Multiple mechanisms affect resistance to an invasive algae in an MPA network

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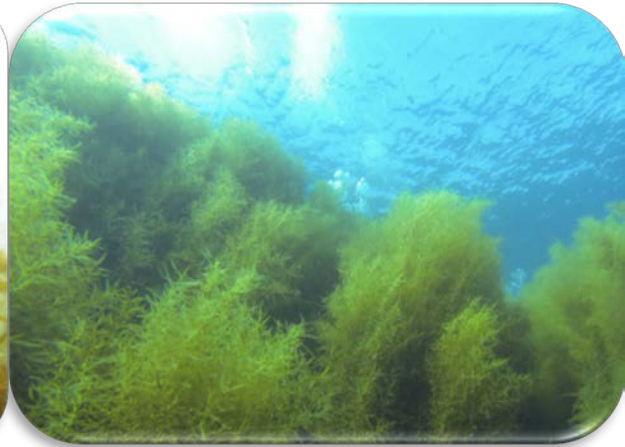
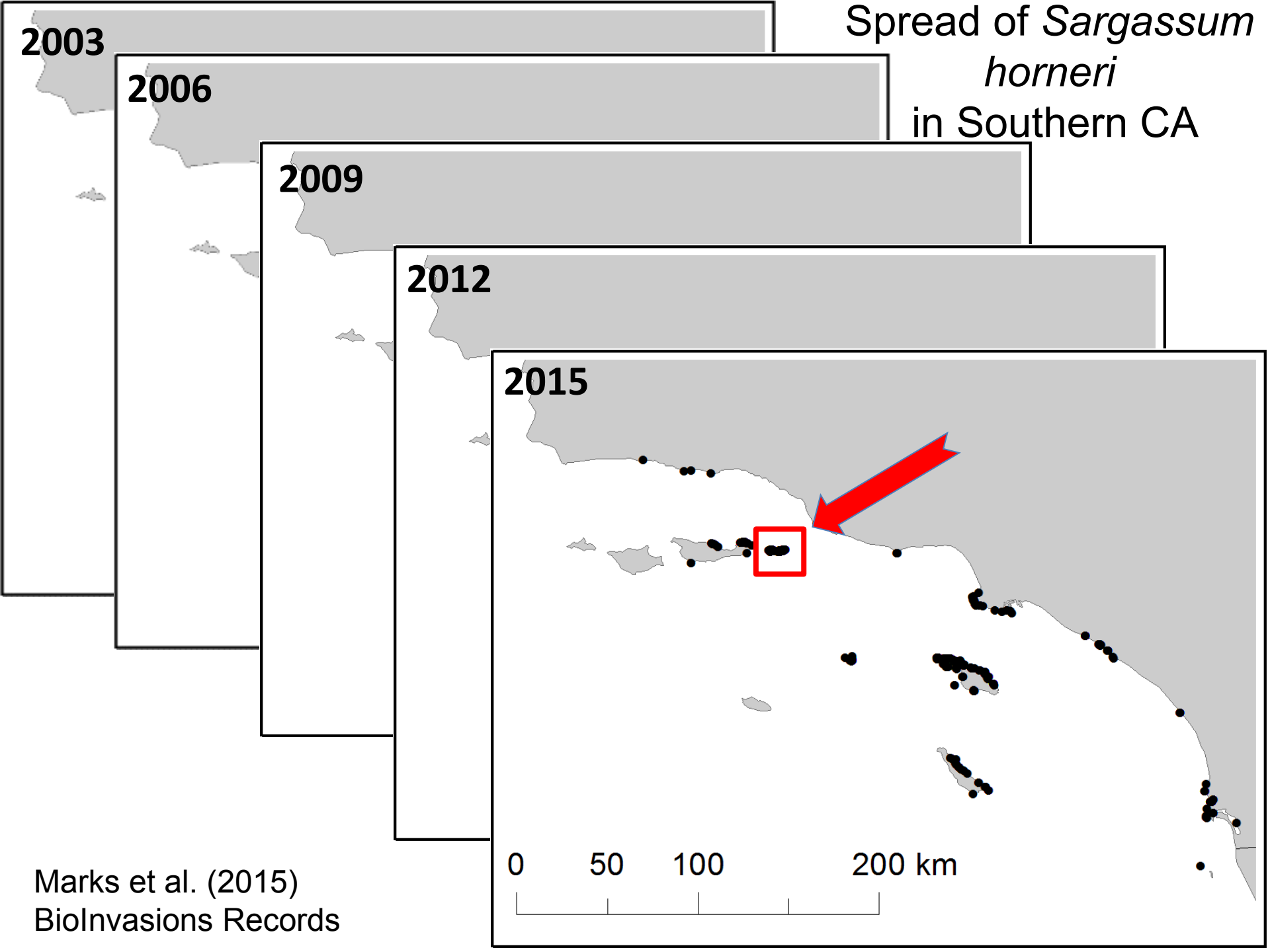


The Invasion of the “DEVIL WEED”

Sargassum horneri

- Native of Korea, Japan, and China as far south as Hong Kong
- Annual fucoid,
- Maximum height up to ~ 3 m,
- Most common on shallow reefs to ~ 15m but found to 30m+
- Recruitment occurs in the spring/summer
- Reproductive receptacles produced in winter

Spread of *Sargassum horneri* in Southern CA



Marks et al. (2015)
BioInvasions Records

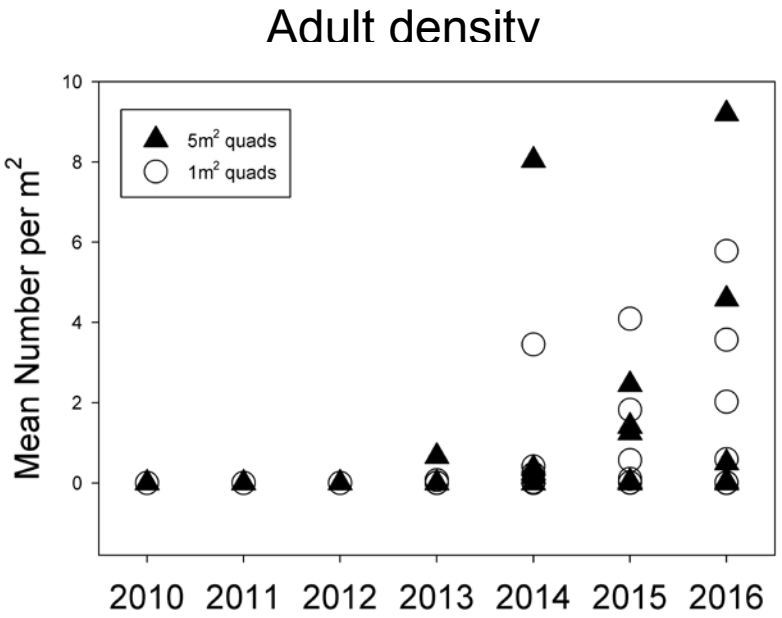
Potential Biological Consequences

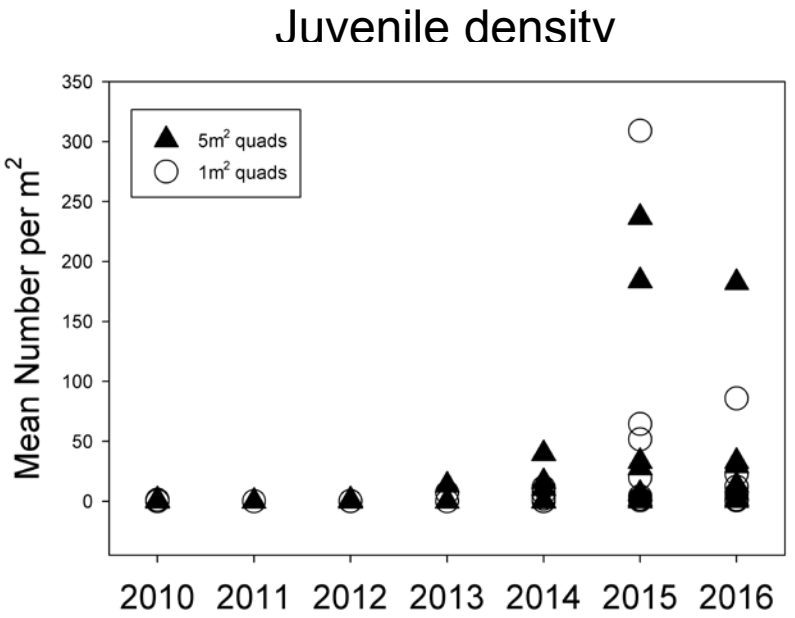
Recruits create dense carpets and may exclude other species

Interactions with native species could have consequences on higher trophic levels

Anacapa Island

Time series of *Sargassum horneri* at Anacapa since 2010 (Kelp Forest Monitoring, NPS)



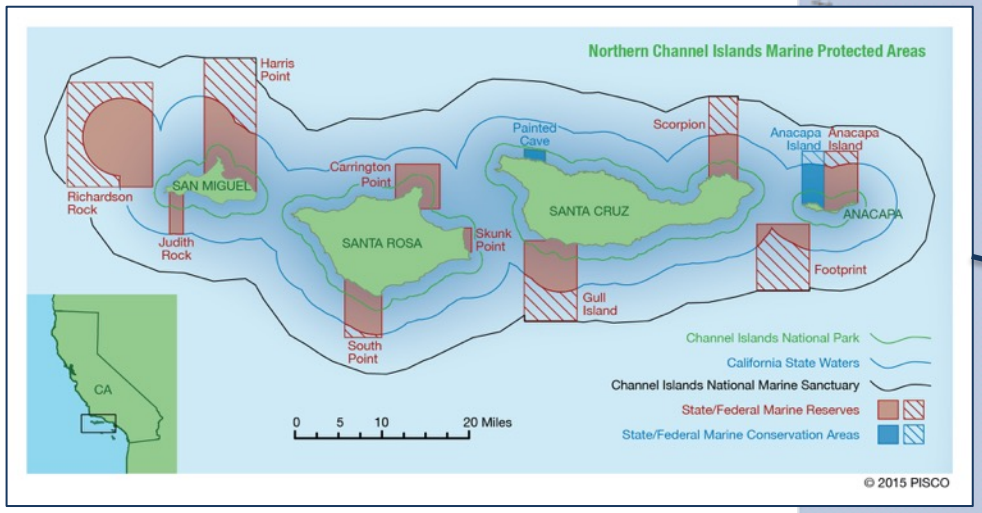


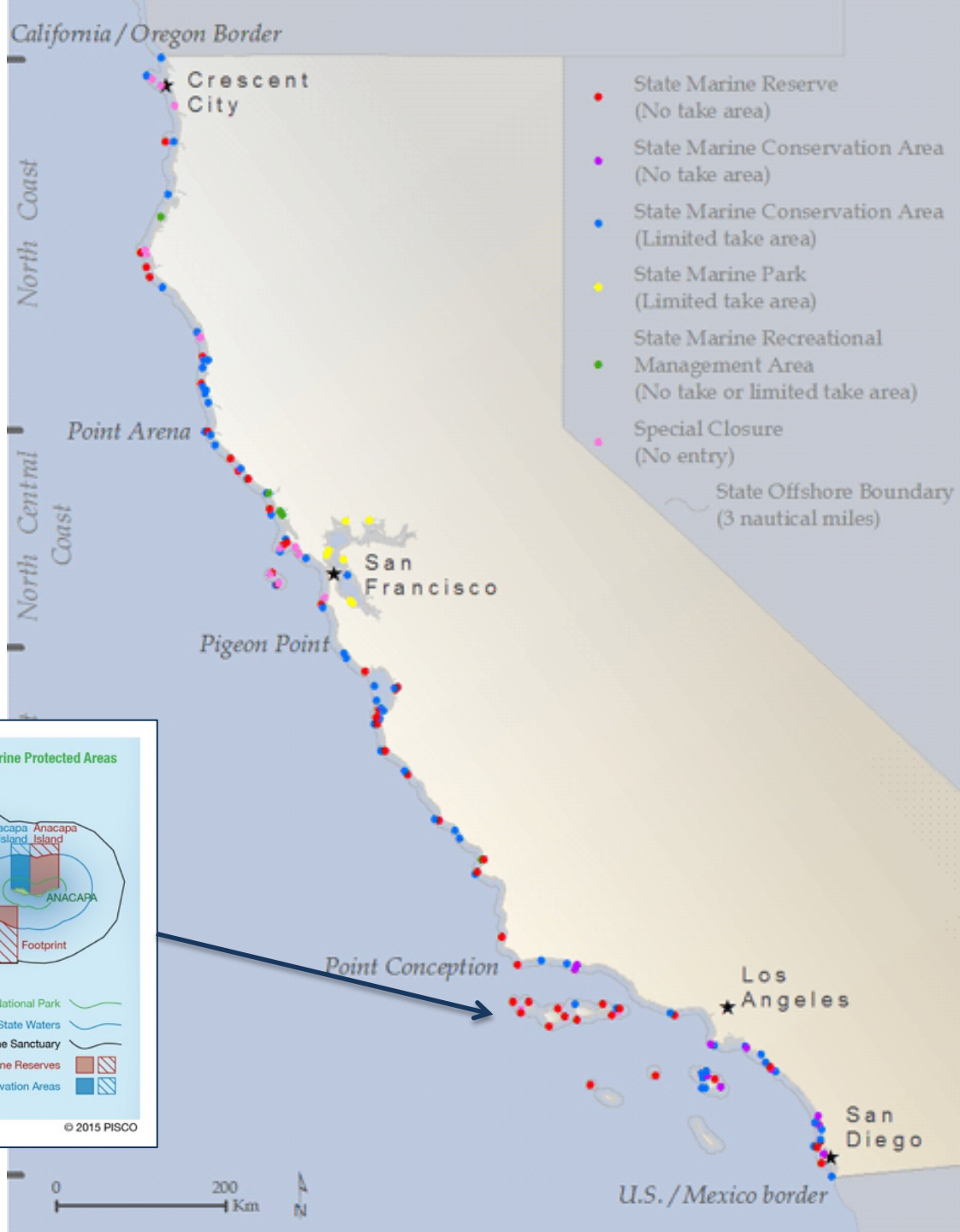
- Abundance increased in 2014 - 2016
- Strong spatial variation

Caselle et al. *In Revision*, Ecology Letters

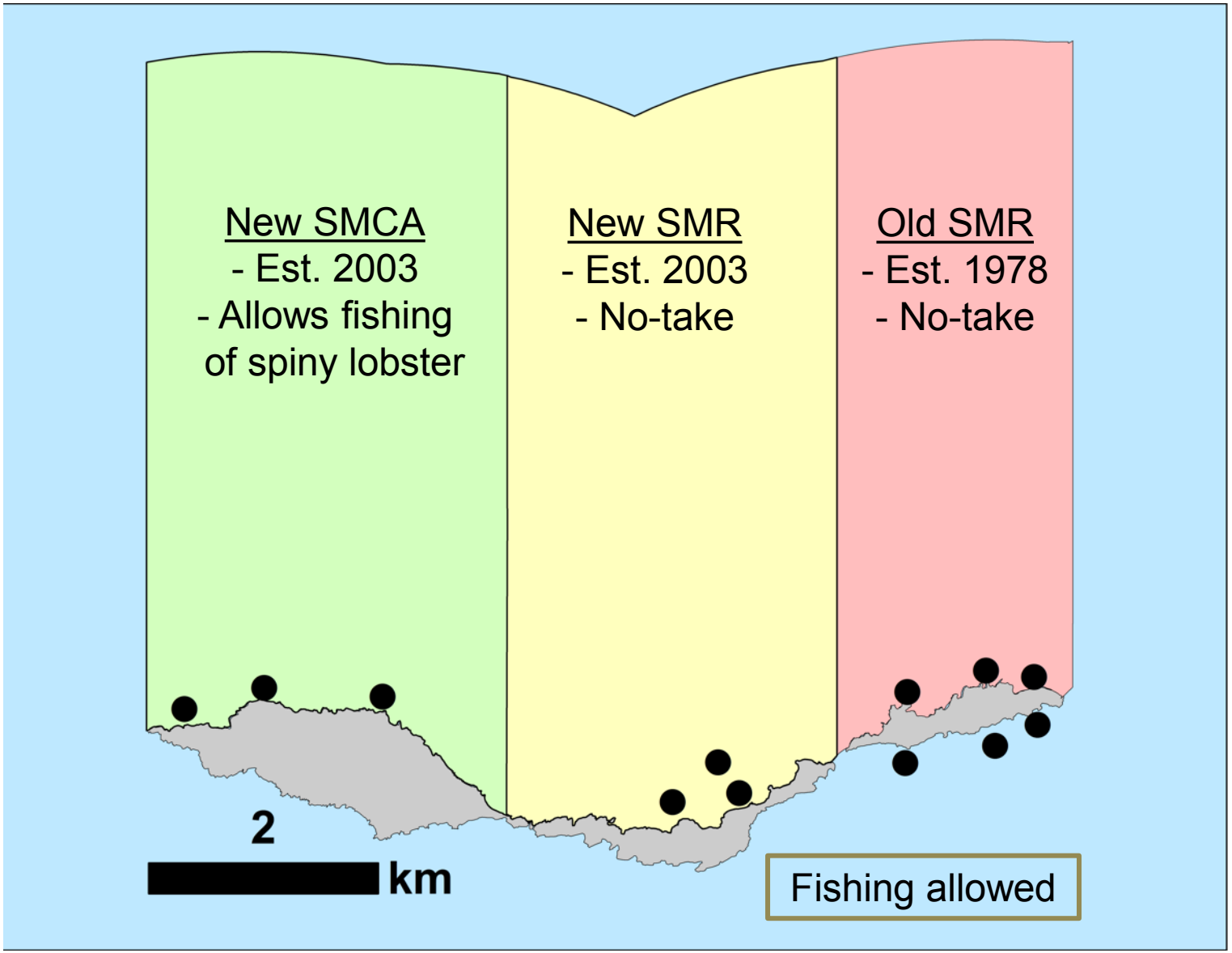
Around same time as *S. horneri* invasion –

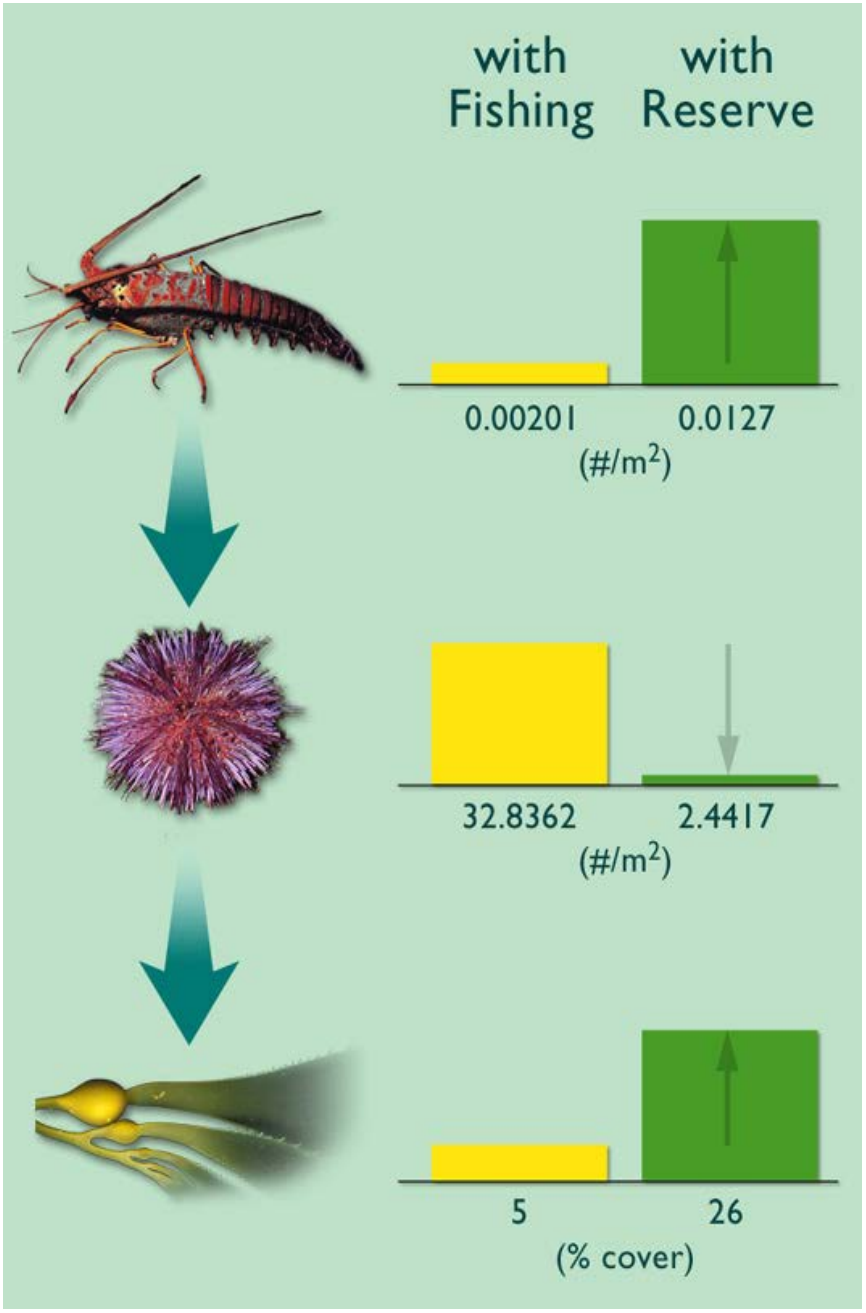
California designated an unprecedented MPA network





Anacapa island protection zones



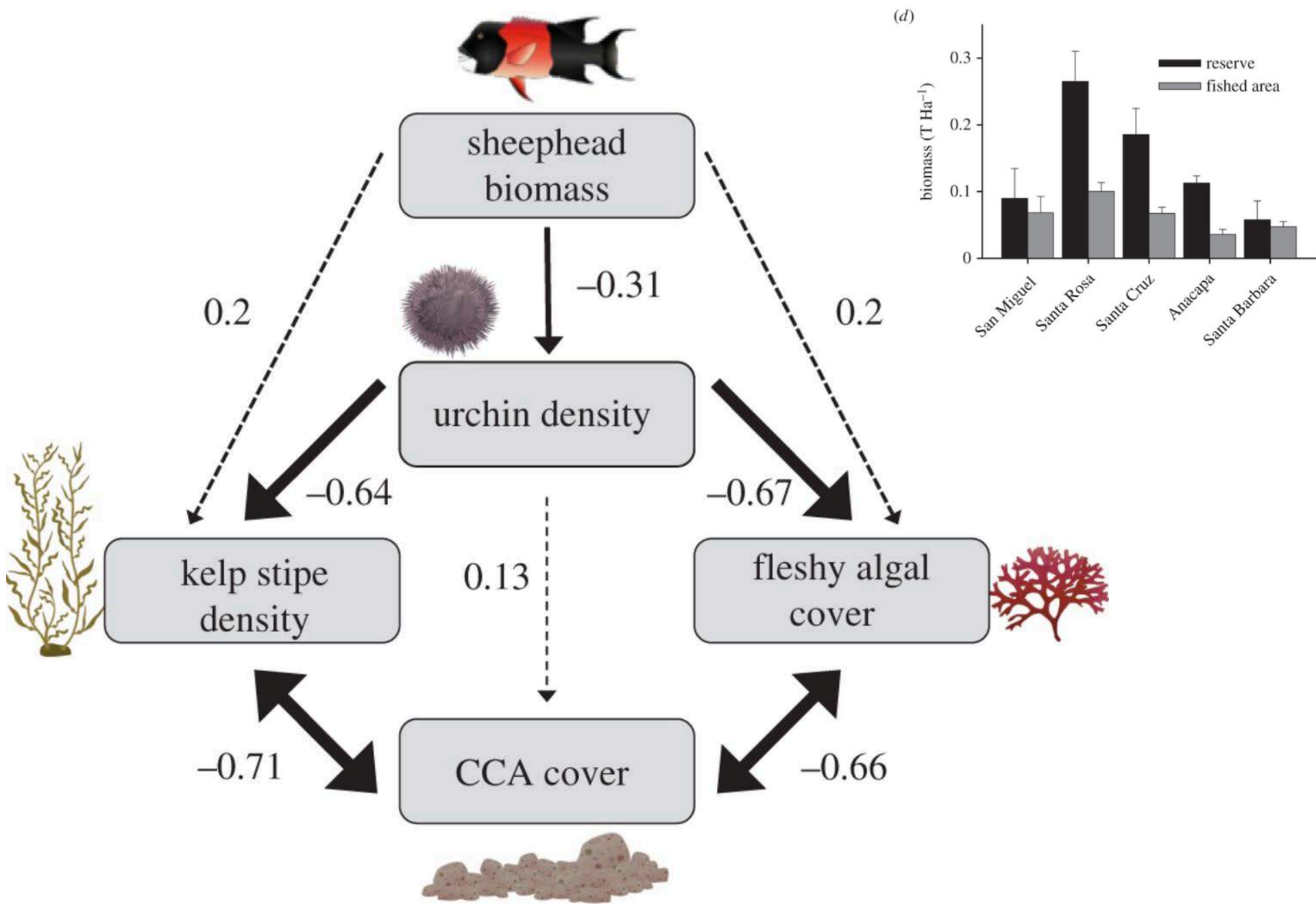


Behrens & Lafferty 2004, Lafferty & Behrens 2005
(Long term monitoring data from NPS)

Reserves affect community structure

Shifts in food webs- trophic cascades

- In Old Reserve - 6x more lobster
- Fished Area - 13x more urchins
- Kelp only persists in Old Reserve



Hamilton and Caselle (2015) Proc. R. Soc. B
Caselle et al. (2015) Nature Scientific Reports

WHAT WE KNOW

ESTABLISHED MPA

Predators

Urchins

Native algae

FISHED AREAS

Predators

Urchins

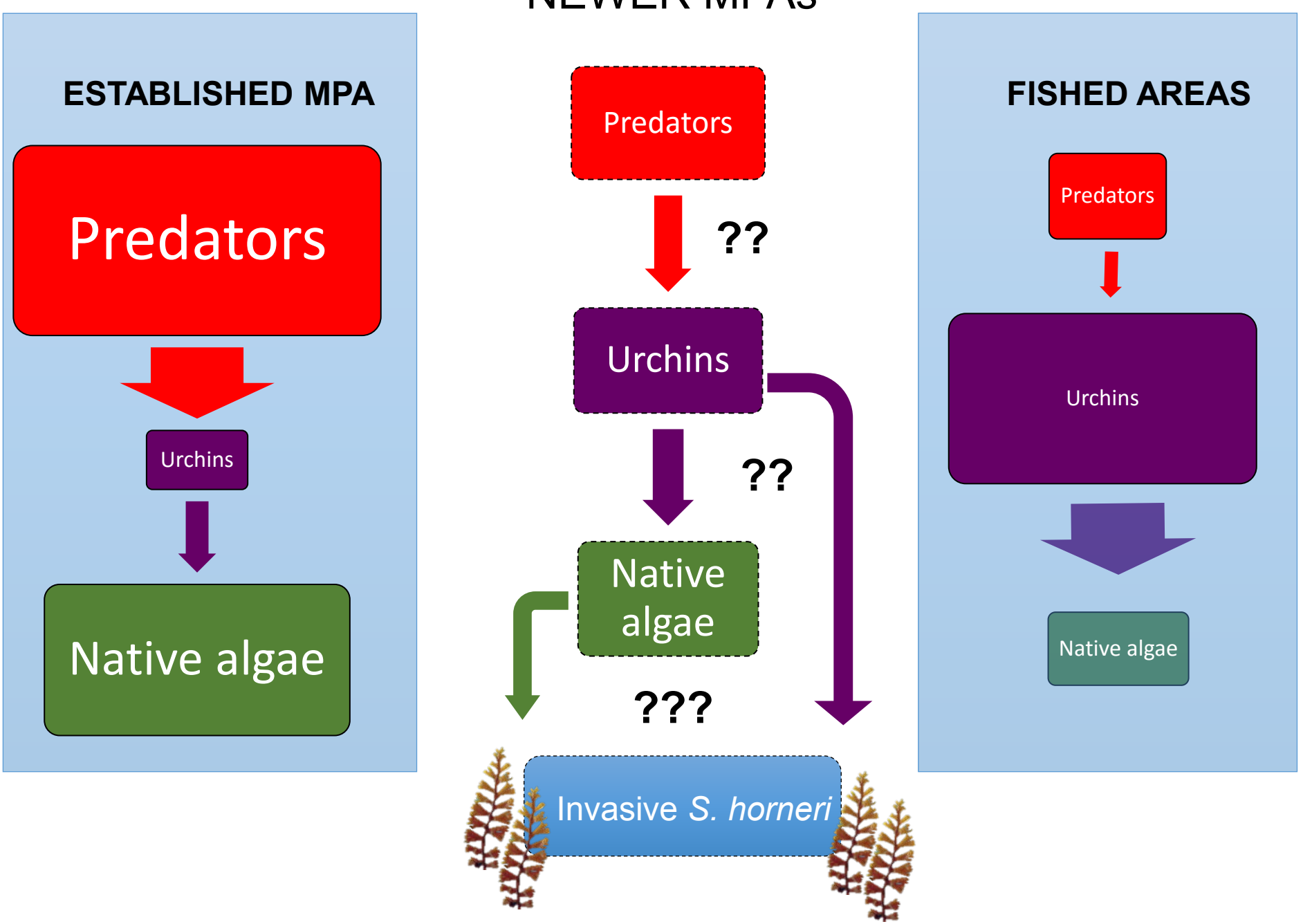
Native algae

WHAT WE DON'T KNOW

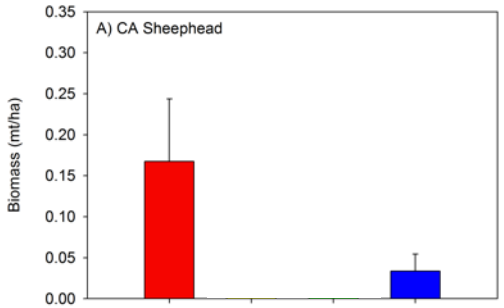
???

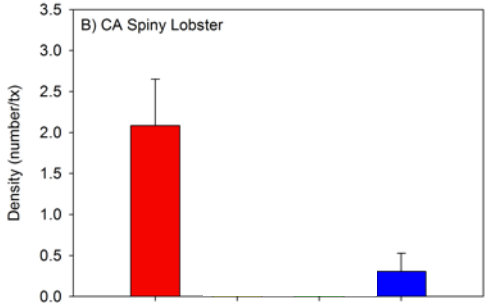
???

Invasive *S. horneri*


NEWER MPAs
ESTABLISHED MPA
Predators
Urchins
Native algae
Predators
??
Urchins
??
Native algae
???
Invasive S. horneri
FISHED AREAS
Predators
Urchins
Native algae

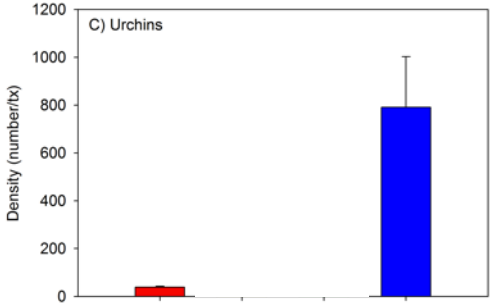
CA sheephead

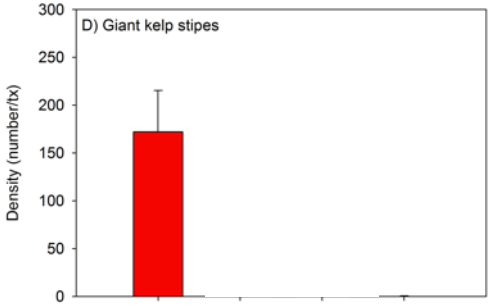




Lobster

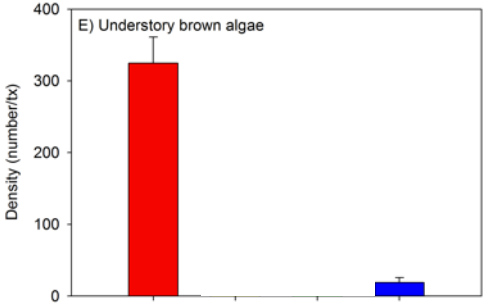
Sea urchins

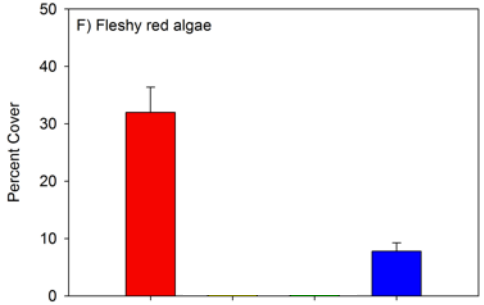




Giant kelp

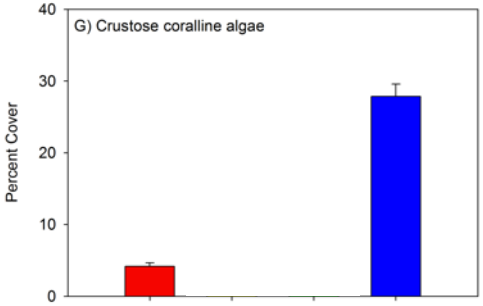
Understory kelps

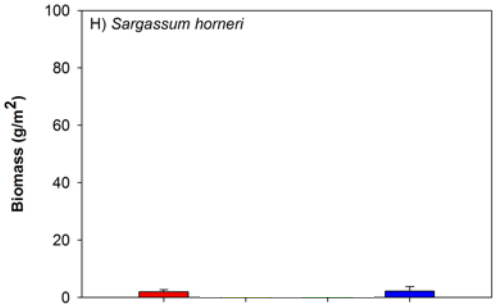




Red algae

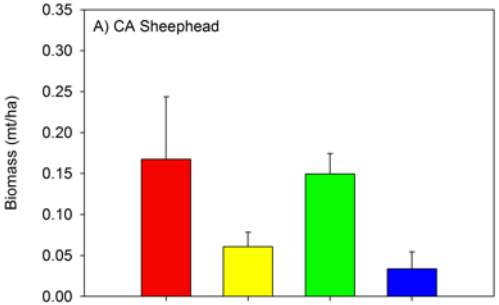
Crustose coralline algae

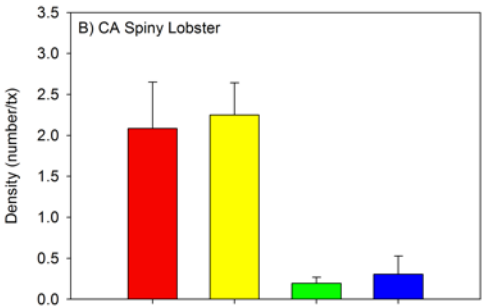




Sargassum horneri

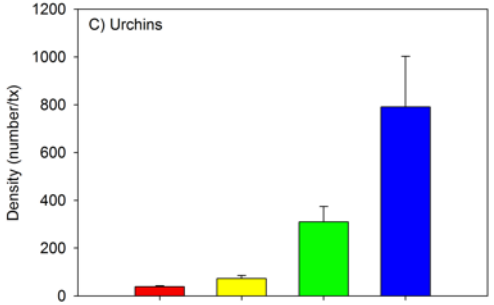
CA sheephead

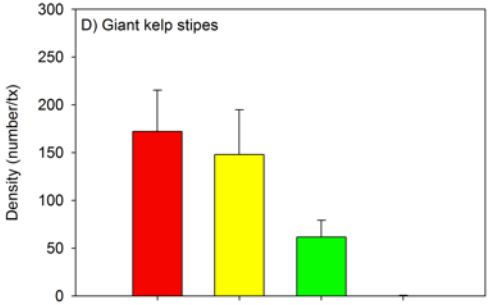




Lobster

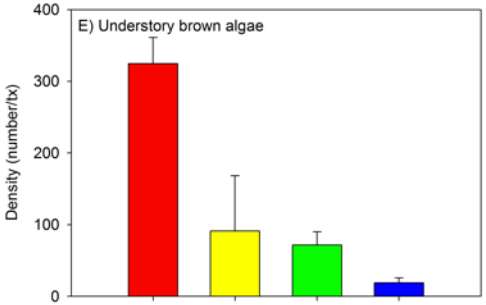
Sea urchins

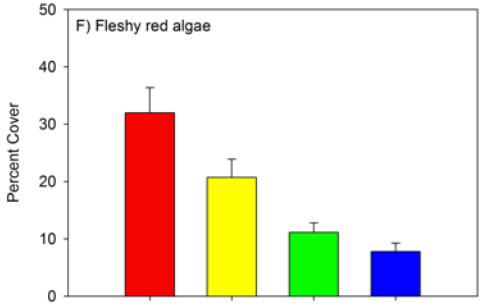




Giant kelp

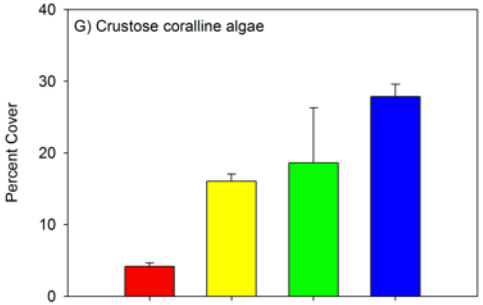
Understory kelps

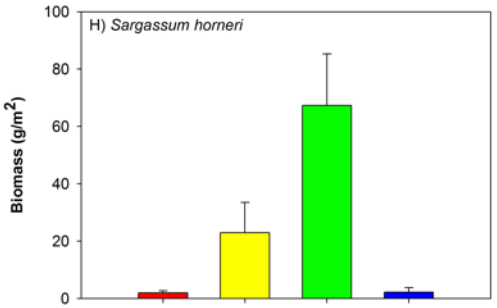




Red algae

Crustose coralline algae



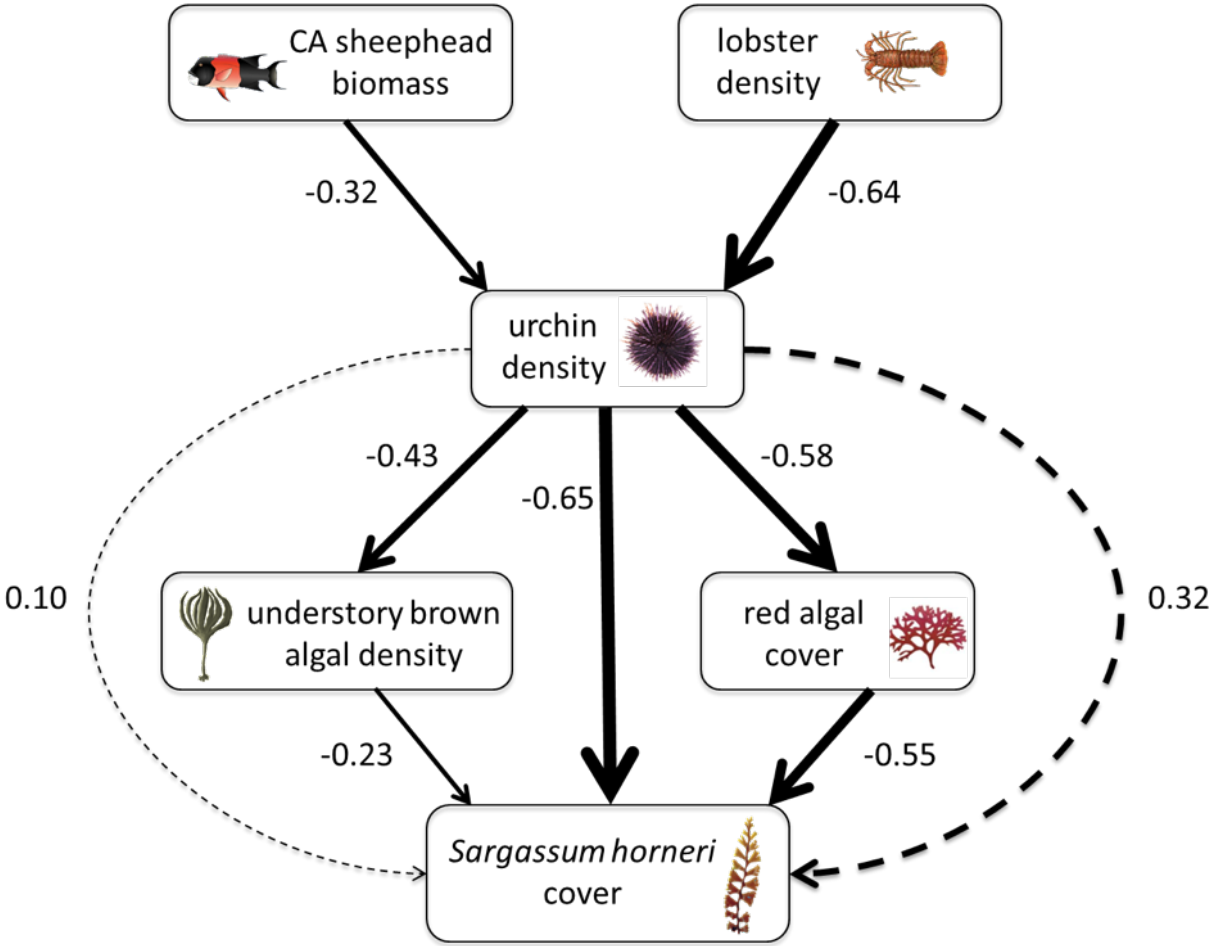


Sargassum horneri

OLD SMR NEW SMR NEW SMCA REF

OLD SMR NEW SMR NEW SMCA REF

The food web with invasive algae



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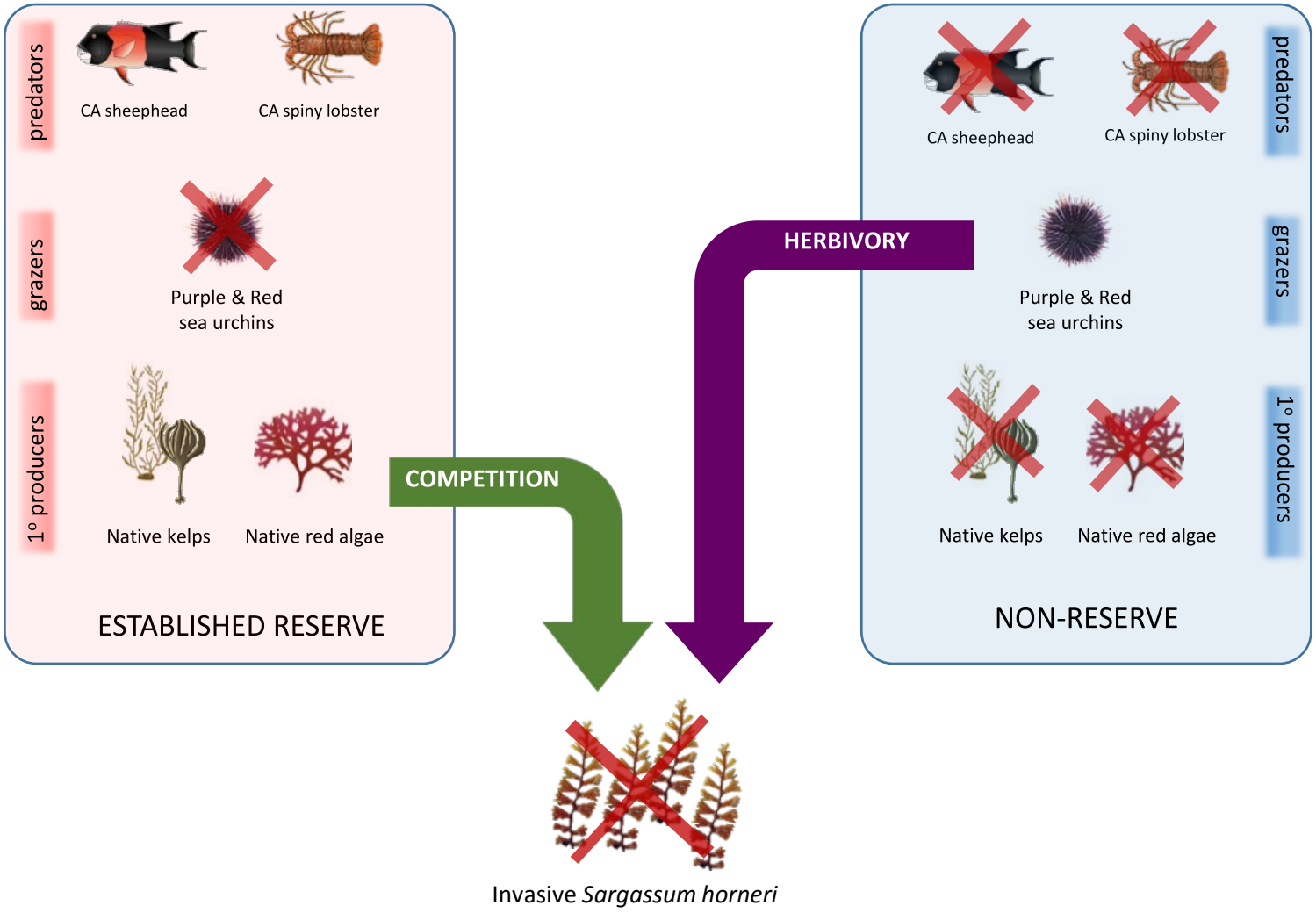
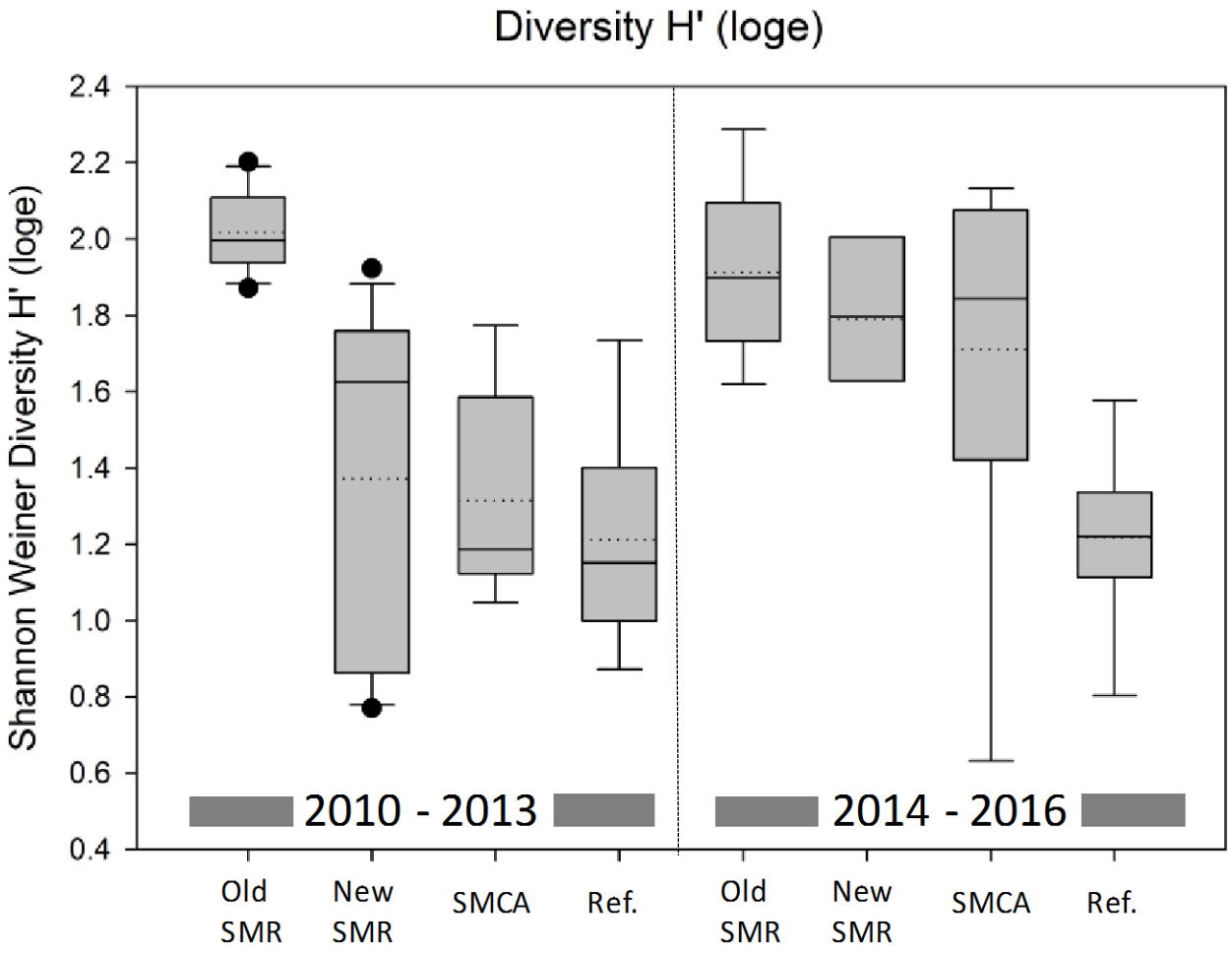
MULTIPLE PATHWAYS TO INVASION RESISTANCE



BUT ARE THE TWO ECOSYSTEM STATES EQUAL (OR DESIRABLE)?

Species diversity is greater in MPAs



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WHAT WILL HAPPEN IN THE NEWER MPAs?

predators

CA sheephead

CA spiny lobster

grazers

Purple & Red sea urchins

1° producers

Native kelps

Native red algae

ESTABLISHED RESERVE

predators

CA sheephead

CA spiny lobster

grazers

Purple & Red sea urchins

1° producers

Native kelps

Native red algae

NEW RESERVES

predators

CA sheephead

CA spiny lobster

grazers

Purple & Red sea urchins

1° producers

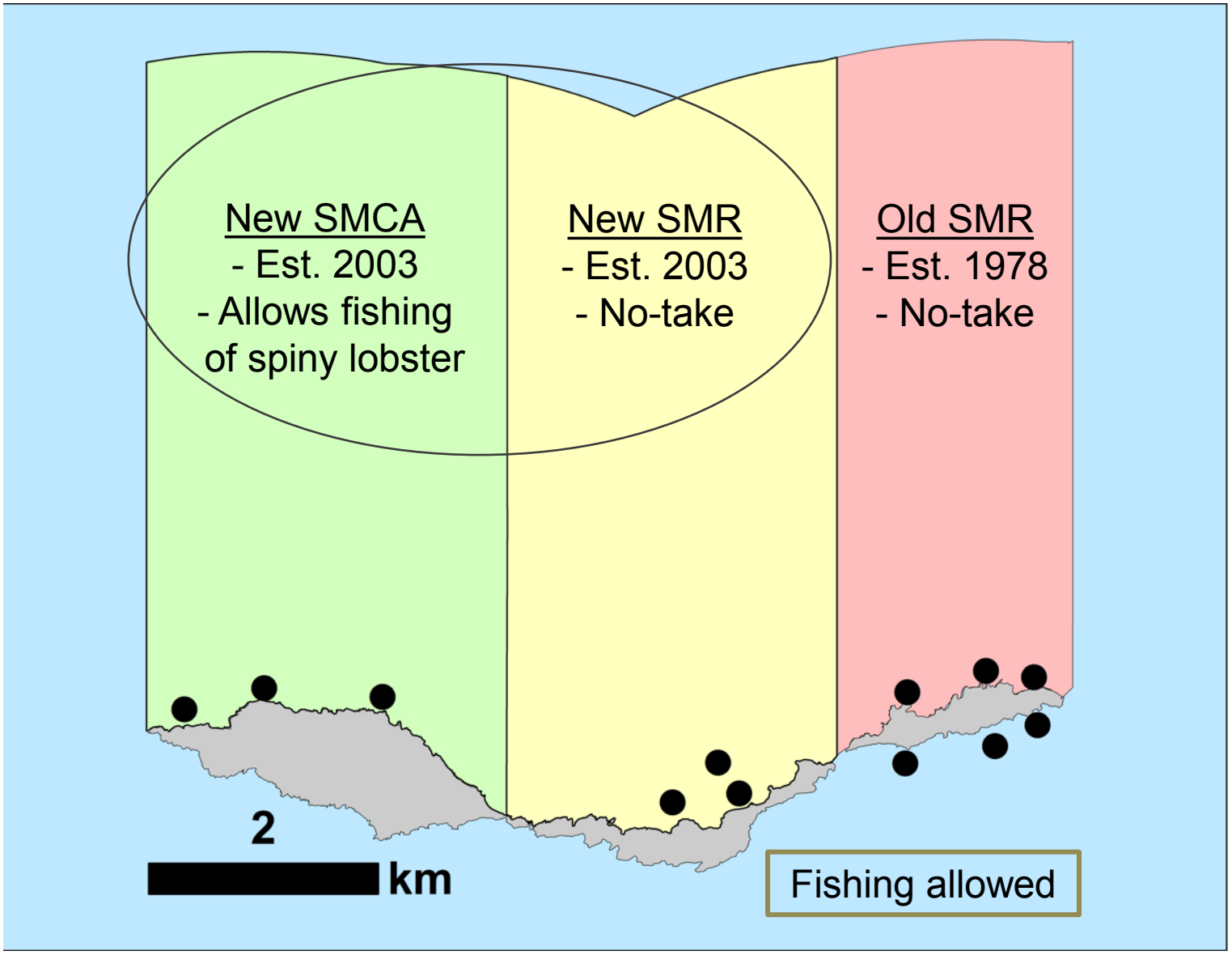
Native kelps

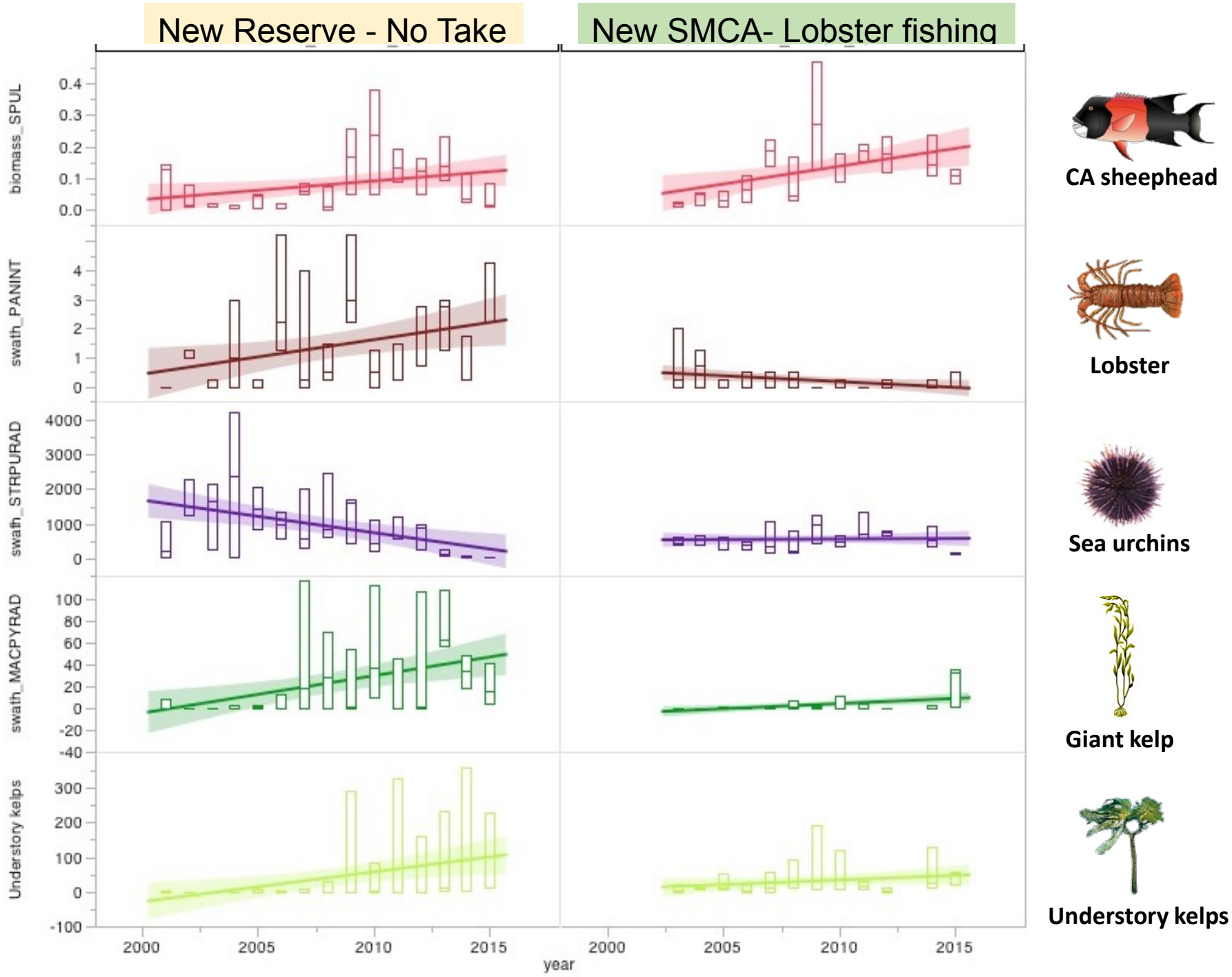
Native red algae

NON-RESERVE

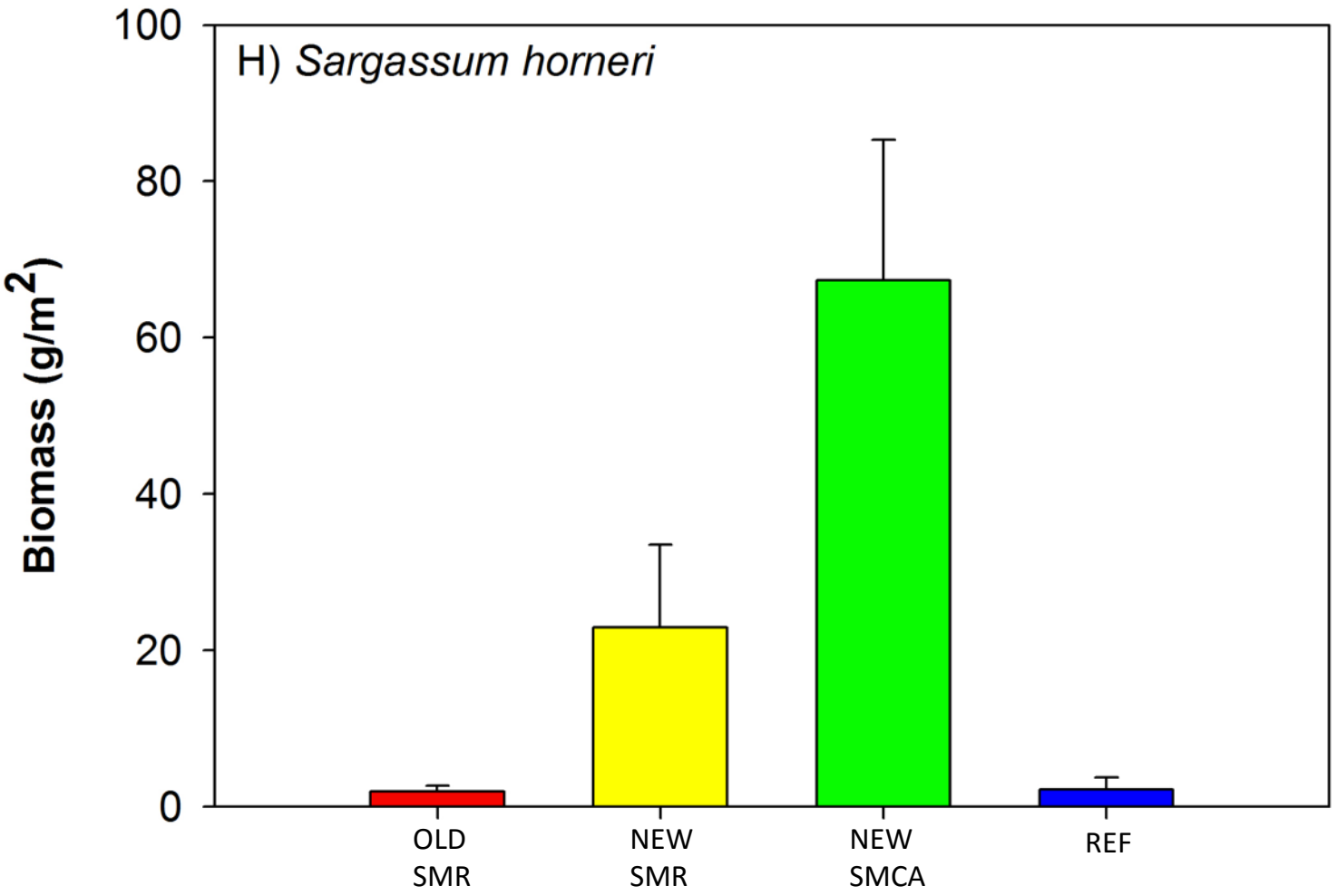
Invasive *Sargassum horneri*

Anacapa island protection zones




New Reserve - No Take
New SMCA- Lobster fishing
biomass_SPUL
swath_PANINT
swath_STRPURAD
swath_MACPYRAD
Understory kelps
year
2000
2005
2010
2015
CA sheephead
Lobster
Sea urchins
Giant kelp
Understory kelps

S. horneri is most abundant at the SMCA that allows lobster fishing



Conclusions

- *Sargassum horneri* is invading southern California with potentially dramatic effects on kelp forest ecosystems
- Marine protected areas with healthy native algal communities may resist the invasion – likely mechanism competition for space and shading
- Overfished, urchin barrens also “resist” invasion – likely mechanism predation by urchins
- This study is correlative but suggestive of a number of interesting next steps including experimental manipulations and broader spatial monitoring

Implications

Kelp forest restoration

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More than 1 million urchins removed in Palos Verdes kelp restoration project

POSTED BY JOHN SCHREIBER ON NOVEMBER 19, 2014 IN LIFE | 1,112 VIEWS | LEAVE A RESPONSE

Volunteers In Palos Verdes Peninsula: Rebuild Kelp Forests And Marine Life Will Come

November 19, 2014 5:41 PM

Filed Under: Conservation, Ecosystem, Kelp, Marine Biology, Marine Life, Nature, Ocean, Palos Verdes Peninsula, The Bay Foundation

Disease dynamics and urchin populations

As Sea Stars Die, New Worries About Urchins

Some urchins waste away, others come out of hiding as the fallout from sea star disease ripples along the California coast.

By **Leslie Willoughby**, National Geographic

PUBLISHED APRIL 1, 2015

Urchins Could Be the Next Victim of Sea Star Wasting Disease

The virus that has struck out Pacific sea star populations could now be affecting their Echinoderm cousins

Acknowledgements