Bonneville Power Administration
Fish and Wildlife Program FY99 Proposal

Section 1. General administrative information

Willamette Hatchery Oxygen Supplementation

Bonneville project number, if an ongoing project 8816000

Business name of agency, institution or organization requesting funding
Oregon Department of Fish and Wildlife

Business acronym (if appropriate) ODFW

Proposal contact person or principal investigator:

Name	Dr. Harold Wm Lorz
Mailing Address	ODFW, PO Box 59
City, ST Zip	Portland, Oregon 97207
Phone	541/757-4186
Fax	541/757-4252
Email address	

Subcontractors.

Organization	Mailing Address	City, ST Zip	Contact Name
Biotech Research & Consulting	2340 SE Ryan St.	Corvallis, OR 97333	Dr. R.D. Ewing

NPPC Program Measure Number(s) which this project addresses.
703(e)1 (1987 NPPC)

NMFS Biological Opinion Number(s) which this project addresses.

Other planning document references.

Subbasin.
Willamette River Subbasin

Short description.
Evaluate oxygen supplementation for use in hatchery production.

Section 2. Key words

Mark	Programmatic Categories	Mark	Activities	Mark	Project Types
X	Anadromous fish		Construction		Watershed
	Resident fish		O & M		Biodiversity/genetics
	Wildlife		Production		Population dynamics
	Oceans/estuaries	X	Research		Ecosystems
	Climate		Monitoring/eval.	X	Flow/survival
	Other		Resource mgmt		Fish disease
			Planning/admin.	X	Supplementation
			Enforcement		Wildlife habitat en-
			Acquisitions		hancement/restoration

Other keywords.

Section 3. Relationships to other Bonneville projects

Project #	Project title/description	Nature of relationship
90005	Umatilla Hatchery Monitoring	Complementory as tests efficiency of oxygen supplementation and Michigan pond in well water system.

Section 4. Objectives, tasks and schedules

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Recover and decode tags from returning adults	a	Collect biological data/samples from returning adults (length, weight,sex, scale sample.
		b	Decode CWT's from all marked fish collected.
2	Analyze and summarize data	a	Summarize estimated fishery catch and calculate total survival of each

			replicate in each treatment for each brood year.
3	Transfer the technology to user groups	a	Write annual report.
		b	Publish results in peer reviewed scientific journals.

Objective schedules and costs

Objective #	Start Date mm/yyyy	End Date mm/yyyy	Cost %
1	9/1998	3/1999	40.00%
2	2/1999	7/1999	35.00%
3	12/1998	9/1999	25.00%
			TOTAL 100.00%

Schedule constraints.

Completion date.
June 30, 2000

Section 5. Budget

FY99 budget by line item

Item	Note	FY99
Personnel		$6,730
Fringe benefits		$1,541
Supplies, materials, non-expendable property		
Operations & maintenance		$1,600
Capital acquisitions or improvements (e.g. land, buildings, major equip.)		
PIT tags	# of tags:	
Travel		
Indirect costs		$2,260
Subcontracts		$30,600
Other		
TOTAL		$42,731

Outyear costs

Outyear costs	FY2000	FY01	FY02	FY03
Total budget	$26,806			
O&M as % of total	9.30%			

Section 6. Abstract

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. The project examined the effects of density, oxygen supplementation, and raceway design on water quality, rearing, and survival of chinook salmon at Willamette Hatchery, Oakridge, Oregon. 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.

Section 7. Project description

a. Technical and/or scientific background.

Willamette Oxygen Supplementation Project was set up in 1988 to test the use of supplemental oxygen for increasing production in a surface water hatchery. It was hoped that the retrofitting of Willamette Hatchery with oxygen supplementation could increase the yield of spring chinook salmon to the Willamette River. This would imply that existing hatcheries in the Columbia River Basin could retrofit their facilities with supplemental oxygen to increase production and help to attain the goals of the Power Planning Council.

The experimental design of the project called for replicates of seven experimental treatments. Three rearing densities would be tested: normal density for Willamette hatchery, half normal density, and three times normal density. Oxygen supplementation would be provided to the triple density raceways, as well as one pair of normal density raceways. Water was used three times before it was discarded. Each of these raceways

was supplied with fish to provide a triple rearing density, but remained at the same load as the control raceways.

Fish were introduced into the raceways in appropriate numbers in July at the time of marking with coded wire tags and fin clips. The fish were then reared until March, when they were loaded into trucks and released in the Willamette River below Dexter Dam. During rearing, extensive sampling provided information on growth, disease incidence, smolt condition, and water quality. Four brood years of fish were released. The final adult returns from these tagged groups will be complete in 1999.

At the final release in March 1994, approximately 3.7 million data points had been taken as part of the project. Analysis of these data points was undertaken while waiting for the adults to return. Major highlights of the results so far indicate:

1. Lower rearing densities seem to provide better adult returns than higher densities in chinook salmon.
2. Oxygen supplementation seems to increase survival in some years, but the results do not seem to be consistent and do not overcome the effects of increased rearing density.
3. Michigan raceways appear detrimental to survival of spring chinook salmon.
4. Fish reared in Michigan raceways show significantly higher metabolic rates than those reared in regular raceways.
5. In seawater tests, fish reared in Michigan raceways showed much higher susceptibility to bacterial kidney disease.
6. Ammonia production was highest in third-pass Michigan raceways, but level of unionized ammonia considered deleterious to the fish were not found.
7. pH decreases with increasing metabolic activity in surface water with little buffering capacity. Consequently, ammonia levels can probably never reach limiting levels in these situations.
8. Water chemistry in surface water hatcheries is completely different from that of well water hatcheries. Well water hatcheries have relatively constant water quality, whereas surface water quality changes with environmental conditions. These changes include circannual and diel changes in temperature, dissolved oxygen, gas saturation, hardness, pH, suspended solids and dissolved solids.

At present, most of the data on fish growth and about one third of the data on water quality has been analyzed. Marked adults are collected each summer and fall and tags are identified. Collection of adults should be complete in 1999. The project should result in many published articles on aspects of fish culture, one of the most extensive databases on hatchery water quality for a surface water hatchery, and clear answers to the objectives originally proposed for the project.

ANNUAL REPORTS AND TECHNICAL 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 G. S. Ewing. An improved guillotine for removing the heads of coded wire-tagged fish. Progressive Fish-Culturist, in review.

Ewing, R. D., J. E. Sheahan. Airlift debris removal system for water intake structures. Progressive Fish-Culturist. 58:284-285.

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 Progress Report. Portland, Oregon.

Ewing, R. D. 1996. Willamette Oxygen Supplementation studies. Analysis of Growth, Feeding and Mortalities. Bonneville Power Administration. Annual Progress Report. Portland, Oregon.

Ewing, R. D. 1997. Willamette Oxygen Supplementation studies. Oxygen Consumption Rates and Adult Returns. Bonneville Power Administration. Annual Progress Report. Portland, Oregon.

b. Proposal objectives.

c. Rationale and significance to Regional Programs.

d. Project history

e. Methods.

f. Facilities and equipment.

g. References.

Section 8. Relationships to other projects

Collaborative Projects

BPA Project 91-22. Implementation of ELISA-based segregation of adult chinook salmon for control of BKD. Results of this project helped to develop the ELISA-based assay

system for chinook salmon currently used to decrease incidence of BKD at Willamette Hatchery and other NW hatcheries.

BPA Project 88-160-3. Migratory characteristics of juvenile and adult spring chinook salmon in the Willamette River. This project characterized the movement both upstream and downstream of spring chinook salmon released from Willamette Hatchery.

BPA Project 89-046. Smolt quality assessment of spring chinook salmon. This project did an extensive characterization of the smolting process in spring chinook salmon reared in Leavenworth, Dworshak, Warm Springs, and Willamette Hatcheries and related these indices to adult returns.

Complementary Studies

BPA Project 90-005. Umatilla Hatchery monitoring and evaluation. This project was complementary in that it tested the efficiency of oxygen supplementation and Michigan ponds for increasing adult returns of chinook salmon and steelhead.

Abernathy Fish Culture Technology Center. Study on the effects of rearing density and oxygen supplementation on the returns of fall chinook salmon. This project was complementary in that it tested the efficiency of oxygen supplementation for increasing adult returns of chinook salmon.

Section 9. Key personnel

Name: Richard D. Ewing

Education: B. S., Reed College, Portland, Oregon 1962; Ph. D., University of Miami, Coral Gables, Florida, 1968.

Current Employment: CEO, Biotech Research and Consulting, Inc., Corvallis, Oregon 97333

Current Responsibilities: 1) Performing business aspects of Biotech Research and Consulting, Inc. (includes corporate meetings, registrations, insurances, proposals, etc.); 2) Analysis and writing of contract reports; 3) Biochemical and chemical analyses for NW fisheries agencies.

Previous Employment: Fish and Wildlife Supervisor 3, Oregon Department of Fish and Wildlife, Corvallis, Oregon 97330, 1975-1992.

Expertise: Expert in biochemical analyses, physiological measurements, hatchery practices. Developed methods for simple analyses of gill (Na+K)-ATPase and

skin guanine concentrations. Used these techniques and others to examine smolting in salmonids. Headed up Technical Services team for solution of hatchery-related problems in ODFW. Presently, developing methods for analysis of fishery and environmental related problems.

Recent publications:

Ewing, R D. and S. K. Ewing. 1995. 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. Airlift debris removal system for water intake structures. Progressive Fish-Culturist. 58:284-285.

Ewing, R. D., M. A. Lewis, J. E. Sheahan, and S. K. Ewing. 1998. Evaluation of inventory procedures for hatchery fish. III. Nonrandom distributions of chinook salmon in raceways. Progressive Fish-Culturist, in press.

Ewing, R. D. and J. D. Rodgers. 1998. Changes in physiological indices of smolting during seaward migration of wild oho salmon, Oncorhynchus kisutch. Aquaculture, in press.

Ewing, R. D., J. E. Sheahan, M. A. Lewis, and A. Palmisano. 1998. Effects of rearing density and raceway conformation on growth feeding and survival of juvenile chinook salmon. Progressive Fish-Culturist, in press.

Section 10. Information/technology transfer

Information derived from the Willamette Oxygen Supplementation Project has been and will be distributed primarily by publication of refereed journal articles and through presentation at fisheries meetings. In addition, information on rearing densities for spring chinook salmon generated by this project is under consideration for implementation in Oregon hatcheries.

The following publications have resulted from this project:

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 inventory procedures for hatchery fish. I. Estimating weights of fish in raceways and transport trucks. Progressive Fish-Culturist. 56:153-159.

Ewing, R. D. and S. K. Ewing. 1995. 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. Airlift debris removal system for water intake structures. Progressive Fish-Culturist. 58:284-285.

Ewing, R. D., J. E. Sheahan, M. A. Lewis, and S. K. Ewing. 1998. Evaluation of inventory procedures for hatchery fish. III. Nonrandom distributions of chinook salmon in raceways. Progressive Fish-Culturist, in press.

Ewing, R. D., J. E. Sheahan, M. A. Lewis, and A> Palmisano. 1998. Effects of rearing density and raceway conformation on growth, feeding and survival of juvenile chinook salmon. Progressive Fish-Culturist, in press.

In addition, the following presentations have been made in fisheries meetings:

M. A. Lewis, R. D. Ewing, and T. R. Walters, 1992. Changes in specific gravity of coho and chinook salmon, steelhead, and rainbow trout in relation to fish hauling. 43rd Annual NW Fish Culture Conference, December 1-3, 1992, Wenatchee, WA.

Tim Walters, Mark Lewis, Joe Sheahan, and R. D. Ewing, 1992. Sampling procedures for accurate estimates of fish weights in raceways. 43rd Annual NW Fish Culture Conference, December 1-3, 1992, Wenatchee, WA.

R. D. Ewing, Joe Sheahan, Tom Herbst, and H. Lorz. 1992. Oxygen Supplementation at Willamette Hatchery. 43rd Annual NW Fish Culture Conference, December 1-3, 1992, Wenatchee, WA.

R. D. Ewing and S. K. Ewing, 1993. A review of the effects of rearing density on survival to adulthood for Pacific salmon. 44th Annual NW Fish Culture Conference, December 7-9, 1993, Spokane, WA.

R. D. Ewing and J. E. Sheahan. 1994. Diel and circannual changes in ammonium excretion by spring chinook salmon at Willamette Hatchery. 45th Annual NW Fish Culture Conference, December 6-8, 1994, Sunriver, OR.

R. D. Ewing and J. E. Sheahan. 1995. Comparison of raceways and Michigan ponds for rearing chinook salmon. 46th Annual NW Fish Culture Conference, December 5-7, 1995, Fife, WA.

R. D. Ewing. 1997. Comparison of rearing characteristics and survival from chinook salmon reared in raceways and Michigan raceways. NATURES Workshop, Port Ludlow, WA.

WORK PLAN

WILLAMETTE OXYGEN SUPPLEMENTATION PROJECT

Subcontract to Biotech Research and Consulting, Inc.
September 30, 1998 to September 29, 1999

ANALYSIS AND REPORTS

1. Analyze water quality parameters at Dexter collection facility with growth, mortality and feeding of fish reared at Dexter.

   Result: Analyzed data for inclusion in annual report.

2. Collect and analyze water quality data for inflows to Willamette Hatchery to provide a data base for water quality for surface-water hatcheries.

   Result: Analyzed data for inclusion in annual report.

3. Read and analyze scales from returning adults for 1997 and 1998 to determine size of outmigrating juvenile spring chinook salmon that survive to adulthood.

   Result: Analyzed data for inclusion in annual report.

4. Collect and analyze coded-wire tag recoveries for analysis of returning adults from each experimental group.

   Result: Final data for inclusion in annual report.

5. Prepare, edit, and finalize annual report.

   Result: Annual report submitted to ODFW.

6. Prepare special reports to BPA as required.

   Result: Prepared report or presentation.

7. Prepare information for manuscripts to be submitted to refereed journals.

   Result: Manuscripts submitted to journals.

8. Prepare talk for annual fish culture conference or other fisheries agency meetings.

   Result: Talk and abstract for conferences.

BUDGET

WILLAMETTE OXYGEN SUPPLEMENTATION PROJECT

Subcontract to Biotech Research and Consulting, Inc.
September 30, 1998 to September 29, 1999

Personnel	Days	HR Rate	Total
R. D. Ewing	85	$45	$30,600