GUIDE TO PROJECT OPERATIONAL PLANS

FOR DIVISION OF COMMERCIAL FISHERIES, REGION I

2nd Edition

by

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and
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[1] The Regional Information Report Series was established in 1987 to provide an information access system for all unpublished divisional reports. These reports frequently serve diverse ad hoc informational purposes or archive basic uninterpreted data. To accommodate timely reporting of recently collected information, reports in this series undergo only limited internal review and may contain preliminary data; this information may be subsequently finalized and published in the formal literature. Consequently, these reports should not be cited without prior approval of the author or the Division of Commercial Fisheries.

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INTRODUCTION

The Operational Plan is a formal, written description of the goals and objectives of a project, together with a specific description of how the project leaders will meet those objectives. The plan is a means to communicate how the project will be carried out in precise scientific language. The operational planning process is a shared endeavor between project leaders, their assistants, research coordinators, regional supervisors, and biometricians. Peer review is the very basis of American science, and project peer review is almost impossible without a written plan.

Use plain, simple, straightforward writing in an operational plan. Please avoid jargon, pretentious words, and please avoid acronyms. *Methodology* is a classic example of a pretentious word – and a word that is almost always misused. It means the theoretical analysis of the methods appropriate to a field of study. Use the word *method* instead of *methodology* if you mean a procedure or a systematic means of accomplishing something. Use the word *use* instead of *utilize* if that is what you mean (we will *use* mark-recapture *methods*). There are lots of other pretentious words that creep into ADF&G writing. Please look for these and help stomp them out. Acronyms do not save any paper, and eventually they will be an obstacle to some reader. There is absolutely no reason to use *BAA*, *BEG*, *CWT*, *NLS*, *AWL*, or any of these other non-descriptive nouns when the descriptive words takes so little effort. Spell out the words *Southeast Alaska* – do not use the abbreviation of *SEAK* in formal operational plans. There is one exception to the acronym rule: The initials of well-known organizations are acceptable if the organizations are commonly known by their abbreviated names (e.g., ADF&G, USFWS, FRED, NSRAA, PWSAC, etc.).

The statement of the study's objectives is the most important part of the plan. For our plans, the objectives must be stated in such a way that a reviewer can know whether or not each of the objectives was met at the end of the study. In other words, the objectives must be verifiable. For example, "produce the best possible estimate of the population parameter," is not an acceptable objective because there is no impartial way to judge this statement when the study is completed. Similarly, "estimate the true population parameter to within 5%, 95% of the time," is not an objective that can be verified at the end of the study. At no time will we ever know the true population parameter, so there is no way to know if an estimate is within 5% or not. We will only have the one outcome of the study, so "95% of the time" does not have any meaning here. Plans with objectives that cannot be verified will be returned to the author for revision.

These plans are easier to read if the first sentence of each paragraph serves a "topic sentence." Put important new ideas in at the beginning of paragraphs and state important points and conclusions at the end of paragraphs for emphasis. Have a look at Strunk and White (2000) for advice on good, clear writing.

Certain sections, especially the Introduction, will need to be written in paragraph form. For other sections, simplified forms, such as bullets or outlines often are more useful to emphasize key points and simplify presentation. Consider the following paragraph, which is very typical of the style of writing for these plans.

> Other tasks will be done or may be done as part of this study. We will estimate mean length (the 95% confidence interval should be <10mm) of chinook salmon. Additionally, the escapement past Canyon Island of "small" (≤400 mm mid-eye-to-fork) chinook salmon will also be estimated, providing tagging and recovery totals are adequate. Another primary task of this project is to recover coded wire tags from spawning adults to determine the marked fraction of each year class carrying coded wire tags, which is used to estimate smolt production and marine harvests (objective criteria are covered in a separate operational plan for 2001 entitled "Production of chinook and coho salmon in the Taku River").

An alternate, bulleted form, seems easer to grasp at a glance:

- Estimate mean length (mid-eye-to-fork, so the width of the 95% confidence interval is less than 10 mm) of chinook salmon
- Estimate escapement past Canyon Island of "small" (≤400 mm mid-eye-to-fork) chinook salmon, if tagging and recovery totals are adequate
- Recover coded wire tags from spawning adults to determine the marked fraction of each year class carrying these tags. The information is used to estimate smolt production and marine harvests in the project Production of Chinook and Coho Salmon in the Taku River.

To simplify the task of reading and studying these plans, we want a predictable format, but we also want to give authors flexibility. For that reason, we have not developed a rigid standard. Below is a preferred outline that we suggest you follow. An example plan is included in the Appendix.

PROJECT OPERATIONAL PLAN OUTLINE

All plans should be organized into three major sections:

- Title page
- Synopsis (or Executive Summary)
- Detailed plan

Title page

The title page must have the following three elements:

- Title
- Name of the principal investigator and other assisting personnel (including consulting biometrician)
- Place for the signature of the appropriate regional research supervisor, a biometrics reviewer, and the regional supervisor

In almost all cases, there should be one *principal investigator*. This is the one person who is legally responsible for the management of the budget, and the person that will be held accountable for problems with reporting, fraud, or scientific misconduct. Usually, the principal investigator is the fishery biologist III assigned to the project. The principal investigator is not necessarily the person most involved in the actual management of the project; the day-to-day manager of the project should be listed as the *project leader,* if this is not the same person as the principal investigator.

Alternatively, in addition to the principal investigator, one or more individuals can be listed as *co-investigators,* if the project requires close collaboration. In the case of a project that is being run as a graduate student's thesis project, the student's university faculty advisor should be listed as a principal investigator. The student should be listed together with the primary ADF&G staff member under the heading of *co-investigators*.

Synopsis

The synopsis is also known as *the statement of work*. Think of it as the executive summary of the plan. This part of the plan should fit on one or two pages, and it should be organized into the following seven sections:

- Need (or Goals)
- Benefits
- Objectives
- Procedures
- Deliverables

- Location
- Budget Summary

Need (or Goals)

The statement of need provides the justification for this project, and describes scientific question or resource issues to be addressed. A statement of *goals* can replace this statement, as the need and goals are two ways of addressing the same thing.

Goals and *objectives* are usually used as synonyms – but these words mean different things for our purposes. A *goal* is the overarching purpose for a study, and the *objectives* are the specific steps that must be checked off to reach the goal. For example, a *goal* might be to manage a salmon stock for the largest possible sustainable yield. The *objectives* might be to (1) establish an escapement goal, (2) develop an inseason escapement monitoring system, and (3) close the fishery to all fishing in every case when the projected end-of-the-year escapement is not going to be at least 80% of the escapement goal. In general, the goals of the study should be discussed in the Introduction and the statement of Need, and the objectives should be listed, one by one, in the Objectives section.

Benefits

A statement of benefits explains how results from the project will benefit the public and the resource. This is where the *needs* are linked to the *objectives*.

Objectives

This is the most important part of entire plan, and the wording should be crafted with that in mind.

Again, the statement of objectives is an itemized list of specific, measurable, or observable things that will be accomplished by this project. These objectives appear in two places: in the Synopsis and in the Detailed Plan, described below. Of course, all of the objectives listed in the Synopsis should also be in the Detailed Plan, and vice versa, and the wording should be the same in both places. For a description of the differences between goals and objectives, refer three paragraphs under Need (Goals), in the Synopsis section just three paragraphs above.

Again, do not list objectives that cannot be determined to have been met or not at the end of the study. Examples of good objectives include, "Estimate the spawning stock size so that the estimated coefficient of variation is less than 5%," "Mark all fish present on July 15," or "Estimate the total number of sonar targets in the lake so that the width of the 95% confidence interval is less than 20% of the estimate." An example of an unacceptable objective is, "Estimate the spawning stock size of sockeye salmon, such that the estimate is within 10% of the true abundance 95% of the time." As previously mentioned, at the end of the study, we will not be able to tell if we met this objective or not. The difference between the true abundance and our estimate is unknowable. Also, notice that it is not clear how to evaluate what will have happened “95% of the time,” because we will be evaluating the success of this one study by itself — without reference to all the statistical outcomes in all other, similar studies.

Procedures

The description of procedures briefly explains the general methods to be used in this project. In general terms, explain experimental or sampling designs, how data will be collected, and the analyses to be performed. In this part of the plan, avoid complicated equations and technical terms. Descriptions like, “and then the data will be analyzed using analysis of variance,” or “mark-recapture methods will be used to validate the weir counts,” are about as detailed as this section should be.

Deliverables

Deliverables are the quarterly, annual, or final reports that must be written to fulfill the project requirements. Quarterly reports are generally one or two page summaries, with information on budgets, data collected, and whether project deadlines for the previous three months have been met. Annual reports contain the full analysis of data collected during the previous field season. Final reports are written for projects with specific ending dates, and resemble annual reports. For this section, list types of reports (quarterly, annual, or final), and their due dates.

Location

The description of the location should provide a specific, geographic site of the populations to be studied, or where other data will be collected. Include a description of specific lakes, streams, estuaries, access points, fisheries, and so forth.

Budget Summary

In this section, describe how much money is available by line item. Multiyear budget summaries will be necessary for projects that have a specific ending date. List the budget manager and all personnel that are funded by the project, by name and PCN.

Detailed Plan

The Detailed Plan should contain up to ten or so sections, and each section should go into considerable detail. The following is a suggested list of sections. The items noted with an asterisk are required for any field project.

- Introduction*
- Objectives*
- Data Analysis*
- Schedules and Reports*

- Study Design
- Data Collection
- Data Reduction
- Responsibilities*
- Literature Cited*
- Appendices

Introduction

The Introduction should provide a context for the project. You should review relevant literature and discuss previous attempts to do this kind of study. After reading this section, the reader should understand the problem you are trying to address, and have some understanding of what others have previously done with this kind of problem.

Objectives

Make objectives specific. Wherever practical, include a measurable value or criteria, but be sure to include some objectives that tie into the larger goals of the study. A measurable objective might be "to collect at least 400 tissues samples for genetic analysis, by week" or "measure at least 40% of the scales recovered in the escapement." Still, a plan with these objectives need the additional objectives of "use genetic stock identification techniques to estimate the stock proportions in the fishery mixture," or "develop age structure estimates of the escapement" to tie into the larger goals of the study. In other words, include sampling objectives (e.g., "collect at least 60 heads for otolith sampling," or "measure every 9th fish"), as well as project objectives (e.g., "determine the proportion of hatchery fish present such that the sample coefficient of variation is less than 10%," or "determine whether zooplankton densities have decline."). For a description of the differences between goals and objectives, refer back to Need (Goals) in the Synopsis section, above.

We made the following point a couple of times already, but we repeat it for emphasis: state each objective in such a way that at the end of the study a reviewer will know for sure whether or not it was achieved.

Justification for the sample sizes should be in the Study Design section, not in the Objectives.

Study Design

This section should be written in the future tense, as a description for a reviewer or a scientist trying to understand the project.

If the study is primarily about sampling, describe sampling using appropriate sampling terms. Name what you consider to be the *statistical universe* and the *sampling units*. The statistical universe is that collection of things you will make inference about, and each thing in that universe is called a sampling unit. If a plan calls for sampling the escapement to determine the age class distribution of the return, that indicates muddled thinking about the statistical universe: the age class distribution of the catch might be very different from the distribution in the escapement – especially if the harvesting method is size selective. Here, the author wants the *return* to be the statistical universe, but this universe must be partitioned into two sampling domains – the catch and the escapement. Both sampling domains must be sampled to make an inference about the age distribution of total return. In some surveys, the boat or landing is the appropriate sampling unit, and the number of fish on the boat is just an attribute of the sampling unit. In other cases, the fish are the sampling units.

Spell out specific, desired sample sizes and expected precision. Consider how the sample is to be generated, and write this down clearly. Mention sampling goals and provide a brief outline of your reasons for choosing these sample sizes. Do not gratuitously pair the word "random" with the word "sample." A *random sample* is a specific kind of sample (again, refer to Thompson 1992 as the standard reference on this subject).

Variance and *sampling error* are not the same thing. Animals within a population might vary among each other, and you may estimate a mathematical variance of some quantitive measure – if you have a *random sample*. Recall that an unbiased estimate of the variance parameter is not achievable with just any sample. An estimate of the population's *variance* is often an intermediate step in the calculation of some measure of *sampling error*, but don't confuse these two things. *Sampling error* is the difference between the true population parameter and the estimate that is caused by sampling, as opposed to examining every element in the statistical universe. *Non-sampling error* is the same as *bias*, which means a systematic inaccuracy in the estimation process. Note that *data* are not *biased.* B*ias*, or lack of it, refers to parameter estimates. Similarly, an estimate is not *biased* just because it is not the same as the true underlying parameter value. If all of the animals will be counted or measured, usually this is called a *census* (i.e., sample size and population size are the same). In this case the sampling error is zero, but the variance (among animals within the population) is almost certainly not.

If the study uses techniques like analysis of variance, describe the construction of hypothesis test, experimental units, error terms, and expected mean-squared errors.

If statistics are modified, describe and defend these modifications. Include a literature citation for standard methods. However, when citing a source for methods, the methods must be completely described within that citation. Unpublished statistical methods should be fully developed and described in an appendix.

Talk about the mechanics of sampling. Describe the sampling gear, the means by which it will be used, and how samples are to be handled. Be sure to be specific about what information the sampling crews are to record, where it is to be recorded, and how this information will accompany the samples.

Data Collection

The data collection section contains descriptions of types of data collected, and protocols for collecting them. Consider using further subheadings, bulleted forms, or outlining to clarify the descriptions. This should be written in the future tense as a description for a reviewer or a scientist trying to understand the project. The following paragraph is an example taken from the *data collection subsection* of an operational plan:

> Every coho salmon captured at the fish pass will be counted, visually inspected for the presence of a missing adipose fin, and passed through a detector to determine the presence of metal (indicating a coded wire tag) in its snout. Fish that are missing their adipose fin but have no indication of metal in their snout will be sacrificed for closer inspection for a coded wire tag (in the Tag, Age, and Mark lab). During the first several weeks of sampling, every coho salmon will also be sampled for scales, length (nearest 5 mm, mid-eye-to-fork), and sex (visual examination of secondary maturation characteristics). All data will be recorded on the appropriate forms noted below.

Later, these authors added a very useful summary that was written in the form of instructions to the samplers:

> In Summary:
>
> (1) count **every** coho salmon encountered; check each fish (regardless of size) for an adipose fin and metal (a coded wire tag) in its snout, and record all data on the appropriate form (Daily Trap Sampling Summary Form or Adult Coho Cumulative Summary Form Appendices A1, A2); **and**
>
> (2a) sample **every** coho salmon for length, scales, and sex. Be sure to gather ageable scales by taking scales from the preferred area. Record data on ADF&G Alternate Age Weight Length Version 1.0; **or**
>
> (2b) if an unexpectedly large return occurs, discontinue (2a) above, and sample **every-other** coho salmon for length, scales, and sex. Also determine the relative size (jack = under 16 inches or 1-ocean adult = 16 inches or more) of every fish not measured for length. Be sure to gather ageable scales by taking scales from the preferred area. Record data on an ADF&G Alternate Age Weight Length Version 1.0 form.

Data Reduction

If this section is included in the plan, the author should use it to outline the path data will take from the field to final analysis. This section should also be written in the future tense as a description for a reviewer or a scientist trying to understand the project. The following is an example.

> It is the responsibility of the field crew leader to insure that all data are recorded on a daily basis. Data forms must be kept up to date at all times. If time allows and if a computer is available in the field, Daily Sampling Summary and Adult Coho Cumulative Summary forms will be transferred from field forms to EXCEL spreadsheet files. Otherwise, this step will be performed in the office. Data will be

sent to the Petersburg ADF&G office at regular intervals and inspected for accuracy and compliance with sampling procedures.

Once the data has been transferred to EXCEL files, the original field forms will be compared with the electronic files and error checked. Inspection for errors will include: mathematical errors, incorrect dates, transposed nonsensical lengths (i.e., 360 mm when the fish was actually 630 mm), correct length measurement method used. Scale cards will be checked to insure that scales are clean and mounted correctly, and that cards are correctly labeled and match up with corresponding data forms.

At the end of the field season, age-weight-length mark sense forms will be checked for errors and sent to Juneau with the associated scale cards. There, the scale samples will be read to determine ages, and recorded on the age-weight-length forms. These completed forms are given a final check for errors before sending them to Anchorage for op scanning; the final electronic age-weight-length results will be inspected for obvious errors and copied to EXCEL files after they are returned to Petersburg.

Data Analysis

In this section, the project leader demonstrates a command of analysis methods he or she proposes to use. Common statistical or fishery procedures or equations, like the *t*-tests, confidence intervals, Petersen estimate, or fishery recruitment laws should be described by citation, using standard references (e.g., Quinn and Deriso 1999, Thompson 1992, Seber 1982). Otherwise, the methods should be described in detail using full mathematical notation. Variable names should all be in italics; abbreviations for units should not be (i.e., 5*m* means, 5 times the variable named by *m*, but 5 m means, five meters in length). In general, variable names should be introduced before they are used. Avoid using variables in equations, and then defining them afterwards, following the word “where.” If a complex key analysis method has not been published in citable, peer-reviewed literature, a complete derivation of the method should be presented in an appendix.

Schedules and Reports

The schedules and reports section contains timelines for milestone dates and activities for the project. List deadlines for sampling events and other field activities, data compilation, analysis, and reports due.

Responsibilities

This section contains the names of all personnel associated with this project, their position control numbers, and their duties. You may describe duties for each person in incomplete sentences.

Literature Cited

The purpose of this section is to allow a reviewer a means to go and actually get a physical copy of some piece of scientific literature that has been cited in the plan. Do not include *personal communications*, *unpublished data*, or memoranda here. References to these things should be in parentheses, within the text – not in the Literature Cited. Reports that are in process or even in preparation may be cited as *in prep* and included in the Literature Cited in these plans, even though *in prep* is usually inappropriate for a final report.

Appendices

Materials which are relevant to the project but which do not fit neatly into a section are placed into an appendix. This includes maps, examples of data, sampling forms, detailed explanations of statistical procedures, and so forth.

LITERATURE CITED

Quinn II, T.J. and R.B. Deriso. 1999. Quantitive fish dynamics. Oxford University Press. Oxford.

Seber, G.A.F, 1982. The estimation of animal abundance, 2nd ed. Blackburn Press. Caldwell, N.J.

Strunk, W. and E. B. White. 2000. Elements of style, 4th ed. Allyn and Bacon, Needham Heights, Massachusetts.

Thompson, S. K. 1992. Sampling. John Wiley and Sons, New York.

Appendix 1. Example operational plan.

APPENDIX

Appendix 1. Example Operational Plan

OPERATIONAL PLAN

Alaska Department of Fish and Game
Commercial Fisheries Division
Southeast Region

Hugh Smith Lake Sockeye Weir and Escapement

Period Covered: 2003 Field Season

POP-2003-001

Principal Investigator:

Steven C. Heinl, Fishery Biologist, ADF&G

Assisting Personnel:
Harold J. Geiger, Fisheries Biologist
Andrew W. Piston, Fish & Wildlife Technician
Kim A. Vicchy, Area Administrative Supervisor

	Approved	Date
Regional Research Supervisor	______________________	________________
Biometrics Reviewer	______________________	________________
Regional Supervisor	______________________	________________

SYNOPSIS -- Hugh Smith Lake Sockeye Salmon Escapement

Principal Investigator and Project Leader:

Steven C. Heinl, Fisheries Biologist, 2030 Sea Level Drive, #205, Ketchikan, AK 99901

Need:

The Alaska Board of Fish formally identified sockeye salmon (*Oncorhynchus nerka*) at Hugh Smith Lake as a *stock of concern*, and adopted an action plan that outlined rehabilitation efforts for the run in February 2003. This project is the sole means to estimate the spawning escapement of sockeye into Hugh Smith Lake, and is critical to evaluating rehabilitation efforts there.

Benefits:

The Hugh Smith Lake sockeye salmon run has been monitored since 1982. This information has been important in U.S./Canada treaty negotiations, in the management of the southern Southeast pink salmon fisheries, and as an important part of the sockeye stock assessment program in Southeast Alaska. This is a cost effective site for this research as it is conducted in conjunction with the long-term coho salmon (*O. kisutch*) research at the lake.

Objectives:

1. Enumerate the adult salmon escapement through the weir, by species.
2. Provide a back-up estimate of the total spawning population of adult (non-jack) sockeye salmon in Hugh Smith Lake with an estimated coefficient of variation no greater than 15% of the estimate.
3. Estimate the age, length, and sex composition of adult sockeye salmon.
4. Estimate the proportions of naturally spawned and enhanced adult sockeye salmon that return to spawn in Hugh Smith Lake.
5. Estimate the age and size composition of sockeye salmon smolt.
6. Estimate the proportions of naturally spawned and enhanced sockeye salmon smolt.

Procedures:

Salmon will be enumerated through a weir at the outlet of Hugh Smith Lake, and escapement will be additionally estimated by means of mark-recapture methods. Biological data will be collected at the weir, and at the spawning grounds on Buschmann and Cobb Creeks. Daily cumulative weir counts and weekly projected run-size will be forwarded to the Ketchikan Area management biologist.

Deliverable products:

A stock status report in the form of a Regional Information Report will be produced at 3-year intervals (next due in fall 2005). Additional reporting will include: 1) a section of semi-annual progress reports for Pacific Salmon Commission section entitled: Northern Boundary Annex: Fisheries management and stock assessment, and 2) a section of 3-year progress reports for Pacific Salmon Commission, section entitled: Northern Boundary Annex: Fisheries management and stock assessment.

Location:

Hugh Smith Lake (55° 06’ N, 134° 40’ W; Orth 1967) is located 97 km southeast of Ketchikan, on mainland Southeast Alaska, in Misty Fjords National Monument (Figure 1). The lake empties into Boca de Quadra inlet via Sockeye Creek (50 m; ADF&G stream number 101-30-10750).

Budget: Funded from: PSC Hugh Smith Weir 11319023-11319163

	STATE FY			
Line	2004	2005	2006	Total
100	24,921			
200				
300	11,024			
400	7,134			
500				
Total 100-500	43,079			
3% Admin.				
Total	43,079			

DETAILED PROJECT DESCRIPTION

INTRODUCTION

Hugh Smith Lake was historically the dominant sockeye salmon producer in Boca de Quadra. From 1895 to 1912, the sockeye salmon (*Oncorhynchus nerka*) catch in Boca de Quadra ranged from 42,000 to 210,000 (Rich and Ball, 1933). Moser (1898) gives sockeye salmon catch figures of 97,000 in 1895, 137,000 in 1896, and 65,000 in 1897, all of which were harvested at the mouth of Hugh Smith Lake and “approaches.” It is not clear, however, what portion of those harvests came from the waters around the entrance of Boca de Quadra. Tagging studies have shown that sockeye salmon migrating through the waters surrounding Boca de Quadra are from highly mixed stocks (Hoffman et al. 1983 and 1984). A saltery was located near the outlet of Hugh Smith Lake in the late 1800s and two canneries were located nearby in Boca de Quadra in the early 1900s. A private hatchery was operated at the head of Hugh Smith Lake from 1901 to 1903, and from 1908 to 1935, but numbers of adult sockeye salmon returning to the lake were not recorded (Roppel 1982). Moser (1898) suggested that despite overfishing, the lake should produce annual returns of 50,000 sockeye salmon under average conditions.

Sockeye salmon escapement enumeration was conducted by the Alaska Department of Fish and Game (ADF&G) at Hugh Smith Lake from 1967 to 1971, and has been conducted annually since 1980. Escapements have varied considerably from year to year, and have ranged from 1,138 (1998) to 65,586 (1992). Escapements averaged 17,500 during the 1980s, 12,000 during the 1990s, and only 5,000 over the past five years. There has clearly been a long-term decreasing trend in escapements since 1980.

ADF&G conducted coded wire tagging studies at the lake from 1980 to 1983, 1986 to 1988, and 1991 to 1996 (Geiger et al. 2003). Coded wire tagged Hugh Smith Lake sockeye salmon were harvested primarily in commercial fisheries in District 101, and District 104, and Alaska commercial harvest rates averaged 60.2%, and ranged from 27.6% (1983) to 94.3% (1990). These harvest rate calculations did not include the Hugh Smith sockeye harvested in Northern British Columbia, since those fisheries were not sampled for coded wire tags. Joint U.S.-Canada tagging studies in 1982 and 1983 showed that Hugh Smith Lake sockeye salmon migrate through northern British Columbia waters in Dixon Entrance. For example, in 1982, 195 adult sockeye salmon that had been tagged and released in northern British Columbia waters were recovered at the Hugh Smith Lake weir suggesting annual Canadian harvests of unknown magnitude (Hoffman et al. 1983).

Attempts to enhance and rehabilitate the sockeye salmon run at Hugh Smith Lake have been ongoing since 1981. The ADF&G Fisheries Rehabilitation, Enhancement, and Development Division (FRED) fertilized the lake from 1981 to 1984 (Peltz and Koenings 1989). This project was discontinued because it was determined that the size of age-1 smolt was inhibited by unfavorable temperature regimes in the lake, rather than limited food supply (Peltz and Koenings 1989). FRED Division began taking sockeye eggs at Hugh Smith Lake in 1984. The eggs were incubated at the Beaver Falls CIF Hatchery in Ketchikan, and unfed fry were returned to Hugh

Smith Lake (1986-1990), and nearby Badger Lake (1985-1986, 1988 and 1990). Southern Southeast Regional Aquaculture Association (SSRAA) took over this rehabilitation activity in 1991. SSRAA has returned unfed fry (1994-1997), fed fry (1992), and pre-smolt (1996), to the lake. Since 1999, SSRAA has pen-reared the fry in the lake from May through July prior to releasing them. To date, FRED Division and SSRAA rehabilitation efforts have not been effective at increasing returns of this stock but may have stabilized the stock's decline in light of the existing high harvest rates.

Geiger et al. (2003) summarized previous attempts to set escapement goals for this system and recommended a goal range of 8,000 to 18,000. In 2003, the Alaska Board of Fisheries formally adopted this goal as an *optimal escapement goal*; to include both naturally produced salmon, and salmon produced from the supplementation efforts by SSRAA. The Board also formally classified Hugh Smith Lake sockeye salmon as a *management stock of concern*, and adopted an action plan to rebuild the sockeye salmon run to levels that will meet that escapement goal range (Hugh Smith Lake Sockeye Salmon Action Plan, Final Report to the Board of Fish, RC-106, February 2003). The Action Plan directs the department to review stock assessment and rehabilitation efforts at the lake, and contains measures to reduce commercial harvests of Hugh Smith Lake sockeye salmon, by triggering small closures in the District 101 drift gillnet and purse seine fisheries in the vicinity of the entrance to Boca de Quadra.

The primary objectives of this project are to continue monitoring the sockeye salmon escapement and to partially evaluate the current rehabilitation effort. Thermal marks were applied to all Hugh Smith Lake sockeye salmon incubated at Burnett Inlet Hatchery beginning in 1999 (1998 brood year), and this marking program has continued each year that fish were pen-reared in the lake. In 2003, otolith-marked age 1.3 adults will be returning from SSRAA's 1999 release of 202,000 pre-smolt, and otolith-marked age 1.2 adults will be returning from SSRAA's 2000 release of 380,000 pre-smolt. We will sample salmon carcasses at the spawning streams for otoliths to determine the fraction of the adult run that were enhanced fish. SSRAA personnel will collect monthly zooplankton samples at the lake, and conduct a hydroacoustic survey to estimate the fall fry population in the lake. The ADF&G Commercial Fisheries Coho Salmon Research Project has conducted coded-wire tagging of coho salmon (*O. kisutch*) at the lake since 1982. Coded-wire tagged adult coho salmon will be returning in 2003, and we will collect adult coho salmon data in conjunction with our sockeye salmon work during the summer.

STUDY SITE

Hugh Smith Lake (55° 06' N, 134° 40' W; Orth 1967) is located 97 km southeast of Ketchikan, on mainland Southeast Alaska, in Misty Fjords National Monument (Figure 1). The lake is organically stained with a surface area of 319.7 ha, mean depth of 70.0 m, maximum depth of 121 m, and volume of $222.7 \cdot 10^6$ m^3 (Figure 2). The lake empties into Boca de Quadra inlet via Sockeye Creek (50 m; ADF&G stream number 101-30-10750). Sockeye salmon spawn in two inlet streams: Buschmann Creek flows northwest 4 km to the head of the lake (ADF&G stream number 101-30-10750-2006); and Cobb Creek flows north 8 km to the southeast head of the lake (ADF&G stream number 101-30-10750-2004).

OBJECTIVES

1. Enumerate the adult salmon escapement through the weir, by species.
2. Provide a back-up estimate of the total spawning population of adult (non-jack) sockeye salmon in Hugh Smith Lake with an estimated coefficient of variation no grater than 15% of the estimate.
3. Estimate the age, length, and sex composition of adult sockeye salmon.
4. Estimate the proportions of naturally spawned and enhanced adult sockeye salmon that return to spawn in Hugh Smith Lake.
5. Estimate the age and size composition of sockeye salmon smolt.
6. Estimate the proportions of naturally spawned and enhanced sockeye salmon smolt.

DATA COLLECTION

Adult Salmon Enumeration

The Hugh Smith Lake adult salmon counting weir is located at the outlet of the lake, approximately 0.5 km from saltwater. The weir is an aluminum bi-pod, channel, and picket design, with an upstream trap for enumerating and sampling salmon. Sandbags and fencing are used along the upstream edge of the weir to keep fish from passing upstream uncounted. The integrity of the weir will be verified by periodic underwater inspections, and through a secondary mark-recapture study (see below).

In order to minimize handling of fish, we will enumerate fish through the weir by pulling one-two pickets at a counting station, prior to August 1. The counting station will have a white board or white sandbags on the bottom of the streambed to aid in fish identification. Once coho salmon begin to enter the lake (typically around August 1), we will revert to dipping fish out of the trap as it is very important that all coho salmon are sampled for adipose clips. After August 1, sockeye salmon that are not sampled for scales and fin-clips will simply be dip-netted out of the trap and released. If the field crew is overwhelmed by returning pink and sockeye salmon, they may have the authority to pass fish by pulling pickets at a counting station *only* after first consulting with the project leader.

In addition to enumeration by species, all sockeye and coho salmon sampled in the trap will be enumerated as jacks or adults. All sockeye salmon < 375 mm in length, and all coho salmon < 450 mm in length, are considered jacks. There is almost no overlap in size between jack and adult coho salmon; however, the size of jacks and adults varies from year to year. If the field crew notices a lot of coho salmon near the break-off length of 450 mm, they will notify the supervisor so that the break-off length can be adjusted. The adult weir will be in operation from June 16 to September 15, the period when 99% of all sockeye salmon have been observed to enter the lake since this weir project began in 1981. ADF&G Coho Research project personnel will continue to operate the weir from September 16 to early November.

Table 1 shows the projected weekly cumulative weir count needed to achieve the lower end of the escapement goal (8,000 sockeye salmon). The projected weekly cumulative weir count was calculated by simply multiplying 8,000 fish by the average daily cumulative percentage of the run through the weir over the past 21 years, 1982-2002 (Table 2; Figure 3).

Mark-Recapture Population Estimate

A two-sample mark-recapture population study will be conducted to estimate the total spawning population of sockeye and coho salmon at Hugh Smith Lake. This study will help to determine if there were weir problems (i.e., the weir was not fish tight and allowed fish to pass uncounted), or if sockeye salmon entered the lake before the weir was fish tight in mid-June. Fish will be marked with a readily identifiable fin clip at the weir. Adult sockeye salmon will be marked at the weir at a rate of 1 in 10 (10%). In previous years, 50% and even 100% of the fish were marked at the weir for weir validation studies. In 2003, we will drastically reduce the mark rate to address the possibility that handing might be contributing to reduced survival or fitness. Fish that are to be marked will be dip-netted from the trap, anesthetized, clipped, scale-sampled, and released upstream next to the trap to recover. Fish that do not appear healthy will not be marked with a fin-clip. Marking will be stratified through time on the following schedule: Right ventral fin clip: June 16 - July 18; Left ventral fin clip: July 19 - August 15; and Partial dorsal fin clip: August 16 - November. All (100%) jack sockeye salmon will be marked on the same fin-clipping schedule as adults. Separate mark-recapture estimates will be generated for adults and jacks. All coho salmon (100%) will be given a partial dorsal fin clip through September 15.

We wish to confidently conclude that the sockeye salmon escapement is below the lower end of the escapement goal range when the actual escapement is 5,000 or less, even if the weir has failed (allowing a large number of fish to pass undetected). From Figure 3.5 in Seber (1982), we can see that for a population size of 5,000, with a 10% mark rate, and with a recapture sample size of near 600 fish, the probability is nearly 0.95 that the mark-recapture estimate will be within 25% of the true value, assuming no non-sampling errors. Our goal will be to examine at least 600 sockeye salmon for fin clips in Buschmann and Cobb Creeks, with sampling distributed over the length of the spawning season. This sample size of 600 fish in the second sampling event should yield a Petersen population estimate with a coefficient of variation less than 15%, when the population size of nearly 5,000 is marked at a rate of 10% (Robson and Regier 1964).

Note that if m denotes the expected number of recaptures, then the approximate coefficient of variation is given by $1/\sqrt{m}$ (Seber 1982). Assume that the actual escapement is not 5,000, but it is only 1,000 fish. Then, if the mark rate is 10%, we will expect far lower precision than in the case of an escapement of 5,000. That is because of a lower sample size at each capture event. For example, if 120 fish can be found for the second recapture sample (nearly the same second-event sampling *rate* as before), then the coefficient of variation would be expected to be nearly 30%. With a 10% mark rate, even though the coefficient of variation will increase as the run size goes down, if we attempt to get a second-event sample of about 8% to 10% of the population, the results should clearly indicate whether the escapement was (1) very low (less than 2,000 with a coefficient of variation expected to be near 20% or larger), (2) a low value (such as 4,000 with a coefficient of variation expected to be near but slightly greater than 15%), or (3) a value near the lower end of the escapement goal (with a coefficient of variation expected to be less than 15%).

Surveys will be conducted at least once a week beginning in statistical week 34 (August 17-23), but preferably more often if time and weather permit. All dead fish found during stream surveys will be examined for fin clips. Live fish will be captured and examined for marks using dip nets in the creeks, or by using a beach seine off the creek mouths. Fish that are killed during a SSRAA egg-take will also be sampled for presence or absence of fin-clips. Each fish will be recorded as unmarked (no fin-clip) or by the appropriate fin clip (Right Ventral, Left Ventral, or Dorsal fin clips). Any dead fish that wash up on the weir, or found floating in the lake, will also be examined for marks. All sampled fish (live and dead) will be given a secondary mark by punching the left operculum with a round hole punch. This will identify fish that have already been sampled and prevent double sampling.

Adult Length, Sex, and Scale Sampling

The age composition of adult sockeye salmon will be determined from a minimum of 600 scale samples collected from live fish at the weir. This sample size will yield an adequate number of scales of the major age classes for scale pattern-based stock identification of sockeye salmon in southern Southeast Alaska commercial fisheries harvests (Oliver et al. 1990). We will begin the season by taking scale samples at a rate of 1 in 10 (10%). Therefore, we will simply take scales from all fish that dipped from the trap for fin-clipping. We will adjust our scale sampling inseason, to ensure that we reach our goal of 600 scale samples. The sex and length (mid-eye-to-fork to the nearest 5 mm) will be recorded for each fish sampled. One scale will be taken from the preferred area (INPFC 1963), mounted on a gum card, and prepared for analysis as described by Clutter and Whitesel (1956). In addition, scale samples will be collected from all coho salmon (4 scales per fish), and all chum salmon (1 scale per fish).

Adult Otolith Sampling

We will collect 400 otoliths from dead sockeye salmon at Buschmann and Cobb Creeks, with sampling distributed over the length of the spawning season. We will also collect otoliths from any dead salmon that wash up on the weir, or found floating in the lake. This information will be used to estimate the proportions of naturally spawned and hatchery-reared sockeye salmon in the escapement. The sex and length (mid-eye-to-fork to the nearest 5 mm) will be recorded for each fish sampled. We will also record the carcass condition of each fish sampled for otoliths, as spawned, unspawned, or bear-killed.

Coded-Wire Tag Sampling

All coho salmon returning to Hugh Smith Lake will be examined at the weir for missing adipose fins. A portable metal detector will be use to determine if adipose-clipped fish are coded-wire tagged. All adipose-clipped coho salmon that are coded-wire tagged (i.e., that register a metal tag when the wand is passed over the snout) will be released upstream alive. We will kill all adipose-clipped coho salmon that do not have a coded-wire tag, and recover the heads. Experience has shown that very few adipose-clipped fish lack a coded-wire tag; thus, only a few fish will need to be sacrificed. Heads recovered from adipose-clipped fish will be sent to the ADF&G Mark, Tag, and Age Lab where the tags will be removed and decoded.

Stray chinook salmon are occasionally recovered at the Hugh Smith Lake weir. This system does not support a natural chinook salmon spawning stock, and chinook salmon will not be passed into the lake. All adipose-clipped chinook salmon will be killed and the heads recovered.

Stream Surveys

The number of live and dead salmon in the creek will be estimated, by species, during each survey of Buschmann and Cobb Creeks. Cobb Creek will be surveyed from the mouth to the barrier falls (0.4 miles; 55 05.35 N, 130 38.673 W). Buschmann Creek will be surveyed at least to the first fork, and to the beaver ponds on the left fork (0.35 miles; 55 06.43 N, 130 37.30 W). The right fork will be surveyed up to 0.3 miles from the fork (55 06.28 N, 130 37.01 W), but ideally could be surveyed further on high escapement years. The length of the survey will be estimated in 10ths of a mile. Data will be entered into the ADF&G database at the end of the field season.

Smolt Sampling

The ADF&G Coho Research Project operates an annual smolt weir at the outlet of Hugh Smith Lake. The weir design and sampling procedures are outlined in Peltz and Haddix (1989). Coho Research personnel will enumerate all species (including sockeye smolt) throughout the weir, and collect scale samples and length-weight data. Sockeye smolt will be sampled at a rate of 16 fish per day when fewer than 100 fish are captured at the weir on a daily basis; 28 fish per day when >100 fish are captured per day. The length (snout to fork to the nearest 1 mm) and weight (to the nearest 0.1 g) will be recorded for each fish sampled. A preferred area scale smear (Clutter and Whitesel, 1956) will be taken from each fish, and mounted on a 2.5 cm × 7.5 cm glass slide, four fish per slide.

Between 400 and 450 sockeye smolt will be collected for otolith evaluation. Samples will be collected at the following weekly rate in proportion with historic smolt timing, assuming sampling beginning the last week of April:

Week	Number of Samples per Week	Number of Samples per Day
1	25	~ 4
2	50	~ 7
3	75	~ 10
4	125	~ 20
5	100	~ 15
6	50	~ 7
7	25	~ 4

Otolith samples will be taken from smolts that are sampled for scales. The smolt will be frozen whole in plastic bags labeled with the date and location. Smolt samples will be sent to the ADF&G Otolith Lab where the otoliths will be removed, aged, and identified as thermally marked (artificially spawned) or not (naturally spawned).

Physical Data

We will record the daily water level (0.1 in), the water and air temperature (Centigrade), and daily precipitation (0.01 in). Gauging stations and instruments have been standardized to enable comparisons between years.

DATA ANALYSIS

Mark-Recapture Population Estimate

We will use Stratified Population Analysis System (SPAS) software (Arnason et al. 1996) to generate mark-recapture estimates of the total spawning population of sockeye salmon. SPAS was designed for analysis of 2-sample mark-recapture data where marks and recoveries take place over a number of strata, and is based on work by Chapman and Junge (1956), Darroch (1961), Seber (1982), and Plante (1990). We will use this software to calculate: 1) maximum likelihood (ML) Darroch estimates and pooled-Petersen (Chapman's modified) estimates, and their standard errors; 2) chi-square tests for goodness-of-fit based on the deviation of predicted values (fitted by the ML Darroch estimate) from the observed values; and 3) two chi-square tests of the validity of using fully pooled data – a test of complete mixing of marked fish between release and recovery strata, and a test of equal proportions of marked fish in the recovery strata. We will consider passing either of those tests (p>0.05) as sufficient to validate full pooling of the data (i.e., the pooled-Petersen estimate). The manipulation of release and recovery strata in calculating estimates (the method used in SPAS) is also presented and discussed at length by Schwarz and Taylor (1998). Again, a separate analysis will be conducted for adults and jacks.

We will deem the weir count to be "verified" if it falls within the 95% confidence interval of the mark-recapture estimate of adult sockeye salmon, and the weir count will be entered as the official escapement estimate. Please note that this is the same criterion as used in previous years, however, the marking fraction in the mark-recapture estimate has been greatly reduced. The escapement goal range for this system is 8,000 to 18,000 spawners. The escapement goal will be deemed to have been met if the weir count is within 8,000 to 18,000 adult sockeye salmon, and the weir count is within the 95% confidence interval of the mark-recapture estimate for adult sockeye salmon. The escapement goal will be deemed to have not been met if the weir count and the mark-recapture estimates are both outside of the escapement goal range. In the case where one or the other estimate is within the escapement goal range, the weir count will be used, unless the weir count is below the lower end of the 95% confidence interval of the mark-recapture estimate. The mark-recapture estimate will be the "point" estimate, and not one or the other end of a confidence interval, for the purpose of judging an escapement objective.

Length, Sex, and Scale Sampling

Adult sockeye salmon scales will be aged at the ADF&G, Commercial Fisheries, Aging Lab in Douglas, Alaska. A video-linked microscope will be used to age sockeye smolt scales at the Ketchikan office. The weekly age-sex distribution, the seasonal age-sex distribution weighted by week, and the mean length by age and sex weighted by week, will be calculated as outlined in

Heinl et al. (2000), and standard errors will be calculated using equations from Cochran (1977; pages 52, 107-108, and 142-144).

Let

h	=	index of the stratum (week),
j	=	index of the age class,
p_{hj}	=	proportion of the sample taken during stratum h that is age j,
n_h	=	number of fish sampled in week h, and
n_{hj}	=	number observed in class j, week h.

Then the age distribution will be estimated for each week of the escapement in the usual manner:

$$\hat{p}_{hj} = n_{hj} / n_h \ . \tag{1}$$

If N_h denotes the number of fish in the escapement in week h, standard errors of the weekly age class proportions will be calculated in the usual manner (Cochran 1977, page 52):

$$SE(\hat{p}_{hj}) = \sqrt{\left[\frac{(\hat{p}_{hj})(1-\hat{p}_{hj})}{n_h - 1}\right][1 - n_h/N_h]} \ . \tag{2}$$

The age distributions for the total escapement will be estimated as a weighted sum (by stratum size) of the weekly proportions. Let N denote the total escapement. Then estimated proportion for age j is given by,

$$\hat{p}_j = \sum_h p_{hj} (N_h / N), \tag{3}$$

The standard error of a an estimated seasonal proportion is the square root of the weighted sum of the weekly variances (Cochran 1977, pages 107–108):

$$SE(\hat{p}_j) = \sqrt{\sum_h [SE(\hat{p}_{hj})]^2 (N_h/N)^2} \ . \tag{4}$$

The mean length, by sex and age class (weighted by week of escapement), and the variance of the weighted mean length, will be calculated using the following equations from Cochran (1977, pages 142-144) for estimating means over subpopulations. That is, let i denote the index of the individual fish in the age-sex class j, and y_{hij} denote the length of the ith fish in class j, week h, so that,

$$\hat{\bar{Y}}_j = \frac{\sum_h (N_h/n_h) \sum_i y_{hij}}{\sum_h (N_h/n_h) n_{hj}} \text{, and} \qquad (5)$$

$$\hat{V}\left(\hat{\bar{Y}}_j\right) = \frac{1}{\hat{N}_j^2} \sum_h \frac{N_h^2 (1 - n_h/N_h)}{n_h (n_h - 1)} \left[\sum_i \left(y_{hij} - \bar{y}_{hj}\right)^2 + n_{hj} \left(1 - \frac{n_{hj}}{n_h}\right) \left(\bar{y}_{hj} - \hat{\bar{Y}}_j\right)^2 \right]. \qquad (6)$$

Otolith Sampling

Otolith samples will be processed, aged, and analyzed at the ADF&G Commercial Fisheries Tag Otolith Laboratory, Juneau, Alaska. The proportions of naturally spawned and enhanced smolt, the proportions of naturally spawned and enhanced 2-ocean adults, and standard errors (Cochran 1977, page 52), will be calculated using the usual method (by analogy to equations 1 and 2, above).

SCHEDULES AND REPORTS

The adult weir will be installed and fish-tight by June 16, and we will begin passing fish, taking scale samples and marking fish at the weir, shortly thereafter. Field crews will be contacted daily for fish counts and sampling progress. Daily cumulative weir counts and weekly run size projections will be forwarded to Ketchikan Area Management Biologist.

RESPONSIBILITIES

The Southern Southeast Salmon Research Project Leader, Steve Heinl, will be responsible for the weir operation, all aspects of the mark-recapture studies, for sampling of spawning population portions of the project including personnel coordination, data collection, data analysis, and reporting escapement estimates to management staff and other agencies.

The Stock Assessment Research Supervisor, Harold J. Geiger, will be responsible for statistical and biometric assistance with the project, and editorial assistance with the project reporting.

Andrew W. Piston, Fish & Wildlife Technician, will assist with the project logistics and help coordinate field activities.

Kim A. Vicchy, the Area Administrative Supervisor, will provide administrative support, including help to track project budgets, schedule airplane flight, help maintain contact with the field crew, and provide other assistance, as needed.

Limnological investigations and hydroacoustic surveys are the responsibility of Southern Southeast Regional Aquaculture Corporation. The Coho Research Project shares some data collection activities. The Coho project is responsible for smolt sampling and for all coho data analysis.

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Table 1. Average cumulative proportion of Hugh Smith Lake sockeye salmon counted through the adult salmon weir by statistical week, 1982–2002, and projected number of adults needed by week to meet the lower end of the Optimal Escapement Goal (8,000 sockeye salmon).

Mid-Week Date	**Statistical Week**	**1982-2002 Average Cumulative Percentile**	**Projected Daily Cumulative Needed for Minimum Escapement Goal of 8,000 Adults**
18 Jun	25	1%	73
25 Jun	26	3%	276
2 Jul	27	8%	672
9 Jul	28	14%	1,130
16 Jul	29	24%	1,945
23 Jul	30	36%	2,900
30 Jul	31	48%	3,874
6 Aug	32	60%	4,776
13 Aug	33	70%	5,575
20 Aug	34	77%	6,200
27 Aug	35	86%	6,867
3 Sep	36	91%	7,307
10 Sep	37	95%	7,625
17 Sep	38	97%	7,790
24 Sep	39	99%	7,914
1 Oct	40	100%	7,961
8 Oct	41	100%	7,987
15 Oct	42	100%	7,995
22 Oct	43	100%	7,998
29 Oct	44	100%	7,999
5 Nov	45	100%	8,000

Appendix 1. Example operational plan.

Table 2. Cumulative proportion of Hugh Smith Lake sockeye salmon counted through the adult salmon weir by statistical week, 1982–2002.[a]

	Year																					
Stat Week	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Average
23	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	0.017	0.003	0.001	0.001	0.000	0.000	0.000	0.001	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
25	0.084	0.010	0.012	0.006	0.008	0.002	0.001	0.002	0.006	0.001	0.002	0.000	0.000	0.019	0.005	0.003	0.021	0.000	0.000	0.009	0.002	0.009
26	0.192	0.021	0.029	0.015	0.017	0.007	0.027	0.008	0.012	0.004	0.021	0.048	0.002	0.072	0.018	0.045	0.074	0.019	0.019	0.071	0.005	0.035
27	0.377	0.040	0.055	0.052	0.079	0.015	0.088	0.022	0.097	0.013	0.073	0.110	0.003	0.119	0.037	0.123	0.087	0.060	0.127	0.138	0.048	0.084
28	**0.552**	0.061	0.104	0.129	0.141	0.038	0.093	0.052	0.186	0.042	0.093	0.138	0.006	0.193	0.052	0.178	0.112	0.166	0.277	0.224	0.130	0.141
29	0.736	0.234	0.157	0.187	0.465	0.110	0.094	0.078	0.222	0.090	0.248	0.295	0.015	0.414	0.059	0.391	0.161	0.261	0.392	0.322	0.175	0.243
30	0.806	0.305	0.281	0.274	**0.720**	0.390	0.216	0.098	0.322	0.210	0.324	0.387	0.137	**0.508**	0.119	**0.595**	0.387	0.356	**0.600**	0.365	0.214	0.362
31	0.873	0.347	0.435	0.318	0.841	0.483	0.288	0.263	0.339	0.367	**0.876**	**0.565**	0.208	0.636	0.164	0.782	**0.507**	**0.512**	0.749	0.387	0.229	0.484
32	0.906	0.446	**0.549**	0.425	0.904	**0.529**	0.316	**0.660**	0.387	0.428	0.891	0.671	0.296	0.773	0.229	0.873	0.537	0.622	0.896	0.400	**0.801**	**0.597**
33	0.940	**0.538**	0.622	0.468	0.919	0.646	**0.568**	0.876	0.420	0.455	0.924	0.765	0.337	0.887	0.381	0.920	0.816	0.740	0.929	**0.537**	0.946	0.697
34	0.958	0.608	0.697	**0.504**	0.935	0.648	0.663	0.921	0.442	**0.538**	0.940	0.838	0.342	0.933	**0.654**	0.950	0.965	0.852	0.981	0.934	0.973	0.775
35	0.961	0.694	0.826	0.691	0.963	0.691	0.795	0.961	**0.675**	0.621	0.962	0.883	**0.802**	0.961	0.727	0.972	0.969	0.935	0.985	0.971	0.981	0.858
36	0.973	0.747	0.868	0.866	0.967	0.956	0.929	0.968	0.756	0.671	0.972	0.917	0.907	0.965	0.799	0.986	0.989	0.980	0.999	0.973	0.994	0.913
37	0.982	0.793	0.950	0.902	0.971	0.991	0.957	0.974	0.889	0.810	0.994	0.941	0.980	0.974	0.951	0.992	0.991	0.990	1.000	0.987	0.998	0.953
38	0.984	0.810	0.988	0.979	0.972	0.999	0.996	0.997	0.935	0.892	0.998	0.955	0.986	0.993	0.990	0.992	0.994	0.997	1.000	0.996	0.999	0.974
39	0.985	0.952	0.989	0.984	0.993	1.000	0.997	0.998	0.970	0.951	0.999	0.982	0.994	0.996	0.998	0.997	0.994	0.999	1.000	0.998	1.000	0.989
40	0.988	0.994	0.993	0.987	1.000	1.000	0.999	0.999	0.984	0.969	0.999	0.996	0.996	0.997	0.998	0.999	0.997	0.999	1.000	1.000	1.000	0.995
41	0.996	0.998	0.994	0.996	1.000	1.000	1.000	1.000	0.995	1.000	1.000	0.998	0.997	0.998	0.998	1.000	0.997	1.000	1.000	1.000	1.000	0.998
42	1.000	0.999	0.995	1.000	1.000	1.000	1.000	1.000	0.999	1.000	1.000	0.998	0.997	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999
43	1.000	1.000	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999	1.000	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
44	1.000	1.000	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
45	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
46	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
47	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[a] Bold numbers represent period when 50% of the weir counts are achieved.

FIGURES

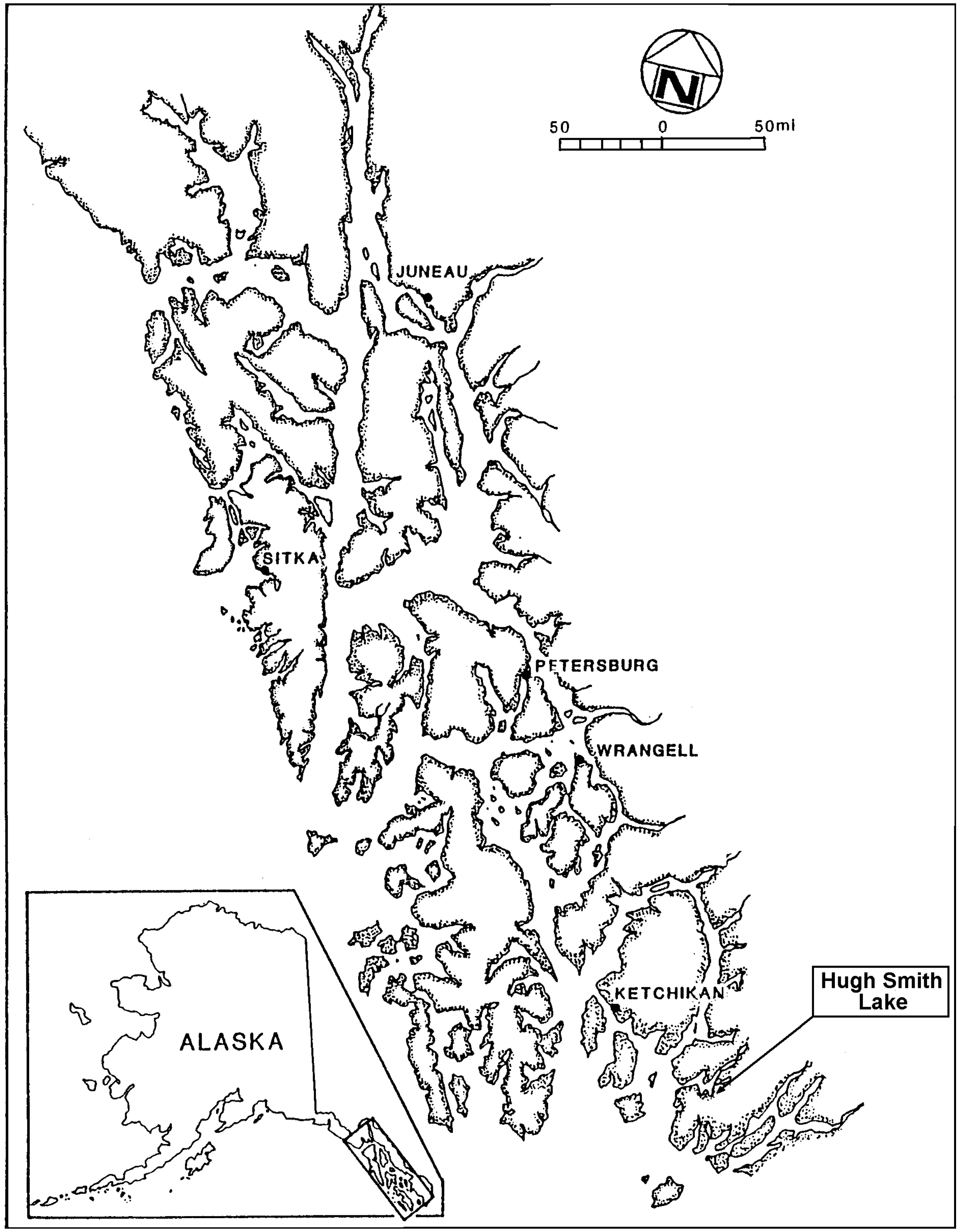

Figure 1. The geographic location of Hugh Smith Lake, Southeast Alaska

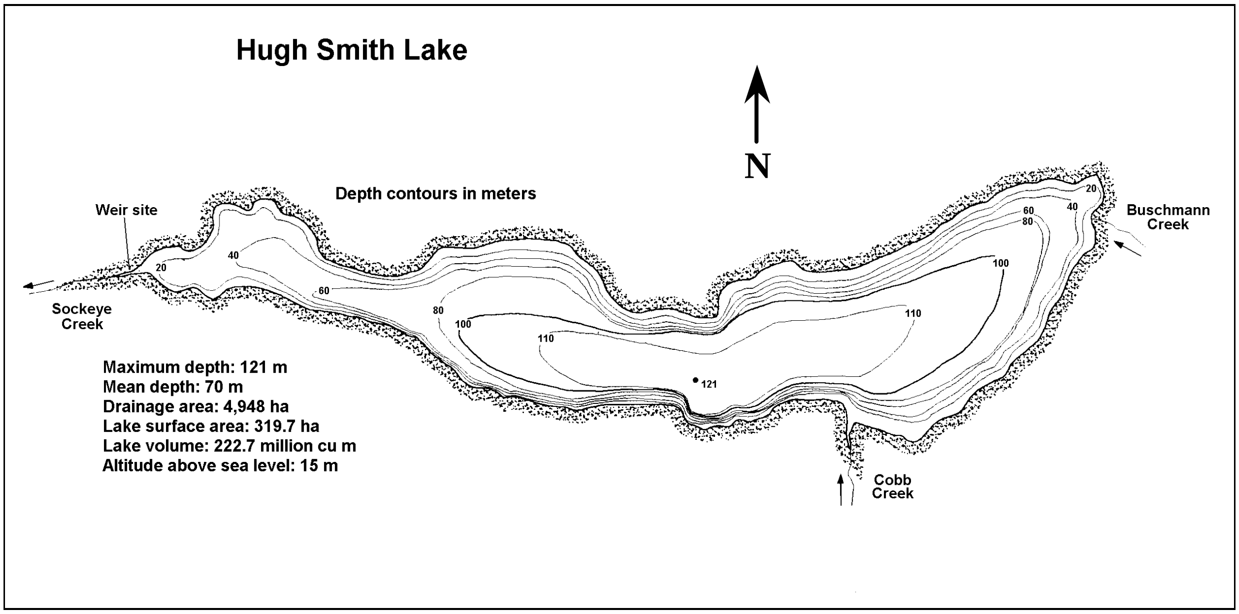

Figure 2. Bathymetric map of Hugh Smith Lake, Southeast Alaska.

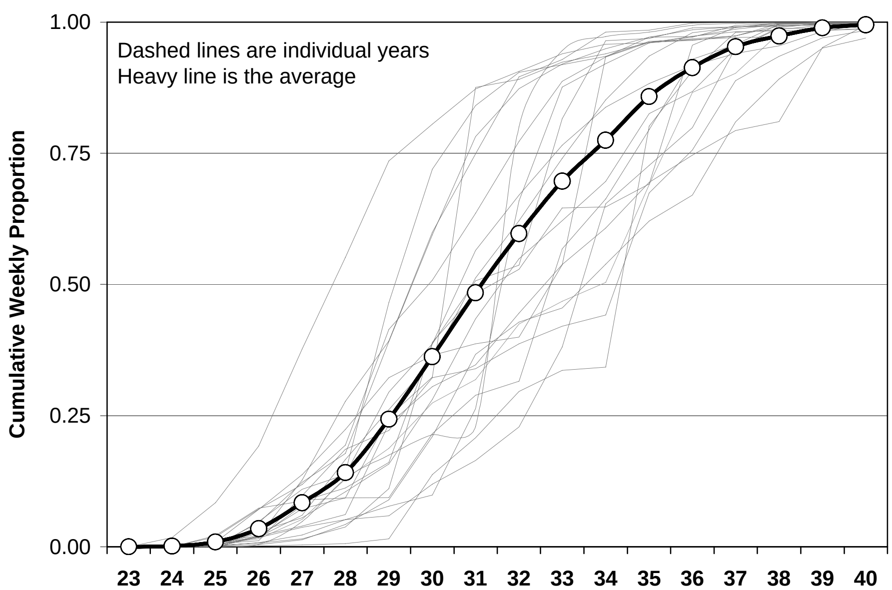

Figure 3. Cumulative mean weekly run timing of sockeye salmon at Hugh Smith Lake, 1982-2002.