

CLIMATE CHANGE AND AQUACULTURE: Research Strategies for Environmental Sustainability in the Northeast

BACKGROUND

The issues surrounding the potential impacts of global climate change have been extensively addressed in scientific fora, but the general public has had less opportunity to translate global changes into localized effects that could directly and indirectly change livelihoods and the heritage they leave their progeny.

In a series of symposia, a consortium of non-governmental organizations, universities, and Federal agencies have attempted to explore these more localized changes. The first Symposium brought experts in marine fisheries, physical and chemical oceanography, meteorology, and socio-economics together to discuss the implications of climate change on the Gulf of Maine region looking specifically at the potential impacts on the fishing community. A combination of background white papers and brief presentations set the stage for group discussions and a vigorous question-answer session. The outcome of the symposium demonstrated an underlying focus on aquaculture as well as commercial fishing and the habitat impacts that threaten the viability of both wild and farmed species

CHANGE SYMPOSIUM II FISHERIES AND THE GULF OF MAINE: Natural And Manmade Stressors

The second forum on Climate Change and Fisheries in the Gulf of Maine was held at the Darling Center Conference facility on September 25, 2003. The premise of the symposium series is that presented with scenarios of potential impacts of climate change, scientific experts and the representatives of the coastal community can scale events anticipated to accompany global changing climate to the concerns and activities of local or regional community and propose means of mitigating adverse impacts and augmenting advantageous ones.

The 2002 Symposium was an open forum that provided the focus for the second symposium by emphasizing the importance of viewing the marine ecosystem as a complex whole and including human activities as both effectors and affected components. The first symposium emphasized that wild fisheries, along with marine aquaculture, are local activities that will require mitigation and modification to adapt to the many factors that may alter with a changing climate.

The temptation of the experimental scientist is to focus on one aspect of change, not to the exclusion of other factors, but with a myopia that does not lend itself well to the broader consideration of the competing and amplifying elements in the real world. This symposium series' goal is to look not just at climate change and wild fisheries, or, in the case of this second symposium, climate change and marine aquaculture, but to consider the matrix of factors that affect the health of wild and farmed stock. These factors include but are not be limited to temperature, current, nutrient inflow, harmful algae, contaminant loading, invasive species, and sources and vectors of faunal and human disease elements in coastal and marine habitats. In addition, policy, management, and socio-economic experts provided an integration of these changes on the communities that may be affected.

Panel discussions were initiated by provocative scenarios. The first panel focused on environmental and economic implications of climate change for industry and government planning, siting, and operation of aquaculture facilities. The second round focused on implications for the ecological and economic effects of aquaculture on wild species and habitat under projected environmental and climatic conditions. While the initial discussion was among expert panelists, each discussion concluded with open interactions with the other invited participants.

Breakout groups were organized around the topics, of monitoring/assessment, basic research, and forecasting/modeling. Each group included a cross section of the participants and the focus on issues and solutions led to an amazing level of cooperation and understanding despite some enmity among the parties involved. Their charge was to develop recommendations and priorities for research that can most effectively assist planning and management of finfish and shellfish aquaculture, in both the nearshore and offshore.

RECOMMENDATIONS

Recommendations of critical needs regarding assessment of global warming impacts (direct and indirect) on aquaculture:

1st group breakout – research needs –

- Carrying capacity at the ecosystem scale;
- Secondary impacts of development on water quality (including more concerted research efforts on factor interactions, e.g. temperature x disease organisms; temperature x nutrients, on aquatic communities).
- Polyculture – regional demonstration projects at a production scale.
- Aquaculture as beneficial habitat.
- Strong database on before/after effects at aquaculture sites (data mining and *synthesis*).
- Changes in circulation patterns and impacts on life history stages (especially larvae / juvenile stages).

- Stress assays (new tools that can help in “early warning” systems to prevent additional stress and death; and new tools that can help detection of certain pollutants for seafood safety issues).

[It was noted that it would be advantageous for aquaculturists to act as proactively as possible, rather than to rely only on growth rates and move to act when growth rates decline

Integrated social/economic studies at local and regional scales.

During the open discussion session, additional recommendations were tendered:

- Increase the number of aquaculture researchers in the U.S. (tenured professors, beyond extension services).
- Dedicated funding sources for aquaculture research.
- Establish marine aquaculture experimental stations (funded by federal agency(ies) with maritime experience and purview)
- Regional centers of excellence and training in aquaculture (e.g. a New England Center of Excellence and Training).

2nd group breakout – forecasting, monitoring, and modeling

The following parameters need to be monitored with attention to climate change effects over the short term (5-10 years):

- Meteorological – wind direction, speed, precipitation, air temperature;
- Water temperature (minimum, maximum, average);
- Salinity;
- Light (photosynthetically active radiation, PAR);
- Dissolved oxygen;
- Nutrients (total N, ammonium, nitrate, dissolved organic N, dissolved organic C, total P, soluble reactive phosphate);
- Current – water depth, speed;
- Suspended solids (erosion);
- Drift ice where appropriate;
- Harmful algal blooms toward predicting onset and movement;
- Fecal coliforms (additional monitoring, especially surficial sediments).

The recommended mechanisms include:

- Greatly enhance early warning system capabilities: Real-time *in situ* remote monitoring (RTRM) stations (automated buoys, platforms) at key locations (local, regional) – including, data hourly for meteorological parameters and various physical/chemical parameters. Detection of sudden changes in, e.g., salinity or temperature or dissolved oxygen. Capture of pollutant loadings and parameter changes throughout storm events, including early on during the storm events.
- Satellite surveillance: Including, ground-truthing at selected inlet entrances and aquaculture operations as important representative locations (e.g., Pleasant, French Bay, Damariscott, Blue Hill, Cobscott, and Machias).
- Long-term Water sampling profile (20 years): In appropriate locations, at high and low tide, every 2 weeks.

- Operational information and prediction (weeks, months, years): – At key locations / entrances, including: Rainfall events (10 inches of rain or more); superchill and temperature extremes; Ice; and 20°C isotherm map for shellfish; 16°C – 0°C for salmon.
- Storm surge models.
- Likely intensity and frequency of rainfall (seasonal forecasts).
- SST forecasts.
- GIS maps (local, regional) of:
Aquatic areas (suitable habitats); and
Sources and sinks of sediments, pollutants of concern (e.g. toxic substances).

And –

- There is a critical need to make the synthesized information rapidly available to aquaculturists in easily understood and usable form (GIS maps on accessible websites; summaries of accessible trends; updated every five years).

Participating Panelists included:

Dr. H. Suzanne Bolton, NOAA Fisheries, Office of Science and Technology
Dr. JoAnn Burkholder, NC State University
Dr. Barry Costa-Pierce, Director, Rhode Island Sea Grant Program
Dr. Allan Michael, Cape Ann Fisheries Institute
Dr. Sandy Shumway, University of Connecticut
Dr. Juli Trtanj, Climate Variability and Health Program Manager, NOAA Global Program