WILLAMETTE HATCHERY OXYGEN SUPPLEMENTATION 8816000

SHORT DESCRIPTION:
Determine if chinook salmon can be reared at increased densities with oxygen supplementation without detrimental effects on the returns of adult salmon. Examine the effects of density, oxygen supplementation, and raceway design on water quality, rearing, and survival of chinook salmon at Willamette Hatchery, Oakridge, Oregon.

SPONSOR/CONTRACTOR: ODFW
Oregon Department of Fish and Wildlife
Harry Lorz, Assistant Regional Supervisor
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SUB-CONTRACTORS:
Dr. Richard Ewing - Biotech

GOALS

GENERAL:
Supports a healthy Columbia basin, Maintains biological diversity, Maintains genetic integrity, Increases run sizes or populations, Adaptive management (research or M&E)

ANADROMOUS FISH:
Research, M&E

NPPC PROGRAM MEASURE:
4.1; 7.2; 7.2D

RELATION TO MEASURE:
Hydropower development and operations in the Columbia River basin have caused the loss of 5 million to 11 million salmonids. An interim goal of the Northwest Power Planning Council is to reestablish these historical numbers by doubling the present runs from 2.5 million adult fish to 5.0 million adult fish. This increase in production will be accomplished through comprehensive management of both wild and hatchery fish, but artificial propagation will play a major role in the augmentation process. The current husbandry techniques in existing hatcheries require improvements that may include changes in rearing densities, addition of oxygen, removal of excess nitrogen, and improvement in raceway design. Emphasis will be placed on the ability to increase the number of fish released from hatcheries that survive to return as adults. This study was desig

TARGET STOCK	LIFE STAGE	MGMT CODE (see below)
Willamette Spring Chinook	Juvenile to returning adult	

BACKGROUND

Stream name:
Middle Fork Willamette River

Subbasin:
Willamette River

Land ownership:
Both public and private

HISTORY:
The hypothesis to be tested was that the rearing capacity of chinook salmon in a surface water hatchery could be increased through use of supplemental oxygen without reduction in survival to adulthood. Initial activities concerned modification of existing raceways to the conformation of Michigan raceways, installation of contact columns for introducing oxygen, and modification of the intake structure to protect the water supply. Experimental design called for spring chinook being reared and released for four years. Water quality was to be monitored and growth of rearing fish measured. Duplicate raceways contained juvenile chinook salmon at normal rearing conditions without oxygen, fish reared at normal density with oxygen supplementation, fish reared at triple density with oxygen supplementation, and fish reared in a series of three Michigan ponds with oxygen supplementation. Representative samples of fish were tagged with coded wire tags. Water quality was recorded weekly, with a continuous monitoring system throughout the rearing period. Growth, size distribution, and mortality were followed throughout the rearing period. Returning adults will be collected, heads removed, and coded wire tags decoded for

determination of survival of the various groups. Analysis of data and final report will be completed by September 2000.

Costs were as follows:

1987-1989	$987,627-Major intake construction & pond modification
1989-1990	$429,525-Includes Subcontract to OSU-Migration studies
1990-1991	$450,872-Includes Subcontract to OSU-Migration studies
1991-1992	$289,039
1992-1993	$284,267
1993-1994	$263,106
1994-1995	$ 97,996
1995-1996	$ 94,811
1996-1997	$ 89,203
TOTAL	$2,986,446

BIOLOGICAL RESULTS ACHIEVED:

To date, the project is still in the data collection phase and only preliminary results are available. The next few years will be devoted to analysis of water quality and rearing data, collection and analysis of adult returns, and preparation of papers for publication. Manuscripts have been published and a few manuscripts are nearing publication.

PROJECT REPORTS AND PAPERS:

Colt, J., J.E. Sheahan, and G.R. Bouck. 1993. Evaluation of the "Michigan" type pure oxygen columns for oxygen addition and nitrogen removal. Aquacultural Engineering 12:141-154.
Ewing, R.D., T.R. Walters, M.A. Lewis, and J.E. Sheahan. 1994. Evaluation of fish transport procedures. I. Estimates of weights of fish in raceways and liberation trucks. Progressive Fish-Culturist. 56:153-159.
Ewing, S.K. and R.D. Ewing. 1995. A review of the effects of rearing density on survival to adulthood for Pacific salmon. Progressive Fish-Culturist. 57:1-25.
Ewing, R.D. and J.E. Sheahan. 1996. Air lift debris removal system. Progressive Fish-Culturist, 58:284-285.
Ewing, R.D., M.A. Lewis, J.E. Sheahan, and S.K. Ewing. 1997. Evaluation of inventory procedures for hatchery fish. III. Nonrandom distributions of chinook salmon in raceways. Prog. Fish-Cult., in press.
Ewing, R.D., A. Palmisano, M.A. Lewis, and J.E. Sheahan. 1997. Comparison of the growth, feeding and mortalities of juvenile chinook salmon reared in raceways and Michigan ponds. Prog. Fish-Cult., in review.
Ewing, R.D., J.E. Sheahan, M.A. Lewis, and A. Palmisano. 1997. Effects of rearing density on growth, feeding and mortalities of juvenile chinook salmon. Prog. Fish-Cult., in review.
Schreck, C.B., J.C. Snelling, R.E. Ewing, C.S. Bradford, L.E. Davis and C.H. Slater. 1994. Migratory Characteristics of juvenile spring chinook in the Willamette River. Completion Report. Bonneville Power Administration. Portland.
Schreck, C.B., J.C. Snelling, R.E. Ewing, C.S. Bradford, L.E. Davis and C.H. Slater. 1994. Migratory behavior of adult spring chinook salmon in the Willamette River and its tributaries. Completion Report. Bonneville Power Administration. Portland.

Annual Progress Reports

Ewing, R.D. and J.E. Sheahan. 1990. Willamette oxygen supplementation studies. Bonneville Power Administration, Annual Contract Research Report, Portland.
Ewing, R.D. and J.E. Sheahan. 1991. Willamette oxygen supplementation studies. Bonneville Power Administration, Annual Contract Research Report, Portland.
Ewing, R.D. and J.E. Sheahan. 1992. Willamette oxygen supplementation studies. Bonneville Power Administration, Annual Contract Research Report, Portland.
Ewing, R.D., S.K. Ewing, and J.E. Sheahan. 1993. Willamette oxygen supplementation studies. Bonneville Power Administration, Annual Contract Research Report, Portland.
Ewing, R.D., S.K. Ewing, and J.E. Sheahan. 1994. Willamette oxygen supplementation studies. Bonneville Power Administration, Annual Contract Research Report, Portland.
Ewing, R.D. 1995. Willamette Oxygen Supplementation Studies. Ammonia analysis and adult returns. Bonneville Power Administration, Annual Contract Research Report, Portland.
Ewing, R.D. 1996. Willamette Oxygen Supplementation Studies. Analysis of growth, feeding and mortalities. Bonneville Power Administration, Annual Contract Research Report, Portland.

ADAPTIVE MANAGEMENT IMPLICATIONS:
An interim goal of NPPC is to reestablish historical numbers of salmon to the Columbia River basin. Increases in production are to be accomplished through comprehensive management of both wild and hatchery fish, but artificial propagation will play a major role in the augmentation process. This study was designed to examine the feasibility of increasing production in existing hatcheries rather than incur large capital construction costs for new hatcheries. The present study to date has indicated that Michigan raceways, such as those constructed at Umatilla Hatchery, should not be incorporated into hatcheries for chinook production. It suggests that ammonia production from rearing increased numbers of fish will probably not be a problem in Columbia River hatcheries. It further suggests that oxygen supplementation will not be effective in permitting increased rearing densities of chinook salmon. According to preliminary data from this study, and from numerous other smaller studies, it appears that the most efficient use of hatchery facilities may be attained by rearing the juveniles at densities far lower than those presently used. In rearing chinook salmon, survival and lack of disease in the hatchery do not predict the survival of the juveniles to adulthood.

PURPOSE AND METHODS

SPECIFIC MEASUREABLE OBJECTIVES:
The overall goal of the project is to determine if chinook salmon can be reared at increased densities with oxygen supplementation without detrimental effects on the returns of adult salmon. We have completed the rearing phase of this project, and we are about 2/3 of the way through the adult collection phase of the project and about halfway through the analysis portion of the project. While we cannot reach scientifically sound conclusions before all the data is collected and analyzed, present results seem to indicate:

1. With supplemental oxygen, chinook salmon juveniles can be reared at three times their normal rearing density without increases in disease or mortality.
2. Michigan-style raceways do not provide a healthy environment for rearing juvenile chinook salmon.
3. Ammonia concentrations do not reach limiting levels with increased fish rearing densities in surface water supplies with low buffering capacity.
4. Returns of adult chinook salmon are inversely related to rearing density. Supplemental oxygen can alleviate, but not restore, the decrease in survival resulting from increased rearing densities.
5. Oxygen supplementation may successfully increase the productive capacity of hatcheries for coho salmon, but not chinook salmon. Instead, chinook salmon rearing densities at present hatcheries should be decreased to provide more efficient use of our declining broodstocks.

CRITICAL UNCERTAINTIES:
Will we have adequate funding to complete data collection and analysis for completion of the project?

BIOLOGICAL NEED:
To determine if increased hatchery production is possible without sacrificing adult survival and within the existing hatchery facilities.

HYPOTHESIS TO BE TESTED:
Rearing capacity of spring chinook could be increased threefold in a surface water hatchery through use of supplemental oxygen, without reduction in survival to adulthood.

ALTERNATIVE APPROACHES:
N/A

JUSTIFICATION FOR PLANNING:
N/A

METHODS:

The statistical analyses to be used includes analyses of variance and covariance, followed by Tukey's tests when significant differences are found. Linear regression models will be used when required. Adult returns will be tested by nested analysis of variance if returns are sufficient; otherwise, binomial and/or Poisson distribution tests will be used.

PLANNED ACTIVITIES

SCHEDULE:

PROJECT COMPLETION DATE:
2000

OUTCOMES, MONITORING AND EVALUATION

SUMMARY OF EXPECTED OUTCOMES

Expected performance of target population or quality change in land area affected:
Should be able to determine if chinook salmon juveniles can be reared at increased densities with oxygen supplementation without detrimental effects on adult returns.

Present utilization and convservation potential of target population or area:
N/A

Assumed historic status of utilization and conservation potential:
N/A

Long term expected utilization and conservation potential for target population or habitat:
N/A

Indirect biological or environmental changes:
N/A

Physical products:
N/A

Environmental attributes affected by the project:
N/A

Changes assumed or expected for affected environmental attributes:
N/A

Measure of attribute changes:
N/A

Coordination outcomes:
See description of Project 92-024-00 for more detail.

MONITORING APPROACH
The experimental design, number of fish per experimental groups, and description of equipment needs was laid out in the original project proposal funded in 1988. The statistical analysis to be used includes Analysis of variance, analysis of co-variance and linear regression.

Provisions to monitor population status or habitat quality:
N/A

EVALUATION
Evaluation - Results from this project will be written into manuscripts which will be reviewed at the national level and published in refereed journals.

Incorporating new information regarding uncertainties:
N/A

Increasing public awareness of F&W activities:
N/A

RELATIONSHIPS

RELATED BPA PROJECT	RELATIONSHIP
8903500 Umatilla Hatchery Operations and Maintenance	Umatilla Hatchery Operations and Maintenance
9000500 Umatilla Hatchery Monitoring and Evaluation Project	Umatilla Hatchery Monitoring and evaluation project. Study uses Michigan pond design, oxygen but well water source.
8816003	Dr. Schreck's studies utilized our released juvenile salmon migrants to determine characteristics of seaward migration as related to oxygen supplementation.

COSTS AND FTE

1997 Planned: $94,077

FUTURE FUNDING NEEDS:

FY	$ NEED	% PLAN	% IMPLEMENT	% O AND M
1998	$95,600			100%
1999	$60,600			100%
2000	$39,600			100%

PAST OBLIGATIONS (incl. 1997 if done):

FY	OBLIGATED
1988	$743,490
1989	$673,662
1990	$450,872
1991	$289,039
1992	$284,267
1993	$263,106
1994	$97,996
1996	$94,811
1997	$94,077
TOTAL:	$2,991,320

Note: Data are past obligations, or amounts committed by year, not amounts billed. Does not include data for related projects.

1997 OVERHEAD PERCENT: 22%

HOW DOES PERCENTAGE APPLY TO DIRECT COSTS:
[Overhead % not provided so BPA appended older data.] Indirect charged only an ODFW personal services and service and supply costs not to the subcontract with Biotech.

SUBCONTRACTOR FTE: 0.3 FTE - Dr. Richard D. Ewing