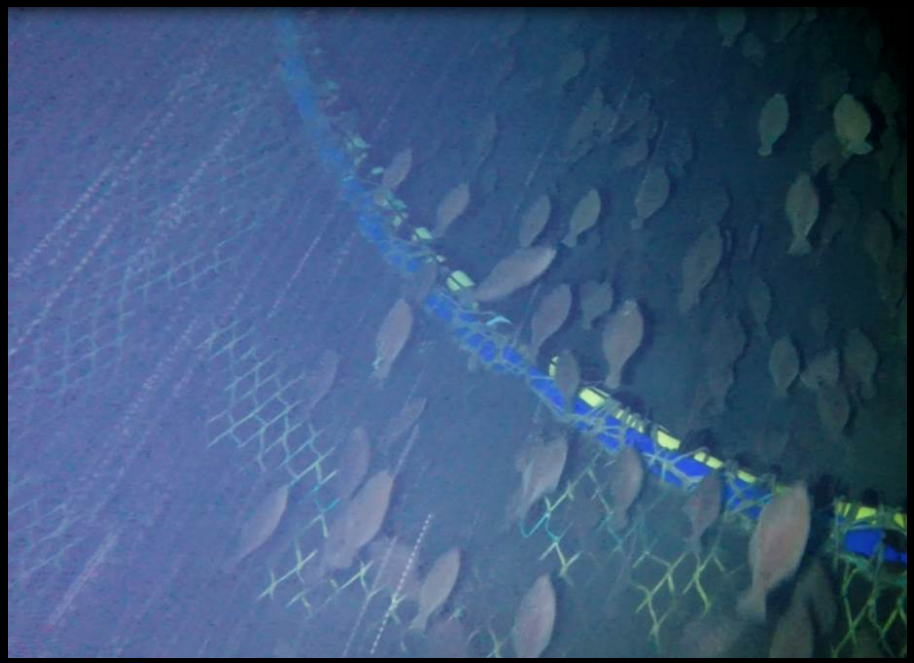
Quantification of Seafloor Habitat Impacts Under Selected Trawl Modifications

A Collaborative Approach to Resolving Pressing Management Questions



MBNMS Sanctuary Advisory Council
17 August 2018

IfAME
Institute for Applied Marine Ecology

James Lindholm, Larissa Lemon & Jordan Smith
Institute for Applied Marine Ecology at CSU Monterey Bay

Thanks to:

Giuseppe Pennisi – FV *Pioneer*

Huff McGonigal – Environmental Defense Fund

David Crabbe – Pacific Fishery Management Council

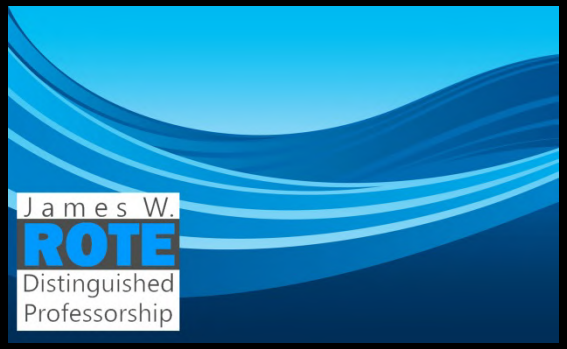
Dr. Andrew DeVogelaere – Monterey Bay
National Marine Sanctuary

Crew of the FV *Donna Kathleen*

Crew of Marine Research and Exploration (MARE)

Generous Support From:

Saltonstall-Kennedy Grant Program

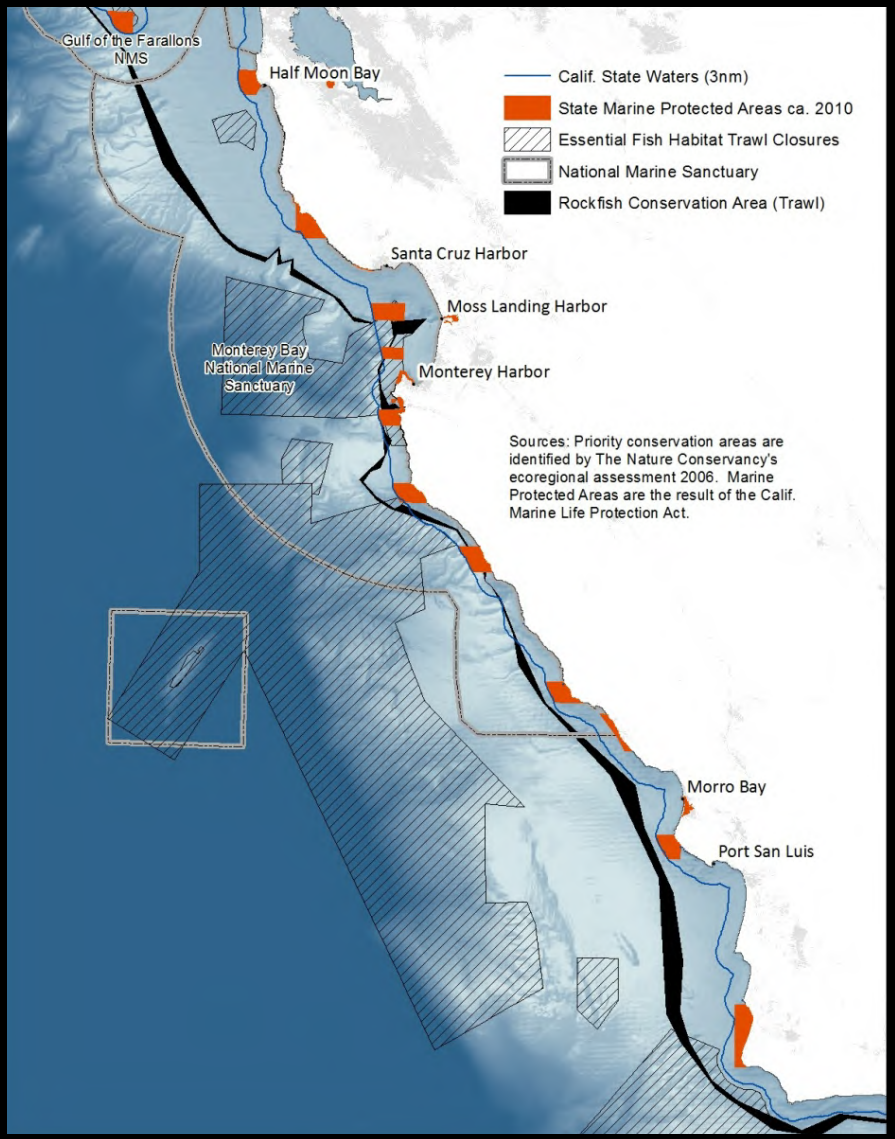


Existing Management Context

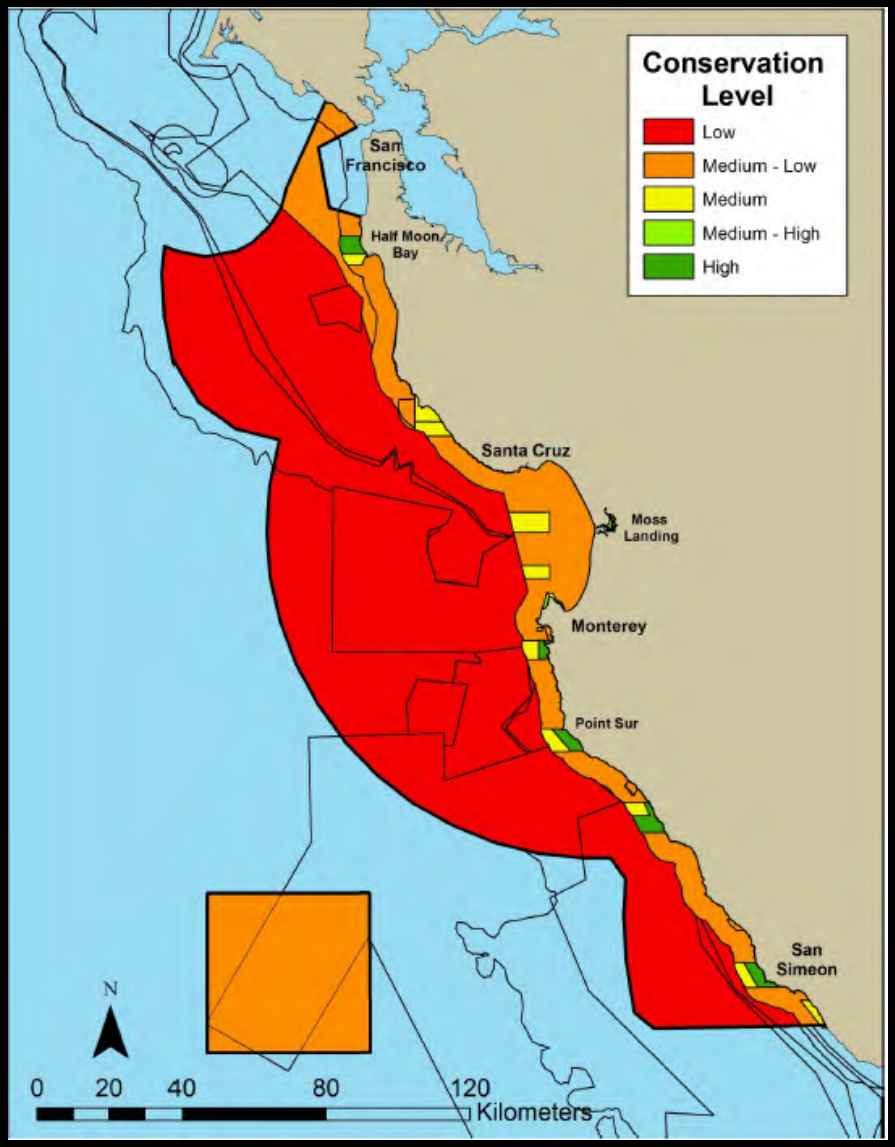
Extensive spatial management in CA

Up to 60% of the area between Cape Mendocino and Pt. Conception is closed to trawling through regulation.

Further zoning of trawl in open areas through private agreements



Extensive spatial management in CA



Is *everywhere* protected?

One answer is *NO*. Fifty-one discrete management zones ranked according their conservation value.

< 1% of Sanctuary scored *High* or *Medium High*

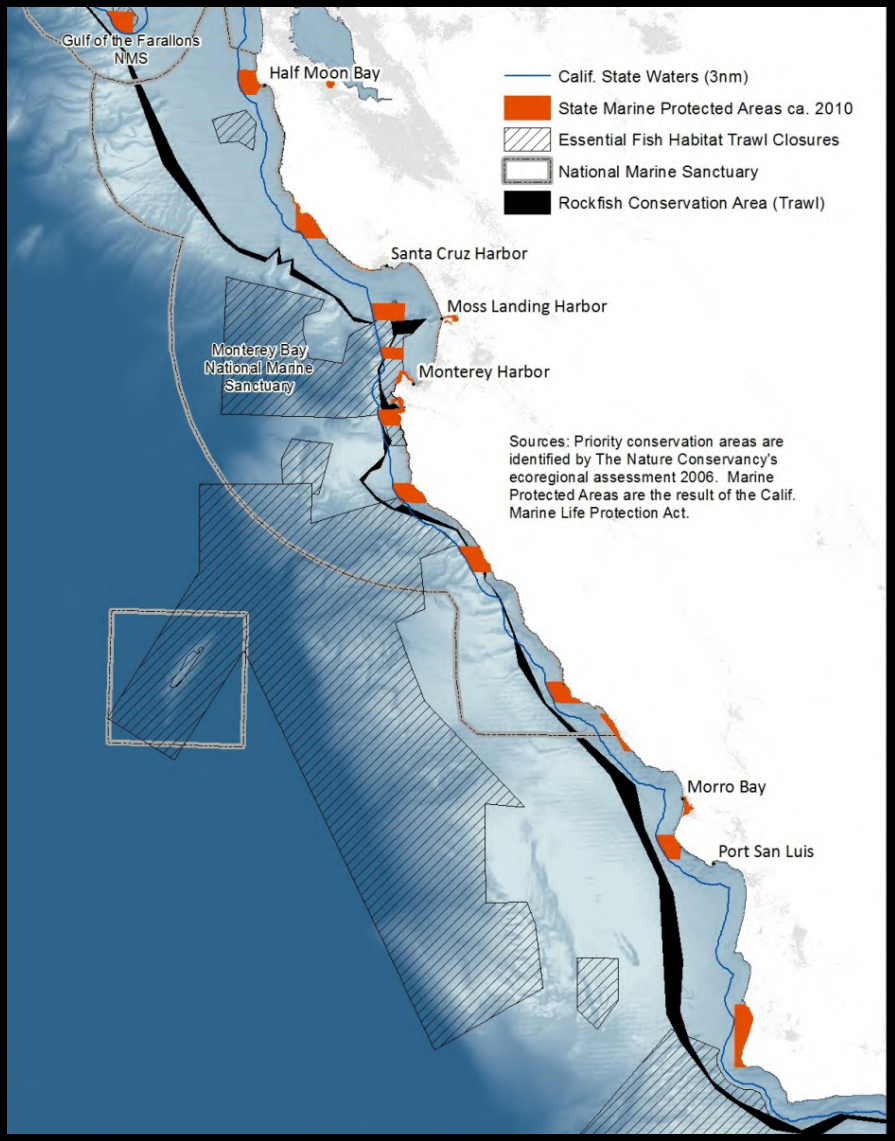
Adelaars et al., (2015)

Extensive spatial management in CA

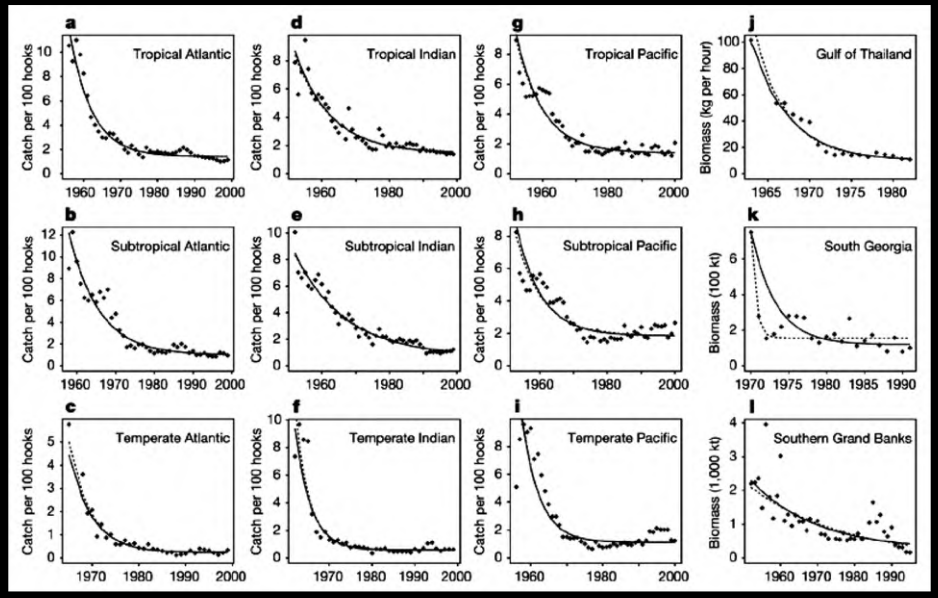
Will the footprint remain the same?

SHOULD the footprint remain the same?

What kind of science would support more nuanced decision-making?



Three-fold impact of fishing on ecosystems

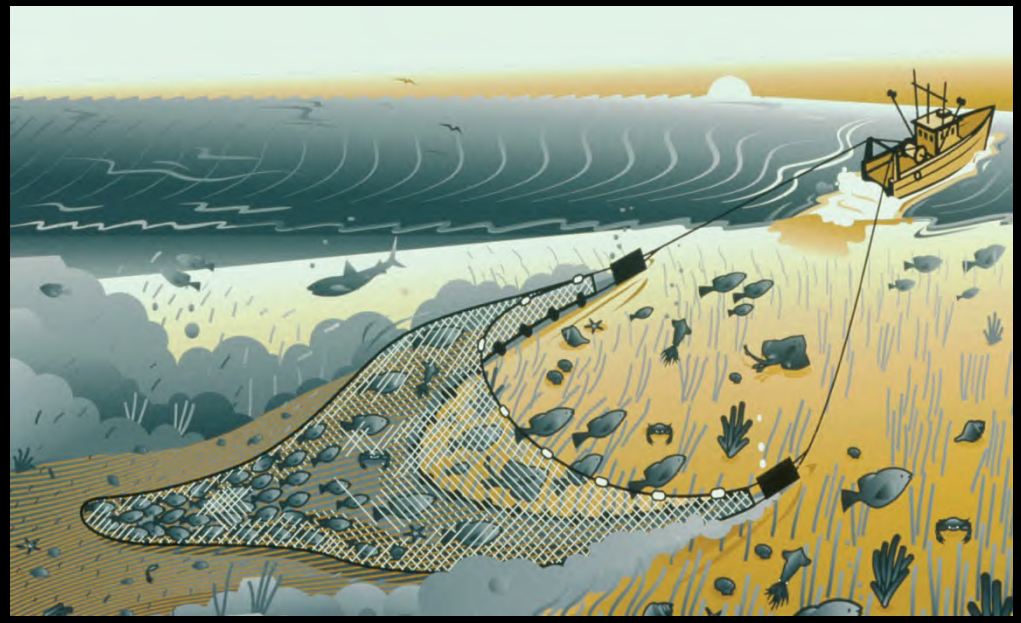


DIRECT removal of organisms that are…

<<< Targeted

and not >>>

INDIRECT alteration of demersal fish habitat >>>



Fish-Habitat Interactions

What are *fish* habitats?

	DEMERSAL	PELAGIC
10-100s km	**Temperature+ Depth**	**Temperature+ Depth**
km	**Sediment Type**	**Boundary Conditions**
m - cm	**Sediment Texture+ Biogenic Structure**	**Biogenic Structure**

Stolen from Peter Auster

Survivorship strongly associated with structure

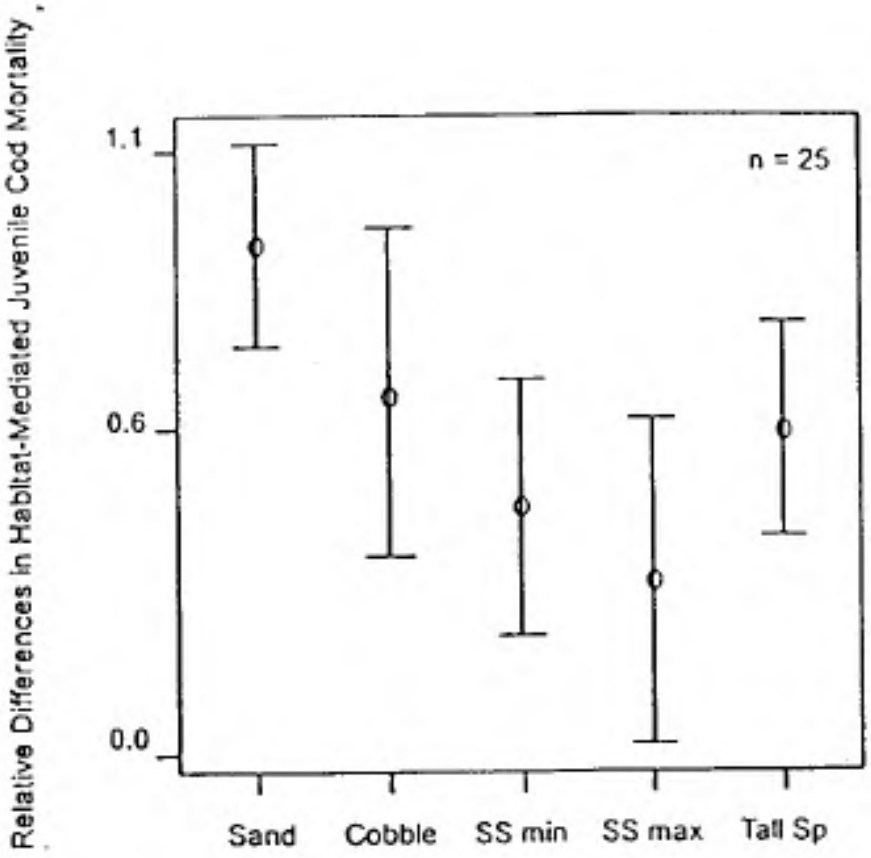
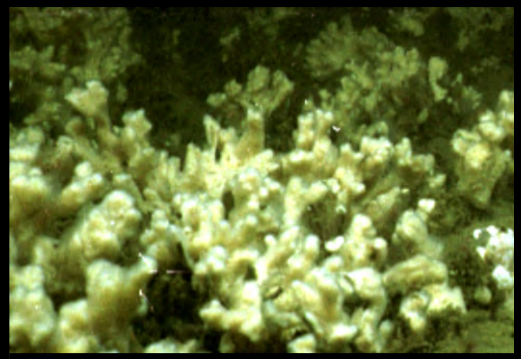


Fig. 2. Comparison of relative differences in juvenile cod mortality between habitat types (arcsine transormed). Means are reported with 95% confidence interval. SS min, SS max: minimum and maximum density short sponge; Tall sp: tall sponge

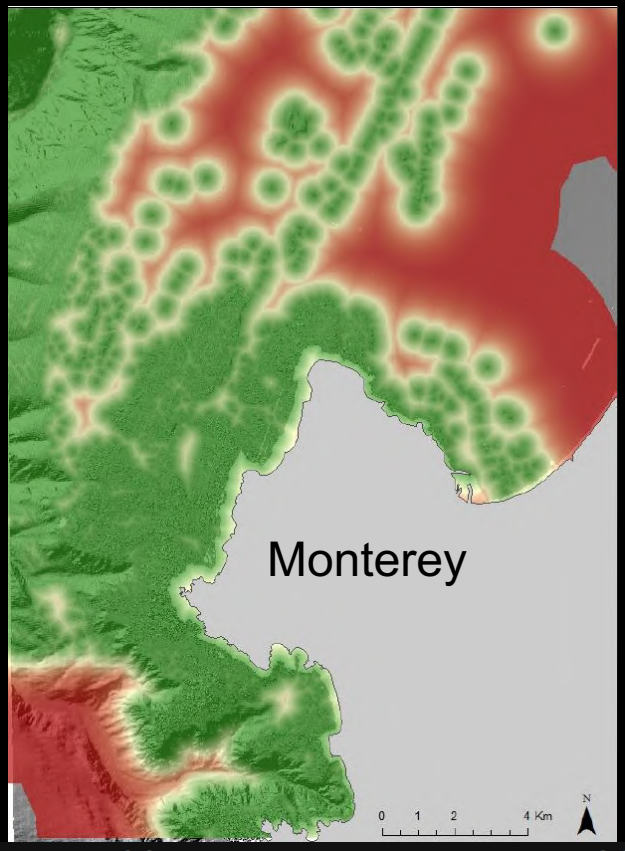


Lindholm et al. (1999)

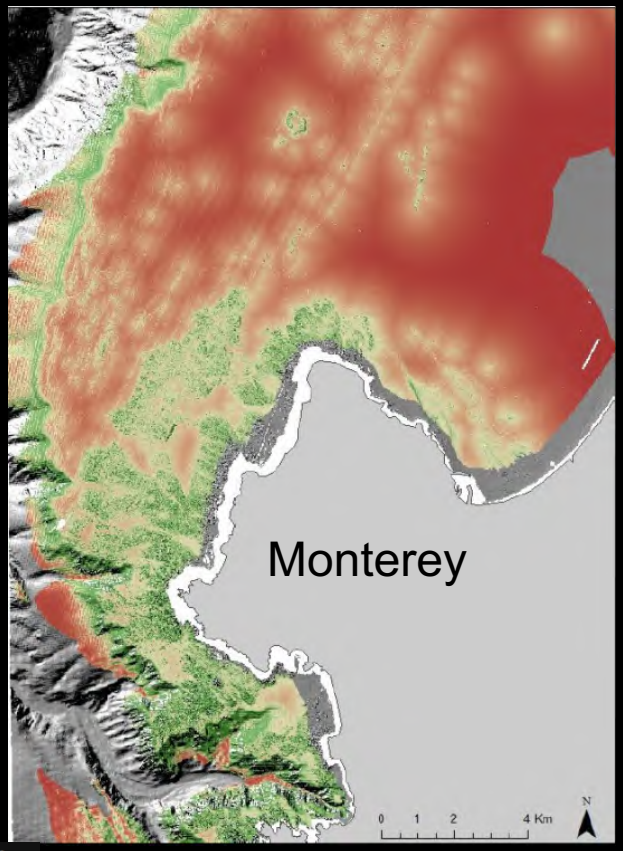
Ontogenetic shift in Lingcod habitat from low relief to high

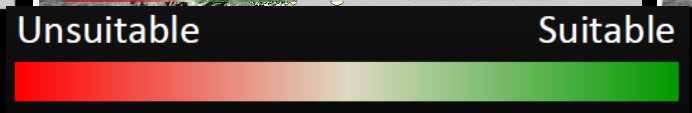
Year 1

Year 2



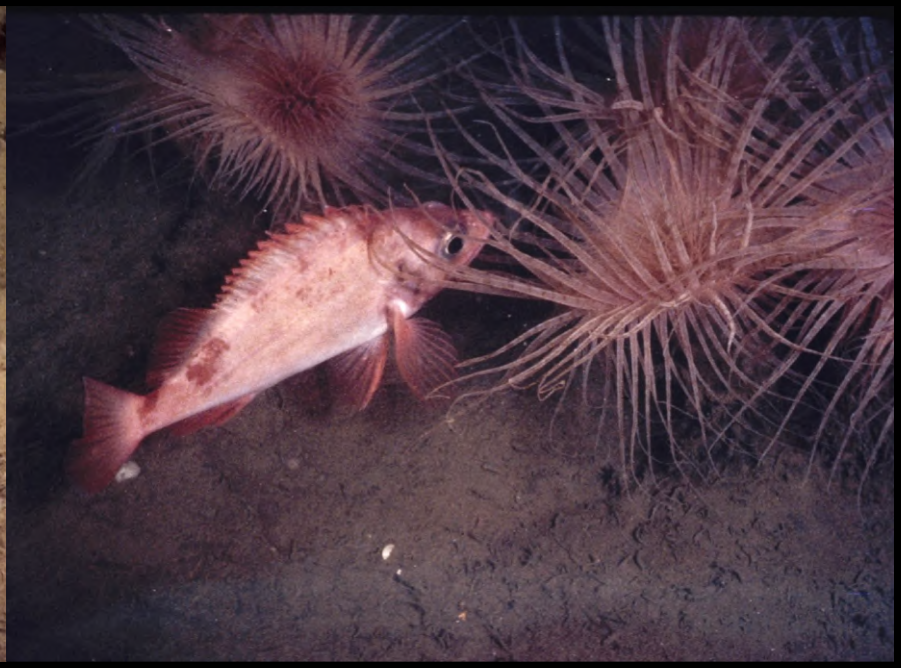
Year 3+





Bassett et al, (2017)

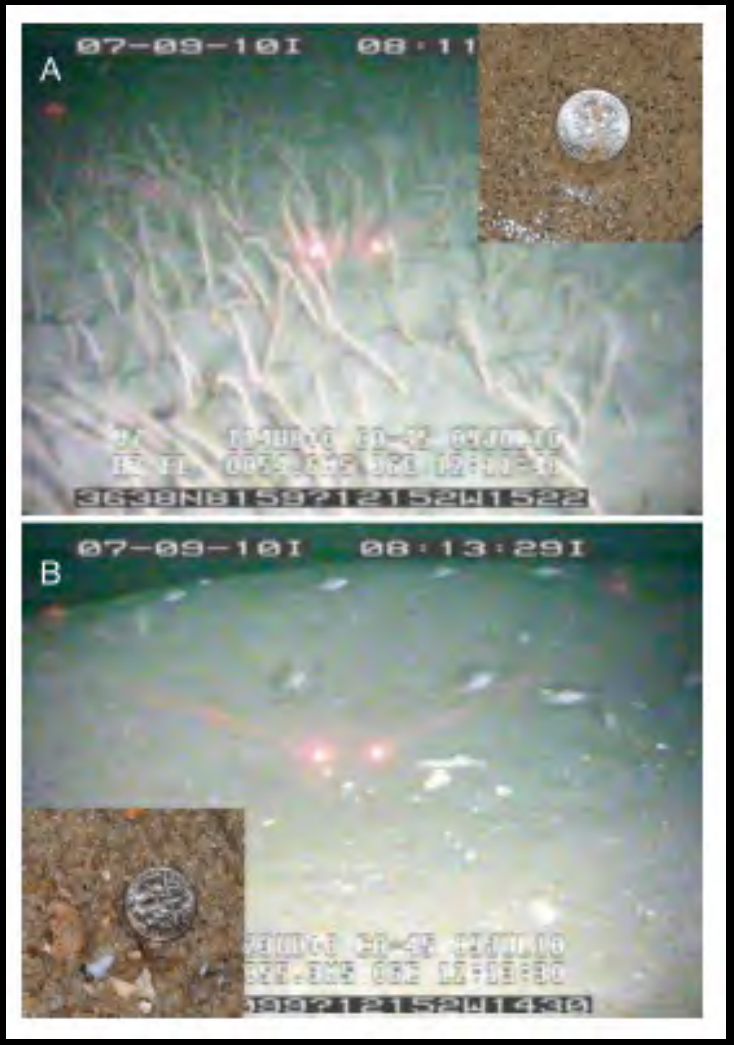
Acadian Redfish shift from high to low to no habitats



Habitat Type	Size Class			Totals
	0-10 cm	11-20 cm	21+ cm	
Boulder	689	346	4	1039
Cerianthid	4	119	69	192
Totals	693	465	73	1231

Auster et al. 2003

RSDs provide structure for 0-year Canary Rockfish



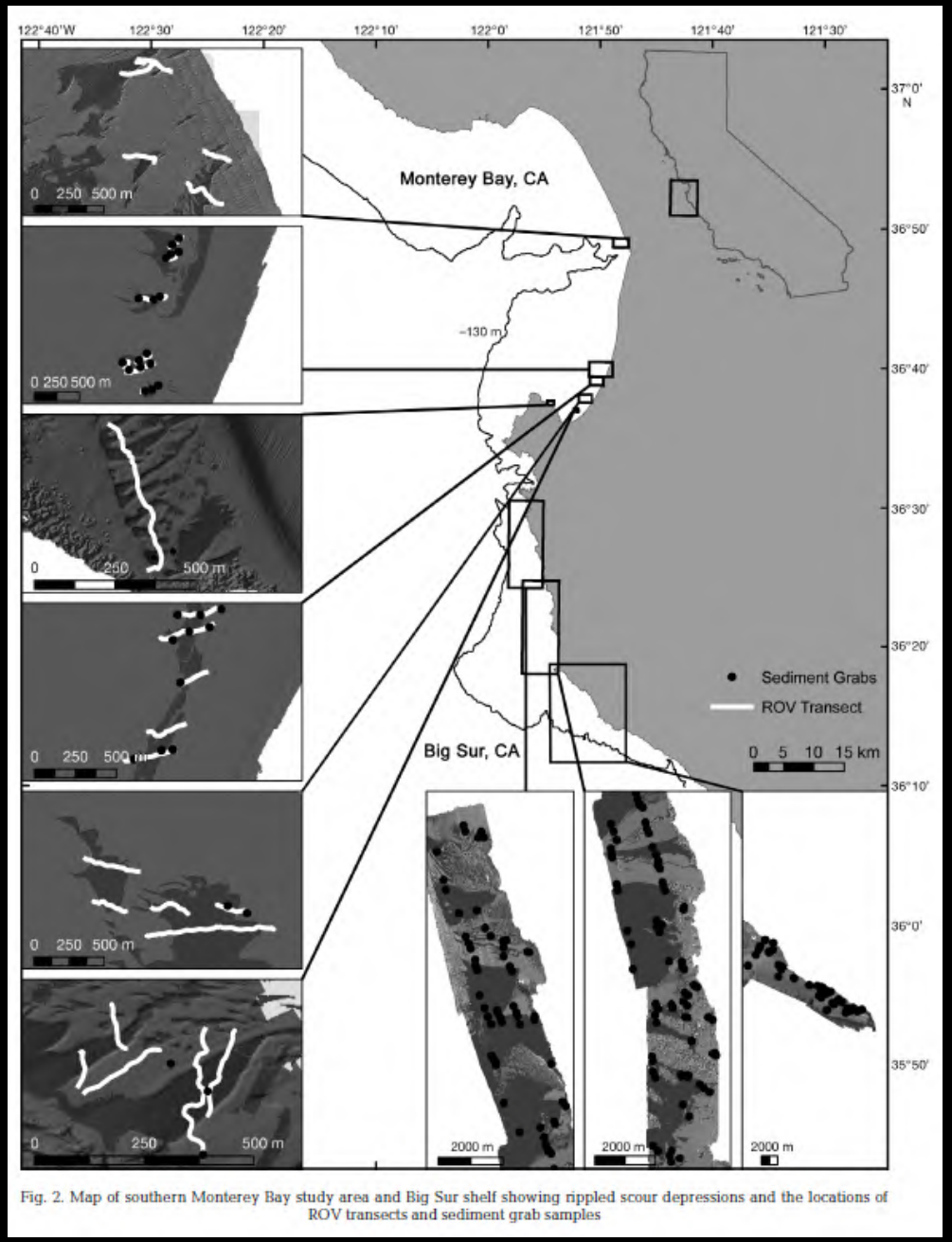
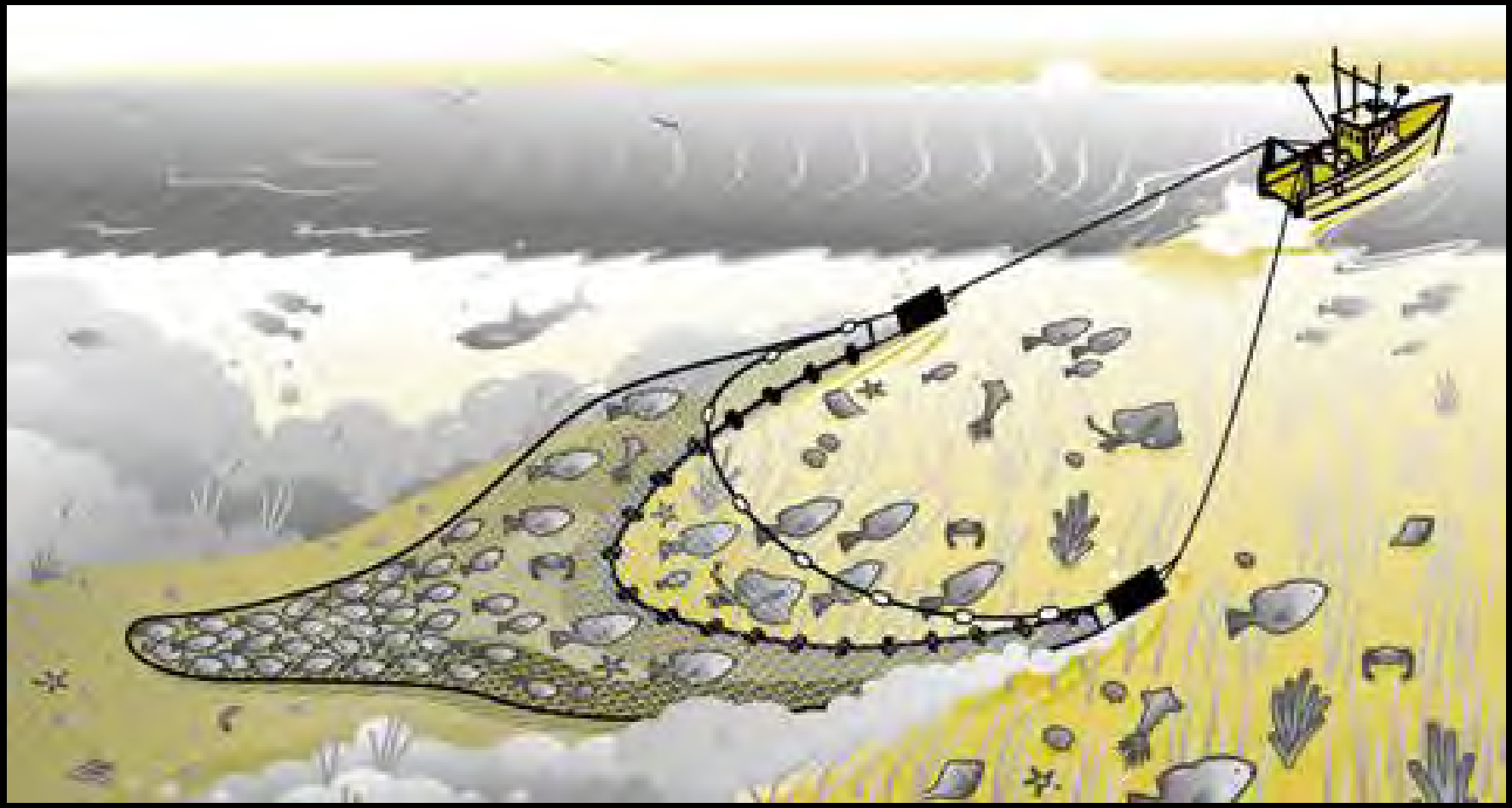


Fig. 2. Map of southern Monterey Bay study area and Big Sur shelf showing rippled scour depressions and the locations of ROV transects and sediment grab samples

Hallenbeck et al. (2012)

Seafloor Habitat Alteration

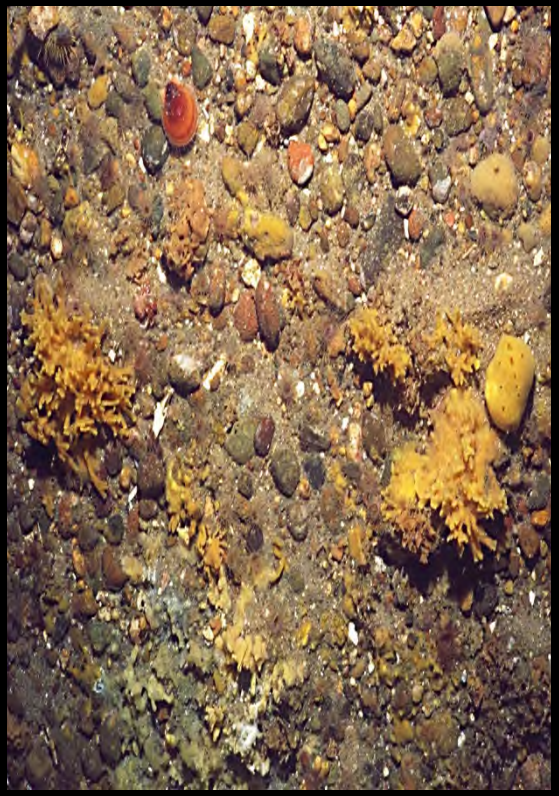
Bottom trawling *alters* seafloor habitats



Clear *impacts* to hard bottom habitats

Northeast Peak of Georges Bank

Actively trawled



Closed 2.5 years

Closed > 10 years

Courtesy of Page Valentine, US Geological Survey

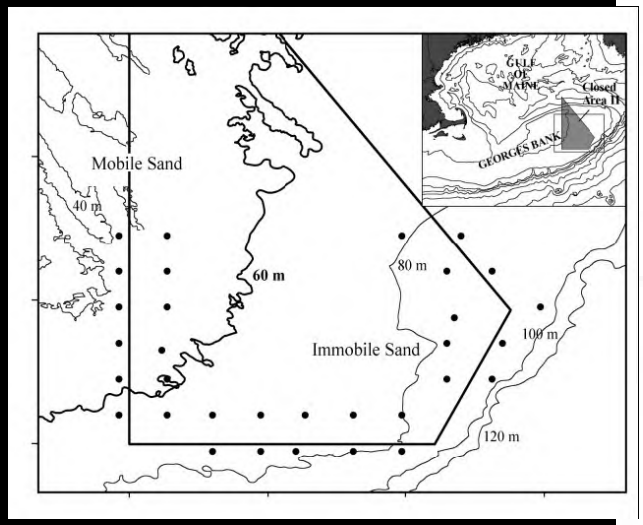
Clear *impacts* to hard bottom habitats

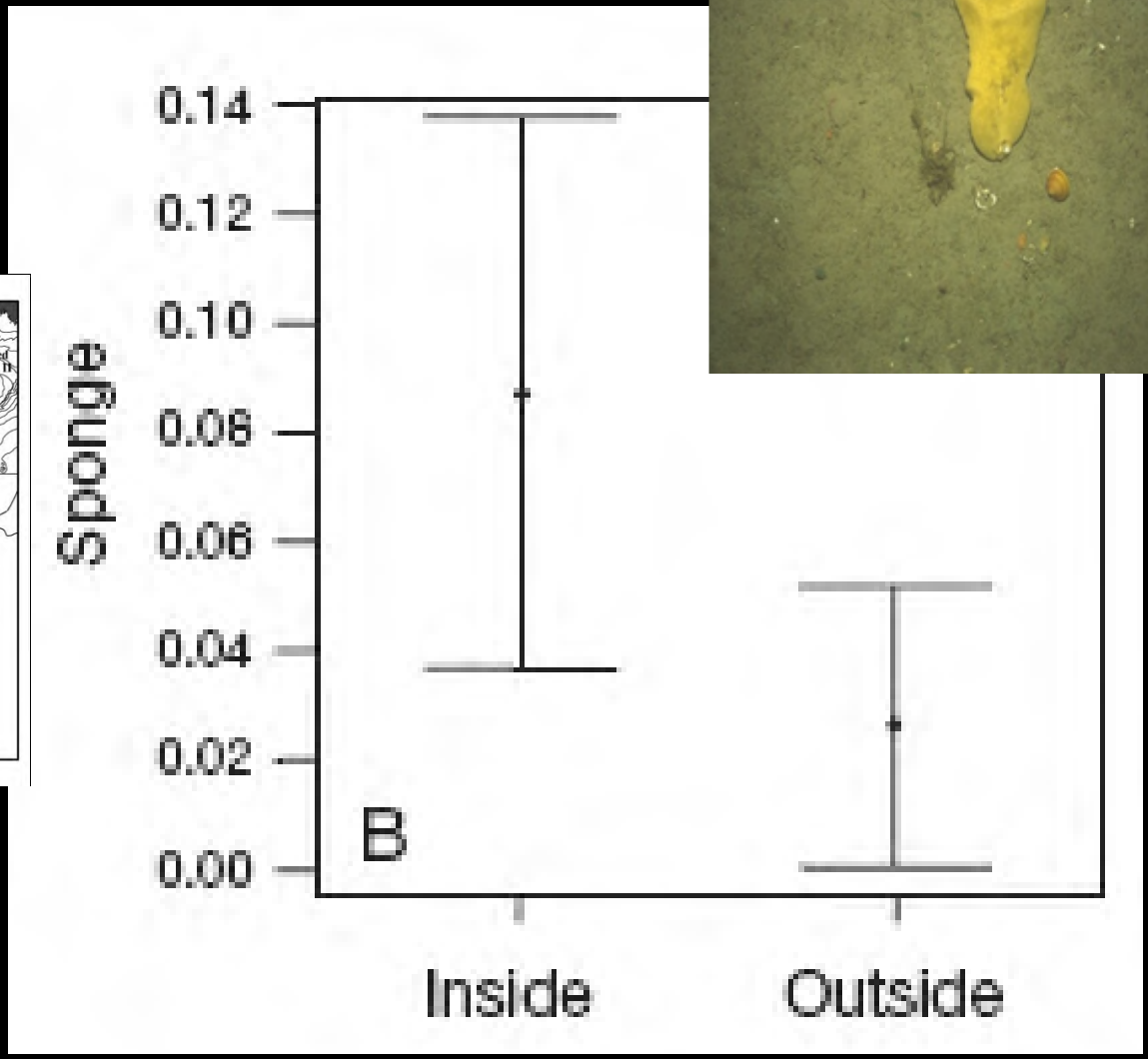
Stellwagen Bank in Western Gulf of Maine

Tamsett et. al. (2010)

Impacts to unconsolidated sediments variable

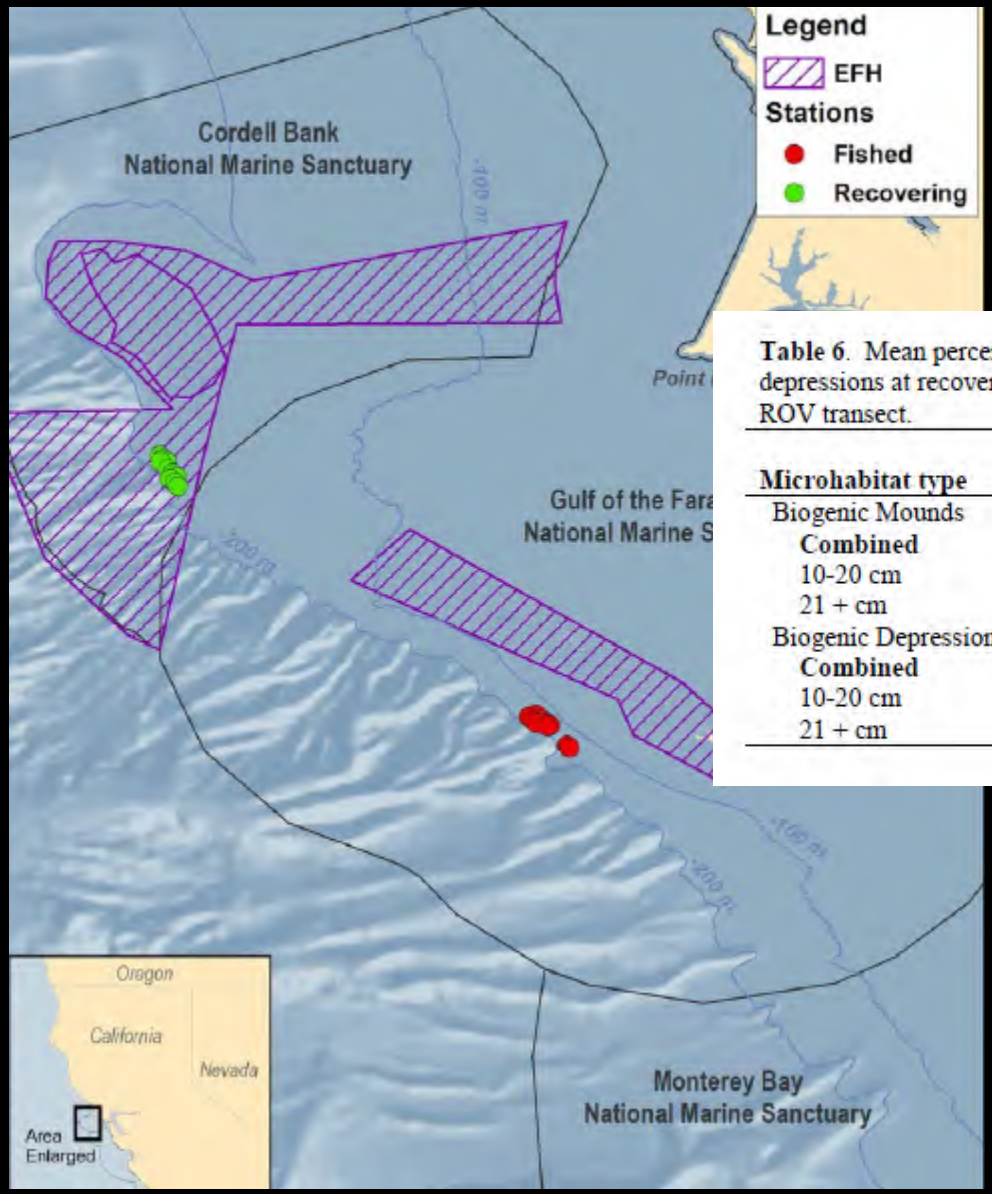
Georges Bank





Lindholm et al. (2004)

Impacts to unconsolidated sediments variable



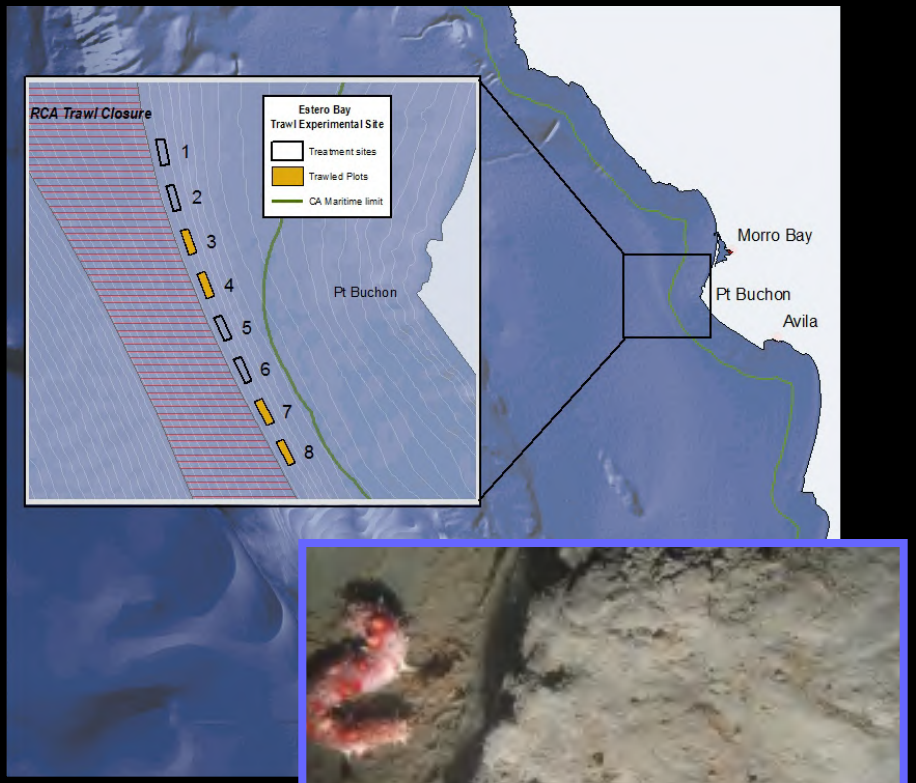
Central California Shelf Break

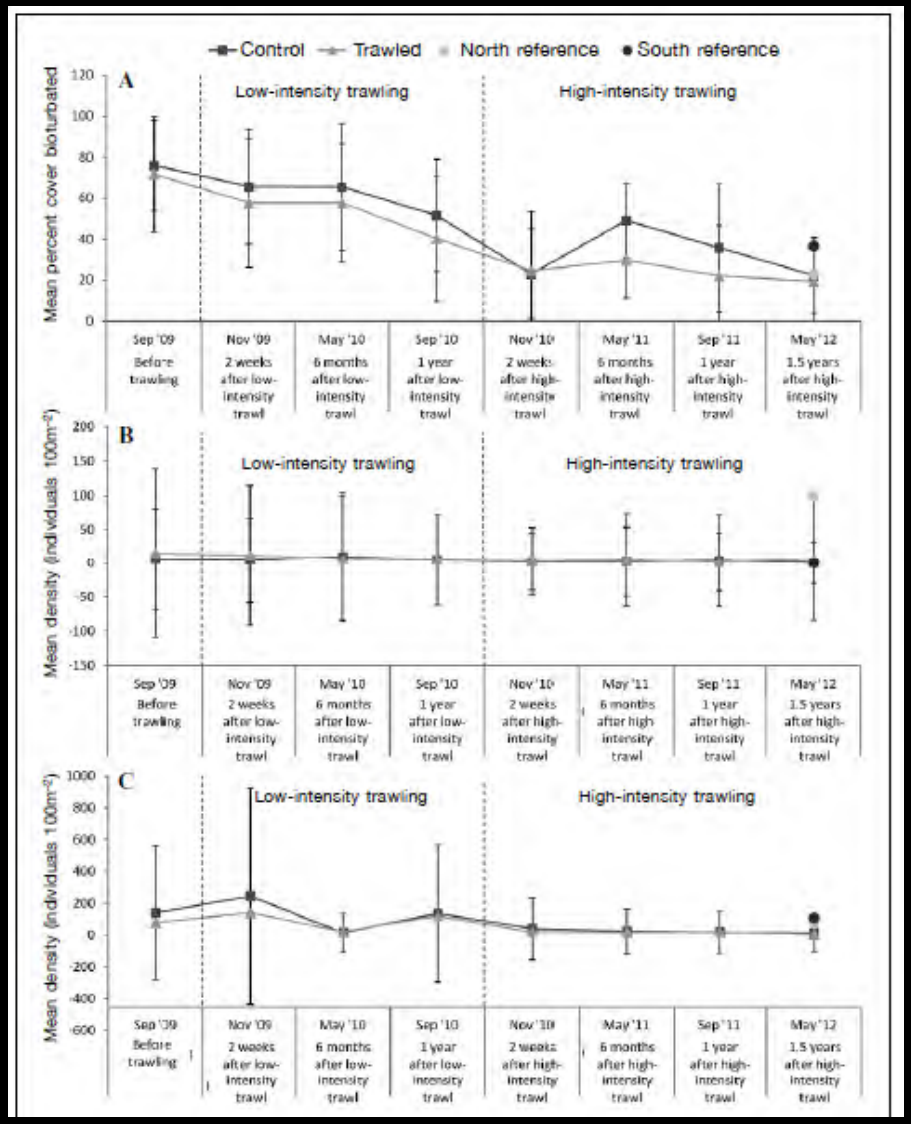
Table 6. Mean percent relative abundance of rare microhabitat types, biogenic mounds, and depressions at recovering and trawled transects in 2006, based on the number of video frames per ROV transect.

	Mean percent relative abundance	
Microhabitat type	**Trawled**	**Recovering**
Biogenic Mounds		
Combined	**11.9**	**28.3**
10-20 cm	11.1	23.5
21 + cm	0.78	4.9
Biogenic Depressions		
Combined	**12.9**	**31.6**
10-20 cm	11.4	22.8
21 + cm	1.6	8.8

de Marignac et al. (2010)

Impacts from variable levels of trawl effort





Lindholm et al. (2015)

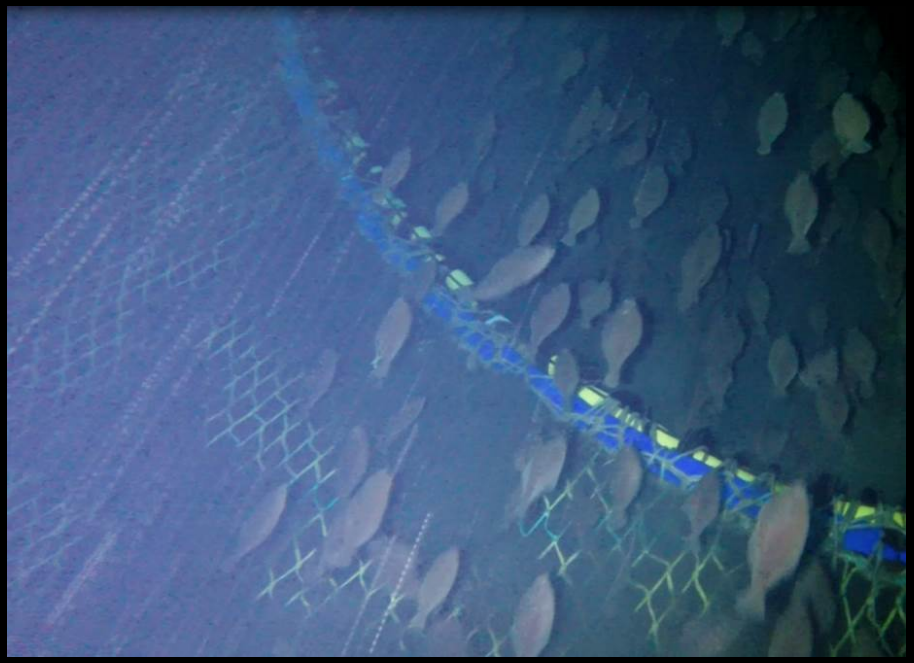
Monterey Bay Trawl Impact Study

Impacts from different trawl configurations

“Traditional” Trawl

- Thyboron Type 3, 4.5 sq. meter, ground tending doors
- 8 inch discs
- 2 seam net

“Modified” Trawl



- Thyboron Type 15VF 5.5 sq. meter pelagic trawl doors
- Marport door depth/spread sensors
- Elevated sweeps
- Elevating bobbins
- 14” discs
- Combination wire rigging
- Dantrawl POP 282/8B four seam net

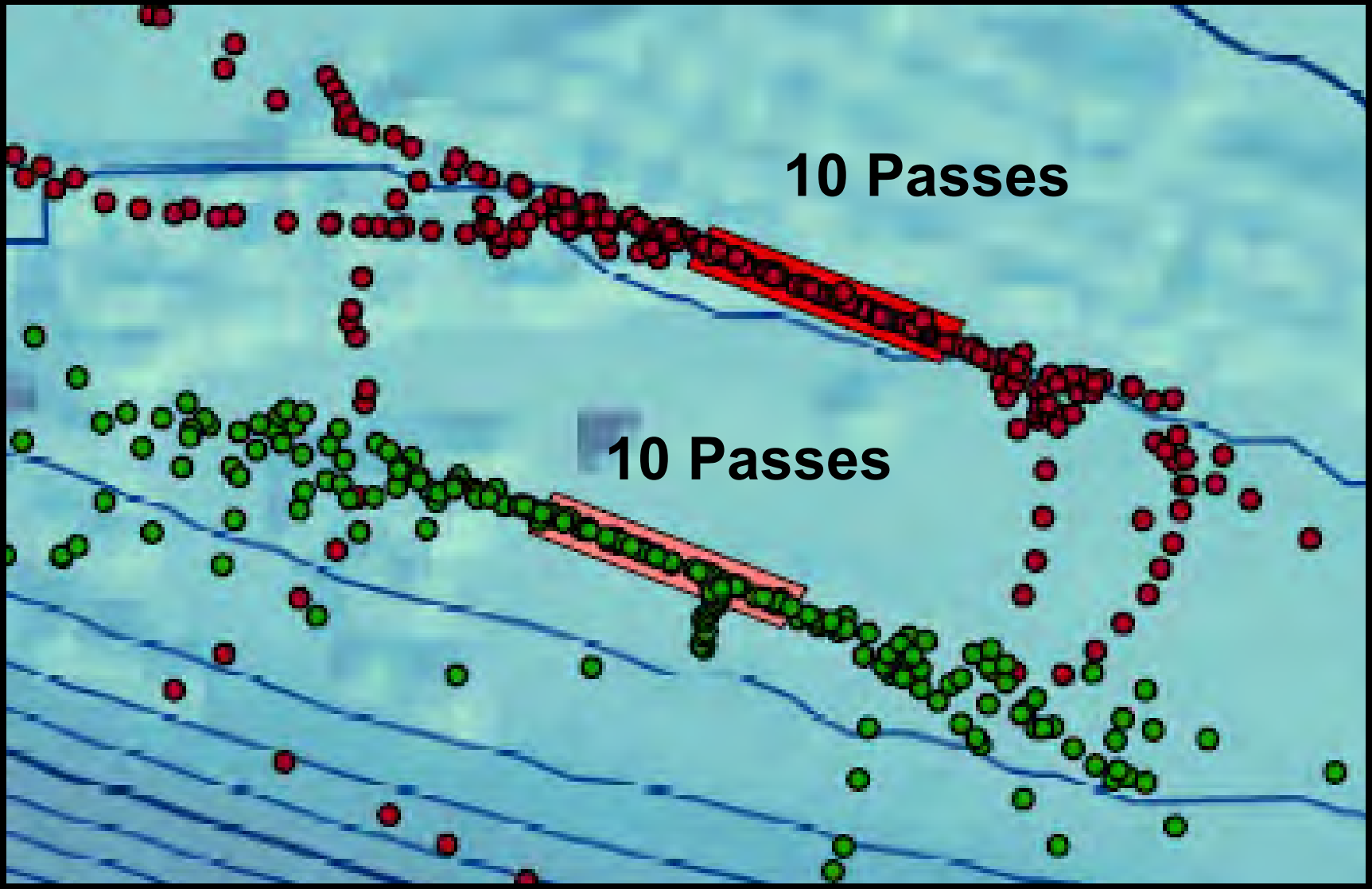
Collaborative approach

FV *Pioneer*

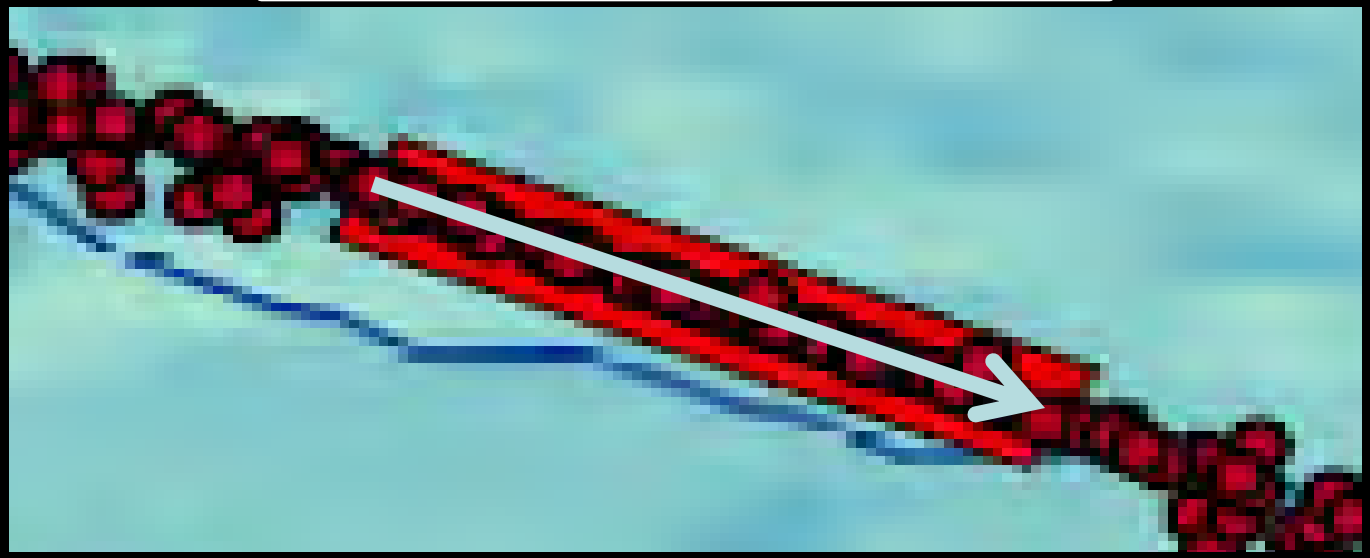
DOER Vector 4 ROV

FV *Donna Kathleen*

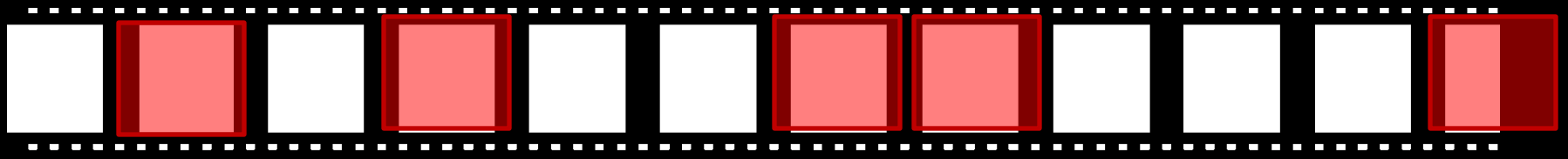
Comparable Effort per Treatment

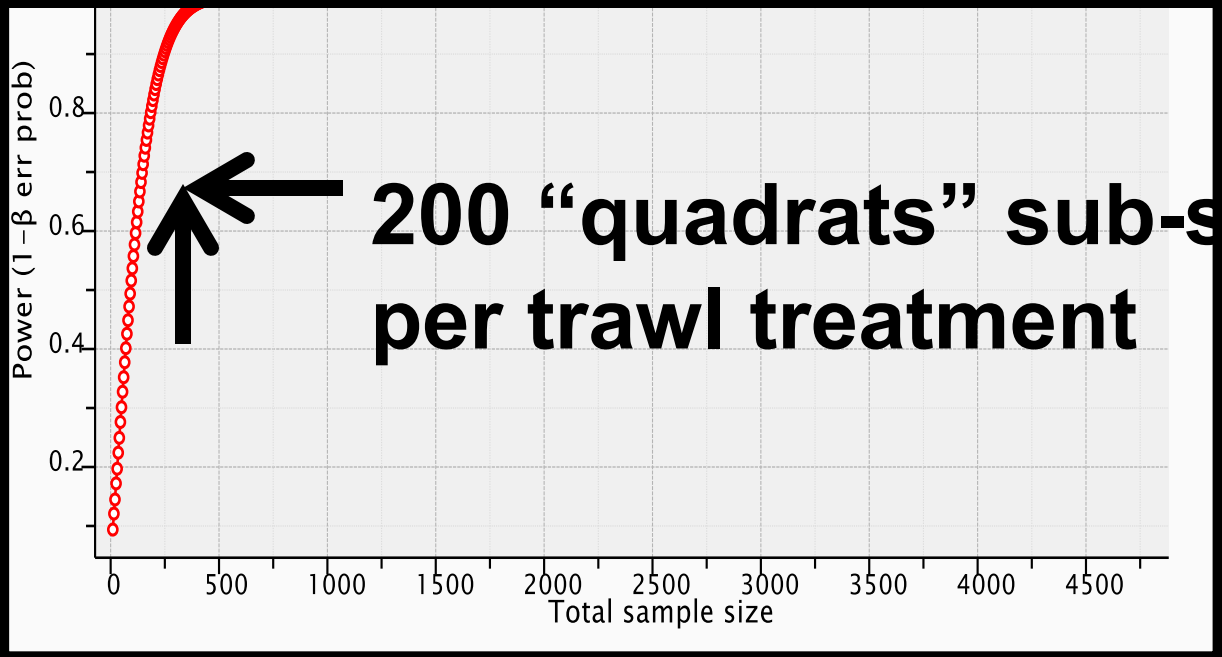


Non-overlapping video “quadrats”

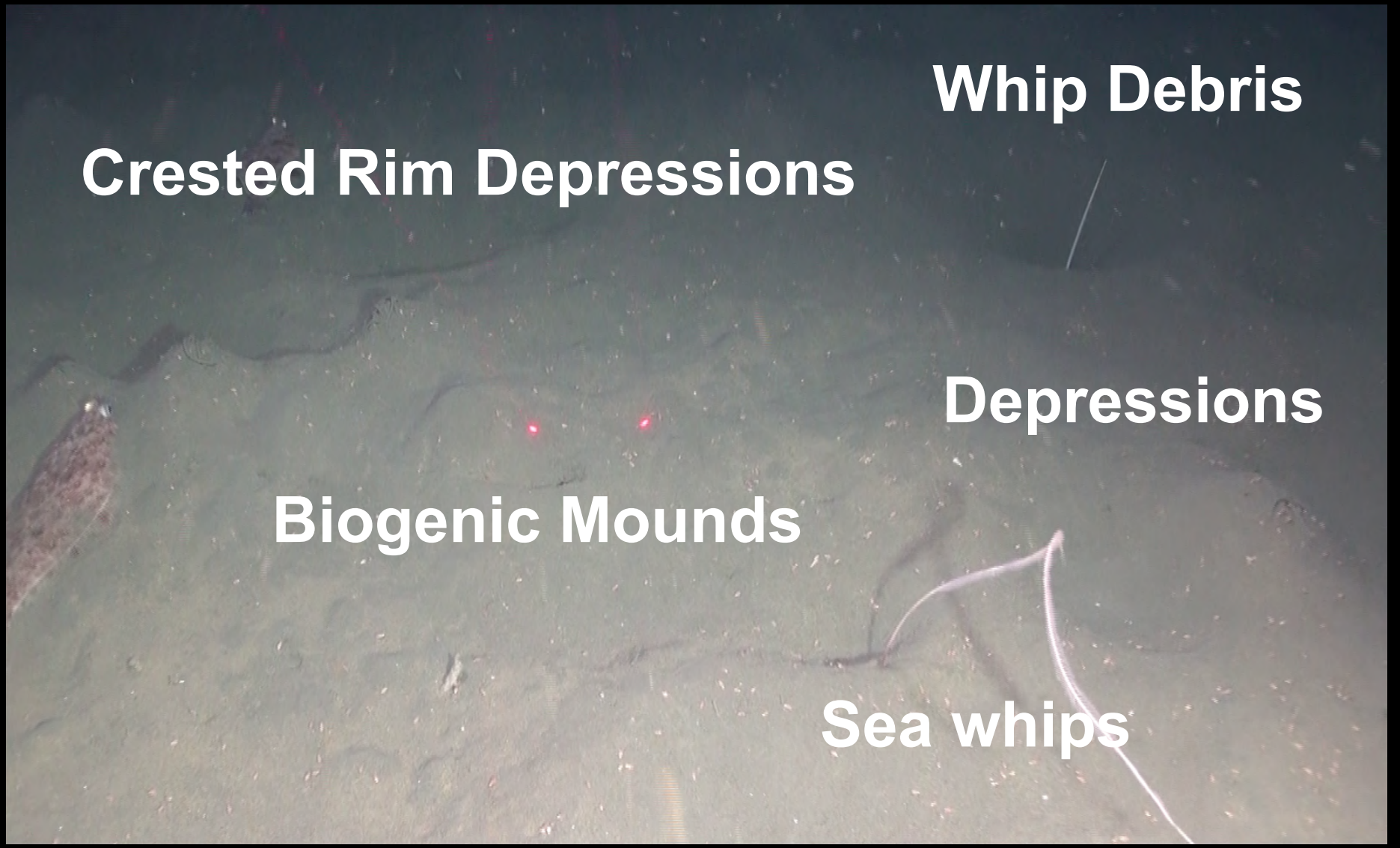


Randomly Sub-Sampled for High Statistical Power



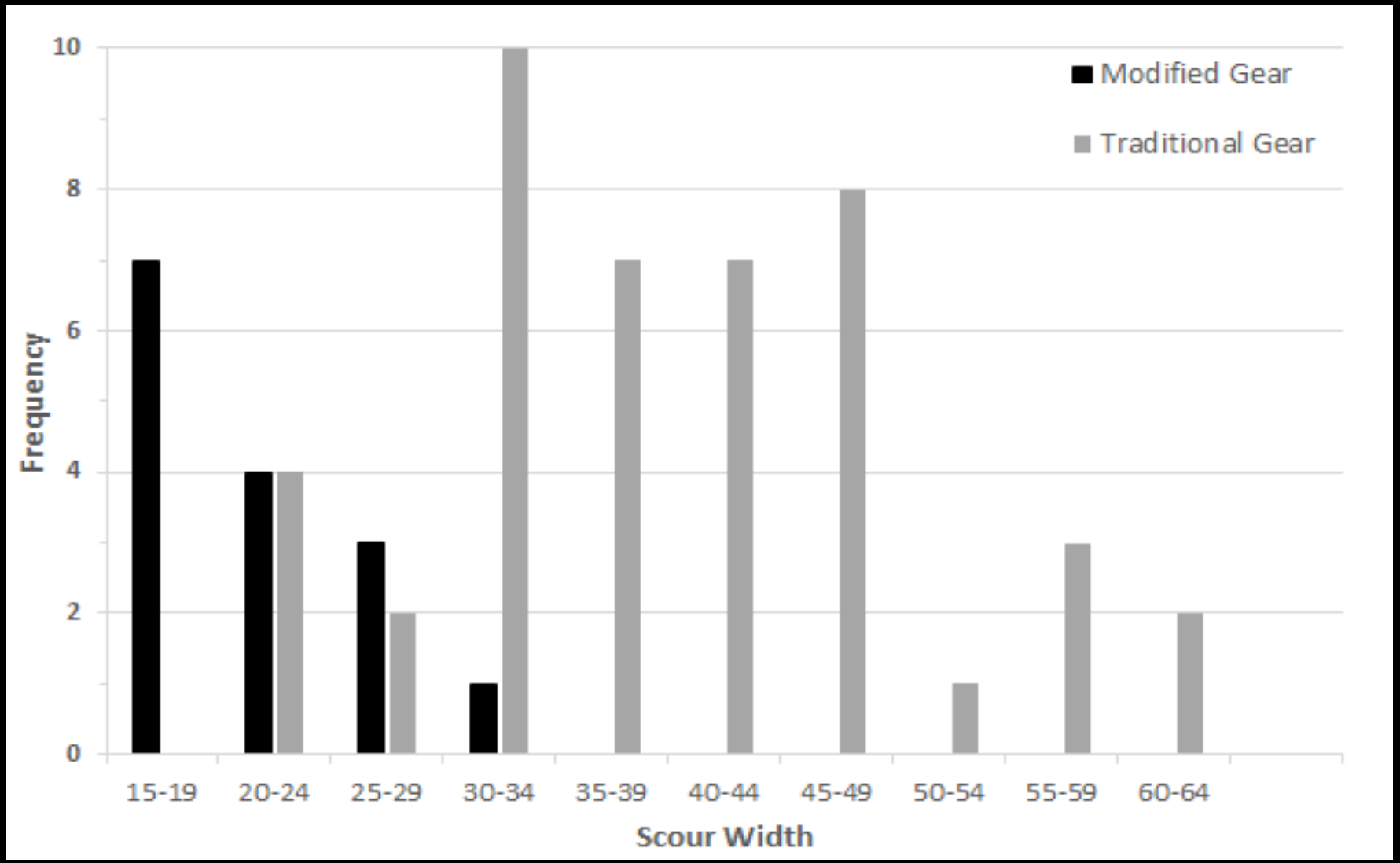


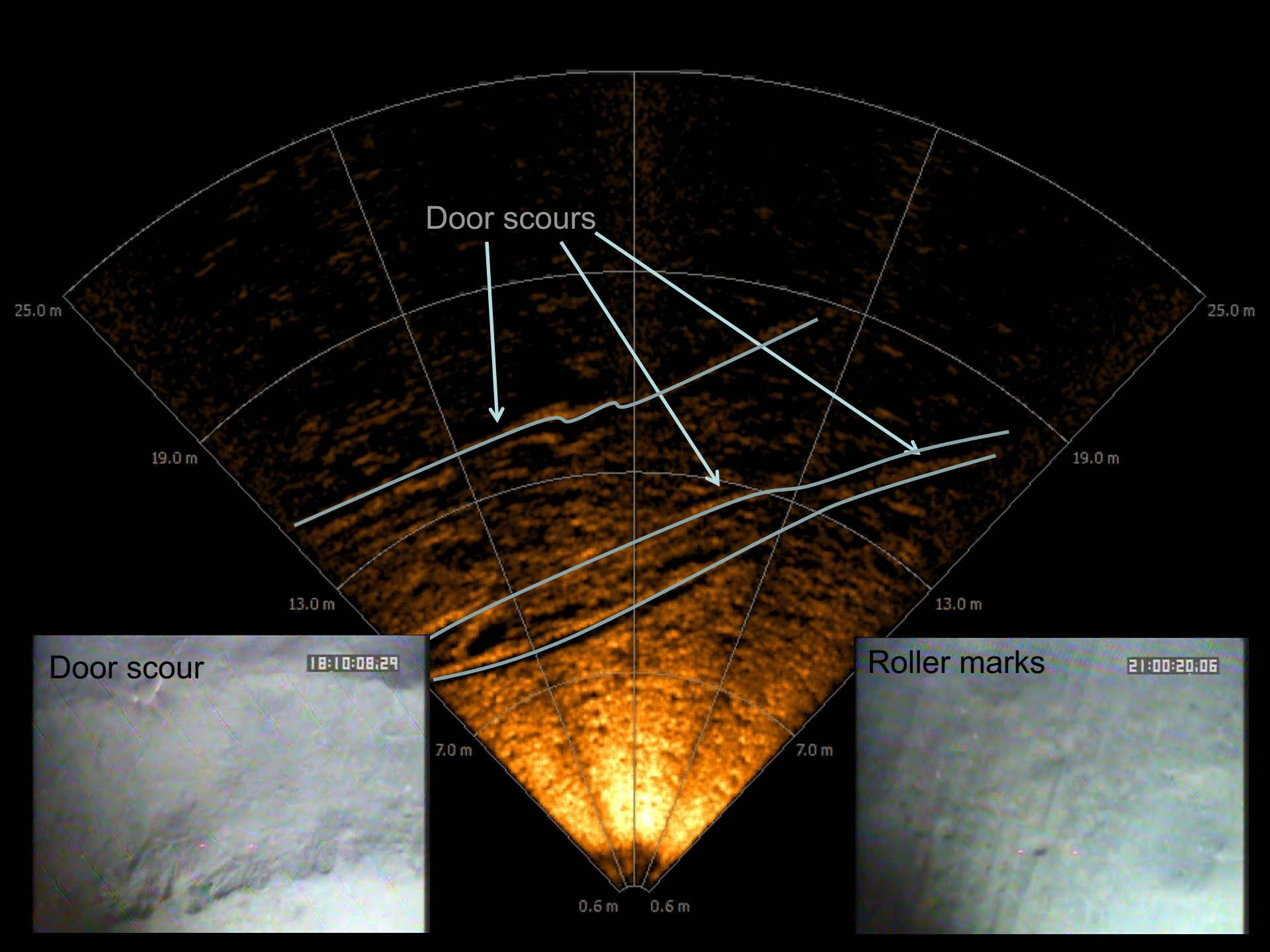
Physical and Biological Habitat Attributes



Results

Larger footprint on bottom from traditional door scour

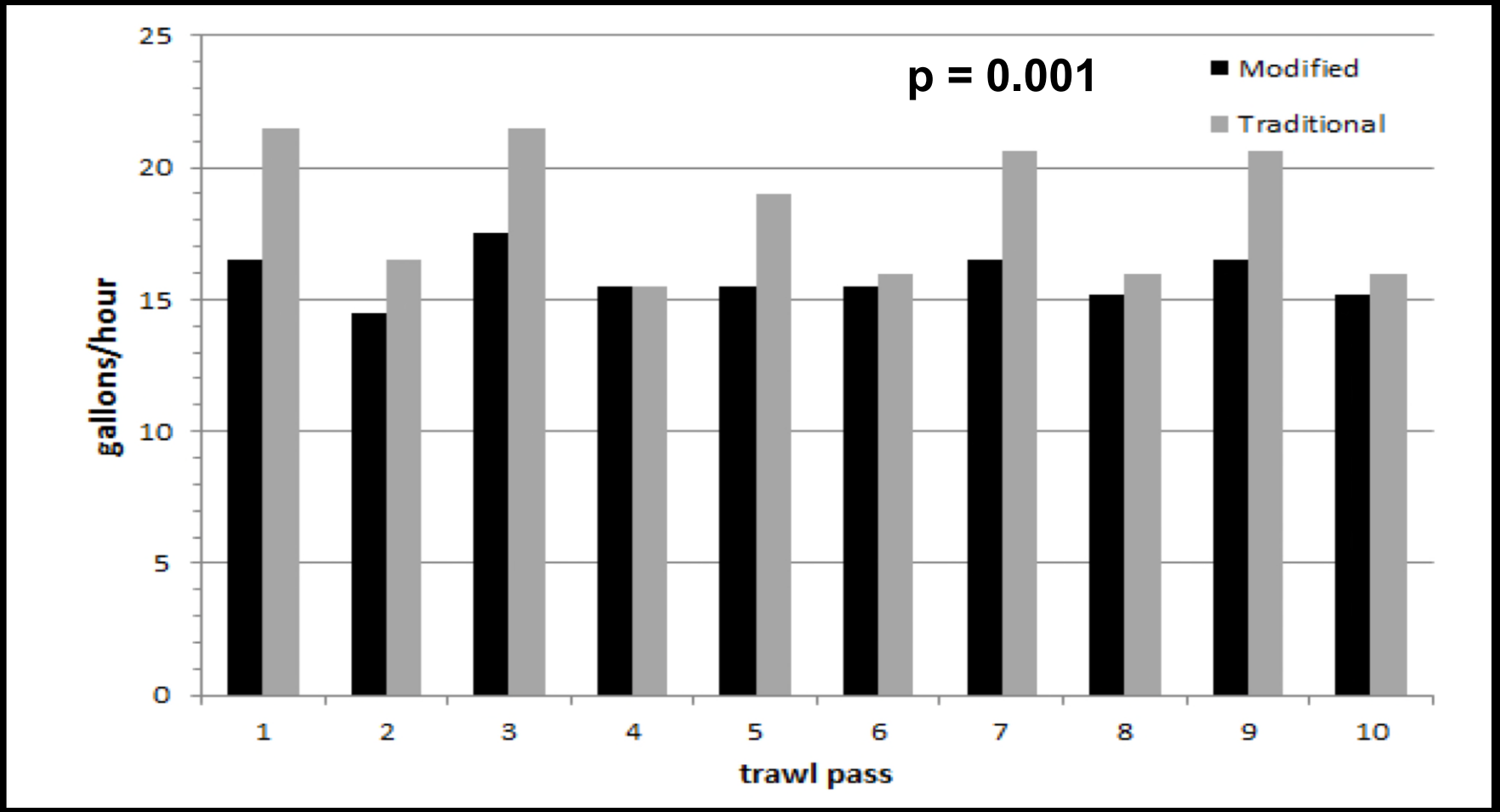



Door scours
25.0 m
25.0 m
19.0 m
19.0 m
13.0 m
13.0 m
7.0 m
7.0 m
0.6 m
0.6 m
Door scour
18:10:08:29
Roller marks
21:00:20:06

Physical Attributes

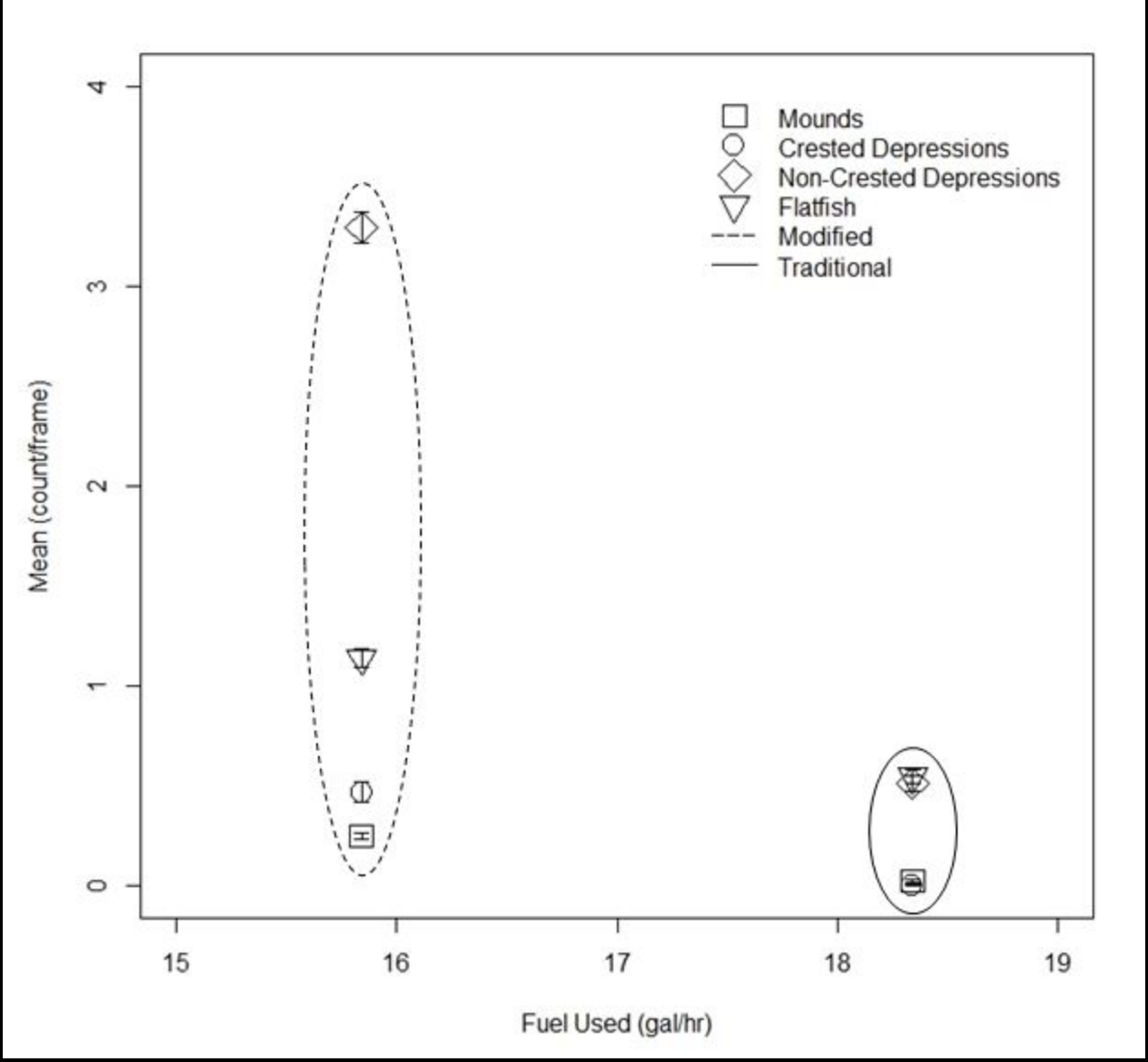
	Traditional	Modified
Crested Depressions	- 99%	- 34%
Depressions	- 86%	- 16%
Mounds	- 80%	- 64%

Traditional trawl used significantly more fuel **



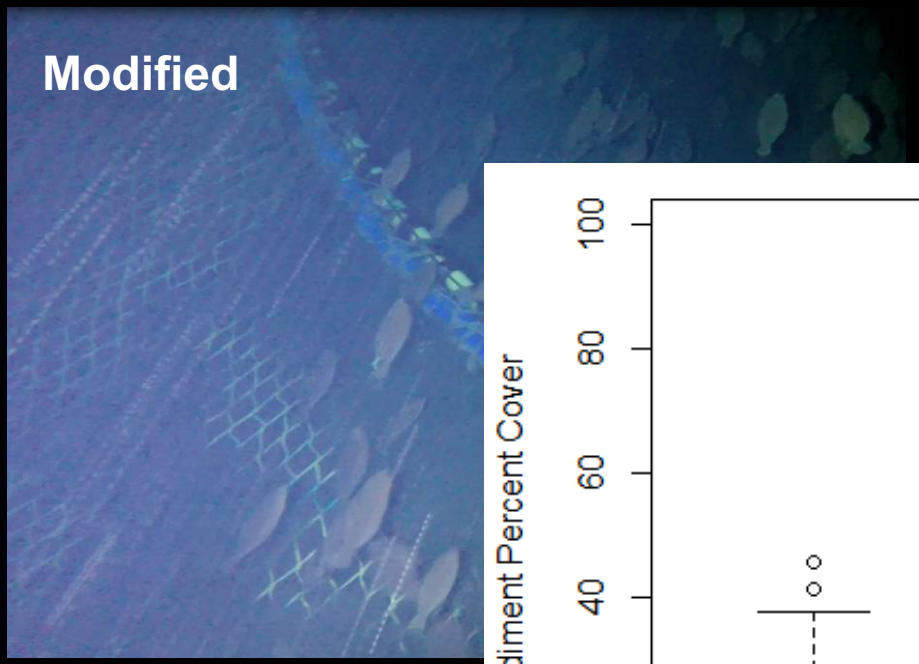
** Cod end of traditional trawl was left open so these numbers would actually be much larger.

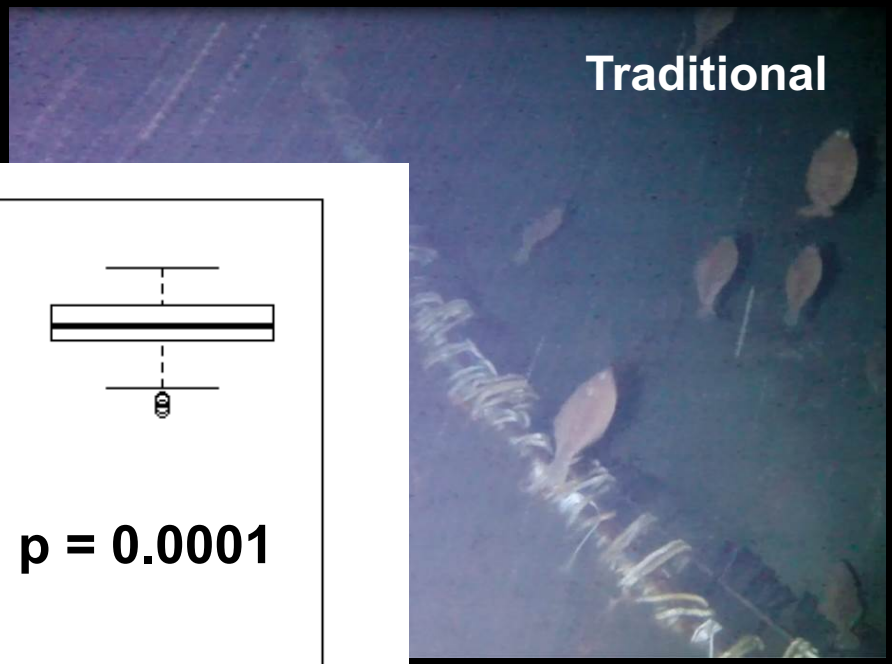
Less fuel, *fewer* impacts for modified trawl

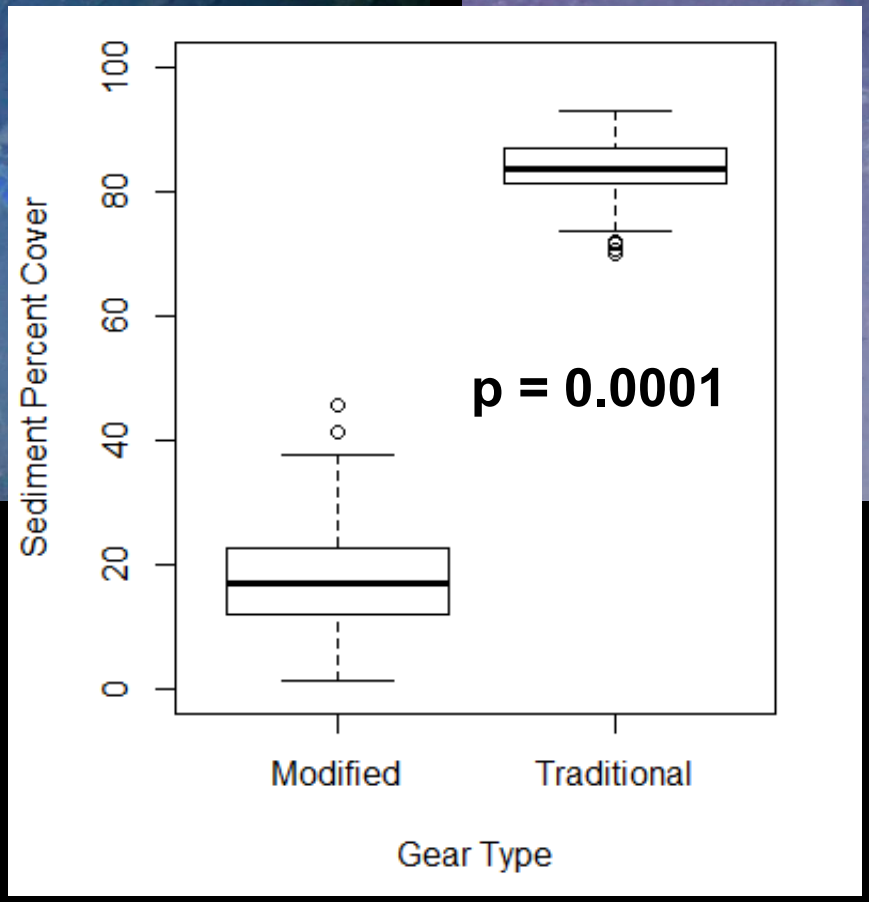


One more thing…

Analysis of netcam videos – using sedimentation as proxy for bottom contact time for two footropes.







What to make of these results?

Combined results of the Morro Bay project and this northern Monterey Bay project suggest that:

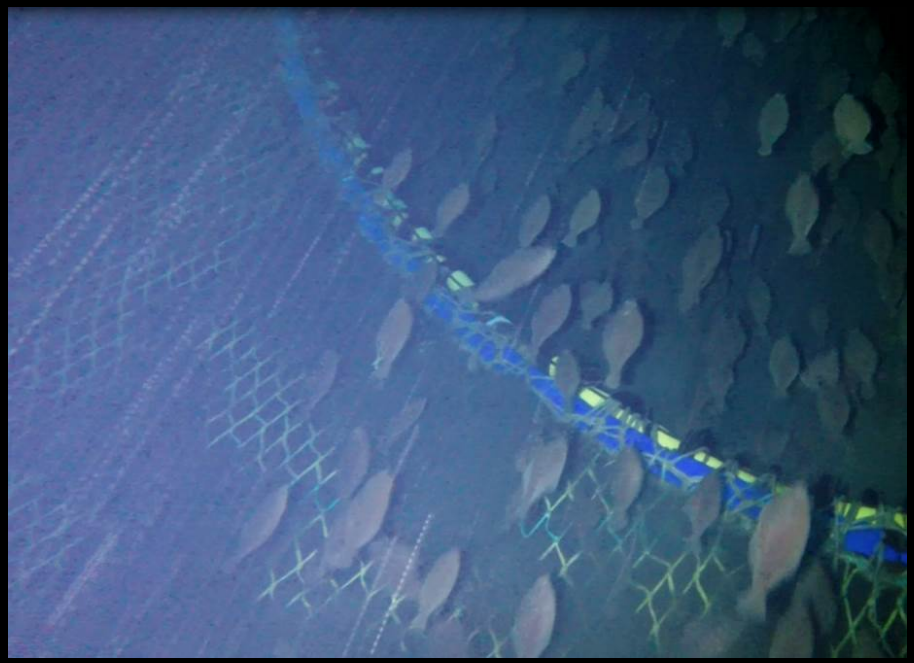
- in low-relief sedimentary environments of CA's continental shelf impacts to seafloor habitats from small footrope gear are minimal to non- existent.

- in lumpier low-relief habitats, impacts from small footrope gear are more pronounced, but considerably less than traditional trawl gear.

-Thus the habitats that characterize much of CA's continental shelf may be less vulnerable to impacts from selected gear than we had previously thought.

Quantification of Seafloor Habitat Impacts Under Selected Trawl Modifications

A Collaborative Approach to Resolving Pressing Management Questions



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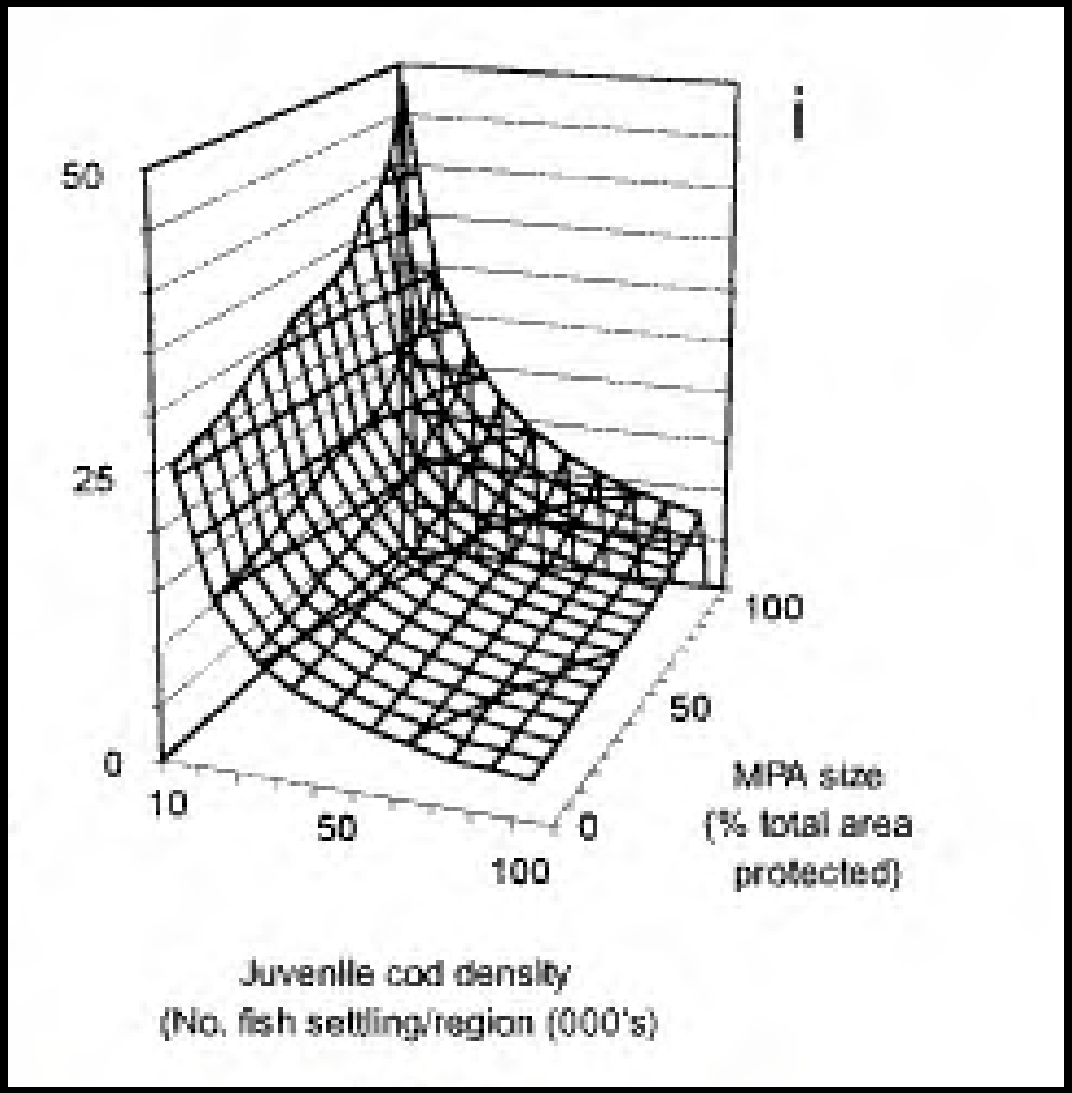
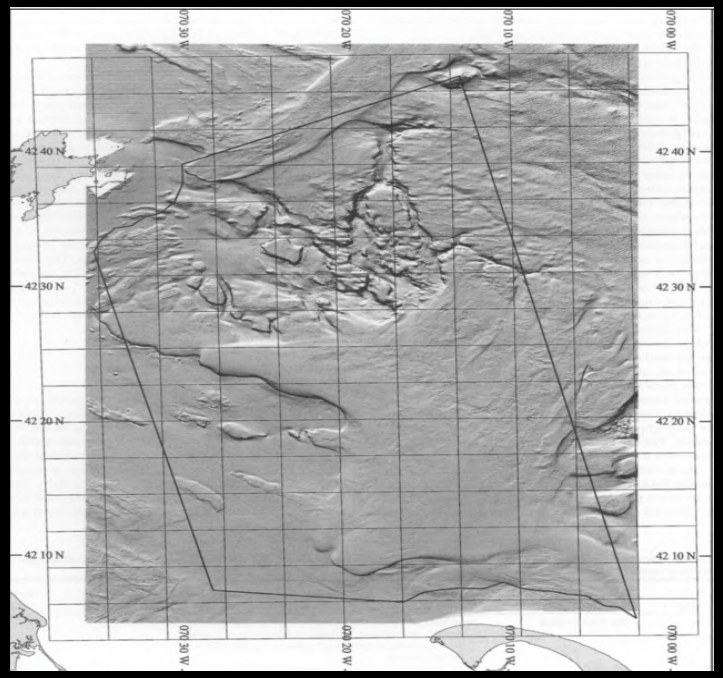
...and that population-level impacts are possible.





$$\frac{dN_i}{dt} = S_i - m_i N_i + \bar{M}_i ,$$

$$m_i = \frac{\alpha_i x_i^2}{1 + c_i x_i + \beta_i x_i^2} z_i ,$$

Lindholm et al. (2001)