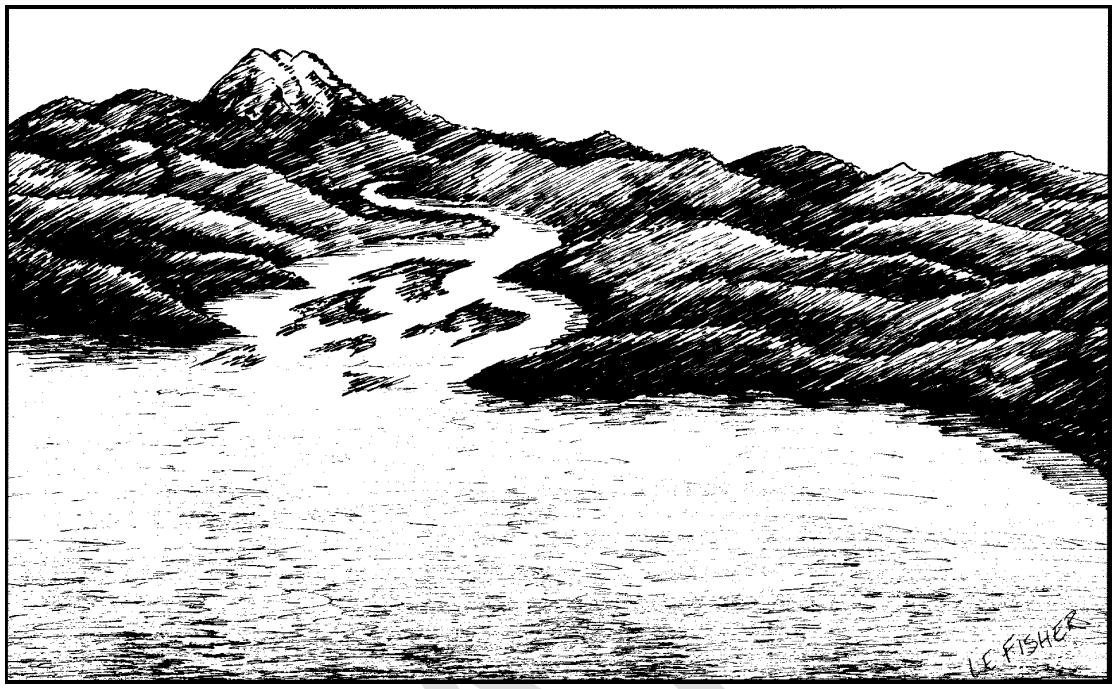

Nisqually Chinook Stock Management Plan

January 2011

DRAFT

Prepared by the

Nisqually Chinook Work Group

Nisqually Chinook Stock Management Plan Participants

The Nisqually Chinook Stock Management Plan is a collaborative product between Nisqually Indian Tribe and Washington Department of Fish and Wildlife with assistance from consultants at ICF International. The individuals listed below attended one or more of the Nisqually workshops or contributed to developing the management plan.

Adicks, Kyle	Washington Department of Fish and Wildlife
Dorner, Jeanette	Nisqually Indian Tribe
Ellings, Christopher	Nisqually Indian Tribe
Hodgson, Sayre	Nisqually Indian Tribe
Hughes, Kirt	Washington Department of Fish and Wildlife
Kautz, Georgiana	Nisqually Indian Tribe
Laborde, Sara	Washington Department of Fish and Wildlife
Leischner, Florian	Nisqually Indian Tribe
Pattillo, Pat	Washington Department of Fish and Wildlife
Phillips, Larry	Washington Department of Fish and Wildlife
Smith, Craig	Nisqually Indian Tribe
St. Jean, Bill	Nisqually Indian Tribe
Troutt, David	Nisqually Indian Tribe

Consultants:

Barr, John	John Barr Consulting
Blair, Greg	ICF International
Mobrand, Lars	ICF International

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Abbreviations and Acronyms

3-Year Update	*Nisqually Watershed Chinook Salmon Three-Year Work Program Update*
AHA	All-H-Analyzer
All-H	hatchery, harvest and habitat
APR	Annual Project Review
CWT	coded wire tags
EDT	Ecosystem Diagnosis and Treatment
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FRAM/TAMM	Fishery Regulatory Assessment Model/Terminal Area Management Model
HGMP	hatchery and genetic management plan
HOR	hatchery-origin recruits
ISIT?	In-Season Implementation Tool
M&E	monitoring and evaluation
MSY	maximum sustainable yield
NCRT	Nisqually Chinook Recovery Team
NOR	natural-origin recruits
pHOS	proportion of hatchery spawners
PNI	proportionate natural influence
pNOB	percent natural-origin brood stock
RM	river mile
SAR	smolt-to-adult ratio
SASSI	Salmon and Steelhead Stock Inventory
NCSMP	Nisqually Chinook Stock Management Plan
USFWS	U.S. Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife

Executive Summary

Salmon are important to the economic, social, cultural, and aesthetic values of the people in the Pacific Northwest. The recovery of Nisqually fall Chinook is best achieved within the context of a comprehensive plan that takes into account all of the factors that affect productivity, abundance, and diversity across the migratory range of the species. The Nisqually Chinook Stock Management Plan (NCSMP) is a next step in the process towards recovery of fall Chinook in the Nisqually River Basin. Recent hatchery and harvest management practices have provided for a Chinook escapement however they have been inconsistent with the recovery of a locally adapted, self-sustaining natural population because they have allowed straying of hatchery fish onto the spawning grounds and have resulted in overharvesting of the natural component. The intent of this plan is to provide a framework for moving past the period of hatchery colonization and into a period of natural fish adaptation.

Goals identified in the *Nisqually Chinook Recovery Plan* (Nisqually Chinook Recovery Team 2001) included the development of a locally adapted natural population of fall Chinook in the basin to take advantage of improvements in habitat identified in the recovery plan. Many of the major elements of the plan have been implemented over the last 10 years (Mashel River, Ohop Creek, and the estuary) and model assessments of habitat potential suggest fall Chinook potential has increased by over 60% since the habitat components of the recovery plan were started in 2001. To achieve the goal of a locally adapted natural population it will be necessary to severely reduce hatchery influence and harvest on the natural fall Chinook population. This will require revisions to hatchery operations, operation of a weir to remove hatchery-origin strays from the river, and increasing the use of fisheries that selectively harvest hatchery-origin adults while reducing harvest of natural-origin adults. To decrease the impact of hatchery strays, a small portion of the natural-origin run will be used for hatchery brood stock. As a consequence of these complementary actions, it is expected that the number of natural-origin adults in the spawning escapement will increase. However, the total number of fish spawning in nature will decrease in some years as hatchery strays are removed at the weir. It is expected that these actions will promote the selection for population traits that improve the survival of natural-origin Nisqually fall Chinook and will increase the benefits of habitat restoration investments.

The NCSMP management framework begins with biological targets that are established each February when decision rules are applied to pre-season run size forecasts. Nisqually River run size updates beginning in August may necessitate adjustments to decisions for hatchery operations, weir operations, and harvest. A robust monitoring and evaluation component informs the entire process.

The NCSMP management framework has three elements:

1. Clear, specific conservation and harvest goals with measurable targets for the natural and hatchery components of the Nisqually Chinook population.

2. An annual monitoring program for the natural and hatchery populations that collects information to improve predictions of biological targets for the upcoming year (e.g., key assumptions, preseason run size forecasts, in-season run size updates, etc). The

monitoring program also audits the previous year's preseason and in-season predictions against actual performance.

3. An annual process that identifies objectives for the current fall Chinook management period in response to new information.

Goals

The NCRT established NCSMP recovery goals for Nisqually fall Chinook based on the *Nisqually Watershed Chinook Salmon Three-Year Work Program Update* (3-Year Update) (Puget Sound Partnership 2010). Although these goals focus on fall Chinook, the plan update includes broader goals that encompass all species and the protection and enhancement of broader ecosystem functions in the Nisqually River Basin and relevant marine nearshore regions.

Long-term conservation goals for Nisqually fall Chinook are as follows:

- Ensure natural production of fall Chinook by providing high quality habitat.
- Achieve a self-sustaining, locally adapted natural population.

Long-term goals for harvest are:

- Ensure sustainable harvest of 10,000 to 15,000 Chinook annually in the treaty terminal net fishery.
- Ensure a sustainable sport fishing opportunity in the Nisqually River targeting hatchery produced Chinook.

The short-term goals over the next 10 years will be used to evaluate progress toward long-tem conservation and harvest goals and guide annual decisions. These are as follows:

Short-term goals for conservation are:

- Reduce the proportion of hatchery origin spawners (pHOS) in the total natural spawning population.
- Develop a hatchery program that has a genetic continuity to the natural population, as measured by:
    - an integrated hatchery component with a proportionate natural influence (PNI) greater than 0.67, and
    - a stepping-stone[1] hatchery component to support the terminal net and sport fisheries.

[1] In a stepping-stone program, the entire program brood stock is taken from the integrated hatchery program. This ensures a level of genetic continuity of the harvest program to the natural population that would not occur with a typical segregated harvest program.

- Reduce harvest impacts on natural origin fish to a level that will promote a self-sustaining natural population.
- Update key assumptions using best available science to ensure that harvest, hatchery, and habitat objectives remain consistent with recovery goals

Short-term goals for harvest are the same as long-term goals:

- Ensure sustainable terminal Chinook harvest, including 10,000 to 15,000 annually in the treaty terminal net fishery, consistent with conservation goals.
- Ensure a sustainable sport fishing opportunity in the Nisqually River targeting hatchery produced Chinook.

Monitoring

Monitoring is key to the overall success of the Chinook recovery plan. The following monitoring objectives were identified as critical to the analysis of status and trends of biological targets and to specific elements of the short-term goals:

- Annual estimates of natural spawning composition (pHOS).
- Annual estimates of total natural spawning escapement abundance and distribution.
- Annual estimates of hatchery brood stock composition (percent natural-origin broodstock [pNOB] adults in the integrated program and brood stock composition of the stepping-stone program).
- Annual estimates of total catch and natural and hatchery composition, and natural and hatchery harvest rates in the terminal treaty net and terminal sport fisheries.

A broader suite of monitoring activities in the Nisqually River Basin includes evaluating the effectiveness of habitat protection and restoration actions in the basin; monitoring fish use of existing and newly created habitats; monitoring abundance, behavior, and distribution of fall Chinook at specific life stages (e.g., adult migrants, spawning); and monitoring overall population response to habitat actions and local adaptation. The monitoring activities for 2010 are described in the 2010 NCSMP Action Plan (Appendix A).

Management Action Response

Key to the success of the NCSMP is efficient and timely inclusion of information in the management structure and a planned process to review and act on information. Specifically, the NCSMP must audit performance, challenge key assumptions, guide decisions, and plan activities for the upcoming year (Figure ES-1). The process is formalized in a database and a set of management tools that ensure consistency and accountability from year to year.

A critical element of the NCSMP is the 3-day Annual Project Review (APR) convened each February. The APR will be planned by Nisqually Indian Tribe and Washington Department of

Fish and Wildlife (WDFW) during monthly Nisqually Stock Assessment Workgroup meetings. The APR will be when Nisqually natural resources staff and the Washington Department of Fish and Wildlife (WDFW) set plans and biological targets for the upcoming management season. The APR includes the following elements:

- A review of the previous year's performance against preseason and in-season biological targets.
- An update and review of the status and trends analysis, which includes an analysis of the 4-year running averages of key biological metrics (e.g., natural-origin abundance, pHOS,

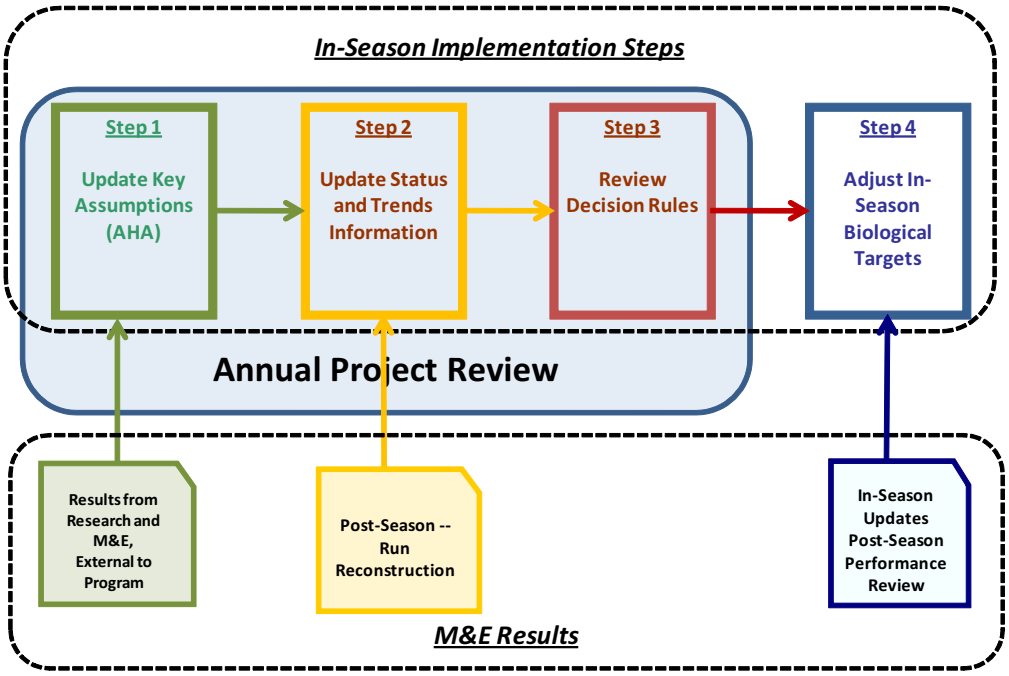


Figure ES-1. Process for reviewing and updating information during the APR and in-season updates.

catch, harvest rates). Indicators of progress toward goals will help guide decisions for the upcoming year.

- Update key assumptions in the plan from research, and monitoring and evaluation (M&E) activities.
- Review and apply the decision rules for hatchery, harvest and weir operations using pre-season run size projections and generate biological targets for upcoming year. The decision rules guide development of the harvest schedule, hatchery brood stock collection, and the number of fish removed or passed at the weir.
- Develop an action plan to guide and coordinate activities across all management components and to communicate Nisqually activities and priorities to the region via the

3-Year Update (Puget Sound Partnership 2010). Activities described in the action plan are organized by the following categories:

- Harvest management
- Hatchery operations
- Weir operations
- Habitat work plan
- M&E
- Policy coordination

The reliability of modeled pre-season forecasts for the natural-origin run is expected to improve through the years as run size and fishery impact information improve. However there will always be uncertainty going into the management season. This uncertainty requires periodically adapting the decision rules to the new run sizes and making in-season updates to the action plan.

Decision Rules

The decisions rules described below are actions affecting outcomes associated with the fully implemented program. Implementation of all elements of the plan is anticipated to occur as soon as possible, with weir placement and hatchery fish exclusion beginning in 2011 and gear testing and refinement, expansion of hatchery capabilities, and development of measures to selectively harvest hatchery-origin adults while protecting natural-origin adults from harvest occurring over the next 5 years. The first adult returns from the integrated program to support the stepping-stone program will not be available until 3 years after the first integrated program release. However, the collection of natural-origin brood stock for the integrated program is dependent on successfully reducing harvest impacts on natural fish. The schedule to implement all elements of the plan still needs to be developed. The APR workshops will be where these details are developed. The decision rules are described below.

Harvest Management

- Restructure terminal net fishery to selectively harvest hatchery-origin adults and implement a natural fish protection program.
  - Maintain high harvest rates on marked hatchery-origin adults using effective, alternative gear types and time and area openings
  - Reduce terminal harvest rates on unmarked natural-origin adults to 20–25% by implementing measures to avoid their capture and measures to release unharmed, unmarked adults captured in the fishery.
  - Manage pre-terminal and terminal fisheries to not exceed a total exploitation rate of 47% on natural-origin Chinook.

Hatchery Management

- Develop an integrated hatchery program to generate brood stock to support the stepping-stone harvest program and to provide a demographic safety net in years of critically low adult abundance.
    - Total brood stock: 420 adults
    - pNOB (percent natural-origin adults in broodstock): 25% (75 to maximum 105 adults), dependent on sufficient natural-origin returns. Smolt release: 400,000 to maximum 600,000 fish, dependent on sufficient natural-origin returns.
    - Release location: Kalama Creek, and move to Clear Creek when it demonstrates the capability to support another 600,000 released fish
    - Marking: 100% coded wire tags (CWT), 75,000 CWT/adipose fin clip for double-index tagging program, the remainder no adipose fin clip
- Develop a stepping-stone hatchery program to provide harvest using brood stock collected from the integrated program return.
    - Brood stock: 2,300 adults taken from integrated hatchery return
    - pNOB (percent natural-origin adults in broodstock): 0% at projected near-term abundance levels, future decisions may increase to 25% based on pre-season and in-season natural-origin run size forecasts
    - Smolt release: 3.4 to maximum 3.6 million, dependent on size of integrated program
    - Release location: Clear Creek
    - Marking: 100% adipose fin clip, 100,000 CWT/adipose fin clip

Weir Operations

- Operate an adult weir at river mile (RM) 12.3 in the Nisqually River during fall Chinook management season (early July to October 30).
    - Monitoring: count escapement at weir and number unmarked Chinook passed upstream of weir. All fish captured at the weir will be run through a CWT detector to identify CWT only returns from the integrated program.
    - Escapement composition: exclude all hatchery-origin adults (adipose-marked or CWT fish) from escapement upstream of weir except in years of critically low abundance (fewer than 500 projected natural spawners above the weir).
    - Escapement goals: manage the release of CWT-only adults from the integrated program to natural escapement in the occasional year that natural spawn escapement of all fish (natural-origin and hatchery strays from leakage at the weir) is projected to be less than 500 fish above the weir.

- Brood stock collection: collect up to 105 unmarked adults at weir for the integrated hatchery program and, as necessary, CWT-only integrated program adults for the stepping-stone program.

2010 NCSMP Action Plan

The 2010 NCSMP Action Plan reflects numerous transition steps toward full implementation. The harvest schedule for the terminal net fishery has been modified to reduce terminal harvest rates on natural-origin adults and the adult weir will be installed and tested beginning in late July. Also of priority the reminder of 2010 and prior to the 2011 APR workshop in February 2011 will be the scoping and if possible development of analytical tools to improve pre-season and in-season run size forecasts. These activities are described below. A complete list of activities, information summaries, responsible parties, and projected completion dates are provided in the NCSMP Action Plan (Appendix A).

Harvest Management

The 2010 terminal net harvest schedule has been revised from previous years to reduce the harvest rate on natural-origin Nisqually fall Chinook. The objective is a 40% harvest rate in the Nisqually treaty net fishery. Measures to differentially harvest hatchery-origin adults at a higher rate will not be implemented in 2010.

Implementation of the NCSMP will focus on the following actions:

- Develop forecast tools and protocols for pre-season and in-season updates.
- Estimate hatchery and natural composition in tribal (Nisqually) and sport (WDFW) fisheries annually.
- Estimate tribal and sport terminal harvest rates on hatchery and natural-origin Chinook and update harvest model for next year.
- Develop methods to harvest hatchery fish at the highest rate possible while keeping mortality of natural fish at low, sustainable rates.
- Develop a data management and reporting system.
- Update and refine operations budget and staffing.

Hatchery Management

Hatchery operations are unchanged from previous years. Additional measures are being developed to address the larger-than-average surplus of hatchery adults expected in 2010 because of the lower terminal net harvest rate.

- The Clear Creek program will collect approximately 2,300 adults for brood stock from adults returning to the Clear Creek hatchery. There is not intent to collect natural-origin fish (fish with adipose fins and without CWT) for the Clear Creek program in 2010

(pNOB = 0%). Unmarked adults at the hatchery are likely unmarked hatchery-origin adults.

- The 2010 planned smolt release from Clear Creek is 3.4 million Chinook. The entire release will be marked with an adipose fin clip, except for 200,000 that will also have a CWT and 200,000 that will have a CWT but without adipose fin clips to be used as part of the double-index tagging program.

- The Kalama Creek program will collect approximately 420 adults for brood stock from adults returning to the Kalama Creek hatchery. There is not intent to collect natural-origin fish (fish with adipose fins and without CWT) for the Kalama Creek program in 2010 (pNOB = 0%). Unmarked adults at the hatchery are likely unmarked hatchery-origin adults.

- The 2010 planned smolt release from Kalama Creek is 600,000 Chinook. The entire release will be marked with adipose fin clips. A portion of the release (100,000) will also have a CWT for survival and harvest rate studies.

- The number and composition of brood stock, hatchery surplus, smolts released, and fish marking will be recorded.

Other hatchery activities include preparing for the transition to an integrated program at Kalama Creek, planned to occur in 2011:

- Develop an operations plan for integrated and stepping-stone programs.

- Develop a plan for natural-origin brood stock objective (weir permit states 105 adults for 600,000 release program) and update hatchery and genetic management plan (HGMP) accordingly.

- Develop a brood stock management plan and spawning protocols for adult returns of the integrated program.

- Develop rearing and release objectives for integrated and stepping-stone programs.

- Develop a long-term plan to release entire Chinook production (4 million) to Clear Creek.

- Update and refine operating budget and staffing.

- Develop consistent standards for identifying and recording partial adipose fin clipped fish at release and as adults at the hatchery and weir.

Weir Operations

The adult weir at RM 12.3 was intended to be installed and operating in 2010 but was not installed due to difficulties with logistics, including contracting logistics. Specific operation objectives for the 2010 season were as follows:

- Test systems, operate at various seasonal flows, develop operating procedures, and train staff in operations and safety for staff and fish.
- Release all species (marked and unmarked), except hatchery steelhead (remove), to upstream of weir; there is no objective defined for the first year to manage encountered fish on the basis of composition or abundance.
- Enumerate escapement (all species) to weir and hatchery/natural composition, defined on the basis of presence or absence of adipose fin-clip, or CWT.
- Estimate daily and weekly run timing at weir for all species, including pink salmon.
- Develop sampling plan and collect biological data.
- Estimate weir efficiency for Chinook with a mark recapture study.
- Develop and implement a preliminary study to estimate weir-induced mortality for all species.
- Develop and implement preliminary studies to estimate incidence of natural spawning downstream of weir, weir delay, and trap rejection for Chinook salmon.

Several activities not related to weir operations were identified for 2010 to improve the future success of the NCSMP:

- The NCSMP Work Group will develop an operating manual for future use.
- Develop an operating plan to collect brood stock at weir to initiate an integrated stepping-stone hatchery program.
- Develop a data management and reporting system.
- Update and refine operating budget and staffing.

Habitat Work Plan

The habitat work plan for 2010 will focus on the following objectives (see Habitat 3 year workplan for more detail):

- Complete Mashel River Restoration Phase IIB.
- Ohop Creek: activate a new channel.
- Continue riparian planting program and control of invasive knotweed.
- Continue salmon carcass placement for nutrient enhancement.
- Acquire key properties for protection and restoration.
- Track progress and support reduction of impervious surface and improve stormwater management in key areas of the Nisqually watershed.

- Communicate the importance and value of habitat protection and restoration in the Nisqually watershed and marine areas.
- Continue development of the lower Nisqually mainstem restoration plan.
- Finalize plan for Red Salmon Slough Phase III restoration for summer 2011 (river dike removal).
- Continue riparian plantings in estuary.
- Develop restoration plan for Nisqually nearshore marine areas.
- Develop habitat data management plan.
- Formalize process for collecting and archiving information about unplanned events.
- Update Ecosystem Diagnosis and Treatment (EDT) model inputs.
- Evaluate and update status of elements in 3-Year Update.
- Update and refine operating budget and staffing.

Monitoring and Evaluation

Monitoring and evaluation activities (as defined by the NCSMP Work Group) for 2010 will include the following:

- Estimate the abundance and composition of natural spawning escapement.
- Estimate spatial distribution and composition of natural spawning escapement.
- Complete annual juvenile outmigration estimates (using screw trap at RM 13).
- Develop population status and trend protocols.
- Develop methods to use empirical data to evaluate validity of key assumptions in the NCSMP.
- Develop monitoring plan that will provide data for evaluating the effectiveness of habitat actions.
- Complete Nisqually River Basin adaptive management plan and link with NCSMP.
- Measure and report on progress of estuary habitat recovery and juvenile use of estuary habitat zones.
- Identify data management and analysis tools required to improve process; schedule their development and testing.
- Update and refine operations budget and staffing.

Policy Coordination

The following policy coordination activities for 2010 will focus on those activities that affect implementation of the NCSMP and monitoring and evaluation:

- Coordinate objectives and activities between the co-managers.
- Develop and communicate objectives and activities with other interested parties.
- Address Endangered Species Act (ESA) issues.
- Ensure that agreements with permitting agencies are consistent with NCSMP construction and operation objectives.
- Establish the NCSMP work group consisting of technical experts working toward salmon recovery in the Nisqually River by improving data collection, cooperation, and methodologies, using the best available science.

Chapter

1

1. Introduction / Overview

Salmon are important to the economic, social, cultural, and aesthetic values of the people in the Nisqually River Basin. The recovery of Nisqually Chinook is best achieved within the context of a comprehensive plan that takes into account all of the factors that affect productivity, abundance, and diversity across the migratory range of the species. This Nisqually Chinook Stock Management Plan (NCSMP) initiates the development of an integrated hatchery, harvest and habitat (All-H) plan for Nisqually fall Chinook. The restoration of Nisqually Chinook production will contribute toward the recovery of the Puget Sound Chinook, listed as threatened under the Endangered Species Act (ESA).

The health of a salmon population depends upon the condition of its environment and the genetic fitness of that population. Information about past and current Nisqually River Chinook populations and their environment provides clues to the causes of their decline and to the potential for their recovery. The Nisqually Basin, like most of southern Puget Sound, has a long history of hatchery enhancement. Hatchery production is currently necessary for sustaining harvest that natural production cannot support due to habitat degradation and reduced population productivity. As a consequence of high harvest rates associated with the hatchery program, habitat degradation, hydropower development, and hatchery straying, native Nisqually Chinook salmon populations have long been extirpated.[2] The NCSMP, therefore, includes a strategy that integrates hatchery, harvest, and habitat actions in order to promote the development of a locally adapted, naturally spawning Chinook population in the Nisqually River Basin.

The NCSMP defines actions for managing fisheries, for operating hatcheries, and for operating the fish weir, that will work in concert to achieve natural spawning escapement and harvest goals. In defining these actions, we considered the consequence of past management actions on the abundance and composition (hatchery vs. wild) of naturally spawning Chinook. A variety of possible harvest and escapement outcomes were evaluated tested based on assumptions about (1) the effectiveness of proposed actions for hatcheries, (2) projected future run sizes of the natural and hatchery populations, (3) the potential of the habitat to support Chinook now and into the future, and (4) projected improvements to population fitness with each option. Actions defined in the NCSMP are considered to have the best likelihood of achieving the goals for conservation and harvest of Nisqually fall Chinook.

The NCSMP (developed and updated by the NCSMP Work Group) describes actions that will be phased in over the next 5 years to move the population toward long-term recovery. The

[2]Records indicate that hatchery fall Chinook have been planted in the Nisqually since 1943, and likely earlier. Data from early years on stock origin are not available, but plants in the 1960s and 1970s were from at least nine different Puget Sound and Hood Canal hatcheries. As in most of southern Puget Sound, harvest rates for fall Chinook have been based on full harvest of hatchery-produced fish.

NCSMP takes into account all of the known impediments to, and likely opportunities for, achieving Chinook salmon recovery goals in the basin. Predicted outcomes of the actions are based on key assumptions that will be refined in response to new information produced by a carefully designed monitoring program and a clear decision-making process.

The evaluation of hatchery effects on the natural population abundance and survival, and the actions described in the NCSMP are based on the scientific principles, standards, and general recommendations developed by the Hatchery Scientific Review Group (HSRG) for hatchery reform in the Pacific Northwest (HSRG 2009). The HSRG has concluded that hatchery programs should either be managed to achieve proper integration with or segregation from, natural populations. The decision to integrate or segregate a hatchery program must be evaluated on a case-by-case basis depending on the unique circumstances of the program and the natural population. The HSRG has stated that proper integration or segregation is necessary to ensure that hatchery programs are not an impediment to recovery and conservation of key natural populations of salmon and steelhead.

The biological principle behind proper integration or segregation of hatchery programs is local adaption. When populations are allowed to adapt to the local conditions of the natural environment, their productivity will increase. The HSRG has developed standards for hatchery influence on natural populations for integrated and segregated programs. For integrated programs the intent is for the combined hatchery/natural population to attain the genetic characteristics of the locally adapted natural population. This requires that the natural habitat has a stronger selective influence than the hatchery environment. To this end, the HSRG concluded that the proportion of hatchery brood stock comprised of natural-origin fish (pNOB) must be greater than the proportion of the natural spawning population that is of hatchery-origin fish (pHOS). The Proportionate Natural Influence (PNI) is calculated as pNOB/(pNOB+pHOS). For populations with the highest biological significance within their ESU, the PNI index should exceed 0.67. For other populations with different roles within the ESU, a PNI of 0.5 may be acceptable.

For segregated programs the intent is to maintain a genetically distinct hatchery population, isolated from the natural population. For populations with the highest biological significance within their ESU, the HSRG has recommended that pHOS be less than 5 percent or less. For other populations, pHOS values up to 10 percent may be acceptable.

The HSRG has evaluated the long-term genetic risks to natural populations of hatchery strays using the phenotypic fitness model described by Ford (2002). The HSRG incorporated the equations of Ford (2002) in the All-H-Analyzer (AHA) to predict the effects of hatchery influence on fitness of natural populations. Our analysis of hatchery effects on natural Nisqually Chinook adopted the fitness model parameters used by the HSRG in the Pacific Northwest, including a fitness floor of 50% to bound the maximum fitness effects on a population. The high percent hatchery fish spawning in nature over multiple generations suggests the maximum effect is appropriate for Nisqually Chinook. Finally, the NCSMP will use new tools and concepts as they are developed to incorporate new understandings as the science develops, if applicable to the Nisqually.

This report describes the short-term and long-term goals for conservation and harvest of Nisqually fall Chinook, followed by a review of past, current, and future expectations for habitat,

411 harvest, and hatchery programs. Finally, the NCSMP management framework is outlined, and an
412 analysis of the fully implemented plan is provided.

Chapter

2

2. Goals for Nisqually Chinook Salmon

The Nisqually Chinook Recovery Team (NCRT) identified goals for the Nisqually River Basin and for Chinook recovery in the 2001 *Nisqually Chinook Recovery Plan* (Nisqually Chinook Recovery Team 2001). These goals represent the vision of the Nisqually watershed community and the future of its salmon populations. The goals presented here are modified slightly from those described in the 2001 recovery plan and are specific to fall Chinook. Goals are presented as a hierarchy, moving from long-term watershed goals to specific, shorter-term recovery goals.

Short-term goals described in this plan are for the next 10 years. The NCSMP is expected to be implemented in phases over the next 5 years and will be a significant step towards achieving short-term goals. Long-term goals are beyond the next 10 years and represent the future expectations for Nisqually fall Chinook.

Historically, Chinook have been managed in the Nisqually Basin for harvest goals. As a result, exploitation of the natural population has greatly exceeded a sustainable rate. Natural production in the Nisqually River Basin has been sustained only by several thousand hatchery-origin strays spawning in nature each year. The hatchery fish are derived from historical transfers of fish from other basins in Puget Sound.

The long-term conservation goals for Nisqually fall Chinook are as follows:

- Ensure natural production by providing high quality, functioning habitat and by developing a self-sustaining, naturally spawning population with diverse geographic distribution.
- Achieve a self-sustaining, locally adapted natural population.
- Provide significant contributions to ecosystem functions.

The long-term harvest goals for Nisqually fall Chinook are as follows:

- Ensure sustainable harvest of natural-origin Chinook.
- Ensure sustainable harvest of 10,000 to 15,000 Chinook annually in the treaty terminal net fishery.
- Ensure a sustainable sport fishing opportunity in the Nisqually River targeting hatchery produced Chinook.

The long-term goals help guide short-term efforts. The short-term conservation goals (for fall Chinook are to promote local adaptation through reduced hatchery influence and to increase spawning abundance of natural origin Chinook. Specific short-term goals are as follows:

- Reduce the total proportion of hatchery- origin spawners (pHOS) in the natural spawning population.
- Develop a hatchery program that has a genetic continuity to the natural population, as measured by:
    - an integrated hatchery component with a proportionate natural influence (PNI) greater than 0.67, and
    - a stepping-stone[3] hatchery component to support the terminal net and sport fisheries.
- Reduce harvest impacts on natural origin fish to promote a self-sustaining natural population.

Short-term goals for harvest are as follows:

- Ensure sustainable terminal Chinook harvest, including 10,000 to 15,000 annually in the treaty terminal net fishery, consistent with conservation goals.
- Ensure a sustainable sport fishing opportunity in the Nisqually River targeting hatchery produced Chinook.

The habitat management goals are to use protection and restoration actions to support Nisqually Chinook and are as follows:

- Habitat protection: allow no further degradation of the Nisqually and Puget Sound watersheds, to ensure their ability to support the productivity, abundance, and life history diversity of natural origin Nisqually Chinook.
- Habitat restoration: restore habitat in the Nisqually Puget Sound watersheds to continue progress toward a diverse, productive, and abundant population of natural origin Nisqually Chinook.

[3] In a stepping-stone program, the entire program brood stock is taken from the integrated hatchery program. This provides a level of genetic continuity to the natural population that would not occur with a typical segregated harvest program that the entire brood stock comes from returns to the segregated program.

Chapter

3

3. Nisqually Chinook Salmon

The Salmon and Steelhead Stock Inventory (SASSI) lists the Nisqually Chinook as a summer/fall Chinook stock (Washington Department of Fisheries et al. 1993). Adults enter the river from July through September. Peak spawning is mid-October. Historically, there was a spring run in the Nisqually. This run was last observed in the early 1950s and is now considered extinct.

Since the mid 1970s, Nisqually Chinook have been managed as a single stock for the purpose of supporting treaty and non-treaty fisheries. Current Chinook production consists primarily of on-station hatchery releases at Clear Creek Hatchery and Kalama Creek Hatchery, with natural production from the mainstem and the lower reaches of major tributaries. Natural-origin spawners are derived from prior hatchery releases with continuing contributions from hatchery strays. Native Nisqually Chinook were extirpated as a consequence of habitat loss, hatchery introductions, and high harvest rates.

The natural population of Nisqually fall Chinook has been and continues to be significantly affected by high rates of harvest. The total annual exploitation rate for Nisqually Chinook, as described by post-season FRAM runs, has declined slightly since the early 1990's (Figure 1), but still averaged 76% from 2000-2008. FRAM rates are assumed to accurately index the recent trend in exploitation rate, but may not accurately quantify annual exploitation rates, because of the lack of CWT data in the model base period. Exploitation rates in northern fisheries have increased since the late 1990's, averaging 7% from 1995-2002, and 20% from 2003-2008. Pre-terminal Southern United States exploitation rates have remained fairly constant, averaging 18% from 1998-2008. Terminal rates have been more variable, and have averaged 45% over the same period. The Nisqually fall Chinook natural population is not sustainable under these conditions.

The Nisqually fall Chinook hatchery programs at Kalama Creek and Clear Creek were developed to provide for both treaty Indian and non-Indian, terminal and pre-terminal fisheries. Approximately 4.0 million fall Chinook are released annually (0.6 million from Kalama Creek and 3.4 million from Clear Creek). Between 2004 and 2009, these programs provided an average treaty terminal harvest of about 16,000 adults. During this same period, approximately 11,000 adults annually escaped all fisheries and were recovered at Clear Creek and Kalama Creek Hatcheries. An estimated additional 2,000 to 3,000 fish escaped all fisheries and naturally spawned in the Nisqually River Basin. It is estimated that, from 2004 to 2009, most of these natural spawners were of hatchery origin (pHOS averaged 78%).

There has been and remains a strong emphasis on protecting and restoring habitat in the Nisqually River Basin and estuary. Major habitat restoration efforts have been implemented in the Nisqually Estuary to restore tidal influence and fish access to areas of the estuary blocked by levees, including a major effort to restore tidal channels in the Nisqually National Wildlife Refuge in 2009, managed by the U.S. Fish and Wildlife Service (USFWS). Restoration of freshwater habitats has occurred in the Mashel River and Ohop Creek and in several smaller streams.

This chapter summarizes the history and current conditions of Nisqually fall Chinook with respect to habitat, harvest, and hatchery operations. Section 3.1 describes the effects of habitat actions on the potential of the Nisqually basin to produce Chinook. Section 3.2 summarizes past harvest rates in pre-terminal and terminal fisheries and total exploitation rates on natural origin Chinook. Section 3.3 summarizes hatchery operations and coded wire tag (CWT) recovery rates for fish released from Clear Creek and Kalama Creek Hatcheries. Data presented in the following sections for habitat, harvest, and hatchery operations were the basis for the baseline and current conditions analyzed in the hatchery, harvest, and habitat (All-H) analysis model (All-H-Analyzer or AHA).

3.1. Habitat Potential

Habitat potential for Nisqually Chinook was estimated using the Ecosystem Diagnosis and Treatment (EDT) model. The EDT model was used to evaluate trends in habitat potential and is used by the Nisqually Work Group to guide restoration and protection actions. Specially, the EDT model is used to formulate and document working hypotheses with respect to the potential of the Nisqually freshwater and estuary. The model is applied to account for past actions, gauge the benefits of current actions, and to guide future direction, as described in Chapter 4 of this report.

The EDT model estimates population productivity and capacity parameters for the Beverton-Holt survival function. Estimated abundance is expressed where the Beverton-Holt production curve crosses the replacement line. Maximum sustainable yield (MSY) exploitation rate and escapement are points on the production curve that maximize harvest. Harvest rates and population fitness are not included in the EDT estimates of habitat potential. Results from the EDT model presented in this section do not include assumptions of fitness loss or harvest impact. The assumed maximum effect of fitness loss is shown for each habitat scenario to illustrate the effect of fitness loss on population productivity, abundance, and MSY.

The habitat scenarios described below represent reference points to evaluate the effectiveness of past habitat restoration and protection activities and the benefits of predictions of future habitat restoration actions in the basin. The 4 to 5 year life cycle of Chinook means that the population response will lag behind changes in the habitat. So even though we describe these as point estimates, in reality the population is always in transition with, ideally, an observed trend over time of greater average abundance and higher estimated productivity.

Estimates of habitat potential for fall Chinook are provided for the following time periods:

- Baseline condition prior to 2001
- Status as of 2009
- Current condition in 2010
- Predicted long-term future condition

Baseline (Pre-2001) Condition

The baseline condition describes the potential of the freshwater habitat and estuary prior to major restoration projects implemented since 2001. This potential differs slightly from that reported in the *Nisqually Chinook Recovery Plan* (Nisqually Chinook Recovery Team 2001) because of improvements to the model and better information about the environment.

Under baseline conditions, fall Chinook productivity (recruits per spawner) and capacity (adults) potential is estimated to be 3.4 and 5,211 respectively (Table 1). This provides a maximum sustainable yield (MSY) exploitation rate of 46% and a MSY escapement of 1,292 adults for the fully fit population.

Table 1. Nisqually fall Chinook habitat potential for the baseline, current, transition and long-term future conditions assuming a fully fit population and a hatchery-dominated population (population fitness of 50%). The MSY escapement and rate are estimated from the Beverton-Holt survival function.

	Maximum Habitat Potential (fully fit)					Hatchery-Dominated Potential (50% fitness)				
Scenario	Prod	Cap	Abund.	MSY Escape	MSY Rate	Prod	Cap	Abund.	MSY Escape	MSY Rate
Baseline (2001)	3.4	5,211	3,665	1,292	0.46	1.7	2,606	1,059	461	0.23
Status 2009	3.9	6,140	4,558	1,535	0.49	1.9	3,070	1,488	622	0.28
Current 2010	4.6	7,564	5,916	1,883	0.53	2.3	3,782	2,135	849	0.34
Long-Term Future	5.0	8,616	6,884	2,131	0.55	2.5	4,308	2,576	1,000	0.37
Historic	9.2	15,365	13,700	3,393	0.67					

Notes: MSY = predicted maximum sustainable yield and rate based on habitat potential

Productivity and capacity for the same habitat assuming a hatchery-dominated population (i.e., a 50% fitness handicap) are 1.7 and 2,606, respectively. The MSY exploitation rate is 23% with an MSY escapement of 461 adults.

Status 2009 Condition

The 2009 condition is based on empirical observations of the effectiveness of habitat restoration actions throughout the Nisqually River Basin, implemented since 2001 and prior to 2009. Several significant restoration projects were implemented in the Mashel River (engineered logjams) and Nisqually estuary (restoration of estuarine tidal channels on Braget Farm). Projects implemented since 2001 have matured and contribute to improved habitat potential.

Fall Chinook productivity and capacity potential for the current condition is estimated to be 3.9 and 6,140, respectively (Table 1). This provides a fully fit MSY exploitation rate of 49% and a MSY escapement of 1,535 adults.

Productivity and capacity for the same habitat assuming a hatchery-dominated population (i.e., a 50% fitness handicap) are 1.9 and 3,070, respectively. The MSY exploitation rate is 28%, with an MSY escapement of 622 adults.

Current 2010 Condition

The 2010 current condition represents the benefits of large-scale habitat restoration projects in the Nisqually estuary and additional engineered logjams installed in the Mashel River. However, by far the greatest effect on habitat potential is predicted to occur from the restoration of tidal habitat in the Nisqually estuary on the Nisqually National Wildlife Refuge.

Fall Chinook productivity and capacity potential for 2010 current is estimated to be 4.6 and 7,564, respectively (Table 1). This provides a fully fit MSY exploitation rate of 53% and an MSY escapement of 1,883.

Productivity and capacity for the same habitat assuming a hatchery-dominated population (i.e., a 50% fitness handicap) are 2.3 and 3,782, respectively. The MSY exploitation rate is 34%, with an MSY escapement of 849 adults.

Long-Term Future Condition

Projected habitat potential for the long-term recovery plan is based on the predicted effectiveness of multiple habitat restoration actions planned for the Nisqually River Basin (Ohop Creek, additional projects in the Mashel River, and a restoration project in the lower Nisqually River mainstem) and predicted benefits of projects implemented and matured since 2001. The long-term projection assumes that habitat protection activities will be successful. The goal of the long-term plan is to move the population potential toward the performance expected from a properly functioning condition. This state is not the same as the historic habitat potential. The long-term plan does not address all constraints on population survival and abundance caused by infrastructure and habitat alterations in the Nisqually watershed and Puget Sound.

Fall Chinook productivity and capacity potential for long-term restoration planning are estimated to be 5.0 and 8,616, respectively (Table 1). This provides a fully fit MSY exploitation rate of 55% and a MSY escapement of 2,131 adults.

Productivity and capacity for the same habitat assuming a hatchery-dominated population (i.e., a 50% fitness handicap) are 2.5 and 2,576, respectively. The MSY exploitation rate is 37%, with an MSY escapement of 1,000 adults.

3.2. Harvest

Harvest rates and total exploitation of Nisqually fall Chinook are based on validated Fishery Regulatory Assessment Model/Terminal Area Management Model (FRAM/TAMM)(December 21, 2009 results) for the years 1996 to 2008 (Tables 2 and 3).

Beginning in 2003, harvest was estimated separately for marked (adipose fin-clipped) and unmarked Chinook. Marked rates are assumed to represent harvest of Nisqually hatchery-origin adults and unmarked rates represent harvest of Nisqually natural-origin adults. In reality, actual harvest of hatchery adults also depends on the mark rate of hatchery adults returning to the Nisqually River. The mark rate of the Nisqually hatchery adults has averaged 89% from 2004 to 2008.

605 FRAM/TAMM reports fishery exploitation rates for marked and unmarked Nisqually fall Chinook.
606 These fishery exploitation rates were summed by the fishery groups shown in Table 2. Approximate
607 harvest rates for each fishery group in Table 2 were calculated assuming sequential fisheries
608 beginning with the Alaska/British Columbia fishery group. The exploitation rates and harvest rates
609 are the same in the first fishery. Harvest rates for the next fishery group (U.S. Southern Ocean, i =
610 2) in the sequence is calculated using the following equation:

611 $$HR_i = \frac{ER_i}{1 - ER_{i-1}}$$

612

613 Harvest rate in the Puget Sound fishery group (i=3) are approximated by the following equation:

614 $$HR_i = \frac{ER_i}{1 - ER_{i-1} - ER_{i-2}}$$

615 The terminal area harvest rates (i=4) are calculated by:

616 $$HR_i = \frac{ER_i}{1 - ER_{i-1} - ER_{i-2} - ER_{i-3}}$$

617 Mark-selective regulations were implemented for Puget Sound marine sport fisheries beginning in
618 2003 and for the Nisqually River sport fishery beginning in 2006.

Table 2. Estimates of exploitation rates and harvest rates for Nisqually hatchery-origin (marked) fall Chinook, 1996 to 2008. Exploitation rate estimates are from FRAM/TAMM validation outputs (December 21, 2009. Harvest estimates from FRAM/TAMM for 1996 to 2002 were not separated into marked and unmarked.

	Exploitation Rates					Harvest Rates			
Year	Alaska / British Columbia	Southern United States Ocean	Puget Sound	Terminal (net & sport)	Total	Alaska / British Columbia	Southern United States Ocean	Puget Sound	Terminal (net & sport)
1996	0.04	0.01	0.27	0.50	0.82	0.04	0.01	0.29	0.74
1997	0.07	0.01	0.21	0.43	0.72	0.07	0.01	0.23	0.60
1998	0.04	0.02	0.15	0.57	0.78	0.04	0.02	0.16	0.72
1999	0.05	0.02	0.11	0.61	0.79	0.05	0.02	0.12	0.74
2000	0.11	0.02	0.28	0.26	0.67	0.11	0.03	0.32	0.43
2001	0.08	0.01	0.17	0.47	0.73	0.08	0.01	0.19	0.63
2002	0.10	0.03	0.14	0.49	0.76	0.10	0.03	0.16	0.67
2003	0.16	0.03	0.19	0.45	0.84	0.16	0.04	0.24	0.74
2004	0.23	0.04	0.22	0.31	0.79	0.23	0.05	0.30	0.60
2005	0.26	0.05	0.19	0.23	0.73	0.26	0.07	0.27	0.46
2006	0.16	0.07	0.21	0.39	0.83	0.16	0.08	0.28	0.69
2007	0.17	0.04	0.25	0.36	0.82	0.17	0.05	0.32	0.66
2008	0.16	0.03	0.19	0.47	0.85	0.16	0.03	0.23	0.77

624 **Table 3. Estimates of exploitation rates and harvest rates on Nisqually natural-origin (unmarked) fall Chinook, 1996 to 2008. Exploitation**
625 **rates are from FRAM/TAMM validation outputs (December 21, 2009). Harvest estimates from FRAM/TAMM for 1996 to 2002 were not**
626 **separated into marked and unmarked.**

	Exploitation Rates					Harvest Rates			
Year	Alaska / British Columbia	Southern United States Ocean	Puget Sound	Terminal (net & sport)	Total	Alaska / British Columbia	Southern United States Ocean	Puget Sound	Terminal (net & sport)
1996	0.04	0.01	0.27	0.50	0.82	0.04	0.01	0.29	0.74
1997	0.07	0.01	0.21	0.43	0.72	0.07	0.01	0.23	0.60
1998	0.04	0.02	0.15	0.57	0.78	0.04	0.02	0.16	0.72
1999	0.05	0.02	0.11	0.61	0.79	0.05	0.02	0.12	0.74
2000	0.11	0.02	0.28	0.26	0.67	0.11	0.03	0.32	0.43
2001	0.08	0.01	0.17	0.47	0.73	0.08	0.01	0.19	0.63
2002	0.10	0.03	0.14	0.49	0.76	0.10	0.03	0.16	0.67
2003	0.16	0.03	0.17	0.47	0.83	0.16	0.04	0.21	0.74
2004	0.23	0.04	0.20	0.32	0.78	0.23	0.05	0.27	0.60
2005	0.26	0.05	0.17	0.24	0.71	0.26	0.07	0.24	0.46
2006	0.16	0.07	0.21	0.38	0.83	0.16	0.09	0.27	0.69
2007	0.19	0.04	0.14	0.41	0.79	0.19	0.05	0.19	0.66
2008	0.16	0.03	0.14	0.46	0.79	0.16	0.03	0.17	0.68

The total exploitation rate of marked hatchery fish averaged 0.78 from 1996 to 2008. Total exploitation rate of unmarked natural fish was nearly the same, averaging 0.77 from 1996 to 2008. For the period from 2003 -2008, when a limited number of mark selective fisheries were in place, total exploitation rates for marked and unmarked did not differ substantially, at 0.81 and 0.79, respectively.

Finally, harvest rates applied to each of the scenarios in the AHA model were based on a particular year, as described below.

Baseline (Pre-2001) Condition

Baseline exploitation and harvest rates are based on 2001 rates (Table 4). Because harvest was not estimated separately for marked and unmarked Chinook prior to 2003, rates for each are identical in the baseline.

Terminal harvest rates for natural-origin and hatchery-origin Chinook were 0.63 in the combined Nisqually treaty net fishery and non-treaty sport fisheries (0.56 in the Nisqually treaty net fishery and 0.07 in the Nisqually non-treaty terminal sport). Pre-terminal and terminal fisheries exploitation rates were 0.26 and 0.47, respectively. The total exploitation rate across all fisheries was 0.73 for natural and hatchery fish.

Current 2010 Condition

Current condition exploitation and harvest rates are based on the 2008 rates for marked and unmarked Nisqually Chinook in FRAM/TAMM (Table 4).

Terminal harvest rates for unmarked natural-origin Chinook were 0.68 in the combined Nisqually treaty net fishery and non-treaty sport fisheries (Nisqually treaty net and non-treaty terminal sport were 0.66 and 0.02, respectively). Terminal harvest rates for marked hatchery-origin Chinook were 0.77 in the combined Nisqually treaty net fishery and non-treaty sport fisheries (Nisqually treaty net and non-treaty terminal sport were 0.66 and 0.11, respectively). Estimated terminal harvest rates reported in Section 4.6 (Status and Trends Analysis) are slightly different than those estimated from FRAM/TAMM because of how they were estimated; rates in the Status and Trends analysis are based on estimated of terminal run size and terminal harvest. The FRAM/TAMM rates are used in the AHA model.

Pre-terminal and terminal fisheries exploitation rates on unmarked natural-origin Chinook were 0.32 and 0.46, respectively. The total exploitation rate across all fisheries on unmarked natural-origin fish was 0.79. Pre-terminal and terminal fisheries exploitation rates for marked hatchery-origin Chinook were 0.38 and 0.47, respectively. The total exploitation rate across all fisheries for marked hatchery-origin fish was 0.85. The biggest change between the baseline and current condition was an increase in pre-terminal harvest attributable to fisheries in British Columbia, and a shift in the Puget Sound pre-terminal and Nisqually terminal sport fisheries to mark-selective regulations.

663 **Table 4. Exploitation rates and harvest rates for hatchery- and natural-origin fall Chinook assumed for the Baseline and Current scenarios**
664 **in the AHA analysis. Exploitation rates for 2001 and 2008 are from FRAM/TAMM validation model outputs (December 21, 2009).**

	Exploitation Rates					Harvest Rates			
Period	Alaska / British Columbia	Southern United States	Puget Sound	Terminal (net & sport)	Total	Alaska / British Columbia	Southern United States	Puget Sound	Terminal (net & sport)
Hatchery-origin (marked)									
Baseline (2001)	0.08	0.01	0.17	0.47	0.73	0.08	0.01	0.19	0.63
Current (2008)	0.16	0.03	0.19	0.47	0.85	0.16	0.03	0.23	0.77
Natural-origin (unmarked)									
Baseline (2001)	0.08	0.01	0.17	0.47	0.73	0.08	0.01	0.19	0.63
Current (2008)	0.16	0.03	0.14	0.46	0.79	0.16	0.03	0.17	0.68

665

666

3.3. Hatcheries

The goal of hatchery production of fall Chinook in the Nisqually River Basin has been to provide harvest opportunity. Hatchery facilities in the Nisqually Basin are Kalama Creek Hatchery (RM 9.5) and Clear Creek Hatchery (RM 6.1), both operated by Nisqually Indian Tribe. A third hatchery facility in McAllister Creek is no longer operated by the Washington Department of Fish and Wildlife (WDFW). The Kalama Creek Hatchery began operation in 1980. The Clear Creek Hatchery was opened in 1991 and is the primary producer of fall Chinook to the basin.

Brood stock for the hatchery programs has been sourced from a wide mixture of Puget Sound hatchery stocks. The extensive use of eggs from sources outside the Nisqually continued into 1990. The Kalama Creek Hatchery began to develop a Nisqually brood stock in the 1980s. Current brood stock policies stipulate that hatchery production at both facilities must come from Nisqually stock. Each of these facilities includes an adult trap for returning brood stock.

The Nisqually Indian Tribe releases approximately 4.0 million subyearlings into the basin each year to support fisheries. Hatchery juveniles are released in May and are assumed to migrate quickly through the lower river to the Nisqually River Estuary.

There is an attempt to mark the entire 4.0 million release with either an adipose fin clip or a CWT. From 2003 to 2008 on average of 89% of the release had an adipose fin clip and 94% of the release had either an adipose fin clip and CWT or a CWT to positively identify the fish as hatchery-origin. Marking operations at the hatcheries improved in release years 2009 and 2010, with at least 94% of the fish adipose clipped and at least 99% of the fish either clipped or tagged. An adult mark rate greater than 97% is expected in the coming years.

Table 5 - Mark rates at release (combined Clear Creek and Kalama Creek hatcheries) for Nisqually hatchery fall Chinook.

Brood year	Release Year	Adipose Fin Clip	Adipose Fin Clip and/or CWT
2002	2003	88.0%	93.5%
2003	2004	92.2%	97.1%
2004	2005	88.3%	94.6%
2005	2006	85.7%	89.3%
2006	2007	89.8%	94.5%
2007	2008	90.7%	94.9%
2008	2009	94.0%	99.0%
2009	2010	94.6%	99.4%

Baseline and Current Conditions

The baseline and current condition are essentially the same for the purpose of this analysis and are summarized together.

695 The Clear Creek Hatchery releases 3.4 million subyearling Chinook (Table 6). An attempt is
696 made to mark (adipose fin clip) nearly all fish released. A portion of the release has an adipose
697 fin clip and CWT and a portion has just CWT to provide information for analysis of mark-
698 selective fisheries. The average annual return of fish to Clear Creek Hatchery from 2004 to 2009
699 was 8,359 adults and 6,263 jacks. Mark rates (adipose fin clip or CWT) of adults sampled at the
700 Clear Creek hatchery averaged 95% for 2003 to 2009 (Table 7). The average annual return of
701 fish to the Kalama Creek Hatchery from 2003 to 2009 was 768 adults and 384 jacks. The percent
702 of adults with a mark or CWT (adipose fin clipped or CWT) averaged 95% at Kalama Creek
703 Hatchery.

704 **Table 6. Nisqually fall Chinook hatchery programs.**

Period	Hatchery	Program Purpose	Program Type	Brood Stock Management HOR (adults)	Program Size (million)	Marking Objectives
Baseline and Current	Kalama Creek	Harvest	Segregated	420	0.6	65,000k CWT/ad clip; 100% of program ad clip
	Clear Creek	Harvest	Segregated	2,321	3.4	200,000 CWT/ad clip; 200,000 CWT no ad clip; 3.0 million ad clip only

Notes: HOR: hatchery-originated recruits, CWT=coded wire tag, ad clip= adipose fin clip

705

706 Mark rates from adults sampled at the hatcheries are similar to rates reported at release.
707 Although the goal is 100% of the release to have a mark of either an adipose fin clip or CWT,
708 past experience has shown that this goal is difficult to achieve in some years. When evaluating
709 the NCSMP actions we decided to evaluate decisions assuming a more conservative 95% mark
710 rate in the hatchery return. The lower the mark rate then more hatchery-origin fish will not be
711 correctly identified to be removed in selective fisheries or at the weir.

712 In addition, we noted that there may be some inconsistencies between the percentage of marked
713 fish reported at release and the percent marked reported for adults sampled at the hatcheries.
714 These inconsistencies may be due to sampling bias or inconsistent classification of partial
715 clipped fish at release and during adult sampling. This suggests that consistent standards should
716 be developed for classifying and recording partial clipped fish.

717

718

719 **Table 7. Mark rates (percent fish with adipose fin clip or CWT) from adult sampling at Clear**
720 **Creek and Kalama Creek hatcheries in 2003 to 2009.**

Year	Adult Marked % (adipose fin clip and/or CWT)		
	Clear Creek	Kalama Creek	Combined
2003	92%	90%	92%
2004	96%	93%	96%
2005	93%	94%	93%
2006	98%	97%	98%
2007	97%	95%	96%
2008	95%	98%	95%
2009	94%	98%	94%
Average	95%	95%	95%

721

There is an indication that the adult recovery rate at the hatchery adult trap is higher for the Clear Creek Hatchery than for the Kalama Creek Hatchery. An analysis of CWT recoveries of Chinook released from both hatcheries between 2000 and 2004 (recoveries from 2001 to 2008) shows that contribution to pre-terminal fisheries is roughly similar (Table 8). In 2 of the 5 years, Kalama Creek Hatchery had a higher contribution rate, Clear Creek had a higher contribution rate in 1 year, and recovery rates were similar between the two programs in 2 years. The geometric mean contribution rate was the same (0.002; number of CWT recovered/number of CWT released), for both programs. This suggests that survival is similar, at least to pre-terminal fisheries, for the two hatcheries. However, recovery rates of CWTs at the hatchery rack are consistently higher for fish released from the Clear Creek Hatchery (Table 9). The geometric mean recovery rate (number of CWT recovered at the hatchery/number of CWT released) for Clear Creek Hatchery fish was 0.003 versus 0.002 for Kalama Creek Hatchery fish. The lower recovery rate of Kalama Creek Hatchery Chinook may be due to poor attraction to the Kalama Creek adult trap.

Table 8. Adipose fin clipped and coded wire tag release and contribution rates for Clear Creek and Kalama Creek Hatchery programs for fish release from 2000 to 2004.

		CWT Release		Pre-Terminal Fishery Contribution Rates	
Brood Year	Release Year	Clear Creek	Kalama Creek	Clear Creek	Kalama Creek
1999	2000	199,030	88,949	0.002	0.002
2000	2001	170,725	86,833	0.003	0.004
2001	2002	216,070	89,811	0.001	0.002
2002	2003	180,600	96,859	0.002	0.002
2003	2004	209,240	96,473	0.004	0.002
			Geometric mean:	0.002	0.002

Notes: CWT=coded wire tag

Table 9. Adipose fin-clipped and coded wire tag release and contribution rates for Clear Creek and Kalama Creek Hatchery programs for fish release from 2000 to 2004.

		CWT Release		Net Fishery		Hatchery	
Brood Year	Release Year	Clear Creek	Kalama Creek	Clear Creek	Kalama Creek	Clear Creek	Kalama Creek
1999	2000	199,030	88,949	0.003	0.002	0.002	0.002
2000	2001	170,725	86,833	0.004	0.002	0.003	0.002
2001	2002	216,070	89,811	0.001	0.001	0.002	0.001
2002	2003	180,600	96,859	0.002	0.002	0.004	0.002
2003	2004	209,240	96,473	0.006	0.003	0.005	0.001
			Geometric mean:	0.003	0.002	0.003	0.002

Notes: CWT=coded wire tag

Chapter

4

4. Components of Nisqually Chinook Management Plan

The keys to achieving Nisqually fall Chinook recovery goals over time are to assemble the most recent and relevant information, and to use this information to operate fisheries, the weir, and the hatchery consistent with the established guidelines. To this end, a four-step process is defined to annually establish NCSMP plans and objectives for the upcoming management season. As shown in Figure 1 and discussed in Section 4.3, the following steps are used to carry out the NCSMP:

- Update key assumptions
- Update status and trends information
- Review and apply the decision rules
- Compute in-season biological targets and review for consistency with conservation and harvest objectives

These steps are represented in Microsoft Excel spreadsheets that store and document data and assumptions, and calculate biological targets for the operation of terminal fisheries, the weir, and hatchery programs. The resulting tools document the basis for these targets and establish expectations for all performance indicators. They also help simplify the implementation process and document the rationale for the management actions taken each year. Persons with responsibility for implementation of in-season management will use these tools in preparation for an annual workshop, the Annual Project Review (APR), where analytical results will be presented and shared with all interested parties and an action plan is prepared for the upcoming season.

The information that informs the tools is gathered and analyzed from a wide variety of sources, as illustrated in Figure 1. Some of this information is updated annually with results from specific research projects and results from the previous year operations; some information may not be available for several years.

4.1. Annual Project Review

The APR workshop will be conducted each year by the NCSMP Work Group, after pre-season projections are available and before decisions about harvest and brood stock management for the coming season are made. The agenda will follow the four-step procedure for implementing the NCSMP described below and outlined in Figure 1, with special emphasis on fall Chinook terminal area management. The APR is a science-driven process that informs the workshop participants and will result in an action plan for the coming season. This action plan will be presented as a

recommendation to decision-makers. The APR participants will include habitat, harvest, and hatchery biologists. The workshop and

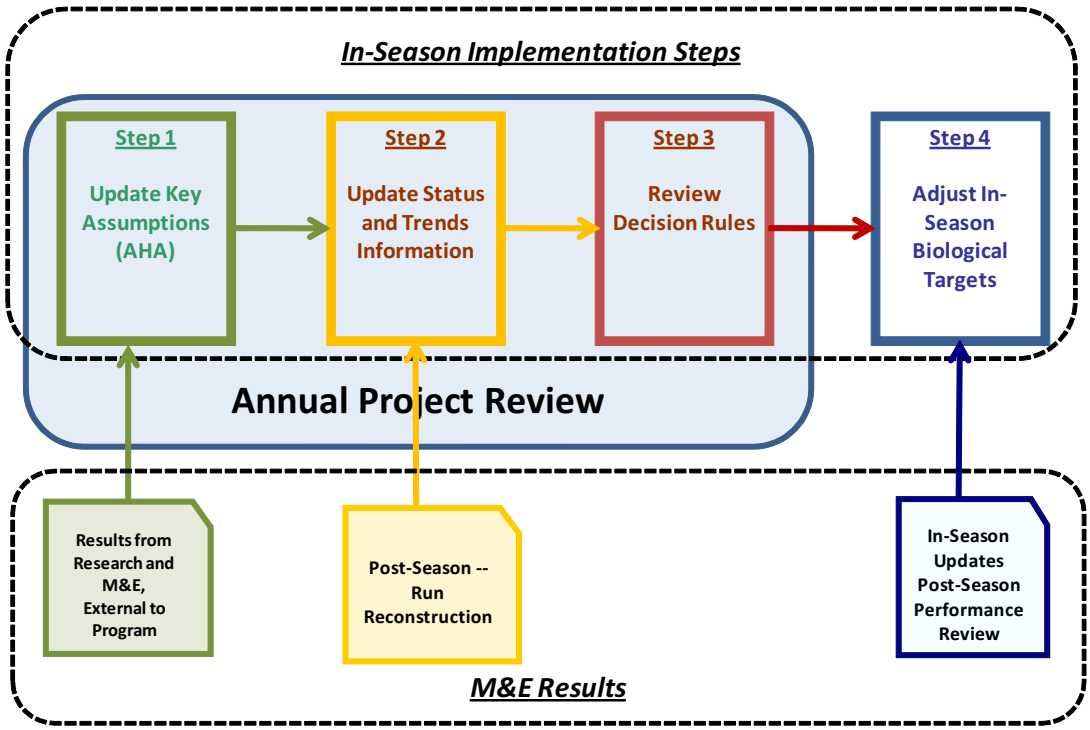


Figure 1. Process for reviewing and updating information during the APR.

subsequently adopted action plan constitute the All-H coordinated implementation component of the Nisqually NCSMP for fall Chinook.

The APR workshop will occur over a 3-day period (Table 10). The first day will be devoted to results from monitoring and research activities related to the key assumptions (see Step 1 of the NCSMP), and facilitation will be coordinated by NIT and WDFW. The monitoring and research presentations will be organized into three sessions covering the following topics:

- Habitat and natural production
- Terminal and pre-terminal harvest
- Hatchery and weir operations

Prior to the workshop, the NCSMP Work Group will meet with the various action leads to compile draft annual reports on each of these subjects to be available at the workshop. The NCSMP tools will be populated with the most recent data and analytical results. The facilitator will invite a panel of reviewers for each of the three topics to address two questions:

- Given the information provided, what are the best estimates for the key assumptions used for planning (see Step 1 of the NCSMP)?

- How could the M&E program be improved in the coming year?

The facilitator will then summarize the conclusions at the end of the first day.

Table 10. Overview of APR workshop focusing on Nisqually fall Chinook Nisqually Chinook Stock Management Plan.

Workshop Day	Purpose	Products
Day 1	Presentation of results from monitoring and research programs	Share information relevant to key assumptions in NCSMP (including models updates)
Day 2	Presentation and review of results from last year's operations specified in the NCSMP, analysis of status and trends specific to program objectives, and a report of habitat protection and enhancement activities	Recommendations on how operations can be improved to meet biological targets
Day 3	Review implications of information presented on Days 1 and 2, and set objectives for coming year	Revised NCSMP (key assumptions and operation guidelines) for the coming year

The second day of the workshop will be attended by project staff and their policy and science supervisors. Results from last year's operations will be presented and reviewed, as well summaries of analyses of population status and trends, and projected habitat potential. The second day will include sessions covering pre-terminal and terminal fisheries, operation of weir and other capture activities, hatchery operations run-reconstruction results, and results of habitat protection and enhancement activities during the past year. These sessions also will be facilitated by the NCSMP lead. The objective for the second day is to address four questions:

- Were biological targets met last year and if not, why not?
- What are trends in biological targets?
- How can operations be improved in terms of effectiveness and efficiency in the coming year?
- Should biological targets be modified; are they consistent with most recent and best available science?

The management team will meet on Day 3 to review the implications of information presented in the previous days for the decision rules (see Step 3 of the NCSMP). The management team consists of policy and technical personnel. The NCSMP lead scientist will present conclusions from Days 1 and 2, and alternative options for the decision rules. Note that the purpose of the decision rules is to

ensure that the long-term goals for conservation and harvest established in the NCSMP are met over time. The product of Day 3 will be a recommendation to decision-makers for an updated action plan for operating fisheries, the weir, hatchery activities and habitat protection and enhancement in the coming year. A final task of the APR workshop will be staff assignments for year-end activities (i.e., finalizing annual reports) and for implementing harvest, hatchery, weir, habitat, and M&E plans for the coming year. Following the APR, the annual NCSMP Action Plan (Section 4.4) will be updated and distributed to the participants and policy decision-makers.

4.2. All-H-Analyzer (AHA)

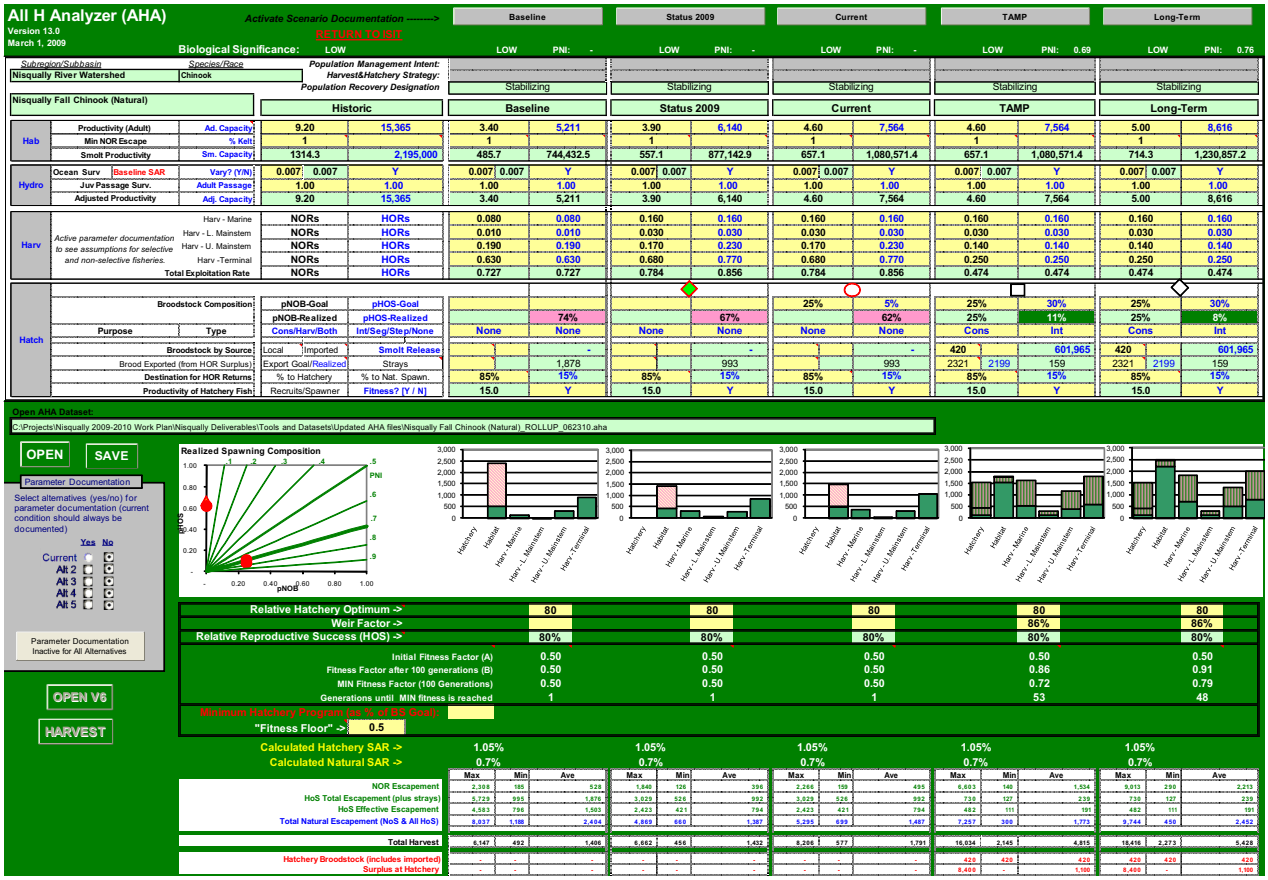
The AHA analysis was used to evaluate the average, long-term effects of different strategies for harvest, hatchery, habitat, and escapement management on conservation and fishery objectives. The effect of strategies on natural population abundance and productivity was made using the genetic fitness model in AHA. Also included in the AHA analyses were the projected benefits of improvements in habitat potential as estimated by the EDT model.

The conservation goals for the natural Nisqually Chinook population were assessed in terms of estimated natural population abundance and productivity, the resulting natural versus artificial selection pressures on the population, and their potential effect on natural population fitness. Harvest goals were assessed in terms of the projected average number of fish in the terminal fisheries.

The analysis of these strategies entailed integrating: (1) Nisqually habitat productivity and capacity parameters estimated from the EDT model, (2) harvest rates for hatchery- and natural-origin fish in all applicable fisheries taken from FRAM/TAMM validation output (December 21, 2009), and (3) hatchery operations data, with special emphasis on brood stock, escapement management, and hatchery stray rates. This involved estimating natural and hatchery reproduction, marine survival, and the harvest rate in pre-terminal fisheries. In turn, the fate of adults returning to the Nisqually River was assessed in terms of homing fidelity, the composition of spawning escapement, relative reproductive success, relative contribution to the conservation objectives of Nisqually natural Chinook, and relative contributions to harvest by the Nisqually treaty net and non-treaty sport fisheries.

The AHA analysis does not estimate what might happen in any particular year; rather, it projects the average outcome after many generations. The analysis tracked each hatchery and natural population component over 100 generations.

The main AHA population screen for natural Nisqually Chinook is shown in Figure 2. The AHA screen shows average outcomes for the Baseline (Pre-2001), Status 2009, Current 2010, Long-Term Future Conditions, and NCSMP. The difference between the NCSMP and Long-Term Future Conditions is the expected improvement in natural population productivity and capacity with full implementation of the Nisqually habitat plan. The differences between the current conditions and NCSMP scenarios are harvest, hatchery, and escapement strategies identified in the NCSMP.



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851 **Figure 2. Population screen in the All-H-Analyzer.**

4.3. In-Season Implementation Tool

The In-Season Implementation Tool (ISIT?) is a Microsoft Excel 2007-based application that is organized to follow the outline of the APR. It includes worksheets for each of the components of the APR (key assumptions, status and trends, decisions rules, and biological targets). Its purpose is to store and document data and assumptions, and derive biological targets for the operation of the Nisqually terminal fisheries, weir, and hatchery programs. The ISIT? documents the basis for these targets and establishes expectations for all performance indicators; it also simplifies the implementation process and documents the rationale for the management actions taken each year. The NCSMP Work Group is responsible coordinating activities will use this tool to prepare for and present at the APR workshop in February. The Work Group will also be responsible for updating information in tool following conclusion of the annual North of Falcon process and during the in-season management period.

Inputs to ISIT? are mostly summaries of information collected for status and trend monitoring and evaluation of key assumptions, and results from pre-season and in-season forecasting models. The ISIT? tool is not a replacement for a comprehensive database system to store and manage information collected to support the NCSMP. In addition, the NCSMP will need other to develop and manage other tools and models (some existing such as EDT to track habitat and some that need to be developed such as for in-season updates).

Step 1 - Update Key Assumptions

The first step in the NCSMP is to update key assumptions based on data collected from M&E activities. This ensures that the best available information is applied to the in-season management process. The Nisqually fall Chinook plan is based on key assumptions about the following parameters:

- Quality and quantity of Nisqually basin habitat
- Ocean survival
- Harvest rates in pre-terminal and terminal fisheries
- Effectiveness of the planned weir to remove hatchery fish from the spawning environment without killing substantial numbers of natural-origin Chinook
- Productivity of both natural- and hatchery-origin adults spawning naturally
- Number and origin of spawning adults below the weir (and the productivity of these fish)

Figure 3 shows key assumptions with respect to the ability to remove hatchery fish from natural spawning. Specifically, key assumptions address the mark rate of hatchery return, weir efficiency, incidental mortality of natural-origin adults at the weir, the percent hatchery fish return to hatchery adult trap, and the spawning distribution of natural- and hatchery-origin Chinook with respect to the weir location. Additional key assumptions are detailed in Step 2, below.

Key Assumptions (Step 1 Information)

Inputs from Key Assumptions worksheet

Mark rate in Hatchery Return (Int|Step)	95%	95%
Maxmum weir efficiency (Int| Step)	95%	95%
Incidential Weir Mort on NORs	3%	
Hatchery Return Rate (*Int Prog*)	85%	
Hatchery Return Rate (*Step Prog*)	85%	
% NORs Spawning below weir	20%	
% HORs Spawning below weir	20%	
HOR Relative Reproductive Success	80%	

Figure 3. Key assumptions with respect to weir operations, hatchery and natural adult distribution, removal of hatchery fish from natural spawning.

Step 2 - Update Status and Trends Information

In Step 2, the most recent stock status information is entered into the database for both the hatchery and natural components of the run. Natural spawning escapement, hatchery escapement, weir counts, and harvest are entered by origin (hatchery vs. natural). This updated information is compared to a previous year running average and to biological targets identified in the previous APR (Figure 4). The 4-year running average is used to establish status of targets for the coming management season. A 4-year average is used because of the average generation cycle of four years for Nisqually fall Chinook.

In the example in Figure 3, the 4-year average pHOS is high and greatly exceeds the criteria for low hatchery influence (pHOS less than 10%), indicating that the plan is consistently not meeting the pHOS target. Work Group would use this information to conclude that additional measures (e.g., escapement management, brood stock management, harvest management) should be considered for the upcoming season to increase the likelihood of achieving the pHOS target. Otherwise, conservation goals will not be achieved for the natural population. Alternatively, if the 4-year average pHOS was less than the target set by the Work Group then other options such as passing more fish at the weir to increase natural spawning abundance may be considered for the upcoming year.

Population Status (Status & Trends - Step 2 Information)

Calculated values from Status and Trends worksheet

Prev Yr Review - 2009		4 - Yr Running average - 2006 - 2009	
PNI (if applicable)	NA	PNI (if applicable)	NA
NOR Spawners	36	NOR Spawners	569
HOR Spawners *(Int)*	NA	HOR Spawners *(Int)*	NA
HOR Spawners *(Step)*	836	HOR Spawners *(Step/seg)*	1,479
pHOS *(Int)*	NA	pHOS *(Int)*	NA
pHOS *(Step)*	95%	pHOS *(Step/Seg)*	61%

Figure 4. Key information from the status and trends analysis.

Section 4.4 of this report has a more detailed presentation of methods for computing the metrics shown in Figure 4 and additional status reports for escapement, harvest, and hatchery. These more detailed reports are examined in Step 2. Examining the underlying patterns at the hatchery and in the escapement and fishery will help workshop participants better evaluate trends and the reasons behind the information presented in Figure 4.

Step 3 – Review Decision Rules

Once the key assumptions have been updated and the status and trend analysis is complete, a review of the decision rules (Figure 5) should determine if they need alteration for the coming season. This step should occur at the APR workshop. Once the NCSMP is fully implement decision rules are not expected to change frequently, but they may need to be altered to account for changes in population policy status (e.g., ESA listing), collapse of the run, new science discoveries, or other changes in salmon management in the basin or the region. However, it is likely that during the implementation phase of the plan that the decision rules will be updated annually at the APR as gear is tested and refined, hatchery capabilities are online, and selective harvest measures are implemented.

The main purpose of Step 3 is to reaffirm the existing decision rules and to assure that all involved with the management and operation of the programs are aware of these rules and understand their importance. The decision rules also guide actions for the upcoming year.

Decision Rules (Step 3 Information)

Biol Significance (based on S&T)	Low	
Natural Escapement Triggers		
Min natural spawn escapement	500	
Target NOR spawning escapement	700	
Hatchery Brood		
Int. Hatchery Prog. (Min|Max)	300	420
Harv. Hatchery Program		2,321
pNOB (Int|Step)	25%	0%
Maximum NOB (Int|Step)	105	-
% of NORs to ESC (Int prog.|Step prog.)	50%	100%

Treaty Net Harvest Rates

NOR Runsize	500	996	1,596	
Marked	40%	60%	60%	70%
Unmarked	20%	20%	20%	25%

Terminal Sport Harvest Rates

Marked	2.0%	3.0%	4.0%	5.0%
Unmarked	0.2%	0.3%	0.4%	0.5%

Figure 5. Decision rules in the In-Season Implementation Tool.

Step 4 – Set Biological Targets

Step 4 compute biological targets for the coming season and review these to ensure that standards for the Nisqually fall Chinook population are met and progress toward conservation and harvest goals is maintained. Biological targets (brood stock needs, harvest levels, weir catch, and escapement) are computed for the coming migration year based on terminal area run-size predictions for the natural and hatchery returns, and decision rules for harvest, escapement, and hatchery operations confirmed in Step 3 (Figure 6).

The revised biological targets are automatically computed when the updated run-size forecasts are entered into ISIT?.

Pre-season & In-season Runsize Forecast (Step 4 Inputs)

NOR Runsize	2,500
Hatchery Runsize (Int)	4,000
Hatchery Runsize (Step)	16,000

In-season Updates (Step 4 Inputs)

NORs	-
HOR(Int)	-
HOR(Step)	-

Final Runsize

NORs	2,500
HOR(Int)	4,000
HOR(Step)	16,000

Biological Targets

Broodstock Composition

	BS #	pNOB	pStep Stone	Hatch Rel
HOR Broodstock (Int Prog)	420	25%	75%	601,965
HOR Broodstock (Step Prog)	2,321	0%	100%	3,326,573

Harvest

NOR	HOR (int)	HOR (step)
638	1,020	11,604

Escapement Composition (effective pHOS)

	# spawners	# NOS	# HOS (Int)	# HOS (Step)	pHOS (Int)	pHOS (Step)	Total pHOS	PNI
Entire Nisqually	2,064	1,715	124	224	5%	9%	14%	0.64
Downstream Weir	573	352	89	132	14%	20%	33%	0.43
Upstream Weir	1,491	1,364	35	92	2%	5%	7%	0.78

Figure 6. Run size prediction for the upcoming season and resulting biological targets based on the decision rules.

Targets derived from the decision rules and computed by ISIT? include the following:

- **Escapement target**: number of fish of all origins targeted to spawn in the Nisqually (upstream and downstream of the weir) [this season].
- **pHOS target**: proportion of hatchery-origin adults in spawning escapement [this season].
- **pNOB** for integrated program: percent natural-origin broodstock (pNOB) target for adults in brood stock [this season].
- **Brood stock for stepping-stone program**: targeted number of brood stock for the segregated program [this season].
- **Weir mortality**: maximum natural-origin mortality due to weir

Harvest rates for natural and hatchery adults and brood stock management of the integrated hatchery program will vary depending on natural-origin run size to the Nisqually River and projected total abundance of spawners in nature. The effect on outcomes for a 2,500 natural-origin run size is shown in Figure 7. Figure 8 shows results using the same decision rules, but with a natural-origin run size of 500 adults, an integrated hatchery run size of 1,000 adults, and a stepping-stone hatchery run size of 5,000 adults. This worse-case scenario shows how brood stock and weir operations would change with a change in run size. A portion of the integrated hatchery fish is passed upstream of the weir to meet the minimum escapement target and, as a result, the integrated program brood stock is reduced to 300 fish (maintaining the 25% pNOB objective). The 1,596 natural-origin run size trigger point in Figures 6 and 7 is calculated to ensure the escapement objective of 700 natural-origin adults before moving to the maximum integrated program brood stock requirement (420 adults with 105 natural-origin fish, meeting the 25% pNOB objective). This trigger point will change for different pNOB decisions for the integrated program, harvest rates, and natural-origin escapement objectives.

Projected Adult Disposition for Coming Year

Trigger Points for Min Escapement/NOR Runsize

	NORs	Int-HORs	Step-HORs	
A				Natural Escapement (upstream of weir)
				Integrated Program Brood Stock
				Harvest Program Brood Stock
				Catch (treaty and sport)
500				Surplus at Hatchery
500				Removed at Weir + Incident Weir Mort
	NORs	Int-HORs	Step-HORs	
B				Natural Escapement (upstream of weir)
				Integrated Program Brood Stock
				Harvest Program Brood Stock
				Catch (treaty and sport)
700				Surplus at Hatchery
998				Removed at Weir + Incident Weir Mort
	NORs	Int-HORs	Step-HORs	
C				Natural Escapement (upstream of weir)
				Integrated Program Brood Stock
				Harvest Program Brood Stock
				Catch (treaty and sport)
1,596				Surplus at Hatchery
1,596				Removed at Weir + Incident Weir Mort
	NORs	**Int-HORs**	**Step-HORs**	
D	**1,718**	**124**	**230**	**Natural Escapement (upstream of weir)**
	105	**315**	**-**	**Integrated Program Brood Stock**
	-	**2,321**	**-**	**Harvest Program Brood Stock**
	635	**1,016**	**11,451**	**Catch (treaty and sport)**
		-	**3,866**	**Surplus at Hatchery**
	42	**224**	**453**	**Removed at Weir or Incident Weir Mort**

Figure 7. Projected adult distribution based on decision rules governing harvest, the weir, and brood stock management. This scenario assumes a natural-origin recruit (NOR) run size of 2,500 fish, an integrated hatchery-origin (Int-HOR) run size of 4,000 fish and a stepping-stone hatchery-origin (Step-HOR) run size of 16,000 fish.

Projected Adult Disposition for Coming Year

Trigger Points for Min Escapement/NOR Runsize

	NORs	Int-HORs	Step-HORs	
A	316	55	128	Natural Escapement (upstream of weir)
	75	225	-	Integrated Program Brood Stock
	-	518	1,923	Harvest Program Brood Stock
	101	202	2,100	Catch (treaty and sport)
500		-	542	Surplus at Hatchery
500	8	-	307	Removed at Weir + Incident Weir Mort
	NORs	Int-HORs	Step-HORs	
B				Natural Escapement (upstream of weir)
				Integrated Program Brood Stock
				Harvest Program Brood Stock
				Catch (treaty and sport)
700				Surplus at Hatchery
998				Removed at Weir + Incident Weir Mort
	NORs	Int-HORs	Step-HORs	
C				Natural Escapement (upstream of weir)
				Integrated Program Brood Stock
				Harvest Program Brood Stock
				Catch (treaty and sport)
1,596				Surplus at Hatchery
1,596				Removed at Weir + Incident Weir Mort
	NORs	Int-HORs	Step-HORs	
D				Natural Escapement (upstream of weir)
				Integrated Program Brood Stock
				Harvest Program Brood Stock
				Catch (treaty and sport)
				Surplus at Hatchery
				Removed at Weir or Incident Weir Mort

Figure 8. Projected adult distribution based on the decision rules governing harvest, the weir, and brood stock management. This extreme scenario assumes a natural-origin (NOR) run size of 500 fish, an integrated hatchery-origin run size of 1,000 fish and a stepping-stone hatchery-origin run size of 5,000 fish.

4.4. NCSMP Action Plan

A key purpose of the APR is to use information from the M&E program to update status and trends and key assumptions, and to articulate clear and consistent annual targets for management actions affecting Nisqually fall Chinook. New information and modified management targets inform the annual NCSMP Action Plan, used to guide operations at the weir, in the fishery, and at the hatchery. The updated annual NCSMP Action Plan also highlights research objectives to investigate key assumptions. The NCSMP Action Plan does not have to be large or comprehensive with respect to all activities in the Nisqually River Basin, but it does need to have enough detail to provide clear direction at the weir, in the fishery, at the hatchery and expectations for monitoring and evaluation and habitat actions.

The 2010 NCSMP Action Plan is provided in Appendix A.

4.5. Monitoring and Evaluation Program

The M&E program should be designed to collect data that support implementation of the NCSMP Action Plan. Although these data may vary from year to year, they should be monitored precisely enough to ensure performance parameters are being achieved. The M&E elements provide information for the following:

- Key assumptions
- Status and trends analysis
- Decision Rules
- Assessment of biological targets

The Nisqually M&E plan will be organized under the headings listed below. Except for the M&E activities identified in the 2010 NCSMP Action Plan (Appendix A), the timing of M&E activities has not been determined.

Variables Monitored in Fisheries and at the Nisqually Weir

Variables that will be monitored in fisheries and at the Nisqually weir are summarized below. Recruits are defined as natural-origin recruits (NORs) and hatchery-origin recruits (HORs).

Acoustic-Tag Fish Recoveries (below or at the weir)

Attributes and Parameters Estimated	NCSMP Purpose
Weir efficiency, weir delay, and Nisqually HOR spawning below the weir.	Used in NCSMP Step 1 to update key assumptions

Count of Dead Fish Handled or Harvested and Live Fish Released

Attributes and Parameters Estimated	NCSMP Purpose
Weir mortality	Used in NCSMP Step 1 to update key assumptions

Fishing Gear Effectiveness

Attributes and Parameters Estimated	NCSMP Purpose
Terminal harvest rate on NOR and HOR	Used in NCSMP Step 1 to update key assumptions and Step 3 to update decision rules

Counts of NORs and HORs (number and timing of adults)

Attributes and Parameters Estimated	NCSMP Purpose
pHOS, PNI, mark rate and total census escapement	Used in NCSMP Step 3 to update stock status and trends and in Step 4 to update in-season biological targets

Terminal Catch (number and composition of fish caught in terminal fisheries and the incidence of multiple capture in the fisheries)

Attributes and Parameters Estimated	NCSMP Purpose
Total NOR and HOR recruitment, total catch (NOR and HOR), and terminal harvest rates on NOR and HOR	Used in NCSMP Step 2 to update stock status and trends and in Step 4 to update in-season biological targets

Coded Wire-Tag Recoveries (number of HORs recovered everywhere)

Attributes and Parameters Estimated	NCSMP Purpose
Pre-terminal exploitation rate (for marked fish and for unmarked); total catch of NOR and HOR; total HOR and NOR recruitment; total exploitation rate of NOR and HOR; rate of return to point of release (homing); contribution to fisheries and escapement of other populations; stray rate to Nisqually River; hatchery productivity; and mark rate	Used in NCSMP Step 1 to update key assumptions and in Step 2 to update stock status and trends

Variables Monitored on Spawning Grounds

Variables that will be monitored on the spawning grounds are identified below.

NOR and HOR Spawning Success (number of NOR and HOR that spawned successfully)

Attributes and Parameters Estimated	NCSMP Purpose
Pre-spawn survival, relative productivity spawning spatial distribution and composition, relative reproductive success of HOR	Used in NCSMP Step 1 to update key assumptions and Step 2 to update stock status and trends

NOR and HOR Demographics (age, size and sex-ratio of spawning NOR and HOR natural spawners)

Attributes and Parameters Estimated	NCSMP Purpose
Pre-spawn survival, spawning distribution and composition	Used in NCSMP Step 1 to update key assumptions and Step 2 to update stock status and trends, and Step 4 to update in-season biological targets

Variables Monitored at Clear Creek and Kalama Creek Hatcheries

The quality of the fish produced at hatchery facilities depends on the fish husbandry protocols used in hatchery operations. Thus, all rearing phases of the hatchery program will be monitored based on the best management practices. The hatchery will be operated to maximize survival at all life stages by implementing standard best management practices for disease control and disease prevention. Hatchery operations will be monitored to ensure fish releases meet size targets and are in good health, therefore posing little disease risk to natural fish populations.

Variables that will be monitored at the Clear Creek and Kalama Creek Hatcheries are identified below.

Number of NORs and HORs used for Brood Stock

Attributes and Parameters Estimated	NCSMP Purpose
pNOB, percent females, total brood stock	Used in NCSMP Step 2 to update stock status and trends, and Step 4 to update in-season biological targets

Composition of Brood Stock Spawned

Attributes and Parameters Estimated	NCSMP Purpose
Age, sex, timing, composition of hatchery brood	Used in NCSMP Step 1 to monitor key assumptions, and Step 4 to update in-season biological targets

Holding Mortality (number of fish that die from time of brood stock collection until spawning)

Attributes and Parameters Estimated	NCSMP Purpose
Pre-spawning mortality	Used in NCSMP Step 1 to monitor key assumptions

Eggs per Female Spawned

Attributes and Parameters Estimated	NCSMP Purpose
Fecundity	Used in NCSMP Step 1 to monitor key assumptions

Juvenile Census Information (counts of live and dead eggs or fish from incubation to release)

Attributes and Parameters Estimated	NCSMP Purpose
Egg to release survival for sub-yearlings, and total release number	Used in NCSMP Step 1 to monitor key assumptions

Fish Marking Efficiency (sampling of juveniles for CWT or adipose fin clips prior to release)

Attributes and Parameters Estimated	NCSMP Purpose
Mark rate for each of the release components	Used in NCSMP Step 1 to monitor key assumptions

Variables Monitored during Juvenile Outmigration

Hatchery fish released into the Nisqually River have the potential to compete for food and space with naturally produced fall Chinook. In addition, the large number of large hatchery subyearlings released each year may prey on wild juvenile fall Chinook fry (and other species). These impacts on naturally produced fish have the potential to reduce natural population abundance and productivity.

Variables that will be monitored at the Clear Creek and Kalama Creek Hatcheries are identified below. These variables will develop estimates for juvenile abundance (Nisqually RM 12.5),

productivity and capacity (Beverton-Holt survival function), and for smolt-to-adult ratio (SAR) in the absence of harvest.

Juvenile Trap Counts in the Lower Nisqually River

Attributes and Parameters Estimated	NCSMP Purpose
Natural smolt abundance, productivity, capacity, and smolt-to-adult survival	Used in NCSMP Step 1 to monitor key assumptions, Step 2 to monitor stocks and trends, and in Step 3 to improve pre-season forecasts

Juvenile HOR Predation on NOR Juveniles (number of NOR juveniles consumed by HOR juveniles released from facilities)

Attributes and Parameters Estimated	NCSMP Purpose
HOR out-migrant abundance, timing, habitat use and diet composition	Used in NCSMP Step 1 to monitor key assumptions, and in Step 2 to monitor stocks and trends

Juvenile Monitoring in Estuary (detections of marked hatchery and natural fish at beach seine and fyke nest sites spread across habitat zones in the Nisqually River estuary)

Attributes and Parameters Estimated	NCSMP Purpose
Juvenile relative abundance indices, density indices and otoliths and scales for life history evaluation	Used in NCSMP Step 1 to monitor key assumptions, and in Step 2 to monitor stocks and trends

4.6. Status and Trends Analysis

The section provides an overview of the status and trends analysis, which focuses on natural escapement, harvest, and hatchery operations. Results of the 2004–2009 status and trends analysis are presented.

The terminal run reconstruction analysis evaluates past performance and guidance for updating this analysis into the future. Conceptually hatchery and natural-origin ((*HOR* and *NOR*, respectively) Chinook returning to the Nisqually River are either harvested in the tribal fishery (*TC*) and sport fishery (*SC*), return to the hatchery (*H*), are collected at the weir (*W*) or escape to spawn (*HOS* and *NOS*) (Figure 9). Catch is the harvest rate for each fishery and origin (t and s) multiplied by run size. A portion of the hatchery run "escapes" the fisheries and home to the hatcheries (h) to be recovered at the adult traps. Another portion of the hatchery run "stray" ($1-h$) to attempt to spawn in nature (*HOS*). Some of these "strays" are recovered at the weir (*W*). The number of fish recovered at the weir is a function of the fraction that encounter the weir (some adults will likely stop short and attempt to spawn downstream of the weir) and the weir efficiency (the ability of the weir to trap adults as the weir may not be operating at all times).

Completing a run reconstruction analysis requires additional computations and assumptions because key information is not available (in the future, weir operations will provide additional information that will improve estimates). For a given annual Nisqually River run size in year y of *HOR* and *NOR* adults, the number of fish by origin harvested in the treaty net (*TC*) and non-treaty sport (*SC*)

fisheries in year *y* and harvest rates of these fisheries (*t* and *s*) on hatchery (*H*) and natural (*N*) are calculated as catch divided by estimated terminal run.

The total Chinook catch is known for each fishery in the Nisqually River. However, not all hatchery fish are marked, therefore to estimate hatchery-origin catch the unmarked portion of the catch must be estimated. Rather than take the mark rate reported at release, all adults (excluding jacks) captured at the Clear Creek and Kalama Creek hatcheries are assumed to be hatchery-origin and the mark rate in the hatchery run is estimated from mark sampling at the hatcheries.

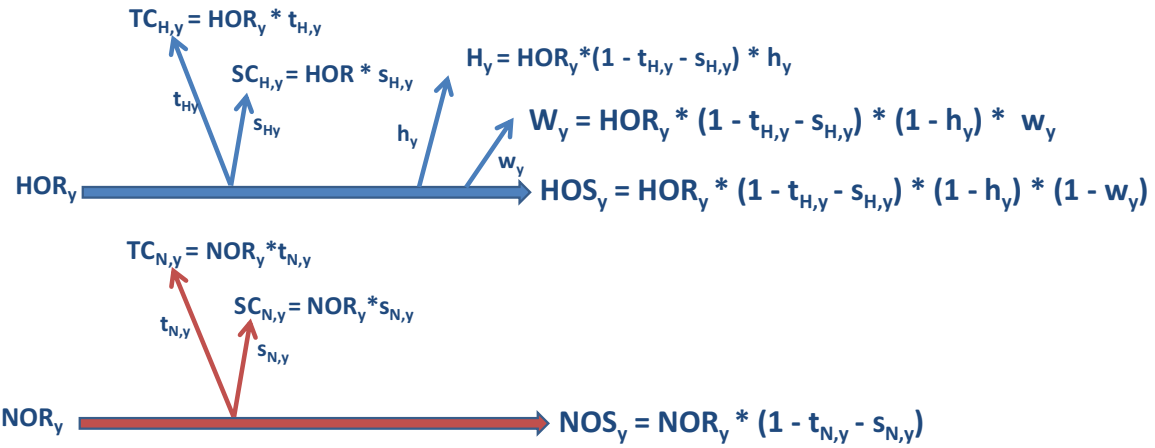


Figure 9. Conceptual overview of steps to complete a run reconstruction.

The unmarked catch (*C_Unmark;* fish with no adipose fin clip or CWT) that is of hatchery-origin is estimated by the following:

$$C\_Unmark_{H,y} = Catch\_Ad\left[\frac{1}{Hatch\_\%Ad} - 1\right]\left[\frac{Hatch\_Unmark}{Hatch\_CWT + Hatch\_Unmark}\right]$$

Where *Catch_Ad* is the catch of adipose fin clip adults with or without a CWT, *Hatch_%Ad* is the percent of fish sampled at the hatcheries with an adipose fin clip, *Hatch_Unmark* is the number of unmarked adults (no adipose fin clip or CWT) in the hatchery sample and *Hatch_CWT* is the number of fish without an adipose fin clip adults but have a CWT in the hatchery sample.

Total catch of all hatchery-origin adults in the fishery (C_H) is estimated by the following:

$$C_{H,y} = Catch\_Mark_{H,y} + Catch\_Unmark_{H,y}$$

Where *Catch_Mark* is the catch of adipose fin clip adults or CWT marked adults (fish of known hatchery-origin) in the fishery.

Computed catch of natural-origin adults ($C_{N,y}$) is the total unmarked catch minus the estimated unmarked catch of hatchery-origin.

The previous equations to estimate unmarked hatchery-origin catch have the risk of "over-expanding" the unmarked catch. In other words, if the unmarked catch is low, and the mark rate in the hatchery is low the results may be that all unmarked fish are of hatchery-origin. This method also uses mark rates from sampling in the hatcheries, fish that escaped the fishery. This is currently not a

problem because the terminal net fishery is not selective for marked fish, but will be a problem when the fishery is selective for marked fish. The mark rate in the hatchery escapement will be different than in the fishery. Achieving a high mark rate will be important to ensure accurate catch by origin estimates.

A similar series of calculations was made to estimate the number of unmarked hatchery-origin adults in the natural escapement. The Nisqually Indian Tribe natural resource staff and WDFW provide annual escapement estimates calculated by expanding redd counts from index reaches in the basin. In addition to redd counts, the survey crews also report the incidence of adipose fin clip marked and unmarked adults from carcass sampling. The number of fish without an adipose fin clip but with a CWT is not reported so the formulas are slightly different.

The unmarked escapement (E_Unmark_H) of hatchery-origin is estimated by the following:

$$E\_Unmark_{H,y} = E\_Mark \left[\frac{1}{Hatch\_\%Marked} - 1 \right]$$

Where *E_Mark* is the estimated escapement of adipose fin clip or CWT only adults and *Hatch_%Marked* is the percent of fish sampled at the hatcheries with an adipose fin clip or CWT only.

Mark sampling from the escapement surveys are used to estimate the mark rate in the spawning escapement and to estimate the number of hatchery-origin adults spawning in nature but, because carcass sampling is not random across the entire spawning escapement, and because the mark rate of straying hatchery adults is variable, the mark rate estimate is not an accurate or precise estimate of the number or proportion of hatchery-origin adults in the natural spawn environment. Data from weir sampling will greatly improve estimation of the incidence of hatchery adults in the spawning escapement, at least upstream of the weir. Other estimation techniques will be used to estimate the number of hatchery fish spawning downstream of the weir.

The following sections present the results of the run reconstruction for natural escapement, harvest, and hatchery brood stock for 2004 to 2009. Underlying each of these sections are worksheets in the ISIT where information for harvest, hatchery brood stock, and escapement is entered.

Terminal Run Size and Natural Escapement

Total abundance of hatchery and natural-origin Chinook returning to the Nisqually River from 2004 to 2010 varied from approximately 19,973 to 40,054 and 408 to 2,845, hatchery and natural-origin respectively (Table 11). The largest natural-origin return was in 2008 with 2,845 adults and the smallest return was in 2009 with 408 adults. The largest hatchery-origin return was in 2010 with 40,054 adults and the smallest return was in 2008 with 19,973 adults.

Between 2004 and 2010, natural spawning escapement varied from approximately 900 to nearly 3,400 adults (Figure 10), averaging 2,172 annually (Table 11). Natural-origin adults in the escapement averaged 593 fish using the previously described methods to expand unmarked escapement estimates to account for unmarked hatchery-origin adults. The 2009 escapement was the lowest, with an estimated 82 natural-origin adults spawning. Using the hatchery and natural-origin adjusted escapement estimates the percent hatchery origin averaged 73% from 2004 to 2010. Note that average pHOS is computed across multiple years and is not simply an average of annual pHOS. In other words, years of high escapement have a greater influence on the average than years of low

escapement. This was done to account for the potential effect of brood year abundance on pHOS and population fitness. Years with more spawners are assumed to have a greater effect on population fitness simply because those years would produce more adults to return and spawn in subsequent years.

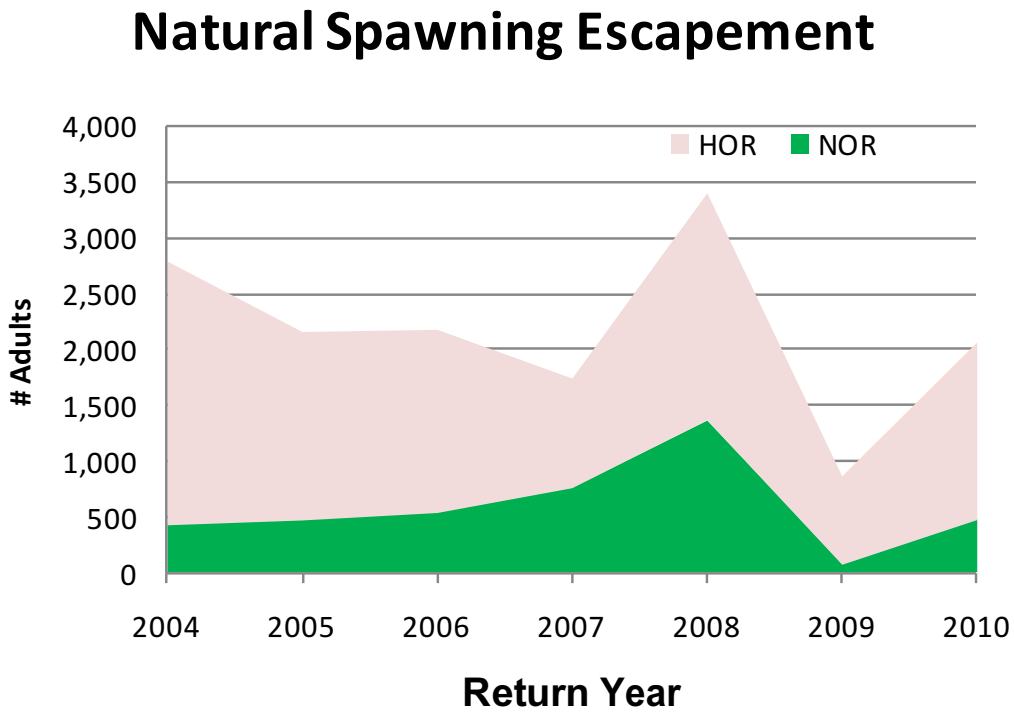


Figure 10. Natural spawning escapement of Nisqually fall Chinook.

1135 **Table 11. Nisqually fall Chinook terminal area run size and natural spawning escapement**
1136 **abundance of natural and hatchery-origin adults and pHOS.**

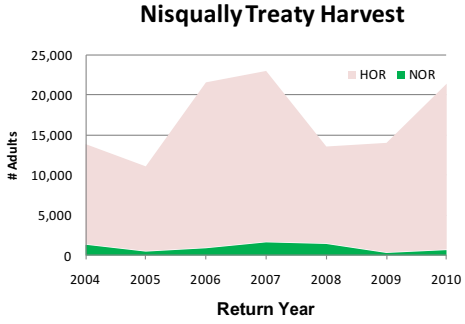
Return Year	NOR Run	HOR Run	NOR Natural Spawners	HOR Natural Spawners	Total	pHOS (census)	pHOS (effective)
2004	2,132	23,676	434	2,354	2,788	84%	81%
2005	972	25,736	477	1,682	2,159	78%	74%
2006	1,464	35,037	544	1,635	2,179	75%	71%
2007	2,431	39,447	765	979	1,744	56%	51%
2008	2,845	19,973	1,371	2,027	3,398	60%	54%
2009	408	21,892	82	790	872	91%	89%
2010	1,159	40,054	481	1,586	2,067	77%	73%
Average	1,630	29,402	593	1,579	2,172	73%	68%

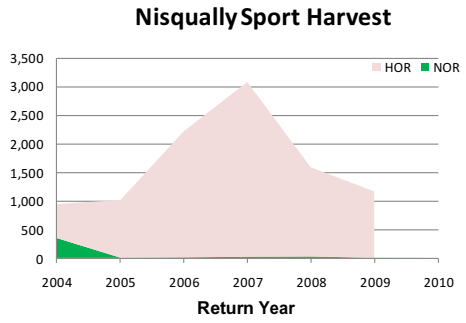
Notes: NOR=natural-origin recruit; HOR=hatchery-origin recruit, pHOS= proportion of hatchery spawners based on abundance (census) and effective hatchery spawners - assumes that 80% of hatchery-origin spawners are effective in nature

1137 ## Harvest

1138 Between 2004 and 2010, catch of hatchery adults in the treaty net fishery has ranged from 10,575 to
1139 21,352 (Figure 11), averaging 15,941 annually (Table 12). Harvest of natural-origin adults in the
1140 treaty net fishery ranged from 325 to 1,645 and averaged 978 annually. The terminal sport fishery on
1141 hatchery fish ranged from 598 to 3,056 fish and averaged 1,599 annually (2010 data were not
1142 available). The number of natural-origin fish impacted in the sport fishery ranged from 2 to 347 and
1143 averaged 68 annually (2010 data were not available). The sport fishery shows a definite trend of
1144 reduced impacts on natural-origin fish following implementation of non-retention of unmarked fish.
1145 Natural-origin impacts in the sport fishery from 2005 on are an estimate of non-retention mortality.

1146 Harvest rates in the treaty net fishery on natural-origin Chinook varied considerably among years
1147 (Table 12). In 2009 estimated terminal harvest rate on natural-origin Chinook was 80%, whereas the
1148 harvest rate in 2005 was 50%. Terminal harvest rates on hatchery-origin Chinook did not vary as
1149 widely, ranging from 41% in 2005 to 62% in 2009[4]. As previously mentioned, harvest rates on
1150 natural-origin Chinook in the Nisqually sport fishery have declined over the period and rates on
1151 hatchery-origin Chinook have increased following implementation of non-retention of unmarked
1152 fish.





1153

[4] Confidence intervals around NOR harvest rate estimate are much wider than around HOR rates because of low recovery of natural-origin fish in the escapement.

Figure 11. Catch (number of fish) of natural and hatchery origin Nisqually fall Chinook in the terminal area treaty net and sport fisheries.

Table 12. Catch and harvest rates (HR) in the terminal treaty net and sport fishery of natural origin and hatchery origin Nisqually fall Chinook.

	Nisqually Treaty Net				Nisqually Sport			
Year	NOR Catch	NOR HR	HOR Catch	HOR HR	NOR Catch	NOR HR	HOR Catch	HOR HR
2004	1,351	0.63	12,499	0.53	347	0.16	598	0.03
2005	491	0.50	10,575	0.41	4	0.00	1,009	0.04
2006	910	0.62	20,658	0.59	10	0.01	2,209	0.06
2007	1,645	0.68	21,350	0.54	21	0.01	3,056	0.08
2008	1,449	0.51	12,100	0.61	25	0.01	1,561	0.08
2009	325	0.80	13,679	0.62	2	0.00	1,162	0.05
2010	678		20,725		Data incomplete		Data incomplete	
Average	978		15,941		68		1,599	

Notes: NOR=natural-origin recruit; HOR=hatchery-origin recruit; HR=harvest rate

Adult Returns to Hatcheries

Fall Chinook are reared and released at Clear Creek and Kalama Creek Hatcheries. The majority is from Clear Creek. Between 2003 and 2010, the number of adults captured at Clear Creek has ranged from 3,980 to 17,027, averaging 9,304 annually (Table 13). The brood stock requirement for this program is approximately 2,800 adults; another 2,000 to nearly 10,000 jacks are captured at Clear Creek each year.

Table 13. Fall Chinook adult and jack sampling at Clear Creek Hatchery.

	Adults							Jacks						
	Adipose Clip		No Adipose Clip					Adipose Clip		No Adipose Clip				
Year	CWT	No CWT	CWT	No CWT	Un sampled	Sample rate	Total Adults	CWT	No CWT	CWT	No CWT	Un sampled	Sample rate	Total Jacks
2003	476	4,852	431	475	0	100%	6,235	108	1,504	81	194	0	100%	1,887
2004	415	5,690	469	259	422	94%	7,255	295	4,613	441	179	0	100%	5,528
2005	607	8,749	780	710	711	94%	11,557	310	2,956	311	221	254	94%	4,052
2006	680	7,922	889	198	314	97%	10,003	623	7,433	623	317	507	95%	9,503
2007	845	9,283	987	393	1,119	91%	12,627	261	5,295	306	364	0	100%	6,226
2008	187	3,359	211	202	21	99%	3,980	119	2,543	124	120	551	84%	3,457
2009	260	3,761	253	288	1,184	79%	5,746	351	6,344	333	299	1,486	83%	8,813
2010	539	13,013	692	570	2,213	87%	17,027	72	1,539	80	47	383	82%	2,121

Between 2003 and 2010, the number of adults captured at Kalama Creek ranged from 305to 1,462

averaging 856 annually (Table 14). The brood stock requirement for this program is approximately 450 adults; another 137 to 852 jacks are captured at Kalama Creek each year.

Table 14. Fall Chinook adult and jack sampling at Kalama Creek Hatchery.

	Adults							Jacks						
	Adipose Clip		No Adipose Clip					Adipose Clip		No Adipose Clip				
Year	CWT	No CWT	CWT	No CWT	Unsampled	Sample rate	Total Adults	CWT	No CWT	CWT	No CWT	Unsampled	Sample rate	Total Jacks
2003	136	1,132	44	150	0	100%	1,462	24	150	6	9	0	100%	189
2004	110	775	18	67	0	100%	970	63	394	7	17	0	100%	481
2005	152	691	13	57	0	100%	913	11	109	1	11	100	57%	232
2006	71	432	14	16	0	100%	532	86	735	12	19	0	100%	852
2007	186	1,071	48	64	66	95%	1,435	21	268	4	18	0	100%	311
2008	26	263	9	7		100%	305	14	103	4	1	15	89%	137
2009	41	385	4	10	75	85%	515	19	255	3	3	12	96%	292
2010	33	582	11	5	85	88%	716	2	48	3	0	4	93%	57

Chapter

5

5. Nisqually Chinook Stock Management Plan

The following analysis of the NCSMP best fits the conservation and harvest goals identified in Chapter 2. The AHA analysis and decision rules in ISIT for harvest, hatchery operations, and operation of the weir all are important in determining the success of this plan. Alternative strategies considered while developing the plan and are discussed in Section 5.2.

Resource management goals directly affected by and relevant to management activities in the Nisqually River (harvest, hatcheries and weir operations) are to rebuild and maintain sustainable naturally spawning fall Chinook in the Nisqually Basin, and to provide harvest for treaty and non-treaty fishers.

As discussed in Chapter 3, the Nisqually River Basin has the potential to produce several thousand natural Chinook. This potential is largely because of efforts undertaken since 2001 to protect existing habitat and to restore high-priority habitat in the river and estuary. The future potential is even greater following successful completion of the Nisqually Chinook recovery plan. However, application of current theory as to the effects of hatchery influence on natural population fitness would suggest that a substantial portion of this current and future habitat potential is unrealized because of loss of fitness of the natural population (Figure 12). The goal to promote a locally adapted natural population will take better advantage of past and future habitat investments.

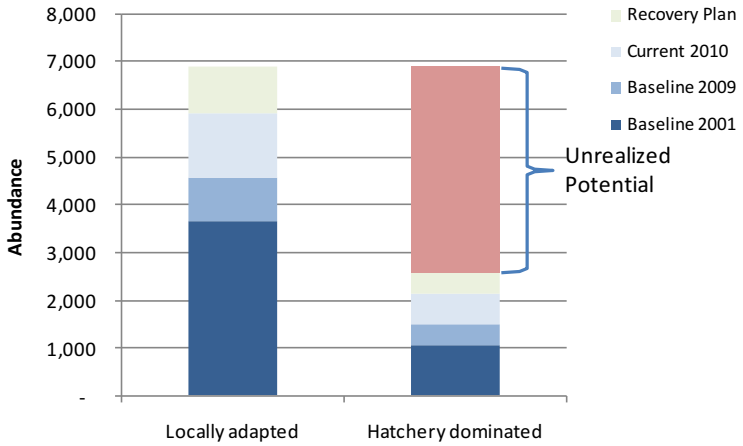


Figure 12. Natural population abundance potential (adult recruits) of a fully fit Chinook population versus a hatchery-dominated Chinook population.

The goals for conservation and harvest will require revisions to hatchery operations, harvest management, and the operation of an adult weir to manage natural spawn escapement. Management of hatchery production and natural escapement will adhere to guidelines that minimize the genetic

and ecological influence of hatchery fish on the naturally spawning population. These guidelines define the limits on the proportion of the natural spawning escapement composed of hatchery-origin fish. The short-term emphasis on reducing the percent hatchery fish spawning in nature will likely mean that the total abundance of fish spawning in the Nisqually River will be less than in previous years. Over the long term, with increased abundance and improved fitness, a sustainable, locally adapted natural population is expected to be established.

Measures to reduce the influence of hatchery fish on the natural population include the following:

- Increase productivity of the natural run as an outcome of habitat improvements.
- Reduce harvest rates for natural-origin adults in the pre-terminal and terminal fisheries.
- Increase harvest rates for hatchery-origin fish in the pre-terminal and terminal fisheries.
- Eliminate or reduce hatchery fish naturally spawning by removal at a weir.
- Reduce the size of the hatchery program.

Recognizing that harvest is an important goal for treaty and non-treaty fisheries, the NCSMP initially will maintain the current hatchery production of 4.0 million fish while implementing measures to meet conservation goals.

5.1. Key Assumptions

Key assumptions with respect to weir efficiency, hatchery stray rate, and the percent natural and hatchery origin fish spawning downstream of the weir are shown in Figure 13. The NCSMP was evaluated using an assumed 95% hatchery adult mark rate (adipose fin clip or CWT). Recent year sampling of juveniles at the hatchery suggests this rate has been exceeded (e.g., 99% in 2010). The assumption that 20% of the natural-origin adults would spawn downstream of the weir is roughly based on the amount of fall Chinook spawning potential estimated downstream of the weir relative to the entire Nisqually River Basin. The estimate of spawning potential is based on results from the EDT model for the current condition. The assumed 85% return rate of hatchery fish to the hatchery adult traps (Hatchery Return Rate in Figure 13) is slightly higher than the 2006–2009 estimated average of 84%. The NCSMP assumed that 20% of the hatchery-origin strays (the 15% of escapement not collected at the hatcheries) would spawn downstream of the weir. Information is not available to determine an appropriate value for the relative hatchery-origin adult spawner reproductive success. The 80% assumption described in the NCSMP is the same as used in hatchery assessments for Chinook completed by the HSRG (Hatchery Scientific Review Group 2009).

Key Assumptions (Step 1 Information)

Inputs from Key Assumptions worksheet

Mark rate in Hatchery Return (Int|Step)	95%	95%
Maxmum weir efficiency (Int| Step)	95%	95%
Incidential Weir Mort on NORs	3%	
Hatchery Return Rate (*Int Prog*)	85%	
Hatchery Return Rate (*Step Prog*)	85%	
% NORs Spawning below weir	20%	
% HORs Spawning below weir	20%	
HOR Relative Reproductive Success	80%	

Figure 13. Key assumptions applied to the analysis of the Nisqually Chinook Stock Management Plan.

Appendix B of this report provides additional details on key assumptions for the baseline, current conditions, and NCSMP.

5.2. Decision Rules

The decision rules represent actions affecting outcomes associated with the fully implemented program (Figure 14). Implementation of all elements of the plan is expected to occur over 5 years, as gear is tested and refined, hatchery capabilities are expanded, and measures to selectively harvest hatchery-origin adults while protecting natural-origin adults from harvest loss are developed. However, the first adult returns from the integrated program to support the stepping-stone program will not be available until 3 years after the first integrated program release.

The decision rules in Figure 14 describe natural escapement triggers for weir operations, harvest rates, and hatchery brood stock operations, brood stock operations for the two hatchery programs, and harvest rates at three levels of projected Nisqually River natural-origin run size.

The rules set a minimum spawn escapement above the weir trigger of 500 fish (hatchery and natural-origin). If escapement is projected to be below the minimum then weir operations would be modified to pass hatchery-origin adults from the integrated program upstream to ensure 500 spawners in the system above the weir. The 700 NOR escapement trigger is the point when the full integrated hatchery program would be implemented. If the projected natural-origin escapement upstream of the weir is less than 700 adults then the minimum integrated program is implemented and 75 natural-origin adults would be collected (PNOB - 0.25; brood stock = 300 adults). Escapement above 700 would increase the integrated program brood stock based on the percent of natural-origin adults to natural escapement (% of NORs to Esc) rule. The 50% NORs to Esc rule says that 50% of the fish above 700 would be collected for brood stock until the full program natural-origin brood stock of 105 fish is achieved (PNOB - 0.25; brood stock = 420 adults).

At this time the decision is brood stock for the stepping stone (Step) hatchery program will be entirely from returns from the integrated hatchery program. Therefore, the pNOB rule for the stepping stone program is 0%.

Harvest rates for the treaty net fishery are stepped based on projected terminal run size, escapement, and escapement triggers. The lowest harvest rate rule is applied when escapement (hatchery and natural-origin) is projected to be less than 500 fish. Another step in harvest rates occurs when project natural-origin escapement is projected to exceed 500 and be less than 700 fish. The next step is when projected natural-origin escapement is projected to exceed 700 fish. The last step is calculated to be when natural-origin escapement is projected to exceed 1,596. The harvest step triggers are calculated based on the integrated program brood stock size, pNOB for the program, and harvest rates.

Harvest rates for the Nisqually non treaty sport fishery are keep constant across most of the range in terminal run size. The impact of the selective sport fishery on unmarked Chinook is low enough that setting a stepped harvest rule for this fishery would not have a measurable benefit to achieving other management objectives such as natural origin brood stock and escapement targets. The exception is the sport fishery would be reduced in years when natural spawning escapement is projected to be critically low - less than 500 fish of all types.

Decision Rules (Step 3 Information)

Biol Significance (based on S&T)	Low	
Natural Escapement Triggers		
Min natural spawn escapement	500	
Target NOR spawning escapement	700	
Hatchery Brood Stock Management		
Int. Hatchery Prog. (Min|Max)	300	420
Harv. Hatchery Program		2,321
pNOB (Int|Step)	25%	0%
Maximum NOB (Int|Step)	105	-
% of NORs to ESC (Int prog.|Step prog.)	50%	100%

Treaty Net Harvest Rates

Min Escape or NOR Target Escapement	500	700	1,596	
Marked harvest rates	40%	60%	60%	70%
Unmarked harvest rates	20%	20%	20%	25%

Terminal Sport Harvest Rates

Marked harvest rates	2.0%	4.0%	4.0%	4.0%
Unmarked harvest rates	0.2%	0.4%	0.4%	0.4%

Figure 14. NCSMP decision rules for natural escapement triggers, hatchery brood stock, and terminal fisheries.

Harvest Management

Harvest decisions developed for the NCSMP reflect the goal of reducing terminal harvest of natural-origin adults while continuing to achieve harvest goals for hatchery-origin adults (Figure 14). Maintaining high harvest rates on hatchery-origin adults is necessary to meet the biological targets for conservation. Specifically, the terminal fishery needs to remove a substantial portion of the hatchery return to achieve pHOS objectives. Achieving the intended differential harvest of natural-origin and hatchery-origin Chinook will require use of as yet undefined gear and fishing strategies. Testing and development of successful gear types and fishing strategies is expected to begin in 2011 and take 3-5 years to fully implement.

Harvest rates evaluated in the NCSMP are based on validated FRAM/TAMM results for the 2008 fishing year (December 21, 2009 results) (Table 15). The harvest rates used for Alaska/British Columbia and southern United States ocean sport and troll fisheries are unchanged from the 2008 FRAM/TAMM results. Puget Sound marine area sport fishery harvest rates were projected assuming the 2008 FRAM/TAMM harvest rates on marked hatchery fish and a reduction in the

2008 harvest rate on unmarked natural fish of approximately 40%. The 2008 unmarked harvest rate was reduced to approximate full implementation of Puget Sound mark-selective fisheries that are place in 2010. These pre-terminal harvest projections are necessary for planning purposes. However, the work group recognizes the problem with using one year and that these rates will need to be revisited as more years of data are available. The annual harvest rates are stepped based on forecast terminal run size of natural-origin adults and projected escapement. At low abundance, terminal harvest will be reduced to help meet escapement objectives. At high abundance maximum harvest rates for the terminal area treaty net fishery are 0.70 and 0.25 for hatchery- and natural-origin fish, respectively. Maximum harvest rates in the terminal area sport fishery are 0.05 and 0.005 on hatchery and natural fish, respectively. The range of harvest rates for the treaty net and non-treaty sport fisheries are detailed in Figure 14.

Assuming maximum harvest rates in the terminal fisheries, the analysis that was done projected pre-terminal and terminal fisheries exploitation rates for unmarked natural-origin Chinook of 0.30 and 0.17, respectively (Table 15). The total exploitation rate across all fisheries on unmarked natural-origin fish is projected to be 0.47. Also, assuming maximum harvest rates in the terminal fisheries, pre-terminal and terminal fisheries exploitation rates for marked hatchery-origin Chinook are 0.38 and 0.44, respectively. Total exploitation rate across all fisheries for marked hatchery-origin fish is projected to be 0.82. The biggest change between the current condition and the NCSMP projections is the reduction in total exploitation of natural-origin Chinook, largely through the terminal treaty net fishery.

In summary, harvest management decision rules identified in the NCSMP would restructure the terminal net fishery to selectively harvest hatchery adults and implement a natural fish protection program. Specific rules are identified below.

- Maintain high harvest rates on marked hatchery-origin adults using gear types and possible time and area openings - harvest rates on hatchery-origin of 60-70% except in critically low years when it will fall to 40%.

- Reduce terminal harvest rates for unmarked natural-origin adults to 20–25%.

The overall objective is to manage pre-terminal and terminal fisheries to not exceed a total exploitation rate for natural-origin adults of 47%.

Hatchery Management

Several options were considered when developing hatchery strategies for the NCSMP. All options recommended moving Chinook production from Kalama Creek to Clear Creek. Historic CWT recoveries suggest a lower return rate of adults to the Kalama adult trap which presumably means more of these fish stray to spawn in nature. Moving production to Clear Creek may also reduce the incidence of hatchery-origin adults spawning in the reach downstream of the weir (i.e., in the vicinity of the Kalama Creek Hatchery).

The NCSMP includes a small integrated hatchery program (25% of the brood stock would be natural-origin adults) (Table 16). Total brood stock size would be between 300 and 420 adults producing a release between 400,000 to 600,000 fish annually. The range in brood stock and program size is dependent on natural-origin run size and projected escapement. Adult returns from this program would be used to provide brood stock to the integrated program and to a much larger

stepping-stone program of 3.4 to 3.6 million release. The range in release number for the two programs is to ensure a total hatchery release of 4.0 million Chinook. The stepping-stone program is solely for harvest purposes and the entire release would be marked by an adipose fin clip to provide quick identification in the fisheries, at the hatchery and at the weir. A portion (approximately 100,000) would also include CWT to evaluate fisheries and survival. None of the stepping-stone fish are used for hatchery brood stock. The size of the integrated program and survival to adult from past experience suggests this program is sufficient to support brood stock requirements of both programs.

The existing double-index tagging program currently based on releases from the Clear Creek hatchery program would be moved to the integrated program (Table 16). All of the integrated program fish would have a CWT to uniquely identify these fish at the hatchery and at the weir as fish from the integrated program for use in brood stock and to pass upstream if needed. A portion of the release (75,000) would also have an adipose fin clip for the double-index tagging program. We will not be able to distinguish adipose fin clipped adults from this program and from adults from the stepping stone program. The number of adipose fin clip/CWT in the integrated release was set low to not jeopardize brood stock requirements, but is high enough to ensure sufficient recoveries to maintain the double-index tagging program (Appendix C).

1344 **Table 15. Exploitation and harvest rates for Nisqually hatchery- and natural-origin fall Chinook assumed for the NCSMP scenario used in**
1345 **the AHA analysis. The rates evaluated in the NCSMP are based on a combination of FRAM/TAMM results for 2008, a projected reduction**
1346 **in pre-terminal harvest on natural-origin adults in selective fisheries in Puget Sound, and the projected Nisqually River terminal net and**
1347 **sport fisheries rates.**

	Exploitation Rates					Harvest Rates			
Scenario/Population Component	Alaska / British Columbia	Southern United States Ocean	Puget Sound Marine (Net & Sport)	Terminal (Net & Sport)	Total	Alaska / British Columbia	Southern United States Ocean	Puget Sound Marine (Net & Sport)	Terminal (Net & Sport)
NCSMP – Natural-Origin	0.16	0.03	0.12	0.17	0.47	0.16	0.03	0.14	0.25
NCSMP – Hatchery -Origin	0.16	0.03	0.19	0.44	0.82	0.16	0.03	0.23	0.70

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Table 16. Nisqually River fall Chinook hatchery operation decisions for the Nisqually Chinook Stock Management Plan.

Period	Program	Program Purpose	Program Type	Brood Stock Management	Program Size (million)	Marking objectives
NCSMP (develop integrated and step stone programs)	Kalama Creek	Plan to move to Clear Creek				
	Clear Creek integrated program	Brood stock/ Conservation	Integrated	25% pNOB (420 adults total program)	0.6	100% CWT except 75,000 CWT/adipose fin clip for double-index tag program
	Clear Creek stepping-stone program	Harvest	Stepping-stone	100% HOR returns from integrated program (2,321 adults)	3.4	100% adipose fin clip except 100,000 CWT/adipose fin clip for fishery/survival evaluation

Notes: HOR: hatchery-originated recruits, pNOB= percent natural-origin broodstock, CWT=coded wire tag, ad clip= adipose fin clip

Biological targets to achieve the goal of promoting local adaptation of the natural population are less stringent under the integrated-stepping-stone hatchery options. Targets with respect to the integrated program are a PNI greater than 0.67 and pHOS less than 30% (Hatchery Scientific Review Group 2009). The HSRG did not explicitly address pHOS targets for stepping-stone programs, however, follow-up communications suggests that the biological target for the stepping-stone program is a pHOS less than 10%. The pHOS target is different than that for a segregated program (pHOS less than 5%), because the stepping-stone adults are more closely related to the natural population. Hence, the domestication effect on a related natural population is hypothesized to be less for a stepping-stone program than for a completely unrelated segregated program.

In summary, hatchery management decision rules would develop an integrated hatchery program to generate brood stock to support the stepping-stone harvest program and to provide a demographic safety net in years of critically low adult abundance. These rules would specify the following criteria for the integrated program portion:

- Total brood stock: 300 to 420 adults
- pNOB: 25% (75 to 105 adults)
- Smolt release: 400,000 to 600,000
- Release location: Kalama Creek, and move to Clear Creek once it is determined it has the capability to rear and release another 600,000 fish.
- Marking: 100% coded wire tags (CWT), 75,000 CWT/adipose fin clip for double-index tagging program, the remainder no adipose fin clip.

The hatchery management decision rules also include developing a stepping-stone hatchery program to provide harvestable production using brood stock collected from the integrated program return. Specifically:

- Brood stock: 2,300 adults taken from integrated hatchery return
- pNOB: 0% at projected near-term abundance levels, future decisions may increase to 25% based on pre-season and in-season natural-origin run size forecasts
- Smolt release: 3.4 to 3.6 million
- Release location: Clear Creek
- Marking: 100% adipose fin clip, 100,000 CWT/adipose clip

Weir Operations

The NCSMP includes the operation of an effective, low-impact weir to remove hatchery adults from the spawning escapement and to collect natural-origin adults for the integrated brood stock. The weir operation decision rules would dictate operating an adult weir at RM 12.3 in the Nisqually River during fall Chinook management season (early July to October 30) to meet the following criteria:

- Monitoring: count escapement at weir and number of unmarked and marked Chinook passed upstream of weir.
- Escapement composition: exclude hatchery-origin adults (adipose fin clip or CWT fish) from escapement upstream of weir except in years of critically low abundance (fewer than 500 projected natural spawners above the weir).
- Escapement goals: manage the release of integrated program adults to natural escapement in the occasional year that natural spawn escapement of all fish (hatchery-origin strays from leakage at the weir and from spawners downstream of the weir, and natural-origin spawners) is projected to be less than 500 fish above the weir.
- Brood stock collection: collect up to 105 unmarked adults at weir for the integrated hatchery program and, as necessary, CWT-only adults (returns from the integrated program) for the stepping-stone program.

5.3. Biological Targets

The potential for the NCSMP to achieve biological targets was evaluated using AHA and the ISIT? worksheet. Both tools use the same key assumptions identified previously in this report.

All-H-Analyzer

Results from the AHA analysis are averages for a range of marine survival conditions. Consistent with analysis of status and trends, the AHA analysis generates a Baseline (Pre-2001) Condition, 2009 Condition, and Current 2010 Condition pHOS of approximately 70% (Figure 15). The NCSMP

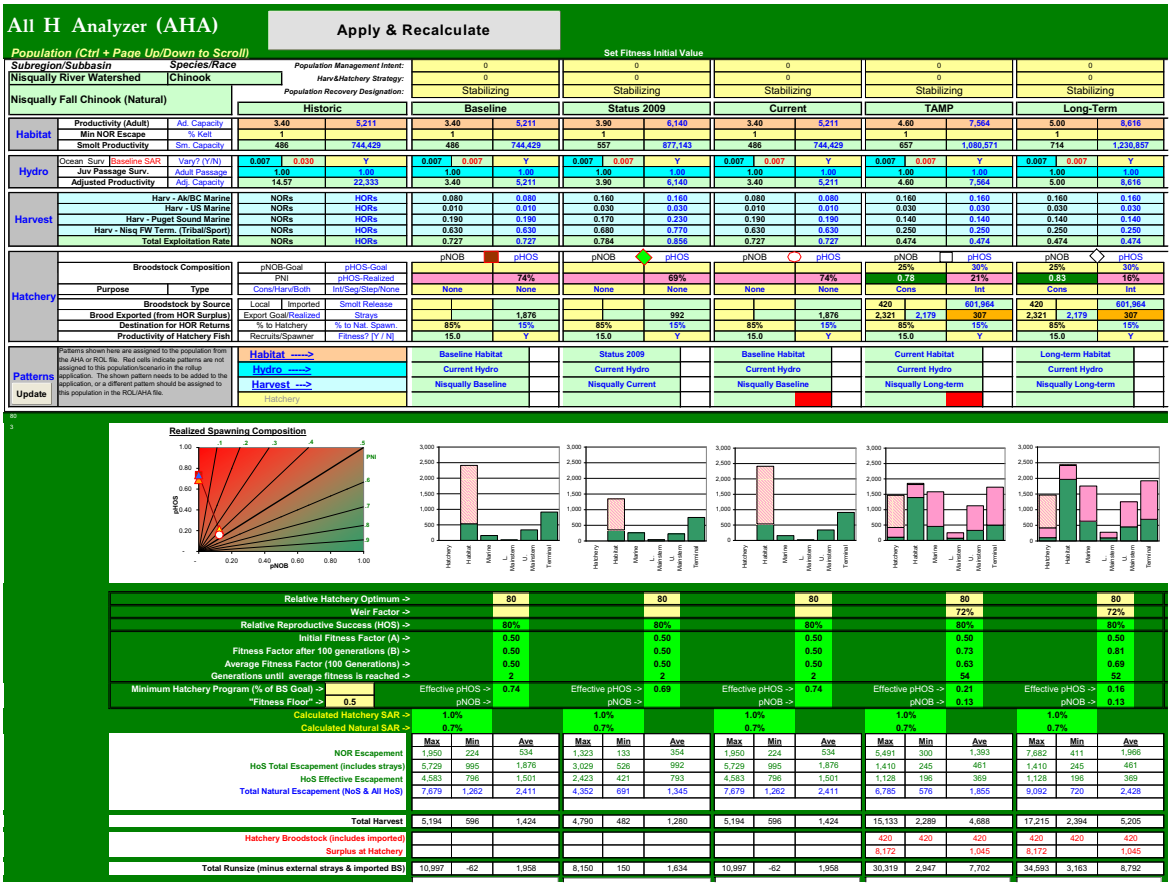
scenario in AHA predicts an average combined program effective pHOS with current habitat conditions of 21% (a combination of integrated and stepping-stone programs). Average effective pHOS from the stepping-stone program is 14% (average effective strays 246 divided by 1,762 total effective spawners). The pHOS just exceeds the less than 10% standard for this program. The integrated program PNI is approximately 0.78, which achieves the PNI standard of greater than 0.67.

The integrated program does not achieve the brood stock requirements for both programs in all years. The average number of brood stock adults available to export to the stepping-stone program is 2,179 fish over a range of ocean survival conditions, whereas the program requires 2,300 fish for brood stock. This suggests that in years of predicted low survival of hatchery fish a decision will need to be made to either reduce the program size or use other fish in the brood stock.

The AHA worksheet in Figure 15 only shows harvest from the integrated program and natural population. The stepping-stone program was analyzed using a separate AHA worksheet specific to that program. Total average harvest for the natural population and integrated and stepping-stone hatchery programs is approximately 43,000 fish (4,688 integrated and natural plus 38,848 stepping-stone fish). Hatchery harvest rates in Figure 15 are just for the integrated program. This program is not adipose fin-clipped (CWT only) so harvest rates on the hatchery fish are expected to be the same as on natural fish.

The weir factor of 72% shown in Figure 15 is an estimate of the fraction of hatchery-origin strays assumed to be recovered at the weir and includes an assumed 95% weir effectiveness, a 95% mark rate of hatchery fish, and a weir encounter rate for hatchery fish of 80% (e.g., 0.72 = 0.95 * 0.95*0.80).

The AHA analysis is useful to evaluate the long-term average response to the NCSMP with varying marine survival. The combination of actions described in the NCSMP approach targets necessary to promote local adaptation of the natural population. Key assumptions will need testing and validation and include such items as the ability to identify hatchery adults and prevent them from straying, the ability to affect differential harvest rates on hatchery- and natural-origin adults, and the composition and number of hatchery and natural adults that spawn downstream of the weir.



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1436 **Figure 15. Nisqually River fall Chinook All-H-Analyzer population results for the Pre-2001 Baseline, 2009 Status, 2010 Current, Nisqually**
1437 **Chinook Stock Management Plan (NCSMP) and Long-Term Conditions.**

In-Season Implementation Tool

In contrast to AHA, ISIT? is based on a particular assumed terminal run size of hatchery and natural adults to the Nisqually River. The ISIT? assessment assumes the following for run size to the Nisqually River (Figure 16):

- a natural-origin run size to the Nisqually River of 2,500 adults,
- 4,000 integrated hatchery adults, and
- 16,000 stepping-stone hatchery adults.

With these run sizes the PNI standard is achieved for the population upstream of the weir (PNI = 0.78) and pHOS for the integrated program is well under the 30% upper limit. The 10% pHOS upper limit for the stepping-stone program is not achieved for the portion of the population downstream of the weir (pHOS = 20%), but is less than the 10% standard for the entire population (pHOS = 9%). Total number of natural spawners (hatchery- and natural-origin) is projected to be 2,064 adults.

Terminal harvest of hatchery fish is approximately 12,600 adults (compared to a recent average of 15,000 reported in Section 4.4).

Pre-season & In-season Runsize Forecast (Step 4 Inputs)

NOR Runsize	2,500
Hatchery Runsize (Int)	4,000
Hatchery Runsize (Step)	16,000

In-season Updates (Step 4 Inputs)

NORs	-
HOR(Int)	-
HOR(Step)	-

Final Runsize

NORs	2,500
HOR(Int)	4,000
HOR(Step)	16,000

Biological Targets

Broodstock Composition

	BS #	pNOB	pStep Stone	Hatch Rel
HOR Broodstock (Int Prog)	420	25%	75%	601,965
HOR Broodstock (Step Prog)	2,321	0%	100%	3,326,573

Harvest

NOR	HOR (int)	HOR (step)
638	1,020	11,604

Escapement Composition (effective pHOS)

	# spawners	# NOS	# HOS (Int)	# HOS (Step)	pHOS (Int)	pHOS (Step)	Total pHOS	PNI
Entire Nisqually	2,064	1,715	124	224	5%	9%	14%	0.64
Downstream Weir	573	352	89	132	14%	20%	33%	0.43
Upstream Weir	1,491	1,364	35	92	2%	5%	7%	0.78

Figure 16. Biological targets for a 2,500 natural-origin run size, a 16,000 stepping-stone hatchery-origin run size and a 4,000 integrated hatchery run size.

The number of adults from the stepping-stone program collected at the hatchery is projected to be 3,737 (Figure 17). A combined total (both programs) of 665 hatchery adults are projected to be removed at the weir. Incidental weir mortality is assumed to be 3%, and would result in a projected mortality of 42 natural-origin adults. The full integrated program brood stock (420 adults with 105 natural-origin fish) can be collected as the number of natural-origin spawners is projected to exceed the 700 minimum natural-origin escapement rule. Approximately 140 of the CWT only hatchery fish (i.e., integrated program adults) collected at the weir will be used for brood stock either for the integrated program or the stepping stone program. The analysis projects 220 integrated program and 435 stepping-stone program fish collected at the weir surplus to brood stock needs.

Projected Adult Disposition for Coming Year

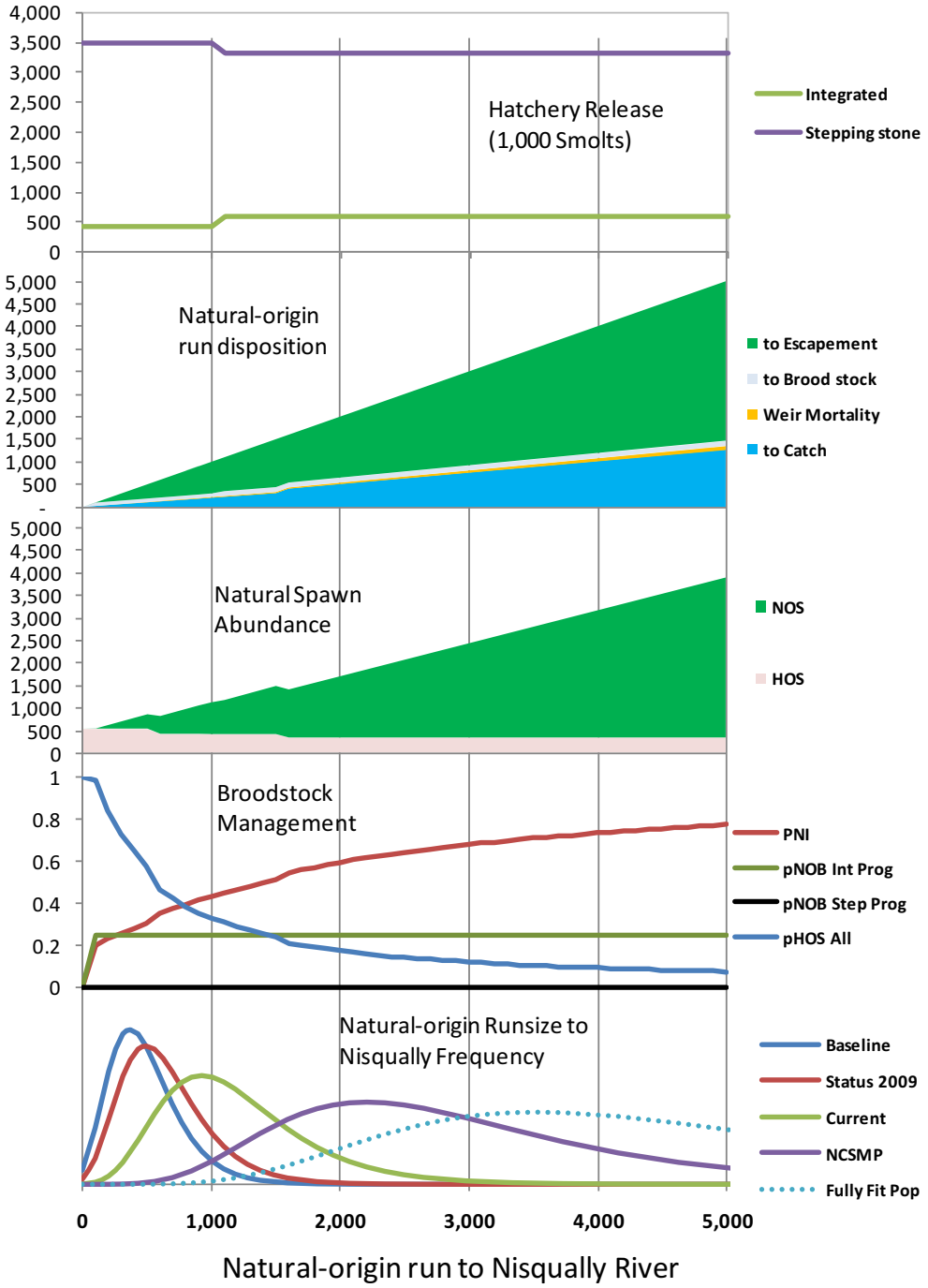
Trigger Points for Min Escapement/NOR Runsize

	NORs	Int-HORs	Step-HORs	
A				Natural Escapement (upstream of weir)
				Integrated Program Brood Stock
				Harvest Program Brood Stock
				Catch (treaty and sport)
500				Surplus at Hatchery
500				Removed at Weir + Incident Weir Mort
	NORs	Int-HORs	Step-HORs	
B				Natural Escapement (upstream of weir)
				Integrated Program Brood Stock
				Harvest Program Brood Stock
				Catch (treaty and sport)
700				Surplus at Hatchery
998				Removed at Weir + Incident Weir Mort
	NORs	Int-HORs	Step-HORs	
C				Natural Escapement (upstream of weir)
				Integrated Program Brood Stock
				Harvest Program Brood Stock
				Catch (treaty and sport)
1,596				Surplus at Hatchery
1,596				Removed at Weir + Incident Weir Mort
	NORs	Int-HORs	Step-HORs	
D	1,718	124	230	Natural Escapement (upstream of weir)
	105	315	-	Integrated Program Brood Stock
	-	2,321	-	Harvest Program Brood Stock
	635	1,016	11,451	Catch (treaty and sport)
		-	3,866	Surplus at Hatchery
	42	224	453	Removed at Weir or Incident Weir Mort

Figure 17. Projected disposition of natural, integrated, and stepping-stone Chinook returning to the Nisqually River based on decision rules in Figure 14. Assumes a terminal run of 2,500 natural-origin adults (NORs), 4,000 integrated hatchery-origin adults (Int-HORS) and 16,000 stepping-stone hatchery-origin adults (Step-HORs).

The decision rules developed for the NCSMP place a priority on removing hatchery fish from natural spawning except when the projected natural spawning escapement above the weir is less than 500 adults. An analysis of adult disposition for a range of natural-origin terminal run size is presented in Figure 18. The combined abundance of hatchery fish (integrated and stepping-stone) returning to the Nisqually River is fixed at 20,000 in the analysis. The top chart shows how number of fish released for the two programs will change with terminal run size of natural-origin adults. A terminal run greater than 1,000 adults is where the integrated program starts to increase to its maximum of 600,000 fish. The full program can occur at approximately 1,200 adults returning to the Nisqually River. The second chart from the top shows disposition of natural-origin adults. Escapement and harvest are roughly proportional to run size. The number of natural-origin fish used in hatchery brood stock does not exceed 105 fish. The middle chart shows abundance and composition of fish spawning in nature. Natural spawning is dominated by hatchery fish when natural-origin run is less than 500 fish. Combined pHOS is less than 20% at natural-origin run size greater than 1,500 fish (chart second from bottom). The bottom chart shows a hypothetical

distribution of natural-origin run size to the Nisqually River (predicted total abundance minus pre-terminal harvest) for the various habitat scenarios presented in Section 3.1. The baseline, 2009 status and current distributions all include assumptions of fitness loss. The distribution for the NCSMP is based on current habitat potential with improved population fitness. The fully fit population distribution includes predicted improvements to habitat potential with the Chinook recovery plan and a fully fit population. The intent is not to make a specific prediction of run sizes, but instead to show: 1) that the Nisqually Basin has the habitat potential to produce terminal run sizes necessary to achieve success of the plan and 2) that allowing the population to adapt to local conditions of the natural environment is critical to that success. Finally, biological targets are not achieved with a run size less than 1,000 natural-origin adults to Nisqually River. Run sizes that exceed 2,000 adults will result in substantial progress towards conservation goals. Improvements to population fitness are projected based on the AHA fitness model run sizes over 2,000 fish. The projected potential of a fully fit population with current habitat is 3,000 to 4,000 natural-origin adults returning to the Nisqually River.



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1499 **Figure 18. Range of outcomes for Nisqually fall Chinook based on natural-origin run sizes and**
1500 **decision rules; assumes an integrated hatchery run of 4,000 adults and a stepping-stone hatchery run**
1501 **of 16,000 adults.**

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5.4. Alternatives Considered and Rejected

Several alternatives to the NCSMP were considered and analyzed, but were rejected because they did not achieve harvest and conservation goals with reasonable assumptions (Table 17). The alternatives analyzed are not exhaustive, but are intended to bracket a range of choices and actions to consider for Nisqually fall Chinook. The alternatives were analyzed using the ISIT tool assuming a hatchery- and natural-origin run to the Nisqually River of 20,000 and 2,500, respectively. The exception is alternative 4, which evaluated reducing the size of the hatchery program from 4.0 million to 1.5 million. In that alternative the hatchery-origin terminal run was adjusted to reflect the reduced hatchery release. Results will differ for each alternative for different inputs of run size.

Alternative 1 represents the status quo management for comparison. The terminal net fishery harvest rate was assumed to be 70% and the Nisqually sport harvest rate was assumed to be 5% on hatchery-origin and 0.5% on natural--origin Chinook. The existing 4.0 million hatchery release is managed as a segregated program. The status quo alternative does not include a weir to manage natural escapement. In this alternative harvest goals are maintained, but conservation goals are not met for escapement composition. Natural spawning is 45% hatchery-origin.

Alternative 2 is identical to the status quo except it includes operation of the weir to manage natural escapement. The weir is assumed to remove 95% of the hatchery-origin adults that encounter the weir. The alternative also assumes that 20% of the hatchery strays stop short of the weir and would not be removed from the escapement. This alternative highlights that operating the weir, is not sufficient to achieve conservation goals. Natural escapement is severely reduced because of high harvest rates on natural-origin fish and pHOS (19%) is still well above HSRG criteria for low hatchery influence (pHOS less than 5%).

Alternative 3 includes operation of the weir and also includes reduced harvest rates in the treaty net fishery. This alternative does not assume selective harvest of hatchery adults in the net fishery. Natural escapement is high (~2,400 adults), but pHOS is also high (21%). Reducing harvest rates does not achieve the goal of promoting a locally adapted natural population. Harvest under this management alternative is reduced by over half with no progress towards conservation goals.

Alternative 4 evaluated outcomes by reducing hatchery production to 1.5 million, along with reduced treaty net harvest rates and operation of the weir. This management alternative partially achieves conservation goals (pHOS = 9%). However, the hatchery program would need to be reduce more to get pHOS less than the 5% criteria for low hatchery influence recommended by the HSRG. Reducing hatchery production had a corresponding reduction in net and sport harvest. Not analyzed, but also a consequence of this management alternative, would be a reduction in marked fish available in pre-terminal mark selective sport fisheries.

Alternative 5 evaluated the effects of implementing a selective treaty net fishery. Harvest rates on hatchery adults are assumed high (70%) and low on natural adults (25%). This alternative did not include a weir to management escapement composition. This alternative highlights that implementing a selective fishery is not sufficient to reduce pHOS in the natural spawning escapement. pHOS is projected to be 26% under this alternative.

Alternative 6 is the same as 5, except it includes operation of the weir. This alternative comes close to achieving conservation goals (pHOS = 11%, escapement = 2,098 adults). However, the hatchery

strays with this alternative are from the existing segregated hatchery program. The HSRG recommended criteria for low hatchery influence is less than 5%.

Finally, the NCSMP is presented in Table 17 to provide a comparison of the elements of the plan to the alternatives analyzed. The pHOS of 9% is for the stepping-stone hatchery strays. The integrated program is evaluated based on the PNI criteria. PNI is just under the 0.67 criteria (PNI should be greater than 0.67) recommended by the HSRG. Under the plan the Nisqually sport catch is less because 525,000 of the 4.0 million hatchery release do not have an adipose fin (CWT only).

1551 **Table 17. Summary of alternatives evaluated for Nisqually Fall Chinook. Each alternative was evaluated using the ISIT application. See text**
1552 **for additional explanation for each alternative.**

	Operations			Run size to Nisqually		Terminal Harvest Expectations		Conservation Expectations		
Alternative	Harvest	Hatchery	Weir	Natural-origin	Hatchery-origin	Net	Sport	pHOS	PNI	Natural Escape
1	Status quo (~70% terminal HR)	Status quo (4.0 million)	None	2,500	20,000	15,750	968	45%	NA	1,494
2	Status quo (~70% terminal HR)	Status quo (4.0 million)	95%	2,500	20,000	15,750	968	19%	NA	934
3	Reduced treaty net harvest (25%)	Status quo (4.0 million)	95%	2,500	20,000	5,625	968	21%	NA	2,406
4	Reduced treaty net harvest (25%)	Reduced hatchery (1.5 million)	95%	2,500	7,500	2,500	371	9%	NA	2,038
5	Selective treaty net (25% NOR; 70% HOR)	Status quo (4.0 million)	None	2,500	20,000	14,175	968	26%	NA	2,687
6	Selective treaty net (25% NOR; 70% HOR)	Status quo (4.0 million)	95%	2,500	20,000	14,175	968	11%	NA	2,098
NCSMP	Selective treaty net (25% NOR; 70% HOR)	Integrate (0.6 million) & Step (3.4 million)	95%	2,500	20,000	12,465	797	9%	0.64	2,064

5.5. 2010 NCSMP Action Plan

The 2010 NCSMP Action Plan includes a modified terminal net fishery, and development of new analytical tools to improve future pre-season and in-season run size estimates. These activities are described below. A complete list of activities, information summaries, responsible parties, and projected completion dates are provided in the 2010 NCSMP Action Plan (Appendix A).

Harvest Management

The 2010 terminal net harvest schedule has been revised from previous years to reduce the harvest rate of natural-origin Nisqually fall Chinook. The objective is a 40% harvest rate in the Nisqually treaty net fishery. Measures to differentially harvest hatchery-origin adults at a higher rate will not be implemented in 2010.

Implementation of the NCSMP will focus on the following goals:

- Develop analytical tools for pre-season and in-season run size estimates.
- Estimate hatchery and natural composition in tribal (Nisqually) and sport (WDFW) fisheries, weekly and annually.
- Develop methods to maintain high harvest rates of hatchery fish while keeping mortality of natural fish at allowable rates.
- Determine the success of 2010 reduced fishing schedule in meeting the preseason exploitation (40% term).
- Develop a data management and reporting plan.
- Update and refine operations budget and staffing.

Hatchery Management

Hatchery operations in 2010 are unchanged from previous years. Additional measures at the hatchery are being developed to dispose of the larger-than-average surplus of hatchery adults expected in 2010 because of the lower terminal net harvest rate. The NCSMP focus in 2010 will be to develop plans and test equipment and procedures to transition the Kalama Creek program to an integrated program with NCSMP objectives for 2010 are the following:

- The Clear Creek program will collect approximately 2,300 adults for brood stock from hatchery-origin adults returning to the Clear Creek hatchery. No natural-origin fish will be collected (pNOB = 0%).
- The 2010 planned smolt release from Clear Creek is 3.4 million Chinook. The entire release will be marked with adipose fin clips, except for 200,000 that will have a CWT and no adipose fin clip and another 200,000 with a CWT/adipose fin clip for the double-index tagging program. The target adipose clip rate target is - 97-98% at release.

- The Kalama Creek program will collect approximately 420 adults for brood stock from hatchery-origin adults returning to the Kalama Creek hatchery. No natural-origin fish will be collected (pNOB = 0%).
- The 2010 planned smolt release from Kalama Creek is 600,000 Chinook. The entire release will be marked with adipose fin clips. A portion of the release (100,000) will also have a CWT for survival and harvest rate studies.
- The number and stock composition of brood stock will be recorded, as well as the number of hatchery surplus fish, the number of smolts released, and the results of fish marking programs.

Other hatchery activities include preparing for the transition to an integrated program at Kalama Creek, planned to occur in 2011:

- Develop an operations plan for integrated and stepping-stone programs.
- Develop a plan for natural-origin brood stock objective (weir permit states 105 adults for 600,000 release program) and update hatchery and genetic management plan (HGMP) accordingly.
- Develop a brood stock management plan and spawning protocols for adult returns of the integrated program
- Develop rearing and release objectives for integrated and stepping-stone programs.
- Evaluate a long-term plan to release entire Chinook production (4 million) at Clear Creek.
- Update and refine operating budget and staffing.

Weir Operations

The plan is to install and have operating the adult weir at RM 12.3 by late July of 2010. Specific operation activities defined to meet the NCSMP objectives for 2010 are as follows:

- Test systems, operate at various seasonal flows, develop operating procedures, and train staff in operations and safety for staff and fish**.**
- Release all species (marked and unmarked), except hatchery steelhead (remove) to upstream of weir; there is no objective to manage for composition or abundance.
- Enumerate escapement (all species) to weir and hatchery/natural composition.
- Estimate daily and weekly run timing at weir relative to timing in fisheries for all species, including pink salmon.
- Develop sampling plan and collect biological data.
- Estimate weir efficiency for Chinook only.
- Estimate weir-induced mortality for all species

- Estimate incidence of natural spawning escapement downstream of weir, weir delay, and trap rejection.

Several activities not related to weir operations were identified for 2010 to improve the future success of the NCSMP:

- Develop an operating manual for future use.
- Develop an operating plan to collect brood stock at the weir to initiate an integrated stepping-stone hatchery program.
- Develop a data management plan.
- Update and refine operating budget and staffing.

Habitat Work Plan

The habitat work plan for 2010 will focus on the following objectives (see Habitat 3 year workplan for more detail):

- Complete Mashel River Restoration Phase IIB.
- Activate a new channel at Ohop Creek.
- Continue riparian planting program and control of knotweed.
- Continue salmon carcass placement for nutrient enhancement.
- Acquire key properties for protection and restoration.
- Track progress and support reduction of impervious surface and improve stormwater management in key areas of the Nisqually watershed.
- Communicate the importance and value of habitat protection and restoration in the Nisqually watershed and marine areas.
- Continue development of the lower Nisqually mainstem restoration plan.
- Finalize plan for Red Salmon Slough Phase III restoration for summer 2011 (river dike removal).
- Continue riparian plantings in estuary.
- Develop restoration plan for Nisqually nearshore marine areas.
- Develop habitat data management plan.
- Formalize process for collecting and archiving information about unplanned events.
- Update Ecosystem Diagnosis and Treatment (EDT) model inputs.
- Evaluate and update status of elements in 3-Year Update.

- Update and refine operating budget and staffing.

Monitoring and Evaluation

M&E in 2010 will continue on-going projects such as juvenile assessments in the estuary, juvenile out-migration trapping at RM 13 of the Nisqually River, and spawning escapement estimation. Additional activities planned for 2010 specific to the NCSMP are to challenge key assumptions of the plan such as measuring weir efficiency, assessing the incidence of natural spawning downstream of the weir by hatchery- and natural-origin adults, and helping assess weir-induced mortality.

Policy Coordination

Policy coordination activities for 2010 that affect implementation of the NCSMP with respect to monitoring and evaluation include:

- Coordinate objectives and activities between the Nisqually Tribe and WDFW
- Communicate objectives and activities with other interested parties.
- Ensure activities are consistent with the ESA permitting requirements.
- Ensure that agreements with permitting agencies are consistent with NCSMP for construction and operation objectives.

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