A Proposal For An Integrated Research and Monitoring Program For Oregon Coastal Chinook Populations

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Oregon Department of Fish and Wildlife

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TABLE OF CONTENTS

SECTION I

Overview

INTRODUCTION

Among the many chinook salmon populations contributing to large, mixed stock ocean net, troll, and recreational fisheries managed by the Pacific Salmon Commission (PSC) there is a good deal of diversity with respect to productivity, life history characteristics, and ocean distribution. During the years immediately following the adoption of the original 1985 Pacific Salmon Treaty (PST), lack of adequate data prevented the PSC from managing effectively for these differences. Instead, chinook management outlined in Annex IV of the original treaty was based upon long term population trends for very large aggregates of stocks. Although harvest ceilings were established as part of a PST recovery plan for over-exploited stocks, they were based on average coast-wide production trends and resulted in over harvest of weak stocks in some years and failure to take advantage of large returns in other years.

By the mid-1990's, data relative to the distribution and abundance of many salmon stocks contributing to PST fisheries was improving. At the same time, there was increasing dissatisfaction with quota-based management and strong interest in instituting annual abundance-based management for stock aggregates that share geographic proximity of spawning areas, similar life history and genetic characteristics, and similar distributions in the ocean. Abundance-based management for aggregated stocks would establish and implement annual fishery exploitation rates in fisheries that insure long-term sustainability for all aggregates and related individual stocks.

In the absence of bilateral agreement between the U.S. and Canada regarding implementation of abundance-based management, the three voting U.S. PSC Commissioners signed the 1996 Letter of Agreement (LOA) that defined elements of an abundance-based management approach for chinook salmon fisheries in southeast Alaska. The LOA was designed to: 1) set the stage for future bilateral negotiations regarding abundance based management; 2) clarify the role of PST fisheries in rebuilding depressed natural stocks; and 3) provide a means for sharing conservation responsibility of far-north migrating stocks originating from watersheds in Oregon and Washington. The foundation for abundance-based management set forth in the LOA was subsequently expanded upon and incorporated as Aggregate Abundance-Based Management (AABM) in Annex IV, Chapter 3 of the 1999 PST.

Application of the abundance-based management outlined in the 1996 LOA and the subsequent 1999 amendments to the PST requires knowledge of the stock recruitment relationships, biological spawning escapement goals, and annual forecasts of ocean abundance and distribution for stocks in each aggregate to regulate fishery harvest. Managers must also have annual post-season estimates of aggregate specific exploitation rates and in-river escapements to assess the effectiveness of regulatory measures. The base-monitoring program for Oregon's coastal chinook under the 1985 PSC met only a few of these data requirements. In recognition of requirements for new and more precise data, the signatories of the original LOA sought out additional federal funds for new and expanded monitoring programs. Since 1997 Congress has annually approved approximately $1.8 million for additional research and monitoring needed to implement terms of the LOA. The PSC delegated discretionary authority for the use of those funds to the U.S. Section's Chinook Technical Committee (CTC).

ATTRIBUTES OF AGGREGATE ABUNDANCE BASED MANAGEMENT

Stock Aggregation

As the name implies, one important attribute of AABM is the aggregation of stocks based upon geographic proximity of spawning areas, life history and genetic characteristics, and similar ocean distributions. Oregon has nineteen identified coastal chinook stocks that are far-north migrating and contribute to troll and recreational fisheries in southeast Alaska and Canada (Figure 1). These stocks are grouped into, the North Oregon Coast (NOC) and mid-Oregon Coast (MOC) aggregates (Figures 1).

Annual Forecasts of Ocean Abundance For Aggregates

Once again, as the name implies, an annual projection of ocean abundance for each aggregate is an essential feature of AABM. Annex IV, Chapter 3 of the 1999 agreement requires the responsible managing agencies to provide accurate preseason abundance forecasts and postseason estimates of chinook abundance for each stock aggregate. Estimates of ocean abundance for each aggregate are based upon estimates of the exploitation rate and in-river escapement for the aggregate.

Exploitation Rate Indicator Stocks

Successful implementation of AABM is contingent upon the PSC's ability to model and predict changes in exploitation rates associated with specific harvest regimes. Exploitation rate indicator stocks (ERIS) provide annual, post-season estimates of actual age-specific exploitation rates for a specified stock that can be applied to the aggregate. Typically, coded-wire-tagged hatchery stocks have served as surrogate indicators for wild stock aggregates because they are an easily identifiable group of fish of known origin and age that can be accurately inventoried in fisheries and escapements.

Even prior to AABM, coded wire tag data from certain large hatchery releases within each of several large stock aggregates were used to estimate annual fishery exploitation rates. The estimated exploitation rates coupled with available escapement data were used to make estimates of ocean harvest and total abundance for aggregates and to model the

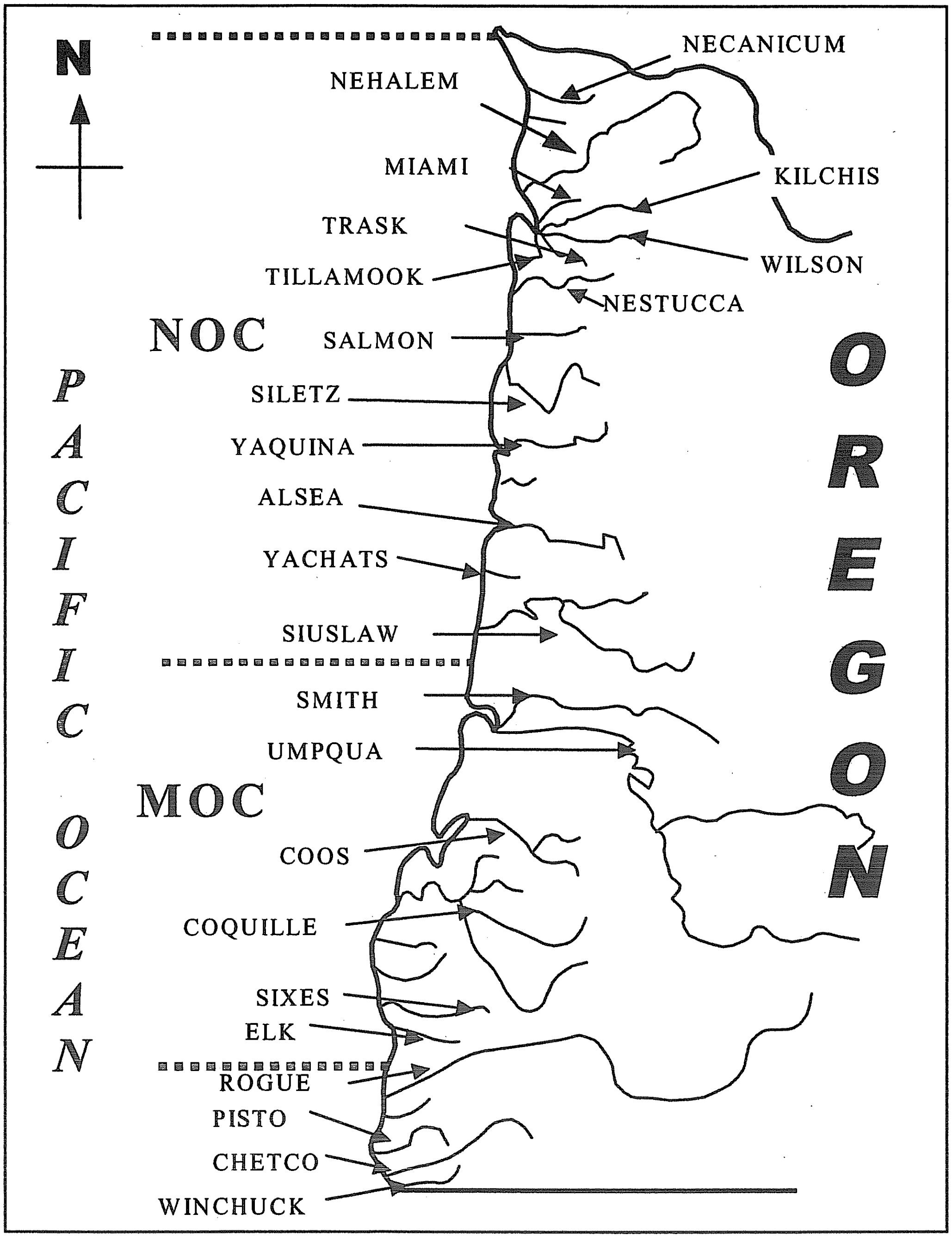

Figure 1. Map of the Oregon coast showing the locations of the NOC and MOC and the river basins that support runs of chinook salmon.

long term effectiveness of harvest ceilings with respect to the PST rebuilding plan. With the advent of exploitation rate management under AABM, data from exploitation rate indicator stocks have taken on added importance. In addition to being used to estimate ocean harvest and total age specific abundance for stock aggregates, exploitation rate indicators are also used annually to assess the effectiveness of management actions in achieving desired fishery exploitation rates.

Inriver Escapement Estimates for Aggregates

Annual forecasts of ocean abundance for each aggregate of stocks are the basis of AABM. Although predictive models used to make these annual forecasts vary among aggregates, all require annual post-season estimates of total ocean abundance. Forecast models such as stock recruitment functions or sibling relationships require age specific ocean abundance data. Age specific post-season estimates of total ocean abundance for an aggregate are estimated by applying age specific ocean exploitation rates from ERIS's to age specific estimates of inriver escapements for the entire aggregate. It is important to note that an age specific estimate of the inriver return for an aggregate incorporates age specific harvest from inriver fisheries and age specific estimates of spawning escapement.

Because estimates of spawning escapement for an aggregate incorporate data from many stocks that are typically derived from periodic, and coarsely stratified visual estimates of live and dead fish on the spawning grounds, they are imprecise and probably biased. Ideally, there are concurrent accurate estimates of spawner abundance for at least a few of the stocks within an aggregate that can be used to verify and calibrate the less precise visual survey estimates. Examples of more accurate methods include weirs and mark-recapture experiments. To partition unbiased estimates of spawners by age, adequate scale samples must be available for all surveyed systems.

Escapement Indicator Stocks

Escapement indicator stocks (EIS) are an integral component for AABM. Each EIS is selected to be representative of all stock characteristics and abundance trends located in each aggregate. Annex IV, Chapter 3, paragraph 9 of the 1999 PST specifically outlines trigger points to reduce harvest if indicator stocks are reduced below established, CTC approved escapement goals. Regional co-managers are responsible for nominating indicator stocks to represent stock aggregates within their jurisdiction. They must establish scientifically defensible biological-based escapement goals for each stock, and provide precise annual, age/sex specific estimates of inriver escapement from ocean fisheries. The Oregon Department of Fish and Wildlife (ODFW) is the regional co-manager responsible for coastal Oregon chinook salmon.

ODFW'S RESEARCH AND MONITORING NEEDS FOR AABM

The limited monitoring program conducted by ODFW prior to the 1996 LOA met some of the data needs for quota based management but fell far short of meeting the data needs of abundance-based management. Congressional approval of additional annual funding to implement the 1996 LOA afforded ODFW an opportunity to expand upon the limited research and monitoring activities already funded by the PSC base budget. Since 1998 ODFW has utilized these funds to incrementally implement an integrated coast-wide stock assessment and monitoring program that meets the needs of AABM.

Goals and Objectives

The long term goals and objectives of ODFW's chinook research and monitoring program are as follows:

1) Estimate age specific inriver returns for NOC and MOC stock aggregates. Inriver returns are the sum of fish caught in inriver recreational fisheries and fish that escape fisheries to spawn. Monitoring programs must:
   a) Estimate age specific harvest from inriver recreational fisheries in each aggregate. Total harvest for inriver recreational fisheries within each aggregate is the pooled harvest from all watersheds within the aggregate. Harvest estimates for each watershed traditionally come from harvest tags (punch cards) that are voluntarily returned by anglers. Monitoring programs needed to insure accurate harvest estimates include:
      i) Independent harvest estimates from statistical creel surveys on selected watersheds that can be used to calibrate comparable estimates from punch card data.
      ii) Representative scale sampling of fish caught to estimate the age composition of harvest.
   b) Estimate the age specific spawning escapement for each aggregate. Total escapements for each aggregate are pooled estimates from stocks that comprise the aggregate. Spawner abundance estimates for each stock will be based upon a stratified random survey (SRS) of all available chinook spawning habitat. Specific monitoring programs required to achieve this goal include:
      i) Inventories of available spawning habitat for each basin.
      ii) Precise independent estimates of escapement in representative stream reaches based upon methods such as weirs or mark/recapture experiments. Independent estimates will be used to calibrate comparable SRS estimates for the same stream reach. A portion of adult fish captured as part of a mark/recapture experiment can also be radio tagged to verify the temporal and spatial distribution of spawners relative to mapped spawning habitat.

iii) Continuation of non-random surveys of traditional spawning areas until historic indices of spawner abundance from these surveys can be calibrated to results from a SRS program.

iv) Scale sampling of fish during spawning ground surveys to estimate the age composition of the spawning population. Stock age composition estimated from spawners will be adjusted for bias using the age composition estimated from regional EIS stocks.

2) Provide biological spawning escapement goals and high precision estimates of inriver returns for at least two escapement indicator stocks per basin (Figure 2). Failure to achieve desired escapement from ocean fisheries must be demonstrated for two basins within an aggregate to trigger conservation measures for the aggregate under the new PST. Hence, a minimum of two escapement indicator stocks with biologically based and CTC approved escapement goals must be maintained for each aggregate. Monitoring programs to achieve this goal must provide:
   a) Precise age specific estimates of freshwater harvest based on:
      i) statistical creel surveys for fisheries in each indicator watershed and
      ii) scale samples from of fish examined during the creel surveys.
      iii) harvest estimates with relative precision of < 10%.
      iv) harvest age composition estimates with relative precision of < 0.05.
   b) Precise age specific estimates of escapement based on:
      i) basin wide mark recapture experiments for each indicator watershed and
      ii) scale samples from live fish captured for marking and from unmarked carcasses sampled during tag recovery on the spawning grounds.
      iii) escapement estimate goal = relative precision goal <25%
      iv) escapement age composition goal = relative precision < 0.05

   Note that precise estimates of freshwater harvests and spawning escapements from indicator stocks can also serve to calibrate harvest estimates from punch cards and spawner abundance estimates for SRS surveys, respectively.

3) Provide estimates of exploitation rates for each aggregate. These estimates will be based upon coded wire tag recoveries for exploitation rate indicator stocks including:
   a) The Salmon River and Elk River hatchery indicator stock representing the NOC and MOC, respectively (Figure 2).
   b) One wild indicator stock per aggregate. Because code-wire-tagging programs are relatively easy to implement for hatchery stocks, the latter have traditionally served as surrogates for wild stocks with respect to estimating exploitation rates. However, it is unknown if hatchery stocks are truly representative of wild stocks and verification of that assumption requires direct estimates of exploitation rates for wild fish. Programs that must be implemented to achieve these estimates for each aggregate include:
      i) Trapping and tagging of a representative cross-section of the wild smolt outmigrants from a basin in numbers comparable to those achieved in a hatchery indicator stock.
      ii) Recovery of coded-wire-tagged adults from inriver fisheries and spawning escapements.

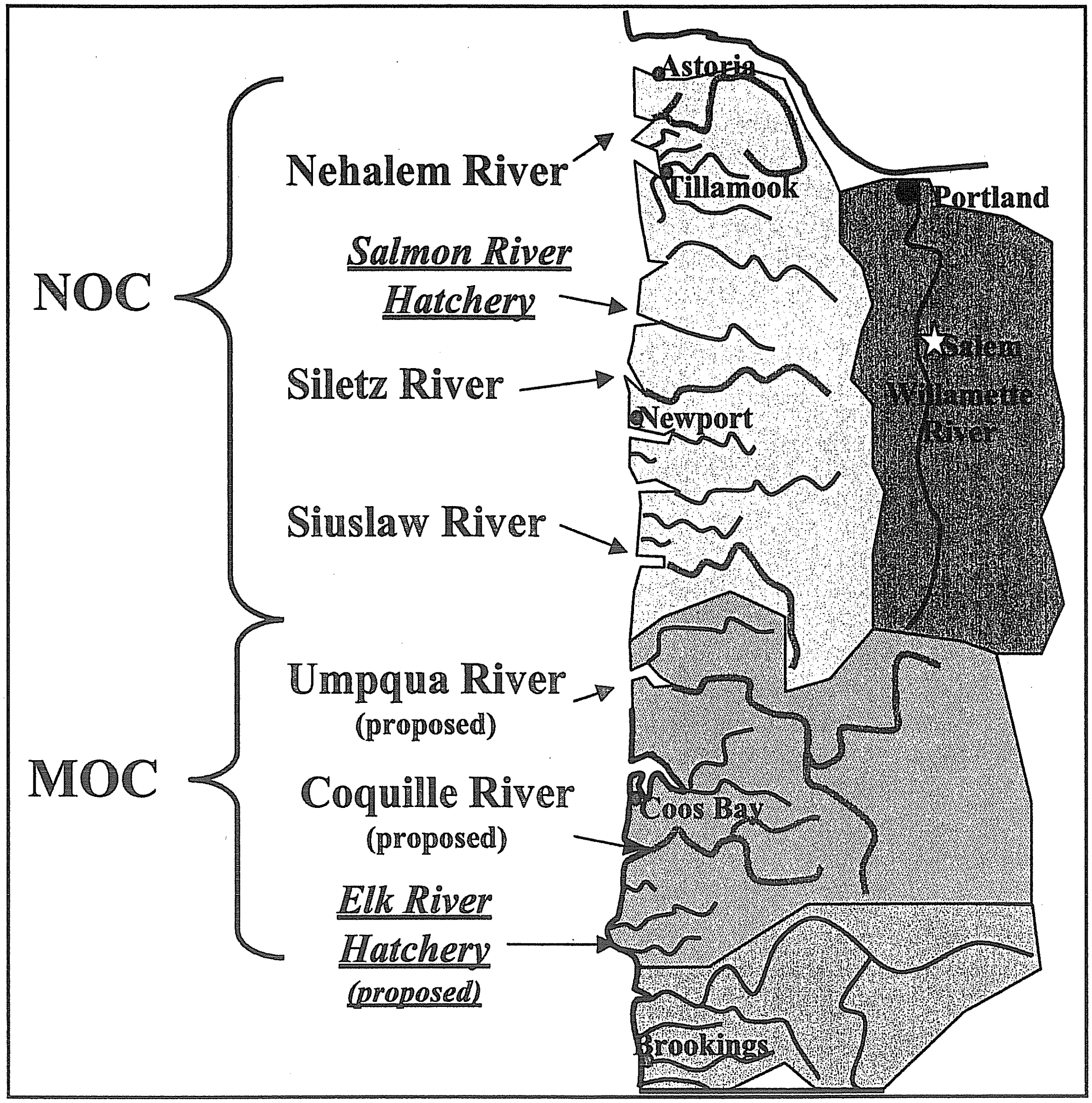

Figure 2 Location of existing and proposed escapement and exploitation rate indicator stocks for the NOC and MOC aggregate. Shaded areas indicate current ODFW aggregation of watersheds into gene conservation groups.

Ideally, wild exploitation rate indicator stocks would be selected from among escapement indicators since the extensive creel and spawning ground surveys required for those stocks could also recover the coded wire tags.

4) Improve forecasts of ocean abundance for the NOC and MOC. Present forecasts are merely based on long-term average abundance. Future forecasts will likely be based upon sibling relationships or spawner recruitment relationships and will require some additional model development and cohort reconstruction from estimates of catch and escapement at age. Forecasts may also benefit from the ability to separate the effects of freshwater variables and marine variables on overall survival.
5) Improved resolution of the stock structure of aggregates (Figure 2) through genetic sampling. Tissue samples for this purpose can easily be collected opportunistically during spawning ground surveys but analyses of the tissue will require additional funds.

Evolution of ODFW's Existing Coastal Chinook Monitoring Program

Pre-LOA

When they signed the original PST in 1985, Canada and the U.S. committed to annual funding of monitoring activities required to implement the treaty. This base level funding continues to the present and for Oregon includes approximately $575,000 annually for exploitation rate and stock assessment monitoring programs.

Following ratification of the 1985 PST, ODFW designated coastal hatchery stocks from Salmon and Elk rivers as exploitation rate indicator stocks for fall chinook in the NOC and MOC, respectively (Figure 2). They have used base level funds to initiate coded-wire tagging programs for those stocks. However, because of computer memory constraints, only the stock from Salmon River Hatchery could be incorporated into the existing chinook harvest model. It is very unlikely that the Salmon River stock alone is adequate to represent the range of diversity exhibited by 19 stocks in the combined NOC and MOC aggregates. The CTC is in the process of developing a new chinook harvest model that can incorporate many more exploitation rate indicator stocks including the Elk River Hatchery stock.

PSC base budget funds are also used to estimate NOC and MOC spawning escapements. Estimates for all streams in each aggregate are based on analyses of data from non-random surveys of traditional sites where fish were known to spawn (Appendix C). The estimates are likely very imprecise and biased.

Prior to the signing of the LOA in 1996, escapement goals for Oregon coastal chinook stocks were based on long-term average spawner densities, there were no established escapement indicator stocks for the NOC and MOC, and the annual coastwide forecast was based upon long term average indices of abundance.

LOA (1998 -2000)

When the LOA was first implemented in 1997, ODFW began to compile historic catch, escapement, and age composition data for stock recruitment analyses of potential NOC and MOC escapement indicator stocks. Pending completion of stock recruitment analyses and designation of indicator stocks, ODFW focused monitoring and research efforts during the first two years of LOA funding towards improving inriver age-specific escapement estimates for the NOC and MOC in aggregates. These efforts focused on four principal objectives:

1. Develop of an SRS design that will eventually replace the biased and unreliable non-random surveys of traditional spawning areas. As a first step in the survey design, ODFW initiated an LOA funded project to inventory available chinook spawning habitat in all coastal streams.
2. Calibrate visual survey estimates. To meet this objective, ODFW needed very precise estimates of escapement for stream reaches that could be compared to estimates from traditional surveys of the same sites. ODFW initiated mark recapture experiments to obtain precise escapement estimates for the North Fork Nehalem, Coos, and South Umpqua rivers. These locations were selected based upon the location of traditional survey sites, and the feasibility of installing or using existing instream structures for capturing fish.
3. Calibrate inriver harvest estimates based on punch card data. A comprehensive creel census was implemented to make precise harvest estimates for the Nehalem River basin that could be compared with the estimates from punch card data.
4. Improve the extent and precision of age composition data for coastal spawning escapements. Scale collections from opportunistic sampling of carcasses during spawning surveys were supplemented with samples collected by a crew dedicated solely to carcass sampling in seven coastal rivers.

Habitat inventories, Nehalem River creel surveys, augmented scale sampling, and mark recapture experiments in the Coos River and tributaries of the Nehalem and Umpqua rivers were continued in 2000. However, in 2000 escapement indicator stocks took on added importance in the ODFW's monitoring program.

Precise escapement estimates from indicator stocks are a primary tool for triggering as well as assessing the effectiveness of PSC management actions. In accordance with the provisions of Annex IV, Chapter 3, paragraph 9 and procedures outlined by the CTC (Pacific Salmon Commission Report USTCHINOOK (97)-1), ODFW has nominated stocks from the Nehalem, Siletz, and Siuslaw rivers as indicators for the NOC. Stocks from the Coquille and Umpqua rivers have been nominated as escapement indicators for the MOC. Stock recruitment analyses completed by ODFW were used to establish biological escapement goals for the Nehalem River in 1998 and for the Siletz and Siuslaw rivers in 1999 (Zhou and Williams 1998, Zhou and Williams 1999). The CTC approved the analysis and biological escapement for the Nehalem in 1999 and the analyses and goals for the Siletz and Siuslaw in 2000. All three are now included in Attachments I-V of Annex IV as escapement indicators for the NOC. The analysis of historic exploitation rate data for the MOC exploitation rate indicator stock at Elk River Hatchery must be finalized before the stock recruitment analyses for nominated MOC escapement indicator stocks in the Coquille and Umpqua rivers can be completed.

Based upon partial completion of stock recruitment analyses for nominated NOC and MOC escapement indicator stocks and upon experience gained from mark recapture experiments at survey calibration sites in 1998 and 1999, ODFW expanded the emphasis of its coastal chinook monitoring efforts in 2000. New emphasis was placed upon obtaining precise basin-wide estimates of spawner abundance for escapement indicator stocks. These same precise basin-wide estimates could also serve to calibrate traditional survey results. ODFW initiated basin-wide mark recapture programs in the Nehalem and Umpqua rivers in 2000.

LOA 2001

The balance of this document includes descriptions, methods, and budgets for Oregon coastal chinook monitoring and research projects that ODFW is proposing to complete with LOA funding in fiscal year 2001. The package of integrated projects closely resembles the package implemented in 2000 with the following exceptions: 1) a basin-wide mark recapture experiment for the MOC escapement indicator stock in the Coquille River has been added as a high priority project and the mark recapture project on the Coos River has been reduced to secondary importance; and 2) the request for LOA funding of the habitat inventory has been dropped.

The three original mark recapture sites on Coos, South Umpqua, and North Fork Nehalem rivers were all selected because existing fish capture structures facilitated marking activities. In the case of the Coos River, there was an existing trap in the river. Precise escapement estimates from the Coos River project are valuable for calibrating spawning ground survey estimates but the lack of adequate historic age composition data for the stock and the confounding history of hatchery influence in the basin precludes the use of this stock as an escapement indicator. In contrast, hatchery influence in the Coquille River basin is minimal and there is a good time series of historic escapement age composition data. Hence, as we have gained confidence in our ability to implement basin-wide mark recapture experiments we have opted to shift our efforts in the MOC from the Coos River to the Coquille River. The latter can provide information for survey calibration formerly supplied by the Coos River project and, in addition, can serve as an escapement indicator stock.

Data from the habitat inventory project is critical to the final design of a stratified random survey program for Oregon coastal chinook. Exclusion of the habitat inventory project from the 2001 proposal package does not reflect a change in priority for that project. ODFW is confident that funds from an alternate source are available to complete that work. The savings in LOA funds that result from dropping the habitat inventory portion of the ODFW proposal can be diverted into other high priority monitoring activities such as the proposed new mark recapture on the Coquille River. Table 1 summarizes the budgets for ODFW's proposed suite of new and continuing projects that are being submitted for funding under terms of the LOA in 2001.

LOA Beyond 2001

The integrated package of proposed new LOA projects, continuing LOA projects, and base budget projects meet many but not all of ODFW's long term research and monitoring goals for coastal chinook populations. The existing integrated package includes:

- exploitation rate estimates for hatchery stocks in the NOC and MOC;
- continuation of the traditional spawner surveys;
- ongoing development of a stratified random survey design based on habitat inventories and radio tagging data and;
- precise basin-wide spawner escapement estimates for three of five proposed escapement indicator stocks (one NOC and two MOC stocks).

As additional or alternative funding becomes available ODFW must continue to expand the existing package of projects to include:

- precise basin wide estimates of escapement for the remaining two NOC escapement indicator stocks (the Siletz and Siuslaw);
- exploitation rate analyses from wild stock coded-wire-tagging and recovery projects in the NOC and MOC;
- completion of collection and GIS mapping of habitat inventory data;
- implementation of a calibrated SRS program for all coastal watersheds;
- improvements in forecasting methods;
- genetics analyses of the growing archive of tissue samples collected from Oregon coastal rivers for improved understanding of stock structure;
- enumeration of smolts in basins where coded-wire-tagging of wild fish is proposed to further our understanding of freshwater and marine survival and improve our forecasting capabilities and;
- inventory and mapping of juvenile rearing areas.

Projects	Costs		
	Line Item	Project	Total w/overhead
New			
Nehalem Escapment Indicator Watershed		$ 215,526	$ 259,924
Basinwide Spwner Est.			
Personnel Cost	$ 126,541		
Travel	$ 10,040		
Supplies	$ 7,955		
Telemetry	$ 6,990		
Nehalem Creel/Punch Card Calibration			
Personnel Cost	$ 51,000		
Travel	$ 8,000		
Supplies	$ 5,000		
Umpqua Escapement Indicator Watershed		$ 165,577	$ 199,686
Basinwide Spwner Est.			
Personnel Cost	$ 96,069		
Travel	$ 6,960		
Supplies	$ 1,970		
Telemetry	$ 7,900		
Umqua Creel/Punch Card Calibration			
Personnel Cost	$ 39,678		
Travel	$ 8,000		
Supplies	$ 5,000		
Coquille Escapement Indicator Watershed		$ 84,482	$ 101,967
Personnel Cost	$ 54,912		
Travel	$ 6,600		
Supplies	$ 4,820		
Telemetry	$ 18,150		
NOC Feasibility Studies		$ 48,212	$ 61,036
Personnel Cost	$ 39,327		
Travel	$ 3,675		
Supplies	$ 5,210		
Continuing			
Age Composition		$ 39,895	$ 48,113
Personnel Cost	$ 31,715		
Travel	$ 6,360		
Supplies	$ 1,820		
Total All Projects		$ 553,692	$ 670,726
Personnel	$ 439,242		
Travel	$ 49,635		
Supplies	$ 31,775		
Telemetry	$ 33,040		

Table 1. Line item budgets for proposed new and existing continuation projects submitted to the CTC by ODFW for funding in 2001.

SECTION II

New 2001 LOA Proposals

SECTION II-A

Nehalem River Escapement Indicator Stock Monitoring and Spawner Survey Methods Development

CHINOOK SALMON FUNDING PROPOSAL

SUBMITTED TO:

Pacific Salmon Commission's Chinook Technical Committee (US Section)
for Funding under the Letter of Agreement (LOA)

PROJECT TITLE:

Nehalem River Escapement Indicator Stock Monitoring Project and Spawner Survey Methods Development

(New Project)

REQUESTING AGENCY:

Oregon Department of Fish and Wildlife
Marine Resources Program
2040 SE Marine Science Dr.
Newport, Oregon 97365

PERIOD COVERED:

1 June 2001 through 31 May 2002

FEDERAL FUNDING REQUESTED:

$ 259,925

<u>Principle Investigators</u>:
Jody White, Pacific Salmon Treaty Field Projects Leader, ODFW
Brian Riggers, Research and Monitoring Biologist, ODFW

OBJECTIVES

The Nehalem River chinook stock has been designated as and escapement indicator for the North Oregon Coast (NOC) in the 1999 Pacific Salmon Treaty, Chinook Chapter. For a river to be designated as an indicator stock for the NOC or Mid-Oregon Coast (MOC) aggregates, three components are necessary: 1) an existing or planned biologically based escapement goal, 2) a precise annual estimate of the total freshwater escapement, and 3) a less precise annual spawner estimates from a random survey design that can be correlated to the more precise estimate.

The goal of the Nehalem River Escapement Indicator Project is to precisely estimate the annual escapement at age of adult chinook salmon to the Nehalem River and to annually update a brood-year run reconstruction for that stock. These data will augment the stock recruitment analysis used to estimate the biologically based escapement goal for the basin, they will permit post season assessment of management success at meeting escapement goals, and they will enable managers to calibrate escapement estimates in the Nehalem and other NOC basins that are based on less precise random survey methodologies. In keeping with this goal, the specific objectives of the project are:

1. Estimate the total 2001 escapement of adult chinook from ocean fisheries into the Nehalem River within ± 25% of the true value 95% of the time and to estimate the age specific proportions of the escapement within ± 5% of the true value 95% of the time. Specific tasks that must be completed to achieve the overall objective are:
   a) Estimate the 2001 sport harvest of chinook salmon in Nehalem Bay such that the estimate is within ± 20% of the true value 95% of the time, and estimate age/sex specific proportions of that harvest such that the estimates are within ± 0.05 of the true value 95% of the time.
   b) Estimate the 2001 sport harvest of chinook salmon in Nehalem River such that the estimate is within ± 20% of the true value 95% of the time, and estimate age/sex specific proportions of that harvest such that the estimate is within ± 0.05 of the true value 95% of the time.
   c) Estimate the 2001 spawning escapement of chinook salmon in Nehalem River such that the estimate is within ± 25% of the true value 95% of the time, and estimate age/sex specific proportions of that spawning escapement such that the estimate is within ± 0.05 of the true value 95% of the time.
2) Determine the appropriate spawner survey methodology that can be implemented at the aggregate level to estimate chinook spawner abundance including:
   a) Estimate spawner indices using ODFW's standard spawning survey methods.
   b) Estimate the resultant spawner distribution in survey strata using radio transmitters such that the stratum estimate is within ± 25% of the true value 95% of the time.
   c) Describe the timing and distribution of chinook spawners using the spawner densities as determined by radio telemetry and accompanying habitat surveys.

RELATIONSHIP AND SIGNIFICANCE TO IMPLEMENTING ABUNDANCE-BASED MANAGEMENT OF CHINOOK SALMON IN FISHERIES GOVERNED BY THE PSC AND IDENTIFIED CTC-LOA RESEARCH THEMES

Most of Oregon's coastal chinook stocks migrate into fisheries governed by the Pacific Salmon Treaty (PST). Chinook management under the original 1985 Pacific Salmon Treaty was quota-based with designated ceilings that did not respond to stock sizes. Co-managers were only required to provide information for stocks under their jurisdiction that was adequate to assess long term spawning escapement trends. In contrast, under the terms of Aggregate Abundance Based Management (AABM) in the 1999 treaty, fisheries are managed for harvest rates. Harvest rates are adjusted annually based upon annual pre-season projections of ocean abundance for stock aggregates and post-season assessments of management success relative to achieving scientifically defensible biological escapement goals that insure sustainable production for both domestic and mixed stock ocean fisheries.

Escapement indicator and exploitation rate indicator stocks are two key features of AABM. They are needed to make the required preseason forecasts of abundance and distribution for stock aggregates. They also provide post season measures of management success. Both types of indicator stocks are selected to represent much larger stock aggregates. Among coastal chinook stocks in Oregon, the NOC and MOC are the two stock aggregates that contribute significantly to PST fisheries. Escapement indicator stocks are typically selected to represent much larger stock aggregates based upon geographic, habitat, genetics, and life history characteristics as well the extent of the historic data available.

Chapter 3, Section 9 of the PST specifies trigger mechanisms to adjust harvest rates when escapement goals of indicator stocks are not being met. An aggregate is considered depressed if two or more indicator stocks within an aggregate do not meet the established escapement goals. If two or more aggregates are depressed, harvest reductions are triggered within PST governed fisheries. In the case of Oregon stocks, if spawning escapement goals are not achieved for two or more individual indicator stocks within either the NOC or MOC two consecutive years, then that stock aggregate will be considered depressed.

The PSC can determine the status of the NOC and MOC only if Oregon provides defensible biological escapement goals and accurate and precise annual escapement estimates for indicator stocks designated for each aggregate. Hence, as consequence of the new agreement, Oregon must improve its escapement monitoring to provide the levels of accuracy and precision required by the CTC to satisfy the Section 9 assessment of escapement and to provide reliable abundance forecasts for setting harvest rates in the next fishing season.

The Oregon Department of Fish and Wildlife (ODFW) has selected the Nehalem, Siletz, and Siuslaw rivers as escapement indicator stocks for the NOC, has completed stock recruitment analyses for these stocks, and has estimated biological escapement goals for them that have been approved by the Chinook Technical Committee (CTC) of the Pacific Salmon Commission (PSC). The Coquille and Umpqua rivers have been selected as potential indicator stocks for the MOC. ODFW is still completing the stock recruitment analyses that will be used to estimate biological escapement goals for these two stocks. Ideally, ODFW will eventually implement intensive monitoring programs to precisely estimate freshwater harvest and spawning escapement in all five of these rivers. In the interim, we have proposed detailed monitoring programs for one NOC stock and two MOC stocks.

In conjunction with each basin-wide escapement estimate, the resulting spawner escapement estimate could be used to provide a calibration procedure to use for the coast-wide spawner survey program. Currently the coast-wide escapement estimate is stratified at the stock aggregate level (NOC and MOC) and monitored by means of a biased survey design. ODFW is planning to modify the coast-wide spawner survey method to incorporate a statistically valid stratified random survey design and use a measurement unit appropriate to give a reliable estimate of the inter-annual change in escapement. Using data from indicator stock watersheds to calibrate the survey technique to an independent spawner estimate allows the aggregate-level escapement estimate to be adjusted to yearly variations in climate, run strength, and regional effects. (note: see the introductory chapter for a more detailed description of Oregon's Coastal Chinook Research and Monitoring Program goals and objectives and their relationship to the Pacific Salmon Treaty abundance-based management of chinook salmon.).

The proposed project, "Nehalem River Escapement Indicator Stock Monitoring Project and Spawner Survey Methods Development", directly relates to the U.S. CTC research theme of "Improve Escapement Estimates to USCTC Standards" subheading "Improved escapement estimates for the Nehalem River: continuation of the program funded by the USCTC to develop basin-wide escapement estimates for this Northern Oregon Coastal (NOC) indicator stock." In order to fully implement the PST's Chinook Annex, an accurate estimate that meets CTC data standards needs to be made for the Nehalem River chinook stock. The goal of the Nehalem Escapement Indicator Project is provide an annual escapement estimate and to begin to develop a survey design that can be used to estimate spawner abundance for the NOC stock aggregate.

BACKGROUND

The Nehalem River is one of the largest coastal rivers in Oregon with a mainstem length of over 120 miles (Figure 1). The river is located entirely in the Oregon Coastal Mountain Range with a maximum watershed elevation of 3,510 ft. Average annual river discharge is 2,672 cubic feet per second (cfs) and historically has ranged from 34 – 70,300 cfs. Peak discharges typically occur during the winter rainy season from November until February. Upland areas of the watershed are dominated by commercial timberlands and floodplains are predominately pastureland.

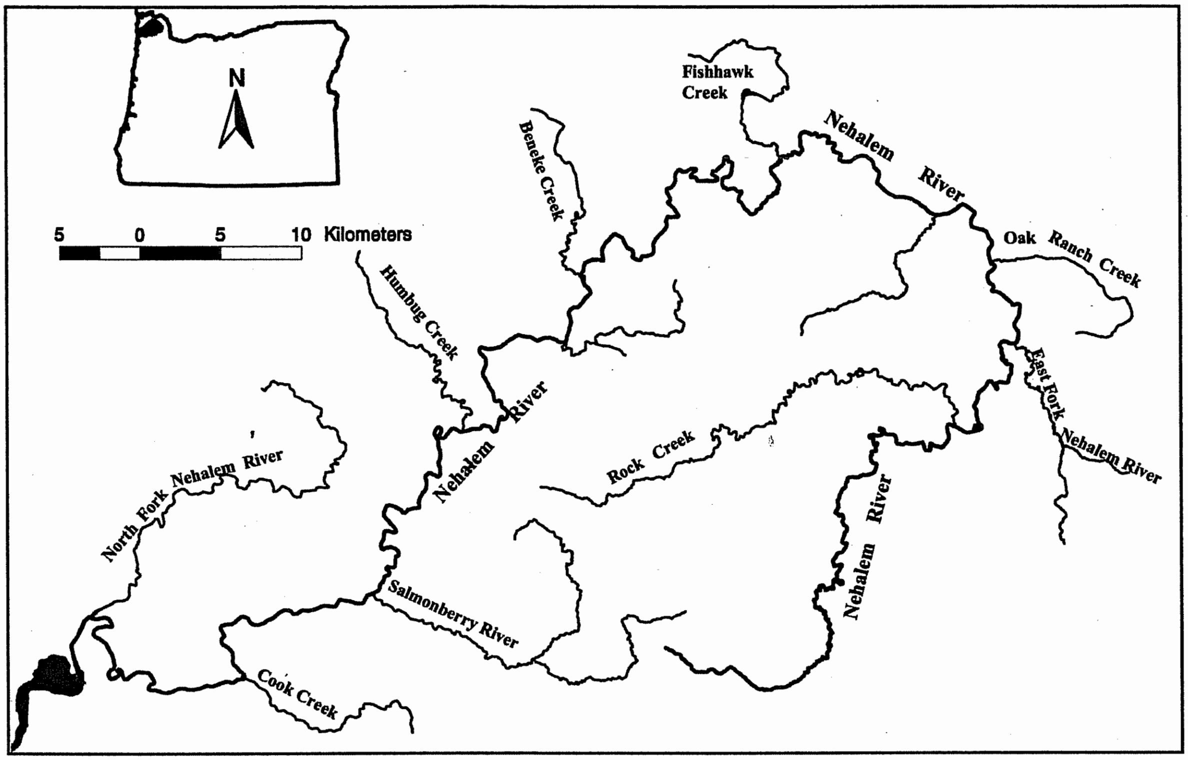

Figure 1. Map of the Nehalem River watershed.

The Nehalem River chinook salmon stock is categorized as a fall run (Nicholas and Hankin 1988). However, the fact that chinook start entering Nehalem Bay in May and are found spawning as early as September in the mainstem above Vernonia (RM 90) as well as headwater tributaries including Wolf Creek and Rock Creek suggests that a smaller component of summer run fish is also present (Germond and Boechler 1988). Most observed fall chinook spawning occurs in and below Humbug Creek (RM 35) and spawning peaks in November. Oregon coastal fall chinook are considered ocean-type chinook. Nicholas and Hankin (1988) classify the Nehalem River chinook as a late-maturing stock with females maturing at age 5 and males at age 4.

Historically (1950-present) the only assessment of run-size was by foot surveys of "standardized" spawning reaches. Counts of live and dead chinook are used to generate a spawner density index (Peak fish/mile). We do not know the relationship of this index to the actual escapement. Depending on the year, from 1.0 to 5.2 miles have been surveyed. Hodges and Jacobs (1997) and Riggers (1999, per. comm.) have estimated a total of 121 miles of high-quality spawning habitat. Zhou and Williams (1999) analyzed stock and recruitment data from 1967-1996 and estimated interim biologically based escapement goals. Maximum sustainable production was estimated between 7,400 to 16,700 adult spawners (47 to 105 spawners/mile) with an exploitation rate of 0.19– 0.68. Figure 2 illustrates the historic escapement estimates.

Nicholas and Hankin (1988) summarized commercial harvest data from fish-packing plants from 1896 until commercial harvest was eliminated in the early 1950's. Commercial harvests ranged from 8,000 – 18,000 fish. Reliable freshwater recreational harvest data before 1964 is limited. A creel survey from 1946-1949 was completed by ODFW and is also illustrated in Figure 3 (Hodges 1948, Henry et al. 1950). Since 1964, ODFW has used a voluntary angler reporting system to estimate freshwater harvest (Figure 3).

Compared to other coastal rivers, the Nehalem River chinook stock has had minimal hatchery influence (Wallis 1961, Nicholas and Hankin 1988, PSFMC StreamNet Database). Seventy-six hatchery releases (36 were spring run stocks) over ninety years have ranged from 15,600 to 1,460,000 chinook juveniles. All but three releases occurred before 1952. All fish were off-site hatchery releases and most were fingerlings or of unknown age. Three smolt releases of Trask River stock occurred in the early 1970's.

EXPERIENCE AND EXPERTISE OF KEY PROJECT PERSONEL

Jody White:

Education:

BS in Fisheries Biology from University of Idaho
MS in Aquatic Ecology from University of Idaho

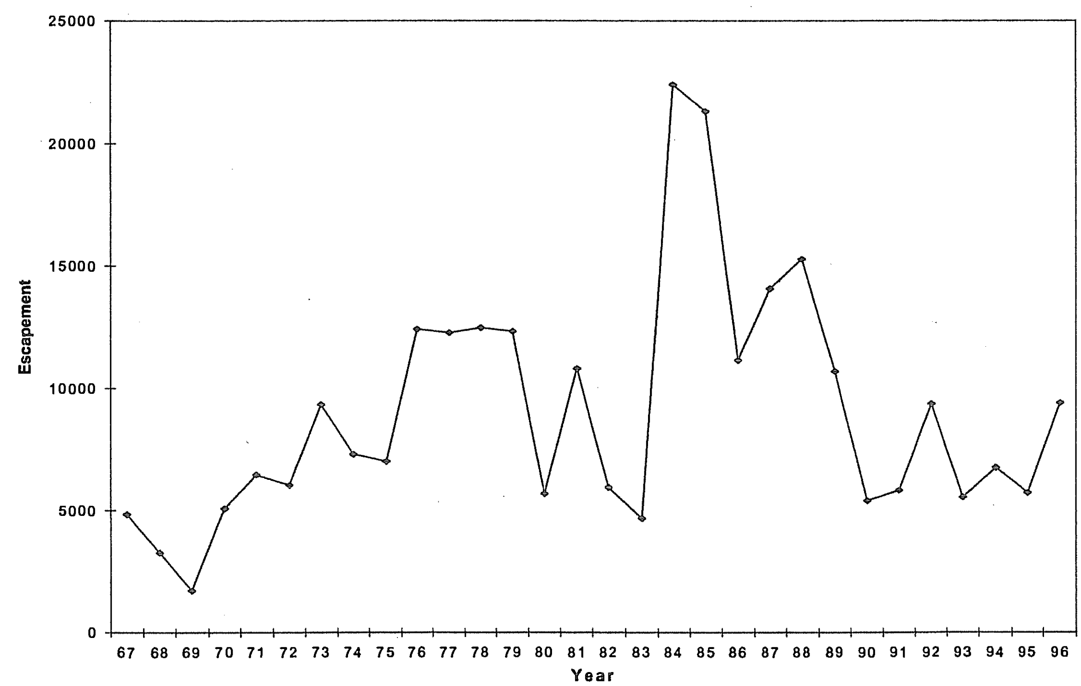

Figure 2. Estimated escapements of fall chinook in Nehalem River from 1967-1996 from Zhou and Williams (1999).

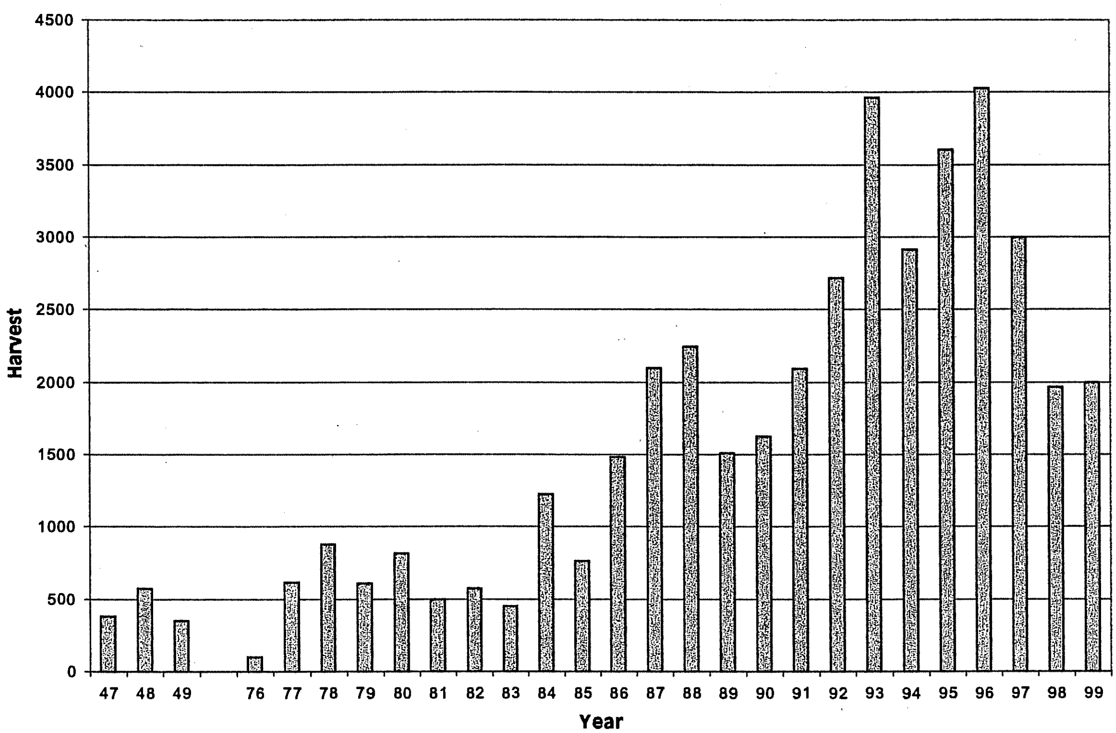

Figure 3. Historical freshwater harvest estimates for the Nehalem Bay and River. Creel surveys were used to obtain estimates in 1946-49 and 1998 -1999. Estimates from 1976-1996 were generated from a voluntary angler reporting system.

Experience:

ODFW PSC Field Projects Leader – two years
Aquatics Research Program Director, Xerces Society – two years
Freshwater Research Biologist, WA Dept. of Ecology – three years
Fisheries Biologist, Owner, EcoAnalysts, Inc. – four years

Expertise Specific to this Project

Conducted and supervised fisheries research projects in Oregon, Washington, and Idaho for ten years. Currently responsible for Oregon's PSC coastal chinook research projects.

Brian Riggers:

Education:

BS in Oceanography from Humboldt State University

Experience:

ODFW Fishery Research and Monitoring Biologist - three years
ODFW Field Technician adult and juvenile salmonid sampling - six year

Expertise Specific to this Project:

Conducted and coordinated adult salmon inventories in Oregon Coastal Basins for five years. Three years experience with field crew supervision. Currently responsible for coordination of field crews for ODFW's PSC coastal chinook projects.

METHODOLOGY AND PROJECT DESIGN

The total freshwater escapement of chinook salmon in the Nehalem Basin will be estimated by a mark-recapture experiment and a creel survey. The creel survey is a companion project currently funded by the CTC under the LOA. The calibration portion of the Oregon indicator stock program will use spawner surveys that are correlated to the escapement estimate to provide a yearly and regionally derived expansion factor. This expansion factor will be used to adjust aggregate level spawner surveys. Currently, only limited spawner surveys are being completed for each aggregate. However, the Oregon Coastal Chinook Program plans to implement a randomized survey technique once methods have been developed.

Live Capture - Multiple Recapture

The extended duration of the Nehalem chinook stock creates a situation that must be stratified into two capture areas and several geographically/temporally stratified recovery areas. A stratified Petersen mark-recapture experiment will be used to estimate chinook escapement. In order to capture fish more efficiently and to alleviate handling during the freshwater to saltwater transition phase, chinook will be captured in the riverine freshwater areas of the North Fork and mainstem. The North Fork enters the Nehalem River at the head of the Nehalem Bay saltwater wedge so capture below the confluence is not desirable. Chinook move into the Nehalem Bay from May to December and the relationship between time in the bay and freshwater entry date is unknown. Pending completion of the 2000 mark-recapture project we will have more information. During the 2000 mark-recapture project, significant numbers of fish were observed on the spawning areas that were assumed to be "spring" run chinook that entered before tagging began in July. For the 2001 project we are proposing to being tagging in early May.

Chinook will be captured by entanglement nets and seines. Two tagging crews of two-persons will capture fish during eight hour work sessions, five nights a week, from mid-May to the end of the run (late November). One crew will work the North Fork Nehalem River and the other crew will work on the mainstem Nehalem River. It does not appear feasible to tag below the confluence of the rivers because of overlap with the salt-water wedge in the Nehalem Bay. It will be necessary to work at night to minimize net avoidance by chinook and negative interactions with anglers. All captured chinook will have length measured (FL), sex and scales sampled, and tagged. Multiple tags will be used to ensure all marked fish are recognized in the subsequent recapture event - a single, numbered anchor tag will be placed on the left side of the dorsal fin, the operculum punched, and one axillary appendage will be removed.

The second capture event will consist of recovering tags in the recreational fishery and on the spawning grounds. All fish will be sampled for length (POH), scales and sex, and checked for marks. Each fish will only be sampled once. Recovery will start in the upper river spawning areas and tributaries in late August and continue until fish are no longer observed. All river locations will be sampled by late-September or when spawning activity begins. Surveyors will use both foot and boat surveys to locate carcasses. The feasibility of using additional methods to collect fish will also be assessed including but not limited to carcass weirs, netting or seining, and diving. The North Fork stratum will use a fish ladder fifteen miles above the tagging location to recover tags as well as carcasses.

The Nehalem Bay and River has a very active recreational chinook fishery. ODFW, with CTC funding, has estimated the chinook catch since 1998. The survey is stratified by month and area (bay, tidewater, and riverine areas). In 1998 and 1999, an estimated 1,964 (95% C.I. = ± 364) and 2,002 (95%C.I. = ± 255) chinook were harvested during the July – November fishery and surveyors physically sampled 438 and 524 chinook (22% and 26 % of estimated harvest). Since the first capture location will be located in the upper part of the tidewater fishery, the creel will be used as a method to recover tags. The creel survey is geographically stratified into the same strata as the mark-recapture experiment. Only those fish that are checked, both tagged and non-tagged, will be used as recoveries. Released fish that are not observed by surveyors will not be used in the estimate.

Analysis methods for the stratified Petersen estimate will follow the descriptions in Arnason, et al. (1996) and Schwarz and Taylor (1998) and use the program SPAS (Stratified Population Analysis System). The usual assumptions for use of the pooled Petersen estimator are:

1) all fish have an equal probability of being marked at the trap site; or,
   a) all fish have an equal probability of being inspected for marks; or,
   b) marked fish mix completely with unmarked fish in the population between events; and,
2) there is no recruitment to the population between capture events; and,
3) there is not trap induced behavior; and,
4) fish do not lose their marks and all marks are recognizable.

However, when using the stratified estimator these assumptions are expanded to include:

5) all fish have a non-zero probability of being found in the recovery strata and all fish in the recovery strata were present in one of the initial capture strata;
6) there is no tag loss - if there is tag loss the assignment of the probability of losing tags must be assigned proportionally to the distribution of initial strata tags in the marked recoveries; and,
7) all tagged and untagged fish in each recovery stratum have equal probability of being sampled.

Additionally, all tagged fish released in each capture area have the same probability of movement to the recovery strata as well as the tagged and untagged fish move with the same probability distribution.

Information about size and age selectivity during the two capture events can be estimated through a battery of tests (Appendix A) to determine if further stratification of the data set is appropriate to meet the assumptions. If age and size selectivity is not found then the population can be assumed to not have size/sex bias. It is assumed that netting will bias the first capture event towards larger fish. If multiple techniques are used to capture fish in the second event it is unlikely that it will be biased. However, it is very likely that only Assumption 3 (of the first three assumptions) will be met. To estimate if there is random geographic and temporal mixing of marks, the ratios of marked to unmarked fish will be compared between strata. Chi-square analysis will be used to determine if there are significant differences between the strata.

Assumptions 4, 5, and 7 do not apply to this situation. Only adult chinook salmon migrating upstream of the capture site will be used in the mark-recapture study and recruitment to the population is not possible. The second capture event is an active sampling technique utilizing multiple capture techniques to collect tags within the spawning areas upstream of the trap sites and trap induced behavior will not occur. However, for the first event, trap induced behavior can occur and this is estimated as discussed above for age/sex selectivity.

Tag loss (assumption 6 and 8) will be zero through the use of multiple tags. From 1999 and 2000 field data, when projects used these multiple tags, at least one of the multiple tags was observed if a fish was tagged. We will assume all tags will be seen on fish if present and that at least one of the tags will be observed if a fish was captured in the first event. The redundant application of floy tags, opercule punches, and axillary clips should insure that trained field crews will identify marked individuals among all fish observed.

A pooled Petersen estimator may be used if either of the two following conditions are met:

1. the recovery probabilities are similar between all strata; or,
2. the tagged to untagged ratios are constant between recovery strata.

The tests for condition one or two will follow Arnason et al. (1996). Condition 1 requires a non-significant result from a chi-square test of a 2 by s matrix (the number of tagging strata) with rows filled in by $m_{i.}$ and u^c_i and condition 2 requires a non-significant result from a chi-square test of a 2 by t matrix (the number of recovery stratum) with rows filled by $m_{.j}$ and u^r_j where:

$m_{i.}$= number of fish tagged in capture stratum *I,*
$m_{.j}$= number of fish tagged captured in stratum *j,*
u^r_j =, recovered the number of unmarked fish in the sample in recovery stratum *j*, and
u^c_i = the number of fish tagged in capture stratum *i* and are never seen.

Estimation of variance and associated confidence intervals for the stratified Petersen estimator will follow Arnason et al. (1996) unless alternative estimators are recommended by the CTC (e.g. bootstrap method). For the pooled Petersen estimator, a bootstrap method will be use to estimate variance, bias, and confidence intervals of the population estimate (Buckland and Garthwaite 1991, Mooney and Duval 1993).

Sample Size

Since FY 2000 data collection has not been concluded, sample sizes estimates will follow assumptions and recommendations in the FY 2000 proposal. In 1998 and 1999, ODFW estimated ~2,000 chinook were harvested in the Nehalem. Assuming a 25% freshwater harvest rate the total run was around 8,000 chinook in 1998 and 1999. The total North Fork Nehalem run was estimated in 1998 and 1999 and it was determined that the upper 50% of the spawning habitat contained ~700 adult chinook. Extrapolating the estimate to the total North Fork sub-basin would estimate ~1,400 chinook of the 8,000 spawn in the North Fork Nehalem River.

To achieve the 25% precision objective, the minimum numbers of marked fish were calculated for two strata, the North Fork and the mainstem Nehalem. Using the 1999 mark-recapture data on the North Fork, 12% of the total North Fork run (150 chinook) was captured at the North Fork Falls fish ladder. If this percentage holds true in 2000, then a minimum of 350 chinook must be marked at the head of tidewater to obtain a population estimate of 1,400 for the North Fork (note: the estimate number of recaptures is 44, or 12% of the 350).

The population size is estimated as 6,600 for the remainder of the Nehalem Basin. Over the last two years, 40 chinook have been checked annually by creel surveyors in the mainstem stratum; and the number of chinook carcasses found in the standard mainstem spawner surveys have averaged ~300. Because additional field crews were added to supplement recovery of carcasses in 2000, it is possible that at least 800 chinook may be recovered (12% of the estimated run). Assuming random mixing of marked and unmarked fish and comparable sampling levels again in 2001, a minimum of 500 chinook should be marked to meet the 25% precision objective.

Spawner Surveys

In addition to the mark –recapture population estimate for the Nehalem River we will to continue spawner surveys in the basin to use for calibrating the escapement estimates of the NOC stock aggregate. Currently, through companion LOA funded studies, ODFW is evaluating multiple methods of surveying spawning salmon in all Oregon's coastal rivers. When the appropriate method is determined the aggregate level spawning surveys will be conducted accordingly to derive an annual aggregate level escapement estimate. However, to capture the actual inter-annual variation, this estimate needs to be calibrated to an independent population estimate. We propose to use the escapement indicator watersheds to conduct these annual calibrations. The Nehalem watershed will be used to calibrate the NOC aggregate level escapement estimate. To accomplish this, both the M-

R technique and the appropriate spawner survey estimation technique will be conducted annually in this indicator watershed starting in year 2000.

During the spawning surveys a randomized design will be implemented and in addition to recapture of marked and unmarked fish, sampling crews will also count carcasses, live fish and redds.

Radio-Tracking

The application of radio transmitters to a portion of the fish tagged during the 2000 project has provided valuable information about the different races returning to the river, as well as the residence time and final migratory route of the tagged fish. However, based upon the absence of tags among early spawners in the upper basin, we appear to have missed a significant portion of the early run fish in the year 2000. In 2001, we propose to continue to place transmitters in chinook captured in the lower river net operations. Depending upon the availability of radio transmitters from other projects, up to 150 may be applied to chinook in the Nehalem basin in 2001. Two fixed stations will be used to record migration timing – one at the Humbug Creek (RM 32) and the other at Vernonia, OR (RM 80). Every two weeks, one surveyor will also drive the river basin locating fish to determine the extent of upstream movement.

Transmitters will be placed into the esophagus of each adult without the use of anesthetics and then released. Fish to be tagged will be selected by a systematic sample with a random start. Every tenth fish will have a transmitter placed, starting with the second fish captured. Only healthy fish will be tagged.

One hundred and ten transmitters are needed to partition the chinook spawner distributions into survey strata. The sample size is determined by using an estimated escapement of 6,000 adult chinook and a precision ±10% and α=0.05. To be conservative, if an equal proportion of the population spawn in each strata, we would need 100 transmitters. If a 10% transmitter failure rate is assumed than at least 110 transmitters would be needed to achieve the desired level of precision. There are multiple reasons for loss of transmitters including regurgitation, pre-spawn mortality, harvest, predation, transmitter malfunction, and battery failure.

Seven-volt, digitally encoded Lotek ® radio transmitters will be used. Each transmitter weighs 13 g in water and is 16 X 83 mm in dimensions with a 30 cm whip antennae and a battery life of 265 days. Each fixed station will have a Lotek ® SRX-4000 receiver with two directional Yagi antennas to monitor movement of tagged chinook. One antennae will be pointed upstream of the fixed station and the other antennae pointed downstream to determine each chinook's direction of movement.

Genetic Analysis

The extended duration of the Nehalem chinook run has raised the question of whether several genetically distinct races are present in the basin. ODFW, with assistance from chinook salmon genetics personnel with the National Marine Fisheries Service (NMFS) in Seattle, WA, initiated a DNA tissue survey during 2000 for the Nehalem Basin as well as all other coastal chinook stocks. Tissues are archived at the Newport ODFW office. All handled chinook in the Nehalem Basin in 2001 will have a rayed-fin clipped and stored in ethanol for future analysis. A subset of chinook will have tissues taken for allozyme (protein) analysis. Radio-tagged chinook distribution will be used to determine distinct geographical and spatial strata. Fifty to one-hundred chinook per strata will be sampled. Allozyme tissues will be stored in Newport in a ultra-cold freezer.

Age Composition Sampling

All chinook located in both capture events will have scales sampled. Since all fish captured will be sampled, expected sample sizes are not calculated. Four to five scales will be taken from each fish. Ages will be determined at the Corvallis, OR research lab using ODFW standard methods.

Creel Survey

Sport caught chinook salmon in the Nehalem Bay and River will be estimated from data collected by a stratified random, multi-stage creel survey conducted from July 1, 2001 until November 30, 2001. Harvest of chinook occurs mainly in the bay until September and the survey will emphasize catch areas 1-3 for July and the first half of August, however all catch areas will be sampled from mid-August until the end of November (Table 1).

Depending on the catch area and location, a roving-access survey or roving-roving survey design will be employed (Pollock et al. 1994). For an access point survey, anglers that have completed fishing are interviewed as they leave a boat landing or marina and angling effort is determined from the total number of anglers that left the sampled access point during the day. Access point surveys are appropriate for areas with only one or two access points and effort is determined by using data generated from interviews during the sampling period as opposed to an instantaneous measure used in the "roving" survey. In roving surveys, a surveyor will move or "rove" through a fishing area making angler or boat counts to determine effort (pressure counts) after which they will conduct angler interviews. Roving-access surveys are used when most anglers are concentrated at numerous, known locations (e.g. marinas) and anglers are interviewed as they leave an

Table 1. Catch Areas for the 2001 Nehalem Bay and River Creel Project.

Catch Area	Description
1 – Ocean	An "area" within 1 mile of the mouth of the bay that lies outside an imaginary line drawn perpendicular across the west ends of the jetties.
2 – Lower Nehalem Bay	The bay area from a line perpendicular across the west end of the jetties up to a line perpendicular across the bay at the State Park Boat Ramp.
3 - Upper Nehalem Bay	A line perpendicular across the bay at the State Park Boat Ramp up to and including the first visible portion of the North Fork Nehalem River.
4 – Tidewater	The mainstem Nehalem River from an imaginary line drawn across the river just upstream of the North Fork mouth upstream to the Roy Creek Bridge.
5 – Mainstem below Falls	Nehalem River from the Roy Creek Bridge upstream to the base of the Nehalem River Falls.
6 – Mainstem above Falls	All areas open to Chinook fishing upstream of the Nehalem River Falls
7 – North Fork Nehalem	An area ½ mile above the mouth to the N. Fork Nehalem Falls.

area once fishing is completed. However, with roving-roving style surveys, anglers are not concentrated at known locations (bank anglers) and a surveyor moves through the fishery interviewing anglers while they are still fishing.

The survey will be stratified by catch area, month, day (weekend, weekday), and angler type (bank or boat). Anglers will be separated into two groups, private anglers and guided anglers, and post-stratified if catch rates are found to differ. Angler interviews will include the number of hours fished, number of anglers in the boat or on shore, the number of salmonids by species caught or released, and residency of the angler. All data will be entered into hand-held electronic dataloggers. All fish that are checked will have scales sampled, length measured, sex identified, and the number and types of fin marks noted. If an adipose fin is missing a "detection wand" will be used to determine if a coded wire tag is present. If present, the snout will be removed for future tag decoding.

The number of surveyors employed by month and area is shown in Table 2. Individual weekly work schedules will vary depending on the month and catch area worked.

Table 2. Number of surveyors by area and month for the 2001 Nehalem River Creel Survey.

	July	August	September	October	November
Nehalem Bay and Tidewater	2	2	2	2	
Mainstem and N. Fk. Nehalem		1	2	2	2
Total	2	3	4	4	2

Nehalem Bay and Tidewater (Catch Areas 1-4)

A roving-access creel survey will be used for all bay and tidewater locations. More specifically, access points will be sampled proportionally to the monthly effort observed at each landing in 1998-1999. Surveyors will travel a predetermined schedule of wait and travel time, with access points randomly chosen, moving between the eight access points interviewing anglers. The sampling schedule will allow each access point to be sampled proportional to the amount of angling effort. Amount of effort per access point was calculated from interview data gathered in 1998-2000.

Two surveyors will interview boat anglers as they return from fishing. To alleviate problems with differing effort due to time of day and tidal cycles, each day will be surveyed in its entirety. At each location, all boats returning to the marina will be interviewed. The amount of time and the number of fish caught in each area will constitute each interview. If large numbers of boats return to the dock and all cannot be interviewed, the surveyor will interview a systematic random sample. Because the pressure counts record total number of boats in each catch area, all boats regardless of target species or activity will be interviewed. If a contacted boat has fished for multiple fish types (e.g. salmon and crabbing or bottom fishing), two interviews will be completed, one for the salmon angling and an additional one for non-salmon activities. Similarly, if a single boat fished multiple areas, multiple interviews will be completed - one interview for each area fished.

Fishing effort in Catch Areas 1-4 will be estimated by counting boats from several vantage points around the bay. Pressure counts typically take less than 30 minutes to complete and are considered instantaneous. Four or five pressure counts, depending on time of year, will be recorded throughout the day at assigned 3 hour time intervals. Boats in moorage and kayaks will not be included in the count.

Mainstem and North Fork Nehalem River (Catch Areas 5-7)

Both boat and bank anglers will be interviewed on the mainstem Nehalem below Nehalem River Falls (Catch Area 5). Surveys will begin in early to mid-August, depending on water conditions and angling effort. One surveyor will sample both the

North Fork Nehalem and mainstem Nehalem River in August, and as fishing effort increases in September and October another surveyor will be added. Historically, riverine angling effort is insignificant until water flows increase (usually in September) and large numbers of fish move into the river. The North Fork Nehalem River survey will begin in mid-September. Since water conditions dictate the angler use on the North Fork, it is best to plan surveys beginning in mid-September to assure comprehensive coverage of catch.

Each surveyor will work four, ten-hour days a week, two weekend days and two-week days. A day will be stratified into an AM shift and a PM shift. AM shifts will begin at 6:00 and end at 4:00 and PM shifts are from 11:00 – 9:00. AM shifts will be sampled at twice the rate as PM shifts.

For bank anglers, a roving-roving style survey will be used. A surveyor will "rove" or move through Catch Area 5 (including the shore areas just below the Roy Creek Bridge in Catch Area 4) randomly interviewing anglers. Angling effort or pressure counts will occur at three intervals depending on day length by driving the mainstem and Andersen Creek roads and counting all people fishing. Pressure counts will consist of counting all cars located in the catch area that are parked in locations used by anglers. Pressure counts typically take less than 45 minutes and are considered instantaneous. Once the pressure count is complete, the surveyor will interview anglers until the next scheduled pressure count. Interviews will consist of the same information gathered in the boat surveys. However, a sample will consist of interviewing a group of anglers that are attributed to each car. Non-anglers in the catch area will also be interviewed to estimate the use by non-anglers and appropriately adjust the effort count.

The roving surveyor on the mainstem Nehalem will also sample boats that have completed fishing at Mohler Sand and Gravel. There are only three access points in Catch Area 5 that anglers can use to launch boats. The most upstream put-in is the Beaver Slide, several miles downstream is the Mohler Sand and Gravel access and the most downstream landing is Roy Creek. The 1998 census, interviewed no boat anglers above Roy Creek. However, from discussions with the district biologist, there can be significant use of the Mohler Sand and Gravel access as a boat take-out depending on water flows . Effort will be determined by counting trailers at the Beaver Slide put-in during the bank angler pressure count.

Sampling has not been scheduled initially for the Nehalem River above the Nehalem River Falls (Catch Area 6). Periodic surveys in 1998-2000 determined that angler effort and catches in the area were too small to significantly affect the catch estimate for the basin and did not warrant the required survey effort.

Creel Data Analysis

The Nehalem River creel survey is stratified by month, catch area, and angler type (shore or boat). Depending on harvest rates, anglers could be further post-stratified into private trips and guided trips. Data analysis procedures for post-stratification of private and guided trips will follow Bernard et al. (1998) if harvest rates differ significantly between the trip types. There was no difference between guided and private anglers in the 1998 and 1999 surveys but the 2000 data has not been analyzed. Missing data points from surveyor illness or equipment failures will be treated as random events and removed from the sampling frame. Bernard et al. (1998) describes several other events which must be taken into account during analysis that can bias harvest estimates including 1) zero interviews, but angling effort was counted, 2) zero harvest rate, but effort was counted, and 3) very low (1-2) numbers of interviews but with harvest. If any of these situations are encountered and deemed to bias the data-set, the data will be treated as missing data points and the substituted values derived from methods described in Bernard et al. (1998) and Guthrie et al. (1991).

Roving-Access Survey: Harvest will be determined separately for kept fish and for released fish. Estimated harvest per sample day in a particular stratum is (Pollock et al. 1994, Bernard et al. 1998)

$$\hat{H}_i = \hat{E}_i \overline{cpue_i}$$

where,
i denotes sampling days,
$\hat{E}_i$= estimated effort, and
$\overline{cpue_i}$=average catch per unit.

Because the roving-access surveys only interview completed angler trips average catch per unit effort is estimated as the ratio of means (Hoenig et al. 1997):

$$\overline{cpue_i} = \frac{\sum_{k=1}^{m_i} h_{ik}}{\sum_{k=1}^{m_i} e_{ik}}, \text{ where}$$

k denotes individual anglers,
m denotes the number of anglers interviewed,
h is the number of fish caught during fishing trips that were interviewed, and
e is the length in hours of fishing trips of interviewed anglers.

Variance of cpue is estimated as (Bernard et al. 1998):

$$v(\overline{cpue_i}) = \frac{\sum_{k=1}^{m_i} (h_{ik} - e_{ik}\overline{cpue_i})^2}{\bar{e}_i^2 m_i (m_i - 1)}.$$

Fish harvested per catch/month strata equals:

$$\hat{H} = D\frac{\sum_{i=1}^{d}\hat{H}_i}{d} \text{ where,}$$

d = number of sampled days in stratum, and
D = total available sampling days in stratum.

Daily effort is estimated as:

$$\hat{E}_i = T\frac{\sum_{t=1}^{r}x_{it}}{r} \text{ where,}$$

t denotes the individual roving count of anglers
r = number of pressure counts per day, and
T = the length of the sampling period (usually day length).

Since effort is determine systematically and not randomly the variance equation is (Wolter 1985):

$$v(\hat{E}_i) = T^2\frac{\sum_{t=2}^{r}\left(x_{it} - x_{i(t-1)}\right)^2}{r^2(r-1)}.$$

The variance of the daily harvest is (Goodman 1960 as cited by Bernard et al. 1998):

$$v(\hat{H}_i) = \hat{E}_i^2(\overline{cpue}_i) + \overline{cpue}_i^2 v(\hat{E}_i) - v(\overline{cpue}_i)v(\hat{E}_i)$$

and the variance for each catch/month stratum is:

$$v(\hat{H}) = D(D-d)\frac{s_1^2}{d} + \frac{D}{d}\sum_{i=1}^{d}v(\hat{H}_i), \qquad \textit{where}$$

$$s_1^2 = \frac{\sum(\hat{H}_i - \overline{\hat{H}})^2}{d-1},$$

Total harvest is the sum of all catch in each strata and the total variance of the catch is the sum of all strata variances (Pollock et al. 1994).

Roving-Roving Surveys: The only difference in estimation between the roving – roving survey and the roving – access survey is the catch per unit effort (*cpue*) estimator. With roving surveys anglers are interviewed that have not completed fishing and the mean of ratios estimator should be used (Pollock et al. 1994).

$$\overline{cpue_i} = \frac{\sum_{k=1}^{m_i} \frac{h_{ik}}{e_{ik}}}{n}, \text{ where}$$

k denotes individual anglers,
m denotes the number of anglers interviewed,
h_{ik} is the number of fish caught for an interviewed angler,
e_{ik} is the length in hours fished for an interviewed angler, and
n is the number of interviews for each day *i*.

The variance is calculated as (Jones et al. 1995):

$$v(\overline{cpue_i}) = \frac{\sum_{k=1}^{m_i} e_{ik}\left(\frac{h_{ik}}{e_{ik}} - \overline{cpue_i}\right)^2}{m\sum_{i=1}^{m} e_{ik}}.$$

DEPENDENCE OF THE PROJECT UPON RELATED PROJECTS

1. ODFW's "Salmonid Life Cycle Project" will cooperatively operate the fish ladder and traps at the North Fork Nehalem Falls and help collect carcasses in survey reaches.

2. ODFW's "Coastal Salmonid Inventory Project" will continue the historic sampling so that parallel information is collected for the period and conversion of historic database is possible.

REQUIRED PERMITS

We are working closely with NMFS to obtain any permits that may be needed in association with Endangered Species Act (ESA) status of some coastal salmonid populations. Permission from landowners will be needed to access streams adjacent to private property.

PROPOSED DURATION OF PROJECT

The Nehalem River Indicator Stock Project will continue for the duration of the Pacific Salmon Treaty agreement. We are currently searching for funding to continue the project in the event that CTC LOA funds are terminated. The radio-tracking portion will continue for 1-2 years.

TIME LINE

May 1 - May 15:	complete sampling plan incorporating results of 2000 study, purchase equipment and supplies, and hire field personnel.
May 15 – November 31:	begin trapping and tagging.
August 15 - December 31:	initiate spawning surveys and tag recoveries.
January 1 – March 30:	data entry, data analysis, and draft technical progress report.
March 1 – March 31:	distribute draft progress report for review.
April 1 - 31:	finalize progress report.

PROPOSED BUDGET

Type	Description	Number	Amount	Rate	Total	Sum
Personnel	**Classification**	**Persons**	**Months**	**Rate**	**Total**	**$177,541**
Project Leader	NRS 3 Step 5	1	5	$ 3,580.00	$17,900	
Project Asst. Leader	NRS 2 Step 4	1	5	$ 2,746.00	$13,730	
Crew Leaders	EBA - Step 4	2	14	$ 1,729.92	$24,219	
Field EBA's	EBA - Step 2	11	42.5	$ 1,587.12	$67,453	
Scale Technician	FWT-3 Step 1	1	0.5	$ 2,063.46	$ 1,032	
Data Entry	EBA - Step 2	1	1	$ 1,587.12	$ 1,587	
OPE for Full Time				38%	$12,019	
OPE for Seasonals				42%	$39,601	
Travel	4x4 Pickups	9	41	$ 270.00	$11,070	**$ 18,040**
	Mileage	1000	41	$ 0.17	$ 6,970	
Equipment	Transmitters		30	$ 223.00	$ 6,690	**$ 6,690**
Supplies	Nets and Accessories		10	$ 300.00	$ 3,000	**$ 13,255**
	Tags		2	$ 420.00	$ 840	
	Boat Accessories		3	$ 200.00	$ 600	
	Boat Maintenance		3	$ 200.00	$ 600	
	Tagging Accessories		2	$ 150.00	$ 300	
	Waders		9	$ 135.00	$ 1,215	
	Rain Gear		12	$ 75.00	$ 900	
	Telemetry Station Acc.		3	$ 100.00	$ 300	
	Supplies		1	$ 2,000.00	$ 5,500	
Direct						**$215,526**
Indirect					**20.6%**	**$ 44,398**
Total						**$259,924**

LITERATURE CITED

Arnason, A. N., C. W. Kirby, C. J. Schwarz, and J. R. Irvine. 1996 Computer Analysis of Data from Stratified Mark-Recovery Experiments for Estimation of Salmon Escapements and Other Populations. Canadian Technical Report of Fisheries and Aquatic Sciences 2106.

Bernard, D. R., A. E. Bingham, and M Alexandersdottir. 1998. Robust harvest estimates from on-site roving-access creel surveys. Transactions of the American Fisheries Society 127:481-495.

Buckland, S.T. and P.H. Garthwaite. 1991. Quantifying Precision Of Mark-Recapture Estimates Using Bootstrap And Related Methods. Biometrics 47:255-268.

Germond, J. P. and J. L. Boechler. 1988. Investigation of Nehalem River Summer Chinook Salmon Stocks. Oregon Department of Fish and Wildlife, Portland, OR. Progress Report.

Goodman, L. A. 1960. On the exact variance of products. Journal of the American Statistical Association 55:708-713.

Henry, K. A., A. R. Morgan, and R. L. Rulifson. 1950. The Salmon Catch of the Sport Fishery on the Coastal Rivers of Oregon in 1949. Fish Commission Research Briefs, Fish Commission of Oregon, 2(2):33-38. Portland, OR.

Hodgson, B.L. and Jacobs, S.E. 1997. Inventory of Spawning Habitat Used by Oregon Coastal Fall Chinook Salmon. Oregon Department of Fish and Wildlife, Corvallis Research Department, Corvallis, OR. Project Report.

Hoenig, J. M., C. M. Jones, K. H. Polock, D. S. Robson, and D. L. Wade. 1997. Calculation of catch rate and total catch in roving surveys of anglers. Biometrics 53-306-317.

Jacobs, S.E. and Cooney, C.X. 1997. Oregon coastal salmon surveys. Oregon Department of Fish and Wildlife, Ocean Salmon Management Information Report, Portland.

Jacobs, S.E. and T.E. Nickelson 1998. Use of Stratified Random Sampling to Estimate the Abundance of Oregon Coastal Coho Salmon. Final Report Oregon Department of Fish and Wildlife, Portland.

Jones, C. M., D. S. Robson, H. D. Lakkis, and J. Kressel. 1995. Properties of catch rates used in analysis of angler surveys. Transactions of the American Fisheries Society 124:911-928.

Mooney, C.V. and R. D. Duvall. 1993. Bootstrapping: A Non Parametric Approach To Statistical Inference. Sage Publications, Newbury Park, CA, 73 p.

Nicholas, J.W. and D. G. Hankin. 1988. Chinook Salmon Populations in Oregon Coastal River Basins: Description of Life Histories and Assessment of Recent Trends in Run Strengths. Oregon Department of Fish and Wildlife, Corvallis, OR. Information Report 88-1.

ODFW (Oregon Department of Fish and Wildlife), 2000. Coastal Salmon Spawning Survey Procedures Manual. Coastal Salmon Inventory Project, Corvallis.

Pollock, K. H., C. M. Jones, and T. L. Brown. 1994. Angler survey methods and their applications in fisheries management. Special Publication 25, American Fisheries Society, Bethesda, Maryland.

PSFMC. 1999. StreamNet Database, at URL http://www.streamnet.org. Gladstone, Oregon

Schwartz, C. J., R. E. Bailey, J. R. Irvine, and R. C. Dalziel. 1993. Estimating Salmon Spawning Escapement Using Capture-Recapture Methods. Canadian Journal of Fisheries and Aquatic Science 50: 1181-1197.

Schwarz, C. J. and C. G. Taylor. 1998. Use of the Stratified-Petersen Estimator in Fisheries Management: Estimating the Number of Pink Salmon Spawners in the Fraser River. Canadian Journal of Fisheries and Aquatic Sciences 55:281-296.

USCTC, 1997. A review of stock assessment data and procedures for U.S. chinook salmon stocks. Pacific Salmon Commission Report USTCHINOOK (71)-1. Vancouver, British Columbia, Canada. 75 pp.

Wallis, J. 1961. An Evaluation of the Nehalem River Salmon Hatchery. Oregon Fish Commission Report, Portland, OR.

Wolter, K.M. 1985. Introduction to varience estimation. Springer-Verlag, New York.

Zhou, S. and R. Williams. 1999. Stock and Recruitment Analysis and Escapement Goals for Nehalem River Fall Chinook. Oregon Department of Fish and Wildlife, Portland Oregon. Information Report 99-4.

Zhou, S. and R. Williams. 2000. Escapement Goals for Siletz River and Siuslaw River Fall Chinook Based on Stock and Recruitment Analysis. Oregon Department of Fish and Wildlife, Portland Oregon. Information Report 2000-04.

APPENDIX A. Detection of size-selectivity in sampling and its effects on estimation of size composition [taken from Bernard 1991].

Results of Hypothesis Tests (K-S and χ^2) on lengths of fish MARKED during the First Event and RECAPTURED during the Second Event	Results of Hypothesis Tests (K-S and χ^2) on lengths of fish CAPTURED during the First Event and CAPTURED during the Second Event
Case I:	
"Accept" H_O	"Accept" H_O
There is no size-selectivity during either sampling event.	
Case II:	
"Accept" H_O	Reject H_O
There is no size-selectivity during the second sampling event but there is during the first.	
Case III:	
Reject H_O	"Accept" H_O
There is size-selectivity during both sampling events.	
Case IV:	
Reject H_O	Reject H_O
There is size-selectivity during the second sampling event; the status of size-selectivity during the first event is unknown.	

Case I: Calculate one unstratified abundance estimate, and pool lengths, sexes, and ages from both sampling events to improve precision of proportions in estimates of composition.

Case II: Calculate one unstratified abundance estimate, and only use lengths, sexes, and ages from the second sampling event to estimate proportions in compositions.

Case III: Completely stratify both sampling events, and estimate abundance for each stratum. Add abundance estimates across strata to get a single estimate for the population. Pool lengths, ages, and sexes from both sampling events to improve precision of proportions in estimates of composition, and apply formulae to correct for size bias to the pooled data .

Case IV: Completely stratify both sampling events and estimate abundance for each stratum. Add abundance estimates across strata to get a single estimate for the population. Use lengths, ages, and sexes from only the second sampling event to estimate proportions in compositions, and apply formulae to correct for size bias to the data from the second event.

SECTION II-B

Umpqua River Escapement Indicator Stock Monitoring and Spawner Survey Methods Development

CHINOOK SALMON FUNDING PROPOSAL

SUBMITTED TO:

Pacific Salmon Commission's Chinook Technical Committee (US Section)
for Funding under the Letter of Agreement (LOA)

PROJECT TITLE:

Umpqua River Escapement Indicator Stock Project
and Spawner Survey Methods Development
(New Project)

REQUESTING AGENCY:

Oregon Department of Fish and Wildlife
Marine Resources Program
2040 SE Marine Science Dr.
Newport, Oregon 97365

PERIOD COVERED:

1 June 2001 through 31 May 2002

FEDERAL FUNDING REQUEST:

$ 199,686

Principle Investigators:

Dave Loomis, Umpqua District Biologist, Roseburg, OR
Tom Loynes, Assistant District Biologist, Roseburg, OR
Jody White, Pacific Salmon Treaty Field Projects Coordinator, Newport, OR
Brian Riggers, Research and Monitoring Biologist, Newport, OR

OBJECTIVES

The Umpqua River chinook stock is a candidate escapement indicator stock for the MOC. For a river to be designated as an indicator stock for either the North Oregon Coast (NOC) or Mid-Oregon Coast (MOC) aggregates, three components are necessary: 1) an existing or planned biologically based escapement goal, 2) a precise annual estimate of freshwater escapement, and 3) a less precise annual spawner estimates from a random survey design that can be correlated to the more precise estimate.

The goal of the Umpqua Escapement Indicator Project is to precisely estimate the annual escapement at age of adult chinook salmon to the Umpqua River and to annually update a brood-year run reconstruction for that stock. These data will augment the stock recruitment analysis that is underway to estimate the biologically based escapement goal for the basin, they will permit post season assessment of management success at meeting escapement goals, and they will enable managers to calibrate escapement estimates in the Umpqua and other MOC basins that are based on less precise random survey methodologies. In keeping with this goal, the specific objectives of the project are:

1) Estimate the total 2001 escapement of adult chinook from ocean fisheries into the Umpqua River within ± 25% of the true value 95% of the time and to estimate the age specific proportions of the escapement within ± 0.05 of the true value 95% of the time. Specific tasks that must be completed to achieve the overall objective are:
   a) Estimate the 2001 sport harvest of chinook salmon in Umpqua River such that the estimate is within ± 20% of the true value 95% of the time, and estimate age/sex specific proportions of that harvest such that the estimate is within ± 0.05 of the true value 95% of the time.
   b) Estimate the 2001 spawning escapement of chinook salmon in Umpqua River such that the estimate is within ± 25% of the true value 95% of the time, and estimate age and sex specific proportions of the spawning escapement such that estimates are within ± 0.05 of the true value 95% of the time.
2) Determine the appropriate spawner survey methodology that can be implemented at the aggregate level to estimate chinook spawner abundance including:
   a) Estimate spawner indices using Oregon Department of Fish and Wildlife's (ODFW) standard spawning survey methods.
   b) Describe the timing and distribution of chinook spawners using the spawner densities as determined by radio telemetry and accompanying habitat surveys.

RELATIONSHIP AND SIGNIFICANCE TO IMPLEMENTING ABUNDANCE-BASED MANAGEMENT OF CHINOOK SALMON IN FISHERIES GOVERNED BY TH PSC AND IDENTIFIED CTC-LOA RESEARCH THEMES

Most of Oregon's coastal chinook stocks migrate into fisheries governed by the Pacific Salmon Treaty (PST). Chinook management under the original 1985 Pacific Salmon Treaty was quota based. Co-managers were only required to provide information for stocks under their jurisdiction that was adequate to assess long term spawning escapement trends. In contrast, under the terms of Aggregate Abundance Based Management (AABM) in the new 1999 treaty, fisheries are managed for harvest rates. Harvest rates are adjusted annually based upon annual pre-season projections of ocean abundance for stock aggregates and post-season assessments of management success relative to achieving scientifically defensible biological escapement goals that insure sustainable production for both domestic and mixed stock ocean fisheries.

Escapement indicator and exploitation rate indicator stocks are two key features of AABM. They are needed to make the required preseason forecasts of abundance and distribution for stock aggregates. They also provide post season measures of management success. Both types of indicator stocks are selected to represent much larger stock aggregates. Among coastal chinook stocks in Oregon, the NOC and MOC are the two stock aggregates that contribute significantly to PST fisheries. Escapement indicator stocks are typically selected to represent much larger stock aggregates based upon geographic, habitat, genetics, and life history characteristics as well the extent of the historic data available. The Chinook Technical Committee (CTC) of the Pacific Salmon Commission (PSC) is responsible for reviewing biological escapement goals that co-managers submit for indicator stocks and for assessing the scientific rigor of escapement and exploitation rate monitoring programs.

Chapter 3, Section 9 specifies trigger mechanisms to adjust catch when escapement goals of indicator stocks are not being met. If two or more indicator stocks within an aggregate are considered depressed, harvest reductions within the North Pacific fisheries are triggered. In the case of Oregon stocks for example, if spawning escapement goals are not achieved for two or more individual indicator stocks within either the NOC or MOC two consecutive years, then that stock aggregate will be considered depressed. The PSC can determine the status of the NOC and MOC only if Oregon provides defensible biological escapement goals and accurate and precise annual escapement estimates for indicator stocks designated for each aggregate. Hence, as consequence of the new agreement, Oregon must improve its escapement monitoring to provide the levels of accuracy and precision required by the CTC to satisfy the Section 9 assessment of escapement and to provide reliable abundance forecasts for setting harvest rates in the next fishing season.

ODFW has selected the Nehalem, Siletz, and Siuslaw rivers as escapement indicator stocks for the NOC, has completed stock recruitment analyses for these stocks, and has estimated biological escapement goals for them that have been approved by the CTC. The Coquille and Umpqua Rivers have been selected as potential indicator stocks for the

MOC. ODFW is still completing the stock recruitment analyses that will be used to estimate biological escapement goals for these two stocks. Ideally, ODFW will eventually implement intensive monitoring programs to precisely estimate freshwater harvest and spawning escapement in all five of these rivers. In the interim, we have proposed detailed monitoring programs for one NOC stock and two MOC stocks.

In conjunction with each basin-wide escapement estimate, the resulting spawner escapement estimate would be used to provide a calibration procedure to use for the coast-wide spawner survey program. Currently the coast-wide escapement estimate is stratified at the stock aggregate level (NOC and MOC) and monitored by means of a biased survey design. ODFW is planning to modify the coast-wide spawner survey method to incorporate a statistically valid stratified random survey design and use a measurement unit appropriate to give a reliable estimate of the inter-annual change in escapement. By using the indicator stock watersheds to calibrate the survey technique to an independent spawner estimate, would allow the aggregate-level escapement estimate to be adjusted to yearly variations in climate, run strength, and regional effects. (Note: see the introductory chapter for a more detailed description of Oregon's Coastal Chinook Research and Monitoring Program goals and objectives and their relationship to the Pacific Salmon Treaty abundance-based management of chinook salmon.)

The proposed project, "Umpqua River Escapement Indicator Stock Project and Spawner Survey Methods Development", directly relates to the U.S. Section of the CTC (USCTC) research theme of "Increase Number of Escapement Indicator Stocks" under the sub-heading "Improved escapement estimates for the Umpqua River: continuation and expansion of the program funded by the USCTC to develop basin-wide escapement estimates for a MOC indicator stock".

BACKGROUND

ODFW is implementing the fourth year of a multi-year study designed to develop methods that provide reliable estimates of fall chinook (*Oncorhynchus tshawytscha*) spawner escapements for Oregon coastal streams. Funding for this study has been obtained through the US letter of Agreement (LOA) and is administered by the CTC. The CTC is responsible for evaluating the rebuilding process of naturally spawning chinook stocks covered by the Pacific Salmon Treaty and is comprised of scientists from all member states and countries. Three stock aggregates have been identified to originate from Oregon coastal basins. These aggregates are thought to represent distinct genetic and behavioral characteristics and are managed separately. The NOC and MOC are the two stock aggregates that are north migrating, and are subjected to the CTC's abundance-based management program (USCTC 1997).

Natural coastal chinook stocks from four rivers along the mid-coast are grouped in the MOC stock aggregate for rebuilding assessment and CTC modeling. One of the major populations within this aggregate of stocks is from the Umpqua River. The Umpqua River is composed of four major tributaries, South Umpqua, North Umpqua, Cow Creek, and Smith River (Figure 1). Chinook salmon in the Umpqua River are managed as a unique genetic stock according to the ODFW's wild fish policy (Umpqua Gene Conservation Area). . Most fall chinook spawning occurs in the main Umpqua, South Umpqua, Cow Creek, and a small component in the Smith River. Adult returns are monitored through counts at a dam on the North Umpqua (generally between 200 and 500 fish), aerial counts of redds on the South Umpqua (currently being calibrated under LOA funded project), and peak count surveys on the Smith River. The aerial counts of chinook spawning redds within the South Umpqua River and a major tributary, Cow Creek, have been conducted by ODFW's Southwest Region in Roseburg since 1978 (Figure 2). In 1998 ODFW, with funding from the CTC, initiated a six-year mark-recapture experiment to estimate the spawner escapement to the South Umpqua watershed to calibrate these aerial redd count surveys.

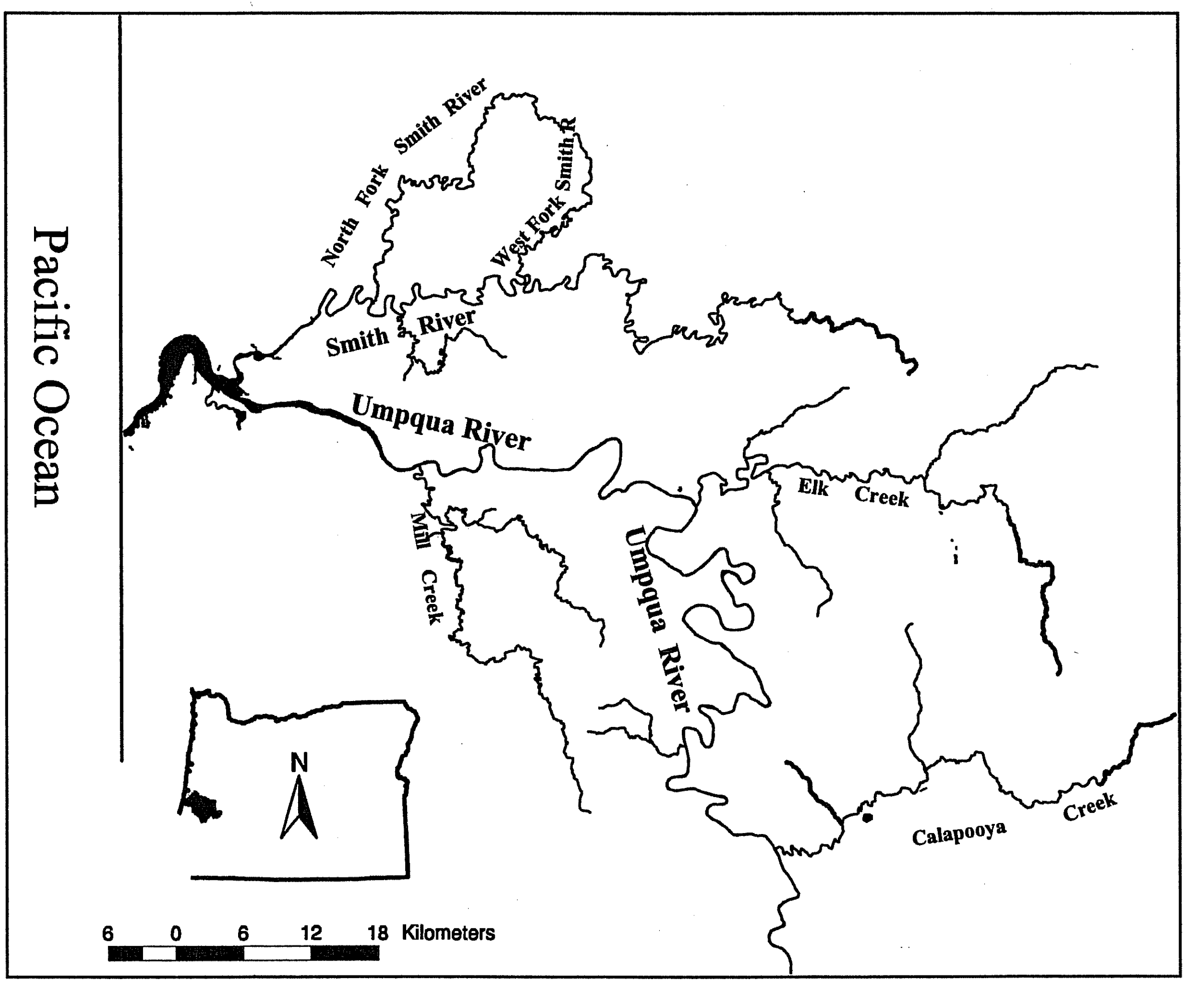

Figure 1. Map of the lower portions of the Umpqua River basin.

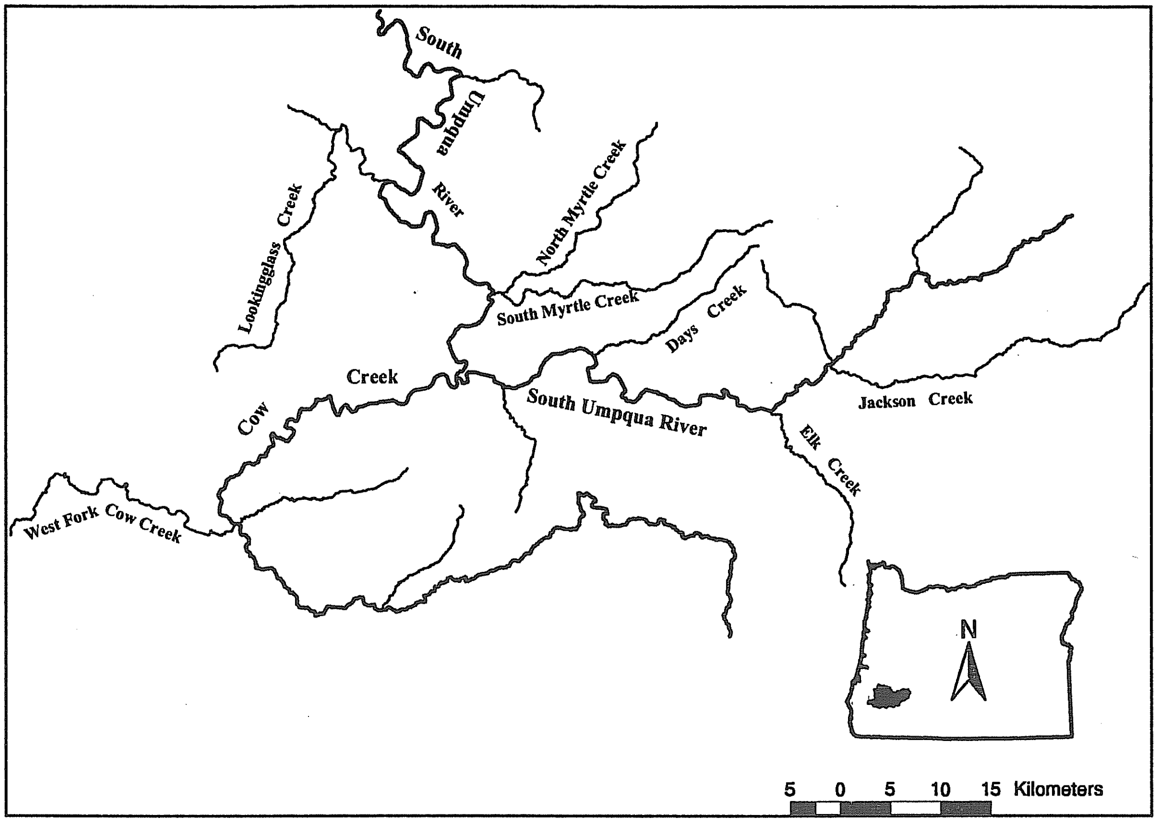

Figure 2. Map of the upper portions of the Umpqua River basin.

With the objective of elevating the Umpqua Basin to indicator stock status, a study to assess the feasibility of estimating spawner escapement to the entire the entire Umpqua River basin was completed in 2000 using LOA funds. Capture sites were found in the lower Umpqua River above tidewater but downstream of the confluence of the North and South forks. Capture techniques were developed that can likely intercepted chinook salmon in sufficient number for a successful mark recapture experiment. Effective implementation of a complete indicator stock project for the entire basin will require funding for 1) lower river capture and tagging, 2) tag recovery of fish at both the Happy Valley weir site and on the spawning grounds, and 3) a creel survey to estimate Umpqua River sport harvest. A radio tagging project will also be required to understand the distribution and migration timing of fish within the basin. These distribution and timing data help target spawning ground recovery efforts and are a pre-requisite to designing a stratified random spawner survey for the basin.

EXPERIENCE AND EXPERTISE OF KEY PROJECT PERSONEL

Dave Loomis:

Education:

BS in Fisheries Science from Oregon State University

Experience:

ODFW District Biologist: ten years

ODFW Assistant District Biologist: six years

ODFW Project Biologist: four years

Expertise Specific to this Project:

Conducted and supervised broodstock collection activities on Umpqua (14 years)

Conducted and supervised several tagging studies for fish during 20 year Career with ODFW

<u>Tom Loynes:</u>

Education:

BS in Fisheries Science from Oregon State University

Experience:

ODFW Assistant District Biologist: three years

ODFW Assistant Project Leader Ocean Salmon: two years

ODFW Experimental Biological Aide: nine years

Expertise Specific to this Project:

Conducted and supervised several tagging and age and sex sampling studies of fish during most of a twelve year career with ODFW.

<u>Jody White:</u>

Education:

BS in Fisheries Biology from University of Idaho

MS in Aquatic Ecology from University of Idaho

Experience:

ODFW PSC Field Projects Leader – two years

Aquatics Research Program Director, Xerces Society – two years

Freshwater Research Biologist, WA Dept. of Ecology – three years

Fisheries Biologist, Owner, EcoAnalysts, Inc. – four years

Expertise Specific to this Project

Conducted and supervised fisheries research projects in Oregon, Washington and Idaho for ten years. Currently responsible for Oregon's PSC coastal chinook research projects.

<u>Brian Riggers:</u>

Education:

BS in Oceanography from Humboldt State University

Experience:

ODFW Fishery Research and Monitoring Biologist - three years

ODFW Field Technician adult and juvenile salmonid sampling - six years

Expertise Specific to this Project:

Conducted and coordinated adult salmon inventories in Oregon Coastal Basins for five years. Three years experience with field crew supervision. Currently responsible for coordination of field crews for ODFW's PSC coastal chinook projects.

METHODOLOGY AND PROJECT DESIGN

The total freshwater escapement of chinook salmon in the Umpqua Basin will be estimated by a mark-recapture experiment. The calibration portion of the Oregon indicator stock program will use spawner surveys that are correlated to the escapement estimate to provide yearly and regionally derived expansion factors that will be used to adjust aggregate level spawner surveys. Currently, only limited spawner surveys are being completed for each aggregate. However, the Oregon Coastal Chinook Program plans to implement a randomized survey technique once methods have been developed.

Live Capture - Multiple Recapture

Fall chinook will be captured and tagged in the lower mainstem Umpqua River as the first capture event of a basin-wide mark-recapture experiment. Seines and entanglement nets will be used to capture fish in the lower Umpqua River following the same methods used in the 2000 feasibility project. In order to capture fish more efficiently and to alleviate handling during the freshwater to saltwater transition phase, chinook will be captured in the freshwater areas of the lower Umpqua River directly above tidal influence.

The project will run from June to October. A tagging crew will work five days a week eight hours a day to capture chinook. The crew will consist of two or three people depending on the number fish being captured. It will be necessary for the crew to work at night to minimize net avoidance by chinook and negative interactions with anglers. All fish that are captured will follow the same methods as the Happy Valley Weir (ODFW 1999). Fish will be sampled for length (FL), sex and scales. Multiple tags will be used including a single numbered floy tag, a single opercule punch, and an axillary clip.

The second capture event will use the Winchester Dam fish ladder on the North Umpqua, the floating weir at Happy Valley on the South Umpqua, and spawner surveys located in smaller tributaries. The ODFW Umpqua District operates several temporary weirs on smaller tributaries and these will also be used to collect fish.

In order to calibrate aerial counts of redds and other spawner survey estimates to actual population levels in the South Umpqua, the mark-recapture experiment will be stratified into subbasins based on radio-transmitter distributions. If, crews at lower capture site are intercepting low numbers of chinook, fish that are captured at the Happy Valley trap site (river mile 21) on the South Umpqua and will be tagged and released with another set of unique marks to ensure a South Umpqua Basin estimate. The second capture event will occur upstream of the trapping location where chinook carcasses will be inspected for tags and marks.

Spawner surveys will be initiated in October and will follow ODFW standard methods (ODFW 2000). Aerial counts of redds are conducted 2-3 times during the spawning season in late October and around the third week of November. Visibility, water flow, and weather conditions determine the exact date of each flight. During each flight all new and old chinook redds are counted and an annual index is derived as the peak number of new redds seen on all combined flights.

For the first capture (tagging) event, fish will be collected, measured for mid-eye to fork length (MEF), sex, and tagged. Collection will begin in August and continue through December as flow permits. A temporary collection structure consisting of a two-paneled floating weir and cobble berm is used to trap fish. Chinook salmon will be removed from the trap and placed into a hooded cradle for tagging, measurements, and inspection. Multiple tags will be used to assess tag loss as well as ensure accurate identification of carcasses on the spawning groups. Each fish will have a numbered-floy anchor tag and a combination of an operculum punch and removal of the axillary appendage used to help identify fish that have lost tags. Sex, length, and scales will be sampled. Each fish will be released upstream of the trap. A small percentage of chinook will be removed systematically throughout the run for hatchery brood stock. Fish collected for broodstock will include all coded wire tagged fish encountered and randomly selected fish that are not coded wire tagged.

The second capture event will consist of actively locating chinook carcasses throughout the river basin upstream of each trapping site. Since the second capture is an active sampling method, all methods necessary to locate and collect carcasses will be used. Locations of known, high-density areas of fish carcasses will be emphasized, however, all areas in the South Umpqua and Cow Creek will be sampled in order to locate fish. Surveyors will walk the smaller tributaries and use boats to survey the mainstem. Only carcasses with an intact skeleton will be used for the second capture event. All carcasses sampled will be examined for tags and fin clips, measured for length (fork) and sex, and sampled for scales.

The Chapman modification of the Petersen estimator will be used to estimate the population size of adult chinook in each river as long as all assumptions are met (Seber 1982). The assumptions for use of the Petersen estimator are:

1) all fish have an equal probability of being marked at the trap site; or,
   a) all fish have an equal probability of being inspected for marks; or,
   b) marked fish mix completely with unmarked fish in the population between events; and,
2) there is no recruitment to the population between capture events; and,
3) there is not trap induced behavior; and,
4) fish do not lose their marks and all marks are recognizable.

From data taken in 1998-2000 mark-recapture projects, assumptions 1 and 2 probably will not be met during the 2001 sampling season. The proportion of chinook marked at the trap sites varied wildly due to varying flow conditions and trap inefficiencies. The same held true on the spawning grounds for carcass collection. However, information about size and age selectivity during the two capture events can be estimated through a battery of tests (Appendix A) to determine if further stratification of the data set is appropriate to meet the assumptions. If age and size selectivity is not found then the population can be assumed to not have size/sex bias; but, as shown in 1998, 1999, and 2000 projects, the data will probably need to be stratified by at least size. Assumption 3 will be estimated if data from the spawning grounds are stratified by area and/or time. If there is area/time stratification for the second capture event, the ratios of marked to unmarked fish will be compared between strata. Chi-square analysis will be used to determine if there are significant differences between the strata. If differences are found, alternative estimators (e.g. Darroch 1961) will be used.

Assumptions 4 and 5 do not apply to this situation. Only adult chinook salmon migrating upstream of the trap sites will be used in the mark-recapture study and recruitment to the population is not possible. The second capture event is an active sampling technique to collect carcasses within the spawning areas upstream of the trap sites and trap induced behavior will not occur. However, for the first event, behavior can occur and this is estimated as discussed above for age/sex selectivity.

Tag loss (assumption 6) will be minimized through the use of multiple tags. We will assume all tags will be seen on fish if present and that at least one of the tags will be observed if a fish was captured in the first event. The redundant application of floy tags, opercule punches, and axillary clips should insure that trained field crews will identify marked individuals among all fish observed.

A bootstrap technique will be use to estimate variance, bias and confidence intervals of the population estimate (Buckland and Garthwaite 1991, Mooney and Duval 1993). The fate of chinook that pass by each trapping facility will be divided into several capture histories to form an empirical probability distribution as follows:

1. marked and harvested in fishery,
2. marked and were captured out of the experiment area,
3. marked and recaptured on the spawning grounds,
4. marked and never seen again,
5. unmarked and inspected on the spawning grounds, and
6. unmarked and never seen.

Sample Size

At this time, the number of spawning chinook salmon in the Umpqua Basin in 2000 is unknown because Umpqua basin and South Umpqua mark-recapture projects are still in progress. The South Umpqua chinook spawning escapement estimate for 1999 was 1,104 (19% relative precision). Two hundred twenty-eight chinook were tagged at Happy Valley and 232 (21% tagging rate) carcasses were collected of which 60 were tagged. The 2001 chinook run has not been forecasted however it is assumed that it will be as large or larger than the 1999 estimate. The effort expended in 1999 was sufficient to collect the sample size needed to reach the target precision of 25%. Since the objective is to tag and collect scales from every chinook sampled, a projected sample size has not been estimated.

Spawner Surveys

Due to time and budgetary constraints, most river basins cannot be surveyed in their entirety and a sample of sites must be selected. Depending on the estimator of interest, this sample of sites should be selected randomly and systematically surveyed. Several factors, including budgetary constraints, will determine the number of reaches surveyed, the expected sampling accuracy of the proposed estimators (if known), the number of personnel, and the number of available spawning reaches. A sampling frame of all possible spawning locations will be developed from a database that has been developed by ODFW, the U.S. Forest Service, and the U.S. Bureau of Land Management. From this sampling frame, a stratified random sample of survey locations will be taken following the ODFW Stratified Random Survey (SRS) protocols (Jacobs and Nickelson 1998; ODFW 1998). All chinook spawner surveys will be conducted according to the ODFW spawner survey protocol (ODFW 2000). Several factors will determine the number of reaches surveyed including the expected sampling accuracy of the estimator, the number of personnel, and the number of available spawning reaches. Periodic spawning surveys will be conducted as systematically as possible throughout span the length of the fall chinook spawning season. In sampled reaches, surveyors will count the number of fish, dead or alive, and redds. Surveys will be conducted by raft or kayak and by foot depending on stream size.

Radio-Tracking

During other Oregon mark-recapture projects, radio transmitters have been used successfully to provide valuable information about different races returning to the rivers as well as the residence time and final migratory route of the tagged. We propose to incorporate radio telemetry into the Umpqua project. Transmitters will be placed in chinook captured in the lower river net operations. Up to 100 transmitters will be used if available from other projects. Two fixed stations will be used to record migration timing and every two weeks, one surveyor will also drive the river basin locating fish to determine the extent of upstream movement.

Transmitters will be placed into the esophagus of each adult without the use of anesthetics and then released. Fish to be tagged will be selected by a systematic sample with a random start. Every tenth fish will have a transmitter placed, starting with the second fish captured. Only healthy fish will be tagged.

Seven-volt, digitally encoded ATS ® radio transmitters will be used. Each transmitter weighs 13 g in water and is 16 X 83 mm in dimensions with a 30 cm whip antennae and a battery life of 265 days. Each fixed station will have a Lotek ® SRX-4000 receiver with two directional Yagi antennas to monitor movement of tagged chinook. One antennae will be pointed upstream of the fixed station and the other antennae pointed downstream to determine each chinook's direction of movement.

Genetic Analysis

ODFW, with assistance from chinook salmon genetics personnel with the National Marine Fisheries Service (NMFS) in Seattle, WA, initiated a DNA tissue survey during 2000 for the Umpqua Basin as well as all other coastal chinook stocks. Tissues are archived at the Newport ODFW office. All handled chinook in the Umpqua Basin in 2001 will have a rayed-fin clipped and stored in ethanol for future analysis. A subset of chinook will have tissues taken for allozyme (protein) analysis. Fifty to 100 chinook will be sampled from broodstock at Rock Creek Hatchery. Allozyme tissues will be stored in Newport in a ultra-cold freezer.

Age Composition Sampling

Scales will be collected from all live chinook tagged and from all unmarked carcasses examined for tag recovery. Since all fish captured or examined for tag recovery will be sampled, expected sample sizes are not calculated. Four to five scales will be taken from each fish. Ages will be determined at the Corvallis, OR research lab using ODFW standard methods.

Creel Survey

Sport caught chinook salmon in the Umpqua River will be estimated from data collected by a stratified random, multi-stage creel survey conducted from July 1, 2000 until November 30, 2000. Depending on the angler type, a roving-access survey or a roving-roving survey design will be employed (Pollock et al. 1994). In roving surveys, a surveyor will move or "rove" through a fishing area making angler or boat counts to determine effort (pressure counts) then conduct angler interviews. Roving-access surveys are used when most anglers are concentrated at numerous, known locations (e.g. boat launches) and anglers are interviewed as they leave an area upon completion of fishing. However, with roving-roving style surveys, anglers are not concentrated at known locations (bank anglers) and a surveyor moves through the fishery interviewing anglers while they are still fishing.

The creel survey will be stratified by catch area (two: upper and lower river), month, day (weekend, weekday), and angler type (bank or boat). Anglers will be separated into two groups, private anglers and guided anglers, and post-stratified if catch rates are found to differ. Angler interviews will include the number of hours fished, number of anglers in the boat or on shore, the number of salmonids by species caught or released, and residency of the angler. All data will be entered into hand-held electronic dataloggers. All fish that are checked will be sampled for scales, length, sex, and the number and types of fin marks. If an adipose fin is missing a "detection wand" will be used to determine if a coded wire tag is present. If present, the snout will be removed for future tag decoding.

Both boat and bank anglers will be interviewed on the mainstem Umpqua River. Chinook harvest is not allowed on the South Umpqua River. Survey timing will begin in early to mid-July and continue through November, depending on water conditions and angling effort. Four surveyors will be used to sample the two catch areas. Each catch area will have one surveyor work the morning shift and one surveyor work the evening shift to ensure all angling hours are sampled.

Angling effort or pressure counts will be conducted by driving the river in each catch area and counting all people fishing and will occur at three intervals spaced equally throughout the day. Pressure counts will take ~1 hour and are considered instantaneous. Once the pressure count is complete, the surveyor will interview anglers until the next scheduled pressure count. Interviews of non-anglers in the catch area will also occur in order to estimate the use by non-anglers to appropriately adjust the effort count. The roving surveyor will also sample boats at boat launches when they have completed fishing. Effort will be determined by counting trailers at each boat launch during the bank angler pressure count.

Creel Data Analysis

The Umpqua River creel survey is stratified by month, catch area, and angler type (shore or boat). Depending on harvest rates, anglers could be further post-stratified into private trips and guided trips. Data analysis procedures for post-stratification of private and guided trips will follow Bernard et al. (1998) if harvest rates differ significantly between the trip types. Missing data points from surveyor illness or equipment failures will be treated as random events and removed from the sampling frame. Bernard et al. (1998) describes several other events which must be taken into account during analysis that can bias harvest estimates including 1) zero interviews, but angling effort was counted, 2) zero harvest rate, but effort was counted, and 3) very low (1-2) numbers of interviews but with harvest. If any of these situations are encountered and deemed to bias the data-set, the data will be treated as missing data points and the substituted values derived from methods described in Bernard et al. (1998) and Guthrie et al. (1991).

<u>Roving-Access Survey:</u> Harvest will be determined separately for kept fish and for released fish. Estimated harvest per sample day in a particular stratum is (Pollock et al. 1994, Bernard et al. 1998):

$$\hat{H}_i = \hat{E}_i \overline{cpue}_i,$$

where:

i denotes sampling days,
$\hat{E}_i$ = estimated effort, and
$\overline{cpue}_i$ =average catch per unit.

Because the roving-access surveys only interview completed angler trips, average catch per unit effort is estimated as the ratio of means (Hoenig et al. 1997):

$$\overline{cpue}_i = \frac{\sum_{k=1}^{m_i} h_{ik}}{\sum_{k=1}^{m_i} e_{ik}}, \text{ where,}$$

k denotes individual anglers,
m denotes the number of anglers interviewed,
h is the number of fish caught during fishing trips that were interviewed, and
e is the length in hours of fishing trips of interviewed anglers.

Variance of cpue is estimated as (Bernard et al. 1998):

$$v(\overline{cpue}_i) = \frac{\sum_{k=1}^{m_i} \left(h_{ik} - e_{ik}\overline{cpue}_i\right)^2}{\overline{e}_i^2 m_i (m_i - 1)}.$$

Fish harvested per catch/month strata equals:

$$\hat{H} = D\frac{\sum_{i=1}^{d} \hat{H}_i}{d} \text{ where,}$$

d = number of sampled days in stratum, and
D = total available sampling days in stratum.

Daily effort is estimated as:

$$\hat{E}_i = T\frac{\sum_{t=1}^{r} x_{it}}{r} \text{ where,}$$

t denotes the individual roving count of anglers,
r = number of pressure counts per day, and
T = the length of the sampling period (usually day length).

Since effort is determine systematically and not randomly the variance equation is (Wolter 1985):

$$v(\hat{E}_i) = T^2 \frac{\sum_{t=2}^{r} \left(x_{it} - x_{i(t-1)}\right)^2}{r^2(r-1)}.$$

The variance of the daily harvest is (Goodman 1960 as cited by Bernard et al. 1998):

$$v(\hat{H}_i) = \hat{E}_i^2 (\overline{cpue_i}) + \overline{cpue}_i^2 v(\hat{E}_i) - v(\overline{cpue_i}) v(\hat{E}_i),$$

and the variance for each catch/month stratum is:

$$v(\hat{H}) = D(D-d)\frac{s_1^2}{d} + \frac{D}{d}\sum_{i=1}^{d} v(\hat{H}_i), \qquad \textit{where}$$

$$s_1^2 = \frac{\sum (\hat{H}_i - \overline{\hat{H}})^2}{d-1}.$$

Total harvest is the sum of all catch in each strata and the total variance of the catch is the sum of all strata variances (Pollock et al. 1994).

Roving-Roving Surveys: The only difference in estimation between the roving – roving survey and the roving – access survey is the catch per unit effort (*cpue*) estimator. With roving surveys anglers are interviewed that have not completed fishing and the mean of ratios estimator should be used (Pollock et al. 1994).

$$\overline{cpue}_i = \frac{\sum_{k=1}^{m_i} \frac{h_{ik}}{e_{ik}}}{n}, \text{ where,}$$

k denotes individual anglers,
m denotes the number of anglers interviewed,
h_{ik} is the number of fish caught for an interviewed angler,
e_{ik} is the length in hours fished for an interviewed angler, and
n is the number of interviews for each day i.

The variance is calculated as (Jones et al. 1995):

$$v(\overline{cpue}_i) = \frac{\sum_{k=1}^{m_i} e_{ik}\left(\frac{h_{ik}}{e_{ik}} - \overline{cpue}_i\right)^2}{m\sum_{i=1}^{m} e_{ik}}.$$

DEPENDENCE OF THE PROJECT UPON RELATED PROJECTS

ODFW's Roseburg District personnel will provide assistance in capturing fish at other temporary weirs and ODFW project sites in the Umpqua Basin as well as in the fish ladder at Winchester Dam on the North Umpqua River.

REQUIRED PERMITS

We will be working closely with the National Marine Fisheries Service to obtain any permits that may be needed in association with ESA status of some coastal salmonid populations. Permission from landowners will be needed to access streams adjacent to private property.

PROPOSED DURATION OF PROJECT

This is the first year of the Umpqua River Escapement Indicator Stock Project. It will continue for the duration of the Pacific Salmon Treaty agreement. We are currently searching for funding to continue the project in the event that CTC LOA funds are terminated. The radio-tracking portion will continue for 1-2 years.

TIME LINE

June 1-30:	complete sampling plan incorporating results of 1999 study; recruit and hire field staff; buy nets and associated equipment.
July 1-September 31:	initiate creel survey and tagging in lower Umpqua River.
September 31-January 1:	begin trapping at the Happy Valley weir, conduct spawner surveys in the South Umpqua and Cow Creek, and complete aerial flights in October and November.
January 1- February 28:	complete data entry, begin data analysis.
1 March-30 April 31:	complete data analysis, draft technical progress report, and distribute report draft for review.
May 1-31:	Revise, print and distribute technical progress report.

PROPOSED BUDGET

Type	Description	Number	Amount	Rate	Total	Sum
Personnel	Classification	Persons	Months	Rate	Total	**$135,747**
Project Leader	NRS 3 Step 5		5	$ 3,580.00	$17,900	
Project Asst. Leader	NRS 2 Step 4		5	$ 2,746.00	$13,730	
Crew Leaders	EBA - Step 4	1	6	$ 1,729.92	$10,380	
Field EBA's	EBA - Step 2	8	33	$ 1,587.12	$52,375	
Scale Technician	FWT-3 Step 1	1	0.25	$ 2,063.46	$ 516	
Data Entry	EBA - Step 2	1	1	$ 1,587.12	$ 1,587	
OPE for Full Time				38%	$12,019	
OPE for Seasonals				42%	$27,240	
Travel	4x4 Pickups	7	34	$ 270.00	$ 9,180	**$ 14,960**
	Mileage	1000	34	$ 0.17	$ 5,780	
Equipment	Transmitters		50	$ 150.00	$ 7,500	**$ 7,500**
Supplies	Nets and Accessories		6	$ 300.00	$ 1,800	**$ 7,370**
	Tags		1.5	$ 420.00	$ 630	
	Boat Accessories		1	$ 300.00	$ 300	
	Boat Maintenance		1	$ 400.00	$ 400	
	Tagging Accessories		2	$ 150.00	$ 300	
	Waders		4	$ 135.00	$ 540	
	Rain Gear		8	$ 75.00	$ 600	
	Telemetry Station Acc.		2	$ 200.00	$ 400	
	Capture Site Set-up		1	$ 500.00	$ 500	
	Supplies		1	$ 1,900.00	$ 1,900	
Direct						**$165,577**
Indirect					**20.6%**	**$ 34,109**
Total						**$199,686**

LITERATURE CITED

Boydstun, LB 1994. Analysis of two mark-recapture methods to estimate the fall chinook salmon (*Oncorhynchus tshawytscha*) spawning run in Bogus creek, California. Calif. Fish and Game 80(1):1-13.

Buckland, S.T. and P.H. Garthwaite. 1991. Quantifying Precision Of Mark-Recapture Estimates Using Bootstrap And Related Methods. Biometrics 47:255-268.

Goodman, L. A. 1960. On the exact variance of products. Journal of the American Statistical Association 55:708-713.

Henry, K. A., A. R. Morgan, and R. L. Rulifson. 1950. The Salmon Catch of the Sport Fishery on the Coastal Rivers of Oregon in 1949. Fish Commission Research Briefs, Fish Commission of Oregon, 2(2):33-38. Portland, OR.

Jacobs, S.E. and Cooney, C.X. 1997. Oregon coastal salmon surveys. Oregon Department of Fish and Wildlife, Ocean Salmon Management Information Report, Portland.

Jacobs, S.E. and T.E. Nickelson 1998. Use of Stratified Random Sampling to Estimate the Abundance of Oregon Coastal Coho Salmon. Final Report Oregon Department of Fish and Wildlife, Portland.

Mooney, C.V. and R. D. Duvall. 1993. Bootstrapping: A Non Parametric Approach To Statistical Inference. Sage Publications, Newbury Park, CA, 73 p.

Law, P.M. 1994. Simulation Study Of Salmon Carcass Survey Capture-Recapture Methods. California Fish and Game 80(1):14-28.

ODFW (Oregon Department of Fish and Wildlife), 1998. Coastal Salmon Spawning Survey Procedures Manual. Coastal Salmon Inventory Project, Corvallis.

Schwartz, C. J., R. E. Bailey, J. R. Irvine, and R. C. Dalziel. 1993. Estimating Salmon Spawning Escapement Using Capture-Recapture Methods. Canadian Journal of Fisheries and Aquatic Science 50: 1181-1197.

USCTC, 1997. A Review of Stock Assessment Data and Procedures for US Chinook Salmon Stocks. Report of the Pacific Salmon Commission U.S. Chinook Technical Committee. USTCCHINOOK (97-1). Pacific Salmon Commission, Vancouver. BC. Canada.

Wolter, K.M. 1985. Introduction to varience estimation. Springer-Verlag, New York.

Zhou, S. and R. Williams. 1999. Stock and Recruitment Analysis and Escapement Goals for Nehalem River Fall Chinook. Oregon Department of Fish and Wildlife, Portland Oregon. Information Report 99-4.

Zhou, S. and R. Williams. 2000. Escapement Goals for Siletz River and Siuslaw River Fall Chinook Based on Stock and Recruitment Analysis. Oregon Department of Fish and Wildlife, Portland Oregon. Information Report 2000-04.

APPENDIX A. Detection of size-selectivity in sampling and its effects on estimation of size composition [taken from Bernard 1991].

Results of Hypothesis Tests (K-S and χ^2) on lengths of fish MARKED during the First Event and RECAPTURED during the Second Event	Results of Hypothesis Tests (K-S and χ^2) on lengths of fish CAPTURED during the First Event and CAPTURED during the Second Event
Case I:	
"Accept" H_0	"Accept" H_0
There is no size-selectivity during either sampling event.	
Case II:	
"Accept" H_0	Reject H_0
There is no size-selectivity during the second sampling event but there is during the first.	
Case III:	
Reject H_0	"Accept" H_0
There is size-selectivity during both sampling events.	
Case IV:	
Reject H_0	Reject H_0
There is size-selectivity during the second sampling event; the status of size-selectivity during the first event is unknown.	

Case I: Calculate one unstratified abundance estimate, and pool lengths, sexes, and ages from both sampling events to improve precision of proportions in estimates of composition.

Case II: Calculate one unstratified abundance estimate, and only use lengths, sexes, and ages from the second sampling event to estimate proportions in compositions.

Case III: Completely stratify both sampling events, and estimate abundance for each stratum. Add abundance estimates across strata to get a single estimate for the population. Pool lengths, ages, and sexes from both sampling events to improve precision of proportions in estimates of composition, and apply formulae to correct for size bias to the pooled data .

Case IV: Completely stratify both sampling events and estimate abundance for each stratum. Add abundance estimates across strata to get a single estimate for the population. Use lengths, ages, and sexes from only the second sampling event to estimate proportions in compositions, and apply formulae to correct for size bias to the data from the second event.

Section IIC

Coquille River Escapement Indicator Stock Feasibility Study

CHINOOK SALMON FUNDING PROPOSAL

SUBMITTED TO:

Pacific Salmon Commission's Chinook Technical Committee (US Section)
for Funding under the Letter of Agreement (LOA)

PROJECT TITLE:

Coquille River Escapement Indicator Stock Feasibility Study
(New Project)

REQUESTING AGENCY:

Oregon Department of Fish and Wildlife
Marine Resources Program
2040 SE Marine Science Dr.
Newport, Oregon 97365

PERIOD COVERED:

1 June 2001 through 31 May 2002

FEDERAL FUNDING REQUEST:

$ 102,367

Principle Investigators:

Jody White, Pacific Salmon Treaty Field Projects Coordinator, Newport, OR
Brian Riggers, Research and Monitoring Biologist, Newport, OR

OBJECTIVES

The Coquille River chinook stock as a candidate escapement indicator stock for the mid-Oregon Coastal Aggregate (MOC). For a river to be designated as an indicator stock for either the North Oregon Coast (NOC) or MOC aggregates, three components are necessary: 1) an existing or planned biologically based escapement goal, 2) a precise annual estimate of freshwater escapement, and 3) a less precise annual spawner estimates from a random survey design that can be correlated to the more precise estimate.

The goal of the Coquille River Escapement Indicator Project is to develop methods for precisely estimating the age specific escapement of adult chinook salmon to the Coquille River and to annually update a brood-year run reconstruction for that stock in partial fulfillment of the requirements for and escapement indicator stock.. These data will augment the stock recruitment analysis that is underway to estimate the biologically based escapement goal for the basin, they will permit post season assessment of management success at meeting escapement goals, and they will enable managers to calibrate escapement estimates in the Coquille and other MOC basins that are based on less precise random survey methodologies. In keeping with this goal, the specific objectives of the project are to:

1. estimate the total escapement of adult chinook salmon in Coquille River in 2001 such that the estimate is within ± 50% of the true value 95% of the time, and
2. estimate the age and sex composition of chinook salmon spawning in 2001 in the Coquille River such that all estimated fractions are within ± 0.05 of their true values 95% of the time

RELATIONSHIP AND SIGNIFICANCE TO IMPLEMENTING ABUNDANCE-BASED MANAGEMENT OF CHINOOK SALMON IN PSC FISHERIES AND IDENTIFIED CTC-LOA RESEARCH THEMES

Most of Oregon's coastal chinook stocks migrate into fisheries governed by the Pacific Salmon Treaty (PST). Chinook management under the original 1985 PST was quota based. Co-managers were only required to provide information for stocks under their jurisdiction that was adequate to assess long term spawning escapement trends. In contrast, under the terms of Aggregate Abundance Based Management (AABM) in the new 1999 treaty, fisheries are managed for harvest rates. Harvest rates are adjusted annually based upon annual pre-season projections of ocean abundance for stock aggregates and post-season assessments of management success relative to achieving scientifically defensible biological escapement goals that insure sustainable production for both domestic and mixed stock ocean fisheries.

Escapement indicator and exploitation rate indicator stocks are two key features of AABM. They are needed to make the required preseason forecasts of abundance and distribution for stock aggregates. They also provide post season measures of management success. Both types of indicator stocks are selected to represent much larger stock aggregates. Among coastal chinook stocks in Oregon, NOC and MOC are the two stock aggregates that contribute significantly to PST fisheries. Escapement indicator stocks are typically selected to represent much larger stock aggregates based upon geographic, habitat, genetics, and life history characteristics as well the extent of the historic data available. The PSC Chinook Technical Committee (CTC) is responsible for reviewing biological escapement goals that co-managers submit for indicator stocks and for assessing the scientific rigor of escapement and exploitation rate monitoring programs.

Chapter 3, Section 9 specifies trigger mechanisms to adjust catch when escapement goals of indicator stocks are not being met. If two or more indicator stocks within an aggregate are considered depressed, harvest reductions within the North Pacific fisheries are triggered. In the case of Oregon stocks for example, if spawning escapement goals are not achieved for two or more individual indicator stocks within either the NOC or MOC two consecutive years, then that stock aggregate will be considered depressed. The PSC can determine the status of the NOC and MOC only if Oregon provides defensible biological escapement goals and accurate and precise annual escapement estimates for indicator stocks designated for each aggregate. Hence, as consequence of the new agreement, Oregon must improve its escapement monitoring to provide the levels of accuracy and precision required by the CTC to satisfy the Section 9 assessment of escapement and to provide reliable abundance forecasts for setting harvest rates in the next fishing season.

The Oregon Department of Fish and Wildlife (ODFW) has selected the Nehalem, Siletz, and Siuslaw rivers as escapement indicator stocks for the NOC, has completed stock recruitment analyses for these stocks, and has estimated biological escapement goals for them that have been approved by the CTC. The Coquille and Umpqua rivers have been selected as potential indicator stocks for the MOC. ODFW is still completing the stock recruitment analyses that will be used to estimate biological escapement goals for these two stocks. Ideally, ODFW will eventually implement intensive monitoring programs to precisely estimate freshwater harvest and spawning escapement in all five of these rivers. In the interim, we have proposed detailed monitoring programs for one NOC stock and two MOC stocks.

In order to implement the PST's Chinook Annex, an additional indicator stock must be developed and the feasibility of an accurate escapement estimate that meets CTC data standards needs to be assessed for the Coquille River chinook stock. Currently, ODFW is only investigating improving the escapement estimate in one MOC indicator stock, the Umpqua River. The proposed project, "Coquille River Escapement Indicator Stock Feasibility Study", directly relates to the U.S. CTC research theme of "Increase Number of Escapement Indicator Stocks" under the sub-heading "Feasibility of development of a second MOC indicator stock besides the Umpqua".

BACKGROUND

Natural coastal chinook stocks from four rivers along the mid-coast are grouped in the MOC stock aggregate for rebuilding assessment and CTC modeling. One of the major populations within this aggregate of stocks is from the Coquille River that is composed of four major tributaries, the South, North, East and Middle Fork (Figure 1). The mainstem downstream of the convergence of the North Fork and South Fork Coquille River at river mile 36.3 is entirely tidal. The head of tide is located on the South Fork Coquille River near the confluence with the Middle Fork at river mile 41. The Coquille is the largest of all Oregon's rivers originating only in the coastal range and drains an area of approximately 1,058 square miles. Median monthly discharges at the mouth of the Coquille River range from less than 100 cfs during the summer months to 7,600 cfs in January.

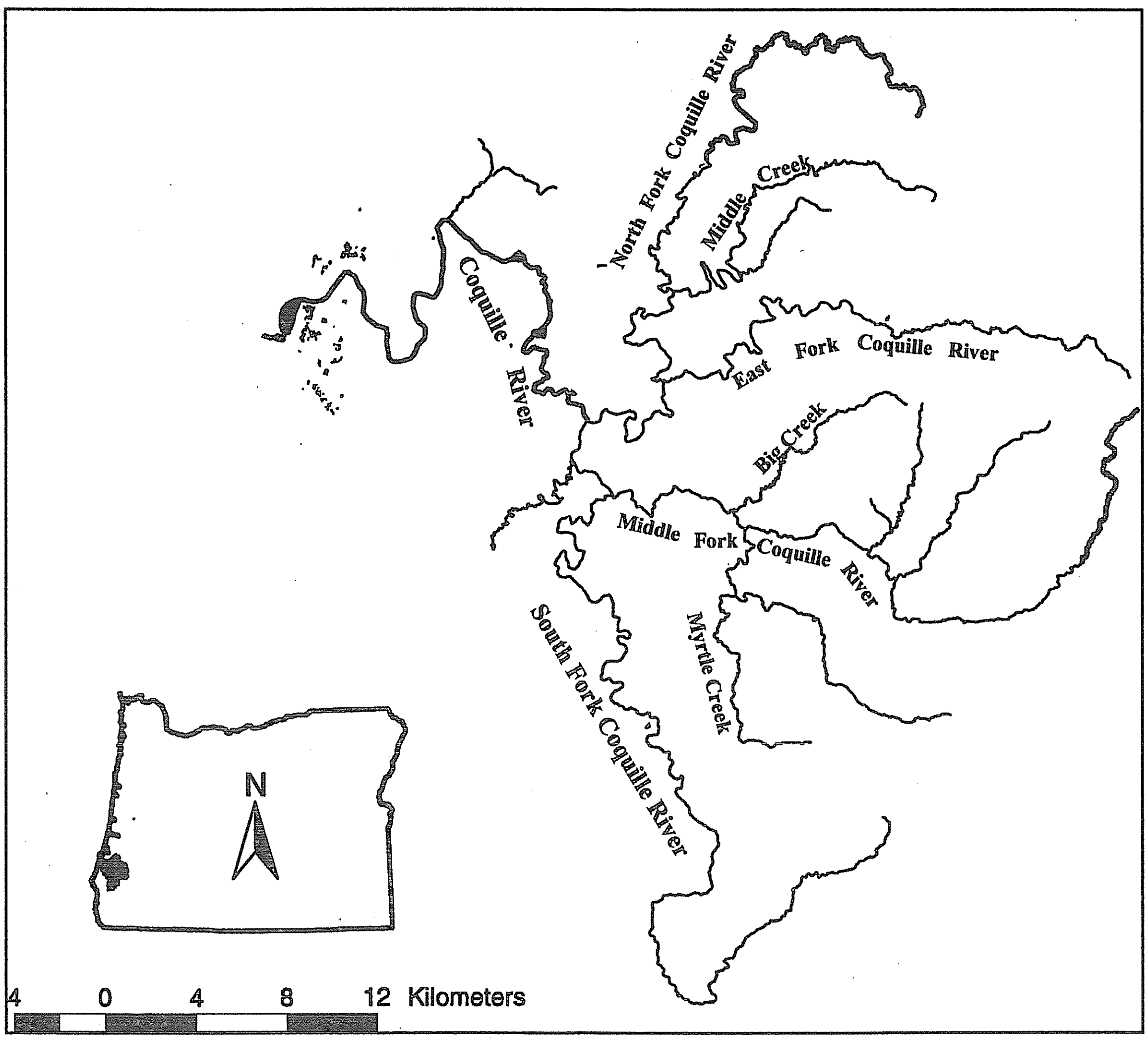

Figure 1. Map of the Coquille River basin.

Nicholas and Hankin (1988) classify Coquille River chinook salmon as mid-maturing, or Age-4 dominant. The majority of Coquille chinook are considered to be fall run fish, however a small spring run exists. The spawning escapement is cursorily monitored by ODFW at two PSC funded standard survey sites. Peak counts from these standard sites gathered since 1957 suggests that chinook abundance has increased. No abundance estimates are available for the river and district biologists assume that 6,000-10,000 chinook return annually to the river. Historically, between 1,000 – 19,000 chinook were commercially harvested in the Coquille estuary (Nicholas and Hankin 1988). Releases of hatchery chinook in the Coquille River have been relatively modest compared to other coastal basins. In the last few years, volunteers funded by ODFW's Salmon Trout Enhancement Program have released small numbers of fingerlings in the mainstem.

With the objective of elevating the Coquille Basin to indicator stock status, an evaluation of the feasibility of estimating the spawner escapement is required before full implementation of the project is warranted. ODFW needs to assess how to capture fish in the lower Coquille River and perform the subsequent recapture. If successful, a basin-wide escapement estimate and a creel survey will be used to reconstruct the Coquille River fall chinook freshwater escapement.

EXPERIENCE AND EXPERTISE OF KEY PROJECT PERSONEL

Jody White:

Education:

BS in Fisheries Biology from University of Idaho

MS in Aquatic Ecology from University of Idaho

Experience:

ODFW PSC Field Projects Leader – two years

Aquatics Research Program Director, Xerces Society – two years

Freshwater Research Biologist, WA Dept. of Ecology – three years

Fisheries Biologist, Owner, EcoAnalysts, Inc. – four years

Expertise Specific to this Project

Conducted and supervised fisheries research projects in Oregon, Washington and Idaho for ten years. Currently responsible for Oregon's PSC coastal chinook research projects.

Brian Riggers:

Education:

BS in Oceanography from Humboldt State University

Experience:

ODFW Fishery Research and Monitoring Biologist - three years

ODFW Field Technician adult and juvenile salmonid sampling - six year

Expertise Specific to this Project:

Conducted and coordinated adult salmon inventories in Oregon Coastal Basins for five years. Three years experience with field crew supervision.

Currently responsible for coordination of field crews for ODFW's PSC coastal chinook projects.

METHODOLOGY AND PROJECT DESIGN

The total spawning escapement of chinook salmon in the Coquille Basin will be estimated by a mark-recapture experiment. The temporal and spatial distribution of spawners in the basin will be estimated using radio telemetry, genetic samples from spawner carcasses will augment the historic genetic stock structure database, and the age composition of the spawning escapement will be estimated from scale samples.

Live Capture - Multiple Recapture

A stratified Petersen mark-recapture experiment will be used to estimate chinook escapement. Based upon the large numbers of tributaries in the basin and the assumption that the run is protracted, it will probably be necessary to partition recovery areas into several geographic and temporal strata. Chinook move into the Coquille Bay from July to December and the relationship between time in the bay and freshwater entry date is not known. It is considered impractical and prohibitively expensive to install and operate a weir on the mainstem Coquille, hence, seines and entanglement nets will be required to capture fish. ODFW has netted extensively for broodstock collection in the mainstem Coquille River in the past and the district biologist has located several netting sites in the upper tidewater area and lower river that fall chinook are known to hold in while waiting to move upstream. To alleviate handling during the freshwater to saltwater transition phase only sites upstream of tidal saltwater intrusions were selected.

It will be necessary to work at night to minimize net avoidance by chinook and negative interactions with anglers. All captured chinook will have length measured (FL), sex and scales sampled, and tagged. Multiple tags will be used to ensure all marked fish are recognized in the subsequent recapture event - a single, numbered anchor tag will be placed on the left side of the dorsal fin, the operculum punched, and one axillary appendage will be removed.

The second capture event will consist of recovering tagged chinook on the spawning grounds. All fish will be sampled for length (posterior orbit of the eye to the hypural plate), scales and sex, and checked for marks. Each fish will only be sampled once. Recovery will start in the upper river spawning areas and tributaries in late September, depending on rain, and continue until fish are no longer observed. Surveyors will use both foot and boat surveys to locate carcasses. The feasibility of using additional methods to collect fish will also be assessed including but not limited to carcass weirs, netting or seining, and diving.

Analysis methods for the stratified Petersen estimate will follow the descriptions in Arnason, et al. (1996) and Schwarz and Taylor (1998) and use the program SPAS (Stratified Population Analysis System). The usual assumptions for use of the pooled Petersen estimator are:

1. all fish have an equal probability of being marked at the trap site; or,
2. all fish have an equal probability of being inspected for marks; or,
3. marked fish mix completely with unmarked fish in the population between events; and,
4. there is no recruitment to the population between capture events; and,
5. there is not trap induced behavior; and,
6. fish do not lose their marks and all marks are recognizable.

However, when using the stratified estimator these assumptions are expanded to include:

7. all fish have a non-zero probability of being found in the recovery strata and all fish in the recovery strata were present in one of the initial capture strata;
8. there is no tag loss - if there is tag loss the assignment of the probability of losing tags must be assigned proportionally to the distribution of initial strata tags in the marked recoveries; and,
9. all tagged and untagged fish in each recovery stratum have equal probability of being sampled.

Additionally, all tagged fish released in each capture area have the same probability of movement to the recovery strata and tagged as well as untagged fish move with the same probability distribution.

Information about size and age selectivity during the two capture events can be estimated through a battery of tests (Appendix A) to determine if further stratification of the data set is appropriate to meet the assumptions. If age and size selectivity is not found then the population can be assumed to not have size/sex bias. It is assumed that netting will bias the first capture event towards larger fish. If multiple techniques are used to capture fish in the second event it is unlikely that it will be biased. However, it is very likely that only Assumption 3 (of the first three assumptions) will be met. To estimate if random mixing of marks occurs both geographically and temporally, the ratios of marked to unmarked fish will be compared between strata. Chi-square analysis will be used to determine if there are significant differences between the strata.

Assumptions 4, 5, and 7 do not apply to this situation. Only adult chinook salmon migrating upstream of the capture site will be used in the mark-recapture study and recruitment to the population is not possible. The second capture event is an active sampling technique utilizing multiple capture techniques to collect tags within the spawning areas upstream of the trap sites and trap induced behavior will not occur. However, for the first event, behavior can occur and this is estimated as discussed above for age/sex selectivity.

Tag loss (assumption 6 and 8) will be zero through the use of multiple tags. Specifically, we will employ an opercular punch, axillary appendage removal, and a single-numbered anchor tag to insure that trained field crews do not overlook marked fish. Based upon results from 1999 and 2000 field projects, when multiple tags were also applied, at least one of the multiple tags was observed if a fish was tagged. We will assume all tags will be seen on fish if present and that at least one of the tags will be observed if a fish was captured in the first event.

A pooled Petersen estimator may be used if either of the two following conditions are met:

3. the recovery probabilities are similar between all strata; or,
4. the tagged to untagged ratios are constant between recovery strata.

The tests for condition one or two will follow Arnason et al. (1996). Condition 1 requires a non-significant result from a chi-square test of a 2 by s matrix (the number of tagging strata) with rows filled in by $m_{i.}$ and u^c_{i}. Condition 2 requires a non-significant result from a chi-square test of a 2 by t matrix (the number of recovery stratum) with rows filled by $m_{.j}$ and u^r_{j}.

$m_{i.}$= number of fish tagged in capture stratum i
$m_{.j}$= number of fish tagged captured in stratum j
u^r_j =, recovered the number of unmarked fish in the sample in recovery stratum j
u^c_i = the number of fish tagged in capture stratum i and are never seen

Estimation of variance and associated confidence intervals for the stratified Petersen estimator will follow Arnason et al. (1996). If suggested by the CTC, alternative estimators for variance and confidence intervals will be used (e.g. bootstrap method). For the pooled Petersen estimator, a bootstrap method will be use to estimate variance, bias and confidence intervals of the population estimate (Buckland and Garthwaite 1991, Mooney and Duval 1993).

Sample Size

No population size estimates are available for Coquille River chinook. We will use the district biologist's intuitive guess of 6,000-10,000 fish. ODFW has collected an average of 270 carcasses over the last 15 years in the standard survey reaches. Also, Bureau of Land Management and U.S. Forest Service field crews collect ~100 carcasses per year. Using our additional field personnel, ~800 carcasses could be recovered on an average year. ODFW has had considerable experience collecting broodstock in the mainstem Coquille River and after discussion with the district biologist, 400-600 tagged fish is assumed to be reasonable. An estimate 40 – 65 tagged carcasses would need to be collected to achieve a 25% precision, the precision goal for an indicator stock escapement estimate. Considering the uncertainty of a feasibility study, we propose a 50% precision goal.

Radio-Tracking

The use of radio transmitters has provided past projects with valuable information on the different chinook stocks returning to river, as well as helping to understand the relationship of the initial capture and the residence time and final migratory route of the tagged fish. We will place transmitters in 50 chinook captured in the lower river net operations. Every two weeks, one surveyor will also drive the river basin locating fish to determine the extent of upstream movement. Fixed stations will be used to record migration timing – the number and location have yet to be located.

Transmitters will be placed into the esophagus of each adult without the use of anesthetics and then released. Fish to be tagged will be selected by a systematic sample with a random start. Every tenth fish will have a transmitter placed, starting with the second fish captured. Only healthy fish will be tagged.

Seven-volt, digitally encoded Lotek ® radio transmitters will be used. Each transmitter weighs 13 g in water and is 16 X 83 mm in dimensions with a 30 cm whip antennae and a battery life of 265 days. Each fixed station will have a Lotek ® SRX-4000 receiver with two directional Yagi antennas to monitor movement of tagged chinook. One antennae will be pointed upstream of the fixed station and the other antennae pointed downstream to determine each chinook's direction of movement.

Genetic Analysis

Through consultation with chinook salmon genetics personnel with the National Marine Fisheries Service (NMFS) in Seattle, WA, ODFW has initiated a DNA tissue collection from all handled chinook in the Coquille Basin in 2000. We will continue this work in 2001.

Age Composition Sampling

All chinook located in both capture events will have scales sampled. Since all fish captured will be sampled, expected sample sizes are not calculated. Four to five scales will be taken from each fish. Ages will be determined at the Corvallis, OR research lab using ODFW standard methods.

DEPENDENCE OF THE PROJECT UPON RELATED PROJECTS

None

REQUIRED PERMITS

We will be working closely with the National Marine Fisheries Service to obtain any permits that may be needed in association with Endangered Species Act status of some coastal salmonid populations. Permission from landowners will be needed to access streams adjacent to private property.

PROPOSED DURATION OF PROJECT

The Coquille River Escapement Indicator Stock Project is planned to last one-two years to determine the feasibility of estimating the spawner escapement of fall chinook salmon in the Coquille Basin. If it is deemed feasibility to fully implement a mark-recapture, creel survey and spawner surveys, the project will continue for the duration of the Pacific Salmon Treaty agreement as an MOC Aggregate Indicator Stock. We are currently searching for funding to continue the project in the event that CTC LOA funds are terminated.

TIME LINE

June 1-July 31:	complete sampling plan; recruit and hire field staff; buy nets and associated equipment.
August 1:	initiate trapping feasibility study in lower Coquille River.
September 1-January 1:	continue tagging and begin carcass surveys in the North, South, Middle, and East Fork Coquille River.
January 1- February 28:	complete data entry, begin data analysis.
1 March-30 April 31:	complete data analysis, draft technical progress report, and distribute report draft for review.
May 1-31:	Revise, print, and distribute technical progress report.

PROPOSED BUDGET

Type	Description	Number	Amount	Rate	Total	Sum
Personnel	Classification	Persons	Months	Rate	Total	**$ 54,912**
Crew Leaders	EBA - Step 4	1	6	$ 1,729.92	$10,380	
Field EBA's	EBA - Step 2	4	17	$ 1,587.12	$26,981	
Scale Technician	FWT-3 Step 1	1	0.25	$ 2,063.46	$ 516	
Data Entry	EBA - Step 2	1	0.5	$ 1,587.12	$ 794	
Fringe				42%	$16,241	
Travel	4x4 Pickups	3	15	$ 270.00	$ 4,050	**$ 6,600**
	Mileage	1000	15	$ 0.17	$ 2,550	
Equipment	Transmitters		50	$ 223.00	$11,150	**$ 18,150**
	Receiver		1	$ 7,000.00	$ 7,000	
Supplies	Nets and Accessories		6	$ 300.00	$ 1,800	**$ 5,220**
	Tags		1	$ 420.00	$ 420	
	Boat Accessories		1	$ 200.00	$ 200	
	Boat Maintenance		1	$ 200.00	$ 200	
	Tagging Accessories		1	$ 150.00	$ 150	
	Waders		5	$ 135.00	$ 675	
	Rain Gear		5	$ 75.00	$ 375	
	Telemetry Station Acc.		2	$ 200.00	$ 400	
	Capture Site Set-up		1	$ 500.00	$ 500	
	Supplies		5	$ 100.00	$ 500	
Direct						**$ 84,881**
Indirect					20.6%	**$ 17,485**
Total CTC Funds						**$102,366**

LITERATURE CITED

Arnason, A. N., C. W. Kirby, C. J. Schwarz, and J. R. Irvine. 1996 Computer Analysis of Data from Stratified Mark-Recovery Experiments for Estimation of Salmon Escapements and Other Populations. Canadian Technical Report of Fisheries and Aquatic Sciences 2106.

Boydstun, LB 1994. Analysis of two mark-recapture methods to estimate the fall chinook salmon (*Oncorhynchus tshawytscha*) spawning run in Bogus Creek, California. Calif. Fish and Game 80(1):1-13.

Buckland, S.T. and P.H. Garthwaite. 1991. Quantifying Precision Of Mark-Recapture Estimates Using Bootstrap And Related Methods. Biometrics 47:255-268.

Goodman, L. A. 1960. On the exact variance of products. Journal of the American Statistical Association 55:708-713.

Henry, K. A., A. R. Morgan, and R. L. Rulifson. 1950. The Salmon Catch of the Sport Fishery on the Coastal Rivers of Oregon in 1949. Fish Commission Research Briefs, Fish Commission of Oregon, 2(2):33-38. Portland, OR.

Jacobs, S.E. and Cooney, C.X. 1997. Oregon coastal salmon surveys. Oregon Department of Fish and Wildlife, Ocean Salmon Management Information Report, Portland.

Mooney, C.V. and R. D. Duvall. 1993. Bootstrapping: A Non Parametric Approach To Statistical Inference. Sage Publications, Newbury Park, CA, 73 p.

Nicholas, J.W. and D. G. Hankin. 1988. Chinook Salmon Populations in Oregon Coastal River Basins: Description of Life Histories and Assessment of Recent Trends in Run Strengths. Oregon Department of Fish and Wildlife, Corvallis, OR. Information Report 88-1.

ODFW (Oregon Department of Fish and Wildlife), 2000. Coastal Salmon Spawning Survey Procedures Manual. Coastal Salmon Inventory Project, Corvallis.

PSFMC. 2000. StreamNet Database, at URL http://www.streamnet.org. Gladstone, Oregon

Schwartz, C. J., R. E. Bailey, J. R. Irvine, and R. C. Dalziel. 1993. Estimating Salmon Spawning Escapement Using Capture-Recapture Methods. Canadian Journal of Fisheries and Aquatic Science 50: 1181-1197.

Schwarz, C. J. and C. G. Taylor. 1998. Use of the Stratified-Petersen Estimator in Fisheries Management: Estimating the Number of Pink Salmon Spawners in the Fraser River. Canadian Journal of Fisheries and Aquatic Sciences 55:281-296.

USCTC, 1997. A review of stock assessment data and procedures for U.S. chinook salmon stocks. Pacific Salmon Commission Report USTCHINOOK (71)-1. Vancouver, British Columbia, Canada. 75 pp.

Zhou, S. and R. Williams. 1999. Stock and Recruitment Analysis and Escapement Goals for Nehalem River Fall Chinook. Oregon Department of Fish and Wildlife, Portland Oregon. Information Report 99-4.

Zhou, S. and R. Williams. 2000. Escapement Goals for Siletz River and Siuslaw River Fall Chinook Based on Stock and Recruitment Analysis. Oregon Department of Fish and Wildlife, Portland Oregon. Information Report 2000-04.

APPENDIX A. Detection of size-selectivity in sampling and its effects on estimation of size composition [taken from Bernard 1991].

Results of Hypothesis Tests (K-S and χ^2) on lengths of fish MARKED during the First Event and RECAPTURED during the Second Event	Results of Hypothesis Tests (K-S and χ^2) on lengths of fish CAPTURED during the First Event and CAPTURED during the Second Event
Case I:	
"Accept" H_O	"Accept" H_O
There is no size-selectivity during either sampling event.	
Case II:	
"Accept" H_O	Reject H_O
There is no size-selectivity during the second sampling event but there is during the first.	
Case III:	
Reject H_O	"Accept" H_O
There is size-selectivity during both sampling events.	
Case IV:	
Reject H_O	Reject H_O
There is size-selectivity during the second sampling event; the status of size-selectivity during the first event is unknown.	

Case I: Calculate one unstratified abundance estimate, and pool lengths, sexes, and ages from both sampling events to improve precision of proportions in estimates of composition.

Case II: Calculate one unstratified abundance estimate, and only use lengths, sexes, and ages from the second sampling event to estimate proportions in compositions.

Case III: Completely stratify both sampling events, and estimate abundance for each stratum. Add abundance estimates across strata to get a single estimate for the population. Pool lengths, ages, and sexes from both sampling events to improve precision of proportions in estimates of composition, and apply formulae to correct for size bias to the pooled data .

Case IV: Completely stratify both sampling events and estimate abundance for each stratum. Add abundance estimates across strata to get a single estimate for the population. Use lengths, ages, and sexes from only the second sampling event to estimate proportions in compositions, and apply formulae to correct for size bias to the data from the second event.

SECTION II-D

North Oregon Coast (NOC) Aggregate Escapement Indicator Stock Feasibility Study

CHINOOK SALMON FUNDING PROPOSAL

SUBMITTED TO:

Pacific Salmon Commission's Chinook Technical Committee (US Section)
for Funding under the Letter of Agreement (LOA)

PROJECT TITLE:

North Oregon Coast (NOC) Aggregate
Escapement Indicator Stock Feasibility Study
(New Project0

REQUESTING AGENCY:

Oregon Department of Fish and Wildlife
Marine Resources Program
2040 SE Marine Science Dr.
Newport, Oregon 97365

PERIOD COVERED:

1 June 2000 through 31 May 2001

FEDERAL FUNDING REQUEST:

$ 61,036

<u>Principle Investigators</u>:

Jody White, Pacific Salmon Treaty Field Projects Coordinator, Newport, OR
Brian Riggers, Research and Monitoring Biologist, ODFW

OBJECTIVES

For a river to be fully functional as an indicator stock for the North Oregon Coast (NOC) or Mid-Oregon Coast (MOC) aggregates, three components are necessary: 1) an existing or planned biologically based escapement goal, 2) a precise annual estimate of the total freshwater escapement, and 3) a less precise annual spawner estimates from a random survey design that can be correlated to the more precise estimate. The Chinook Technical Team (CTC) of the Pacific Salmon Commission (PSC) has approved Nehalem, Siletz, and Siuslaw Rivers as escapement indicator stocks for the NOC. Of these three stocks, only the Nehalem River stock has all three components of a fully functional indicator. The other two, the Siletz and Siuslaw, have CTC approved biologically based escapement goals but no monitoring programs in place that are sufficient to provide either precise, annual, age specific escapement estimates or independent escapement estimates based upon a random survey design.

The goal of this project is to develop methods for precisely estimating the age specific escapement of adult chinook salmon to the Siletz and Siuslaw rivers in partial fulfillment of the requirements for fully functional escapement indicator stocks. The objectives of the project are:

1. Test the feasibility of implementing full-scale mark recapture experiments in the lower reaches of the Siletz and Siuslaw rivers. Specifically, the project will test the feasibility of marking and recovering marks in sufficient numbers by time and area such that future mark recapture experiments could be used to estimate the total escapement to the basin within ± 25% of the true value 95% of the time. If it become apparent during the capture phase of the project that sufficient numbers can be marked for an escapement estimate in one of the basins then, for that basin the project will:
    a. estimate the total escapement of adult chinook salmon in the basin such that the estimate is within ± 50% of the true value 95% of the time, and
    b. estimate the age and sex composition of chinook salmon spawning in the basin such that all estimated fractions are within ± 0.05 of their true values 95% of the time

RELATIONSHIP AND SIGNIFICANCE TO IMPLEMENTING ABUNDANCE-BASED MANAGEMENT OF CHINOOK SALMON IN PSC FISHERIES AND IDENTIFIED CTC-LOA RESEARCH THEMES

Most of Oregon's coastal chinook stocks migrate into fisheries governed by the Pacific Salmon Treaty (PST). Chinook management under the original 1985 PST was quota based. Co-managers were only required to provide information for stocks under their jurisdiction that was adequate to assess long term spawning escapement trends. In contrast, under the terms of Aggregate Abundance Based Management (AABM) in the new 1999 treaty, fisheries are managed for harvest rates. Harvest rates are adjusted annually based upon annual pre-season projections of ocean abundance for stock aggregates and post-season assessments of management success relative to achieving scientifically defensible biological escapement goals that insure sustainable production for both domestic and mixed stock ocean fisheries.

Escapement indicator and exploitation rate indicator stocks are two key features of AABM. They are needed to make the required preseason forecasts of abundance and distribution for stock aggregates. They also provide post season measures of management success. Both types of indicator stocks are selected to represent much larger stock aggregates. Among coastal chinook stocks in Oregon, the NOC and MOC are the two stock aggregates that contribute significantly to PST fisheries. Escapement indicator stocks are typically selected to represent much larger stock aggregates based upon geographic, habitat, genetics, and life history characteristics as well the extent of the historic data available. The CTC is responsible for reviewing biological escapement goals that co-managers submit for indicator stocks and for assessing the scientific rigor of escapement and exploitation rate monitoring programs.

Chapter 3, Section 9 specifies trigger mechanisms to adjust catch when escapement goals of indicator stocks are not being met. If two or more indicator stocks within an aggregate are considered depressed, harvest reductions within the North Pacific fisheries are triggered. In the case of Oregon stocks for example, if spawning escapement goals are not achieved for two or more individual indicator stocks within either the NOC or MOC two consecutive years, then that stock aggregate will be considered depressed. The PSC can determine the status of the NOC and MOC only if Oregon provides defensible biological escapement goals and accurate and precise annual escapement estimates for indicator stocks designated for each aggregate. Hence, as consequence of the new agreement, Oregon must improve its escapement monitoring to provide the levels of accuracy and precision required by the CTC to satisfy the Section 9 assessment of escapement and to provide reliable abundance forecasts for setting harvest rates in the next fishing season.

The Oregon Department of Fish and Wildlife (ODFW) has selected the Nehalem, Siletz, and Siuslaw rivers as escapement indicator stocks for the NOC, has completed stock recruitment analyses for these stocks, and has estimated biological escapement goals for them that have been approved by the CTC. The Coquille and Umpqua rivers have been selected as potential indicator stocks for the MOC. Presently, only the Nehalem River indicator stock for the NOC has a fully implemented intensive harvest and escapement monitoring program. The Umpqua River, a candidate indicator for the MOC has a partial monitoring program. Under the new PST, escapement shortfalls must be demonstrated for at least two indicator stocks per aggregate to trigger a management response. Hence, intensive harvest and spawning escapement monitoring programs will have to be implemented in at least four Oregon indicator stocks (two per each aggregate) and ideally in all five Oregon indicator stocks in the future.

In conjunction with each basin-wide escapement estimate for indicator stocks, the resulting spawner escapement estimates would be used to provide a calibration procedure to use for the coast-wide spawner survey program. Currently the coast-wide escapement estimate is stratified at the stock aggregate level (NOC and MOC) and monitored by means of a biased survey design. ODFW is planning to modify the coast-wide spawner survey method to incorporate a statistically valid stratified random survey design and use a measurement unit appropriate to give a reliable estimate of the inter-annual change in escapement. By using the indicator stock watersheds to calibrate the survey technique to an independent spawner estimate, would allow the aggregate-level escapement estimate to be adjusted to yearly variations in climate, run strength, and regional effects. (Note: see the introductory chapter for a more detailed description of Oregon's Coastal Chinook Research and Monitoring Program goals and objectives and their relationship to the Pacific Salmon Treaty abundance-based management of chinook salmon.)

The proposed project, "NOC Escapement Indicator Stock Feasibility Study", directly relates to the U.S. CTC research theme of "Improved escapement estimates for a second Oregon NOC indicator stock to be used for assessment and adjustment of the fishery harvest rates as stipulated in the Chinook Annex". Currently, Oregon Department of Fish and Wildlife (ODFW) is only investigating improving the escapement estimate in one NOC indicator stock, the Nehalem River. To fully implement the PST's Chinook Annex, an accurate estimate that meets CTC data standards needs to be made for the Siuslaw River and Siletz River chinook stocks.

EXPERIENCE AND EXPERTISE OF KEY PROJECT PERSONEL

Jody White:

Education:

BS in Fisheries Biology from University of Idaho
MS in Aquatic Ecology from University of Idaho

Experience:

ODFW PSC Field Projects Leader – two years
Aquatics Research Program Director, Xerces Society – two years
Freshwater Research Biologist, WA Dept. of Ecology – three years
Fisheries Biologist, Owner, EcoAnalysts, Inc. – four years

Expertise Specific to this Project

Conducted and supervised fisheries research projects in Oregon, Washington and Idaho for ten years. Currently responsible for Oregon's PSC coastal chinook research projects.

Brian Riggers:

Education:

BS in Oceanography from Humboldt State University

Experience:

ODFW Fishery Research and Monitoring Biologist - three years
ODFW Field Technician adult and juvenile salmonid sampling - six year

Expertise Specific to this Project:

Conducted and coordinated adult salmon inventories in Oregon Coastal Basins for five years. Three years experience with field crew supervision. Currently responsible for coordination of field crews for ODFW's PSC coastal chinook projects.

METHODOLOGY AND PROJECT DESIGN

Zhou and Williams (2000) estimated the MSY escapement goals for the Siuslaw and Siletz Rivers as 10,400-20,700 and 2,400-4,700 adult spawners respectively. However, the spawner escapement data used in the analysis was from a historical peak count database and its relationship to true spawner abundance is unknown. Both of these watersheds have had limited historical abundance analysis other than commercial fisheries records (Nicholas and Hankin 1988). Commercial fishing records indicate that the harvest on the Siuslaw and Siletz rivers ranged from 5,000-13,000 and 4,000-14,000, respectively. Chinook populations in both basins are assumed to be either stable or increasing, according to ODFW district biologists.

Both the Siuslaw and Siletz watersheds are located in Oregon's Coast Range. The rivers are similar in climate conditions with most moisture coming from winter and spring rain events. Lower watershed riparian zones are mostly privately owned and both have small estuaries with tidally influenced riverine channels that are 10-20 miles in length. The upper watersheds are owned mainly by commercial forestry companies, however the Siuslaw National Forest and the Bureau of Land Management have ownership on the Siuslaw River.

Chinook move into the Siletz Bay and Siuslaw Bay from May to December and the relationship between time in the bay and freshwater entry date is not known. Some fish are known to begin migrating in the summer, however most of the runs migrate on the fall freshets in October and November. In order to efficiently capture fish and alleviate handling during the freshwater to saltwater transition phase, chinook will be captured in mainstem areas of the each river that are upstream of tidal saltwater intrusions. The target capture locations in each river will also be located to minimize interactions with anglers.

Initially, field crews will use sonar to locate and map all holding areas as well as any potential snags. Once potential tagging areas are located, the type of gear most feasible to fish will be found by experimenting with floating nets, sinking nets, and seines. Field crews will keep daily log books that record every net set, the netting location, type of net, time of set, duration of the set, number of fish caught, and any pertinent information on quality of the area for future sets. Time of day and tidal stage will also be recorded. Once the location and optimal times are established for each netting areas, daily routines will be assigned to optimize fish collection. A monthly barometric, air temperature, water temperature, and river flow record will be kept at the Newport office to combine with the daily log books to help in determining future, optimal netting conditions. It will be necessary to work at night to minimize net avoidance by chinook and negative interactions with anglers. The Siletz Native American Tribe has offered use of their boat and motor and several crew members to assist in tagging of chinook and collection of carcasses.

All captured chinook will have length measured (mid-eye to fork of tail), sex and scales sampled, and tagged. Multiple tags will be used to ensure all marked fish are recognized in the subsequent recapture event: a single, numbered anchor tag will be placed on the left side of the dorsal fin, the operculum punched, and one axillary appendage will be removed.

If enough fish are marked in one basin, carcasses on the spawning grounds will serve as a second capture event and will be sampled for recovery of tags. All fish will be sampled for length (posterior orbit of the eye to hypural plate), scales and sex, and checked for marks. Each fish will only be sampled once. Recovery will start in the upper river spawning areas and tributaries in late September and continue until fish are no longer observed. Surveyors will use both foot and boat surveys to locate carcasses. The feasibility of using additional methods to collect fish will also be assessed including but not limited to carcass weirs, netting or seining, and diving.

Analysis methods for the stratified Petersen estimate will follow the descriptions in Arnason, et al. (1996) and Schwarz and Taylor (1998) and use the program SPAS (Stratified Population Analysis System). The usual assumptions for use of the pooled Petersen estimator are:

1) all fish have an equal probability of being marked at the trap site; or,
   a) all fish have an equal probability of being inspected for marks; or,
   b) marked fish mix completely with unmarked fish in the population between events; and,
2) there is no recruitment to the population between capture events; and,
3) there is not trap induced behavior; and,
4) fish do not lose their marks and all marks are recognizable.

5) However, when using the stratified estimator these assumptions are expanded to include:

6) all fish have a non-zero probability of being found in the recovery strata and all fish in the recovery strata were present in one of the initial capture strata;
7) there is no tag loss - if there is tag loss the assignment of the probability of losing tags must be assigned proportionally to the distribution of initial strata tags in the marked recoveries; and,

8) all tagged and untagged fish in each recovery stratum have equal probability of being sampled.

Additionally, all tagged fish released in each capture area have the same probability of movement to the recovery strata as well as the tagged and untagged fish move with the same probability distribution.

Information about size and age selectivity during the two capture events can be estimated through a battery of tests (Appendix A) to determine if further stratification of the data set is appropriate to meet the assumptions. If age and size selectivity is not found then the population can be assumed to not have size/sex bias. It is assumed that netting will bias the first capture event towards larger fish. If multiple techniques are used to capture fish in the second event it is unlikely that it will be biased. However, it is very likely that only Assumption 3 (of the first three assumptions) will be met. To estimate if there is random geographic and temporal mixing of marks, the ratios of marked to unmarked fish will be compared between strata. Chi-square analysis will be used to determine if there are significant differences between the strata.

Assumptions 4, 5, and 7 do not apply to this situation. Only adult chinook salmon migrating upstream of the capture site will be used in the mark-recapture study and recruitment to the population is not possible. The second capture event is an active sampling technique utilizing multiple capture techniques to collect tags within the spawning areas upstream of the trap sites and trap induced behavior will not occur. However, for the first event, trap induced behavior can occur and this is estimated as discussed above for age/sex selectivity.

Tag loss (assumption 6 and 8) will be zero through the use of multiple tags. From 1999 and 2000 field data, when projects used these multiple tags, at least one of the multiple tags was observed if a fish was tagged. We will assume all tags will be seen on fish if present and that at least one of the tags will be observed if a fish was captured in the first event. The redundant application of floy tags, opercule punches, and axillary clips should insure that trained field crews will identify marked individuals among all fish observed.

A pooled Petersen estimator may be used if either of the two following conditions are met:

5. the recovery probabilities are similar between all strata; or,
6. the tagged to untagged ratios are constant between recovery strata.

The tests for condition one or two will follow Arnason et al. (1996). Condition 1 requires a non-significant result from a chi-square test of a 2 by s matrix (the number of tagging strata) with rows filled in by $m_{i.}$ and u^c_i and condition 2 requires a non-significant result from a chi-square test of a 2 by t matrix (the number of recovery stratum) with rows filled by $m_{.j}$ and u^r_j where:

$m_{i.}$= number of fish tagged in capture stratum I,

$m_{.j}$= number of fish tagged captured in stratum j,
u^r_j =, recovered the number of unmarked fish in the sample in recovery stratum j, and
u^c_i = the number of fish tagged in capture stratum i and are never seen.

Estimation of variance and associated confidence intervals for the stratified Petersen estimator will follow Arnason et al. (1996) unless alternative estimators are recommended by the CTC (e.g. bootstrap method). For the pooled Petersen estimator, a bootstrap method will be use to estimate variance, bias and confidence intervals of the population estimate (Buckland and Garthwaite 1991, Mooney and Duval 1993).

Sample Size

As with the Coquille River Indicator Stock Feasibility Study, we only have the district biologist's intuitive guess of 6,000-10,000 fish in each river. ODFW has collected an average of 200 and 400 carcasses over the last 15 years in the standard survey reaches of the Siletz and Siuslaw rivers, respectively. Using our additional field personnel, ~500 carcasses could be recovered on an average year. Considering the uncertainty of a feasibility study and the funding to staff only one basin for recovery purposes, we propose a 50% precision goal in one basin only. Using the Siuslaw as an example, if 500 carcasses are recovered from a population of 10,000 fish, and we assume equal mixing of both tagged and untagged fish, than we need to tag ~400 fish and recover 20 tagged carcasses to achieve the precision goal.

Genetic Analysis

Through consultation with chinook salmon genetics personnel with the National Marine Fisheries Service (NMFS) in Seattle, WA, ODFW has initiated a DNA tissue collection from all handled chinook in each river basin.

Age Composition Sampling

All chinook located in both capture events will have scales sampled. Since all fish captured will be sampled, expected sample sizes are not calculated. Four to five scales will be taken from each fish. Ages will be determined at the Corvallis, OR research lab using ODFW standard methods.

DEPENDENCE OF THE PROJECT UPON RELATED PROJECTS

None

REQUIRED PERMITS

We will be working closely with the National Marine Fisheries Service to obtain any permits that may be needed in association with Endangered Species Act status of some coastal salmonid populations. Permission from landowners will be needed to access streams adjacent to private property.

PROPOSED DURATION OF PROJECT

The NOC Escapement Indicator Stock Feasibility Study is planned to last one-two years to determine the feasibility of estimating the spawner escapement of fall chinook salmon in the Siuslaw or Siletz rivers. If it is deemed feasibility to fully implement a mark-recapture, creel survey and spawner surveys, the project will continue for the duration of the Pacific Salmon Treaty agreement if funding is available. We are currently searching for funding to continue the project in the event that CTC LOA funds are terminated.

TIME LINE

June 1-August 15:	complete sampling plan; recruit and hire field staff; buy nets and associated equipment.
August 15 - December 31:	initiate trapping feasibility study.
September 31- December 31:	conduct spawner surveys.
January 1- February 28:	complete data entry, begin data analysis.
March 1 - April 30:	complete data analysis, draft technical progress report, and distribute report draft for review.
May 1-31:	Revise, print and distribute technical progress report.

PROPOSED BUDGET

Type	Description	Number	Amount	Rate	Total	*Sum*
Personnel	Classification	Persons	Months	Rate	Total	**$ 39,327**
Crew Leaders	EBA - Step 4	1	5	$ 1,729.92	$ 8,650	
Field EBA's	***EBA - Step 2***	3	12	$ 1,587.12	$19,045	
Fringe				42%	$11,632	
Travel	4x4 Pickups	0	7	$ 270.00	$ 1,890	**$ 3,675**
	Mileage	1500	7	$ 0.17	$ 1,785	
Supplies	Nets and Accessories		8	$ 300.00	$ 2,400	**$ 5,210**
	Tags		1	$ 420.00	$ 420	
	Boat Accessories		1	$ 200.00	$ 200	
	Boat Maintenance		1	$ 200.00	$ 200	
	Tagging Accessories		1	$ 150.00	$ 150	
	Waders		4	$ 135.00	$ 540	
	Rain Gear		4	$ 75.00	$ 300	
	Supplies		2	$ 500.00	$ 1,000	
Direct						**$ 48,212**
Indirect					20.6%	**$ 12,824**
Total						**$ 61,036**

LITERATURE CITED

Arnason, A. N., C. W. Kirby, C. J. Schwarz, and J. R. Irvine. 1996 Computer Analysis of Data from Stratified Mark-Recovery Experiments for Estimation of Salmon Escapements and Other Populations. Canadian Technical Report of Fisheries and Aquatic Sciences 2106.

Buckland, S.T. and P.H. Garthwaite. 1991. Quantifying Precision Of Mark-Recapture Estimates Using Bootstrap And Related Methods. Biometrics 47:255-268.

Goodman, L. A. 1960. On the exact variance of products. Journal of the American Statistical Association 55:708-713.

Henry, K. A., A. R. Morgan, and R. L. Rulifson. 1950. The Salmon Catch of the Sport Fishery on the Coastal Rivers of Oregon in 1949. Fish Commission Research Briefs, Fish Commission of Oregon, 2(2):33-38. Portland, OR.

Jacobs, S.E. and Cooney, C.X. 1997. Oregon coastal salmon surveys. Oregon Department of Fish and Wildlife, Ocean Salmon Management Information Report, Portland.

Mooney, C.V. and R. D. Duvall. 1993. Bootstrapping: A Non Parametric Approach To Statistical Inference. Sage Publications, Newbury Park, CA, 73 p.

Jacobs, S.E. and Cooney, C.X. 1997. Oregon coastal salmon surveys. Oregon Department of Fish and Wildlife, Ocean Salmon Management Information Report, Portland.

Nicholas, J.W. and D. G. Hankin. 1988. Chinook Salmon Populations in Oregon Coastal River Basins: Description of Life Histories and Assessment of Recent Trends in Run Strengths. Oregon Department of Fish and Wildlife, Corvallis, OR. Information Report 88-1.

Schwarz, C. J. and C. G. Taylor. 1998. Use of the Stratified-Petersen Estimator in Fisheries Management: Estimating the Number of Pink Salmon Spawners in the Fraser River. Canadian Journal of Fisheries and Aquatic Sciences 55:281-296.

USCTC, 1997. A review of stock assessment data and procedures for U.S. chinook salmon stocks. Pacific Salmon Commission Report USTCHINOOK (71)-1. Vancouver, British Columbia, Canada. 75 pp.

Zhou, S. and R. Williams. 1999. Stock and Recruitment Analysis and Escapement Goals for Nehalem River Fall Chinook. Oregon Department of Fish and Wildlife, Portland Oregon. Information Report 99-4.

Zhou, S. and R. Williams. 2000. Escapement Goals for Siletz River and Siuslaw River Fall Chinook Based on Stock and Recruitment Analysis. Oregon Department of Fish and Wildlife, Portland Oregon. Information Report 2000-04.

APPENDIX A. Detection of size-selectivity in sampling and its effects on estimation of size composition [taken from Bernard 1991].

Results of Hypothesis Tests (K-S and χ^2) on lengths of fish MARKED during the First Event and RECAPTURED during the Second Event	Results of Hypothesis Tests (K-S and χ^2) on lengths of fish CAPTURED during the First Event and CAPTURED during the Second Event
Case I:	
"Accept" H_o	"Accept" H_o
There is no size-selectivity during either sampling event.	
Case II:	
"Accept" H_o	Reject H_o
There is no size-selectivity during the second sampling event but there is during the first.	
Case III:	
Reject H_o	"Accept" H_o
There is size-selectivity during both sampling events.	
Case IV:	
Reject H_o	Reject H_o
There is size-selectivity during the second sampling event; the status of size-selectivity during the first event is unknown.	

Case I: Calculate one unstratified abundance estimate, and pool lengths, sexes, and ages from both sampling events to improve precision of proportions in estimates of composition.

Case II: Calculate one unstratified abundance estimate, and only use lengths, sexes, and ages from the second sampling event to estimate proportions in compositions.

Case III: Completely stratify both sampling events, and estimate abundance for each stratum. Add abundance estimates across strata to get a single estimate for the population. Pool lengths, ages, and sexes from both sampling events to improve precision of proportions in estimates of composition, and apply formulae to correct for size bias to the pooled data .

Case IV: Completely stratify both sampling events and estimate abundance for each stratum. Add abundance estimates across strata to get a single estimate for the population. Use lengths, ages, and sexes from only the second sampling event to estimate proportions in compositions, and apply formulae to correct for size bias to the data from the second event.

SECTION III

Continuing LOA Projects

SECTION III-A

Estimating Age and Sex Composition of Oregon Coastal Fall Chinook Salmon NOC and MOC Aggregate Stocks

CHINOOK SALMON FUNDING PROPOSAL

SUBMITTED TO:

Pacific Salmon Commission's Chinook Technical Committee (US Section)
for Funding under the Letter of Agreement (LOA)

PROJECT TITLE:

Estimating Age and Sex Composition of Oregon Coastal Fall Chinook Salmon NOC and MOC Aggregate Stocks
(continuing: initial funding in 1999)

REQUESTING AGENCY;

Oregon Department of Fish and Wildlife
Marine Resources Program
2040 SE Marine Science Dr.
Newport, OR 97365

PERIOD COVERED:

1 June 2001 through 31 May 2002

FUNDING REQUEST:

$ 48,113

Principle Investigators:
Jody White, Pacific Salmon Treaty Field Projects Leader, ODFW, Newport, OR
Brian Riggers, Research and Monitoring Biologist, ODFW, Corvallis, OR

PROJECT OBJECTIVE

1. To estimate the age, sex, and size composition of carcasses from spawned out chinook salmon in the Nehalem, Wilson, Siletz, Siuslaw, Coquille, Sixes, and Chetco rivers such that proportion of each age group is estimated within ± 0.05 of their true values 95% of the time.
2. Use data from age stratified mark recapture experiments conducted by other projects to adjust for bias in the age composition based on carcass samples and estimate the true portions (and associated variances) of each age group in the spawning population.

RELATIONSHIP AND SIGNIFICANCE TO IMPLEMENTING ABUNDANCE-BASED MANAGEMENT OF CHINOOK SALMON IN FISHERIES GOVERNED BY THE PSC

The North Oregon Coast (NOC) and Mid Oregon Coast (MOC) aggregates are the two stock aggregates that are north-migrating (USCTC 1997), thus subjected to Aggregate Abundance Based Management (AABM) under the new 1999 Pacific Salmon Treaty (PST). The Oregon Department of Fish and Wildlife (ODFW) has conducted standard surveys for more than 40 years to monitor the status of Chinook stocks along coastal Oregon (Jacobs and Cooney 1997). A total of 56 standard index surveys (45.8 miles) are monitored on an annual basis to estimate peak escapement levels and stock status trends of north-migrating stocks that spawn in approximately 2,600 miles of coastal streams.

Reliable estimates of age composition are an integral component of the technical management process in PSC fisheries management. These data are used in forecasting stock abundance and assessing fishery harvest impacts. Scale analysis is the preferred method of estimating age composition of natural stocks of pacific salmon. Beginning in 1986, the Oregon Department of Fish and Wildlife (ODFW) instituted a program to collect and analyze scales from returning spawners to obtain annual estimates of age composition for the NOC and MOC stock aggregates (Borgerson and Bowden 1997). This program has involved analyzing scales collected from carcasses recovered during annual spawning surveys of NOC index stocks in the Nehalem, Wilson, Salmon, Siletz, and Siuslaw rivers and MOC stocks in the Coquille, Sixes, and Chetco rivers. Generally, sample sizes that have been obtained for scale analysis have averaged about 230 samples per each index basin (Table 1). These sample sizes are not large enough to estimate multinomial proportions with an accuracy of ± 0.05, 95% of the time. Using procedures described by Thompson (1987) for determining sample sizes required to estimate multinomial proportions and modifying results for finite population size and sample loss due to scale regeneration, we have determined that approximately 550 fish per basin must be sampled for those levels of accuracy and precision.

Table 1. Age composition and sample size of Oregon Coastal fall chinook salmon stocks from seven index rivers, 1997. The combined age composition for 1986-1996 is given for comparison.

Basin	**Percent of Spawners at Age**						**Average number aged per year**
	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	
Nehalem	0.9	6.2	37.5	47.4	7.7	0.3	182
Wilson	0.4	4.0	34.0	50.0	11.6	0.1	254
Salmon	0.9	9.4	32.0	48.9	8.7	0.1	270
Siletz	0.9	4.3	27.0	55.1	12.5	0.2	171
Siuslaw	3.3	11.3	13.5	38.6	3.2	<0.1	387
Coquille	3.8	14.2	48.6	31.8	1.5	--	267
Chetco	6.0	12.3	59.1	21.7	0.9	--	178

The ability to achieve desired sample sizes is dictated by the availability of chinook carcasses in survey areas and the amount of effort expended to detect and sample those carcasses. In the past, limitations in available funding prevented us from conducting additional surveys to bolster scale collections to obtain adequate sample sizes. We are requesting additional funding for supplemental surveys to augment scale collections and to support technician time needed to process and analyze the increased number of scale samples that this project would generate. This is the third year of funding from the U.S. Section of the Chinook Technical Committee. Data from the project's first year is shown in Table 2.

Table 2. Scales collected by the standard and augmentation crews in 1999 compared to the average sample taken by standard spawning crews between 1986-1996.

Basin	Standard Survey Crews	Augmentation Crew	Total	1986-96 Average
Nehalem	98	52	235 [a]	182
Wilson	35	12	47	254
Siletz	113	218	331	171
Siuslaw	507	27	534	387
Coquille	337	188	525	267
Sixes	102	77	179	
Chetco	44	53	97	178

EXPERIENCE AND EXPERTISE OF KEY PROJECT PERSONEL

Brian Riggers:

Education:

BS in Oceanography from Humboldt State University

Experience:

Field Technician adult and juvenile salmonid sampling - six years
Fishery Research and Monitoring Biologist - two years

Expertise Specific to this Project:

Conducted and coordinated adult salmon inventories in Oregon Coastal Basins for five years. Three years experience with field crew supervision. Currently responsible for coordination of field crews and projects for ODFW's PSC coastal chinook projects.

Jody White:

Education:

BS in Fisheries Biology from University of Idaho
MS in Aquatic Ecology from University of Idaho

Experience:

PSC-New Agreements Project Coordinator – two year
Aquatics Research Program Director, Xerces Society – two years
Freshwater Research Biologist, WA Dept. of Ecology – three years
Fisheries Biologist, Owner, EcoAnalysts, Inc. – four years

Expertise Specific to this Project

Conducted and supervised fisheries research projects in Oregon, Washington and Idaho for ten years. Currently responsible for coordination and technical assistance of Oregon's PSC coastal chinook monitoring projects.

Lisa Borgerson:

Education:

BS in Fisheries from Oregon State University

Experience:

Fishery Research and Monitoring Biologist - 16 years. Presently responsible for leading ODFW Fish Scale Project.

Expertise Specific to this Project:

Skilled in the analysis and interpretation of Pacific salmon scales.

METHODOLOGY AND PROJECT DESIGN

Scale Collection

This project will fund a two-person crew that will collect scale, sex, and size data from post-spawned carcasses. Carcass sampling funded by this project will supplement existing sampling programs that occur during systematic spawning ground surveys that are conducted to estimate spawner abundance and sampling conducted as part of LOA funded mark and recapture experiments. Survey sites will be located within Index River Basins throughout the NOC and MOC spawning habitat. Since intensive carcass sampling is already proposed for index streams such as the Nehalem River and the Coquille River where mark and recapture experiments are being, or proposed, conducted, it is likely that effort in this project will be focused on the Wilson, Siletz, Siuslaw, and Chetco rivers. Typically, in these rivers, supplemental surveys conducted by this project will have to provide approximately half of the samples need to meet the 550 fish sampling goal. Sampling effort in non-index streams such as the Sixes River where a continuous time series of historical age composition data exists may supplemented by this project on as available basis. Supplemental survey effort will be prioritized by basin according to sample needs. Surveys will be selected based on known occurrences of spawner concentrations. Surveys will consist of walking or floating pre-selected stream reaches to sample all available carcasses. Survey methods will follow established protocols (ODFW 2000). Sex, POH (posterior orbital to hypural plate) length and condition will be recorded for all sampled carcasses. Additionally, all carcasses will be inspected for fin clips and snouts for coded-wire tag recovery will be removed from all adipose-clipped carcasses.

Procedures outlined by Thompson (1987) were used to determine sample sizes that are required to estimate the age composition of spawners in each basin with an accuracy of ±5%, 95% of the time. Sample numbers were adjusted for finite population size and the average incidence of unreadable scales among samples taken from Oregon Coastal chinook. Based on these criteria, we will attempt to obtain a minimum of 550 scale, sex, and size samples for each index basin within the NOC and MOC stock aggregates.

Sample Processing and Analysis

Scale samples will be mounted on gummed cards. From these, we will make acetate impressions using a heat press. All data recorded on the scale collection envelope will be transcribed to an electronic database. Experienced staff will determine age by visual interpretation. Two different readers will independently age each sample and disagreements will be resolved by a third joint reading. Fish age will be determined by counting winter annuli. Total age will be computed as the count of all annuli plus one. Age estimates will be entered into the database to cross-reference recovery data.

Data Analysis

Scale analysis results will be compiled to estimate the age composition of the spawned out carcasses in each of the index basins. Comparisons of age composition data from systematic, stratified sampling of live fish as they enter a basin and age composition data from subsequent sampling of post-spawning carcasses indicate that the fraction of small, younger aged fish is underestimated by the carcass sampling method (Jacobs and Boechler 1988). Data from mark-recapture experiments on the Nehalem, Salmon, Elk, Coquille, and Umpqua rivers will be used to analyze the extent of this bias in Oregon coastal streams. In those streams, mark-recapture experiments will be stratified by sex and age. Sex and age specific recovery data for marked fish will be used to adjust for sex and age specific carcass loss and subsequent bias in age composition data from carcasses as follows:

$$p_{ujl} = p_{ujc}\left(\frac{p_{mjl}}{p_{mjc}}\right)$$

Where:

p_{ujl} = fraction of live fish (l) aged j in a river (u) where no mark recapture data are available and carcass samples must be used to estimate the age compostion of the spawning population.

p_{ujc} = fraction of caracasses (c) aged j in a river where no mark recapture data are available and carcass samples must be used to estimate the age compostion of the spawning population.

p_{mjl} = fraction of live fish (l) aged j in a river (m) where the fraction of live fish is known from mark and recapture that is stratified by age.

p_{mjc} = fraction of carcasses (c) aged j in a river where carcass samples as part of from mark and recapture data that is stratified by age.

The variances for each of these proportions are as follows:

$$v(p_{ujc}) = \left(\frac{N_u - n_{uc}}{N_u}\right)\frac{p_{ujc}(1 - p_{ujc})}{(n_{uc} - 1)},$$

$$v(p_{mjl}) = \left(\frac{N_m - n_{ml}}{N_m}\right)\frac{p_{mjl}(1 - p_{mjl})}{(n_{ml} - 1)},$$

$$v(p_{mjc}) = \left(\frac{N_m - n_{mc}}{N_m}\right)\frac{p_{mjc}(1 - p_{mjc})}{(n_{mc} - 1)}, \text{ and}$$

where:

N_u = spawning population size in river u (river where no mark - recapture done)

N_m = spawnin population size in river m (river where mark - recapture done)

n_{mc} = number of carcasses sampled in river m

n_{uc} = number of carcasses sampled n river u

n_{ml} = number of live fish marked and sampled in river m

The variance of the adjustment term *(f)* becomes:

$$v(f) = v\left(\frac{p_{mjl}}{p_{mjc}}\right) = \left(\frac{p_{mjl}}{p_{mjc}}\right)^2 \left[\frac{v\left(p_{mjl}\right)}{p_{mjl}^2} + \frac{v\left(p_{mjc}\right)}{p_{mjc}^2}\right] \text{ and}$$

the variance of the adjusted proportion p_{ujl} becomes :

$$v(p_{ujl}) = f^2\, v\left(p_{ujc}\right) + p_{ujc}^2\, v(f) - v\left(p_{ujc}\right)v(f)$$

and the variance of the estimated number of fish aged j in river u, N_u is :

$$v\left(N_{uj}\right) = N_u^2 v(\, p_{ujl}\,)$$

where N_u is the population estimate for all ages in river u.

Adjusted age composition data will then be used to reconstruct cohort size and forecast ocean population size of incomplete broods.

DEPENDENCE OF THE PROJECT UPON RELATED PROJECTS

Sampling efforts and results from this project are directly dependent upon other ongoing ODFW escapement enumeration projects. Because age composition data form this project will originate from carcass samples. Because these samples are likely biased for older fish, results from this study will have to be adjusted based on relationships between age composition from carcasses and true age composition. The latter may be estimated from age stratified mark and recapture studies or temporally stratified, systematic sampling of live fish during the upstream migration to spawning areas. Adjustment factors used to correct for bias in age compositions determined from carcasses sampled in index streams will be based on results from PSC funded mark and recapture studies on the Salmon and Elk Rivers and other similar studies on the Coquille, Umpqua and Nehalem rivers that are funded under the LOA.

Information about spawning areas from the proposed spawning habitat inventory study will be used by this project to identify sampling areas where carcasses are likely to aggregate after spawning. Scales samples from this project will processed and aged by the ODFW scale laboratory in Corvallis.

REQUIRED PERMITS

No permits are presently needed. We are working closely with the National Marine Fisheries Service (NMFS) to obtain any permits that may be needed in association with Endangered Species Act (ESA) status of some coastal salmonid populations. Permission from landowners will be needed to access streams adjacent to private property.

PROPOSED DURATION OF PROJECT

This study will need to continue as long as age composition estimates are needed. Implementation of a revised escapement monitoring program that is currently being tested may in the future preclude the need for the sampling portion of this proposed work.

TIME LINE

June 1-30:	Complete Sampling Plan.
July 1-31:	Recruit for field staff.
August 1-31:	Hire field staff, purchase major equipment items.
October 1-31:	Initiate spawning surveys to recover scale samples.
November 1-December 31:	Continue spawning surveys, begin scale mounting, and data entry.
January 1- February 28:	Complete spawning surveys, continue scale mounting, and data entry begin age analysis.
March 1- April 30:	Complete data analysis, draft technical progress report, and distribute report draft for review.
May 1-31:	Revise, print, and distribute technical progress report.

PROPOSED BUDGET

Type	Description	Number	Amount	Rate	Total	Sum
Personnel	Classification	Persons	Months	Rate	Total	$ 31,714.55
Project Leader	NRS 3 Step 5		2	$ 3,580.00	$ 7,160.00	
Project Asst. Leader	NRS 2 Step 4		2	$ 2,746.00	$ 5,492.00	
Field EBA's	EBA - Step 2	2	6	$ 1,587.12	$ 9,522.72	
Scale Technician	FWT-3 Step 1	1	0.25	$ 2,063.46	$ 515.87	
Fringe for Full Time				38%	$ 4,807.76	
Fringe for Seasonals				42%	$ 4,216.21	
Travel	4x4 Pickups		9	$ 270.00	$ 2,430.00	$ 6,360.00
	Mileage	1000	9	$ 0.17	$ 1,530.00	
	Per Diem		6	$ 400.00	$ 2,400.00	
Supplies	Waders		2	$ 135.00	$ 270.00	$ 1,820.00
	Rain Gear		2	$ 75.00	$ 150.00	
	Supplies		1	$ 1,400.00	$ 1,400.00	
Direct						$ 39,894.55
Indirect					20.6%	$ 8,218.28
Total						$ 48,112.83

LITERATURE CITED

Borgerson, L.A. and R.K. Bowden. 1997 Scale Analysis. Oregon Department of Fish and Wildlife, Fish Research Project F-145-R-6, Annual Progress Report, Portland.

Jacobs, S.E. and J.L. Boechler. 1988. Catch and Escapement of Fall Chinook Salmon from Salmon River, Oregon, 1987. Oregon Department of Fish and Wildlife, Contract Number NA-87-abh-00017, Annual Progress Report, Portland.

Jacobs, S.E. and Cooney, C.X. 1997. Oregon coastal salmon surveys. Oregon Department of Fish and Wildlife, Ocean Salmon Management Information Report, Portland.

ODFW (Oregon Department of Fish and Wildlife), 2001. Coastal Salmon Spawning Survey Procedures Manual. Coastal Salmon Inventory Project, Corvallis.

Thompson, S. K. 1987. Sample size for estimating multinomial proportions. The American Statistician 41:42-46.FPC equation from: Cochran (1977, equation 4.3, page 76).

USCTC, 1997. A Review of Stock Assessment Data and Procedures for US Chinook Salmon Stocks. Report of the Pacific Salmon Commission U.S. Chinook Technical Committee. USTCCHINOOK (97-1). Pacific Salmon Commission, Vancouver. BC

SECTION IV

PSC BASE BUDGET PROJECTS

SECTION IV-A

OREGON COASTAL FALL CHINOOK INDEX SURVEYS

INTRODUCTION

In order to fulfill one of Oregon's participant obligations in the initial Pacific Salmon Treaty (1985), ODFW began to develop a program to monitor the spawning escapement of stocks of chinook salmon that contribute to ocean salmon fisheries addressed by the treaty. These chinook stocks originate from coastal basins from the Necanicum River through the Sixes River. ODFW elected to use spawning surveys to accomplish this objective, thereby creating a need to expand the historical program of standard coastal chinook surveys. Standard surveys were areas that had been surveyed consistently over a long period of time, and were used to index spawning abundance in the basin where they occur. These areas were selected as early as 1948 based on varied criteria including ease of access and the assurance of finding some level of spawning. Beginning in 1986, ODFW increased the survey effort for monitoring the spawning escapement of coastal chinook salmon stocks. New survey sites were selected and pilot surveys were conducted during 1986 through 1988. Based on the evaluation of that survey effort, portions of those surveys were incorporated into the standard index for coastal chinook salmon beginning in 1989. Stream segments were evaluated and chosen if they (1) were surveyed on a regular basis during the chinook salmon spawning season and (2) appeared to be a valid index of spawning escapement in the basins where they were located.

BACKGROUND

Spawning surveys were first established in 1948 by the Oregon Fish Commission to monitor spawning escapement of wild salmon past commercial net fisheries that operated in several large river basins. Shortly thereafter, the Oregon Game Commission began conducting spawning surveys. When most commercial net fisheries were closed in 1957, both agencies retained their surveys in order to determine spawning escapement trends as ocean commercial and recreational fisheries developed. In 1958, both agencies agreed to exchange data collected on spawning surveys in order to eliminate duplication of effort. Comparisons of counts between years were used to make conclusions regarding annual trends in coast-wide spawning escapement.

Standardization of the spawning survey program has been an almost continuous process since 1950. However, the number of surveys included in the standard index and the mileage surveyed has varied from year to year primarily due to personnel changes, shifts in management priorities, changes in funding levels, and human-induced changes in the Oregon coastal environment. In 1971, the spawning survey program was substantially modified. Surveys that were not representative because of habitat changes, difficult access, or other physical reasons were eliminated from the standard index, leaving areas thought to be good spawning streams. In 1974, the beginning and ending points of each survey area were re-defined and re-measured so historic counts for the surveys that remained in the standard index could be adjusted and compared to present data.

The merger of the Oregon Fish Commission and the Oregon Game Commission into the Oregon Department of Fish and Wildlife (ODFW) in 1975 caused more dramatic changes to occur. Reassignment of personnel and changing priorities resulted in the consolidation, review, and revision of the spawning fish survey program. The number of surveys was reduced, however the surveys that were retained represented more basins than the previous index. Spawning escapement indexes were then developed from these surveys and compared to base period median counts that were developed for each stream basin. Beginning in the early 1980's, changes in funding status, recommendations of research studies, and changing information needs brought about a gradual shift towards expansion of the spawning survey program to the current level

METHODS AND PROGRAM DESIGN

Survey Design

The standard spawning index for fall chinook salmon consisted of 53 stream segments from 19 different river basins and totaled 52.3 miles in 1994. In 1995, the standard spawner index consisted of 54 stream segments from 19 different river basins and totaled 53.5 miles. Additionally, 49 supplemental stream segments (55.4 miles) and 11 spot check stream segments (8.8 miles) were conducted in 1994, while 54 supplemental stream segments (53.2 miles) and 8 spot check stream segments (8.3 miles) were conducted in 1995.

Surveys conducted for fall chinook salmon in 1994 and 1995 were given hatchery influence classifications based on the following criteria: streams were classified as being influenced by *fed-fish* if fed hatchery fall chinook (i.e. smolts or fingerlings) were released within 10 stream miles of the downstream end of the survey segment during 1989-93 for 1994 surveys and 1990-94 for 1995 surveys; streams were classified as being influence by *unfed-fish* if unfed hatchery fall chinook (i.e. fry) were released within 10 stream miles of the downstream end of the survey segment in 1989-93 for 1994 surveys and 1990-94 for 1995 surveys; streams were classified as being influenced by *broodstock* collection if live adult fall chinook were removed within 10 miles of the survey segment during the 1994 or 1995 spawning season, respectively. All survey segments not matching any of these conditions were classified as *wild* streams. Classifications of standard chinook stream segments during 1994 and 1995 are listed in Table 1.

Field Methods

Seasonal personnel are hired to conduct intensive stream surveys on pre-established index stream segments. In 1994, district fishery biologists were responsible for supervising the surveyors in their respective districts to ensure all surveys were completed, and to ensure the accuracy of the data during the survey period. In 1995, surveyors designated as "Crew Chiefs" adopted the primary role as supervisor in all areas except in the Lincoln and Siuslaw districts. Survey stream segments were repeatedly sampled, either by floating or walking, during the spawning season to obtain counts of live and/or dead salmon. Counts of jacks (chinook salmon $\leq$60 cm fork length) were kept

Table 1. Standard spawning surveys for fall chinook salmon in Oregon coastal river basins classified into hatchery-influenced and wild stream segments, 1994 and 1995. F = fed fish; U = unfed fish; B = broodstock; W = wild index.

River basin or subbasin	Stream segment	Miles	Classification 1994	Classification 1995
	North Coast fishery management district			
Nehalem:				
Mainstem	Cook Creek	1.0	W	W
	Cronin Creek[a]	1.0	W	W
	Humbug Creek[b]	1.0	W	W
	East Humbug Creek	1.0	W	W
North Fork	Soapstone Creek	0.7	W	W
Salmonberry R.	Salmonberry River	0.5	W	W
	Tillamook fishery management district			
Kilchis	Clear Creek	0.6	U	W
	Little South Fork, Kilchis River	1.0	U	W
Wilson	Little North Fork, Wilson River	0.5	U	F
	Cedar Creek	2.8	U	F
Tillamook	Tillamook River[b]	1.8	U	F
	Simmons Creek	0.6	U	F
Nestucca	Clear Creek	0.8	F	F
	Lower Moon Creek[c]	0.5	W	W
	Niagara Creek[b]	0.4	W	W
	Lincoln fishery management district			
Siletz:				
Main stem	Cedar Creek	1.6	W	W
	Euchre Creek	1.0	W	W
	Sunshine Creek[b]	1.2	W	W
Rock Creek	Big Rock Creek	0.9	W	W
Yaquina	Upper Yaquina River[d]	2.0	W	W
	Grant Creek[b,c]	1.7	W	W
	Salmon Creek	0.6	W	W
Alsea:				W

Drift Creek	Lower Drift Creek	1.5	W	W
Five Rivers	Lower Lobster Creek	2.2	W	W
	Buck Creek[b]	1.0	W	W
North Fork	North Fork Alsea River	1.5	W	W
	Siuslaw fishery management district			
Siuslaw:				
Main stem	Sweet Creek	0.5	W	W
	Lower Whittaker Creek	0.3	W	W
	Upper Whittaker Creek	0.4	W	W
	Esmond Creek	1.0	W	W
North Fork	North Fork Siuslaw River	0.8	W	W
	Siuslaw fishery management district (continued)			
Lake Creek	West Fork Indian Creek	1.2	W	W
	Rogers Creek	1.3	W	W
	Lake Creek[b]	0.8	W	W
	Coos-Coquille fishery management district			
Coos:				
Millicoma River	West Fork Millicoma River[b]	0.5	F	F
	East Fork Millicoma River	0.5	F	F
South Fork	South Fork Coos River	1.0	B	B
	Williams River	1.0	B	B
Coquille:				
North Fork	North Fork Coquille River	1.0	U	U
	Middle Creek D	2.0	W	W
East Fork	East Fork Coquille River	1.0	U	U
	East Fork (above Dora) Coquille R.	0.3	U	U
Middle Fork	Middle Fork Coquille River	0.5	U	U
	Rock Creek	0.5	U	U
South Fork	South Fork Coquille River	1.0	U	U
	Lower Salmon Creek[b]	0.8	U	U
	South Coast fishery management district			
Floras Creek	Upper Floras Creek	0.5	W	W
Sixes River	Lower Dry Creek	1.7	W	W
	Upper Dry Creek	1.7	W	W

[a] *Not surveyed in 1994.*
[b] *Stream segments formerly composing the ODFW standard index, 1959-88.*
[c] *Not surveyed in 1994 or 1995.*
[d] *Surveyed 1.75 miles 1994.*
[e] *Stream segments representing south-migrating populations of fall chinook salmon.*

separate from adults. Secondary information such as weather conditions, water clarity, number of redds observed. Carcasses of spawned-out salmon encountered in all surveys are inspected for fin-clips and, when the adipose fin is missing, they are sampled for coded-wire tags by removing snouts. Scale samples for chinook salmon salmon are examined to estimate age composition. Sex, MEPS (mid-eye to posterior scale) length, sampling location, and date are recorded for each fish sampled.

Measures of Spawning Escapement

Spawning escapement is indexed as the peak count of live and dead fish observed in a given survey area. Peak counts are used to index spawning escapement in all survey areas except those conducted for middle Rogue fall chinook salmon in the Upper Rogue fishery management district.

Average peak count per mile in a given set of stream segments (S) is calculated as follows:

$$S = \left(\sum_{i=1}^{n} P_i\right) / \left(\sum_{i=1}^{n} m_i\right) \qquad (1)$$

where:

n = number of stream segments surveyed,
P_i = peak count of live and dead fish in stream segment i, and
m_i = miles surveyed in stream segment i.

Separate peak fish per mile and total carcass count per mile indexes are calculated for adults and jacks.

SECTION IV-B

North Oregon Coast (NOC) and Mid-Oregon Coast (MOC) Exploitation Rate Indicator Stock Studies

INTRODUCTION

Exploitation rate indicator stocks (ERIS) provide annual, post-season estimates of actual age-specific exploitation rates for a specified stock that can be applied to the aggregate. Coded wire tag data from certain large hatchery releases within each of several large stock aggregates are used to estimate annual fishery exploitation rates. The estimated exploitation rates coupled with available escapement data were used to make estimates of ocean harvest and total abundance for aggregates and to model the long term effectiveness of harvest with respect to the PST rebuilding plan. In addition to being used to estimate ocean harvest and total age specific abundance for stock aggregates, exploitation rate indicators are also used annually to assess the effectiveness of management actions in achieving desired fishery exploitation rates. Currently, coded-wire-tagged hatchery stocks serve as surrogate indicators for wild stock aggregates.

Oregon Department of Fish and Wildlife (ODFW) uses two exploitation rate indicator stocks, the Salmon River and Elk River, to assess marine survival of chinook salmon relative to changes in ocean harvest. Salmon River chinook are considered representative of the North Oregon Coast (NOC) far north migrating chinook stocks that include the Nehalem, Miami, Kilchis, Wilson, Trask, Tillamook, Nestucca, Salmon, Siletz, Yaquina, Alcea, and Siuslaw Rivers. Elk River chinook are considered representative of the mid-Oregon Coast (MOC) stock aggregate. This group is composed of chinook populations from the Coos, Coquille, Floras, Sixes and Umpqua River.

ELK RIVER EXPLOITATION RATE INDICATOR STOCK

Background

Oregon has developed the Elk River fall chinook stock as an exploitation rate indicator stock to represent the natural stocks in the mid-Oregon coast aggregate (MOC). To date the mid-coast group has not been included in the CTC exploitation rate analysis nor in chapter 3 section 9 of the 1999 agreement for harvest reduction triggers. The current form of the chinook model was unable to accept more stocks due to limitations inherent in the programming. With development of the new model, Oregon will petition to include these stocks in the model and exploitation rate analysis as well as in chapter 3 section 9 when the negotiations are reopened.

The development of the Elk River domestic stock began with the coded wire tagging at the CTC recommended level, of the 1990 brood. Prior to 1990 these fish had been tagged somewhat continuously since the 1977 brood. The tagging program had generally tagged about 25,000 to 35,000 smolts annually. In-river recovery efforts have been in place since 1970 and began with a research study to provide an estimate of the run size through a mark recapture experiment. This experiment was conducted for 11 years from 1970 –

80 by the Oregon Department of Fish and Wildlife. After the end of the mark recapture study, in-river recovery was scaled back but continued at a level sufficient enough to provide an index that could be used to reconstruct the run annually. A run reconstruction model was synthesized from the mark/recapture experiments that uses an index of annually sampled carcasses, catch and hatchery returns to estimate total ocean escapement. Run components are stratified by wild and hatchery origin fish based on scale pattern analysis of fish sampled on the spawning ground, in the fishery and the hatchery broodstock. Components of the run are derived from the annual sampling and used to estimate the number of coded wire tagged indicator fish returning to the river.

Study Area

Located in the Southwest corner of Oregon near Cape Blanco, the Elk River is a small and very unique salmon producing river on the Oregon coast. The river is located entirely in the Oregon Coastal Mountain Range. Peak discharges typically occur during the winter rainy season between November – February. Land ownership is dominated by National Forest in the uplands with private pastureland in the floodplain.

The river has no estuary and is bar bound in the late summer and early fall. As such adult salmon cannot migrate into the river until serious fall rains begin. The stock spawns later than many coastal stocks due to this anomalous characteristic of the river. The predominant anadromous salmon in the system is the fall chinook. Only small numbers of coho and late run winter steelhead enter the system to spawn. The ocean catch distribution of the fall chinook stock is similar to the other MOC stocks, and during the base period, occurred most often off WCVI and in PFMC fisheries (Figure 2). The age composition is classified as a mid-maturing stock meaning ages 2-5 are almost equally represented. These characteristics differentiate the MOC from the NOC stocks which have an ocean catch distribution off SEAK and North BC, and older age at maturity – predominated at age 4-5.

Objectives

The goals of the sampling program are: 1) Estimate the number of coded wire tagged chinook, by tag code, that are in the terminal run; 2) continue historic data collection to characterize the chinook run.

Specific sampling objectives are: 1) conduct a statistical creel survey to sample the catch of chinook; 2) assist with broodstock and hatchery collection tasks to recover coded wire tagged chinook, and other population characteristics; 3) sample the spawning grounds to obtain a random sample of spawning chinook.

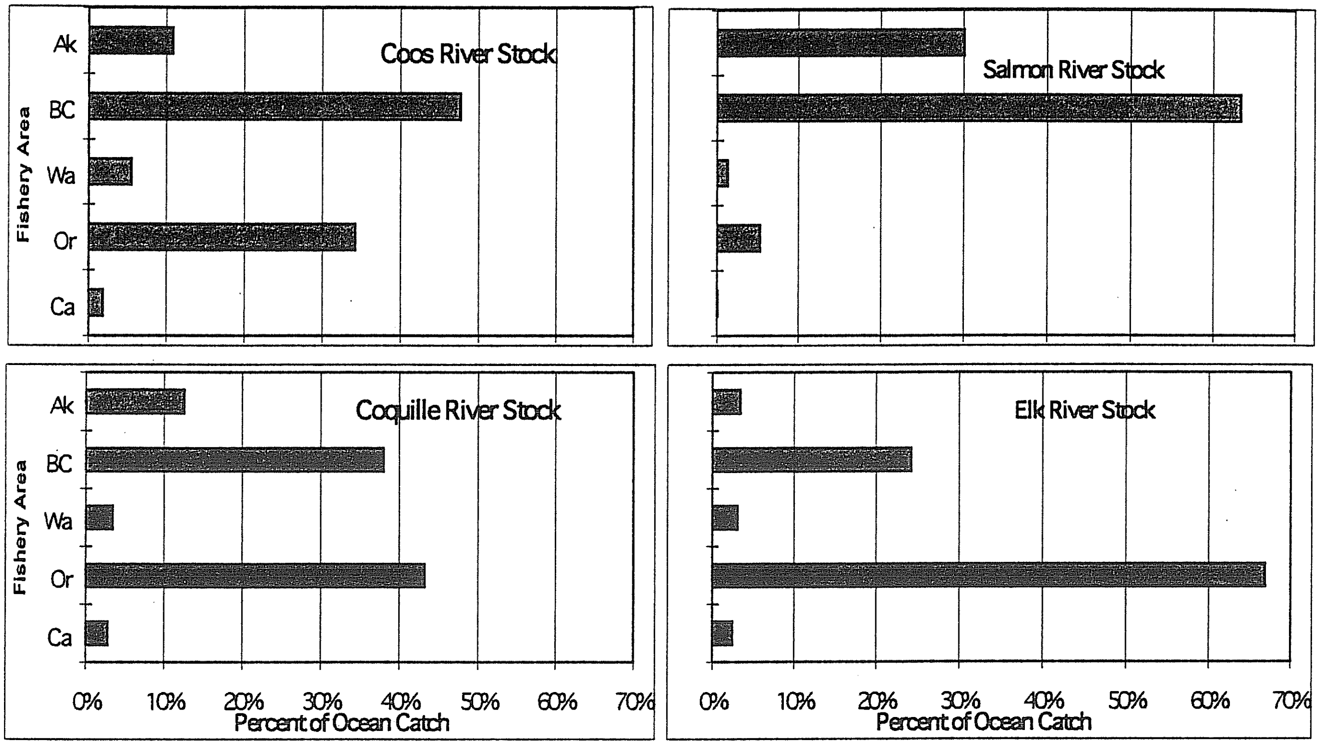

Figure 2. Ocean Catch Distribution of 2 MOC fall chinook stocks (Coos and Coquille) compared to the catch distribution of the 2 coastal Exploitation Rate Indicator stocks, 1983-90 broods combined.

SALMON RIVER EXPLOITATION RATE INDICATOR STOCK

Background

Since 1986, the Pacific Salmon Commission has funded the Salmon River Exploitation Rate Indicator Stock Study to assess marine survival of chinook salmon relative to changes in ocean harvest. Salmon River chinook are considered representative of the North Oregon Coast (NOC) far north migrating chinook stocks that include the Nehalem, Miami, Kilchis, Wilson, Trask, Tillamook, Nestucca, Salmon, Siletz, Yaquina, Alcea, and Siuslaw Rivers. Coded-wire tagged fall chinook salmon from Salmon River Hatchery are used to estimate the exploitation rate, incidental fishing mortality, catch distribution, and survival rate of this population aggregate. Ocean harvest of Salmon River chinook occurs primarily off of Alaska and British Columbia.

ODFW personnel estimate the total return of chinook salmon to Salmon River each fall. Chinook returning to the Salmon River are either caught in the recreational fishery in tidewater, are caught in the recreational fishery above tidewater, are captured at the hatchery or spawn in the river basin above tidewater. A statistical, roving creel survey is conducted in the bay and river to estimate harvest by anglers. The number of chinook collected at the hatchery for broodstock are counted and a mark-recapture experiment is used to estimate the spawning escapement. The total numbers of coded wire tagged chinook are estimated by brood year.

Escapement estimates are available from the Salmon River project since 1986. Total escapement of adult chinook to Salmon River has ranged from 2100-7500 fish. Angler harvest has been between 650 and 2000 adult chinook annually. Spawning escapement estimates have ranged from 1000-5200 adult chinook. Prior to 1986, standardized spawning surveys were used to assess trends in abundance by generating a peak fish per mile index.

Study Area

The Salmon River is a small stream that drains from the Coast Range Mountains on the north-central coast of Oregon. The basin is situated just north of the town of Lincoln City, and meets the ocean on the south side of Cascade Head. The river drains an area of approximately 195 sq. km. Normal stream flows in Salmon River range from a low of about 25 cubic feet per second (cfs) to a high of 6000 cfs. Average annual flow is approximately 400 cfs (basin plan). Low flows occur in late summer, with peak discharges generally in December or January.

The headwaters and upper mainstem Salmon River primarily flows through corporate timberlands, with minor federal holdings (U.S. Forest Service and Bureau of Land Management). Land use is dominated by commercial forestry. Extensive residential development exists along the lower five miles of the mainstem and three major tributaries: Slick Rock Creek, Bear Creek, and Panther Creek (basin plan). The tidewater and bay are dominated by pasture land and lowland marshes.

Salmon River is home to several species of salmonids, including chinook salmon (*Onchorynchus tshawystcha*), coho salmon (*O. kisutch*), steelhead (*O. mykiss*), and cutthroat trout (*O. clarkii*). Fall chinook salmon from Salmon River are far north migrating, rearing in the ocean primarily off Alaska and British Columbia. Salmon River fall chinook are a late maturing stock, returning to freshwater primarily at ages 3-6. Adults return to Salmon River from August through November. Spawning occurs primarily from October to December. Peak spawning is in November. Juvenile chinook move from the area of spawning to rear in the lower mainstem and estuary (basin plan). Chinook juveniles migrate to the ocean as sub-yearlings.

In addition to naturally producing populations, hatchery fall chinook (and coho) salmon are released into the system from Salmon River Hatchery. The hatchery is located at river km 8, at the head of tidewater. Construction of the hatchery was completed in 1976, and fish releases began in 1977. Fall chinook releases have ranged from approximately 100,000 to 330,000 fish annually. Two additional releases in the system occurred in 1933

(10,000) and 1940 (50,000). Current production is 200,000 chinook smolts. Since 1987, these releases have been 100% coded wire tagged.

Objectives

The goals of the sampling program are: 1) Estimate the number of coded wire tagged chinook, by tag code, that are in the terminal run; 2) continue historic data collection to characterize the chinook run.

Specific sampling objectives are: 1) conduct a statistical creel survey to sample the catch of chinook; 2) assist with broodstock and hatchery collection tasks to recover coded wire tagged chinook, and other population characteristics; 3) conduct a mark-recapture experiments to estimate spawning escapement; and, 4) conduct spawning ground surveys to recover coded wire tagged fish.

SECTION V

PROJECTS FUNDED BY OTHER SOURCES

SECTION V-A

Inventory of Spawning Habitat in Mainstem Reaches of Oregon's Coastal Rivers and Streams

Inventory of Spawning Habitat in Mainstem Reaches of Oregon's Coastal Rivers and Streams

Sampling Plan

Brian Riggers
Oregon Department of Fish & Wildlife
Coastal Salmonid Inventory Project

June 2000

INTRODUCTION

The Oregon Department of Fish and Wildlife (ODFW) is seeking funding to inventory fall chinook spawning habitat along Oregon's coastal rivers and streams. This inventory is intended to enhance the survey methodologies that were recently implemented to improve escapement estimates of Oregon's of fall chinook salmon. Formerly, funding for this study was initiated through the US Letter of Agreement (LOA) and is administered by the Chinook Technical Committee (CTC) of the Pacific Salmon Commission. The CTC is comprised of fishery scientists that are responsible for the abundance-based management of north migrating fall chinook salmon stocks covered by Pacific Salmon Treaty. Previous fall chinook monitoring programs consisted of conducting 56 standard surveys, totaling 45.8 miles annually. Although this approach may be sufficient to detect long term trends in fall chinook abundance, they do not supply the CTC of the Pacific Salmon Commission the information required for their management program. Abundance estimates extrapolated from these standard surveys rely on peak counts and are expressed as fish per mile. This procedure assumes that standard survey areas are representative and that the habitat database accurately reflects the extent of spawning habitat. Neither of these assumptions has been verified and are generally thought to be inaccurate. Accurately determination of the extent and distribution of spawning habitat is a prerequisite to a random survey design that will result in more reliable estimates of spawner escapement. It is also critical to future land use planning in the watershed as it relates to wild chinook salmon production.

The North Oregon Coast (NOC) and Mid Oregon Coast (MOC) are the two north-migrating stock aggregates identified as originating from Oregon coastal streams. There are approximately 700 miles of NOC and MOC mainstem habitat currently listed in the ODFW database as being available for chinook spawning (Table 1), but little is known of the actual amount of gravel available for spawning. Studies have shown that carcasses are retained in the generally vicinity of the spawning grounds (Cederholm et al. 1989), particularly during the first days after death (Glock et al. 1980.) Documenting the extent and location of suitable fall chinook spawning habitat in mainstem reaches may narrow the sampling universe and improve the efficiency of the fall chinook survey procedures that are currently being evaluated (Riggers et al. 1998). This will ultimately result in improved, more efficient monitoring methods and reliable escapement estimates. The objective of this study is to document the size and distribution of spawning habitat areas within mainstem and large tributary reaches of NOC and MOC river basins. This information will be incorporated into the database and used as a framework to refine the survey design for estimating fall chinook escapement.

Table 1. Estimated spawning habitat (miles) available to fall chinook in NOC and MOC river basins. Spawning mileage is partitioned into tributary and mainstem reaches.

	Fall chinook spawning habitat (miles)		
Basin	Total	Within coho spawning distribution (Tributary)	Downstream from coho spawning distribution (Mainstem)
North Oregon Coast (NOC)			
NECANICUM RIVER	26	18	8
ECOLA CREEK	3	3	0
NEHALEM RIVER	122	75	47
MIAMI RIVER	8	6	2
KILCHIS RIVER	29	17	12
WILSON RIVER	67	34	33
TRASK RIVER	59	32	27
TILLAMOOK RIVER	22	21	1
SAND LAKE	3	3	0
NESTUCCA RIVER	124	62	62
NESKOWIN CREEK	4	4	0
SALMON RIVER	33	24	9
SILETZ RIVER	98	35	63
YAQUINA RIVER	78	42	36
ALSEA RIVER	147	79	68
YACHATS RIVER	16	11	5
BOB CREEK	1	1	0
TENMILE CREEK	8	8	0
CAPE CREEK	2	2	0
SIUSLAW RIVER	238	123	115
Total for NOC	1,089	599	490
Mid Oregon Coast (MOC)			
COOS RIVER	128	56	72
COQUILLE RIVER	191	88	103
NEW RIVER	5	5	0
FLORAS CREEK	10	10	0
SIXES RIVER	34	14	20
ELK RIVER	29	13	16
Total for MOC	396	186	210
Total	1486	785	701

APPROACH

A study by Hodgson and Jacobs (1995) successfully documented the existence of fall chinook spawning habitat in mainstem reaches and the subsequent use by spawners. They indicated that 89% of fall chinook spawners were associated with habitat units identified in the study. A modified version of the procedures and methods established by this study will be used to inventory the extent and distribution of spawning habitat within the mainstem reaches and large tributaries of selected coastal basins. The location of each habitat unit will be documented through the use of GPS receivers.

Mainstems are classified as the portion of river or tributary that is too large to support spawning activity of coho salmon. This stratification was determined from the local knowledge of district biologist and is reflected in ODFW Spawning Habitat Database. Surveys will be conducted from the head of tide water to the point where coho spawning begins. In year 2000, priority will be given to the Nehalem and Umpqua River Basins. These are indicator basins for the on-going study to calibrate methods to estimate fall chinook escapement. (Riggers et al. 1998). Information gathered during this inventory will used for revisions and refinements of the fall chinook survey design. A list of these of mainstem and large tributary reaches to be inventoried will be distributed to the field crews.

DEFINTION OF CHINOOK SPAWNING HABITAT

We will modify the criteria for identifying chinook spawning habitat used by Hodgson and Jacobs (1995) to reflect only those components applicable for mainstem and large tributary reaches. We will not attempt to rank the quality of habitat due to the vast array of interpretation possibilities and the lack of utility from such an assessment. Location of spawning habitat will be documented by reach and unit number. A reach is defined as a section of stream from the mouth or a named tributary to a named tributary or from the mouth or named tributary to the end of habitat. A unit is defined as a contiguous qualifying patch of spawning gravel with an area of a least 4 square meters.

There are a number of physical parameters that must be considered in order to determine whether any particular habitat unit is suitable for chinook spawning activity. Water depth and velocity, substrate composition, streambed slope and hydrological conditions are generally cited as the factors most instrumental in the selection process of chinook spawning habitat (Geist 1999). We will follow the criteria described in Hodgson and Jacobs (1997) for most of these factors in order to qualify habitat as spawning units. Some of these criteria are difficult to quantify during low-flow stream conditions or without sophisticated equipment and must be assessed individually.

Location of Habitat Units

Optimal spawning gravel provides spawners with constant sub-gravel flow; assuring buried eggs will receive the required flow of oxygenated water necessary for their survival. These conditions are most readily found, but not limited to the pool-riffle interface known as "tailouts" (Figure 1). Quantifying sufficient hydrological conditions that are conducive to downwelling may be problematical; thus an intuitive approach will be taken. Substantial flow, water depth, unit orientation and substrate are all factors to consider when making judgement of a qualifying unit. Hydrological conditions required for spawner activity may be found at various locations within the stream channel. The proportion of the unit within riffles, glides and tailouts will be documented. Gravel deposited in low energy areas, such as the inside bend of a stream channel, may not be suitable for spawning due to lack of intra-gravel flow. Qualifying units should consist of uniform substrate that is associated with shallow slope angles, and located in mid-channel.

Pools

Recent studies imply a correlation of spawner abundance to channel types with high pool densities (Montgomery et al. 1998). This relationship could be associated with cover and resting area provided from pools, or just a function of low gradients associated with pools. We will document pool habitat in conjunction with spawning habitat during this inventory. Each pool will be assigned a sequential unit number for each reach. Pool units will be distinguished from spawning units by recording depth on the data form. Pools are defined as a portion of a stream with reduced current velocity, often with deeper water than the surrounding area. Each qualifying pool unit should have a width of at least 50% of the wetted channel width, and a length of at least 1 wetted channel width.

Water Velocity

Stream velocity is another important component to consider when determining suitable spawning habitat of fall chinook. The Hodgson and Jacobs (1997) study selected a criteria derived from the literature ranging from 0.3-0.8 m/s. We will again use an intuitive approach for qualifying; otherwise it would require calibration to summer flows and measuring instruments. Water velocities flowing over qualifying spawning units should range from a minimum of perceptible water flow to a maximum of apparent surface turbulence, but not dominated by whitewater.

Substrate Size

Chinook have been observed spawning in a wide range of gravel size and substrate composition. Our criteria for substrate size and composition will be based on the Hodgson and Jacobs study as determined through their literature search. At least 50% of the qualifying unit should consists of substrate within the large gravel through small cobble size range. Gravel should be of sufficient depth and not a thin layer over bedrock. A rule of thumb is that you should be able to bury your foot into the gravel.

Unit Depth

Hodgson and Jacobs reports highly variable water depth requirements of fall chinook spawners as cited in the literature. They selected a 24-100 cm range of water depth over the spawning habitat during spawning flows. Summer flow will create very difficult conditions to

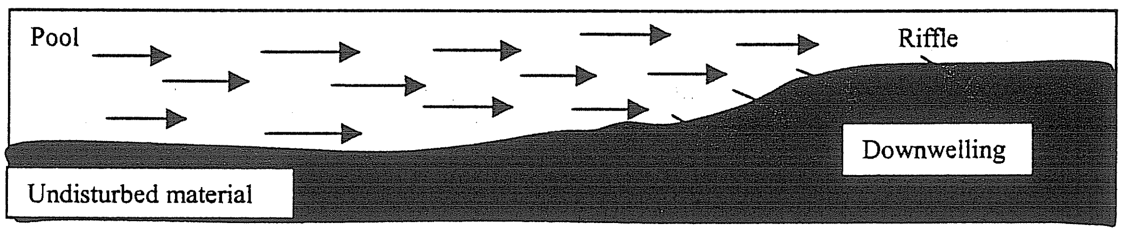

Figure 1. The pool-riffle interface creates the optimal downwelling conditions preferred by chinook salmon for spawning (taken from Groot and Margolis 1991).

gauge water depth during winter flows. We will use their optimal depth criteria calibrated to summer flows of 15-60 cm. This approximately equates to water that is from ankle to knee deep.

SURVEY PROCEDURES

The habitat inventory will begin in mid-June and continue through August or early September. This time period was selected to take advantage of summer flow conditions and good visibility. A two-person crew who should expect 10 to 12 hour workdays will conduct the surveys. Overnight camping may be necessary to maximize survey efficiency in remote locations. Personnel will be compensated at the standard per diem rate, and camping fees reimbursed. Mainstem reaches will be floated in kayaks or walked depending on flows and navigability hazards. Spawning and pool habitat will be identified, measured, reach and unit number recorded, and location documented from GPS receivers (UTM).

Inventory Surveys

Consult the list of reaches to be inventoried. This list is organized from upper reaches to lower reaches with start and end points from upper boundaries to lower boundaries. It is easiest to survey downstream, so begin at the upper most location and work down the list. Float or walk downstream scanning the channel bottom for habitat that meets our selected criteria. Habitat that matches our criteria will be designated as a spawning unit. Partners should discuss the criteria and both should be in agreement before designation is made. Measure each unit using a tape measure or range finder. One crewmember stands on the edge of the unit while the others walks to the widest portion of the unit. Record the unit width on the data form. Repeat the procedure for the unit length and channel width. Direct measurement is the preferred method when habitat is sparse and there are few units to contend with.

Surveyors will be given a list of reaches to be inventoried. This list will include Basin, Subbasin, Reach ID, Reach Name, Reach Length, Start and Endpoints. Survey downstream and assess all gravel areas to whether they qualify as a habitat unit. Each contiguous habitat area that conforms to the stated criteria will be designated as a numerical unit and recorded. Units should be recorded in chronological order from the upper boundary to lower boundary of each reach. Surveyors will verify the upper boundaries of the mainstem strata in the given basins.

Verification Surveys

Spawner surveys will be conducted during the following fall spawning season as part of the ongoing Salmonid Inventory Project. Randomly selected reaches in the Nehalem, Coos and Smith River basins will be used to verify spawner use of each identified habitat unit, or use of areas not identified as a spawning unit. Surveyors will document the presence and density of spawners and Redds for each habitat unit within the survey.

DATA FORM

The data forms (Appendix A) are printed on waterproof paper and are intended to be filled-out in the field. One form should be filled out for every reach listed, even if there are no habitat units identified. The following is a summary of the information that is to be recorded on the data form and how or where to obtain it:

Surveyors Print the name of each surveyor (this can be found on your drivers license or birth certificate)

Date Record the date the survey was conducted, consult a calendar if you are unsure of the days date.

Basin Record the river basin in which the surveyed reach is located. This information can be found on the list of reaches to be inventoried.

Subbasin Record the river subbasin in which the surveyed reach is located. This information can be found on the list of reaches to be inventoried.

Reach Record the name of the reach surveyed. This information can be found on the list of reaches to be inventoried.

Reach # Record the reach identification number. This information can be found in the database and on the list of reaches to be inventoried

Weather Choose the appropriate code to describe the overall weather conditions during the survey.

C - Clear
PC - Partly Cloudy
O - Overcast
R - Rain

Visibility Choose the appropriate code as it applies to the ability to assess habitat throughout the survey.

C - Clear
H - High Glare
T - Turbid/Tannins

Quad. Map A 7.5 minute map will be provided. The quadrangle name is on the upper right hand corner.

Unit # Record sequential numbers identifying each qualifying spawning habitat unit within the reach. Units should be in order of upper reach to lower reach.

Coordinates Record the UTM coordinates of each unit as acquired from you GPS receiver. If coordinates can not be obtained due to topography or canopy closure, mark the location a topographic map.

Area/Volume Record the measured width, length and depth (for pool units) of the qualifying habitat unit.

Chan. Width Record the measured bankfull channel width where the unit is located.

Chan. Form Identify the channel form and enter the appropriate two-letter code in this column.

CB - Constrained by Bedrock (bedrock dominated gorge)
CH - Constrained by Hillslope
CF - Constrained by alluvial Fan
US - Unconstrained-predominantly Single channel
UA - Unconstrained-Anastomosing (several complex interconnecting channels)
UB - Unconstrained -Braided channel (numerous, small channels often flowing over alluvial fans.
TC - Terrace Constrained
CA - Constrained by Alternating terraces and hillslope
CL - Constrained by Land use (road, dike, landfill)

Substrate Estimate the percentage of each substrate classifications, a mutual consensus between both crewmembers should be made for each reach:

Fines - silt and sand, smaller than pea size grains.
Small gravel - size range from that of a pea to that of a golfball.
Large gravel - size range from that of a golfball to that of a baseball.
Small Cobble - size range from that of baseball to that of a grapefruit.
Large Cobble - size range from that of grapefruit to that of a basketball.
Boulder - larger than a basketball
Bedrock - large, continuous, non-transported underlying rock

Unit Location By consensus of both crewmembers, enter the estimated proportion of the qualified unit that is within a **Tailout**, **Riffle** and **Glide**.

Channel Features By consensus of both crewmembers; enter the code that best describes channel features that may promote carcass deposition. Note whether these features are vegetated with the addition of a "v" next to the two-letter code. Include the UTM coordinates and area dimensions of these features.

Pb(v) - Point bar (vegetated)
Mb(v) - Mid channel bar (vegetated)
Sb(v) - Side channel bar (vegetated)
Is(v) - Island (vegetated)
Bw - Backwater
Sc - Side channel

Comments Record a general description of the reach and any problems encountered. Document anything that either crewmember feels is important to the study (landowners, fish presence, wildlife observations, riparian features etc.). You may also add any component of the inventory that you believe the data does not capture; no consensus is necessary for this portion of the data form.

EQUIPMENT

Proper equipment is an important aspect of a successful, safe survey season. All the necessary equipment will be assigned to you, and it will be your responsibility to maintain it. Comfort and safety are essential for maintaining a positive work attitude and efficient and accurate data gathering. The following is a list of equipment and supplies that will be provided for you prior to the start of the field season. Check your inventory against this list before embarking into the field.

1) Maps - USGS topographic maps will be helpful for locating reach boundaries and following your exact location. A state forestry map will be most useful for navigating roads.
2) Kayaks - Inflatable kayaks and related equipment will be supplied to make surveys more efficient.
3) Attire - Chest wader, felt soled wading shoes, raincoat, polarized sunglasses and a safety vest will be issued.
4) Measuring instruments - A GPS receiver (extra batteries), hip chain (extra string), and a 50-meter tape measure, depth staff and range finder will be issued.
5) Data recording materials - A clipboard with an ample supply of data forms and pencils, and a copy of this manual should be included on every survey.

LITERATURE CITED

Cederholm, C. J., D. B. Houston, D.L. Cole, and W. J. Scarlett. 1989. Fate of Coho Salmon (*Oncorhynchus kisutch*) Carcasses in Spawning Streams. Can. J. Fish Aquat. Sci. 46: 1347-1355.

Geist, D. R. 1999. Redd Site Selection and Spawning Habitat Use by Fall Chinook Salmon. Oregon State University, PhD Thesis, 1999, 132 p.

Glock, J. W., W. G. Hartman, and L. Conquest. 1980. Skagit River Chum Salmon Carcass Drift Study. Seattle City Light., Seattle WA. 48 p.

Groot, C. and L. Margolis, 1991. Pacific Salmon Life Histories. University of British Columbia Press, Vancover BC. 312-393.

Hodgson, B. L. and S. E. Jacobs. 1997. Inventory of Spawning Habitat used by Oregon Coastal Fall Chinook Salmon. Oregon Department of Fish and Wildlife, Project Report, August 1997, 171 p.

Montgomery, D. R.,E. M. Beamer, G. R. Pess, and T. P. Quinn, 1999. Channel Type and Salmonid Spawning Distribution and Abundance. Can. J. Fish Aquat. Sci. 56: 377-387.

Riggers, B. L., S. E. Jacobs, and J. White, 1998. Calibration of Methods to Survey for Fall Chinook Salmon in North Fork Nehalem and South Fork Coos Rivers. Oregon Department of Fish and Wildlife, Annual Report, September 1998, 27 p.

CHINOOK SPAWNING HABITAT INVENTORY
FIELD DATA FORM

rs______________ Date______________ Weather______________

______________ Reach______________ Visibility______________

n ______________ Reach #______________ Quad. Map______________

UTM Coordinates		Area/Volume			Channe	Channel	Substrate (%)							Unit Locati	
X Easting	Y Northing	L	W	D	Width	Form	Fines	Sm Grvl	Lg Grvl	Sm Cobl	Lg Cobl	Bldr	Bedrk	Tailout	Riff