EVOS #879
006

STATE/FEDERAL NATURAL RESOURCE DAMAGE ASSESSMENT
DETAILED STUDY PLAN

Project Title:	INJURY TO SALMON SPAWNING AREAS IN PRINCE WILLIAM SOUND
Study ID Number:	Fish/Shellfish Study Number 1
Lead Agency:	State of Alaska, ADF&G; Commercial Fish Division
Cooperating Agency(ies):	Federal: USFS State: DNR
Principal Investigator:	Sam Sharr, Fishery Biologist III
Assisting Personnel:	Steve Moffitt, Fishery Biologist I Brian Bue, Biometrician II John Wilcock, Fishery Biologist II
Date Submitted:	February 26, 1990

CONFIDENTIAL

Titles	Signature	Date
Principal Investigator:		3/3/90
Consulting Biometrician:		3/5/90
Regional Research Supervisor:		3/5/90
Regional Supervisor:		3/5/90
OSIAR Program Manager:		3-8-90
OSIAR Director:		

ACE 644127

INTRODUCTION

Wild stock production of pink salmon in Prince William Sound (PWS) has ranged from 10 to 15 million fish in recent years. Chum salmon returns have ranged from 800,000 to 1,500,000. In addition to contributing to major commercial fisheries, huge populations of salmon are an important link in the food chain and nutrient recycling mechanisms in the terrestrial, near-shore estuarine, and high seas ecosystems. Outmigrating juvenile salmon are important seasonal prey items for a variety of predatory fish and marine birds. Maturing salmon in the high seas and adult salmon returning to the inland waters of PWS are the major portion of the diet of marine mammals such as sea lions, seals, and killer whales. Salmon are also the summer mainstay for eagles and many species of gulls. Spawning adults in the streams constitute almost 100% of the summer diet bear and land otter and are a very important link between the marine and terrestrial ecosystems in PWS. Salmon carcasses in the streams and estuaries are a crucial source of nutrients for near-shore pelagic planktonic communities and benthic organisms such as larval crab which rear in the estuaries of important salmon streams.

Much of the spawning for pink and chum salmon (up to 75% in some years) occurs in intertidal areas. Intertidal spawning areas are susceptible to marine contaminants and the 24 March 1989 oil spill from the Exxon Valdez may adversely affect spawner distribution and success in Prince William Sound. To detect injury to pink and chum salmon stocks, intertidal contamination must be documented and correlated with a negative trend in adult returns. Return estimates are based on accurate appraisals of catch and escapements. This project is designed to document oil contamination of intertidal spawning habitat; provide accurate estimates of escapements of wild stocks; and provide estimates of the intertidal and upstream area available for spawning. Natural Resource Damage Assessment Fish/Shellfish (NRDA F/S) Study 3 provides estimates of wild stock component of the commercial catch. Results from NRDA F/S Study 3 and this study will be combined to estimate total return of wild stocks. NRDA F/S Study 2 estimates eggs and fry per square meter and egg to fry survival by tide zone in a subset of the streams in this study. Egg and fry density and survival data from NRDA F/S Study 2 will be combined with stream bed area estimates by tide zone from this study to estimate total egg deposition and egg to fry survival by tide zone in 138 streams.

The Alaska Department of Fish and Game (ADF&G) has performed spawning ground surveys of the major salmon spawning streams in PWS since the late 1950's. An aerial survey program provides weekly estimates of numbers of fish in 218 spawning streams and a ground survey program on a subset of approximately 116 has provided corresponding estimates of numbers during the peak of spawning. During 1987 and 1988 funding for the ground survey program was severely curtailed and only 58 streams were walked. This study includes a thorough and extensive ground escapement survey program on salmon spawning streams for which there are past ground survey data and includes additional oiled and unoiled streams in western PWS. The study also includes ground surveys of salmon streams to document the presence of oil in intertidal spawning habitat.

In 1989 a total of 411 streams were surveyed for the presence of oil in intertidal spawning areas and 138 streams were included in the ground census of pink and chum salmon escapements. In 1990 the oil survey will be limited to the 138 streams in the escapement censusing portion of the project. The total area of intertidal and upstream spawning habitat will be estimated for each stream. Estimates of stream

residence time (stream life) will be made for pink and chum salmon in 11 of the 138 streams.

The results of the study will provide accurate estimates of the pink and chum salmon escapement to each stream surveyed; will be correlated with escapement estimates based on aerial counts to estimate past and current year escapements for 218 streams included in the ADF&G aerial survey program; will provide estimates of post oil spill distribution of spawning within stream zones and among streams; will estimate total available intertidal and upstream spawning habitat for each stream; will estimate the average stream life for pink and chum salmon in PWS; and will provide an atlas of aerial photographs and detailed maps for important spawning sites.

OBJECTIVES

1. Determine the presence or absence of oil on intertidal habitat used by spawning salmon through visual observation, aerial photography, and hydrocarbon analysis of tissue samples from intertidal mussels at the stream mouth (Mytilus sp.).

2. Document the physical extent of oil distribution on intertidal spawning areas.

3. Estimate the number of spawning salmon by species within standardized intertidal and upstream zones for 138 streams in Prince William Sound.

4. Enumerate the total intertidal and upstream escapement of pink and chum salmon through a weir installed on a moderately large stream which is representative of streams in the aerial and ground escapement survey programs.

5. Estimate the error in aerial counts for the 218 aerial index streams by comparison of ground and aerial counts from the same or adjacent survey dates and by comparison of aerial, ground, and weir counts on one stream.

6. Estimate the average stream life of pink and chum salmon in 11 streams in PWS using a variety of techniques.

7. Estimate 1961 through 1988 pink and chum salmon escapements to the 218 aerial index streams using the average observed error in the aerial survey method and on stream life data from 1989 and 1990.

8. Estimate the stream area available for spawning within standardized intertidal and upstream zones for the 138 streams surveyed.

9. Produce a catalogue of aerial photographs and detailed maps of spawner distribution for the more important pink and chum salmon streams of Prince William Sound for use in designing sampling transects in the egg deposition and pre-emergent fry studies.

10. Identify streams appropriate for enumerating and coded wire tagging pink salmon fry.

11. Identify potential alternative methods and strategies for restoration of lost use, populations, or habitat where injury is identified.

METHODS/DATA ANALYSIS

This project is an integral part of the study of impacts of the oil spill from the Exxon Valdez on Pacific salmon populations in Prince William Sound. Streams examined by this project are a subset of the anadromous salmon streams monitored by the ongoing ADF&G aerial survey program. Two additional NRDA F/S studies in Prince William Sound, pink and chum salmon egg deposition and pre-emergent fry studies (NRDA F/S Study 2) and salmon coded wire tagging studies (NRDA F/S Study 3), will rely on information about salmon spawning and distribution obtained from this project.

Study Design

The project is designed to evaluate changes in the numbers and distribution salmon which spawn in intertidal and upstream spawners relative to oil contamination from the Exxon Valdez spill on 24 March 1989. Three crews of two people each will perform foot surveys of intertidal and upstream portions of 138 major pink and chum salmon spawning streams. Each stream will visited once prior to the salmon returns to measure and mark tide levels and survey intertidal areas in and adjacent to the stream for presence of oil. Live and dead pink and chum salmon will be enumerated by ground survey crews in standardized intertidal and upstream zones in each stream. Streams will be enumerated three times at approximately two week intervals during the spawning season.

Streams to be surveyed will be selected according to the following criteria:

1. The stream is included in the ADF&G aerial survey program.
2. The stream is included in the pink and chum salmon egg deposition and pre-emergent fry project (NRDA F/S Study 2).
3. The stream was enumerated in prior spawning ground foot survey programs.
4. The streams are representative of the early, middle, and late run pink and chum salmon stocks in PWS.
5. The streams are representative of the spatial distribution of pink and chum salmon stocks in PWS and include streams from oiled and unoiled areas.

Maps of all streams in the program were prepared from aerial photographs prior to the 1989 field season and were modified and corrected during the three survey circuits in 1989. These same scaled maps will be used and updated during the 1990 field season.

The pre-season survey to mark tide zones and document the presence of oil in the intertidal area at the stream mouth will be conducted in June, prior to the return of the pink and chum salmon. The location of tide levels 1.8, 2.4, 3.0, and 3.7 m above mean low water will be measured from sea level using a surveyors's level and stadia rod. Sea level at each site will be referenced to mean low water with site specific, computer generated tide tables which predict tides at five minute intervals. Tide zone boundaries will be delineated with color coded steel stakes.

The linear length of the stream within each intertidal zone will be measured with a surveyors chain or range finder. The linear length of the stream in the upstream zone will be measured similarly on short streams and estimated from accurately scaled aerial photos on long streams. The average stream width will be determined from systematic width measurements taken in each zone. The number of intervals in each zone will depend on the length of the zone. Each measurement will be recorded at the appropriate location on the stream maps prepared in 1989.

Crews marking, measuring, and mapping tide zones will also conduct foot surveys of the intertidal stream bed and adjacent beaches to document, map, and classify any oil present.

During the escapement enumeration portion of the project, streams will be surveyed visually from the ground in a systematic order. The ADF&G R/V Montague or a chartered vessel will house and support the three survey crews. Each crew will use a skiff to travel between the Montague and the survey streams. During each stream survey the following data will be recorded:

1. Anadromous stream number and name (if available);
2. Latitude and longitude of the stream mouth;
3. Date and time (24 hour military time);
4. Tide stage;
5. Observer names;
6. Counts of live and dead salmon by species and tide zone (0.0-1.8 m, 1.8-2.4 m, 2.4-3.0 m, and 3.0-3.7 m above mean low water and upstream);
7. Weather and comments on visibility, lighting, and other survey conditions.

All data will be recorded on pre-printed mylar data sheets which will overlay a map of the stream. Maps will be improved and modified during the survey to show spawner distribution within each zone and the upstream limit of spawning. Particular attention will be given to spawner density and distribution observations for the 46 streams to be sampled during NRDA F/S Study 2.

During the first survey circuit, a composite sample of mussels (Mytilus sp.) will be collected at the mouth of each stream for hydrocarbon analysis. Results of the analysis will be used to document the level of oil impact that the stream sustained. Each sample will consist of enough mussels to provide 10 grams of tissue (approximately 30 mussels) for analysis. The mussels will be collected in the zone from 0-2 m above mean low water in the immediate vicinity of each stream mouth and will be collected above water to avoid contamination by hydrocarbons on the water surface. The samples from each stream will be stored in separate glass jars with teflon lined lids. Each jar and lid will be pre-rinsed three times with dicloromethane, dried, and kept in locked storage prior to use. Care will be taken not to contaminate the jar or lid prior to or during sampling. Each sample jar will be neatly labeled with indelible ink or pencil on "Rite-In-The-Rain" paper. The label will bear a sample number, sampling date and time, tide stage, species, the ADF&G stream name and number, the stream mouth latitude and longitude, and the sampler name(s). The samples will be stored in the freezer aboard the R/V Montague until the boat reaches port at which time they will be moved to locked shore based freezer storage. Appropriate chain of custody forms will accompany each sample.

During all three circuits counts of live and dead salmon will be made for the five tide zones (the intertidal zones < 1.8 m, 1.8-2.4 m, 2.4-3.0 m, 3.0-3.7 m above mean low water and the upstream zone) from the 1.8 m tide level to the limit of

upstream spawning on all 138 streams. Tide stage will be monitored continuously and survey times and direction will be adjusted accordingly. If the tide stage at the time of the walk is at or below the 1.8 m level the stream walk will begin at the mouth of the stream and progress upstream. The mouth or downstream limit of the stream will be defined as the point where a clearly recognizable stream channel disappears or is submerged by salt water. Fish seen below the downstream limit will be included in an estimate of fish off the stream mouth and noted as a comment on the data form. If the intertidal portions of the stream above the 1.8 m level are submerged at the time the walk begins the crew will proceed to the upstream limit of the walk, walk downstream, and coincide the end of the walk with the time predicted for the tide to at or below the 1.8 m level. The upstream limit of a walk will be determined by the presence of natural barriers to fish passage (ie. waterfalls), by the end of the stream, or by the upstream limit of spawning. The upstream limit of spawning will be marked on U.S. Geological Survey color aerial photos of each stream following each survey.

Counts of live and dead fish on each stream will be done by a crew of two technicians or biologists. For streams of moderate size and having a single channel the crew members will walk together but independently count live fish in each intertidal zone. Each member will enter their count on a mechanical hand tally. At the end of each zone the two crew members will compare counts. If the two counts differ by less than 10%, the two counts will be averaged. If the two counts differ by more than 10% both surveyors will re-count the zone until their counts differ by 10% or less. Upstream counts in a single channel will be similarly compared at convenient stopping points (ie. log jams or other clear counting delineators). To avoid confusion with counts of live fish, counts of dead fish will be recorded on the return leg of the stream walk. For large braided or branched streams duplicate counting and comparisons will not be possible and each crew member will count separate channels or upstream forks. To avoid perpetuating counting biases within a counting crew, personnel will be rotated between crews daily. When possible, crew members will not be assigned to the same streams on succeeding survey circuits.

Tests for variability among observers and among counting crews (observer pairs) will be conducted on 10 streams during each of the three enumeration survey circuits. At test streams, all observers will estimate numbers of live and dead pink salmon by zone and will record their counts independently. Counts will be compared after all test streams have been surveyed. Three crews of randomly paired observers will also replicate counts on ten streams and results among observer pairs will be compared.

At 11 of the 138 streams in the ground survey program fish will be included in a stream life study. Stream life studies will be modeled in part after previous studies in PWS (Helle et al. 1964; McCurdy 1984). For each stream, fish will be captured at the stream mouths with beach seines and tagged with Peterson disk tags color coded for day of capture. Tagging will be conducted at four day intervals at each stream and during each tagging episode 150 fish will be tagged. If fewer than 150 fish are available, all fish captured will be tagged. Daily counts of live and dead pink and chum salmon will be made by tide zone in each of the 11 streams. Live and dead fish bearing tags will enumerated separately by color code. Only fish that have died since the previous count will be tallied in the daily surveys. To prevent duplicate counts between surveys, tails and tags of all dead pink and chum salmon observed will be removed.

One moderately_large stream from among the 138 surveyed will be weired. The weir will be installed at the six foot tide level. Weir crews will record daily passage through the weir and will tag a portion of each days escapement. Tags will be numbered sequentially and a unique color code will be used for each four day interval. The weir crew will survey the intertidal and upstream portions of the stream daily for stream life data. Counts of live and dead pink and chum salmon will be made by tide zone. Fish bearing tags will enumerated by color code and the sequential number on tags from dead fish will be recorded. Only fish that have died since the previous count will be tallied in the daily surveys. To prevent duplicate counts between surveys, tails and tags of all dead pink and chum salmon observed will be removed.

Data Analysis

Streams will be divided into categories based on levels of hydrocarbon contamination (as determined from visual observations and hydrocarbon level in mussel tissues). Counts of salmon by species, stream zone, and stream for each will be assigned to one of the categories. Categorical data analysis techniques such as log linear models using chi-square statistics will be used to compare differences in spawning among streams and tide zones, and relate these disruptions to the level of hydrocarbon contamination. Counts and spawner distribution data will also be compared with historical stream survey data and related to the level of hydrocarbon impact.

Stream life will be estimated using three methods. The first estimate is the mean difference between date of tag recovery from dead fish and the tagging date and the estimate will be made for color coded tag lot to examine changes in stream life through time. The second estimate will use weir data and will be based on similar data for numeric tag codes from individual fish. The third method will be based on the difference in the dates between peak live count and the peak dead count.

Statistics that will be estimated include:

1. Counts of spawning salmon by anadromous stream code, date, time, and tide stage will be used to estimate percent usage by stream zone.
2. Total spawning escapement by species for each stream.
3. Date of tagging by color or numeric code and the mean dates of recovery for each code will be used to estimate stream life by tag code.
4. Dates of peak live counts and dates of peak dead counts will be used to estimate average stream life by species and stream.
5. Daily weir counts will be compared to daily ground counts and periodic aerial counts of the weired stream to estimate the percent error in ground and aerial methods.

SCHEDULES AND REPORTS

Date(s)	Activity
Jul. - Aug. 1990	Replicate surveys of 138 streams.
Aug. - Sep. 1990	Laboratory work and data entry.
Oct. - Dec. 1989	Data analysis.
Jan. 1990	Draft report on impacts of oil on salmon spawning distribution in Prince William Sound.
Feb. 1990	Prepare final study plan for the 1991 field season.
Jul. 1991	Replicate surveys of 138 streams.

PROJECT BUDGET [1]

Line Item	Category	Budget
100	Personnel Services	$ 179,200
200	Travel	$ 2,000
300	Contractual	$ 145,300
400	Commodities	$ 25,000
500	Equipment	$ 40,000
700	Grants	$ 0
Total		$ 391,300

[1] Budget is for all activities performed from March 1, 1990 to February 28, 1991.

FUNDED PERSONNEL

Class	PCN	Name	PFT_mm	SFT_mm
FB II	11-			6.0
FT II	11-			3.0
FT II	11-			2.3
FT II	11-			2.3
FT II	11-			2.3
FT II	11-			2.3
FT II	11-			2.3
FT II	11-			2.3
FT II	11-			1.8
FT II	11-			1.8
FT I	11-			1.8
FT I	11-			1.8
FB II	11-			2.0
DP II	11-			2.0

LITERATURE CITED

Helle, J.H., R.S. Williamson, J.E. Bailey. 1964. Intertidal ecology and life history of pink salmon at Olsen Creek, Prince William Sound, Alaska. U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries. Special Scientific Report-Fisheries No. 483. Washington D.C.

McCurdy, M.L. 1984. Eshamy District Pink Salmon Streamlife Study, 1984. Alaska Department of Fish and Game, Division of Commercial Fisheries. Prince William Sound Data Report No. 94-18. Cordova.