Climate and marine birds and mammals in the North Pacific

By Yutaka Watanuki, Shoshiro Minobe and William J. Sydeman

A workshop on "*Responses of marine mammals and seabirds to large-scale and long-term climate change: Mechanisms of environmental forcing*" was held on October 12, 2006, in conjunction with PICES XV in Yokohama, Japan. The workshop was developed by the PICES Advisory Panel on *Marine Birds and Mammals* and the Physical Oceanography and Climate Committee, and supported financially by PICES and the "Neo-science of natural history" Centre of Excellence (led by Prof. Hisatake Okada) at Hokkaido University, Sapporo, Japan (http://nature.sci.hokudai.ac.jp/). The workshop was convened by Drs. Yutaka Watanuki and Shoshiro Minobe (Japan), and William J. Sydeman (U.S.A.), and invited speakers included Drs. Sarah Wanless (U.K.), Arthur Miller and Julie Thayer (U.S.A.), and Shin-ichi Ito and Sei-ichi Saitoh (Japan) (**Photos 1** and **2**).

Photo 1 Front row: Workshop co-convenors, Yutaka Watanuki (left) and Shoshiro Minobe (right); back row: invited speaker, Sarah Wanless.

Photo 2 Front row: Workshop co-convenor, William Sydeman (left); second row: invited speaker, Julie Thayer; back row: invited speaker, Shin-ichi Ito (second from left).

Low-frequency climate variability often has profound effects on marine ecosystems, yet its influence on top predators, such as large fishes, seabirds and marine mammals, has not been adequately quantified, especially for the North Pacific. In the North Atlantic, the breeding performance and population dynamics of many species are known to be related to changes in the North Atlantic Oscillation. The aim of this workshop was to examine responses by these types of fauna to interannual and interdecadal climate variability in the North Pacific. A secondary purpose was to facilitate collaboration between researchers working in disparate marine science disciplines (*e.g.*, climatology to mammalogy). Various studies describing patterns and testing potential mechanisms of environmental forcing, from physics to prey to predators, were presented.

Approximately 25 scientists from the PICES community attended the workshop, and lively discussion followed each presentation. Using an elaborate modeling approach based on NEMURO.FISH, Shin-ichi Ito showed how growth of fishes (herring and saury) varies between regions of the North Pacific relative to ocean climate, suggesting that different physical or biological factors limit growth in the eastern and western Pacific. Regional differences in primary production (Sei-ichi Saitoh) and responses of marine birds (Sarah Wanless, Julie Thayer, Shoshiro. Minobe and M. Ito) and mammals (Steller sea lion – Arthur Miller and Keiko Kato, northern fur seals – Andrew Trites and Shiroh Yonezaki, western grey whales – Hyun-Woo Kim) to variation in temperature and regime shifts were described. The potential mechanisms of responses (changes in food webs, diets, nutritional condition of prey, *etc*.) were also discussed. Dr. S. Minobe demonstrated how correlation analyses between sea temperature, sea level pressure, and breeding performance of marine birds may provide new insights toward specific mechanisms (**Fig. 1**). The relative importance of spatial variability in ocean climate, in addition to temporal variability, was a recurring theme of the workshop.

During general discussion, the following key points were elaborated:

- Collaboration between climatologists, oceanographers, and marine bird and mammal experts is essential to developing the science of climate change and climate effects on seabirds and marine mammals.
- Whereas marine bird and mammal specialists may offer local mechanistic hypotheses, climate scientists and oceanographers often provide a larger-scale physical context, and coupling these scales of analysis is likely to be critical to understanding the effects of climate change on these top predators.
- Marine birds and mammals should be considered in developing PICES ecosystem models, including NEMURO. Seabirds and marine mammals may exert "top-down" control of fish and zooplankton, and the effect of their consumption should be estimated.

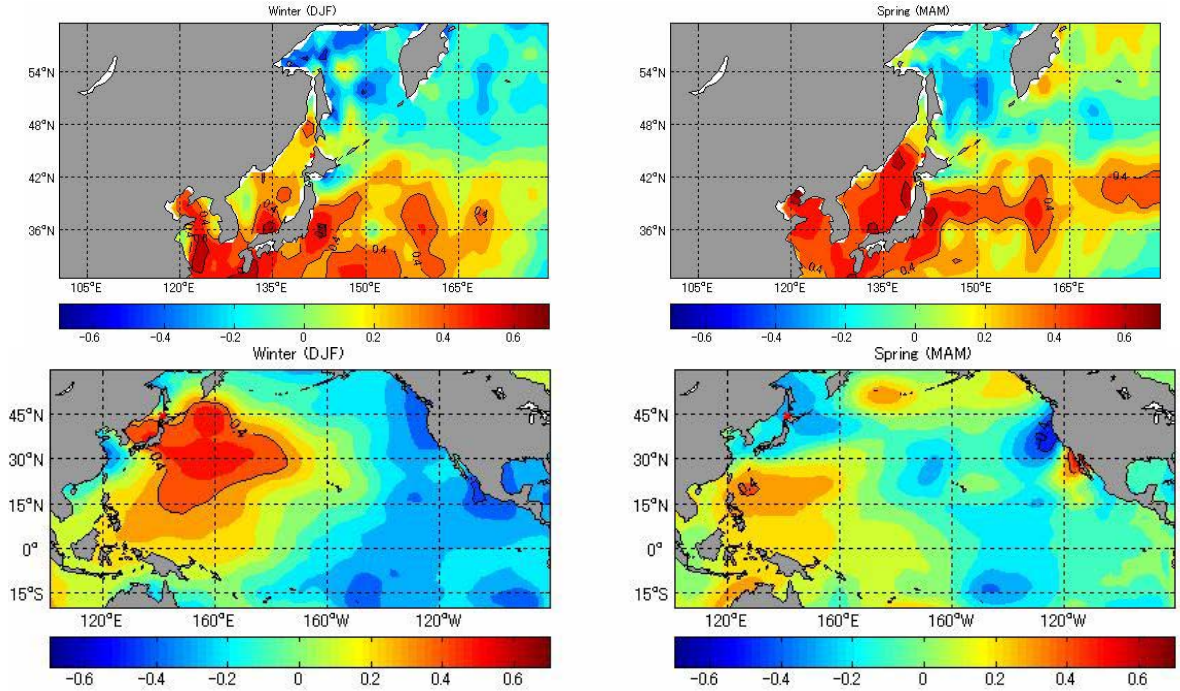

Fig. 1 Spatial correlation between physics – sea surface temperature, SST (top row) and sea level pressure, SLP (bottom row) – and the breeding success of Rhinoceros Auklets at Teuri Island on the west coast of Hokkaido, Japan (S. Minobe et al. *unpublished). Winter SLP forces winter and spring SST, probably by changing winds, and the inflow of the Tsushima Warm Current to the Japan/East Sea. In turn, this affects the distribution of a primary prey (anchovy) for the auklet. Since winter SLP is measured 4-6 months prior to the completion of the auklet's annual breeding cycle, this study suggests that predictions of reproductive success may be possible.*

- Correlations between climate indices and the food habits, breeding success and population parameters of marine birds and mammals in the Atlantic and the Pacific are, in some cases, well known, but an understanding of the mechanisms driving correlative relationships is lacking. Until mechanisms are studied, established and modeled, our ability to predict effects of climate change on marine birds and mammals will be limited.
- Scale-dependent responses (spatial and temporal) and species-specific life history characteristics (*i.e.*, variation in trophic and foraging ecology and demographic strategies) must be considered in analyzing the relationships between climate variability and change and responses of marine birds and mammals. For example, species with narrow diets, restricted foraging ranges may be especially susceptible to climate induced changes to local food webs.
- Due to their visibility, and rapid and substantial responses, marine birds and mammals may be excellent indicators of marine ecosystem change. But, to use them fully, calibration of climate–predator responses is needed. Fortunately, many long-term research studies and datasets of PICES member nations and their academic communities are available for synthesis and analysis. The available information includes detailed data on food habits, movements and migration, and the demographic attributes (*e.g.*, fecundity, survival, recruitment) that drive abundance and biomass. Therefore, studies of marine birds and mammals are likely to contribute to a better understanding of climate change effects on marine ecosystems in the North Pacific.

Dr. Yutaka Watanuki (ywata@fish.hokudai.ac.jp) is an Associate Professor of the Graduate School of Fisheries Sciences at Hokkaido University, Hakodate. Dr. Watanuki studies the foraging behavior of seabirds using bio-loggers and telemetry, and conducts long-term studies of climate and seabirds at Teuri Island, Hokkaido, Japan. He is a member of the PICES Advisory Panel on Marine Birds and Mammals.

Dr. Shoshiro Minobe (minobe@ep.sci.hokudai.ac.jp) is a Professor of the Graduate School of Sciences at Hokkaido University, Sapporo. Dr. Minobe studies physical oceanography, with particular interest in coupling changes in the atmosphere and ocean, and in numerical simulations of oceanic variability.

Dr. William J. Sydeman (wsydeman@prbo.org) is Director of the Marine Ecology Division at PRBO Conservation Science, in California. Dr. Sydeman studies climate effects on coastal and pelagic marine ecosystems in the eastern North Pacific, and conducts long-term studies of climate, seabirds and marine mammals at the Farallon Islands (California, U.S.A.). He co-chairs the PICES Advisory Panel on Marine Birds and Mammals.