Forecasting the flock: using species distribution models to evaluate the effects of climate change on future seabird foraging aggregations in the California Current System

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Motivation for Study

- 2011 multispecies “hotspot” study

- Modeled 16 species, few pelagic

- Coastal hotspots, no pelagic areas

- Large data gaps, esp. OR & WA

Nur et al. 2011
Questions

1. How do multispecies foraging aggregations (hotspots) shift with increasing ocean temperature?

2. How might different species be affected to climate-related changes?
Seabirds

• Conspicuous marine predators

• Threatened marine group

• Important indicators of marine ecosystem status
California Current System

- Eastern boundary current system
- Spring/summer upwelling, high productivity
- 5 federally protected national marine sanctuaries
Seabird Data

- At-sea transects divided into 3km segments (bins)
- Bin midpoints aggregate seabird counts by species
- Doubled data – bins and species

75652 Bins
Oct 1997 – June 2012

Cruise Data Points
(some points may be masked by others)
- NWFSC (2003-2012)*
- GLOBEC (2000, 2002)*
- CWS & Environment Canada (1997-2010)**
- CalCOFI (1997-2007)**
Environmental/Climate Predictors

Physical
- Average depth (m)
- Contour Index (topographic relief, %)
- Distance to land
- Distance to 200m, 1km, 3 km isobaths

Remotely Sensed
- Chlorophyll-a conc. (mg/m³)
- Sea Surface Height (m)
- Sea Surface Temperature (°C)

Effort
- Bin area

Climate Indices
- SOI
- NPGO
- PDO

Other Temporal/Spatial
- Year
- Month
- Day
- Latitude
- Spring Transition Anomalies

All data aggregated to bin midpoints
Statistical Model Development & Predictive Modeling

- Negative binomial regression
- 30 species: coastal and pelagic species locally breeding and migratory species

Statistical Model Development & Predictive Modeling

- February (winter), May (spring), July (summer), October (fall)
- Rel. densities standardized, averaged by month

Sample through matrices to predict rel. density
Developing Future Scenarios

• 10 regions
Developing Future Scenarios

• Assessed relationship between SST and SSH or Chla to predict future SSH and Chla

“Best estimates of ocean warming in the top one hundred meters are about 0.6°C (RCP2.6) to 2.0°C (RCP8.5)”

-- IPCC AR5 report
Future Scenario Predictions

- Increase SST
- Predict future SSH and Chla

Predict future species distributions

Group species based on estimated sensitivity to changing seascape
- Diving vs. Surface Feeders
Suitable habitat

- ↓ within 200m
- ↓ in south
- ↑ beyond 200m
- ↑ along northern CA, southern OR, north of Van. Island
Results: Surface Feeders (Rel. Density & Difference Maps)

Suitable habitat

- **↑** beyond 200m
- **↑** along CA, southern OR, west of Van. Island
- Cobb Seamount retains suitability
Projected future suitable habitat:

- Some NMS will remain suitable
- Some NMS will become suitable
- Some areas without protection will become suitable in the future
Summary

- Offshore and northward shifts
- Suitable habitat ↓ within 200m isobath
- Divers and surface feeders sensitive to climate related changes, esp. year-round residents and breeders
- Cobb Seamount may retain suitable habitat

Bob Whitney/BirdNote

http://animalspartner.blogspot.com/2015/01/storm-petrel.html
Caveats and Conclusions

• Models are representations of reality
  ➢ Statistical correlations
  ➢ Non-stationary relationships
  ➢ No consideration of intra- or inter-species interactions, adaptation etc.

• Climate-related changes are leading to novel conditions, responses will be difficult to predict

• Initial step in understanding magnitude and direction underlying projected changes in seabird habitat in CCS
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Questions?