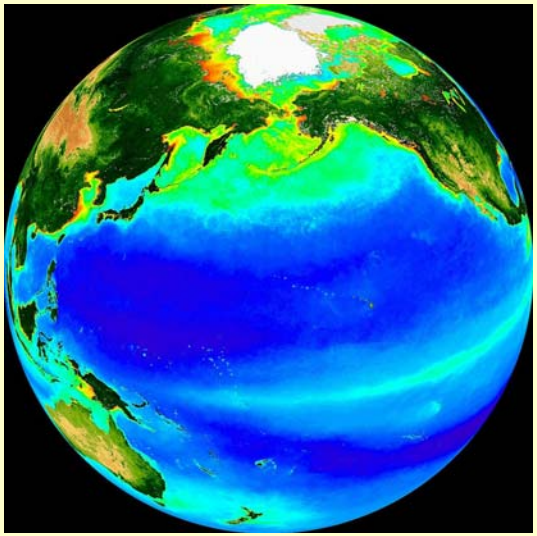
Workshop 2: Criteria for Marine Mammal Critical Habitat to make MPA Networks more Effective

MPA designs:
large dynamic features and oceanic species

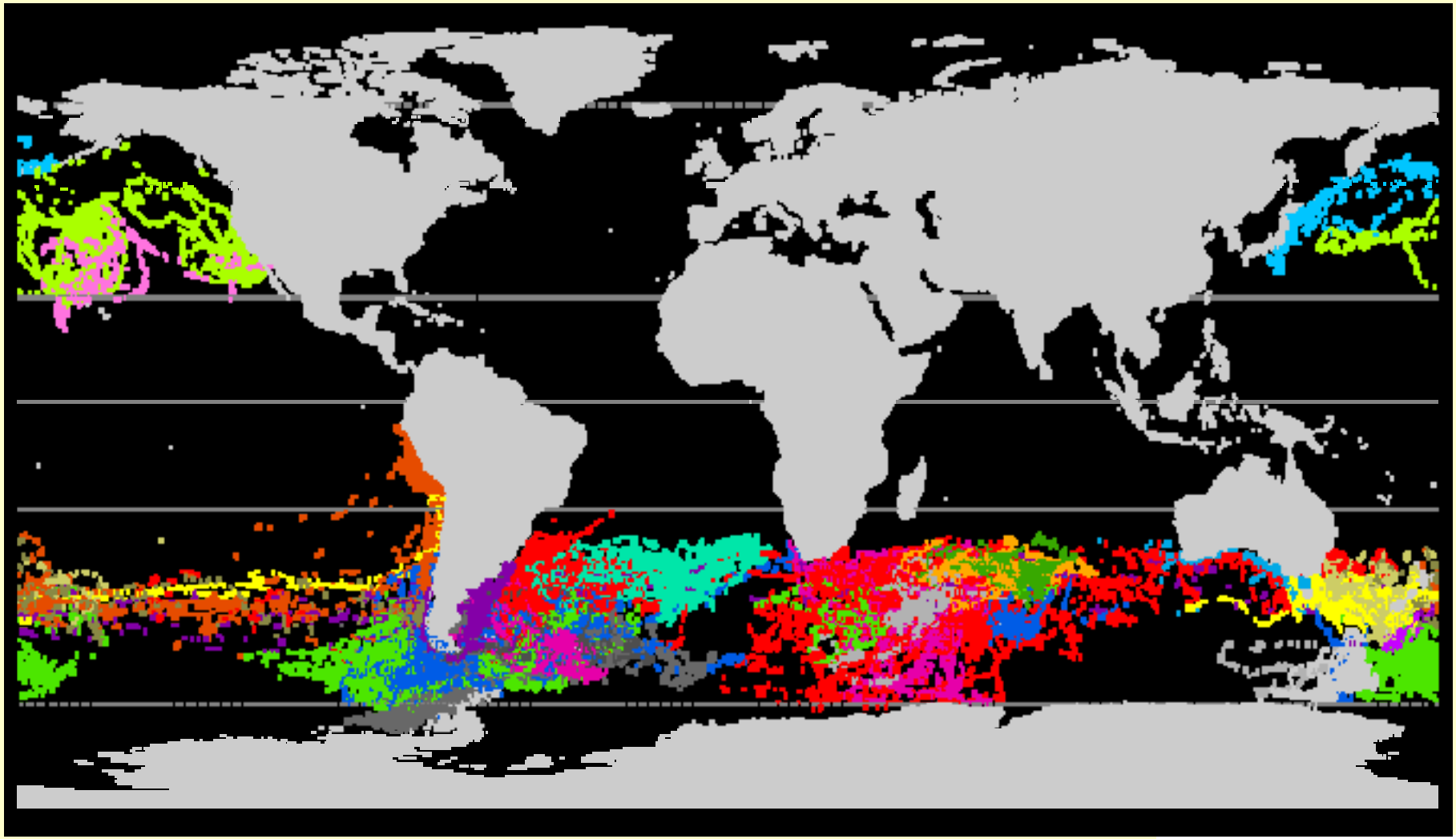


David Hyrenbach
khyrenba@duke.edu

Outline

- Importance of protecting the open ocean
- Importance of considering dynamic features
- Considerations of seasonal / temporal MPAs
- Challenges
- What can we learn from other taxa?

Pelagic Conservation – One Ocean



Procellariiformes Tracking Database

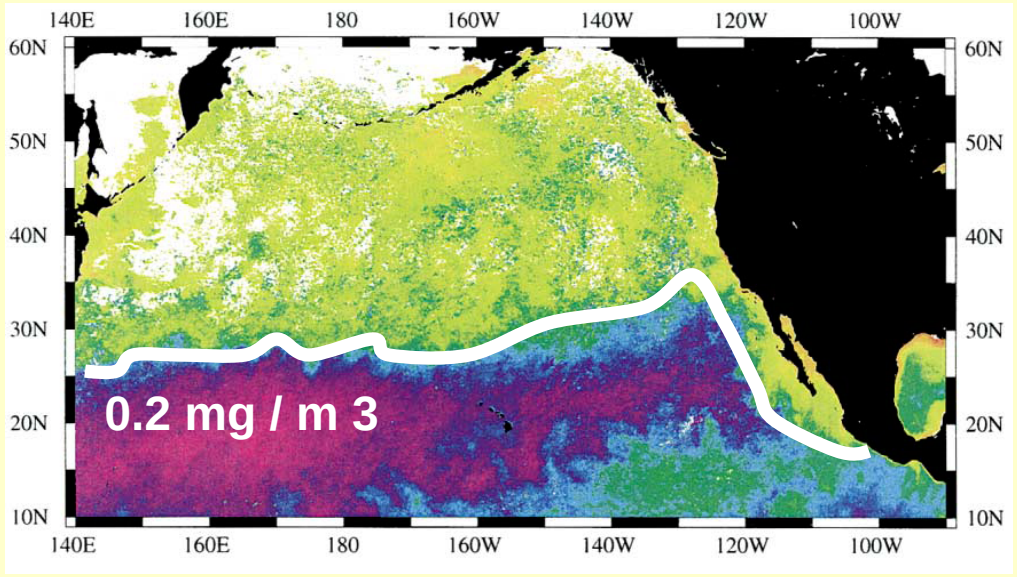
21 species & 30 researchers

BirdLife INTERNATIONAL

Dynamic Hotspots

Loggerhead turtles migrate across Pacific along dynamic front

Fisheries target albacore tuna along the same feature



(Polovina et al. 2001)

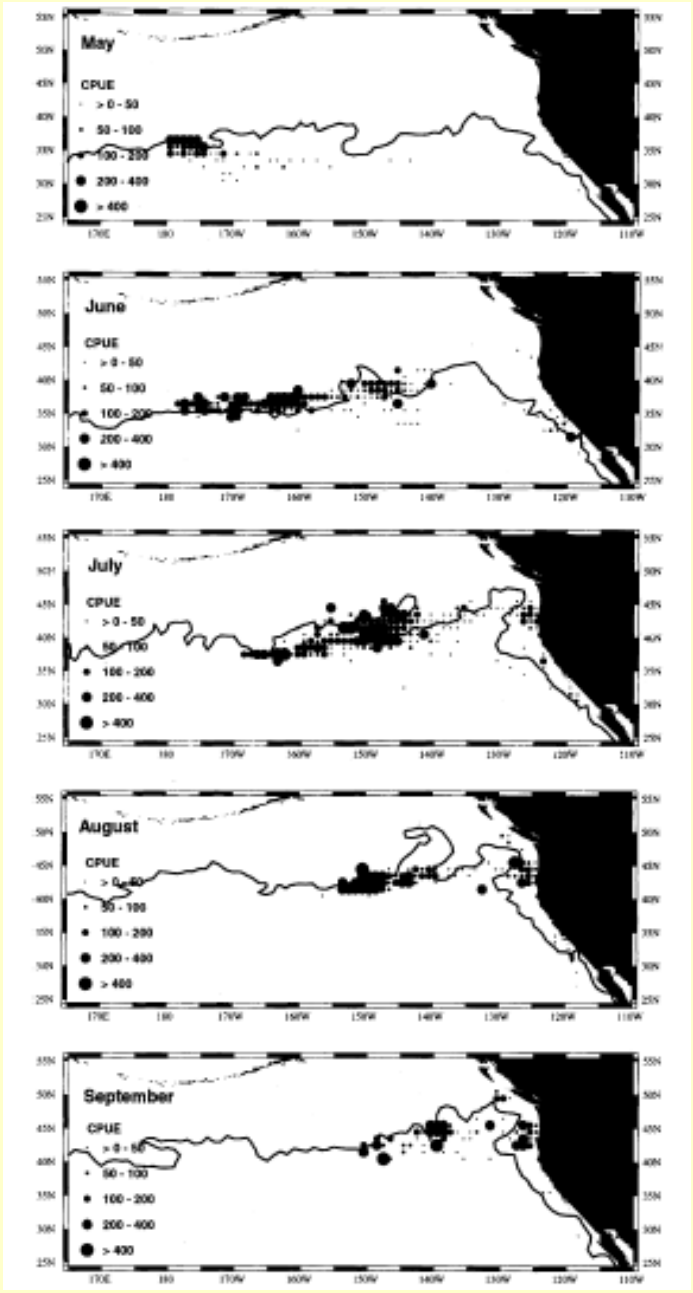



Photo: Nevins

Case Study I: Upwelling Plume

- Spring cruises

(late Feb – early May)

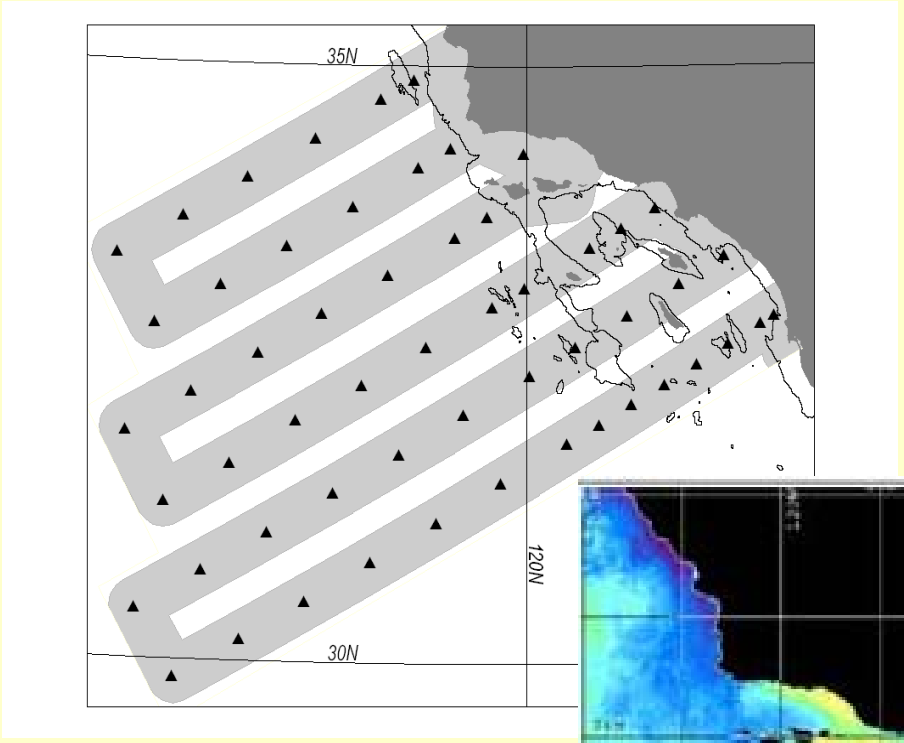
- 17 years (87 – 04)

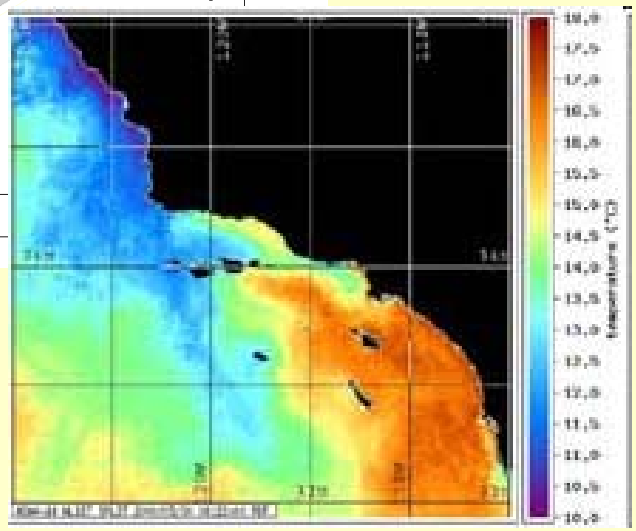
(no data for 1999)

- 1600 km / cruise

- 66 CTD stations

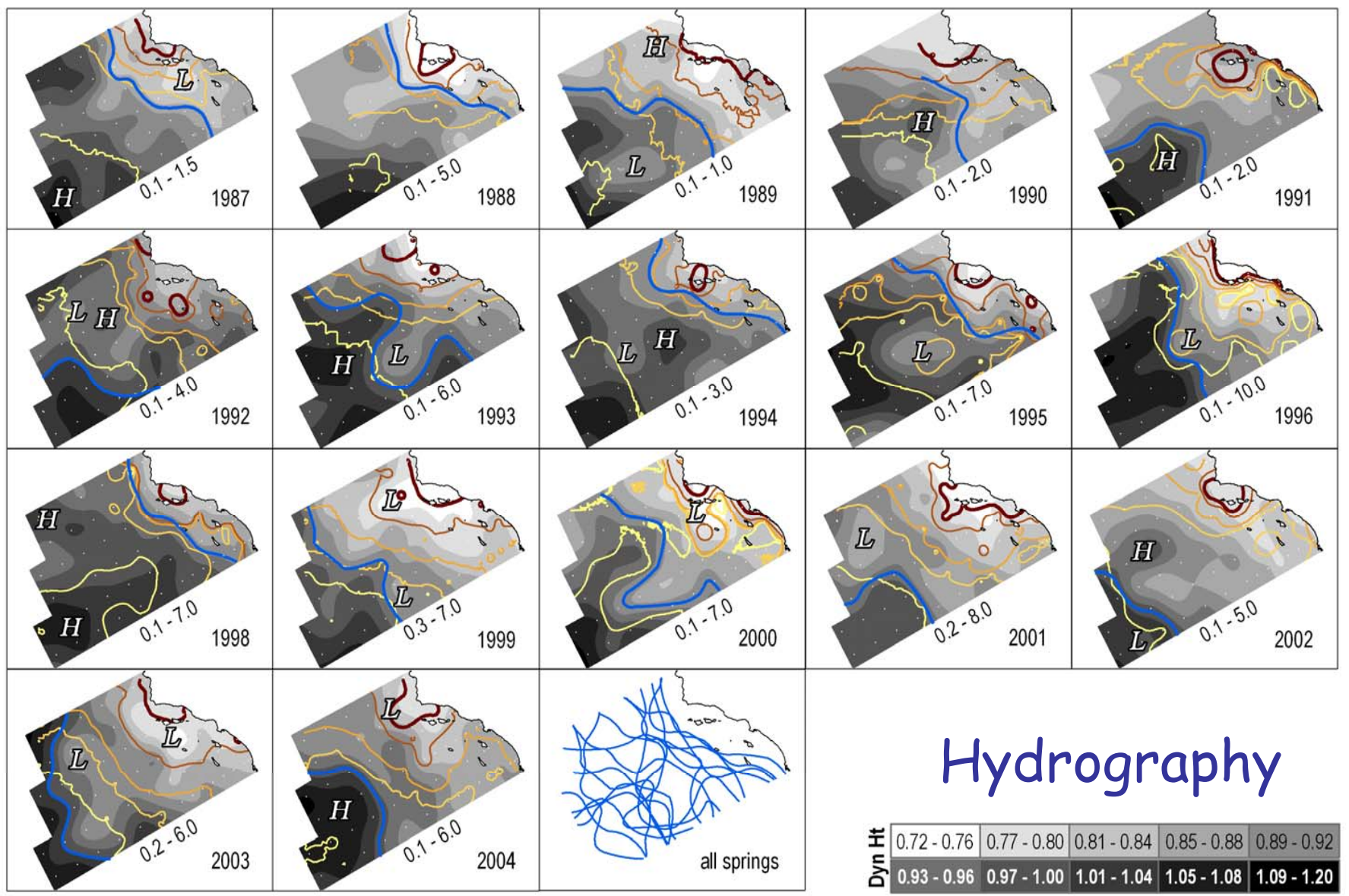
(Chl a, nutrients)





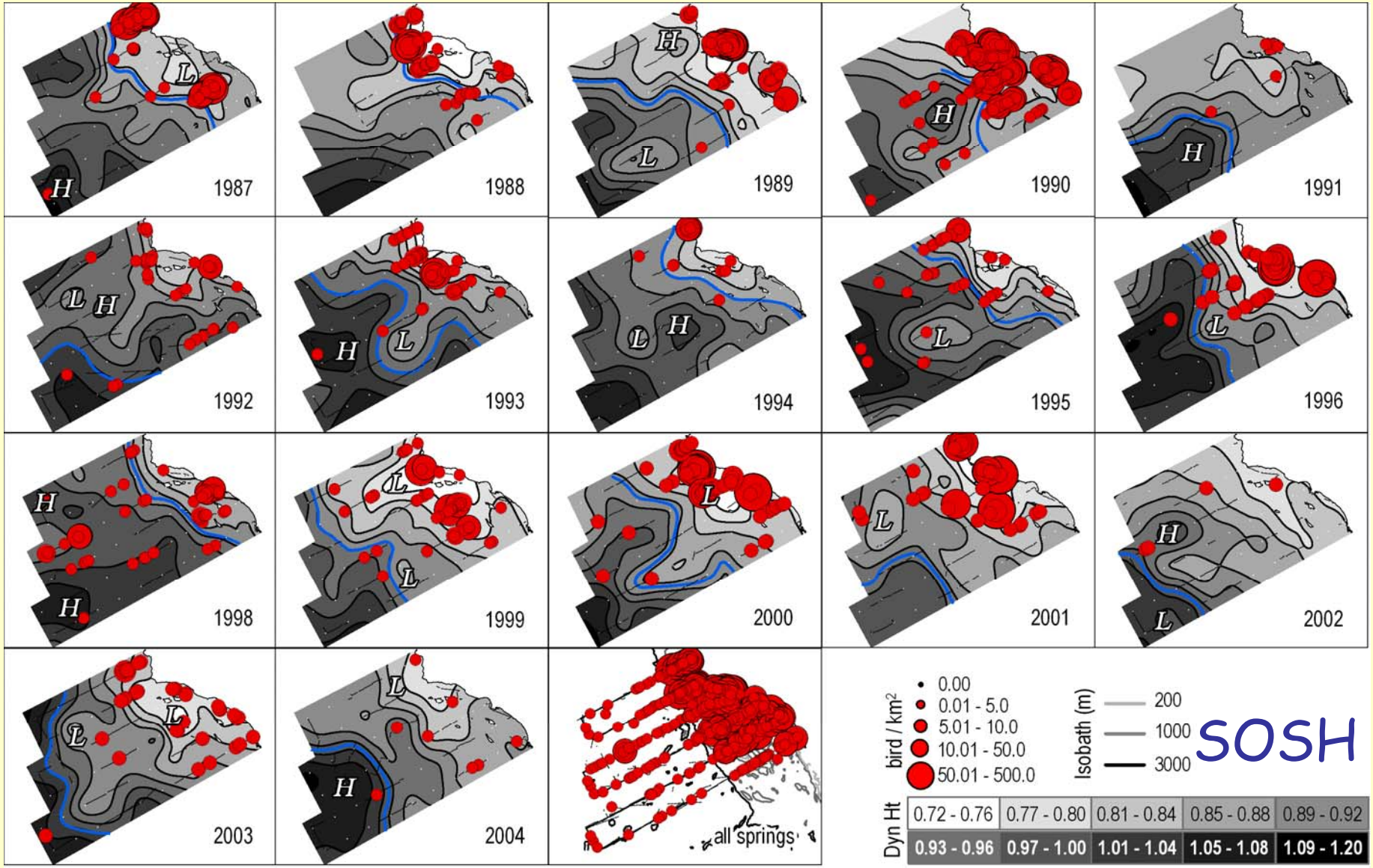
(Yen et al., 2006)

A Complex and Dynamic Seascape



(Yen et al., 2006)

Sooty Shearwater Distribution



(Yen et al., 2006)

Results – Presence / Absence

- Logistic Regression: Encounter Probability

Shearwater

Upwelling Plumes

Far - California Current
Far – high SSH areas

In - low SSH regions
In - "green" water
In - nutrient-rich water

Variable	Result	Interpretation
CC jet	+	Farther
Dyn ht	-	Lower
Dyn ht CI	+	
Chl a	+	Greener
NO_3	+	Higher
L eddy	+	
H eddy	+	Farther

(Yen et al., 2006)

Results – Density (when present)

- Ordered Logistic Regression: Aggregation

Shearwater

Upwelling Fronts

In - nutrient-rich water
In - low SSH waters
In – high SSH gradients

Variable	Result	Interpretation
CC jet	+	
Dyn ht	-	Lower
Dyn ht CI	+	Steep
Chl a	+	
NO_3	+	Higher
L eddy	+	
H eddy	+	

(Yen et al., 2006)


Photo: Webb

Case Study II: Seasonal Migration

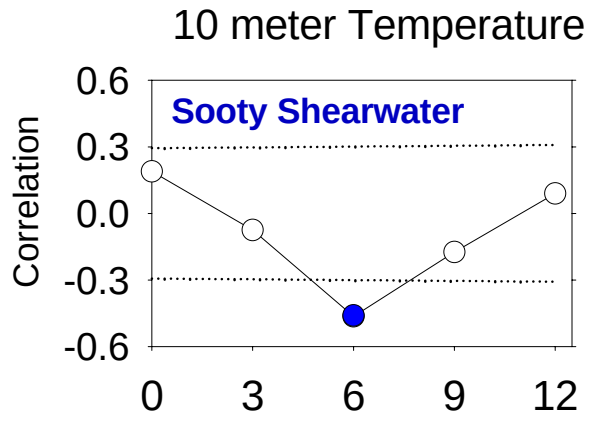
- Cross- correlations with environmental conditions

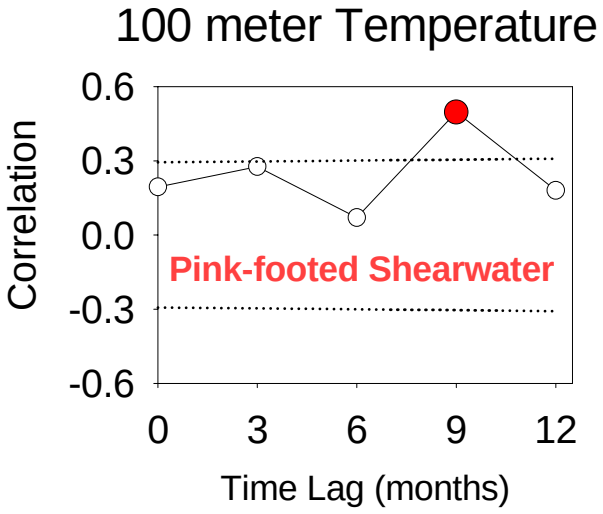
Sooty Shearwater

Avoids Warming

Pink-footed Shearwater

Follows Warming





(Hyrenbach & Veit, 2003)

Movement Corridors

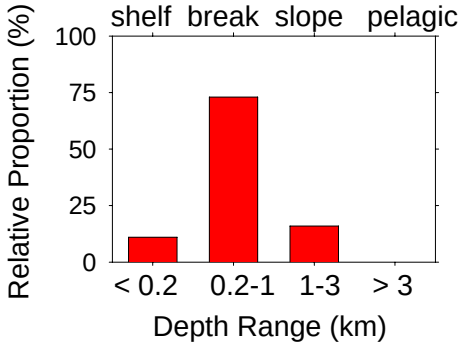
- Pink-footed Shearwaters more frequent on shelf-break, during oceanic season
  - MMS dataset (1975 - 1997)
  - Step-wise logistic regression

Parameter	p-value	Effect
BATH_pelagic	< 0.001	-
BATH_slope	< 0.001	-
BATH_shelf-break	0.031	+
SEASON_CC	< 0.001	-
SEASON_UP	< 0.001	-
EFFORT	< 0.001	+

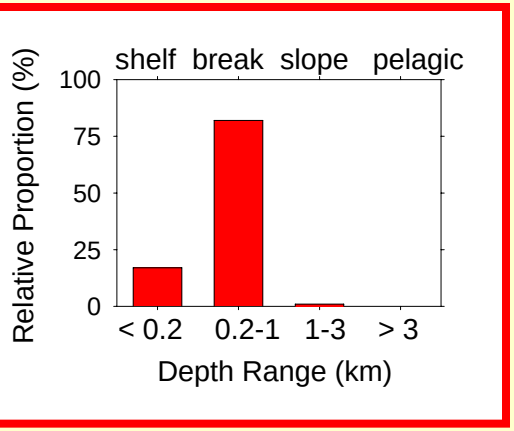
(Freeman & Hyrenbach)

Movement Corridors

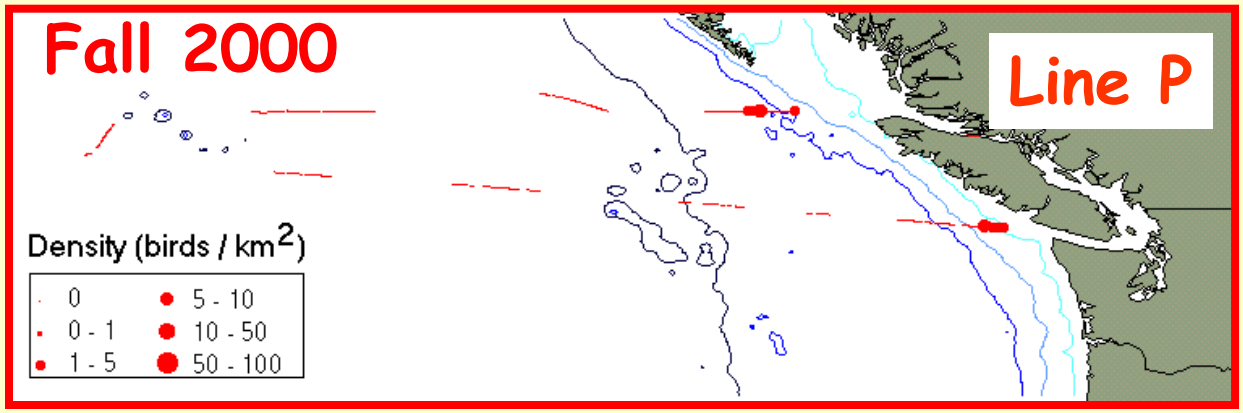
- Shearwater distribution in different regions

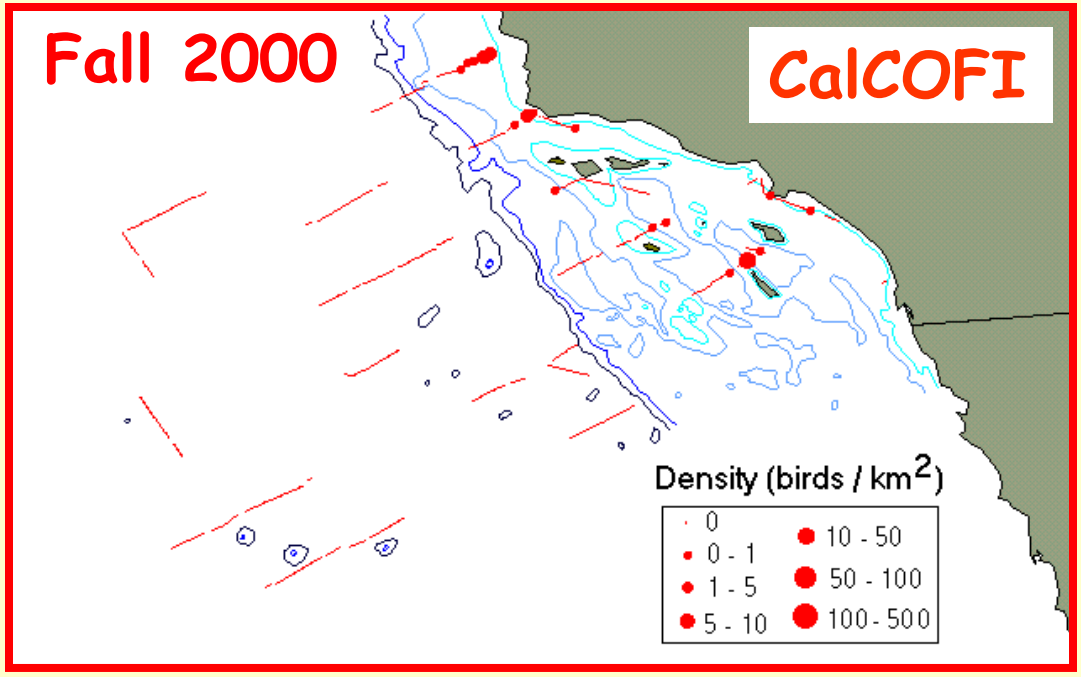


(p < 0.001)



(p < 0.001)





Case Study III - Balearic Shearwater

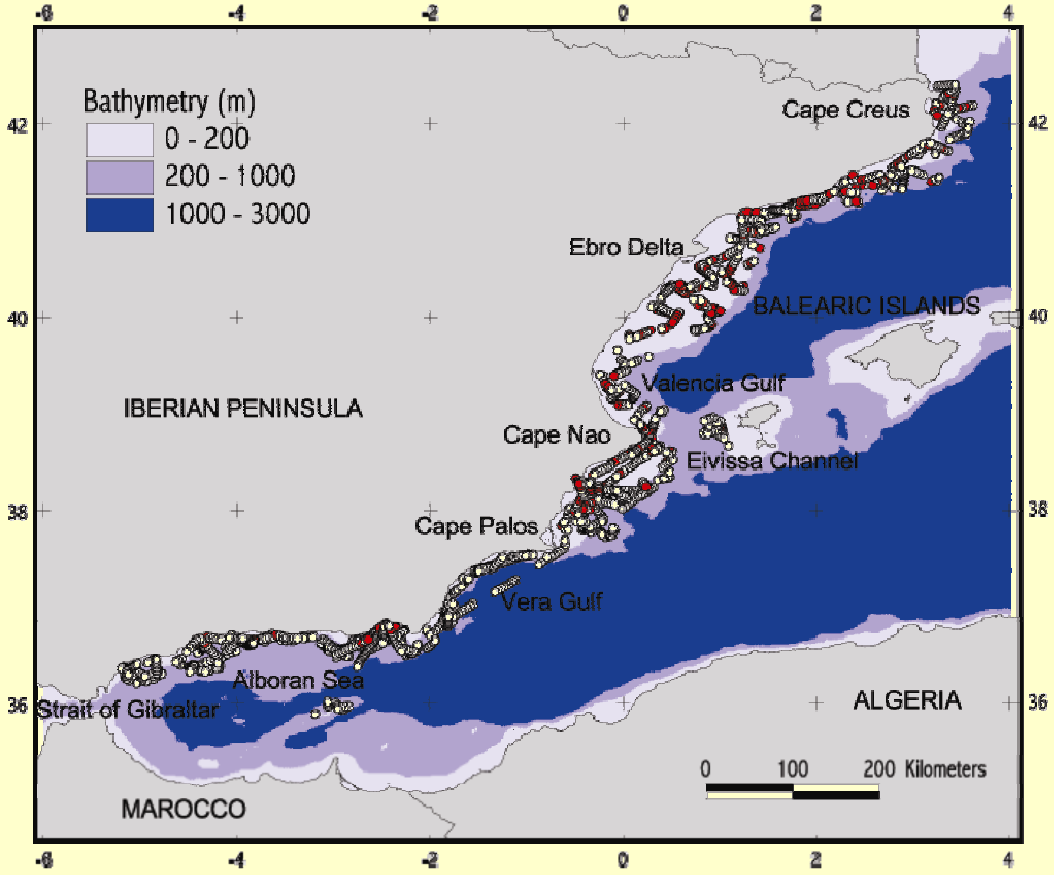
- Approach:
  - Range (Pres / Abs)
  - Concentration (> 0)
- Eight variables

Distance to Shore
Distance to Colony
Median Depth
Depth Gradient

Median Chl a
Chl a Gradient

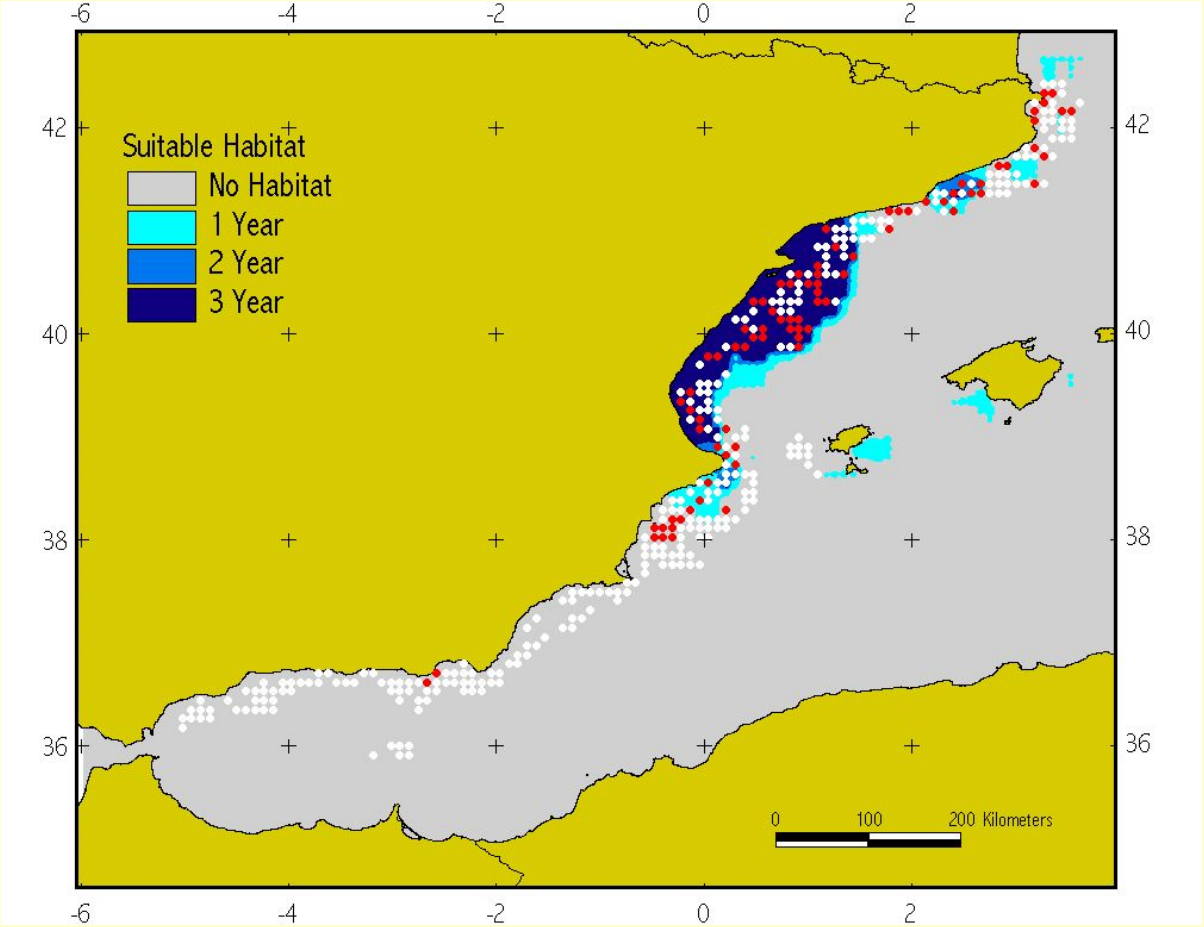
Median SST
SST Gradient

(Louzao et al., 2006)



- MEDITS (99, 00, 02) (May - June)
- 567 grid cells (9 x 9 km)
- 657 birds, 140 presences (24.7 %)

Results: Shearwater Presence / Absence

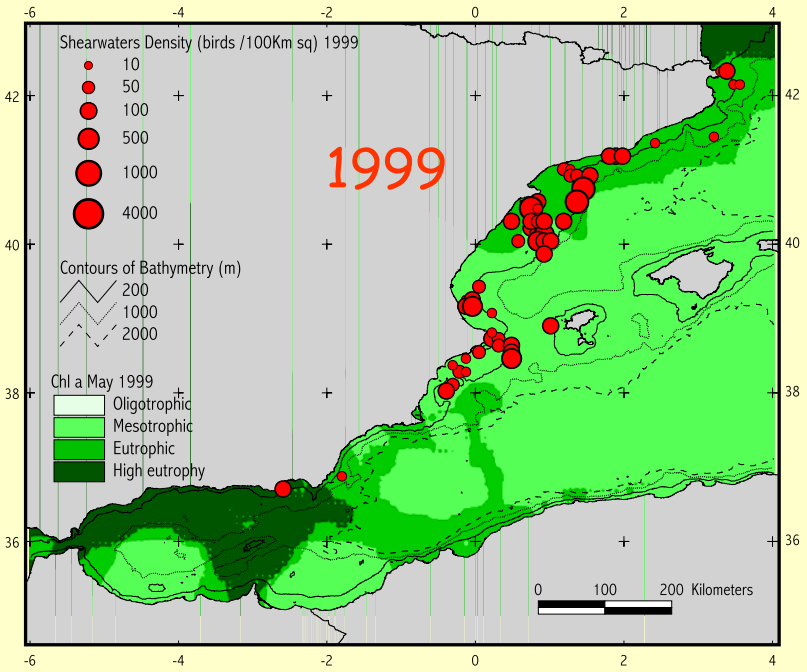


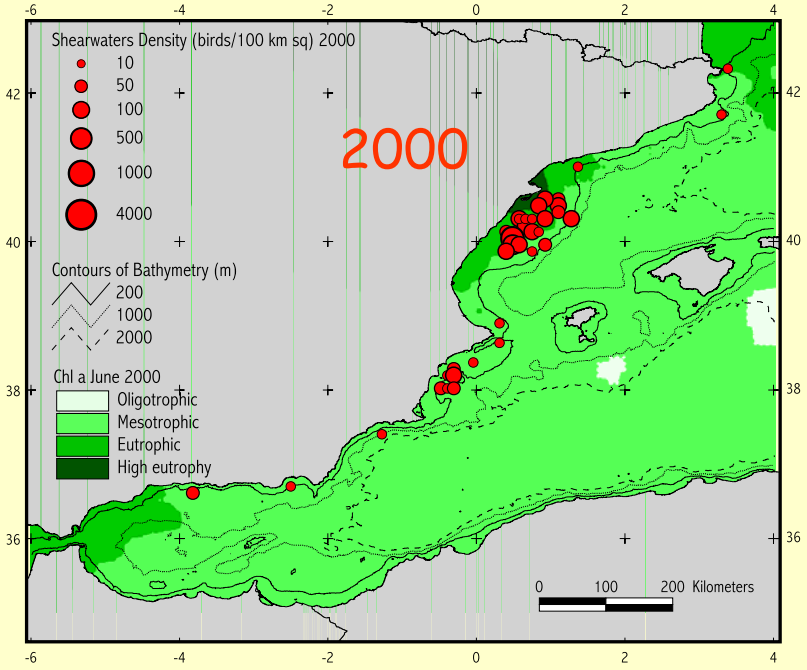
- The Balearic Shearwater occurs over shallow and productive shelves (flat, high Chl a)

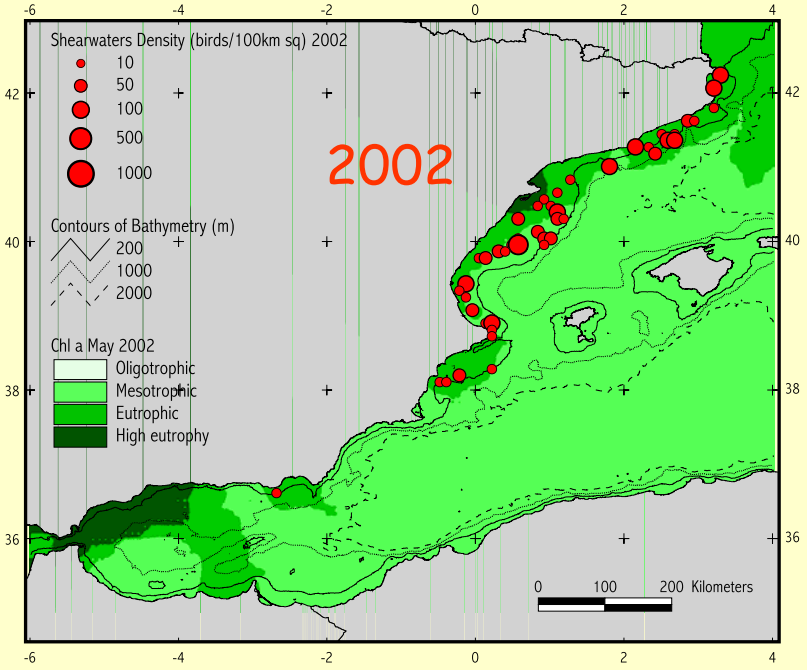
(Louzao et al., 2006)

Results: Shearwater Concentrations

- Density: up to 500 birds/km^2
- Higher densities in areas of strong Chl-a gradients
- More numerous in 1999







Challenges

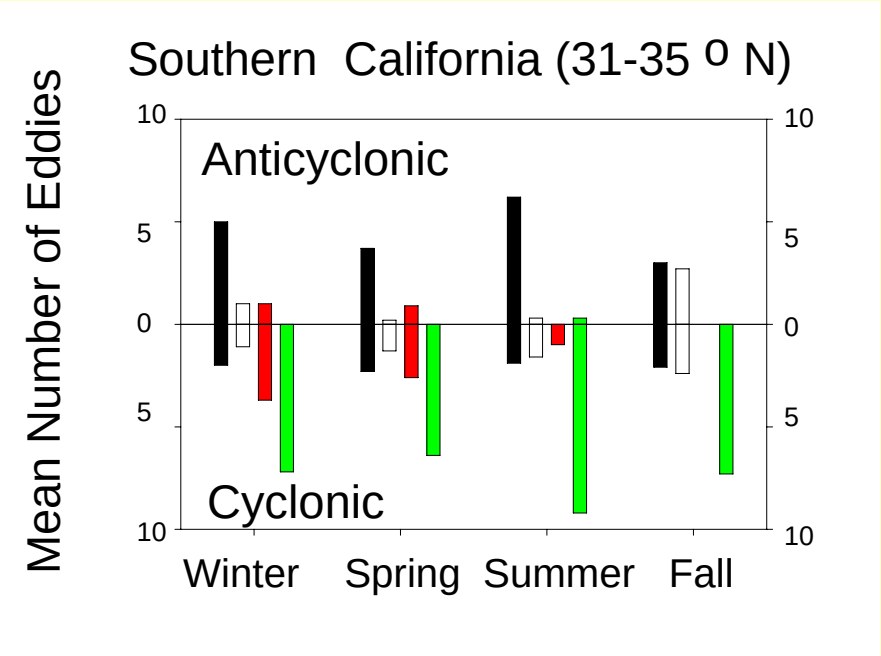
Conceptual

- MPAs better suited for taxa which concentrate in large densities – *Need to deal with "corridors"*
- For HMS, range area will exceed sanctuary extent – *Need to link MPAs with regional monitoring / mgmt.*

Methodological

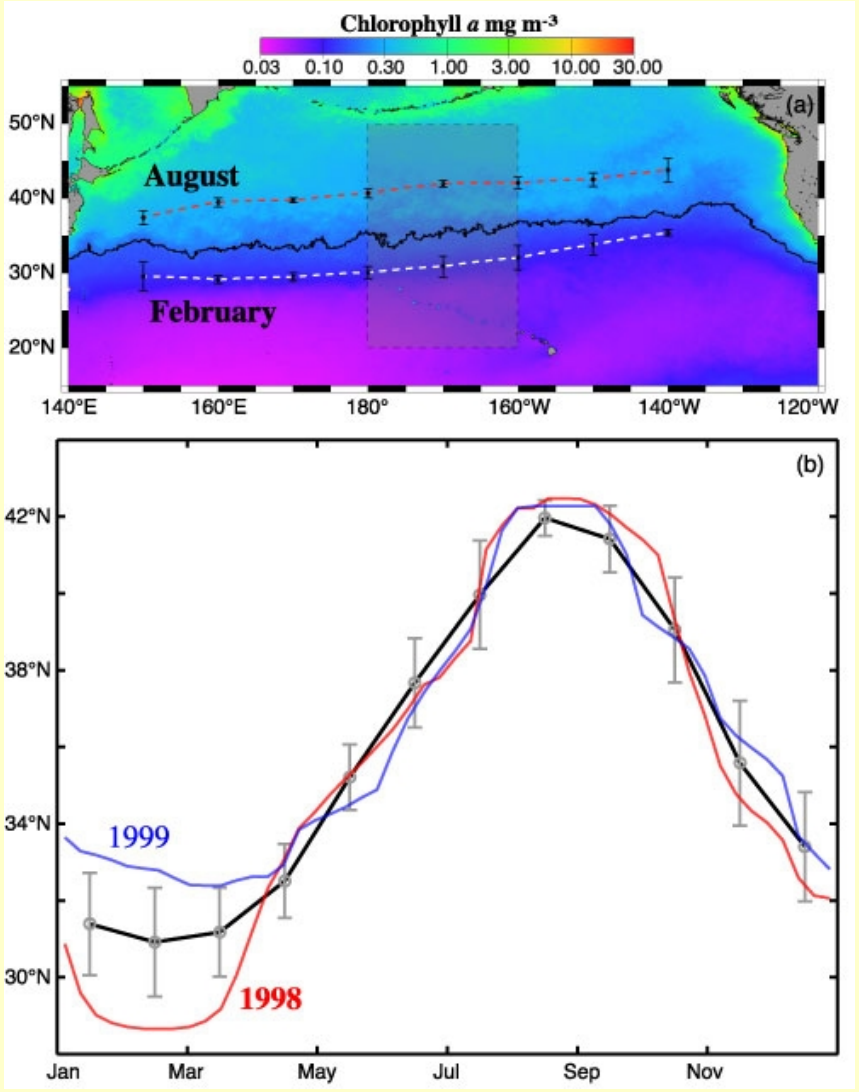
- Accommodate Dynamic Features: Need to characterize the dynamics / predictability of habitat features
- Accommodate Dynamic Distributions: Mobile predators shift distributions across seasons, years, decades…

Dynamic Hotspots



10-year incidence of eddies
(All Seasons, 1949 - 65)

(Owen, 1980)



(Bograd et al., 2001)

PEW INSTITUTE FOR OCEAN SCIENCE

Acknowledgements

The First International Conference on Marine Mammal Protected Areas