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On
Science of Pacific Salmon Stronghold Management
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Madam Chairwoman, ranking member and members of the Subcommittee, my name is Gordon Reeves. I very much appreciate the opportunity to appear before you today to discuss the science that underlies the Salmon Stronghold Conservation Act of 2009. I am a research fish biologist with the Pacific Northwest Research Station of the US Forest Service in Corvallis, OR and have held this position for 27 years. I have a PhD in fisheries science from Oregon State University and a Master of Science in fisheries from Humboldt State University. I also worked as a commercial salmon fisherman in northern California while I was in graduate school. I have published more than 75 papers on the freshwater ecology of various species of Pacific salmon in the Pacific Northwest and Alaska and on the impacts of land management activities on the freshwater habitats of these fish. I was involved with the development of options for managing federal lands in the Pacific Northwest and Alaska and evaluating their effects on Pacific salmon (*Oncorhynchus* spp.) and other aquatic organisms.

The primary focus of my testimony is on the science that underlies the salmon stronghold concept therefore, I will not be speaking to S 817 itself. More than 29% of the estimated 1400 populations of native salmon and trout in the contiguous western United States have been lost (Gustafson et al. 2007). Currently, about one third are listed as threatened or endangered under the Endangered Species Act. As a result, the conservation of these fish is the focus of much effort by scientists in federal and state agencies, universities, NGOs, and private industry. Initial conservation efforts were directed at habitat units, such as pools and riffles, and small segments of streams. However, no fish species or population unit was recovered sufficiently to be removed from the Endangered Species list and these approaches were judged to be ineffective (Williams et al. 1989). In the early 1990s, Moyle and Yoshiyama (1994) advocated for the focus shifting to watersheds with a particular emphasis on intact watersheds. It was also recognized that recovery and protection efforts should focus on ecological processes, and not solely on in-channel conditions (e.g., Reeves et al. 1995, Gustafson et al. 2007). These approaches have been echoed by several researchers and managers since that time, but there are few examples of where this approach has actually been applied, particularly on a large spatial scale. Perhaps the best examples are the key watersheds, which are part of the Aquatic Conservation Strategy of the Northwest Forest Plan (NWFP) that guides management on federal lands within the range of the northern spotted owl (*Strix occidentalis caurina*).

Key watersheds had currently good habitat, the best potential to respond to restoration, or were municipal water supplies (Reeves et al. 2006). The purpose of the former two types was to aid in the recovery of listed fish. Ten years after the implementation of the NWFP, the proportion of key watersheds (70%) whose condition improved at a greater rate than that of non-key watersheds (50%). The primary reasons for this were: (1) restoration efforts were focused in the key watersheds rather than dispersed; and (2) watershed analyses provided a basis for any management activities undertaken and helped reduce the risk of negative consequences.

Principles of Conservation Biology

Protecting populations and their ecosystems is a primary principle of conservation biology. Conservation is most successful when proactive actions are directed at protecting populations before they decline, and protecting ecosystems before they are degraded (McGurrin and Forsgren 1997), which is the foundation of a stronghold strategy. Populations that are in decline are much more difficult to conserve and to recover than are productive, intact ones. Focusing efforts on intact populations, where they exist, is a prudent component for the long-term conservation of native salmon and trout (Gustafson et al. 2007).

The identification and selection of a stronghold network is premised on principles of systematic conservation design, which are well established in the scientific literature (see Soulé and Terborgh 1999). These include: (1) comprehensiveness - the extent to which the network protects the desired level of biodiversity and abundance; (2) irreplaceability - the inclusion of areas or populations that are necessary to achieve the conservation goals; and (3) efficiency - the network is designed to be the most efficient manner that achieves the conservation goals while minimizing the area involved. An integrated suite of planning tools based on these principles has been developed by scientists from the Wild Salmon Center, other NGOs, the Forest Service, and universities. These tools can provide stakeholders and other interested parties the ability to identify and develop a scientifically sound stronghold network.

Native salmon and trout in the Pacific Northwest and Alaska occupy a wide geographic range over a wide variety of environmental conditions. The fish are uniquely adapted to local conditions, and it is difficult for populations from one area to survive in other areas (Waples 1991). Examples of local adaptation include resistance to disease, timing of return to freshwater, and size and age at maturity (Hodgson et al. 2009, Quinn 2005). These differences among populations are recognized by responsible management and regulatory agencies and in the status designation under the Endangered Species Act. As a result, it is important that the design and establishment of a stronghold network be focused at ecoregional levels in order to maintain this variability of locally adapted populations and to have the greatest chance of success.

The Challenge of Climate Change

The potential impacts of climate change pose a threat to native salmon and trout, particularly weak populations, in the Pacific Northwest and Alaska. These fish are particularly vulnerable because of their dependence on both freshwater and marine ecosystems. Potential impacts in the marine environment include: (1) changes in the thermal regime and timing and intensity of upwelling; and (2) increased acidification. Likely impacts on freshwater ecosystems include: (1) alteration of flow and temperature patterns; and (2) more frequent disturbances such as wildfire and drought (Hamlet and Lettenmaier 2007). The primary cause of decreasing summer flow is increasing air temperatures, which are decreasing snowpacks and melting existing accumulations earlier in the spring (Regonda et al. 2005; Stewart et al. 2005). As a result, streams runoff 1 – 3 weeks sooner than they did historically (Regonda et al. 2005; Stewart et al. 2005) and subsurface aquifers provide less groundwater for stream flow late in the summer and early fall (Hamlet et al. 2005). There will be wide variation in the expression of potential impacts of climate change within and among watersheds in any given area. Additionally, there will be large variation among regions. The average annual air temperature increase in the West has been 0.8°C; warming rates have been faster at higher elevations and more northerly latitudes, and slower at lower elevations and southern latitudes (Diaz and Eischeid 2007).

The likely consequences of climate change for salmon and trout include changes in the: (1) behavior and growth of individuals (Neuheimer and Taggart 2007); (2) phenology, growth, dynamics, and distribution of populations (Hari et al. 2006; Rieman et al. 2007); (3) persistence of species and fish communities (Hilborn et al. 2003); and (4) functioning of whole ecosystems (Moore et al. 2009). The vulnerability of salmon and trout species and population units to climate change will depend on the characteristics of the species or population, and local environmental conditions, as well as past habitat alteration, fragmentation, and loss (Hodgson et al. 2009). Larger, more productive populations have a better likelihood of adapting to climate change, in part, because of the inherent genetic and phenotypic diversity within them (Hodgson et al. 2009).

The potential effects of climate change are relatively minor compared to the environmental variation native fish have faced over time (Waples et al. 2009). However, change is occurring more rapidly than many of the past changes (IPCC 2007) and is following a period of extensive and fairly rapid ecosystem alteration. Consequently, these fish no longer have the historical intact networks and diversity of habitats and have reduced genetic, life-history, and evolutionary potential to respond to the impacts of climate change.

Conserving and creating networks of watersheds across large spatial scales could be a key component of providing opportunities for native salmon and trout to respond to a number of stressors. Salmonids are most likely to persist in larger and more complex habitat networks (Fausch et al. 2006, Greene et al. 2009). Large networks are more likely to provide diverse habitat required over the life span of these fish, the complexity and area to absorb catastrophic disturbances without loss of entire populations, and greater species, genetic and phenotypic diversity (Fausch et al. 2009).

A network of strongholds that is distributed across the Pacific Northwest and Alaska will also likely provide important ecological services to the local communities. These include protection of other aquatic species, production of clean water for drinking and irrigation, natural flood control, sites of carbon sequestration, and opportunities for recreation.

Conclusion

The foundation of the salmon stronghold network approach is well embedded in the principles of conservation biology and has the potential to help prevent further declines of native populations of salmon and trout and the ecosystems in which they reside. Additional strongholds would complement and expand the existing network of strongholds, which are generally limited in size and distribution, and would increase the overall effectiveness of the network. In the longer term, such a network would have good potential to contribute to the recovery of populations that are currently depressed. This network would likely be the base for Pacific salmon and other native fishes to respond to the challenges of adapting to climate change and where important ecological services are provided to local communities, the region, and the nation.

Thank you for this opportunity to testify. I would be happy to answer any questions.

References

Diaz, H.F. and J. K. Eischeid. 2007. Disappearing ‘‘alpine tundra’’ Köppen climatic type in the western United States. Geophysical Research Letters 34: L18707, doi:10.1029/2007GL031253

Fausch, K.D., B.E. Rieman, M.K. Young, and J.B. Dunham. 2006. Strategies for conserving native salmonid populations at risk from nonnative invasions: tradeoffs using barriers to upstream movement. General Technical Report RMRS-GTR-174. USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Fausch, K.D., B.E. Rieman, J.B. Dunham, M.K. Young, and D.P. Peterson. 2009. Invasion versus isolation: Trade-offs in managing native salmonids with barriers to upstream movement. Conservation Biology 23: 859-870.

Greene, C.M., J.E. Hall, K.R. Guilbault, and T.P. Quinn. 2009. Improved variability of populations with diverse live-history portfolios. Biology Letters doi: 10.1098/rsbl.2009.0780.

Gustafson, R.G., R.S. Waples, J.M. Myers, L.A. Weitkamp, G.J. Bryant, O.W. Johnson, and J.J. Hard. 2007. Pacific salmon extinctions: quantifying lost and remaining diversity. Conservation Biology 21: 1009-1020.

Hamlet, A.F. and D.P. Lettenmaier. 2007. Effects of climate change on hydrology and water resources in the Columbia River basin. Journal of the American Water Resources Association 35: 1597-1623.

Hamlet, A., P.W. Mote, M.P. Clark, and D.P. Lettenmaier. 2005. Effects of temperature and precipitation variability on snowpack trends in the western United States. Journal of climate 18: 4545-4561

Hari, R.E., D.M. Livingstone, Siber, R. Burkhardt-Holm, P., and H. Güttinger. 2006. Consequences of climate change for water temperature and brown trout in Alpine rivers and streams. Global Change Biology 12: 10-26 doi: 10.1111/j.1365-2486.2005.01051.x

Hilborn, R., T.P. Quinn, D.E. Schindler, and D.E. Rogers. 2003. Biocomplexity and fisheries sustainability. Proceedings of the National Academy of Sciences 100: 6564-6568.

Hodgson, J.A., C.D. Thomas, B.A.Wintle, and A. Moilanen. 2009. Climate change, connectivity and conservation decision making: back to basics. Journal of Applied Ecology 46: 964-969.

IPCC (Intergovernmental Panel on Climate Change). 2007. Climate change 2007: the physical science basis. (http://www.ipcc.ch)

Moore, M.V., S.E. Hampton, L.R. Izmest'eva, E.A. Silow, E.V. Peshkova, and B.K. Pavlov. 2009. Climate change and the world's sacred sea-Lake Baikal, Siberia. BioScience 59: 405-417.

McGurrin, J. and H. Forsgren. 1997. What works, what doesn't, and why? Pp. 459-471. In: J.E. Williams, C.A. Wood, and M. P. Dombeck, editors. Watershed Restoration: Principles and Practices. American Fisheries Society, Bethesda, MD.

Moyle, P.B. and R.M. Yoshiyama. 1994. Protection of aquatic biodiversity in California: five-tiered approach. Fisheries 19920; 6-19.

Neuheimer, A.B. and C.T. Taggart. 2007. The growing degree-day and fish size-at-age: the overlooked metric. Canadian Journal of Fisheries and Aquatic Sciences 64: 375-385.

Quinn, T.P. 2005. The behavior and ecology of Pacific salmon and trout. American Fisheries Society, Bethesda, MD.

Reeves, G.H., J.E. Williams, K.M. Burnett, and K. Gallo. 2006. The aquatic conservation strategy of the Northwest Forest Plan. Conservation Biology 20: 319-329.

Reeves, G.H., L.E. Benda, K.M. Burnett, P.A. Bisson, and J.R. Sedell. 1995. A disturbance-based ecosystem approach to maintaining and restoring freshwater habitats of evolutionarily significant units of anadromous salmonids in the Pacific Northwest. American Fisheries Society Symposium 17: 334-349.

Regonda, S.K., B. Rajagopalan, M. Clark, and J. Pitlick. 2005. Seasonal cycle shifts in hydroclimatology over the Western United States. Journal of Climate 18: 372-384.

Rieman, B.E., D. Isaak, S. Adams, D. Horan, D. Nage, and C. Luce. 2007. Anticipated climate warming effects on bull trout habitats and populations across the interior Columbia River basin. Transactions of the American Fisheries Society 136: 1552-1565.

Stewart, I.T., D.R. Cayan, and M.D.Dettinger. 2005. Changes toward earlier streamflow timing across western North America. Journal of Climate 18: 1136-1155.

Soulé, M.E. and J. Terborgh. 1999. Continental conservation: scientific foundations of regional reserve networks. Island Press, Washington, D.C.

Waples, R.S. 1991. Pacific salmon, *Oncorhynchus* spp., and the definition of "species" under the Endangered Species Act. Marine Fisheries Review 53: 11-22.

Waples, R., Beechie, T., and Pess, G.R. 2009. Evolutionary history, habitat disturbance regimes, and anthropogenic changes: what do these mean for resilience of Pacific Salmon Populations? Ecology and Society 14(1): 3. [online] URL: http://www.ecologyandsociety.org/vol14/iss11/art13/.

Williams, J.E. and 7 co-authors. 1989. Fishes of North America: endangered, threatened, and of special concern. Fisheries 14(6): 2-21.