (Acipenser transmontanus) Richardson, 1836. Department of Fisheries and Oceans. Fisheries Research Branch. Pacific Biological Station. Canadian Manuscript Report of Fisheries and Aquatic Sciences Number 1828. Nanaimo, British Columbia.

Kreitman, G. 1984. Status of white sturgeon resource in the mainstem Columbia River. Washington Department of Fisheries Job Performance Report F-77-R Segment 2. Battle Ground.

Kreitman, G. 1985. Status of white sturgeon resource in the mainstem Columbia River. Washington Department of Fisheries Job Performance Report F-77-R Segment 3. Battle Ground.

Kreitman, G. 1986. Status of white sturgeon resource in the mainstem Columbia River. Washington Department of Fisheries Job Performance Report F-77-R Segment 4. Battle Ground.

Malm, G. W. 1981. White sturgeon (Acipenser transmontanus) population characteristics in the Bonneville Reservoir of the Columbia River (1976-1978). U.S. Fish and Wildlife Service. Fisheries Assistance Office. Vancouver. Washington.

APPENDIX C

1. Description of reproduction and early life history characteristics of white sturgeon populations in the Columbia River between Bonneville and McNary dams.

2. Definition of habitat requirements for spawning and rearing of white sturgeon and quantification of extent of habitat available in the Columbia River between Bonneville and McNary dams.

Prepared By:

Lance G. Beckman
Douglas E. Palmer
Michael J. Parsley

U.S. Fish and Wildlife Service
National Fishery Research Center
Willard Field Station
Cook, Washington 98605

CONTENTS

ABSTRACT

Primary study responsibilities of the Fish and Wildlife Service (FWS) are concerned with describing the reproduction and early life history characteristics of white sturgeon populations and defining habitat requirements for their spawning and rearing. The FWS plans to initiate field operations in The Dalles pool in April with a variety of sampling techniques and gear types to collect eggs, larvae, and juveniles. The primary objective this first year will be to develop a standardized sampling system. Field preparations have been completed, a literature review has been conducted, and obtaining a "Key-Collection" of early life stages is in progress. The project is closely coordinated among the participating agencies to assure comparable results.

INTRODUCTION

FWS is responsible for parts of Study Objectives 1 and 3. Initial efforts are focusing on Objective 1 in The Dalles pool and except for locating and establishing permanent sampling sites, minimal efforts to attain Objective 3 will occur before 1989. This report describes the activities, preparations, and initial sampling procedures established for field operations by FWS to study white sturgeon reproduction and early life history requirements in The Dalles pool from October 1986 through June 1987.

During this initial period a standardized sampling system will be developed and continued in The Dalles pool and expanded into the Bonneville and John Day pools in future years. This will be accomplished with a variety of gears and techniques. The system will be coordinated with those of NMFS and WDF.

MATERIALS AND METHODS

A variety of sampling techniques and gear types will be used by FWS to assess the reproduction and rearing requirements of white sturgeon in The Dalles pool. Based on sampling activities during April, the most suitable sites and sampling techniques and gears will be selected to establish a standardized sampling system to collect eggs, larvae, and juveniles. The standardized sampling system will be coordinated with those of NMFS and WDF. Alternative sampling gears will be used if some habitats cannot be sampled with the available gears or some life history stages are not collected. Standardized data codes and sampling procedures have been established and all data will be stored on BPA's mainframe computer system.

Initial sampling by FWS for eggs and young-of-the-year of white sturgeon in The Dalles pool will be conducted with paired 0.5 m nets, a 3.0 m beam trawl, and a 6.2 m rock-hopper shrimp trawl. The most effective gear type(s) will be selected for standard sampling based on statistical analysis of catch per unit of effort (C/f), versatility in different habitats, frequency of successful catches, and cost of collection. If the gears fail to collect early life stages in The Dalles pool, their effectiveness will be estimated by testing them below Bonneville Dam in areas where successful sampling of these life stages by WDF and NMFS occurs. Our work will be closely coordinated with similar efforts by those agencies to assure valid comparisons of results. Alternative methods/gears will be developed as necessary.

The gears will be fished at various times of the day in all available habitats. Results of laboratory studies by the University of Washington School of Fisheries, are serving as a guide to determine the most suitable diel periods and habitat types for sampling. Field efforts will be biweekly in April and weekly in May and June. Eggs and young-of-the-year will be preserved in 5% buffered formalin in the field and transferred later to alcohol for examination in the laboratory. Lengths (standard, fork, total) and weights of up to 50 young-of-the-year per sample will be recorded to the nearest millimeter and one-tenth gram, respectively. The basic measure of relative abundance and distribution of the early life stages of white sturgeon will be the mean catch per unit of effort (C/f) for each gear type (i.e., numbers per volume of water filtered, substrate area sampled, or towing time or distance). The C/f will be compared and correlated with time and location of collection. Habitats will be defined based on physical and chemical parameters using standard methods. Physical environmental measurements at each sampling site will include water temperature, depth, velocity, turbidity, and substrate type; dissolved oxygen will be the only chemical parameter measured and no biological factors will be measured this first year.

The literature review initiated this year will continue as additional information becomes available. The Animal Science Department of the University of California at Davis will supply us with a "Key-Collection" of developmental stages of white sturgeon eggs, larvae, and juveniles. This collection will be used to assist in estimating time of spawning of those stages collected in the field.

RESULTS AND DISCUSSION

The study contract between ODFW and FWS was negotiated during October-December 1986 and the final cooperative agreement approved. Primary efforts by FWS have been directed toward selection and procurement of sampling equipment and recording instruments, preparation of field operations support equipment, development of field procedures, coordination with the other agencies, and literature review. All necessary preparations for field sampling, scheduled to begin the first week in April in The Dalles pool, have been completed. Results from field efforts to sample early life stages during the period from April through June will be presented in the next report. Our primary objective during this initial sampling period will be to locate suitable sampling sites in habitat types present and to develop procedures and become proficient in handling equipment. The "Key-Collection" of early life stages being assembled and results from efforts by others on artificial propagation and controlled laboratory studies associated with reproduction and early life requirements will provide valuable tools in our attempts to characterize spawning and rearing requirements of white sturgeon in the Columbia River.

In preparation for the start of field operations we have developed standardized data codes and sampling procedures in coordination with the cooperating agencies. We developed the specifications and procured necessary field equipment including a rock-hopper shrimp trawl, beam trawl, chart recorder, and various field support gear. An 18-ft tow net boat was equipped with a stanchion and davits for deploying 0.5 m nets for collecting eggs and larvae. Flow meters were calibrated. Free-spooling release mechanisms have been installed in the hydraulic winches of a 23-ft trawl boat to increase efficiency and safety of operation. All maintenance and upgrading of boats, motors, trailers, vehicles and assorted support gear has been performed. Aerial photos of The Dalles pool prior to impoundment were obtained from the Corps of Engineers (COE) to assist in identification of various habitat types and potential sampling sites. Periods of no spill at John Day Dam have been scheduled through the Fish Passage Center and COE to facilitate safe and effective sampling in the immediate tailrace area below John Day Dam.

From our on-going literature review we have obtained as assortment of papers and articles associated with white sturgeon reproduction and early life history. From this review, it became apparent that little is known about reproduction, development, and early life history of white sturgeon in the natural environment. For example, no one has recorded an incidence of white sturgeon spawning; eggs have been captured in the drift, but none have been collected from the substrate to document a spawning site. However, WDF has captured eggs and larvae in the main channel drift, three miles or less below Bonneville Dam, indicating that spawning occurred in the immediate vicinity of the tailrace (G. Krietman, WDF, personal communication). Spawning is assumed to occur in swift water over a rocky substrate (Conte et al. unpublished; Scott and Crossman 1973; Kohlhorst 1976; Brannon et al. 1985) though no one has defined what constitutes swift water or a rocky substrate. Kohlhorst (1976) believed that some white sturgeon in the Sacramento River system spawned over a sand/mud substrate in moderate current (no velocity was reported).

All research on development and early life history of white sturgeon, aimed primarily at artificial propagation of the species, has been conducted in vitro. A study by Brannon et al. (1985) sought to investigate white sturgeon development, distribution, behavior, and the influence of certain environmental conditions on the survival of larvae and fry in the Columbia River by creating an artificial environment in aquaria.

The laboratory studies by Brannon et al. (1985) and publications that report the capture of white sturgeon larvae in the environment (Stevens and Miller 1970; Kohlhorst 1976) and those describing the development of white sturgeon larvae and fry at known water temperatures (Conte et al. unpublished; Kohlhorst 1976; Wang et al. 1985) will provide the basis for our attempts to document white sturgeon spawning in The Dalles reservoir. A bibliography of several articles pertaining to white sturgeon reproduction and early life history is presented in the REFERENCES Section. BPNL prepared a complete bibliography on white sturgeon through 1985 under the Research Plan contract by BPA (Fickeisen, 1985).

REFERENCES

Conte, F.S., S.I. Doroshov, P.B. Lutes, and E.M. Strange. Unpublished. Sturgeon hatchery manual for the white sturgeon (*Acipenser transmontanus* Richardson), with application to other North American Acipenseridae. University of California, Davis, California.

Fickeisen, D.H. 1985. White Sturgeon Research Program Implementation plan. Bonneville Power Administration. Portland, Oregon

Fickeisen, D.H. 1985. White sturgeon bibliography. U.S. Department of Energy. Bonneville Power Administration Final Report. Project Number 85-64. 48pp.

Kohlhorst, D.W. 1976. Sturgeon spawning in the Sacramento River in 1973, as determined by distribution of larvae. California Fish and Game, 62(1): 32-40.

Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. Bulletin 184. Fisheries Research Board of Canada. Ottawa, Canada. 966pp.

Brannon, E., S. Brewer, A. Setter, M. Miller, F. Utter, and W. Hershberger. 1985. Columbia River white sturgeon (*Acipenser transmontanus*) early life history and genetics study. U.S. Department of Energy. Bonneville Power Administration Final Report. Project Number 83-316, 68pp.

Stevens, D.E. and L.W. Miller. 1970. Distribution of sturgeon larvae in the Sacramento - San Joaquin River system. California Fish and Game. 56(2): 80-86.

Wang, Y.L., F.P. Binkowski, and S.I. Doroshov. 1985. Effect of temperature on early development of white and lake sturgeon, Acipenser transmontanus and A. Fulvescens. Environmental Biology of Fishes. 14(1): 43-50.

APPENDIX 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.

Prepared By:

George T. McCabe, Jr.
Robert J. McConnell

Coastal Zone and Estuarine Studies
Northwest and Alaska Fisheries Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
2725 Montlake Boulevard East
Seattle WA 98112

ABSTRACT

From October 1986 to April 1987 the National Marine Fisheries Service (NMFS) prepared for sampling white sturgeon *Acipenser transmontanus* eggs, larvae, young-of-the-year, and subadults in the Columbia River downstream from Bonneville Dam. Four 3.1-m plumb-staff beam trawls were purchased and two 4.9-m semiballoon shrimp trawls were modified by inserting 9.5-mm knotless mesh (stretched) in the wings and throat. The beam trawl and modified shrimp trawl were tested and found to sample properly. The primary research vessel, a 40-ft steel-hulled boat, was prepared for the 1987 field season.

NMFS and the Washington Department of Fisheries began a cooperative sampling effort for white sturgeon eggs and larvae in the Columbia River downstream from Bonneville Dam in March 1987. No eggs or larvae were collected during the March sampling.

A review of the pertinent white sturgeon literature was completed. In addition, NMFS began recoding and entering past NMFS white sturgeon data into computer files, following a data format tentatively agreed to by the four agencies involved in this study.

INTRODUCTION

Under the agreement with ODFW, NMFS is responsible for segments of Study Objectives 1 and 3 of the study. Study Objective 1 is to describe reproduction and early life history of white sturgeon populations, and Study Objective 3 is to define habitat requirements for all life stages of white sturgeon and to quantify available habitat. NMFS's research will be done in the Columbia River downstream from Bonneville Dam--the Columbia River's only reach known to support all developmental stages in sufficient numbers to provide a control against which habitat availability and use between Bonneville and McNary Dams can be compared. Also, under Study Objective 1, NMFS and WDF will attempt to determine the effect of variable flows at Bonneville Dam on the downstream displacement of white sturgeon eggs and larvae.

This report describes progress on NMFS's studies from October 1986 to April 1987. Because final approval of the study came after the 1986 sturgeon spawning period, there was no field sampling in 1986. This report also describes proposed sampling procedures and preparation for NMFS's 1987 field research.

METHODS AND MATERIALS

In March 1987, NMFS and WDF began a cooperative sampling effort for white sturgeon eggs and larvae in the Columbia River downstream from Bonneville Dam. Sampling will be done biweekly through June 1987 using WDF's plankton nets (Kreitman 1983). An epibenthic sled with a mouth width of about 48 cm will also be used in egg and larval sampling. The initial efforts will be in the area immediately downstream from Bonneville Dam; however, as the season progresses, we intend to expand the egg and larval sampling to other downstream areas. Later in the field season, various bottom trawls--a 3.1-m (beam length) plumb-staff beam trawl, a modified 4.9-m (headrope length) semiballoon shrimp trawl, and a standard 4.9-m semiballoon shrimp trawl--will be used for egg and larval sampling. The trawls will also be used to collect young-of-the-year and subadult white sturgeon in the river downstream from Bonneville Dam. During this first field season, permanent sampling sites will be established as index sites for the remainder of the study. Many areas will be sampled before permanent sites are established.

White sturgeon eggs and larvae collected during the study will be fixed in a buffered 2% formaldehyde solution and transferred to WDF. Timing of egg deposition and hatching will be estimated by examining various developmental stages of eggs and larvae.

During the 1987 field season, FWS will be similarly sampling for white sturgeon eggs, larvae, and juveniles in The Dalles Reservoir. FWS will be using trawls that differ from NMFS's trawls. By NMFS and FWS using different gear types in the first year of the study, we will be able to test more types of gear. NMFS and FWS will be in close communication, and if a particular gear type is especially effective in collecting sturgeon eggs, larvae, or juveniles, then the other agency will try the successful gear in its respective study area.

Fish captured in the bottom trawls will be identified and counted. A subsample of up to 50 white sturgeon (juvenile and older) from each sampling effort will be measured (total and fork lengths (mm)) and weighed (g). If more than 50 sturgeon are captured in one sampling effort, the excess will be counted and weighed as a group. Stomachs from sturgeon mortalities will be preserved and retained for determination of food.

At the sampling sites, we will measure depth (minimum and maximum), bottom temperature, bottom turbidity, and bottom current velocity. The substrate of permanent sampling sites will also be described. Distance traveled during a trawl effort will be estimated using a radar range-finder, enabling a calculation of the area fished. A flow meter attached to a WDF plankton net will be used to determine the volume of water sampled for sturgeon eggs and larvae.

Data collected during the present study and during past NMFS studies involving white sturgeon will be entered into computer files and eventually transferred to BPA's mainframe computer. Because four agencies are involved in this study, defining a common format for all data entry was necessary. At a meeting on 12 February 1987, representatives from the four agencies agreed to a tentative data-entry format.

RESULTS AND DISCUSSION

Activities during the period covered by this report were largely confined to procurement, modification, and testing of sampling gear; preparation of the primary research vessel; and a review of the pertinent white sturgeon literature.

Four 3.1-m beam trawls were purchased for use during this study. These trawls were chosen because researchers working in Grays Harbor estuary, Washington, and offshore areas successfully used them to collect young-of-the-year Dungeness crab *Cancer magister*, which live on the bottom or just below the surface of the bottom (Gunderson et al. 1985).

Two 4.9-m semiballoon shrimp trawls were modified by inserting 9.5-mm knotless mesh (stretched) in the wings and throats of the nets; the standard mesh-size in the wings and throat is 31.8 mm (stretched). Also, rib lines were installed in the two modified and two unmodified shrimp trawls. Our experience has shown that rib lines can reduce damage to the net when it is torn by an obstruction on the bottom of the river.

In early 1987, we tested the modified 4.9-m trawl and the 3.1-m beam trawl in the Columbia River estuary. Both nets appeared to fish well. In addition, the beam trawl performed satisfactorily in areas upstream from the estuary. The unmodified 4.9-m trawl was not tested because of successful past use.

The primary research vessel, a 40-ft steel-hulled boat, was prepared for field sampling. Preparation included installation of engine noise suppressors, engine maintenance, modification of the existing sampling boom, and installation of a trawl winch.

No sturgeon eggs or larvae were collected in the March sampling effort downstream from Bonneville Dam. Both the plankton net and epibenthic sled appeared to sample properly.

After a tentative format for data entry was agreed to by the research agencies, NMFS began recoding and entering past NMFS white sturgeon data into computer files for later transfer to the BPA mainframe computer. Because one format will be used by all agencies, there should be no confusion in the data sets from agency to agency. Specific columns were designated for various types of data, and units of measure and degree of resolution were agreed upon.

In reviewing pertinent white sturgeon literature, we found that little information is available on their reproduction and early life history in the Columbia River. WDF has been sampling sturgeon eggs and larvae in the river downstream from Bonneville Dam since 1979 (Stockley 1981; Kreitman 1983, 1985; Kreitman and Bluestein 1985; Bluestein 1986). The WDF studies provide general information on sturgeon spawning and egg and larval distributions immediately downstream from Bonneville Dam. Stevens and Miller (1970) studied the distribution of white or green sturgeon *A. medirostris* larvae in the Sacramento-San Joaquin River system, California. Kohlhorst (1976), from the distribution of larvae, described white or green sturgeon spawning in the Sacramento River, California. The early development of white sturgeon in the laboratory was described by Beer (1981), Doroshov et al. (1983), Brannon et al. (1985), Wang et al. (1985), and Buddington and Doroshov (1986). In laboratory studies at the University of Washington, Brannon et al. (1985) examined effects of current velocity, substrate, temperature, and photoperiod on the distribution of white sturgeon larvae and fry. They also studied the effects of salinity on larvae and fry.

Activities in the period covered by this report were preparatory for the 1987 field season. The major objectives of the field research in 1987 are to develop or improve sampling techniques for sturgeon eggs, larvae, and juveniles and establish permanent sampling sites.

REFERENCES

Beer, K. E. 1981. Embryonic and larval development of white sturgeon (*Acipenser transmontanus*). Masters thesis. University of California, Davis.

Bluestein, N. 1986. 1986 sturgeon larval sampling results. Washington Department of Fisheries memorandum to G. Kreitman, dated 27 August 1986, Battle Ground.

Brannon, E., S. Brewer, A. Setter, M. Miller, F. Utter, and W. Hershberger. 1985. Columbia River white sturgeon (*Acipenser transmontanus*) early life history and genetics study. University of Washington and U.S. National Marine Fisheries Service, Final Report to Bonneville Power Administration (Project 83-316), Seattle.

Buddington, R. K., and S. I. Doroshov. 1986. Structural and functional relations of the white sturgeon alimentary canal (*Acipenser transmontanus*). Journal of Morphology 190:201-213.

Craig, J. A., and R. L. Hacker. 1940. The history and development of the fisheries of the Columbia River. Bulletin of U.S. Department of the Interior, Bureau of Fisheries 49(32):133-216.

Doroshov, S. I., W. H. Clark, Jr., P. B. Lutes, R. L. Swallow, K. E. Beer, A. B. McGuire, and M. D. Cochran. 1983. Artificial propagation of the white sturgeon, *Acipenser transmontanus* Richardson. Aquaculture 32:93-104.

Gunderson, D. R., D. A. Armstrong, and C. Rogers. 1985. Sampling design and methodology for juvenile Dungeness crab surveys. Pages 135-144 in B. R. Melteff, editor. Proceedings of the symposium on Dungeness crab biology and management. Alaska Sea Grant Report 85-3, University of Alaska, Fairbanks.

Haynes, J. M., R. H. Gray, and J. C. Montgomery. 1978. Seasonal movements of white sturgeon (*Acipenser transmontanus*) in the mid-Columbia River. Transactions of the American Fisheries Society 107:275-280.

King, S. D. 1985. The 1984 lower Columbia River recreational fisheries, Bonneville to Astoria. Oregon Department of Fish and Wildlife, Clackamas.

Kohlhorst, D. W. 1976. Sturgeon spawning in the Sacramento River in 1973, as determined by distribution of larvae. California Fish and Game 62:32-40.

Kreitman, G. 1983. 1983 sturgeon larvae sampling results. Washington Department of Fisheries memorandum to D. McIsaac, dated 8 December 1983, Vancouver.

Kreitman, G. 1985. 1985 sturgeon larval sampling results. Washington Department of Fisheries memorandum to D. McIsaac, dated 31 October 1985, Battle Ground.

Kreitman, G., and N. Bluestein. 1985. 1984 sturgeon larval sampling results. Washington Department of Fisheries memorandum to D. McIsaac, dated 26 March 1985, Battle Ground.

Scott, W. B., and E. J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada, Bulletin 184:1-966.

Stevens, D. E., and L. W. Miller. 1970. Distribution of sturgeon larvae in the Sacramento-San Joaquin River system. California Fish and Game 56:80-86.

Stockley, C. 1981. Columbia River sturgeon. Washington Department of Fisheries, Progress Report 150, Vancouver.

Wang, Y. L., F. P. Binkowski, and S. I. Doroshov. 1985. Effect of temperature on early development of white and lake sturgeon, *Acipenser transmontanus* and *A. fulvescens*. Environmental Biology of Fishes 14:43-50.

DOE/BP-63584-1
August 1987
5C