

Collaboration between Atlantic and Pacific salmon biologists to enhance recovery of endangered salmon in North America

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Introduction

Salmon hold an iconic status along the Atlantic and Pacific coasts of North America, historically providing critical ecosystem services and substantial economic benefits to these regions. Overharvest, fish passage barriers and habitat destruction, in combination with other factors, have resulted in extirpation of approximately 30 % of Pacific (*Oncorhynchus* spp.) and 90 % of Atlantic salmon (*Salmo salar*) populations in the contiguous United States (Parrish et al. 1998; Gustafson et al. 2007). Many of the remaining native populations of Atlantic salmon, and Pacific salmon are protected under the U.S.

Endangered Species Act (Ford 2011). Significant population declines are also occurring on both coasts in southern Canada (Irvine et al. 2005), where conservation actions are ongoing.

This conservation crisis has resulted in extensive research to inform management decisions associated with recovery of endangered salmon populations. Collectively, there is a large and productive research effort in North America focused on conservation of endangered salmon populations. Numerous partnerships are in place to facilitate collaborations among researchers within each of the respective Pacific and Atlantic salmon research communities. In contrast, opportunities for sharing information across these two communities are less structured and usually occur on a small scale—e.g., at international meetings. Publications from these international meetings have typically been collections of concept papers each focused on Atlantic salmon or Pacific salmon (e.g., Lynch et al. 2002; Waples and Hendry 2008). Our goal was to help establish new collaborations between these highly productive research communities by teaming up Atlantic and Pacific salmon biologists.

We organized a “Teaming Up” symposium that was held at the 2012 Annual Meeting of the American Fisheries Society in St. Paul, Minnesota, USA. This meeting helped connect scientists with similar interests and it was the catalyst for many new collaborative papers in this special issue. These new teams of Pacific and Atlantic salmon biologists identified areas where collaboration between these research communities

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would be beneficial. This special issue of *Reviews in Fish Biology and Fisheries* features thirteen papers that distill research from both regional viewpoints in an effort to identify new perspectives or techniques to enhance recovery of endangered salmon populations. Three important theme areas that are covered in this issue are: Ecology and Evolution of Salmon, Conservation Hatcheries, and Tools for Conservation Planning. In an effort to give the reader a broad overview, we have provided some highlights from each of these areas.

Ecology and evolution of salmon

Atlantic and Pacific salmon have complex life histories that include transformations from freshwater resident stream fish to highly migratory ocean wanderers. This collection contains papers focused on identifying insights into the freshwater, estuary, and ocean environments used by these anadromous species. Sloat et al. (2014) present a comparative analysis of freshwater maturation in Pacific and Atlantic salmon that shows how freshwater maturing forms provide demographic and genetic compensation to declining salmon populations. Penny and Moffitt (2014) provide new insights into the importance of steelhead iteroparity for conservation and its implications for salmonid conservation. Moving seaward, Weitkamp et al. (2013) compare estuary use by both the suite of anadromous Pacific salmon species and Atlantic salmon and their more species rich diadromous community. Their analysis underscores emerging research that suggests that estuaries are key habitat areas that have potential to enhance salmon recovery on both coasts. Two papers focus on ocean migration ecology of salmonids: Hayes and Kocik (2014) compare steelhead and Atlantic salmon migration ecology, while Byron and Burke (2014) use modeling approaches to better characterize ocean migration behavior. Byron and Burke's (2014) synthesis of modelling underscores the importance of orientation and navigation as evolutionary assets that likely optimize marine growth and survival. Hayes and Kocik (2014) likewise suggest that dynamic ocean habitats, and the adaptive scope of remnant populations, will be important drivers in salmon conservation under future climate change scenarios.

Conservation hatcheries

Salmon hatcheries play a major role in maintaining fisheries, supplementing natural populations, and serving as refugia for critically endangered populations (Paquet et al. 2011). Hatchery-origin fish have also been shown to have negative fitness impacts on wild populations (e.g., Jonsson and Jonsson 2006; Araki et al. 2008). Therefore, in a conservation context, managers spend extensive resources to evaluate benefits and risks of using hatchery-origin fish to aid in recovery of endangered natural populations (Waples 1999; Baskett and Waples 2013). This suite of papers synthesizes how modern conservation hatchery programs are providing demographic and genetic support to enhance recovery of endangered wild populations while attempting to minimize negative impacts of hatchery culture on fitness. First, Maynard and Trial (2014) provide a comprehensive overview of societal paradigm shifts where goals for Pacific and Atlantic salmon hatcheries over the past 140 years evolved from using hatcheries to improve on nature to a focus on natural rearing within hatcheries. The next two papers focus on the essential role hatcheries are playing in preventing extinction of critically endangered salmon populations. O'Reilly and Kozfkay (2014) provide reviews of conservation genetic management of these cutting-edge hatchery programs for Snake River sockeye salmon (*O. nerka*) and inner Bay of Fundy Atlantic salmon, while Stark et al. (2014) document the role that hatchery-origin fish released as adults can play in recovery for Chinook salmon (*O. tshawytscha*) in Idaho and Atlantic salmon in the Gulf of Maine. Both papers highlight that conservation hatchery programs are developing innovative approaches to culture and new ways to use hatchery-reared fish to aid in recovery of endangered populations.

Tools for conservation planning

Effective conservation planning requires a solid understanding of the biology of the species in need of recovery (Waples and Hendry 2008). In this special issue, there are papers focused on linking the biology of salmon to a variety of conservation actions and tools. Pess et al. (2014) provide intensive documentation and explanations of the conservation benefits of removing fish passage barriers as they relate to Atlantic and Pacific salmon life history types. Trumbo et al. (2014) provide recommendations on ways to

enhance smolt survival at hydropower passage facilities. Sweka and Wainwright (2014) provide a comprehensive review and synthesis of how population viability analysis models are used for Atlantic and Pacific salmon recovery planning. They bring the power of these models to the toolbox of fisheries managers. Arismendi et al. (2014) review the invasion of Atlantic and Pacific salmon in Chile and provide recommendations on control efforts based on patterns of invasion and the biology of these species. Finally, Jane et al. (2014) contribute a unique paper that spans biology and archaeology to provide a multidisciplinary context to infer historical abundance and geographic distribution of North American salmon populations. These authors provide guidance on using archaeological data to aid in identification of geographic boundaries and demographic targets for salmon recovery efforts.

Conclusions

Atlantic and Pacific salmon continue to face significant and large-scale threats such as climate change impacts in freshwater (Lawrence et al. 2014) and ocean environments (Piou and Prevost 2013). The thirteen papers in this special issue demonstrate that new approaches to conservation can emerge when Atlantic and Pacific salmon biologists are teamed up, often for the first time, to focus on a common issue. We are planning another “Teaming Up” symposium at the Annual Meeting of the American Fisheries Society in Portland, Oregon, USA in 2015. If you are interested in participating in this symposium, please contact the corresponding author. Hopefully it will be another opportunity to generate new insights into salmon conservation by expanding the “Team” to include biologists from other disciplines and from outside North America.

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