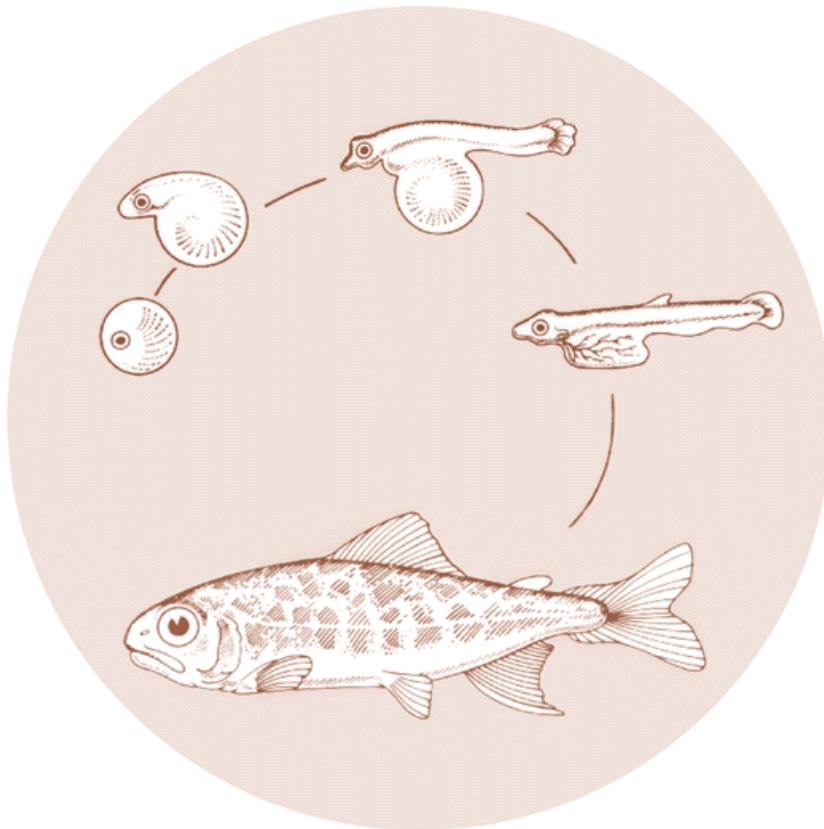


April 1990

PROCEEDINGS OF THE ANADROMOUS FISH RELEASE STRATEGIES WORKSHOP

December 11 - 14, 1989



DOE/BP-01830-7



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 of this report are the author's and do not necessarily represent the views of BPA.

This document should be cited as follows:

Neitzel, Duane A., D. H. Fickeisen, Pacific Northwest Laboratory, Proceedings of the Anadromous Fish Release Strategies Workshop, 1989, to Bonneville Power Administration, Portland, OR, Contract DE-AC06-76RL01830, Project 86-118, 34 electronic pages (BPA Report DOE/BP-01830-7)

This report and other BPA Fish and Wildlife Publications are available on the Internet at:

<http://www.efw.bpa.gov/cgi-bin/efw/FW/publications.cgi>

For other information on electronic documents or other printed media, contact or write to:

Bonneville Power Administration
Environment, Fish and Wildlife Division
P.O. Box 3621
905 N.E. 11th Avenue
Portland, OR 97208-3621

Please include title, author, and DOE/BP number in the request.

PROCEEDINGS OF THE ANADROMOUS FISH
RELEASE STRATEGIES WORKSHOP

December 11 – 14, 1989

Prepared by:

Duane A. Neitrel
Duane H. Fickeisen

Pacific Northwest Laboratory

Prepared for:

U.S. Department of Energy
Bonneville Power Administration
Environment, Fish and Wildlife
PO Box 3621
Portland, Oregon 97208

Project No. 86-118
Contract No. DE-AC06-76RL01830

April 1990

PREFACE

The purpose of this report is to summarize the results of a workshop that reviewed release strategies for anadromous fish which are used or proposed for use at hatcheries in the Columbia River Basin. The workshop was held at the Alton Collins Retreat Center, Eagle Creek, Oregon, on December 11-14, 1989. The workshop focused on specific problems related to moving fish from the hatchery to the environment. However, rearing, disease control, and postrelease survival were also discussed. Discussions were limited to strategies and research for improving the effectiveness of Columbia River Basin hatcheries. .

The Hatchery Effectiveness Technical Work Group (HETWG: Appendix A) developed a research work plan (HETWG 1987) in response to an amendment in the 1987 Fish and Wildlife Plan that was approved by the Northwest Power Planning Council (Council). The Council intends that the research outlined in the work plan will enable existing hatcheries not only to produce more and healthier fish, but to better prepare them for survival after release.

The HETWG identified 10 major questions in the work plan that will require solutions. The number three question in the work plan was, "What are release strategies that improve survival?" To help answer this question, the Bonneville Power Administration (BPA) sponsored the Anadromous Fish Release Strategies Workshop.

The Pacific Northwest Laboratory served as workshop facilitators. The facilitators designed the workshop, provided support services, and prepared this summary report. The BPA participated in workshop planning and implementation. Jerry Bauer (BPA) after consultation with Pacific Northwest fisheries managers prepared the list of fisheries scientists invited to the workshop (Appendix B). Workshop participants represented a broad range of experience in regional hatchery release strategies and research.

ACKNOWLEDGMENTS

The involvement and cooperation of many people during the facilitation and reporting of this workshop are greatly appreciated. Jerry Bauer of the Bonneville Power Administration managed the task for the workshop. The staff at Alton Collins Retreat provided comfortable facilities, good food, and beautiful surroundings for the workshop. The manuscript was reviewed by Susan A. Krenl and C. Dale Becker.

SUMMARY

The objective of the Anadromous Fish Release workshop was to identify release strategies that would lead to improved survival of anadromous fish produced in Columbia River Basin hatcheries. The method used at the workshop was to review anadromous fish release strategies presently used, or proposed for use, at hatcheries and to consider new techniques. Improving release strategies at Columbia River Basin hatcheries may offer a means of enhancing populations of salmon *Oncorhynchus* spp. and steelhead *O. mykiss* within the basin, which is a goal of the Northwest Power Planning Council's Fish and Wildlife Program

The workshop produced ranked research recommendations, a list of release practices to improve hatchery effectiveness, and general comments about hatchery effectiveness research.

Research recommendations were grouped by species. Of the 109 votes cast to rank recommendations, 57% were related to spring/summer chinook salmon *O. tshawytscha*, 25% to steelhead *O. mykiss*, 12% to sockeye salmon *O. nerka*, 2% to fall chinook salmon, and 5% to coho salmon *O. kisutch*. Fifty-five percent of the votes were assigned to four recommendations. As indicated by the votes, the top four research recommendations are to:

- Evaluate size grading and size release criteria (Willamette Strategy) for spring chinook salmon reared and released from hatcheries upstream of Bonneville Dam
- Evaluate the optimum release time for spring chinook salmon
- Evaluate transportation stress for chinook salmon
- Compare yearling versus fed-fry release for sockeye salmon.

Twenty-four release practices were identified and discussed by the participants. They were summarized into four groups or categories:

- Improve the techniques and practices used to count fish as they are released from the hatchery
- Improve the truck transportation system that is being used throughout the Columbia River Basin
- Provide improved instructions to fish transport crews
- Control the environment of the fish at the time of release.

Four general comments related to hatchery practices but not considered release strategies were listed by the participants as part of the workshop summary session:

- . Conduct research and implement programs to reduce disease at all Columbia River Basin hatcheries, especially bacterial kidney disease (BKD)**
- . Implement a standardized data recording system for Columbia River Basin hatcheries**
- . Include hatchery operation personnel in planning and implementation of goals and procedures**
- . Review and evaluate current and future release strategies.**

CONTENTS

PREFACE	iii
ACKNOWLEDGMENTS	iv
SUMMARY	v
GLOSSARY	ix
INTRODUCTION	1
CURRENT RELEASE STRATEGIES	3
WASHINGTON DEPARTMENT OF FISHERIES: ANDY APPLEBY	3
WASHINGTON DEPARTMENT OF WILDLIFE: JACK TIPPING	4
IDAHO DEPARTMENT OF FISH AND GAME: BILL HUTCHINSON	5
OREGON DEPARTMENT OF FISH AND WILDLIFE: MIKE EVENSON	6
BRITISH COLUMBIA MINISTRY OF ENVIRONMENT AND PARKS: BRYAN LUDWIG AND RON PTOLEMY	6
CANADIAN DEPARTMENT OF FISHERIES AND OCEAN: GORDON BEREZAY AND KEN PITRE	7
RESEARCH NEEDS	9
SPRING/SUMMER CHINOOK SALMON	9
STEELHEAD	10
SOCKEYE SALMON	11
FALL CHINOOK SALMON	11
COHO SALMON	11
PARTICIPANT COMMENTS	12
RELEASE PRACTICES RECOMMENDATIONS	13
INVENTORY	13
TRANSPORT	13
INSTRUCTION TO TRUCK DRIVERS	14
ENVIRONMENTAL CONTROLS AT RELEASE SITES	14
GENERAL COMMENTS	17
WORKSHOP RECOMMENDATIONS	19
TOP FOUR RESEARCH RECOMMENDATIONS	19
RELEASE PRACTICES TO IMPROVE HATCHERY EFFECTIVENESS	19
GENERAL COMMENTS	19
REFERENCES	21
APPENDIX A - ANADROMOUS FISH RELEASE STRATEGIES WORKSHOP: HATCHERY EFFECTIVENESS TECHNICAL WORK GROUP	A. 1

**APPENDIX B · ANADROMOUS FISH RELEASE STRATEGIES WORKSHOP: LIST
OF INVITED SCIENTISTS AND PARTICIPANTS..... B-1**

APPENDIX C · ANADROMOUS FISH RELEASE STRATEGIES WORKSHOP: AGENDA..... C.1

GLOSSARY

BKD	Bacterial kidney disease
BPA	Bonneville Power Administration
Council	Northwest Power Planning Council
CWT	Coded wire tag
HETWG	Hatchery Effectiveness Technical Work Group
IDFG	Idaho Department of Fish and Game
NMFS	National Marine Fisheries Service
NPPC	Northwest Power Planning Council
ODFW	Oregon Department of Fish and Wildlife
PIT	Passive integrated transponder
PNL	Pacific Northwest Laboratory (meeting facilitators)
TWG	Technical Work Group
Water budget	A means of increasing survival of downstream migrating juvenile fish by increasing Columbia and Snake river flows during the spring migration period
WDF	Washington Department of Fisheries
WDW	Washington Department of Wildlife

INTRODUCTION

During 1987, the Hatchery Effectiveness Technical Work Group (HETWG) developed a work plan to define research that could improve the effectiveness of present hatchery programs in the Columbia River Basin. Development of the work plan was a response to an amendment of the Council's Fish and Wildlife Program (NPPC 1987). The Council believes that the research will enable existing hatcheries to not only produce more healthy fish but also produce fish that will survive better when released.

To develop a work plan, the HETWG identified and prioritized 10 major questions related to improving hatchery effectiveness. The first 3 questions in order of priority are: 1) What on-station husbandry practices and facility designs maximize survival and production of anadromous fish? 2) How can fisheries management agencies be assured that they will have dependable supplies of nutritious, cost-effective feeds to use for increasing production, health, and survival of hatchery fish? and 3) What are the release strategies that improve survival? The number three priority question was the focus of this workshop.

To define research needs to answer the number three priority question, Bonneville Power Administration (BPA) sponsored the Anadromous Fish Release Workshop on December 11-14, 1989. The workshop assembled participants from throughout the Pacific Northwest who were knowledgeable in hatchery operations and management. The participants discussed various issues related to fish release strategies during the 4-day workshop (Appendix C).

Research needs, current release practices, and general comments to improve hatchery effectiveness were identified by workshop participants. The research needs were then prioritized. Results (recorded in this report) will be presented to the HETWG for evaluation and use in revision of the HETWG work plan.

In this report, results of the workshop are presented in seven sections and three appendices. The sections include an introduction; discussions of current release strategies, research needs, release practices recommendations, and general comments; a list of workshop recommendations; and cited literature. The appendices identify membership in the HETWG, and list the workshop's invited scientists, participants, and workshop agenda.

CURRENT RELEASE STRATEGIES

Current release strategies were discussed during the Monday afternoon session (Appendix C). Participants in attendance were Ron Ptolemy, Bryan Ludwig, Mike Evenson, Mike Cuenco, Ken Pitre, Bob Smith, Alan Ruger, Bill Hutchinson, Bill McNeil, Gordon Berezay, Jim Byrne, Jack Tipping, Andy Appleby, Carl Schreck, and Doug Dampier.

Participants were asked to describe their agencies' release practices for the hatcheries within their jurisdiction. They responded by providing a speaker for each agency (or entity) present.

WASHINGTON DEPARTMENT OF FISHERIES: ANDY APPLEBY

Authority for Washington State hatchery and rearing facilities is divided between the Department of Fisheries (WDF) and the Department of Wildlife (WDW). The WDF manages salmon, and the WDW manages steelhead and trout. Releases from the Washington State salmon hatcheries vary with species, hatchery location, and run. Standard practice has been to release at a specific time after the fish achieve a specific size. During the last 3 to 4 years, release practices have moved toward volitional releases for coho salmon below Bonneville Dam. Evaluation of effectiveness is being accomplished by coded wire tags and recording total survival, that is, adult return plus harvest. The release strategy is not "official" Department policy. However, it is understood and approved by Fish Resource Management (Bill Hopley) of the Salmon Culture Division of WDF.

Release size for fall chinook salmon is 100 fish to the pound. There is no specific reference for this policy, except "bigger is better." The new policy is directed toward 75 to the pound with serial releases, if necessary, to achieve 75 to the pound. This gives the managers more flexibility and "has more meaning from a culturist point of view." Some yearlings are released at Lyons Ferry Hatchery on the Snake River.

Spring chinook salmon are mostly yearling programs. Releases occur from late March through May with fish at 6 to 10 to the pound. The WDF also has a zero-age smolt program for spring chinook salmon in which releases are similar to the fall chinook salmon programs.

Coho salmon are released to the Columbia River during the first week in June, in cooperation with the Oregon Department of Fish and Wildlife (ODFW). The policy is evolving toward a volitional release beginning in mid-April and ending during early June. This results in about 25% of the coho salmon being released during late April, 50% during May, and 25% during early June. Elsewhere in the state, WDF releases the majority of coho salmon during May with only a portion of the total release dedicated to a June release.

Evaluation of releases is accomplished by coded wire tagging of the released fish and monitoring of total survival (i.e., adult returns plus harvest). It is difficult to differentiate time of release from size of release. Other criteria that affect release strategies include the need to decrease estuarine mortalities, decrease natural predation, reduce the potential effects on natural populations, and improve operations at multispecies hatcheries.

The WDF has studied the potential effects of advanced photoperiod with artificial light with coho salmon. This resulted in good smolt transformation; however, results indicated decreased survival. The WDF has instigated fall releases of fall chinook salmon on the lower Columbia River and September, October, and November releases were compared to June releases. September survivals appear equal to or better than June through October, and November releases decreased survival. Fish from November releases did change ocean distribution. Sizes for fall releases of fall chinook salmon are 25 to 35 to the pound.

WASHINGTON DEPARTMENT OF WILDLIFE: JACK TIPPING

The authority for Washington State hatchery and rearing facilities is divided between the Department of Fisheries (WDF) and Department of Wildlife (WDW). The WDF manages salmon and WDW manages steelhead and trout. Steelhead and sea-run cutthroat *O. clarki* are planted only during the period of downstream migration, normally during the period of mid-March to June. The release size is larger than 10 to the pound, preferably 6 to the pound. The preferred method of release is volitional; however, most releases require trucking. Areas of release are selected which provide an optimum opportunity for the catch of returning adult fish. Evaluation of releases is generally accomplished with marked releases and rack returns and/or sport harvest.

Most fish are reared in raceways but rearing in earthen ponds is preferred. The information used to determine the release size is based on studies conducted during the 1950s and 1960s and was briefly reexamined with dart tags in the 1980s. The operational policy reflects the idea that a size of 6 to the pound optimizes rearing costs and smolt-to-adult survival for steelhead.

The WDW is currently investigating relationships between condition factor and improved survival of released fish. The studies are being accomplished with visible implant tags. Current studies "should not" change current policies regarding release times and size.

We are also investigating volitional releases within the framework of the April/May period. Gates from the hatchery ponds are opened on April 15, and steelhead are not forced out until May 15. Further evaluation is planned because release is still based on the assumption that size requirements are met by April 15.

A Computer Hatchery Optimization Program (CHOP) is being evaluated to help reduce feed costs at the hatcheries. The program which was developed for the freshwater rearing phase, uses feed conversion and water temperature information to reduce food costs. Results on cost reduction are inconclusive at the time of this report.

IDAHO DEPARTMENT OF FISH AND GAME: BILL HUTCHINSON

Release strategies for hatchery fish in Idaho vary with species and run. The policy for operation of the hatcheries is to release fish at a specific time with size guides. However, this is an operational policy and is not "official."

Spring chinook salmon are released from mid-March through early April at 1-age and weighing about 20 to the pound. The releases are scheduled to coincide with the water budget and barge transportation schedules. The timing of natural migrations is monitored so hatchery releases can be scheduled to mimic natural outmigrations.

Some satellite facilities have a fall release with size guides. All the sites but two have on site releases. Releases are made over a period of days. not all at one time.

Idaho fisheries staff tries to provide a 2-week "window" or separation period between the spring chinook salmon and steelhead releases, because the larger steelhead smolts stress spring chinook salmon smolts during barge transportation. Because nearly all Idaho anadromous fish are barged downstream separating the release time will reduce the number of steelhead and chinook salmon barged together.

Steelhead are released from mid-April through the first part of May. Releases begin in the upper part of the drainages and progress downstream. Steelhead releases are timed, as with the spring chinook releases, to provide a 2-week window at barge transportation facilities. Idaho does have a limited fall release program for excess fish in the hatchery.

A size-at-release comparison for steelhead reared at Hagerman National Fish Hatchery has been made. Two-to-the-pound fish were compared to five-to-the-pound fish. Results were a "wash" when survival rates, sex ratios, and year class of returning fish were evaluated. The number of returning adults is about the same for a release of a large number of five-to-the-pound fish compared to a release of a lesser number of two-to-the-pound fish. Hatchery capacity is limited by total biomass.

OREGON DEPARTMENT OF FISH AND WILDLIFE: MIKE EVENSON

The practices used at Cole Rivers Hatchery for spring chinook salmon were summarized. Releases are based on time with size guides. This policy holds throughout Oregon, with the time of release being hatchery- and species specific.

Release times at Cole Rivers have been evaluated for June through March. March is too late because of increased incidence of BKD. However, survival for March released fish is comparable to October released fish when BKD levels are low. Additionally, the larger hatchery fish released in March prey on the naturally produced fish. The current policy is to release spring chinook salmon from August through October, with August fish at 12 to 15 to the pound, September fish at 8 to 10 to the pound, and October fish at 6 to 8 to the pound.

Releases are evaluated by coded wire tag monitoring of total survival (adult returns plus harvest). Some of the timing policy for hatchery releases is based on an effort to mimic natural outmigrations, as indicated by evaluation of scales from returning wild adults.

Some new release practices are being evaluated in the state. For example, offsite releases are used to increase the contribution of hatchery fish to the sports fishery. The rearing areas are oxygenated to increase the carrying capacity of the hatcheries. Fish ladders are being used for rearing to supplement limited hatchery space. Ladder-reared chinook salmon at Round Butte Hatchery survive better than those reared in the hatchery.

Fall chinook, steelhead, and coho are released on a time schedule with size guidelines. For coho salmon, river flows on the coast are also important for determining release time.

BRITISH COLUMBIA MINISTRY OF ENVIRONMENT AND PARKS: BRYAN LUDWIG AND RON PTOLEM

The authority for British Columbia hatcheries is divided between the British Columbia Ministry of Environment and Parks and the Department of Fisheries and Oceans. The Ministry manages trout and char. Policy requires that eggs collected from wild adults are used to hatch and rear to smolts. Smolt production goals are based on the Ministry's estimate of historic records. Wild-to-hatchery catch ratios for adults should not be less than 1:1.

Release strategy is based mainly on size. The strategy is to raise the smolts to as large a size as possible. Fish are released from April 15 through late May, with early May as the goal for most fish. Typical smolt size ranges from 45 to 110 g (4 to 10 to the pound) with an average size of 70 g (6.5 to the pound). Transport densities are 100 g/L (0.8 lb/gal).

Some fish are released volitionally; however, after 1 week the remaining fish are forced out of the hatchery or trucked to the lower part of the river. Survival for smolt to adult is 1% to 10% averaging about 4% to 5%. Survival increases by more than 40% when smolts are released into the lower river: lower river releases are preferred to avoid competition of hatchery fish with wild fish.

Steelhead fry have been stocked since the late 1970s. The strategy is to try to colonize vacant or underused habitat and to supplement anadromous habitat where there is insufficient spawner escapement. Release is based on size, with releases at 0.3 to 10 g (1500 to 45 to the pound).

Programs are evaluated by assessing numbers of returning adults where possible. Most evaluation is accomplished by estimating catch from an annual harvest questionnaire and comparing smolts per adult catch among programs. Additional criteria, for example, cost/catch are being developed. Other research is directed toward narrowing the "release timing window," developing new transport methods, and reviewing the impact of rearing and receiving water temperature on smolting.

CANADIAN DEPARTMENT OF FISHERIES AND OCEANS: GORDON BEREZAY AND KEN PITRE

The authority for British Columbia hatcheries is divided between the British Columbia Ministry of Environment and Parks and the Department of Fisheries and Oceans. The Department of Fisheries and Oceans regulates salmon. The release of salmon varies from hatchery to hatchery and is mostly size dependent. Size dependency is based on whether release is for smolts, fry, or fed-fry. The operation of the hatcheries is geographically divided within the province, with three main areas: Vancouver Island, the North Coast, and the Fraser River Basin. Chinook salmon releases on Vancouver Island are fall chinook salmon, with the exception of one hatchery that releases summer chinook salmon. All fish are released as 6- to 10-g fish (280 to 170 to the pound). The timing varies with the hatchery. Studies indicate "the earlier and the bigger the better" with the best being 8- to 9-g fish (215 to 190 to the pound) in mid-May. With coho salmon, smolts yield better returns. With both species most are direct releases, except for outplanting of fed- and unfed-fry by helicopter and truck.

The North Coast hatcheries release chum salmon, coho salmon, and spring chinook salmon. Chinook salmon releases are 10 g (170 to the pound) subyearling smolts at 3 to 5 g (570 to 340 to the pound) fed-fry. Coho are fed-fry and 15- to 20-g (115 to 85 to the pound) smolts.

The Fraser River hatcheries are all satellite facilities. All fish are "stream type" (i.e., 1+ fish that have overwintered in the stream). Time-of-release studies indicate May 15 is the latest release date. After that time, increased predation during rearing reduces survival.

RESEARCH NEEDS

On Tuesday, December 11, 1989 (Appendix C). participants discussed factors affecting release strategies, the relationship of release strategies to hatchery performance, and the effect of release strategies on wild populations. These discussions were summarized by the participants as "Research Needs." Participants ranked the needs that afternoon. Rank or priority was established by each person voting eight times, with no limit on how votes would be distributed (i.e.. a participant could use all or part of their votes on a single issue).

Attendants were Ron Ptolemy, Bryan Ludwig, Mike Evenson, Mike Cuenco. Ken Pitre. Bob Smith, Jerry Bauer, Bill Hutchinson. Bill McNeil, Gordon Berezay. Jim Byrne, Jack Tipping. Andy Appleby. Carl Schreck. and Doug Dampier.

The research needs are listed below by species, in approximate order of priority. The total score or number of votes is shown in parentheses before the description for each item

SPRING/SUMMER CHINOOK SALMON

Current release strategies are primarily administrative and designed to coincide with the Water Budget, to provide hatchery space, and are based on size and quality.

Research needs that were identified include:

- (24) Evaluate the "Willamette" strategy for application to releases above Bonneville Dam. The Willamette strategy is based on the premise that withholding food to retard growth significantly decreases the health of smolts. However, full feeding results in growth to too large a size by spring for some fish. Therefore, reared fish are graded in the fall and the larger ones are then released. The remainder are held until spring for release. The experience of ODFW in the Willamette River indicates this strategy improves total return.**

The experimental design would include releases of three groups of fish (grade part of the total production and release one group, the large fish. in the fall: hold the second group, smaller ones, for spring release: and use a spring release of ungraded fish as the third, control group.) The investigation would include effect of size at release (both 9 to the pound and 20 to the pound released in the fall) and determining the number of jacks that return.

- (14) Investigate the optimum time for fall and spring releases (including the duration of the "window"). This is likely to vary by river basin or station. Instream habitat use by smolts and adult returns should**

be monitored, and the work should be repeated for a minimum of 3 years (preferably at least one full life cycle for the stock).

The study should also consider parameters important to selection of the actual day of release within the optimal period. For example, is it important to consider weather, stream flow, moon phase. etc.?

- (11) Evaluate stress from transportation of reared fish and post-stress recovery. Examine stress physiology during recovery period (i.e.. 0, 3, 7, + days of recovery) to estimate recovery time. Based on that, design release strategy to test effects of recovery from stress on survival to adult return. Consider effects of water hardness on imposition of stress and fish recovery.**
- (6) Investigate effect of volitional and forced release strategies on adult returns. This could involve use of PIT (passive integrated transponders) tags and CW's (coded wire tag). The PIT tags would be detected at the hatchery outlet to identify the times of individual out movement, permitting monitoring of smolt survival to detectors located downstream CW's would permit evaluation of adult harvest rates.**
- (6) Identify guidelines for preferred release strategies based on best professional judgement and available information.**
- (1) Investigate optimal time of day for release. Is it better to release fish at night than during daylight? Are there predation considerations that argue for particular time of release?**
- (0) Investigate effect of release into current compared to backwater.**

STEEL HEAD

- (7) Investigate optimum release window based on size of reared fish and time of release.**
- (5) Evaluate stress from transportation of reared fish and post-stress recovery. Examine stress physiology during recovery period (i.e.. 0, 3, 7, + days of recovery) to estimate recovery time. Based on that, design release strategy to test effects of recovery from stress on survival to adult return. Consider effects of water hardness on the imposition of stress and fish recovery.**
- (4) Evaluate effects of rearing density on survival.**
- (4) Evaluate effects of barging smolts from below Bonneville Dam to the ocean.**

- (4) Evaluate effect of condition factor at smolt release on survival to adult return. Include considerations of length-to-weight ratio, fat content, and other quality factors (fin shape, hematocrit. etc.)
- (1) Investigate effect of volitional and forced release strategies on adult returns. This should start with an investigation of existing information.
- (1) Evaluate return to the hatchery from releases of smolts to estuaries.
- (1) Evaluate causes of high straying rates from releases at Lyons Ferry Hatchery. Current strategy includes conditioning for 2 to 3 months in ponds before release. The problem may be related to poor water quality (turbidity, dissolved oxygen, temperature) in the target streams (i.e.. Tucannon. Walla Walla).
- (0) Investigate effect of finishing diets on survival.

SOCKEYE SALMON

- (11) Evaluate effectiveness of release as yearlings compared to fed-fry.
- (2) Try planting sockeye smolts from Wenatchee River stock into the upper Snake River. Use a protocol developed in consultation with Alaska, Canada, National Marine Fisheries Service (NMFS), and WDF.

FALL CHINOOK SALMON

- (1) Evaluate stress from transportation of reared fish and post-stress recovery. Examine stress physiology during recovery period (i.e., 0, 3, 7, + days of recovery) to estimate recovery time. Based on that, design release strategy to test effects of recovery from stress on survival to adult return. Consider effects of water hardness on imposition of stress and fish recovery.
- (1) Evaluate use of net pens for release into reservoir pools and below Bonneville Dam

COHO SALMON

- (3) Evaluate the success of the Unatilla rearing program to determine factors that might be applied elsewhere.
- (1) Investigate the cause of unbalanced sex ratios (up to 70% males) in returns to Washington State hatcheries.
- (1) Investigate effectiveness of offshore releases.

- (0) Investigate the cause of large cyclic variations in survival of Washington fish.
- (0) Investigate effectiveness of late (August) releases.

PARTICIPANT COMMENTS

After the research recommendations were examined by the participants, they reviewed written descriptions of each recommendation. The following summarizes the comments of the participants.

Much of the discussion centered on the need to release healthy fish. The need to control BKD in hatchery-reared spring chinook salmon has high priority. The following comments by Bill McNeil, Oregon State University, and Bob Smith, National Marine Fisheries Service, summarize most of the ideas generated around BKD and release strategies.

Bill McNeil: *"Although BKD management was not listed for the 'vote', based on discussions subsequent to the 'vote' it appeared to me that BKD is a key issue. I suppose one might argue that BKD management is beyond the scope of this workshop, but maybe it isn't. A release strategy for evaluation purposes might compare smolts resulting from BKD management procedures currently practiced, no BKD management, and intensive BKD management, which includes screening of parents and selecting juveniles resulting from matings where both parents are [infection] negative...It seems that sometimes we exhaust our limited resources **available** for research and development on questions of less than critical importance, rather than focusing on key issues such as BKD management in the spring chinook salmon."*

Bob Smith: *"For any experiment, a detailed **disease** profile must be developed **especially** for the fish at time of **release**.. If this isn't **already** being done, it should be added **as** part of the cost of doing research. We have too many cases where something did or didn't work and we **have no idea** why. A detailed disease profile would **eliminate** one area of uncertainty."*

Other comments related more specifically to listed needs. For several research needs that included evaluations of volitional and forced release strategies, the participants stated that specific definitions of these terms must be included in any definition of research plan. There were some suggestions that the "Willanette" strategy need and the evaluation of optimum "windows" for release be combined into one project. For "evaluation of barging effects" and "evaluation of condition factors," therefore some who commented that this information was available and that there may be a need for technology transfer within hatchery systems of the Columbia River Basin.

RELEASE PRACTICES RECOMMENDATIONS

Tuesday afternoon and Wednesday morning (Appendix C). the participants discussed release practices at hatcheries. Bill Hutchinson reviewed practices at Idaho State hatcheries, including loading, trucking, and release of steelhead. The methods he listed were compared to practices reported by other participants. The discussion resulted in a list of release practices that could be used at Columbia River Basin hatcheries to improve hatchery effectiveness.

Attendants were Ron Ptolemy, Bryan Ludwig, Mike Evenson, Mike Cuenco, Ken Pitre, Bob Smith, Jerry Bauer, Bill Hutchinson, Bill McNeil, Gordon Berezay, Jim Byrne, Jack Tipping, Andy Appleby, Carl Schreck, and Doug Dampier.

INVENTORY

- . Accurate inventory (count) is an important prerelease procedure. Without a good inventory, survival estimates are "worthless."
- † A nonstressing count procedure is necessary.
- † Inventory should be taken before smolting begins.
- . Inventory should not be accomplished at the expense of fish condition.
- † Raceways and channels leading from the pond to the stream should be cleaned before crowding and release of fish.

TRANSPORT

- † All fish holding tanks on transport trucks should be insulated to minimize potential change in water temperature during transport. (Trucks used in Idaho are able to transport fish and water for as long as 20 h during the summer with less than 4°F change in temperature. This is a recommended goal for insulation.)
- . Transport trucks should be equipped with in-cab monitoring of transport water, including water temperature and oxygen concentration.
- † The conditions and chemistry of the transport water should be controlled. These are site specific and should be evaluated at each site. Possible conditions and chemistry to be controlled include water hardness and foaming.
- † Water-chilling facilities should be available at all hatcheries so that transport water can be adjusted to the most effective temperature before loading fish for transport.

- † **Handling fish as they are loaded into transport trucks should be accomplished with the minimum amount of stress. This can be done with state-of-the-art pumps, with gravity loading, and by avoiding the use of nets.**
- † **When loading fish with a pump, only small groups of fish should be crowded together at one time.**
- † **Oxygen levels should be monitored in the transport tank before and during fish loading.**
- **Loading densities will vary with species and equipment; however, densities generally should not exceed 1 to 1.4 pounds of fish per gallon of transport water: at high pH loading should be 0.5 to 0.7 lb/gal.**
- † **After fish are loaded into a truck and before transport begins. They should be given at least a half-hour to "settle down." Fish that do not settle down should be returned to the hatchery rather than transported.**

INSTRUCTION TO TRUCK DRIVERS

- **Truck drivers should be trained fish culturists or accompanied by trained fish culturists when transporting fish.**
- † **Truck drivers or accompanying fish culturist should keep accurate transport and off-loading records. Records should include: transport and off-loading mortalities, transport water temperature, transport water chemistry, receiving water temperature, receiving water conditions, and condition and behavior of fish.**
- **Transport trucks should make regularly scheduled stops (every 45 minutes was discussed at the workshop) so that a qualitative evaluation of fish condition can be made.**

ENVIRONMENTAL CONTROLS AT Release SITE

- † **The amount of light at the time of release is important to reducing stress. Site-specific and safety considerations must be considered when determining the best time of day to off-load fish. Night is probably better than day, cloudy is better than sunny, and shaded is better than open.**
- **Release pipes used to deliver fish from transport trucks to the stream should be placed in the water during off-loading.**

- † **Temperature acclimation is site specific and should be evaluated to provide the most effective off-loading temperature. Trucks should be equipped with circulating pumps to introduce receiving water into the fish tanks before off-loading.**

- † **An acclimation/recovery period is recommended for off-loading fish. If possible a recovery period of at least 1 to 2 days should be allowed.**

- † **Off-loading of fish should be evaluated at every site to identify the sites that will benefit from having acclimation/recovery facilities. Acclimation/recovery ponds should be provided at those sites where fish condition can be improved.**

- † **The selection of forced versus volitional releases is a site- and management specific choice. ("If it works at your site, use it!") After a decision is made to select either forced versus volitional release, a sound evaluation procedure is necessary to ensure that the strategy being used is the best.**

- † **Surface channels are better than closed piping for onsite fish release.**

General COMMENTS

On Wednesday night the participants reviewed the conclusions and recommendations of the previous 2 days. Five "General Comments" were generated by this discussion.

Attendants were Ron Ptoleny, Bryan Ludwig, Mike Evenson, Mike Cuenco, Ken Pitt-e. Bob Smith, Bill McNeil, Gordon Berezay. Jim Byrne, Jack Tipping, and Andy Appleby.

- . Release strategies and practices should be developed to reduce the incidence of disease. This is particularly important with spring chinook, which are susceptible to BKD.**
- . A standard monitoring system should be implemented to record data for release practices and evaluate results.**
- . Hatchery operations staff should be included in planning and implementing goals and procedures.**
- . Current experience and knowledge should be reviewed in relationship to release strategies and practices to determine: 1) what is already known, 2) what additional practices can be recommended, and 3) what additional research is needed.**
- . There should be a commitment to fully evaluate release practices and strategies, and to communicate the results to other agencies.**

WORKSHOP RECOMMENDATIONS

The BPA sponsored the Anadromous Fish Release Workshop to generate recommendations for improving anadromous fish release strategies used or proposed for use at hatcheries in the Columbia River Basin. Three lists of recommendations were compiled by the workshop participants.

TOP FOUR RESEARCH RECOMMENDATIONS

The complete list of research recommendations is listed and discussed in the report section on Research Needs. For brevity, we listed only the top four research recommendations in this section.

- . Evaluate size grading and size release criteria (Willamette Strategy) for spring chinook salmon reared and released from hatcheries upstream of Bonneville Dam
- . Evaluate the optimum release time for spring chinook salmon
- . Evaluate transportation stress for chinook salmon
- . Compare yearling to fed-fry release for sockeye salmon.

RELEASE PRACTICES TO IMPROVE HATCHERY EFFECTIVENESS

Twenty-four release practices that were identified and discussed by the participants may be summarized into four groups or categories as:

- . Improve the techniques and practices used to count fish as they are released from the hatchery
- . Improve the truck transportation system that is being used throughout the Columbia River Basin
- . Provide improved instructions to fish transport crews
- . Control the environment of the fish at the time of release.

GENERAL COMMENTS

Four general comments related to hatchery practices but not considered release strategies were listed by the participants as part of the workshop summary session:

- . Conduct research and implement programs to reduce disease at all Columbia River Basin hatcheries, especially BKD

- . Implement a standardized data recording system for Columbia River Basin hatcheries**
- . Include hatchery operation personnel in planning and implementation of goals and procedures**
- . Conduct a review of and evaluate current and future release strategies.**

REFERENCES

Hatchery Effectiveness Technical Work Group. 1987. Hatchery Effectiveness Research Work Plan. Prepared for the Northwest Power Planning Council. Portland, Oregon by the Hatchery Effectiveness Technical Work Group, Portland, Oregon.

Northwest Power Planning Council (NPPC). 1987. Columbia River Basin Fish and Wildlife Program. Northwest Power Planning Council, Portland, Oregon.

APPENDIX A

**ANADROMOUS FISH RELEASE STRATEGIES WORKSHOP:
HATCHERY EFFECTIVENESS TECHNICAL WORK GROUP**

The Columbia River Basin Fish and Wildlife program (NPPC 1987) contains the means (Section 200 b) for exploring methods to substantially increase and improve hatchery production at existing hatcheries within the next 10 years. The Council believes that production can be increased by a variety of methods, such as improvements in husbandry practices and hatchery rearing operations. Before the Council will assess the need for new production facilities, they require that existing hatcheries solve current problems and realize their full potential.

To develop plans to meet these goals, the Council directed BPA to fund a technical work group to develop a five-year work plan to improve hatchery effectiveness. The work group includes representatives of the fish and wildlife agencies, tribes, hydropower project operators, BPA, and other technical experts. All members have technical expertise in hatchery effectiveness.

The current members of the HETWG are

Mr. Robert Smith, Chairman
National Marine Fisheries
Service
1002 N.E. Holladay, Room 620
Portland, OR 97232

Mr. Mike Erho
Douglas County PUD/PNUCC
1151 Valley Mall Parkway
East Wenatchee, WA 98801

Mr. William Hopley
Washington Dept. of Fisheries
115 General Administration
Building
Olympia, WA 98504

Mr. John Kerwin
Washington Dept. of Wildlife
600 N. Capital Way, GJ-11
Olympia, WA 98504-0091

Dr. Mike Cuenco
Columbia River Inter-Tribal Fish
Commission
975 S.E. Sandy Boulevard
Portland, OR 97214

Dr. Robert Garrison
Oregon Dept. of Fish and Wildlife
850 S.W. 15th Street
Corvallis, OR 97333

Mr. Bill Hutchinson
Idaho Dept. of Fish and Game
P.O. Box 25
Boise, ID 83707

Mr. Ed LaMotte
U.S. Fish and Wildlife Service
Spring Creek National Fish
Hatchery
Underwood, WA 98651

**Mr. Robert Mgne
U.S. Army Corps of Engineers
Fisheries Office
Bonneville Lock and Dam
Cascade Locks, OR 97014**

**Mr. Alan Ruger
Bonneville Power Administration
P.O. Box 3261. PJSR
Portland, OR 97208**

APPENDIX B

ANADROMOUS FISH RELEASE STRATEGIES WORKSHOP:
LIST OF INVITED SCIENTISTS AND PARTICIPANTS

Twenty-six fisheries scientists from throughout the Pacific Northwest were invited to the workshop. The invited scientists were designated by Jerry Bauer of BPA after consultation with the fisheries management agencies in the Pacific Northwest. The list was prepared to represent a wide range of hatchery expertise and a broad range of experience with most of the hatchery-reared salmonids that are considered important to the enhancement efforts of the HETWG. The scientists and managers invited to the workshop were

Mr. Andrew E. Appleby
Washington Department of
Fisheries
General Administration
Bldg., Room 115
Olympia, WA 98504

Mr. Gordon F. Berezay
Pacific Region/Dept of
Fisheries- and Oceans
555 West Hastings St..
Suite 323
Vancouver. BC V6B 5G3

Dr. Ted C. Bjornm
University of Idaho
Idaho Cooperative Fish &
Wildlife Research Unit
Mscow, ID 83843

Mr. Jim Byrne
Washington Department of
Wildlife
Fish Management
5405 N.E. Hazel Dell Ave
Vancouver, BC V6B 5G3

Dr. Mike Cuenco
Columbia River Inter-
Tribal Fish Commission
975 S.E. Sandy Blvd..
Suite 202
Portland. OR 97214

Mr. Doug Dampier
Columbia River Inter-
Tribal Fish Commission
975 S.E. Sandy Blvd..
Suite 202
Portland. OR 97214

Mr. Dan Diggs
U.S. Fish and Wildlife
Service
1002 N.E. Holladay
Portland, OR 97232-4181

Mr. Mike Evenson
Oreagon Department of
Fish and Wildlife
Cole Rivers Hatchery
200 Cole Rivers Dr.
Trail. OR 97541

Dr. Dave East
Yakima Indian Nation
P.O. 80x 151
Toppenish. WA 98948

Dr. Ron E. Gowan
Anadromous Incorp
500 S.W Madison
Corvallis. OR 97333

Mr. Bill Heubach
California Fish and Game
P. O. Box 4287
Arcata. CA 95521

Mr. Bill G. Hutchinson
Idaho Department Fish
and Game
P. O. 80x 25
Boise, ID 83707

Dr. Ted Kerstetter
Humboldt State University
Department of Biological
Sciences
Arcata. CA 95521

Mr. Robert E. Lindsay
Oregon Department of
Fish and Wildlife
850 S.W 15th St.
Corvallis. OR 97333

Mr. Brian Ludwig
BC Mnistry of
Environment
780 Blanshard St.
Victoria, BC V8V 1X5

Dr. William J. McNeil
Hatfield Marine Science
Center
2030 S. Marine Science
Dr.
Newport, OR 97365-5396

Mr. Dexter Pitman
Idaho Department Fish
and Game
P. O. Box 25
Boise, ID 83707

Mr. Ken R. Pitre
Pacific Region/Dept of
Fisheries and Oceans
555 West Hastings St..
Suite 323
Vancouver, BC V6B 5G3

Mr. Ron Ptolemy
BC Ministry of
Environment
780 Blanshard St.
Victoria, BC V8V 1X5

Dr. Carl Schreck
Oregon State University
Nash Hall, 104
Corvallis. OR 97331-
3803

Mr. Paul Seidel
Washington Department of
Fisheries
General Administration
Bldg. Room 115
Olympia, WA 98504

Mr. Bob Smith
National Marine
Fisheries Service
1002 N.E. Holladay. Room
620
Portland, OR 97232

Mr. Mario F. Solazzi
Oregon State University
303 Extension Hall
Corvallis. OR 97332

Mr. Jack Tipping
Washington Department of
Wildlife
2101 Hwy. 508
Onalaska. WA 98570

Mr. Bob Vreeland
National Marine
Fisheries Service
1002 N.E. Holladay. Room
620
Portland, OR 97232

Mr. Terry E. Wight
NW Indian Fish
Commission
6730 Martin Way.
East Olympia, WA 98506

Fourteen fisheries scientists and managers representing nine different agencies, tribes, or universities attended the workshop. Additionally, Jerry Bauer and Alan Ruger represented BPA and participated in the workshop. The workshop attendees and facilitators were:

Mr. Andrew E. Appleby
Washington Department of
Fisheries
General Administration
Bldg., Room 115
Olympia, WA 98504
(206) 586-6344

Mr. Gordon F. Berezay
Pacific Region/Dept of
Fisheries & Oceans
555 West Hastings St..
Suite 323
Vancouver, BC V6B 5G3
(604) 666-8169

Mr. Jim Byrne
Washington Dept of
Wildlife
Fish Management
5405 N.E. Hazel Dell
Ave.
Vancouver. WA 98663
(206) 696-6211

Mr. Mike Cuenco
Columbia River Inter-
Tribal Fish Commission
975 S.E. Sandy Blvd..
Suite 202
Portland, OR 97214
(503) 238-0667

Mr. Doug Dannier
Columbia River Inter-
Tribal Fish Commission
975 S.E. Sandy Blvd..
Suite 202
Portland, OR 97214
(503) 238-0667

Mr. Mike Evenson
Oregon Department of
Fish and Wildlife
Cole Rivers Hatchery
200 Cole Rivers Dr.
Trail, OR 97541
(503) 776-6087

*** Mr. Bill G. Hutchinson**
Idaho Department Fish
and Game
P. O. Box 25
Boise, ID 83707
(208) 334-3791

Mr. Brian Ludwig
BC Ministry of
Environment
780 Blanshard St.
Victoria, BC V8V 1X5
(604) 387-9682

Dr. William J. McNeil
Hatfield Marine Science
Center
2030 S. Marine Science
Dr.
Newport, OR 97365-5396
(503) 867-3011

Mr. Ken R. Pitre
Pacific Region/Dept of
Fisheries & Oceans
555 West Hastings St..
Suite 323
Vancouver, BC V6B 5G3
(604) 666-8169

Mr. Ron Ptolemy
BC Ministry of
Environment
780 Blanshard St.
Victoria, BC V8V 1X5
(604) 387-9582

Dr. Carl Schreck
Oregon State University
Nash Hall, 104
Corvallis. OR 97331-
3803
(503) 737-4531

* **M Bob Smith**
National Marine
Fisheries Service
1002 N.E. Holladay. Room 2101 Hwy. 508
620
Portland, OR 97232
(503) 230-5410

Mr. Jack Tipping
Washington Department of
Wildlife
2101 Hwy. 508
Anchorage, Alaska, WA 98570
(206) 978-4962

Bonneville Power Administration

Mr. Jerry Bauer
Bonneville Power
Administration
P. O. Box 3621, PJSR
Portland, OR 97208
(503) 230-7579

* **Mr. .**
Bonneville Power
Administration
P. O. Box 3261, PJSR
Portland, OR 97208
(503) 230-5365

Facilitators

Mr. Duane Fickelsen
Context Institute
P. O. Box 11470
Bainbridge Island, WA
98110
(206) 842-0216

Mr. Duane Neitzel
Pacific Northwest
Laboratory
P. O. Box 999
Richland, WA 99352
(509) 376-0602

*, HETWG member.

APPENDIX C

ANADROMOUS FISH RELEASE STRATEGIES WORKSHOP:
AGENDA

Monday, December 11, 1989

11:30 Registration

12:00 Lunch

1:00 Opening and Welcome

1:45 Current Release Strategies (Overview)

Standard Practices

Nonstandard Practices

4:45 Conclusions

5:00 Dinner

Evening Recreation & Social

Tuesday, December 12, 1989

8:00 Breakfast

8:45 Good of the Order

9:00 What Factors Affect Release Strategies?

11:00 Effects of Release Strategy on Performance

12:00 Lunch

1:00 Continue with Effects on Performance

2:00 Effects of Release Strategy on Wild Populations

4:30 Conclusions

5:00 Dinner

Evening Open Forum for Unfinished Business

Wednesday, December 13, 1989

8:00 Breakfast

8:45 Good of the Order

9:00 New Approaches to Release Strategies

11:00 Review Priority Research Needs

11:45 Conclusions

12:00 Lunch and Afternoon Free Time

(Staff will draft Statement of Findings)

4:00 Summary of Findings and Research Needs

5:00 Dinner

**7:00 Discussion and Revision of Statement of Findings and
Research Needs**

Thursday, December 14, 1989

8:00 Breakfast

8:45 Good of the Order

9:00 Finalize Statement of Findings and Research Needs

9:45 Research Standards

11:30 Conclusions

11:45 Evaluation

12:00 Adjourn/Lunch