prbo

PRBO Conservation Science

Using seabirds and habitat features to identify 'hotspots' in the California Current

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Presentation for Cordell Bank Sanctuary Advisory Council

February 2010

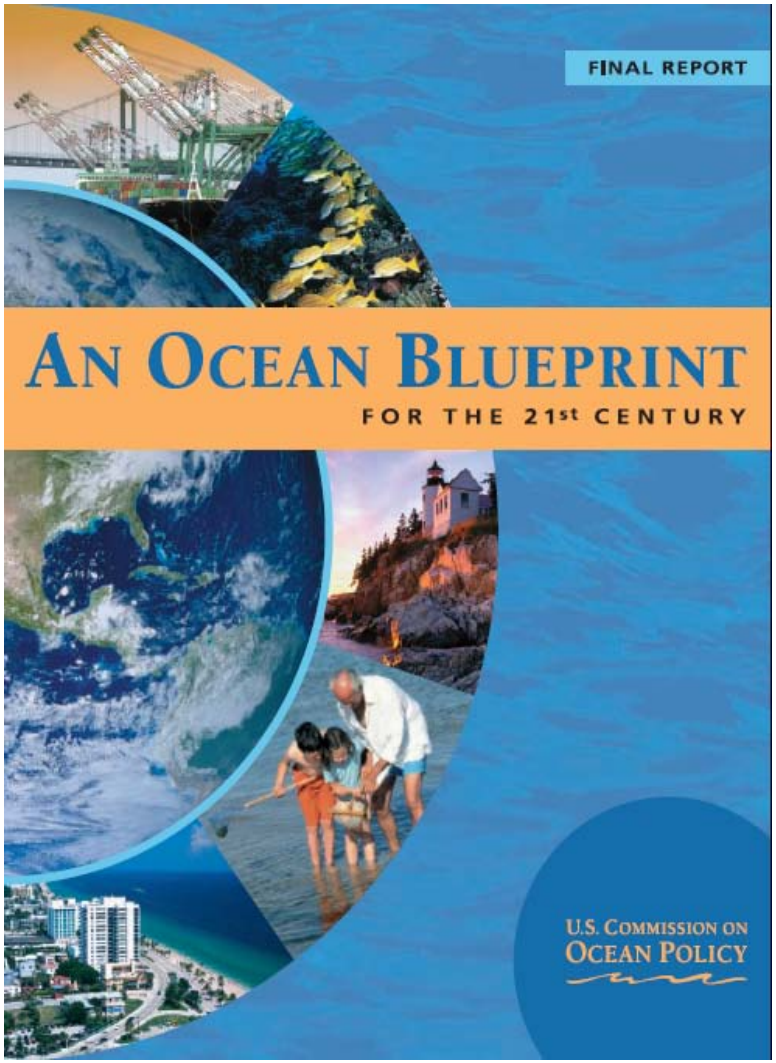
Effective Management Tools

Marine Protected Areas

- Maintain diversity
- Protect habitats,
- Ecological objectives
- Socioeconomic objectives

"a flexible, spatially based management tool"

"can advance sustainable fisheries"



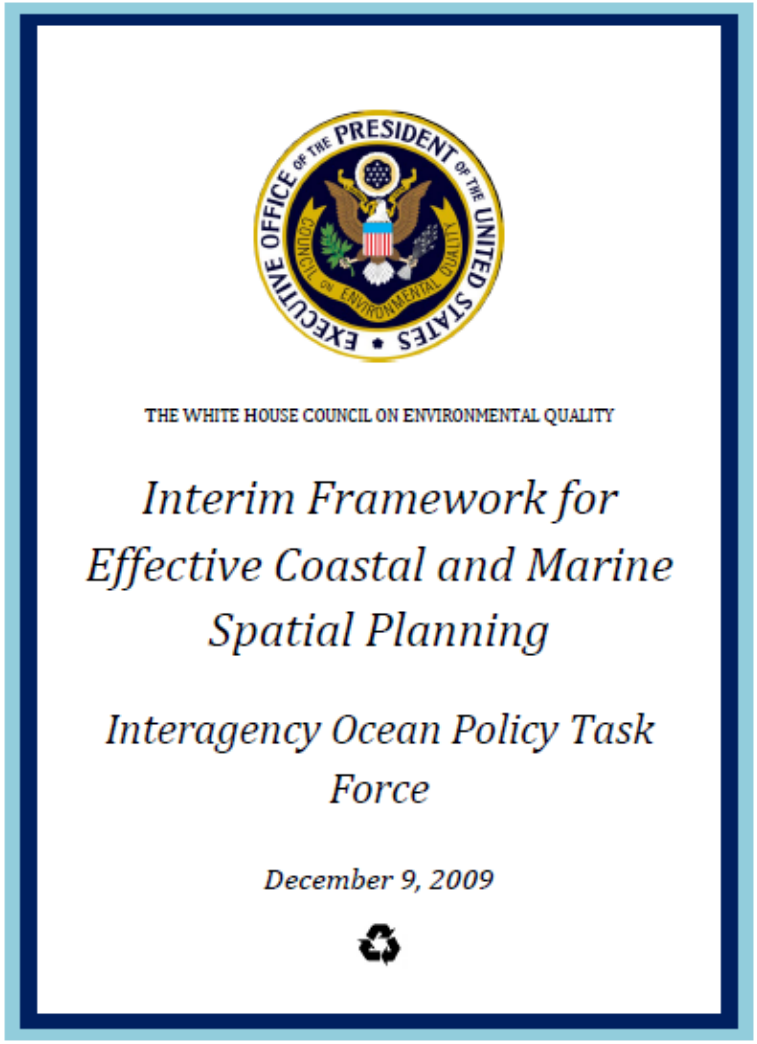
Marine Spatial Planning

Effective spatial planning

- Ensure sustainability
- Decrease conflicts
- Long-term benefits

"depends on sound scientific information"

"analyze current and anticipated uses of ocean"



THE WHITE HOUSE COUNCIL ON ENVIRONMENTAL QUALITY

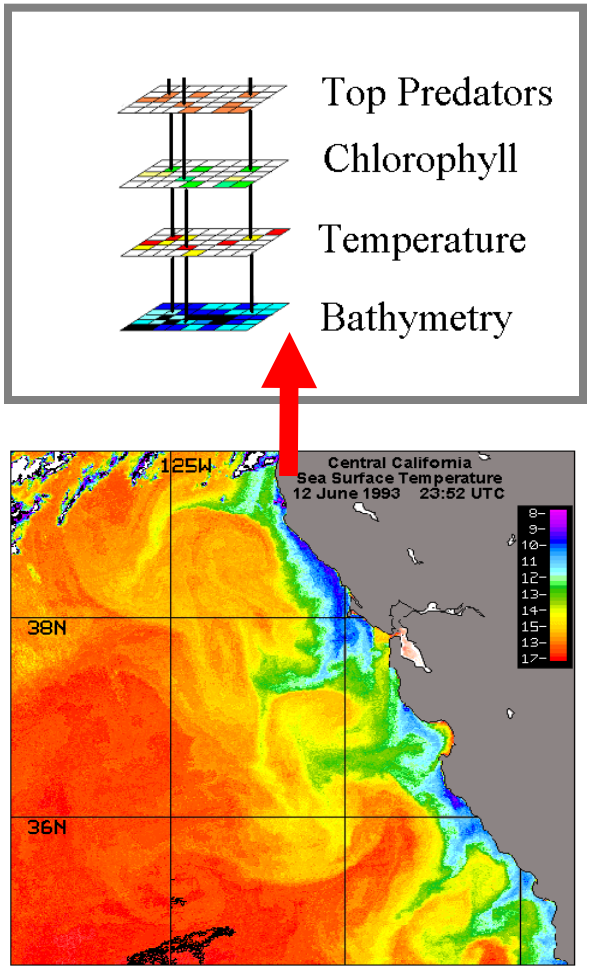
Interim Framework for Effective Coastal and Marine Spatial Planning

Interagency Ocean Policy Task Force

December 9, 2009

Purpose of this work

- Relate seabird data to habitat features and develop predictive models.
- Use models to identify marine 'hotspots' throughout the California Current System.
- Use results as to inform marine spatial planning in California (MLPA) and the U.S. West Coast.



Sea Surface Temperature

Why seabirds?

Seabirds are good models because:

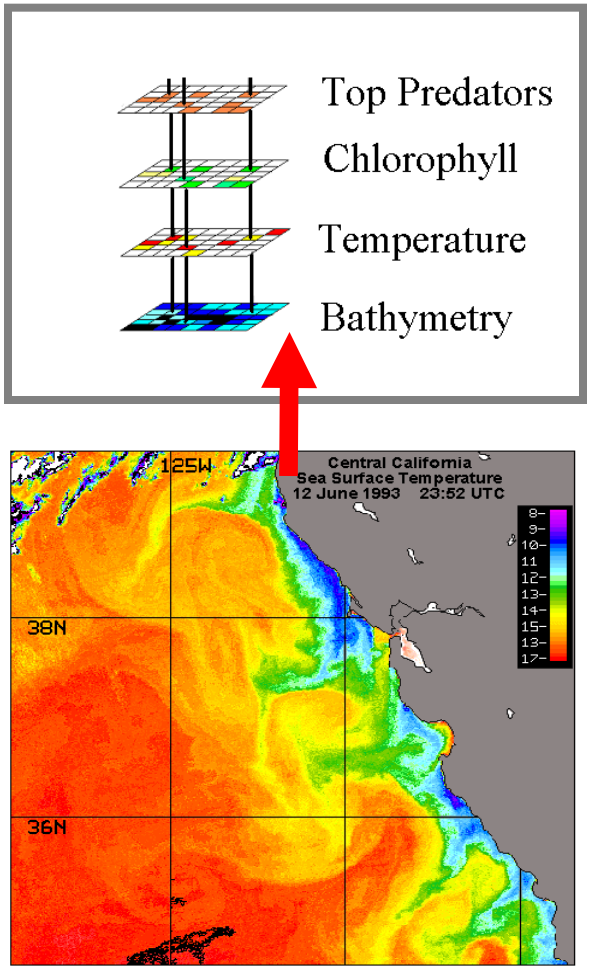
- Upper trophic level predators
- Integrate conditions over broad scales
- Feed on patchy prey
- Visible
- Gather annually at colonies
- Long term data!

Hypothesis

Marine birds and mammals aggregate to forage in predictable areas determined by bathymetric and oceanographic features

Methods

- Consolidate seabird and remote sensed data.
- Develop statistical models that relate seabirds and habitat.
- Test and validate models.
- Extrapolate across CCS and identify 'hotspots'.

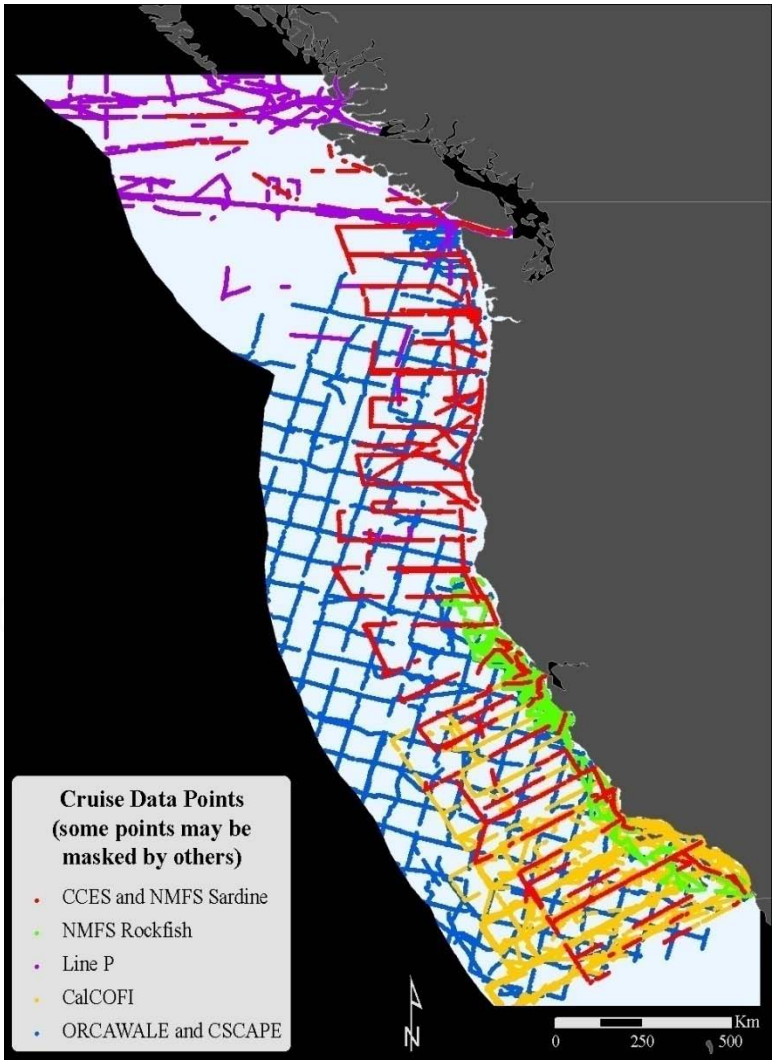


Sea Surface Temperature

Seabird data coverage

- Line P (1997 – 2006) 10yr
- NMFS RF (1997 – 2006) 10yr
- CalCOFI (1997 – 2006) 10yr
- ORCAWALE (2005 – 2008) 2yr
- NMFS SR (2005 – 2008) 2yr

Lots of data
Uneven coverage
WA, OR and NorCA



Variables included during modeling

Bathymetric

- Depth (minimum)
- Depth (average)
- Contour Index

- Dist 200-m isobath
- Dist 1-km isobath
- Dist 3-km isobath
- Dist nearest land

Other

- Year
- Julian date
- Latitude

Oceanographic

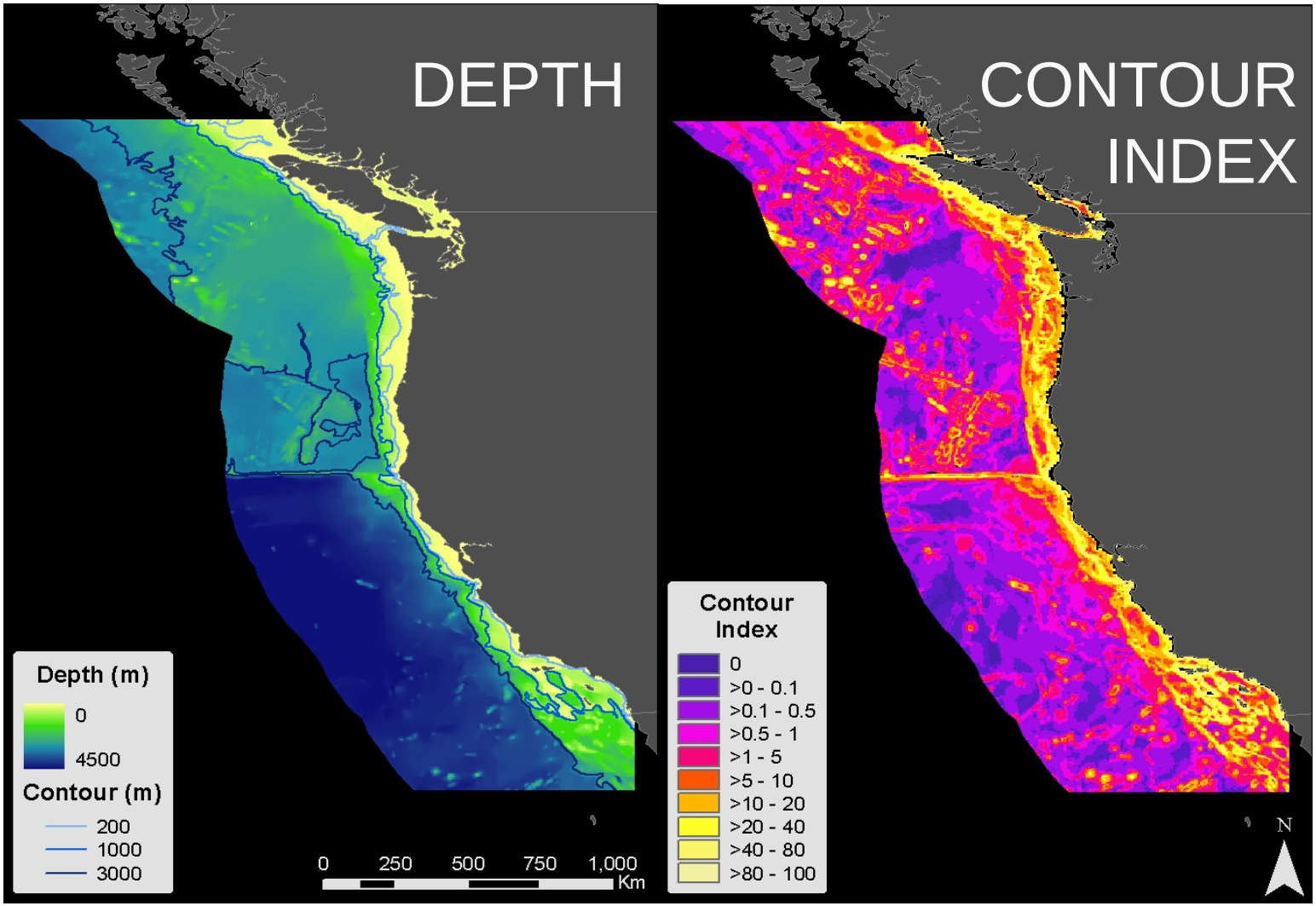
- Transition date

- Sea Surface Temperature
- Sea Surface Height
- Chlorophyll-a

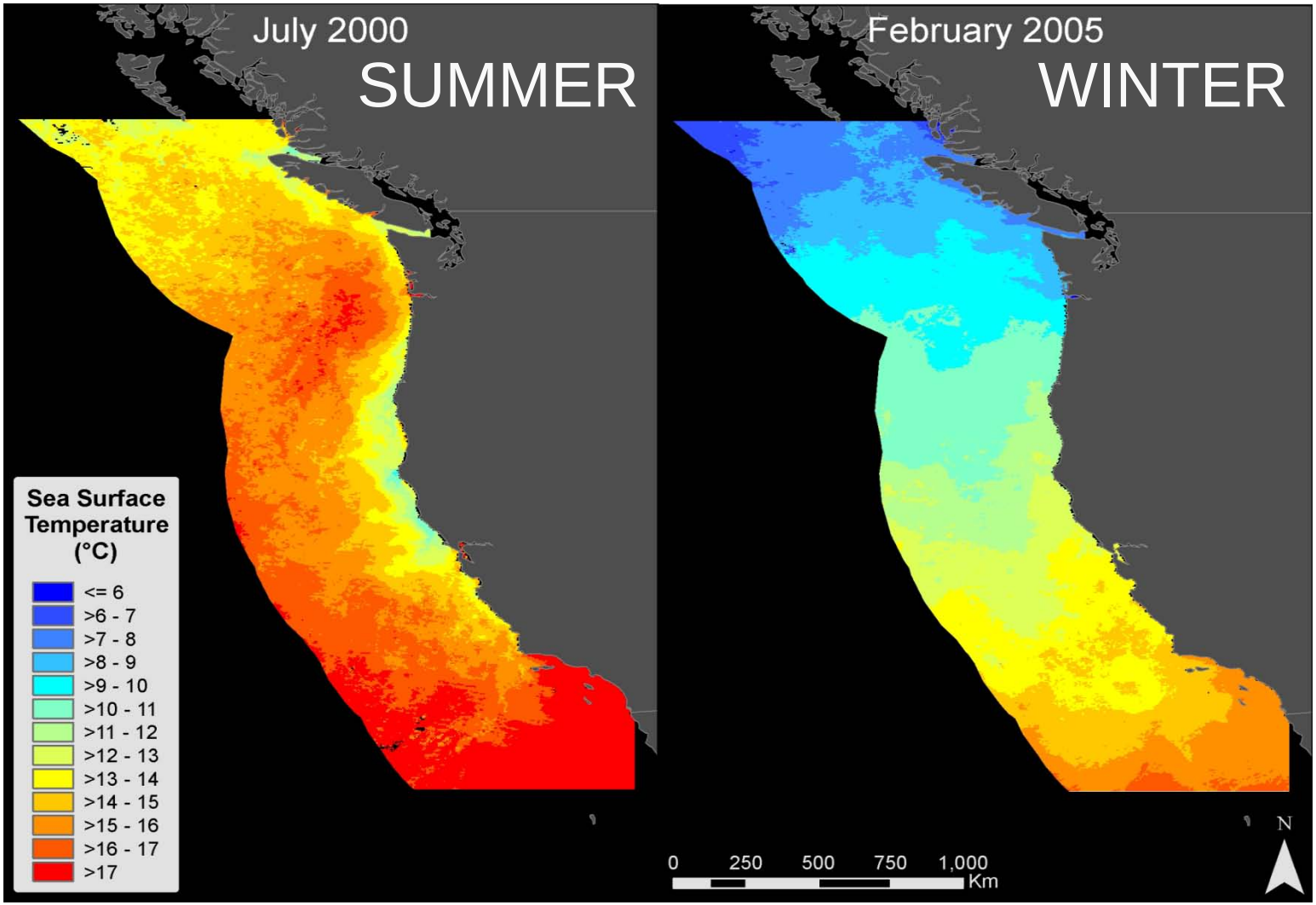
- SOI last 3 months
- PDO last 3 months
- NPGO last 3 months

- SOI 4-6 months prev
- PDO 4-6 months prev
- NPGO 4-6 months prev

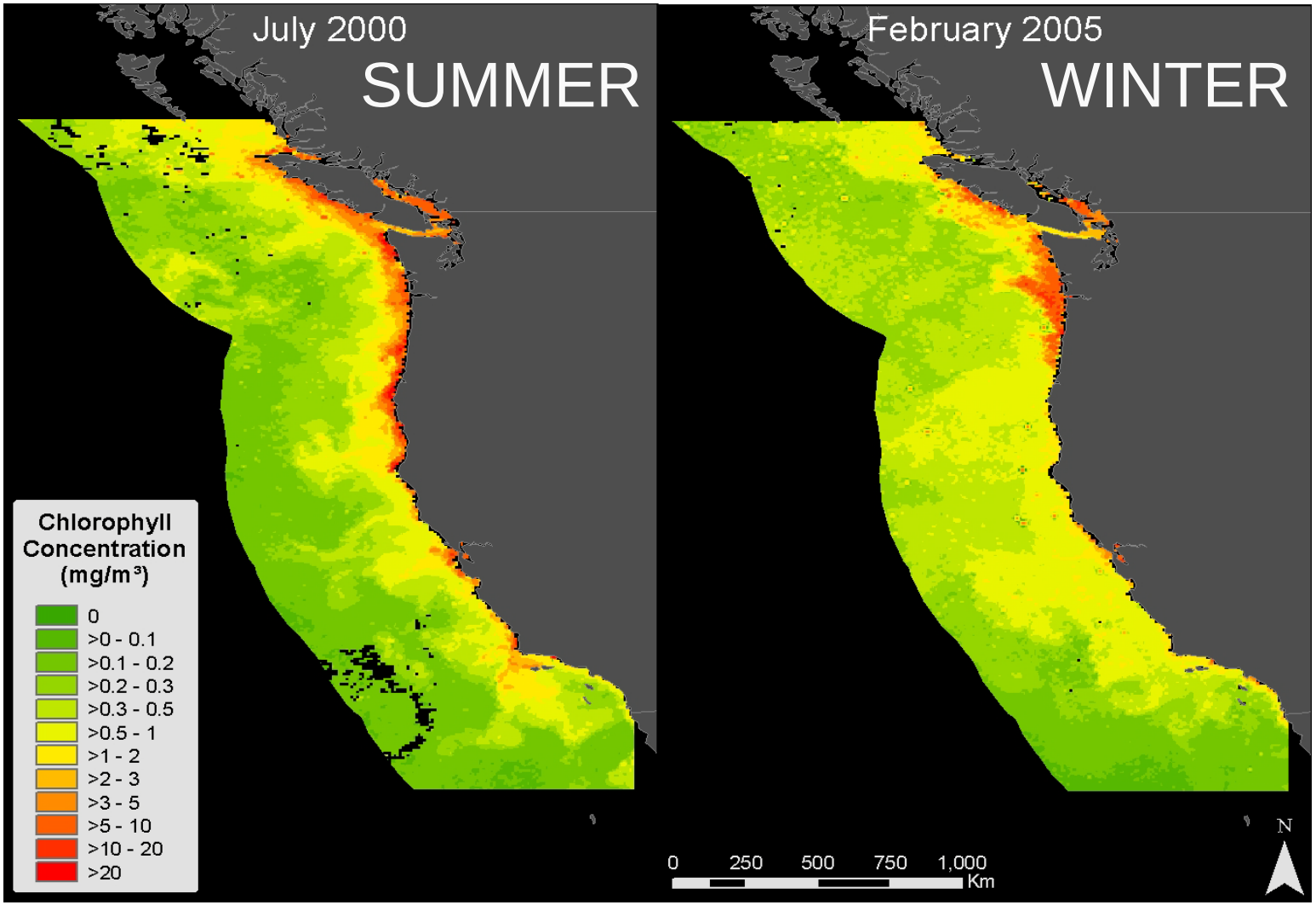
Variables – Depth and Contour Index



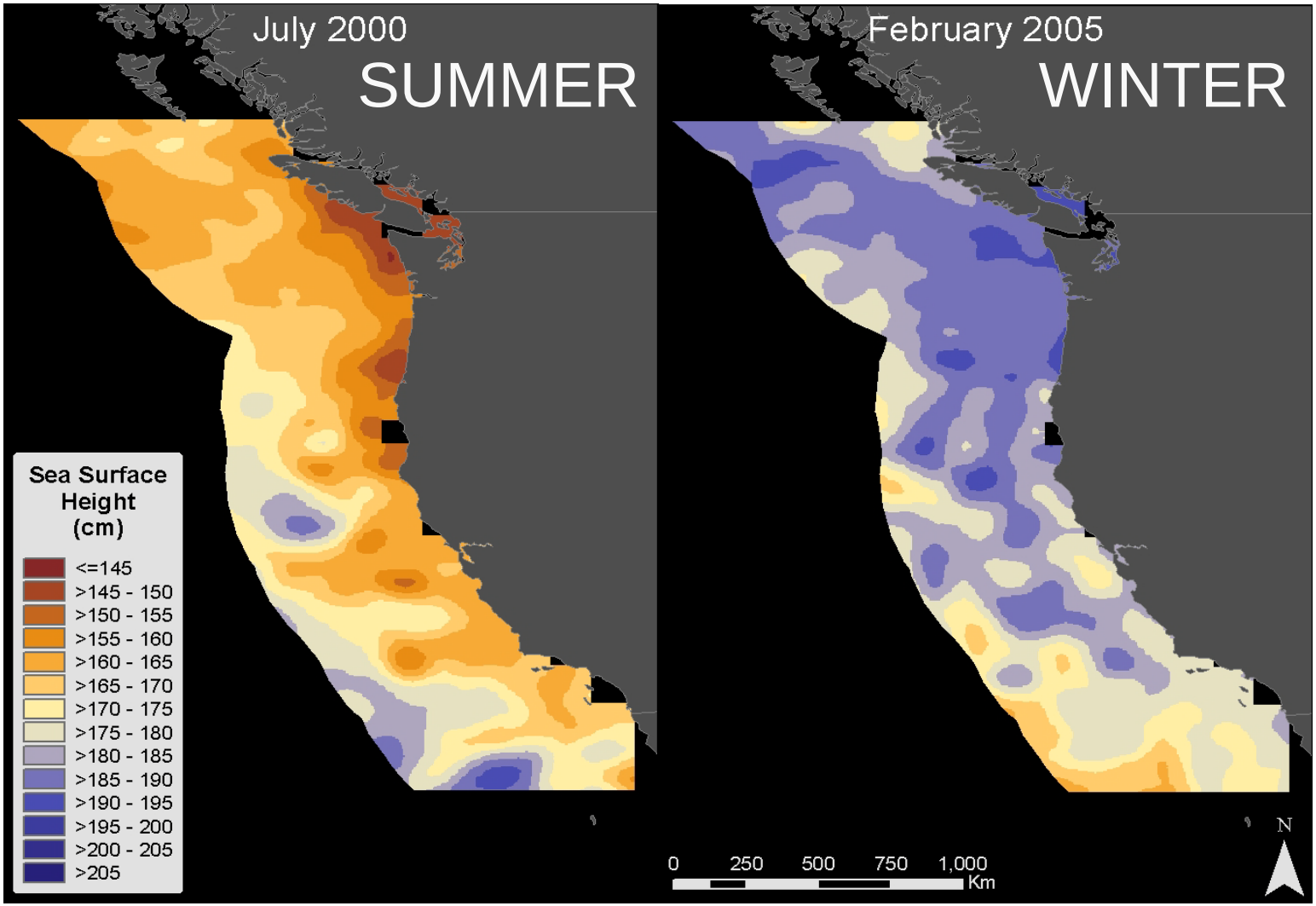
Variables – Sea Surface Temperature



Variables – Chlorophyll-a (productivity)



Variables – Sea Surface Height

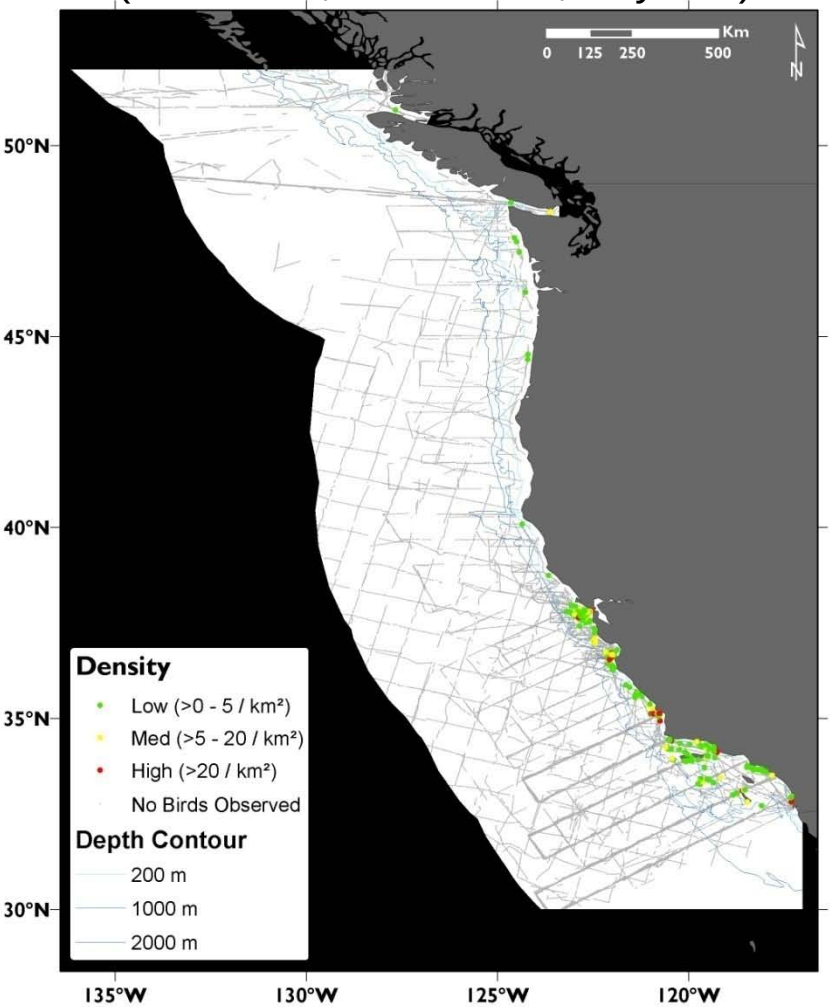


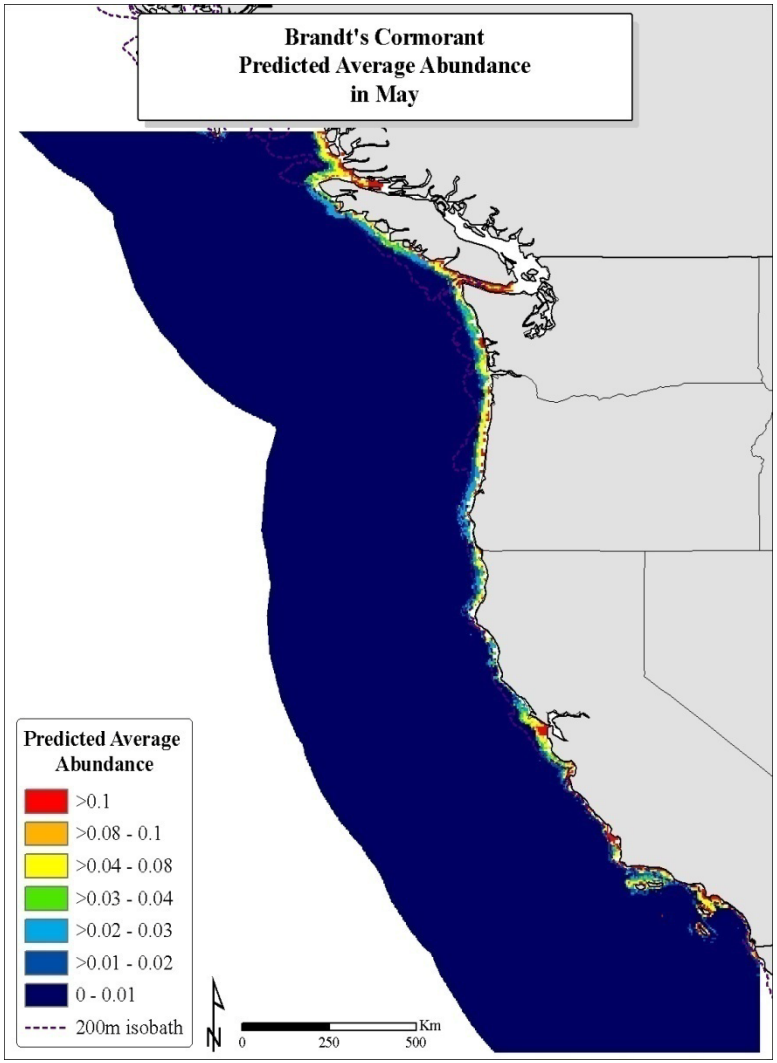
Model development

- Modeled seabird abundance based on habitat features determined by bathymetry or oceanography.
- We used Bagged Decision Trees for statistical analysis (advanced data mining technique used to discover patterns in data)
- We controlled for spatial and temporal differences in the onset of upwelling.
- We controlled for Pacific basin scale oceanographic conditions.
- We modeled a total of 16 birds (2 of conservation concern)

Observations VS Predictions – Brand's Cormorant

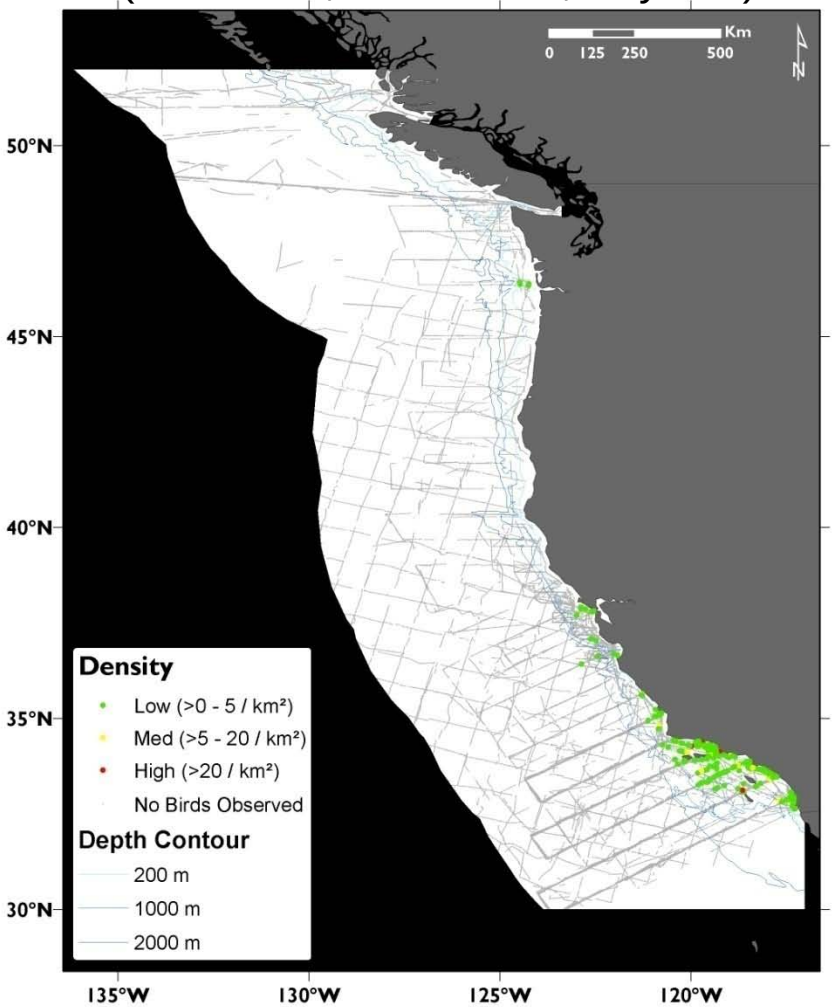
Observed data
(all cruises, all seasons, all years)

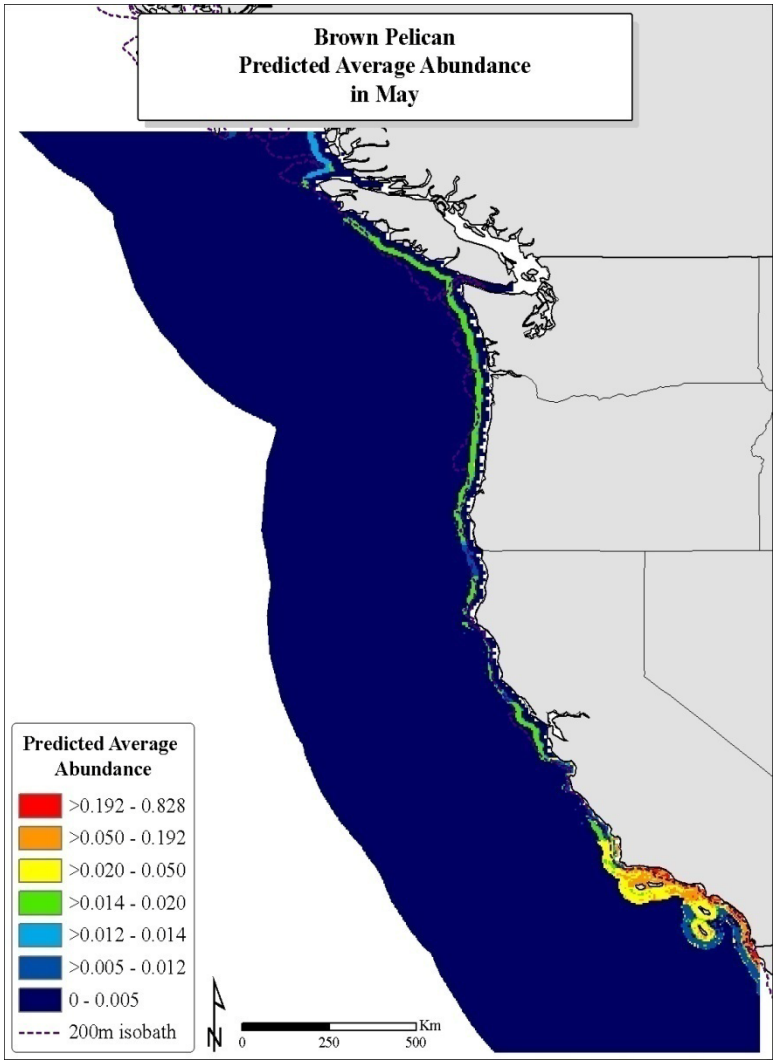




Observations VS Predictions – Brown Pelican

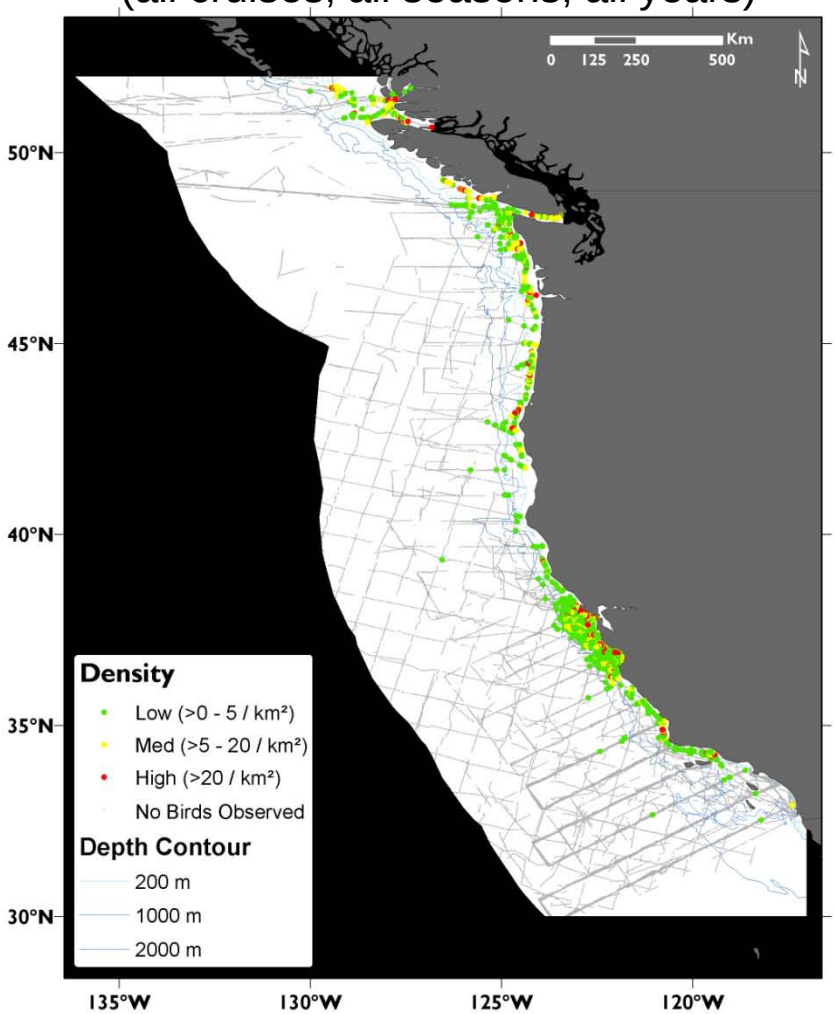
Observed data
(all cruises, all seasons, all years)

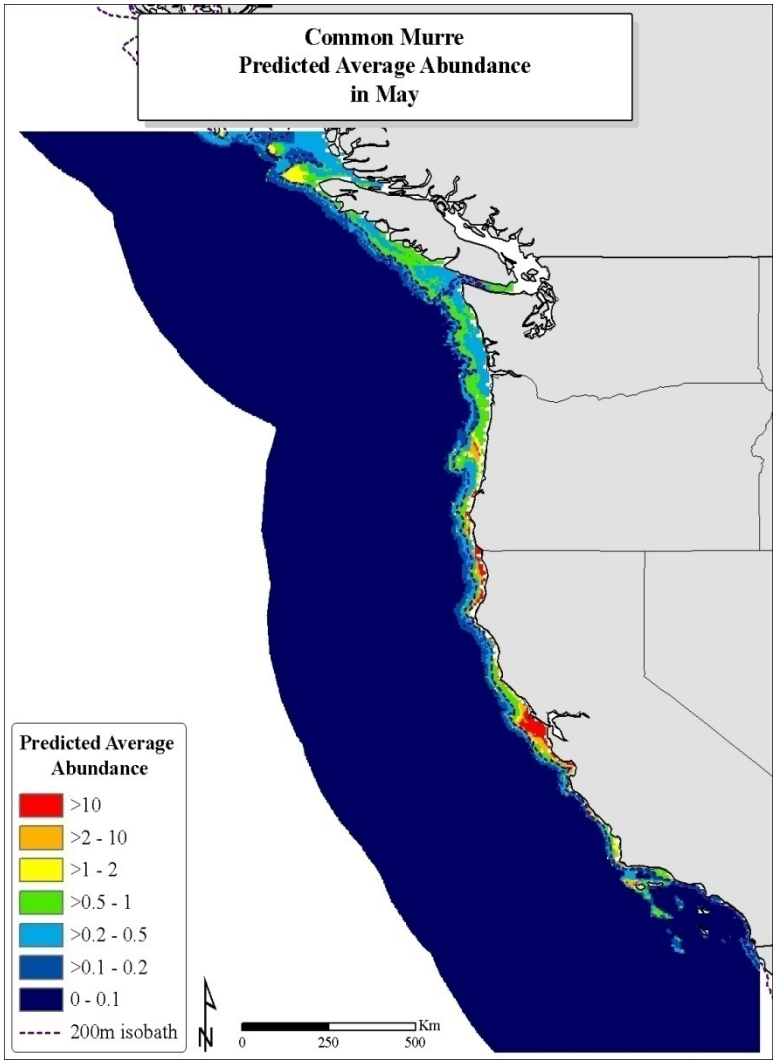




Observations VS Predictions – Common Murre

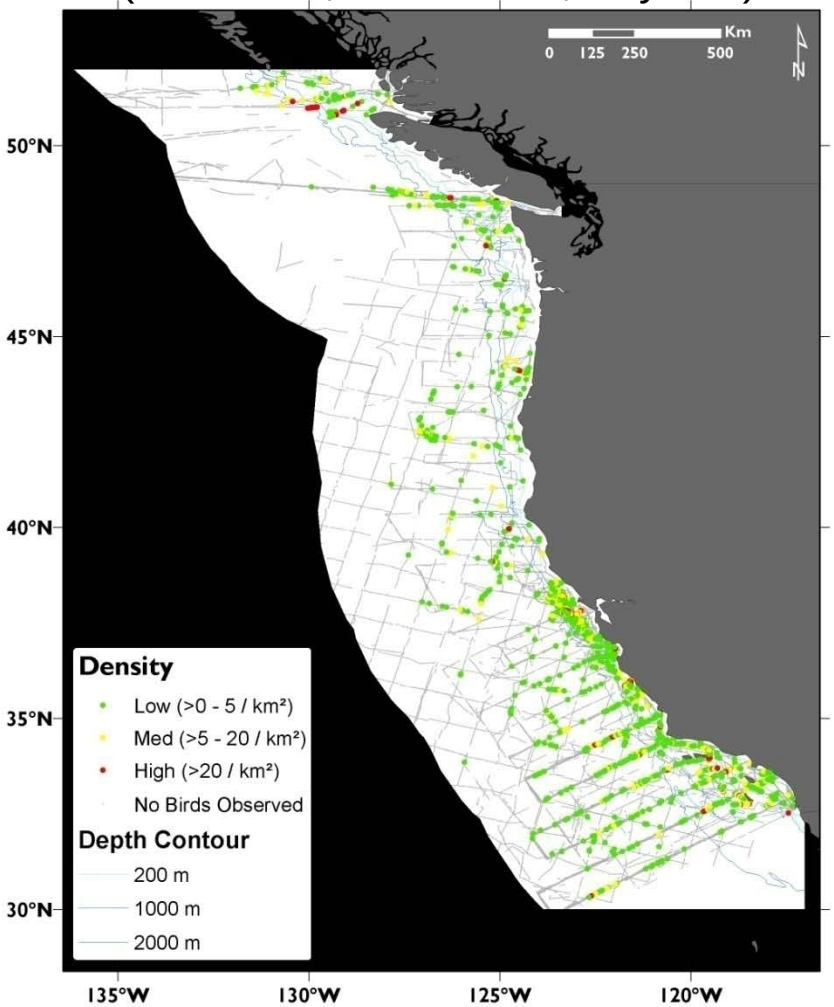
Observed data
(all cruises, all seasons, all years)

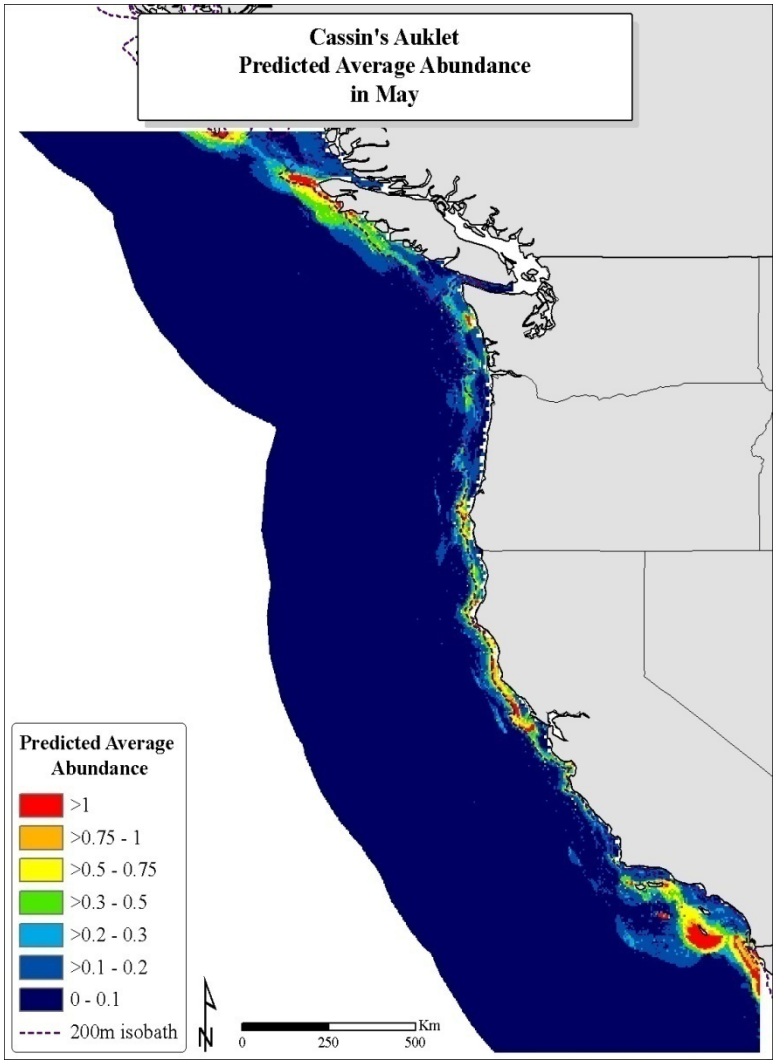




Observations VS Predictions – Cassin's Auklet

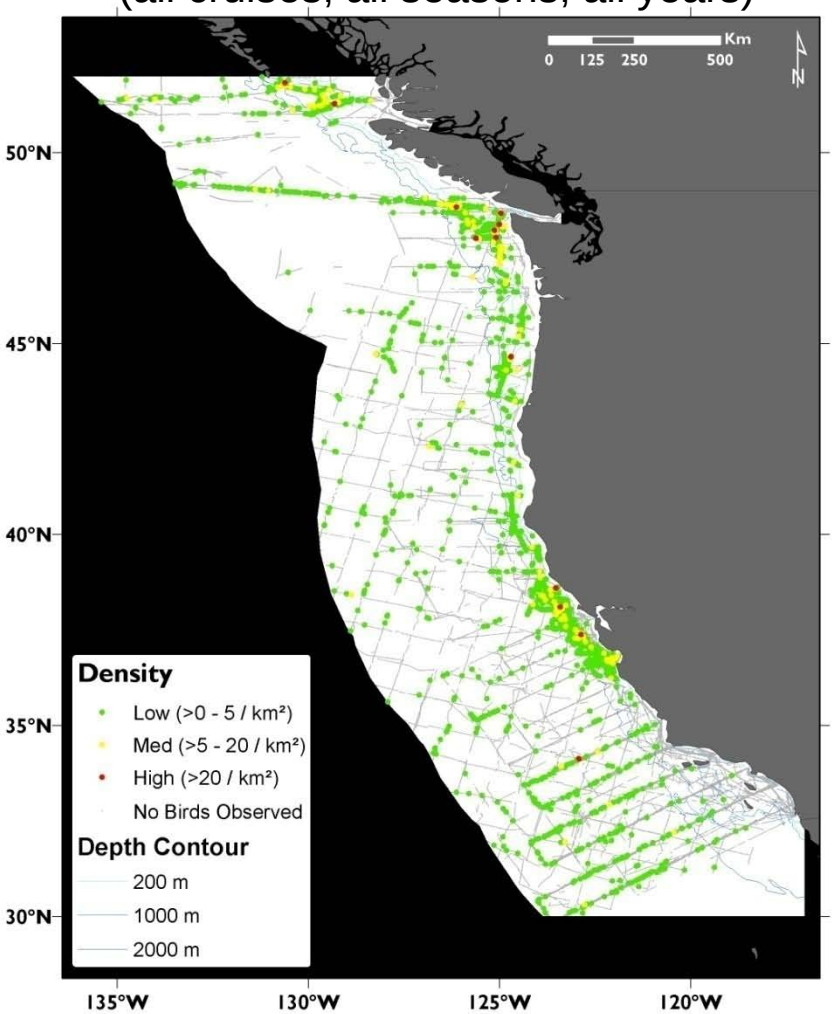
Observed data
(all cruises, all seasons, all years)

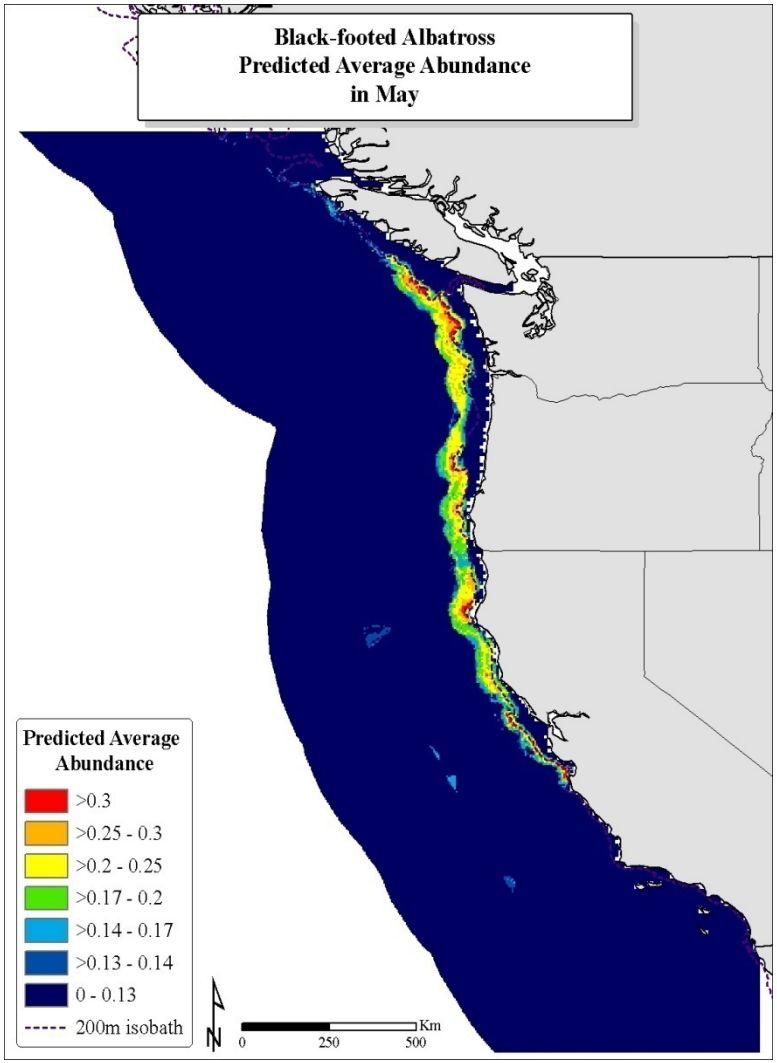




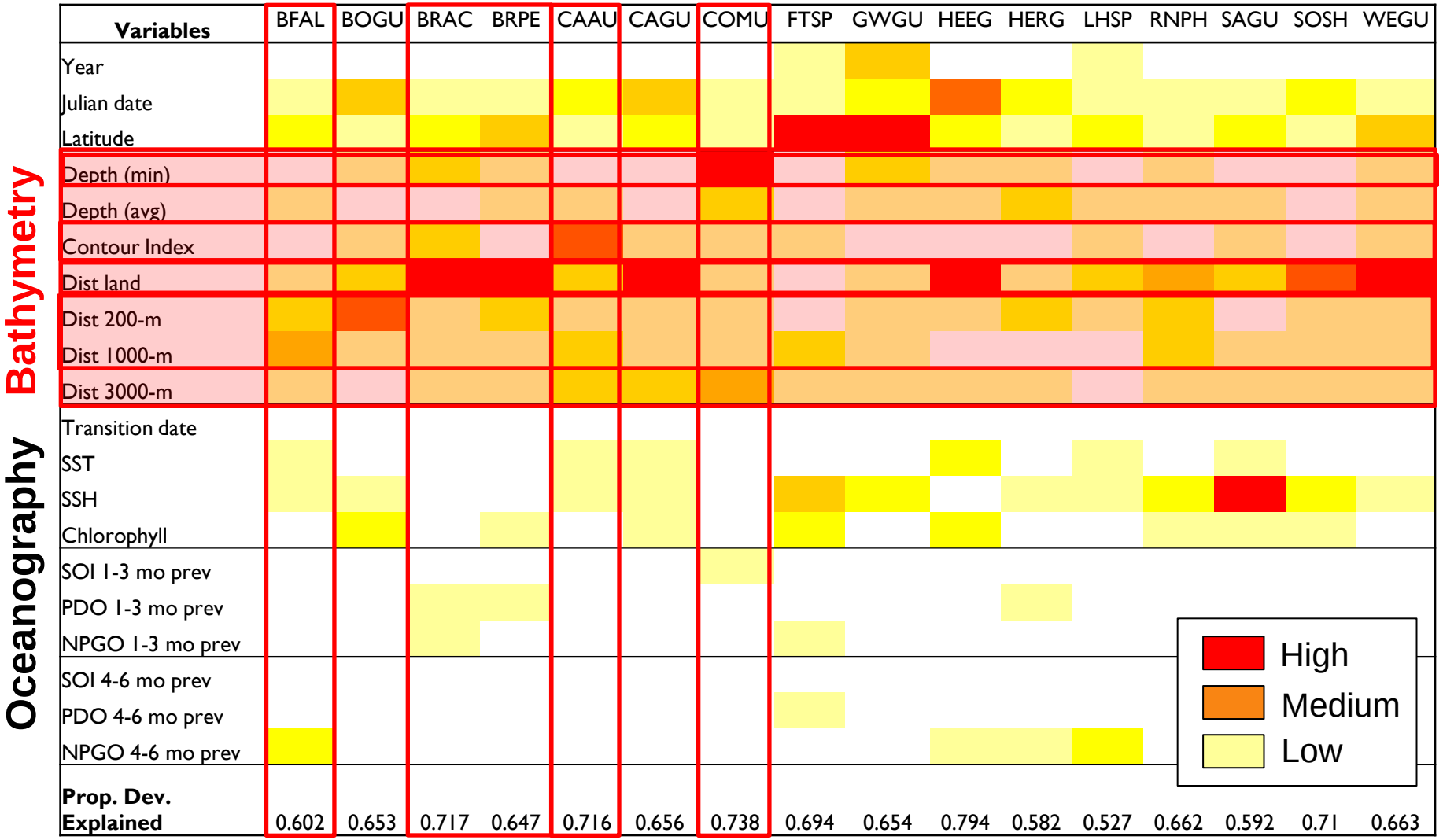
Observations VS Predictions – Black-footed Albatross

Observed data
(all cruises, all seasons, all years)





Model results – Location is most important



Hotspot determination using 3 criteria

- **Abundance:** summed standardized abundance of all species (each spp contributes equally to product)

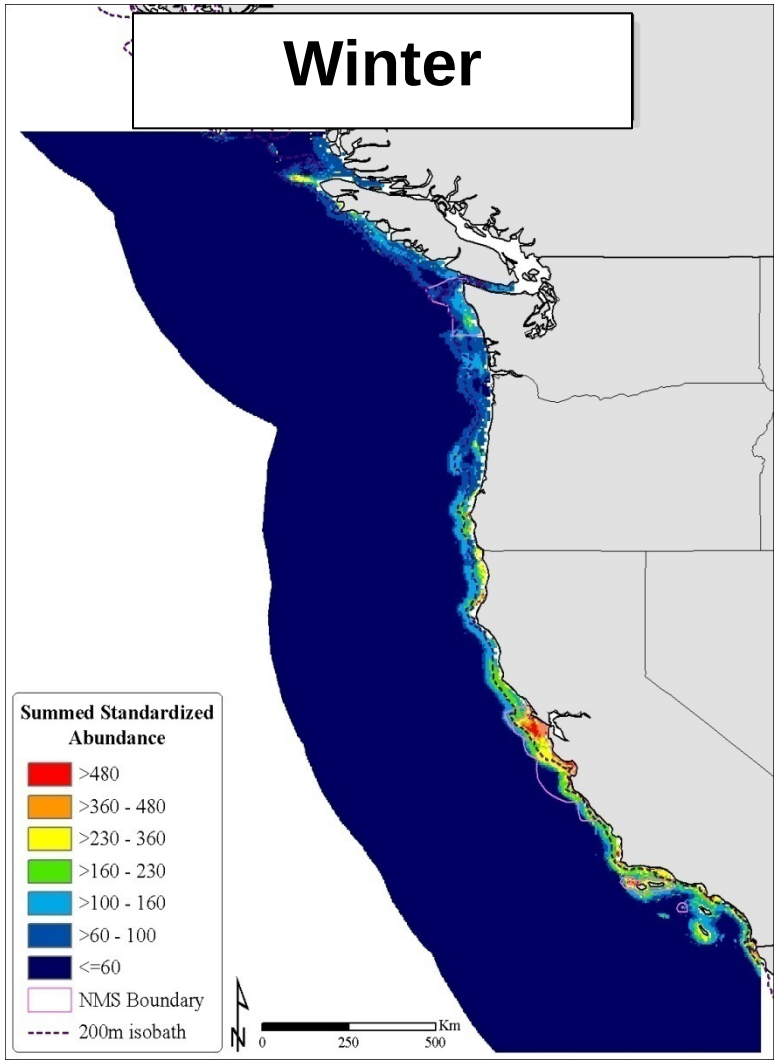
- **Importance:** smallest set of cells that constituted 25% of the species' top total abundance.

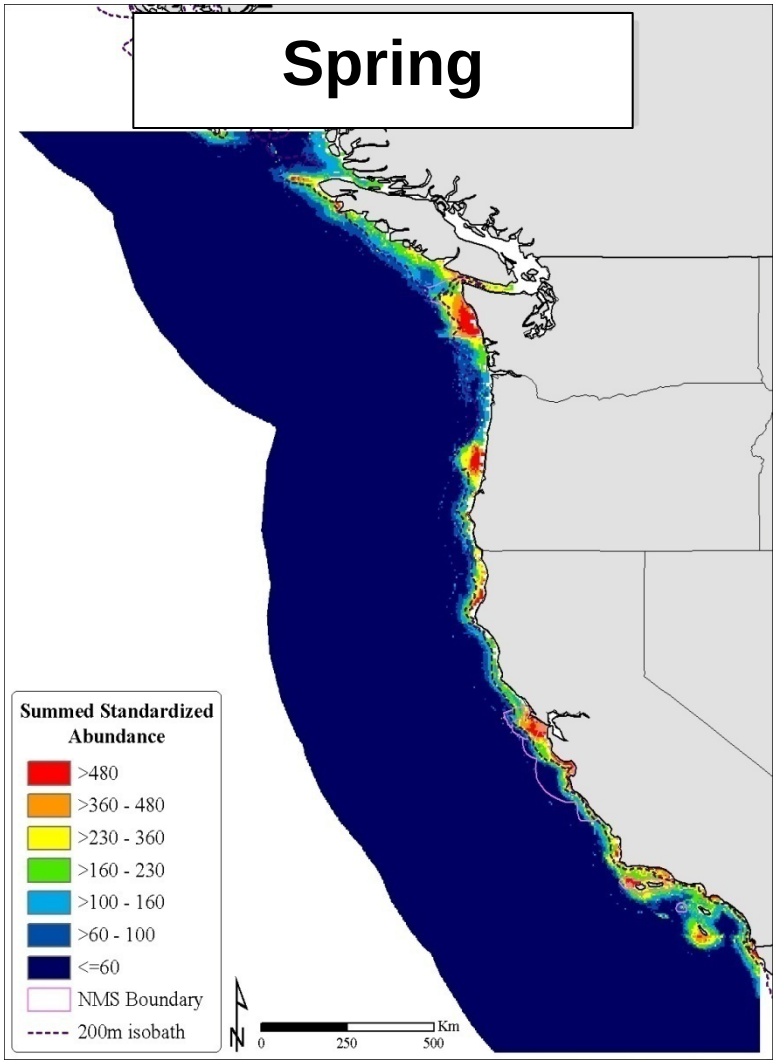
- **Persistence:** number of years that a cell was in the top 95% of predicted abundance for a particular species.

These were calculated on a seasonal basis, and averaged across all seasons.

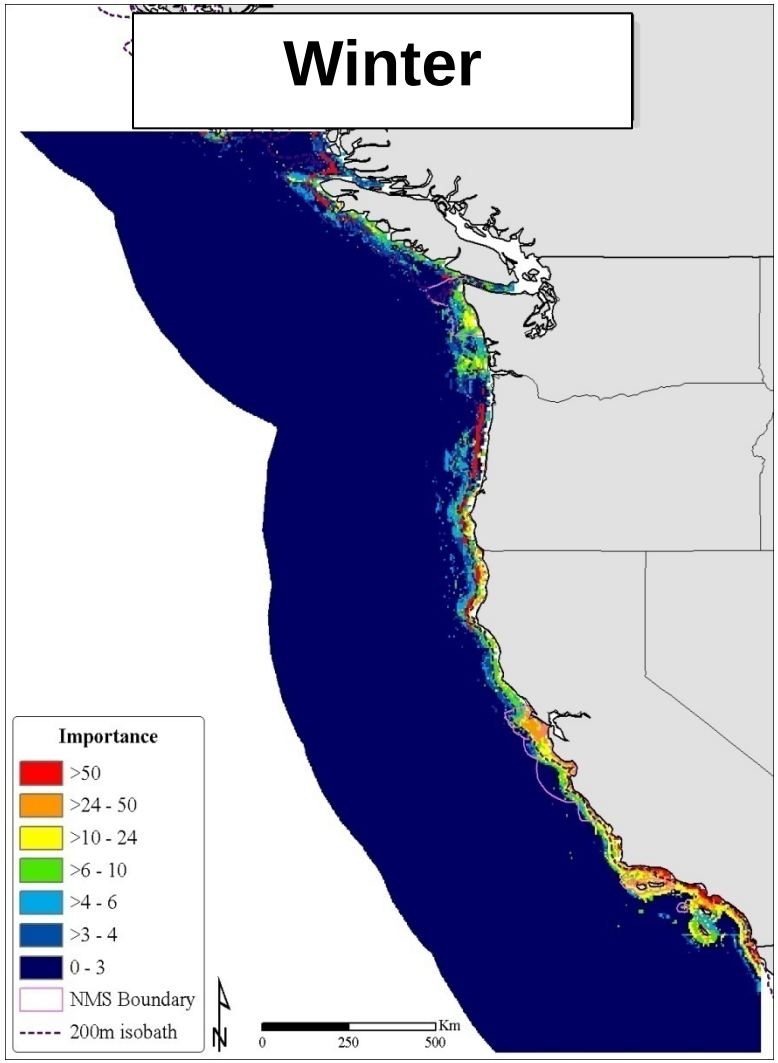
RESOLUTION = 4x4 km cells for prediction

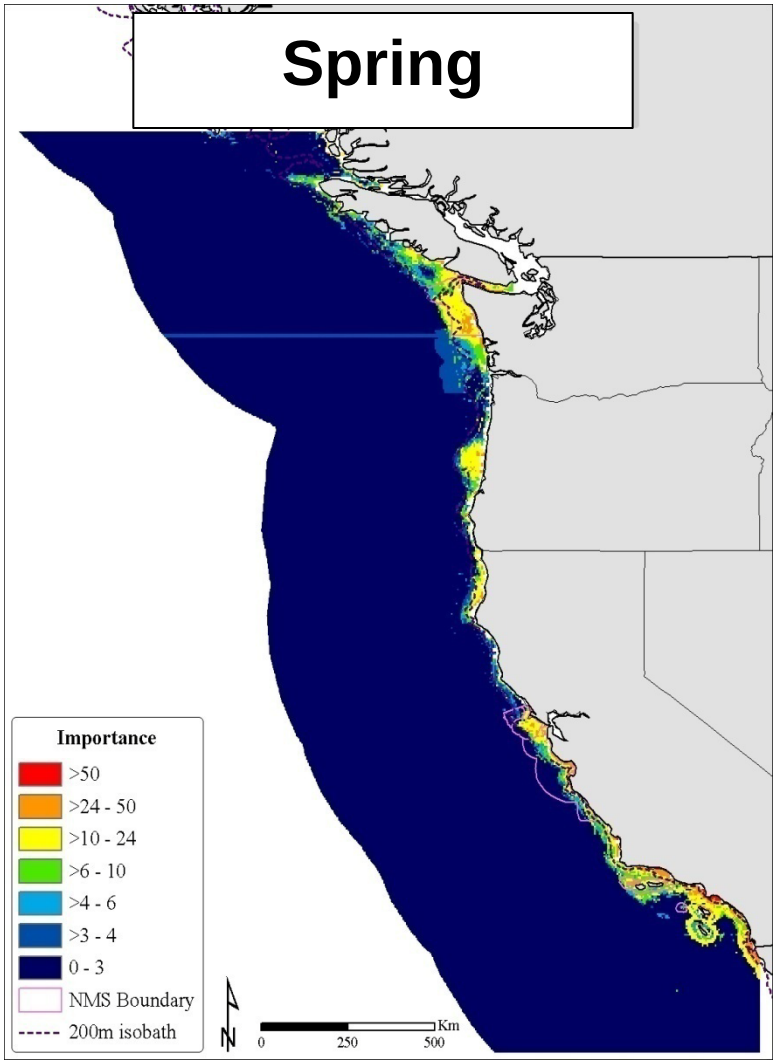
Hotspots – ABUNDANCE



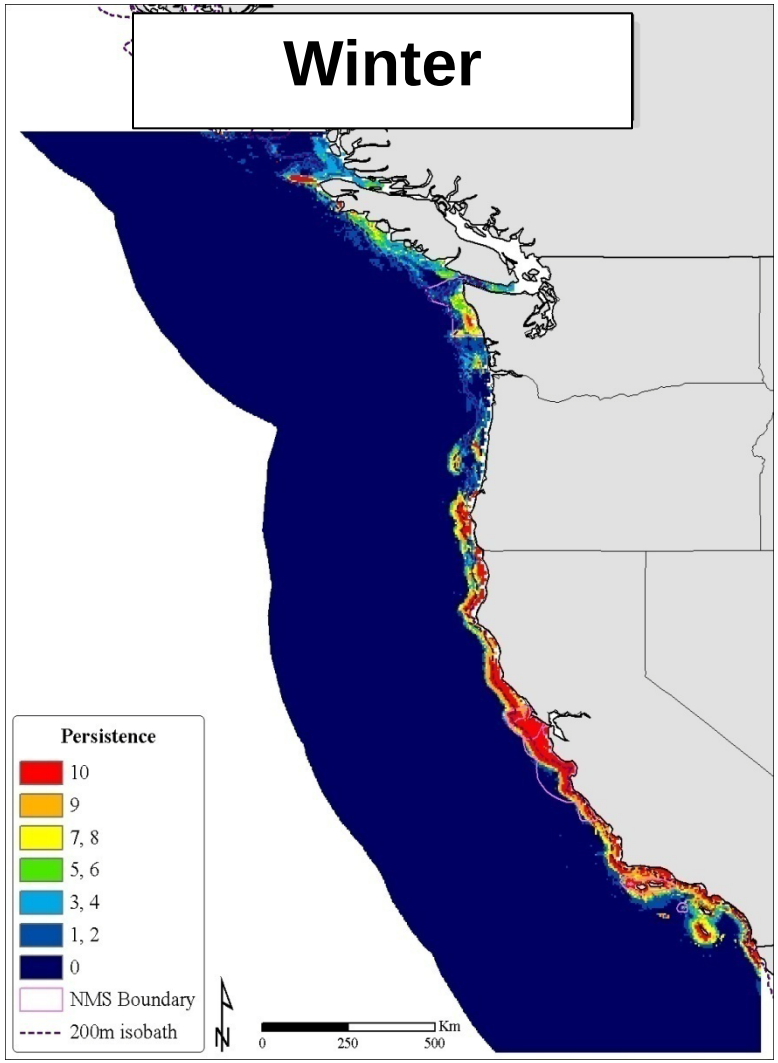


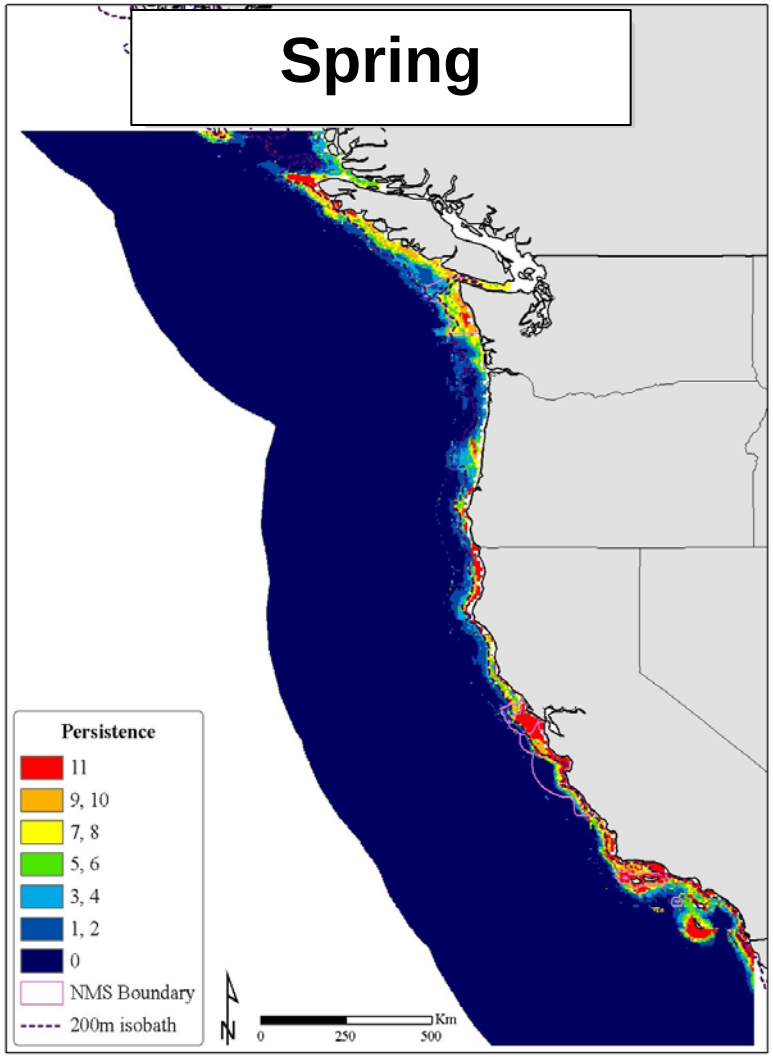
Hotspots – IMPORTANCE



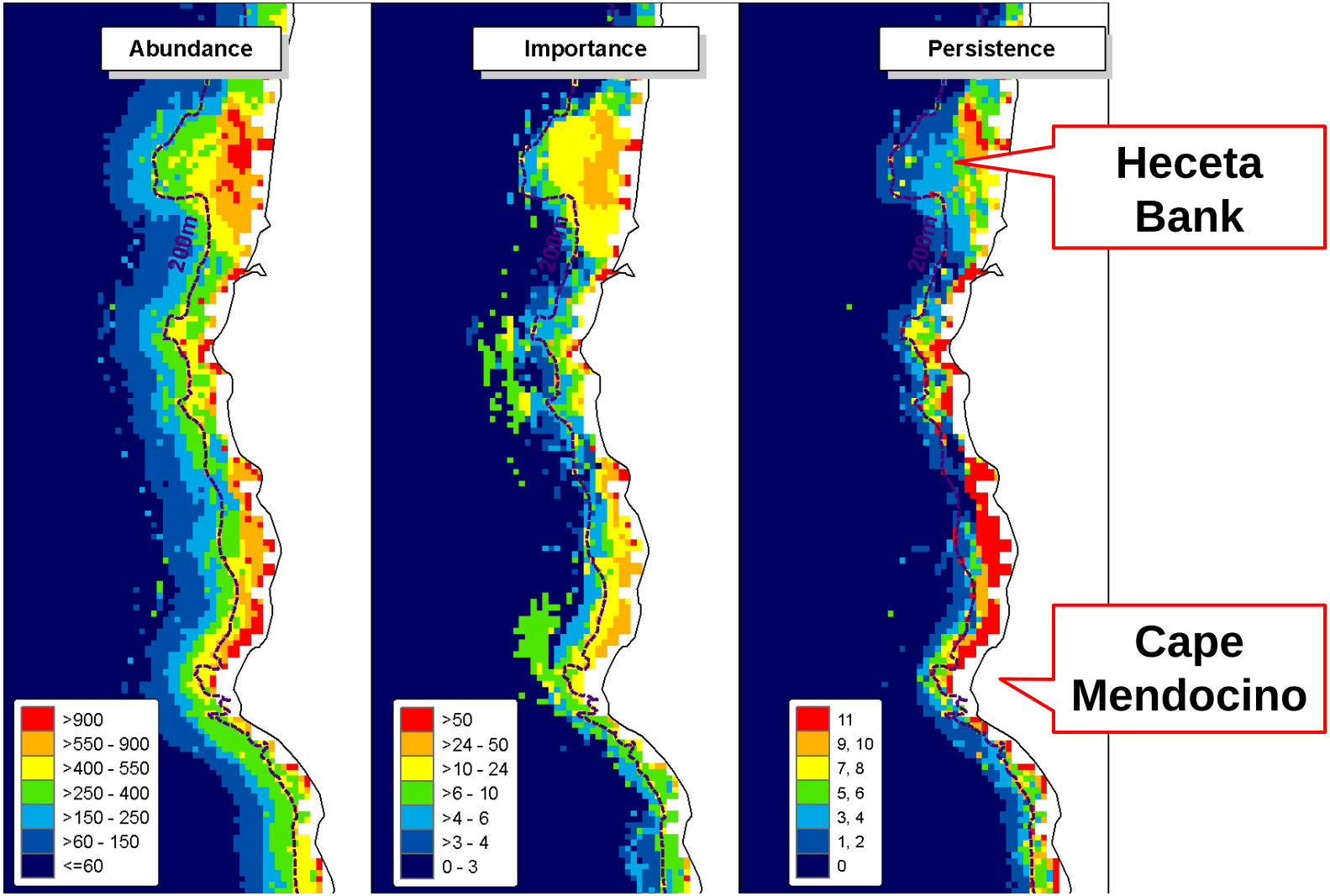


Hotspots – PERSISTENCE (top 5%)

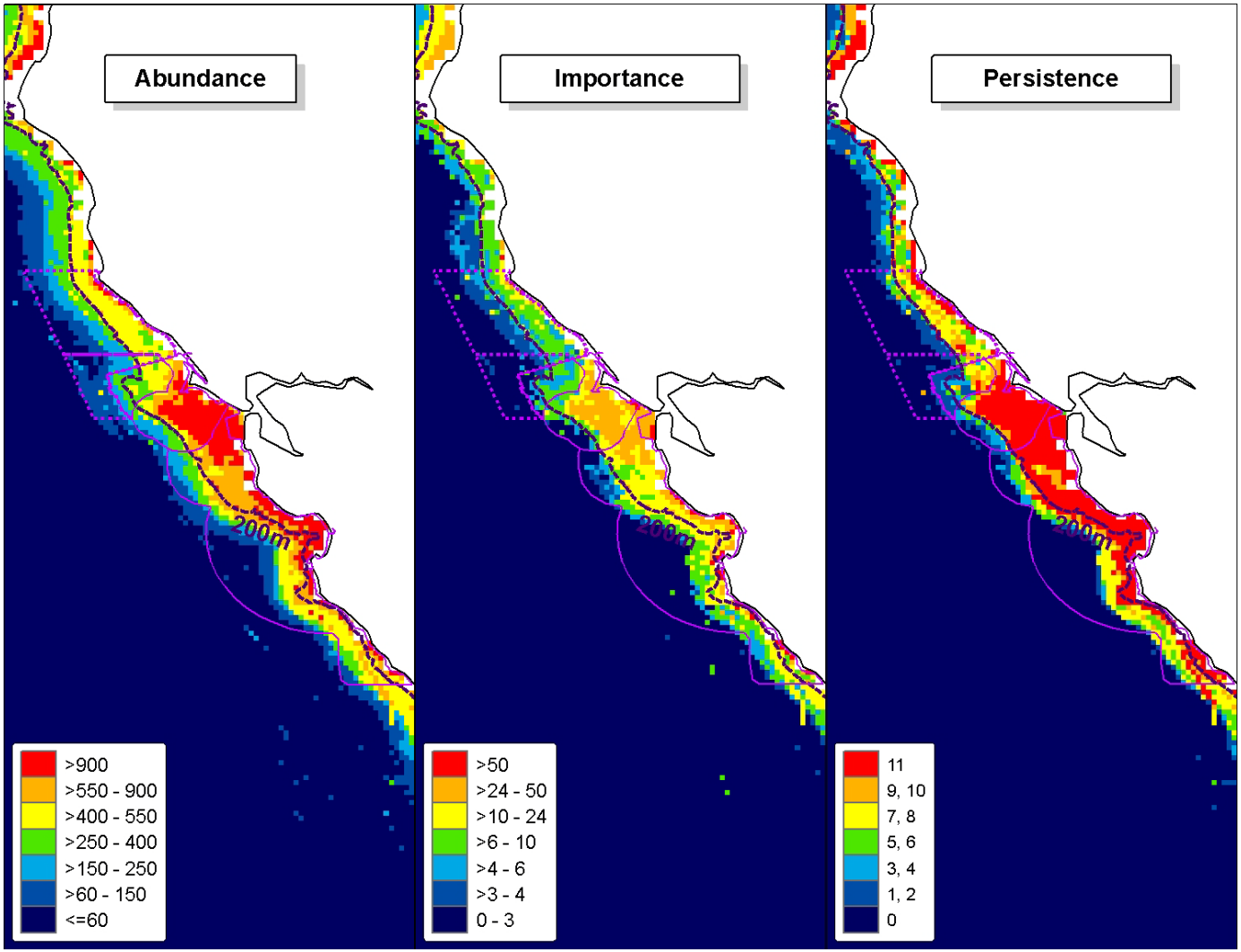




Conservation Gaps



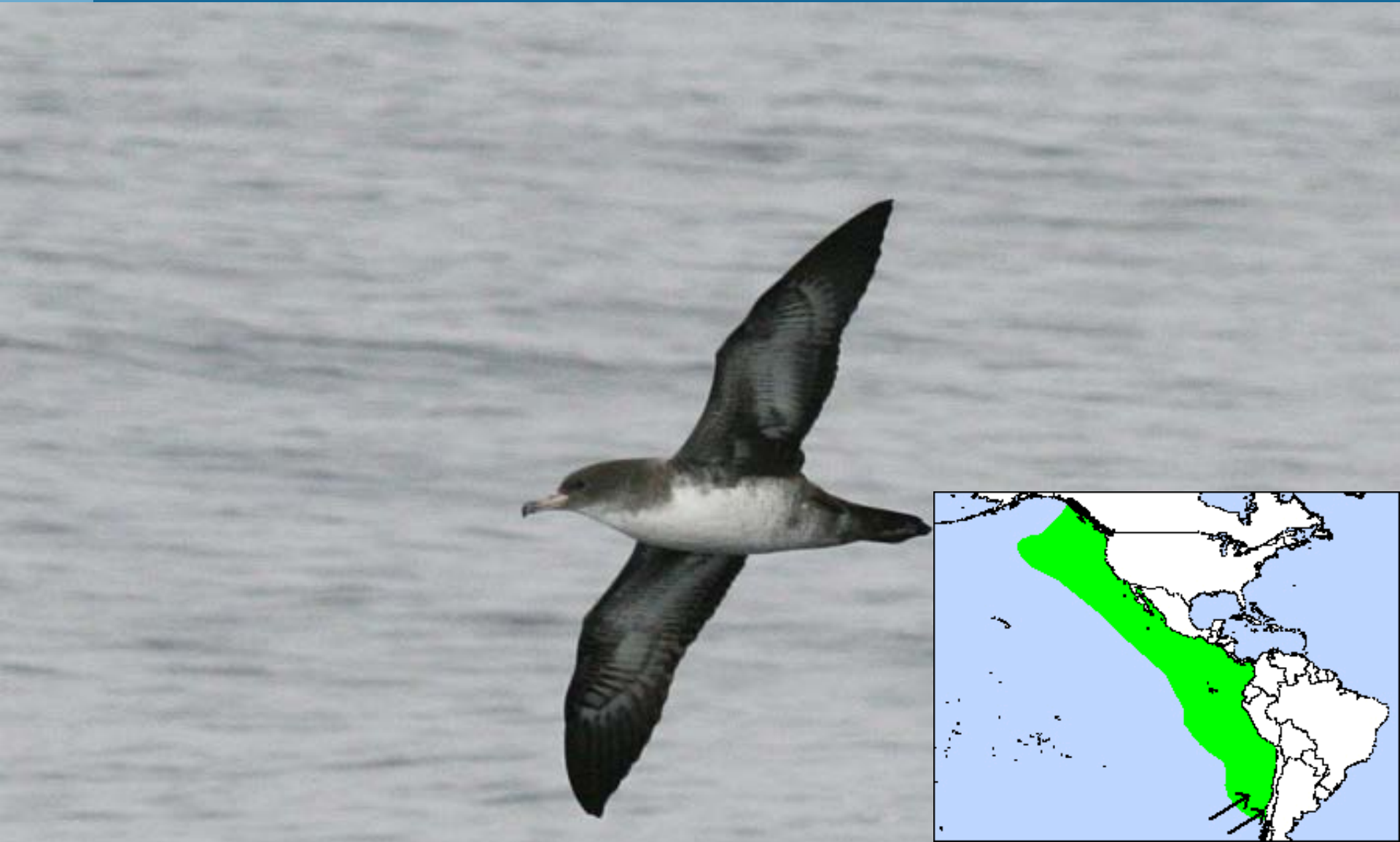
Cordell Bank, Gulf of the Farallones, and Monterey Bay National Marine Sanctuaries



Black-footed Albatross – ENDANGERED (IUCN)

Sooty Shearwater – NEAR THREATENED (IUCN)

Pink-footed Shearwater – THREATENED (IUCN)

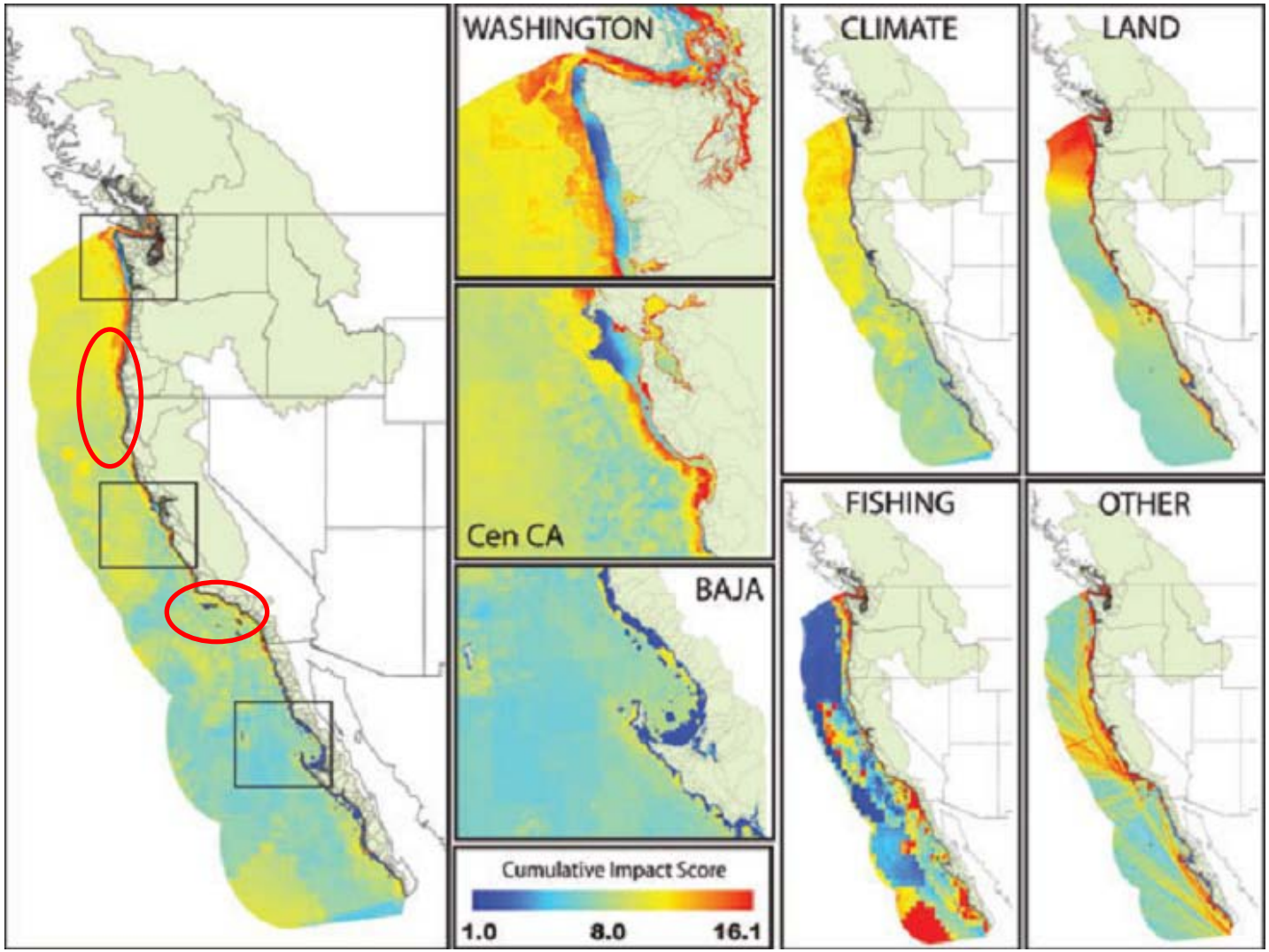


Conclusions

- Assess large geographic area with high temporal variability (within year, between year).
- Models account for large proportion of variability and validation results were good.
- Bathymetric variables were more important in predicting ‘hotspots’.
- ‘Hotspots’ over the shelf often aligned well with current protected areas (e.g., National Marine Sanctuaries).
- ‘Conservation gap’ from Cape Mendocino to Heceta Bank.

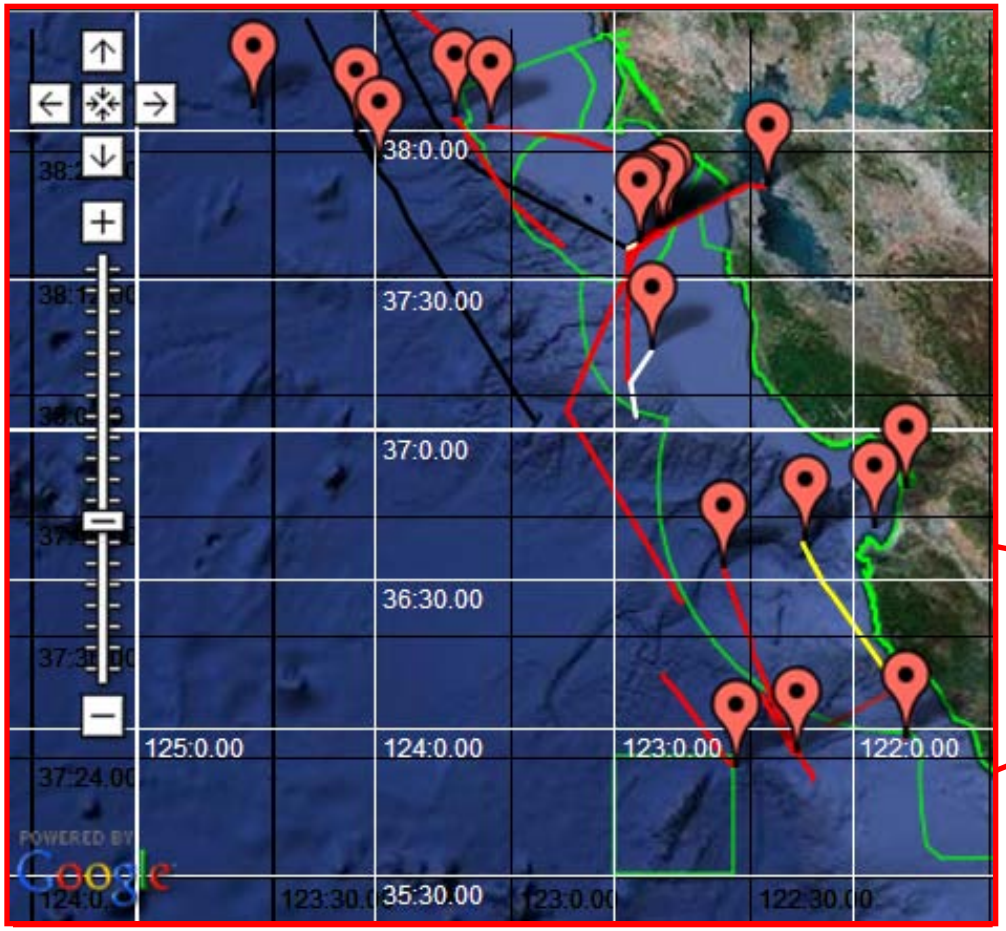
Human threats (25 activities) - NCEAS

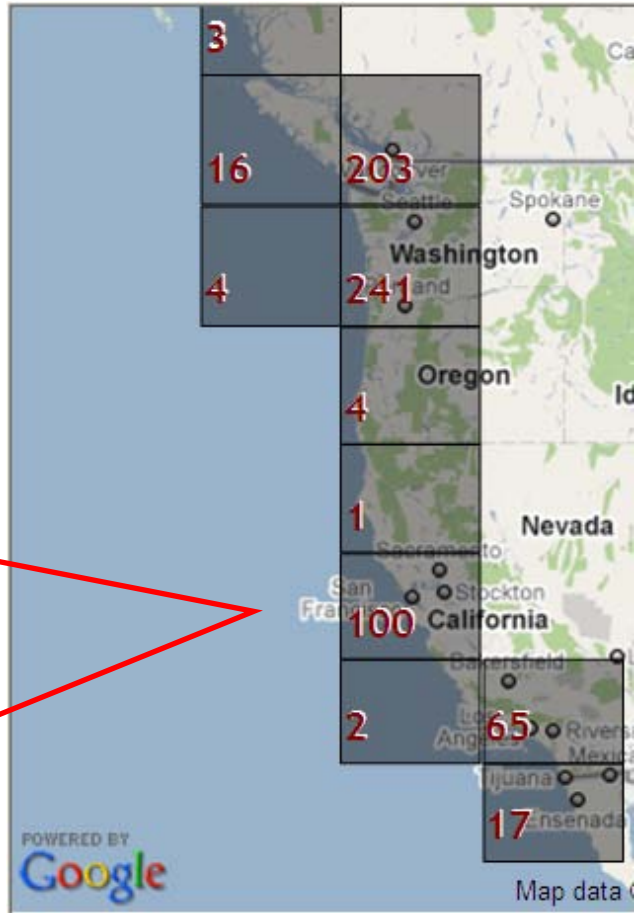
Halpern et al. 2009 from National Center for Ecological Analysis and Synthesis



Atmospheric deposition
SST
UV
Ocean-based pollution
Nutrient input
Inorganic pollution
Organic pollution
Noise/light pollution
Recreational fishing
Invasive species
Commercial shipping
Ocean acidification
Sediment decrease
Demersal destructive
Coastal engineering
Demersal nondestructive high bycatch
Sediment increase
Marine debris (trash)
Human trampling
Demersal nondestructive low bycatch
Pelagic high bycatch
Coastal power plants
Oil rigs
Aquaculture
Pelagic low bycatch
Climate
Land-based
Other
Fishing

Shipping (strikes, pollution)





Vessels equipped with radio transmitters (generally large ships).
Positions determined by a series of receiver stations along the coast.

Next Steps

- **Threats assessment** – Identify current and potential threats to prioritize ‘hotspots’ that may need protection.
- **Outreach** – Ensure that relevant agencies are aware of findings and can use them in marine spatial planning.
- **Regionalization** – Develop predictive models that focus on the Northern California to Southern Oregon region.
- **Climate change** – Assess how climate change may impact marine ‘hotspots’ along over the next 30-60 years

Acknowledgements

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Thank you!