



Deep-water groundfishes of Cordell Bank: the establishment of a baseline monitoring program

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School of Yellowtail Rockfish

- **Groundfish** species, particularly **rockfishes**, are a dominant feature across the continental shelf of the west coast of the US



- For over a century, groundfishes have been an important commercial and recreational fishery along the west coast





Commercial Longline



Commercial bottom trawl



Recreational Catch

... population declines over recent years have lead to coast-wide closures of the fishery, and the designation of several offshore conservation areas

Rockfish (*Sebastes*)

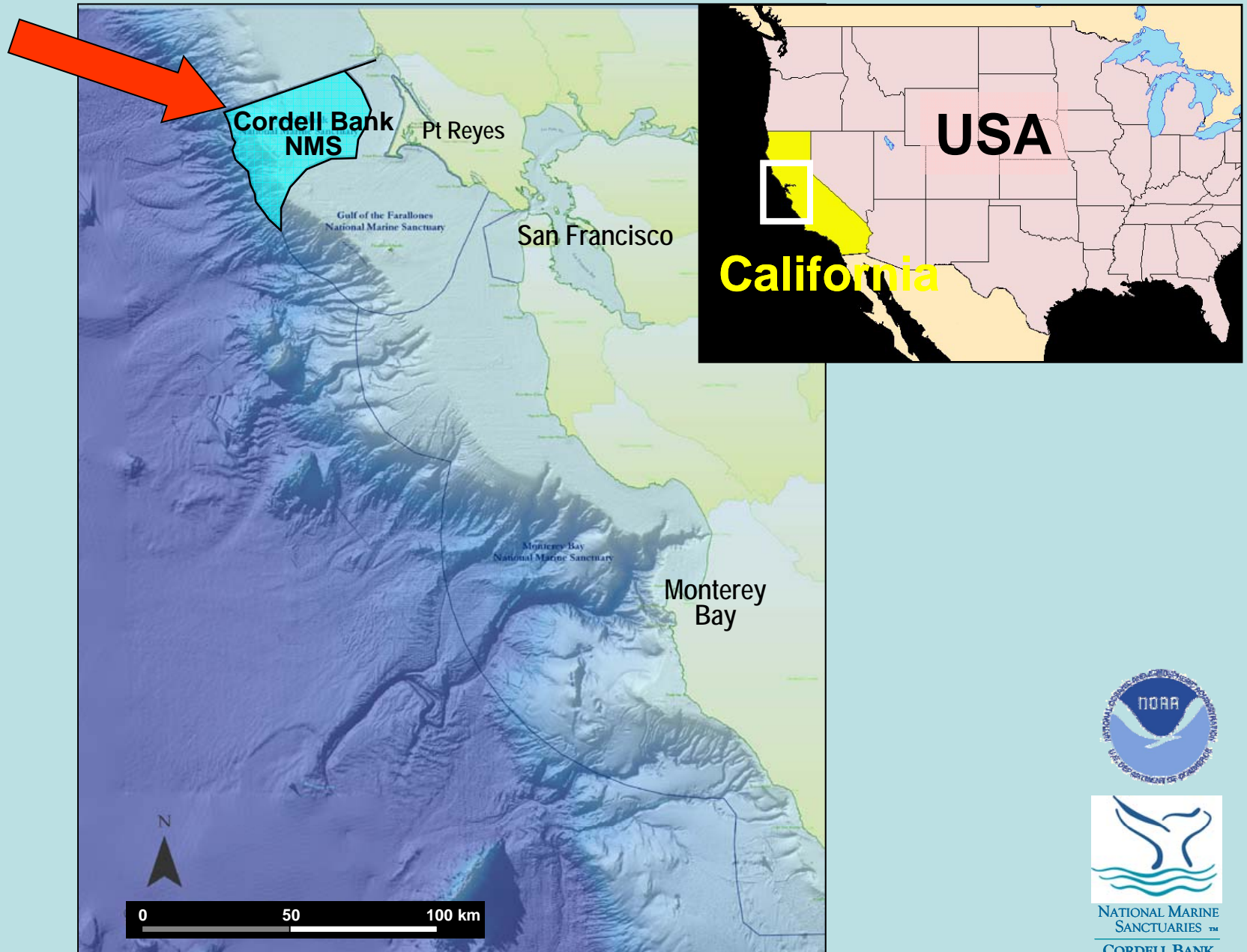
- Very speciose (102 species)
- Slow growing
- Long lived (50-140 yr lifespan)
- Low fecundity (internal fertilization)
- Episodic recruitment
- Broad depth ranges (0 - >400 m)
...scuba surveys unfeasible

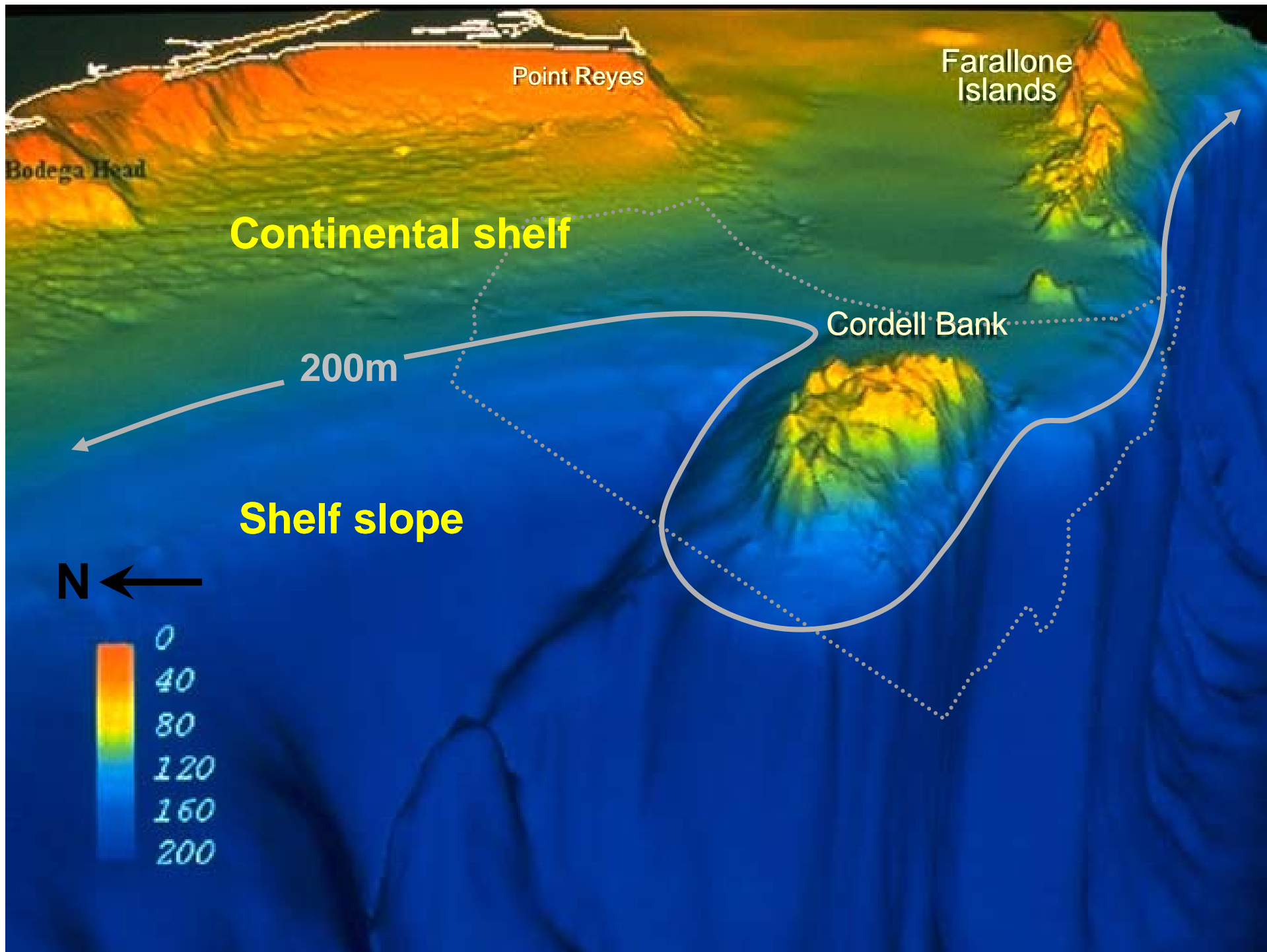
But ... Rockfish species exhibit strong affiliations with benthic habitats...**so potentially good candidates for area-based management approaches**

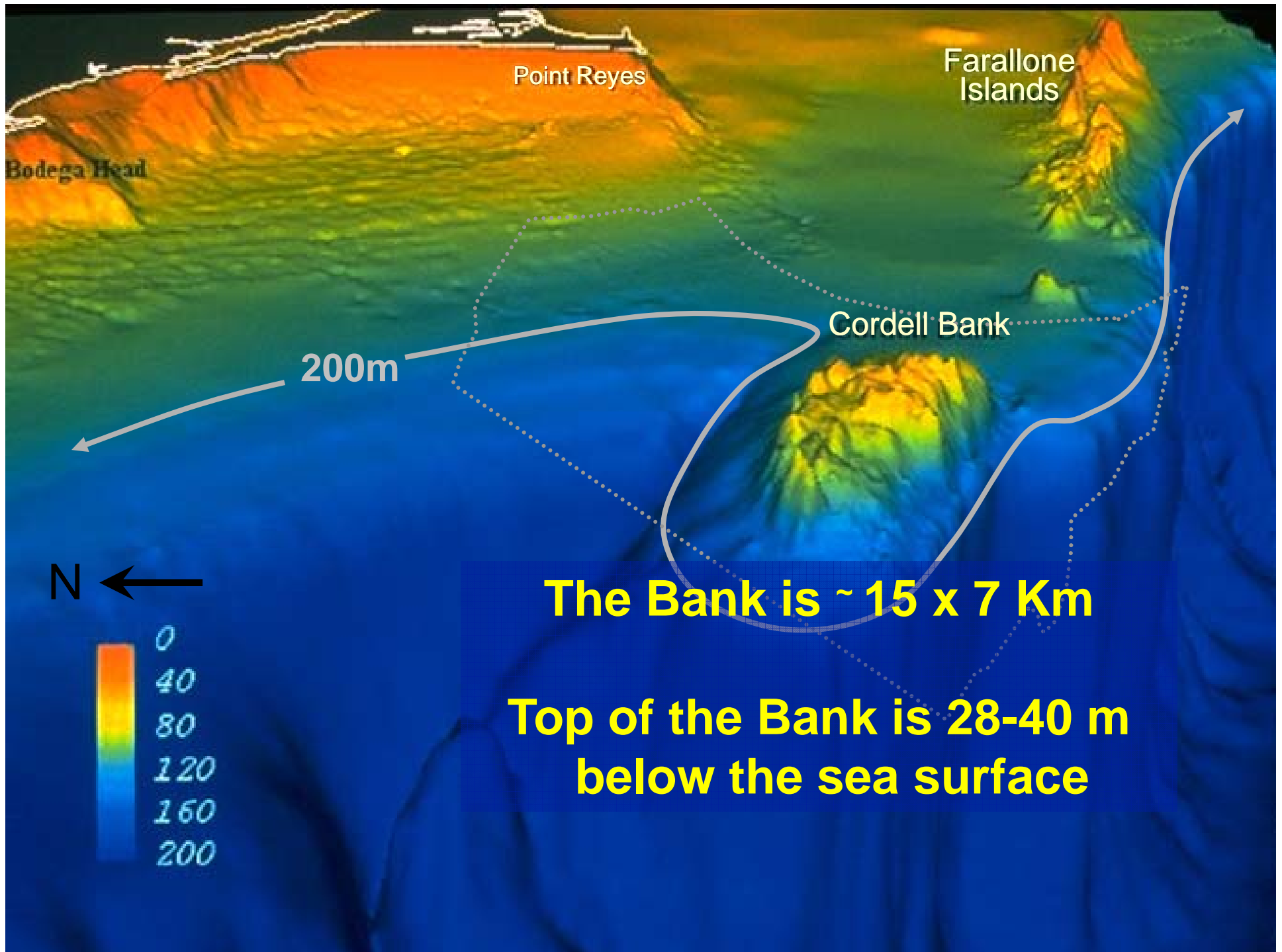


Yelloweye Rockfish
Sebastes ruberrimus

Central California

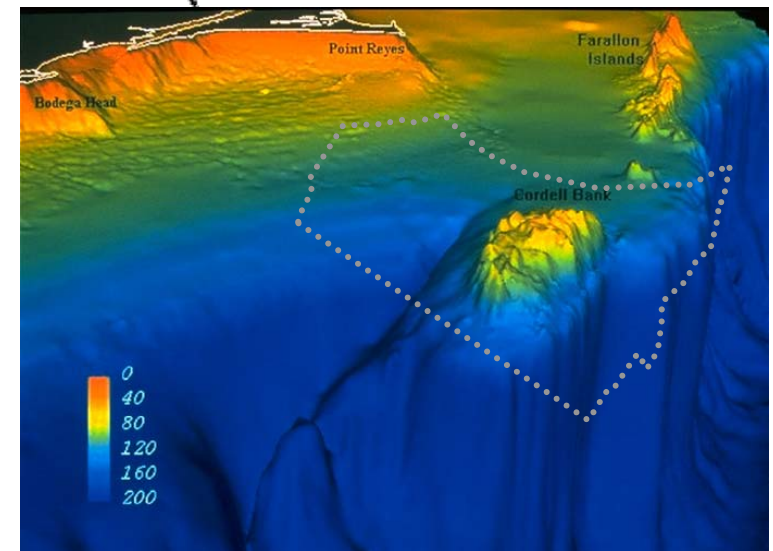
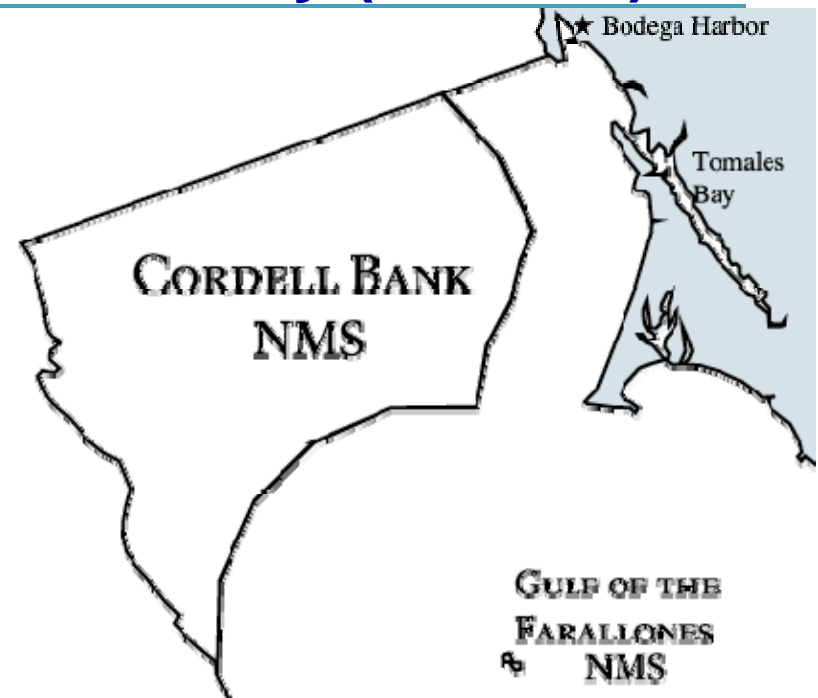






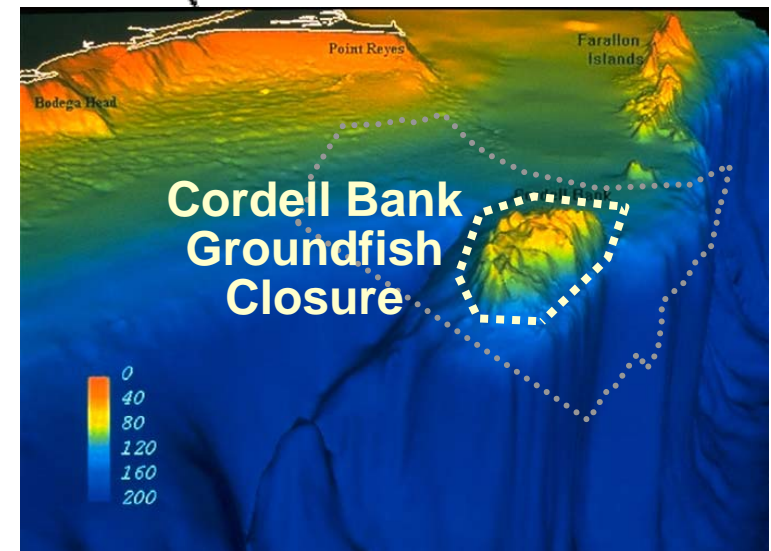
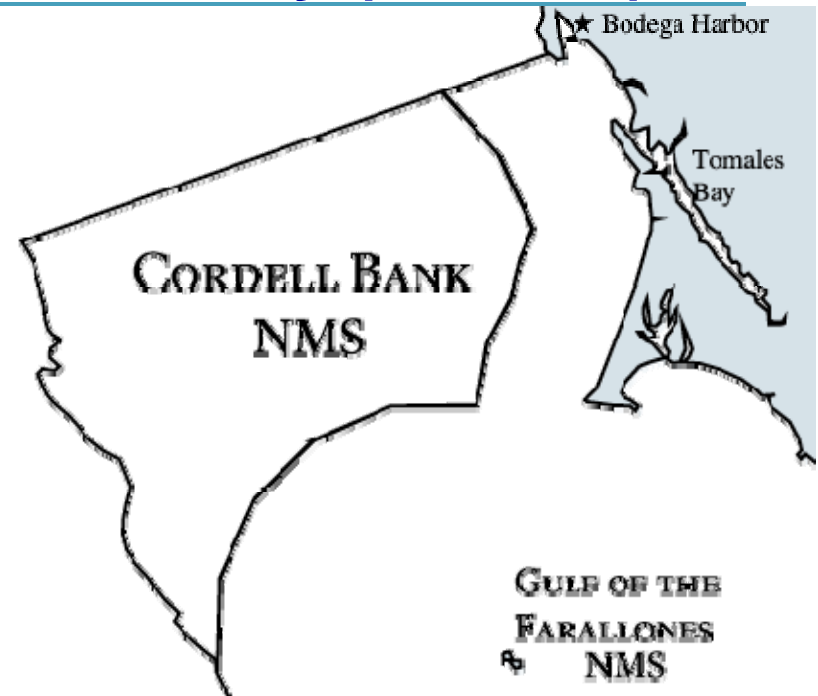
Cordell Bank National Marine Sanctuary (CBNMS)

- designated in 1989
- Prohibits some activities....
 - disturbance of benthic organisms and habitats
 - discharging or depositing substances
 - Oil or gas development
- *but.. commercial longline fishing & recreational catches prior to 2002 were not prohibited.*



Cordell Bank National Marine Sanctuary (CBNMS)

- designated in 1989
- prohibits....
 - disturbance of benthic organisms and habitats
 - discharging or depositing substances
 - Oil or gas development
- In 2003, Cordell Bank was designated as a no-take “Groundfish Conservation Area”



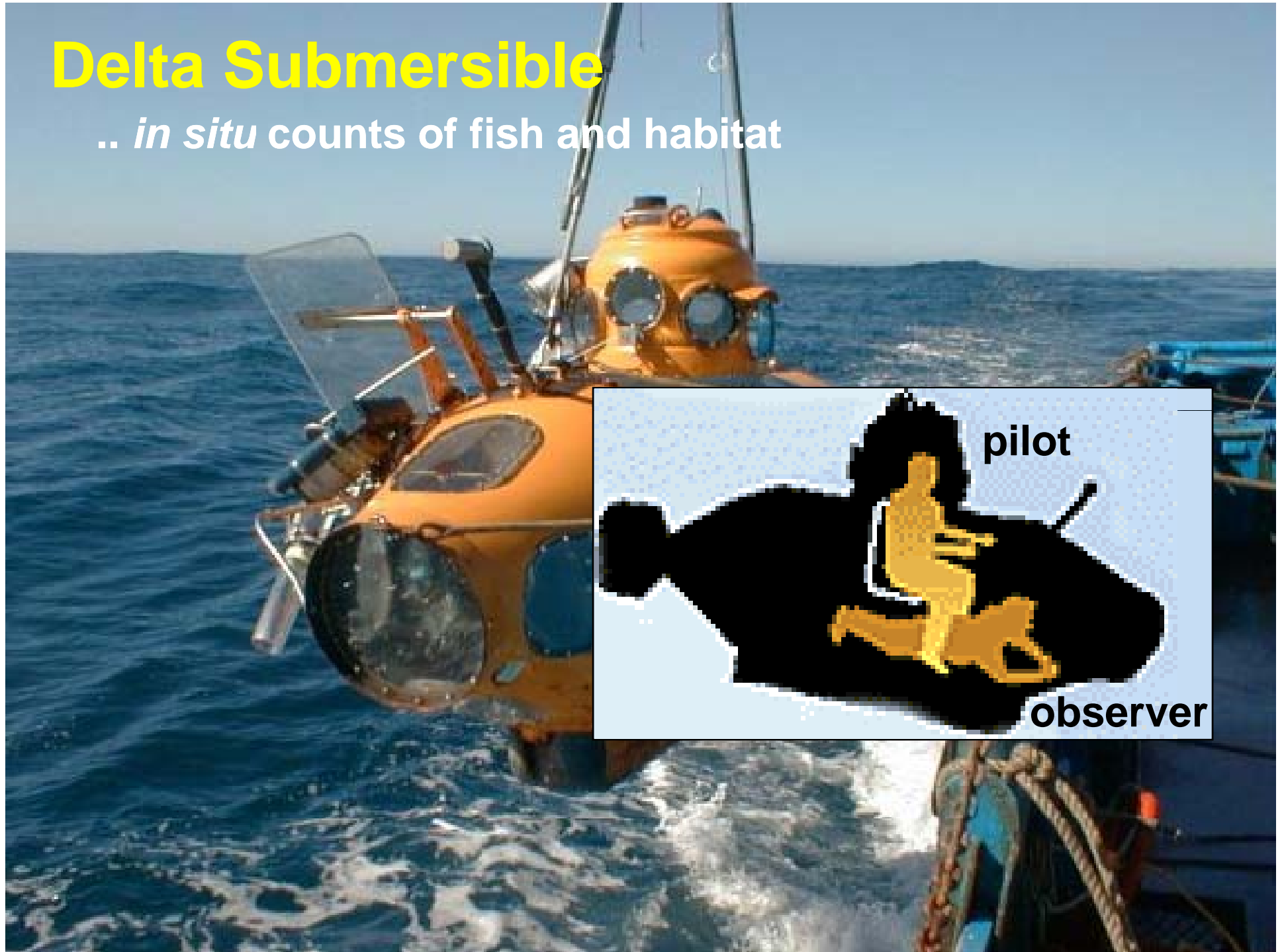
How do we evaluate the effectiveness of the Cordell Bank NMS and closure?

... determine

- **population & assemblage structure of fishes on the Bank**
- **Spatial variation**
- **Temporal variability**

Delta Submersible

.. *in situ* counts of fish and habitat



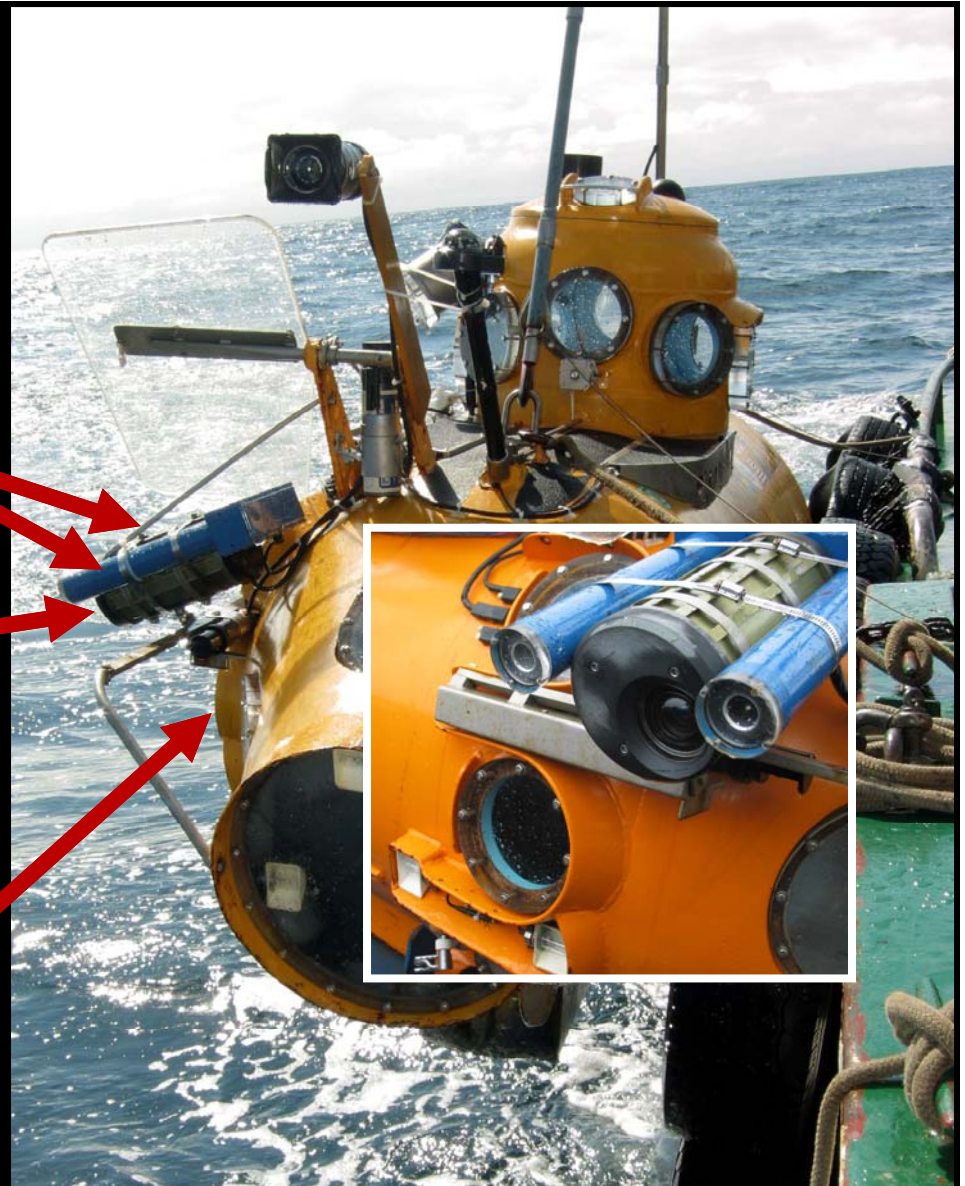
Delta Submersible

Dives to a depth of 370 m

Paired-Lasers

Video-camera

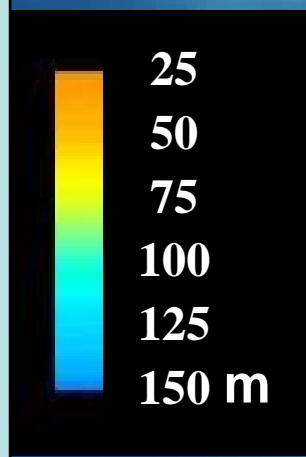
**Observers
viewing-window**



Delta-submersible

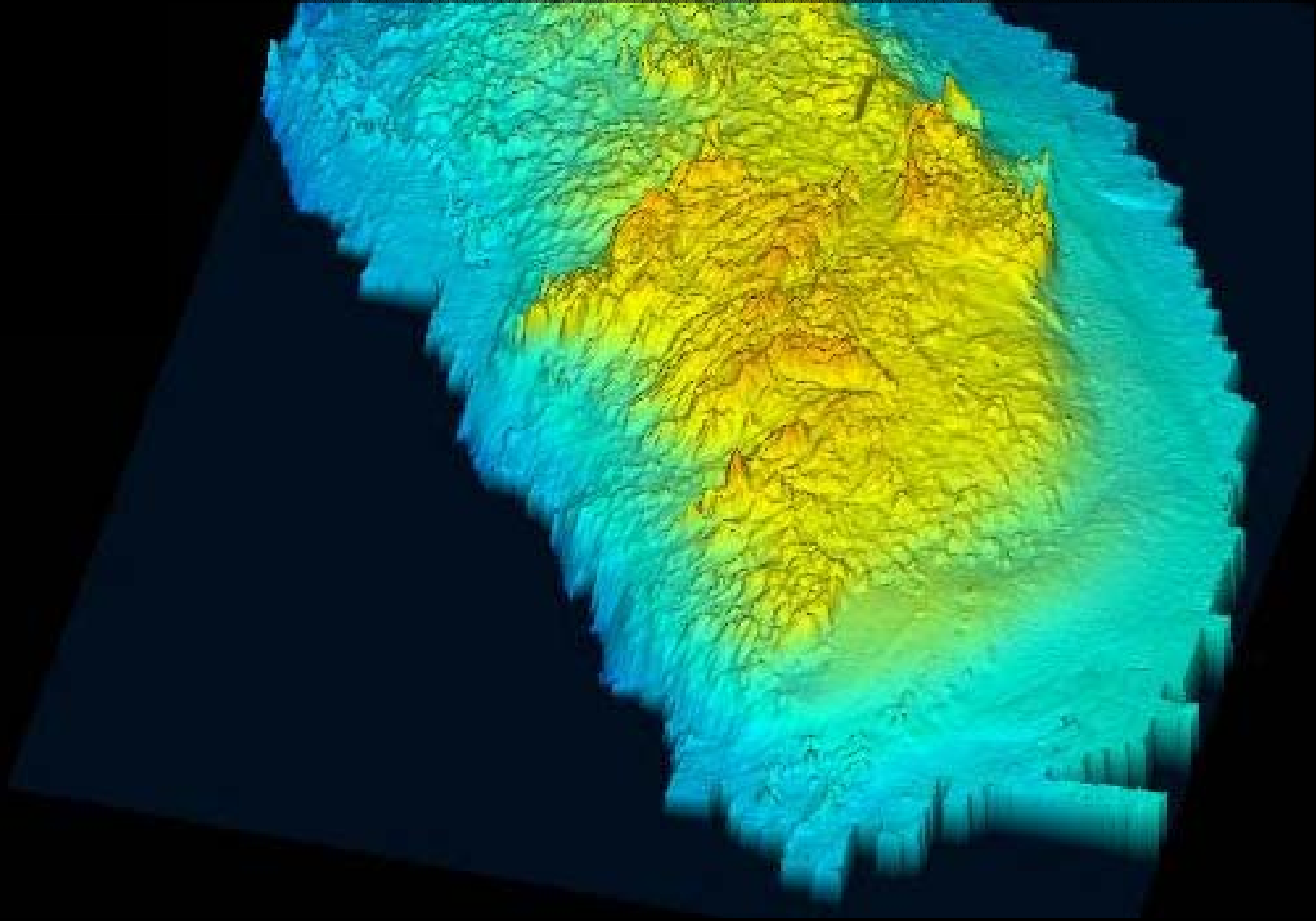
(2,222Kg air weight
4.6m in length x 1.1m beam)

Cordell Bank National Marine Sanctuary



*** In 2002, quantitative submersible survey**

AIM: Describe benthic environment and groundfish assemblage



* In 2002, quantitative submersible survey

AIM: Describe benthic environment and groundfish assemblage

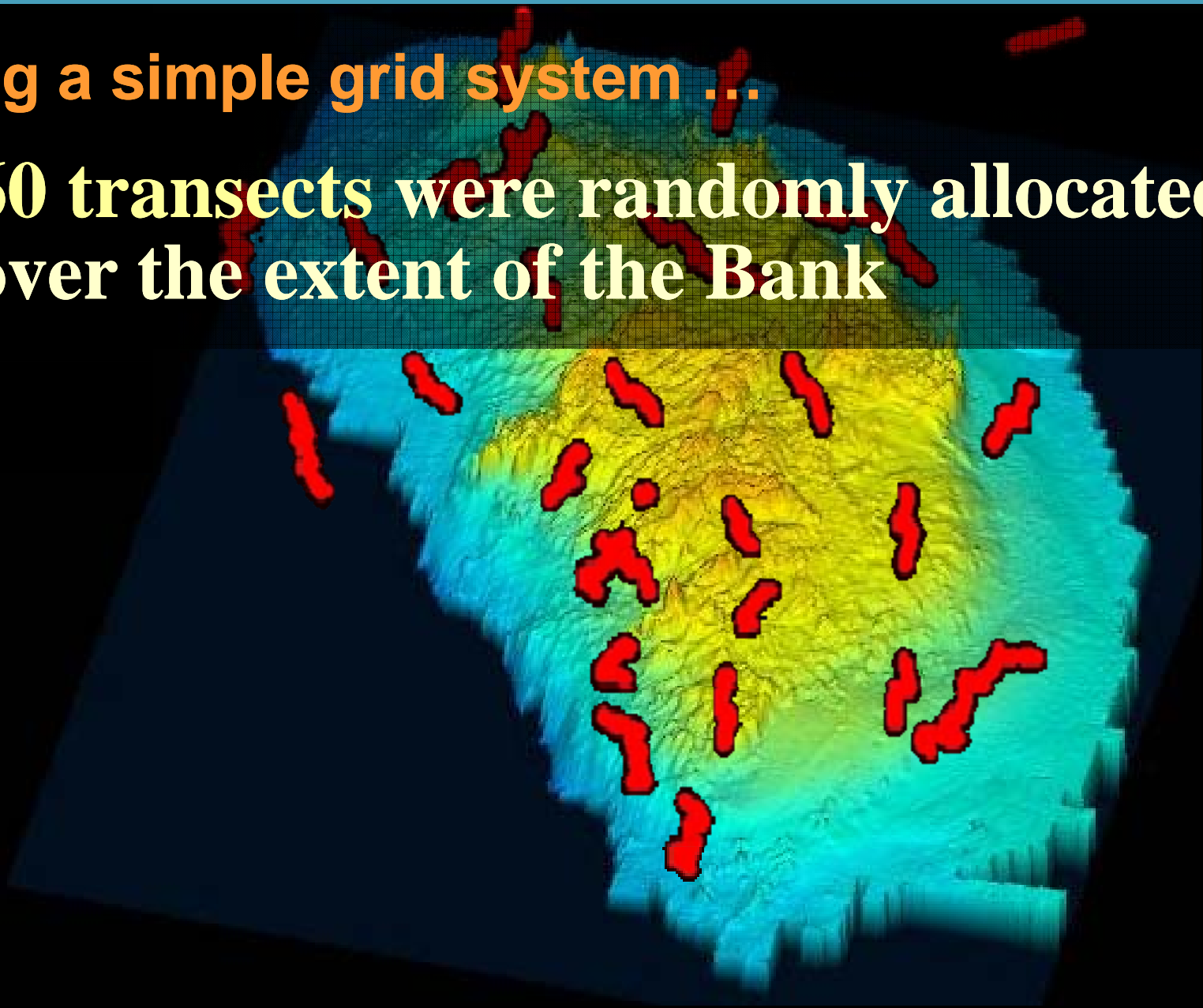
SAMPLING STRATEGY:

- **Sample the spatial extent of the Bank**
... *what habitats and fish occur over the Bank*
- **Sample sites annually for 5 years**
... *assess frequency of temporal change*
... *review sampling frequency*
... ***Adaptive Management***

* 2002 quantitative submersible survey

Using a simple grid system ...

60 transects were randomly allocated over the extent of the Bank



* 2002 quantitative submersible survey

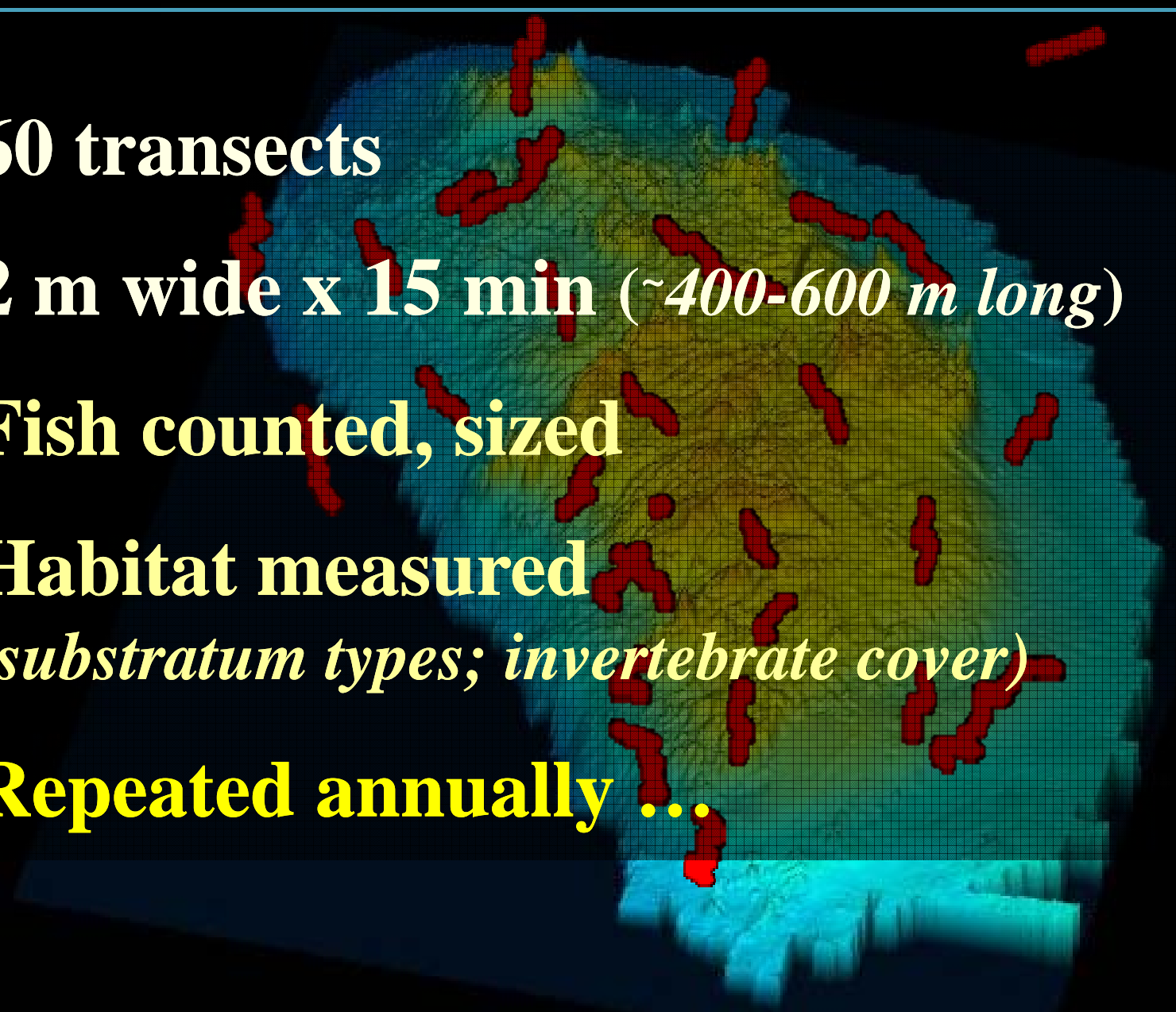
60 transects

2 m wide x 15 min (~400-600 m long)

Fish counted, sized

Habitat measured
(*substratum types; invertebrate cover*)

Repeated annually ...

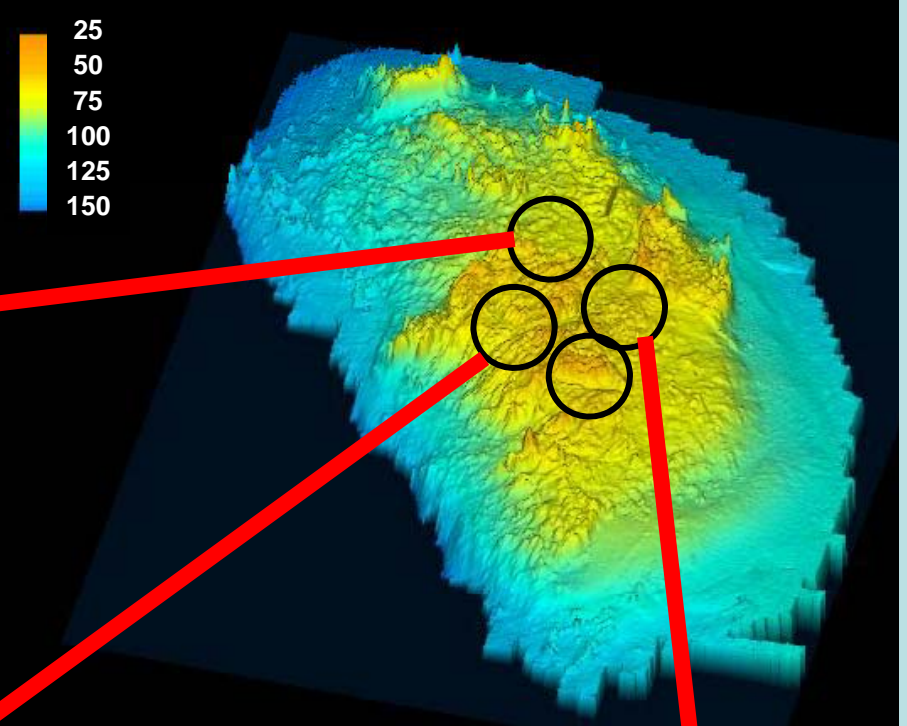
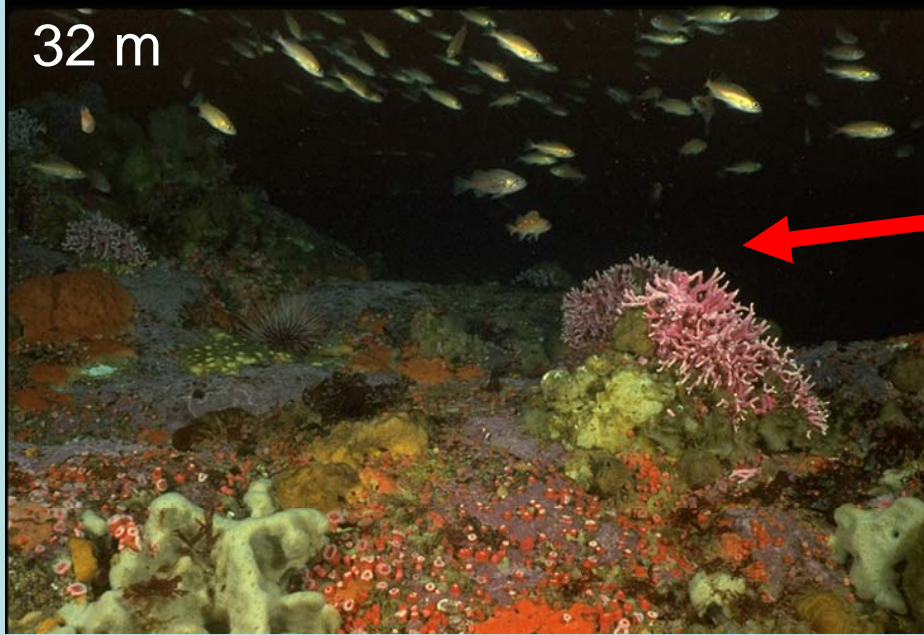


Results:

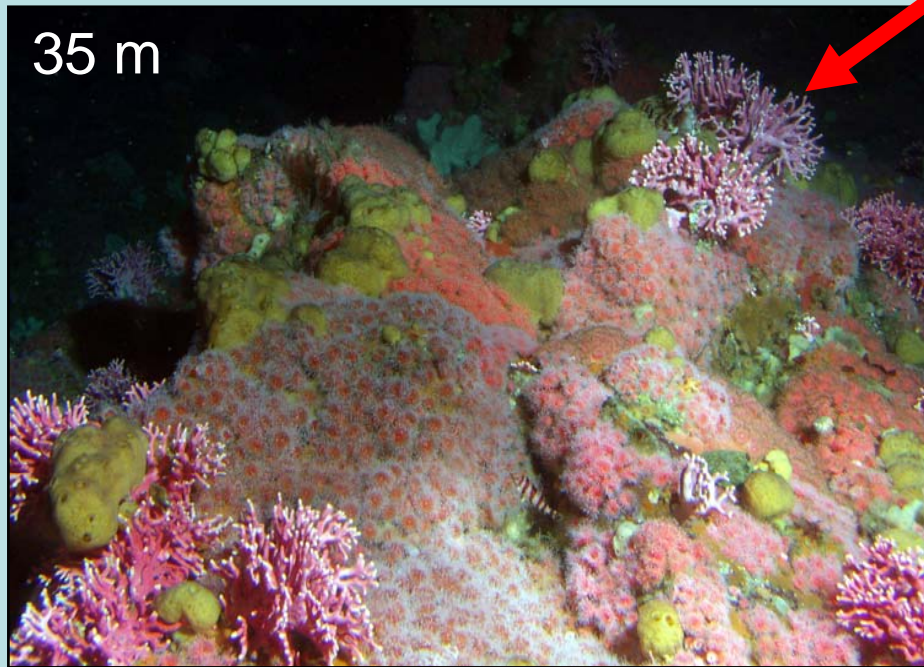
**What habitats occur on
Cordell Bank ?**

Top of Bank – *Diverse inverts*

32 m



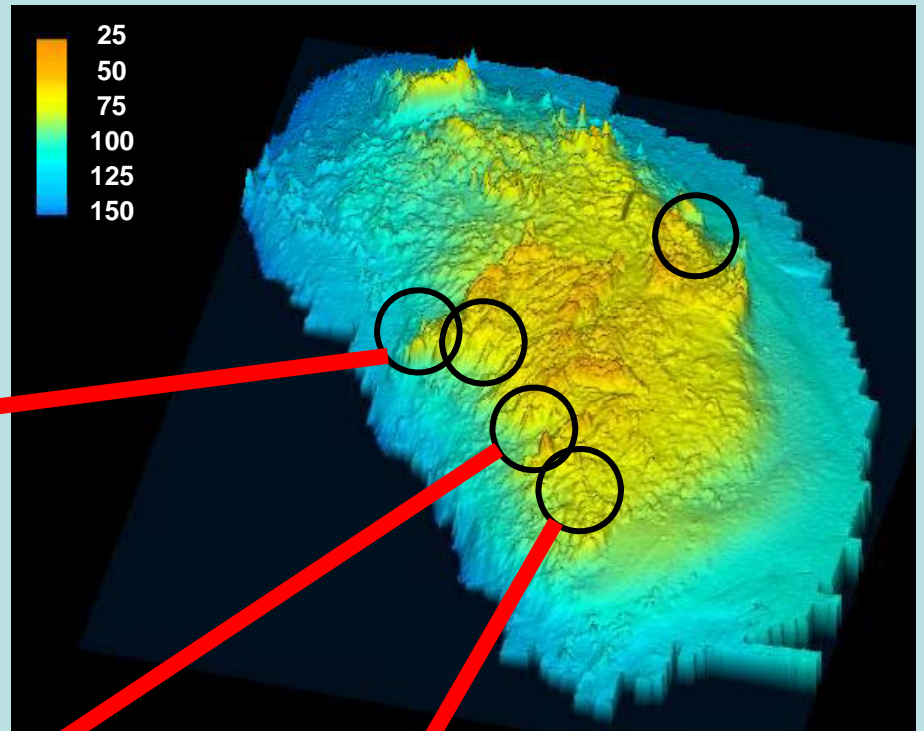
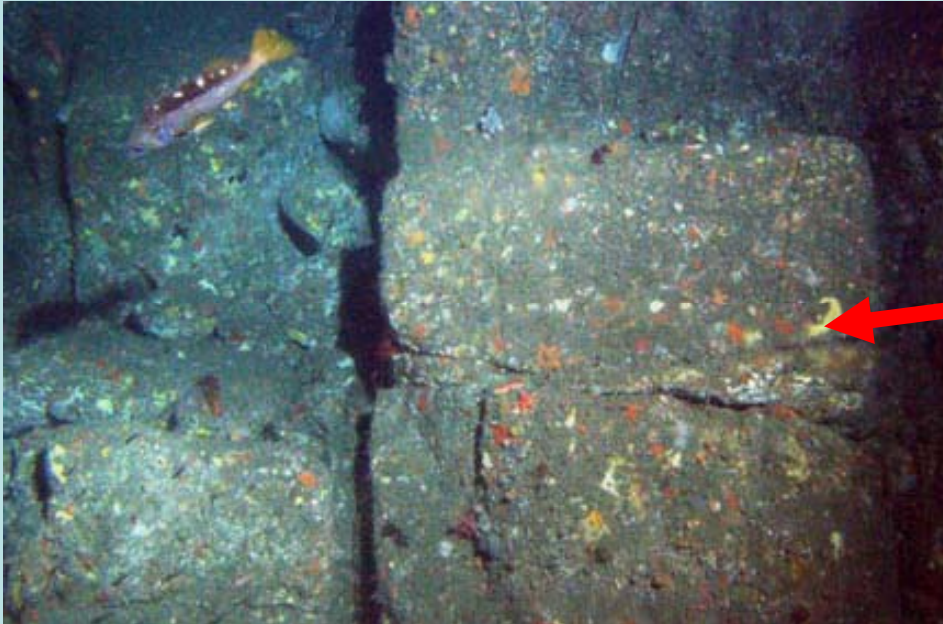
35 m



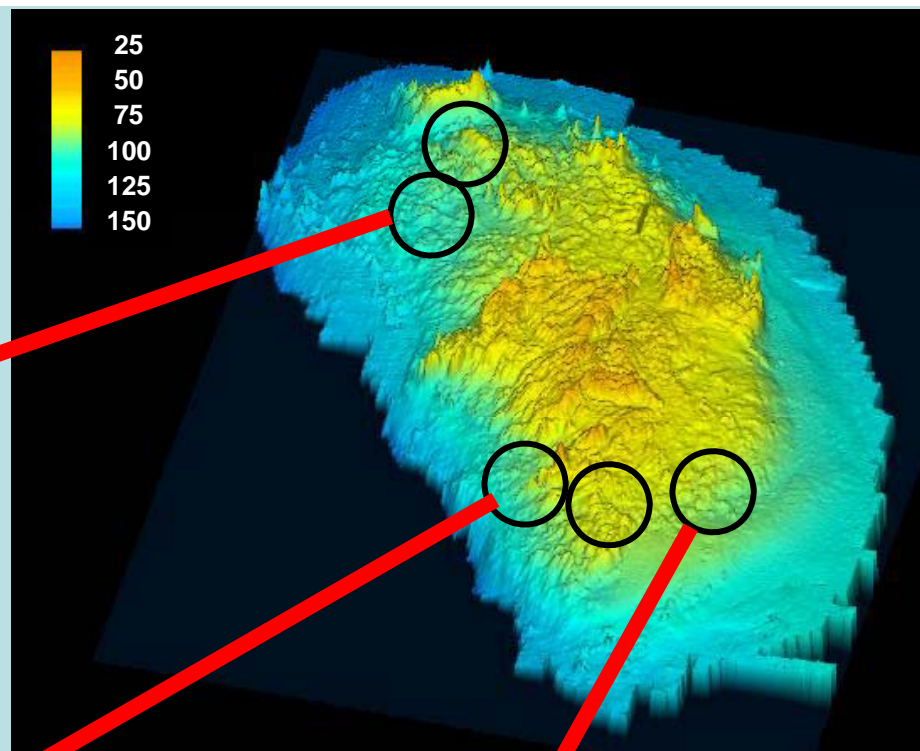
41 m



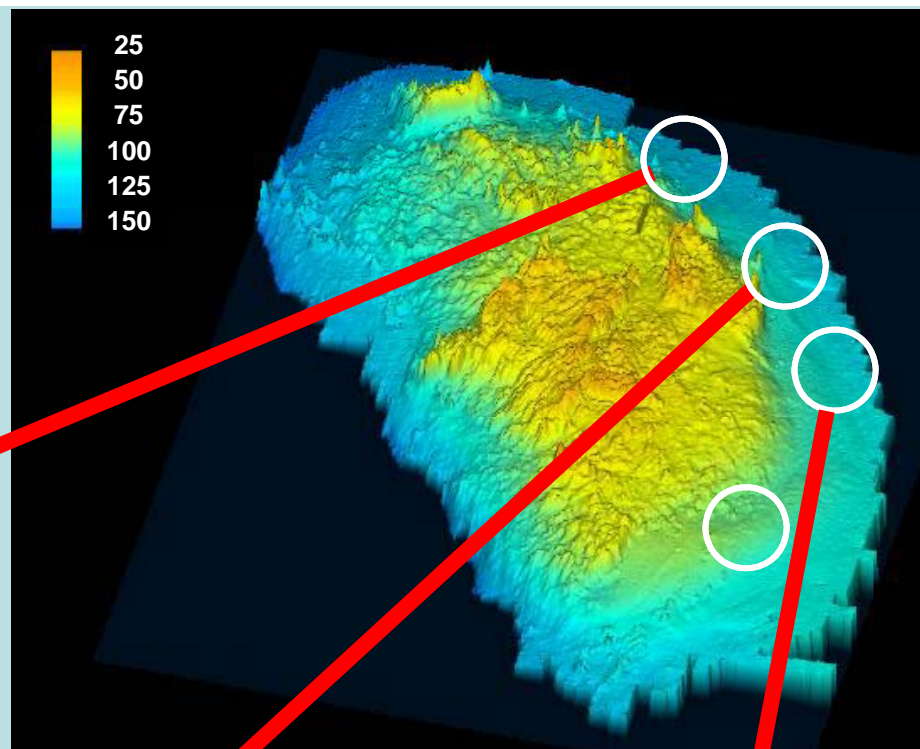
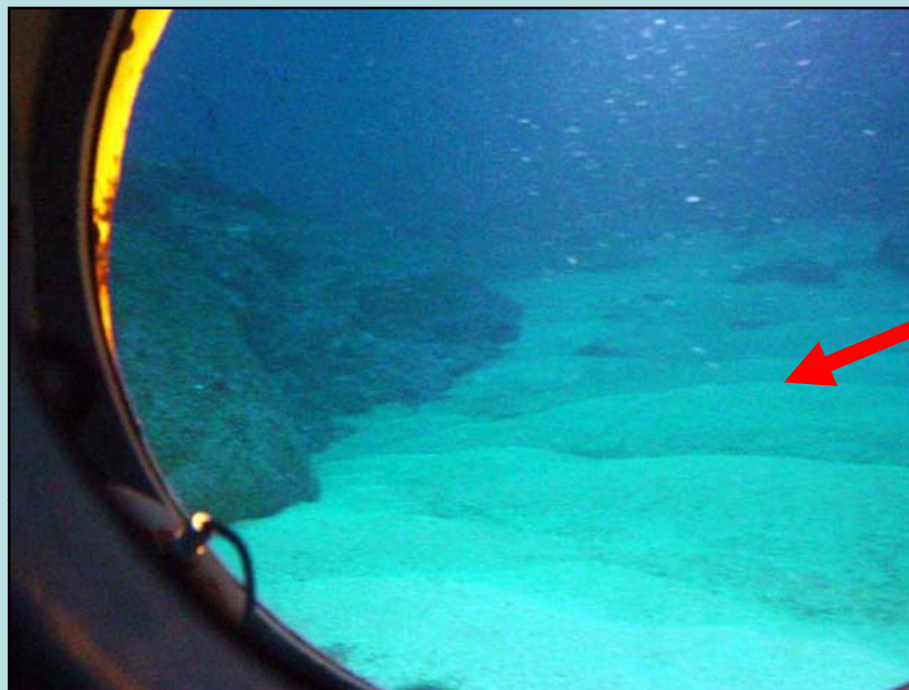
Bank slope - *High-relief pinnacles*



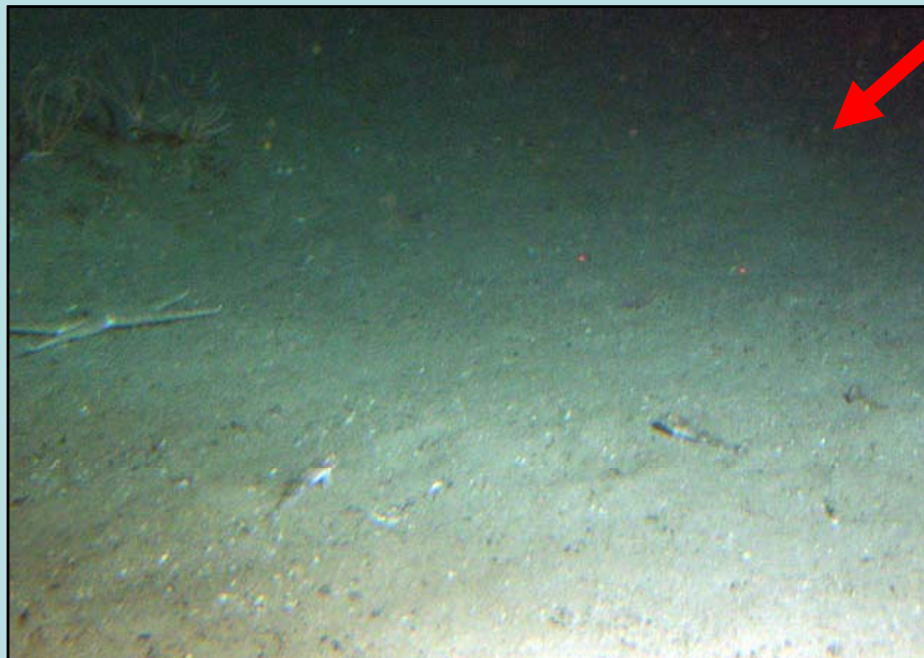
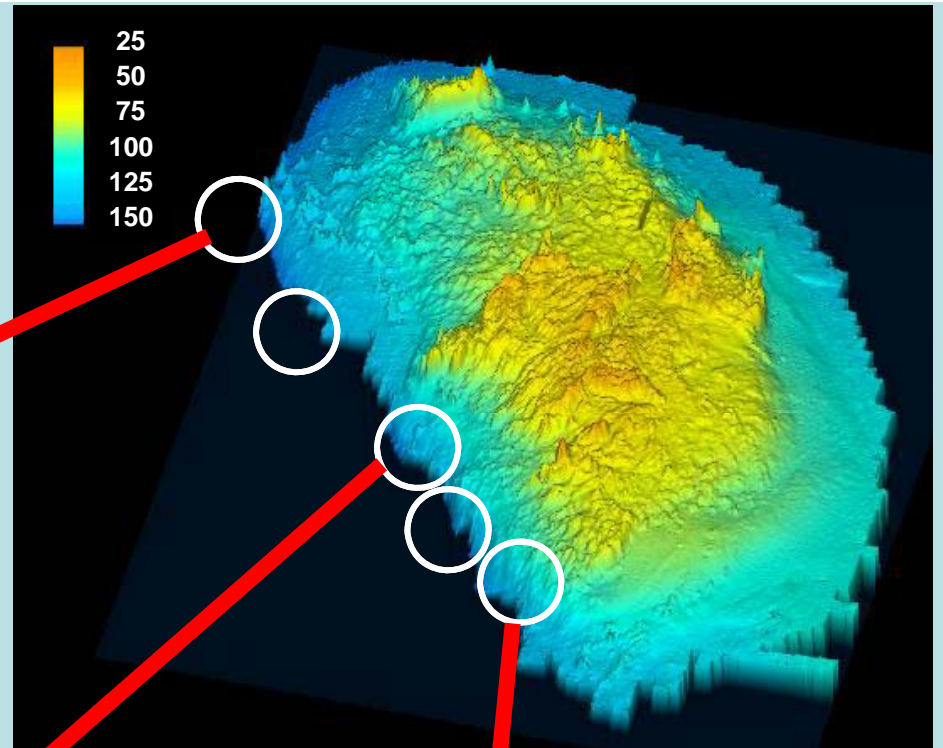
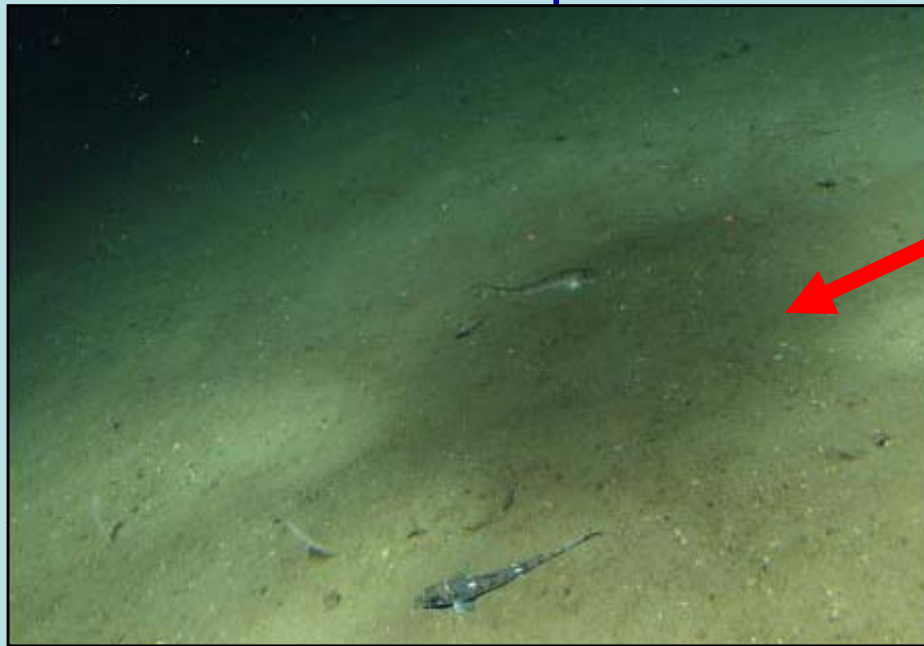
Lower Bank - *Boulder fields*



Lower east-side - *Sand waves*



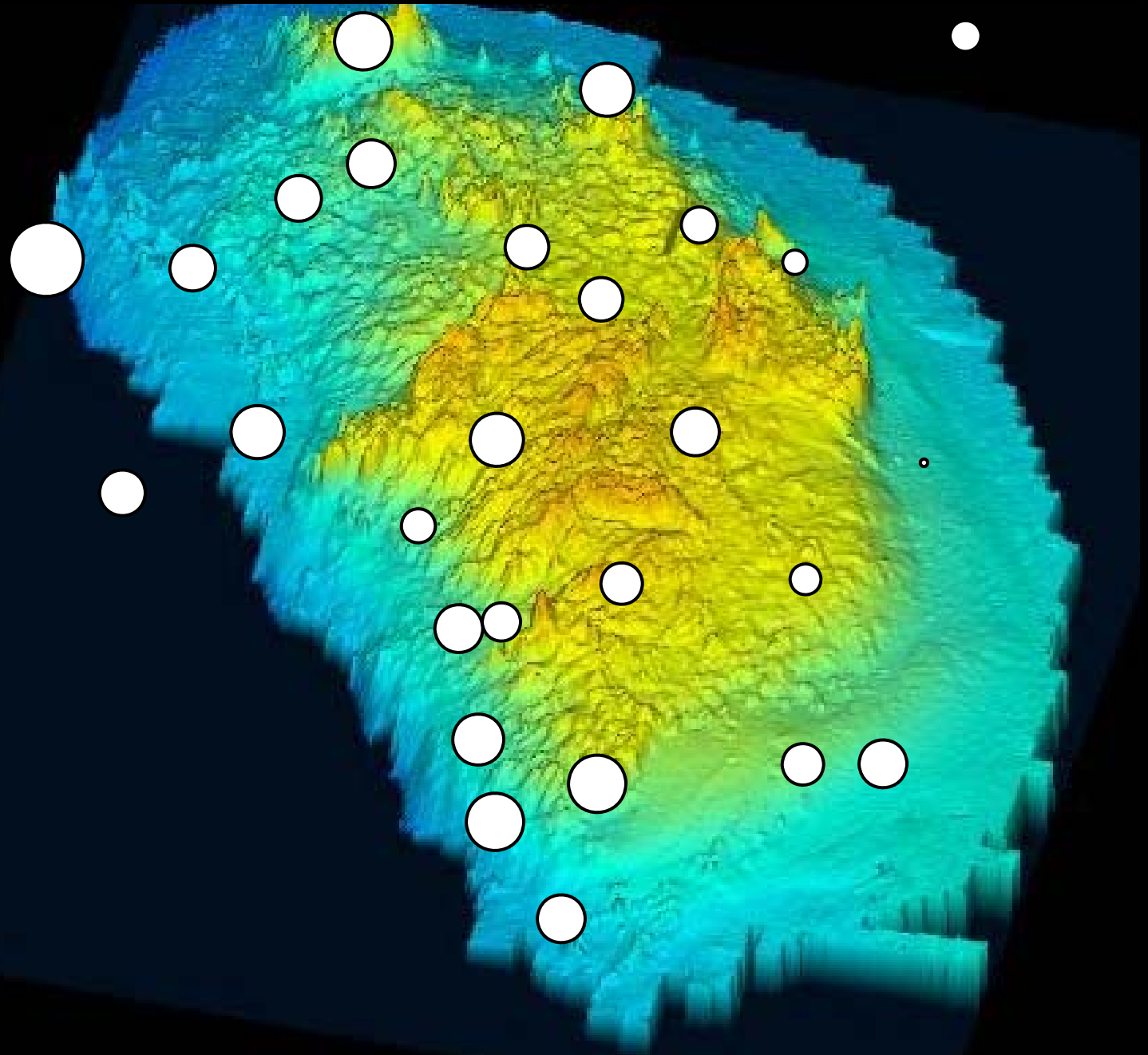
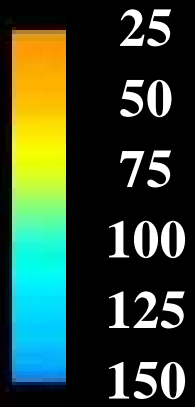
Continental slope - *Mud*



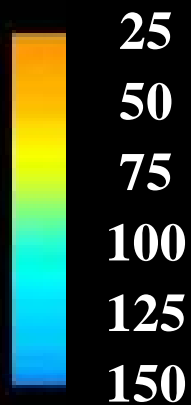
**So the Bank is not
homogenous ...**

**so what does this mean
to the fish ...**

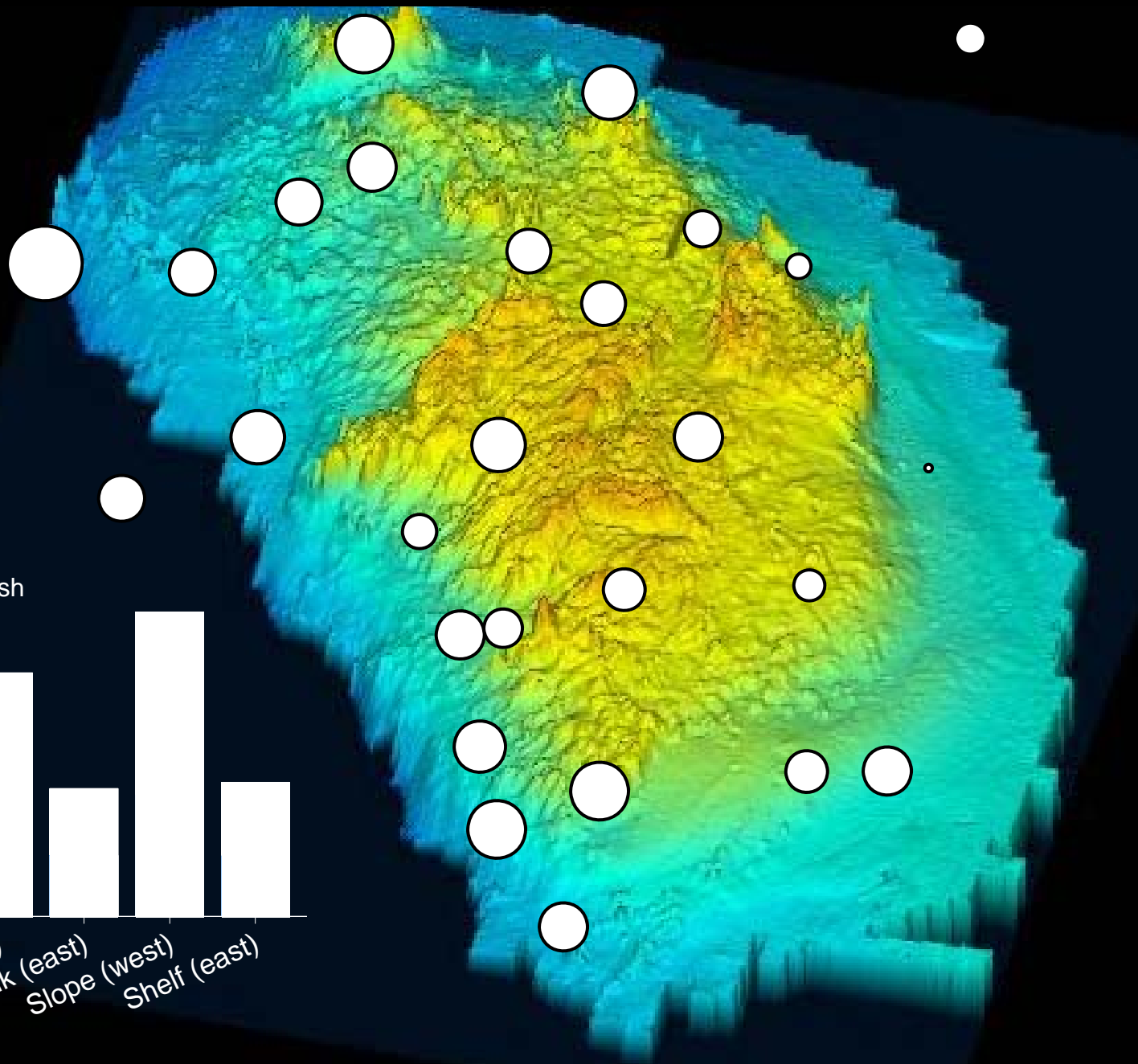
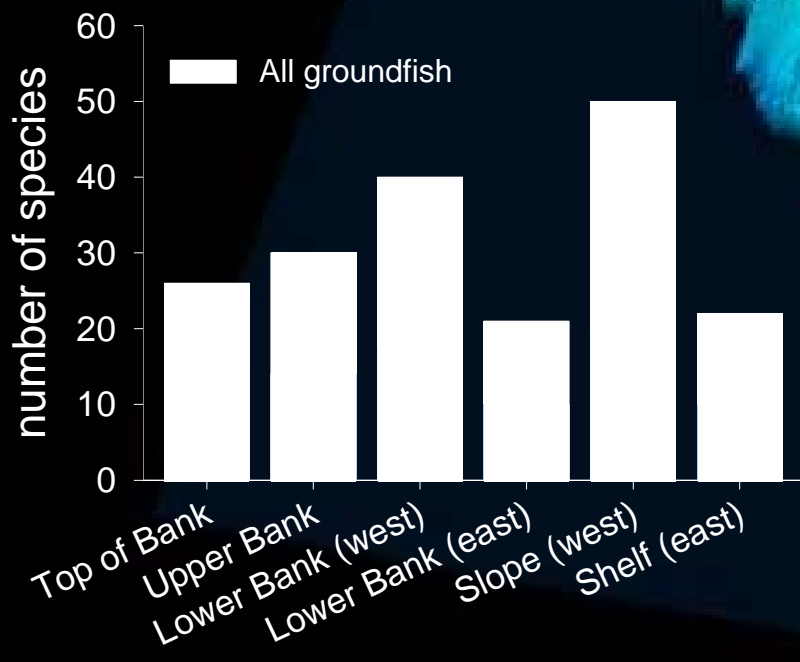
Groundfish Diversity (67 species)



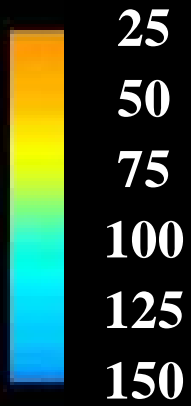
Groundfish Diversity (67 species)



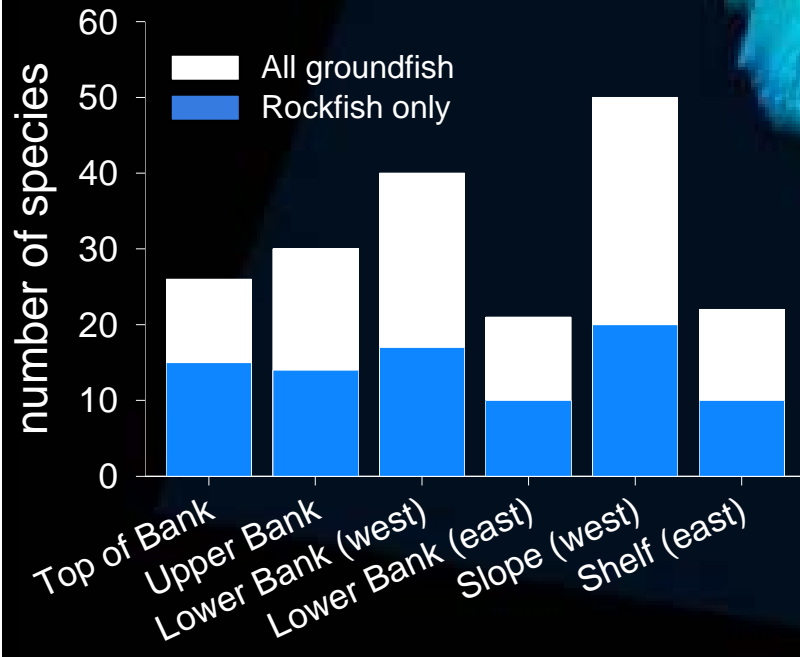
Fish diversity



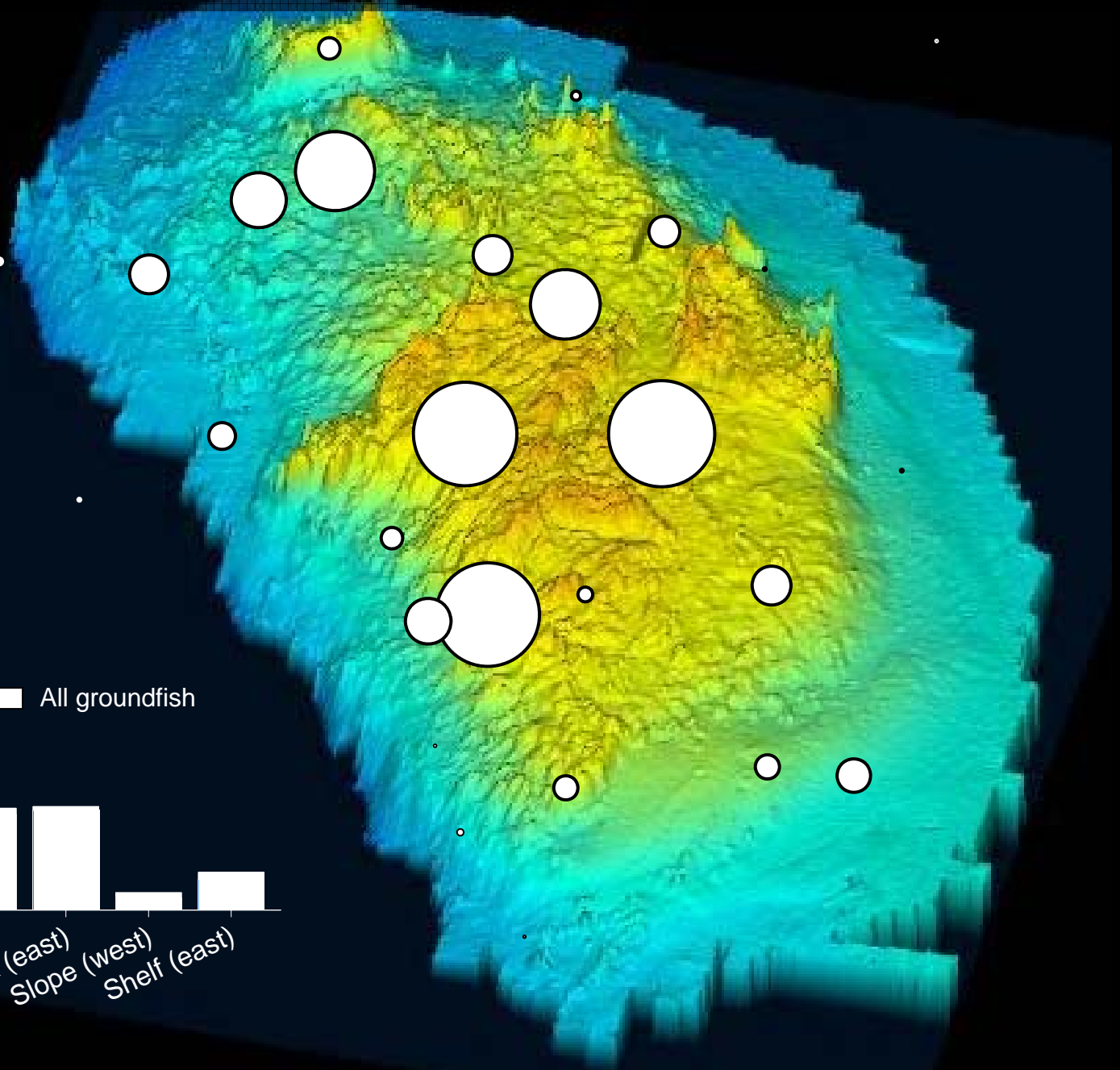
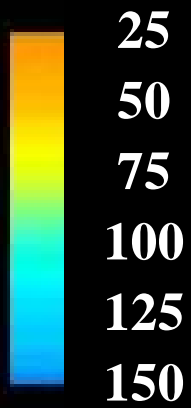
Rockfish Species account for 44%



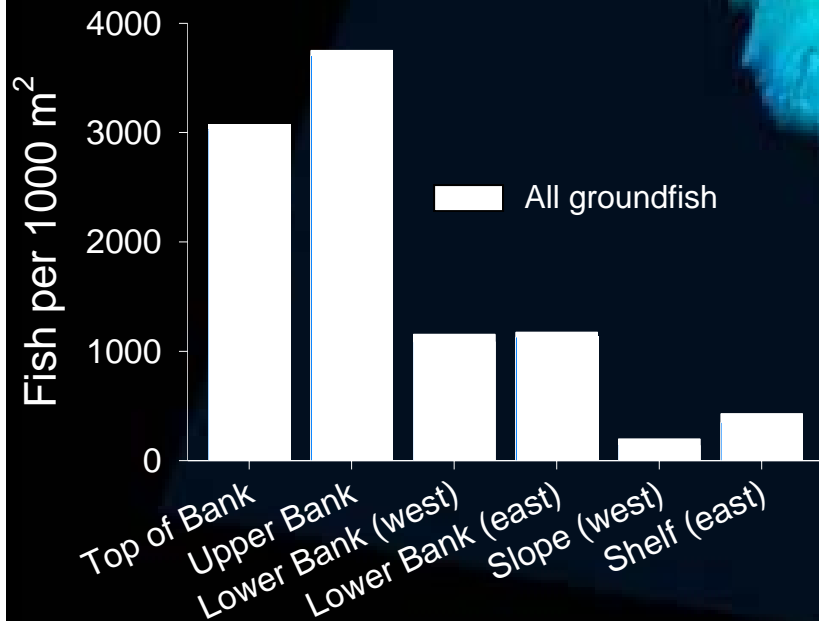
Fish diversity



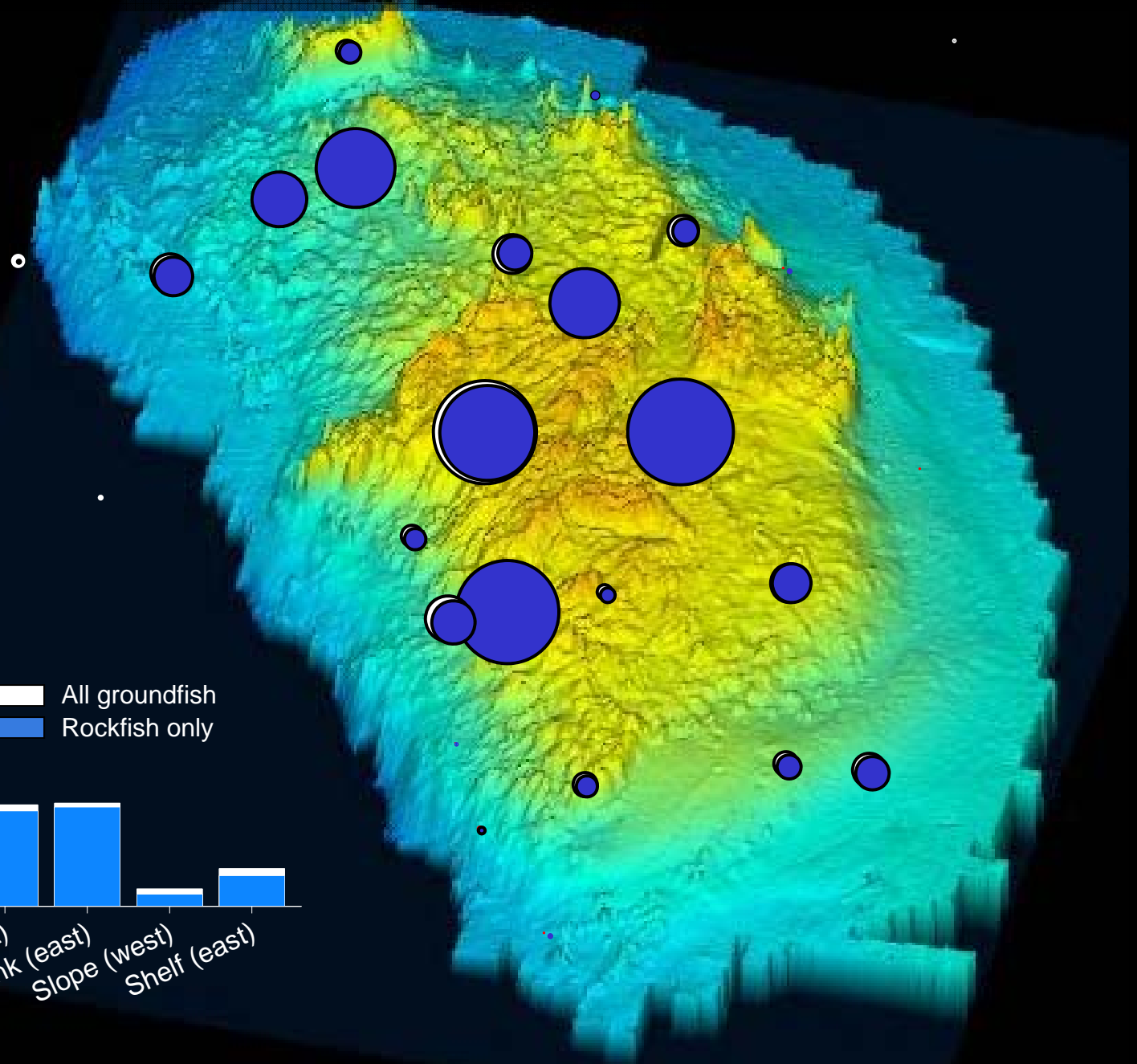
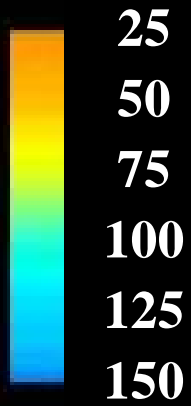
Groundfish Abundance n=86,705



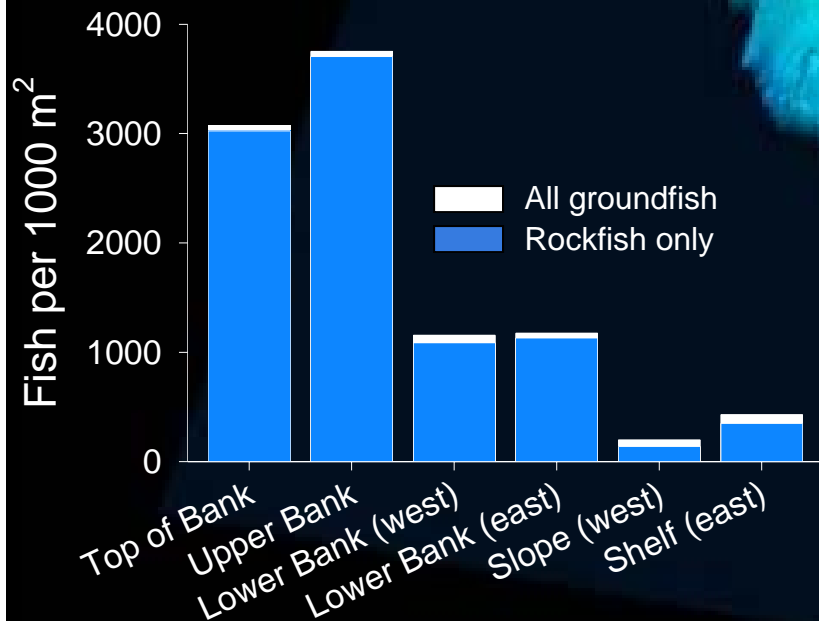
Fish Abundance



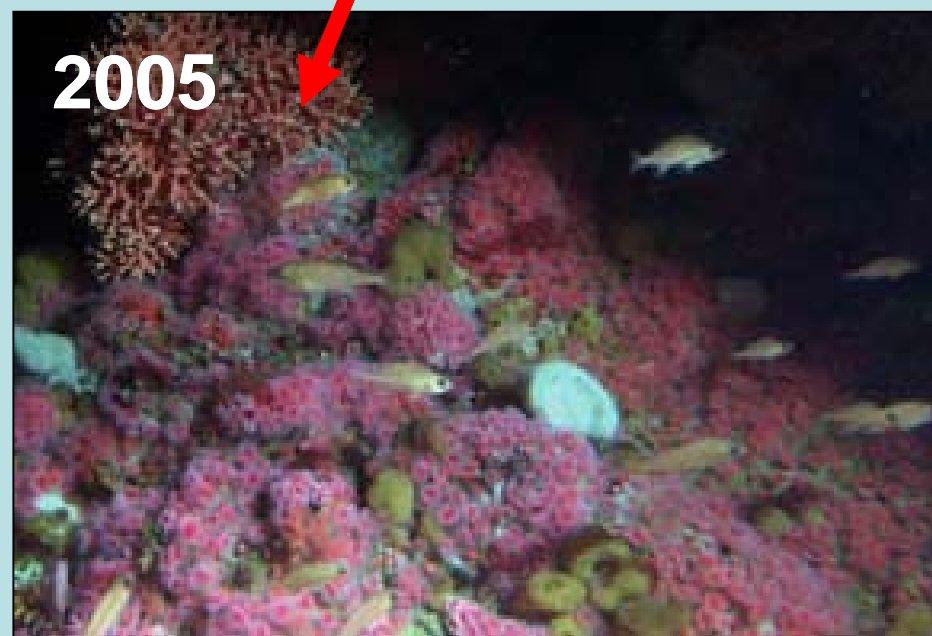
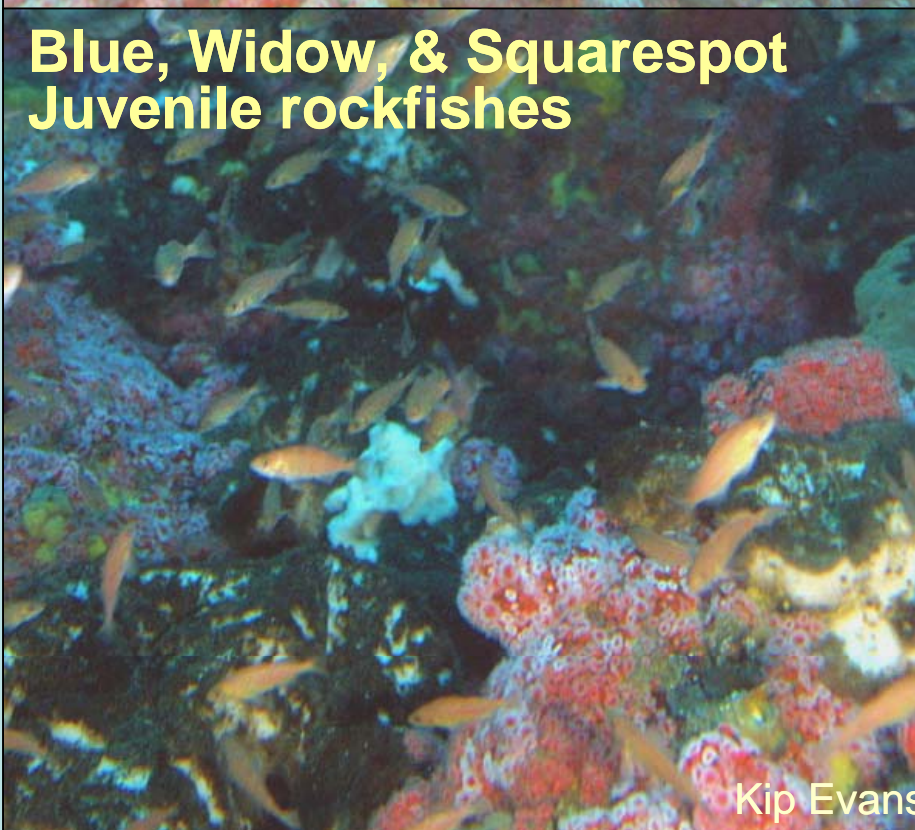
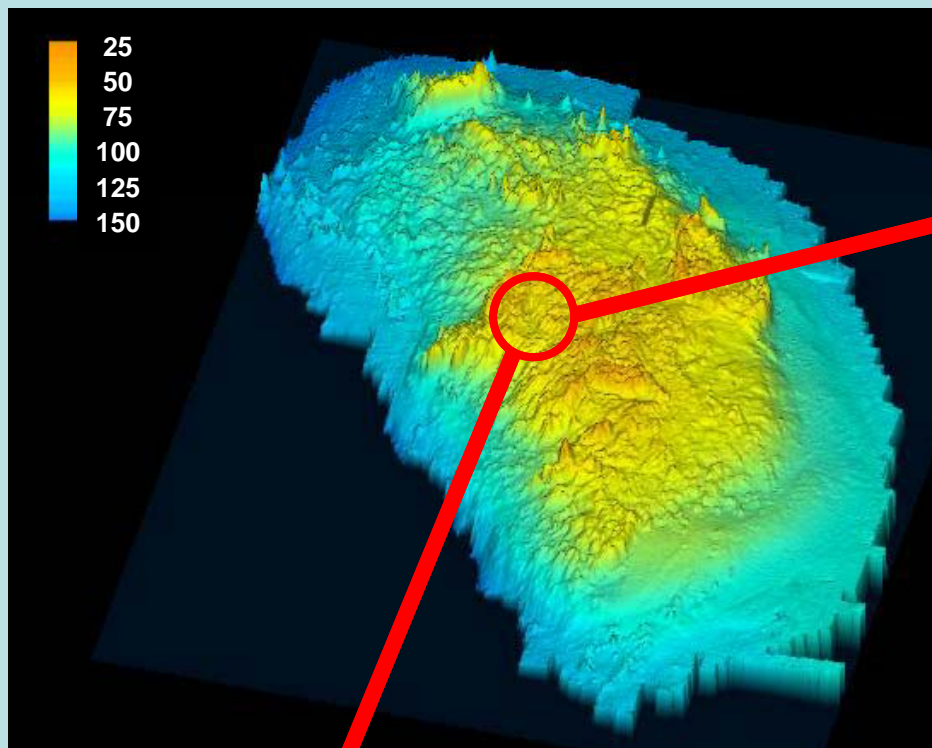
Rockfish Abundances account for 95%



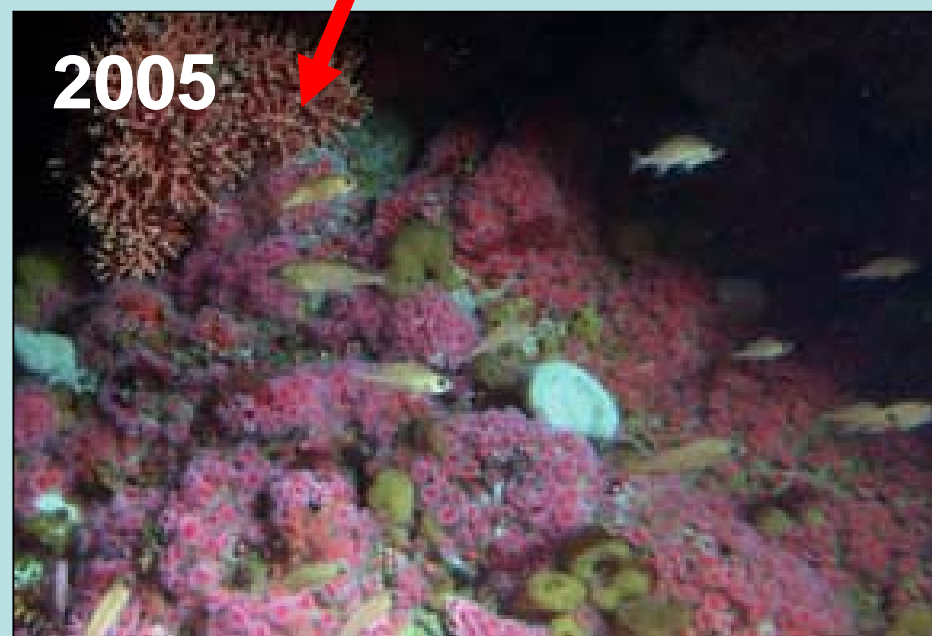
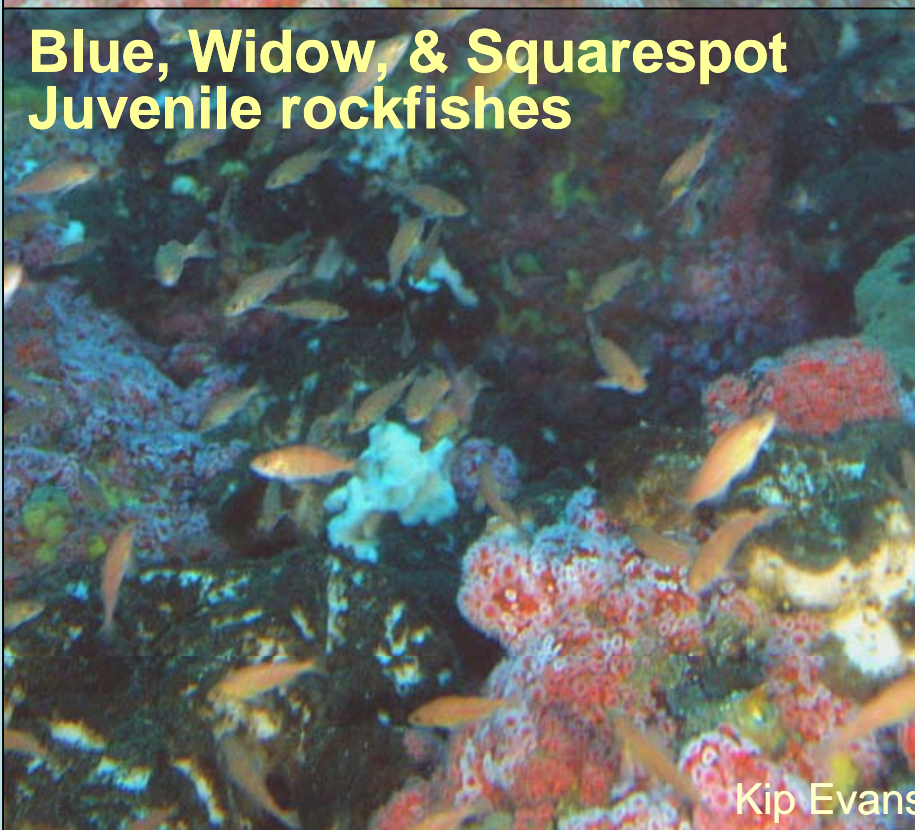
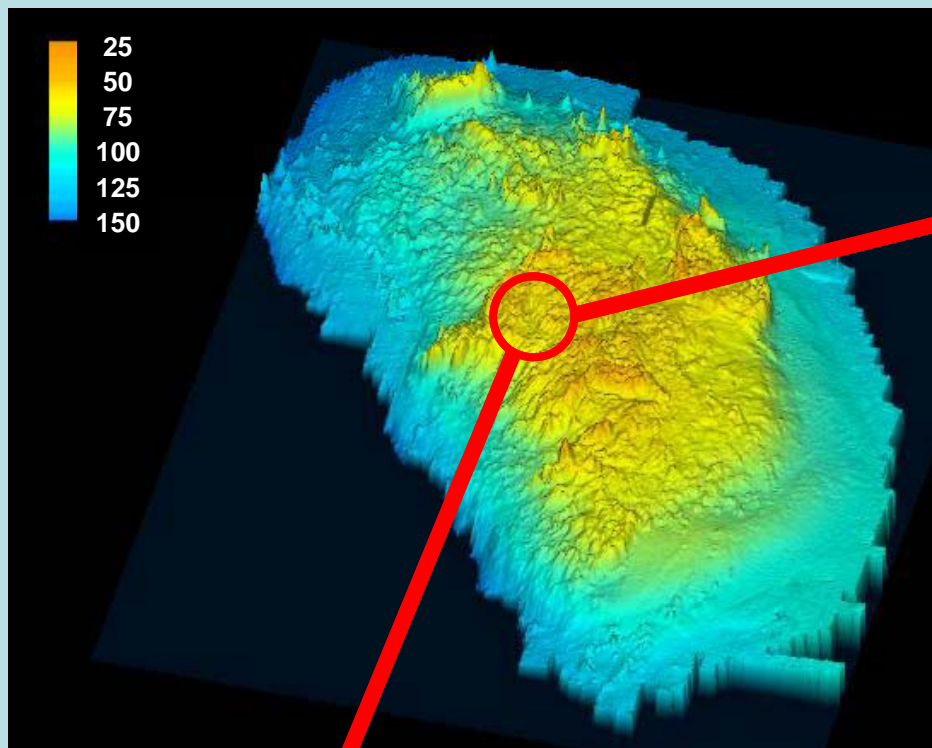
Fish Abundance



**But these numbers
aren't necessarily
constant through time...**

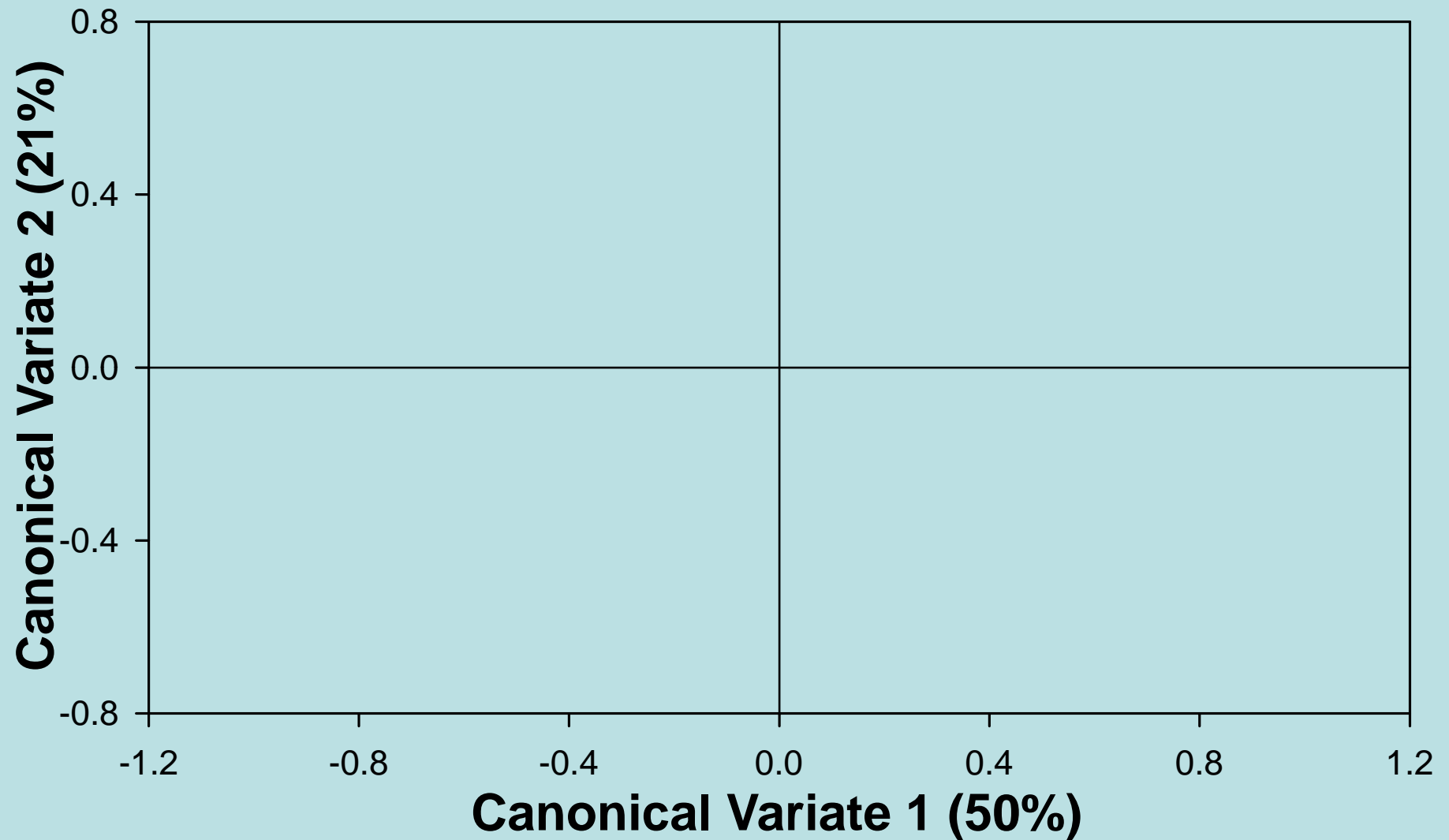


Kip Evans



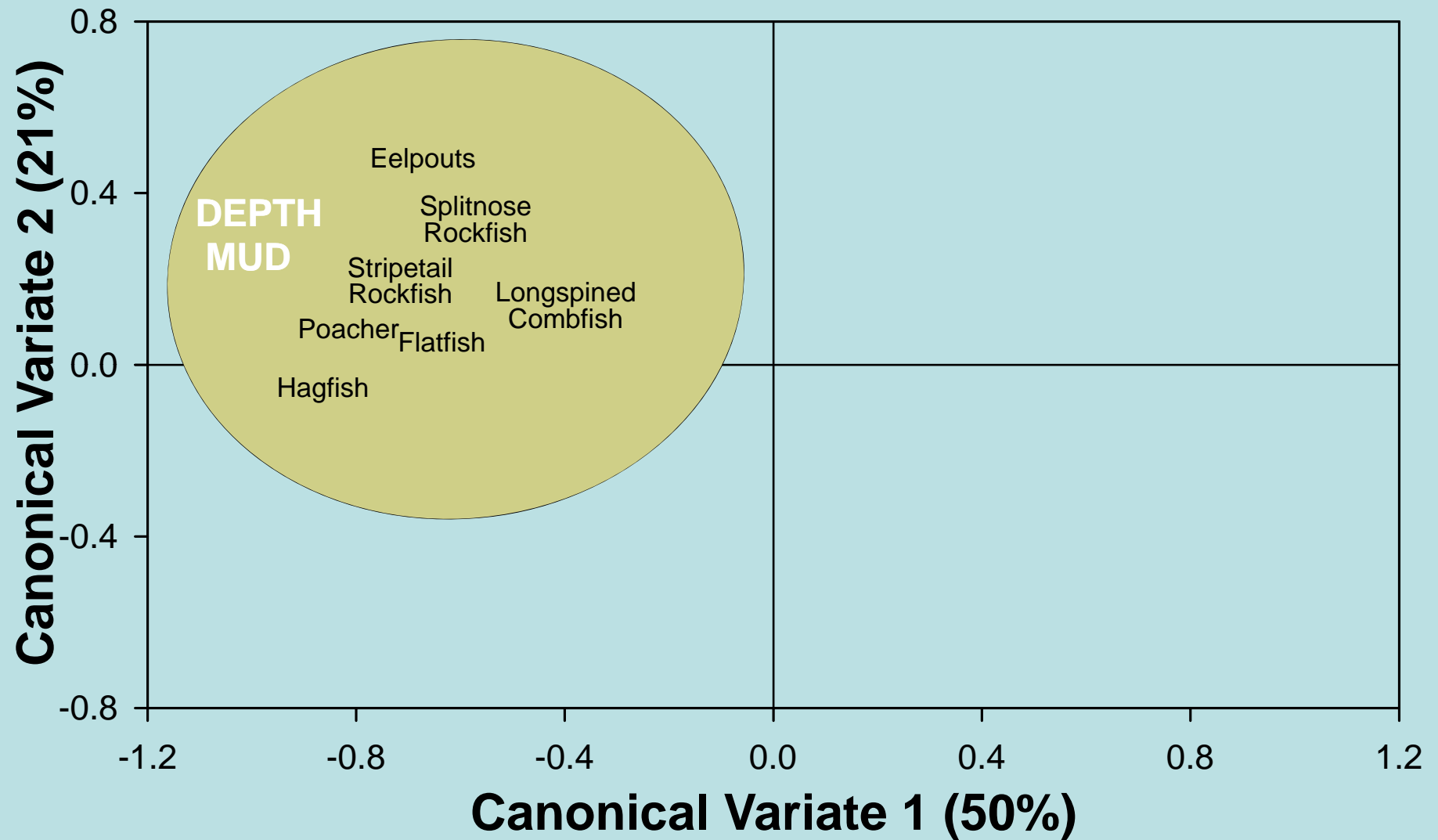
Kip Evans

How does the assemblage vary in space?



Canonical Correlation Analysis

How does the assemblage vary in space?



Canonical Correlation Analysis

Mud Slope

Hagfish Grotto



Spotted Ratfish



Longspined combfish



Poachers



English Sole



Splitnosed Rockfish



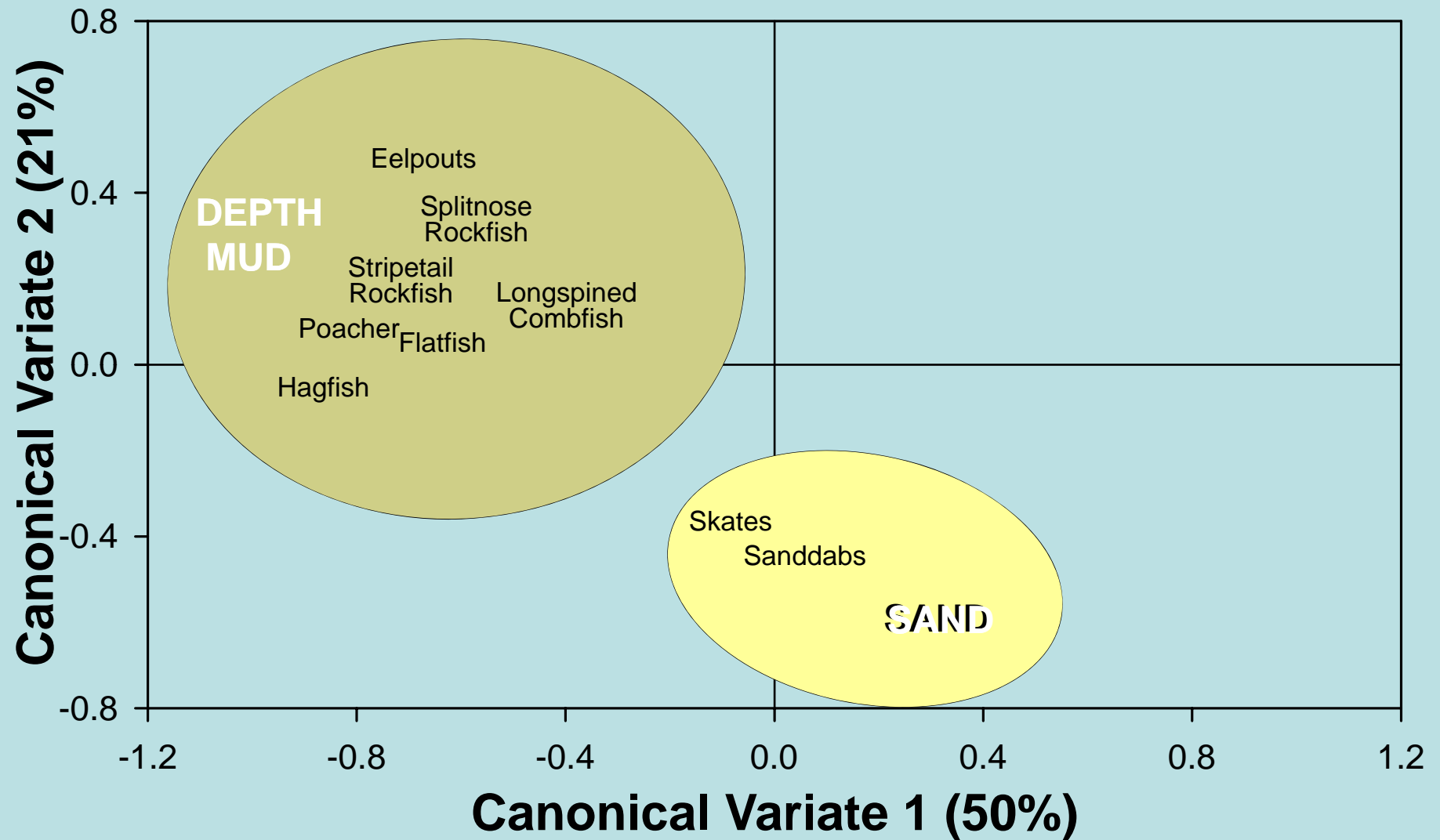
Stripetail Rockfish



Slender Sole

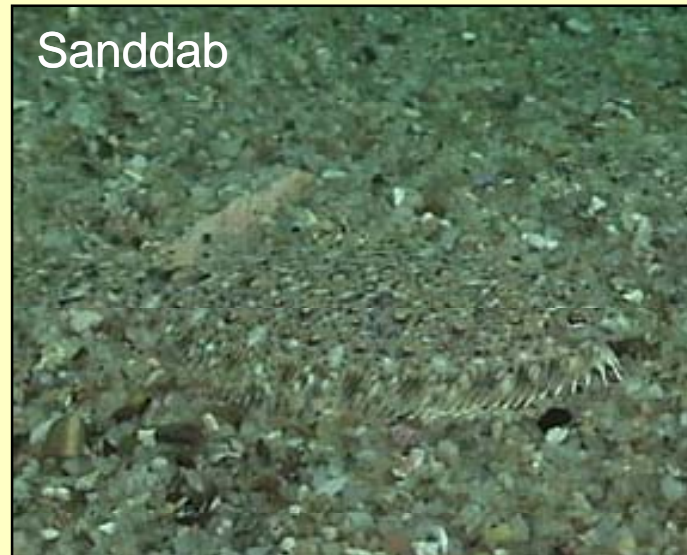
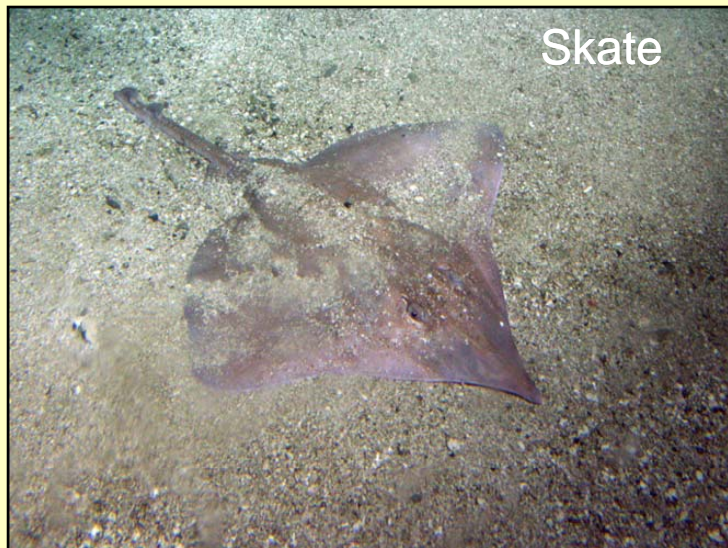


How does the assemblage vary in space?

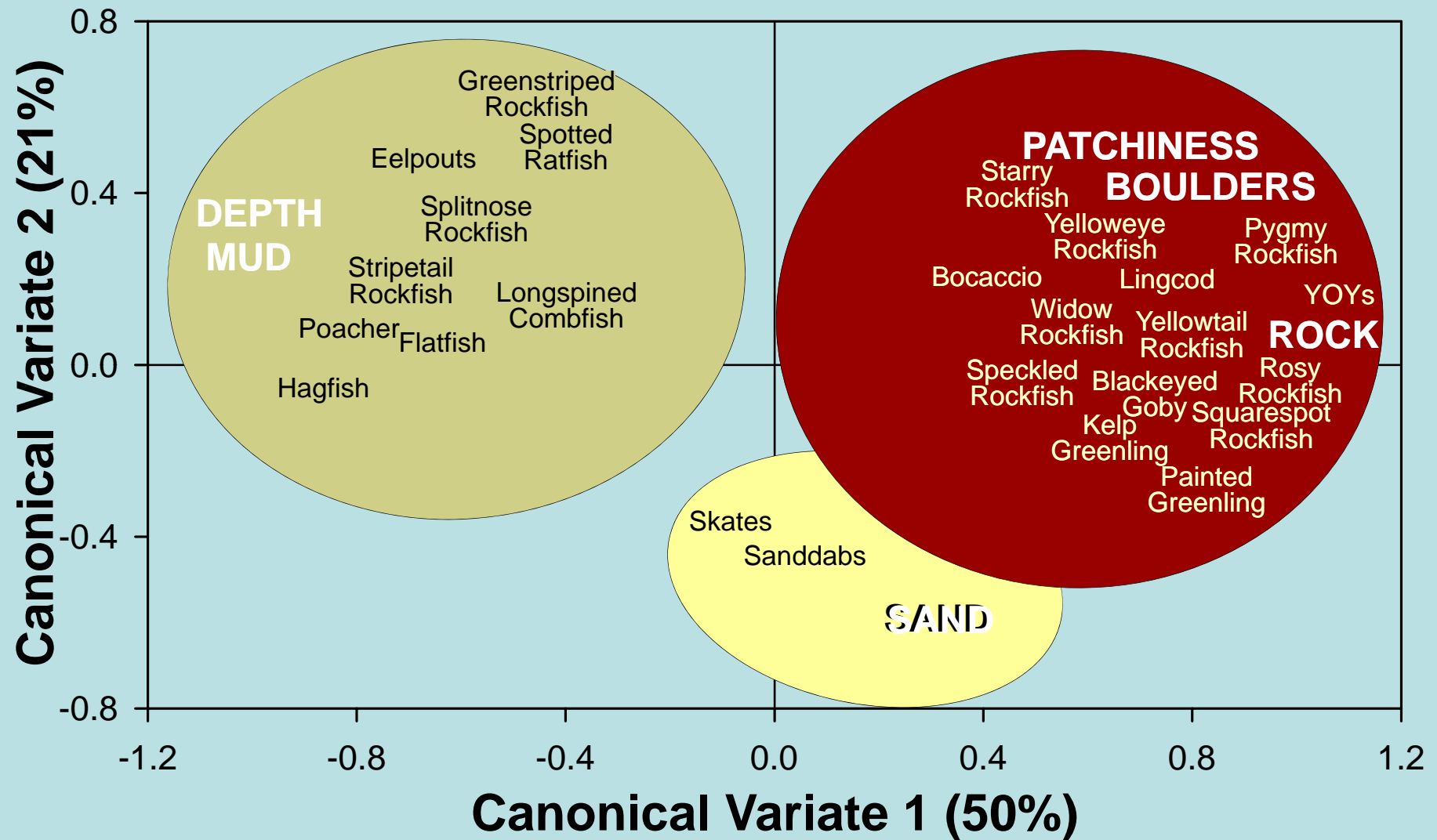


Canonical Correlation Analysis

Lower east-side Sand



How does the assemblage vary in space?



Canonical Correlation Analysis

Top of Bank / Rocks & Boulders



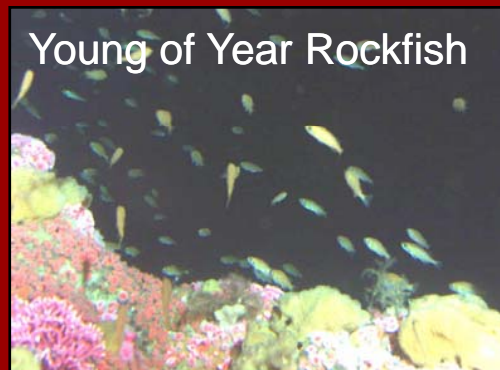
Blue Rockfish



Quillback Rockfish



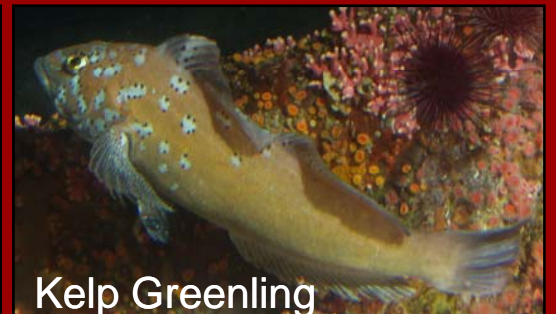
Yellowtail Rockfish



Young of Year Rockfish



Rosy Rockfish



Kelp Greenling



Juv. Yelloweye Rockfish



Squarespot Rockfish

Lower Bank / Rocks & Boulders

Starry Rockfish



Rosethorn Rockfish



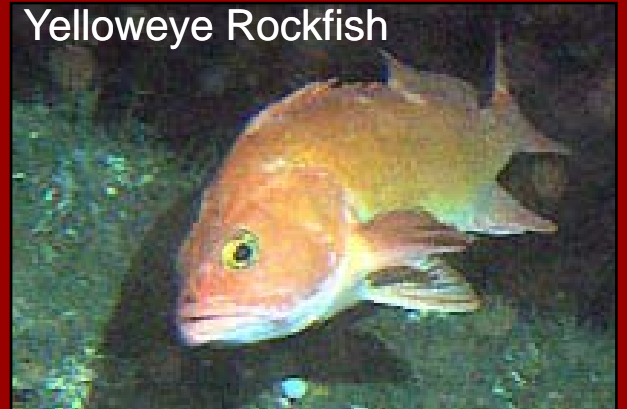
Pygmy Rockfish



Bocaccio



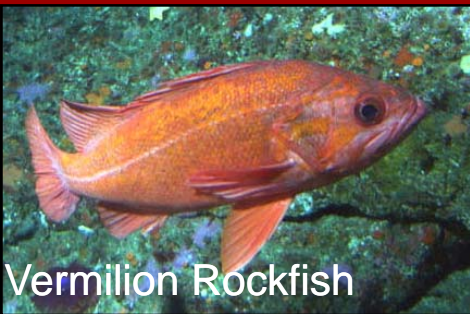
Yelloweye Rockfish



Flag Rockfish



Vermilion Rockfish



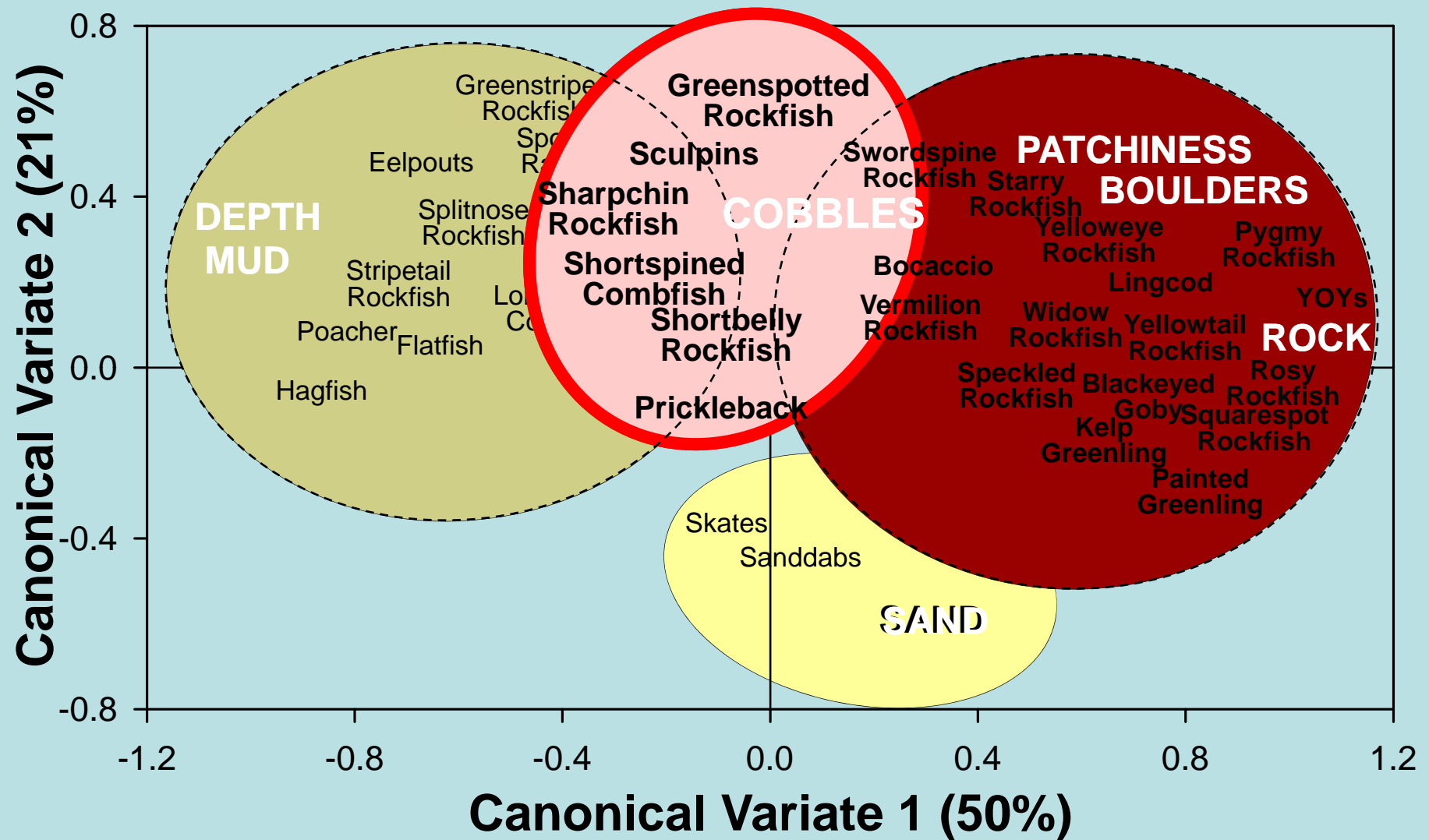
Greenspotted Rockfish



Lingcod



How does the assemblage vary in space?



Canonical Correlation Analysis

Bank-Slope-Interface *Cobble-Mud Areas*

Sculpins



Prickleback



Shortspined Combfish



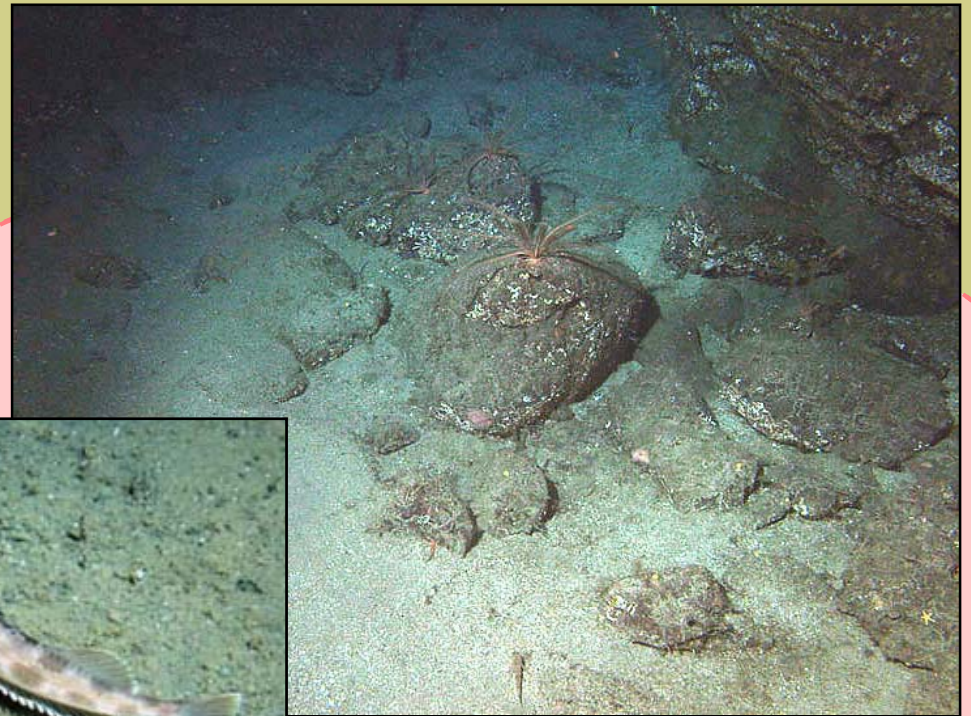
Greenstriped Rockfish



Sharpchin
Rockfish



Greenspotted Rockfish



Synthesis & Future directions

- Clear fish-habitat relationship

Habitat = proxy for adult abundance
area-based management

** 2005/2006 - Multibeam survey to map physical habitats*

** comparison with other MPA and non-MPA sites*

Synthesis & Future directions

- Clear fish-habitat relationship ...
- Little temporal variability in adult numbers ...
tri-annual surveys sufficient...

Synthesis & Future directions

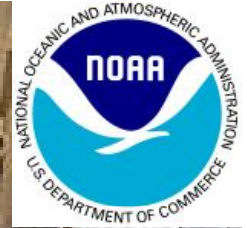
- Clear fish-habitat relationship ...
- Little temporal variability in adult numbers ...

BUT..

- ... Juvenile numbers temporally variable...
recruits critical to the recovery of depleted stocks
consequently... annual recruit surveys will be a critical
source of information on the input requirements and
recovery potential of the Bank.



Acknowledgements



Team photo (left to right) ...

- Dave Slater (*Delta*)
- Dale Roberts (CBNMS)
- Tara Anderson (NMFS)
- Jodi Pirtle (WSU)
- Dan Howard (CBNMS)

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- Bob Lea (Cal. Fish & Game)
- Joe Little (*Delta*)
- Linda Snook (UCSB)
- Chris Ijames (*Delta*)



Acknowledgements



Additional thanks to ...

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- Michael Carver (CBNMS)
- Jenny Stock (CBNMS)
- Craig Syms (UCSC)
- Rowana Forest (CBNMS)
- Pam Van der Leeden (CBNMS)

End of slide show