**NAAFE 2011 Forum**
**Forum Theme: "The Economics of Conflict and Co-existence in an Increasingly Crowded Ocean"**

***Presidential Address: "Integrating Ecology, Economics and Institutions in Fishery Management"***

**By NAAFE President Dan Huppert**

First, I want to thank the principal organizers of this Forum – Pingsun Leung and Minling Pan – for their dedication and hard work. While I am listed as a Forum organizer, along with Pingsun and Minling, they did much more of the work than I.

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Introduction of President-elect Juan Carlos Seijo, and President-elect-elect Eric Thunberg, who were sworn in at the closing session on Friday.

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Note that this is roughly the 10-year anniversary of the first North American Fisheries Economics Forum that was held in 2001 in New Orleans, organized by Walter Keithly and Gunnar Knapp. I believe that Walter was unable to attend the Forum this year, but Gunnar is here, and we should applaud their efforts getting this organization started.
On a personal note, I was surprised to find that none of the previous three Presidents (Lee Anderson, Jon Sutinen, and Ralph Townsend) are attending today's NAAFE Forum. I'm not sure whether bodes well for me, but we shall see.

**Comments on the Forum Theme: "The Increasingly Crowded Ocean"**

The UN estimates that the world population of humans is on a path to increase from ~ 6.1 billion in 2000 to about ~ 8.9 billion by 2050. The growth will not be uniform across continents. But, this will undoubtedly drive increasingly crowded oceans. And one overall implication is that food production will need to grow as population grows - by about 50% by 2050. Since most fertile agricultural land is already used in food production, we can expect increasing intensity in use of irrigated lands to grow crops and, probably, increasing pressure to produce seafood. According to the FAO (SOFIA 2010), the per capita supply of seafood reached an all-time high in 2008 of 17kg. The increase is largely due to increasing aquaculture production, which reached 46% of world food fish supply. Maintaining fisheries production, or increasing it even slightly, will be a challenge. So, increasing human populations will undoubtedly have some long-term impacts on fisheries – marine and freshwater – that could be deleterious without effective management by well-governed institutions. Based upon the likely stability, at best, of wild fisheries supply, and increasing marginal cost of land-based food production, we would expect that food prices should rise relative to standard manufactured items. On the other hand, aquaculture may still be at a stage of rapidly expanding production, which could continue to keep fish prices lower.

Successful governance of fisheries, aquaculture, and other ocean uses will be a necessary condition for meeting the increased demand for food. All this simply means that we can expect

the next generation of fishery economists, and managers, to face more difficult challenges in dealing with the institutional and economic conditions surrounding the world's fisheries. Effective implementation of the various forms of fishing rights (or limited access privileges) will be an essential element of that. But some social scientists have found that catch shares divert attention from other important management dimensions – such as bycatch, impacts on habitat, and ecosystem-based approaches in general (Brewer 2011). Hence, we will need to incorporate broadly adaptive management institutions into our agenda for future success. This will call for integrating our understanding of ecology, economics and management of fisheries
I will focus on a few elements of the broader, more integrated approach that will be needed. Climate change and multispecies interaction are but two dimensions that should be given further attention.

**Climate Change**

One broad trend of importance will be the effects of ***climate change*** on the long-term future scale and geographic distribution of fish species. I think some fishery economists have just begun to focus on this trend, but it will be an important issue over the next decades.

I should note that climate change will be a subject of Special Session 2: *Bio-economic Implications of Growing Climate Uncertainty*. And there are papers dealing with aspects of climate change in other sessions. E.g. Session14 : Large Scale Bioeconomics - Big Picture Fishery Analysis using Global and Spatial Datasets I.

The long term trends in climate – and the related shifts in ocean acidity, temperature patterns, and currents – will cause fundamental changes in the ocean conditions under which ecosystems evolve. We don't have reliable predictions of the specific changes likely to occur. But this should lead us to apply climate-dependent ecological models of ocean regimes that are supporting fisheries (with temperature and acidity as key conditions). Then use various plausible scenarios to test the usefulness (economically and ecologically) of various adaptive management models.

My involvement in climate change research at the University of Washington's Climate Impacts Group focused on the effects of sea level rise. But I also have looked at the effects of increasing ocean acidity on marine organisms. We don't know a whole lot about these effects, but it seems that acidity does affect the ability of juvenile shellfish to form the initial calcareous structures needed to begin life. Juvenile oysters and clams have experienced relatively low survival rates in areas of Washington State where acidity has risen. Some speculate that this is an early sign of ocean acidification. More field data and good science is needed to quantify this, and to determine whether the affected organisms will adapt to the increasing acidity.

Climate change will also affect the geographic distribution of ocean temperatures. And temperature differentials drive the size and direction of ocean currents. In the North Atlantic, for example, reduced seasons melting and sinking of Arctic Ocean ice is expected to reduce broad circulation patterns. I have heard speculation that a long term impact might be a weakening of the Gulf current in the Atlantic Ocean, which could reduce the warming trend in the northern Atlantic Ocean. Iceland, Greenland and Norway could be cooler as a result! Any significant change in currents can have enormous influence on location of fish stocks.

Further, a number of scientists have focused on the likely effects of climate change on salmon ecology in the Pacific Northwest and Alaska. As climate warms, more precipitation falls as rain rather than snow, snow packs decline, and peak stream run-off shifts to earlier dates (apparently they have shifted by 6 days since 1950). Stream temperatures increase. As a result, salmon populations are expected to decline in the southern end of their current range (e.g. California) and may increase in the northern range (e.g. Bristol Bay, Alaska). The economic consequences of changing climate may be a slow, steady trend that is drowned out by the year-to-year and decade-to-decade shifts in salmon populations due to shorter term phenomena – such as El Ninos and Pacific Interdecadal Oscillation.

**Multispecies Interactions**

Early in my career (mid-1970s) I was Chair of the Anchovy Management Plan Team, which dealt with a purse seine fishery delivering to fish meal plants in California. We had extensive data on anchovy abundance over time, and the biologists on the team developed a population model which we used to assess implications of a variety of harvest control rules. We also knew from testimony heard at meetings, and from other biologists, that anchovy were a key prey species in Southern California. So, lacking a multispecies population model, we focused on various harvest rules for maintaining the anchovy population above the MSY level on average.

Today, I suspect that, with more quantitative, multispecies biological and economic models at hand, we would have recommended closing or minimizing the anchovy fishery. All the prey species involved, everything from tunas to mackerel to billfish, had much higher economic values. But, lacking quantitative models of the species interactions, we focused the fishery management plan options on the effects that the fishery would have on the anchovy stock – the single species approach to management.

A second key element of the multispecies approach would be to deal with bycatch -- an integral part of fishing. For example, in Hawaii we have recently seen work on the sea turtle bycatch in the longline fishery. The location and timing of the fishery can be adjusted to reduce the bycatch.

In some cases, the single species approach to fisheries can be way too restrictive on bycatch. This would be likely where the bycatch is also valuable and sustainably harvested. An example would be salmon caught in the Bering sea Pollock fishery. Rather than requiring that all bycaught salmon be discarded, the salmon can be frozen at sea and brought in for donation to food banks. This seems a reasonable innovation. But, typically, where there are competing fisheries targeting the bycatch species, fishery managers tend to adopt rules to minimize bycatch and require that it be discarded – a practice that might ameliorate conflicts between fishing fleets, but doesn't necessarily optimize the fishery output overall. It reflects a collection of single-species management rules, rather than a broad multi-species approach.

Another obvious dimension for enhancing the ecosystem-based approach to fishery management is to incorporate effects of fishing and other human activities on fish habitats. This would involve introducing measures of habitat effects into the fish populations models, so that changes in fishing effort by various gears types (e.g. trawls) would be reflected in the population levels of

fish dependent upon affected habitats. I suspect that many of you have encountered these sorts of ecosystem relationships. I don't know how many have successfully developed useful models of these complex relationships for developing management options.

It is clearly much more challenging and complex to develop and implement reliable models of multi-species systems, but this seems to be an important element of any ecosystem-based approach to fishery management.

**Conclusion**

As suggested in the title of my address, we need to follow the linkages from ecosystems to economic consequences to needed structure of the related institutions of fishery management. Obviously, we don't yet have adequate knowledge of the ecological consequences of the long-term changes in climate -- ocean temperature, currents and acidity – that we would need in order to incorporate them into specific management models. But we could start by expanding our economic models to assess the desirable management approaches to a variety of climate scenarios. Then as the changes in climate and ecosystems become better understood (and observed) we would have a better understanding of how to evaluate alternative management approaches. And these assessments would need to be explained to the fishery managers, just as we currently attempt to incorporate more short-term economic factors (like MEY) into management processes. The more complex issue is whether the structure of the management institutions (geographic scale, range of regulatory options considered, inter-connections along coasts) themselves need to be modified. For example, can we explicitly lay out the range of co-management obligations among coastal management councils in the US?

Obviously, I don't have clear and definite conclusions to offer regarding the outcome of this broad research agenda and institutional adaptation to a changing marine ecosystem. But I think it is worth putting this set of issues on the table, to challenge the brilliant minds of economists in NAAFE.

Thank you for listening to my musings about long-term fundamental changes in the fisheries economics. I hope it sparks some useful innovation in ecological-economic-institutional understanding of the challenges likely to occur over the next few decades.

## References

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