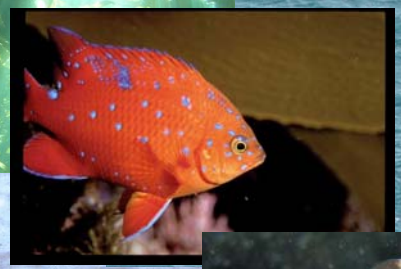
Foundations of Marine Reserves at the California Channel Islands

Daniel Richards

Channel Islands National Park

NPS Aquatic Professionals Meeting, Feb. 2008



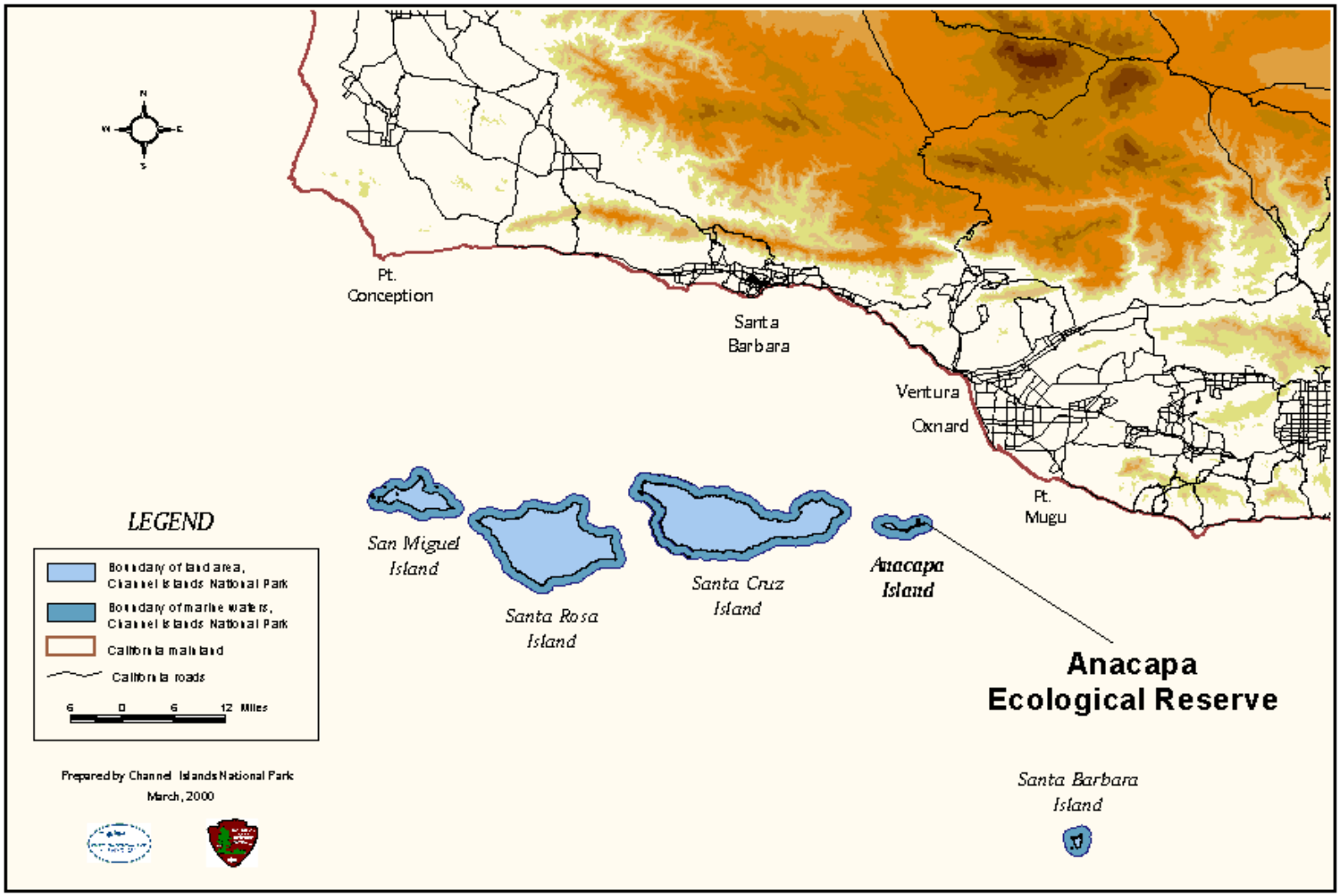





There is strong regional environmental variation across the Channel Islands

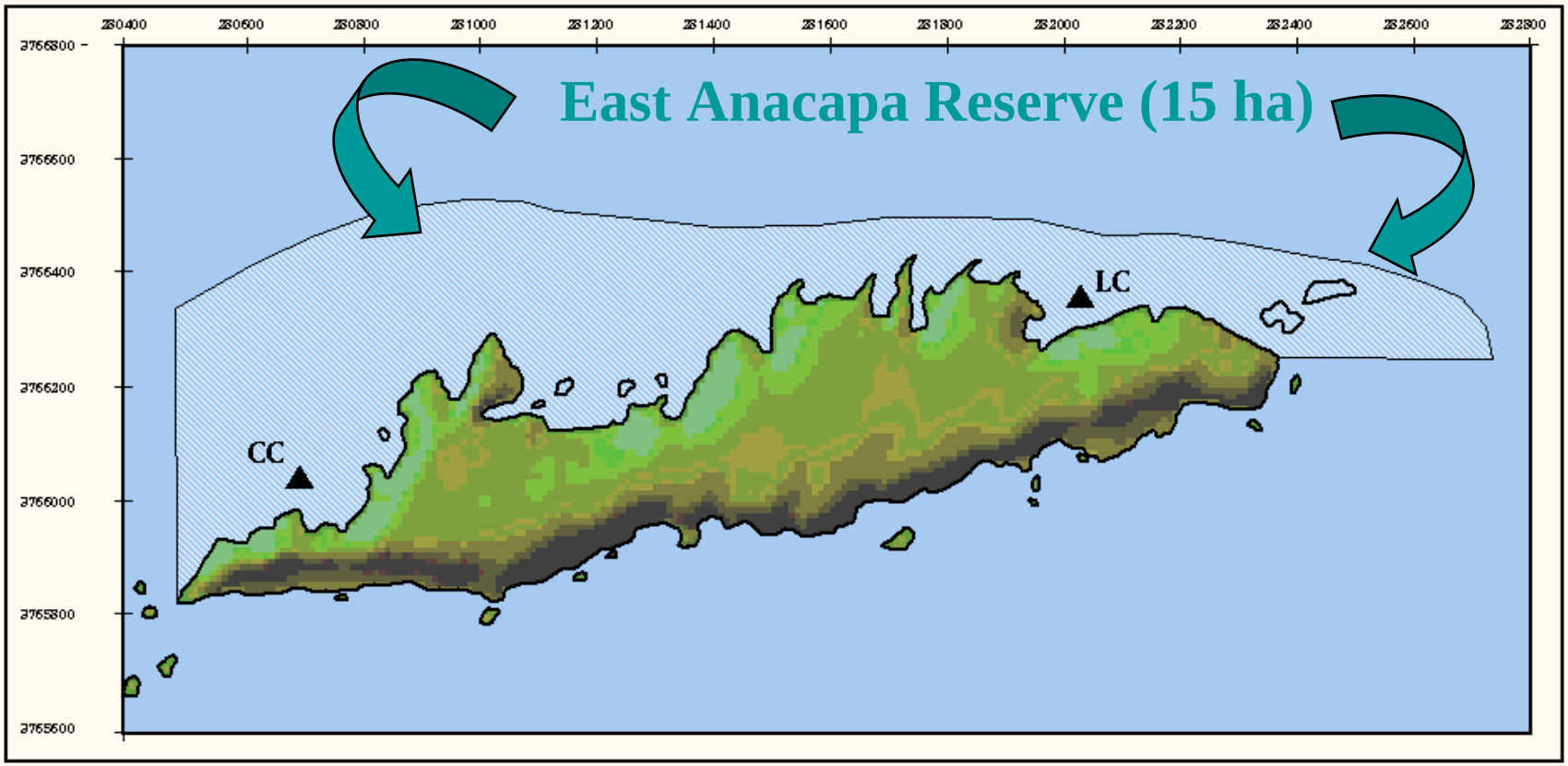
CHANNEL ISLANDS NATIONAL PARK

Location of Channel Islands and Anacapa Island Ecological Reserve



EAST ANACAPA ISLAND

Ecological Reserve and location of Kelp Forest Monitoring sites



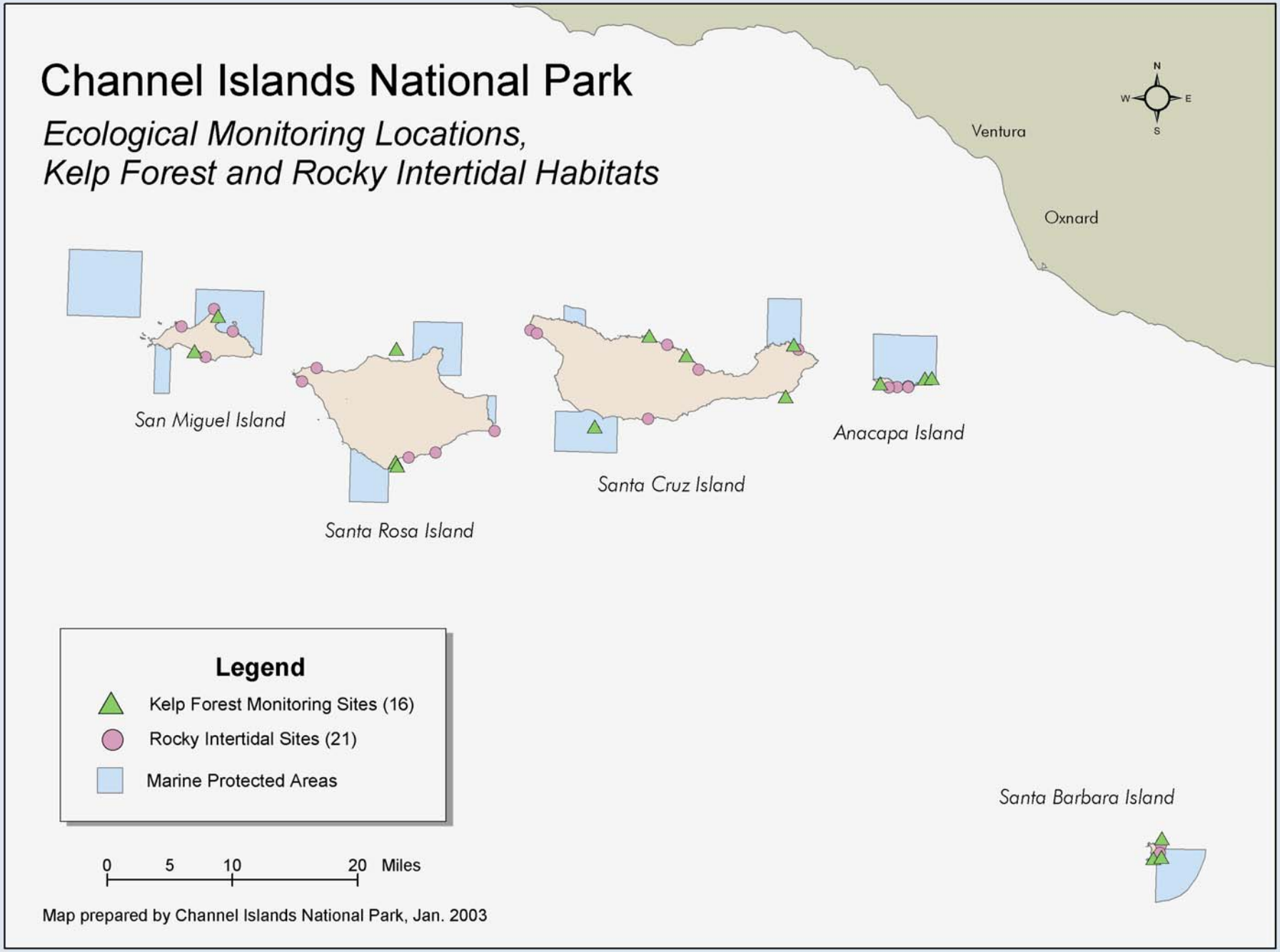
Prepared by Channel Islands National Park
March 2000

100 0 100 200 Meters

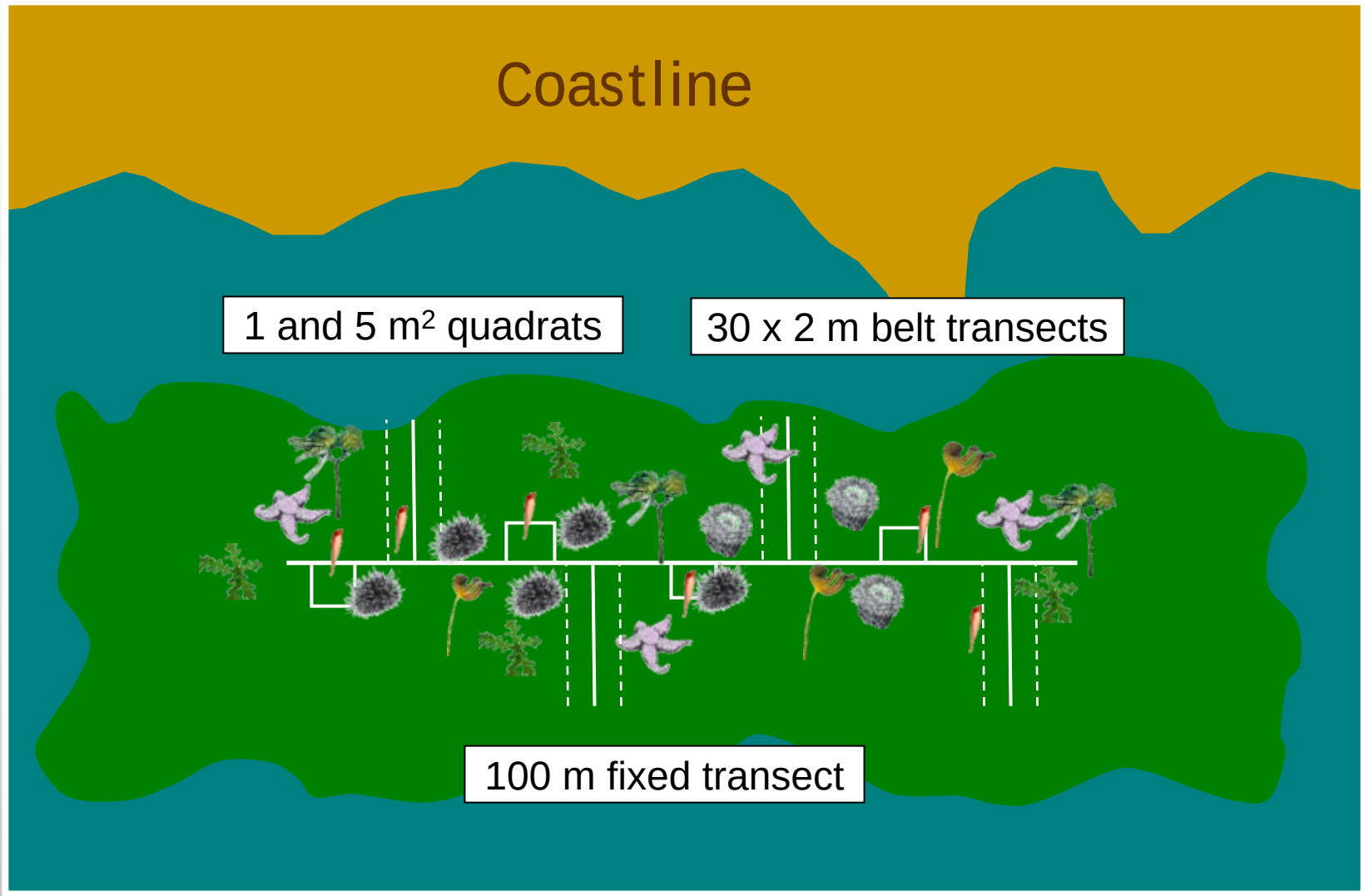
LEGEND

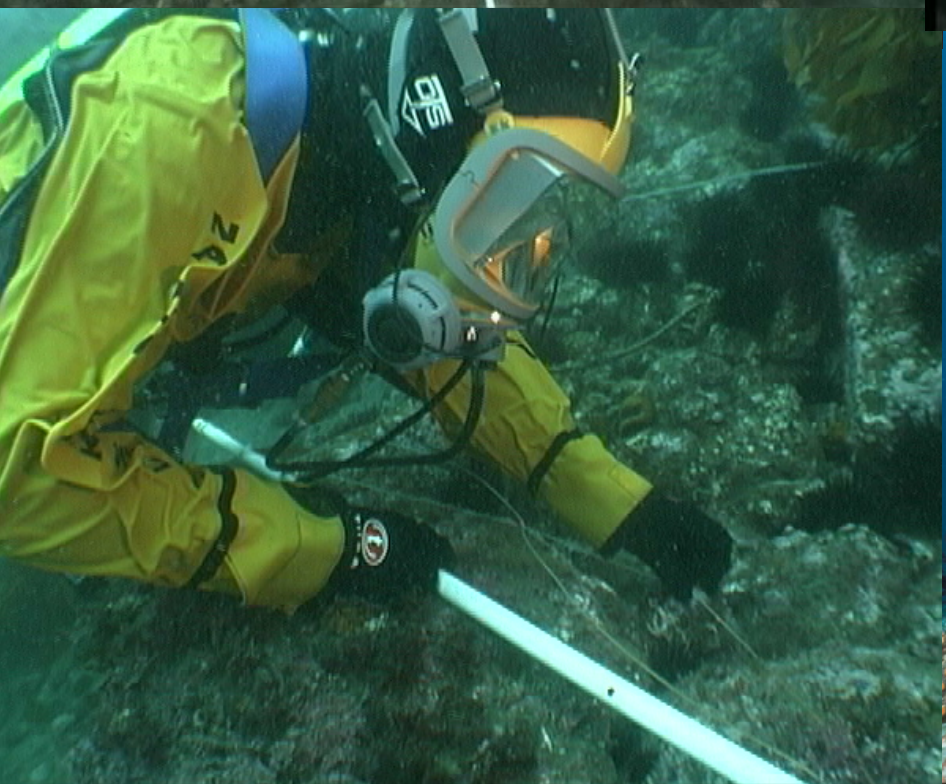
Ecological Reserve to 60 ft. depth from mean high tide; no take or possession of native species allowed.

Kelp Forest Monitoring site locations at Landing Cove (LC) and Cathedral Cove (CC).

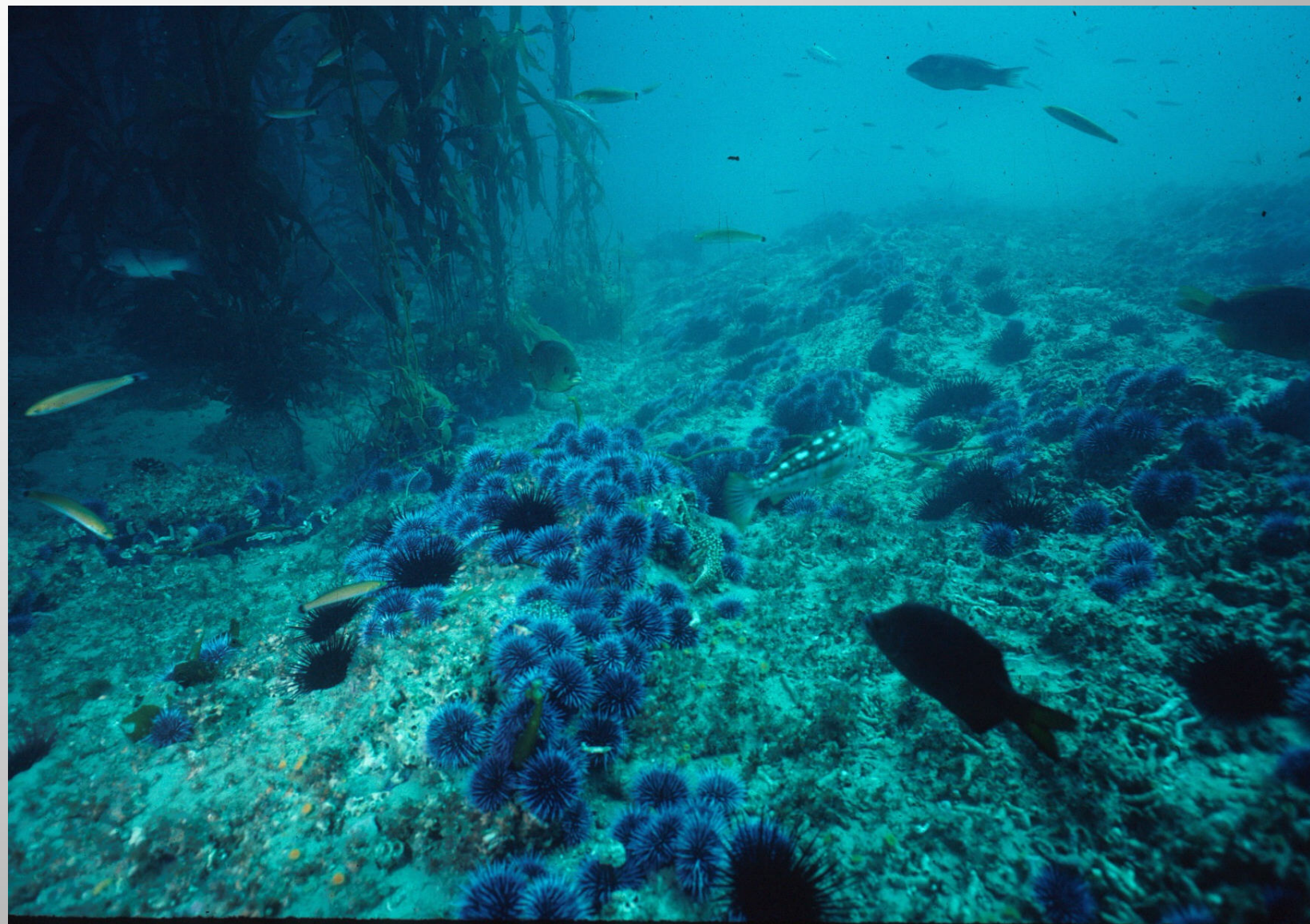

Channel Islands National Park
Ecological Monitoring Locations,
Kelp Forest and Rocky Intertidal Habitats
N
W
E
S
Ventura
Oxnard
San Miguel Island
Santa Rosa Island
Santa Cruz Island
Anacapa Island
Santa Barbara Island
Legend
Kelp Forest Monitoring Sites (16)
Rocky Intertidal Sites (21)
Marine Protected Areas
0 5 10 20 Miles
Map prepared by Channel Islands National Park, Jan. 2003

Approach: KFM sampling design





Kelp Forests Destablized

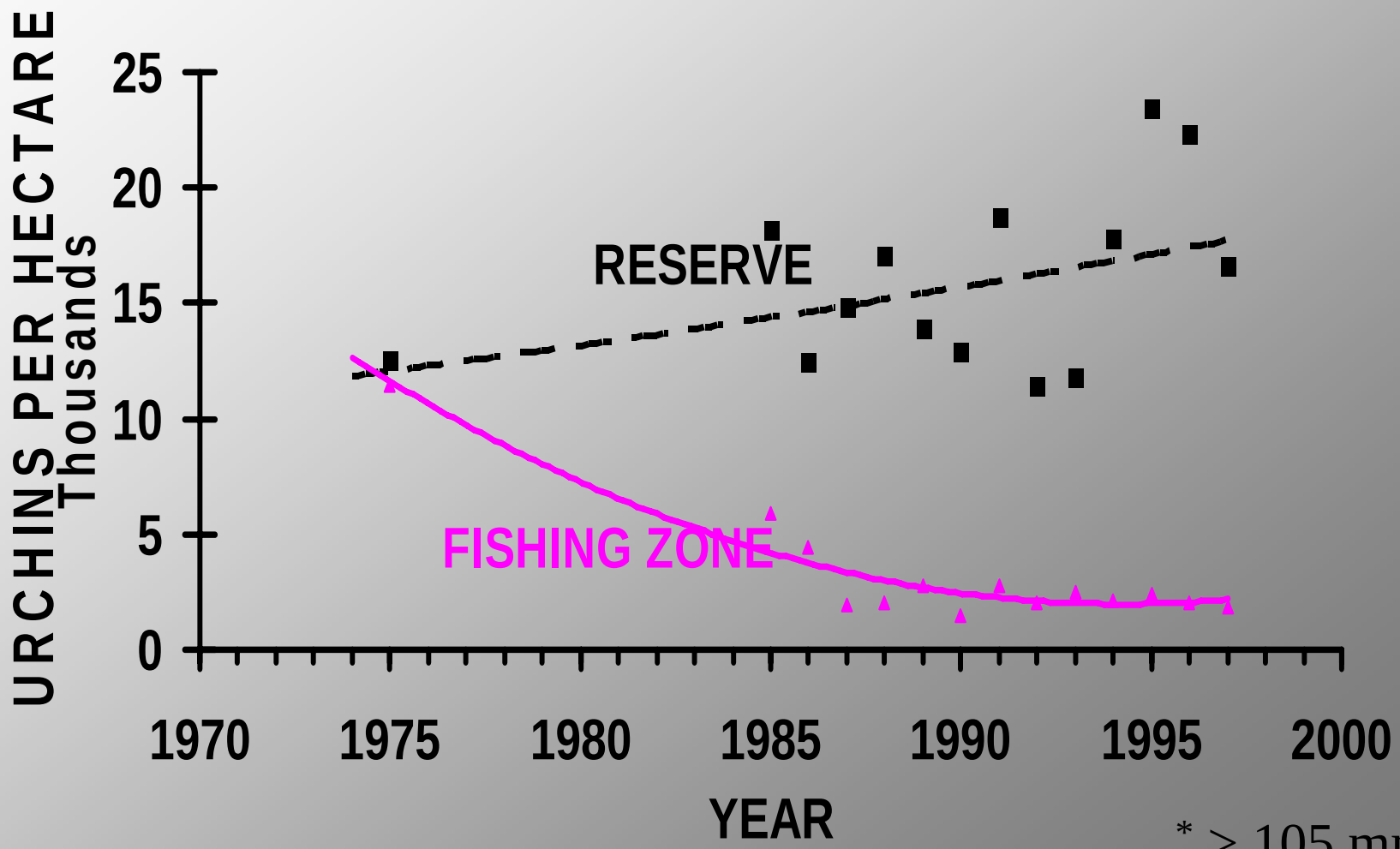


Status & Trends of Ocean Resources

- Five abalone species populations collapsed, at least one species endangered, fisheries closed
- Large resident demersal fishes gone
- Ground fish fisheries in jeopardy, bocaccio and cow cod populations ~5% unfished levels
- Fishing removed large red sea urchins, replaced by small red and unfished purple sea urchins—fishery landings falling
- Fishing reduced sea cucumber populations 30-80% < 6 years, fishery collapsed
- Kelp forests over-grazed, destablilized, declining, nearly 80% gone < 20 years

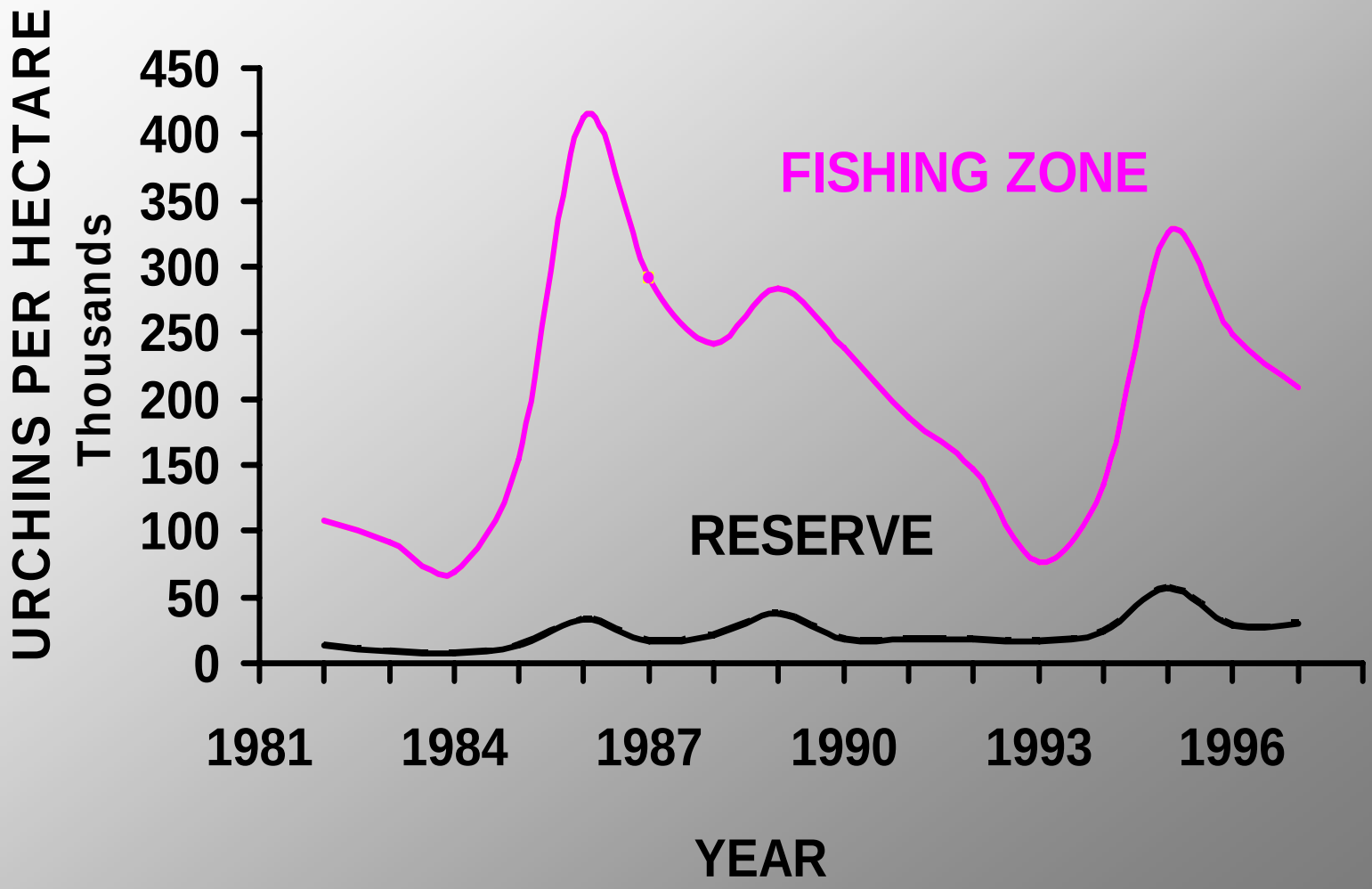
Large Red Sea Urchins*

Strongylocentrotus franciscanus



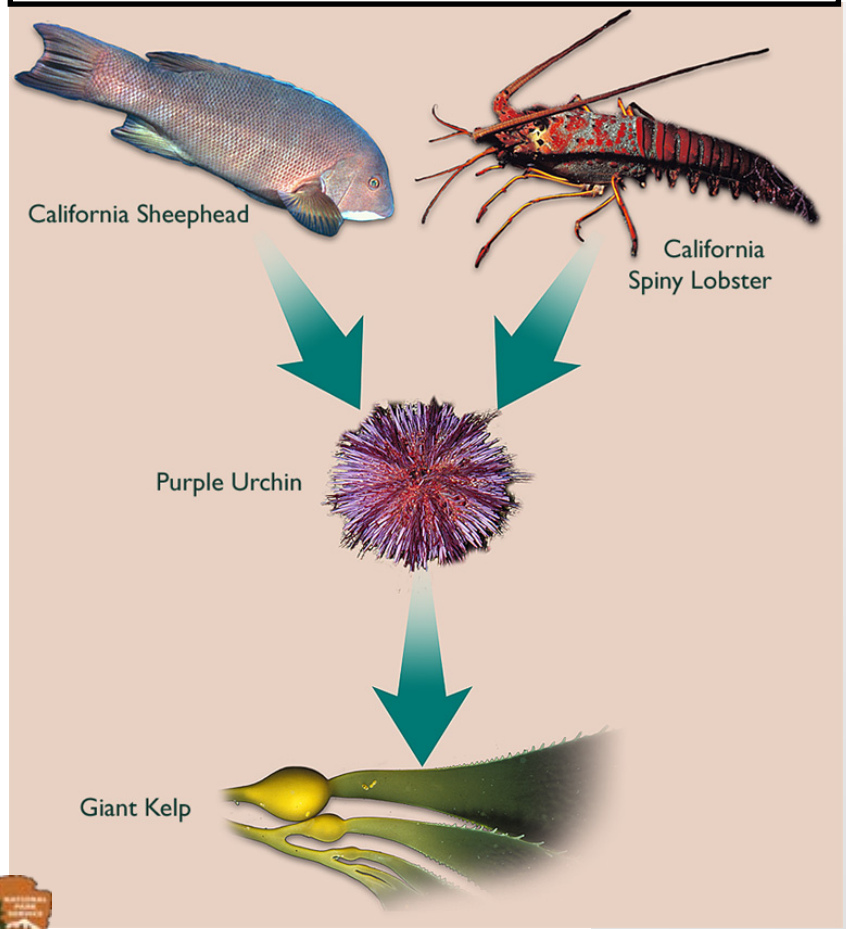
* > 105 mm

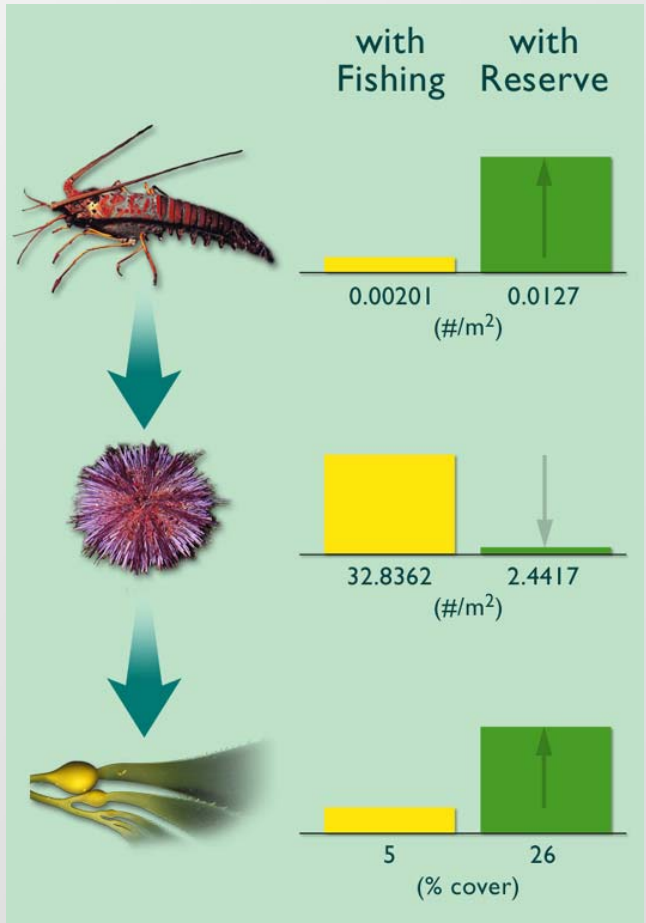
Purple Sea Urchins
Strongylocentrotus purpuratus



Predator-prey interactions can lead to changes at many levels of the food web

Food web of key players in kelp forests





Lafferty and Behrens (2005)

Kelp Forests in Anacapa Reserve More Resilient

- Large predators still present (sheephead, giant seabass, lobster)
- Large red sea urchins still abundant—nursery habitat
- Abalone still present—competing for space and food
- Purple sea urchin population within normal limits


(c) Richard Herrmann


The California Channel Islands
National Park Service
U.S. Department of the Interior
0 12.5 25 Miles
April 2007
Produced by Channel Islands GIS | Data courtesy of USGS and NPS
SANTA YNEZ MOUNTAINS
Point Conception
Santa Barbara
Santa Barbara Channel
Ventura
Camarillo
Oxnard
SAN GABRIEL MOUNTAINS
Santa Monica Mountains National Recreation Area
Los Angeles
San Miguel
Santa Cruz
Anacapa
Santa Rosa
Palos Verdes Point
SANTA ANA MOUNTAINS
Santa Barbara
Santa Catalina
Pacific
Ocean
San Nicolas
(U.S. Navy)
San Clemente
(U.S. Navy)
San Diego
Legend
National Marine Sanctuary
Channel Islands National Park
Marine Protected Areas
State Marine Conservation Area
State Marine Reserve

Questions from the Marine Reserve Working Group

Are there more fish and invertebrates in the CI reserves?

Are fish bigger in marine reserves?

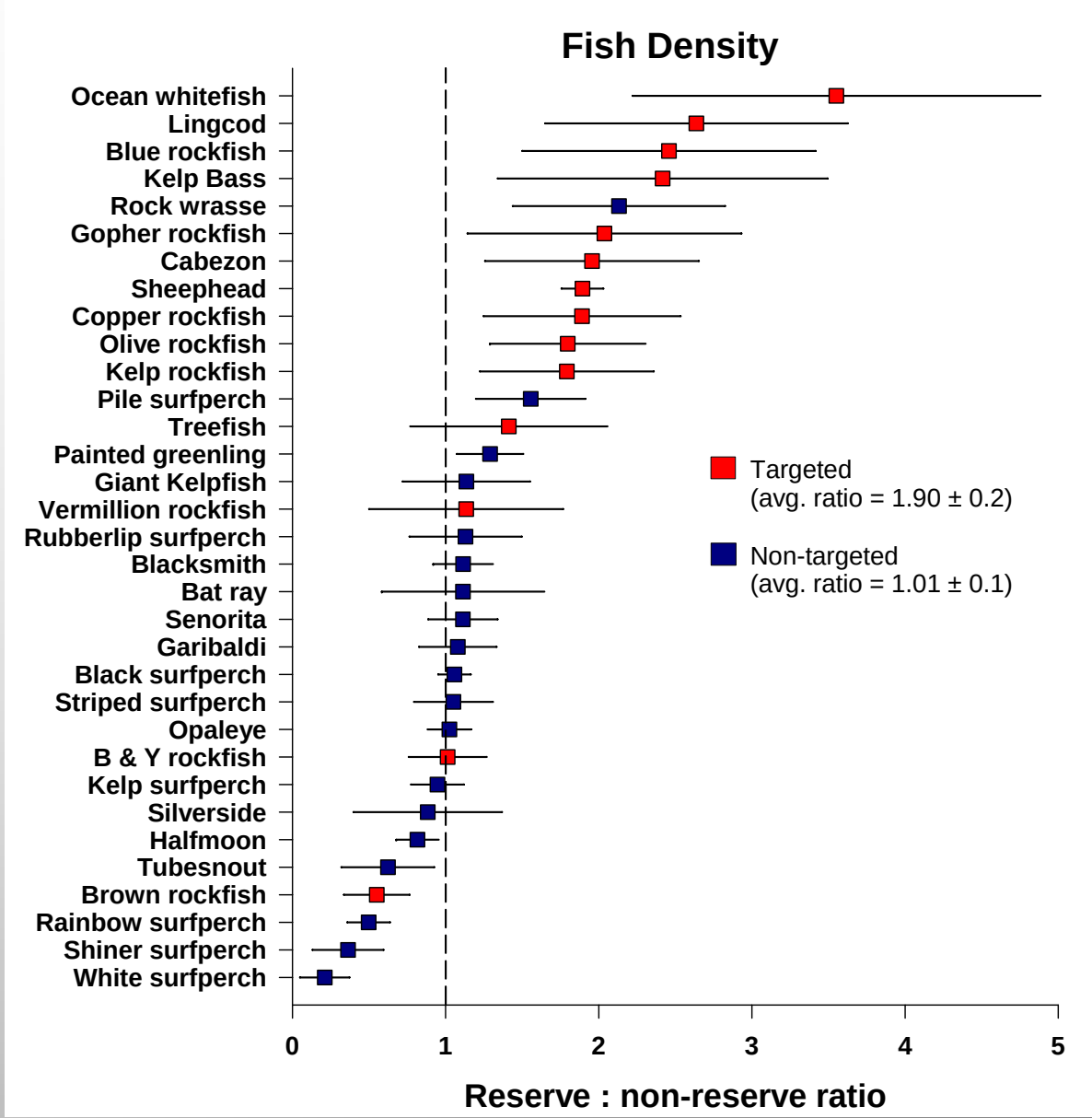
Does community structure differ in and out of reserves?

Report back in five years

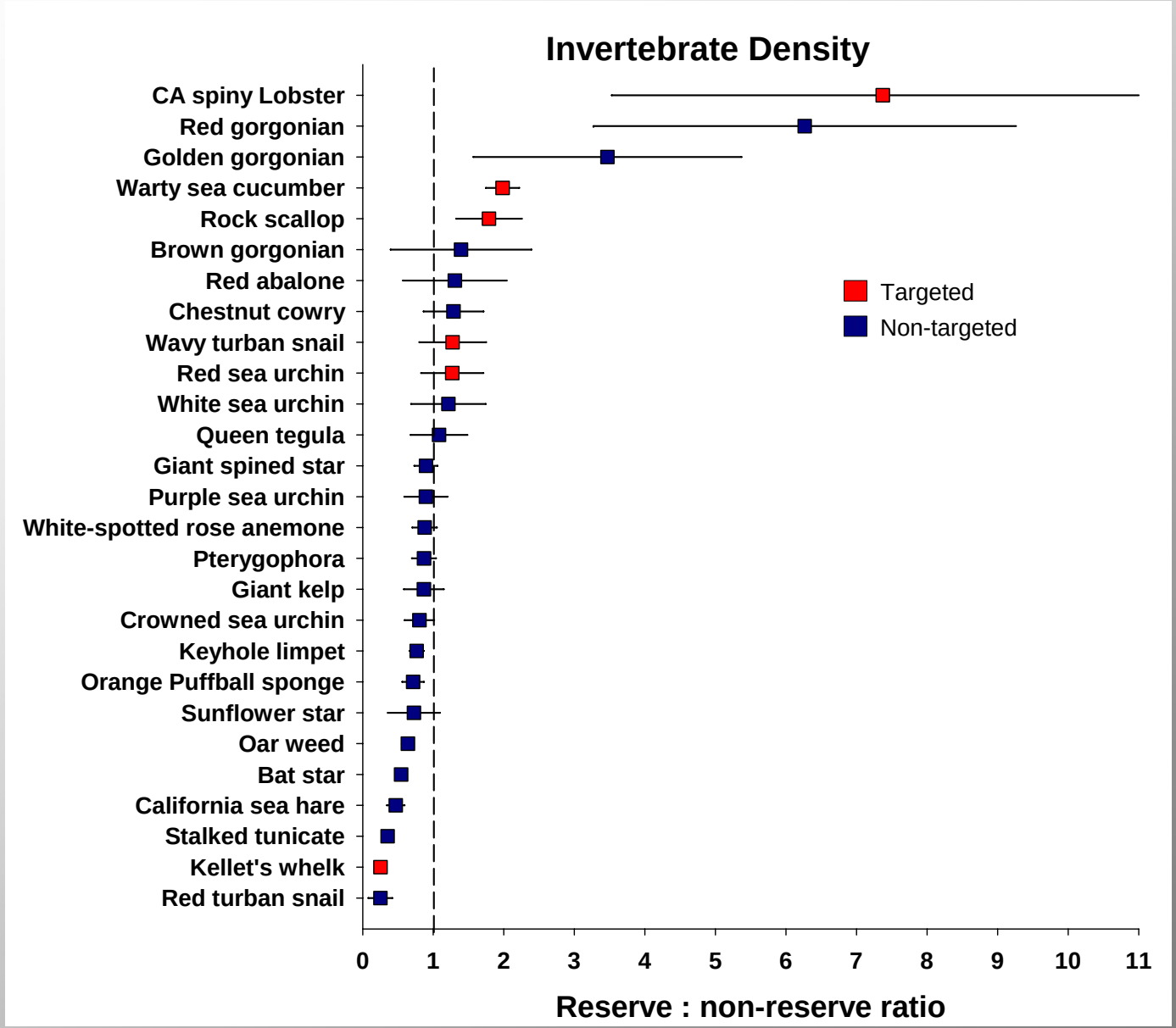
- 2005 expansion of kelp forest monitoring and PISCO programs in coordinated effort to explore the differences between reserves and fished areas

Are there more fish and invertebrates in the CI reserves?

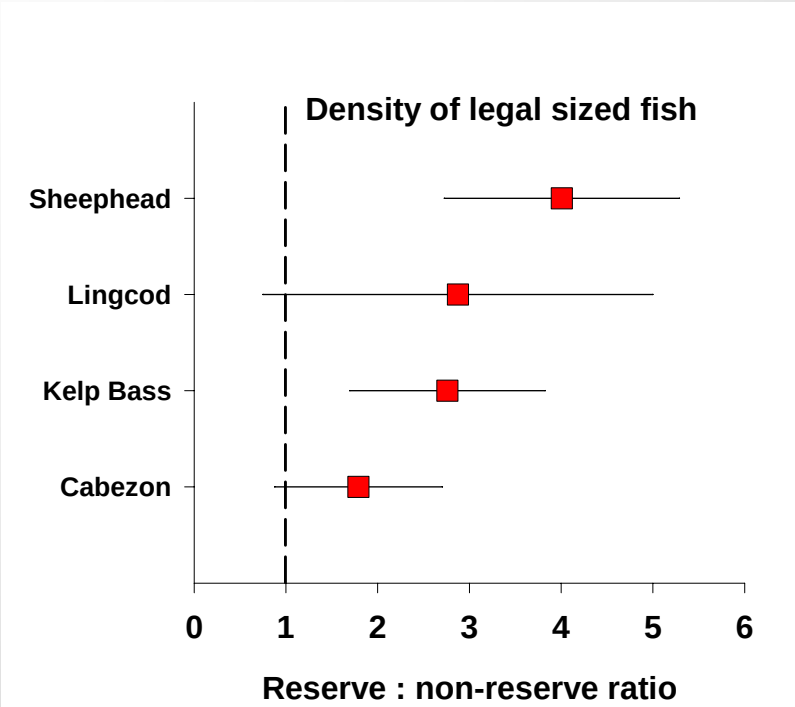
Targeted fish species are more abundant in reserves

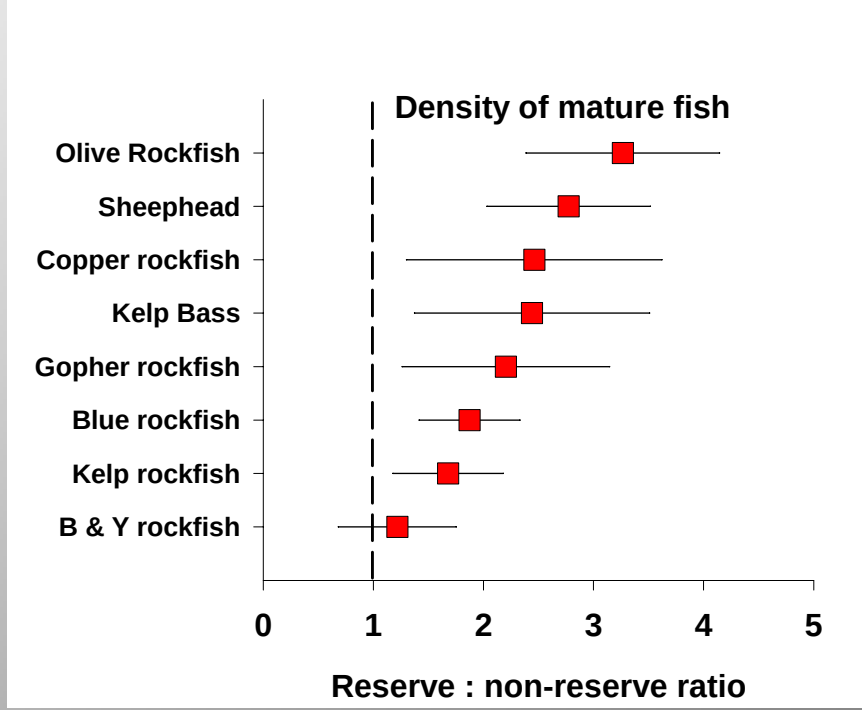


Densities of algae and invertebrates are more equal between reserves and non-reserves

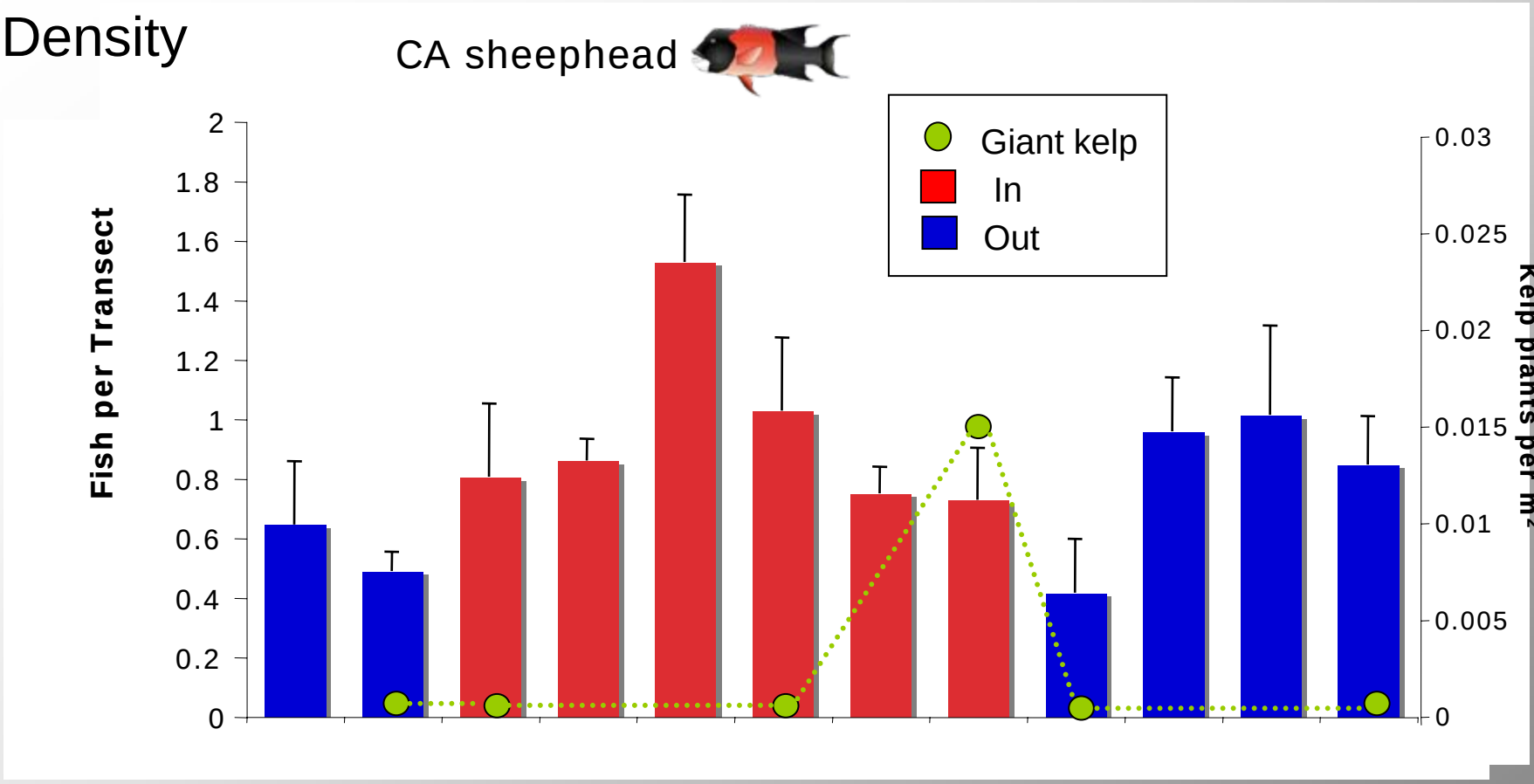


Densities of legal-sized and mature fish are greater in reserves





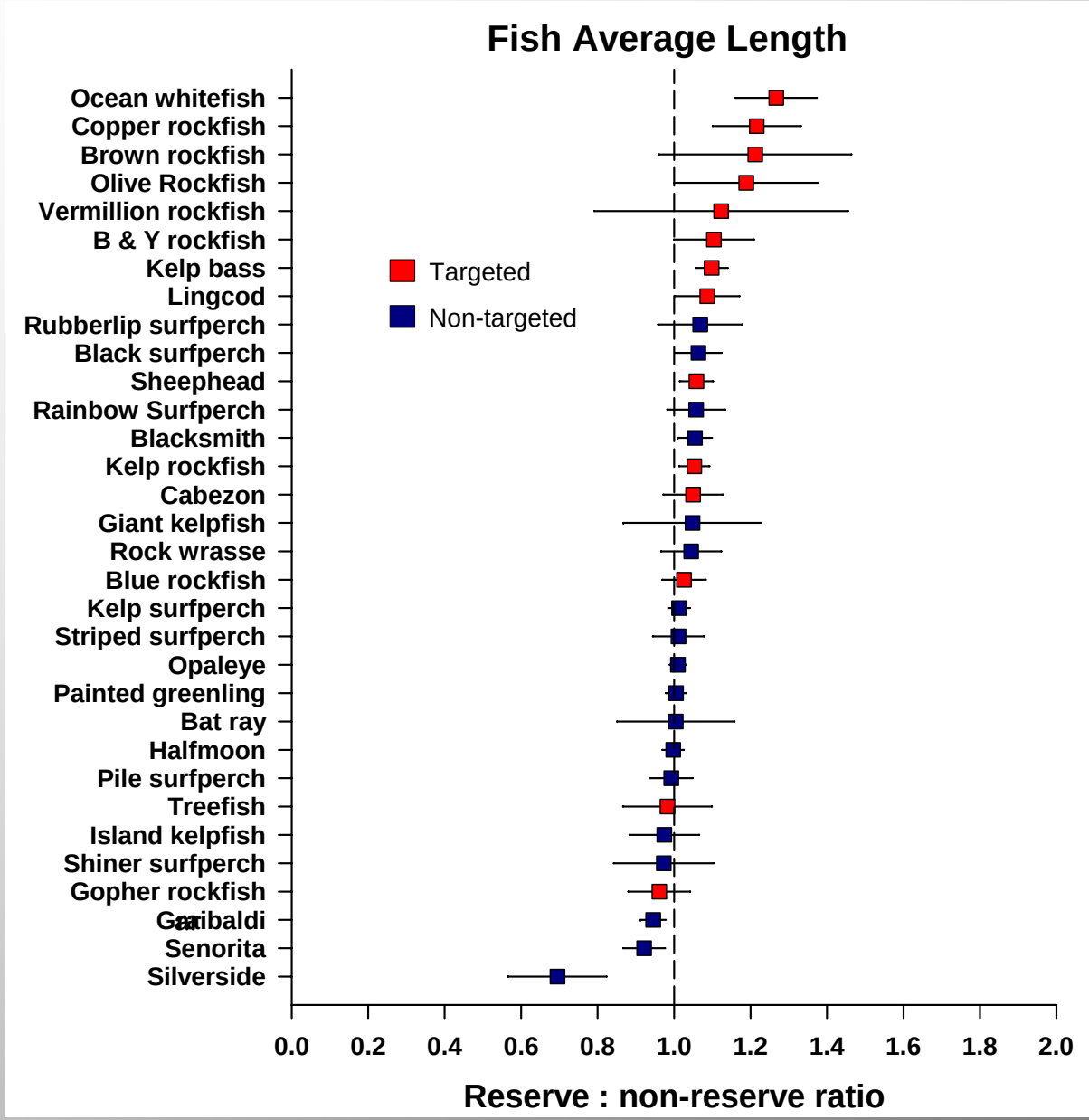
Density


CA sheephead
Giant kelp
In
Out
Fish per Transect
Kelp plants per m²
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
0.005
0.01
0.015
0.02
0.025
0.03


Scorpion MR
1 km

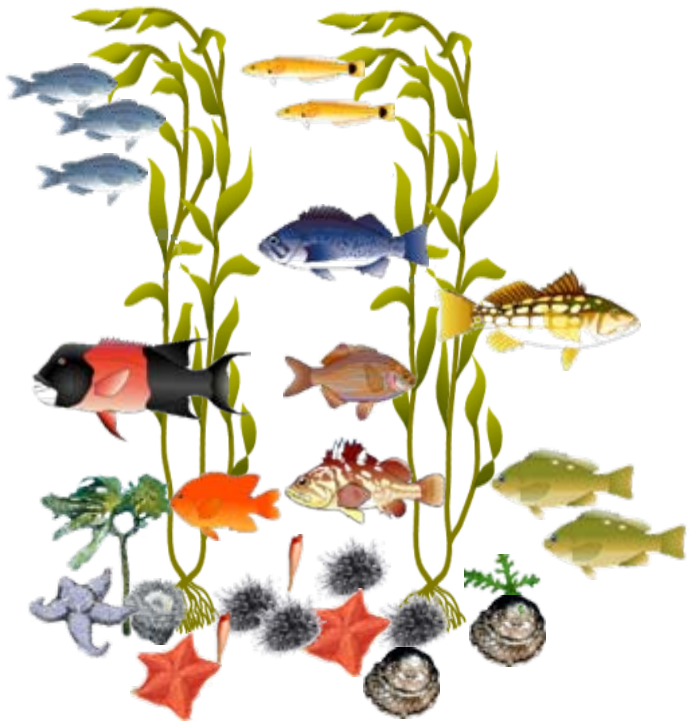
Are fish bigger in marine reserves?

Targeted fish species are larger in reserves



Species composition differs geographically across the Channel Islands…

Does community structure differ in and out of reserves?



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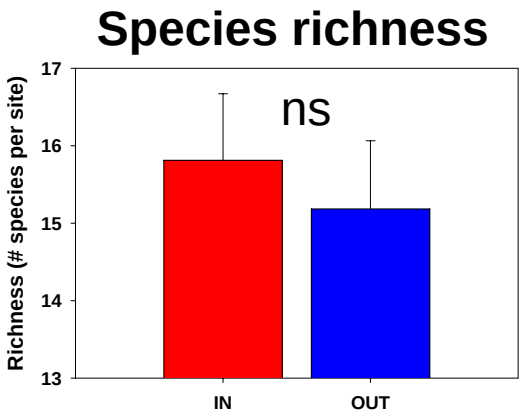
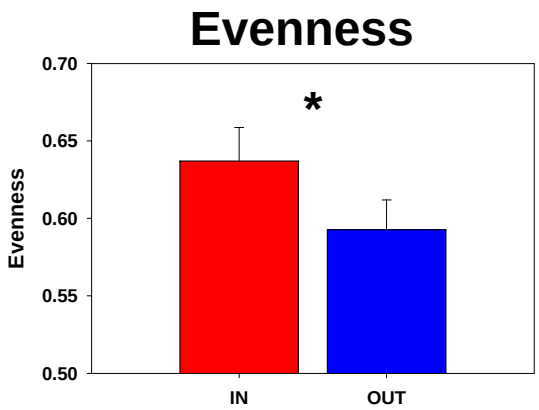
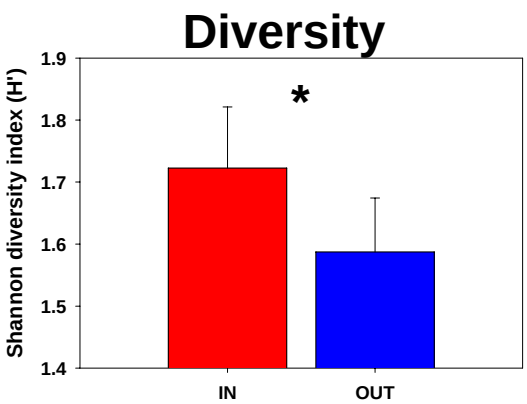
Fish biodiversity differs in reserves





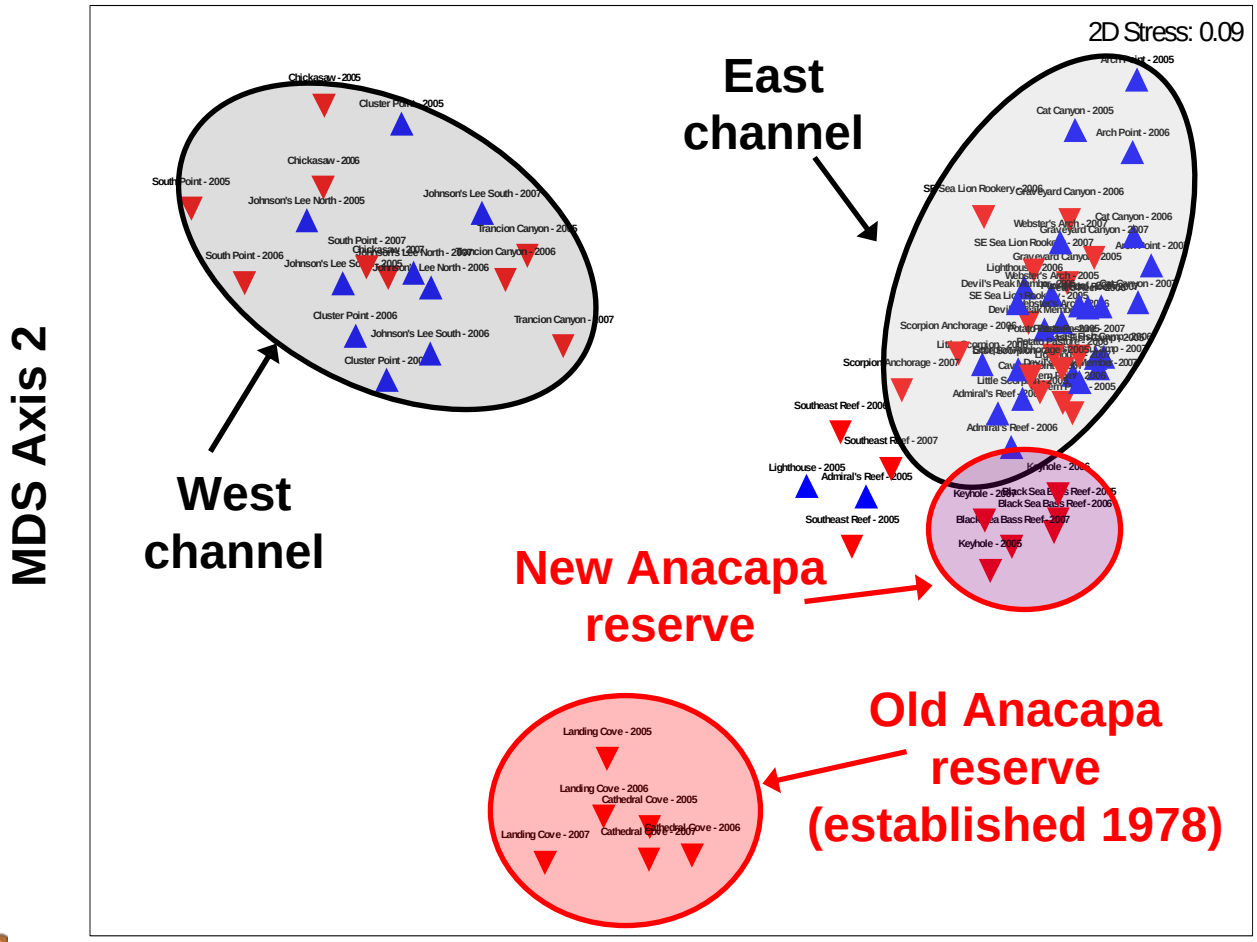


San Miguel and Santa Barbara Islands are important drivers of these patterns

Photo: National Geographic

Differences in community structure of invertebrates and algae

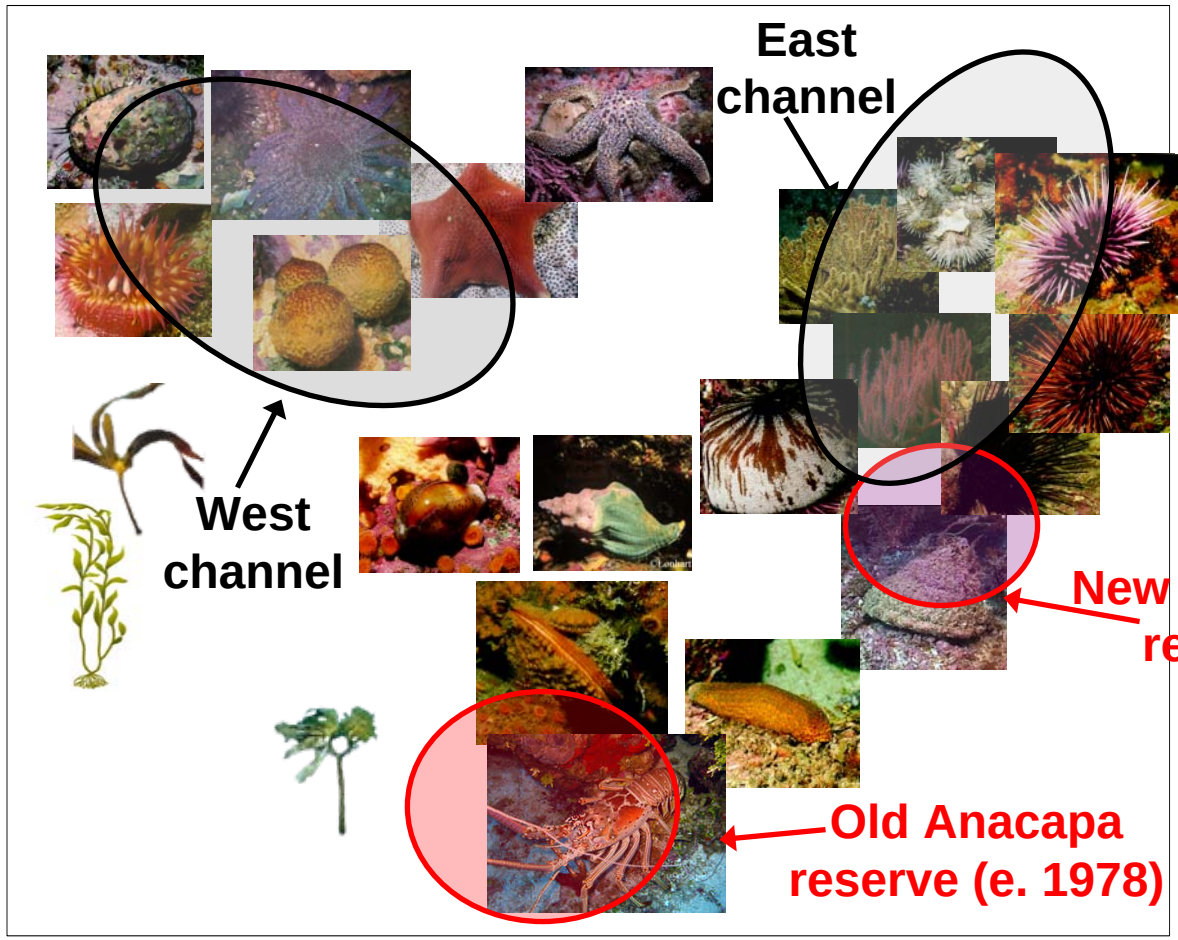
- Strong biogeographic differences (west vs. east)
- Strong differences in Anacapa reserve (old vs. new)



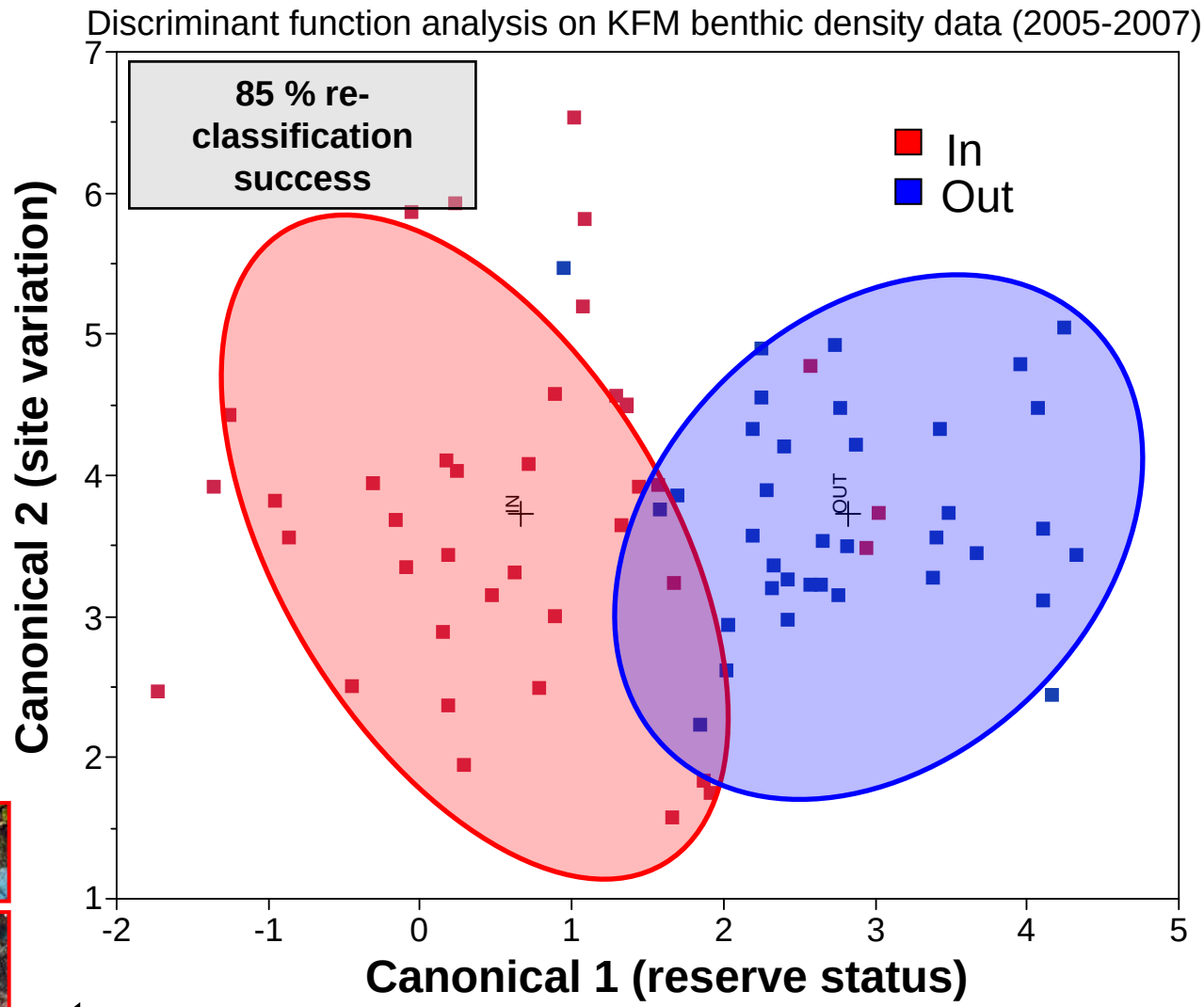
Multi-dimensional scaling (MDS) analysis on KFM data

Fine-scale monitoring 2005-2007

Particular species drive the differences in community structure



Key invertebrate species can distinguish reserves and non-reserves



Lobster, Turban snail, Puffball sponge

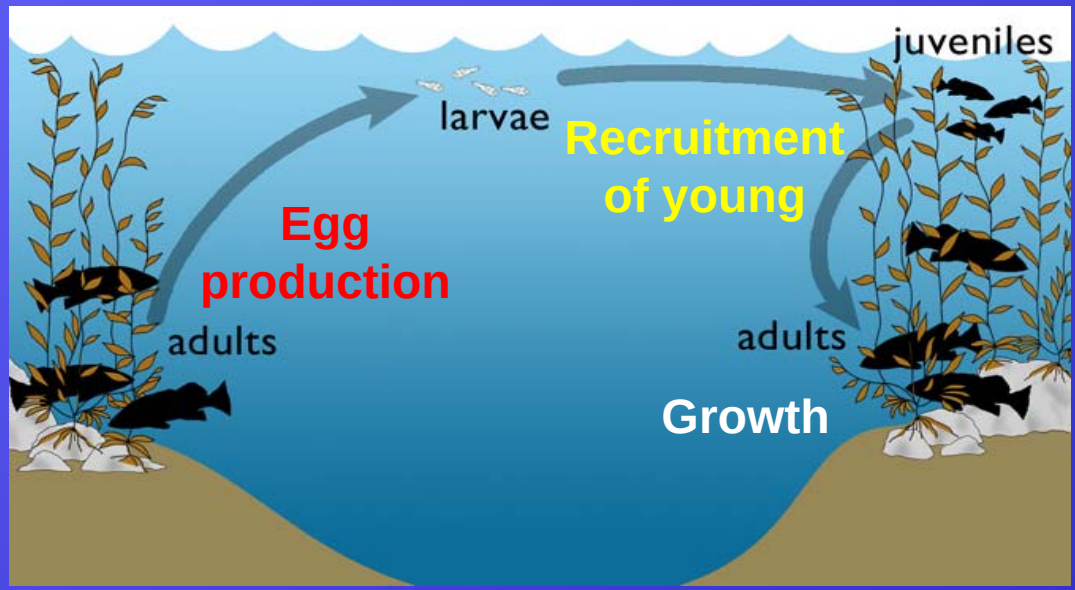
Purple urchin, Sunflower star, Kellet's whelk

Changes in community structure may require more time than changes in abundance or size structure

Changes in community structure require:

1. Successful:

- Egg production
- Recruitment of young
- Growth (of both prey and predators)



Changes in community structure may require more time than changes in abundance or size structure

Changes in community structure require:

2. Species interactions:
- **Competition**
- **Predator-prey interactions**

Summary

Geographic differences in marine communities are shaped by the environment (e.g., temperature)

Fish biodiversity is significantly greater in reserves

Changes in community structure and ecosystem function in reserves takes time (on the order of decades)

Total fish biomass, especially predator biomass, is greater in reserves

Through time, increases in top predators will likely stimulate changes in kelp forest food web structure

Acknowledgments:

- Hard work and dedication of numerous PISCO and KFM survey divers
- Funding: Packard and Moore Foundations, Ocean Protection Council, NPS, CDFG
- NCEAS and the CI MPA Working Group
- Larry Allen for fish icons
- Jenn Caselle, Scott Hamilton, and Anne Solomon for analysis and slides

More Information on Kelp Forest Monitoring Programs:

PISCO-Partnership for Interdisciplinary Studies of Coastal Oceans (www.piscoweb.org)

National Park Service (www.nps.gov)