Puget Sound Chinook Salmon Population Recovery Approach (PRA)

NMFS Northwest Region Approach for Distinguishing Among Individual Puget Sound Chinook Salmon ESU Populations and Watersheds for ESA Consultation and Recovery Planning Purposes

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Introduction –

The National Marine Fisheries Service Northwest Region (NWR) is responsible for federal ESA evaluations and determinations regarding the potential effects of habitat, harvest, and hatchery actions on listed salmon and steelhead populations within the Puget Sound region. This ESA work involves individual project review by the Habitat Conservation Division, the Sustainable Fisheries Division, and the Salmon Recovery Division to determine compliance of actions affecting listed fish with ESA section 4, 7, and/or 10 requirements. Following NMFS's acceptance of the Puget Sound Salmon Recovery Plan (hereafter "the Plan") and NMFS Supplement to the Puget Sound Salmon Recovery Plan (NMFS 2006, SSPS 2007) as the programmatic road map directing recovery of the listed Puget Sound Chinook salmon Evolutionarily Significant Unit (ESU), NMFS staff now has to determine how to consider population and ESU biological viability criteria established as ESU delisting criteria in the Plan and associated NMFS Supplement to the Plan in our ESA work. The agency will propose to delist the Puget Sound Chinook salmon ESU when the criteria, in combination with administrative delisting criteria, are achieved for the entire ESU. The biological delisting criteria, which incorporate viable salmonid population (VSP) concepts developed by NMFS for recovery planning (McElhany et al. 2000), are:

1. The viability status of all populations in the ESU is improved from current conditions.

2. At least two and up to four Chinook salmon populations in each of five biogeographical regions[2] (i.e., major population groups) within the ESU achieve viability, depending on the historical biological characteristics and acceptable risk levels for populations within each region.

3. At least one population from each major genetic and life history group historically present within each of the five biogeographical regions is viable.

4. Tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations are functioning in a manner that is sufficient to support an ESU-wide recovery scenario.

5. Production of Chinook salmon from tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations occurs in a manner consistent with an ESU recovery.

6. Populations that do not meet the viability criteria for all VSP parameters (i.e., abundance, productivity, spatial structure and diversity) are sustained to provide ecological functions and preserve options for ESU recovery.

[2] The five biogeographical regions are: Georgia Strait, Whidbey Basin, Central/South Sound, Hood Canal, and Strait of Juan de Fuca (Ruckelshaus et al. 2006).

In its Supplement to the Plan (NMFS 2006), NMFS identified the need for coordination within the Northwest Region regarding how to consistently apply the above delisting criteria when reviewing proposed projects for ESA compliance and their effects on ESU recovery. Together, these six criteria describe the status of Chinook salmon populations and associated habitat conditions that would result in a naturally self-sustaining ESU with a high likelihood of persistence. Criteria 1, 2, 3, and 6 describe the conditions of extant populations and their primary freshwater areas within the ESU that are consistent with recovery. Criteria 4 and 5 describe the roles that habitat conditions and Chinook salmon juveniles and adults occurring in secondary habitat areas play in ESU viability.

In application, the six criteria allow for a range of risks across populations within the region. The ESU viability criteria do not require that all 22 independent populations delineated for the ESU reach a low extinction risk status over time, but all of them have to improve from current conditions.

Why is NWR PS Domain Team proposing this PRA?

In contrast to other listed salmonid recovery plans recently accepted by NMFS (e.g., LCFRB 2004), the Plan did not prioritize any of the 22 Chinook salmon populations for recovery over any other populations. Accordingly, each of the 14 watershed groups with independent populations of Chinook salmon covered by the Plan chose to work toward low risk status for their respective populations. Their objective over the initial ten years of plan implementation was to set all the stocks on a trajectory towards recovery to a viable status, following a precautionary approach in reserving options for eventual recovery of the entire ESU.

Population Recovery Approach – Rationale and Need

In its Supplement to the Plan (NMFS 2006), NMFS identified some of the 22 populations that need to be at low risk for ESU viability (Table 1). As a logical extension to the Supplement, the NMFS Northwest Region has developed a systematic framework that further distinguishes among the all the Chinook salmon stocks and watersheds in the Puget Sound region. This framework, termed the ***"Population Recovery Approach" (PRA),*** carries forward the biological viability and delisting criteria described in the Supplement to the Plan (NMFS 2006, Ruckelshaus et al. 2002) which allow for varying rather than uniform individual population management strategies to achieve ESU recovery. The purpose of the framework is to identify those populations and watersheds that should be the agency's priority for consultation and recovery activities, with the goal of meeting the ESU delisting criteria. The PRA identifies those populations and watersheds whose preservation and restoration will be required for recovering the listed ESU and for meeting delisting criteria. The PRA also highlights those stocks and watersheds that remain as strongholds relative to others regarding the standing of VSP abundance, diversity, spatial structure, and productivity parameters. As well, other stocks that need to be preserved for retaining ESU diversity and spatial structure are recognized in the PRA. Each of the 22 identified populations, in addition to all other known

Table 1. Puget Sound Chinook Salmon Populations and Risk Status for ESU Viability (NMFS 2006).

Chinook Populations		**Need to be at Low Risk For ESU viability**
Strait of Georgia	North Fork Nooksack South Fork Nooksack	North Fork Nooksack South Fork Nooksack
Strait of Juan de Fuca	Elwha Dungeness	Elwha Dungeness
Hood Canal	Skokomish Mid-Hood Canal	Skokomish Mid-Hood Canal
Whidbey Basin	Skykomish (late) Snoqualmie (late) NF Stillaguamish (early) SF Stillaguamish (moderately early) Upper Skagit (moderately early) Lower Skagit (late) Upper Sauk (early) Lower Sauk (moderately early) Suiattle (very early) Cascade (moderately early)	Suiattle (very early) and 1 each of the early, moderately early, and late forms
Central/South Sound	Sammamish (late) Cedar (late) Green/Duwamish (late) Puyallup (late) White (early) Nisqually (late)	White (early) and Nisqually or 1 of the other late forms

Puget Sound Chinook salmon stocks, is evaluated in the same comprehensive, systematic and transparent process. The PRA overlays watershed and stock information from Volumes I and II of the Plan on the population structure of the ESU (SSPS 2007, Ruckelshaus et al. 2006), to develop a tool that can be used by NMFS staff to prioritize resources and, through ESA consultation processes, guide the agency's assessment of the relative impact to the recovery of the ESU of proposed actions affecting individual populations or watersheds.

This NWR initiative is based on the premise that not all of the 22 Chinook salmon populations or watersheds harboring the species have the same role in terms of their contribution to the recovery and delisting of the ESU. Key considerations are the uniqueness, status, and physical location of the stock, the present condition and use of the populations freshwater, estuarine, and adjacent nearshore habitats, and the likelihood for preserving and restoring those habitats given present and likely future condition. The PRA is **not** designed to define populations and watersheds where protection and recovery actions could be neglected or abandoned. A "preserve all and restore the best" strategy is applied, because populations and watersheds that are rated of lower value to ESU recovery will still need to be sufficiently protected to sustain Chinook salmon populations under NMFS' delisting criteria. The biological viability criteria support the premise that

recovery of the Puget Sound Chinook salmon ESU will likely occur even with some individual populations remaining at a lower certainty of recovery (Ruckelshaus 2002).

In addition to biological and regulatory reasons for using the PRA, the Puget Sound Domain Team believes there are also societal reasons that this approach is needed, given the rapid pace of human population growth and associated development in the Puget Sound region. Increased competition for key natural resources needed by salmon, including water, riparian and shoreline habitats, posed by burgeoning regional growth and development creates an immediate need to protect the remaining key Chinook salmon populations and watersheds where habitat is relatively intact and restorable. In recognition of these threats, several entities, including the Puget Sound Partnership, Washington Department of Fish and Wildlife, and the Puget Sound Tribes are beginning to identify which watersheds and Chinook salmon stocks are priorities for protection and restoration. When implemented by NMFS, the PRA may provide guidance to these entities for their determinations regarding where best to direct Chinook salmon recovery efforts and funds.

Without population assignments afforded by the PRA, NMFS and the Plan implementers will proceed with less information and will likely make investment decisions that dilute the effectiveness of recovery funding and recovery directed actions, slowing the rate of ESU recovery. The PRA provides a biologically credible process for identifying which populations, watersheds and associated nearshore areas most warrant short term protection and restoration investments. The PRA also promotes consistency in the ESU context between the Puget Sound region watershed groups in implementing the recovery plan and the ESA regulatory assessments by NMFS on similar actions. Entities involved in recovery plan implementation in the region also face the reality that available funding for recovery actions will fall well short of total levels identified by individual watershed groups (e.g., the cost of implementing three-year work plans for the Puget Sound's 14 Chinook salmon watersheds was estimated to be $432 million; the state and federal funding resources may provide ~$45 million for Puget Sound/Washington Coastal salmon recovery in FY 2009-10 (NMFS 2010)). Given other high priority federal government funding commitments, and considering the condition of the U.S. economy, we should expect no additional funds and perhaps even less to implement recovery actions. When implemented, the PRA will help NWR staff be more efficient and effective in its ESA work because it provides all the Divisions with common guidance on priority of Chinook salmon populations and watersheds.

As the NMFS Northwest Region's response to recovery needs for the listed Puget Sound Chinook salmon ESU, the PRA is driven by biological factors while informed by political realities. The approach responds to the thoughts and cautions expressed in recent documents and workshops which consider realistic prospects for sustaining viable natural anadromous salmonid populations in highly developed West Coast U.S. regions that are in the process of becoming more developed (e.g., Lackey 2003 and Salmon 2100: The Future of Wild Pacific Salmon 2006).

Population Recovery Approach Elements -
The PRA has two matrices that describe, compare, and allow for the application of values for the populations within the region regarding their contributions to preservation, restoration, and recovery of the listed ESU. The first matrix (Table 2) presents stock status, habitat condition/use, and ESU viability indicators selected for use in identifying the value of the individual stocks for recovery. The second matrix (Table 3) indicates scores applied to each indicator response, developed based on rating schemes specific for each indicator to allow for comparisons to be made between populations and watersheds.

Table 2 - Puget Sound Chinook Population Assessment Matrix
The Puget Sound Chinook Population Assessment Matrix (Table 2) is the primary framework for this approach. The matrix describes and assesses the current status of each of the 22 TRT-delineated Chinook salmon populations, all other known Chinook stocks, and the watersheds that they inhabit. The matrix is divided into five blocks of key parameters for the status, habitat condition, and contribution to ESA delisting criteria of Chinook salmon populations and the watersheds they inhabit for making recovery rating assignments that will guide NMFS Northwest Region ESA consultation work.

Following is a description of each section of Table 2 - the "Puget Sound Chinook Population Assessment Matrix" - and the parameters included as indicators to identify, and determine the standing of, each Chinook salmon stock and its supportive habitat within the Puget Sound Chinook salmon ESU. All extant stocks (regardless of origin) are included primarily to consider the contribution of the habitat in the areas they inhabit to the viability of the 22 Puget Sound Chinook populations. Methods and rationale for assigning ratings for each indicator are described for each specific indicator, with assigned rating carried forth into Table 3.

- **Block #1** – *Population Baseline Information – Stock Name, Origin and Structure*

Matrix "Block #1" identifies the watersheds, delineated Chinook salmon spawning populations, and other Chinook salmon stocks within each Puget Sound Water Resource Inventory Area (WRIA) for assessment in subsequent sections of the matrix. Included in the description of stocks are "major population groupings" that include each of the 22 populations, based on the Plan's biogeographical region delineations. The co-manager assigned stock category for each population or other stock (Category 1, 2, or 3 assignments to identify extant stock origin) is also indicated. Category 1 watersheds are areas where populations are genetically unique and indigenous to Puget Sound. These areas are managed primarily for natural-origin production. Category 2 watersheds are areas where indigenous populations are believed to no longer exist, but where sustainable wild populations existed historically and the habitat could support such populations. The extant populations in Category 2 watersheds are of transplanted origin, and the locally adaptable stock is being used to reestablish a naturally sustainable population. Category 3 watersheds historically did not support natural spawning Chinook populations on a sustainable basis and so do not require specific management for recovery of the species. The major population grouping and stock category assignments are applied for determining viability parameter status ratings based on indicators included in matrix "Block #2".

- **Block #2** – *Population Status and Integrity*

This section of the matrix identifies the VSP parameter standing of indigenous origin Chinook salmon populations in each WRIA/watershed. The key indicators presented in this block were selected to reflect the relative status of each population in terms of the four VSP criteria identified in McElhany et al. (2002): abundance, diversity, spatial structure, and productivity. A rating scheme is applied to each indicator response to allow for comparisons to be made between populations and watersheds. Generally, the indicator responses for each population are rated 1 to 3, with 3 indicating higher standing or importance of a population within the ESU in considerations regarding recovery value (Table 3).

Abundance – Two key indicators are used to describe the abundance status of each population. The first identifies the current abundance status of the extant natural-origin population. The second indicator considers the potential contribution of listed hatchery-origin Chinook salmon to total population abundance, consistent with NMFS's inclusion of certain hatchery aggregations as part of the listed ESU (NMFS 2004; 70 FR 37160, June 28, 2005), applied consistent with the NMFS Hatchery Listing Policy (70 FR 37204, June 28, 2005).

"NOR Abundance Status" – The selected indicator for this metric reflects the abundance status of natural spawning escapements using recent year "critical", "between critical and current capacity", and "current capacity" ("viable") population abundance status designations (NMFS 2005). To prioritize the need for expedited recovery actions for populations at highest extinction risk due to critically low abundance status, for rating purposes, a "critical" status designation is rated "3", between critical and current capacity "2", and current capacity "1". Because the categories are based on abundance relative to the current capacity and productivity of the habitat, the rating provides a sense of the current population level within its available habitat. In assessing abundance, recovery planning targets identified in the Plan were not used. They were not used because Puget Sound Chinook salmon populations are all uniformly well below the potential historical abundance levels set as targets (generally 10-11% of targets in Puget Sound). The use of the targets as abundance indicators would therefore not provide sufficient distinction among the populations for comparison. As populations recover and abundance increases, the indicator used in the matrix will likely be replaced or revised to portray abundance status.

"Hatchery Population ESU Status" - This indicator recognizes the potential contribution of a within-ESU hatchery population to the abundance status of the associated natural Chinook salmon population, consistent with NMFS's Hatchery Listing Policy (70 FR 37204). The potential value of these listed hatchery populations to the total, aggregate abundance of the population from which it was derived, and remains genetically associated with, is described in NMFS's Salmon Hatchery Inventory and Evaluation Report (NMFS 2004). The assigned ESU status of hatchery populations in each of the watersheds is identified, with "in ESU" programs assumed as benefiting total abundance, consistent with determinations made in NMFS 2004. Abundance

contributions by conservation directed hatchery programs are prioritized over contributions from harvest augmentation programs, considering the intentional, beneficial use of conservation programs to preserve and bolster extant native populations. Therefore, hatchery aggregations with an assigned "in ESU" status are rated as "3" if the fish originate from a conservation hatchery, "2" if the hatchery program from which the fish originate has an integrated harvest augmentation intent; and "1" if fish originate from a hatchery operated as an "isolated" program. If there is no associated hatchery program in the watershed, contribution to total abundance is rated as "0". An "Out of ESU" status for hatchery fish in the watershed is also rated as "0".

Diversity - Four key indicators were selected to describe the diversity status of each Chinook salmon population for comparison to others. Two indicators identify population uniqueness within each biogeographical region. The other two diversity indicators address potentially adverse genetic diversity effects to natural Chinook population survival and productivity posed by hatchery-origin fish production and spawning. Of these latter indicators, one (the estimated "PNI" value (from Mobrand et al., 2005) is being applied throughout the Pacific Northwest as a surrogate for indicating hatchery program domestication risks to associated natural populations, and the other (percent hatchery-origin strays) addresses genetic introgression risks potentially posed by out-of-basin origin hatchery fish straying.

"Genetic/Life History Group Frequency in Region" is used as a diversity indicator to highlight the frequency of occurrence, and therefore degree of genetic uniqueness, of each population or stock within each of the five biogeographical regions in the ESU. The frequency of occurrence indicates the relative value of the population to individual region or ESU diversity. The uniqueness of the population or stock within a region is ranked as follows: if the stock is 1 of less than 3 stocks of the same race in the region, a rating of "3" is applied; if it is 1 of 4 stocks, a rating of "2" is assigned; and if it is 1 of 5, a rating of "1" is assigned. The lower the ranking, the less unique the population is within the biogeographical region and the less relative value the population has to the diversity of the biogeographical region or ESU.

"Proportion of Natural Influence (PNI)" is used in the PRA as a surrogate indicator of stock diversity status. This indicator takes into account the potentially adverse effects of hatchery Chinook salmon production and natural spawning in the watershed on natural population fitness and diversity. For watersheds where hatchery programs produce Chinook salmon of the same stock as the natural population under evaluation, the PNI output value from the "AHA" model (Mobrand et al., 2005) is used to indicate domestication risk – a surrogate for identifying the degree to which either hatchery production or natural production are driving genetic diversity of the population (estimated PNI values from A. Appleby, unpublished WDFW data, 2005). PNI values below 0.5 are considered potentially detrimental to the genetic integrity of the assessed population. For this approach, it is assumed that a PNI value of greater than 0.5 equates to a low genetic diversity risk (rated in the PRA matrix as "3"); a PNI of less than 0.5 to 0.4 indicates a moderate risk (rated "2"); and a value of less than 0.4 suggests a high risk (rated "1").

"Percent Non-native Hatchery-Origin (HOR) Strays" indicator addresses the potential effects on extant natural Chinook salmon population diversity resulting from straying by out-of-basin origin hatchery fish into native, natural Chinook salmon spawning areas. The estimated percent of the total population comprised by non-native hatchery strays (estimates from Ruckelshaus et al. 2006) is used to indicate genetic risk. If the percent of non-native hatchery-origin strays in natural spawning areas is less than 5% of the total spawning population, a low genetic introgression risk is assumed (rated "3" in the matrix); non-native hatchery-origin fish proportions of 5% to10% are assigned a moderate genetic risk (rated "2"), and non-native hatchery-origin strays comprising greater than 10% of the total naturally spawning population are considered a high genetic risk (rated "1").

"Percent Sub-yearling Emigrants" is a diversity indicator that highlights the importance of the yearling emigrant life history strategy as a rare and diminishing component of Chinook salmon species diversity in Puget Sound. Spring and summer-run Chinook salmon tend to have relatively high proportions of yearling emigrants as a life history trajectory relative to fall-run Chinook salmon. While mainly sub-yearling emigrant fall-run Chinook populations remain relatively plentiful in abundance and distribution in the ESU, spring and summer-run stocks have diminished greatly, with most Puget Sound Chinook salmon stock extirpations identified by the Puget Sound Technical Recovery Team (PSTRT) being these earlier returning runs (Ruckelshaus et al. 2006). To highlight and prioritize retention of those populations still carrying a substantial proportion of natural-origin yearling migrant fish, if the proportion of sub-yearling emigrants is less than 75% (NWFSC, unpubl. data), the population was rated "3"; if sub-yearlings comprised 75% to 85% of the total annual emigrating juvenile fish population, a rating of "2" was applied; if greater than 86% of the population emigrates as sub-yearlings, a rating of 1 was assigned.

Spatial Structure - A single indicator encompassing several population traits pertaining to population and ESU spatial structure is applied to describe and indicate the relative recovery value and importance of each population based on this VSP parameter.

"ESU and/or Population Contribution" qualitatively reflects the spatial structure value of a population or stock considering five factors: 1) the standing of the population as a boundary stock that defines the geographical extent of the ESU; and/or 2) the ESU connectivity value of the stock as a bridging point between sub-regions or genetic diversity units; and/or 3) the standing of the population as a stronghold and thus source stock for re-colonizing vacant habitat; and/or 4) the extent of Chinook salmon use of the watershed relative to others (miles of habitat used) and therefore the watershed's importance to Chinook production within the ESU; and/or 5) the importance of the area in preserving or re-establishing the sub-yearling life history type (Beechie et al. 2006). A population meeting any of the five metrics above is judged to have a high spatial structure value, and a rating of "3" is applied. A rating of "1" is assigned for watersheds with Chinook salmon populations not meeting any of the five criteria.

Productivity – The lone indicator selected to describe and rate the productivity condition and value of each Chinook salmon population is the short term (1990-2002) median growth rate ("ST lambda (λ)") value derived by the Puget Sound Chinook Salmon Biological Review Team and presented in the last species status review document for the ESU (Good et al. 2005). This metric could be improved by updating the estimated ST λ value to include population data through the 2009 return year.

"Estimated Stock Productivity" is assumed to be reflected by the ST λ identified for each population, under the assumption that the reproductive success of naturally spawning hatchery-origin fish included in population estimates was equivalent to that of natural-origin fish. The ST λ values therefore represent hatchery-origin plus natural-origin spawners. In rating these values, deference was made to indigenous-origin Chinook salmon populations (Category 1 stocks) in recognition that decreasing trends for those stocks would be of greater concern than downward trends for non-indigenous (Category 2) populations that are relatively recent introductions to the watershed and that might feasibly be replaced with the same non-native stock through transfers. For Category 1 stocks, if ST λ is less than 1.0, the population was assigned a rating of "3", and if ST λ is equal to or greater than 1.0, a rating of "2" was assigned. For Category 2 stocks having a ST λ of less than 1.0, a rating of "2" was assigned; Category 2 stocks with a ST λ equal to or greater than1.0 rated "1". All Category 3 stocks were assigned an "NA" or "0" rating.

VSP Block Rating – Cumulative Score for Identified Populations
Under the "Block #2 Prioritization Rating" heading, each population is assigned a cumulative score by summing ratings from Table 3 for the eight VSP parameter indicators to indicate its overall status. The focus of comparisons of VSP parameter scores will be on the 22 populations delineated by the PSTRT. Watersheds lacking an indigenous spawning population receive a "0" score for VSP parameter status.

- **Block #3 –** *Habitat Status and Use*

This section of the Table 2 matrix assesses the relative salmon habitat health status of each WRIA/watershed in the region, including associated estuaries and nearshore areas, and the value/use of each for Puget Sound Chinook salmon populations included in the listed ESU. Two key indicators used to assess the habitat standing of each watershed incorporate findings from a previous expert-based evaluation of watershed ecosystem health and restoration value by the Interagency Science Advisory Team (ISAT 1999). Also applied are parameters created through NMFS's consideration of Chinook salmon habitat use and value to individual population survival and productivity (NMFS Critical Habitat status determinations and the "Nearshore Value" indicator).

Preservation and Restoration Efficiency - "y" and: Relative Existing Ecosystem Condition - "**x**"
The report of a Washington State "Interagency Science Advisory Team" (ISAT) initiative to determine which WRIAs should be the State's highest priorities for salmonid habitat protection and restoration funding (ISAT, 1999) described the relative habitat condition

and value of Puget Sound watersheds. The ISAT authors developed a scientifically based approach for prioritizing and allocating resources that would effectively contribute to recovery of all species of salmon, including Chinook salmon. That report considered the importance of salmonid populations and their status, and the importance of the ecosystems sustaining the populations. While many watersheds have become more developed since that report was prepared, the relative rankings are sensible and NMFS is not aware of a better analysis. The PRA incorporates the portion of the ISAT assessment addressing the importance of ecosystems and the condition of habitats and habitat processes sustaining salmon populations in the Puget Sound region. The ISAT assessment of the importance of salmon populations was not used because it was less informative than Block 2 of the PRA matrix.

The ISAT (1999) report of habitats ranks which watersheds with Chinook salmon populations have the greatest potential for habitat protection and restoration. The report included assessments of the condition of 14 habitat components necessary to sustain healthy salmonid populations, divided into two categories in the PRA:

Preservation and Restoration Efficiency - "y": An indicator of the relative extent to which various elements of habitat within a salmon watershed might benefit from protection and restoration efforts:

- Estuary development
- Nearshore marine condition
- Percentage of urban development
- Channel gradient (productivity)
- Hydrologic modification (dams)

Relative Existing Ecosystem Condition - "x": An indicator of the current condition of salmon habitat as environmental context for distinguishing the health of salmonid watersheds in the Puget Sound region:

- Forage fish (abundance)
- Human population growth
- Water quality
- Percentage of land in agricultural use
- Forest seral stage along streams
- Impervious surfaces – road density
- Fish passage – culverts
- Water availability for fish
- Extent of protected lands

The scores derived from the ISAT assessment of the relative standing of the habitat components within the two categories considering the individual watershed ecosystems in Puget Sound are applied in the PRA. A summary of the scores for each of the 14 components assessed by ISAT is presented in Appendix 3 of the ISAT (1999) report. For application in the PRA, the ISAT Appendix 3 scores were summed for each individual Puget Sound watersheds (WRIA), and sorted high to low. These ecosystem scores are used in the PRA to indicate relative Chinook salmon habitat condition, priority and value

for ESU recovery and delisting. Consistent with the ISAT (1999) view that all WRIAs should be recognized as containing valuable habitats and components of salmonid species and life history diversity, no watershed received a "0" ranking score under either habitat category within the PRA.

PRA ratings for the indicators grouped under the "Preservation and Restoration Efficiency Value" category were assigned based on relative ecosystem score rankings made by the ISAT. A relative ecosystem score ranking of 1-4, indicating that a watershed was among the four highest valued watershed under this category, was rated "3" in the PRA. A ranking of 5-7 for watersheds of median value was assigned a "2". A lowest relative preservation and restoration efficiency value ranking of 8-10 was rated "1".

Relative watershed ratings for the ISAT indicators grouped under the "Relative Existing Ecosystem Condition" category were assigned in the PRA based on rankings made by ISAT regarding the relative existing condition of the wild salmonid ecosystem considering the status of water, riparian, and upland conditions, and factors affecting supportive habitat processes. ISAT rankings of 1-6, reflecting the six watersheds having the highest relative ecosystem condition were assigned a "3" in the PRA. Watersheds ranked of median relative value by ISAT (ranked 7th through 11th) warranted a "2." The group of watersheds viewed by ISAT as having the lowest relative ecosystem value in the region for salmon (valued 12th through 16th) was assigned a "1" under the PRA.

"Nearshore Habitat Value" – Assigned ratings for this indicator were based on the assessment of the number of the 22 Puget Sound Chinook salmon populations that may benefit from the nearshore area associated with the watershed, given its geographic, "stepping stone" location within Chinook salmon seaward migration and rearing areas. The relative habitat condition of these nearshore areas was included in the above ISAT (1999) score pertaining to ecosystem condition and value. If seven or greater populations likely use the area for migration and rearing, the nearshore area was rated as of "high" value (scored "3"); if three to six populations use the area, it was rated as of moderate value (scored "2"); and if less than three populations migrate through and rear in the areas, a low rating was assigned (scored "1").

"Freshwater (FW) Critical Habitat Status" – ESA regulatory protection of habitat for listed Chinook salmon can be more effectively applied if an area is designated as "critical habitat" for the ESU (70 FR 52685, September 2, 2005). Critical habitat determinations for Chinook salmon were made by NMFS in the belief that the determinations reflected current use of the watershed for natural production by one or more of the 22 Puget Sound populations. If the watershed (or tributary) is included as designated critical habitat, a score of "2" was applied; if the watershed is not included, a score of "0" was assigned.

"Habitat Use by Listed Populations" – The degree to which an individual watershed sustains the natural Chinook salmon population life cycle is taken into account through this PRA indicator. A high value ("3") is assigned for those watersheds defined as primary freshwater habitats that sustain the full life cycle for Chinook salmon, including

adult migration, holding, and spawning; and, egg incubation and juvenile fish rearing through seaward emigration. Watershed use by Chinook salmon of associated estuary or nearshore areas for seaward migration and rearing only was assigned a moderate value (scored "2"), and use of nearshore areas by Chinook salmon for rearing only was assigned a lower value (scored "1).

Habitat Block Rating – Cumulative Score for Puget Sound Watersheds
To facilitate comparison between watersheds regarding their value as habitat for Puget Sound Chinook salmon survival and productivity, rating scores for the above five categories are summed under the "Block #3 Prioritization Rating" column heading.

Block #4 – *Stock Contribution to Delisting Criteria*
This section of the Table 2 PRA matrix indicates the role for each Chinook salmon stock and its associated habitat in addressing each of the delisting criteria identified by NMFS for the Puget Sound Chinook salmon ESU (NMFS 2006). The importance of individual populations and their habitat to ESU recovery are evaluated, as determined by the relative number of delisting criteria addressed by the population and its native habitat. Each Chinook salmon stock/habitat is considered for each of the six criteria. The six delisting criteria, and the rationales applied to determine whether a stock/habitat addressed a each criterion are presented below.

1. The viability status of all populations in the ESU is improved from current conditions.

All listed Chinook salmon populations, and the watersheds that harbor indigenous populations, are determined as meeting this criterion. The priority standing of each population does not detract from the need to ensure that all extant populations improve to the extent that further extirpations are prevented.

2. At least two and up to four Chinook salmon populations in each of five biogeographical regions within the ESU achieve viability, depending on the historical biological characteristics and acceptable risk levels for populations within each region.

The Block 2 "VSP Block Rating" and Block 3 "Habitat Block Rating" for each population were summed to derive a cumulative score for comparison within each biogeographical region or major population group. The Georgia Strait (Nooksack), Hood Canal, and Strait of Juan de Fuca biogeographical regions are believed to each have only two extant Chinook salmon populations, so the identified extant populations/watersheds within those areas, by default, are assigned as meeting this criterion. For the Whidbey Basin (NPS) and Central/South Sound (SPS) biogeographical regions, to be conservative, the four populations within each region having the highest combined cumulative population and habitat status scores are assigned as meeting this criterion under the approach.

3. At least one population from each major genetic and life history group historically present within each of the five biogeographical regions is viable.

All populations considered to be "1 of 2" or "1 of 1" major genetic and life history groups within a biogeographical region meet this criterion. For regions with 3 or greater populations with the same major genetic and life history group, the population with the highest combined cumulative "Block 2" population and "Block 3" habitat score is assigned as meeting this criterion. For the Whidbey Basin Region the results were reviewed to make sure they met the additional guidance in NMFS's Supplement to the Plan that the Suiattle (very early) and one each of the populations representing the other life histories (early, moderately early and late) would need to be recovered.

4. Tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations are functioning in a manner that is sufficient to support an ESU-wide recovery scenario.

At this time, all Puget Sound tributaries are believed to need improvements to function in a manner sufficient to support an as yet undefined ESU-wide recovery scenario. In particular, maintenance of watershed processes that contribute to the health of nearshore marine areas and estuaries sustaining listed Chinook salmon in Puget Sound need to be preserved and improved. Listed Chinook salmon range widely within Puget Sound and comprehensive information regarding which areas are used by which populations at which life stages is currently very limited. As new information becomes available, the across-the-board ratings assumed for this criterion could be revised.

5. Production of Chinook salmon from tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations occurs in a manner consistent with an ESU recovery.

All Puget Sound tributaries outside of the primary freshwater habitat sustaining the full life cycle of any identified Chinook salmon population that produce hatchery- and/or natural-origin Chinook salmon need to meet this criterion. Included are all tributaries within watersheds harboring identified populations, and tributaries outside of those watersheds that harbor any stock of Chinook salmon, including areas not designated as critical habitat. Based on Hatchery and Genetic Management Plans (HGMP) submitted for ESA review by the Puget Sound co-managers to NMFS, it is assumed that the hatchery Chinook salmon programs located outside of watersheds where the species is native, and included in the Puget Sound Chinook salmon Recovery Plan watershed components, are operating in a manner consistent with ESU recovery.

6. Populations that do not meet the viability criteria for all VSP parameters (i.e., abundance, productivity, spatial structure and diversity) are sustained to provide ecological functions and preserve options for ESU recovery.

All Chinook salmon populations, and the watersheds that harbor indigenous populations of this species, are determined as meeting this criterion. The recovery value of each population identified through this approach does not detract from the need to ensure that

further stock extirpations are prevented, so the native watersheds serving as the primary freshwater habitats for the 22 populations meet this criterion.

PRA Recovery Values

The combined outcomes of the Puget Sound Chinook salmon PRA ratings for the three categories of indicators ("Block 2" - Population VSP Parameter Status; "Block 3" - Habitat Status and Use; and, "Block 4" - Population Contribution to Delisting Criteria) can be used to distinguish among populations. Populations are best distinguished by contrasting VSP, habitat, and delisting criteria scores among populations using index scores created for each of the three subject blocks. The index scores are derived by comparing the block score of each individual population with the ESU-wide mean score for the block. This approach defines the condition of a population's VSP status, habitat condition, and delisting criteria contribution relative to the average ESU-wide condition for each of the three blocks. The three index scores (VSP, habitat, and delisting criteria) for each population are then summed into a total index score.

Using the total index scores and the delisting guidance in the Puget Sound Salmon Recovery Plan, the Chinook salmon populations are assigned to one of three population tiers: "Tier 1", "Tier 2", or "Tier 3" (Table 4). A population is automatically assigned as "Tier 1" if NMFS identified the population as essential to recovery of the Puget Sound Chinook ESU (e.g., Suiattle). Table 1 in the NMFS Supplement to the Recovery Plan (NMFS, 2006) identified populations in each bio-geographical region that are essential for recovery of the ESU. In bio-geographical regions that contain only two populations, both populations are assigned to Tier 1.[3]. Of the remaining populations, those with a total index score greater than the ESU-wide mean index score are assigned to "Tier 1". If the total index score for the population is less than 1 standard deviation below the ESU-wide mean index score, the population is assigned to "Tier 2". If the total index score for the population is greater than one standard deviation below the mean, the population is assigned to "Tier 3". Based, on index scores alone, the Central/South Sound region would have both Tier 1 and Tier 3 populations. Therefore, to ensure that at least one population in the region is recovered at a sufficient pace to allow for its potential inclusion as a "Tier 1" population if needed for recovery, the "Tier 3" population with the highest total index score in the Central/South Sound biogeographical region (i.e., Green) is assigned to "Tier 2".

The NMFS Northwest Region proposes to use the population tier assignments in Table 5 to indicate the relative role of each of the 22 Puget Sound Chinook populations in the viability and recovery of the ESU. NMFS will use the population tier assignments as a guide in assessing risk to the ESU of proposed actions based on the relative value of a population and its associated habitat to ESU preservation, viability, and delisting. "Tier 1" populations are the primary populations that are most important for preservation, restoration, and ESU recovery. NMFS also will take into consideration the relative role in ESU recovery of Tier 2 and 3 populations when assessing risk to those populations of proposed actions.

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[3] A population that is one of two populations in a biogeographical region is essential for recovery to the ESU based on the ESU delisting criteria (NMFS 2006).

Application of PRA Tier Assignments in NMFS ESA Consultation and Recovery Work for Puget Sound Chinook Salmon Populations

An outcome of NMFS NWR development of the PRA approach and population tier designations is internal agency consistency in assessing the effects of habitat, harvest, hatchery and hydropower actions on Chinook salmon populations and their habitat under ESA consultation and regulatory processes. The population rankings reflect NMFS' determination of each population's relative role in recovery of the listed ESU. The recovery rankings will inform NMFS' assessment of the effects of proposed actions on overall viability and conservation value under the ESA. In general, NMFS expects actions that harm high-value populations would be more likely to reduce the chances of species survival and recovery than actions that harm low-value populations. A similar logic would apply to actions that harm high-value habitat and those that do not. NMFS emphasizes that these concepts only apply when the agency exercises its authority under the ESA. In other contexts, NMFS will emphasize the importance of achieving broad sense recovery of all populations in Puget Sound and Washington's coast to satisfy tribal treaty rights and recreational and commercial fishing goals.

Table 5. NMFS Northwest Region assignments regarding the value of individual Puget Sound Chinook salmon populations within each biogeographical region to the recovery and delisting of the ESU.

Biogeographical Region	Population	PRA Tier Assignment
Strait of Georgia	North Fork Nooksack	1
	South Fork Nooksack	1
Whidbey Basin	Upper Skagit	1
	Lower Skagit	1
	Upper Sauk (early run)	1
	Lower Sauk	1
	Suiattle (early run)	1
	Cascade (early run)	1
	North Fork Stillaguamish	2
	South Fork Stillaguamish	2
	Skykomish	2
	Snoqualmie	3
Central/South Sound	Sammamish	3
	Cedar	3
	Green/Duwamish	2
	Puyallup	3
	White	1
	Nisqually	1
Hood Canal	Skokomish	1
	Mid-Hood Canal	1
Strait of Juan de Fuca	Elwha	1
	Dungeness	1

References:

Federal Register Notices:

70 FR 37160. June 28, 2005. Final ESA listing determinations for 16 ESUs of West Coast salmon, and final 4(d) protective regulations for threatened salmonid ESUs.

70 FR 37204. June 28, 2005. Policy on Consideration of Hatchery-origin Fish in Endangered Species Act Listing Determinations for Pacific Salmon and Steelhead.

Literature Cited:

Beechie, T., E. Buhle, M. Ruckelshaus, A. Fullerton, and L. Holsinger. 2006. Hydrologic regime and the conservation of salmon life history diversity. Conservation:Volume 130, Issue 4, pages 560-572.

Good, T.P., R.S. Waples, and P. Adams (editors). 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-66, 598 p.

Interagency Science Advisory Team (ISAT). 1999. A system for prioritizing water resource inventory areas in western Washington for protection and restoration of wild salmonids. Report to the Washington State Joint Natural Resources Cabinet. Office of the Governor, State of Washington. Olympia, Washington. 103 p.

Lackey, Robert T. 2003. Pacific Northwest salmon: forecasting their status in 2100. Reviews in Fisheries Science. 11(1): 35-88.

Lower Columbia Fish Recovery Board (LCFRB). 2004. Lower Columbia salmon recovery and fish and wildlife subbasin plan. Volume I – regional plan. 10 chapters plus appendices. Available through NMFS Northwest Region, Portland, Oregon.

McElhany, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-42, 156 p.

Mobrand, L.E. and nine others. 2005. Hatchery reform in Washington State: principles and emerging issues. Fisheries; 30: 11-23.

National Marine Fisheries Service (NMFS). 2004. Salmon Hatchery Inventory and Evaluation Report (SHIER) for Chinook salmon hatchery programs within the geographic boundaries of the Puget Sound Chinook salmon ESU. Hatcheries and Inland Fisheries Branch. Salmon Recovery Division. NOAA Fisheries Service. Lacey, Washington. 102p.

National Marine Fisheries Service (NMFS). 2005. Evaluation of and Recommended Determination on a Resource Management Plan (RMP), Pursuant to the Salmon and Steelhead 4(d) Rule. Puget Sound Comprehensive Chinook Management Plan: Harvest

Management Component. NMFS Northwest Region. Sustainable Fisheries Division. January 27, 2005. 99 p.

National Marine Fisheries Service (NMFS) 2006. Final Supplement to the Shared Strategy's Puget Sound Salmon Recovery Plan. NMFS Northwest Region. November 17, 2006. 47 p.

National Marine Fisheries Service (NMFS) 2010. 2010 Report to Congress: Pacific Coastal Salmon Recovery Fund FY 2000–2009.

Northwest Fisheries Science Center (NWFSC). Unpublished data. Abundance and productivity tables for Puget Sound Chinook populations. Compiled by Norma Sands, Ph.D., Conservation Biology Division, NW Fisheries Science Center.

Ruckelshaus, M.H., K. Currens, R. Fuerstenberg, W. Graeber, K. Rawson, N. Sands, and J. Scott. 2002. Planning ranges and preliminary guidelines for the delisting and recovery of the Puget Sound Chinook salmon Evolutionarily Significant Unit. Puget Sound Technical Recovery Team. April 30, 2002. 19 p. Available on the Internet at: http://research.nwfsc.noaa.gov/trt/trtpopESU.pdf.

Ruckelshaus, M.H., K.P. Currens, W.H. Graeber, R.R. Fuerstenberg, K. Rawson, N.J. Sands, and J.B. Scott. 2006. Independent populations of Chinook salmon in Puget Sound. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-78, 125 p.

Salmon 2100. 2006. Salmon 2100 – the future of wild Pacific salmon. Editors: R.T. Lackey, D. H. Lach, and S. L. Duncan. American Fisheries Society. Bethesda, Maryland.

Shared Strategy for Puget Sound (SSPS). 2007. Puget Sound Salmon Recovery Plan. January, 2007. 2 Volumes. Shared Strategy for Puget Sound, 1411 4th Avenue, Suite 1015, Seattle, Washington 98101.