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

E.L. Hazen, R. Suryan, S.J. Bograd, T. Yamamoto, E. Di Lorenzo, J. Polovina, W. Sydeman, K. Weng, R. Ream, Y. Watanuki

10/22/2014

PICES Annual Science Meeting

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Introduction to FUTURE & MBM-AP

- **F**orecasting and **U**nderstanding **T**rends, **U**ncertainty and **R**esponses of North Pacific Marine **E**cosystems
  - 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.

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- 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**

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- Acknowledgements: PICES FUTURE, IMBER-CLIOTOP

Top Predators as Climate Sentinels

- Integrate across food-web dynamics and ocean ecosystems
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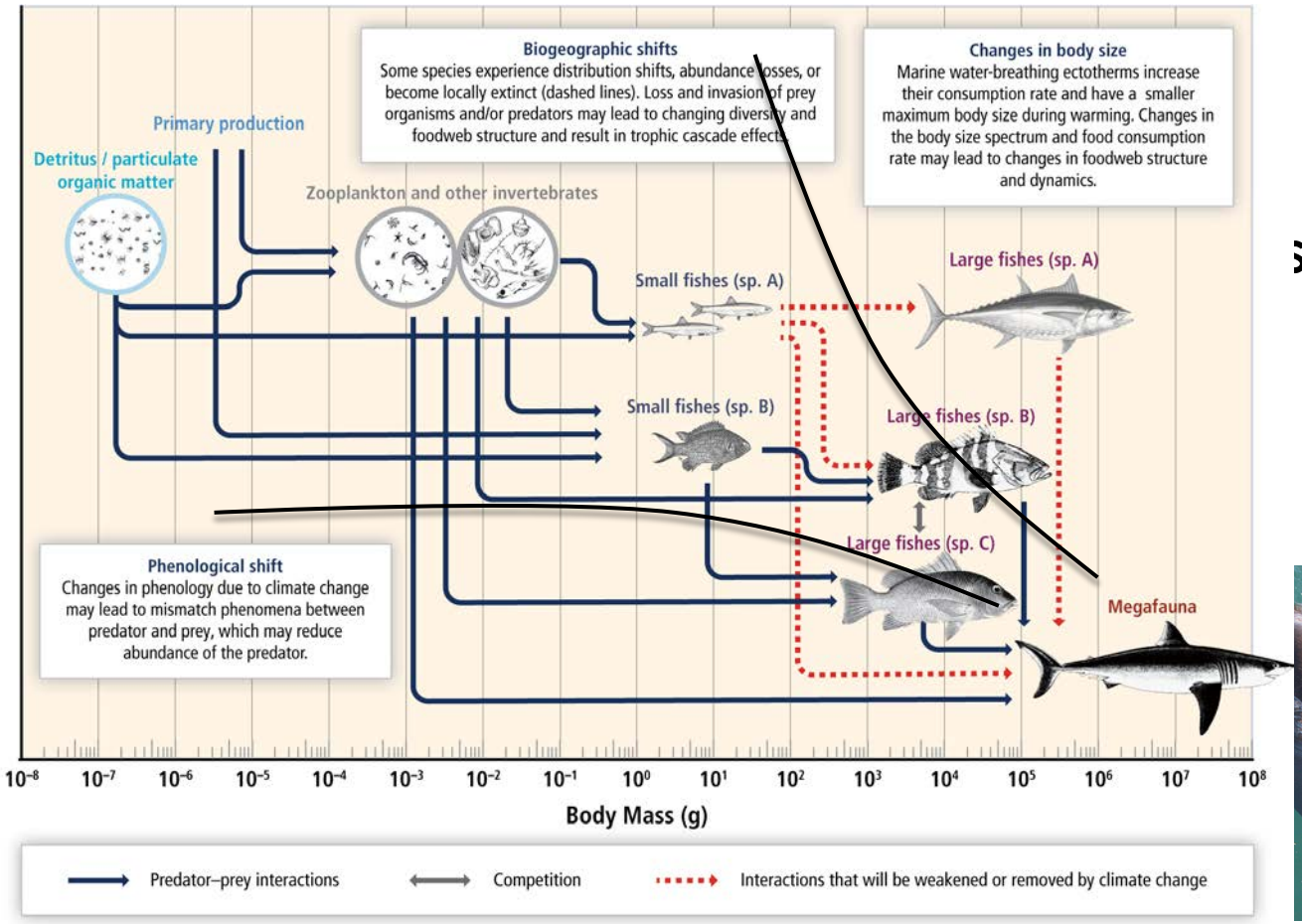
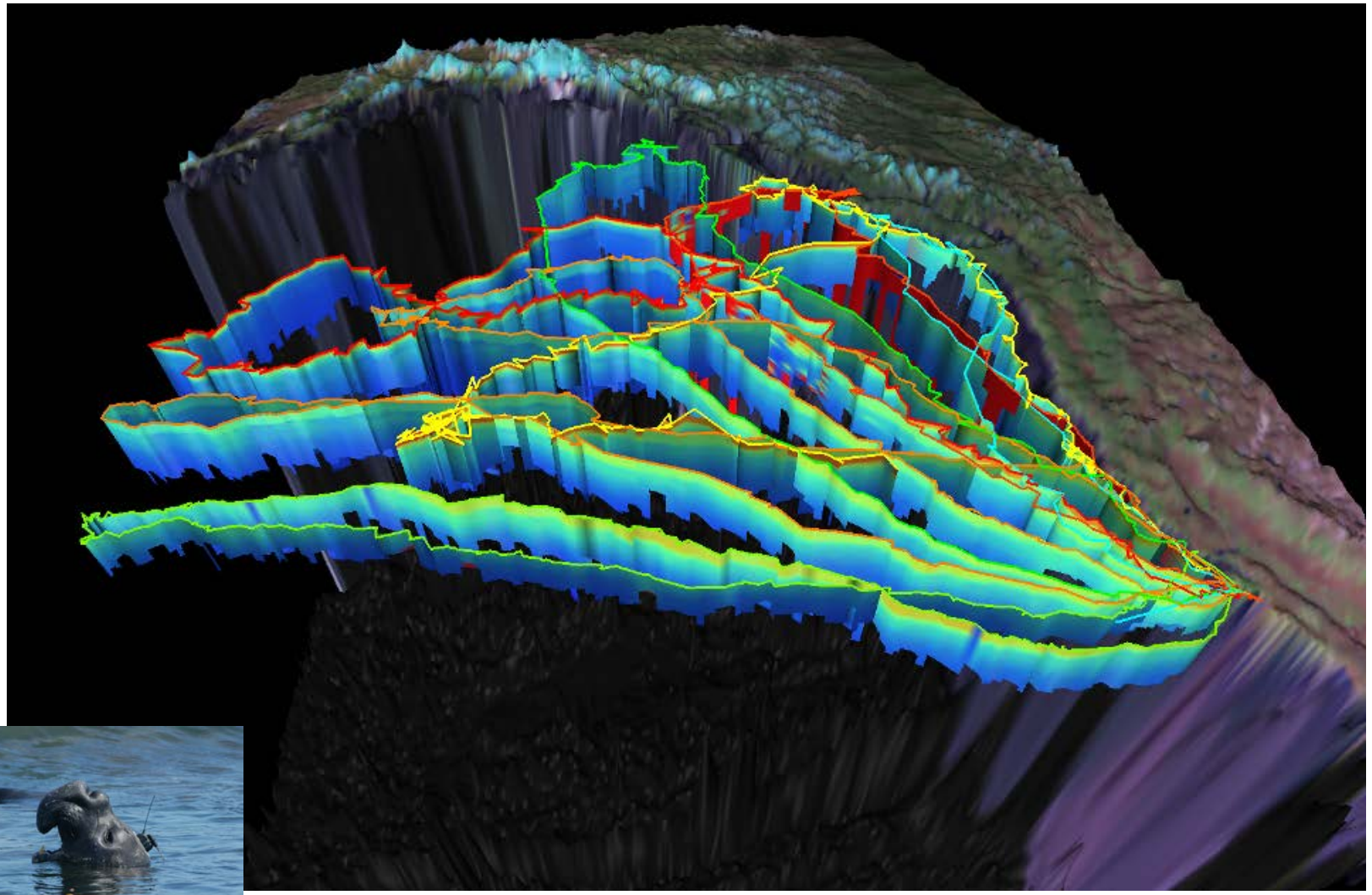
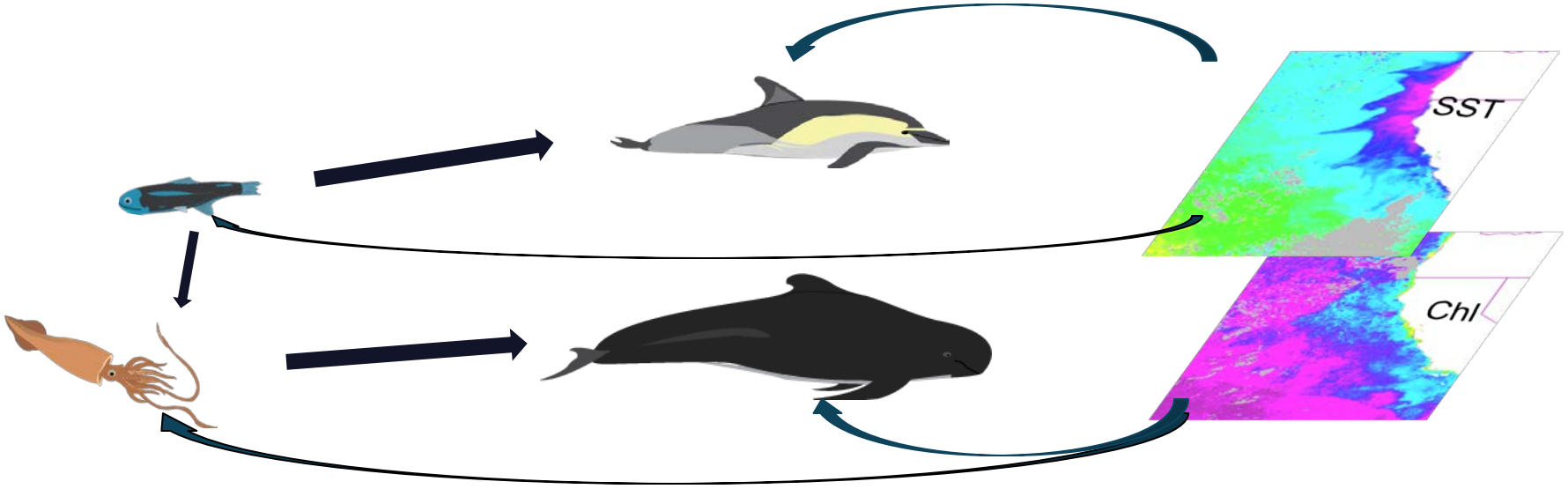


Top Predators as Climate Sentinels



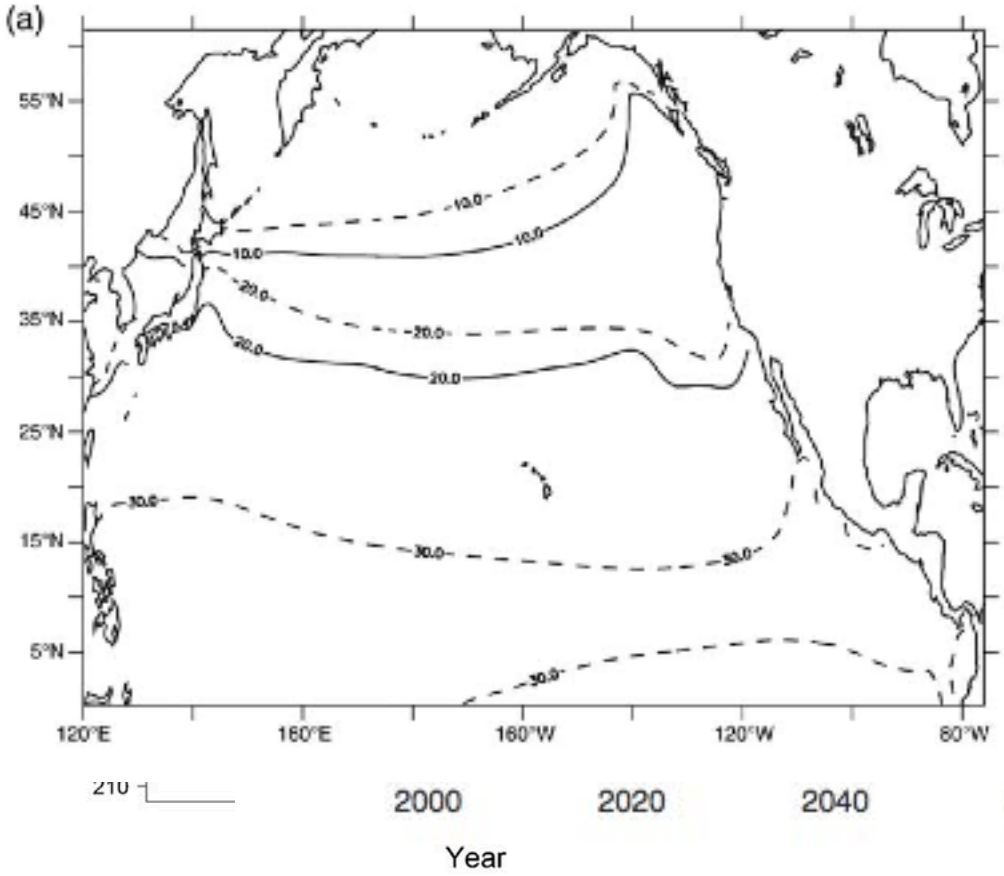
Top Predators Responses

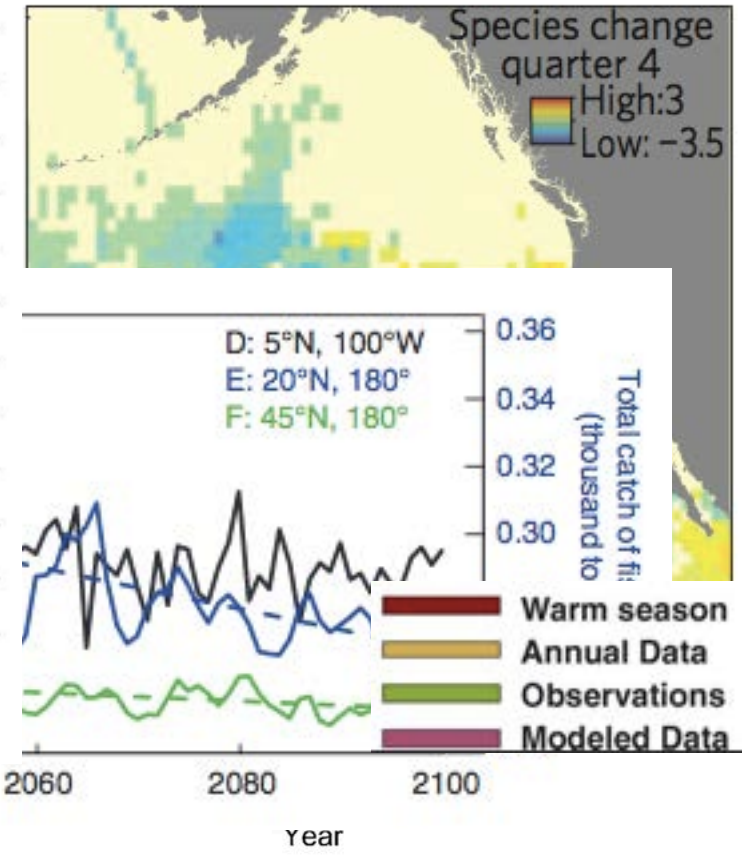
- Spatial – shift in habitat, range or distribution
- Temporal – shift timing of migration, reproduction
- Food Web – change in prey composition, trophic position, foraging effort
- Demographic – change in fecundity, survival, population



Current state of knowledge

- **Predictions:**
  - Northward migration of TZone (Polovina et al. 2011; Hazen et al. 2013)





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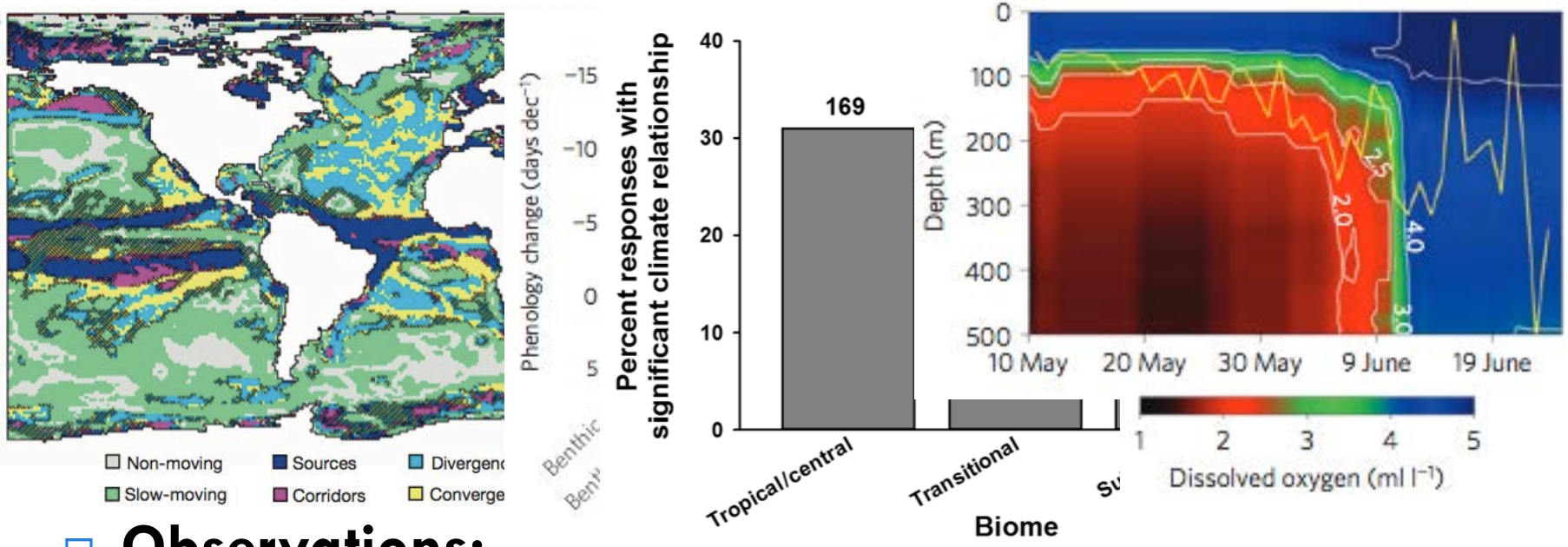

- **Observations:**
  - Range shifts & climate velocity (Stramma et al. 2009, Burrows et al. 2011, 2014, Pinsky et al. 2013)
  - Phenology (Sydeman & Bograd 2010, Schroeder et al. 2009, Poloczanska et al. 2013)
  - Population responses (Piatt and Sydeman 2007, Boersma 2008, Moore 2008, Irons et al. 2008, Wolf et al. 2010, Sydeman et al. 2012)

FUTURE OSM Workshop goals

- Identify existing top predator, ecological, and oceanographic datasets that can be used to examine response to climate variability and change

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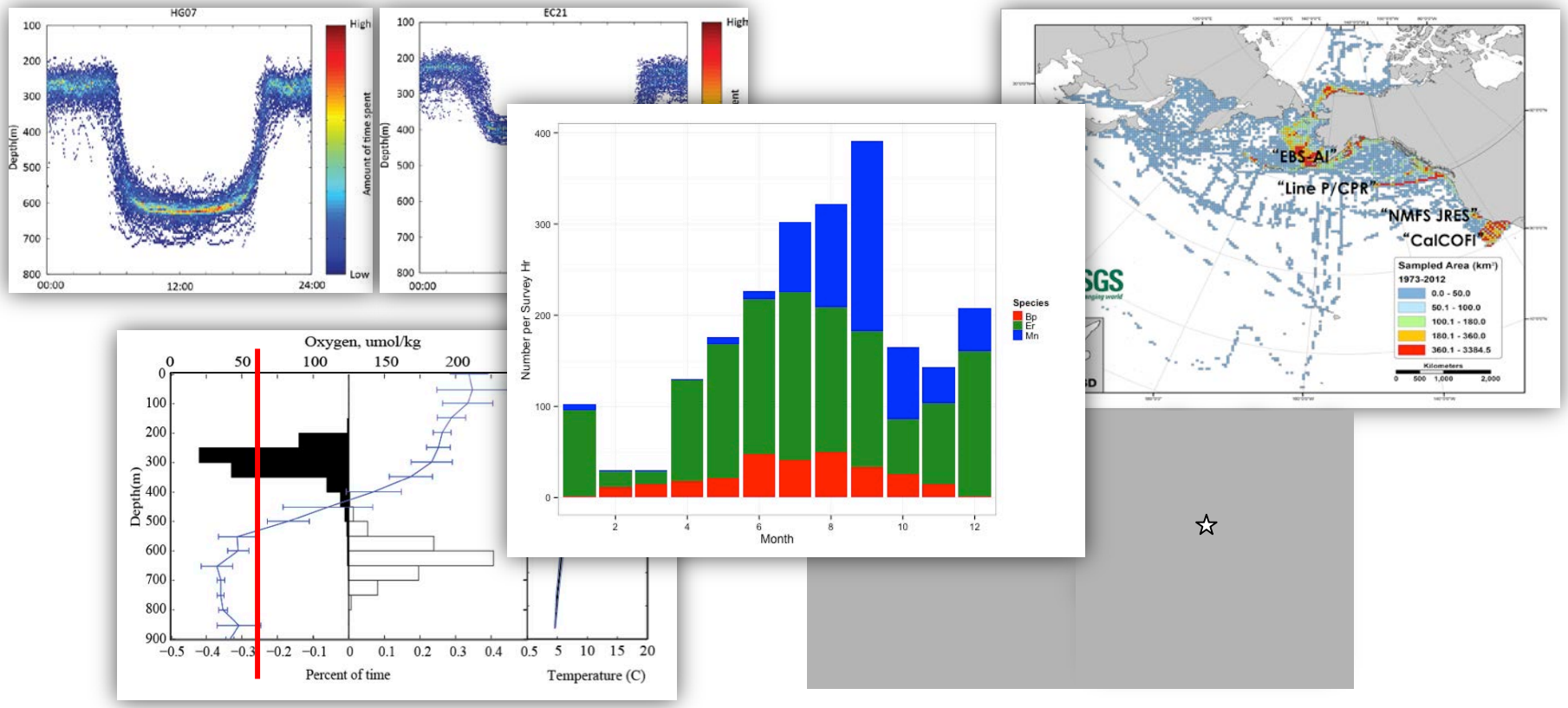
Presented research

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



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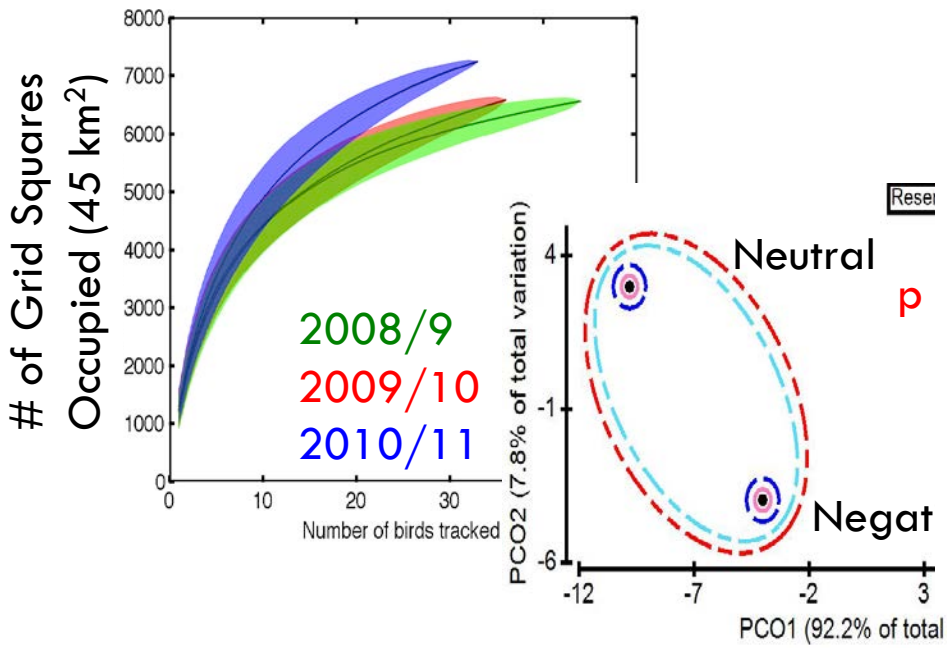

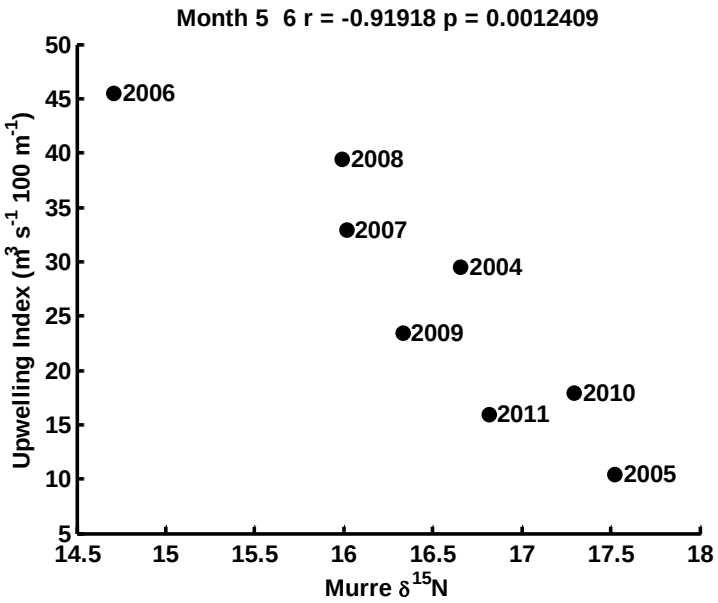

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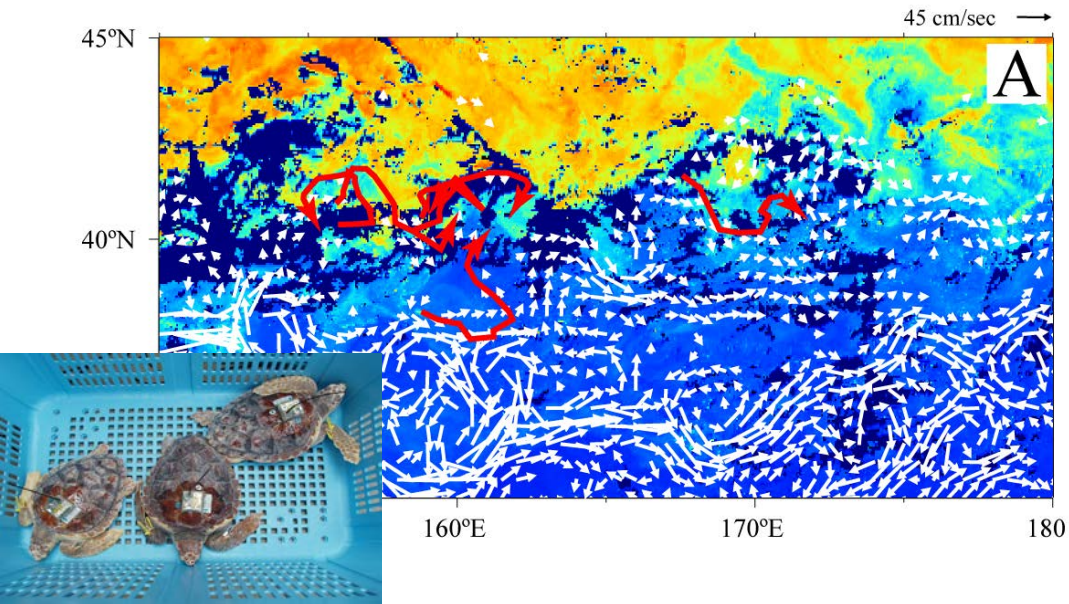
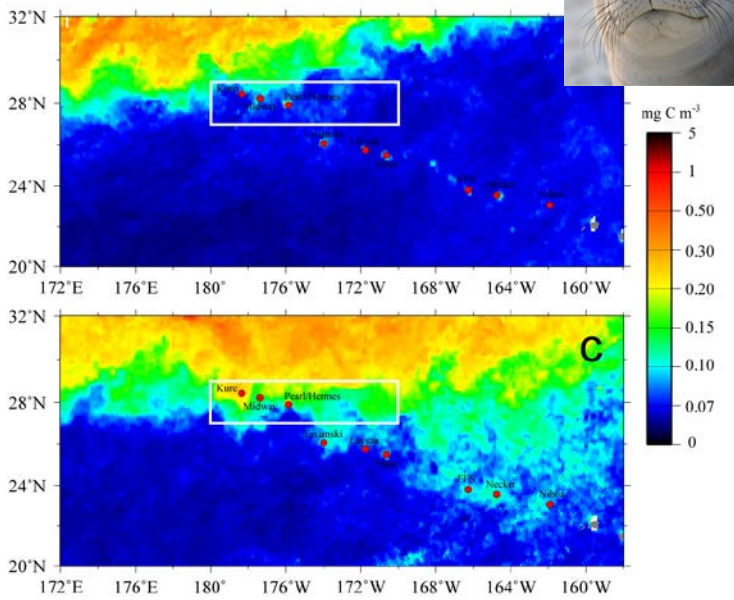
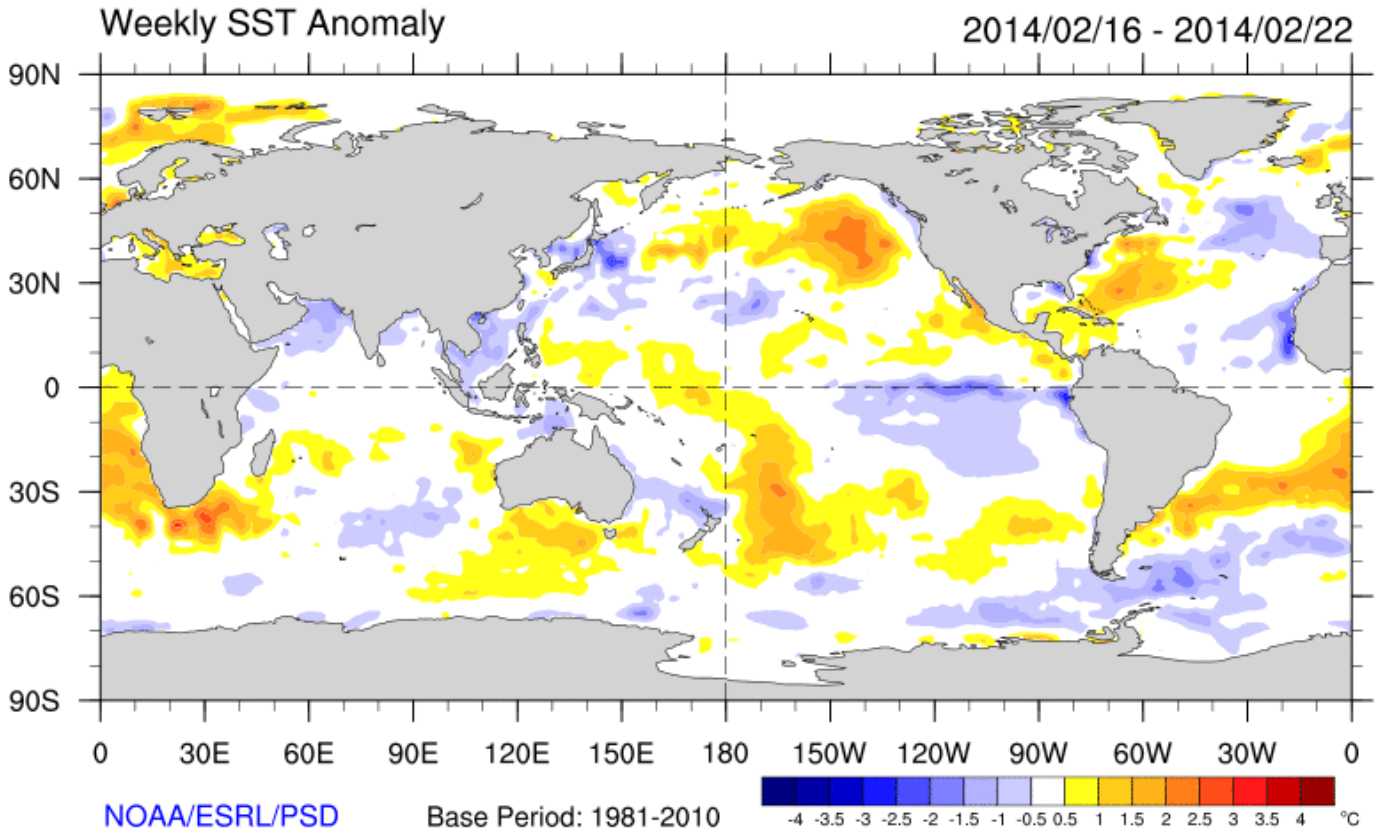
  - Demography (Sydeman, Polovina)





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



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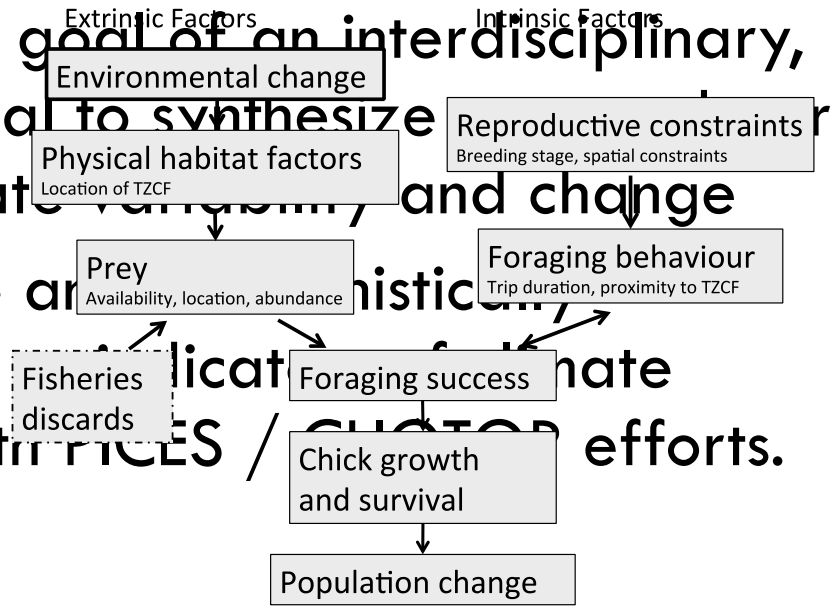
- We developed a statement outlining the need for enhanced sampling for top predator and ecosystem response to the predicted 2014-5 El Niño event
- We sketched a review paper on developing a framework for assessing responses to climate change by N. Pacific top predators
- We discussed a long-term goal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



Thank You