Modeling Pacific top predator hotspots in a changing climate

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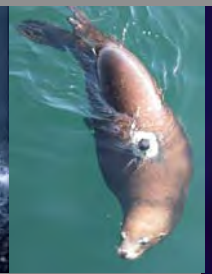
TAGGING OF PACIFIC PREDATORS

topp.org, www.comlsecretariat.org

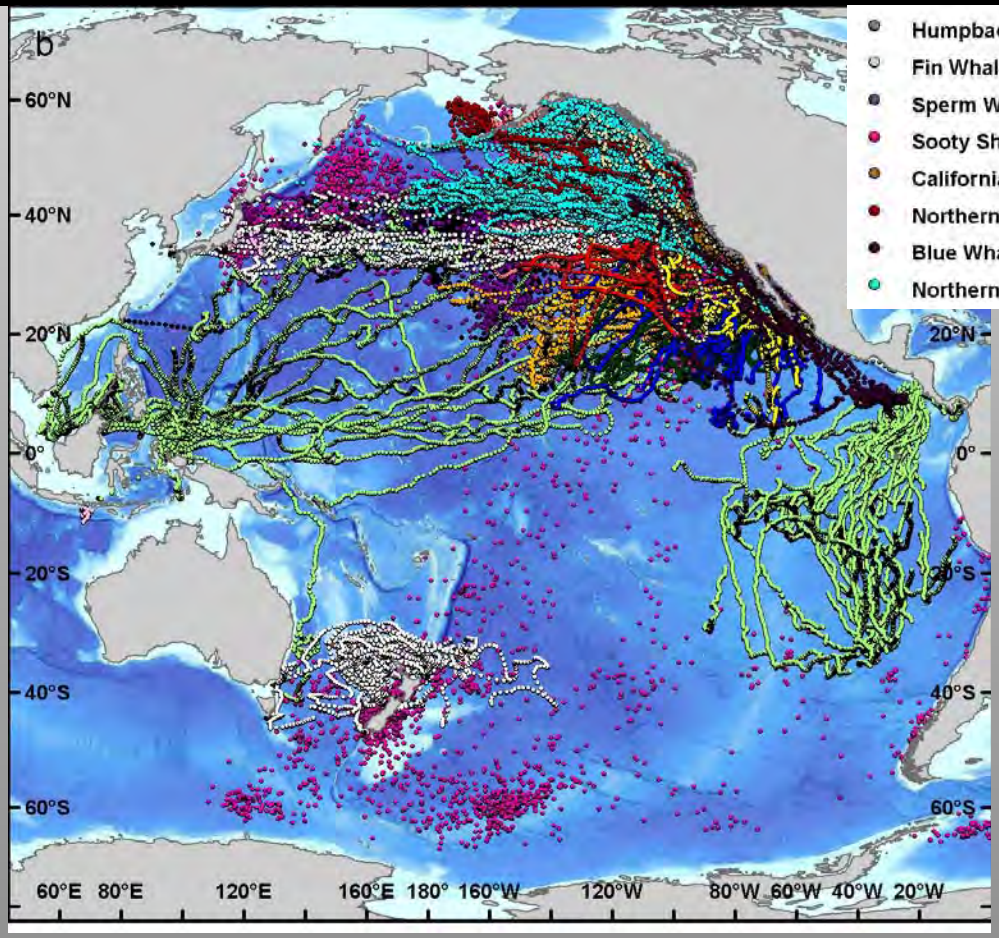





Marine Top Predators

- Integrate over food-web dynamics
- Long-lived, buffer environmental variability
- Key indicators of climate variability and change
- Face serious conservation issues

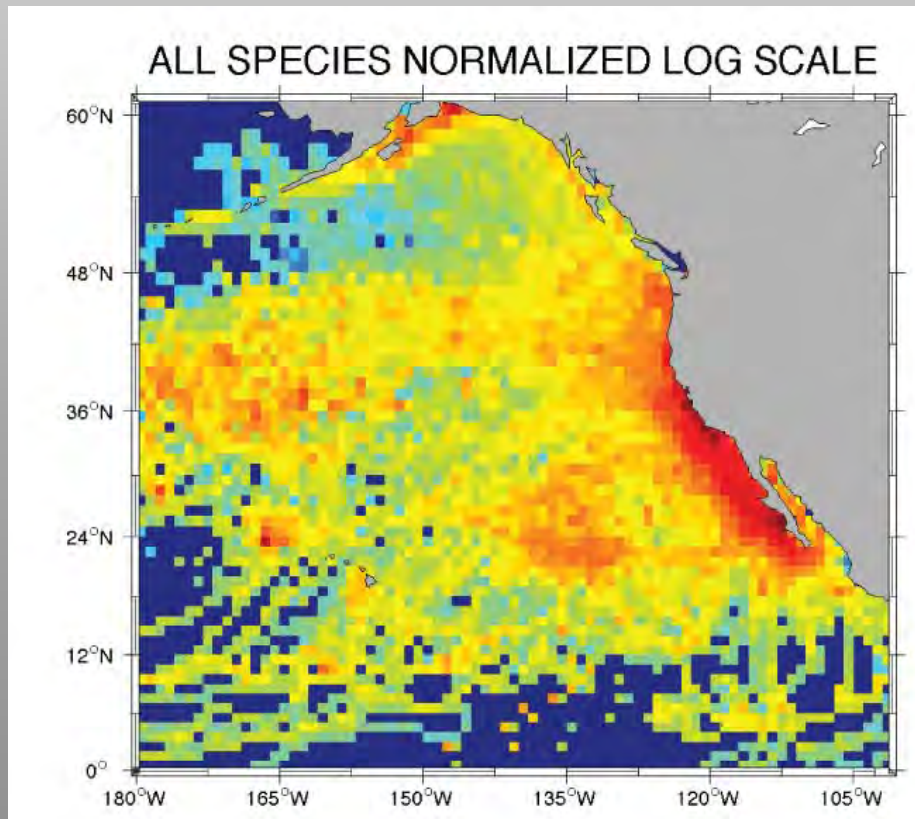
Top Predators in the Pacific Ocean

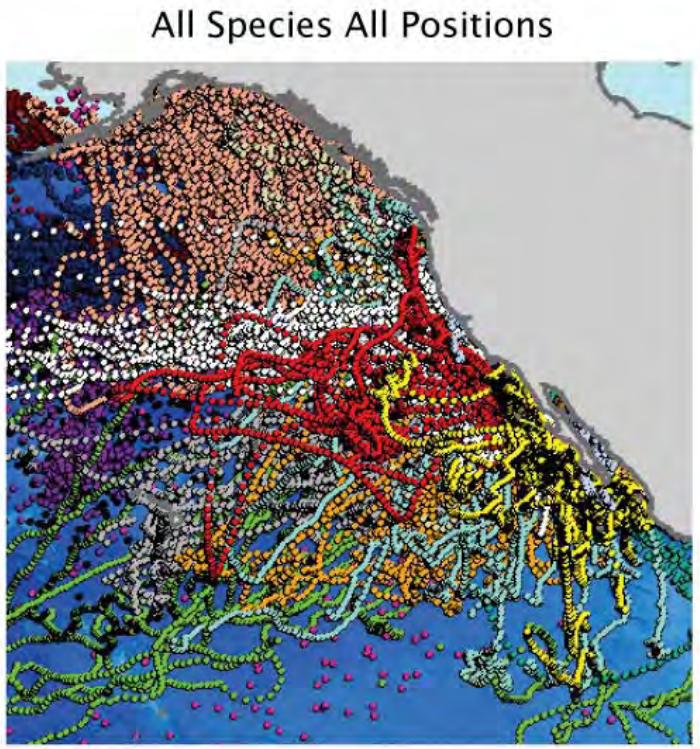


TAGGING OF PACIFIC PELAGICS/ PREDATORS

- 23 species; 4,000 tags; >1 Million profiles
- Tracking, conservation, ocean observation

TOPP Synthesis: Hotspots

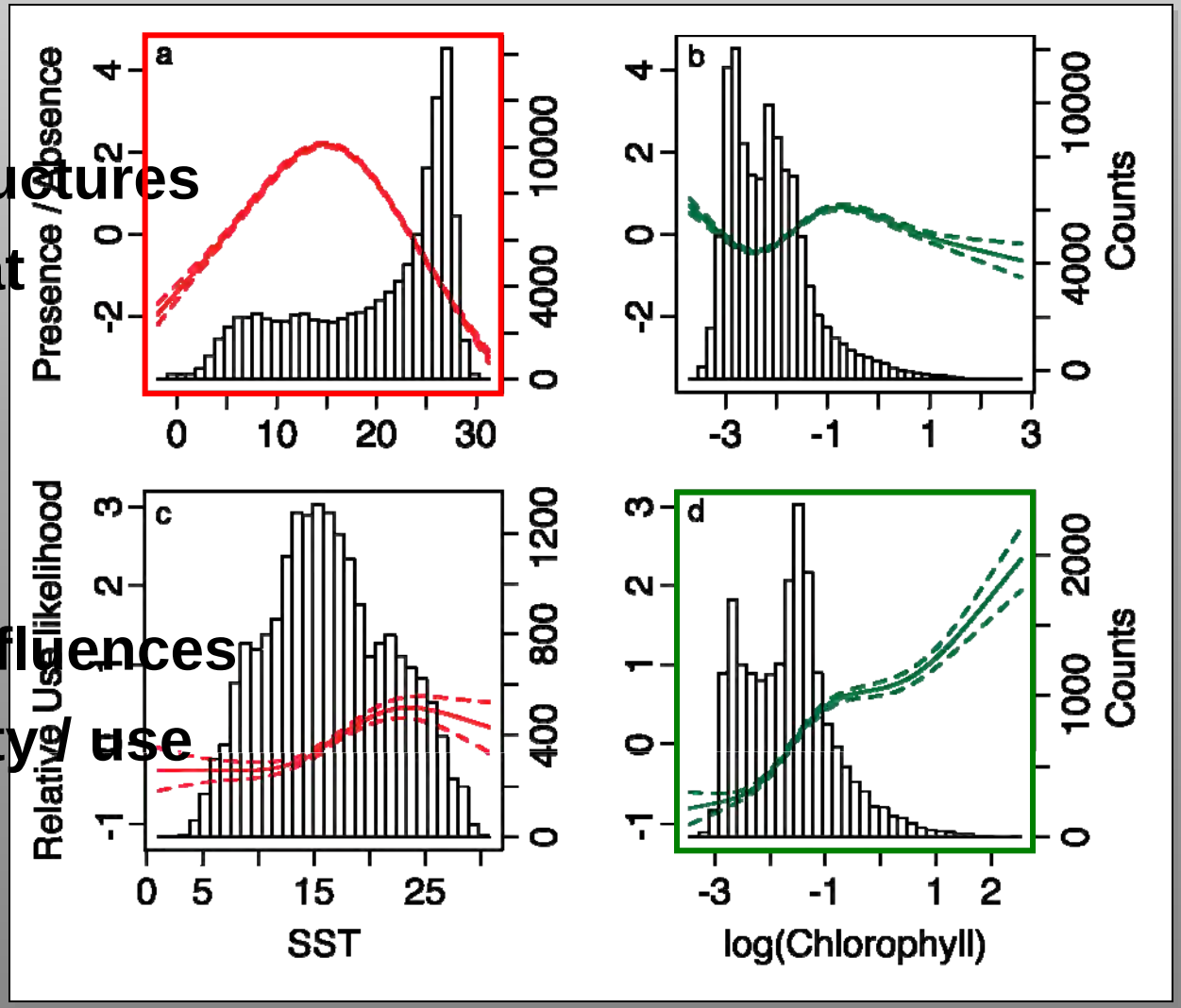




TOPP Synthesis: Hotspots

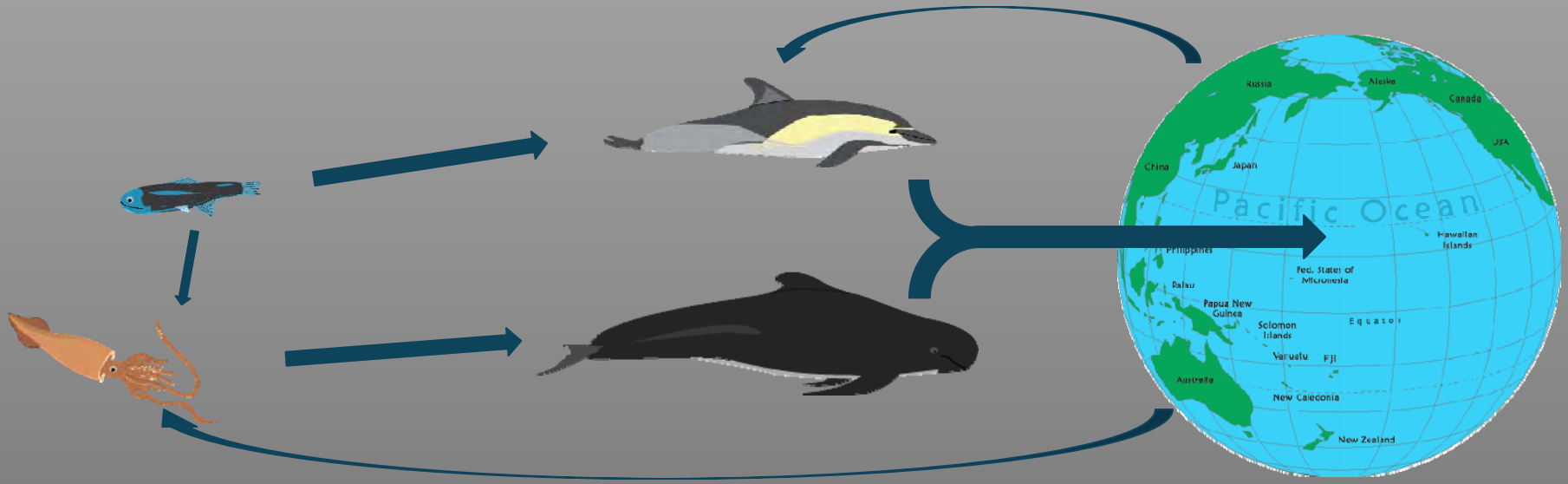
SST structures habitat

Chl-a influences density / use



Climate Change & Top Predators

- **Population effects – reproductive success / failure**
- **Food web effects – reduced accessibility of prey**
- **Phenology effects – timing of migration, reproduction**
- **Spatial effects – loss of habitat, range or distribution shifts**



Methods: habitat models

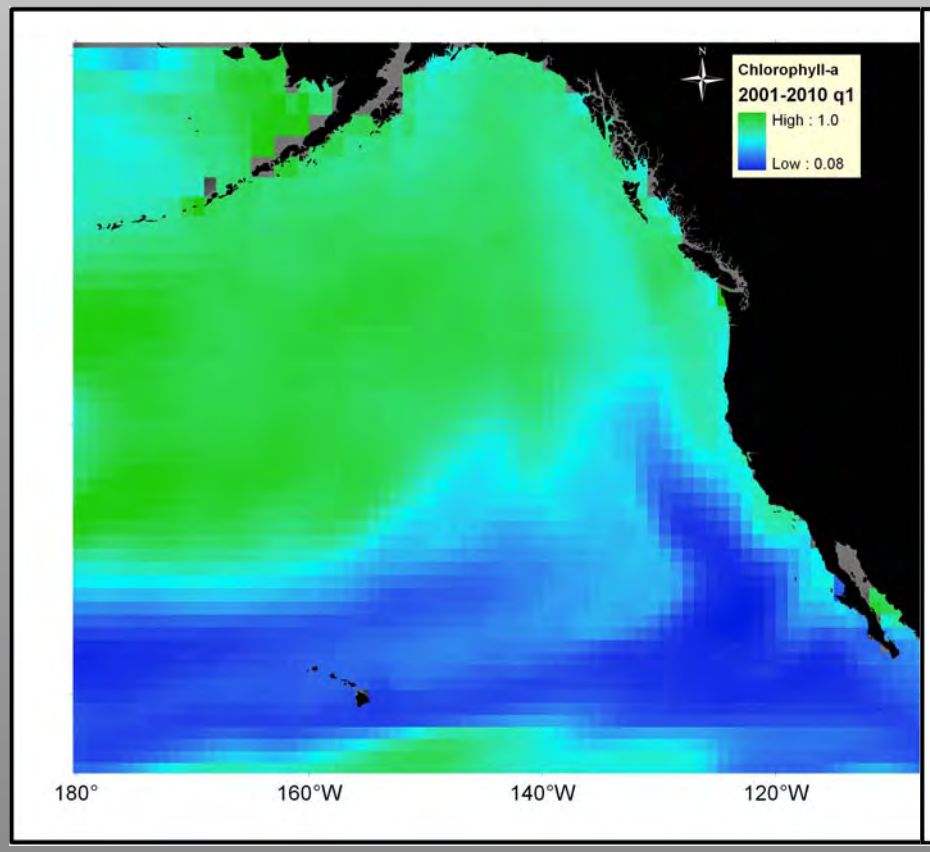
- Generalized additive models (GAMs) were fit using bathymetry and quarterly means of remotely sensed SST and Chl-a from 2000-2009.
- We compared GFDL based habitat predictions as a scenario driven exercise:
  - 2001-2050 vs. 2051-2100
  - Monthly, yearly, and 5 year running mean time series
- Core habitat was defined as top 25% of each species potential habitat.

Methods: GFDL A2

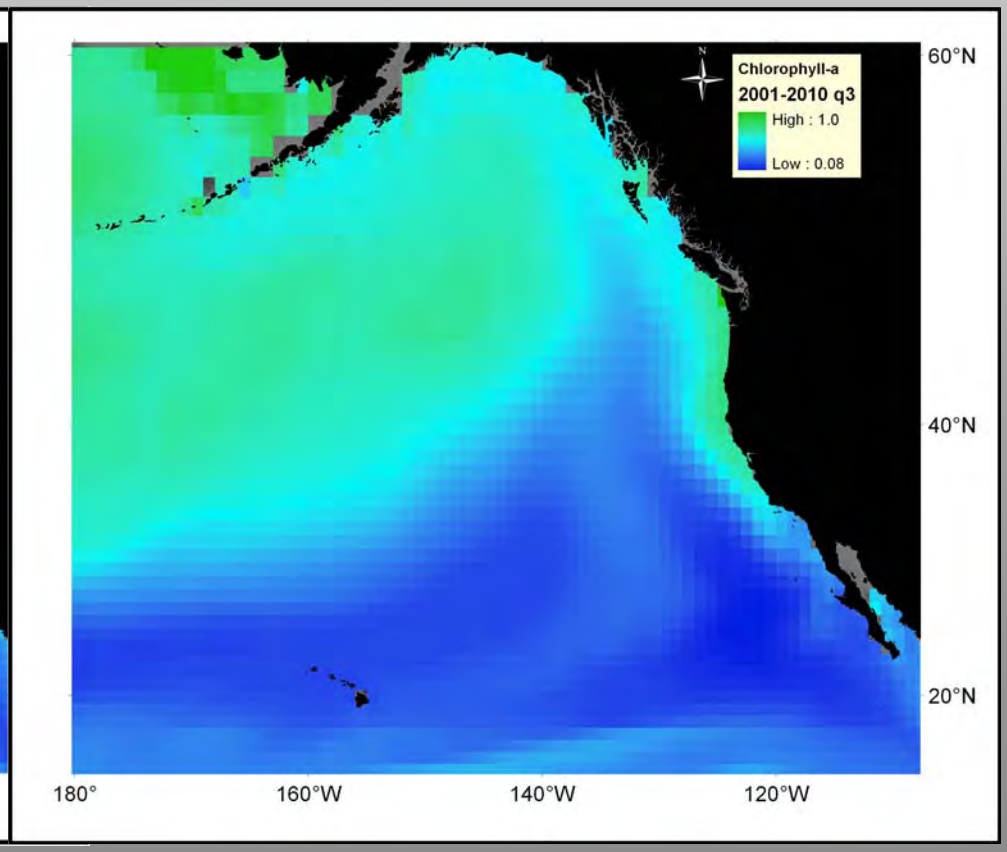
- GFDL coupled atmosphere-ocean general circulation models (CM2.1) with a two-way coupled biogeochemistry model (TOPAZ) at 1° ocean resolution.
- A2 model representing heterogeneous energy sources and development and with CO_2 stabilizing at 836 ppm in 2100.
- GFDL-A2 Chlorophyll-a mean over the top 100m and SST were used to predict habitat changes.

Chl-a ($mg \cdot m^{-3}$) 2001-2010

Winter

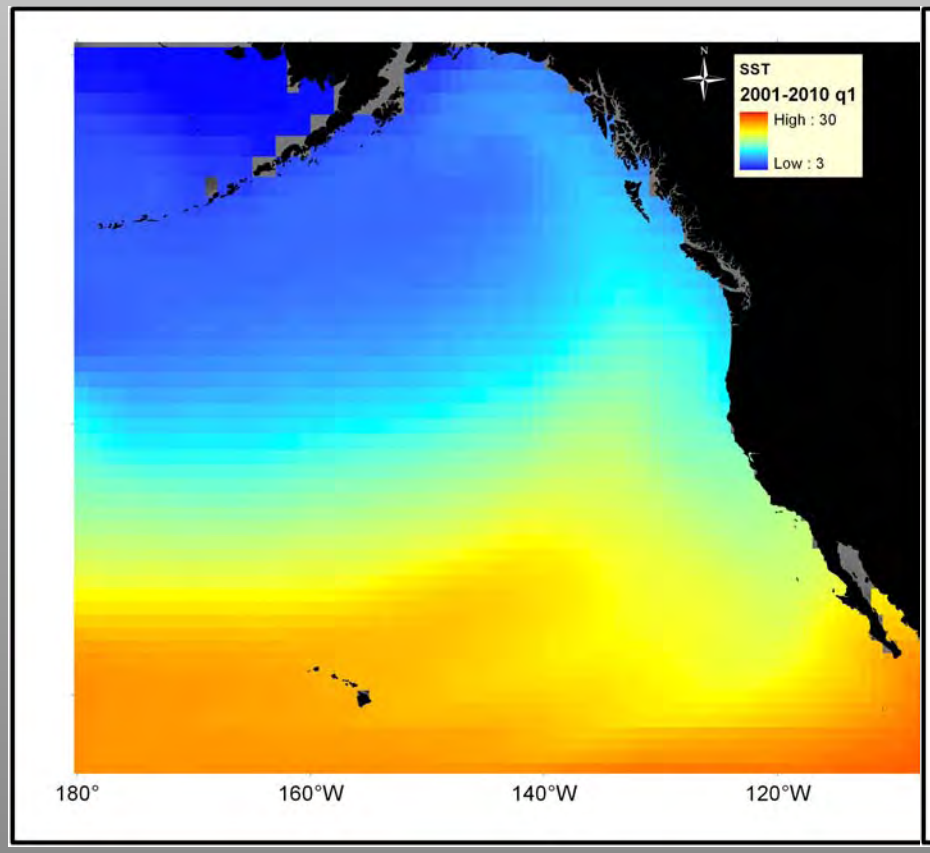


Summer



SST ° C 2001-2010

Winter



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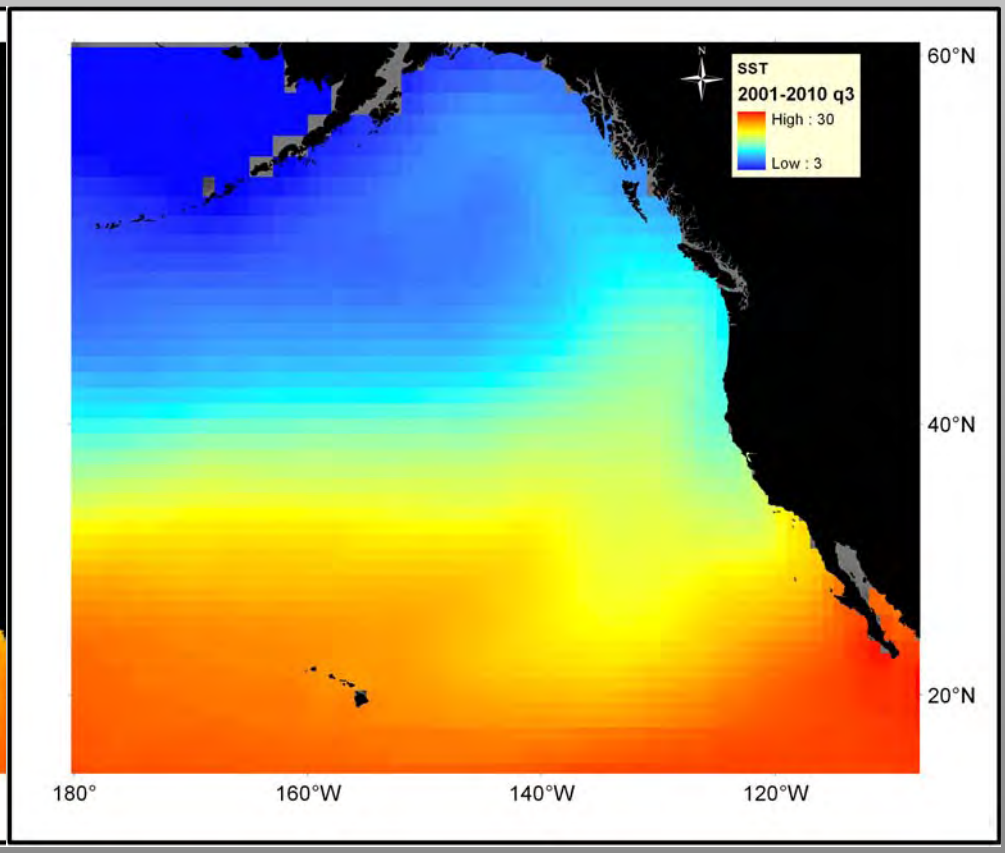
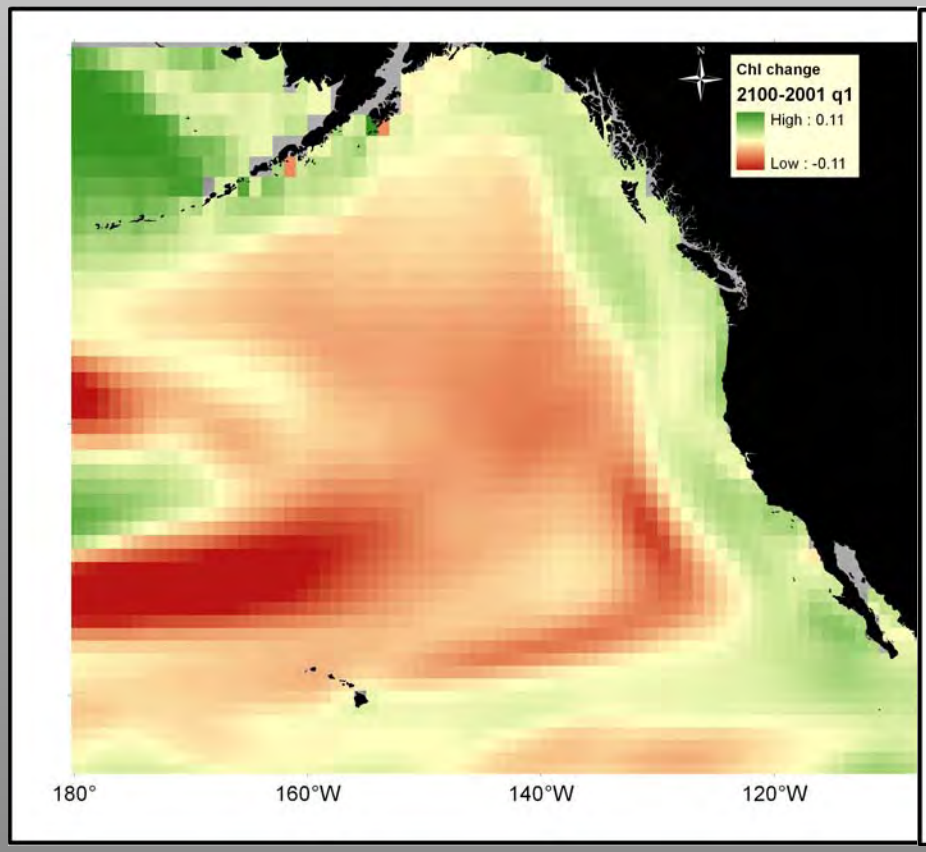


Changes in Chl-a: 2001-2100

Winter



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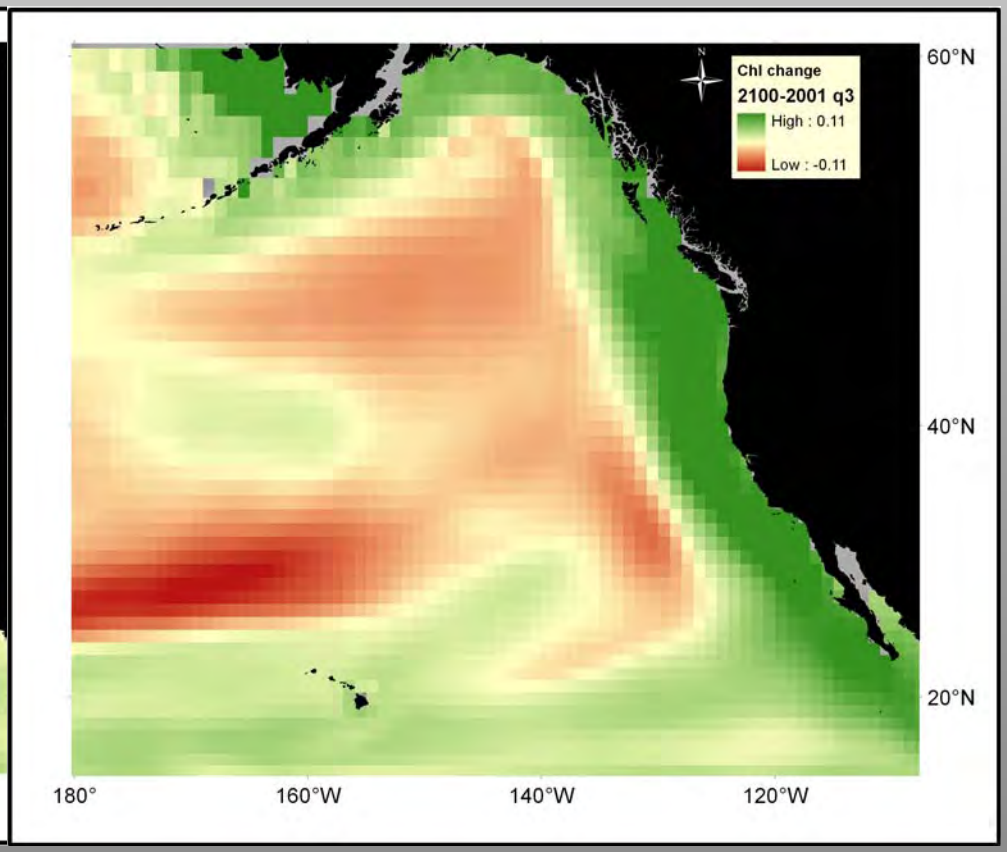
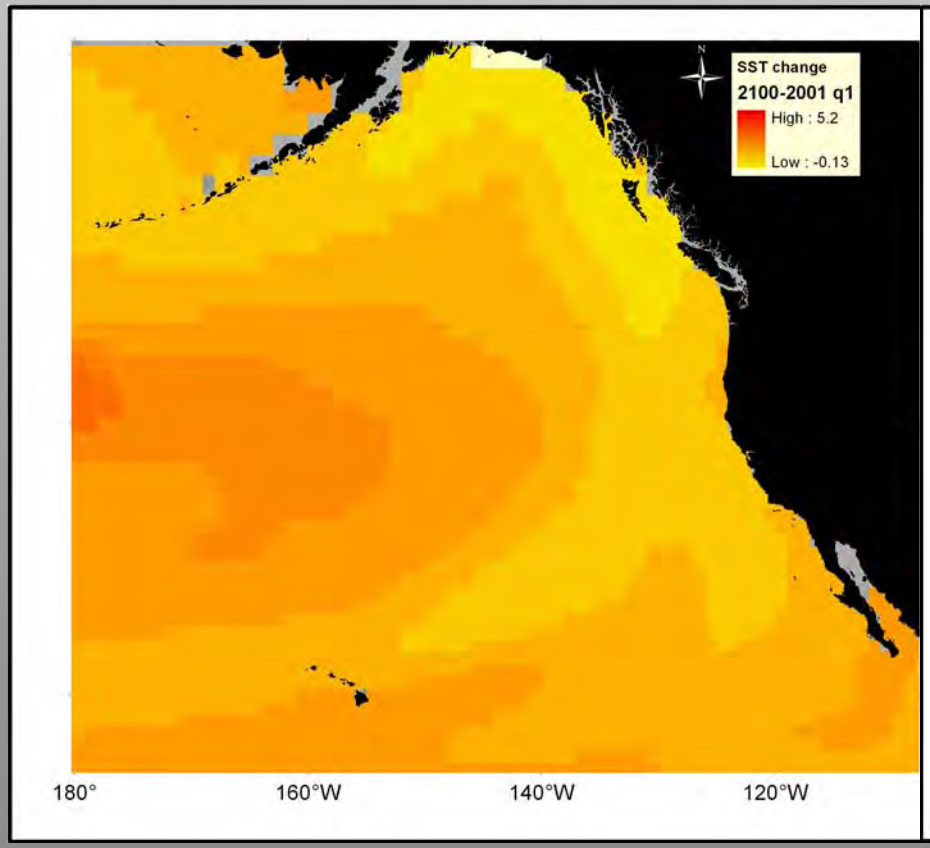


Changes in SST: 2001-2100

Winter



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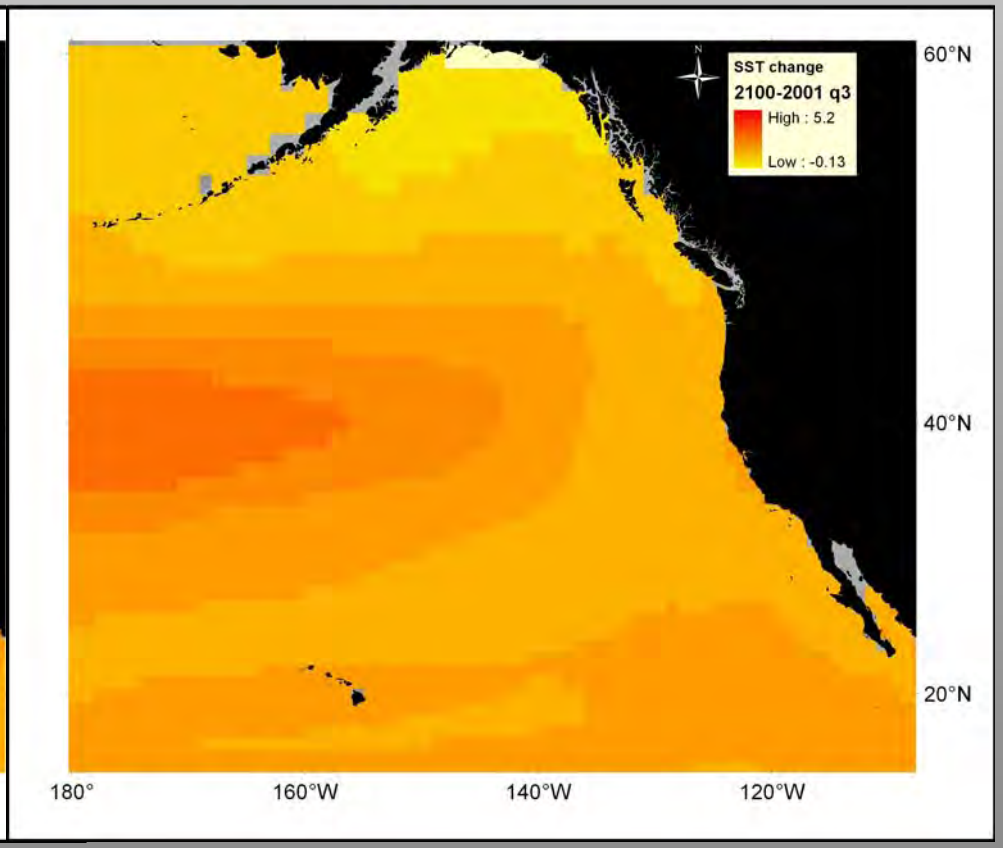
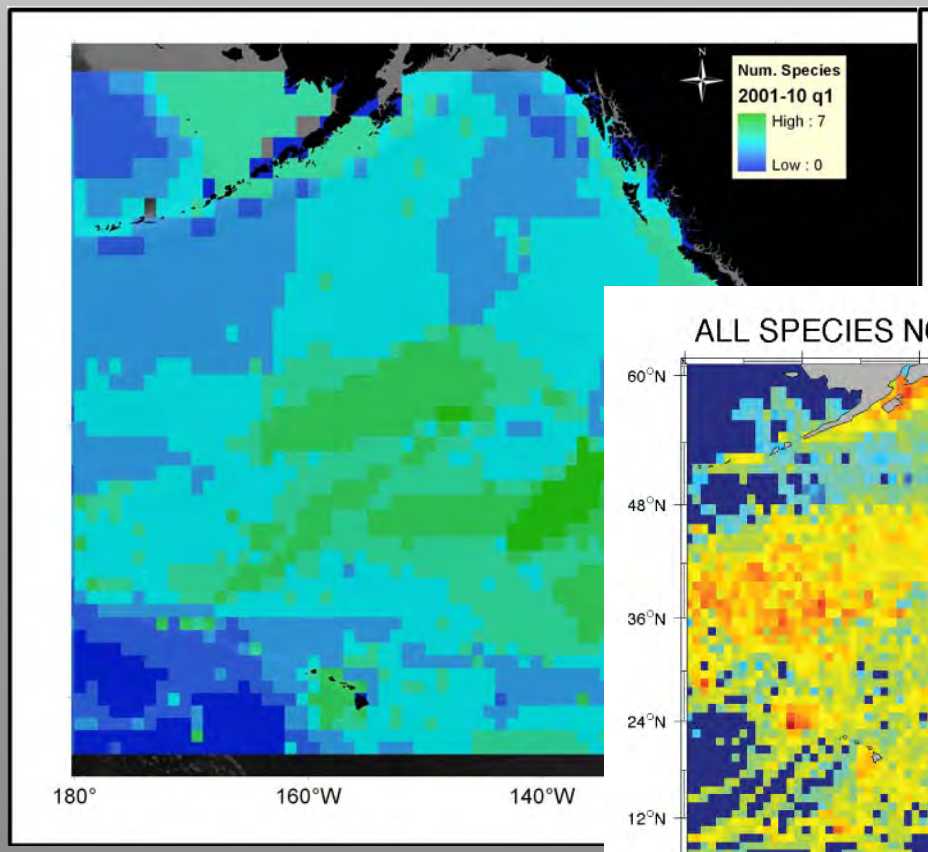
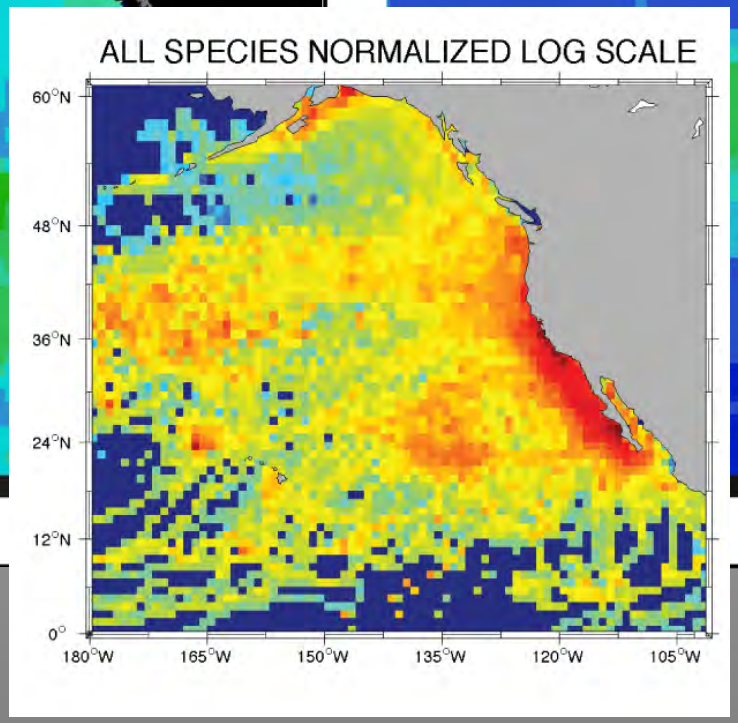


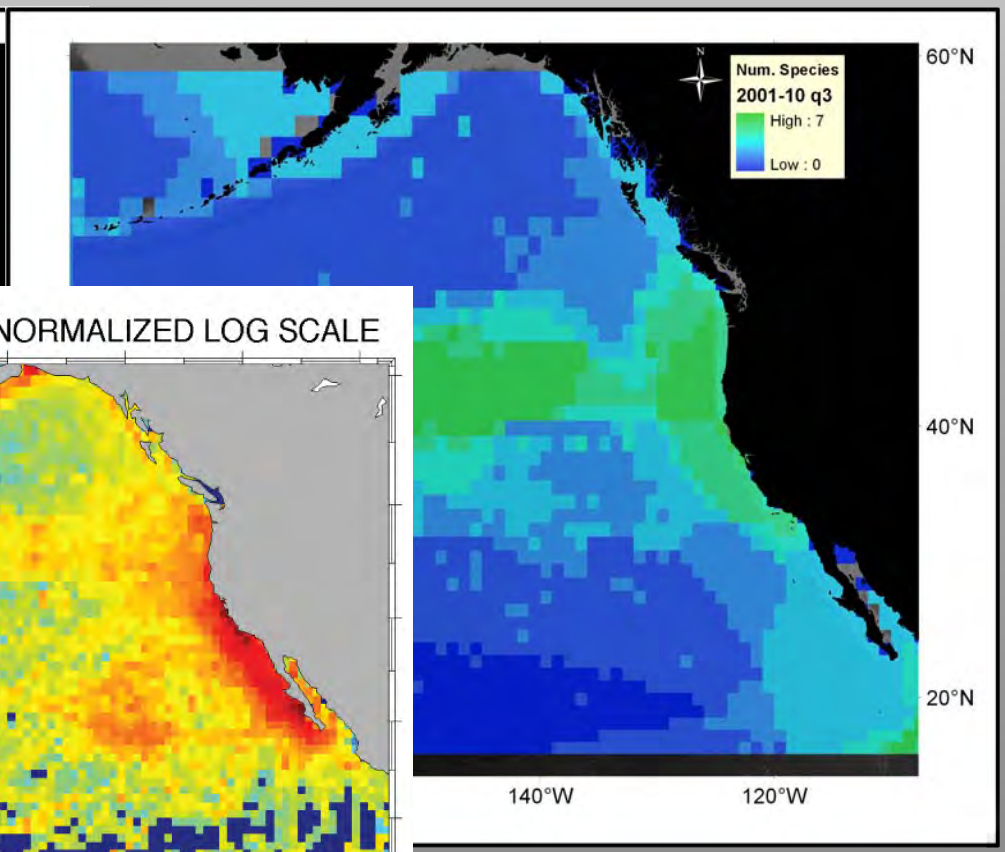
Species Richness: 2001-2010

Winter

Summer

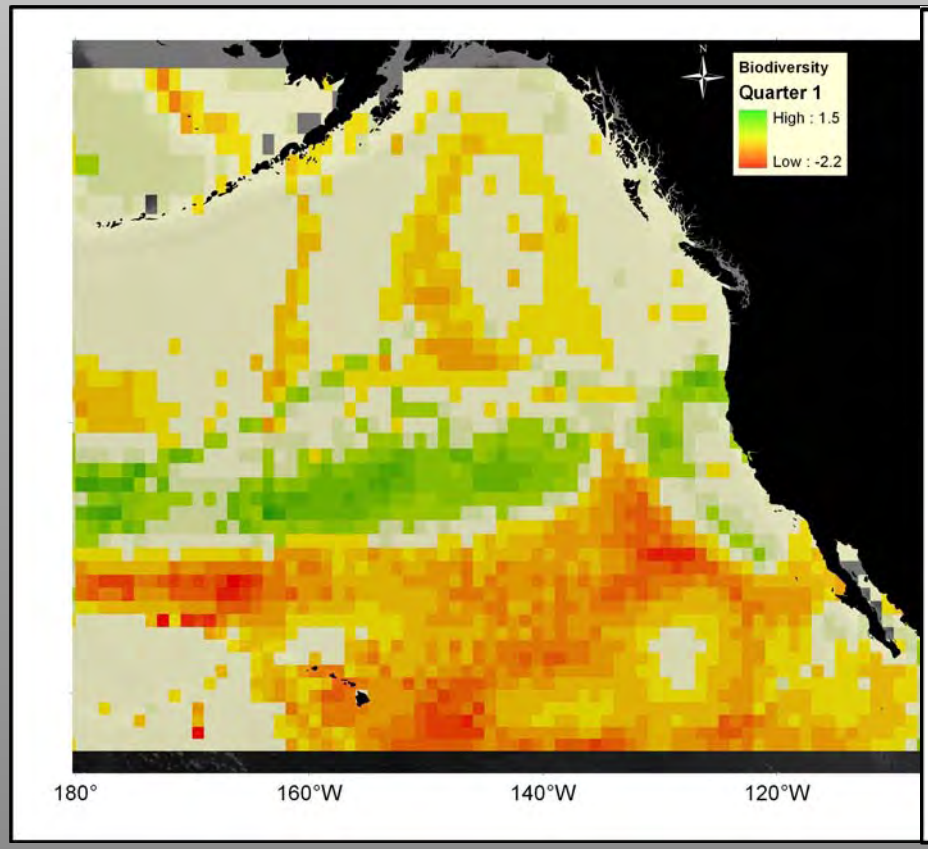




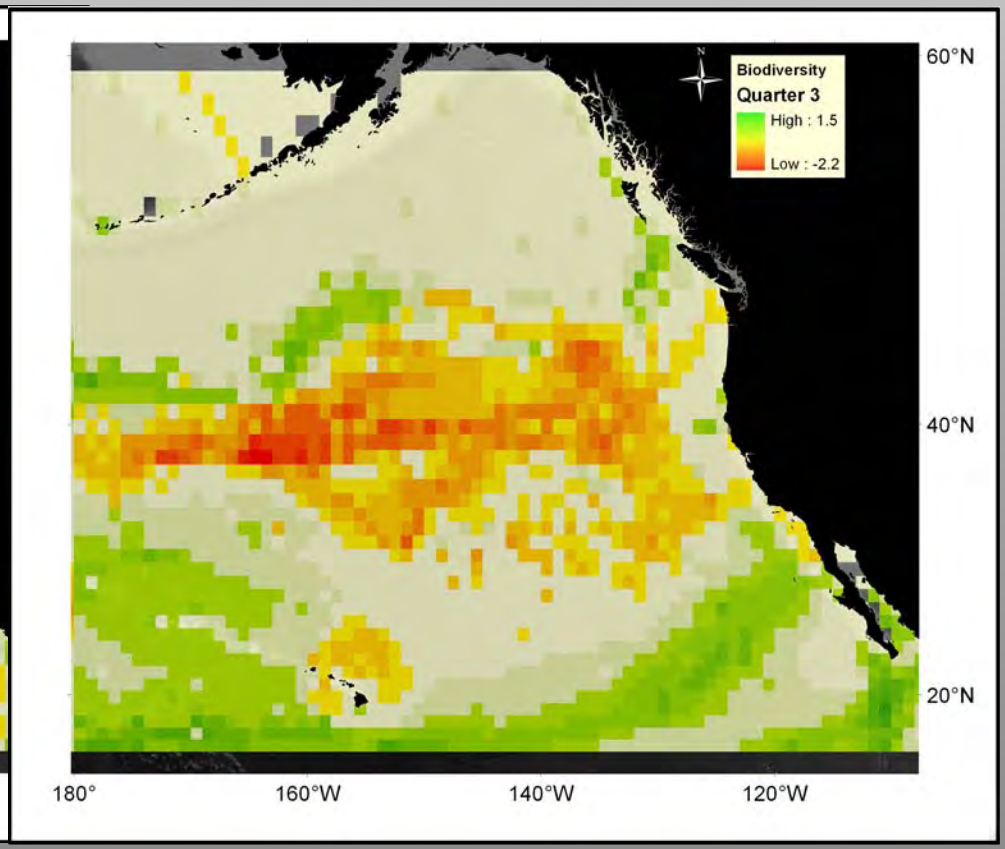


Species richness: 2001-2100

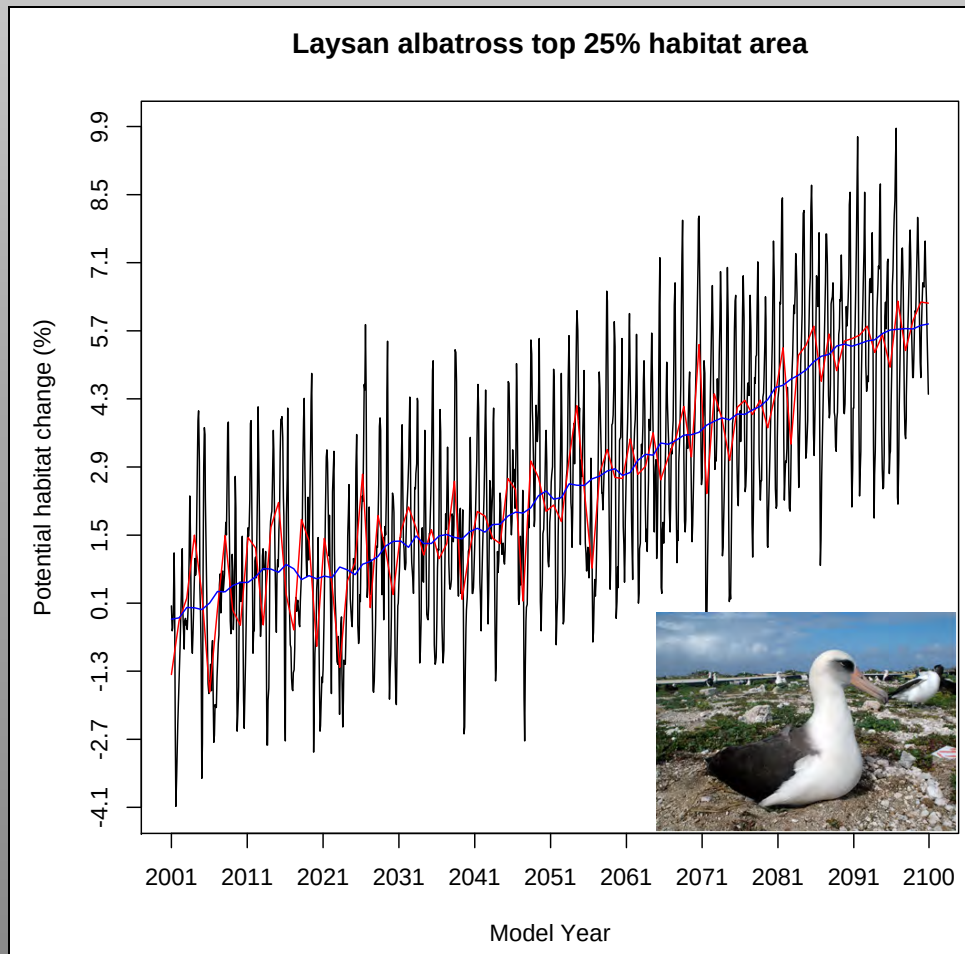
Winter

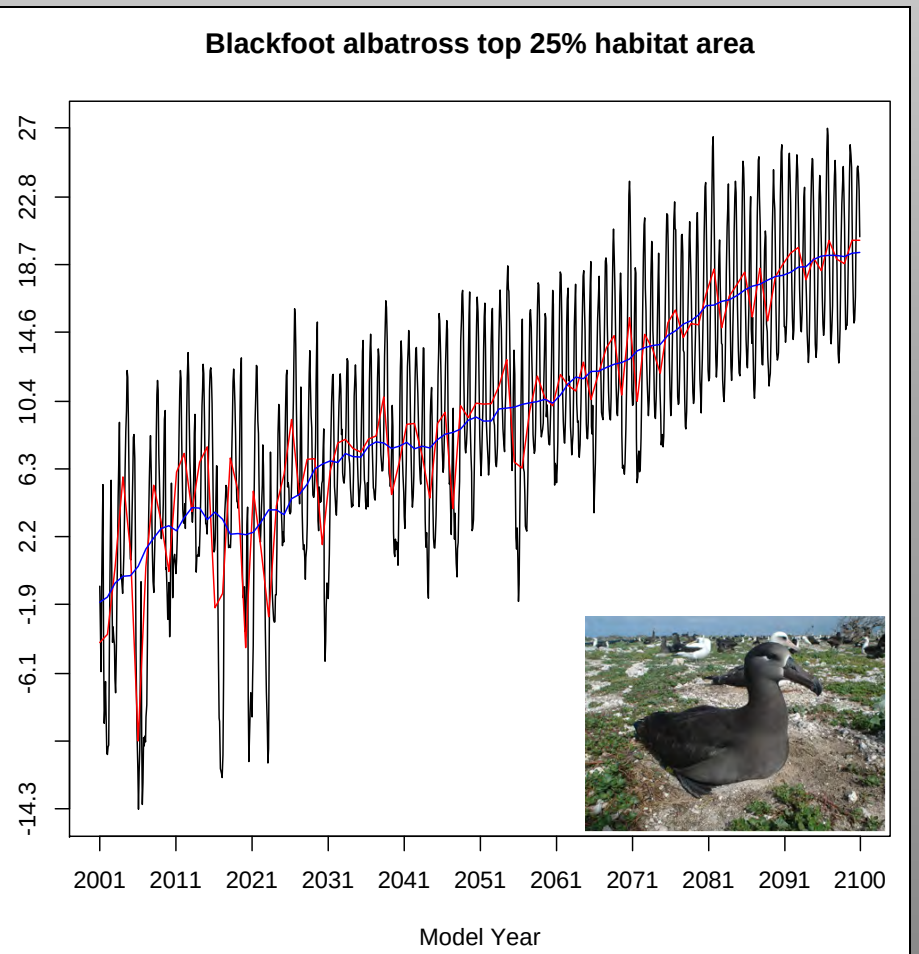


Summer

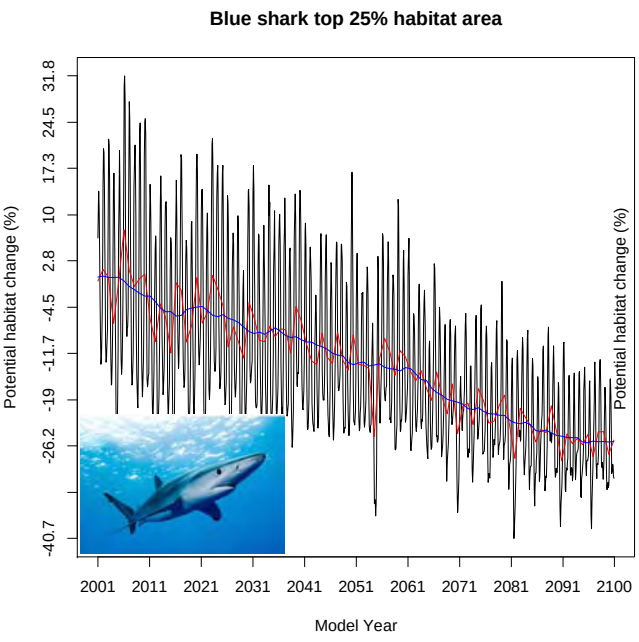


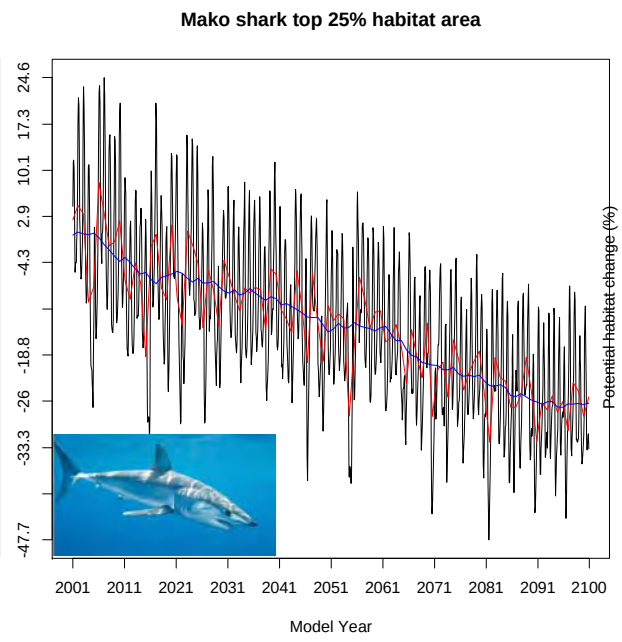
Albatross habitat: 2001-2100

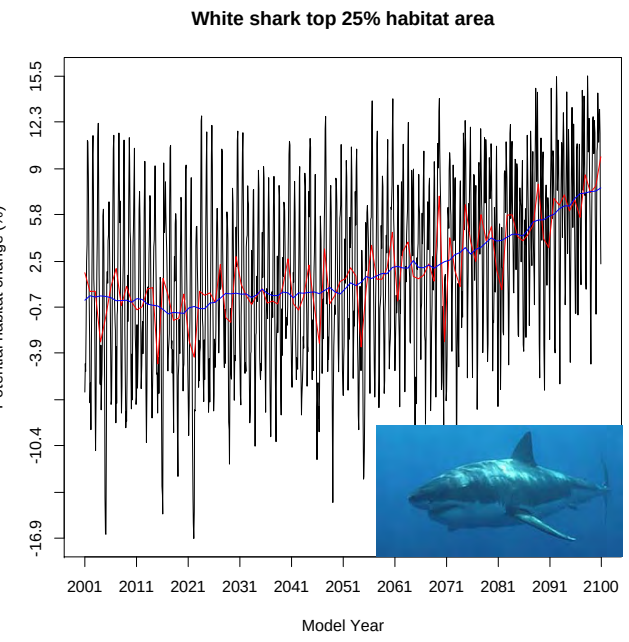




Shark habitat: 2001-2100







Caveats

- Predictions are scenarios, not actual “habitat” – populations not species
- Coastal processes are not well resolved in most climate prediction models
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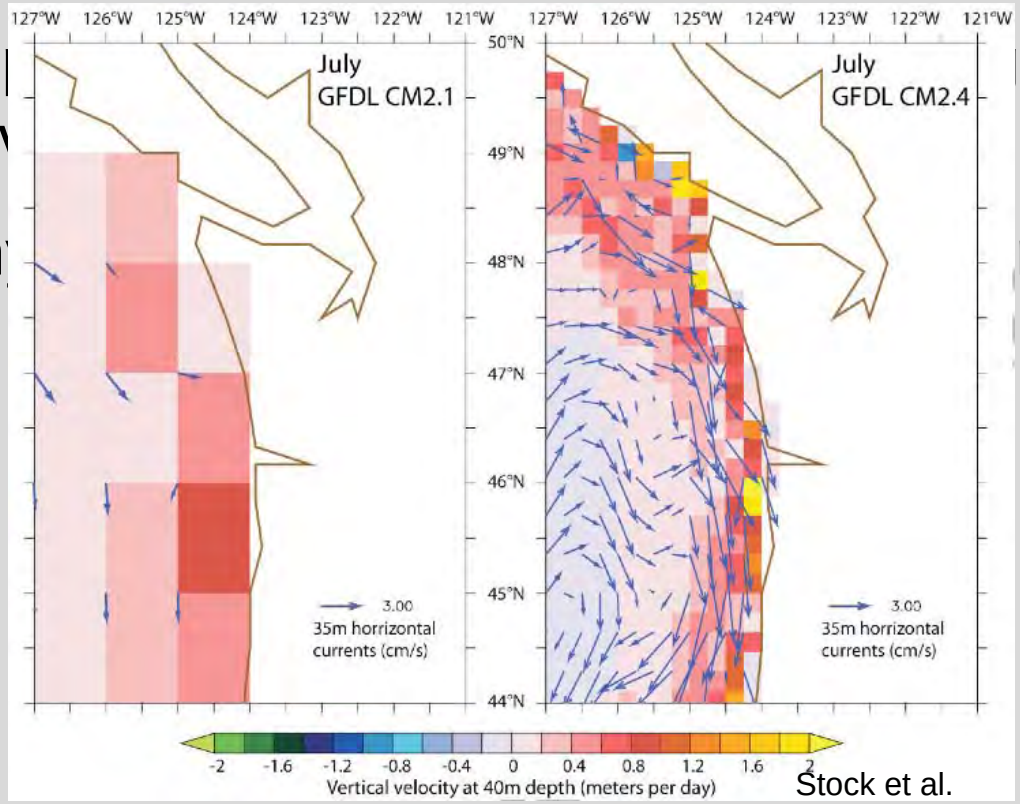

Stock et al. 2010

Conclusions and Future Directions

- Seasonal patterns in diversity gain / loss e.g. around the TZCF
- Up to 25% changes in habitat use by frequency between 2001 and 2100
- Nested / downscaled models to get a better representation of coastal processes
- We should continue to use top predators as ocean sentinels and proactively plan for adaptive management

Sponsors and Supporters

Remote sensing data:

- Aviso/CNES (altimetry)
- NASA/GSFC (SeaWiFS ocean color)
- NOAA/NODC & JPL (SST)
- UCSD/SIO (Bathymetry)

Thank you!