TOP PREDATORS AS INDICATORS OF CLIMATE CHANGE: STATISTICAL TECHNIQUES, CHALLENGES AND OPPORTUNITIES


10/22/2014

PICES Annual Science Meeting
TOP PREDATORS AS INDICATORS OF CLIMATE CHANGE: STATISTICAL TECHNIQUES, CHALLENGES AND OPPORTUNITIES

Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems

To understand and forecast responses of North Pacific marine ecosystems to climate change and human activities at basin and regional scales, and to broadly communicate this scientific information to members, governments, resource managers, stakeholders and the public.
Introduction to FUTURE & MBM-AP

- **Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems**
  - To *understand* and *forecast* responses of North Pacific marine ecosystems to climate change and human activities at basin and regional scales, and to broadly *communicate* this scientific information to members, governments, resource managers, stakeholders and the public

- **Marine Bird Mammal Advisory Panel (MBM-AP)**
  - Provide information on the role of top predators in N. Pacific Ecosystems to rest of PICES community
  - Interest and need for strong integration with **FUTURE**
Introduction to FUTURE & MBM-AP

- **Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems**
  - To *understand* and *forecast* responses of North Pacific marine ecosystems to climate change and human activities at basin and regional scales, and to *broadly communicate* this scientific information to members, governments, resource managers, stakeholders and the public.

- **Marine Bird Mammal Advisory Panel (MBM-AP)**
  - Provide information on the role of top predators in N. Pacific Ecosystems to rest of PICES community
  - Interest and need for strong integration with **FUTURE**

- **Acknowledgements:** PICES FUTURE, IMBER-CLIOTOP
Top Predators as Climate Sentinels

- Integrate across food-web dynamics and ocean ecosystems
- Long-lived, respond to broad scales of environmental variability
- Distribution, abundance, and life history stages more easily tracked than other marine species
- Multiple responses to climate change

Diagram showing the interactions between different species, including primary production, detritus/particulate organic matter, zooplankton, and other invertebrates, small fishes (sp. A, sp. B), large fishes (sp. A, sp. B, sp. C), and megafauna. The diagram also indicates biogeographic shifts, changes in body size, and phenological shifts due to climate change.
Top Predators as Climate Sentinels
Top Predators Responses

- **Spatial** – shift in habitat, range or distribution
- **Temporal** – shift timing of migration, reproduction
- **Food Web** – change in prey composition, trophic position, foraging effort
- **Demographic** – change in fecundity, survival, population
Current state of knowledge

- **Predictions:**
  - Northward migration of TZone (Polovina et al. 2011; Hazen et al. 2013)
  - Upwelling intensification? (Bakun 1990, Sydeman et al. 2014)
  - Changes in size distributions (Cheung et al. 2012, Woodworth et al. 2013)
  - Phenological shifts (Anderson et al. 2013)
Current state of knowledge

- **Predictions:**
  - Northward migration of TZone (Polovina et al. 2011; Hazen et al. 2013)
  - Upwelling intensification?? (Bakun 1990, Sydeman et al. 2014)
  - Changes in size distributions (Cheung et al. 2012, Woodworth et al. 2013)
  - Phenological shifts (Anderson et al. 2013)

- **Observations:**
  - Phenology (Sydeman & Bograd 2010, Schroeder et al. 2009, Poloczanska et al. 2013)
FUTURE OSM Workshop goals

- Identify existing top predator, ecological, and oceanographic datasets that can be used to examine response to climate variability and change.
- Review statistical techniques that can be used to differentiate top predator response from climate variability and change.
- Identify sentinel species and life history characteristics that may best reveal responses to physical and biological changes.
- Discuss synthetic approaches, beyond single measurements, that are needed to understand how climate variability and change are integrated by top predator behavior, distribution, abundance, and demography.
Presented research

- Suite of responses and mechanisms to climate variability and change presented:
  - Change in distribution (Pérez-Andújar, Weng, Kuletz, Yamamoto) and species overlap (Kuletz, Witteveen)
Presented research

- Suite of responses and mechanisms to climate variability and change presented:
  - Change in distribution (Pérez-Andújar, Weng, Kuletz, Yamamoto) and species overlap (Kuletz, Witteveen)
  - Dietary shifts (Orben, Goetsch, Suryan)
Presented research

- Suite of responses and mechanisms to climate variability and change presented:
  - Change in distribution (Pérez-Andújar, Weng, Kuletz, Yamamoto) and species overlap (Kuletz, Witteveen)
  - Dietary shifts (Orben, Goetsch, Suryan)
  - Demography (Sydeman, Polovina)
We developed a statement outlining the need for enhanced sampling for top predator and ecosystem response to the predicted 2014-5 El Niño event.
Future directions

- We developed a statement outlining the need for enhanced sampling for top predator and ecosystem response to the predicted 2014-5 El Niño event.
- We sketched a review paper on developing a framework for assessing responses to climate change by N. Pacific top predators.
- We discussed a long-term goal of an interdisciplinary, North Pacific-wide proposal to synthesize top predator responses relative to climate variability and change.
- Continue efforts to include and mechanistically understand top predators in applications of climate variability and change with PICES / CLIOTOP efforts.
Thank You