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

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• **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.
... 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
The Bank is ~ 15 x 7 Km

Top of the Bank is 28-40 m below the sea surface
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)
* 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
  \( (\text{substratum types; invertebrate cover}) \)
- Repeated annually ...
Results:

What habitats occur on Cordell Bank?
Top of Bank – *Diverse inverts*

- 32 m
- 35 m
- 41 m
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

All groundfish

number of species

Top of Bank
Upper Bank
Lower Bank (west)
Lower Bank (east)
Slope (west)
Shelf (east)
Rockfish Species account for 44%
Groundfish Abundance

n=86,705

Fish Abundance

Fish per 1000 m²

- Top of Bank
- Upper Bank
- Lower Bank (west)
- Lower Bank (east)
- Slope (west)
- Shelf (east)
Rockfish Abundances account for 95%
But these numbers aren’t necessarily constant through time…
Blue, Widow, & Squarespot
Juvenile rockfishes

Kip Evans
Blue, Widow, & Squarespot
Juvenile rockfishes

Kip Evans
How does the assemblage vary in space?

Canonical Correlation Analysis

- Canonical Variate 1 (50%)
- Canonical Variate 2 (21%)
How does the assemblage vary in space?

Canonical Correlation Analysis

Canonical Variate 1 (50%) vs. Canonical Variate 2 (21%)

DEPTH MUD

Eelpouts, Splitnose Rockfish, Longspined Combfish, Stripetail Rockfish, Poacher Flatfish, Hagfish
Mud Slope

- Spotted Ratfish
- Poachers
- Longspined combfish
- English Sole
- Splitnosed Rockfish
- Stripetail Rockfish
- Slender Sole

Hagfish Grotto
How does the assemblage vary in space?

**Canonical Correlation Analysis**

- **Canonical Variate 1 (50%)**
- **Canonical Variate 2 (21%)**

**DEPT**

- Eelpouts
- Longspined Combfish
- Poacher Flatfish
- Splitnose Rockfish
- Stripetail Rockfish
- Hagfish

**MUD**

**SAND**

- Sanddabs
- Skates

**SANDS**

-1.2 -0.8 -0.4 0.0 0.4 0.8 1.2

-0.8
Lower east-side Sand

Skate

Sanddab
How does the assemblage vary in space?
Top of Bank / Rocks & Boulders

- Blue Rockfish
- Quillback Rockfish
- Young of Year Rockfish
- Yellowtail Rockfish
- Rosy Rockfish
- Kelp Greenling
- Juv. Yelloweye Rockfish
- Squarespot Rockfish
Lower Bank / Rocks & Boulders

- Starry Rockfish
- Rosethorn Rockfish
- Pygmy Rockfish
- Bocaccio
- Flag Rockfish
- Vermillion Rockfish
- Greenspotted Rockfish
- Yelloweye Rockfish
- Lingcod
How does the assemblage vary in space?

Canonical Correlation Analysis
Bank-Slope-Interface
Cobble-Mud Areas

Sculpins

Prickleback

Shortspined Combfish

Sharpchin Rockfish

Greenspotted Rockfish

Greensstriped 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.
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End of slide show