FISH/SHELLFISH STUDY NUMBER 11

Study Title:Herring Injury

Lead Agency:ADF&G

PROJECT JUSTIFICATION

Pacific herring, Clupea harengus pallasi, are a major resource in Prince William Sound from both a commercial and ecological perspective. The timing of the Exxon Valdez oil spill overlapped with the annual spring migration of herring spawners to nearshore areas. Over 40% of the herring spawning and egg deposition areas, as well as 90% of the summer rearing and feeding areas, were lightly to heavily oiled prior to the spawning events. As a result, herring encountered oil during each of their four life stages in 1989 and, to a lesser extent, in 1990 and 1991. Adult herring traversed areas covered by oil sheens and mousse while traveling northward and eastward in Prince William Sound. Eggs were deposited on oiled shorelines and were "dipped" in sheen through tidal action while incubating. Larvae hatched that contained lipophilic petroleum hydrocarbons in their yolk sacs, and larvae encountered sheen near the surface while in their most sensitive stages. Post-larval or juvenile herring swam through and remained near lightly to heavily oiled shorelines, regularly encountering sheen, mousse and dissolved oil particulates and components through the summer while feeding in shallow nearshore bays and passes.

Egg and larval mortality, larval tumors, and other larval injury such as elevated anaphase aberration rates, increased cytogenetic and cytologic anomalies, and morphological abnormalities were much greater in oiled areas than in non-oiled areas in 1989 and 1990. Injuries were more common and more severe in oiled areas than unoiled areas, with injuries declining from 1989 to 1990. The broader ecological implications of the loss of these larvae to the food chain can only be contemplated at this time.

Observed injury to adult herring included stress-related hemorrhaging around the vent and enlarged bright gall bladders in 1989, as well as hydrocarbon metabolites throughout the whole fish and its bile. In addition, preliminary data from histopathological examinations revealed that herring captured near and in oiled areas in 1990 suffered increased hepatic lesions in comparison to herring captured in unoiled areas.

The goal of this project is to estimate the injuries accumulating to populations of herring in Prince William Sound. The level of injury needs to be established to evaluate natural restoration

processes and to direct restoration activities. A summary of the lethal and sublethal injury will be completed. In addition, accurate and precise estimates of population abundance, age structure, weight, and length composition data will be completed to measure changes at the population level. Sublethal injury to adults will be evaluated and interpreted in terms of potential impacts on the population and reproduction. An intensive modeling effort will be conducted to look at the overall effects of the Exxon Valdez oil spill on the larval and adult components of herring in Prince William Sound.

OBJECTIVES

1. Estimate the total level of injury of the Exxon Valdez oil spill to the early life stages by:

   a. Summarizing and synthesizing components of the egg mortality, egg incubation, and egg and larval cytogenetic and histologic examinations;

   b. Summarizing the larval herring distribution and abnormality index data from the 1989 larval trawl survey;

   c. Finalizing chemistry data from the hydrocarbon sample database;

   d. Combining components a., b., and c. to relate level of oiling with level of injury.

2. Summarize the results from the laboratory and field exposure dose-response studies and to compare effects of known dosing on egg survival, hatching success, percent viable hatch, larval abnormalities (Graded Severity Index), cytogenetics, and mixed function oxidase (MFO) levels to the field data collected in 1989-1991. This data will be used to refine Objective 1.

3. Complete the literature review and compare results from other studies to the findings in Objectives 1. and 2.

4. Estimate the total level of injury to herring at the adult stage by:

   a. Summarizing and synthesizing the histopathological presence and type of injury to tissues and vital organs from herring collected in oiled and non-oiled areas during 1989, 1990, and 1991;

b. Summarizing the level of egg atrophy in adult female gonads (oocyte-loss) in samples collected during 1989, 1990, and 1991;

c. Coordinate with National Marine Fisheries Service (NMFS/NOAA) to synthesize the results from the adult dose-response experiment (1991 and 1992), the adult parasite study (comparing herring from oiled and unoiled area during 1989 and 1991), and from other studies reported in the scientific literature.

DELIVERABLES

Reports to be prepared by Department staff are listed below:

Title	Deadline
Temporal and spatial comparisons of fecundity of Pacific herring in Prince William Sound	Feb. 1993
Effects of the Exxon Valdez oil spill on Pacific herring eggs and larvae in Prince William Sound	Feb. 1993
Long-term effects of the Exxon Valdez oil spill on Pacific herring in Prince William Sound	Feb. 1993
Loss of Pacific herring eggs deposited in Prince William Sound	Feb. 1993.

In addition, two reports will be completed this year that will provide background and baseline information for the damage assessment summaries:

Estimates of spawning biomass of Pacific herring in Prince William Sound from spawning deposition surveys(review draft)	Feb. 1992
Historical summary of Pacific herring in Prince William Sound (review draft)	Feb. 1992.

Reports and work products that will be produced by the contractors are listed below:

Contractor, Product	Deadline

Hose, Final report on 1991 data and re-analysis of 1989 data (data includes cytogenetics, abnormality indices,cytologic, and oocyte loss) May, 1992

Hose, Synthesis work product for preliminary modeling effort August, 1992

Hose, Synthesis work product for final modeling effort January, 1993

Kocan, Final report on 1991 dose-response experiment March, 1992

Kocan, Literature review and first synthesis product April, 1992

Kocan, Final report on 1992 dose-response work August, 1992

Kocan, Synthesis work product for final modeling effort January, 1992

Hinton, Final work product results on 1989 and 1990 adult histopathology and Dr. Hose's 1990 and 1991 larvae February, 1992

Hinton, Preliminary results of 1991 adult histopathology and first synthesis work product April, 1992

Hinton, Final results of 1991 adult histopathology and larval data from Hose May, 1992

Hinton, Synthesis work product for final report January, 1993

	BUDGET ($K)[1]
Salaries	$ 161.3
Travel	14.5
Contractual	92.6
Supplies	3.1
Equipment	1.4
Subtotal	$ 272.9
General Administration	30.7
Total	$ 303.6

[1] Budget is for all activities performed from March 1, 1992 to February 28, 1993. A detailed line item budget has been prepared and submitted separately to the Trustee Council.