2010 Sendai Workshop on "*Networking across Global Marine Hotspots*"

by Gretta Pecl, Stewart Frusher, Warwick Sauer and Alistair Hobday

A 1-day workshop on "*Networking across global marine hotspots*" was held on April 25, 2010, immediately prior to the international symposium on *"Climate change effects on fish and fisheries*" in Sendai, Japan. The workshop was co-convened by the authors of this article and designed to (1) highlight where global marine 'hotspots' occur throughout our oceans, (2) summarize the information currently emerging on biological climate change impacts in these areas, and (3) discuss the potential for developing a global network of scientists, policy makers and managers working in marine hotspots. The workshop attracted considerable interest and was attended by approximately 50 scientists, including invitees from the identified hotspot regions.

The premise behind the workshop was that areas typified by above-average ocean temperature increases, or ocean 'hotspots', are the planet's early warning system for understanding the impacts and adaptation options for marine climate change. Networking and synthesising outcomes from across hotspots can facilitate accelerated learning and also indicate sensible pathways for maximising adaptation and minimising impacts for other global regions. Research, development, management and communication can all be delivered faster, and with greater certainty, through a coordinated network across global hotspots. In these regions:

- Impacts associated with global warming will be observed earlier;
- Species or ecosystem models developed for prediction can be validated earlier than in other slower changing regions; and
- Adaptation options can be developed, implemented and tested first.

The workshop was introduced by Gretta Pecl who described our approach to defining hotspots, their location, and the rationale for the use of sea surface temperature (SST) to determine potential hotspots to include in a global network. Temperature is the most commonly used variable in marine species distribution studies, and as a metric of marine climate change. It is considered to be the major driver of distribution, abundance, phenology and life history. Temperature was also the most commonly identified metric in the presentations at both our workshop and at the main symposium in the days following the workshop. There was extensive discussion on the merits of using SST to define hotspots and on other potential metrics that are also important, such as productivity, acidification, upwelling and oxygen depletion zones. While it was noted that there are other metrics, the general consensus was that SST is a key factor affecting biological processes, and is also the most accessible global data for defining regions that were rapidly changing, and thus provides the first opportunity to inform society of climate change impacts and adaptation options. It was noted that temperature *per se* may not be the driver as it could be a proxy for wind regime changes and/or current shifts.

The intent behind the workshop was not to develop an exhaustive list of global hotspots, but rather to provide a platform to explore the idea of a network covering fast-changing areas across the globe. There was broad agreement that the network would welcome participation by other areas that are also experiencing significant biological change (*e.g.*, areas experiencing noteworthy changes in productivity) or large socio-economic impacts (such as developing countries highly dependent on fisheries).

Based on historical (last 50 years) and projected (next 50 years) rates of ocean warming, 24 regional hotspots were identified that were warming faster than 90% of the oceans. These hotspots covered tropical, temperate, sub-temperate and polar regions, developed and developing countries with a range of adaptive capacities, a variety of ecosystem types, and areas with varying degrees of anthropogenic pressures and disturbances.

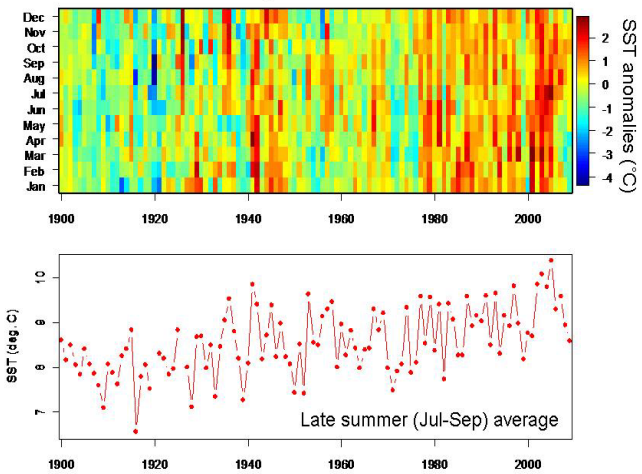


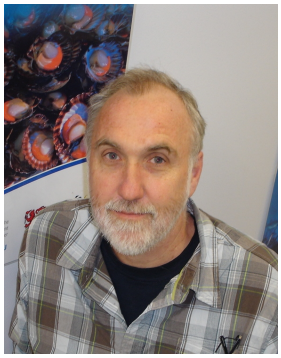
Fig. 1 Sea surface temperature (SST) anomalies in the eastern Bering Sea (from Franz Mueter's workshop presentation).

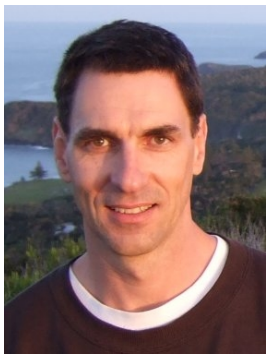
Invited presentations covered the following hotspot regions: Southeastern Australia, Southern Africa/Benguela system, Galapagos archipelago, Mozambique Channel, eastern Bering Sea, British Columbia, North Sea, Japan Sea, East China Sea/Taiwan Strait, South China Sea, and coastal zone of Vietnam. Most speakers provided details on published or unpublished *in situ* temperature records demonstrating significant recent increase in temperatures, 'validating' the selection of regions as hotspots (*e.g.*, see Fig. 1 from Franz

Mueter's talk on the eastern Bering Sea). However, in many cases temperature either was, or was suspected to be, a proxy for current and/or wind regime changes. Common themes emerging from across these regions with high rates of temperature increase included areas of significant deoxygenation, increased frequency of harmful algal blooms, shifts in species diversity of phyto/zooplantkon communities (mainly from large to small individuals) and increased diversity and species richness of fish. Many presenters provided evidence of large-scale range shifts for a wide variety of species, including movements to deeper waters in some cases. In several regions, large changes in the distribution and abundance of range-shifting species resulted in these acting as 'invasives' creating negative ecosystem impacts (*e.g.*, pipefishes in the North Sea and long-spined sea urchins in Tasmania). Interestingly, regions with naturally high climate variability were not less sensitive to climate change factors, instead appearing to be at least equally vulnerable to change and not necessarily 'pre-adapted'. For example, Kyushu in southern Japan and Galapagos archipelago both experience very large seasonal variations in temperature (11–28º and 18–30ºC, respectively), and yet have, in recent decades, undergone regime changes in the inshore areas. In several hotspots redistribution of fisheries effort and associated changes in fleet structure and operations has led to current or impending management implications for harvesting of 'shifting biomass', especially across jurisdictional boundaries.

Formal presentations were followed by a series of discussion topics. The first of these identified the value and practical functions that a global hotspot network could achieve. These were:

(1) Providing a mechanism for scientists, managers and policy makers to communicate and see how science was being translated into policy and practical adaptive management measures in those regions of the world where impacts were occurring;



Dr. Gretta Pecl (Gretta.Pecl@utas.edu.au) is a Fulbright Fellow and a Senior Research Fellow leading several projects within the Climate Change Impacts and Adaptation Theme at the Tasmanian Aquaculture and Fisheries Institute. Her current research activity spans a range of topics, including range extensions associated with climate change, evaluating adaptation options in socio-ecological systems, assessing population and fishery responses to climate change, and using citizen science approaches for ecological monitoring and engagement (http://www.REDMAP.org.au). She was Lead Author of the recent Australian Federal Department of Climate Change interdisciplinary report into the impacts and adaptation response options for the Tasmanian Rock Lobster Fishery (http://www.climatechange.gov.au/en/publications/coastline/east-coast-rock-lobster.aspx). Gretta is currently working in Alaska for her Fulbright Fellowship, a project developed specifically to facilitate collaboration and knowledge exchange between northern and southern hemisphere marine hotspot regions.

Dr. Stewart Frusher (Stewart.Frusher@utas.edu.au) is Associate Professor at the Tasmanian Aquaculture and Fisheries Institute at the University of Tasmania, where he leads the Climate Change Impacts and Adaptation for Marine Resources theme. He co-convenes the bio-physical node of Australia's Adaptation Network for Marine Biodiversity and Resources with Dr. Hobday. His interests are in providing the research to sustainably manage fisheries resources so that they continue to provide social and economic benefits to society. Stewart has extensive experience in crustacean resources and is becoming more involved in the development of interdisciplinary teams to address fisheries issues.

Dr. Warwick Sauer (W.Sauer@ru.ac.za) is Professor and Head of the Department of Ichthyology and Fisheries Science at Rhodes University in South Africa. His interests are in fisheries ecology and management, particularly in the translation of science into practical fisheries management. He serves on a number of management bodies, including the International Cephalopod Advisory Council, and has been involved in numerous regional research projects covering Sub Saharan Africa and the western Indian Ocean. He currently is a member of the Project Coordination Unit for the Agulhas and Somali Large Marine Ecosystem Project, and coordinates training and capacity building initiatives across the Agulhas region.

Dr. Alistair Hobday (Alistair.Hobday@csiro.au) is a Principal Research Scientist at CSIRO in Australia, and leads the Marine Climate Impacts and Adaptation research area (http://www.cmar.csiro.au/climateimpacts). His research has focused on the physical drivers and impacts of climate change on the distribution of marine species around Australia. As a result of his work on fisheries, aquaculture and biodiversity issues, Alistair has been asked to assist with development on national strategy to respond to climate risks. With Dr. Frusher, he co-convenes the bio-physical node of Australia's Adaptation Network for Marine Biodiversity and Resources. He also co-chairs of the international GLOBEC/IMBER program CLIOTOP (Climate Impacts on Top Ocean Predators).

(2) Facilitating comparative studies through:
   - promotion of consistency in data collection, analysis, and reporting, and
   - potential for greater certainty in projection models through first opportunities for validation;
(3) Providing (based on comparisons between regions) greater certainty in the understanding of impacts for stakeholders (*i.e.*, other stakeholders are experiencing similar issues);
(4) Allowing for shared learning and capacity building about adaptation science (successes and failures);
(5) Providing, as the hotspots regions are at the forefront of climate change, valuable insights into the impacts, model validation and the success or failures of adaptation planning for the broader global community.

The workshop participants agreed that a global network of researchers, managers and policy makers working in marine hotspot locations was an appropriate action for providing the science-to-policy framework that would guide climate change adaptation globally.

The final discussion session focused on a path forward and identified the following actions:
(1) A Consensus Statement would be produced to be signed by participants. Participants would be encouraged to obtain in principal support from their respective research/management institutions as further support for the network.
(2) A summary paper of the physical changes documented in last few decades in each region, including observed (or predicted) biological/ecological/fisheries impacts including changes in distribution, abundance and phenology at each of the trophic levels and any observed ecosystem changes and the flow on effects to cultural, social and economic impacts.
(3) A website would be developed for communication of the network and hosting an initial workshop to determine a strategic and operational plan for the network.
(4) Funds would be sought to run targeted workshops on identified areas of need, such as monitoring methodologies, inter-disciplinary approaches for linking science to practical management, *etc*.
(5) Funds would be sought to establish demonstration projects. Examples of such projects could include:
   - identification of key monitoring sites for global comparisons;
   - evaluation of tools/approaches for implementing adaptation options that identify and balance the trade offs in ecological, social and economic indices using some of hotspot regions as case studies.

The workshop was sponsored by Australia's National Climate Change Adaptation Research Facility's Marine Biodiversity and Resources Network (MBRN). The MBRN is an interdisciplinary network aimed at building adaptive capacity and adaptive response strategies for the effective management of Australia's marine biodiversity and natural marine resources under climate change.

NCCARF
National
Climate Change Adaptation
Research Facility
Adaptation Research Network
MARINE BIODIVERSITY AND RESOURCES