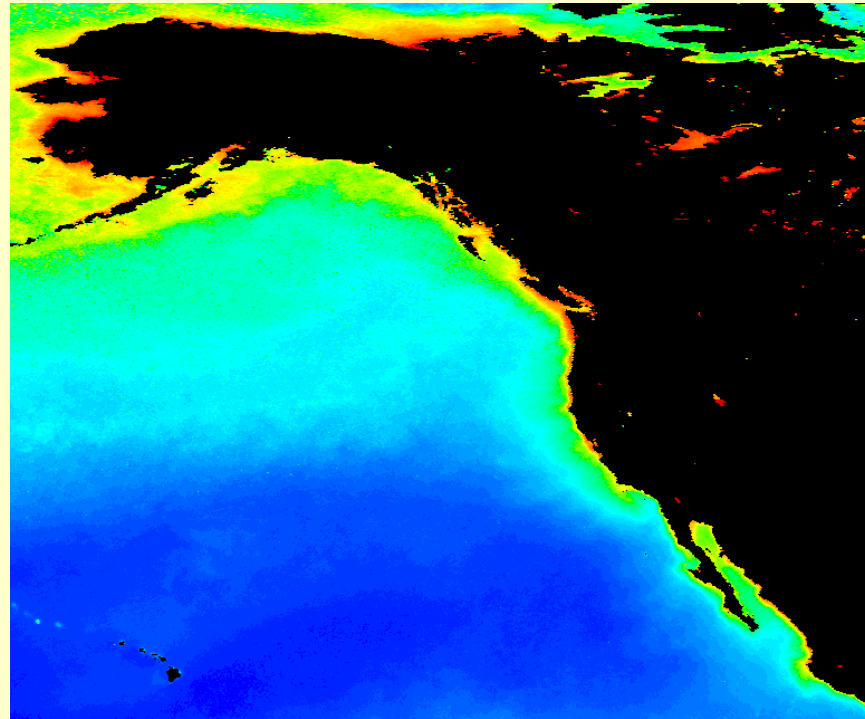


Symposium 3: Networking for the future of MMPAs and MMPA Networks

Oceanographic Considerations



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Motivation

- Upper-trophic oceanic predators:
 - Make a living in a vast, dynamic, and heterogeneous environment
 - Respond to changes in water masses, productivity and prey availability
 - Concentrate within smaller-scale foraging areas (10s - 100s km)
- Thus, in principle, MPAs could be designed to protect "predictable" predator concentrations
- Today's Goal:
Stimulate discussion of pelagic MPA designs



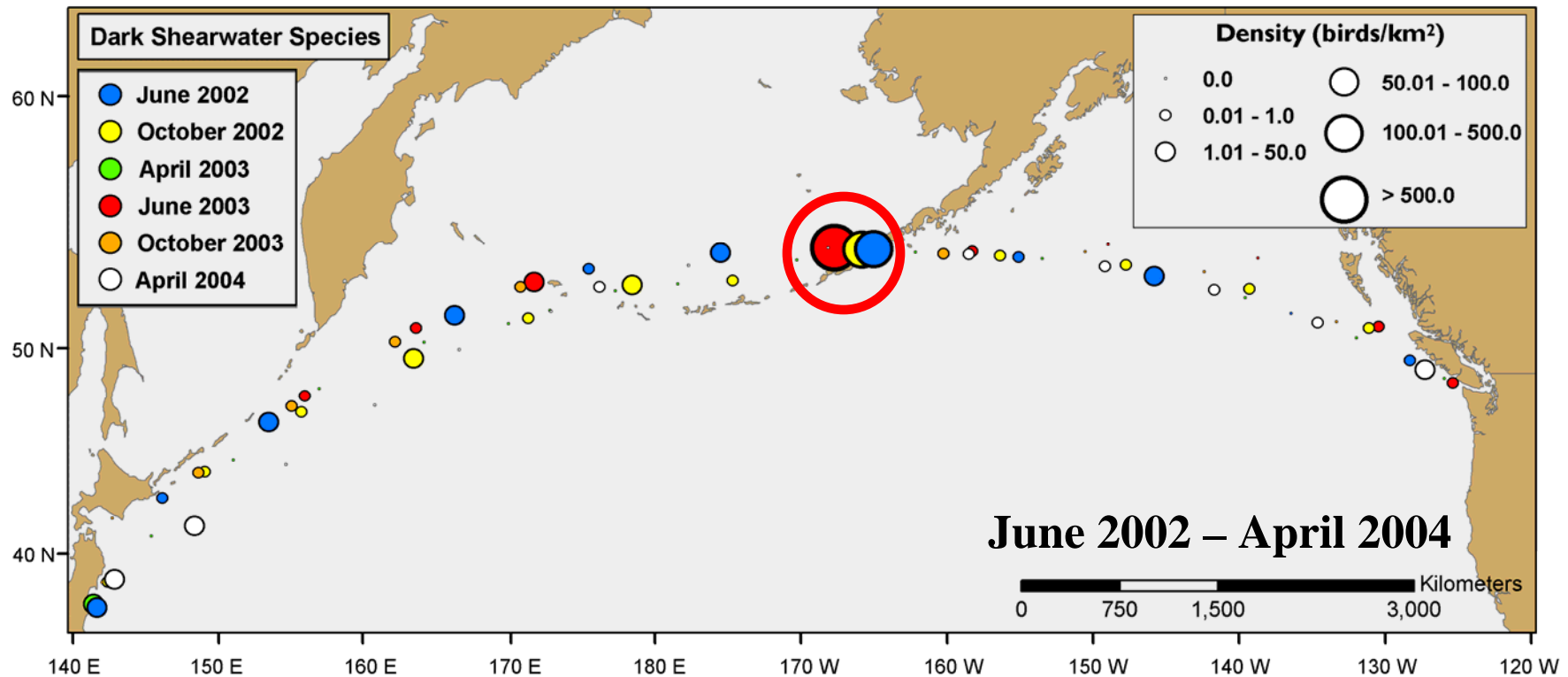
Focus: Predator Aggregations



Photo: Brittain

With 2 - 4 birds m^{-2} , this flock off Unimak Pass contained 5 - 9 million shearwaters (~ 20 - 50 % of world population)

Context: Temporal & Spatial Variability



- Seasonal migration
- Spatial aggregation
- Interannual variability: fall 2002 (High); fall 2003 (Low)

(Sydeman, Hyrenbach, Morgan, Henry)



Photo: Webb

Recommendation - 1

Address a Hierarchy of Scales



Scale-Dependent Patterns in Zooplankton

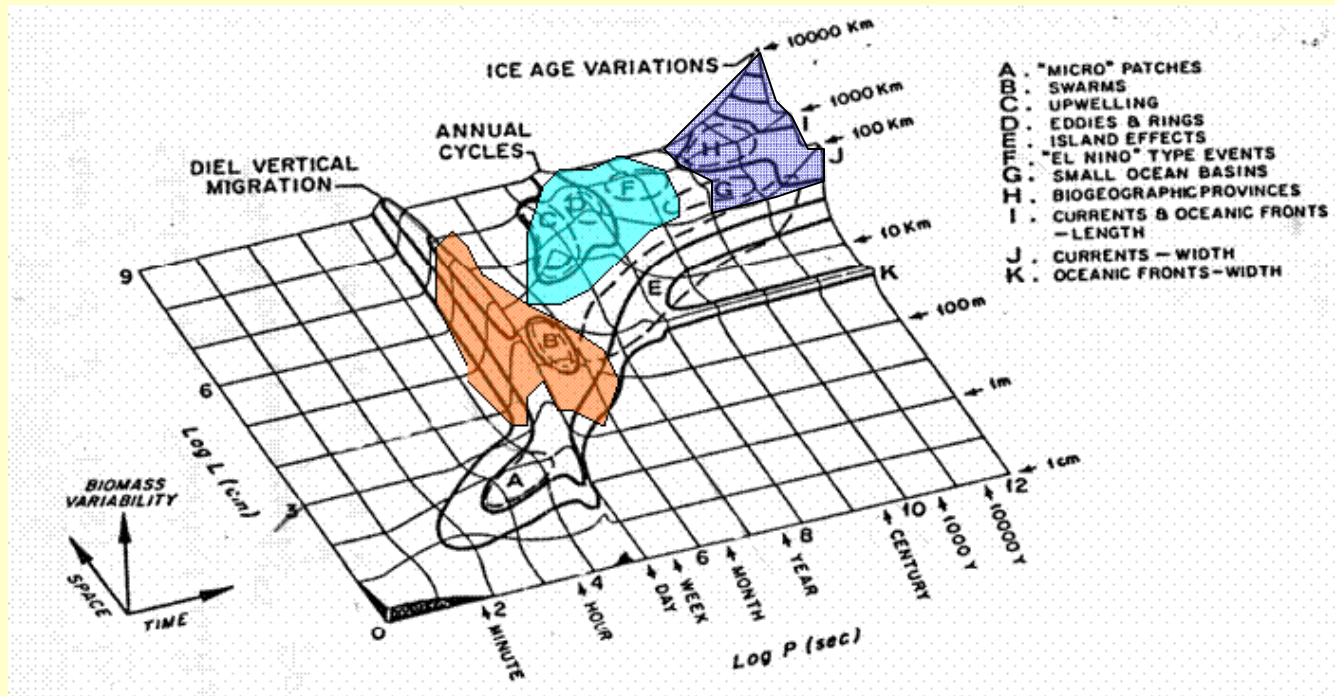


Diagram of plankton abundance variation (Haury et al. 1978)

the orange area shows the scales at which individuals vary
the blue area shows the scales at which populations vary
the purple area shows the scales at which species vary

Spatial Scaling in Seabirds

Scale of Analysis

Macro (1000s km)
(Standing Stocks)

Meso (100s km)
(Community Structure)

Coarse (10s km)
(Abundance)

Process

Ocean
Productivity

Water Mass
Distributions

Prey Availability
and Concentration



Hunt, G.L., Jr., and D.C. Schneider. 1987. Scale dependent processes in the physical and biological environment of seabirds. Pages 7-41 in J.P. Croxall, editor. The feeding ecology of seabirds and their role in marine ecosystems. Cambridge University Press, Cambridge, USA.

Application

➤ Analysis Approach:

- Range: Presence / Absence (All Data)
- Concentrations: Abundance (Present-Only Data)



Range:

Where the species occurs

Diffuse Mgmt: monitoring, gear

Concentrations:

Where the species aggregates

Focused Mgmt: MPAs, closures

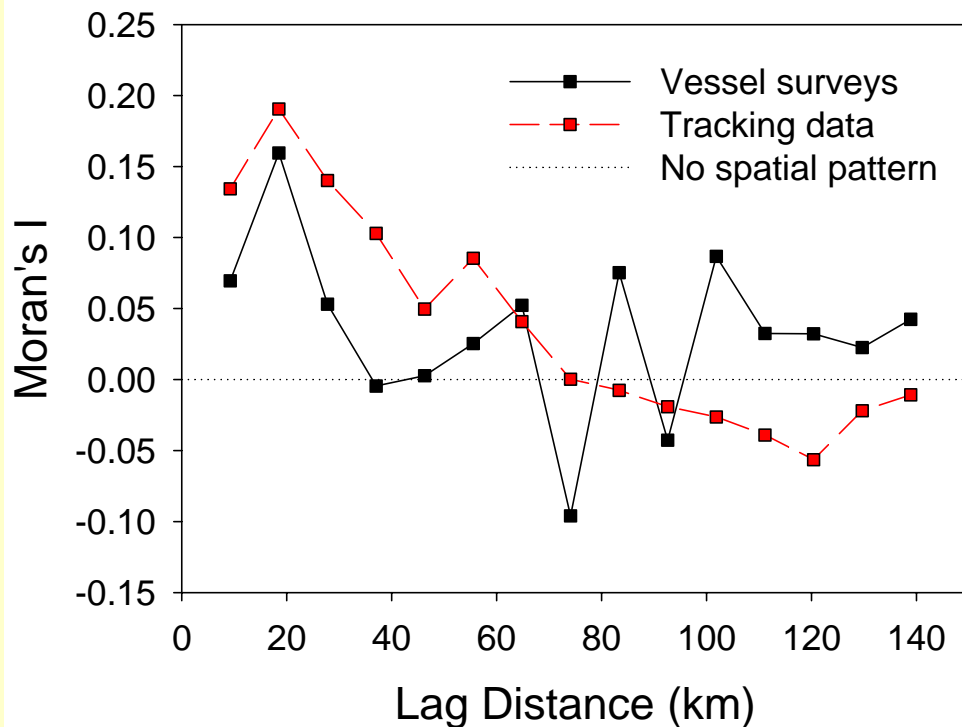
Recommendation - 2

Consider the Spatial Context

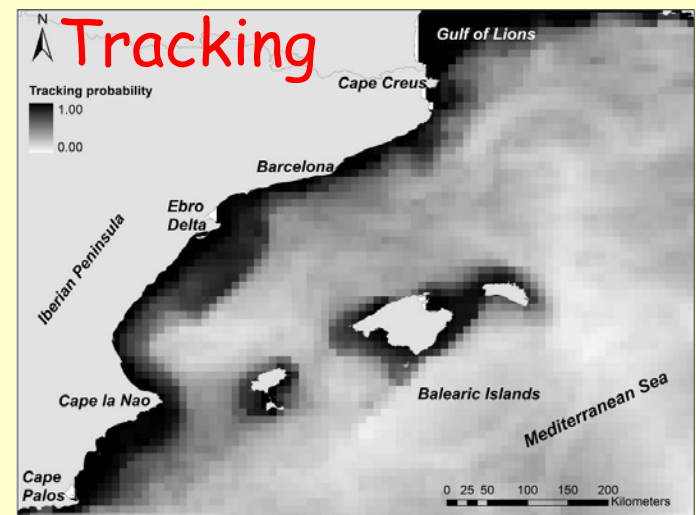
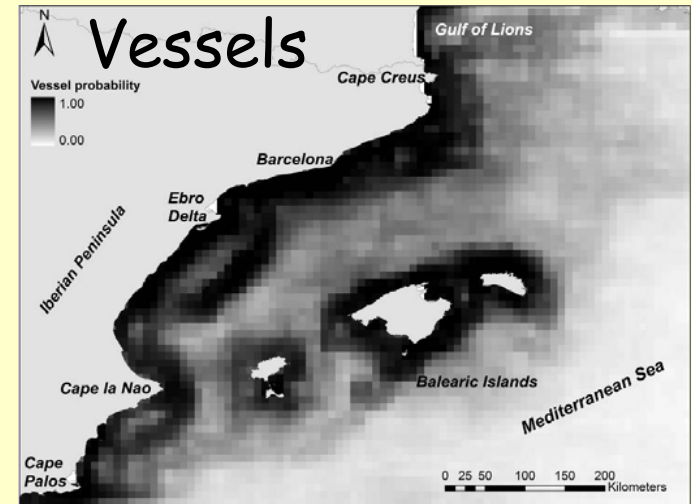


Scales of Aggregation

➤ Individuals vs. Populations

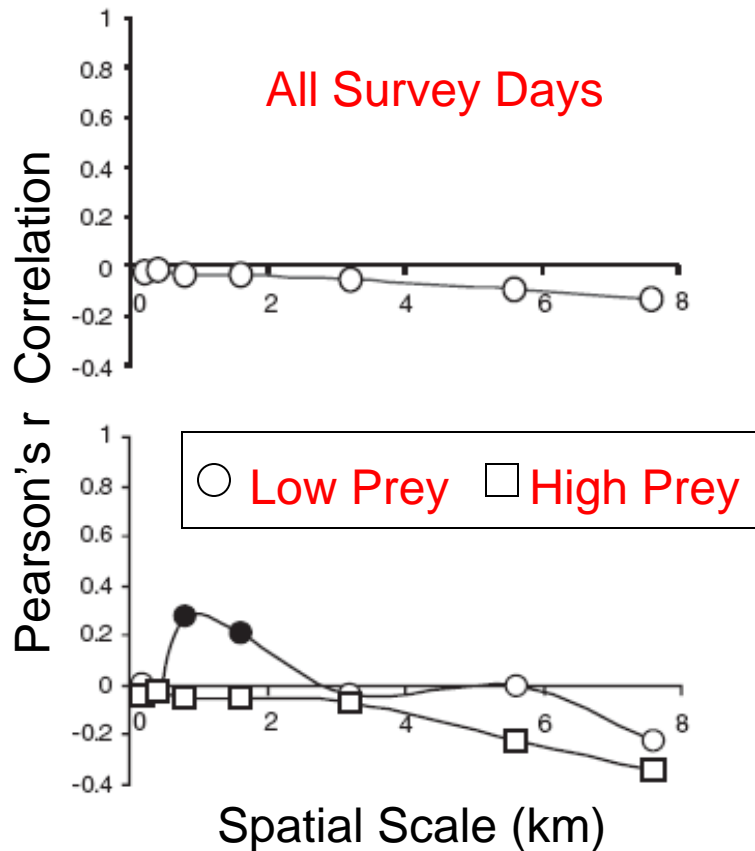


(Louzao, Bécaries, Rodríguez, Hyrenbach, Ruiz, Arcos)

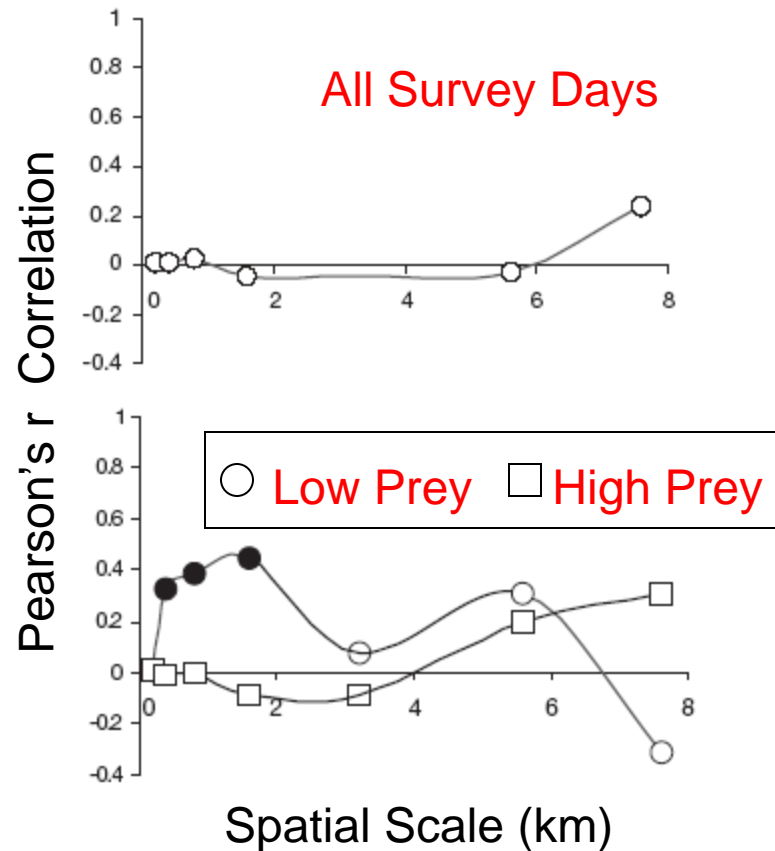


Influence of Prey Resources

Pacific Loon



Rhinoceros Auklet

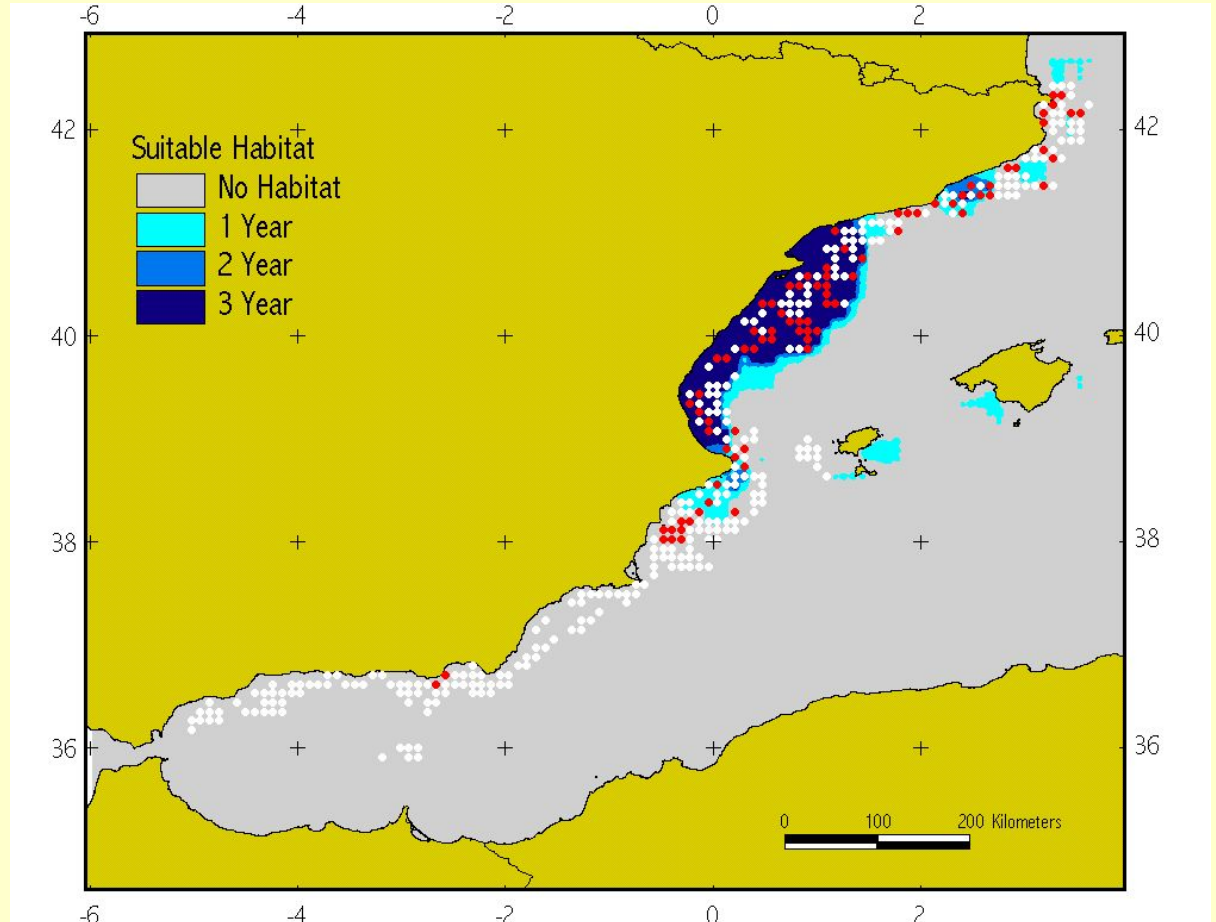


(Vlietstra 2005)

Application



➤ The Balearic Shearwater occurs over shallow and productive shelves (flat, high Chl a)



➤ The spatial extent of this "habitat" varies from year to year and can be defined probabilistically

(Louzao et al. 2006)

Recommendation - 3

Develop Dynamic Measures



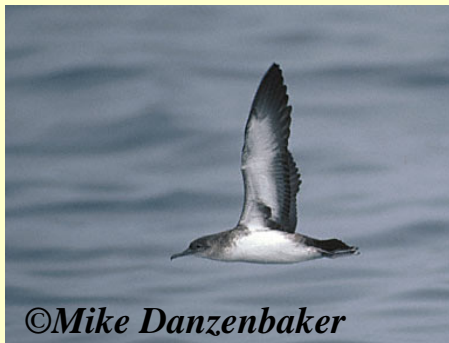
Antecedent Conditions

- Cross- correlations with environmental conditions



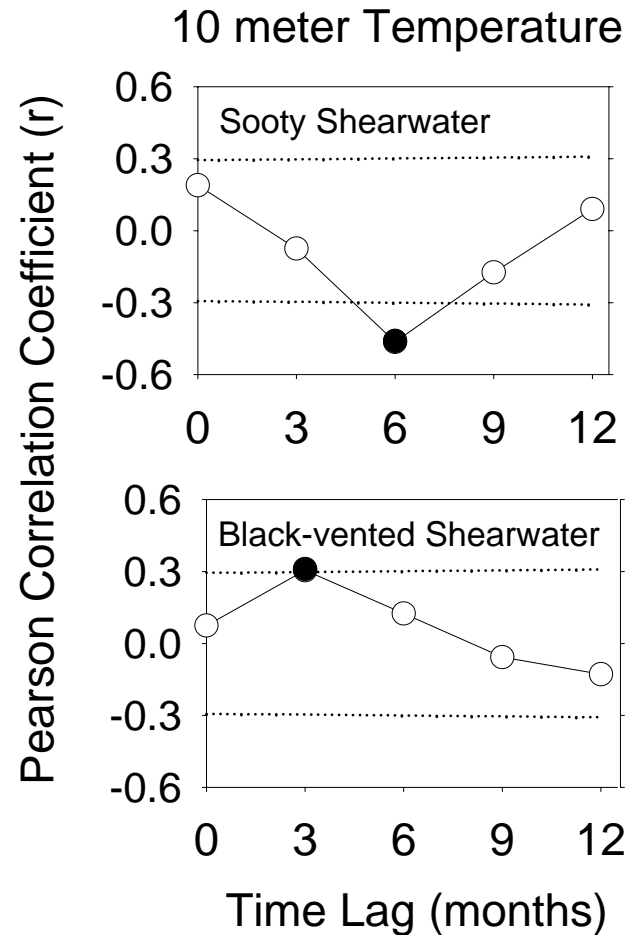
Sooty Shearwater

Avoids
Warming



Black-vented
Shearwater

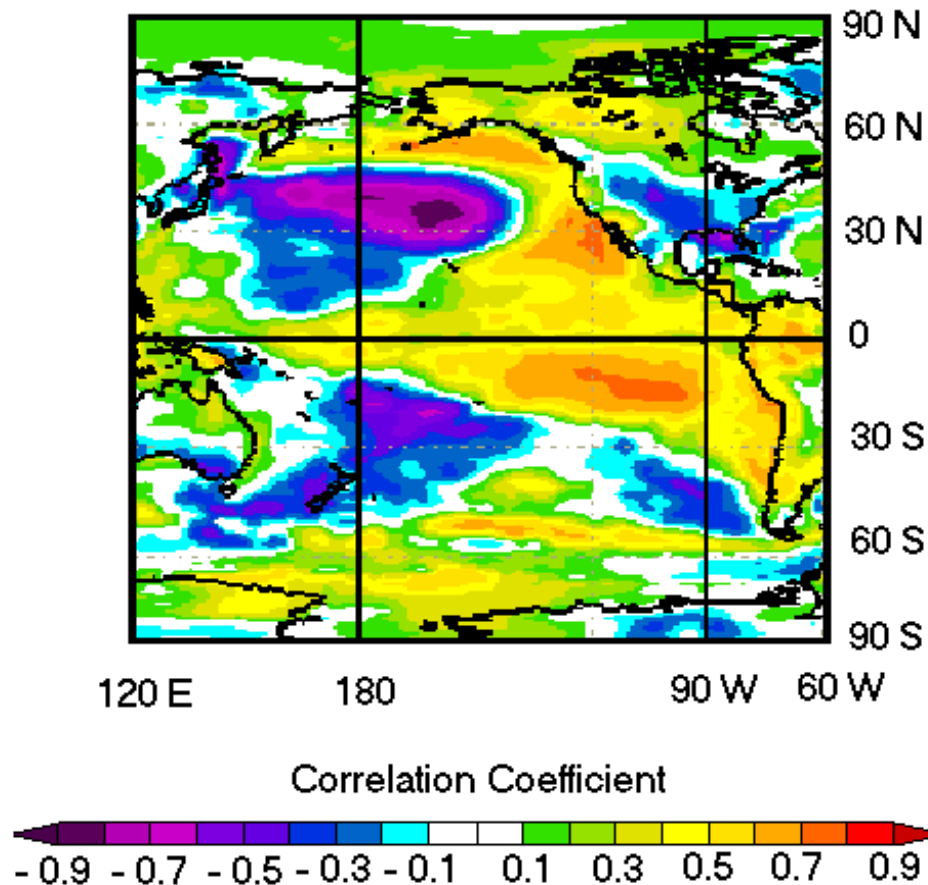
Follows
Warming



(Hyrenbach & Veit, 2003)

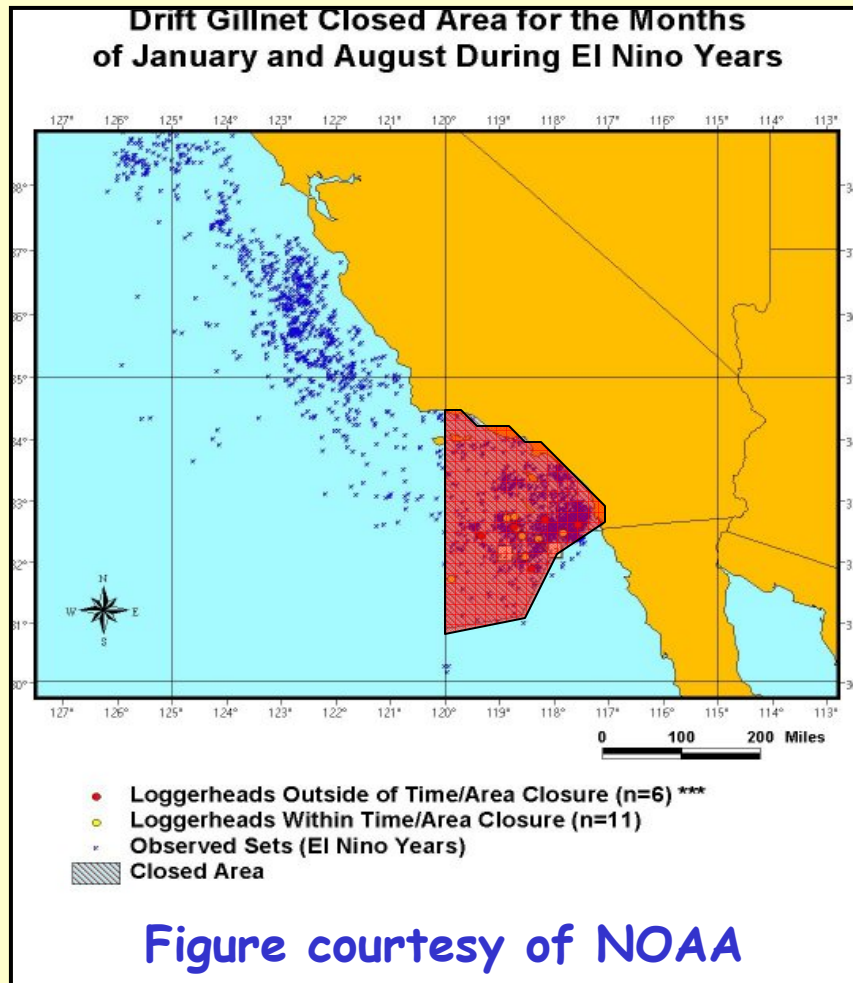
Remote Forcing

Surface Temperature / PDO Correlation
(January 1958 - December 1999)



Application

Drift gillnet closures off southern California during El Niño to mitigate loggerhead turtle gillnet bycatch

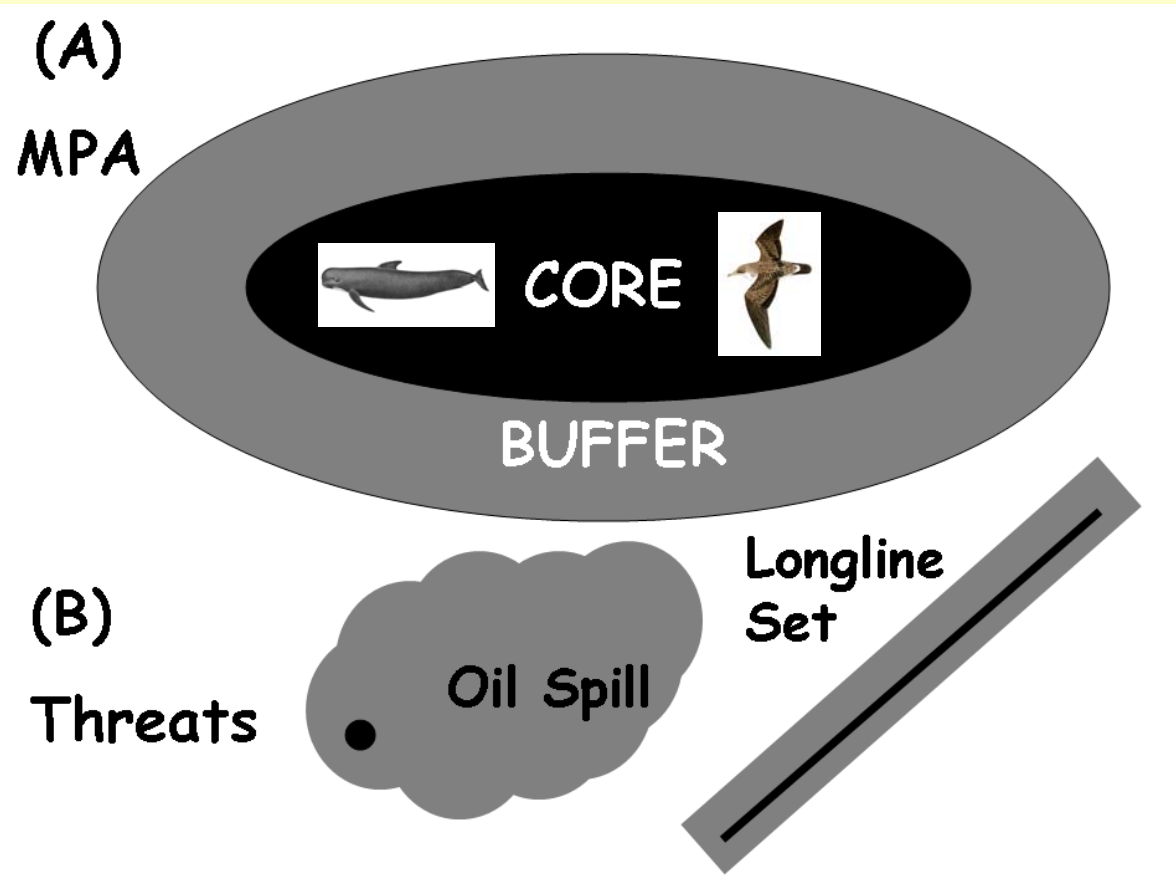


Conclusions

- In principle, MPAs could be designed to protect “predictable” predator concentrations
- Large MPAs May Not Suffice
- Effective MPAs Require Careful Design and a Broader Scale-Explicit Management Scheme:
 - Address a Hierarchy of Scales
 - Consider the Spatial Context
 - Develop Dynamic Metrics



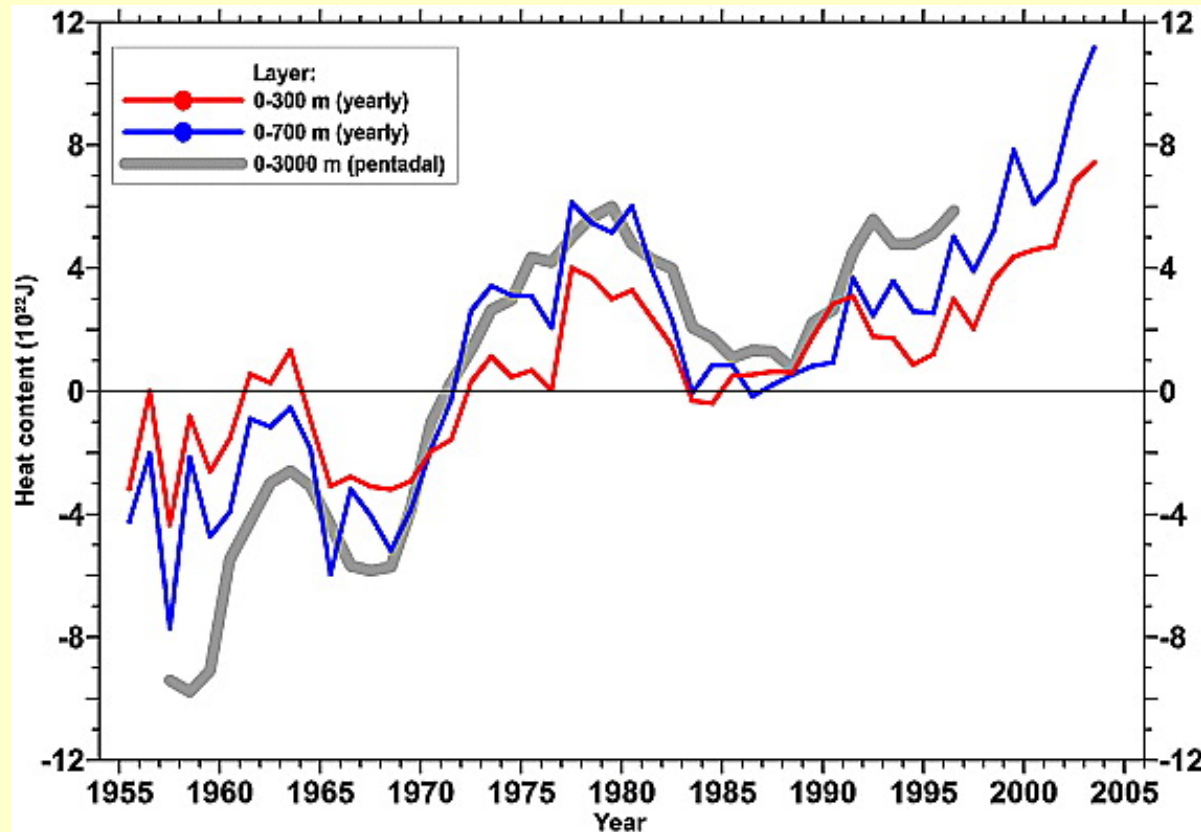
Challenges: Accommodate Threats



Conceptual diagram of a core- buffer MPA (A)
and the "footprint" of different threats (B)

(Hyrenbach 2008)

Challenges: Accommodate Climate



Yearly ocean heat content for the **0-300 m** and **0-700 m** layers and 5-year composites (from 1955-59 to 1994-98) of ocean heat content for the **0-3000 m** layer

(Levitus et al. 2000, 2005)



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Acknowledgements



The First International Conference
on Marine Mammal Protected Areas

