Exhibit DFG-T-9 (6 pages)

# Spatial Conservation Planning for Salmon Strongholds in California

*June 2010 Assessment*

WILD SALMON CENTER

RESOURCE AGENCY CALIFORNIA DEPARTMENT FISH & GAME

TROUT UNLIMITED

FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE

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NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION U.S. DEPARTMENT OF COMMERCE

The Nature Conservancy

CALIFORNIA TROUT KEEPER OF THE STREAMS

NORTH AMERICAN Salmon Stronghold PARTNERSHIP

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*Summary: This report summarizes the methodology used in the identification of six salmon strongholds in California. Collectively, these strongholds represent less than five percent of the state, ten percent of salmon bearing streams, and roughly 70 percent of the diversity of salmon and steelhead populations in California. These strongholds include a total of 69 populations of which 29 were rated as strong, diverse, and wild.*

## The North American Salmon Stronghold Partnership

The North American Salmon Stronghold Partnership (Stronghold Partnership) is a voluntary, incentive-based, public private partnership whose mission is to accelerate the conservation of wild salmon strongholds in North America. The goals of the Stronghold Partnership are to:

1) scientifically identify a network of salmon strongholds;
2) promote the development and implementation of innovative, prevention-focused strategies to protect strongholds and their wild populations from emerging threats; and
3) reduce or eliminate factors currently limiting the viability of wild salmon in strongholds.

Salmon Strongholds represent 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 refers 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, we call these areas "irreplaceable" because they offer the highest proportional contribution toward meeting established conservation targets for a specified spatial scale. The Stronghold Partnership has selected ecoregions[1] as the desired scale of analysis for Washington, Oregon, Idaho, and California. In Alaska, partners are evaluating the applicability of this approach to a region with consistently stronger populations.

Delineation of strongholds is based on spatial and empirical data, decision support tools, and expert judgment. This report explains the methodology used in the identification of six salmon strongholds in California (CA). This process may be summarized as follows:

- First, a project team consisting of state, federal, and non-governmental organization (NGO) representatives approved eco-regional boundaries, reviewed the stronghold identification methodology, and established a working list of CA salmon experts to engage in an evaluation of the state's wild populations.
- Second, these salmon and steelhead experts provided their assessments of the biological status of 507 populations, which yielded a map of strong populations.
- Third, the project team analyzed the strong population data using a conservation decision support tool called Marxan to identify high conservation value watersheds.

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[1] The availability, type, and resolution of salmon data vary widely across state and national borders. In order to measure abundance and biodiversity throughout the range of Pacific salmon, Augerot identified and established a series of spatial units called "salmon ecoregions." The ecoregional approach parses 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. California was divided into the following ecoregions: Strong Upwelling Year Round (referred to here as, North Coast Ecoregion), Klamath River, Sacramento-San Joaquin Rivers, Weak Upwelling Cline (referred to here as, South Coast Ecoregion), and California Undercurrent (referred to here as, Southern California Ecoregion) (Augerot, X. 2005. Atlas of Pacific Salmon: the first map-based Status assessment of salmon in the North Pacific. University of California Press, Berkley, CA).

- Finally, the project team presented the methodology and results of this process to the Stronghold Partnership Board, which approved the CA Salmon Stronghold map.

## Expert Workshops and Populations Scoring

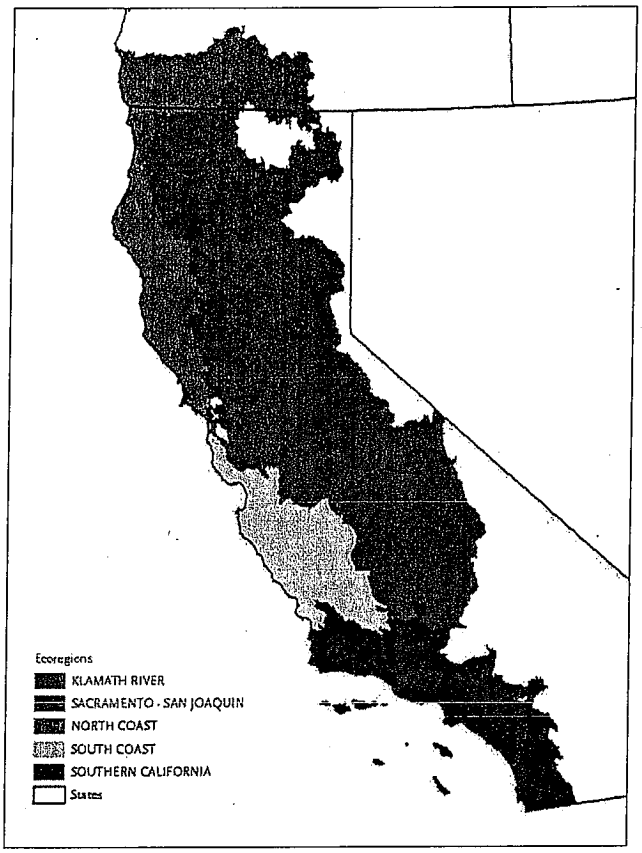


**Figure 1. California Salmon Ecoregions:** The spatial conservation design for salmon strongholds follows from the goals and defining principles of the stronghold strategy: identifying strongholds of high diversity and abundance in each salmon ecoregion. There are five salmon ecoregions in California (with two overlapping into Oregon). This accounts for the geographic diversity across the planning area.

In 2009, the Stronghold Partnership convened a series of workshops throughout CA for salmon and steelhead experts from federal and state agencies, NGOs, and tribal governments. The purpose was to engage experts on the goals and methodology of the project, and to "score" CA's wild populations. Experts assessed the status of 507 populations of salmon and steelhead in the context of the five established ecoregions (Figure 1; Footnote 1). Experts scored populations on a 1-5 scale based on percent of natural origin spawners, life history diversity, and viability (productivity and/or abundance). They also identified their level of certainty for each population score, and were encouraged to provide any relevant supporting documentation/comments. Populations that were scored greater than three were considered strong. This process represents the first time such a diverse set of CA salmon and steelhead experts has synthesized their expert opinions on wild salmon and steelhead populations statewide.

Once the population scores were compiled and quality checked, the project team determined which of these populations were "strong, diverse, and wild". For this purpose the team developed a Decision Support Model (DSM) that aggregated the three different scores, as well as the expert certainty scores. The team used the NetWeaver DSM[2] system, which is a tool for quantifying the amount of support for recognizing a population as wild and strong. Populations with at least moderate support for being strong were considered for further analysis. From the 507 populations in CA, the NetWeaver DSM assisted the team in identifying 121 populations that could be considered strong, diverse, and wild (Figure 2).

[2] 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 (AREMP) of the U.S. Forest Service, as well as other watershed and salmon applications. Available at: http://www.fs.fed.us/biology/fishecology/emp/ (October 2010).

## Marxan Analysis

The next step in identifying strongholds is to identify the watersheds that represent the highest conservation value for protecting strong, wild salmon and steelhead populations within each ecoregion. The team used Marxan software to examine the 121 identified strong populations and highlighted areas that consistently offer the highest conservation value within ecoregions. Marxan is an optimization algorithm that requires an amount or a quantifiable goal to optimize for. In this case, the project team optimized Marxan to select watersheds with the highest number of the strongest populations and the most suitable habitat within the smallest possible area.

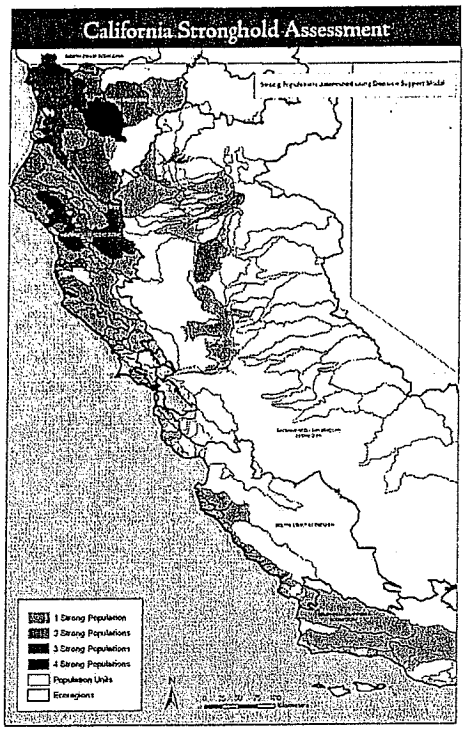


Figure 2. Strong Populations Determined Using Decision Support Model (DSM)

Marxan requires users to input a metric of "suitability cost." Suitability cost is what Marxan uses to optimize conservation networks at the lowest cost. For example, watershed condition was used in this analysis to identify a network of strongholds in the best condition. Watersheds that had more degraded habitat have a lower suitability, thus a higher cost, in protecting key ecological processes. Conversely, more pristine watersheds have a lower cost. Marxan optimizes for the lowest cost scenario.

For Marxan's suitability cost requirement, we used Trout Unlimited's Conservation Success Index (CSI) to evaluate the vulnerabilities of strongholds to emerging threats. CSI is an index of several different indicators of watershed condition, such as habitat integrity, future security, and road density. Habitat integrity indicators use publicly available spatial data sets to characterize in-stream and watershed conditions.

Through Marxan, the team produced maps of network design alternatives that identified "irreplaceable" areas that would conserve the highest number of the strongest populations in the most suitable watersheds. Over 30 different analyses were preformed, with most of the maps showing strikingly similar results. All of the network design results were reviewed by the project team, which included experts from Wild Salmon Center, Trout Unlimited, California Trout, The Nature Conservancy, U.S. Fish and Wildlife Service, U.S. Forest Service, National Oceanic Atmospheric Administration, and California Dept. of Fish and Game. This team made the following observations from the analyses:

- The Smith River and sections of the Mid-Klamath were almost always selected (e.g., irreplaceable) by Marxan in all different alternatives.
- The Mattole and Eel watersheds were always among the most frequently selected watersheds.
- The Big Sur region (not hydrologically connected), when spatially aggregated by Marxan, was also very strong.
- In the Southern Ecoregion, there was no clear "best" between the Santa Maria and Santa Clara watersheds. In the end, the team applied the CSI "Future Security" measure to provide decision support. Future security indicates the long term viability of the watershed to support populations based upon indicators of climate change resiliency, land use conversion, and resource extraction.

Results

The methodology described in this report provided decision support, but it did not decide the "final" selection of CA strongholds (Figure 3). Overall, the final selection recognizes those areas that were typically selected as having high conservation value across numerous Marxan analyses; however, there were key decisions made regarding stronghold selection that were beyond the analytical framework provided by Marxan. Additional variables that were considered in the final analysis included:

a) Ecoregional Approach. The Stronghold Partnership adopted the eco-regional approach to reduce bias towards identifying strongholds in coastal and northern watersheds, where abundance tends to be greater than inland and southerly watersheds. This bias to areas of greater abundance would under-recognize the genetic and life history diversity which exists across the range of Pacific salmon and is vital to promoting population resilience in the face of changing environmental conditions. Also, the North Coast Ecoregion was divided into North and North/Central due to its non contiguous nature. The salmon ecoregions by Augerot (2005) were used as the general template for the salmon ecoregion delineation. Modifications to the salmon ecoregion boundaries were made in consultation with local and regional experts.

b) Scale of the planning unit. The results of the analysis were presented across multiple scales in the watershed hierarchy (HUC 4, HUC 5, and HUC 6[3]). Often times, HUC 6 units were too fine as meaningful strongholds since they often covered only a tributary to a significant salmon ecosystem. HUC 4 units encompassed multiple drainages and appeared too large to be "actionable". The project team found HUC 5 units to often be an appropriate scale to encompass the entire population boundary of interest.

c) Spatial Distribution. Spatial conservation planning provides a process for investigating alternative spatial arrangements of strongholds. In this analysis, the team developed stronghold alternatives where watersheds were a) hydrologically connected, b) adjacent, but not hydrologically connected, and c) not connected or adjacent. In the end, the hydrologically connected alternatives provided the most meaningful results because high conservation value watersheds were clustered together. The adjacent, but not hydrologically connected solutions were also valuable for highlighting the importance of the Big Sur group of HUC 6 watersheds. While not connected hydrologically, this group of small rivers forms an irreplaceable area for strong steelhead populations.

d) Suitability Cost. Suitability cost refers to the relative intactness of watersheds. More intact watersheds will cost less to restore. Since a core component of the stronghold strategy is to protect the best population and watersheds, the suitability cost is a key measure in the stronghold selection. Multiple suitability cost indicators (habitat integrity and future security) were used from the Conservation Success Index. The CSI proved to be a valuable tool for augmenting the expert opinion scores with more quantitative watershed health data.

e) Protected Areas. The team decided that strongholds can build from other protected areas, such as National Parks, Wilderness Areas, U.S. Forest Service Key Watersheds if they have strong populations and are highlighted by Marxan.

[3] The United States is divided and sub-divided into successively smaller hydrologic units which are classified into four levels: regions, subregions, accounting units, and cataloging units. The hydrologic units are arranged within each other, from the smallest (cataloging units) to the largest (regions). Each hydrologic unit is identified by a unique hydrologic unit code (HUC) consisting of two to eight digits based on the four levels of classification in the hydrologic unit system. Available at: http://water.usgs.gov/GIS/huc.html (October 2010).

The approach described above represents the Stronghold Partnership's most comprehensive and technically rigorous stronghold identification process to date. The approach has refined and improved the model for stronghold identification, and the process will soon be replicated in Oregon, Idaho, and Washington. In each of these states, to ensure consistency across the range of strongholds, project teams convened by the Stronghold Partnership will undertake these essential steps: 1) a comprehensive expert assessment, 2) utilization of DSM decision support tools to identify strong populations, 3) utilization of Marxan to develop spatial design alternatives, and 4) expert review and selection of final alternatives, including consideration of scale, connectivity, suitability, and protective status.

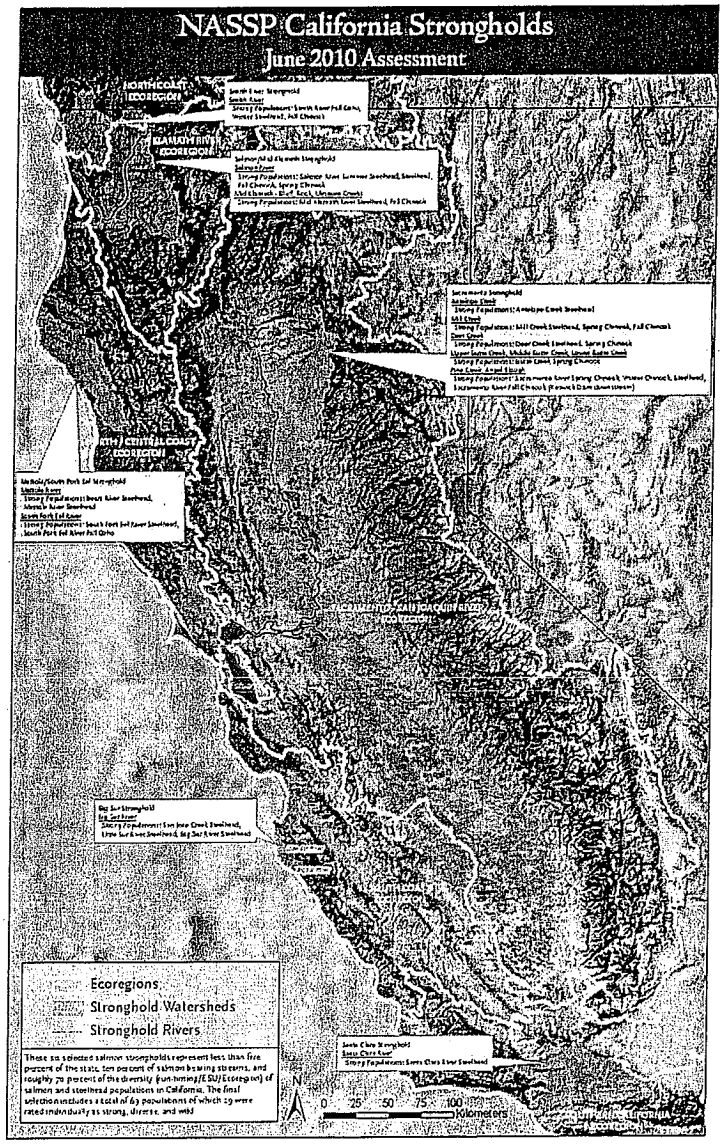


Figure 3. June 2010 Assessment of California Salmon & Steelhead Strongholds

Entering this process, the Stronghold Partnership Board emphasized the roles of sound science and (to the fullest extent possible) the broadest possible engagement of wild salmon experts in the state. During its final review of the process and map, the Board recognized that not all of CA's experts (and other interested parties) could be engaged in the effort. Likewise, the Board recognized that wild salmon populations will inevitably change over time, and that a stronghold today may not be the stronghold of tomorrow. Accordingly, the Board has qualified the CA Stronghold Map as "NASSP California Strongholds, June 2010 Assessment". The Board anticipates that partners in each of the states will re-convene and revisit these results at intervals deemed appropriate by the state and its tribal, federal, and NGO partners. The Board looks forward to working with the states to ensure that data is shared openly and that the process is articulated clearly, so it can be replicated at regular intervals.