2010 Sendai Salmon Workshop on Climate Change

by James Irvine

A 1-day workshop examining climate change impacts on salmon was organized by scientists working with the North Pacific Anadromous Fish Commission (NPAFC) and was held immediately prior (April 25, 2010) to the International Symposium on "*Climate change effects on fish and fisheries*" in Sendai, Japan. The NPAFC assembles and documents various types of biostatistical information, including catch and hatchery release statistics and recently published a *Long-term Research and Monitoring Plan* forecasting how salmon will respond to climate change (http://www.npafc.org/new/index.html).

The workshop consisted of 9 oral presentations (20 min), 5 posters (authors were also allowed to give a 10-min oral presentation), and 2 discussion sessions. Presentations were diverse and informative. The majority (12 of 14) focused on Pacific salmon (9 on marine aspects, 2 on fresh water aspects, and 1 on knowledge/database), while 2 papers dealt with Atlantic salmon.

Irvine and Fukuwaka gave an overview of abundance trends for Pacific salmon at the scale of the North Pacific, Asia, and North America. All nations commercial catch data indicate that marine production of Pacific salmon is at all time high levels (Fig. 1), dominated by chum and pink salmon, albeit with significant contributions from hatcheries. Focusing on chum and pink salmon, Fukuwaka *et al*. found high levels of synchrony among regions in catch, although the response to various climate indices varied. Hyunju Seo, who presented the paper by Kaeriyama *et al*., showed that rising temperatures have increased the growth and survival for Hokkaido age-1 chum salmon. However, this apparent benefit may ultimately lead to population density-dependent effects reducing the growth and extending the maturation schedule for chum salmon in the Bering Sea. Farley *et al*. reported results from the eastern Bering Sea that fortuitously covered four consecutive warm years (2002–2005) followed by four cool years (2006–2009). Warm years tended to benefit age-0 walleye pollock, resulting in generally higher growth potential for salmon. Mundy and Evenson concluded that the timing of spawning migrations of high latitude chinook will become more variable as warming continues. Wainwright and Weitkamp predicted that climate change effects on Oregon coho salmon will be largely negative, although great uncertainty in biological responses remains. Reed *et al*. applied an evolutionary model to forecast how some Fraser River sockeye salmon might respond to predicted changes in river temperature resulting from global warming. They concluded that the persistence of some salmon populations will depend on their ability to adapt quickly, which will be determined by the existence of sufficient genetic variation. Peterman *et al*. described the development of a new website intended to help in designing salmon monitoring programs. Wasserman documented the successful experience of the Skagit Climate Science Consortium that is integrating scientific analyses at the watershed level in order to manage salmon populations experiencing climate change. Piou and Prévost and Prusov *et al*. described their findings on Atlantic salmon in the Scorff River (France) and the White Sea (northwest Russia), respectively. Piou and Prévost's models project climate change-related life history effects, concluding that marine conditions and freshwater flow regimes are of utmost importance in determining stock abundance. Prusov *et al*. documented changes in Atlantic salmon growth and age

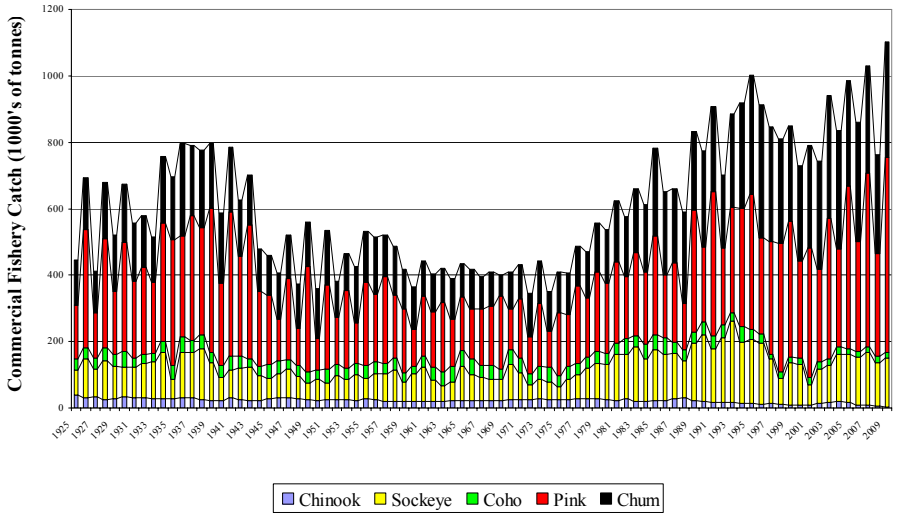

Fig. 1 All nations commercial Pacific salmon catch.

compositions during recent years of increasing temperatures but concluded that changes in management practices have thus far had the greatest impact on the status of northern populations of Atlantic salmon. Miyakoshi *et al*. documented changes in coastal temperatures around Hokkaido and described plans to adjust the release timing of young chum salmon to take advantage of these changes, and thereby increase salmon survivals. Ishida and colleagues' archeological work showed that the distribution of chum salmon in Japan during an earlier warmer period was more northerly than it is today, and predicted similar northerly shifts in salmon distribution with climate change. Jennifer Neilson, presenting the paper by Ruggerone *et al*., showed that chinook salmon growth was related to their previous growth history and pink salmon abundance, while coho salmon growth was strongly linked with pollock abundance, which was linked to temperature.

Following the oral presentations, separate discussion sessions considered the broad topics of forecasting impacts and long-term research needs. Although it was not possible to thoroughly debate all the above questions in the limited time available, there appeared to be consensus on some issues:

- The North Pacific currently produces large amounts of salmon, but rates of increase seen during the last 30 years will not continue.
- Climate change is already affecting salmon differently in northern and southern regions. There will be additional northward shifts in the southern boundary of salmon distribution. There was no consensus on whether or not the Arctic will become a more important area for salmon production.
- Marine production of pink and chum salmon is increasing, but there was no consensus how much of this might be due to ecosystem changes *vs*. enhancement.
- A proper understanding of climate effects on salmon requires consideration of each life history stage. Phases to focus on include: freshwater residence, early marine (first couple of months) and the first winter at sea.
- Important areas of future research include: improving our understanding of effects of interactions between hatchery and wild salmon in their early marine environment, and linkages between coastal oceanography and young salmon growth and survival.
- Integrated research programs with experts from multiple disciplines and countries are most likely to improve our knowledge base.

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