

## 5. MANAGEMENT STRATEGIES AND ACTIONS

### 5.1. Habitat

#### 5.1.1. Recovery Objectives

- Protect and restore freshwater, estuarine, and nearshore marine habitat, including water quantity and water quality conditions, in WRIA 1 sufficient to meet recovery goals for WRIA 1 salmonid populations, prioritizing as follows:
  1. South Fork Nooksack early chinook and North Fork/Middle Fork Nooksack early chinook.
  2. WRIA 1 bull trout
  3. WRIA 1 wild late-timed chinook
  4. WRIA 1 wild-spawning coho salmon
  5. Other WRIA 1 salmonid populations
- Identify and prioritize the sequencing and location of habitat protection and restoration efforts using the *WRIA 1 Salmonid Habitat Restoration Strategy*.
- Protect and restore the natural watershed processes that form and maintain the habitat to which WRIA 1 salmonid stocks are adapted.
- Maintain or increase the quality and quantity of habitat necessary to sustain healthy, self-sustaining runs of other WRIA 1 salmonids to provide for harvest, as well as cultural and social values.
- Retain or provide adequate quantity and quality of water in streams for salmonids.
- Restore access to isolated habitat.

#### 5.1.2. Other Objectives

- Ensure programs and actions are consistent with Endangered Species Act and Clean Water Act requirements.
- Maintain viable forestry, agricultural, and other industries and provide long-term regulatory certainty.
- Ensure that citizens and stakeholders are actively engaged in salmon conservation efforts.
- Uphold existing federal, state, tribal, and local laws and implementation authorities.

#### 5.1.3. Coordination with Watershed Management Plan

The WRIA 1 Watershed Management Project was established in response to the Watershed Management Act, passed in 1998 as Engrossed Substitute House Bill 2514 (ESHB 2514) and codified into state law as RCW 90.82. The Watershed Management Act requires that water quantity issues be addressed, and gives local governments the option of addressing three other issue areas – water quality, fish habitat, and instream flows. The Watershed Management Project will prepare a Watershed Management Plan (WMP) that addresses all four issue areas.

To date, the Watershed Management Project has entailed detailed assessment of surface water and groundwater quantity and quality, as well as actual and projected human water uses and instream flow needs for salmonids. Due to be adopted by 2005, the WMP will suggest strategies for increasing water supplies in the management area, including water conservation, water reuse, voluntary water transfers of existing water rights and claims, aquifer recharge and recovery, additional new water allocations, and new or enhanced water storage. These strategies should provide for both instream flows for fish, and for future out-of-stream uses of water such as agriculture, energy production, and population and economic growth.

The WRIA 1 Salmonid Recovery Plan will:

- **Defer** to the Watershed Management Plan for implementing management strategies and action items related to **low instream flows**.
- **Coordinate** with the Watershed Plan for implementing management strategies and action items related to **water quality**.
- Be the **primary mechanism** for implementing management strategies and action items related to salmonid habitat and high flows.
- Be the **primary mechanism** for integration, monitoring and adaptive management for actions affecting salmon recovery.

#### **5.1.4. Guiding Principles for Habitat Restoration and Protection <sup>11</sup>**

- Recovery of salmonid habitats will require *both* protection of baseline conditions *and* substantial active restoration of lost and damaged habitat.
- Success of salmonid recovery efforts depends on our ability to protect and restore the natural watershed processes that form and maintain the habitat to which WRIA 1 salmonid stocks are adapted.
- Particular emphasis should be placed on protecting areas where salmon populations are healthy and where existing habitat conditions are considered good to excellent. Protecting and preventing degradation of habitats is far more reliable and less expensive than restoration.
- Voluntary and incentive-based projects and programs should be used to the greatest extent possible, but strong regulatory standards and protections will be necessary to protect the baseline. Continual restoration of unmitigated impacts to wild salmonid habitat is undesirable, ineffective, and costly.
- Restoration of habitat-forming processes and reconnecting isolated and/or fragmented high quality habitat should be emphasized in habitat restoration. For stocks and species at critically low abundances (i.e. North Fork/Middle Fork and South Fork early chinook), interim measures (e.g. large wood placement) will also be necessary that can provide more immediate benefit than restoration of processes.

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<sup>11</sup> Additional ecological principles guiding habitat restoration and protection projects are presented in the *WRIA 1 Salmonid Habitat Restoration Strategy*.

- Habitat restoration on private lands will be more readily accepted and implemented if the cost of restoration includes some level of public financing, if restoration provides flexibility to the landowner, and if restoration addresses, at least in part, relief from regulatory processes.
- Investment and use of government resources should be coordinated and used in a cost effective and efficient manner.
- Land use management and habitat restoration and protection should be based on the most current scientific information.
- The effects of individual and cumulative actions should be comprehensively monitored and appropriate corrective measures taken as necessary to achieve the recovery goals.

#### **5.1.5. Habitat Targets**

Habitat targets for WRIA 1 salmonid habitats are presented in Table 5.1. Habitat targets were derived from a combination of the “Properly Functioning Conditions, or “PFC” matrix (NMFS 1996) as interpreted for EDT by Blair (2001), USFWS guidance for what constitutes conditions that are “functioning appropriately” for bull trout (USFWS 1998), standards adopted by the Washington Conservation Commission for what constitutes “good” salmonid habitat conditions (Smith 2002). All of the above were generally developed based upon the principle of “properly functioning conditions”, defined by NOAA (NMFS 1999) as:

*the sustained presence of natural habitat-forming processes in a watershed (e.g. riparian community succession, bedload transport, precipitation runoff pattern, channel migration) that are necessary for the long-term survival of the species through the full range of environmental variation.*

Along with information on the current condition of habitat attributes within specific stream reaches, these targets are intended to indicate which and to what degree habitat attributes are degraded. Habitat targets should be used as guidance on the direction and magnitude of habitat change needed. The ultimate objective is to protect and restore the natural range and variability of habitats required to sustain and recovery salmonid populations, rather than as static conditions to be managed for.

#### **5.1.6. Early Chinook Strategy**

##### **5.1.6.1. Conceptual Approach**

- Since abundance and productivity are important to buffer against extinction in the short term, the strategy for Nooksack early chinook recovery prioritizes actions that will address the habitat attributes and stream reaches that are most limiting abundance and productivity.
- Over the longer term, recovery of Nooksack early chinook will require implementation of actions that improve the populations’ spatial structure and diversity, thus contributing to their ability to persist through environmental fluctuations over the long term (McElhany et al. 2000).

- The strategy for chinook recovery should be based on a life-cycle approach to restoration, which recognizes the need to provide sufficient habitat quantity and quality for a population to successfully complete each life stage, including holding, spawning, incubation, post-emergence/ summer/ overwinter freshwater rearing, estuarine and nearshore marine rearing, and migration. The life-cycle approach will generally require a diverse array of spatially distributed habitats, as well as preservation of the life history types to use those habitats.

#### ***5.1.6.2. Prioritization and Sequencing***

Potential habitat restoration projects will be prioritized for salmon recovery funding using the *WRIA 01 Salmonid Habitat Restoration Strategy*. The version used in the Salmon Recovery Funding Board 5<sup>th</sup> Round grant cycle (2004) is presented in Appendix E. Projects were prioritized based on the following general criteria:

- Salmonid population priorities
- Magnitude of benefit
  - Project location relative to geographic priority areas
  - Importance of Limiting Factor that project is designed to address
  - Magnitude of effect project will have on limiting factor
  - Lifespan of benefit
  - Timing of benefit (i.e. how soon the benefits will begin to accrue)
- Certainty of Success
  - Readiness to proceed
  - Extent to which project addresses habitat-forming processes
  - Likelihood of meeting objectives (i.e. level of design, expertise of project participants, use of proven methods).
- Cost-effectiveness

The *Strategy* will be updated later this year to reflect the priorities and recommendations presented in this *Plan*. Sequencing of projects will follow the “critical pathways” methodology to ensure projects function in relation to each other and address root causes of degradation.

#### ***5.1.6.3. Whatcom County/WRIA-wide Actions***

##### ***5.1.6.3.1. Existing Actions***

###### ***Forest and Fish Rules***

In 1999, after two years of preparation and negotiation, five stakeholder groups, including the Department of Ecology (Ecology) and EPA, produced a plan for protection of water quality and fish habitat covering eight million acres of non-federal forestland in Washington State. The Plan, the *Forests & Fish Report (FFR)*, represents a significant improvement to the state’s forest practices rules. The state Forest Practices Board promulgated emergency rules consistent with the FFR recommendations in January 2000 and passed permanent forest practices rules in May 2001.

Overall performance goals of forest practice rules are:

1. Support harvestable levels of salmonids;
2. Support the long-term viability of covered species; or
3. Meet or exceed water quality standards (protection of designated uses, narrative and numeric criteria, and anti-degradation).

To achieve these performance goals, the Forest and Fish Report (FFR) set functional objectives for various resource issues such as water temperature, LWD loading, sediment, etc (Table 5.2). The functional objectives are achieved through the implementation of the forest practice rules. Salient details of the rules are below:

- **Riparian Buffers:** Riparian management zones on both sides of fish-habitat streams are managed to provide near-maximum shade at levels that approach or exceed the amounts provided by mature conditions. West of the Cascade crest (Westside), fish-habitat streams are protected with buffers that extend up to a site-potential tree height from the outer edge of the stream or channel migration zone. This distance is 90 to 200 feet, depending on the productivity of the land near the stream. Timber management within buffers is progressively more restrictive in the zones closer to the stream with a no-harvest zone of 50' and a shade requirement to leave all available shade using the approved shade model out to 75'.
- **Road Maintenance:** FFR-based forest practices rules require that all existing forest roads must be improved and maintained to provide fish passage to fish in all life stages, prevent landslides, limit delivery of sediment and surface runoff water to streams and avoid capture or redirection of surface or ground water. To accomplish these goals, industrial landowners are required to bring all of their forest roads into an approved road maintenance plan within five years and complete improvements within fifteen years. Small landowners are also required to complete road maintenance plan checklists and to maintain roads to avoid damage to public resources. Improvements on small landowner roads are required at the time of harvest to ensure that costs associated with road improvements can be offset by revenues from the harvests. The DNR is responsible for tracking landowner compliance with road maintenance planning requirements. Landowners must also complete road repairs on a "worst first" basis (i.e. where roads create fish passage barriers, fish passage improvements are completed on streams that open the most habitat first). Standards, priorities and implementation guidelines are established in the rule. The FFR-based forest practices rules also include new road construction standards to meet water quality goals and, specifically, to reduce sediment inputs to the stream.
- **Unstable Slopes:** In addition to the forest practices rules for road maintenance and management practices outlined above, protections for unstable slopes and wetlands will help ensure that hydrologic regimes for surface and groundwater are maintained. The forest practices rules require considerable improvements to permitting processes with the goal of preventing forest practices from causing an

increased rate of landslide-related sediment delivery. Improved topographic and geologic mapping will provide landowners and the Department of Natural Resources (DNR) with more accurate tools to predict where landslides may occur. Detailed standards are being established to field-identify the most hazardous areas. Local slope stability issues are being identified through regional efforts. Resource professionals representing agencies, tribes, and landowners are being trained to recognize potentially unstable slopes and geologists are mapping hazard areas and assisting resource professionals in assessing slope stability issues on the ground.

*DNR HCP (DNR 1997b)*

The DNR HCP is a 70-year multi-species Habitat Conservation Plan (HCP) to address state trust land management issues relating to compliance with the Endangered Species Act. The plan covers about 1.6 million acres of forested state trust lands, mostly in western Washington. The HCP provides mitigation for incidental take permits for the northern spotted owl and the marbled murrelet, but also conserves habitat for several runs of salmonids that were not listed at the time of Plan adoption (November 1996). Protections relevant to salmonids are presented below.

- **Riparian Protection:** Riparian protections consist of an inner riparian buffer to protect salmonid habitat and an outer wind buffer to protect the riparian buffer.
  - *Riparian buffers* Riparian buffers along types 1, 2, and 3 waters are equal to one site-potential-tree-height in a mature conifer stand or 100 feet, whichever is greater. Riparian buffers along type 4 waters are 100 feet. Buffers apply to both sides of stream and are measured from the outer margin of the 100-year floodplain. Buffer widths average about 150 feet for types 1 and 2 and 100 feet for types 3 and 4 waters. Activities within the buffer are restricted thus: (1) no timber harvest is allowed for the first 25 feet from the stream; (2) for the next 75 feet, minimal harvest is allowed provided there is no reduction in stream shading or the ability of the buffer to intercept sediment or contribute nutrients or wood; such harvest is likely to include only selective removal of single trees; (3) in the remaining buffer, low levels of harvest are allowed, e.g. selective removal of single trees, selective removal of groups of trees, thinning operations and salvage operations.
  - *Wind buffers:* Wind buffers are applied to types 1, 2, and 3 waters in areas that are prone to windthrow. For types 1 and 2 waters, wind buffers are 100-foot along the windward side; for type 3 waters wider than 5 feet and with at least moderate potential for windthrow, buffers are 50 feet.
- **Unstable Slopes Protection.** Unstable slopes are identified through field reconnaissance or identified with slope geomorphology models and verified through field reconnaissance. Activities on unstable slopes are avoided that would increase the severity or frequency of slope failure or severely alter the natural input of wood, sediment and nutrients to the stream network.

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- **Road Network Management:** On a Watershed Administrative Unit (WAU) basis, DNR shall minimize adverse impacts to salmonid habitat caused by the road network by developing and instituting a comprehensive landscape-based road network management process. Major components of the process include:
  - Minimization of active road density
  - Site-specific assessment and, where practicable and consistent with conservation objectives, implementation of alternatives to new road construction
  - Baseline inventory of all roads and stream crossings
  - Prioritization of roads for decommissioning, upgrading, and maintenance
  - Identification of fish blockages caused by stream crossings and a prioritization of their retrofitting or removal.
- **Hydrologic Maturity in Rain-on-Snow (ROS) zone:** Two-thirds of DNR-managed forest lands in drainage basins (>1000 acre in size) in the significant ROS zone shall be maintained in forest that is hydrologically mature. Hydrologic maturity is defined on the west side of Cascades as a well-stocked conifer stand at age 25 or older. Exceptions are allowed where:
  - Less than 1/3 of drainage basin area is in significant ROS zone
  - At least 2/3 of the drainage basin area in the significant ROS zone is covered by hydrologically mature forest and there is reasonable assurance it will remain in that condition (e.g. National Park or National Forest Late Successional Reserve)
  - Less than 1/2 of the drainage basin area in the significant ROS zone is under DNR management and there is no reasonable assurance that other landowners will contribute hydrologically mature forests; in such cases, an interdisciplinary team of scientists will be convened to develop a prescription for DNR-managed land within the basin.
- **Wetlands:** Wetlands protection consists of buffers on wetlands at least 0.25 acres in size. For wetlands up to 1 acre in size, 100-foot buffers are applied. For wetlands larger than 1 acre, the buffer is equal to 1 site-potential-tree height in a mature conifer stand or 100 feet, whichever is greater. Within wetlands and wetland buffers, no road building is allowed without mitigation and other forestry operations are to be implemented in accordance with DNR's policy of no overall net loss of wetland function.

Concerns with the DNR HCP include:

- Riparian restoration strategy allows for too much thinning in Riparian Management Zones.
- Water typing of perennial non-fish-bearing streams were changed to the current FFR standards without going through the HCP revision process.

### *Northwest Forest Plan*

Federal lands in the Nooksack River watershed are managed under the Northwest Forest Plan, which allocates land among seven categories. Timber harvesting is limited to thinning and salvage for all categories, except for the matrix. The matrix area is reserved for intensive timber management. Federal lands in the Nooksack River watershed are designated Late Successional Reserve (79,625 acres or 51% of area), Congressionally Reserved Areas (61,427 acres, or 39% of area), Administratively Withdrawn Areas (8,681 acres, or 5.5% of area), and Matrix (7,685 acres, or 4.9% of area); these numbers exclude Riparian Reserves.

- **Congressionally Reserved Areas** – Lands that have been reserved by an act of Congress. These include National Parks and Monuments, Wilderness Areas, Wild and Scenic River corridors, National Wildlife Refuges, Department of Defense lands, and other lands with congressional designations.
- **Late Successional Reserves** – Reserves that will maintain a functional, interactive, late-successional and old-growth forest ecosystem. They are designed to serve as habitat for late-seral and old-growth dependent species including the northern spotted owl.
- **Adaptive Management Areas** – These areas are designed to develop and test state-of-the-art management approaches that integrate and achieve ecological, economic, and social objectives. The federal agencies will use a multi-stakeholder approach to accomplish these objectives. There are 10 Adaptive Management Areas, each with a different emphasis for its prescriptions. Management approaches include maximizing late-seral characteristics, improving riparian conditions through silvicultural treatments, and maintaining a predictable flow of harvestable timber.
- **Managed Late Successional Areas** – Lands are either mapped managed pair areas or unmapped protection buffers. Managed pair areas are delineated for known northern spotted owl activity centers. Protection buffers are designed to protect certain rare and locally endemic species.
- **Administratively Withdrawn Areas** – Includes recreational, visual areas, back country, and other areas not scheduled for timber harvest.
- **Riparian Reserves** – Riparian reserves are areas along streams, wetlands, ponds, lakes, and unstable or potentially unstable areas where the conservation of aquatic and riparian-dependent terrestrial resources is important. These reserves protect aquatic habitat and its dependent species, and provides greater connectivity to late-successional forest habitat.
- **Matrix** – Matrix is the federal land outside the six categories listed above. It is the area in which most timber harvest and silvicultural activity takes place.

#### **5.1.6.3.2. 10-year Actions**

Cities and counties required to plan under the State of Washington Growth Management Act are also required to update both Critical Areas Ordinances (CAO) and

Shoreline Master Programs (SMP) every seven years. Some communities, such as Lynden, completed a CAO update in 2004. Whatcom County and City of Bellingham updates to both the CAO and SMP are slated for completion by the end of 2005. The intent of WRIA 1 local governments is to strive for consistency between each jurisdiction during future updates to meet the needs of both salmon recovery and the individual communities

#### *Whatcom County Critical Areas Ordinance*

Specific to Whatcom County CAO updates, new Growth Management Act guidelines required that Whatcom County make specific changes to the previous version of the CAO including:

- The County must use “best available science” in developing policies and regulations to protect the functions and values of Critical Areas (RCW 36.70A.172(1))
- “Special consideration” must be give to conservation or protection measures necessary to preserve or enhance anadromous fisheries (RCW 36.70A.172(1)).
- The County must record all sources considered in the development of policies and regulations and explain any deviation from best available science.
- The County must ensure “no net loss” of ecological function.

The County had previously contracted an ESA evaluation report for County programs and regulations (URS Corporation 2001) to identify areas where improvements were necessary. The City of Bellingham, under contract with Whatcom County, completed a similar evaluation for their programs and for those at the small cities. Some important changes and additions to the County CAO are proposed based on the study outcomes and the new GMA guidelines. A public review draft of the updated CAO was released on February 8, 2005, and the public comment period ended on March 4, 2005. A brief overview of the proposed County CAO changes is provided below. A description of the update process, full copies of revised ordinances, and supporting materials can be found at: [http://www.co.whatcom.wa.us/pds/shorelines\\_critical\\_areas/index.jsp](http://www.co.whatcom.wa.us/pds/shorelines_critical_areas/index.jsp)

- **Administration.** A suite of administrative changes is being made to improve the efficiency and accountability of the permitting process. Changes include:
  - More detailed standards for permit applicants, county staff and consultants to improve consistency and predictability,
  - Technical analyses will provide greater detail to ensure sound decision-making and predictability of outcomes.
  - Special provisions are provided for agriculture (Conservation Program for Agricultural Lands). Farm plan requirements have been updated based on new information from Natural Resource Conservation Service and other applicable resources.
  - Reasonable use exceptions are a key element for landowners, but will be subject to a more effective process and criteria for review.

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- Integration, as part of an integration strategy, with other regulations will be ensured and will produce a reduction in conflicts between regulations and an assurance that all applicants will meet the same standards.
- Recognition of watershed processes and a clear emphasis on impact avoidance will be employed as first steps in protection critical areas.
- Mitigation banking is offered as a means to provide flexibility to property owners to compensate for critical areas impacts within mitigations banks in Whatcom County. WRIA 1 salmonid recovery priorities and needs will be considered as mitigation banks are instituted.
- **Wetlands.** Wetlands categories are assigned based on the Western Washington Wetland Rating System. This system rates wetlands from Category I (exceptional resource value) to Category IV (limited resource value). The range of standard buffer size is based on the wetland category (Category I wetlands have the largest buffers), the habitat function score (high quality habitat is protected with a larger buffer), and the adjacent land-use intensity (high intensity land-use requires a larger buffer). The final buffer size will be determined by the Critical Areas administrator based on the site conditions and the outcome of an evaluation of the above factors (category, function, adjacent land-use). The range of standard buffers for each wetland category is:
  - Category I: 50 – 300 feet
  - Category II: 50 – 275 feet
  - Category III: 50 – 150 feet
  - Category IV: 25 - 50 feet
- **Fish and Wildlife Habitat Conservation Areas.** A number of improvements and changes have been made to the Fish and Wildlife Habitat Conservation Areas section of the CAO. Endangered Species Act listed, priority, and locally important species are distinguished and anadromous fish are given special consideration. Refinements have been made in how development is regulated in and adjacent to streams and other related habitats such as wetlands in continuity with a river or stream. Other changes include new standards for culverts, storm water facilities, and stream bank and shoreline protection. Finally, beaches and the Chuckanut Corridor (wildlife) are designated as locally important habitats. This designation will be important to protecting and reinforcing to the public the importance and interconnection of freshwater and marine components of the ecosystem. Stream and marine shoreline buffers are described under the Fish and Wildlife Habitat Conservation Areas section.. The buffers are:
  - Streams
    - Shorelines of the State (mean annual flow greater than 20 cfs) – 150 feet
    - Other fish bearing streams (current, presumed, historic use) - 100 feet
    - Non-fish bearing streams – 50 feet
  - Marine Shorelines – 150 feet

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- Other habitats – to be evaluated on a case-by-case basis usually based on State Department of Fish and Wildlife recommendations.
- **Frequently Flooded Areas.** Improvements to the Frequently Flooded Areas section includes better protection of floodplain ecology and management of flood hazards in a manner beneficial to the floodplain functions. Mitigation for floodplain impacts can be required where the impact is unavoidable and is consistent with health and safety standards. Finally, the roles and responsibilities between County departments are clarified to ensure consistency in project evaluation and permitting.
- **Geologically Hazardous Areas.** A number of improvements and changes to the Geologically Hazardous Areas section have been made. The primary driver for these changes is the protection of human life and safety. Yet benefits to protecting human lives are often consistent with and provide a compelling reason to plan for the outcomes of the myriad natural processes that also form and maintain salmon habitats. Further restriction of development on alluvial fans is provided. Many if not all tributaries to the Nooksack forks cross alluvial fans before entering the Nooksack. While attractive for home site development by those unaware of the danger to life and limb, these areas most often provide crucial spawning and rearing habitats. Development is also regulated within 300 feet of potential landslide areas and no new structures are allowed in channel migration zones where maps have been adopted. Riparian buffers begin at the edge of the channel migration zone where those have been mapped and adopted. Critical facilities (such as fire stations, schools, or hospitals) are prohibited in all hazard areas including tsunami, volcanic, and seiche hazards areas. An evaluation of tsunami and volcanic hazards affords the regulator the opportunity to consider not only the human safety perspective, but also the larger ecological context. This has the benefit of providing a compelling reason the public understands to stay back from a given hazard areas, such as a shoreline bluff, while also providing a stronger basis for improved habitat protection.

Salmon in general and chinook salmon and bull trout, in particular, will be clearly be better protected once the updates are completed and fully implemented. However, the CAO and SMP are just two tools in the regulatory toolbox and are designed to produce a “no net loss” of ecological function. They are not primary restoration tools. The intent is to ensure that they contribute appropriately to the protection of existing habitat functions and that this will assist in recovery when implemented against a backdrop of other local regulations (such as clearing and grading permits, flood permits) and state and federal regulatory requirements such as the Washington State Hydraulics Code, Forest Practice Applications, or Army Corps of Engineers permits and a whole suite of voluntary actions.

#### *Whatcom County Shoreline Master Program Updates*

Whatcom County is scheduled to update its Shoreline Management Program by December 1, 2005. The SMP will be updated consistent with the Department of Ecology's *Shoreline Master Program Guidelines*. A Technical Advisory Committee convened for the CAO and SMP updates will provide input and review of work products during the update process; members include technical staff from Whatcom County, Lummi Nation, Nooksack Tribe, Washington Department of Fish and Wildlife, Washington Department of Ecology, Washington Department of Natural Resources, Port of Bellingham, City of Everson, Whatcom Conservation District, and Puget Sound Action Team. The update process will entail: (1) coordination with partner jurisdictions, agencies, and districts to integrate parallel projects and planning processes; (2) providing opportunities for public involvement, such as: open houses, workshops, stakeholder meetings, Citizen Advisory Committee meetings, work sessions, and public hearings; (3) inventory and characterization of the shoreline landscape by maximizing use of available information and resources; (4) integration of shoreline policies and regulations with parallel planning efforts and development regulations; (5) identification and documentation of ecological functions and values of shorelines; (6) coordination of shoreline restoration planning with current restoration programs and efforts; (7) evaluation and update of existing shoreline designations; (8) evaluation and update of policies and development standards; and (9) cumulative impact analysis of potential effects to shoreline ecological functions based on future growth projections and predicted development demands.

#### **5.1.6.4. Lower North Fork**

The proposed actions for the lower North Fork include:

- Riparian planting of the channel migration area for wood recruitment
- Riparian planting for shading benefits
- Construction of stable in-stream wood structures
- Protection of existing in-stream wood
- Monitoring of forest practice activities
- Relocation of stream-adjacent roads and infrastructure

#### **5.1.6.4.1. 10-year Actions**

##### *Riparian planting of the channel migration area for wood recruitment*

Riparian planting throughout the channel migration area of the North Fork and its tributaries will encourage long-term recovery of wood recruitment to the channel. Priorities for planting should be given to areas where the wood recruitment function is currently classified as "low" (Duck Creek, Assoc. 2001), is located where the channel can access the wood through channel erosion, but lies in a protected enough location that the trees can grow to a substantial size.

*Riparian planting for shading benefits*

Riparian planting in the Lower North Fork is expected to highly improve both the maximum monthly and spatial variation of the water temperature in the river. It is expected that upstream shading will have modest downstream benefits to stream temperature, as the water warms more slowly as it loses elevation.

*Construction of stable in-stream wood structures*

Restoration opportunities also exist to construct stable accumulations of wood in confined, low gradient reaches of the North Fork Nooksack. These reaches should be prioritized because wood is more likely to persist in the lower energy sections of the river. Further, these are the reaches with the greatest potential for habitat diversity as the channel migrates across the floodplain, creating secondary channels and potentially floodplain islands. There may be restoration opportunities in the channel to address the legacy effects of channel instability by constructing stable habitat features in the low gradient, unconfined reaches of the North Fork Nooksack. Since the channel actively migrates across the channel migration area, projects will need to treat the entire width of the channel migration area to ensure habitat stability into the future. In-stream restoration projects that focus on stabilizing bars and narrowing the active channel area in unconfined reaches will address channel widening in response to elevated sediment load.

**5.1.6.4.2. Long-Term Actions**

*Protection of existing in-stream wood*

Regulatory protection of wood in the channel exists and will need to be enforced to reduce the loss of wood from the channel. In some reaches of the lower North Fork wood cutting on the gravel bars reduces the function of wood, either by direct removal, or by reducing the size and therefore the potential stability of wood moving through the system.

*Monitoring of forest practice activities*

Extensive storm proofing and abandonment of forest roads has been conducted in the Lower North Fork and its tributaries and continues to be monitored for effectiveness by Lummi Natural Resources and Nooksack Indian Tribe staff. There is the need to continue this monitoring into the future. Forest and Fish regulations will likely have a positive effect on reducing the impacts of forest practices in the Lower North Fork and will need to be monitored for long-term effectiveness. Opportunities for restoration may exist as roads are identified for abandonment and storm-proofing. In places, it may be possible to directly treat slope failures as they are identified. Long-term monitoring of Forest and Fish will work to reduce forest practices impacts on in-stream habitat.

*Relocation of stream-adjacent roads and infrastructure*

Opportunities to relocate stream adjacent roads and infrastructure outside of the channel migration area exist and need to be evaluated. In addition to the loss of wood recruitment, stream adjacent roads have a direct impact on the loss of habitat diversity due to bank protection, which often accompanies roads and infrastructure within the channel migration zone. Roads should be prioritized for relocation by whether it represents critical infrastructure (i.e. is the only access), or secondary and by how strongly it confines the channel migration area of the river. The Mount Baker Highway (RM 44 to 45, RM 50.25-52 and RM 53.5-56) and Truck Road infringe on the channel migration area of the North Fork Nooksack River. The bridges at RM 55 on the Mount Baker Highway and RM 36.8 on State Route 9 should also be replaced with wider spans.

*Monitor Shorelines and Critical Areas Ordinance*

The Whatcom County Shorelines regulations and Critical Areas Ordinance will likely have a positive effect on reducing the impacts of floodplain development in the lower North Fork and will need to be monitored for long-term effectiveness. Critical areas will include channel migration zone and riparian protection, which are critical to the recovery of habitat-forming processes in the river.

**5.1.6.5. Upper North Fork**

The proposed actions for the upper North Fork include:

- Large-scale LWD placement
- Riparian restoration to improve wood delivery to the channel
- Riparian restoration to improve channel shading
- Set back infrastructure from the channel

**5.1.6.5.1. 10-year Actions**

*Large-scale LWD placement*

The primary objective of wood placement in the upper North Fork is to slow wood transport through the river and trap the mobile debris on stable wood structures in unconfined reaches. Much of the unconfined area of the upper North Fork has already been treated by the U.S. Forest Service and currently being monitored for effectiveness. It is expected that the wood accumulations will help stabilize bars in the channel and slow the process of channel migration and avulsion. In reaches where channel incision has degraded habitat, the increased flow resistance of the wood in the channel is expected to slow the incision and improve floodplain connectivity. It is expected that several of these projects could be implemented to provide a variety of habitat values to the channel. Over a longer timeframe as the logjams grow and stabilize, this project is designed to directly address habitat diversity and key habitat quantity for adult holding and spawning in the upper North Fork. Large-scale wood placement in sections of the upper North Fork Nooksack is expected to fully restore wood function in the channel. This will have a high impact on the formation of pools, pool tail-outs and backwater pools. The structures would also be expected to have a minor impact on off channel

habitat and a negligible impact on the formation of beaver ponds. The creation of more pools with complex cover will have a high impact on benthic community richness, a moderate impact on harassment of fish, as well as a minor impact on the retention of salmon carcasses. Spatial variation of temperature is expected to see an improvement from better interaction of pools with groundwater. During high flow, the project would be expected to moderately increase channel width, with a negligible impact on minimum width. The impact of the project on high flow, low flow and intra-annual flow variability would be a negligible benefit.

*Riparian restoration to improve wood delivery to the channel*

By restoring and protecting riparian areas adjacent to the river, this project seeks to reduce bed scour, sediment impacts, and provide more diverse habitat over the long term. By proper management of timberlands, the channel is expected to see moderate decreases in bed scour, embeddedness and fine sediment, as well as a high impact on turbidity. The improvements in pools, backwaters pools, pool tail-outs and beaver ponds are expected to be high with a better functioning riparian ecosystem. A functioning riparian ecosystem is also expected to increasing the minimum (moderate impact) and maximum (high impact) channel width. The riparian functions and woody debris levels of the channel would both have an extreme benefit from the project. It is expected that improving the interface between the terrestrial and aquatic environments would have a moderate impact on salmon carcass retention. Wood delivered to the channel in the upper North Fork would be expected to eventually be transported into the lower North Fork reaches, improving downstream habitat over a longer timeframe.

*Riparian restoration to improve channel shading*

Riparian planting in the Upper North Fork is expected to highly improve both the maximum monthly and spatial variation of the water temperature in the river. It is expected that upstream shading will have modest downstream benefits to stream temperature, as the water warms more slowly as it loses elevation.

**5.1.6.5.2. Long-Term Actions**

*Set back infrastructure from the channel*

Sections of the Mount Baker Highway and Forest Road 37 impinge on the channel migration area of the North Fork River through this reach. Several chronic repair sites were identified by the Department of Transportation in the reach. While the roads have only a modest impact on confining the channel, these repairs periodically degrade habitat and relocating the channel away from the river will reduce the impacts of highway maintenance on the channel.

**5.1.6.6. North Fork Tributaries**

The proposed actions for the North Fork tributaries include:

- Riparian restoration to improve wood delivery to the channel
- Riparian restoration to improve channel shading

- Canyon Creek fish passage improvement
- Canyon Creek habitat restoration

#### **5.1.6.6.1. 10-year Actions**

##### *Riparian restoration to improve wood delivery to the channel*

By restoring riparian areas adjacent to the river, this project seeks to reduce bed scour, sediment impacts, and provide more diverse habitat over the long term. By proper management of timberlands, the channel is expected to see moderate decreases in bed scour, embeddedness and fine sediment, as well as a high impact on turbidity. The improvements in pools, backwaters pools, pool tail-outs and beaver ponds are expected to be high with a better functioning riparian ecosystem. A functioning riparian ecosystem is also expected to increasing the minimum (moderate impact) and maximum (high impact) channel width. The riparian functions and woody debris levels of the channel would both have an extreme benefit from the project. It is expected that improving the interface between the terrestrial and aquatic environments would have a moderate impact on salmon carcass retention. In more confined reaches of tributaries wood can provide an important sediment storage function in the channel, as it creates lower gradient steps in the channel. Addition of recruited wood to the North Fork tributaries will have a longer-term benefit to habitat conditions below the confluence as the wood is slowly transported down to the mainstem North Fork River. Protection of in-channel wood will ensure that the functions that recruited wood provide will be maintained. Priorities for wood recruitment should be given to places where the channel has access to the riparian zone infrequently enough that the trees can grow to a sufficient size to provide functional “key pieces” to the channel.

##### *Riparian restoration to improve channel shading*

Riparian planting in the North Fork tributaries is expected to highly improve both the maximum monthly and spatial variation of the water temperature in the various creeks. Priorities should be given to narrower channels, which can more quickly be shaded by smaller trees.

##### *Canyon Creek fish passage improvement*

As necessary, and consistent with longer-term restoration plan for lower Canyon Creek (see below), short-term improvements will be made to the barrier at RM 0.3 to ensure that early chinook can access upstream habitat.

##### *Canyon Creek habitat restoration*

Canyon Creek restoration focuses on dike setback, large woody debris placement, as well as riparian restoration. The project is expected to remove the impacts of the rock revetment on the alluvial fan of Canyon Creek, and fully restore the historic channel width. The project will have a moderate impact on wood function in the channel, including the formation of pools through the treated reach. Riparian function will be restored to a moderate degree, with shading benefits to the maximum temperature and

the spatial variation of the temperature, which currently exceeds water quality standards. The project will complement upstream sediment management and landslide stabilization work that was recently completed by the USFS.

#### **5.1.6.6.2. Long-Term Actions**

##### *Monitoring of forest practice activities*

Extensive storm proofing and abandonment of forest roads has been conducted in the North Fork and its tributaries and continues to be monitored for effectiveness by Lummi Natural Resources and Nooksack Indian Tribe staff. There is the need to continue this monitoring into the future. Forest and Fish regulations will likely have a positive effect on reducing the impacts of forest practices in the North Fork tributaries and will need to be monitored for long-term effectiveness. Opportunities for restoration may exist as roads are identified for abandonment and storm-proofing. In places, it may be possible to directly treat slope failures as they are identified. Long-term monitoring of Forest and Fish will work to reduce forest practices impacts on in-stream habitat.

##### *Set back infrastructure from the channel*

Sections of the Mount Baker Highway and various forestry roads cross the lower alluvial fan, or debris flow deposition areas, of important tributaries such as Boulder Creek and Racehorse Creek. When these streams have had debris flows, past responses have included channel cleanout and armoring road crossings. For Mt Baker Highway, WSDOT reports have recommended road relocation as the best long-term maintenance solution, and road relocations and replacing bridges that constrict tributary channels in these and other areas will restore important habitat forming processes.

#### **5.1.6.7. Lower Middle Fork**

The proposed actions for the lower Middle Fork include:

- Upland forest management
- Riparian timber managed lands
- Riparian planting of the channel migration area for wood recruitment
- Riparian planting for shading benefits

#### **5.1.6.7.1. 10-year Actions**

##### *Upland forest management*

This action continues the program to upgrade or decommission forest roads on state and federal forests and eliminates logging of unstable slopes in the Middle Fork watershed. It is expected that this action will continue to reduce anthropogenic sediment sources to the river and changes in flow caused by forest management.

*Riparian timber managed lands*

This action includes the natural regeneration of the riparian corridor under current Forest and Fish regulations. Actions include monitoring of forest practices and ensuring Best Management Practices are implemented and adequate to protect the riparian zone.

*Riparian planting of the channel migration area for wood recruitment*

Riparian planting throughout the channel migration area of the Middle Fork and its tributaries will encourage long-term recovery of wood recruitment to the channel. Priorities for planting should be given to areas where the wood recruitment function is currently classified as "low" (Duck Creek, Assoc. 2001), is located where the channel can access the wood through channel erosion, but lies in a protected enough location that the trees can grow to a substantial size. Wood recruited to the channel in this reach would benefit downstream reaches of the lower North Fork Nooksack as well.

*Riparian planting for shading benefits*

Riparian planting in the Lower Middle Fork is expected to highly improve both the maximum monthly and spatial variation of the water temperature in the river. It is expected that upstream shading will have modest downstream benefits to stream temperature, as the water warms more slowly as it loses elevation.

**5.1.6.7.2. Long-Term Actions**

*Protection of existing in-stream wood*

Regulatory protection of wood in the channel exists and will need to be enforced to reduce the loss of wood from the channel. In some reaches of the lower Middle Fork wood cutting on the gravel bars reduces the function of wood, either by direct removal, or by reducing the size and therefore the potential stability of wood moving through the system.

*Large-scale LWD placement*

The primary objective of wood placement in the lower Middle Fork would be to slow wood transport through the river and trap the mobile debris on stable wood structures in unconfined reaches. It is expected that the wood accumulations will help stabilize bars in the channel and slow the process of channel migration and avulsion. It will also help form and maintain side channels and other floodplain habitats. While this reach has not yet been assessed for specific restoration actions and priorities, it is expected that several of these projects could be implemented to provide a variety of habitat values to the channel. Over a longer timeframe as the logjams grow and stabilize, this would help address habitat diversity and key habitat quantity for adult holding and spawning chinook. This will also help form and maintain pools, pool tail-outs and backwater pools.

*Continued monitoring of forest practice activities*

There is the need to continue this monitoring into the future. Forest and Fish regulations will likely have a positive effect on reducing the impacts of forest practices in the Middle Fork and its tributaries and will need to be monitored for long-term effectiveness. Opportunities for restoration may exist as roads are identified for abandonment and storm-proofing. In places, it may be possible to directly treat slope failures as they are identified. Long-term monitoring of Forest and Fish will work to reduce forest practices impacts on in-stream habitat.

*Monitor Shorelines and Critical Areas Ordinance*

The Whatcom County Shorelines regulations and Critical Areas Ordinance will likely have a positive effect on reducing the impacts of floodplain development in the lower Middle Fork and will need to be monitored for long-term effectiveness. Critical areas will include channel migration zone and riparian protection, which are critical to the recovery of habitat-forming processes in the river.

**5.1.6.8. Upper Middle Fork**

The proposed actions for the upper Middle Fork include:

- Restore Passage at Middle Fork Diversion Dam
- Establish and manage for sufficient instream flow at the Middle Fork Diversion Dam
- Upland forest management
- Riparian timber managed lands

**5.1.6.8.1. 10-year Actions**

*Restore Passage at Middle Fork Diversion Dam*

The project includes the installation of a fish ladder and water intake screen at the Middle Fork Diversion Dam. It is expected that the project will allow passage for all anadromous species into the upper Middle Fork basin.

*Establish and manage for sufficient instream flow at the Middle Fork Diversion Dam*

This project will ensure adequate flows in the Middle Fork Nooksack River downstream of the diversion dam in summer and early fall for spawning early chinook. A combination of minimum in-stream flows and control of the ramping rate at the dam will ensure stable flows downstream of the dam.

*Upland forest management*

This action continues the program to upgrade or decommission forest roads on state and federal forests and eliminates logging of unstable slopes in the Middle Fork watershed. It is expected that this action will continue to reduce anthropogenic sediment sources to the river and changes in flow caused by forest management.

*Riparian timber managed lands*

This action includes the natural regeneration of the riparian corridor under current Forest and Fish regulations. Actions include monitoring of forest practices and ensuring Best Management Practices are implemented and adequate to protect the riparian zone.

**5.1.6.8.2. Long-Term Actions**

*Continued monitoring of forest management*

This action continues the program to upgrade or decommission forest roads on state and federal forests and eliminates logging of unstable slopes in the Middle Fork watershed. It is expected that this action will continue to reduce anthropogenic sediment sources to the river and changes in flow caused by forest management. This action includes the natural regeneration of the riparian corridor under current Forest and Fish regulations. Actions include monitoring of forest practices and ensuring Best Management Practices are implemented and adequate to protect the riparian zone.

**5.1.6.9. Middle Fork Tributaries**

The proposed actions for the Middle Fork tributaries include:

- Riparian timber managed lands

**5.1.6.9.1. 10-year Actions**

*Riparian timber managed lands*

This action includes the natural regeneration of the riparian corridor under current Forest and Fish regulations. Actions include monitoring of forest practices and ensuring Best Management Practices are implemented and adequate to protect the riparian zone.

**5.1.6.9.2. Long-Term Actions**

*Monitoring of forest practice activities*

Forest and Fish regulations and USFS Forest Plan will likely have a positive effect on reducing the impacts of forest practices in the Middle Fork tributaries and will need to be monitored for long-term effectiveness. Opportunities for restoration may exist as roads are identified for abandonment and storm-proofing. In places, it may be possible to directly treat slope failures as they are identified. Long-term monitoring of Forest and Fish and the USFS Forest Plan will work to reduce forest practices impacts on in-stream habitat.

**5.1.6.10. Lower South Fork**

The proposed actions for the lower South Fork include:

- Upland forest management through Forest and Fish, Northwest Forest Plan, including forest road maintenance and monitoring, riparian management, and avoidance of unstable slopes
- Protect existing function through CAO/SMP
- Acquisition of priority habitats
- Large-scale LWD placement

- Restoration of channel migration area
- Riparian restoration to improve wood delivery
- Riparian restoration to improve riparian shading
- Set back infrastructure from the channel
- Wetland restoration to improve baseflow, temperature maintenance

#### **5.1.6.10.1. 10-year Actions**

##### *Acquisition of priority habitats*

Continued protection of priority habitat in the lower South Fork will continue through a variety of programs including purchase, acquisition of conservation easements, and voluntary enrollment in the Conservation Reserve Enhancement Program. It is expected that by protecting existing refuge areas in the lower South Fork, restoration activities can work to connect and expand high quality habitat. Acquisition sites further facilitate restoration actions on the property.

##### *Large-scale LWD placement*

Building on the results of the Acme-Saxon In-stream Assessment (Maudlin et al. 2002) and the Acme to Confluence Assessment (NNR in prep.), several areas for in-stream wood placement were identified and prioritized. It is expected that several of these projects could be implemented to provide a variety of habitat values to the channel. This project is designed to directly address habitat diversity and key habitat quantity for adult holding and spawning in the lower South Fork. The project will also have benefits to channel stability. Large-scale wood placement in sections of the lower South Fork Nooksack is expected to fully restore wood function in the channel. This will have an extreme impact on the formation of pools, pool tail-outs and backwater pools. The structures would also be expected to have a minor impact on off channel habitat and a negligible impact on the formation of beaver ponds. The creation of more pools with complex cover will have a high impact on benthic community richness, a moderate impact on harassment of fish, as well as a minor impact on the retention of salmon carcasses. Maximum temperature and spatial variation of temperature is expected to see an improvement from better interaction of pools with groundwater and by providing refuge habitat in known cool water influence areas. During high flow, the project would be expected to moderately increase channel width, with a negligible impact on minimum width. The impact of the project on high flow, low flow and intra-annual flow variability would be a negligible benefit.

##### *Restoration of channel migration area*

By removing constraints to channel migration in the lower South Fork, it is expected that the negative habitat effects associated with hydro-modifications would be reversed in treated reaches. Further, the projects would be expected to have a moderate influence on low flow, high flow and intra-annual flow variation. These benefits would be realized by allowing the channel better access to its floodplain.

*Riparian restoration to improve wood delivery to the channel*

By restoring riparian areas adjacent to the river, this project seeks to reduce bed scour, sediment impacts, and provide more diverse habitat over the long term. By proper management of timberlands, the channel is expected to see moderate decreases in bed scour, embeddedness and fine sediment, as well as a high impact on turbidity. The improvements in pools, backwaters pools, pool tail-outs and beaver ponds are expected to be high with a better functioning riparian ecosystem. A functioning riparian ecosystem is also expected to increasing the minimum (moderate impact) and maximum (high impact) channel width. The riparian functions and woody debris levels of the channel would both have an extreme benefit from the project. It is expected that improving the interface between the terrestrial and aquatic environments would have a moderate impact on salmon carcass retention. Addition of wood to the lower South Fork will have a longer-term benefit to habitat conditions below the confluence as the wood is slowly transported out of the South Fork and into the mainstem Nooksack River.

*Riparian restoration to improve channel shading*

Riparian planting in the Lower South Fork is expected to highly improve both the maximum monthly and spatial variation of the water temperature in the river.

**5.1.6.10.2. Long-Term Actions**

*Set back infrastructure from the channel*

In the Lower South Fork, the channel is confined by several pipeline crossings (Williams natural gas pipeline and City of Bellingham water pipeline), a railroad, State Route 9, Mosquito Lake Road and Saxon Road. Both pipeline crossings should be widened to accommodate the channel migration width, and transportation routes relocated where possible away from the channel. It is expected that these actions will reduce channel confinement and restore floodplain connectivity as the channel is allowed to migrate across its floodplain. These actions would further allow other restoration opportunities as critical infrastructure is moved to a safer location.

*Wetland Restoration to improve baseflow and temperature maintenance*

In the Lower South Fork, extensive wetlands occupied the floodplain of the channel. The largest of these is the Black Slough wetland, near Van Zandt, which likely provided substantial summer inflow to the river before much of it's area was converted to agriculture. The slough currently has a slight cooling effect on the South Fork that could likely be improved with restoration. In other places, drainage ditches have reduced the capacity of floodplain wetlands, such as the Foxglove wetland complex near Acme, and changed the outflow of the wetland. Restoration efforts focused on restoring natural hydrology will greatly improve wetland function in the lower South Fork.

*Protection of existing in-stream wood*

Regulatory protection of wood in the channel exists and will need to be enforced to reduce the loss of wood from the channel. In some reaches of the lower South Fork wood cutting on the gravel bars reduces the function of wood, either by direct removal, or by reducing the size and therefore the potential stability of wood moving through the system.

*Monitor Shorelines and Critical Areas Ordinance*

The Whatcom County Shorelines regulations and Critical Areas Ordinance will likely have a positive effect on reducing the impacts of floodplain development in the lower South Fork and will need to be monitored for long-term effectiveness. Critical areas will include channel migration zone and riparian protection, which are critical to the recovery of habitat-forming processes in the river.

**5.1.6.11. Upper South Fork**

The proposed actions for the upper South Fork include:

- Upland forest management through Forest and Fish, Northwest Forest Plan, including forest road maintenance and monitoring, riparian management, and avoidance of unstable slopes
- Priority habitat acquisition
- Large-scale wood placement
- Decrease river-adjacent sediment inputs to South Fork Mainstem
- Riparian restoration to improve channel shading and wood delivery to the channel

**5.1.6.11.1. 10-year Actions**

*Upland Forest Management- Forest roads*

Forest road management is expected to improve habitat impacts from high winter flow and sediment generated from road failures. Road management in the South Fork basin is expected to show a moderate reduction in interannual variability in high flow and low flow and intra-annual flow pattern. These changes should be associated with a minor reduction in fine sediment, embeddedness and turbidity. Changing the flow patterns should also have a moderate impact on reducing bed scour.

*Priority Property Acquisition*

The Whatcom Land Trust is in the process of acquiring the floodplain of the South Fork Nooksack River from timber interests. This acquisition, along with mitigation property owned by Seattle City Light, will provide protection for the South River from the Acme Valley upstream to the USFS property boundary. This will include all of the most heavily used areas for holding and spawning chinook.

*Upland Forest Management-Protection of unstable slopes*

Elimination of logging on unstable slopes is expected to reduce sediment contributed to the river from forest practice activities. The reduced sediment will benefit habitat for the length of the South Fork Nooksack River.

*Priority Habitat Acquisition*

Acquisition and protection of the floodplain will allow natural recovery of habitat-forming processes, such as channel migration and riparian functions. This acquisition will also facilitate near-term restoration projects, such as those described under the 10-year implementation strategy. The upper South Fork is considered a high priority for preservation.

*Large scale LWD placement*

This project is designed to directly address habitat diversity and key habitat quantity for fry colonization in the upper South Fork. The project will also have benefits to channel stability. Large-scale wood placement in sections of the upper South Fork Nooksack is expected to fully restore wood function in the channel. This will have an extreme impact on the formation of pools, pool tail-outs and backwater pools. The structures would also be expected to have a minor impact on off channel habitat and a negligible impact on the formation of beaver ponds. The creation of more pools with complex cover will have a high impact on benthic community richness, a moderate impact on harassment of fish, as well as a minor impact on the retention of salmon carcasses. The project is further expected to result in a high reduction of bed scour and a minor improvement in gravel embeddedness and fine sediment impacts. Maximum temperature and spatial variation of temperature is expected to see a minor improvement from better interaction of pools with groundwater. During high flow, the project would be expected to moderately increase channel width, with a negligible impact on minimum width. The impact of the project on high flow, low flow and intra-annual flow variability would be negligible. Since the logjams will be an engineering tool to meet habitat objectives, the number of structures in a reach is expected to vary depending on the goals of the project. Based on a previous wood placement project that met similar habitat limitations as those described for the upper South Fork Geographic Area, we estimate 10 logjams per mile across the channel migration zone would be necessary. The expected length treated for the upper South Fork is 10 miles of channel.

*Decrease river-adjacent sediment inputs to South Fork Mainstem*

This project is designed to directly address sediment impacts on sediment impacts on egg incubation by applying source controls to major sediment sources in the upper South Fork. It is expected that reducing sediment delivery from landslides will have a minor impact on reducing embeddedness and fine sediment, but will have a moderate impact on reducing turbidity in the river. It is expected that the project will also have a minor impact on pools and pool tail-out abundance, which have been lost to filling. The project is expected to have a negligible benefit to wood levels in the channel. These

projects would be expected to improve fine sediment conditions in the lower South Fork Geographic Area.

*Riparian restoration to improve wood delivery to the channel*

By restoring riparian areas adjacent to the river, this project seeks to reduce bed scour, sediment impacts, and provide more diverse habitat over the long term. By proper management of timberlands, the channel is expected to see moderate decreases in bed scour, embeddedness and fine sediment, as well as a high impact on turbidity. The improvements in pools, backwaters pools, pool tail-outs and beaver ponds are expected to be high with a better functioning riparian ecosystem. A functioning riparian ecosystem is also expected to increasing the minimum (moderate impact) and maximum (high impact) channel width. The riparian functions and woody debris levels of the channel would both have an extreme benefit from the project. It is expected that improving the interface between the terrestrial and aquatic environments would have a moderate impact on salmon carcass retention. Wood delivered to the channel in the upper South Fork would be expected to eventually be transported into the lower South Fork reaches, improving downstream habitat over a longer timeframe.

*Riparian restoration to improve channel shading*

Riparian planting in the Upper South Fork is expected to highly improve both the maximum monthly and spatial variation of the water temperature in the river. It is expected that upstream shading will have modest downstream benefits to stream temperature, as the water warms more slowly as it loses elevation.

**5.1.6.11.2. Long-Term Actions**

*Riparian timber managed lands (Upper SF Nooksack and major tributaries)*

By restoring riparian areas adjacent to the river, this project seeks to reduce bed scour, sediment impacts, and provide more diverse habitat over the long term. By proper management of timberlands, the channel is expected to see moderate decreases in bed scour, embeddedness and fine sediment, as well as a high impact on turbidity. The improvements in pools, backwaters pools, pool tail-outs and beaver ponds are expected to be high with a better functioning riparian ecosystem. A functioning riparian ecosystem is also expected to highly improve both the maximum monthly and spatial variation of the water temperature, in addition to increasing the minimum (moderate impact) and maximum (high impact) channel width. The riparian functions and woody debris levels of the channel would both have an extreme benefit from the project. It is expected that improving the interface between the terrestrial and aquatic environments would have a moderate impact on salmon carcass retention.

*Set back infrastructure from the channel (Upper South Fork)*

There is a Seattle City Light bridge across the river at RM 29.8 that constrains the channel and that likely contributes to recent movements on a deep seated landslide

landform that is active along the river. Removing this bridge would restore channel width, and may reduce sediment input.

#### ***5.1.6.12. South Fork Tributaries***

The proposed actions for the South Fork tributaries include:

- Riparian restoration to improve wood delivery to the channel
- Riparian restoration to improve channel shading

##### **5.1.6.12.1. 10-year Actions**

###### *Riparian restoration to improve wood delivery to the channel*

By restoring riparian areas adjacent to the river, this project seeks to reduce bed scour, sediment impacts, and provide more diverse habitat over the long term. By proper management of timberlands, the channel is expected to see moderate decreases in bed scour, embeddedness and fine sediment, as well as a high impact on turbidity. The improvements in pools, backwaters pools, pool tail-outs and beaver ponds are expected to be high with a better functioning riparian ecosystem. A functioning riparian ecosystem is also expected to increasing the minimum (moderate impact) and maximum (high impact) channel width. The riparian functions and woody debris levels of the channel would both have an extreme benefit from the project. It is expected that improving the interface between the terrestrial and aquatic environments would have a moderate impact on salmon carcass retention. In more confined reaches of tributaries wood can provide an important sediment storage function in the channel, as it creates lower gradient steps in the channel. Addition of wood to the South Fork tributaries will have a longer-term benefit to habitat conditions below the confluence as the wood is slowly transported down to the mainstem South Fork River.

###### *Riparian restoration to improve channel shading*

Riparian planting in the South Fork tributaries is expected to highly improve both the maximum monthly and spatial variation of the water temperature in the various creeks. Priorities should be given to narrower channels, which can more quickly be shaded by smaller trees.

##### **5.1.6.12.2. Long-Term Actions**

###### *Monitoring of forest practice activities*

Forest and Fish regulations and USFS Forest Plan will likely have a positive effect on reducing the impacts of forest practices in the South Fork tributaries and will need to be monitored for long-term effectiveness. Opportunities for restoration may exist as roads are identified for abandonment and storm-proofing. In places, it may be possible to directly treat slope failures as they are identified. Long-term monitoring of Forest and Fish and the USFS Forest Plan will work to reduce forest practices impacts on in-stream habitat.

#### ***5.1.6.13. Upper Mainstem***

The proposed actions for the upper Mainstem include:

- Riparian and floodplain habitat acquisition
- Riparian restoration for shading in the Upper Mainstem Area
- Riparian restoration for wood recruitment in the Upper Mainstem Area
- Levee setback and removal of bank protection along the Upper Mainstem Nooksack
- Large wood placement

#### **5.1.6.13.1. 10-year Actions**

##### *Riparian and floodplain habitat acquisition*

This action includes locating opportunities to purchase and restore floodplain habitat. Acquisition will be achieved using a combination of conservation easements and purchases. It is expected that the action will facilitate future restoration actions such as levee setbacks and bank protection removal.

##### *Riparian restoration for shading in the Upper Mainstem Area*

Riparian planting in the upper mainstem is expected to highly improve both the maximum monthly and spatial variation of the water temperature in the river. It is expected that upstream shading will have modest downstream benefits to stream temperature. The focus of the planting will be on cooling smaller sloughs and side channels, which will more quickly achieve a full canopy. These smaller channels will be the highest priority for planting.

##### *Riparian restoration for wood recruitment in the Upper Mainstem Area*

Riparian planting throughout the channel migration area of the upper mainstem will encourage long-term recovery of wood recruitment to the channel. Priorities for planting should be given to areas where the wood recruitment function is currently classified as “low” (Duck Creek, Assoc. 2001), is located where the channel can access the wood through channel erosion, but lies in a protected enough location that the trees can grow to a substantial size. Wood recruited to the channel in this reach would benefit downstream reaches of the lower North Fork Nooksack as well.

##### *Levee setback and removal of bank protection along the Upper Mainstem Nooksack*

Setting back levees and removing bank protection should provide a variety of habitat benefits to the upper mainstem Nooksack River. The action is expected to improve floodplain connectivity and restore channel migration where it is limited by bank protection.

##### *Large wood placement*

This action focuses on the placement of large woody debris to provide deep, complex pools and help restore the historic anastomosing channel form above the town of Everson. Wood structures will be sited to protect maturing mid-channel bars and allow vegetation to colonize the sites. The structures will also provide deep and complex

pools, which will be ideal habitat for migrating and holding adults, as well as out-migrating juveniles. The structures would be sited across the channel migration area to meet a variety of habitat objectives, such as bar stabilization and pool development. The number of structures will ultimately be related to the habitat objectives identified for the reach.

#### **5.1.6.13.2. Long-Term Actions**

##### *Monitor Shorelines and Critical Areas Ordinance*

The Whatcom County Shorelines regulations and Critical Areas Ordinance will likely have a positive effect on reducing the impacts of floodplain development in the upper mainstem Nooksack and will need to be monitored for long-term effectiveness. Critical areas will include channel migration zone and riparian protection, which are critical to the recovery of habitat-forming processes in the river.

#### **5.1.6.14. Lower Mainstem**

The proposed actions for the lower Mainstem include:

- Early action projects that integrate floodplain management with habitat recovery: Bertrand Creek area; Whiskey-Schneider Creek area
- Implementation of Best Management Practices on urban and agricultural lands
- Restore mainstem channel complexity
- Systematically integrate flood planning with habitat recovery

#### **5.1.6.14.1. 10-year Actions**

##### *Integrate floodplain management with habitat recovery: Bertrand Creek area*

Integrate flood hazard management with salmon recovery (i.e. pursue opportunities to setback levees for multiple benefits). Nooksack River between Fishtrap and Bertrand creeks has been identified as potential location for levee setback for flood hazard management. Integrate flood hazard with fish habitat restoration by creating side channel sloughs, off-channel wetlands and riparian vegetation. Include large scale LWD placement with project to promote instream complexity. Increase channel width and complexity. Restore channel meander and connection to off-channel wetlands. Provide clear water habitat in the lower river for juvenile chinook rearing.

##### *Integrate floodplain management with habitat recovery: Whiskey-Schneider Creek area*

Integrate flood hazard management with salmon recovery (i.e. pursue opportunities to setback levees for multiple benefits). Nooksack at Whiskey and Schneider creeks has been identified as potential location for levee setback for flood hazard management. Integrate flood hazard with fish habitat restoration by creating side channel sloughs, off-channel wetlands and riparian vegetation. Include large scale LWD placement with project to promote instream complexity. The objectives of the project is to increase channel width and complexity, restore channel meander and connection to off-channel wetlands and provide clear water habitat in the lower river for juvenile chinook rearing.

*Implementation of Best Management Practices on urban and agricultural lands*

Implement BMP's re: filter strips, stormwater management, pesticide application in agricultural and urban areas. Decrease input of toxic contaminants, nutrients, fine sediments; increase riparian filtration.

*Restore mainstem channel complexity*

Placement of wood along river margins; anchored to piling wing walls or other instream structures. Structures placed to increase channel complexity along bank of river at multiple locations. LWD to improve complexity along edge of channel, increase habitat quality for juvenile rearing.

**5.1.6.14.2. Long-Term Actions**

*Integrate flood planning with habitat recovery*

Integrate flood hazard management with salmon recovery (i.e. pursue opportunities to setback levees for multiple benefits). Integrate flood hazard with fish habitat restoration by creating side channel sloughs and off-channel wetlands. Include large scale LWD placement with project to promote instream complexity. Identify opportunities to connect existing floodplain habitat; improve riparian vegetation and provide wider channel migration zone.

*Monitor Shorelines and Critical Areas Ordinance*

The Whatcom County Shorelines regulations and Critical Areas Ordinance will likely have a positive effect on reducing the impacts of floodplain development in the lower mainstem Nooksack and will need to be monitored for long-term effectiveness. Critical areas will include channel migration zone and riparian protection, which are critical to the recovery of habitat-forming processes in the river.

**5.1.6.15. Mainstem Tributaries**

The proposed actions for the mainstem tributaries include:

- Restoration of tributary slough habitat to provide flood refuge for fry and overwintering juveniles in the lower mainstem.
- Small-scale riparian restoration through CREP, voluntary stewardship, or community-based programs that do not compete with early chinook projects.
- Establish and manage for instream flows through Watershed Management Project.
- Implement best management practices to maintain water quality for downstream habitats.
- Restore fish passage using funding sources specifically targeted for fish passage improvements.
- Implement Forest and Fish rules (applies to Smith and Anderson Creek watersheds).

**5.1.6.15.1. 10-year Actions**

*Whiskey-Schneider Creek restoration*

Multiple lower tributary slough habitat restoration. Whiskey Creek: remove flood gate, daylight slough/creek, improve channel to expand habitat and connect flood plain wetlands. Schneider Creek: remove / relocate flood gate to connect Keefe Lake Complex to river. Improve Lower mainstem habitat complexity by restoring tributary slough habitat.

*Kamm Creek restoration*

Small-scale riparian restoration with a few CREP projects; restore Northwood wetland. Increase riparian shading, overhanging vegetation and leaf litter (improve benthos production, water temperatures but narrow buffer width, small-scale treatment so limited improvement in riparian function). Primary benefit to late timed chinook and coho utilizing off-channel habitat. Include side-channel/slough habitat to benefit juvenile rearing early timed chinook.

*Fishtrap Creek restoration*

Limited riparian improvement expected given existing land use, but some CREP likely. Set back levee on 2 mile reach between Guide and River road. Increase riparian shading, overhanging vegetation and leaf litter (improve benthos production, water temperatures but narrow buffer width, small-scale treatment so limited improvement in riparian function). Primary benefit to late timed chinook and coho utilizing off-channel habitat. Include side-channel/slough habitat to benefit juvenile rearing early timed chinook.

*Bertrand Creek restoration*

Bertrand CIDMP/Watershed Improvement District to facilitate limited riparian improvement - anticipate some small-scale improvement (I.e. narrow buffer width, smaller vegetation) over 30% of length. Set Back BC levees on lower 0.5 mile of channel to increase slough habitat area/complexity. Increase riparian shading, overhanging vegetation and leaf litter (improve benthos production, water temperatures but narrow buffer width, small-scale treatment so limited improvement in riparian function).

*Tenmile Creek restoration*

Community-based restoration with Tenmile Creek partnership - anticipate 20-30' riparian buffer over ~70% of length. Increase riparian shading, overhanging vegetation and leaf litter (improve benthos production, water temperatures but narrow buffer width, small-scale treatment so limited improvement in riparian function). Primary benefit to late timed chinook and coho utilizing off-channel habitat. Include side-channel/slough habitat to benefit juvenile rearing early timed chinook. Consider improving channel complexity / open water habitats in 1.5 miles of Barrett lake.

*Anderson Creek restoration*

Active and passive riparian restoration possible in lower reaches. Increase riparian shading, overhanging vegetation and leaf litter (improve benthos production, water temperatures but narrow buffer width, small-scale treatment so limited improvement in riparian function)

*Anderson Creek fish passage*

Regular maintenance of fishway to ensure passage. Restore full passage to upper Anderson Creek

*Smith Creek restoration*

Active riparian restoration possible. Increase riparian shading, overhanging vegetation and leaf litter (improve benthos production, water temperatures but narrow buffer width, small-scale treatment so limited improvement in riparian function).

*Riparian restoration of managed forest lands*

Implement elements of Forest and Fish. Riparian restoration; reduce sediment input, etc.

**5.1.6.15.2. Long-Term Actions**

*Monitor Shorelines and Critical Areas Ordinance*

The Whatcom County Shorelines regulations and Critical Areas Ordinance will likely have a positive effect on reducing the impacts of floodplain development in the tributaries of the mainstem Nooksack and will need to be monitored for long-term effectiveness. Critical areas will include channel migration zone and riparian protection, which are critical to the recovery of habitat-forming processes in the river.

**5.1.6.16. Estuary**

The proposed actions of the estuary include:

- Restore riverine-tidal blind channel network: Marietta Slough
- Restore riverine-tidal blind channel network: Marietta Slough
- Setback levees on LB of river between Slater Road and Ferndale
- Restore channel complexity

**5.1.6.16.1. 10-year Actions**

*Restore riverine-tidal blind channel network: Marietta Slough*

Setback levees on LB of river between mouth of river and Slater Road, and seaward dikes.

*Restore riverine-tidal blind channel network: Tennant Wetland*

Project proposes to enhance floodplain tributary channels by redesigning the channel, introducing wood and planting riparian vegetation on Tennant Creek. This creek drains

the wetlands on the eastern side of the floodplain of the mainstem downstream of Ferndale.

*Setback/ remove levees on LB of river between Slater Road and Ferndale*

Levee setback and removal will encourage floodwater and sediment deposition on the estuarine floodplain above Slater Road. Slater Road will be raised to accommodate flooding and infrastructure will be protected. It is expected that the project will enhance wetland functions on the floodplain and encourage more flow into the Tennant Creek area.

*Restore channel complexity*

Placement of wood along river margins; anchored to piling wing walls or other instream structures. Structures placed to increase channel complexity along bank of river at multiple locations. LWD to improve complexity along edge of channel, increase habitat quality for juvenile rearing.

**5.1.6.16.2. Long-Term Actions**

*Reconnect slough and floodplain habitat*

Reconnection of floodplain sloughs, such as Smuggler's Slough and Slater Slough, will provide enhanced freshwater rearing habitat for juvenile salmon. The project also provides a freshwater transit between the Bellingham Bay delta and the Lummi Bay delta.

*Reconnect distributary habitat*

In places where tidal and distributary channels have been truncated by non-passable tidegates and levees, restoration opportunities exist to improve passage into these habitat areas by updating the or removing the tidegates.

**5.1.6.17. Bellingham Bay**

**5.1.6.17.1. 10-year Actions**

*Prioritize and implement relevant recommendations from the Bellingham Bay Pilot Project*

The Bellingham Bay Pilot Project developed a list of restoration and enhancement projects for the developed portion of Bellingham Bay. These projects could be evaluated and prioritized for their benefit to target species and implemented. Focus should be placed on projects that improve habitat diversity and quantity in the nearshore areas and non-natal estuaries of Padden Creek, Whatcom Creek and Squalicum Creek.

**5.1.6.17.2. Long-Term Actions**

*Monitor Shorelines and Critical Areas Ordinance*

The Whatcom County Shorelines regulations and Critical Areas Ordinance will likely have a positive effect on reducing the impacts of shoreline development along the nearshore areas of Bellingham Bay and will need to be monitored for long-term

effectiveness. Critical areas will include a geotechnical setback for bluffs and riparian protection, which are important to the recovery of habitat-forming processes such as sediment transport and natural beach protection in the nearshore.

#### **5.1.6.18. Other WRIA 1 Nearshore Areas**

##### **5.1.6.18.1. 10-year Actions**

There are currently no proposed actions outside of the Bellingham Bay nearshore area.

##### **5.1.6.18.2. Long-Term Actions**

###### *Restore beach habitat-forming processes*

Restoring beach processes may include removing unnecessary bulkheads, or artificially nourishing the beach where bulkheads cannot be removed. Benefits include reducing beach scour, restoration of littoral sediment supply and movement, restoration of backshore vegetation and the accumulation of driftwood.

###### *Monitor Shorelines and Critical Areas Ordinance*

The Whatcom County Shorelines regulations and Critical Areas Ordinance will likely have a positive effect on reducing the impacts of shoreline development along the nearshore areas of WRIA 1 and will need to be monitored for long-term effectiveness. Critical areas will include a geotechnical setback for bluffs and riparian protection, which are important to the recovery of habitat-forming processes such as sediment transport and natural beach protection in the nearshore.

#### **5.1.7. Bull Trout Strategy**

As described in Section 2.2 *Near Term Priorities*, the near-term strategy for bull trout recovery is to implement actions with mutual benefit to both early chinook and bull trout and also to remove fish passage barriers in presumed bull trout spawning and rearing habitats in the upper Nooksack River watershed. In addition to the Middle Fork diversion dam and the lower Canyon Creek barrier, which hinder upstream access of both early chinook and bull trout, bull trout passage barriers include: Hedrick Creek (SR542), an unnamed RB tributary just downstream of Boulder Creek (SR542), "Chainup" Creek (SR542), Loomis Creek (USFS 12 Rd) and Kenny Creek (North Fork Rd, and additionally on a private road). Three additional tributaries to the upper Middle Fork (USFS 38 Rd) are scheduled to have passage corrected in 2005, and passage was also recently restored under the Mosquito Lake Road crossing of Johnson Creek.

#### **5.1.8. General Salmonid Recovery Strategies**

- Implement local land use regulations, permits, policies, or programs to maintain, prevent further degradation, and restore to target levels the habitat parameters identified above.
- Emphasize voluntary and incentive-based actions in salmon recovery efforts, but use regulatory actions if non-regulatory actions are not being taken or are insufficient to achieve recovery.

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- Use the following hierarchy of approaches in undertaking actions that impact salmonid habitat:
  - Avoid impact by not taking an action or part of an action that would cause adverse impacts;
  - Minimize adverse impacts by limiting the degree or magnitude of the action and its implementation;
  - Rectify adverse impacts by utilizing proven methods that demonstrate success of repairing, rehabilitation, or restoring the affected habitat to its full productive capacity;
  - Reduce or eliminate adverse impacts over time by preservation and maintenance operations during the life of the action; and/or
  - Monitor the impact and take appropriate corrective measures to achieve the identified goal.
  - Seek full restoration, where feasible, or monetary compensation from responsible parties for direct loss of salmonids or adverse impacts to salmonid habitat.
- Implement, adapt, and enforce compliance of existing regulations for the protection and restoration of salmonid habitat. Integrate incentives and other non-regulatory approaches within existing regulatory programs may improve compliance (i.e. use incentives to promote protection and restoration, apply penalty to discourage degradation).
- Develop non-regulatory strategies to motivate landowners and developers to engage in salmonid habitat protection and restoration. Examples include direct financial assistance, credits or rebates, cost-sharing agreements, stewardship agreements, purchase or transfer of development/access/ mineral/timber rights, technical assistance, education and outreach, Public Benefit Rating System-tax incentives programs, purchase of priority lands, land trades, and conservation easements.
- Coordinate salmon recovery planning efforts with other planning processes, including Growth Management, Shorelines Management, and flood control.
- Identify, develop, review, revise, and implement best management practices that limit impacts to salmonid habitats of forestry, agriculture, construction, road maintenance, etc..
- Manage growth wisely:
  - Reduce urban sprawl by concentrate residential, commercial, and industrial growth in urban growth areas.

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- Minimize road density across the landscape by discouraging settlement patterns that promote road building and developing alternatives to automobile use (e.g. bicycle paths, mass transportation).
- Develop mechanisms to prevent or slow land use conversion to more intensive land uses (e.g. forested, agricultural, or rural lands converted to urban or suburban uses). Potential examples include incentives, technical assistance, zoning, re-aggregation of small parcels, and clustering.
- Use education and outreach to increase awareness of human impacts to salmonids, foster land stewardship, and encourage behavior changes to reduce impacts.
- Develop and propose rule changes or legislative changes as needed to improve likelihood of success of salmon recovery.
- Evaluate new regulations, permits, policies or programs for the potential to lead to conservation of salmon habitat by avoiding, minimizing or mitigating human impacts on salmon habitat. Use the following evaluation questions:
  - Would the policy or program lead to degradation of habitat processes and functions?
  - Would the policy or program help develop and implement salmon-friendly best management practices?
  - Would the policy or program result in better knowledge or understanding of the issues surrounding the decline and recovery of salmon populations and their habitat?
  - Would the policy or program contribute to restoration of degraded habitat processes or functions?
  - Would the impacts of the policy or program be temporary and reversible? Or would they be irreversible?
  - What would it take to avoid or mitigate the potential impacts of the policy or program?
  - Does the policy or program identify standards, procedures or guidelines that are accepted as good management practices that protect salmon and habitat?
- Identify and minimize inconsistencies between and within current and new policies that relate to salmonid habitat protection and restoration.
- Develop an organizational structure that can facilitate the technical review of policies, programs, projects, and permits that affect salmonid habitat by local experts. Establish formal pathways for technical input by establishing committees for joint review and/or distribution lists for individual review.

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- Create tax breaks and/or market incentives to encourage the development and implementation of economically and ecologically sustainable land use practices that maximize positive and/or minimize adverse impacts to WRIA 1 salmonids and salmonid habitats.
- Amend zoning regulations to minimize development in and near salmonid habitats, especially priority species:
  - Develop density and open space requirements
  - Employ density transfer procedures to allow for the transfer of development rights from one property to another
  - Prevent parcel splitting, encourage parcel reaggregation
  - Impose moratoriums in new development where appropriate
- Ensure that permitting departments have sufficient levels of staff, expertise, and training to effectively implement regulations.

**5.1.8.1. Access**

- Systematically inventory, assess, prioritize, and correct: (1) fish passage barriers, which block access including tributary, floodplain, and estuarine habitats; and (2) surface water diversions, which have the potential to entrain salmonids. Use WDFW's *Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual* (available at <http://wdfw.wa.gov/hab/engineer/habeng.htm>).
- Enforce and monitor compliance of existing laws that mandate the maintenance or restoration of fish access and passage for man-made structures, such as diversion dams, culverts, levees, dikes, flood gates, tide gates, surface water diversions, pump stations, or bridges (e.g. WAC 220-110-070, RCW 77.55.040, RCW 77.55.060, RCW 77.55.070, RCW 77.16.220).
- Ensure that new stream crossings, fishways, and surface water diversions that are installed conform to WDFW design guidance and standards, including *Fish Passage Design at Road Culverts; Fishways – Design, Operation, and Evaluation; Screening Requirements for Water Diversions* (available at <http://wdfw.wa.gov/hab/engineer/habeng.htm>). All species and life stages expected to use the reach should be considered.
- Ensure that new flood control structures maintain passage into floodplain habitats (e.g. side channels and overflow channels).
- Manage impoundments to minimize the ponded area necessary for surface water diversion

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- Develop and implement regular and effective monitoring and maintenance programs to ensure that fish passage is maintained at stream crossings and fishways.
- Develop education and outreach programs to educate small forest and other private landowners regarding salmonid migration habits and passage issues. When stream crossings are in place or unavoidable, provide technical assistance in the design and construction of structures to facilitate passage.
- Secure long-term funding and develop incentives and cost-sharing programs to help defray and equitably distribute the costs of fish passage restoration.
- Integrate fish passage and screening needs into land and water use planning to reduce the opportunity for additional problems to develop.

***5.1.8.2. Channel Conditions***

*Sediment Supply*

- Evaluate and adapt land use management policies, practices and plans that prevent disturbances to natural rates of sediment supply, deposition, and routing.
- Employ best management practices and implement activity limitations to control surface erosion and fine sediment delivery to streams. Examples of activity limitations include avoiding or minimizing land clearing, timber harvest, and use of unpaved roads during wet weather. Examples of sediment control methods include cover crops, sediment fences, stormwater detention facilities, vegetated buffer strips, and adequate cross drain spacing for road ditches.
- Reduce frequency and magnitude of anthropogenically-induced mass wasting events, including landslides and debris flows:
  - Minimize or avoid land-use activities (logging, yarding, grazing, farming, mining, road construction) on unstable slopes.
  - Inventory and upgrade – or where possible, decommission – roads that have potential to increase mass wasting (e.g. unstable areas, inadequate road drainage, blocked stream crossings, and road fill and sidecast failure). Prioritize roads and road systems with demonstrated problems and that continue to pose a threat to important salmonid habitats downstream.
  - Develop and implement timely monitoring and maintenance of road drainage conditions
  - Consider seasonal road closures
- Maintain and, where possible restore, road densities within watersheds to target levels

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- Develop incentives to manage for cumulative impacts at the watershed scale and encourage long-range strategic planning for roads within a watershed
- Retain roadless areas.
- Avoid construction of new roads
- Decommission existing roads.

*LWD*

- Add large woody debris to streams to increase channel complexity, cover, spawning gravel retention, channel stability, pool frequency and depth, and habitat diversity.
- Maintain and restore natural large woody debris recruitment and routing processes by maintaining and restoring riparian buffers, avoiding and reducing artificial channel confinement, and ensuring that instream structures convey wood (culverts, bridges, diversion dams).
- Prevent removal of wood from rivers and streams:
  - Educate public and road and bridge maintenance crews of importance of wood to salmonid habitat.
  - Develop and enforce regulations to restrict removal of wood from rivers, gravel bars, and floodplains.
  - Where wood removal is unavoidable due to public safety or risk to public or private infrastructure, relocate wood to other areas within the channel.

*Channel*

- Maintain and restore habitats and habitat elements needed by species and life history stages that use a reach, e.g. edge and backwater habitat for fry; undercut banks and pools with cover for summer rearing; floodplain and edge habitats that provide low-flow refuges for overwintering; large, deep pools with cover for holding, and pool tailouts and riffles with adequate spawning gravels for spawning.
- Emphasize restoration of processes that form and maintain historic channel patterns. In highly managed systems where restoration to historic conditions is impossible or infeasible, instream habitat enhancement may also be the only viable alternative.
- In addition to managing upslope sediment supply, reduce fine sediment levels (where elevated) by improving channel complexity, natural bank stability, and channel/floodplain connectivity. Increased in-channel complexity changes the spatial distribution of fine sediment deposition (i.e. deposition in slower pool habitats, transport in faster riffle habitats). Stabilizing stream banks by restoring

natural riparian vegetation reduces bank erosion that can be significant source of fine sediments. Reconnecting channels and floodplains increases fine sediment deposition and storage on floodplain during floods.

- Evaluate alternatives to channel dredging. For example, the need for continuous, intensive channel dredging could be avoided or minimized by identifying and managing upstream and upslope sediment sources, limiting the spread of reed canarygrass that retains fine sediment, and improving storage capacity by promoting channel/floodplain connectivity.
- Avoid gravel mining and dredging in chinook and bull trout habitats. Where channel dredging and gravel mining are unavoidable, minimize negative effects to salmonids and salmonid habitats, by limiting the intensity, location, and/or timing of dredging activities. In particular, avoid: (1) disturbance of salmon redds; (2) increases in downstream turbidity and fine sediment levels; and (3) disruptions to channel equilibrium that can lead to downcutting and channel instability. Fully mitigate impacts using proven methods.
- Remove or set back existing bank hardening that impedes channel migration. Avoid or minimize new channelization projects or encroachments (e.g. bank hardening, narrow bridge or culvert crossing, roads parallel to the stream) that will simplify the channel structure and/or result in a loss of salmonid habitat function. Where bank stabilization is unavoidable, employ softer alternatives to traditional riprap (e.g. incorporate complex wood jams), follow Washington's *Integrated Streambank Protection Guidelines* (WDFW et al. 2003), and fully mitigate impacts using proven methods.

#### **5.1.8.2.1. Floodplain Conditions**

- Conduct comprehensive inventory of man-made structures that constrain the channel or restrict flood flow access to the floodplain and carry out feasibility analyses for their removal or relocation.
- Restore floodplain habitats and habitat-forming processes in WRIA 1 floodplains, especially along the Nooksack River and Forks, using historic conditions as reference:
- Remove or setback bank hardening, dikes and levees, stream-adjacent roads, bridges, buildings, and other infrastructure that constrain the channel or restrict flood flow access to the floodplain.
- Restore connectivity to floodplain habitats (side channels, sloughs, oxbows, wetlands, etc.) that are isolated by hydromodifications and bank stabilization (e.g. Rothenbuhler Slough in lower South Fork, to which fish passage is currently blocked by riprap). Reconnection of floodplain habitats may be a feasible

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method of improving floodplain habitat connectivity even where removal or setback of these structures is currently infeasible.

- Add wood at upstream ends of overflow channels to meter flow and increase floodplain habitat stability.
- Restore riparian forests within channel migration zones.
- Implement projects that can promote channel aggradation where channel incision has effectively disconnected the channel from its floodplain (e.g. lower South Fork, Acme to Saxon reach). Installing channel roughness (large wood and wood jams) may prove effective to this end.
- Develop a strategic Flood Hazard Management Plan for the Nooksack River and Forks that integrates salmonid habitat and human needs and prioritizes projects that maximize mutual benefit.
  - Establish floodplain meander limits informed by historic conditions channel migration areas to the extent possible. Delay non-emergency flood projects until meander limits are in place and the project's relevance to the larger context is clear.
  - Explicitly incorporate chinook and other salmonid habitat needs into flood hazard management planning and implementation by establishing a Technical Advisory Committee that includes state and tribal biologists with expertise in salmon and salmonid habitat.
  - Conduct economic analysis that considers costs of flood control and lost salmonid production and the value destroyed or damaged land or infrastructure.
  - Identify flood-prone properties that should be acquired to avoid future flood damage and/or need for flood control, especially within meander belts.
  - Where flood control is necessary, employ softer alternatives to traditional riprap (e.g. incorporate complex wood jams), follow Washington's *Integrated Streambank Protection Guidelines* (WDFW et al. 2003), and fully mitigate impacts using proven methods.
  - Identify feasible restoration projects (in conjunction with floodplain restoration recommendations described above).
- Protect Nooksack River and other floodplain habitat in WRIA 1 by preventing further encroachment into the floodplain.
  - Enact land use regulations (i.e. Shorelines) to prevent new development and detrimental activities in the 100-year floodplain. In addition to the immediate effects, such development often leads to increased demand and need for flood protection and bank hardening.
  - Acquire undeveloped lands or development rights to protect existing habitat.

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- Maintain and develop incentives and buyback programs to facilitate removal of existing buildings and structures within the floodplain.
- Reduce adverse impacts of transportation network to channel and floodplain condition and function by working with WSDOT and County and City public works departments to:
  - Identify roads and bridges that pose severe constraints to channel width and migration and/or disrupt the routing of flood flow.
  - Minimize construction of new roads in floodplains. If construction is necessary, minimize increases in flood elevations and disruptions to flood flow routing.
  - Relocate or remove stream-adjacent roads and railroads to provide for salmonid habitat-forming processes. Encourage transportation planners to consider the long-term costs associated with road repair and bank stabilization for stream-adjacent roads due to floods. Examples of stream-adjacent roads and railroads include SR-542 (North Fork), Mosquito Lake Road (Middle Fork, South Fork), Rutsatz Road (Middle Fork), and the railroad (South Fork). The SR-9 bridges across the South Fork and the North Fork are examples of constraining bridges.
- Implement a policy of “no net loss” of area or function for wetlands that provide or support salmonid habitat.
- Develop a mechanism for inventory and monitoring of wetland conditions and functions.
- Develop critical areas ordinances to enforce adequate buffers for development and activities that can adversely impact wetlands. Use best available science in establishing buffers (e.g. Sheldon et al. 2003).
- Avoid adverse impacts to wetlands. If alterations are unavoidable, minimize adverse impacts and fully mitigate using proven methods. Wetlands replacement is highly discouraged because of the difficulty of providing adequate replacement of functions and values.
- Off-site mitigation, where necessary, should occur within the affected watershed if possible. Develop wetland mitigation banking program that can guide such off-site mitigation and explicitly incorporates salmonid habitat and habitat needs and the technical expertise of state and tribal experts.
- Over the long term, increase the extent and functionality of wetlands in WRIA 1 that either directly provide salmonid habitat or indirectly support salmonid habitat through fine sediment filtration, groundwater recharge, and stormwater retention):
  - Restore lost or degraded wetlands.

- Remove wetland fill.
- Restore wetland vegetation.
- Reconnect isolated wetlands.
- Reintroduce beavers and/or discourage removal of beavers or destruction of beaver dams. Beaver ponds serve as overwinter rearing and flood refuge habitat for coho and other juvenile salmonids, increase habitat complexity, slow stream incision, increase flood storage, and increase flows during the dry season.

### ***5.1.8.3. Riparian Conditions***

- Protect existing riparian areas and functions along WRIA 1 streams, rivers, and floodplain habitats, as well as recovering riparian areas.
  - Maintain the full array of existing riparian functions (shading, large wood recruitment potential, leaf litter and other organic inputs, bank stability, sediment control, and nutrient and chemical filtration).
  - Develop and enforce land use regulations that prohibit development, roadbuilding, and detrimental activities within as much of the target riparian area width as possible (See *Section 5.1.5* above). If adverse impacts are unavoidable, fully mitigate impacts with proven methods.
  - Establish buffers outside regulated “no-touch” riparian areas in which low impact activities are allowed.
  - Develop and implement non-regulatory measures (e.g. incentives, lease or purchase of land or development rights, tax breaks) that support and complement regulatory measures to prevent loss and degradation of riparian areas (within target width).
- Restore degraded riparian areas where possible along streams, rivers, floodplain habitats, and wetlands throughout WRIA 1:
  - Prioritize riparian restoration in floodplain areas available for channel migration.
  - Focus on restoring structural and functional integrity of riparian areas: (1) establish or expand riparian vegetation zone width to target level (See *Section 5.1.5* above); (2) restore riparian areas to provide the full array of functions, including shading, large wood recruitment potential, leaf litter and other organic inputs, bank stability, sediment control, and nutrient and chemical filtration.
  - Allow for passive restoration of riparian areas where natural vegetational successional processes are operational, such as in forested uplands of the Nooksack River and Forks.

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- Promote and accelerate successional processes by thinning and underplanting desired plant species (e.g. underplanting conifers where historically abundant conifers are absent or in low density).
- Remove non-native invasive plants that hinder natural successional processes and impair riparian function
- Plant native plant species, using historic information from the same or similar system, to restore the natural vegetation composition for the site
- Remove or setback structures that constrain the channel and prevent channel migration and wood recruitment
- If adequate vegetated riparian buffers are infeasible, emphasize activities and land uses that are compatible with or that minimize impacts to salmonids and salmonid habitat, including (in decreasing order of desirability):
  - non-use
  - farm woodlots/non-farmed fields
  - fence rows, ditches, and unpaved roadsides with abundant shrubs, trees, or emergent
  - wetland vegetation
  - low impact recreation (hiking trails, camp, and picnic sites)
  - hay fields or other crops with infrequent tillage
  - corn and grain plantations
  - tree farming
  - moderately-grazed livestock pasture
  - urban parks
  - landscaping (preferably with abundant shrubbery, berries, and/or native vegetation).
- Restrict livestock access to avoid or minimize adverse impacts to streams and riparian areas: (1) install fencing and stream crossings (that maintain full fish passage); and (2) develop watering areas away from streams and riparian areas (i.e. outside of target riparian area widths).
- Develop program for early detection and monitoring of the distribution of non-native invading plant species and act aggressively to eliminate or prevent the spread of such species (e.g. Japanese or other knotweed species; Himalayan blackberry; reed canarygrass; and butterfly bush). Disseminate information on noxious weeds to landowners, public, and nurseries.

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- Encourage Army Corps of Engineers (Emergency Management Section) to reverse its policy of requiring that levee maintenance activities remove vegetation.
- Develop programs and zoning ordinances to prevent or discourage land conversions that degrade habitat conditions, e.g. conversion from forested to agriculture, or from agriculture to industrial or residential development.
- Avoid construction of roads, utility lines, or stream crossings that encroach upon riparian areas; if road construction is unavoidable, align roads perpendicular to streams to minimize riparian vegetation loss. Modify vegetation management programs along existing roads and utility lines to minimize loss of riparian vegetation to the extent possible.
- Limit recreation or design use areas to minimize degradation of riparian habitat (vegetation trampling, soil compaction, and streambank erosion).
- Develop and implement education and outreach materials to communicate to the public the importance of riparian habitat for salmonids.

**5.1.8.4. Water Quality**

*General*

- Employ regulatory and voluntary measures to maintain and restore properly functioning water quality conditions for all WRIA 1 salmonid streams (see *Habitat targets*).
- Seek rigorous enforcement of Clean Water Act:
  - Monitor water quality throughout WRIA 1 salmonid streams to document exceedances of water quality standards for 303d listing (emphasize temperature, dissolved oxygen, and turbidity, as well as toxic contaminants)
  - Work with Ecology to prioritize, schedule and implement water cleanup plans (TMDL). Prioritize timely completion of TMDLs for early chinook and bull trout habitats.
- Monitor and implement measures to ensure that irrigation return flows, water conveyance systems (e.g. road ditches), and stormwater inputs meet applicable water quality standards for receiving waters (temperature, sediment, nutrients, pollutants). Control measures can include settling ponds and water treatment.
- Deny, defer, or condition all permits that will adversely impact water quality in WRIA 1 salmonid streams.
- Ensure best available management practices (BMP) are employed to reduce nonpoint source pollution and other adverse impacts of land uses on water quality

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- Identify and adapt existing BMPs from federal, state, and local resource and governmental agencies
- Support applied research and otherwise encourage the development of new BMPs and technologies
- Encourage BMP implementation through regulatory or non-regulatory measures, combined with education and outreach
- Monitor effectiveness and adapt BMPs accordingly
- Restore wetlands and riparian areas to enhance their capacity to moderate sediment, chemical, and nutrient delivery to streams.
- Evaluate influence of insufficient instream flows on degraded water quality (e.g. elevated temperature, low dissolved oxygen) and incorporate into instream flow planning efforts (see *Water Quantity* section)

*Temperature*

- Protect and restore vegetation along riparian areas of WRIA 1 salmonid streams to provide adequate shading
- Restore natural hydrologic regime, especially conditions that support increased summer base flows (see *Water Quantity* section)
- Identify and protect or restore both unique cold water features (e.g. springs, cold water tributaries, hyporheic and groundwater upwelling zones) and the processes that support them

*Turbidity*

- Control fine sediment sources (see Channel Conditions) section
- Regulate in-channel activities that can suspend sediment (e.g. dredging, gravel mining, instream restoration projects):
  - Enforce standards for turbidity and suspended sediment to avoid conditions that will injure or alter the migration behavior of downstream salmonids
  - Prohibit certain activities
  - Restrict activity timing and location,
  - Employ measures to control downstream routing (e.g. temporary berms and flow diversions)

*Toxic Contaminants*

- Develop and enforce applicable laws and land use regulations to restrict application and runoff of chemicals that have known or likely deleterious effects to salmonids (direct lethal and sublethal effects) and stream habitat (i.e. reduced riparian function) and productivity (e.g. invertebrates that are prey for juvenile salmonids):

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- Conduct regular water quality monitoring to detect where levels of contaminants exceed standards.
- Compile and keep up-to-date with information on banned and restricted chemicals (pesticides, herbicides, fertilizers, etc.) from EPA, NRCS, product labels, and relevant court orders (e.g. 1/22/04 federal court order banning application of 38 pesticides within 100 yards of Northwest salmon streams, except for mosquito prevention and other human-health applications).
- Prohibit aerial and ground spraying within recommended distances of streams and irrigation ditches (accounting for drift).
- Mandate widths and vegetation requirements in riparian areas to provide functional filter strips.
- Avoid, to the extent possible, chemical application during icy or wet weather conditions or on bare ground or immature crops, where elevated runoff increases the likelihood of chemical delivery to streams. Also, avoid aerial application during windy conditions.
- Develop incentives and other non-regulatory measures to encourage alternatives to chemical treatment for forestry, agriculture, and residential use (e.g. organic farming, Integrated Pest Management).
- Use best available technology to maximize efficient use of chemicals and reduce overapplication.
- Evaluate the benefits and risks of chemical control of noxious weeds that impair riparian function and act accordingly.
- Use best available technology to reduce industrial and urban pollution inputs from stormwater, road drainage, and point discharges into WRIA 1 salmonid streams.
- Minimize use and potential for delivery to streams of materials used during road and bridge construction and repair
- Support and facilitate state and federal efforts to fund and implement cleanup of toxic areas
- Clean up and remove dumped material from streams and riparian areas (e.g. large pile of tires in Anderson Creek watershed; creosote-treated wood).

*Dissolved Oxygen*

- Manage land use practices to avoid nutrient concentrations in salmonid streams that increase biological oxygen demand and can lead to critically low dissolved oxygen levels

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- Minimize runoff of fertilizer and livestock waste into streams, by restrict quantities and timing of manure spraying or spreading
- Develop comprehensive plan to evaluate and correct the effects of failing septic systems on stream water quality throughout WRIA 1
- Manage effluent discharge from wastewater treatment plants to minimize nutrient concentrations to the extent possible
- Restrict livestock access to streams and riparian areas to prevent concentration of livestock waste and delivery to streams

***5.1.8.5. Water Quantity***

- Maintain and restore natural hydrologic regimes to properly functioning conditions for WRIA 1 salmonids
- Restore processes and conditions that support summer base flows for WRIA 1 salmonid streams
  - Restore wetlands
  - Reconnect and revegetated floodplains
  - Protect aquifer recharge areas
- Ensure that sufficient instream flows are provided to protect and restore upstream and downstream passage for all lifestages of chinook salmon and other salmonid within the limits of the natural hydrology.
- Work through Watershed Management Project and Comprehensive Irrigation District and Management Plan process to manage water use to provide adequate instream flows to meet salmonid needs, as well as channel-formation and maintenance flows
- Restore hydrologic maturity (especially within rain-on-snow zones):
  - Establish standards for hydrologic maturity of watershed units
  - Develop nonregulatory mechanisms to meet the standards and to manage for cumulative impacts at the watershed-scale
  - Reduce forest harvest rates and cut areas within watersheds
  - Minimize clearcut patch size and cumulative area
  - Transition to longer rotations between timber harvest
  - Replant or reseed harvested areas
- Reduce hydrologic effects of forest roads
  - Establish standards for forest road densities within watershed units

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- Encourage long-range planning for road networks within a watershed to minimize road densities, stream crossings, stream-adjacent road construction
- Maintain roadless areas
- Develop nonregulatory mechanisms to meet road density standards
- Disconnect road drainage networks from stream channel networks by:
  - Constructing frequent cross drains and ditch outlets
  - Designing and building road stream crossings to minimize accumulation of runoff that is delivered directly to the stream
- Minimize effective impervious surface area
  - Establish effective impervious surface area thresholds and adapt and enforce zoning ordinances accordingly
  - Provide incentives to discourage land use conversion from forest, agricultural and rural to urban and industrial land uses
  - Encourage development and application of alternatives to impervious surface materials for construction and development
  - Protect hydrologically mature forest cover to the maximum extent feasible
- Develop and implement best management practices to minimize soil compaction and vegetation disturbance in forestry, agriculture, and grazing practices, especially proximal to stream
- Increase flood water storage capacity and groundwater recharge, especially in the Nooksack River and Forks
  - Restore hydrologic connectivity between channels and floodplains and wetlands
  - Remove or setback dikes, levees and channel constraints
  - Address and correct land use-induced channel incision that effectively disconnects channels and floodplains
  - Protect and restore wetlands and riparian areas
  - Remove floodplain fill
- Prevent channelization and ditching; restore historical channel, floodplain, and wetland morphologies where possible
- Develop Stormwater Management plans that minimize, to the maximum extent feasible, the effects of stormwater on the hydrologic regime (e.g. stormwater detention/retention and infiltration systems)

- Restore channel conditions and habitat elements that will buffer the negative effects of peak flows on salmonid habitat, especially in the Nooksack River and Forks (see also Channel Conditions)
  - Improve incubation success by: (1) reducing lateral and vertical channel instability associated with peak flows, e.g. by adding large wood, reducing channel confinement, and improving channel/floodplain connectivity; and (2) protect and restore the floodplain and tributary habitats that function as spawning refuges (reduced scour during peak flows).
  - Improve juvenile overwintering habitat: (1) reduce channel confinement (reduces mean water column velocity and decreases likelihood that flood flow will flush rearing salmonids); (2) restore connectivity to and encourage formation and maintenance of floodplain, edge, and backwater habitats that serve as flood refuges; and (3) increase instream habitat complexity (i.e. by adding wood and restoring multiple channel and/or meandering channel pattern) to increase hydraulic heterogeneity and the availability of low-flow microhabitats.

#### ***5.1.8.6. Estuarine and Nearshore Marine Habitat***

- Address water quality degradation in streams and rivers flowing to WRIA 1 estuarine and nearshore marine waters (see *Water Quality Conditions*)
- Protect and restore estuaries associated with coastal independent tributaries (especially in Bellingham Bay), especially those have been determined to provide important non-natal estuary habitat to Nooksack River salmonids
- Protect and restore, to the extent feasible, the processes regulating the supply, transport, and deposition of sediment, water, large wood, and nutrients in the estuarine and nearshore marine environment.
  - Use historic conditions as reference
  - Identify sediment sources and sinks, drift cells and prevailing current patterns
  - Inventory anthropogenic uses and structures that disrupt habitat-forming processes (e.g. shoreline modifications, docks and piers)
- Protect and restore nearshore marine habitat structure and function
  - Ensure no net loss of eelgrass habitats, macroalgae habitats, intertidal forage fish spawning habitats (e.g. surf smelt and sandlance), intertidal wetlands, and intertidal mudflats, salt marsh.
  - Avoid or limit dredging activities, and minimize and fully mitigate for adverse impacts (eelgrass destruction, bathymetric changes, resuspension of contaminated sediments)

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- Avoid or limit placement of fill, and minimize and fully mitigate for adverse impacts
- Restore bathymetry where feasible (e.g. remove fill; the Cornwall Landfill has been identified as a high priority through the Bellingham Bay Demonstration Pilot.
- Plant native vegetation
- Protect and restore shoreline conditions
  - Develop and enforce land use regulations (Shorelines Master Plan) to protect and restore marine bluffs (i.e. limit construction, removal of vegetation, new roadbuilding)
  - Prevent new shoreline armaments
  - Develop incentives and identify opportunities to remove, set back, or replace shoreline armoring and bulkheading with softer alternatives
  - Identify opportunities to remove fill and overwater structures in the nearshore environment
  - Restore vegetation along shorelines to provide shoreline stabilization, shading of upper intertidal, and inputs of organic matter and woody debris
- Protect and restore forage fish spawning areas
  - Prohibit development or activities that would adversely impact known forage fish spawning beaches
  - Avoid destruction of eelgrass beds; where infeasible, minimize and fully mitigate for adverse impacts
  - Minimize disturbance in herring pre-spawn holding areas to the extent possible
  - Implement beach nourishment activities to restore forage fish spawning areas:
    - Although not process-based, May be the only available option when restoration of sediment regime is infeasible (i.e. inner Bellingham Bay, other highly modified shorelines)
    - Consider physical context (wave and current patterns) in site selection to minimize the need for costly, frequent maintenance
    - Consider specific substrate size and tidal elevation requirements
    - Secure funding for long-term maintenance
- Improve migratory corridors in estuarine and nearshore marine environment

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- Maintain adequate flows through estuaries to ensure optimal and timely downstream migration for smolts.
- Identify timing, location, and characteristics of migration routes for chinook and other salmonids
- Identify existing structures and shoreline conditions that disrupt or otherwise adversely impact migrating salmonids
- Avoid adverse impacts of new activities and development on migratory corridors
- Restore or enhance conditions in migratory corridors, e.g. by placement of cover, grading to create shallow shelf habitats, restoring eelgrass and other intertidal and subtidal vegetation
- Ensure coordination and cooperation with and among various organizations and committees working within the estuarine and nearshore marine environments of WRIA 1 (e.g. Whatcom Marine Resources Committee, Bellingham Bay Pilot Project, Puget Sound Nearshore Ecosystem Restoration Program, Waterfront Futures) to achieve recovery of estuary and nearshore marine ecological functions beneficial to recovery of chinook salmon and other salmonids.
- Work with the Burlington Northern railroad to seek solutions to reduce impacts to WRIA 1 shorelines (especially Chuckanut Bay)
- Reduce occurrence of treated wood structures in nearshore
  - Use less toxic alternatives to wood treatment
  - Identify, prioritize, and remove or replace existing treated timber structures
- Evaluate, address, and avoid or minimize impacts of industrial and municipal discharges in cherry point to water and sediment quality
- Evaluate and remove creosote logs in WRIA 1 estuaries and nearshore marine habitats
- Promote oil and hazardous substance spill prevention, contingency, and response planning to reduce risk, minimize exposures, remediate contaminated areas, and restore lost resource functions and services.
- Regularly monitor for presence of *Spartina* and other invasive species in WRIA 1, especially on the Lummi Bay and Bellingham Bay mudflats, and develop a plan to quickly respond with control efforts if detected
- Continue to address the cleanup and disposal or appropriate capping of contaminated sediments in inner Bellingham Bay according to the prioritization by the Bellingham Bay Demonstration Pilot

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**Table 5.1:** Habitat targets for Nooksack early chinook freshwater habitats.

(Note: Apply to or adjacent to early chinook habitats, except Watershed Conditions, which apply to watershed upstream.)

Category	EDT Attribute	Definition	Target		
Access	Migration Obstructions <sup>1</sup>	Obstructions to fish passage by physical barriers.	None, or existing obstructions allow full upstream and downstream passage of juveniles and adults .		
Channel Conditions	Fine Sediment <sup>1</sup>	Percentage of fine sediment (<0.85mm)	Riffles	< 11%	
	Embeddedness <sup>1</sup>	Extent that larger cobbles or gravel are surrounded by or covered by fine sediment	Riffle and tailout habitat units (where cobble, gravel substrates occur).	< 25 % covered by fine sediment	
	Wood Debris <sup>1</sup>	Large woody debris (LWD, i.e., pieces >0.1 m diameter and >2m in length) density in pieces per channel width (CW, i.e., average wetted width during high flow month that is less than bankfull)	Large Wood Function	Complex array of large wood pieces (>50cm diameter) but fewer cross channel bars and fewer pieces of sound large wood due to less recruitment than historic conditions; large wood, jams are a prevalent influence on channel morphology.	
			CW <25 ft	2 to 3	
			CW 25 - 50 ft	2 to 4	
			CW 50 - 150 ft	3 to 7	
			CW 150 - 400 ft	10 to 20 (excluding large jams), plus large jams where accumulations occur.	
	CW >400 ft	8 to 15 (excluding large jams), plus large jams where accumulations occur.			
	Bed Scour <sup>1</sup>	Average depth of bed scour during annual peak flow event over ~ a 10-year period.	Spawning areas (i.e., in pool-tailouts and small cobble-gravel riffles)	Frequent scour of depths < 10 cm.	
	Quantity and Quality of Pools <sup>1</sup>	Pool Frequency (pools per mile)	Width 5'	184	
Width 10'			95		
Width 15'			20		
Width 20'			56		
Width 50'			26		

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Category	EDT Attribute	Definition	Target	
			Width 75'	23
			Width 100'	18
		Pool Quality	Pools > 1 meter depth (holding pools) with good cover and cool water, minor reduction of pool volume by fine sediment	
Floodplain Conditions	Hydromodifications <sup>1</sup>	Extent that man-made structures constrict flow (e.g., bridges) or restrict flow access to floodplain (e.g., streamside roads, riprap, levees); extent of ditching or channelization.	Stream channel is fully connected to the floodplain although very minor structures may exist that do not result in flow restriction or constriction.	
	Floodplain Connectivity <sup>2</sup>	Ability of flood flows to access floodplain	Off-channel areas are frequently hydrologically linked to main channel; overbank flows occur and maintain wetland functions, riparian vegetation and succession.	
	Habitat Type - Off Channel <sup>1</sup>	Off-channel habitats, as a proportion of the total wetted area	Use historic conditions as reference	
Riparian Conditions	Riparian Function <sup>1</sup>	Degree to which riparian function has been altered within the reach.	> 70% of functional attributes present	
	Riparian Buffer Width and Composition <sup>3</sup>	Width of riparian zone measured horizontally from the channel migration zone on each side of the stream; species composition and stand age of vegetation.	>150 ft or site potential tree height (whichever is greater) <i>and</i> dominated (>70%) by mature conifers unless hardwoods were dominant historically	
Water Quantity	Annual Variation in Peak Flow <sup>1</sup>	Relative change in average peak annual discharge, as inferred from historical flow data or indicator metrics.	Peak annual flows typical of an undisturbed watershed of similar size, geology, orientation, topography, and geography; OR <20% change in Q <sub>2yr</sub> based on historical record	
	Intra-Annual Variation in Peak Flow <sup>1</sup>	Intra-annual flow variation during the wet season (i.e., "flashiness") as indicated by flow data or watershed condition metrics (e.g., road density, % impervious surface).	Storm runoff response (rates of change in flow) typical of undisturbed watershed of similar size, geology, orientation, topography, and geography; OR <5% reduction in average TQ <sub>mean</sub> compared to the undeveloped watershed state.	
	Annual Variation in Low Flow <sup>1</sup>	Relative change in average daily flow during the normal low flow period, as indicated by historical flow data or inferred from watershed metrics.	Average daily low flows expected to be comparable to an undisturbed watershed of similar size, geology, and flow regime (or the pristine state for the watershed of interest); OR <20% change in the 45 or 60-day consecutive lowest average daily flow.	

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Category	EDT Attribute	Definition	Target			
	Diel Variation in Flow <sup>1</sup>	Average diel variation in flow level during a season or month.	Slight to low variation in flow stage during an average 24-hr period during season or month. This pattern typical of routine slight to low ramping condition associated with flow regulation, averaging <2 inches change in stage per hour.			
Water Quality	General Water Quality <sup>2</sup>	Includes all water quality parameters regulated through the Clean Water Act that affect salmonids.	Low levels of contamination from agricultural, industrial, and other sources; no excess nutrients; no 303-d listed reaches.			
	Temperature - daily maximum <sup>4</sup>	Maximum water temperatures (7-day average of daily maximum) within the stream reach during the period should not exceed:		Incubation	Juvenile Rearing	Adult Migration
			Chinook	11 - 12	14.2 - 16.8	14.2 - 16.8
			Coho	9 - 12	14 - 17	14 - 17
			Chum	10.5 - 12	N/A	Insuff. Data
			Pink	10 - 12	12.5 - 14.5	12.5 - 14.5
			Sockeye	10.5 - 12	12 - 16	13 - 14.5
			Steelhead	13 - 14	16.5 - 17.5	16 - 17
			Bull Trout/Dolly Varden <sup>a</sup>	5.5 - 6.5	10 - 12	14 - 17
			Rainbow Trout	9 - 12	15.5 - 18	
Cutthroat Trout	10 - 11	13 - 15.5	14.5 - 17.5			
	Temperature - spatial variation <sup>1</sup>	Water temperature variation within the reach as influenced by inputs of groundwater.	Intermittent sites of groundwater discharge into surface waters and total quantity of groundwater discharge not a major source of flow in reach.			
	Dissolved Oxygen <sup>1</sup>	Average dissolved oxygen within the water column.	>8 mg/L			
	Turbidity <sup>1</sup>	The severity of suspended sediment episodes within the stream reach (Scale of Severity, or SEV <sup>3</sup> ).	SEV Index ≤ 6; Occasional episodes with low to moderate concentrations (<250 mg/L) of suspended sediment. Concentrations are sublethal, although slight behavioral modification may occur.			
	Pollutants <sup>1</sup>	The extent of dissolved heavy metals and other toxic pollutants within the water column.	No toxicity expected due to dissolved heavy metals to salmonids under prolonged exposure (1 month exposure assumed).			

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Category	EDT Attribute	Definition	Target
Watershed Conditions	Mass Wasting	Occurrence of mass wasting events (e.g., debris flows, shallow-rapid landslides).	No evident impact of land use on the frequency and magnitude of mass wasting events that deliver sediment to streams.
	Road Network Impacts	Measures of the impact of the road network to the stream system, e.g., the length of road network per unit watershed area, number stream crossings per unit channel length, proportion of stream network with stream-adjacent roads.	Road Density <sup>3</sup> : <2 mi/mi <sup>2</sup> ; other thresholds to be developed based on best available science.
	Increase in Drainage Network <sup>2</sup>	Extension of stream network by land use practices, e.g., ditching/drainage of wetlands, road ditches that intercept precipitation or groundwater flow and deliver directly to stream network	Zero or minimum increases in active channel length correlated with human-caused disturbance.
	Riparian Areas <sup>3</sup>	Condition of riparian areas adjacent to stream reaches upstream of but hydrologically connected to Nooksack early chinook habitats	Streams more than 2 ft bankfull width: >100 ft buffer width dominated by mature trees of historically dominant species Streams* less than 2 ft bankfull width: >50 ft buffer width dominated by mature trees of historically dominant species *Applies to streams for which wood is important in sediment storage. Research is underway locally to characterize such streams.
	Hydrologic Maturity <sup>3</sup>	Proportion of watershed area with forest stands aged 25 or more	>60%
	Impervious Surface Area <sup>3</sup>	Percentage impervious surface in the watershed (e.g., calculated by applying effective impervious surface % to land use/land cover types and averaging over watershed	≤ 3%

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Category	EDT Attribute	Definition	Target
Ecological Interactions	Salmon Carcasses <sup>1</sup>	Relative abundance of anadromous salmonid carcasses within watershed that can serve as nutrient sources for juvenile salmonid production and other organisms.	Very abundant -- on average 400 carcasses/mile of main channel habitat

<sup>1</sup> Source: Blair, G. 2001. Puget Sound PFC Rules. May 2001 Memorandum. Moberg Biometrics, Vashon, WA.

<sup>2</sup> Source: USFWS. 1998. A Framework to Assist in Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Bull Trout Subpopulation Watershed Scale. February 1998.

<sup>3</sup> Source: Smith, C. 2002. Habitat Condition Standards (Table 13) *in* Salmon and Steelhead Habitat Limiting Factors in WRIA 1, the Nooksack Basin. July 2002. Washington State Conservation Commission. Lacey, WA. *Note: Standards for good conditions were used.*

<sup>4</sup> Source: Hicks, M. 2000. Preliminary Review Draft Discussion Paper Evaluating Standards for Protecting Aquatic Life In Washington's Surface Water Quality Standards Temperature Criteria. Washington State Department of Ecology, Water Quality Program, Watershed Management Section. Olympia, Washington.

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**Table 5.2.** Functional objectives for resource issues under the Forest and Fish Rules.

<b>Resource Issues</b>	<b>Functional Objective</b>	<b>Forest Practice Rules to Achieve Objectives</b>	<b>Gaps in the Forest Practice Rules</b>
Heat / Water Temperature	Provide cool water by maintaining shade, groundwater temperature, flow, and other watershed processes controlling stream temperature.	<ol style="list-style-type: none"> <li>1. Achieving desired future conditions (DFC) in Riparian Management Zones (RMZs) for fish-bearing waters;</li> <li>2. Partial buffering of non-fish-bearing perennial surface waters.</li> </ol>	<ol style="list-style-type: none"> <li>1. Small forest landowner exemptions for riparian buffers;</li> <li>2. Non-fish-bearing surface waters are only buffered for 50% of their length;</li> <li>3. Inadequate</li> <li>4. No buffers for seasonal streams</li> </ol>
LWD / Organic Inputs	Develop riparian conditions that provide complex habitats for recruiting large woody debris and litter.	<ol style="list-style-type: none"> <li>1. Achieving desired future conditions (DFC) in Riparian Management Zones (RMZs) for fish-bearing waters;</li> <li>2. Partial buffering of non-fish-bearing perennial surface waters.</li> </ol>	<ol style="list-style-type: none"> <li>1. Small forest landowner exemptions for riparian buffers;</li> <li>2. Non-fish-bearing surface waters are only buffered for 50% of their length;</li> <li>3. No buffers for seasonal streams.</li> </ol>
Sediment	Provide clean water and substrate and maintain channel forming processes by minimizing to the maximum extent practicable, the delivery of management-induced coarse and fine sediment to streams (including timing and quantity) by protecting stream bank integrity, providing vegetative filtering, protecting unstable slopes, and preventing the routing of sediment to streams	<ol style="list-style-type: none"> <li>1. SEPA process for harvesting on unstable slopes;</li> <li>2. Mass-wasting buffer prescriptions;</li> <li>3. Rule standards for new road construction;</li> <li>4. Road maintenance and abandonment plans (RMAPs)</li> </ol>	<ol style="list-style-type: none"> <li>1. Small forest landowner exemptions for RMAP;</li> <li>2. Lack of wood recruitment for non-fish bearing streams increases sediment transport capacity for headwater streams;</li> <li>3. Lack of wet season hauling restrictions for forest roads;</li> </ol>
Hydrology	Maintain surface and groundwater hydrologic regimes (magnitude, frequency, timing, and routing of stream flows) by disconnecting road drainage from the stream network, preventing increases in peak flows causing scour, and	<ol style="list-style-type: none"> <li>1. Rule standards for new road construction;</li> <li>2. RMAPs;</li> <li>3. Logging restrictions for wetlands.</li> </ol>	<ol style="list-style-type: none"> <li>1. Small forest landowner exemptions for RMAP;</li> <li>2. No logging restrictions for hydrologic maturity (i.e. cumulative effects).</li> </ol>

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	maintaining the hydrologic continuity of wetlands.		
Chemical Inputs	Provide for clean water and native vegetation (in the core and inner zones) by using forest chemicals in a manner that meets or exceeds water quality standards and label requirements by buffering surface water and otherwise using best management practices.	1. Rules for the handling, storage, and application of chemicals.	.
Stream Typing	Type "fish habitat" streams to include habitat which is used by fish at any life stage at any time of the year, including potential habitat likely to be used by fish which could be recovered by restoration or management, and including off-channel habitat, by using a multi-parameter, field-verified, peer reviewed, GIS logistic regression model using geomorphic parameters such as basin size, gradient, elevation, and other indicators.	1. Interim water typing system based on physical criteria ; 2. Water typing model for fish habitat in validation.	1. Water typing model under predicts low gradient, floodplain anadromous fish habitat.
Fish Passage	Maintain or restore passage for fish in all life stages and provide for the passage of some woody debris by building and maintaining roads with adequate stream crossings.	1. Rule standards for new road construction; 2. RMAP	1. Small forest landowner exemptions.

## 5.2. Harvest

### 5.2.1. Recovery Objectives

The initial objective for harvest (direct or incidental harvest) is that the Nooksack Early Chinook Management unit will increase to the level that would sustain harvests below the agreed Recovery Exploitation Rate (RER) level which will allow incidental impacts sufficient to allow achieving harvest objectives on fisheries with harvestable surpluses. This will allow:

- Annual directed harvest opportunity for the ceremonial, and eventually subsistence, treaty-reserved fishing rights and, non-treaty fishing opportunities, and harvest in Canada.
- Fisheries in Areas 7 and 7A not constrained by the exploitation rate limit on the Nooksack Early Chinook Management Unit.
- Incidental mortality in mixed stock sport fisheries not constrained by the exploitation rate limit on the Nooksack Early Chinook Management Unit.

The Long term objective will be have the populations recover to the level where they would produce three recruits for each spawner, allowing a spawning population of 3,000 to produce a harvestable surplus 6,000 in each of the populations in the Nooksack Early Chinook management unit.

- The Washington Departments of Fisheries and Game (WDFG 1948) estimated Nooksack River annual commercial salmon production contributions to in-river, Puget Sound, and Coastal commercial catches from 1938-1944 as 13,289 chinook. They also estimated that 40% of the chinook run was caught on the Coast, and 10% of the equivalent of 10% of the in-river numeric catch was caught in Puget Sound. When sport estimates are added, annual Nooksack origin chinook catches in Washington were 15,289. The annual river catch of chinook in the river, predominately representing the catch from April through July, averaged 3,800 chinook. Assuming that the primitive fishing gear of the day would be unlikely to harvest 50% of the run entering the river, we would suggest that the average productivity of the populations during that time period was on the order of 4 recruits per spawner. This would suggest that three recruits per spawner is not an unreasonable number, though the population size was apparently 20% lower than the long term goal. It should be noted that commercial catches for Chinook from this period are diminished from Puget Sound District catches from 1913-1928 (WDFG 1930).
- The Beverton Holt production function relates the number of recruits expected given a number of spawners, or parents and a given set of habitat conditions. When the habitat conditions approximating the properly function conditions for survival of chinook are input into the EDT model for each of the two populations

in the Nooksack Early Chinook Management Unit, a population specific estimate of recruits per spawner is generated over a range of spawner populations. It is assumed that the habitat characteristics are limited and that as the population increases the recruits per spawner decreases and eventually levels off so the number of recruits does not increase with increasing spawners.

When the rate of the increase in the population reaches its maximum value relative to the number of spawners, additional spawners are less efficient at increasing the population numbers. This point of diminishing return is the escapement that on average, under average habitat conditions will provide the maximum sustainable yield from the population. The model output provides estimates listed in Table 5.3.

A graphic display of the relationship between spawners and recruits, or total population prior to fishing, the relationship between the return per spawner and the number of spawners is provided in Figure 5.1

### **5.2.2. History of Harvest Management**

Prior to the 1970s, salmon fisheries were concentrated where the highest quality fish could be caught, which was generally on the approaches from the oceans to the internal waters leading to the natal rivers. Salmon traps on these routes were major fisheries until they were outlawed in 1935. Purse Seine gear evolved considerably from the turn of the century through the development of the power block and nylon net became the dominant gear operating in the approach fisheries. Substantial troll fisheries had developed along the coasts of Washington, Oregon and the West Coast of Vancouver Island developed in the late 60s and the 70s. The impact of these fisheries on the numbers of salmon returning to the natal streams was not unnoticed.

A variety of factors during the 70s led to investigations that would identify the origin of stocks taken in fisheries and the development of management tools that would allow management of fisheries so the numbers of chinook of each stock taken in each fishery could be estimated. Developing international agreement on the Law of the Sea inflamed the smoldering discontent in Canada concerning the interception of Canadian origin salmon by United States fisheries. The Boldt decision, requiring allocation of harvestable surplus of stocks on a region by region or stock by stock basis equally between tribal and non-tribal parties in Puget Sound also required this information and tools.

The basic information required to accomplish new management objectives was the ability to identify the natal stream of each salmon killed by fishing activity. Successful generation of this data allows a calculation of the total survival of a brood stock, and the identification of the stock composition of each fishery. With information on the numbers of brood production (spawners, potential egg deposition, or in the case of

hatcheries releases) and the total mortality over time allows insight into the variations in survival and perhaps causes of survival which leads to the ability to make useful forecasts of the numbers of adults returning from the ocean each year. The identification of the origins of chinook caught in each fishery also allowed evaluation of fisheries regulations that would be required to meet agreed or required catch allocation objectives as well as providing information on where chinook were at different times in their marine life history phase.

Initial research was based upon placing plastic disk tags on fish taken in fishing areas where large numbers of tags could be applied, and then surveying likely spawning areas to determine where the tags were found and from the information on the tag, the times and locations the fish were tagged. Much of this work was conducted by the International Pacific Fisheries Commission (IPFSC) created in 1938 to manage the sockeye stocks from the Fraser River passing through US and Canadian territories by the Sockeye Salmon Convention of 1938. A number of assumptions concerning the ability of the fish tagged to represent the fish taken in the fishery and the ability of the tags recovered on the spawning ground to represent all of the tags in the spawning population and the statistical methods of the day allowed the IPFSC to manage the harvest of sockeye with allocation of the harvestable surplus, that which would provide spawning escapements that would provide for the maximum sustainable harvest over time, equally between Canadian and American fisheries.

This line of research was very expensive and was not able to track all fish in all fisheries. New technologies were developed to identify fish identified by stock as juveniles and then to identify them in the catch of fisheries. Initially, information on the survival of juvenile fish, too small for the tags of the day, was obtained from clipping various combinations of fins. The invention of micro-sized coded wire tags (CWTs), up to 1.5 mm length, that could be easily implanted into the tough nasal cartilage of juvenile salmonids greatly changed juvenile marking studies because of the numerous advantages over fin clipping. Binary coded tags were introduced in 1971. The new tags had an exceptional number of available codes. Standard length binary tags (1mm, 6-bit word) for example, have 63 possible agency codes and 3,969 codes per agency (not using zero), for an overall total of 250,047 unique codes.

CWT applications were initially developed in the 1960s to investigate the effectiveness of different hatchery practices. In 1977 a coast wide CWT program was established to provide coordination of CWT release and recovery efforts. Standards were established catch sampling rates, release and reporting to a centralized site, access and ability to extract data of interest, and methods of analysis among managers.

The coded wire tag (CWT) is now widely used by fisheries agencies on the West Coast as a major information collection tool for stocks of salmon. Resource management problems addressed include hatchery contribution studies, differential treatment

studies, fishery contribution studies, and a variety of other related studies which are important for fisheries management and research. The Pacific States Marine Fisheries Commission hosts the Regional Mark Processing Center (RMPC) and maintains an on-line Regional Mark Information System (RMIS) to facilitate exchange of CWT data between release agencies and the sampling/recovery agencies, and other data users. The RMPC also serves as the U.S. site for exchanging U.S. CWT data with Canada for Pacific Salmon Treaty purposes. The CWT database houses information relating to the release, sample, and recovery of coded wire tagged salmonids throughout the Pacific region. These data must meet stringent validation criteria for inclusion in the permanent database.

The estimation of the contribution of stocks to the catch of each in the fishery, requires CWT release groups to represent the component stocks, a statistically adequate number of recoveries, a ratio of the sample for CWTs to the catch in each fishery or group of fisheries is known, and the escapement ratio of tagged to untagged population components. To fully estimate the fishing associated mortality, it is necessary to develop estimates of the non-landed fisheries mortality, i.e. net drop, troll shakers or releases of hooked fish. Chinook are exposed to the fisheries mortality over a number of years due to their range of ages of maturity. This requires estimates of the age specific fisheries mortality to determine brood year production necessary for evaluating productivity

When fisheries are sampled in known proportions, number of individual with a CWT code in a sample of a known proportion of a catch, can be expanded to estimate total numbers of individuals with that CWT code taken in the fishery. The number of tags of a CWT released, the sum of estimated numbers of the CWT code in each fishery's catch, and the total numbers of CWTs recovered in the hatchery or the spawning grounds, an estimate can be made of the survival from release into the river to the return from the ocean. The proportion of the total accounted for CWTs (all fisheries and hatcheries) accounted for in all fisheries estimates the total exploitation rate on that stock. The proportion of the total accounted for CWTs (all fisheries and hatcheries) estimated in a fishery provides an estimate of a fishery specific exploitation rate. With known proportion of the population represented by the individuals with CWTs, the numbers of CWTs estimated in a fishery, and the total catch of that fishery, and estimate of the fishery specific harvest rate on a population can be made. The life history trajectories of the chinook as indicated in Table 1 complicates the extrapolation of annual fisheries data to brood year exploitation rates. In order to estimate the effect of fisheries on the survival of a population, the estimates based on the landed catch must be adjusted by estimates of mortalities caused by the actions of the fishery but included in the estimates of the landed catch.

### **5.2.3. Management Processes**

Because the coded wire tag information indicated that fisheries in other jurisdictions intercepted significant quantities of Puget Sound chinook, Nooksack stocks included, it was necessary for the co-managers to cooperate in national and international management processes in order to ensure that local management objectives are met. The Pacific Fisheries Management manages the fisheries in the Extended Economic Zone of the United States off of the States of Washington, Oregon and California. The PFM is responsible for regulation of ocean fisheries to ensure an escapement of chinook, on a stock by stock basis, from the ocean fisheries to the state coastal and internal waters to required to meet biological and legal requirements for conservation and allocation objective. The co-managers provide the PFM, through the North of Falcon process, the information required to manage ocean fisheries to meet the requirement of conservation and allocation of Puget Sound Stocks. The Pacific Salmon Treaty (1985) created the Pacific Salmon Commission to prevent overfishing, provide for optimum production, and provide for each party to receive benefits equivalent to the production of salmon originating in its waters where intercepting fisheries of one nation affected the ability of the other to achieve conservation and management objectives.

#### **5.2.3.1. The Co-managers**

The Boldt Decision (*U.S. v Washington*) interpreted the language of the treaties made with Washington tribes “the right of taking fish at all usual and accustomed grounds and stations is further secured to said Indians in common with all citizens of the Territory” to mean sharing equally in the opportunity to take fish sharing means the opportunity to take up to 50% of the allowable harvest. Prior to the Decision in 1974, most commercial fisheries on Puget Sound salmon were conducted in marine waters, with no explicit management units or escapement goals. The Boldt Decision encouraged the development of significant tribal fisheries at the mouths of Puget Sound rivers, and required the development of spawning escapement goals for each management unit. The court maintained continuing jurisdiction over the implementation of the decision.

The Fish and Wildlife Service initially provided technical assistance to the tribes to develop the information and management skills required to ensure identification of conservation objectives, identification of harvestable surplus and the allocation of the allowable harvest between tribes and the citizens of the State. The Tribes developed programs to provide them with the ability to make responsible management decisions affecting the treaty reserved natural resources. The tribes, in consultation with the State of Washington were responsible to see that fisheries under their respective jurisdictions were regulated to ensure that the spawning escapements (the numbers of spawning adults), and respective 50% shares on a stock by stock, region by region, basis were met or any differences were agreed.

Initially, the State of Washington did not trust the tribes, and much time and money was spent arguing issued before a federal mediator. In the early 80s the State of

Washington decided that more could be accomplished by cooperation than by litigation, and co-management was born. The Puget Sound Salmon Management Plan (PSSMP 1985) set out agreed management objectives and protocols for developing agreed run forecasts and fishing regimes. The PSSMP identified management units no smaller than a system that flows into saltwater, unless component populations exhibit a difference in migration timing, or as otherwise agreed by the co-managers. The implementation of the PSSMP is now integrated with other management processes.

### ***5.2.3.2. Pacific Fisheries Management Council***

The Fisheries Management and Conservation Act (FCMA) of 1976 (last revised as the Sustainable Fisheries Act of 1999) extended the fisheries jurisdiction of the United States to the Extended Economic Zone, and established regional fish management councils to manage fisheries off shore from 3 to 200 miles. The Pacific Fisheries Management Council is responsible fisheries off the coast of California, Oregon and Washington. The Council recommends fisheries management measures to the National Marine Fisheries Service (NMFS). The Council has 14 voting representatives from Oregon, Washington, Idaho and California chosen by the Governors of each state to represent state or tribal agencies and recreational and commercial fishing and marine conservation.

The directions to the Council are that conservation and management issues shall:

1. Prevent overfishing while achieving optimum yield.
2. Use best available science.
3. Manage stocks through their range as a unit, with interrelated stocks .
4. Not discriminate between residents of different states and contain fair and equitable allocation of opportunity.
5. Promote efficiency without relying solely on economic allocation.
6. Allow for variations in fisheries, resources and catches.
7. Minimize costs and avoid duplications
8. Take into account the importance of fisheries to communities.
9. Minimize bycatch.
10. Promote safety of life at sea.

U.S. fishery regulations must comply with many other laws including the National Environmental Policy Act (NEPA), the Marine Mammal Protection Act (MMPA), The Endangered Species Act (ESA), the Coastal Zone Management Act (CZMA), and the National Marine Sanctuaries Act. International agreements and organizations, and the United Nations Code of Conduct for Responsible Fisheries also play a role in the shaping of U.S. fisheries.

The council is composed of Council members, staff, advisory bodies, and the public. Pacific coast salmon fisheries in Council managed waters focus on chinook and coho salmon. The Councils Salmon Fisheries Management Plan describes the goals and

methods of salmon management. The plan has an annual goal for spawner escapement goals and provides for the allocation of harvest.

The basic theory of conservation included in the plan is the Optimum Yield, the catch that will provide the greatest overall benefit to the nation. The Optimum Yield is the Maxim Sustainable Yield (MSY), the largest long term average catch that can be taken from a stock under prevailing ecological and environmental condition, reduced by economic, social and ecological factors. MSY is associated with the number of spawners required on average to achieve this goal. The MSY is based on long term average that can only be calculated from historical data that might not reflect MSY under current or future conditions.

Most of the conservation objectives for stocks north of Cape Falcon have been included in U.S. District Court Orders. Under these orders for Washington Coastal and Puget Sound Stocks (US v Washington 626 F. Supp. 1405 (1985) and Hoh v Baldrige No. 81 [R] C) the Treaty Tribes and the WDFW agree to annual spawner targets. Because some of the stock components present in waters under the jurisdiction of the Council are subject to minimal harvest impacts because of migration timing or distribution, the Council ability to affect the overall trend in abundance through harvest restrictions is negligible. While harvest has contributed to the declines in salmon abundance, the primary reason for their decline has been the degradation and loss of freshwater spawning, rearing and migration habitats, key factors in determining the MSY of salmon populations. The Council chooses not to reduce the MSY to account for the new degraded freshwater habitat conditions.

The Council follows a pre-season process to develop recommendations for the ocean fisheries. In February, reports of the previous season and forecasts of abundance for the coming season are released. The Council meets in March to develop season options. Hearings are held between March and April to review options and final recommendations are recommended during an April meeting and adopted by NMFS on May 1. There is an iterative process between the levels set by the PFMC for the ocean fisheries and the escapement of salmon required in the coastal and internal waters to meet conservation and allocation objectives. Agreement to a nominal fisheries plan occurs during the North of Falcon (NOF) process within the PFMC process. The specific fisheries in the plan are adjusted during the year when new information generated during fisheries suggests that conservation or allocations objectives will not be met.

#### ***5.2.3.3. Pacific Salmon Commission***

The Pacific Salmon Commission (PSC) succeeded the IPSFC in 1985 with the conclusion of the Pacific Salmon Treaty, an agreement between the United States and Canada concerning the management of their salmon fisheries. In order to fulfill the obligation to prevent over fishing, provide for optimum production and ensure that both countries

receive benefits equal to the production of salmon from their waters, it was necessary to establish agreed programs to provide the information on interceptions by each country on stocks originating in the waters of the other. The Southern Panel was established to coordinate the management of chinook, coho and chum salmon on the southern U.S. Canada region, and the Fraser Panel retained the management functions of the IPSFC for sockeye and pink salmon fisheries in the Fraser Panel Area which included Point Roberts, San Juan Islands and the Strait of Juan de Fuca.

The PSC established a Joint Data Sharing Committee, reporting to the Standing Committee on Research and Statistics to facilitate data exchange between the two parties and develop standard methods of reporting and analyzing CWT data. The U.S. repository for this data is the RMIS at the PSFMC facility. The Chinook Technical Committee (CTC) developed a model to estimate stock-age-specific exploitation rates from a cohort analysis of CWT recovery data. The initial single stock multiple brood and fishery model was developed in 1984 to reduce harvest rates to a level that would allow rebuilding by 1998. This model underestimated the time required for recovery because of the affect of aggregated stocks under the ceiling management. The final model during the 1984 negotiations incorporated four stocks and nine fisheries. As the need for added stratification of fisheries was determined the model was modified in 1987 to simulate 26 stocks and 25 fisheries and by 1994 increased to 30 stocks and 29 fisheries. The University of Washington developed a user friendly version of the CTC model named CRiSP Harvest, based on the 1995 CTC model to explore the effects of various harvest management regulations on chinook stock rebuilding.

The 1999 Annex to the Treaty established chinook fisheries regimes designed to constrain fisheries exploitation to meet spawning escapement goals. Abundance based regimes were established for Southeast Alaska, Northern British Columbia, and the West Coast of Vancouver Island fisheries complexes because of their impacts on mixtures of chinook populations. An abundance Index is the ratio between the projected age specific abundance of natural and hatchery stocks and the abundance observed during a base period (1979-1982). The allowable harvest will vary up or down based on the relationship of the abundance index. The fishery specific exploitation rate each year will be scaled to the same proportion of the base year rate as the projected abundance is related to the base year abundance. Individual Stock Based Management Regimes (ISBM) constrains impacts on individual stocks of naturally spawning chinook. For stocks not achieving escapement goals, there is a general obligation for Canada to reduce its adult equivalent mortality rates by 36.5% from the base period rate and the US to reduce its of the parties adult equivalent mortality rates by 40% from the base period rate.

CWT information the ocean migration patterns and vulnerability of the Nooksack chinook stocks demonstrated that Canadian fisheries in the Strait of Georgia and the Southern West Coast of Vancouver Islands were major harvesters of Nooksack Chinook. The realities of the chinook management in fisheries in the Southern Panel

area is that, as in the PFMC management, the contributions of the Nooksack Early Management Unit represented a negligible contribution to the harvest in those fisheries, but those fisheries accounted for a significant portion of the total exploitation on the stock. As a result most of the time and energy of the PSC is devoted to the larger stocks that contribute a significant portion of the catches in a fishery as a single stock or a group of stocks. The Biological Opinion by the National Marine Fisheries Service concerning the 1999 amendments to the PST acknowledged that it would be difficult to meet the Recovery Exploitation Rate (RER) the level of allowable harvest that would ensure rebuilding of the Nooksack Early Chinook Management Unit with all harvest in US waters south of Canada eliminated given the expected exploitation rates in the Canadian fisheries. The present agreement for conservation and management of salmon between the United States and Canada expires at the end of 2008 except for management of Fraser River sockeye and pink salmon which expire at the end of 2010.

Control of fishing mortality becomes easier as the proportion of the stock of concern in the harvest becomes larger. The limitation of fishing mortality can be implemented in several ways. Where there is sufficient information on the timing and relative abundance of a stock of concern through a particular fishing area, time and area closures become the method of choice. The more precise the information of timing an stock contributions is, the more restricted the time and area closures can be without disrupting the harvest on other stocks with harvestable surplus. In those instances where the chinook of concern may be taken during the course of fisheries on other salmon species, and the fish are alive at capture, chinook may be returned to the water. Although there is fishing mortality in these cases, it is much less the total chinook handled.

It is in this context that the Nooksack Harvest Management plan, a component of the Regional Management Plan governing fisheries in Puget Sound was developed. The Regional Management Plan concerning harvest was submitted to the National Marine Fisheries Service in 2004 for as a limit on the application of the Endangered Species Act take prohibitions imposed by the Secretary of Commerce on activities affecting the Puget Sound Chinook Evolutionarily Significant Unit (ESU) under Section 4d.

#### **5.2.4. Harvest Management Tools**

##### ***5.2.4.1. Fisheries Resource Allocation Model (FRAM)***

The Co-managers developed a Fisheries Resource Allocation Model (FRAM) which combined agreed information on the contributions of salmon stocks to fisheries in a manner that would allow an estimate of the stock contribution to each fishery given pre-season forecasts of each stock abundance, and estimated levels of effort in each fishery by treaty and non-treaty fishers. The summation of the of estimated fisheries mortalities by stock group and allocation group provided the basis for determining whether a particular fishing scenario provided the agreed escapements and allocations on a stock by stock basis.

In the late 1970s, the Washington Department of Fisheries (Now WDFW) and the US National Bureau of Standards (NBS) developed a model for evaluating alternative fishery regulatory packages coded in FORTRAN and run on a mainframe. In the 1980s, the proliferation and development of personal computers allowed the model to be converted into spreadsheet models. The initial conversion, the Coho Assessment Model (CAM) was used until the mid 90s and its report generation capability was improved and a Terminal Area Management Module (TAMM) provided more detailed information on terminal area fisheries. As the demand for information increased, it became difficult to evaluate fisheries regimes in the spreadsheet models, and in the mid 90s the CAM was reprogrammed in Quick BASIC and renamed FRAM. Because common algorithms in the spread sheet models were used to manage both coho and chinook, the new FRAM was developed to evaluate fisheries regimes for either chinook or coho by using different input file configurations. In 1998 FRAM was converted to Visual BASIC to use the user interfaces in MS Windows. A multi Agency Model Evaluation subgroup reviewed model performance and parameter estimation methods and revisions were made between 1998 and 2000.

FRAM is a discrete, time-oriented, age structured, deterministic computer model intended to predict the impacts from a variety of proposed fishery regulation schemes during a single management year. It produces point estimates of fishery impacts by stock for specific time periods and age classes. It tracks the progress of individual stock groups as the fisheries in each time step exploit them. In each time step, all pre-terminal fisheries operate on the entire cohort and all terminal fisheries operate on mature fish.

There are 33 stock groups currently represented in the Chinook FRAM. Each of these groups have adipose clipped and non-clipped components to allow assessment of mark-selective fishery regulations. The model then processes clipped and un-clipped fish as separate stocks, expanding the number of chinook stock groups to 66. The stocks represented in FRAM were chosen based on the level of management interest, their contribution rate to fisheries and the availability of representative CWT recoveries in the fisheries. There are 73 fisheries in the Chinook FRAM including pre-terminal and terminal fisheries in Alaska, Canada, Washington, Oregon and California to allow assessment of and account for all fishing related impacts to the stocks. The time step structure in FRAM provides a level of resolution that corresponds to management planning seasons, and species specific migration and maturation schedules. The number of time steps was restricted to four in the Chinook FRAM those necessary for fish management purposes, October to April 1, May-June, July-September and October-April 2. The time step resolution is limited by the CWT database. Increasing the time steps, decreases the CWT recoveries in a time-area strata and increases the variance of the exploitation rates in those strata. At each time step, a cohort is subjected to natural mortality, pre-terminal fisheries, and maturation.

#### **5.2.4.1.1. FRAM Assumptions**

The value of FRAM are based on the following assumptions:

1. CWT fish accurately represent the aggregated stock group with may contain hatchery and natural components.
2. Chinook length at age is stock specific and constant from year to year to allow estimation of legal size in size-limit fisheries.
3. Stock distribution and migration is constant from year to year and estimated as the average distribution in the base period data. In the absence of information on annual variability, fishery-specific exploitation rates are computed relative to the entire cohort.
4. Chinook are assumed to be vulnerable to gear only once in each time area stratum as the catch equations are discrete and not instantaneous.

The FRAM base period is calibrated using the escapement, catch and CWT recovery data from 1974 to 1979 brood year CWT releases because fisheries were being conducted across an extensive geographic area and over an extended time period giving the best representation of CWT stock distribution. The Nooksack Early Management Unit is an out of base stock, one that had no indicator stock CWTs in the base period, and CWT data for these stocks are translated to the equivalent base period recovery and escapement data using known fishing effort and harvest relationships between recovery years. The base period data are used to estimate base period stock abundances and age-specific time-area fishery exploitation rates and maturation rates for modeled stocks derived from species-specific cohort analysis procedures to reconstruct a pre-fishing cohort size for each stock and age group using assumed natural mortality and incidental mortality rates.

#### **5.2.4.1.2. FRAM Input values**

1. Abundance estimates for each stock or stock aggregate are segregated by age class from age 2 to age 5.
2. Size limits where applicable
3. Catch mortality in either of five forms: quota, exploitation rate relative to the base period, a ceiling, selective harvest or for Puget Sound terminal fisheries, a harvest rate.
4. Release mortality based on studies of hook and line fisheries, or net fisheries. Mark selective fisheries also have mortality due to the inappropriate retention of un-clipped fish, or the mortality of a clipped fish subsequently released.
5. Mortality not otherwise associated with direct handling or landing, i.e. drop off of a hook and subsequently die, or drop out of a net and subsequently die.

#### **5.2.4.1.3. FRAM Operations**

Results of FRAM model runs are expressed in printed FRAM reports or Excel spreadsheets that are linked with FRAM reports. TAMM spreadsheets provide comprehensive summaries of fishery mortality, exploitation rate, run size and escapement for key stocks during the annual salmon season setting processes. For each time step and fishery, FRAM scales the predicted cohort size for the current year to the base period for the age 2 through age 5 cohorts. Each cohort is then processed through a time step loop where natural mortality is applied to the beginning cohort size, the projected catches for all fisheries in the time step are executed and totaled, and the remaining abundance of the stock is calculated. At the end of the time step loop, the program checks for the presence of a TAMM. If no TAMM has been specified, processing is complete and the terminal run sizes are calculated. If a TAMM has been specified, FRAM will repeat processing through specified fisheries and time step loops.

After the pre-terminal catch has been calculated, the number of fish in each cohort maturation is calculated according to a time-area specific rate calculated from the base period data. The mature portion of the cohort is available to those fisheries that have been designated as harvesting only mature fish while the immature portion of the cohort is used to initiate the next time step. All fisheries are designated pre-terminal or terminal in the base period data. Escapement is defined any fish from the mature cohort that does not die from fishery related mortality. All maturation and escapement occurs within a single time step.

Fishery related mortality for chinook is expressed as a nominal value or adjusted for Adult Equivalent (AEQ) to account for the multiple ages that are available to fisheries. This allows all mortalities to be expressed as the number of fish that would have escaped to spawn in the absence of fishing adjusted for natural mortality. The AEQs are calculated from the CWT base period calibration and consider age specific natural mortality and maturation rates calculated from CWT recoveries. The AEQ at maximum age is 1 and all other age-time step values are proportional to this value. The model stock proportion is the proportion of the total catch in a fishery that is accounted for by the modeled stocks as calculated during the model calibration process.

The FRAM interaction with the TAMM allows terminal area fisheries to be evaluated on a finer scale of resolution. The terminal areas are specified in the PSSMP and allow the development of unique regional management goals with the flexibility to analyze FRAM output according to their needs. Abundance levels of every Puget Sound stock are entered into the TAMM with the harvest impacts of all Puget Sound fisheries to allow fisheries specific impact analyses on stocks of interest. This allows TAMM to model fisheries at a finer time and area scale than FRAM. The TAMM fisheries impacts are summed into the terminal area impacts used by FRAM to calculate scalar inputs. TAMM allows the use of harvest rates (% of terminal area abundance) of the escapement of local stocks and the catch of all stocks (TAA) or the escapement and

catch of local area stocks. (ETRS). The difference in fishery control mechanisms in TAMM creates problems in estimating FRAM fishery scalars because the run size in each terminal region is dependent upon the impacts from all other regions. An iterative process reruns terminal area time steps until the difference between TAMM specified expected fishery impacts and the FRAM estimates calculated from base period exploitation rates are within 0.1% of the expected value. On each iteration FRAM scalars are adjusted by the proportion of the expected value divided by the FRAM estimate for each terminal fishery.

#### ***5.2.4.2. Rebuilding Exploitation Rate***

Several Management units have calculated a rebuilding exploitation rate (RER) is the highest allowable exploitation rate for a salmon population given normal or increased levels of return. Lower than usual returns generally require special restrictions in harvest, as outlined in the co-managers' Puget Sound Chinook Management Plan (PSIT and WDFW 2004). The rate is designed to both minimize the risk of natural origin (NOR) spawning escapement falling below some critical escapement threshold (CET) and insure, at a given level of probability, that the escapement would reach an rebuilding escapement threshold (RET) if the RER was maintained over 25 years. The RER is inclusive of all harvest mortalities on the population, direct and indirect.

A general method has been used is to forecast recruits 25 years into the future based on a derived spawner-recruit function for the population and assumed environmental survival conditions; test a range of exploitation rates (ER) on population abundance; and use risk assessment to determine the maximum ER value that satisfies the risk criteria, this maximum ER value becomes the RER. Escapement, age, harvest, and environmental covariate data for recent years are used to determine spawner-recruit function parameters. Environmental covariates include marine survival indices and freshwater discharge during the incubation period.

There are three analytical stages to developing an RER: first is the data collection and run reconstruction in the abundance and productivity (A&P) maintained in an Excel file, next is parameter estimation for the spawner recruit function in the Dynamic Model Excel spreadsheet, and finally the risk assessment analysis done with viability and risk assessment procedure (VRAP), a program in Visual Basic run from an Excel spreadsheet.

The NMFS has generated estimates of RERs for the Nooksack early chinook populations with this analytical method. For each combination of spawner-recruit relationship and exploitation rate they ran 1000 25-year projections. Estimated probabilities of exceeding the RET were based on the number of simulations for which the average of the spawning escapements in years 21-25 exceeded the RET. Estimated probabilities of falling below the CET were based on the number of years (out of the total of 25,000 individual years projected for each target exploitation rate for a particular spawner-

recruit relationship) that the spawning escapement fell below the CET. The VRAP was run for exploitation rates of 0 to 0.51 in steps of 0.01. The percentage of the escapements that fall below the lower abundance threshold and the percentage of the escapements at the end of the 25 years (averaged over the last 5 years) that are above the rebuilding abundance threshold are calculated and presented in Table 5.4.

The RER is chosen as the lower of the exploitation rates that results in escapements 1) falling below the CET by 5 percentage points or less than with no fishing during the 25 year period and, 2a) above the RET at least 80% of the time at the end of 25 years OR 2b) above the RET no more than 10 percentage points different than with no fishing. For the Nooksack, it was the 5% rule that would determine the RER. Due to the variability in estimating the RER with multiple runs of VRAP, the model was run 25 times using the same parameters but a different starting seed that generates at random the parameters for marine and freshwater survival drawn from the 1984-1997 period.

Detailed results of these projections are summarized results are in Table \_. For the Nooksack spring chinook management unit, the indicated target exploitation rates are 0.20 - Ricker, 0.13 - Beverton-Holt, and 0.17 - hockey stick. Since all three models performed similarly, we propose to use the average of these values as the target rebuilding exploitation rate (RER). This average is 0.17, rounding to the nearest whole percentage exploitation rate.

To make the RER compatible with the fishery model used in annual fishery planning (the FRAM model), the RER derived from data in the A&P tables were converted to a FRAM equivalent RER using the 1996-1999 average ratio of the post season exploitation rate estimates derived from FRAM divided by the exploitation rate estimates from the A&P table (Table 5.5). This period of years represents recent fishing patterns and exploitation rates more similar to that of the RER. Using this conversion, the FRAM RER to use for annual preseason fishery planning purposes is 10%.

$$0.17 \text{ (RER from VRAP)} \times 0.57 = 0.10 \text{ (RER in FRAM terms)}$$

The co-managers have not yet agreed with the NMFS analysis because of inconsistencies between the results of the model and the information from EDT modeling and observed returns per spawner in the North/Middle Fork Population.

#### **5.2.5. Guiding Principles for Managing Harvest Impacts on Nooksack Early Chinook**

- Conserve the productivity, abundance and diversity of the Nooksack early chinook management unit.
- Manage risk through fishery mortality limits which incorporate a consideration of the uncertainty of estimates of current and future abundance and productivity,

and on-going monitoring, research and analysis to quantify risk factors and modify the plan as needed to minimize such risks

- Meet ESA Jeopardy standard that harvest does not appreciably reduce the likelihood of survival and recovery of the ESU.
- Provide an opportunity to harvest surplus production from other species and populations.
- Account for all sources of fishery related mortality
- Adhere to the principles of the Puget Sound Salmon Management Plan, and other legal mandates pursuant to US v. Washington to ensure equitable harvest sharing opportunity among tribes, and among treaty and non-treaty fishers.
- Achieve the guidelines on allocation of harvest benefits and conservation objectives that are defined in the 1999 Chinook Chapter to Annex IV to the Pacific Salmon Treaty.
- Ensure exercise of treaty reserved tribal fishing rights.
- Directed fisheries, fisheries in which more than 50% of the total fishery related mortality is made up of listed Puget Sound chinook, are precluded except for small tribal ceremonial and subsistence harvest, and restricted research related fisheries.

Harvest management alone cannot recover or rebuild WRIA 1 chinook stocks, but can help conserve the abundance, and diversity of populations while habitat capacity and productivity recover. Current harvest impacts only represent a small fraction of the historic production capacity of the populations. Restoration and protection of freshwater, estuarine, and nearshore marine habitat in WRIA 01 is essential to substantially improve productivity as is necessary for recovery.

While past harvest may have contributed to the reduced chinook abundances in WRIA 1, it doesn't follow that the absence of harvest will restore historic abundances due to impaired habitat capacity and productivity. For example, wild abundances of North/Middle Fork early chinook have not demonstrably increased despite a large increase in spawners from the large hatchery returns. This supports the hypothesis that habitat capacity and productivity are currently the primary factors limiting recovery.

Stewardship of chinook populations will come first in managing the resource, to ensure adequate annual wild spawning populations will be available for available habitat capacity and productivity. This will ensure harvest provides for recovery of healthy populations as habitat recovers to provide sustainable fishing opportunities over time. When faced with uncertainties, managers will err on the side of the resource.

- Where a mixed-stock fishery substantially impacts more than one stock unit simultaneously, harvest management should be geared to conserve and recover

the weakest of the smaller stock units. This may mean reducing overall harvest rates, implementing selective fishing, or changing the location and timing of harvest activities to allow for stock differentiation (e.g. time or area closures; terminal fishing).

#### **5.2.6. Escapement Goals**

The Maximum Sustainable Harvest escapement goal was the initial objective of the PSSMP to achieve conservation and management objectives for each stock. Due to the lack of information relating spawning abundance to production during the early 20<sup>th</sup> century before major development in the watershed degraded the habitat, a MSH escapement goal can not be directly calculated. The co-managers adopted a goal of 2,000 spawners in each Nooksack early chinook population as a measure of when directed harvest could be considered.

Because the current management focuses on restricting exploitation rates based on the best available scientific information the management focus has changed from meeting escapement goals, which can only effectively managed for in the terminal area to meeting a variety of exploitation rates associated with different spawning escapement levels associated with actual or theoretical stock-recruit functions.

In the Nooksack early chinook management unit, there is insufficient data to compile a MSH escapement from spawner recruit functions under historic conditions and the co-managers are concerned that developing spawner recruit functions under existing degraded habitat conditions would jeopardize the recovery of the ESU and not support the treaty reserved fishing rights.

Where there is adequate spawner recruit information co-managers have chosen to identify an exploitation rate that represents an upper management threshold expected to provide the MSH escapement or a buffered surrogate. At levels above the upper management threshold there is harvestable surplus which would provide for a directed harvest or allow a higher level of incidental harvest. Demographic and genetic theory indicates that when the spawning abundance falls to a very low level, there is a significant risk of demographic instability, loss of genetic integrity and extinction. That level is not clearly identified in salmon populations, but the management plan provides for a low abundance threshold (LAT), a level of spawner abundance set well above the point of instability. In the Nooksack early chinook management unit, the co-managers have set that the LAT at 1,000 natural origin spawners in each population.

When the spawning escapement falls below the LAT, as it does regularly in the Nooksack early chinook management unit, the co-managers will implement extraordinary to increase the spawning escapement above the LAT or reduce the SUS exploitation rate to or below a critical exploitation rate ceiling (CERC). For the

Nooksack early chinook management unit, the CERC is an annual 7% Southern US (SUS) exploitation rate until April 30, 2010, with the possibility that the SUS exploitation rate will exceed 7% but not 9% in one year. Restrictions below this level would effectively limit treaty and non-treaty harvest opportunity on non-listed species and populations without ensuring recovery. If further resource protection is necessary, it must be found in mixed stock fisheries in Canada and Alaska, improving habitat conditions and/or providing supplementation where effective and appropriate. The Minimum Fisheries Regime (MFR) represents the lowest level of fishing mortality that is possible, while allowing a reasonable harvest of the surplus abundance of non-listed chinook, and sockeye, pink, coho and chum salmon. Reducing tribal fisheries to the levels specified in the MFR, while requiring a significant sacrifice of fishing opportunity for treaty reserved fishing rights, provides the minimum acceptable level of fishing that allows some exercise of those rights and their demonstrates their contribution to the recovery of the Chinook ESU to a point that would satisfy their treaty reserved fishing rights. The Co-managers established the CERC in consideration of the MFR and FRAM simulations of responses to the critical status for some management units. If there are significant changes in FRAM that alters the calculation of exploitation rates,

#### **5.2.7. Harvest Management Actions and Strategies**

The co-managers will take the following actions through April 30, 2010, consistent with, and in addition to commitments contained in the Harvest Management Component of the Comprehensive Management Plan for Puget Sound Chinook determined by NMFS to be in according to the Section 4d rule exempting fisheries covered by the plan from take prohibitions of Section 9a of the ESA:

- When escapement levels projected to be less than 1,000 NOR spawners, the LAT, in each of the Nooksack early chinook management unit populations:
- Fisheries in the Southern US will be planned using the best available information and tools during the PSSMP, PFMC, and PSC processes to limit the total mortality of all fisheries less than 7% of the returning adults, with the potential to exceed 7% but not 9% in one year under exceptional conditions according to the Minimum Fishing Regime.
- Total mortality will include only two limited directed harvest fishers
- A limited tribal ceremonial harvest of Nooksack early chinook in the Nooksack river, amounting to less than 10 natural origin spawners, and co-migrating cultured stock in excess of spawning requirements.
- A limited tribal subsistence fisheries targeted at less than 20 natural origin spawners and co-migrating cultured stock in excess of spawning requirement early July from Slater Road crossing to the river mouth in the lower Nooksack, and from the Mosquito Lake road crossing down to the SR 9 bridge in the lower North Fork to meet minimum tribal requirements.

- Fisheries in Bellingham Bay and the Nooksack River directed at fall chinook will not open prior to August 1. Subsequent fishing in the Nooksack River will occur in upstream zones on a weekly basis as early chinook clear these areas. Accordingly, the area extending two miles downstream of the confluence of the North and South Forks will not open prior to September 16.
- If escapement levels are projected to exceed 1,000 NOR spawners, the LAT, in each of the Nooksack early chinook management unit populations, remain at the MFR, unless that total mortality in all fisheries falls under an RER developed by jointly by the co-managers and NMFS, in which case Southern US harvest will be planned to equal or less than the agreed RER.
- Regulations will be promulgated to govern fisheries according plans developed and agreed in the PSSMP, PFMC and PSC processes.
- Enforcement actions necessary to verify that the regulations governing fisheries are observed and provide penalties for violations sufficient to deter violation of regulations promulgated to implement agreed fisheries will be implemented.
- Focus harvest management and monitoring of populations on ESA-listed or at-risk stocks. Both harvest management and hatchery production strategies should focus on the protection and recovery of at-risk wild salmon stocks (chinook, coho). Harvest monitoring should also include listed bull trout. Strategies should be designed to maintain the level and distribution of spawning escapements of naturally-produced salmonids that will protect the genetic diversity and resilience of populations within each ESU or genetic diversity area (GDU). Escapements in excess of targets will provide ecological benefits for chinook, bull trout and coho potentially increasing their abundance and productivity.
- Harvest management decisions are made at the management unit scale, and each management unit can contain more than one recognized population, within population diversity, and small groups of diverse groups of fish not yet recognized as stocks (upper North Fork coho, riverine sockeye etc.). When fisheries exist that may impact unique salmonids that appear to exist in small abundances, escapement and population data will be collected to help ensure genetic and ecological diversity are maintained.
- The State and Tribes will seek agreement on the total escapement rates, escapement levels, or escapement ranges that are most likely to maximize long-term surplus production (maximum sustainable yield or MSY) for wild populations or combinations of wild populations or management units. These rates, levels, or ranges will be based upon achieving MSH and will account for all relevant factors, including current abundance and survival rates, habitat capacity and quality, environmental variation, management imprecision, and uncertainty,

and ecosystem interactions. MSH shall be calculated by using long-time series of accurate spawner and recruit statistics for each population where possible. When such statistics are not available, MSH may be calculated by using historical production, habitat availability, or the best available methods for calculation. Additionally, harvest management will consider the needs of smaller units or populations (upper North Fork coho, riverine sockeye, summer run steelhead, bull trout) to maintain viable population abundances and within population diversity and to maintain geographic distributions into less strong habitats (i.e. South Fork chum).

- Harvest management will be responsive to annual fluctuations in abundance of salmonids. Abundance of all WRIA 1 salmonid stocks that are likely to be harvested will need to be estimated yearly, both pre-season, in-season, and post-season. Survey effort will vary depending on stock priorities. Where direct measurement of spawner abundance are not possible, surrogate measures will need to be employed, such as abundance of index reaches.
- To accomplish the goal of maintaining or increasing genetic diversity within and among stocks, harvest should be managed to minimize differential selection for size, age, and return timing of wild populations, so as not to impede the goal of maintaining or increasing genetic diversity within and among stocks. Fishery selection within populations will be minimized to insure that population characteristics such as adult size, timing and distribution of population migration and spawning, and age at maturity are similar between the fished and unfished portions of the population. This means that the population will not be changing over time as the result of harvest influences except that a population may change back to its natural patterns as a result of this policy and other management actions. For the salmonids that have multiple spawning capabilities (bull trout, steelhead, cutthroat), the primary goal will be to prevent any significant harvest caused shift to sexual maturity at a smaller size and/or age.
- The fishery and hatchery management principles that are stated in the WDFW-Tribal Wild Salmonid Policy (WDFW and WWTT 1997) will be implemented by the Lummi Nation, Nooksack Tribe, and WDFW, who will cooperatively review and, where there is agreement, jointly amend management agreements and plans relating to affected fisheries. Such review and agreements shall utilize best available science and be made with appropriate consultation with affected stakeholders. Follow the principles of the Puget Sound Salmon Management Plan (PSSMP 1985), and other legal mandates pursuant to *U.S. v. Washington* (384 F. Supp. 312 (W.D. Wash. 1974), and *U.S. v Oregon*, in equitable sharing of harvest opportunity among tribes, and among treaty and non-treaty fishers.
  - Harvest Management Policy (WDFW and WWTT 1997): The fisheries will be managed to meet the spawning escapement policy as well as genetic conservation and ecological interaction policies.

- Spawner Escapement Policy (WDFW and WWTT 1997): The wild populations or management units to which this spawner escapement policy applies will be defined on a comprehensive, statewide, or regional basis. The parties will review existing court orders, joint agreements, and management plans to seek agreement on whether changes are necessary to be consistent with the goals of the wild salmonid policy. Within this context, sufficient escapement of appropriate naturally spawning fish will be provided to encourage local adaptation and maximize long-term surplus production that sustains harvest, and to provide for recreational opportunities and ecological benefits. Exceptions to this general policy may be developed on a regional basis through agreement of the Department and affected Tribes to provide for recovery and rebuilding of wild stocks or where natural productivity is low.
- Conserving Genetic Diversity Policy (WDFW and WWTT 1997): Genetic diversity within and among stocks will be maintained or increased to encourage local adaptation and sustain and maximize long-term productivity. Conditions will be created that allow natural patterns of genetic diversity and local adaptation to occur and evolve.
- Ecological Interactions Policy (WDFW and WWTT 1997): Wild salmonid stocks will be maintained at levels that naturally sustain ecosystem processes and diverse indigenous species and their habitats. Healthy populations of other indigenous species will be maintained within levels that sustain or promote abundant wild salmonid populations and their habitats
- Conserve the productivity, abundance, and diversity of the chinook populations that make up the Puget Sound ESU (PSIT and WDFW 2004).
- Manage risk. The development and implementation of the fishery mortality limits in the co-manager chinook harvest management plan (PSIT and WDFW 2004) incorporate measures to manage the risks, and compensate for the uncertainty associated with estimating current and future abundance and productivity of populations. In addition, the 'management error' associated with forecasting abundance and the impacts of a given harvest regime is built into simulating the long-term dynamics of individual populations. Furthermore, the plan commits the co-managers to ongoing monitoring, research, and analysis, to better quantify and determine the significance of risk factors, and to modify the plan as necessary to minimize such risks.
- Harvest plans must meet ESA or DPS jeopardy standards to not "appreciably reduce the likelihood of survival and recovery" of the ESU (50 CFR 223 vol 65(1):173).
- Harvest plans that assess total exploitation (harvest) rates will account for all sources of fishery-related mortality, whether landed or non-landed, incidental or

directed, commercial or recreational, and occurring in the U.S. (including Alaska) or Canada.

- To minimize conflict between recovery and other objectives, first priority in harvest management regimes should be to meet treaty fishing obligations. It is important to maintain fishing traditions and customs. Alternatives for fishers may be necessary (license buyback, alternate uses for fishermen's boats and gear), where harvest opportunities diminish.

### **5.2.8. Specific Harvest Actions**

The low abundance management threshold is currently under review and under current conditions may be significantly less than 1000 spawners. After reviewing the best available information the co-managers in consultation with NMFS may establish more appropriate low abundance management thresholds.

With approximately 87% percent of the total annual harvest mortality occurring in Alaskan and Canadian fisheries (Table 4.10), the scope for total reducing fisheries impacts in Washington waters is limited. Net, troll, and recreational fisheries in Puget Sound have been shaped to minimize incidental chinook mortality to extent possible while maintaining fishing opportunity on other species such as sockeye and summer/fall chinook. The net fishery directed at Fraser River sockeye, in catch areas 7 and 7A in late July and August has caught very few Nooksack early chinook.

Total exploitation rates projected by the FRAM model for the 2001 – 2003 management years were 18%, 15%, and 20%, respectively. The analysis supporting derivation of a rebuilding exploitation rate (RER) for the Nooksack MU is in progress. It is recognized that tag data do not exist to support a direct analysis of the productivity of the South Fork stock, and given its status, there is ample reason to exert conservative caution in planning fishing regimes.

The co-managers are evaluating the productivity, abundance and diversity of the early chinook runs that could be expected from the Nooksack watershed under properly functioning habitat conditions, as well as those that might have been expected to exist under historical conditions at Treaty time. The calculation of a normal exploitation rate has not be made but at the current escapement goal of 2000 natural origin spawners in each population, and an exploitation rate of 60%, a AEQ recruit abundance of 5,000 in each population would be anticipated. An ambitious and long-term effort to restore and protect habitat, working in concert with appropriate hatchery production and harvest management regimes, is essential to recovery.

- The projected total harvest of early chinook by in-river tribal ceremonial and subsistence fisheries will be determined, during preseason planning, with reference to forecasted abundance of natural-origin and hatchery returns.

### 5.2.9. Data Gaps

Following are the highest priority needs for technical information necessary to understand stock productivity and refine harvest management objectives:

- 1) Improve estimates of population specific total escapement to the Nooksack basin, with emphasis on North/Middle and South Fork populations, including natural origin fish, and age data on these fish.
  - a) Secure resources to read backlog of otoliths collected at the Kendall Creek hatchery to provide a complete evaluation of the contribution of the different release strategies.
  - b) Improve the microsatellite DNA stock baselines of all chinook in the Nooksack Basin and conduct analyses to evaluate
    - i) the NOR contribution of North/Middle Fork strays to the South Fork that can no longer be identified by otolith marks
    - ii) the most appropriate break point to separate early and late chinook spawning in the South Fork
    - iii) the relative success of chinook in the South Fork of the different populations as indicated by samples from the South Fork Smolt Trap
    - iv) the relative success of North/Middle Fork spawners as indicated by samples collected at the Hovander smolt trap after eliminating the supplementation production identifiable by external mark (fin clip)
  - c) Develop alternative spawning ground population estimates that will allow:
    - i) Update pre-spawning migration behavior through radio tags or DIDSON technology.
    - ii) Increase recovery of carcasses on the spawning ground to improve estimates of the NOR age structure, yearling/sub-yearling contributions, and population composition.
- 2) Investigate rearing conditions in the river and the estuary and near shore areas to assist in the development of habitat restoration and protection actions.
- 3) Improve estimates of stock specific natural early chinook smolt outmigration from the North/Middle and South Fork populations and late timed chinook.
- 4) Develop stock/recruit functions, or other estimates of freshwater survival data to monitor the productivity of the two populations and late timed chinook.
- 5) Collect information to determine whether the current SUS fishing regime, or the hatchery supplementation program, are exerting deleterious selective effects on the size, sex, or age structure of spawners.

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**Table 5.3.** Optimum Values Calculated from the Beverton Holt Productivity Curves for the Nooksack Early Chinook Stocks Generated by EDT Model with Properly Functioning Conditions for Chinook Habitat

Stock	Spawners	Harvest	Return/Spawner	Population
North/Middle Fork	3,818	8,787	3.3	12,604
South Fork	1,960	5,161	3.6	7,121

**Table 5.4.** Results of VRAP runs for the Nooksack spring chinook management unit for each spawner-recruit function.

*Note: The exploitation rate that results in escapements below the CET 5% or less, and above the RET 10% or more, than with no fishing are noted in the first two columns for each function. For each model run, the exploitation rate that results in a five percentage point or less difference than with no fishing is in the third column.*

Run	Ricker			Bev-Holt			Hockey		
	0.20			0.13			0.17		
	AT NO FISHING		ER meeting	AT NO FISHING		ER meeting	AT NO FISHING		ER meeting
	percentage of time	5% criteria	percentage of time	5% criteria	percentage of time	5% criteria			
	<LT	>UT	5%	<LT	>UT	5%	<LT	>UT	5%
1	27.1	59.0	0.21	76.3	0.10	0.11	78.4	0.40	0.17
2	28.2	60.0	0.20	76.6	0.10	0.11	78.3	0.80	0.17
3	29.1	55.6	0.24	75.6	0.10	0.11	78.2	0.60	0.17
4	27.1	60.2	0.19	76.6	0.20	0.14	78.7	0.40	0.18
5	29.6	58.7	0.24	75.5	0.30	0.10	78.7	0.40	0.18
6	29.6	57.5	0.23	76.4	0.20	0.13	77.6	0.50	0.15
7	25.9	61.8	0.18	75.6	0.30	0.10	77.8	1.20	0.16
8	27	61.0	0.21	75.6	0.30	0.12	78.4	0.90	0.17
9	28	57.9	0.18	76.2	0.00	0.13	78.2	0.40	0.17
10	27.6	59.9	0.24	76	0.10	0.11	78.2	0.40	0.17
11	26.4	60.4	0.21	76.1	0.10	0.11	79.5	0.50	0.20
12	29.3	58.1	0.25	76.3	0.00	0.12	78.3	0.40	0.17
13	27.5	58.2	0.18	76.6	0.00	0.13	78.1	1.00	0.16
14	28	58.6	0.24	77	0.10	0.15	78.3	0.90	0.17
15	27.1	61.1	0.21	76.8	0.20	0.15	78.2	0.60	0.17
16	27.5	59.9	0.20	76	0.20	0.11	78.2	1.00	0.17
17	25.6	61.4	0.12	76	0.10	0.12	78.7	0.20	0.18
18	26.4	61.6	0.17	76.8	0.30	0.14	78	0.60	0.16
19	25.6	61.2	0.21	77.3	0.10	0.17	79.1	0.20	0.18
20	28.6	57.8	0.23	77.1	0.10	0.15	78.3	1.10	0.17
21	26.6	61.8	0.21	77.1	0.10	0.15	78.4	0.70	0.16
22	26.2	61.9	0.18	75.9	0.60	0.11	79	0.50	0.19
23	27.3	59.8	0.17	76.5	0.20	0.12	77.8	1.30	0.16
24	28	58.4	0.21	76.4	0.10	0.13	77.9	0.60	0.16
25	25.2	61.2	0.14	75.8	0.30	0.11	78.6	0.70	0.18

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**Table 5.5.** Ratio of FRAM exploitation rates to A&P derived exploitation rates for the Nooksack spring chinook management unit.

Return Year	A&P	FRAM	FRAM/A&P
1984	97%	43%	0.44
1985	94%	42%	0.44
1986	86%	41%	0.48
1987	94%	40%	0.43
1988	96%	49%	0.51
1989	85%	36%	0.42
1990	66%	30%	0.46
1991	79%	34%	0.44
1992	70%	34%	0.48
1993	33%	30%	0.91
1994	72%	27%	0.38
1995	46%	23%	0.51
1996	31%	18%	0.57
1997	36%	21%	0.58
1998	26%	15%	0.57
1999	28%	16%	0.57
1996-99 avg			0.57

**Table 5.6.** Estimates of the Origin of the Early Chinook Stocks Entering the Nooksack River.

Return Year	North Fk NOR	Total NF w/ Stray to SF	South Fk NOR	Total River Entry	SF+NF NOR	% NOR
1995	171	224	290	514	461	90%
1996	209	537	203	740	412	56%
1997	74	574	180	754	254	34%
1998	37	370	157	527	194	37%
1999	85	3820	166	3986	251	6%
2000	160	3426	284	3710	444	12%
2001	264	8146	267	8413	531	6%
2002	224	9723	289	10012	513	5%
2003	210	8519	204	8723	414	5%

**Figure 5.1.** Display of Beverton Holt Curves Generated By the EDT Model for North/Middle Fork and South Fork Nooksack Chinook Populations.

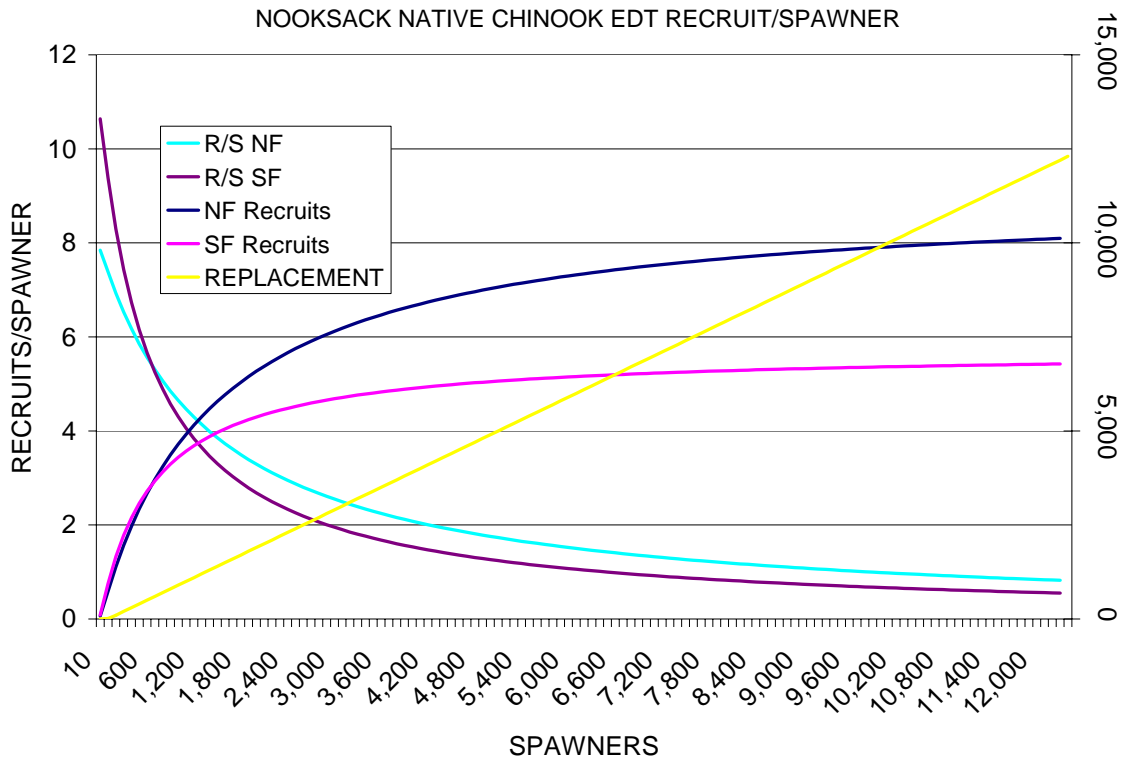
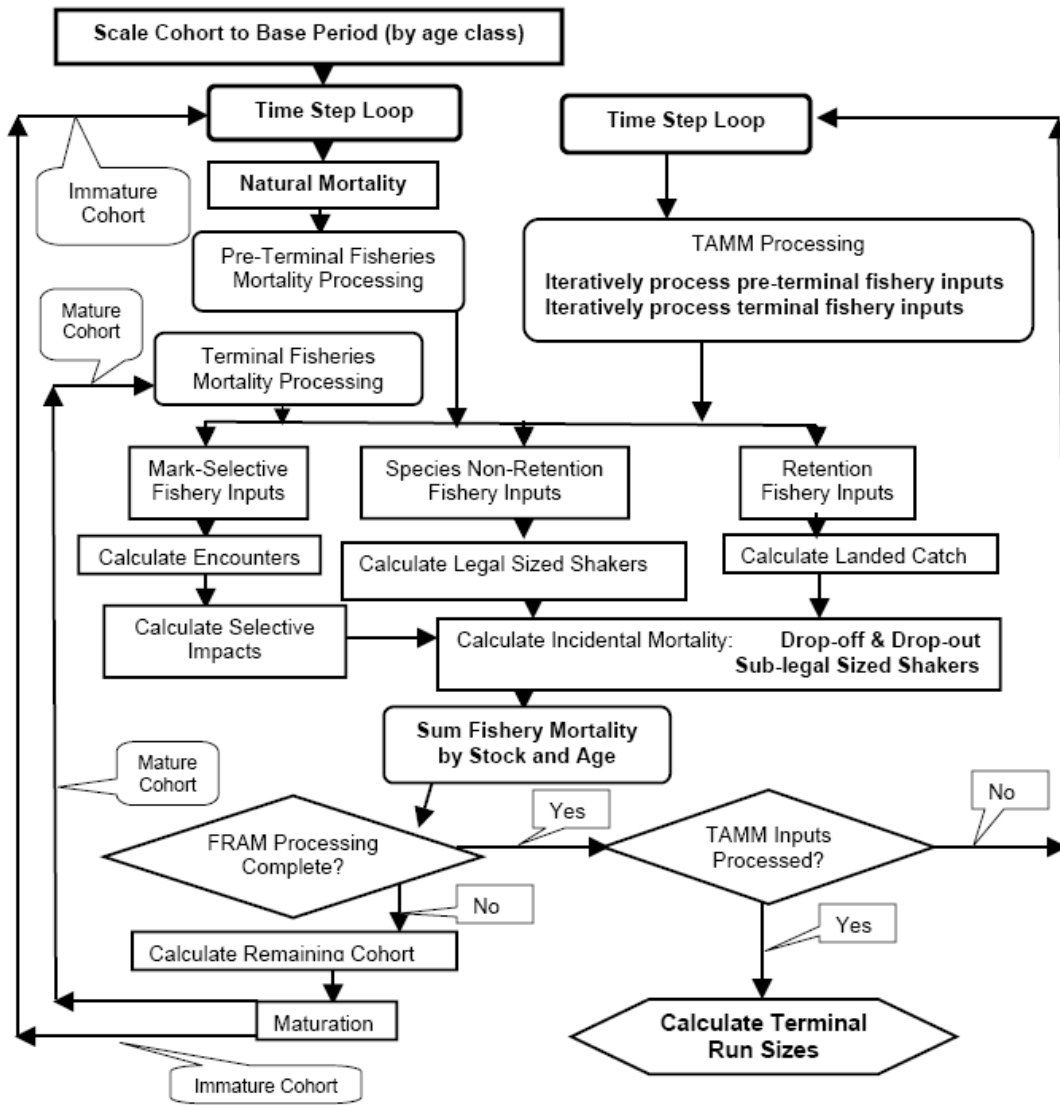


Figure 5.2. Flow Chart For the Chinook FRAM.



### **5.3. Hatchery**

#### **5.3.1. Recovery Objectives**

- Use hatcheries to aid in the recovery of WRIA 1 wild salmonid populations using integrated principles of genetic conservation, ecology, fish culture, and fisheries management.
- Hatchery production of chinook and other salmon will neither cause further decline nor inhibit recovery of WRIA 1 naturally spawning early chinook populations. Genetic diversity within and among stocks will be maintained. Hatchery programs will be managed, and adaptively managed, to minimize adverse genetic and ecological interactions between hatchery origin (HOR) and natural origin (NOR) early chinook, which can include interbreeding among different stocks or populations, loss of genetic diversity within populations, domestication, competition, predation, and disease transmission between hatchery and wild fish.

#### **5.3.2. Other Objectives**

- Use hatcheries to sustain treaty-reserved fisheries and non-treaty fishing opportunities, in a manner consistent with salmon recovery.
- Use hatchery chinook coded-wire tag (cwt) and other marking programs (otoliths), and recovery programs in fisheries (cwt) and on spawning grounds (cwt, otoliths, adipose clip), to provide statistically reliable data for stock assessment and fishery evaluations.
- Use hatchery programs for education and outreach and to engage the community in salmon recovery, in a manner consistent with salmon recovery.

#### **5.3.3. Guiding Principles**

- Hatcheries cannot recover WRIA 1 early chinook populations, but can conserve genetic diversity for critically low abundance populations while habitat improvements occur. Hatcheries focused on recovery of at risk species can be considered an interim measure to conserve genetic diversity of native populations that are critically low in abundance while habitat recovers. They can also assist with restoring population spatial structure.
- Other hatchery programs will focus on maintaining genetic diversity within and among populations, minimizing risks from domestication, and potential ecological impacts to wild populations from competition and predation.
- As throughout Puget Sound, hatcheries currently provide the majority of the harvest for treaty and non-treaty fisheries as mitigation for past habitat degradation. Fishing opportunities and traditions need to be maintained through hatchery production, while the hatchery programs need to be managed

to not degrade the genetic diversity, productivity, abundance and spatial structure of wild populations.

- While hatchery programs focused on recovery of at risk populations can maintain genetic diversity in the short term, hatcheries inherently can create a level of risk, however low, to wild populations (Busack and Currens 1995, Flagg et al. 2000). Over time these risks may increase, especially if wild population abundances are small. It is critical that restoration of habitat and habitat forming processes occur to increase wild population productivity, abundance, and spatial distribution. Healthy wild populations will support harvest, and reduce the need for artificial propagation. Healthy wild populations and reduced reliance on artificial propagation are important components of a comprehensive plan to minimize long-term risks of hatchery impacts to wild populations. Restoring habitat capacity and productivity are critical to reducing the risks from hatchery programs, even where overall population sizes are substantially increased from hatchery returns such as North/Middle Fork chinook.
- Hatchery management of chinook will ensure the maintenance of genetic diversity, productivity, abundance and spatial structure of wild populations, particularly native wild populations. Hatchery programs for listed and at risk species will have consistent, frequent evaluation, and adaptive management to avoid genetic or ecological impacts to wild chinook.
- Hatchery management will be integrated with harvest management to ensure natural origin (NOR) early chinook populations are protected through adequate escapements of NOR fish with minimal stray contributions from non-native or mixed origin hatchery fish.
- Habitat protection and recovery is critical to the survival of both wild and hatchery salmonids. For example hatchery propagation requires excellent water quality and sufficient quantity for efficient on-station incubation and rearing. After release, hatchery fish rely on the same habitats as wild fish. If habitat and water quantity and quality declines continue, most hatcheries and other fish rearing facilities will eventually fail. We cannot rely on increases in hatchery fish production to maintain harvest levels without addressing the habitat issues affecting wild and hatchery salmonids.

#### **5.3.4. Management Strategies and Priorities**

Hatchery reviews and operational commitments for anadromous salmonid hatcheries in WRIA 1 have recently been conducted under two processes. The first is the preparation of Hatchery Genetic Management Plans (HGMPs) for each facility program. Tribes submitted HGMPs for tribal programs and WDFW submitted them for WDFW programs and for third party operations including the Maritime Heritage Hatchery programs. The HGMPs are in a format developed by NOAA Fisheries to evaluate potential program risks to chinook, and include operational commitments for each

program to ensure these risks are minimized. The NOAA Fisheries will consult with USFWS for potential impacts to other listed species such as bull trout that the USFWS is responsible for, as part of the NEPA review of NOAA Fisheries' Section 4d decision for HGMPs. These HGMPs include adaptive management and will be updated as needed by fisheries co-managers.

The second hatchery review process was by the Hatchery Scientific Review Group (HSRG 2003), which evaluated each hatchery program with respect to program and stock goals as described by fisheries managers. In addition to evaluating each program, the HSRG developed Statewide hatchery reform recommendations. The following principles include many of these recommendations.

- Operate hatchery programs as either genetically integrated or segregated relative to naturally spawning populations.

Hatchery programs may be classified and implemented either as *integrated* or *segregated* programs, depending on the genetic management goal for the broodstock.

Hatchery programs are integrated if a principal goal is to manage the broodstock as an artificially propagated component of a naturally spawning population. In contrast, hatchery programs are segregated if the management goal is to propagate the hatchery broodstock as a discrete or genetically segregated population, relative to naturally spawning populations.

A fundamental goal of an integrated program is to minimize genetic divergence between the hatchery broodstock and a naturally spawning population in areas where fish are released and/or collected for broodstock. The long-term goal is to maintain genetic characteristics of a local, natural population among the hatchery-origin fish, by minimizing genetic changes resulting from artificial propagation and potential domestication. In an idealized integrated program, natural-origin and hatchery-origin fish are genetically equal components of a common gene pool. A hatchery supporting an integrated program can be viewed conceptually as an artificial extension of the natural environment, where the population as a whole (hatchery plus wild) is sustained at a higher level of abundance than would occur without the hatchery. A properly managed integrated broodstock can potentially serve as a genetic repository, in the event of a major decline in the abundance of natural-origin fish.

An integrated program is not meant to imply that natural spawning of hatchery-origin fish is desired. Hatchery-origin fish spawning naturally does not make a hatchery broodstock genetically integrated. A program is considered integrated only if natural-origin fish are included in the broodstock. In this context, the management goal of an integrated program is to maintain the genetic characteristics of wild fish among hatchery-origin fish, not vice-versa.

Specific long-term recommendations for *integrated programs* include:

- ❑ Include natural-origin fish in the hatchery broodstock so that an annual average of 10–20% of the broodstock is composed of natural-origin adults from the watershed where adults are collected for broodstock. In some instances this is not currently possible due to very low numbers of wild spawners such as North/Middle Fork Chinook.
- ❑ Collect and spawn adults randomly with respect to time of return, time of spawning, size, and related characteristics.
- ❑ Impose hatchery management practices that minimize the potential domestication effects of the hatchery environment.
- ❑ Monitor and control natural spawning by hatchery-origin adults so that they constitute, at most, one-third of the natural spawners of a population within a stream.

The fundamental goal of a *segregated* program is to propagate the hatchery broodstock as a discrete population or gene pool that is segregated, genetically and reproductively, from naturally spawning populations. Once established, segregated broodstocks are composed almost entirely of hatchery origin adult returns. As a consequence, genetically segregated hatchery populations can, and will, change genetically, relative to naturally spawning populations. Such changes can be intentional to maximize the desired benefits of the program, while minimizing risks to naturally spawning populations.

Specific recommendations for *segregated programs* include:

- ❑ Release fish in areas where opportunities to capture non-harvested adults are maximized (for example from facilities that have an adult trap adults can return to) thus minimizing genetic risks to natural populations.
  - ❑ Release fish in a manner and/or at a location that minimizes potential straying and opportunities for natural spawning.
  - ❑ Ensure hatchery-origin adults constitute no more than one to five percent of natural spawners in a population.
  - ❑ Mark all released hatchery-origin fish to maximize potential harvest, and to assess stray rates and genetic risks to naturally spawning populations.
  - ❑ Avoid trapping natural-origin adults, and exclude them from the broodstock.
- Operate hatcheries within the context of their ecosystems

The benefits and risks of hatcheries can only be properly evaluated in the context of their ecosystems, including the status of naturally spawning stocks and their habitats. This will determine the potential for success and the limitations needed for hatchery programs. Set releases (numbers) to the levels needed for harvest, ceremonial, conservation or educational needs, and no larger, for cost efficiencies and to minimize genetic and ecological risks to wild populations. Program release sizes should take into

account the habitat carrying capacity of both freshwater and marine environments. Ocean conditions may have a very large influence of annual adult abundances. In addition to addressing carrying capacity concerns, this may also help reduce the proportion of hatchery strays into wild populations. Off-station releases (fry, fingerlings, smolts), including net pen releases, should be minimized to the smallest number needed to accomplish the intended goal (i.e. education, harvest) and eliminated if possible, to reduce genetic and ecological risks to wild populations.

Integrated harvest programs should be sized consistent with the productivity of the natural population and the capacity of the habitat to support that population. An integrated harvest program will be successful only if the habitat is capable of sustaining the naturally produced component of the population at a level consistent with guidelines for the proportions of natural and hatchery fish on the spawning grounds and in the hatchery broodstock. Conservation programs should be sized consistent with achieving rebuilding goals (including gene banking, reintroduction). This may require deviation from the hatchery/ wild proportional guidelines mentioned above (30% for integrated). Segregated harvest programs should be sized consistent with goals for potentially affected natural stocks and habitat. This requires limiting negative genetic and ecological interactions with other stocks. Determine the proportion of hatchery fish on the spawning grounds and adaptively manage hatchery programs (numbers released) to attempt to stay within segregated and integrated recommendations of hatchery origin fish spawning with wild fish.

More specific recommendations regarding acceptable proportions of hatchery origin fish are a maximum of 5% of any spawning population being comprised of spawners from another population (Withler 1997-NOAA Tech. Memo), and for hatchery contributions that are the same population as the wild population, guidance is only approximately 10% of a population should be comprised of hatchery spawners ((McElhany et al. 2000-VSP tech memo).

- Incorporate flexibility into hatchery design and operation

Facilities should be designed and operated in such a way that they are able to respond relatively easily to changes in harvest and conservation goals and priorities, ocean carrying capacity, stock status, freshwater habitat conditions, and the myriad other factors that will alter current policies and programs.

- Evaluate and adaptively manage hatchery programs regularly to ensure success

Commitments within HGMPs for the respective WRIA 1 anadromous salmon hatchery programs require a great deal of data collection, interpretation and continued adaptive management to ensure programs are successful, and are not further impacting natural populations, particularly for chinook. All chinook releases in and near the Nooksack River are now to enable samplers to determine release location (mostly through otoliths

but also with coded wire tags). Evaluating survival, spawning escapements, and the relative contributions from various hatchery releases into wild populations requires adequate funding and dedicated commitment from fisheries co-managers to comprehensively conduct spawn surveys, evaluate carcasses, recovery scales, otoliths and coded wire tags, rapidly read these, then adjust programs as appropriate to protect wild populations.

- Locate and time releases of hatchery fish to minimize potential for interactions with naturally produced fish

Hatchery releases of yearling fish (steelhead, coho) into areas cohabited by chinook and other wild salmon will be released at sizes that increase their migratory tendency (i.e., reduce residualization) and to reduce potential predation on sub-yearling chinook and other small juveniles. Releases at sizes too small tend to residualize, and at sizes too large have a higher propensity to prey on sub-yearling chinook or other small juveniles. Additionally, releases will be timed to avoid ecological interactions with wild chinook to the extent possible, recognizing the need to maintain release timing within the normal smolt window for the species being propagated. Additionally, fisheries managers will minimize within species competition for chinook releases through timing releases to maximize downstream migration (minimizing the duration of potential competition).

- Take eggs throughout the natural period of adult return

One form of domestication is the shift in spawn timing resulting from not spawning fish over the entire natural period of adult return. Natural life history traits of the various hatchery stocks should be conserved or recovered to assure long-term sustainability.

- Develop spawning protocols to maximize effective population size

The mating of hatchery fish should strive to achieve two principal objectives: 1) maximize the genetic effective number of breeders; and 2) ensure that every selected adult has an equal opportunity to produce progeny. This is particularly critical in conservation programs, where populations are small. To achieve this, male and female hatchery fish can be mated following pairwise (one male to one female), nested (e.g., one male to three females), or factorial (e.g., three-by-three spawning matrix) designs. One common hatchery practice, the pooling of sperm, can reduce effective population size, since equal contributions of individual males are not assured. The approaches of single family mating and modified factorial mating have proven to be feasible and effective (up to 94% fertilization) even in some of the largest programs reviewed (up to five million eggs taken per year). Because these methods achieve the two principle objectives and can be implemented relatively easily, all programs should adopt one of these protocols. Additionally, including an initial rate of 10% jacks (young males) in spawning should occur, with adjustment after investigations are made to determine

jacking rates among natural spawning populations. The inclusion of jacks to maintain year-to-year genetic variation among coho is especially important, because they mostly mature as three year olds.

- Establish goals for educational program releases and minimize numbers released

Fisheries managers will work with education and enhancement programs to develop clear goal statements for each program and make sure the participants understand these. These programs will be operated consistent with conservation principles (at numbers and with methods that minimize genetic and ecological risks to wild fish). Additional to developing the goals, methods will be developed and implemented by the programs for determining whether the goals are being met. In the process of establishing the appropriate sizes determine whether existing habitat capacity is adequately seeded with natural fish to minimize the potential for displacement of wild fish with hatchery fish. Also consider whether wild fish may differ genetically from the hatchery fish.

- Operate hatcheries in compliance with the Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State (NWIFC and WDFW 1998)

Fish will be regularly inspected by fish health professionals and appropriate treatments are prescribed as needed. Broodstock are screened for pathogens and treated to control fungus and pathogens. Potential for amplifying diseases in hatchery environments will be minimized by focusing on fish quality over quantity, and avoiding overcrowding which can increase stress and susceptibility to disease. Additional to the provisions of the disease control policy, funding will continue to be sought to distribute carcasses, except for pre-spawn mortalities from broodstocking and any adults surplus to broodstocking needs, to spawning grounds consistent with carcass distribution guidelines (WDFW 2002b). Prespawn mortalities have greater potential to amplify pathogens in the wild, and the risks of this may outweigh the benefits of distributing the carcasses to provide marine derived nutrients for wild anadromous salmonids.

- Use hatchery fish as indicators of wild salmon populations for fisheries management purposes for listed and at risk species

Hatchery managers will continue to mark and recover hatchery fish for listed or at risk species (chinook and coho) to enable fisheries managers to gain information on harvest rates, distributions, and timing, and for determining overall exploitation (harvest) rates, survival rates, age compositions and the proportion of the escapements that are hatchery origin. The North Fork Nooksack early chinook coded wire tag (CWT) program is one of eleven indicator stocks for Puget Sound chinook (WDFW and PSTT 2004). After tags are inserted into 400,000 fingerlings prior to release, the various fisheries are monitored to detect and recover these tags, then spawning ground recoveries are also conducted. These releases, and the data recovered from them, serve

as indicators of harvest and survival rates for both Nooksack early chinook populations. Additionally, hatchery releases will be externally marked so as to be identifiable as hatchery origin fish at smolt traps to aid in the effort to estimate natural origin outmigration estimates (and ultimately productivity), and so as to be identifiable in juvenile studies in freshwater, estuarine or marine areas.

### **5.3.5 Specific Hatchery Actions**

#### **Existing Actions**

- All hatchery production of anadromous fish follow the provisions of the HGMP's that are reviewed and agreed to by NOAA Fisheries, including adaptive management, and will also be consistent with the co-manager future brood document. These HGMPs reflect many program changes intended to protect the early chinook populations.
- Hatcheries also follow the provisions in the co-manager disease control policy.
- No brook trout hatchery releases will occur in WRIA 1.
- All Chinook released in or near WRIA 1 will be marked as to enable release locations to be determined through spawning ground sampling efforts

#### **Additional Actions within 10 years**

- Develop a HGMP, and implement a South Fork early-chinook integrated recovery rebuilding program at Skookum Creek Hatchery to maintain this population's genetic diversity by increasing abundances, while habitat recovery actions increase population productivity and abundances.

Additional to increasing abundances, the objective is also to increase the proportion of South Fork population chinook in this geographic area by 2015, with the long-term objective of increasing these each decade until <10% of spawners in the spring chinook period are from other populations. Relatively minor facility improvements are needed and will occur by 2006. Eventual program size is proposed to release 250,000 fingerlings (70-80 fish/lb) on station, although program will initially be smaller, and limited by the number of adults that are captured and determined to be suitable. Releases will occur in May or June. Improved DNA baselines are anticipated from WDFW by end of May 2005, and if funded, the program could begin in 2006. Juvenile releases will be marked with coded wire tags, and released with the initial objective of maximizing the likelihood of adults returning to Skookum Hatchery to provide broodstock.

Snorkel surveys conducted during the summer will help identify holding areas prior to capture, and collection will attempt to target the period of August or early September to reduce likelihood of including late-timed chinook or North/Middle Fork chinook. Once holding pools are identified, adults will be isolated from the rest of the river by using block nets. Broodstock will be collected from the wild using helicopter or other rapid transport options for transferring adults to the hatchery. Collection will be by seining if suitable, or by drift gill net, and will begin at first light when temperatures are cooler. If river temperatures rise above an established temperature threshold collection efforts will end. Chinook will be transferred to holding tubes immediately after capture and placed in areas with good river water velocity. Each day adults will be transferred to totes with at least 12 inches of fresh river water, then transported to the hatchery and held on creek water.

After delivery, adults will be injected with erythromycin, then again as recommended by NWIFC fisheries pathologists to control bacterial kidney disease. They will also be injected with oxytetracycline to control furunculosis, to minimize the potential for pre-spawn mortalities. Adult females will be screened for *Renibacterium salmoninarum*, and progeny segregated based on parental levels. Additionally all adults will have a floy tag inserted into their dorsal fin, and a fin clip taken and labeled with the floy tag number. Prior to spawning, rapid turn around microsatellite DNA will be run on each wild adult to verify that their genotypes match the South Fork Nooksack baseline. When returns from initial releases are possible, coded wire tags will be read at the facility after eggs and milt are taken, but prior to spawning.

The DNA tissue will be rapidly transported to the WDFW genetics laboratory, and stock of origin assignments will be made within 48 hours after arrival. Those that are deemed desirable after consultation with co-manager geneticists will be segregated when the adult pond is sorted. Undesirable stock will be removed from the South Fork population and not spawned. Remaining adults will be spawned in randomly determined pairings of single males with single females to maximize effective population size. Jack males will be included as thought to represent proportions in the wild population. Efforts will be taken to maximize productivity of collected broodstock without disrupting the scheme of single pair matings; for instance, in the event of a female-biased sex ratio, sperm will be frozen from any male pre-spawn mortalities that occur.

State and tribal geneticists will evaluate risks to the South Fork Nooksack population gene pool and adapt broodstock management protocols as needed to respond to changes in the population through time. Fertilized eggs will incubate in a half stack vertical incubator on well water. Initially fry will be reared in segregated raceways in a sheltered area. Segregation will assure different sizes are not mixed. The Integrated Hatchery Operations Team (IHOT) guidelines (IHOT 1995) will be reviewed and considered in refining the rearing strategy.

- By 2008 facility improvements will occur at the Lummi Bay facility to improve ability to capture returning fall chinook adults.

The objective is to reduce the potential for fall chinook straying to Nooksack early chinook spawning areas, particularly the South Fork. This will occur through improving the ability to entice and capture returning adults which appear to home back, but are reluctant to enter the facility. This will also lead to establishing a local broodstock, and improved homing may also occur by having juveniles incubate and rear entirely at the Lummi Bay facility.

- Maintain or reduce the size of the current hatchery release abundances for the fall chinook to the lower Nooksack River and by 2007 develop an alternate release strategy that is more likely to reducing potential for straying (such as having returning adults home to a location where adults can be captured upon return). Implement new strategy by 2008.
- Conduct another comprehensive evaluation of releases contributing to the South Fork by 2008. If Kendall Hatchery origin contributions to South Fork early chinook still exceed 10%, further reduce the program to best meet recovery objectives. Similarly, monitor fall chinook hatchery strays, particularly in the South Fork, and conduct a comprehensive evaluation of stray rates and sources by 2008. If hatchery fall chinook stray abundances exceed 10% of South Fork early chinook abundances, adjust fall release strategies to address highest contribution sources until less than 10% stray rate is attained.
- Collect tissue samples from natural origin late-timed chinook, as all hatchery releases are now mass marked. Conduct microsatellite DNA analysis of any groups that appear likely to be remnant genetic reserves.

#### **5.3.5. Long-term Actions**

- As habitat recovery occurs and productivity increases the abundance of natural origin (NORs) chinook within the two early chinook populations, incorporate NORs into broodstock.

When wild abundances increase appreciably, develop a strategy to begin to capture and incorporate NORs into the early chinook hatchery broodstocks annually. If wild populations rebuild sufficiently through increased productivity, decrease the percentage of hatchery origin (HORs) adults spawning naturally to limit potential domestication effects in the populations.

- As habitat recovery occurs and productivity increases the abundance of natural spawners, re-evaluate program sizes (potentially downward) to minimize competition with wild juvenile chinook.

Co-managers will evaluate the results from the Kendall and Skookum re-building programs every ten years and propose program adjustments through revised HGMPs and Future Brood Document changes as needed to maximize recovery effectiveness and minimize risks to the populations.

## **5.4. Hydropower**

Existing small hydroelectric facilities located in salmonid streams should be evaluated and facility upgrades made and operations adjusted as necessary to avoid any impacts to salmon and trout. Specific areas to evaluate include ramping changes in flow, screening (if salmon or trout are present at the intake), minimum instream flows and how these are determined, and tailrace protection. Existing small hydroelectric facilities in salmonid streams need to have instream flows, ramping, screening, tailrace attraction and other operations revisited, with improvements and revisions made as appropriate to avoid impacting salmonids. New facilities need to address the same issues to avoid impacts to salmonids. Instream flow requirements need to be adhered to.

### **5.4.1. Recovery Objectives**

- Ensure that hydropower projects have no net adverse impact on salmonids and salmonid habitat. Projects should ensure fish passage, maintain water quality, provide sufficient instream flows, provide tailrace protection, screen intake structures to prevent entrainment, and manage water releases using ramping, as well as mitigate fully for any habitat loss and degradation.

### **5.4.2. Other Objectives**

- Provide inexpensive energy source.

### **5.4.3. FERC Authority**

Nearly all non-federal dams must be licensed by the Federal Energy Regulatory Commission (FERC). FERC is an independent regulatory agency within the Department of Energy. It is designated by Congress to carry out the provisions of FPA and to oversee the construction and operation of hydroelectric projects. Modifying the operations at federally licensed hydroelectric projects is also done through FERC. FERC issues licenses for hydroelectric projects for a period of 30 to 50 years. A few non-federal projects are not licensed by FERC, either because FERC has determined that it does not have jurisdiction over the project, or the project is exempt (generates less than 5 Megawatt, or it is located on a non-navigable water body), or it was constructed prior to the passage of the Federal Power Act and no modification was made to the project.

### **5.4.4. Management Strategies and Priorities**

#### ***5.4.4.1. New Hydropower Projects***

- Contest the siting of any new hydropower projects within known, presumed or potential/historic distribution of anadromous or resident salmonids, as depicted in the most current version of the WRIA 1 Salmonid Distribution maps.
- If a new project is sited within known salmonid-bearing waters, work with FERC, EPA, NOAA Fisheries, USFWS, WDOE, and WDFW to ensure adequate

fish passage and intake screening, evaluate and set sufficient instream flows, and minimize and fully mitigate for any habitat loss.

***5.4.4.2. Existing Hydropower Projects***

- Ensure that ramping rates are established consistent with criteria set forth in:
  - Hunter, M.A. 1992. Hydropower Flow Fluctuations and Salmonids: A Review of the Biological Effects, Mechanical Causes, and Options for Mitigation. September 1992. State of Washington, Department of Fisheries, Habitat Management Division. Olympia, WA.
- Ensure that instream flow needs are met for all species and life stages likely to be affected.
- Ensure that structures do not interrupt routing of sediment, wood and other organic matter.
- Monitor impacts of water release fluctuations (e.g. redd dewatering, juvenile stranding), establish communication pathways between facility operators and local biologists, and develop mechanism for timely adaptive management of water releases.

## **5.5. Integrated**

### **5.5.1. Recovery Objectives**

- Achieve recovery goals outlined in *Goals* section of this plan.

### **5.5.2. Other Objectives**

- Provide regulatory certainty for ongoing activities.
- Ensure fair and equitable distribution of costs and impacts for salmon recovery.

### **5.5.3. Guiding Principles**

- Salmonid recovery will require an integrated approach to habitat, harvest, and hatchery management. Inherent in such an integrated approach is the need for analysis across multiple scales, jurisdictions, and activities and understanding of cumulative effects.
- Collaboration and cooperation from diverse interests, perspectives, and parties will be necessary to provide the funding, technical expertise, information, labor, land use permission needed for salmon recovery.
- Actions must be taken in the face of scientific uncertainty, but risk of negative impacts of actions should be minimized.
- Monitoring and adaptive management will be critical to successful salmon recovery. By incorporating flexibility into implementation of salmon recovery efforts, we can adapt to new information and to changes in the problems, conditions, technology, and sociopolitical context that affect salmon recovery.

### **5.5.4. Management Strategies and Priorities**

- Establish governance and implementation structure that will oversee the implementation of the management strategies and actions outlined in this plan, as well as the overall monitoring and adaptive management framework.
- Develop coordinated monitoring approach and periodically assess progress toward recovery goals and review and revise action priorities
- Design decision-making processes to use best available science, (taking into consideration limited knowledge and inherent uncertainty of salmon recovery).
- Convene monthly meetings to review progress on recovery plan implementation.
- Generate annual progress reports on recovery plan implementation.

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- Use and adapt existing programs and regulations to the extent possible, but develop new legislation and programs as the need arises.
- Coordinate salmon recovery efforts among governments, non-governmental organizations, stakeholders, and citizens to avoid duplication of effort and maximize efficient use of limited resources.
- Secure and expand state, federal, local and private funding to support salmon recovery efforts. Stable funding sources are necessary to provide time and predictability for planning, development, implementation and monitoring.