

Nushagak River Chinook Salmon Research Plan

Preliminary draft for discussion with ADF&G and others

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Introduction

This research plan (Plan) sets a course to guide efforts and investments in stock assessment and research to improve the management of, and ultimately the yield from, all species of salmon from rivers that flow into Nushagak Bay, Alaska. The Plan outlines a 10-20 year effort to build and sustain a stock assessment program. Funding for the initial 5 years or so of the effort described below is largely “in-hand” due in part to a Direct Legislative Grant from the State of Alaska to the Bristol Bay Science and Research Institute (BBSRI). We anticipate that the State, BBSRI, and other area stakeholders will come together to support the program over the longer term.

This version of the Plan is an initial draft prepared by BBSRI for review with the Alaska Department of Fish and Game (ADF&G) and stakeholders. When finalized, the Plan will represent a collaborative effort between the ADF&G, BBSRI and interested stakeholders. The Plan sets out a problem statement, describes research goals and objectives, implementation stages, and describes a process and specific projects to accomplish the goals and objectives. The Plan does not delve into a lengthy review of past management or stock assessment activities. However, Appendix A provides a brief background on the Nushagak Chinook salmon stock, its management, shortcomings of the current assessment program, and recommended readings for a more complete understanding of the background. The Plan has been prepared by a group of fisheries managers and research biologists familiar with all aspects of salmon management and the regulatory environment in Alaska, and in Bristol Bay.

The audience for the Plan is numerous. Local stakeholders who depend heavily on area fish stocks (subsistence, commercial, and sport) are active and essential participants in the management process, and routinely provide financial and technical support to assessment programs in Bristol Bay. Fishery managers and research staff responsible for managing these fisheries are the greatest users of stock assessment information. Research organizations and Universities seeking funding can use this plan as a guide for developing collaborative research on Nushagak Chinook salmon to improve

management. Finally, members of the Alaska Board of Fisheries are mandated to make allocative and conservation-based decisions based on the status of salmon stocks and these decisions can have enormous economic impacts. In all, there are tens of thousands of people who depend heavily on well-managed Nushagak area salmon stocks.

Problem Statement

Existing stock assessment of Nushagak River Chinook salmon is inadequate to manage the complex and highly valuable commercial, sport, and subsistence fisheries. The costs of continuing with inadequate Nushagak Chinook salmon stock assessment are very high, and far outweigh the cost to improve the assessment of Chinook salmon. Factors contributing to the problem include, but are not limited to, the following.

- Nushagak Chinook salmon co-migrate through a fishing district that has a high-value, mixed-species, and mixed-stock sockeye salmon fishery.
- The subsistence fishery on this stock is very large and feeds thousands of people in a rural and remote area where the cost of living is high.
- The sport fishery is large and cannot easily be opened and closed without incurring substantial economic impact.
- Recent declines in the annual abundance of Chinook salmon amidst a dramatic increase in returns of sockeye salmon to area rivers, including the Nushagak.
- The assessment program is made up of a single sonar project that has been shown to be an unreliable index of abundance for Chinook salmon.
- Direct investments in Chinook salmon assessment have not kept up with the growing management challenges associated with current conditions.
- It will be difficult-to-impossible to evaluate outcomes from proposed management actions and regulatory changes amidst these conditions.

Goal of the Plan

The goal of this plan is to make clear for all stakeholders how best we can collectively address the shortcomings of the existing Nushagak salmon stock assessment. The management of Nushagak Chinook salmon is directly impacted by management measures taken on co-migrating sockeye salmon and therefore the Plan takes into consideration sockeye salmon assessment and management where relevant. The Plan will succeed if it can effectively guide discourse and investments to improve overall *salmon management* to the Nushagak area rivers.

Goals and Objectives of the Research

Needs of Escapement-Goal Management

Nushagak District salmon are managed by ADF&G, which regulates time, area, and fishing gear used by harvesters to achieve annual spawning escapement goals (i.e., biological targets) that are thought to sustain and/or maximize harvests. Therefore, management's fundamental nature is

escapement-goal based and to achieve these biological targets managers “control” escapement entering rivers daily by opening and closing fisheries. Biological targets are developed by comparing the numbers of salmon that return from parent-year escapement levels. Therefore, Bristol Bay salmon management requires real-time and annual information on the catch and escapement by species and stock to sustain and maximize harvests. It is this real-time and post-season information about catch and escapement that constitutes a large part of the term “stock assessment” that this Plan is designed to address. Stock assessment also includes research into understanding impacts of biological and physical processes over time, especially those that are affected by management actions.

The Problem Statement (above) asserts that the current stock assessment program for Nushagak Chinook salmon is inadequate. Specifically, we have little, and in some places no confidence in daily and annual catch and escapement information. This lack of quality information manifests itself into difficulty setting of biological targets (escapement goals), turning the fisheries on and off to maximize and sustain harvests, and assessing the effectiveness of various regulatory measures implemented by ADF&G and the Alaska Board of Fisheries.

Research Plan Goal

Develop, deploy, and refine over time stock assessment projects to provide long-term solutions to better manage Nushagak River salmon, with an emphasis on Chinook salmon.

The goal of the research will be met if, in 5, 10, or 15 years we have developed and can deploy in a financially sustainable manner a suite of stock assessment components that address these overarching needs:

- biologically robust escapement goals for all species and river-based stocks that travel through the Nushagak district,
- real-time assessments of the catch and escapement of Chinook, sockeye, and other salmon,
- optimal fishery harvests by all fisheries considering many competing management targets, and
- fishery regulations that collectively maximize the benefits from the fish stocks to all stakeholders.

The focus of this research plan is Chinook salmon. However, sockeye (and chum) salmon assessment and management in the Nushagak directly affects the ability to improve management of Chinook salmon. Therefore, work proposed here must consider complementary and multi-species management.

Research Objectives

1. Provide accurate and reliable in-season escapement information to subsistence, commercial and sport fishery managers.
2. Estimate the annual age-specific catch and system-wide numbers of spawning Nushagak Chinook and sockeye salmon.

3. Rebuild/improve brood tables for Chinook and sockeye salmon that can be used to establish biologically robust escapement goals for Chinook salmon, and eventually provide preseason forecasts of run size.
4. Provide information to assess changing productivity (recruits/spawner; size and age composition) of Nushagak Chinook and sockeye salmon and develop or update management targets that reflect changes in productivity.
5. Develop and refine cost-effective methods and institutional capacity to manage Nushagak River salmon that can be sustainably funded by the State of Alaska and regional stakeholders for the next several decades.
6. Assess the impacts and efficacy over time of proposed management measures to increase Chinook salmon spawning escapement.
7. Conduct applied research into biological and physical processes that affect salmon productivity with an emphasis on those affected by management outcomes.

Achieving these objectives will provide long-term, sustainable management and harvests for all stakeholders. Given the shortcomings of the existing stock assessment, the research will need to refine current assessment methods, and will certainly need to develop new and innovative methods.

Phased Approach, Research Timeline

It is helpful to envision a sequence of phases to this plan as its emphasis will change over time.

Phase I

This initial phase is the “augment and innovate stage” and would likely occur over the next 5-7 years. We currently lack the infrastructure, knowledge, and experience to conduct some essential aspects of the needed research. The first phase can be thought of as the “roughing in” stage to ensure that a range of methods are examined, and results obtained to build a more refined, low-cost, and sustainable program in the future. The information needed to develop *long-term* solutions to Chinook salmon assessment and management will require a length of time for Phase I for several practical method- and program-development reasons. It is essential to operate these assessment efforts over enough seasons to obtain information across a contrast in the abundance of multiple species, and across environmental conditions that we know or expect will affect project performance (e.g., mainstem and tributary discharge, temperatures).

The first phase will make immediate investments in augmenting existing projects to gather essential data to meet the Plan objectives. These investments are necessary but not sufficient to achieve all the program objectives. For example, existing projects will not provide a reliable means of estimating the age-specific, system-wide escapement of Chinook salmon to the Nushagak River. In addition, we do not have a reliable index of daily Chinook salmon escapement and field projects and analytical approaches must be explored to develop such. Investments in independent counts of spawning escapement will be an essential part of Phase I.

Phase II

The second phase will begin when we have confidence that methods and projects developed and refined in Phase I are meeting or are likely to meet the overarching research objectives. Phase II will likely explore the financial suitability of a subset of the project components done in Phase I. The goal of Phase II will be to critically evaluate the suitability of individual and collections of projects to provide long-term and sustainable inputs to management that still accomplish the long research program goals.

Phase III

The third phase is simply a sustainable and long-term stock assessment program. Phase III will involve routine enumeration and assessment projects. In addition, it must fulfil evolving management and regulatory needs. There is no doubt that applied research to review program performance and alternate methods above and beyond the routine monitoring would be part of this Phase. Phase III will have a regular program review feature that can identify and scope once-off applied research projects and new methods and technologies.

Assessment Program Components

The research plan is composed of two categories of assessment work: core monitoring projects and applied research to support core monitoring objectives. The narrative below lays out the logic and an initial scope of work associated with each program component. Table 1 provides an outline of existing, to-be-augmented projects, and new projects to support the research plan in Phase I. This plan *does not* provide project descriptions to the level found in Project Operational Plans.

Core Monitoring Projects

Core monitoring projects are those that provide “*the*” information to manage the fish stock and fishery. Most often, these will be executed every season but there will be some that can be done on a regular basis but in a subset of years (e.g., 3 out of 5 years, every other year, etc.). Some projects provide real-time information that is of lower precision and accuracy than is needed for development of brood tables, escapement goals, etc, but is necessary for inseason management.

Given that the Nushagak drainage salmon stocks are managed on an escapement-goal basis and the assessment program must develop brood tables, all core monitoring programs enumerate and/or estimate the number of fish in the annual catch and escapement. In the case of inseason management, much of the information is developed daily. Post-season monitoring are projects collecting inseason, but the information becomes available over the winter following the summer season.

In-season Monitoring Projects

These projects provide managers daily or near daily indications of run strength (and composition) upon which to open, close, or in other ways alter harvesting effort. Some of these projects, like catch monitoring, provide information for both in-season and post-season analysis and use.

1. *Catch monitoring* provides age-specific harvest in the commercial, sport, and subsistence fishery. There is currently some effort done in this regard (i.e., commercial fishery) but in general, Chinook salmon catch monitoring is inadequate to meet the needs of the program objectives (i.e., age-specific catch and returns, brood tables).
2. *In-season indices of abundance* provide real time indications of run strength from which to make fishery management decisions. In the Nushagak River and commercial fishing district this information must be generated daily or multiple times per week to be useful. While some in-season indices of Chinook salmon abundance are currently available, better in-season information will be a key part of improving Chinook salmon management in the Nushagak, and this research plan contains several new project components to address this need (Table 1).
 - a. *Currently Available:*
 - i. *Portage Creek Sonar*
 - ii. *Informal reporting from subsistence and sport fisheries*
 - iii. *In-District Nushagak gillnet test fishery.*
 - b. *In-season abundance "expansion" projects:*
 - i. *Nushagak Sport Fish Creel*
 - ii. *Portage Creek Sonar improvement*
 - iii. *In River Test Fishery*

Post-season Monitoring Projects

Ultimately, post-season monitoring projects should provide annual age-specific estimates of catch and escapement upon which to base brood tables, escapement goals, preseason forecasts, and evaluations of the effectiveness of inseason management actions.

These projects provide information that is generally not available in time to be used by managers during the fishing season. The extent of the existing work done in this regard are aerial surveys of Chinook salmon spawning grounds, annual harvest surveys in the sport fishery, and a run reconstruction (modeling) exercise that integrates information across sonar-based estimates, aerial surveys, and catch monitoring components to derive an estimate of the annual system-wide Chinook salmon run (catch and escapement). These total run estimates are not made to the level of age-specific returns.

1. *Age-specific Catch Estimates* – catch sampling projects provide this piece of the annual total run tables used to develop brood tables, escapement goals, and preseason forecasts. Existing projects provide little -to-no information in this regard and scope of the research plan will augment existing and add new projects to provide this information.
2. *Annual System-wide Escapement* – Portage Creek sonar project as a first approximation of the annual system-wide escapement. Much has been done to document the inadequacy of this sockeye project to assess Chinook salmon abundance; in short, it is too inaccurate and imprecise to be of value for inseason management and post-season stock assessments. However, there are things that can be done to improve the sonar project and it currently provides the primary inseason index of abundance, and a key piece of information upon which

the post-season run reconstruction model uses. In addition, it provides a historical timeseries beginning in the early 1980s that will always have some value in assessing long-term changes in productivity. Ideally, Portage Creek sonar can provide some continuity between the past and future annual escapement; at least until the historical information becomes of little value in 10 or more years.

Applied Research to Support Core Monitoring Objectives

The nexus for all applied research is that it must be directly tied to either improving fishery management or the annual stock assessments that salmon management relies upon. This research will focus on developing and evaluating new and existing methods and sampling designs that will improve stock assessment or reduce its cost. Examples fall into three categories: 1) new projects that are less costly or provide better/more accurate information, 2) research to reduce the cost of existing assessment projects, and 3) projects to evaluate current or proposed management targets (e.g., escapement goals) and regulations.

Evaluate New Project Opportunities

1. Weirs and towers on various tributaries.
2. Develop/evaluate drones (UAVs) for aerial survey chinook salmon spawning grounds.
3. Evaluate gillnet test fishery between the commercial district and the Portage sonar site to provide a better real-time index of Chinook salmon escapement.
4. Benefits and costs of video technology to improve and reduce the cost of weir, tower-based, and aerial-based enumeration methods.
5. Augment baseline collections for genetic stock composition estimates used in the generation of annual system-wide escapement estimates.

Reduce Cost of Existing Projects

1. Develop machine-aided/artificial intelligence software to reduce the cost of video-based information from weirs, towers, and aerial surveys.
2. Sensitivity analyses of the level of effort of assessment programs, including those for used with the annual run reconstruction modeling (e.g., AWL sample sizes, number of weirs, frequency of aerial surveys, etc.), apportionment efforts at Portage sonar, etc.
3. Evaluate innovative genetic methods to reduce the cost and scope of a genetics-based mark-recapture project (e.g., can be done with fewer weirs or on different tributaries).

Applied Research to Evaluate Management Strategies and Management Targets

As better and more information is obtained from an expanded stock assessment program it will become possible to evaluate the appropriateness of management targets. The most important management targets for Nushagak salmon are the escapement goals. For Chinook salmon, the EGs of interest are those for Chinook and sockeye salmon. For the purposes of this research plan, we highlight some research that we expect will become *possible* and relevant to management as we collectively develop a stream of much better catch and escapement information.

1. *Biological and Physical Effects on Productivity and Implications for Management Targets*

Biological factors that affect Nushagak Chinook salmon include the abundance of other species' on spawning and rearing success. In particular is the potential impacts of recent very large escapements of sockeye salmon. Physical factors include climate change effects (and associated changes in nutrients) on the productivity of freshwater and marine environments. All these effects have the potential to feedback into management because they all would affect escapement goal evaluations. Knowledge of and an understanding of the magnitude will lead to better escapement goal setting.

2. Escapement Goal Evaluation

Escapement goals (EGs) directly affect yield (i.e., harvest) and are ultimately based on the current productivity of a salmon stock and productivity changes through time. EGs that are too low for a particular productivity regime result in foregone future harvest opportunities by “under seeding” the spawning grounds. Conversely, EGs that are too high result in little or no harvest because the escapement is so high that the spawning fish only just replace themselves in number in future generations. EGs are routinely evaluated by ADF&G around the region and state but Nushagak Chinook salmon spawning and catch estimates are entirely inadequate to develop a biologically robust EG. Furthermore, it is likely that we are in a new phase of productivity and different goals may need to be used. For example, research under this category might use a various time-varying productivity parameter to ensure EGs more current to optimize harvest opportunities among all fisheries.

3. Management Strategy Evaluation

Management strategies are approaches to prosecuting fisheries such as when, where, and at what times to open and close fisheries based on the information available at the time. “Management Strategy Evaluations” (MSEs) are desktop exercises that are used to inform regulators (e.g., Alaska Board of Fisheries) and fishery managers on the relative effectiveness of existing and alternate ways of managing harvesting activities. For example, recent analyses done to evaluate management strategies such as “triggers” proposed for the management plan that dictate when fisheries may or must open. As more accurate assessment information becomes available, we expect innovative management ideas and MSEs can be a cost-effective way to examine the potential value of these.

4. Factoring Economics and Biological Factors into Management Plans and Actions

Many management actions involve trade-offs in biological yield and socio-economic yield in the subsistence, sport, and commercial fisheries. In the Nushagak, sockeye salmon harvests have a large economic impact and changes to management plans create benefits and costs across and among users. Economic research integrated with biological responses to management can inform regulators as to the social and economic benefits and cost of alternative actions is extremely helpful

Table 1: Outline of Program Goal, Objectives, and Project Components for Nushagak Salmon Stock Assessment

Program Goal: Improve Management of Nushagak Salmon, Emphasis on Chinook				
Project Components	Project Status		Project "Role"	
	Existing	Augment		New
Objectives				
Annual Monitoring				
Inseason Projects				
1. Inseason Catch and Escapement Information for Management.				
Catch sampling				
Commercial fishery		X	Add staff and resources to existing project	
Sport fishery			X	Begin collecting ASL data from the Sport Fishery
Subsistence fishery			X	Begin collecting ASL data from the Subsistence Fishery
Indicies of Chinook salmon abundance				
District Test Fishery	X			Identify fish entering district and Chinook/sockeye ratio
Portage Creek sonar	X	X		Address shortcoming of species apportionment
Sport Fishery Creel			X	Collect Sport Fish CPUE information for management
Inriver test fishery			X	Identify fish past the district and tagging site for M/R
Post-season projects				
2. Post-season, system-wide age-specific catch and escapement				
Age-specific catch estimates across all fisheries			X	Desk-top using catch sampling data
Portage Creek sonar		X	X	Address shortcoming of species apportionment
Tributary weirs			X	Operate weirs on two tributaries to enumerate Chinook
Mark-recapture system-wide escapement			X	Use weirs and genetic or traditional marks to estimate
Aerial surveys	X	X		Continue and improve existing program
Run reconstruction	X			Integrate additional data sources
3. Build/improve brood tables for Chinook and sockeye for escapement goals.				
Annual total catch and escapement, brood table			X	Re-establish brood table for Chinook
Run reconstruction		X		Create a consistent time series of catch and esc.
Preseason forecasts			X	Begin generating a Chinook forecast

Table 1 Continued:

Program Goal: Improve Management of Nushagak Salmon, Emphasis on Chinook			
Project Components	Project Status		Project "Role"
	Existing	Augment	
Objectives			
<u>Applied Research to Support Annual Management and Monitoring Projects - Examples for illustration</u>			
5. Develop cost-effective methods and institutional capacity to operate and fund a sustainable program.			X Make investments in projects with a goal of long-term financial sustainability.
6. Annual and periodic rigorous reviews of program and management performance.			X Make program review an integral part of the research plan.
7. Assess changing productivity, update escapement goals for Chinook and sockeye salmon.	X		Use improved data input for escapement goal setting.
8. Assess impacts and effectiveness of management measures to increase Chinook escapement.			Management strategy evaluation.
Review management performance annually with an emphasis on how existing or better information may have affected performance.	X		X Make explicit how management performance is affected by assesment program.
9. Applied research into biological and physical processes that affect salmon productivity.			
Examine the effect of sockeye escapement levels on Chinook salmn productivity.			X Identify whether sockeye management and escap ement levels alter chinook salmon management targets.