

Dedicated to the Memory of Dr. Susan Williams

“Professor Susan Williams from BML was instrumental in providing congressional testimony about the biological significance of the Point Arena upwelling center and associated marine productivity downstream – facts that were crucial to justify extending the northern boundary of the GFNMS.”

(NOAA Office of Response and Restoration)





Causes and Consequences of Recent Large-Scale Kelp Loss in Northern California

Dr. Cynthia Catton

GFNMS-CDFW Kelp Recovery Working Group

April 25, 2018

Bull Kelp (*Nereocystis luetkeana*)

A critical
foundation
species for
kelp forest
ecosystems on
the north
coast



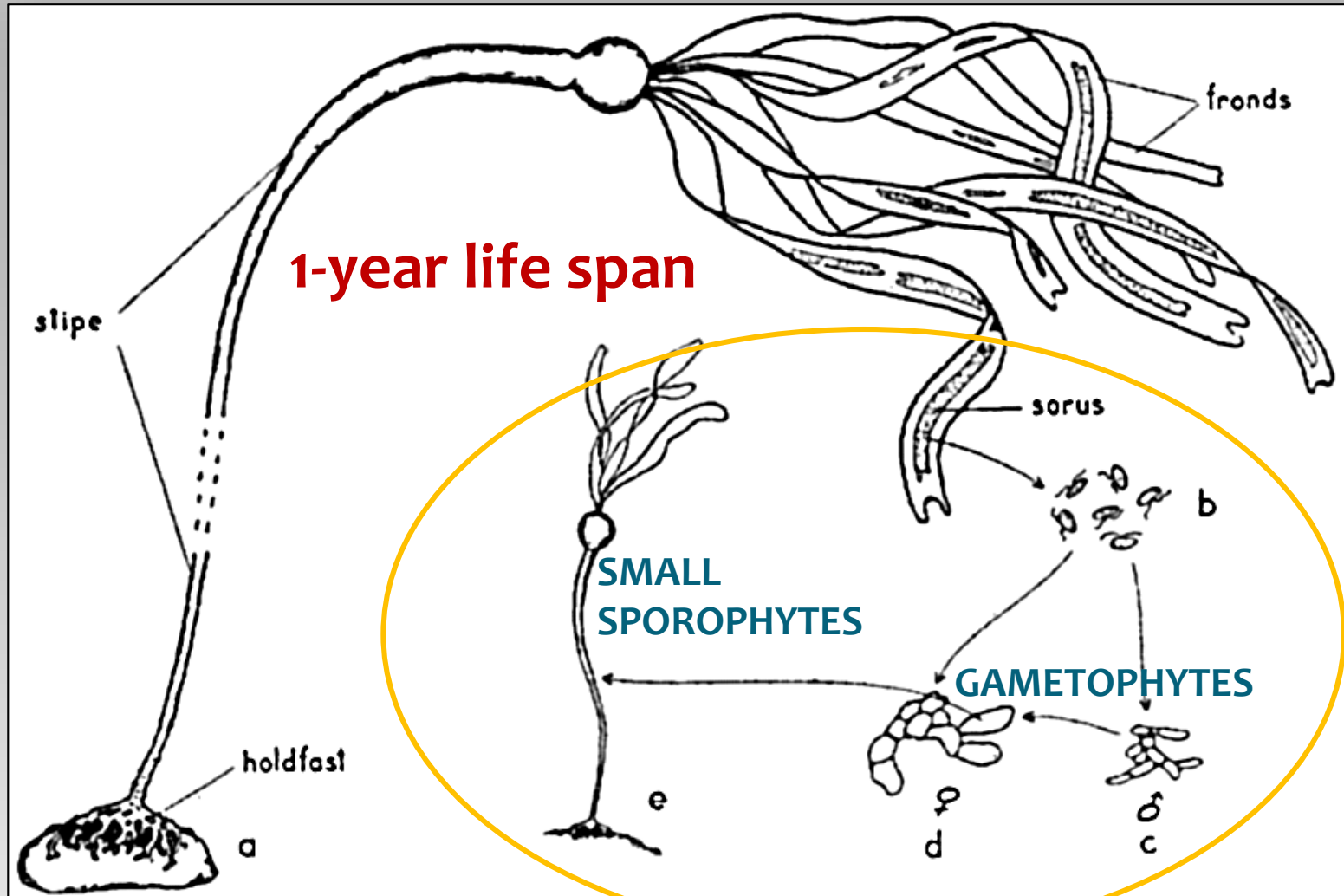


Bull kelp provides food and habitat for fish and shellfish

Grows to the surface of the water during Summer

Aerial surveys can be used to track natural fluctuations of kelp growth over time

Annual Life-History of Bull Kelp



Other shorter kelp species are also important and may have thick woody stalks



Pink crustose algae are very hard and not good to eat, but **very important** habitat for young shellfish



Red Abalone





Flat Abalone



Pinto Abalone



Flat Abalone

Pinto Abalone

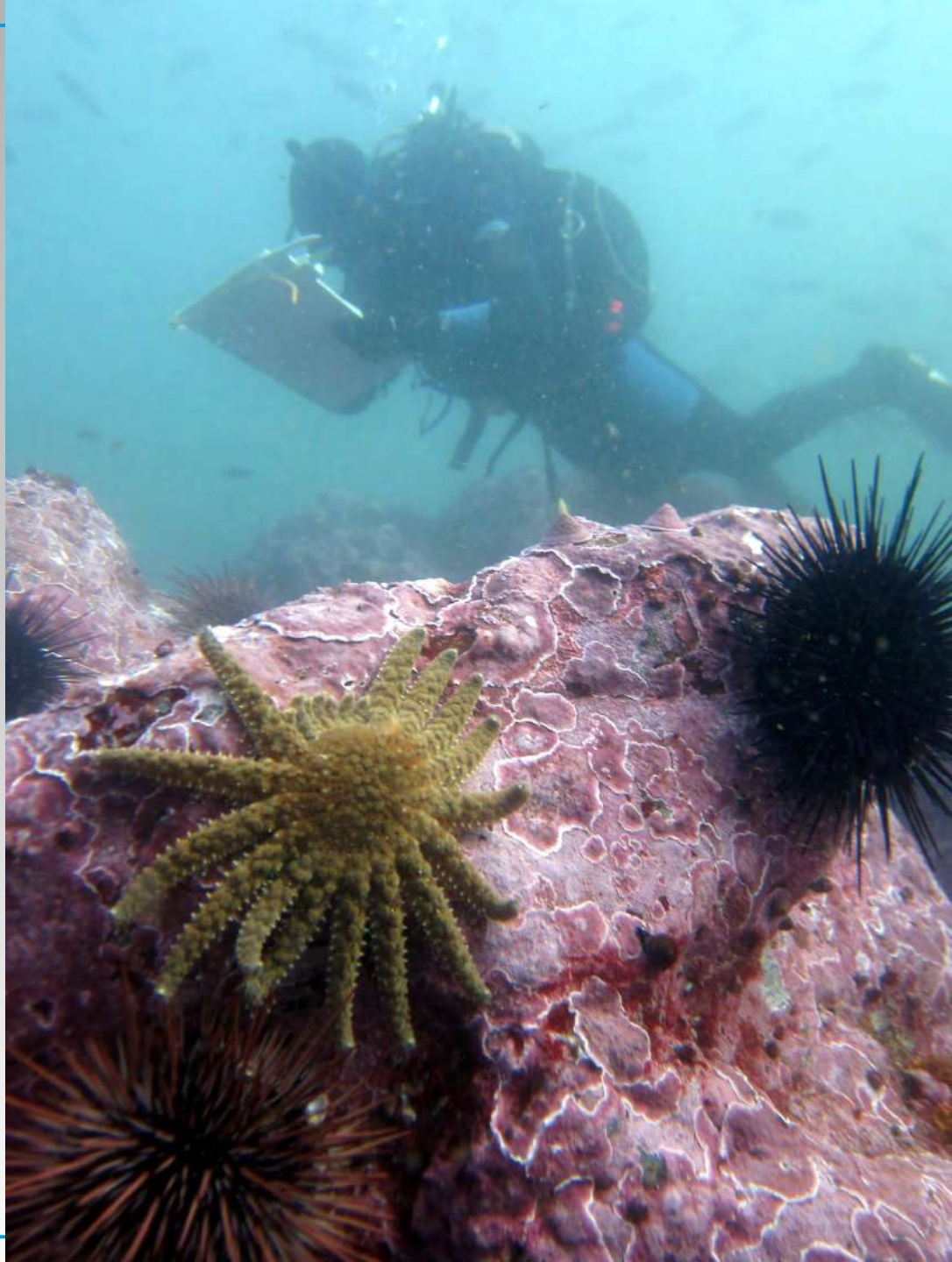
Red Abalone



Red Urchins

Purple Urchins

**Sunflower Star –
Important urchin
predator**



Giant-Spined Star



An underwater photograph showing a cluster of ochre seastars on a rocky reef. The seastars are bright orange with a white, crystalline pattern on their arms. They are surrounded by other marine life, including a large white sea slug with long, feathery tentacles in the upper right, a dark purple sea slug on the left, and a sea urchin with long spines at the bottom. The background is a colorful, textured rock surface with various algae and sponges.

Ochre Seastars

Leather Star



**Six-Armed
Star**



Sea Otter in Bodega Bay (May 10, 2017)



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J. Sones

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Climate Change Expectations

- Increased:

- Global surface temperature
- Sea level rise
- Ocean acidification

Variable Effects by Latitude & Altitude

Large-Scale Impacts

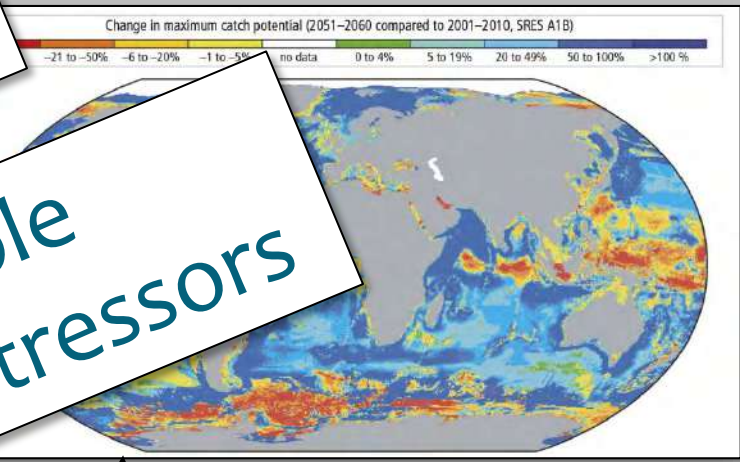
Likely Multiple Compounding Stressors

- Decreased: and Intensity of:

- Precipitation
- Hypoxic zones
- Diseases

- Reduced:

- Extreme weather events
- Sea ice and snow cover
- Ocean fisheries



Recent Marine Heat Waves

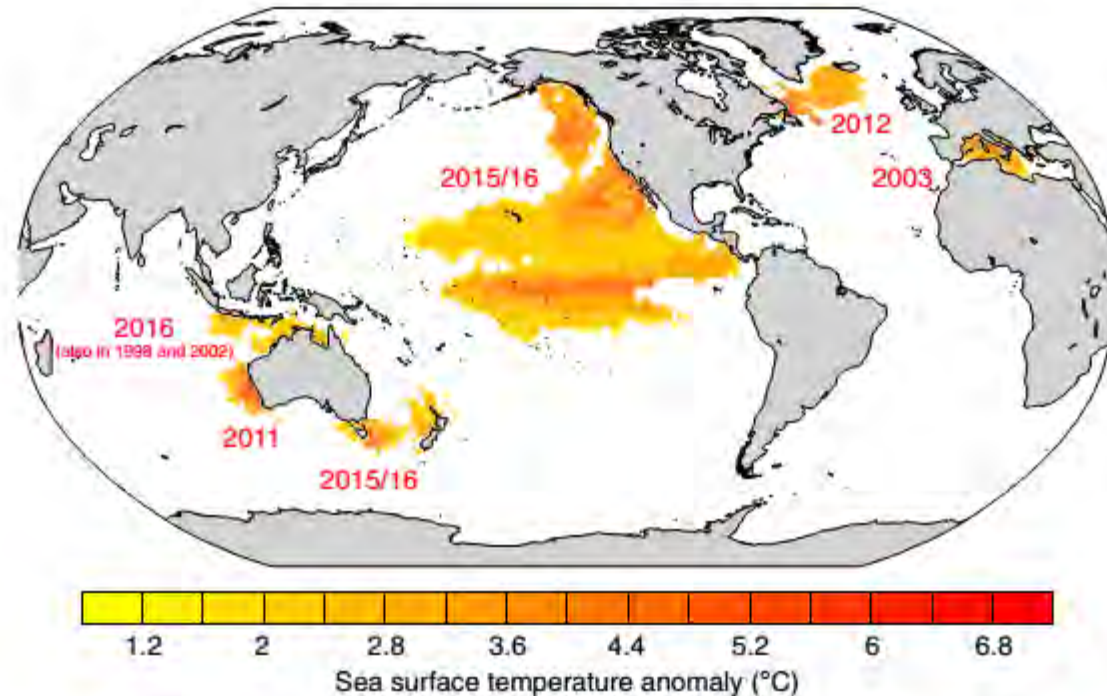


Fig. 1 Summary of prominent recent marine heat waves that are documented and analyzed in the literature. The figure shows the maximum sea surface temperature anomaly in regions where temperature exceeds the 99th percentile using NOAA's daily Optimum Interpolation sea surface temperature dataset¹¹. The numbers indicate the year of the MHW occurrence. The 99th percentile is calculated over the 1982-2016 reference period. The map was created using the NCAR Command Language (<https://www.ncl.ucar.edu>)

“Perfect Storm” Decimates Northern California Kelp Forests

Northern California
Beyond Tipping Point

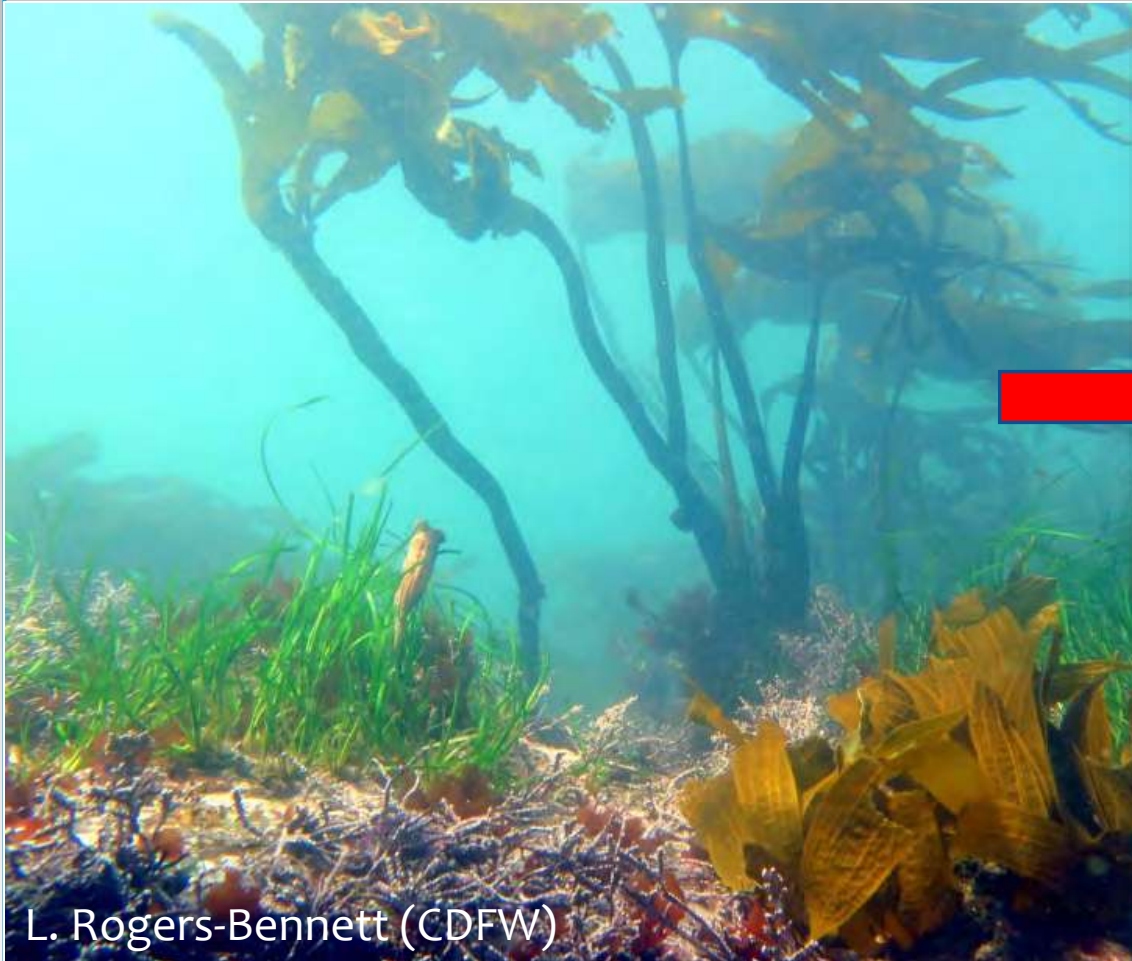
**Dramatic Changes in Kelp
Forest Ecosystems**

Total bull kelp habitat area ~15 km²

Key range ~250 km coast



Recent Severe Kelp Loss in Northern California



L. Rogers-Bennett (CDFW)



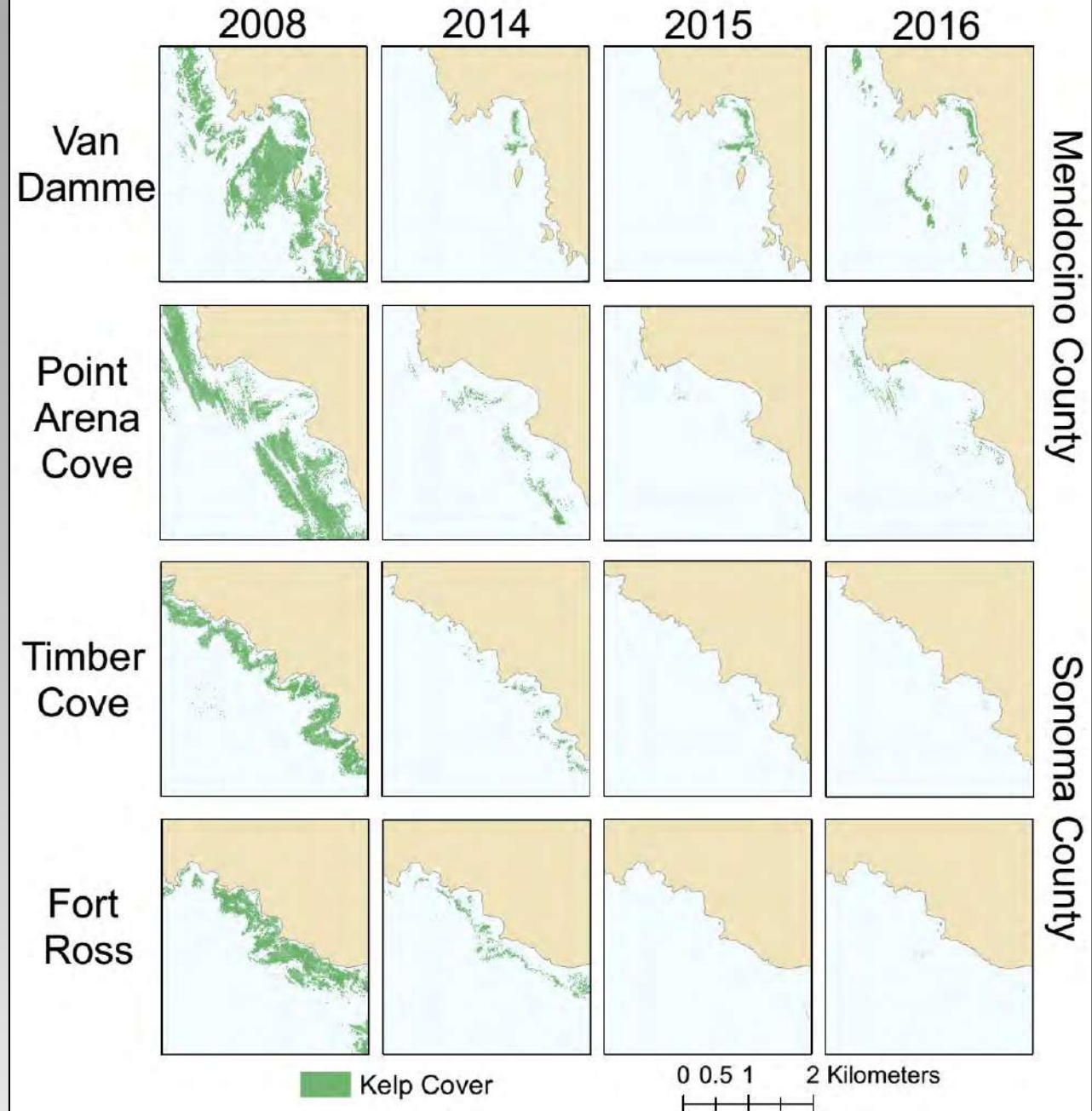
A. Weltz (CDFW)

Aerial Kelp Surveys (CDFW)

**93% kelp loss
in 2014**

**Additional 33%
loss in 2015**

**Limited kelp
growth in 2016
and 2017**



Van Damme – August 2017

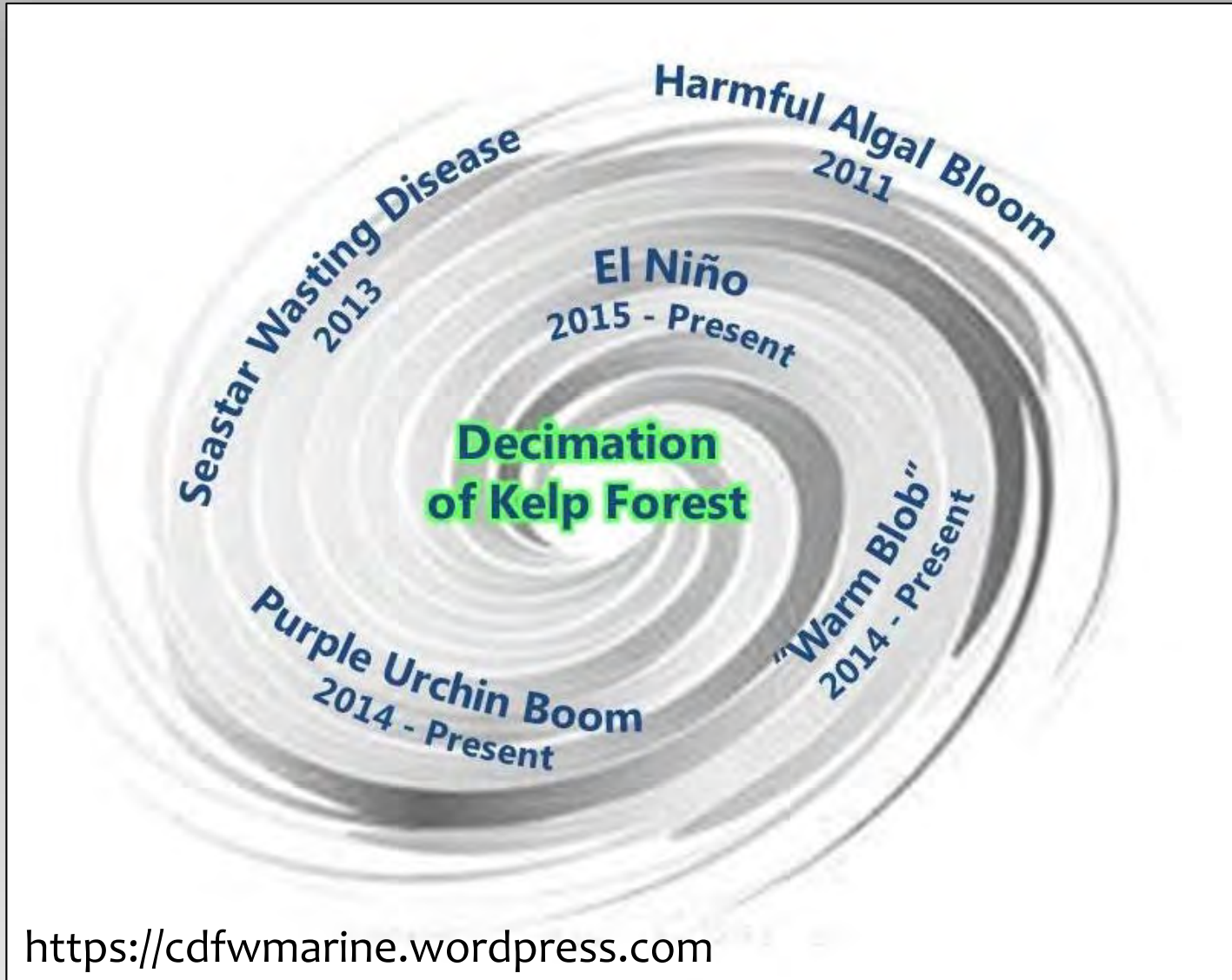


Van Damme – August 2017



M. Engelbrecht

“The Perfect Storm”



Multiple, Large-Scale Impacts

- >60 km • Harmful Algal Bloom (2011)
- >4,000 km • Sea Star Wasting Disease (2013)
- >4,000 km • Persistent Warm Water (2014 -)
- >600 km • Purple Urchin Explosion (2014 -)



Harmful Algal Bloom (Red Tide) Sonoma County 2011



Photo:
Nate Buck
Fort Ross 2011

Sea Star Mass Mortalities Sonoma County 2011, Both Counties 2013

Pycnopodia particularly impacted

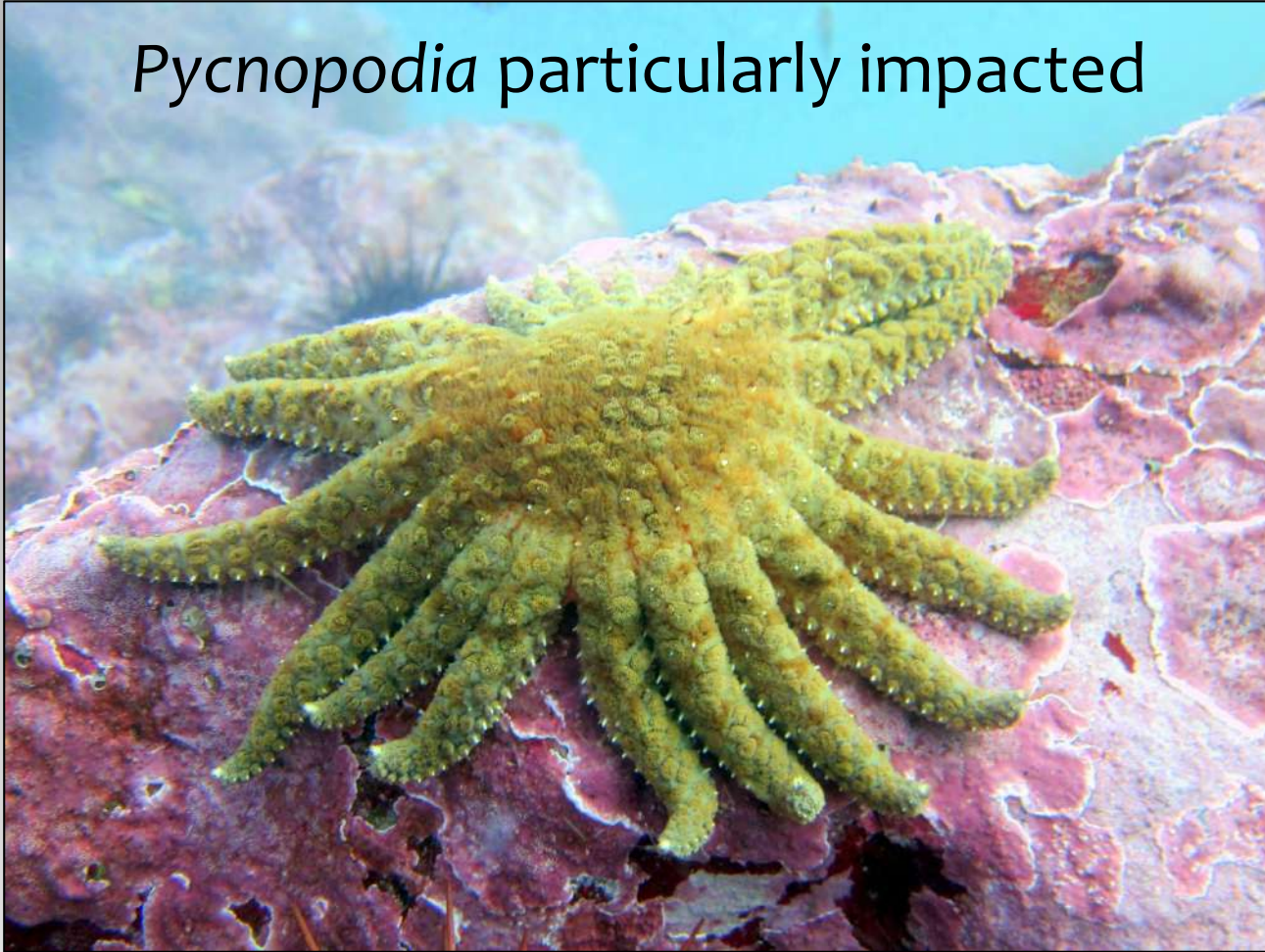
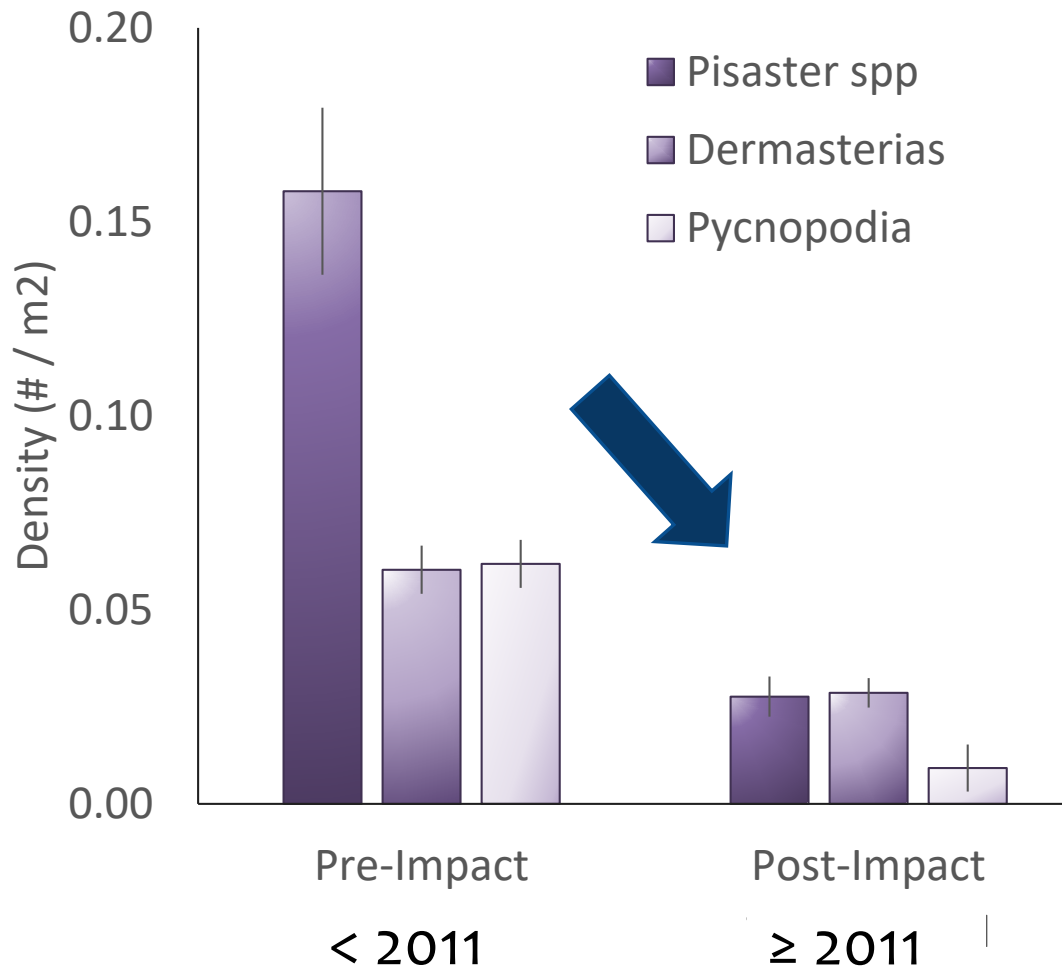
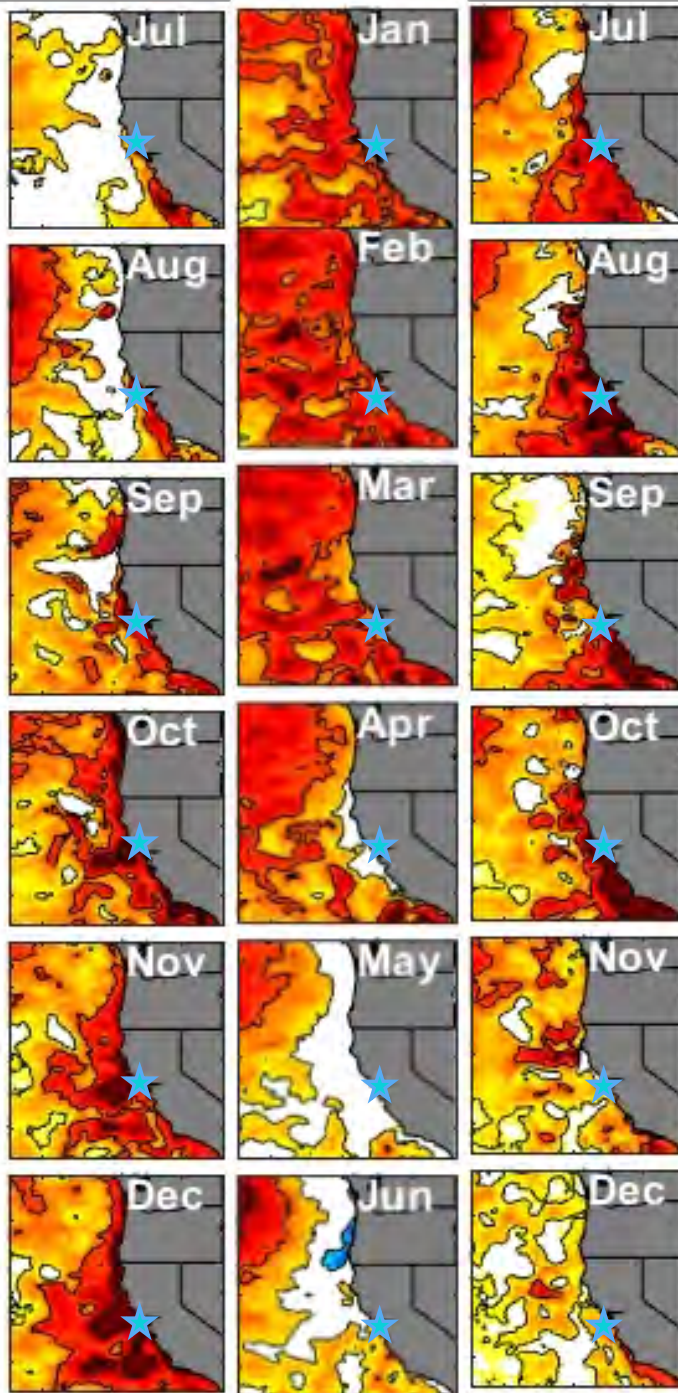


Photo A. Maguire

Seastar Density Declines After HAB and Wasting Disease

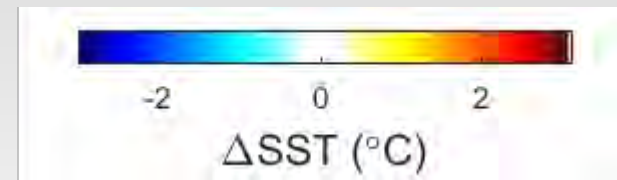


July 2014



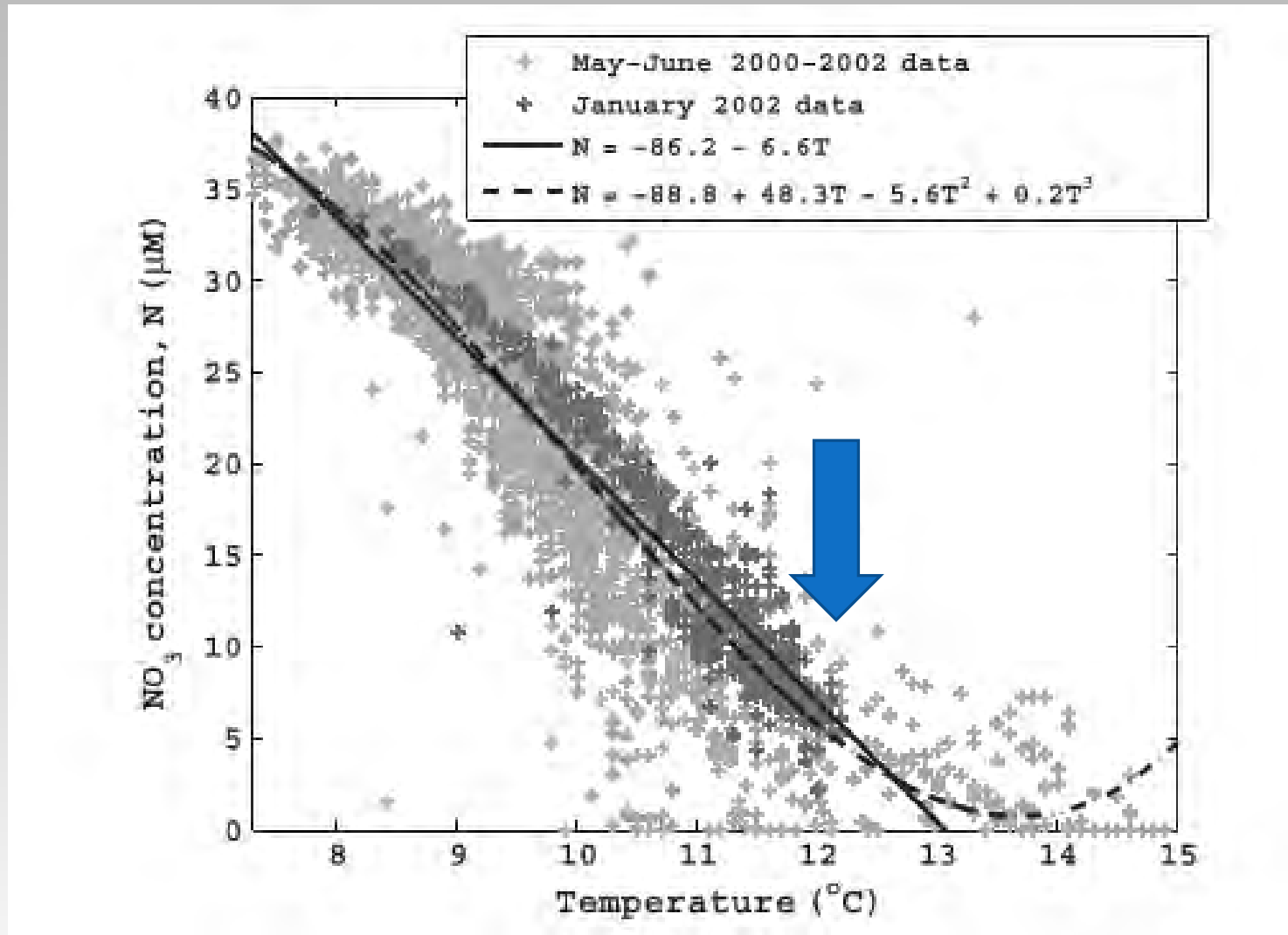
Persistent Warm Ocean Temperatures

Sea Surface Temperature (SST) anomalies in California and Oregon coast during the “Blob” and El Niño events in 2014-2015. Source: Modified from Gentemann et al. 2017.



Dec 2015

Bodega Bay Coast: Warm Water = Low Nutrients

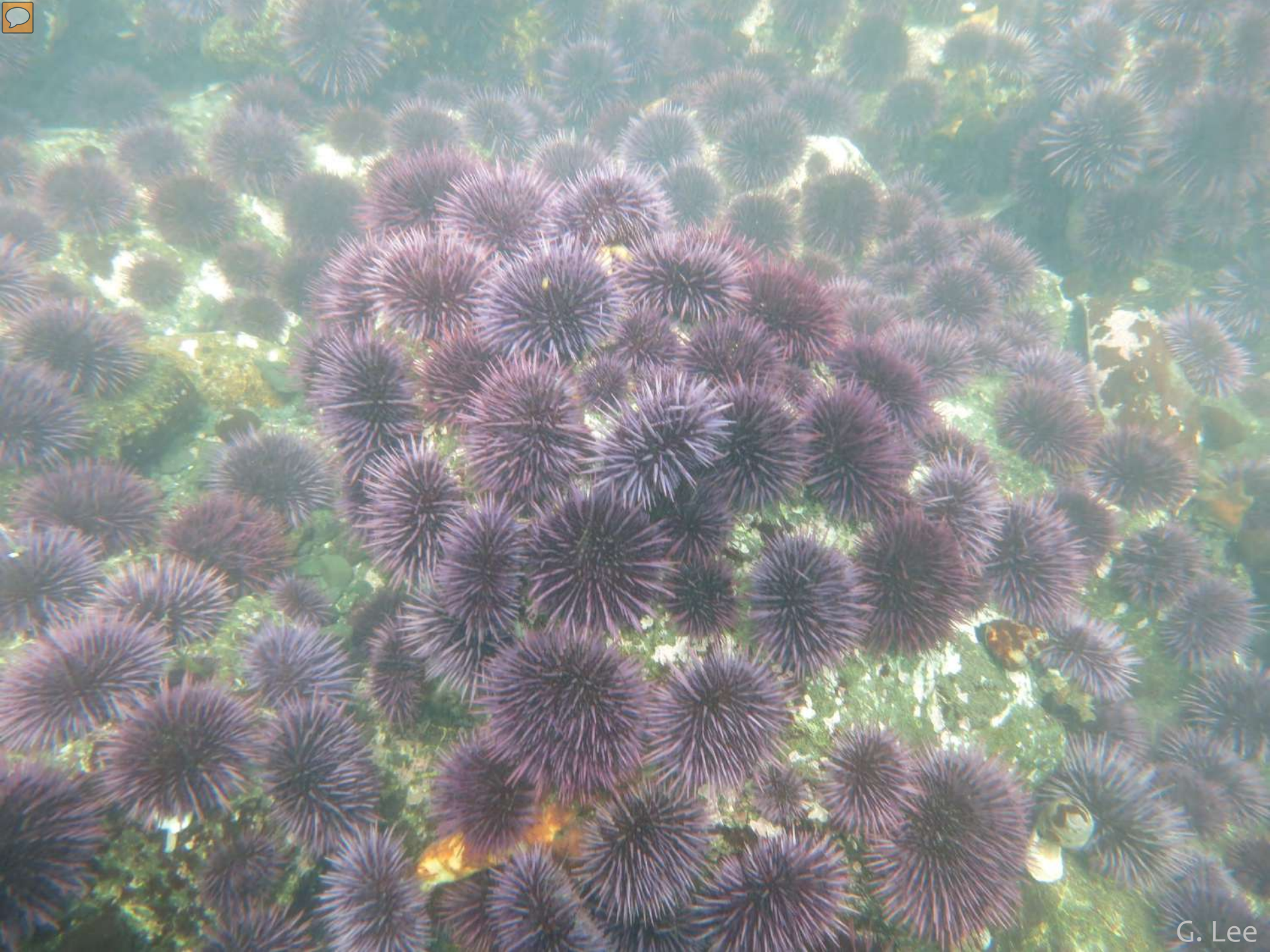


Unprecedented Large-Scale Purple Sea Urchin Explosion in 2015

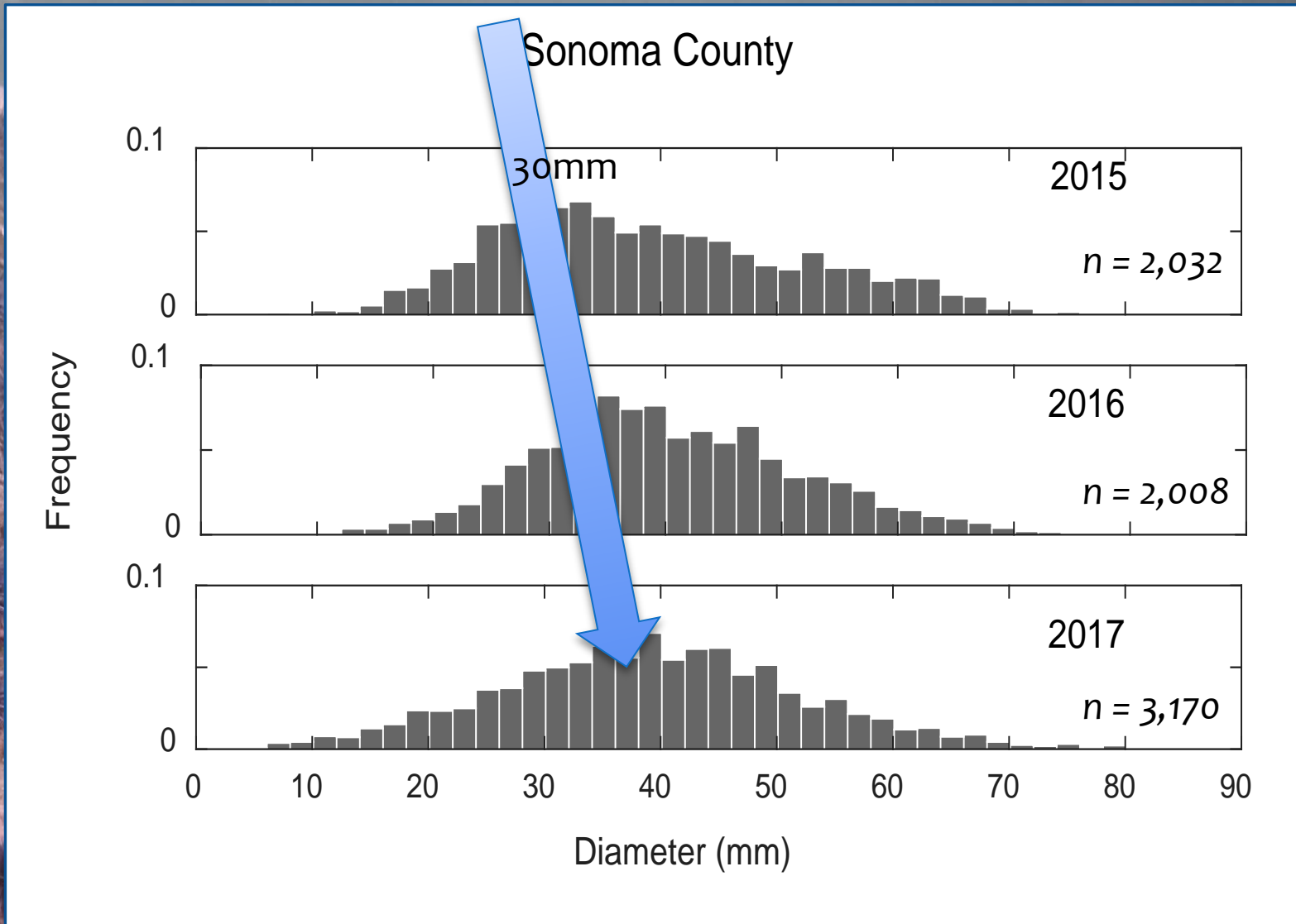


**> 60x historic
densities in N.
California**

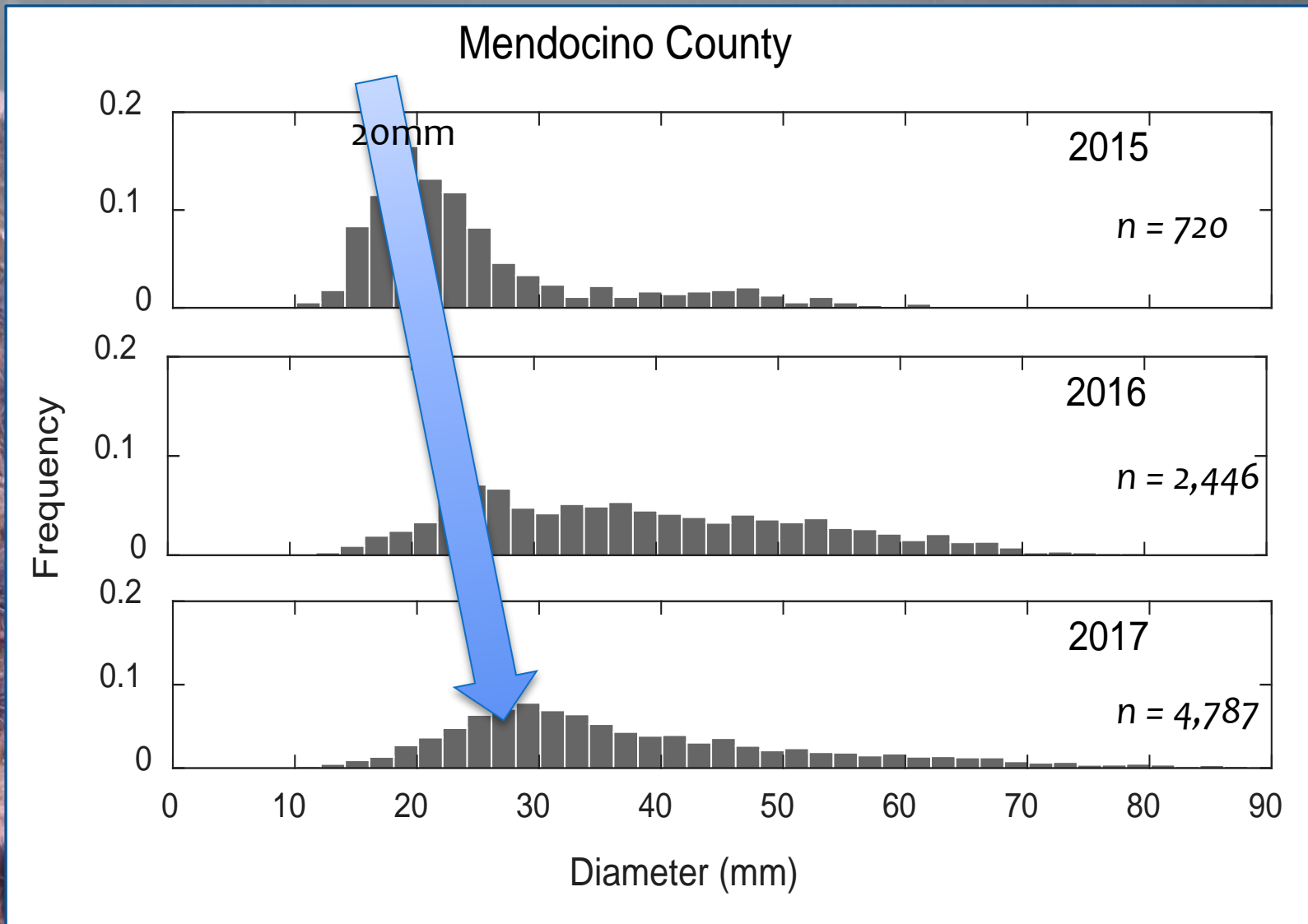
Reports of high
urchin numbers
from Central
California to
Washington State



Sonoma County – Purple Urchin Recruitment in 2013?

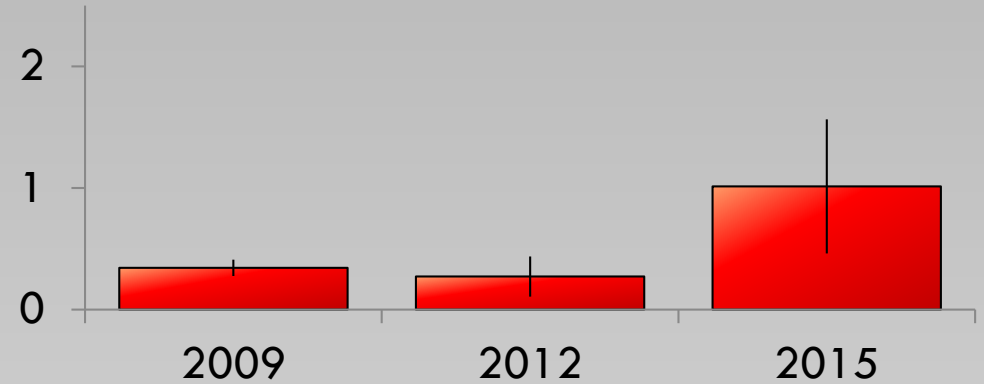


Mendocino County – Purple Urchin Recruitment in 2014?

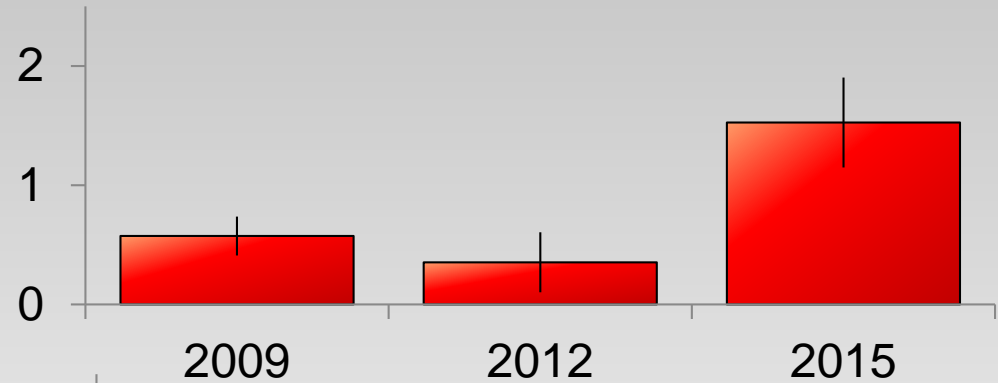


Red Urchin Densities (#/m²)

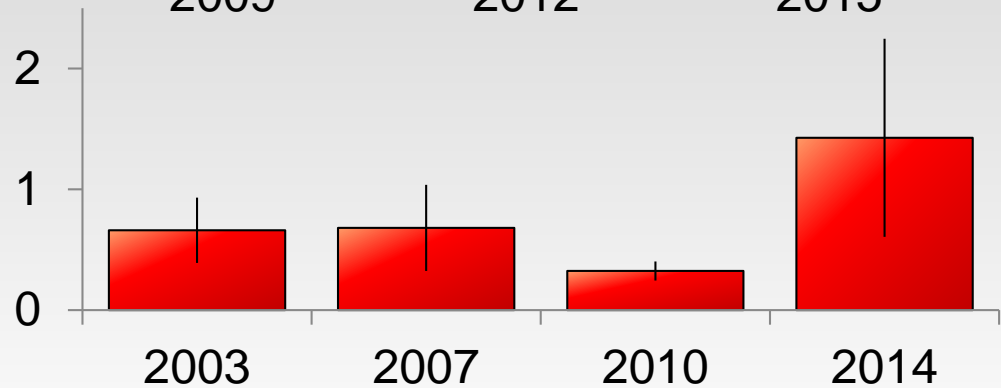
Fort Ross



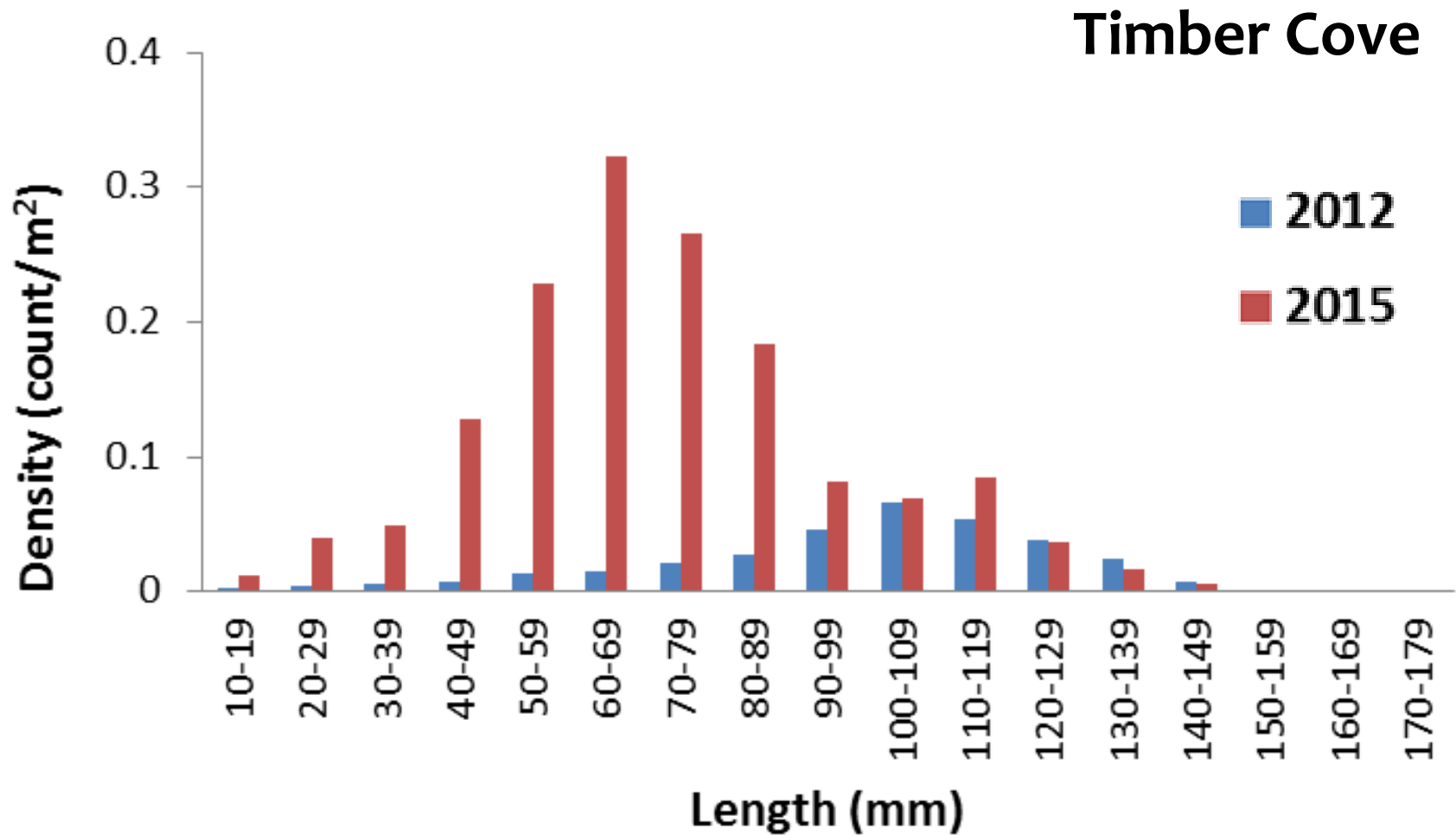
Timber Cove



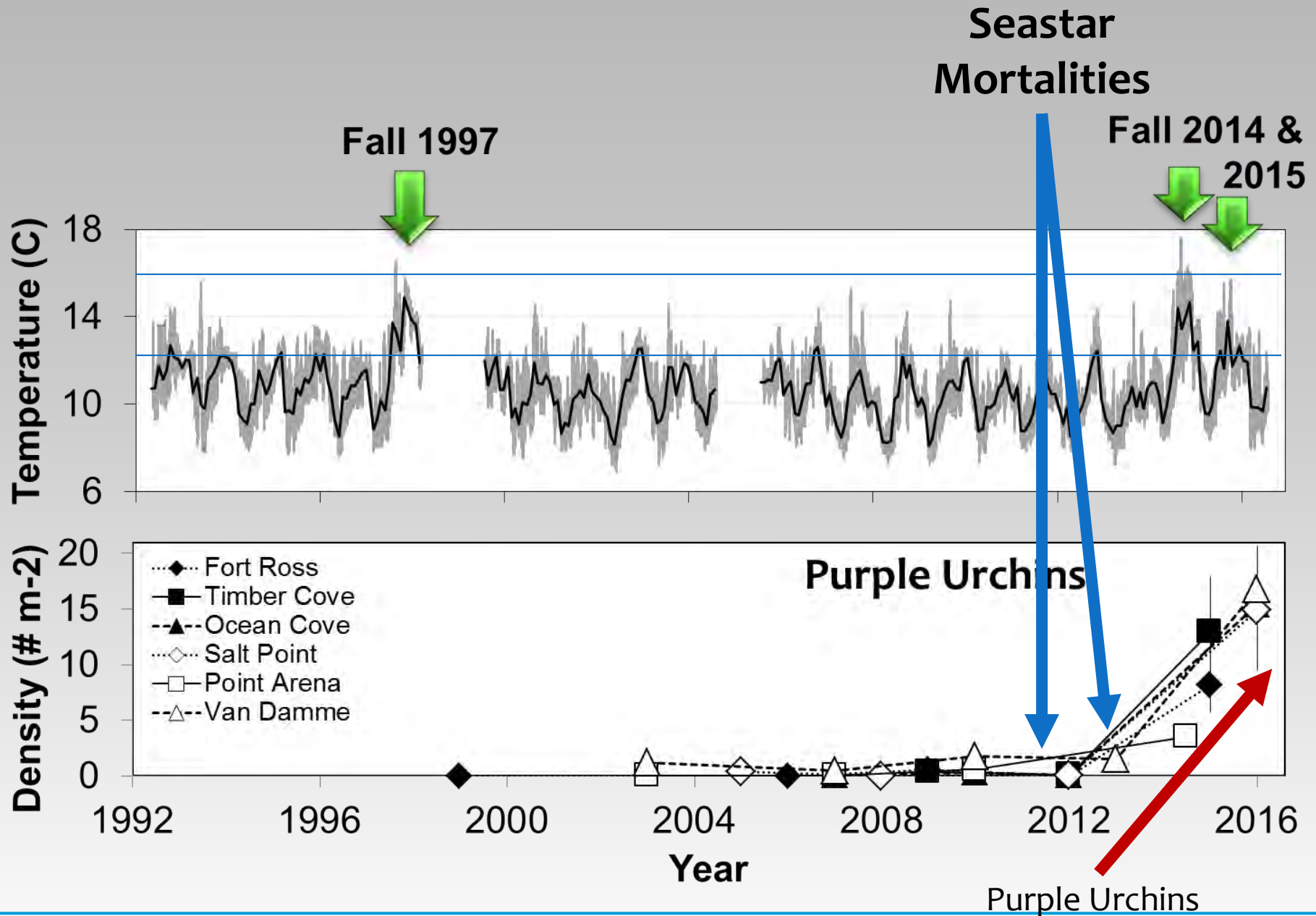
Point Arena

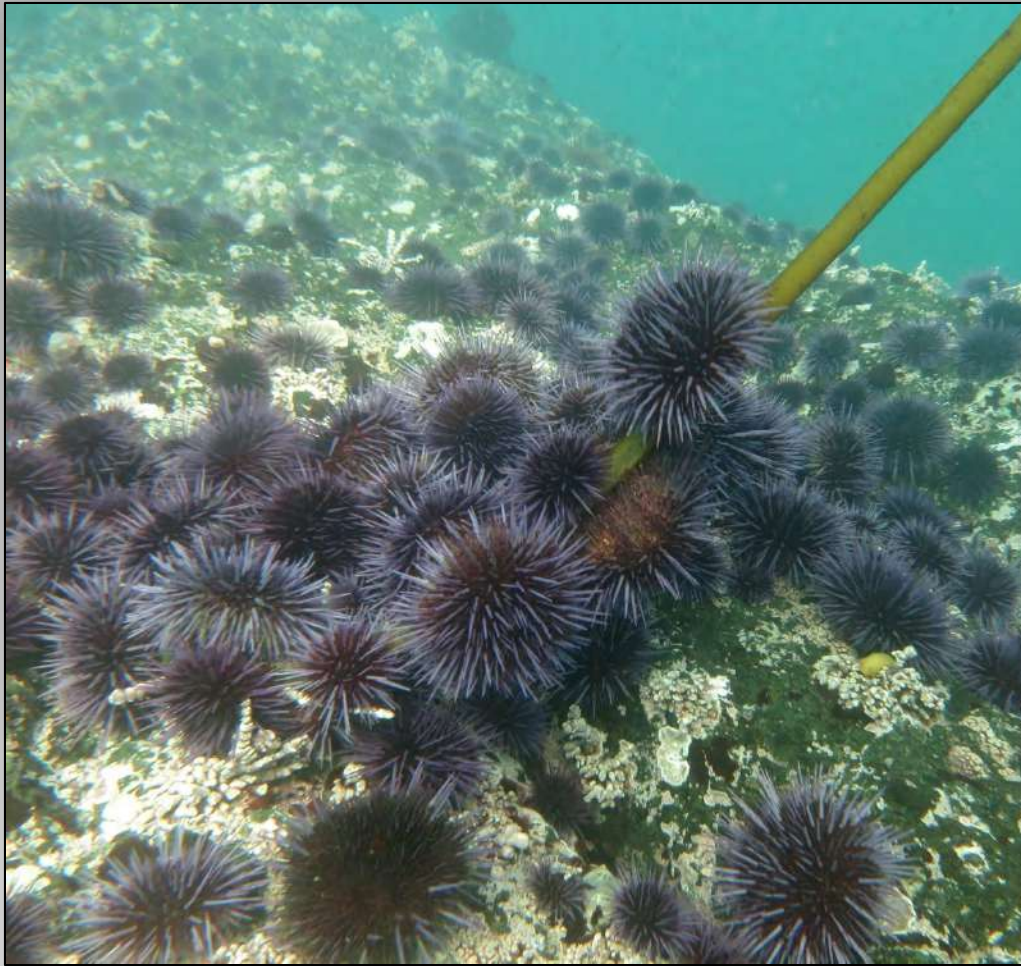


Red Urchin Recruitment



Timeline of Stressors





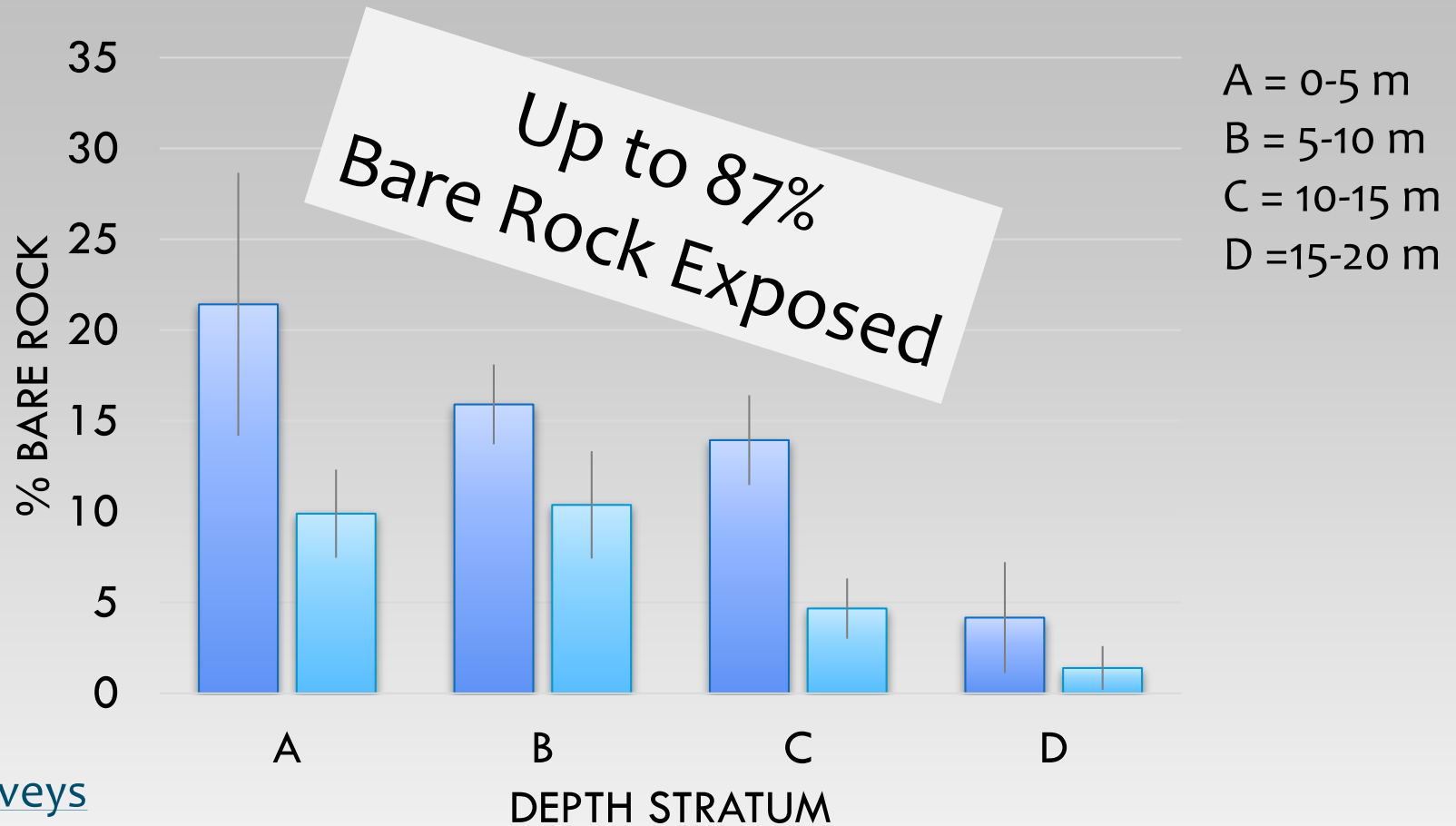
Urchins overgrazing
Bull Kelp at the holdfast

Mendocino County September 2017





Exposure of Bare Rock Due to Overgrazing Pressure



2017 Surveys

- 30-m transects
- 2.4 ha of surveyed area

■ Mendocino ■ Sonoma

Starvation Conditions in Northern California (2014-2018)



A. Maguire (CDFW)



K. Joe (CDFW)

Impacts to Fisheries

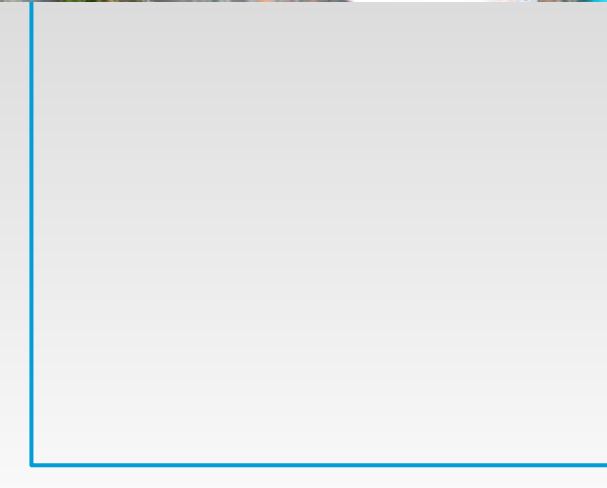
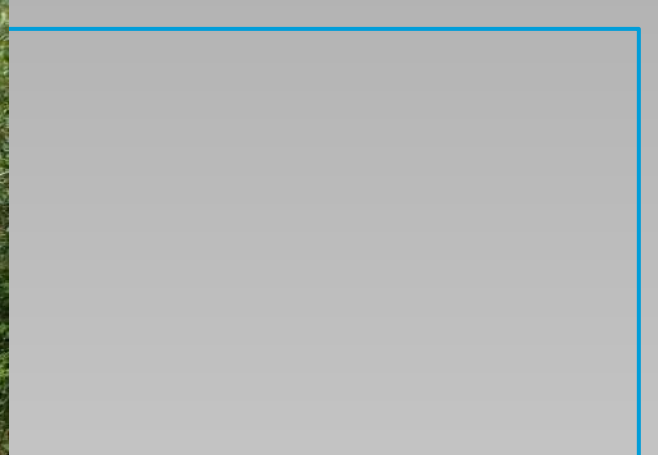
- Red abalone fishery closure 2018
- Red urchin fishery
 - 80% decline in catch
 - Requested federal disaster relief



Economically Important Fisheries

- **Recreational Red Abalone**
~\$44 million dollars (non-market value)
- **Commercial Red Sea Urchin**
~\$3 million dollars (ex-vessel value)





Red Abalone Health Assessment

Creel surveys

Sonoma, Mendocino, and Humboldt

Spring 2016 and 2017

>12,000 abalone inspected



> 25% of abalone shrunken at key fishery locations

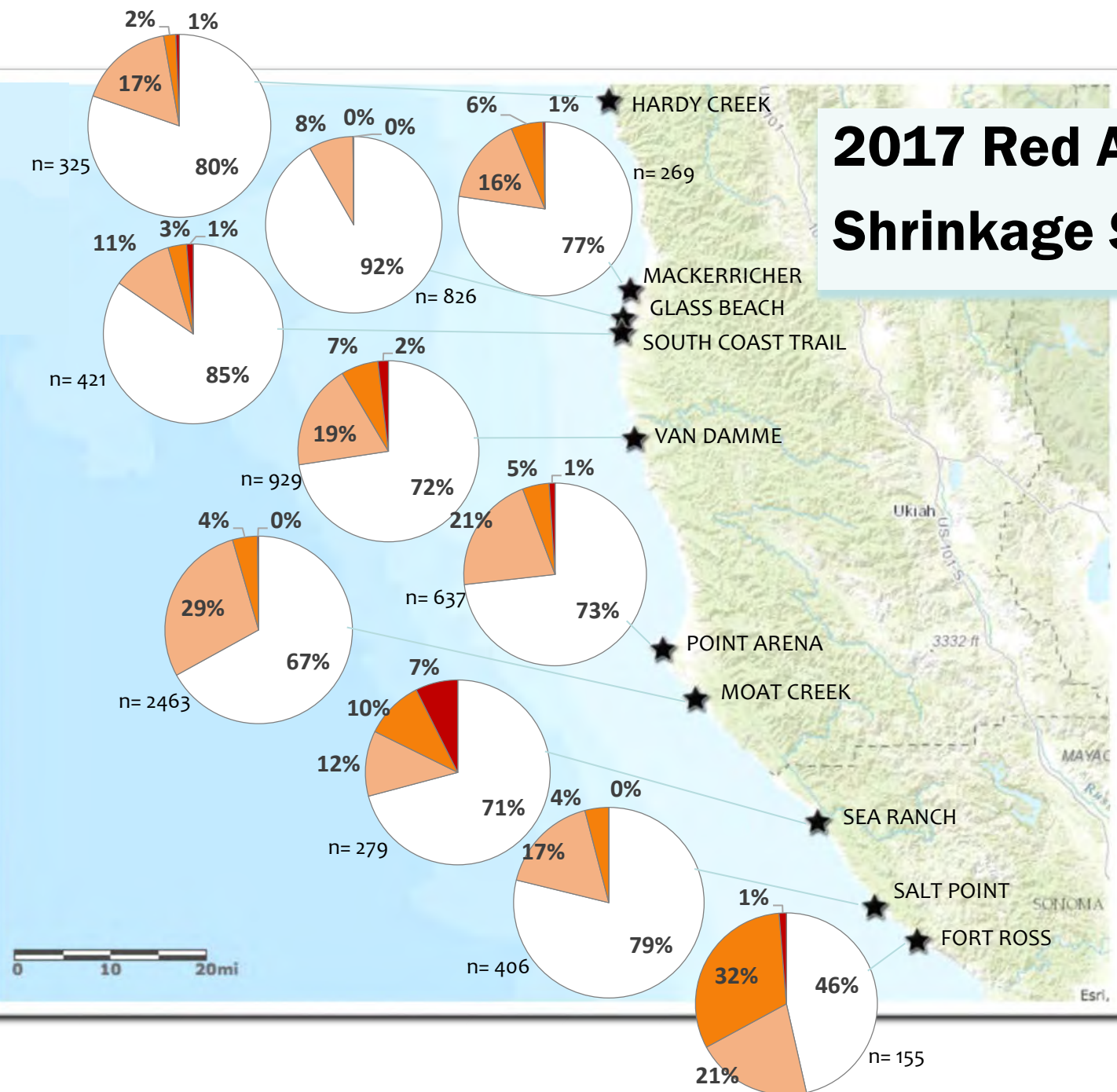
Body Shrinkage
Score 0

Body Shrinkage
Score 1

Body Shrinkage
Score 2

Body Shrinkage
Score 3

2017 Red Abalone Creel Shrinkage Scores by Site



Shrinkage Scores

- zero
- one
- two
- three

Severe Reductions to Reproductive Condition

Lowest ever recorded gonad index in 2016-2017

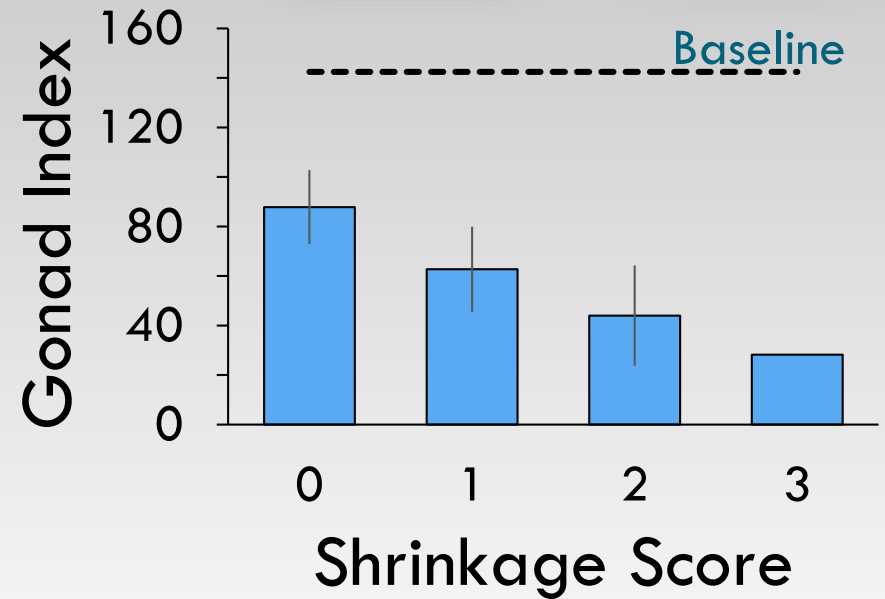
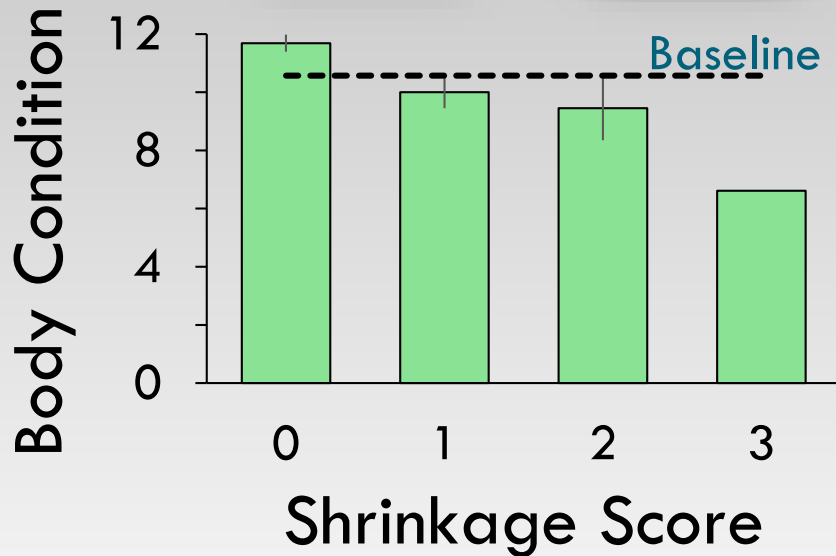
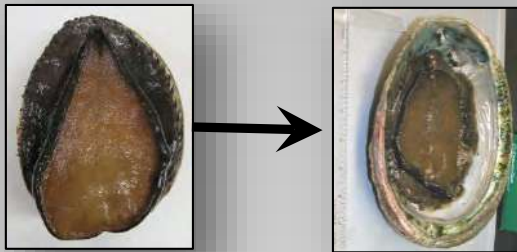
Normal Gonad



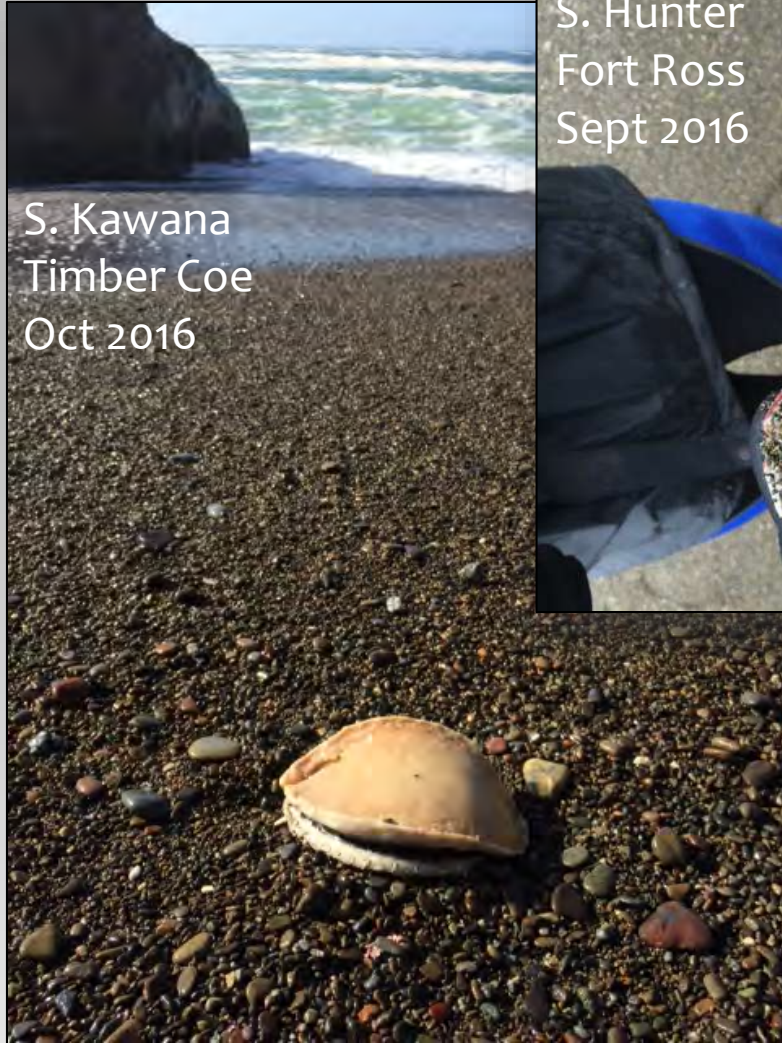
Starved Gonad



SHRINKAGE SCORES VS HEALTH INDICATORS



Large swells dislodge dying abalone



S. Kawana
Timber Coe
Oct 2016



S. Hunter
Fort Ross
Sept 2016



K. Magana
Timber Cove
Oct 2016



Fishery Closure in 2018

- Most live abalone are now shallow and vulnerable to the fishery.
- Four years of very poor reproduction
- Mass mortalities due to starvation
- 75% decline in population density (1/2 of minimum density requirement)

ABALONE REHABILITATION EXPERIMENT

No Kelp Recovery

- Abalone health will worsen
- Greater starvation mortality
- Continued Reproductive failure

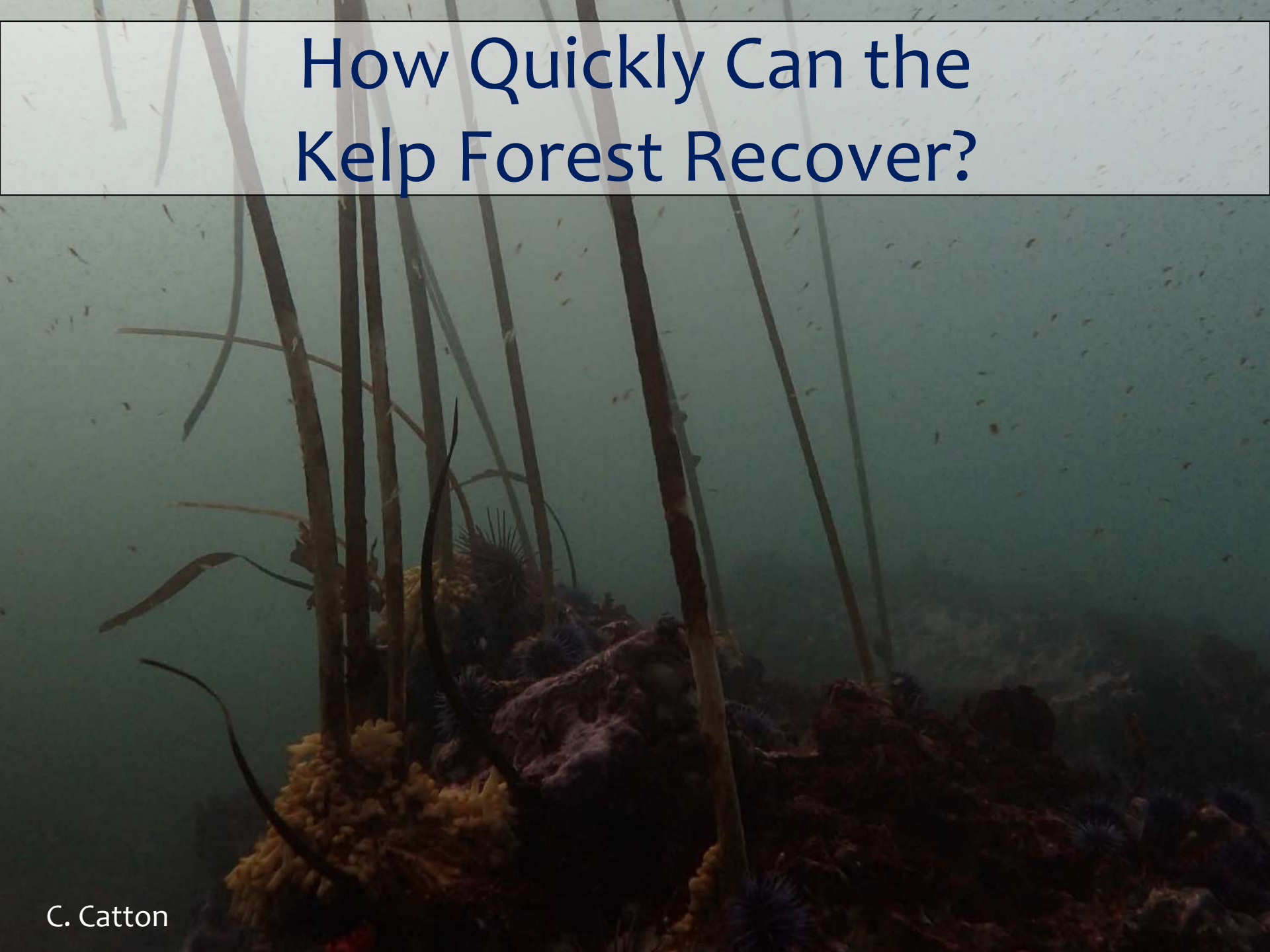


Kelp Recovery

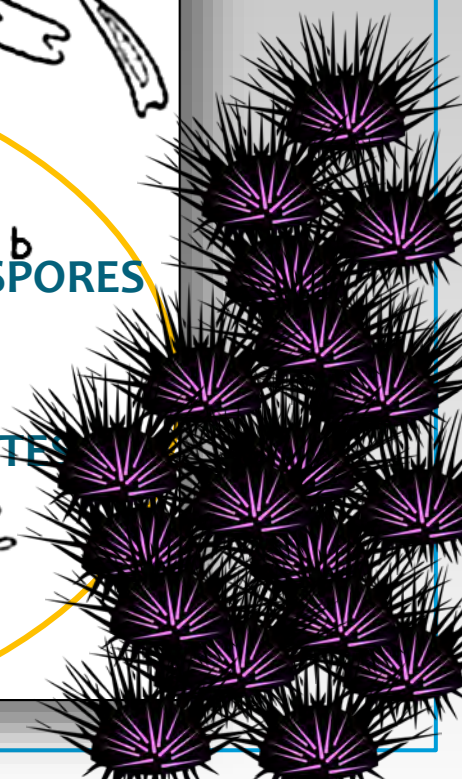
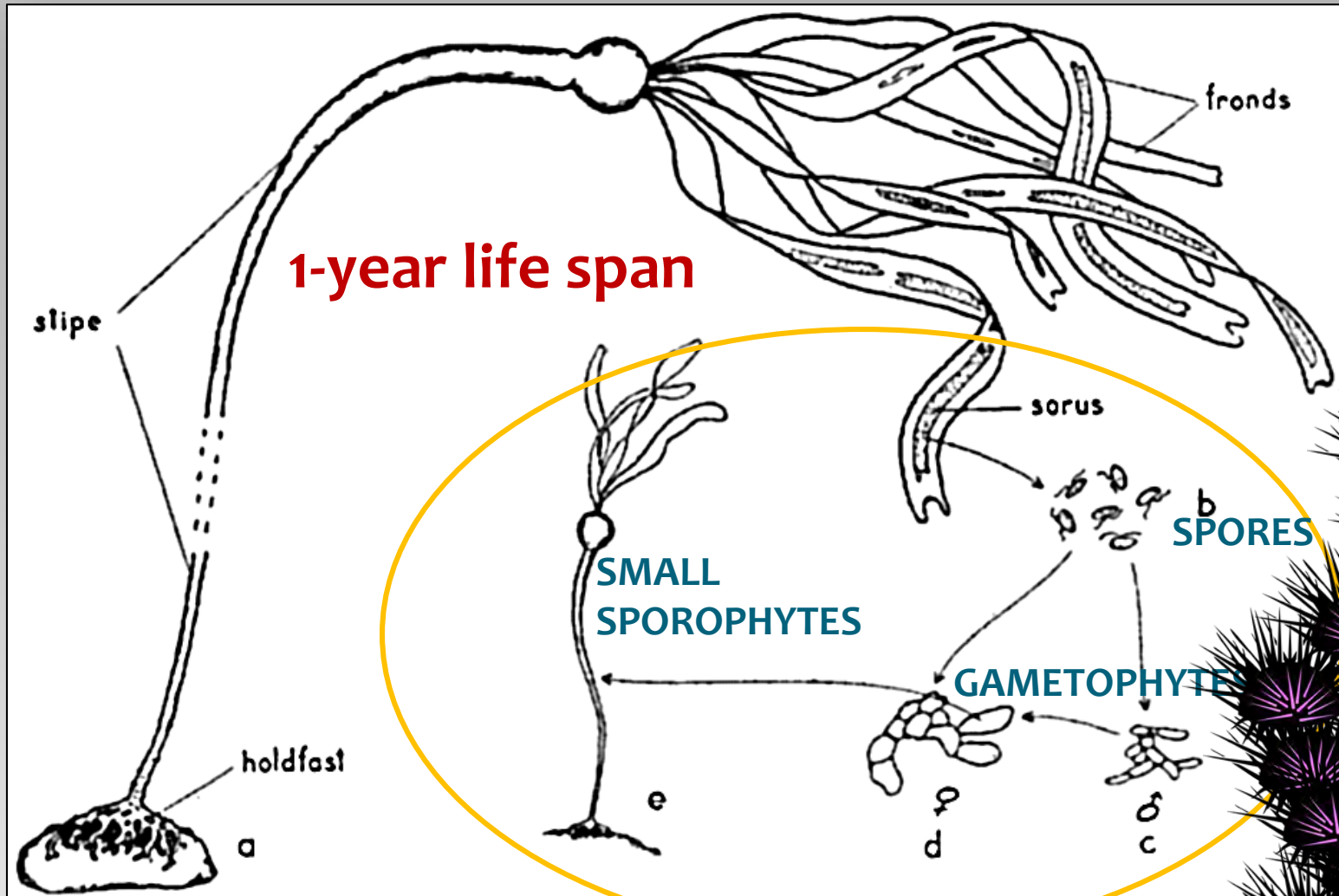
- Abalone body condition improves within 2 months
- Reproductive recovery >18 months



How Quickly Can the Kelp Forest Recover?



Concern for Bull Kelp Recovery



Management Challenges

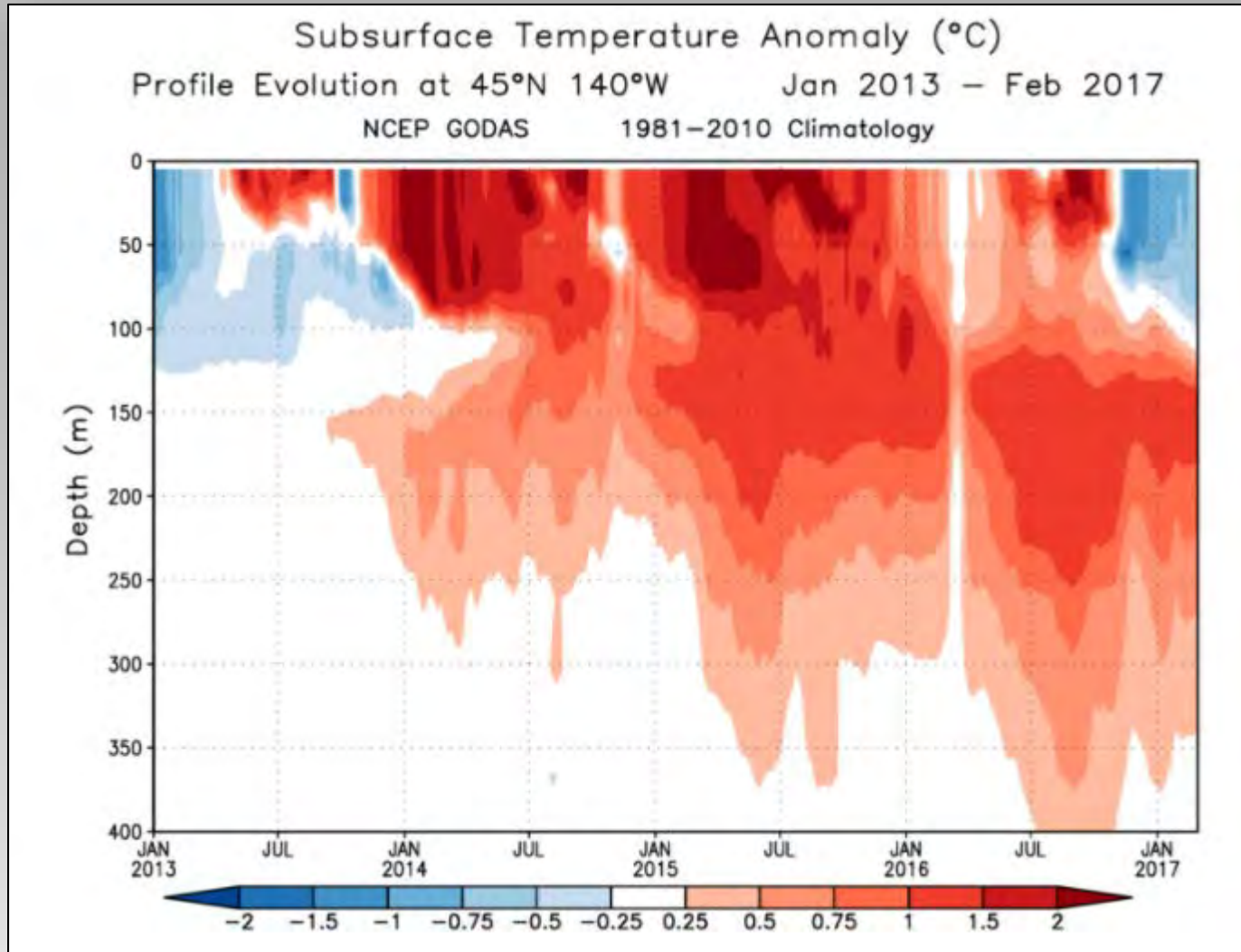
- Rapid kelp forest recovery required for healthy ecosystems

- Uncertainty of

- Lack of knowledge of large-scale kelp population dynamics

Scale of Research & Management
≪≪ Scale of dynamics

The Warm Blob in Hibernation?

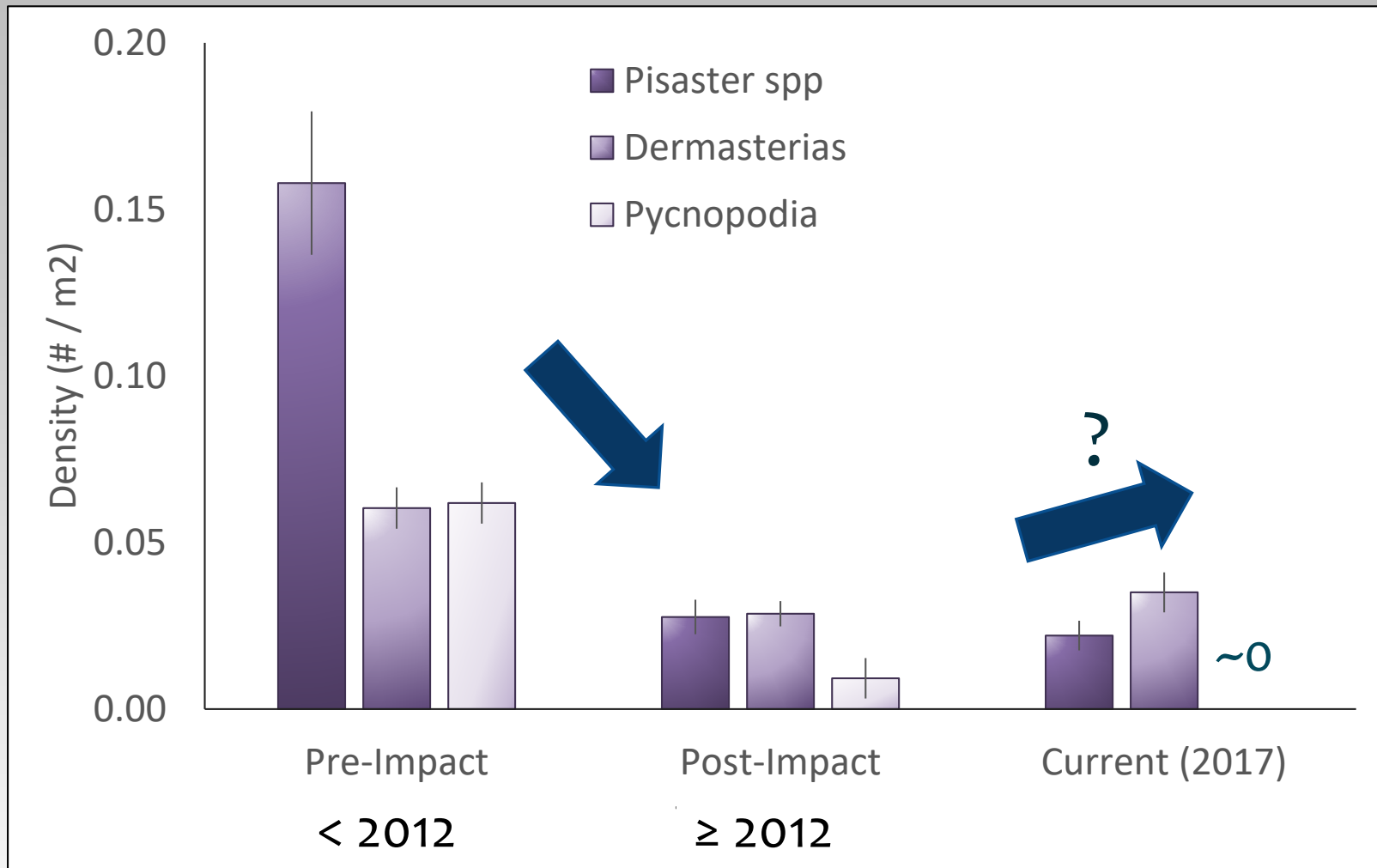


Leather stars and bat stars are dominating now

Very few observations of
seastar wasting disease



Seastar Recovery Beginnings?



Bull Kelp Recovery Requires:

- Innovative thinking
- Improved scientific understanding
- Attention to scales (landscape and local)
- Strong collaborative partnerships





Thank you!

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K. Joe