Riverscape Analysis Project

Conducted by the Flathead Lake Biological Station with support from the Gordon and Betty Moore Foundation

The problem

Wild Pacific salmon populations have been declining over the last hundred years, and billions of dollars have been spent trying to stem this decline. Two major challenges to conserving and restoring wild salmon are knowing how many fish a river is producing (which is difficult to assess because of ocean harvest, hatchery supplementation of salmon populations, and lack of data for many rivers) and estimating how many fish a river could produce naturally (based on available food supply and habitat).

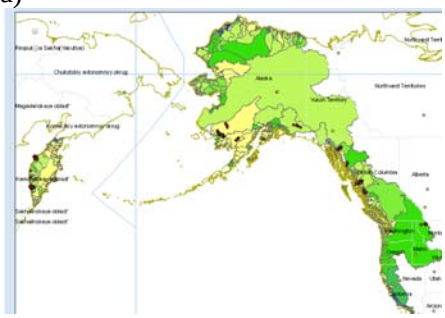
A major goal of resource managers and conservationists is to sustain and protect the most productive and intact rivers for salmon. This is challenging for many reasons, including limited financial resources and the vast number of salmon rivers around the Pacific Rim (some of which are very remote). So, is it possible to know which rivers have the highest salmon production potential without conducting expensive and time consuming field studies on them all?

The approach

Most wild Pacific salmon begin their lives in freshwater rivers – in the same rivers to which they eventually return to spawn and die. The quantity, quality and complexity of freshwater habitat directly influence the production potential and survival rate of wild salmon (Stanford et al. 2005). The Riverscape Analysis Project (RAP) based at The University of Montana's Flathead Lake Biological Station (FLBS) determines and ranks freshwater habitat abundance and production potential of Pacific salmon rivers. The project offers an overview of North Pacific salmon rivers by utilizing globally available satellite remote sensing imagery and other geospatial information to assess the physical structure of over 1500 rivers and watersheds around the Pacific Rim.

More than 30 physical characteristics, such as river gradient, floodplain area, and channel complexity, are used to rank rivers for their potential to produce wild salmon. Human influences, including dams, roads, and land use, can also be incorporated into the ranking, so it is possible to represent not only habitat characteristics but also habitat stresses.

a)



b)

c)

Figure 1. Rankings of wild Pacific salmon watersheds ranging from high quality (yellow), to intermediate (green) and low (blue) quality based on a) production potential, b) human influence, and c) estimated physical habitat conditions.

Physical and human impact data and rankings for all major rivers around the Northern Pacific Rim are publically available

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through a web-based decision support system accessible at http://rap.ntsg.umt.edu/.

The solution

The RAP river basin rankings were compared with salmon data from a variety of sources, including FLBS's Salmonid Rivers Observatory Network, literature reviews, and agency databases, to relate the rankings with known wild salmon populations. Rivers with similar habitat characteristics are assumed to have similar production potentials for wild salmon, so production potential can be extrapolated to unstudied rivers based on RAP river habitat information.

The result of this work is a framework relating different river habitats, quality, and abundance to potential salmon production. This habitat-based approach can be used to help determine how many juvenile salmon a certain river could produce in the absence of fish removal (harvest) or supplementation (hatcheries) practices. This provides a reference condition for a river's natural potential for salmon production and sustainability and can help guide management objectives.

The advantage

Adult wild Pacific salmon populations vary drastically between years due to natural climate oscillations, ocean conditions, harvest levels, and other factors, but the quality and abundance of available freshwater habitat may control salmon populations over the longer term. Therefore, RAP's use of habitat-based potential production estimates allows for consistent management planning relative to more traditional approaches using annual fish counts. Basing potential production estimates on the freshwater spawning and rearing habitats of wild Pacific salmon, rather than (or in conjunction with) lesser known ocean habitats, also gives managers information on both current and future production potential.

The RAP system provides an analysis tool to assist resource managers in determining which of the thousands of rivers across the Pacific Rim should be the best producers of wild salmon. Rivers and watersheds can be systematically compared and contrasted on the basis of salmon production potential, even for relatively remote areas where available field observations are limited.

Figure 2. A bear eating a sockeye salmon on the Mulchatna River, Alaska.

The most appropriate expenditures of limited financial and human resources for salmon conservation can then be made on the basis of maximizing potential return on investment (e.g., recovery and sustainability of wild salmon populations) rather than expenditures on areas with relatively low salmon production potential.

Currently, the project is also incorporating climate projections to understand how climate change will influence the distribution and abundance of wild salmon over the next 100 years. The river rankings from RAP help to promote consistent, proactive, and cost effective conservation efforts.

References

Stanford, J. A., M. S. Lorang, and F.R. Hauer. 2005. The shifting habitat mosaic of river ecosystems. Verh. Internat. Verein. Limnol. 29(1): 123–136.

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