NORTH AMERICAN
Salmon Stronghold
PARTNERSHIP

Salmon Stronghold Identification in Oregon

2008 and 2010 Assessments

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In 2008, the North American Salmon Stronghold Partnership (Stronghold Partnership) established a process to evaluate wild Pacific salmon populations throughout North America with a goal of scientifically identifying "wild salmon strongholds." While the criteria used to evaluate populations has been applied consistently across the Pacific Northwest and California, the processes and forums used for this assessment have varied by state. This report summarizes the process used to evaluate wild populations in Oregon, and the steps taken to identify and formally recognize the state's salmon strongholds.

Similar to the processes in California, Washington, and Idaho, the results of Oregon's efforts to identify strongholds represent a snapshot in time. The impacts of climate change, habitat restoration, changes in land use, revisions to hatchery and harvest practices, and natural population fluctuations will all continue to modify population strength and watershed condition. In addition, ongoing population monitoring will continue to improve our ability to evaluate population status and trends. Consequently, the strongholds of today may not be the strongholds of the future. The Stronghold Partnership will continue to review and refine the Stronghold map as desired by the states.

Background: North American Salmon Stronghold Partnership and the "Stronghold Approach"

The Stronghold Partnership is a voluntary, public private partnership whose mission is to identify and conserve the healthiest remaining ecosystems in North America to ensure the long-term survival of salmon, steelhead and the many species that depend on them. Since its establishment in 2007, the Stronghold Partnership has pursued its mission through the development and implementation of the "the stronghold approach." The stronghold approach is a wild salmon conservation strategy designed to complement ongoing salmon recovery efforts. It recognizes a portfolio of watersheds that supports "wild, diverse, and abundant" salmon populations that make the greatest contributions towards regional conservation goals. Once strongholds are recognized the approach seeks to support locally-driven efforts to both restore these watersheds and prevent future harm to the anadromous populations that rely on them.

While the Stronghold Partnership recognizes habitat restoration in strongholds as a priority, the Board emphasizes the need to address emerging threats, partners must engage the complex economic, legal, and cultural challenges that continue to drive habitat loss. Accordingly, in defining the stronghold approach the Partnership prioritized placed the highest priority on projects that: 1) address the systemic forces that drive continued habitat loss; 2) demonstrate innovative approaches to preventing emerging threats; 3) can be replicated across multiple strongholds, and 4) advance solutions that integrate habitat, hatchery, hydro, and harvest management.

On behalf of the Stronghold Partnership, the Portland-based Wild Salmon Center (WSC) is working to integrate the stronghold approach into existing programs and leverage funds to implement projects. This is taking place at the federal level through WSC's support of the Pacific Salmon Stronghold Conservation Act and at the state level through the development of public-private partnerships. The goals of these efforts are to both institutionalize pro-active, incentive driven conservation in strongholds and build the capacity of local/regional partners to take on emerging threats. By increasing the resources available to local stakeholders, the Stronghold Partnership seeks to support – not determine - local priorities.

The Science of Identifying Strongholds

In addition to defining the stronghold approach, upon its establishment the Stronghold Partnership set out to develop a methodology to identify salmon strongholds. The group defined strongholds as watersheds that have high anadromous salmonid abundance, productivity, and diversity (life history and run timing), as well as habitat quality or other biological attributes important to sustaining viable populations of wild Pacific salmon throughout their range. The term stronghold, it decided, may refer to a watershed, multiple watersheds, or other defined spatial units where populations are strong and diverse, and habitats have a high intrinsic potential to support a particular species, or suite of species. For conservation planning purposes, these areas are often defined as "irreplaceable" because they offer the highest proportional contribution toward meeting established conservation targets for a specified spatial scale. Because the stronghold approach seeks to anchor range-wide recovery efforts (in the Pacific NW and California), conservation targets are typically those found in species' recovery plans.

After numerous refinements to draft stronghold selection methodologies, the team arrived at an approach that could be applied consistently across the region, yet be tailored to meet the unique environmental conditions and conservation priorities of each state. This methodology can be summarized as follows:

1. Assess ("score") wild populations within the study area based on three criteria: percent of natural origin spawners, life history diversity, and viability (productivity and/or abundance);
2. Identify populations that meet or exceed the threshold for "strong, diverse, and wild";
3. Identify and map salmon stronghold design alternatives, based foremost on the strong population data;
4. Convene a team of regional conservation partners to review stronghold alternatives and agree upon a recommended set of salmon strongholds; and
5. Present the recommended strongholds to the Stronghold Partnership Board for review and approval.

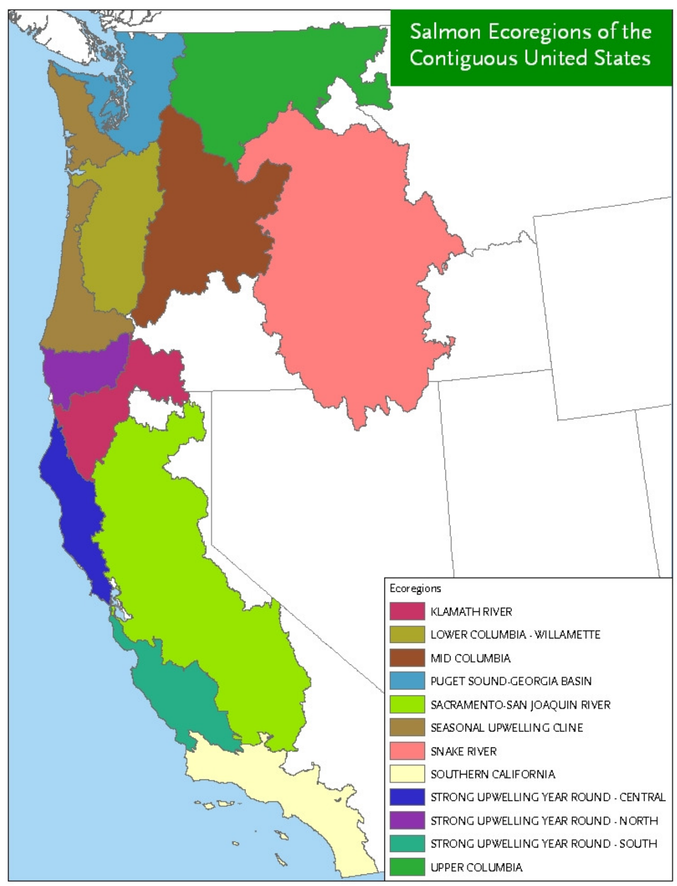

Figure 1. Salmon Ecoregions: The spatial conservation design for salmon strongholds follows from the goals and defining principles of the stronghold strategy: identifying strongholds of high diversity and abundance in each salmon ecoregion. There are six salmon ecoregions in Oregon, five of which overlap neighboring states.

Ecoregions. The Stronghold Partnership recognized early on in the process that strong populations would be heavily biased to the coastal and northern watersheds, where both the number of species present and overall population abundance/diversity would be far greater than inland and southern watersheds. Because this bias would under-recognize the importance of relatively small but genetically valuable populations in promoting species' resilience to changing environmental conditions, the Partnership chose to identify strongholds according to ecoregions. (Note: this applies to Washington, Oregon, Idaho, and California; partners in Alaska are evaluating the applicability of this approach across its ecoregions, which boast consistently strong populations.)

The Stronghold Partnership selected an approach developed by Augerot (2005), which identified and established a series of spatial units called "salmon ecoregions." Augerot's salmon ecoregions parse the Pacific Rim into a series of ecosystems that salmon use from rivers to coastal areas, to semi enclosed seas, to straits, to areas of strong and weak upwelling etc. Oregon is divided into six salmon ecoregions, five of which overlap with neighboring states, including the Klamath River, the Strong Upwelling North (Rogue); the Seasonal Upwelling Cline (Coast); the Lower Columbia (Willamette); the Middle Columbia; and the Snake River ecoregions.

When states initiate the stronghold identification process, planning teams may make minor modifications to the salmon ecoregion boundaries. (Oregon and Washington agreed to separate the Seasonal Upwelling Cline – the coast – into two ecoregions, for example.) As a general rule, states are encouraged – though not required – to recognize one stronghold per ecoregion.

Populations and Evaluation. The stronghold identification methodology does not use a new population delineation approach, but relies on those used by technical recovery teams (TRTs), state agencies, and tribes. Although different population identification sources are used to delineate populations, all of the population identification efforts use similar or identical concepts and definitions of independent populations, as described by McElhany et al. (2000). Characterization and assessment of populations rely on three metrics and associated criteria, including percent natural origin spawners, viability (as represented by abundance and productivity), and life history diversity. The rationale for these metrics is similar to that described for the VSP parameters (McElhaney et al. 2000) and by NOAA TRTs.[1]

Below is a brief rationale for the three criteria:

1. Proportion Natural Origin Spawners. Salmon populations develop local adaptation and unique genetic characteristics due to their tendency for strong homing to their place of birth. The presence of hatchery fish can disrupt these natural evolutionary processes through genetic and ecological factors. The genetic disruption, particularly through wild and hatchery salmon interbreeding, and its impact on fitness has been well documented in several species (e.g. Araki et al. 2007, Theriault et al. 2011), and was reviewed recently by Nash et al. (20xx). Ecological interactions (including competition, predation, and disease) are much more poorly understood, but have been recognized as an important factor in some studies (e.g. Nickelson et al. 19xx). Our emerging understanding of these ecological interactions has been addressed in a review by Rand et al. (2012). Both of these factors can work in concert to depress productivity and reduce fitness of wild salmon. For most populations, we lack detailed data on these factors, but a useful metric is the proportion of natural-origin salmon on the spawning grounds. This can be measured more directly through marking programs, or estimated in more indirect ways. This measure is presumed to relate directly to the degree of risk that hatchery fish pose to wild salmon fitness. We compiled data on the proportion of natural origin spawners to serve as a measure of hatchery influence on each population.

2. Viability (as represented by abundance/productivity). Individual population extinction risk is directly related to productivity of the population. High productivity, typically measured for populations as recruits

[1] Note that McElhaney et al (2000) and some TRT's (e.g. Wainright et al. 2008) also considered spatial distribution (the proportion of available habitat occupied by a population), but the assessment teams concluded that this information is lacking for most populations in the Pacific NW and, therefore, not applicable range-wide. However, the assessment does consider sub-population structure as an important component of one of our criteria (Viability), and we infer that the existence of sub-populations could indicate a higher rate of occupancy of available habit for a given population.

per spawner, is a measure of the ability of a population to withstand stressors or threats, thus providing a safeguard to minimize extinction risk (McElhany et al. 2000). Because productivity can be inversely related to abundance through density-dependent processes, highly productive populations can exhibit a broad range of abundances. We recognize, however, that "strong" populations can at least periodically exhibit high levels of abundance, and also exhibit quick recovery periods following disturbances that can periodically drive abundance to low levels. We refer to this intrinsic quality of populations as viability in the context of our assessment. We note that this viability is often underpinned by the diversity and distribution of sub-populations, allowing populations to better cope with disturbance.

3. Life History Diversity. Life history diversity is critical to long term persistence and for maintaining natural evolutionary processes. Habitat conditions continually change and over the long term major habitat areas are lost and others created. Populations that exhibit broad life history diversity have greater adaptability and resilience to environmental change. Diversity also allows populations to exploit a broader range of environmental conditions across all life stages. The ability of a population to sustain high survival throughout the life cycle under variable environmental conditions is closely linked to the degree of life history diversity. Examples of life history traits that we considered include adult run and spawn timing and juvenile migration patterns (e.g. river type or ocean type juvenile life histories). This line of reasoning is akin to the 'portfolio effect', where it was shown that sockeye populations that exhibit high life history diversity provide for a more stable commercial fishery in Bristol Bay (Schindler et al. 20XX).

Phase 1 - Populations Scoring

Because of the inconsistency in salmonid population data available across the states and regions, the Stronghold Partnership opted to use an expert opinion survey process to obtain metric ratings for individual populations. This process asked experts to score populations on a scale of 0 to 5 based on individual knowledge of the three criteria discussed above. To reduce the subjectivity of scoring, reviewers were provided written definition for each score (Appendix 1). In addition, reviewers were asked to characterize their level of certainty, also on a 0 to 5 point scale. In Oregon, this scoring process was implemented in two phases.

Phase I. In 2008 and 2009, the Stronghold Partnership hosted three meetings attended by scientists with population specific information and knowledge of spawner origin, abundance/productivity, and life history diversity. Two meetings were held in Portland, Oregon; the first focused on populations in the Interior Columbia River Basin, and the second focused on Western Washington, Puget Sound, and the Lower Columbia River Basin. The third meeting was held in Medford, Oregon to collect data for Southwestern Oregon and Northern California populations.

At each of the workshops, the experts were oriented to the project objectives, survey process, and the metrics and criteria. Worksheets were provided with lists of all the populations for the geographic area experts were being requested to rate. The sources of information used by the experts varied significantly. In many cases the experts had extensive datasets and viability status reports that had been completed as part of the TRTs viability assessments. At the other extreme no data sources were in hand, and the ratings were developed based strictly on the knowledge and experience of the expert with the subject populations.

Although data were obtained for many populations at the workshops, there remained a significant number of populations within certain geographic areas that were unrated. On behalf of the Partnership, WSC undertook numerous online, phone, and in-person contacts to fill data gaps. WSC also followed up with these contacts the workshop participants to error check data and review expert ratings to ensure consistency and completeness.

Phase II. Following the 2008-09 process, agency staff from Oregon and California participated in additional scoring sessions to resolve scoring discrepancies, fill remaining data gaps, and generally bolster the expert scoring dataset. (Washington participated in a similar review on the coast. Idaho did not provide additional scores because the first round consisted of primarily agency staff.) In Oregon, the Oregon Department of Fish and Wildlife was charged with reviewing the first round of Oregon scores and supplementing the data with scores from local District Biologists and field staff. This review took place in 2010.

Phase II: Stronghold Identification

The first step in identifying strongholds is to determine a list of "strong populations", i.e. populations that have had relatively little or no influence from hatchery fish, express a wide range of life history diversity traits, and have high wild abundance and productivity, relative to the ecoregion or ESU. In Oregon, once the population scores were compiled and quality checked, conservation planners with the WSC and US Fish and Wildlife Service developed a tool for identifying strong populations using a decision support model called NetWeaver. The NetWeaver DSM system is a commonly used decision support system that has been used by the U.S. Forest Service Aquatic and Riparian Effectiveness Monitoring Program in similar watershed analyses and prioritizations.

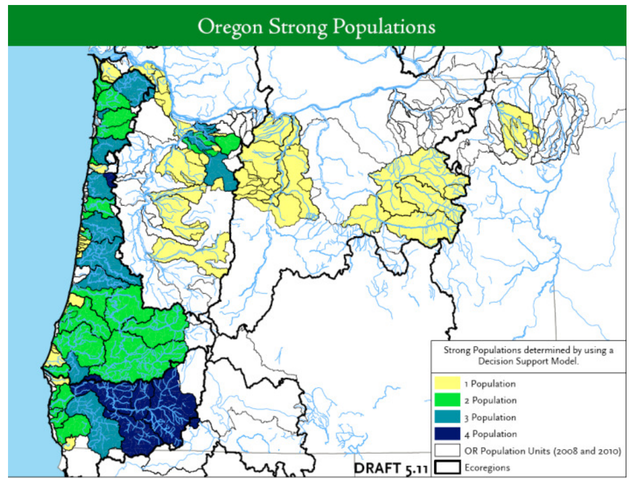

Figure 2. Strong Populations Determined Using Decision Support Model (DSM)

The model is relatively straightforward. First, an advisory team of stronghold partners assigned a value to each score (shown in the table below) based on the definitions of each score used by the reviewers (Appendix 1). In assigning values, the team recognized the non-linear relationship among scores; for example, the team agreed that based on the best available science, a population with 25-50% of its spawners being of hatchery origin (scored as a 3) is impacted to a similar degree as those with 50-75% hatchery origin fish (scored as a 2). Therefore, although the scores differed, in this case the value assigned to the two scores was the same (-1). Expert certainty was evaluated similarly, though a linear relationship exists across from one pole (high confidence, scored as a 5) to the other (no confidence, scored as a 0).

Populations that had an aggregate score (referred to as a "transformed score" in the database) of the three biological criteria of .5 or more AND a positive certainty score were recognized as "Strong". Populations that had a transformed score below -.5 were identified as not strong, while populations between .5 and -.5 were evaluated by WSC in consultation with ODFW and given a final strong or not strong determination.

Table 1. Value Given to Expert Review Scores by Criteria

Criteria	Reviewer Scores					
	5	4	3	2	1	0
Abundance/Productivity	1	.75	.25	-1	-1	Na
Life History Diversity	1	.75	0	-1	-1	Na
Percent Natural Origin	1	.25	-1	-1	-1	Na
Expert Certainty	1	.5	.25	-.25	-.5	0

Strong Population Determination – Results. Of the 210 populations first reviewed in 2008, 36 were removed from consideration during the 2010 review, considered by ODFW as dependent, functionally extinct, or part of another populations already contained in the assessment. Of the remaining 174 populations, 78 were considered strong, 57 not strong, and 39 given additional evaluation. Of these 39, WSC and ODFW reviewers recommended _______ populations as strong and ________ not strong.

<u>Habitat Considerations and the Use of Marxan.</u> The next step in identifying strongholds is to isolate the watersheds that present the greatest opportunities to conserve multiple strong wild salmon and steelhead populations within each ecoregion with the smallest possible investment of restoration funds. To inform this process, the team used Marxan, a software package that is often used to generate conservation network design alternatives. The tool relies on setting quantifiable goal(s) to optimize for and then runs thousands of alternatives that maximize these goals at the lowest possible "suitability cost."

Suitability cost refers to the relative investment required to restore habitats to suitability for salmonid spawning, rearing, and/or migration. It is used by Marxan to optimize the cost-effectiveness of the network. In simplest terms, watersheds that have more degraded habitat have a lower suitability, requiring greater investment to restore key ecological processes. Conversely, more pristine watersheds have a lower cost. In our analysis, habitat suitability was determined at the HUC _____ scale using Trout Unlimited's Conservation Success Index (CSI). The CSI characterizes watershed function using publically available data to assess a range of criteria that roll up into indicators, such as water quality, flow modification, and watershed connectivity. The HUC____ scale was chosen because it offers the greatest flexibility in designing stronghold boundaries from population units that vary in size from HUV 4 to smaller than HUC 6.

The population assessment described above identified 78 strong populations in Oregon. To determine habitat area across these units, we used the miles of distribution for each of the strong species (available at www.streamnet.org). For this analysis we used 50% of stream miles as the goal level to optimize for. This process generated maps of network design alternatives that identified "irreplaceable" areas that would conserve the largest number of strong populations in the most suitable watersheds. Over 30 different analyses were preformed, with most of the maps showing strikingly similar results.

Figure 3. June 2010 Assessment of California Salmon & Steelhead Strongholds

<u>Additional Considerations</u>. In addition to the 30 Marxan analyses, ODFW and WSC also developed a summary spreadsheet to aggregate population scores by watershed. The spreadsheet was designed to quickly and with minimal complexity indicate population health at the watershed scale. In addition the summary allowed the consideration of two additional criteria valued by the state, including the magnitude of unique life histories expressed and the presence of rare species. Both of these metrics were incorporated to highlight the degree to which individual basins could anchor species recovery efforts and the protection of vulnerable populations. The consideration of the Marxan runs coupled with a review of this spreadsheet produced the draft Oregon stronghold map shown at right.