

### III. Workshop Review

A growing body of scientific evidence supports hypotheses about the direct and indirect effects of environmental change on fish production. These effects are often a consequence of complex changes in marine and freshwater ecosystems. The causal mechanisms linking the various physical and biological processes are neither completely defined nor understood, but there is general consensus that these links exist.

Recognizing the importance of these issues, the North Pacific Anadromous Fish Commission (NPAFC) hosted a 2-day workshop to examine evidence from around the Pacific rim on the effects of climate change on the production of Pacific salmon. Discussions focused on the oceanographic conditions and trends in the North Pacific (particularly in 1997), changes in primary productivity both in terms of biomass and species composition, trends in regional and global indices of climate change, and the effects of biological and oceanographic factors on the production of various Asian and North American salmon stocks. While it was clear that El Niño resulted in anomalous conditions in 1997, there was also a recognition that longer term decadal-scale trends in climate were also affecting salmon production.

Salmon catches in the North Pacific have undergone significant fluctuations in the past 70 years, and have been at or near historic high levels (about 900,000 t) in the last few years. Some of this observed increase can be attributed to the significant salmon enhancement activities around the Pacific rim, but evidence presented at this workshop suggests strong connections between climate change and subsequent increases in marine productivity and survival. For example, a strong correspondence between salmon catch and the Atmospheric Climate Index (ACI) in the northern hemisphere indicates that salmon production increased naturally because of a shift to a more productive regime in the late 1970s. A number of speakers at the workshop noted similar patterns (synchronous shifts) in other indices of climate change, supporting the concept of decadal-scale shifts between low- and high-productivity regimes. Evidence presented at the workshop suggests there may have been a shift to a new productivity level (regime) in the late 1980s or early 1990s, but this shift was not a return to the pre-1977 levels. If confirmed, then this shift would at least partially account for the observed changes in salmon catches in the 1990s, particularly for North American stocks.

The effects of the 1997 El Niño continue to influence oceanographic conditions particularly along the North American coast, and are expected to persist for some time. There is still no clear pattern developing for 1998, and no bold predictions either for or against renewed El Niño conditions were ventured at the workshop. There was some recognition by participants that La Niña or the colder climate (reverse) equivalent of El Niño also had dramatic influences on our climate, ocean conditions, and fish stocks. However, the La Niña phenomenon has received considerably less attention than El Niño, and this should change. Although both types of extreme events are likely to cause transient changes in coastal ecosystems, there was no strong evidence to link either El Niño or La Niña events to longer-term shifts in productivity. These events may signal or perhaps even trigger longer-term shifts in productivity, but these isolated and random events do not account for the observed persistent trends in salmon productivity.

There was a recognition that environmental conditions need to be explicitly accounted for in our assessment and management of fish stocks. This concept is not new and indeed has been alluded to in the process of explaining away large discrepancies encountered with traditional fisheries models. What is new is the relative importance given to the environment and ecosystem changes. The effects of climate change on fish production are now being given nearly equal consideration to the competing hypothesis that fish production is governed solely by an intrinsic stock-recruitment relationship and fishing. In reality, all of these factors are important, and ways must be found to incorporate all of the relevant information when assessing and managing fish populations. Such fundamental changes in approach will require time and, above all, education both within and outside the scientific community. The NPAFC Workshop on Climate Change and Salmon Production and efforts in other related programs will help speed the process. However, much work remains to be done. There is a need to continue both regional and global studies on climate change and fisheries, and international collaboration is essential to resolve this important issue.

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