

Project Title: Were pink salmon embryo studies in PWS biased?

Project Number: 02492

Restoration Category: Research

Proposer: John Thedinga, Mark Carls, Ron Heintz,
NMFS, Auke Bay Laboratory
ABL Program Manager: Dr. Stanley Rice

Lead Trustee Agency: NOAA

Alaska Sea Life Center: No

Cooperating Agencies:

Duration: 1 year (close out)

Cost FY02: \$24.0

Geographic Area: Auke Bay Laboratory

Injured Resource/Service: Pink salmon

ABSTRACT

Effects of the *Exxon Valdez* oil spill on wild pink salmon embryo survival in Prince William Sound are disputed among government- and industry-sponsored researchers. Exxon contends the government's conclusions that reduced embryo viability in oiled streams was caused by persistent oil contamination were biased because sampling times were earlier in oiled streams than in reference streams. We conducted experimental studies to determine the ability to discriminate eggs killed by sampling (shock mortality) and previously dead eggs in order to help ascertain if estimates of pink salmon embryo survival in Prince William Sound were accurate or biased. Preliminary results of our studies indicate that shock resistance of eggs increased in a sigmoidal fashion from the end of September to mid November and that the timing of egg examination after being pumped from a stream is critical in differentiating shocked eggs from previously dead eggs. By removing eggs pumped from stream gravel soon after sampling, shocked eggs were easily discernable and could easily be separated from previously dead eggs. This method can alleviate discrimination of egg condition problems posed by differing egg maturity within and between streams and over time. These results suggest that further examination of procedures used for egg sampling in PWS following the oil spill would not help clarify the controversy over potential biased estimates of egg survival.

INTRODUCTION

The Trustee Council view of damage to pink salmon in Prince William Sound (PWS) is different than that of Exxon (Rice et al. 1999; Brannon and Maki 1996; Brannon et al. 1999). One controversial issue has been embryo mortality in oiled vs. non-oiled streams. Bue (1998) found that oiled streams had significantly higher pink salmon embryo mortality than non-oiled streams and Heintz et al. (1999a) confirmed that incubation in oiled substrate can cause damage to embryos. Brannon (1996), however claimed that increased mortality in oiled streams was an artifact of sample design due to shocking and bias from sampling timing. Collins et al. (2000) showed that hydraulic sampling of embryos can cause mortality that can bias mortality estimates upward if not accounted for.

After 11 years, the questions remain- -was there bias in the sampling because of run timing differences between oiled and non-oiled streams? Were egg counters able to separate new mortalities caused by shocking during the sampling, and did they account for the sampling mortalities? Is it possible to account for the mortalities? These questions are basic to the assessment of damage to pink salmon from the spill, and to restoration strategies that should result. This project examined this continuing controversy with an experimental study.

The experimental study focused on the ability to separate live eggs and dead eggs from newly shocked eggs. This was done first in a controlled laboratory situation (hatchery) with a series on known life stages. A field test was also conducted to test the relationship between run timing and susceptibility of eggs to pumping damage. For the field test, we used the spawning channel at Lovers Cove Creek near Little Port Walter (LPW). A proportion of the eggs in these experiments were repeatedly viewed by several observers to test discrimination of recent and past mortality as a function of time.

In order to determine what level of misinterpretation of egg condition (live or dead) would bias the results of the embryo mortality study, we modeled the 1989-1993 PWS embryo data. Based on Bue's (1996) data, we modeled the number of eggs counted in the oiled and control streams in PWS to account for the misidentification of eggs shocked and killed by the egg pumping procedure. We used a GLM two factor model based on the height above intertidal where the eggs were collected and compared the oiled vs. non-oiled streams. The difference in egg mortality between the oiled and non-oiled streams became non significant ($P = 0.05$) when 9.5% of eggs in all of the oiled streams were incorrectly counted as dead, but were actually killed by egg pumping and should have been counted as live. Whereas in the non-oiled streams, 11.3% of dead eggs would have to be incorrectly counted as live before mortality between oiled and non-oiled streams was no longer significantly different.

Spawning for pink salmon began in August and September; Auke Bay Laboratory provided in kind funds to facilitate initiation of this project in late FY02 so that it could be fully functional for FY01.

Our FY01 proposal called for conducting experimental studies for identifying shocked eggs and the effect of time on egg shock resistance. These studies were successfully carried out in fall 2000. For FY02, we originally suggested conducting an analysis of the 1990-1991 preserved eggs from PWS and evaluating ADFG's egg sampling procedures to help determine if the egg mortality studies done following the oil spill were biased. A preliminary analysis of the preserved eggs showed that the developmental stage of the eggs could not be determined because of deterioration of the eggs. Preliminary results of our experimental studies showed that the timing of egg examination after being pumped from a stream is critical in differentiating shocked eggs from previously dead eggs, and that the amount of experience a person has in classifying eggs significantly affects the accuracy of separating live, dead, and shocked eggs. Results from an ADFG study indicate that when egg mortality data from 1991 was controlled for run timing and sensitivity to mechanical shock, oiled streams still had higher egg mortality than non-oiled streams (Craig et al. 1999). Based on these preliminary results we feel that further investigation is unnecessary and would not help clarify the controversy over potential bias in the egg mortality studies. Therefore, we feel that only a final report that synthesizes the two experimental studies and relates our findings to the egg mortality studies in PWS following the oil spill is necessary in FY02.

NEED FOR PROJECT

A. Statement of problem

There is an ongoing dispute between government and industry researchers concerning the impact of the Exxon Valdez oil spill on pink salmon in PWS. Government researchers concluded that pink salmon embryo survival was lower in oiled streams than in non-oiled streams from 1989-1993. Industry researchers allege that government sampling in oiled streams was earlier than in reference streams relative to run timing, thus biasing estimates of egg survival, because early egg stages are more susceptible to mechanical damage caused by hydraulic pump sampling than later stages. Industry researchers further contend that government observers failed to discriminate between previously dead eggs and those killed by sampling, thereby compounding the problem. The controversy continues after 11 years; this study was conducted in to attempt to clarify the controversy if possible. The controversy continues to cloud estimates of damage, restoration strategies, the impact of long term damage, and the definition of full recovery for this species.

B. Rationale/Link to Restoration

Pink salmon are listed as a recovering species, but before they can be added to the list of recovered species we need to know if persistent oil caused increased mortality of pink salmon embryos in PWS streams. Controversy over how sampling techniques and run timing affected the results of past embryo mortality studies needs to be resolved in order to determine the extent of possible damage from EVOS. Recent studies have shown that oil still exists near natal habitats and that pink salmon embryos are significantly more sensitive to oil exposure than

previously believed (Heintz, et al. 1999a, b). If embryos are continuing to be exposed to oil in streams then the extent of damage needs to be understood. Understanding the damage that oil can cause to pink salmon embryos is also important in realizing potential risks associated with future oil spills.

C. Location

The field portion of the project took place at Lovers Cove Creek near the Little Port Walter field station (LPW) in Southeast Alaska and at Auke Creek Hatchery in Juneau. Lovers Cove Creek provided a uniform spawning channel and an intertidal spawning population of pink salmon that allowed repeated sampling. This location was appropriate because the streams physical characteristics are conducive to this type of project and it close to LPW which provides the necessary logistical and infrastructure support.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

Scientists involved in this study will regularly present progress reports and results in scientific and public forums, including the annual workshop. They will be available to talk with interested public and will provide information for Trustee Council newsletters and annual reports as appropriate.

PROJECT DESIGN

A. Objectives

The objective is to finish two manuscripts based on the two experimental studies conducted in FY01 and to complete a final report that synthesizes both experiments and relates those results with the egg mortality studies in PWS following the oil spill. Further investigation is unwarranted based on our experimental results and the inability to determine the developmental stage of preserved eggs that were sampled by ADFG in 1990-1991 from oiled and non-oiled streams.

B. Methods

Complete two manuscripts and a final report

C. Cooperating agencies, contracts and other agency assistance

NMFS pumped eggs in the field and tested egg shock mortality recognition in the hatchery. In order to sample eggs from the year 2000 pink salmon run, this project started in FY02. NMFS facilitated the start of the experimental portion of this project by making preparations in summer

2000 for sampling in September 2000.

SCHEDULE

A. Measurable tasks for FY02 (October 1, 2001 - September 30, 2003)

Complete final report

B. Project Milestones and Endpoints

Winter 2002: Initiate preparation of final synthesis report

Spring 2002: Complete final synthesis report

C. Completion Date

Two manuscripts on egg shocking will be submitted in 2002.

A final report will be submitted April 15, 2002.

PUBLICATIONS AND REPORTS

Final report

peer-reviewed manuscripts: Thedinga, J. T. et al. Detection of pink salmon eggs killed by hydraulic sampling. Journal unknown.

Carls, M. G. et al. Ability of observers to discriminate shock mortality in pink salmon eggs as a function of time after shock. Journal unknown.

PROFESSIONAL CONFERENCES

Travel to 2002 oil spill symposium is included.

NORMAL AGENCY MANAGEMENT

This project seeks to address the hypothesis that the effects of oil in streams on pink salmon embryo mortality was confounded by time of sampling through a cooperative relationship

between NMFS and the Trustees. NMFS would not be conducting this project if the oil spill had not occurred. NMFS proposes to make a significant contribution to the operation of this project, making it a cooperative venture with the Trustee Council.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The design of this project has been coordinated with work performed in the past by ADFG. NMFS will coordinate with the Trustees by providing labor requirements and laboratory overhead.

PROPOSED PRINCIPAL INVESTIGATOR

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PRINCIPAL INVESTIGATOR

GS-12 Fisheries Research Biologist - John F. Thedinga. BS Fisheries and Wildlife Management, University of North Dakota (1975); MS Fisheries Science, University of Alaska (1986). He has been employed by the National Marine Fisheries Service, Auke Bay Laboratory since 1978 specializing in research on the effects of logging on salmon and freshwater habitat. He has been principle investigator and co-investigator on several projects. Recently he was co-investigator of Trustee project 98076 and principal investigator of Trustee project 00163A. He has published over 20 scientific papers.

CO INVESTIGATORS

GS-12 Fisheries Research Biologist - Mark G. Carls Received BA (1975) in Biology from Gustavus Adolphus College, St. Peter, MN, and MS (1978) in Biological Oceanography from Dalhousie University, Halifax, Nova Scotia. Mark has been employed at the Auke Bay Fisheries Laboratory since 1979. His principal involvement has been in research of petroleum hydrocarbon toxicology to marine fish and invertebrates, including egg, larval, and adult life stages. Mark has published 17 papers, and has 5 Exxon Valdez damage assessment papers in

preparation or pending publication. Since 1989, he has been involved as a principal investigator and co-investigator on several studies resulting from the Exxon Valdez oil spill involving Pacific herring, pink, and chum salmon, and mussels.

GS-12 Fisheries Research Biologist - Ron A. Heintz Education: BS Ecology, University of Illinois (1979); MS Fisheries Science, University of Alaska (1986). Ron has been involved in examining the effects of Exxon Valdez oil on pink salmon since 1992. He has published 4 peer-reviewed papers and has another in press on this topic. To date his work has identified the sensitivity of pink salmon embryos to low concentrations of oil, demonstrated the existence of delayed effect on marine survival and the persistence of oil in stream deltas in Prince William Sound. He is currently working on two other EVOS projects related to this same topic.

OTHER KEY PERSONNEL

GS-9 Fisheries Research Biologist - Jacek M. Maselko will assist in analyzing data.

LITERATURE CITED

- Brannon, E. L. and A. W. Maki. 1996. The Exxon Valdez oil spill: Analysis of impacts on the Prince William Sound pink salmon. *Reviews in Fisheries Science* 4(4): 289-337.
- Brannon, E. L., L. Moulton, K. Parker, M. Cronin, and K. Collins. 1999. Resolution of oil spill affects on incubation pink salmon Prince William Sound. Center for salmonid and freshwater species at risk, University of Idaho, Moscow, ID. Research Bulletin 99-1.
- Bue, B. G., Sharr, S. D. Moffitt, and A. Craig. 1996. Injury to salmon eggs and preemergent fry due to the T/V Exxon Valdez oil spill. In S. D. Rice, R. B. Spies, D. A. Wolfe, and B. A. Wright (eds.). *Exxon Valdez Oil Spill Symposium Proceedings*. American Fisheries Society Symposium Number 18.
- Bue, B. G., S. Sharr, and J. E. Seeb. 1998. Evidence of damage to pink salmon populations inhabiting Prince William Sound, Alaska, two generations after the Exxon Valdez oil spill. *Trans. Am. Fish. Soc.* 127:35-43.
- Craig, A. K., M. Willette, D. G. Evans, and B. G. Bue. 1999. Injury to pink salmon embryos in Prince William Sound - field monitoring. Exxon Valdez Trustee Council Restoration Project 98191A-1 Final Report.
- Heintz, R. A., S. D. Rice, A. C. Wertheimer, R. Bradshaw, F. P. Thrower, J. E. Joyce, and J. W. Short. 1999a. Delayed effects on growth and marine survival of pink salmon after exposure to crude oil during embryonic development. P. 5.1-5.19 in A. C. Wertheimer,

A. C., R. A. Heintz, J. F. Thedinga, J. M. Maselko, A. G. Celewycz, R. Bradshaw, and S. D. Rice. Effects of oiled incubation substrate on straying and survival of wild pink salmon. Exxon Valdez Trustee Council Restoration Project 98076 Final Report.

Heintz, R. A., J. W. Short, and S. D. Rice. 1999b. Sensitivity of fish embryos to weathered crude oil: part II. Increased mortality of pink salmon (*Oncorhynchus gorbuscha*) embryos incubating downstream from weathered Exxon Valdez crude oil. *Environ. Toxicol. Chem.* 18(3):494-503.

Rice, S. D., R. E. Thomas, R. A. Heintz, A. Moles, M. Carls, M. Murphy, J. W. Short, A. Wertheimer. 1999. Synthesis of long term impacts to Pink Salmon following the Exxon Valdez oil spill: persistence, toxicity, sensitivity, and controversy. Final Report: project 99329, Exxon Valdez Trustee Council.

FY 02 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002						
Personnel	\$22.5	\$20.0						
Travel	\$8.1	\$1.0						
Contractual	\$16.8	\$0.0						
Commodities	\$9.0	\$0.0						
Equipment	\$2.0	\$0.0						
Subtotal	\$58.4	\$21.0						
General Administration	\$3.7	\$3.0	Estimated					
Project Total	\$62.1	\$24.0	FY 2003					
			\$0.0					
Full-time Equivalent (FTE)		0.2						
LONG RANGE FUNDING REQUIREMENTS								
Dollar amounts are shown in thousands of dollars.								
Other Resources								
<p>Comments:</p> <p>This project addresses the controversy between government and industry -sponsored researchers over the effect of oil on pink salmon embryo mortality in Prince William Sound streams.</p> <p>NOAA Contribution: Principal Investigator - John Thedinga 1 mo. @ \$8K Co-PI - Mark Carls 1 mo. @ \$8.2K</p>								

FY02

Prepared: 4/12/01

Project Number: Number: 02492
 Project Title: Were Embryo Studies Biased
 Agency: National Oceanic & Atmospheric Administration

FY 02 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Personnel Costs:		GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	
Name	Position Description					
John Thedinga	PI	GS12/4	1.5	8.0		
Mark Carls	Co-PI	GS12/5	1.0	8.0		
Subtotal			2.5	16.0	0.0	
Personnel Total						
Travel Costs:		Ticket Price	Round Trips	Total Days	Daily Per Diem	
Description						
Juneau to Anchorage (Restoration Workshop/Thedinga)		0.4	1	3	0.2	
Travel Total						

FY02

Prepared: 4/12/01

Project Number: Number: 02-492
 Project Title: Were Embryo Studies Biased
 Agency: National Oceanic & Atmospheric Administration

FY 02 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Contractual Costs:		
Description		
When a non-trustee organization is used, the form 4A is required.		Contractual Total
Commodities Costs:		
Description		
		Commodities Total

FY02

Prepared: 4/12/01

Project Number: Number: 02-492
 Project Title: Were Embryo Studies Biased
 Agency: National Oceanic & Atmospheric Administration

FY 02 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

New Equipment Purchases:		Number of Units	Unit Price	
Description				
Those purchases associated with replacement equipment should be indicated by placement of an R.			New Equipment Total	
Existing Equipment Usage:		Number of Units		
Description				

FY02

Prepared: 4/12/01

Project Number: Were Embryo Studies Biased
 Project Title: Were Embryo Studies Biased
 Agency: National Oceanic & Atmospheric Administration