

# Where are the coral gardens?

Mapping density and condition of gorgonian octocorals in Southern California

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# Research questions about coral habitat inspired by NOAA Deep-Sea Coral Research Technology Program

Tom Hourigan, Bob Stone, Kevin Stierhoff,  
Mary Yoklavich, Elizabeth Clarke, and others

How do we compare deep-sea coral assemblages?

Which attributes are most important to measure?

How can we tell healthy from unhealthy corals?

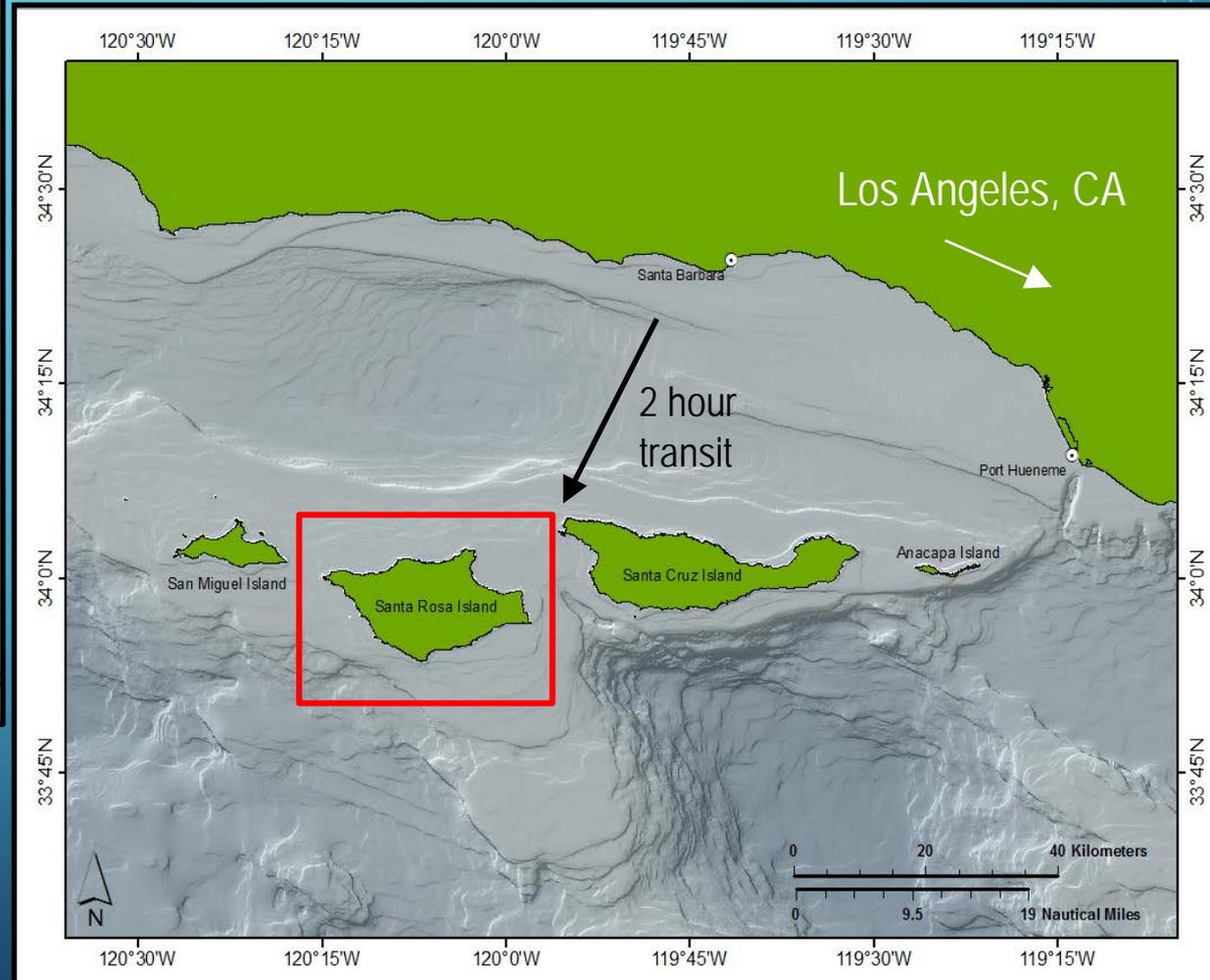


# 'Coral gardens'

- *Term intends to measure habitat quality & prioritize conservation effort*
- *Refers to density, colony size, extent of gorgonian and black corals*
- *Stone 2005/2006 – density (3.85 colonies per m<sup>2</sup>)*
- *Oslo/Paris Convention (OSPAR) 2008/2010 - invoked range of density, larger extent, diversity*
  - *Single species gardens, e.g. 50 – 200 colonies per 100 m<sup>2</sup>*
  - *Multispecies gardens, e.g. 100 - 700 colonies per 100 m<sup>2</sup>*
- *Two North Atlantic studies seek to quantify coral gardens for the UK (Bullimore et al 2013, Henry & Roberts 2014)*

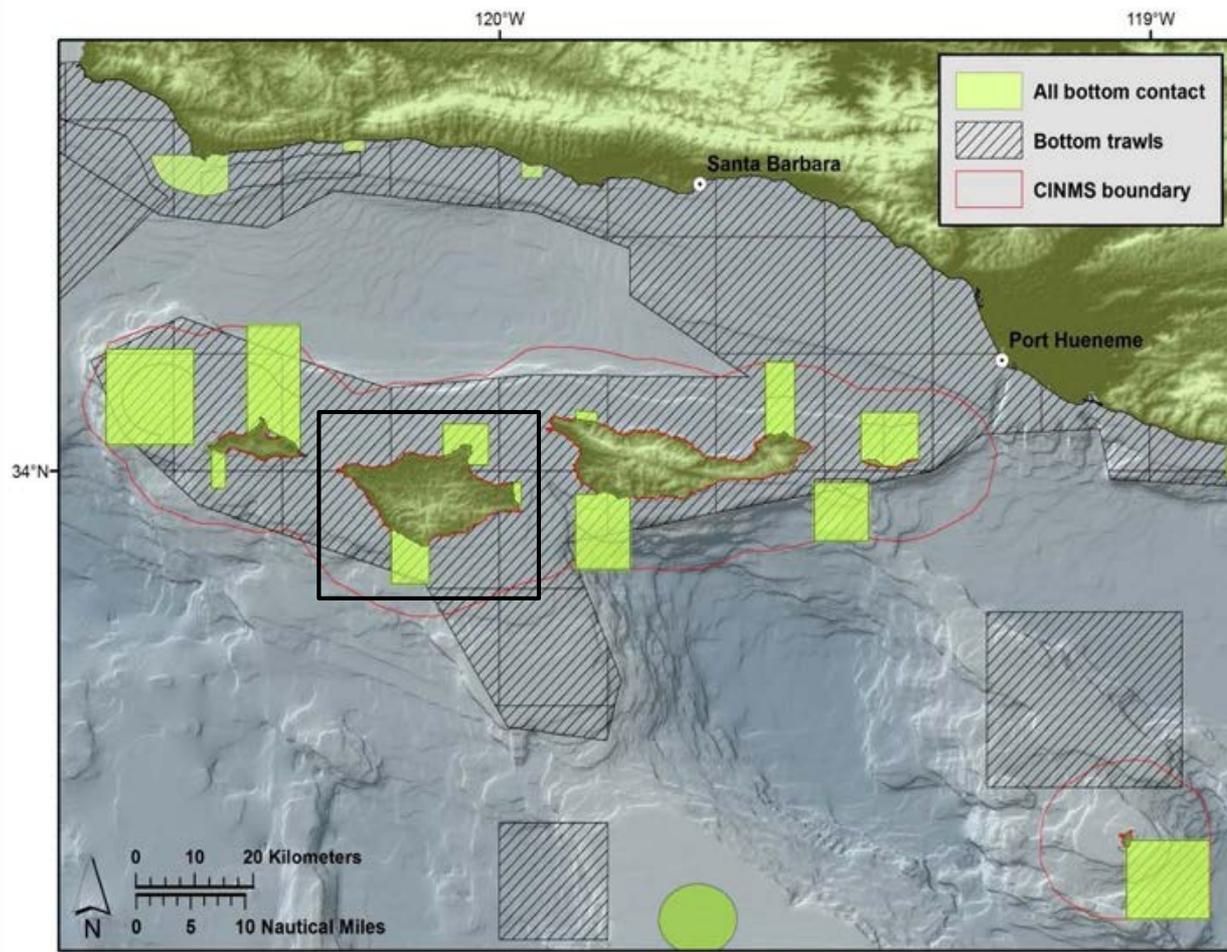
# Study Location: Santa Rosa Island

4 islands, W-E gradient, 2 hrs transit offshore



# Channel Islands National Marine Sanctuary (CINMS) in Southern California

- CINMS shown in red.  
Most of the shelf is off limits to bottom trawling by Rockfish Conservation Area (RCA, hatched)
- Small parts are off limits to all bottom fishing gear, these are Essential Fish Habitat (EFH, in green)
- NOAA is mapping all of CINMS to characterize benthic habitat
- 'Coral gardens' found outside of EFH are protected by RCA



# Methods: Ships and ROVs



Beagle ROV  
from MARE



NOAA RV *Shearwater*



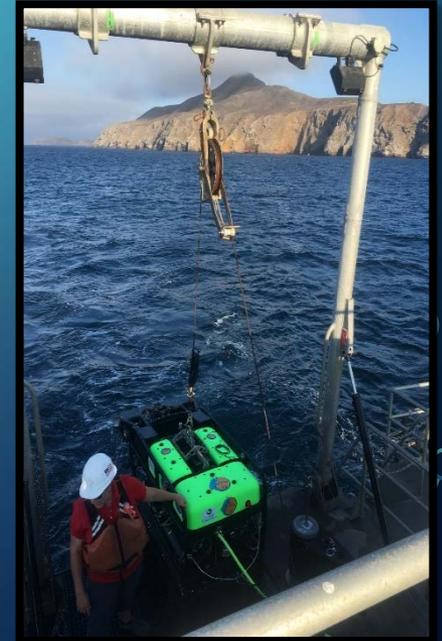
EV *Nautilus* & Hercules



NOAA ship *Bell Shimada*

# Methods: Visual Survey Techniques

- We conduct 8-10 ROV dives (2 km) in these areas
  - North Santa Rosa (Carrington Point to San Miguel Pass)
  - South Santa Rosa (Santa Rosa Flats)
- Parse the dive by 3 transect methods
  - 100 meters in GIS
  - 5 minutes in video
  - 15 minutes in video
- ROV flies at 0.8 m alt. and 0.5 knot speed, w/ lasers
- Still images every ~ 5 seconds (ID, size & health)
- Density (no. colonies/area) derived from
  - a) frame grabs over 5 min = 100 m and
  - b) HD video segments by time or distance



# Example images of CINMS Deep Corals (30-300 m)

Image credits: NOAA, Marine Applied Research and Exploration



*Leptogorgia chilensis*



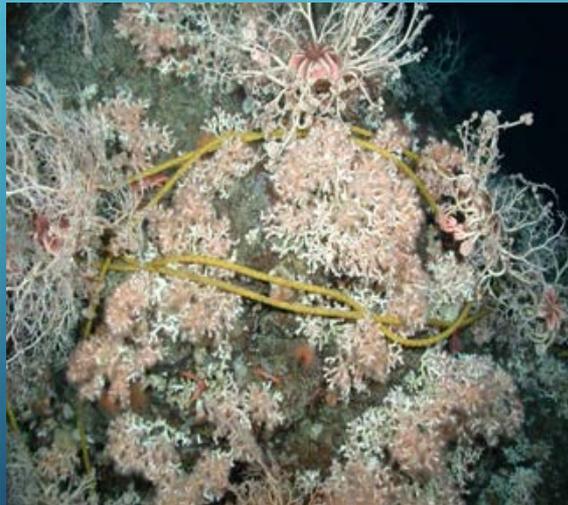
*Eugorgia rubens*



*Adelogorgia phyllosclera*



*Acanthogorgia* sp.  
(gorgonian octocoral)



*Lophelia pertusa*  
(branching stony coral)



*Antipathes dendrochristos*  
(black coral)

# Species identified at each site and total counts

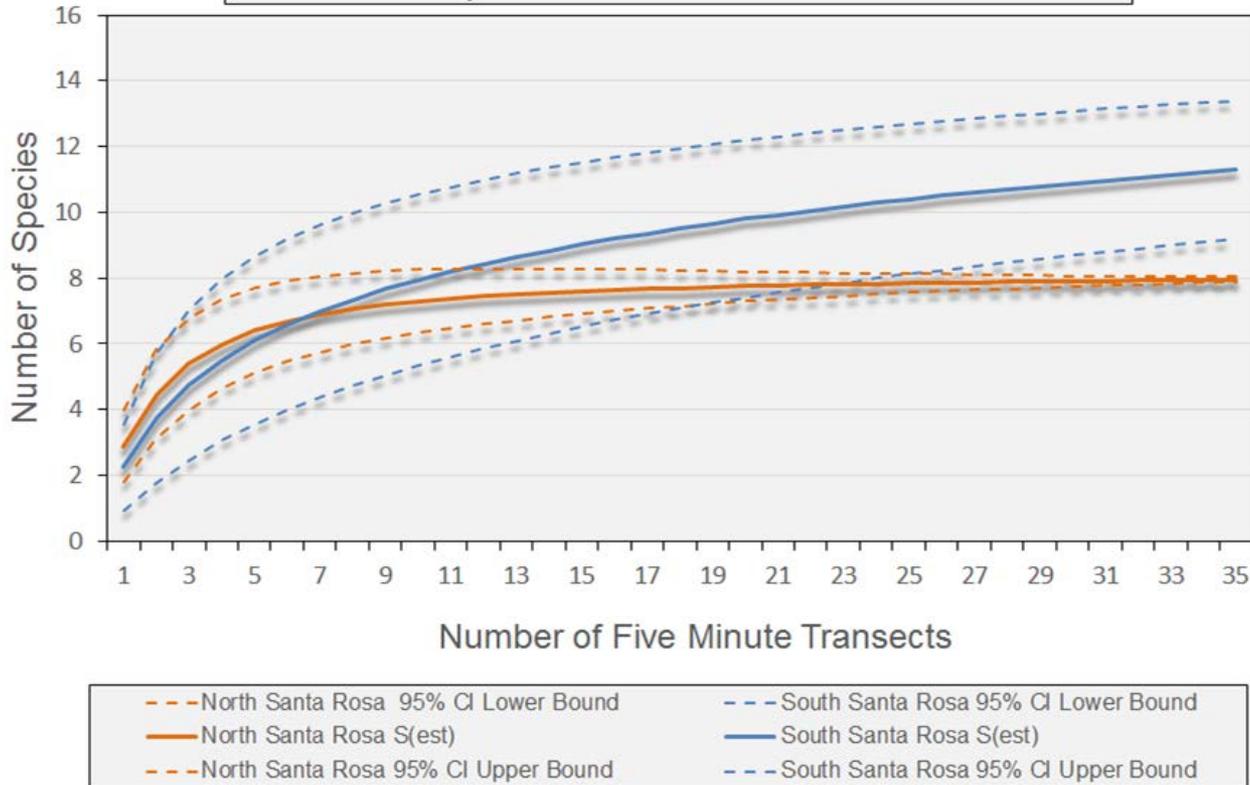
Locality	Taxa	Count
<b>Carrington Point</b>	<i>Eugorgia rubens</i>	1400
	<i>Adelogorgia phyllosclera</i>	224
	<i>Leptogorgia sp.</i>	217
	<i>Halimeteris sp.</i>	122
	<i>Ptilosarcus gurneyi</i>	13

Locality	Taxa	Count
<b>San Miguel Pass</b>	<i>Adelogorgia phyllosclera</i>	498
	<i>Eugorgia rubens</i>	239
	<i>Coenocyathus bowersi</i>	123
	<i>Ptilosarcus gurneyi</i>	81
	<i>Lophelia pertusa</i>	78
	<i>Halimeteris sp.</i>	73

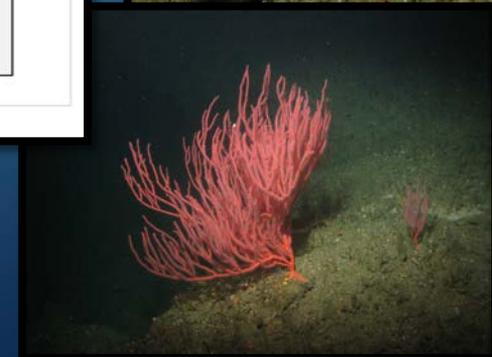
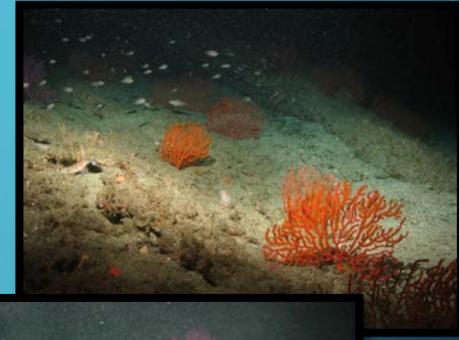
Locality	Taxa	Count
<b>South Santa Rosa</b>	<i>Adelogorgia phyllosclera</i>	1568
	<i>Eugorgia rubens</i>	597
	<i>Halimeteris sp.</i>	112
	<i>Pennatulacea</i>	95
	<i>Coenocyathus bowersi</i>	48
	<i>Leptogorgia sp.</i>	42
	<i>Stylaster sp.</i>	33
	<i>Lophelia pertusa</i>	8
	<i>Alcyonacea</i>	7
	<i>Muricea sp.</i>	4
	<i>Plexauridae</i>	2
	<i>Ptilosarcus gurneyi</i>	1
	<i>Swiftia sp.</i>	1

# Diversity of Corals on CINMS Shelf

Channel Islands National Marine Sanctuary  
Coral Species Accumulation Curves



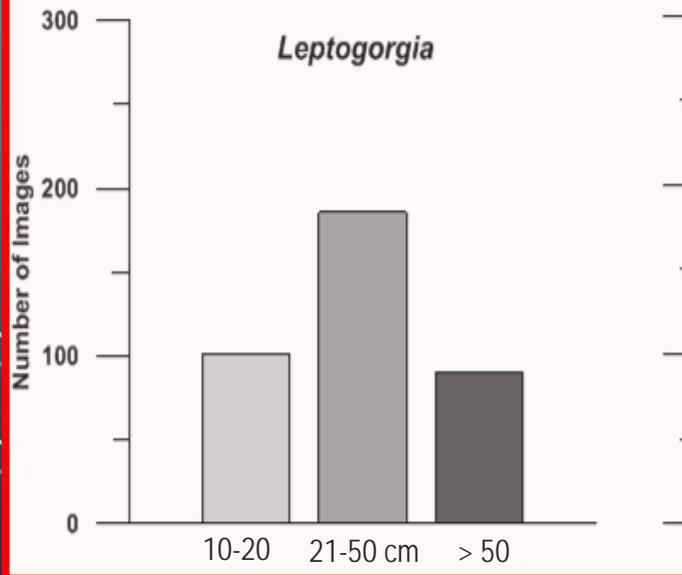
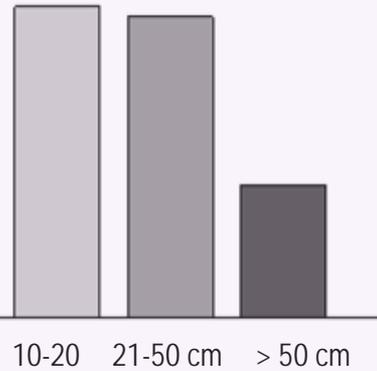
- Highest diversity on Santa Rosa appears to be on south side
- ~ 20 transects were required to identify a significant difference



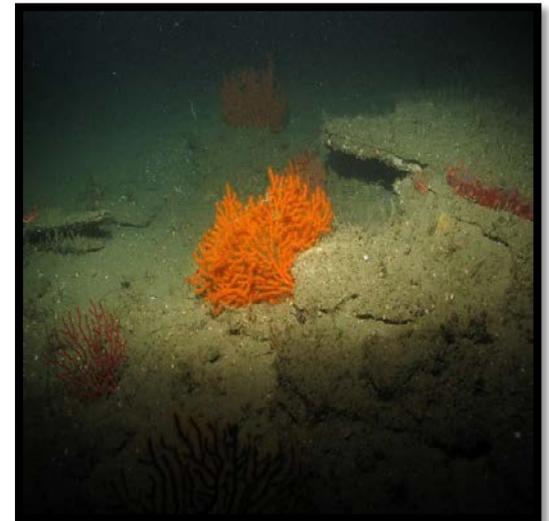
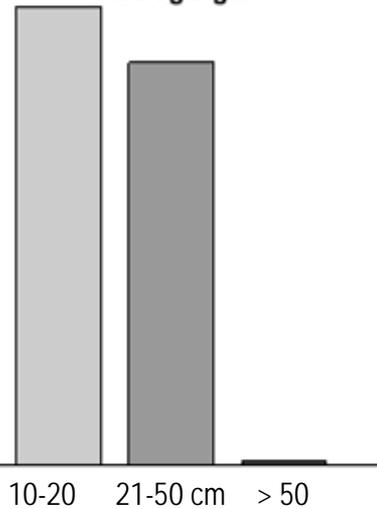
# Octocoral Size Classes



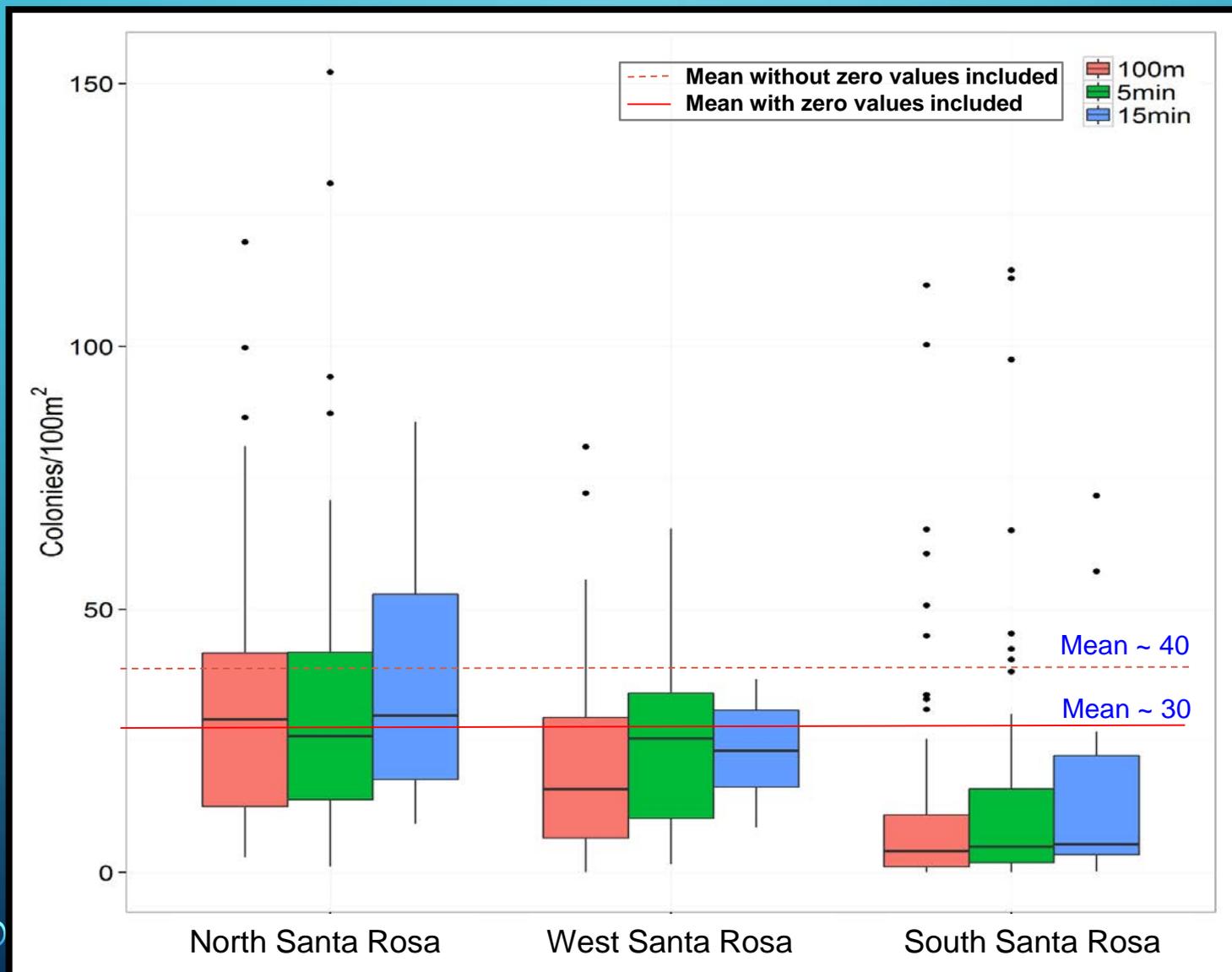
*Eugorgia*



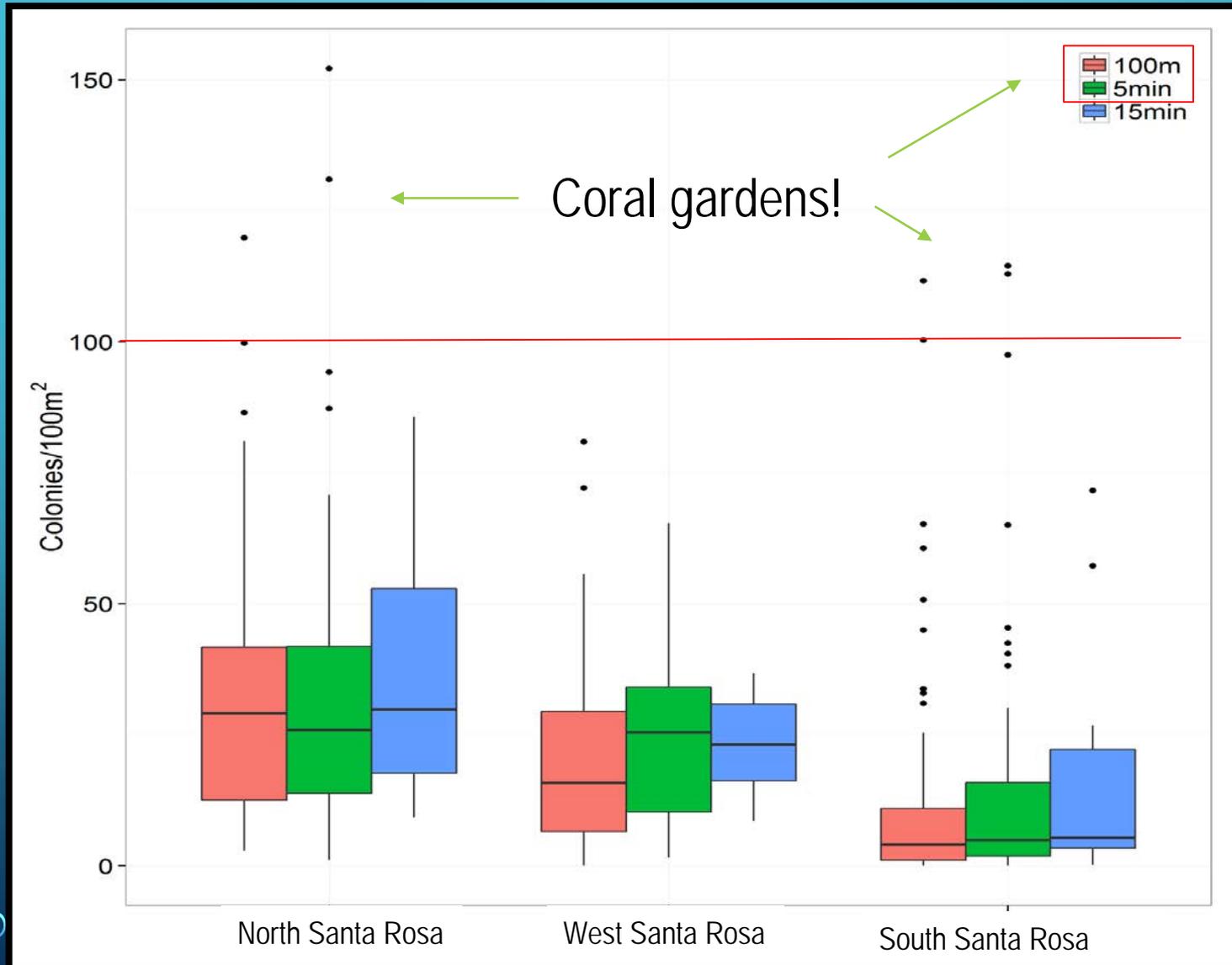
*Adelogorgia*



# Multi-species densities using 3 different time/distance methods (2015)



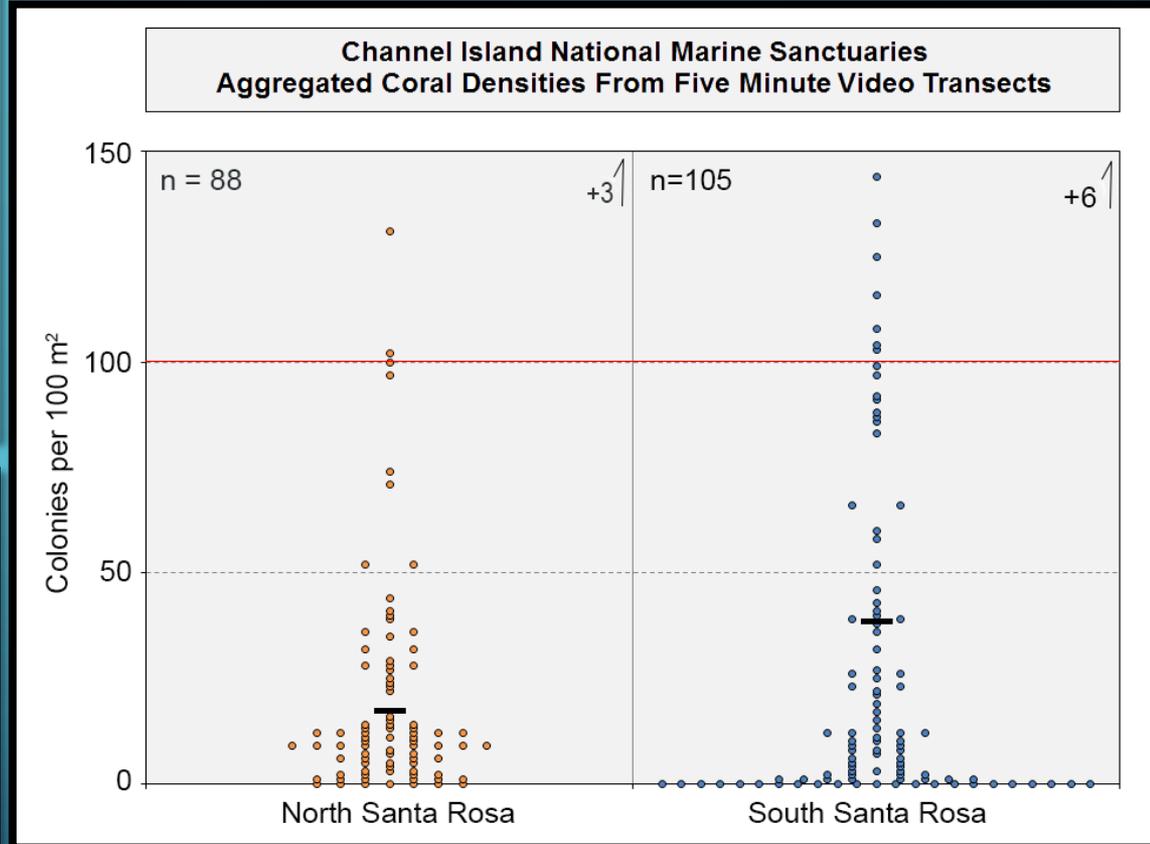
# Multi-species densities using frame grabs (2015)



# Multi-species Frame Grab Densities Summary

100 meter Transect Method	Mean	Median	Std. Dev.	3rd Quartile	MAX	IQR
Carrington Point	35.81	29.05	29.62	41.67	119.85	29.16
San Miguel Pass	21.98	15.76	21.71	29.44	80.90	22.89
South Santa Rosa	10.99	4.03	19.97	10.94	111.65	9.91
5 minute Transect Method	Mean	Median	Std. Dev.	3rd Quartile	MAX	IQR
Carrington Point	37.07	25.92	35.62	41.82	152.14	28.05
San Miguel Pass	23.83	25.45	16.63	34.05	65.41	23.78
South Santa Rosa	13.87	4.88	23.66	15.86	114.50	14.05
15 minute Transect Method	Mean	Median	Std. Dev.	3rd Quartile	MAX	IQR
Carrington Point	35.73	29.80	25.32	52.88	85.69	35.17
San Miguel Pass	23.22	23.09	10.62	30.85	36.76	14.65
South Santa Rosa	13.93	5.33	18.23	22.20	71.63	18.85

# Multi-species Frame Grabs from Video (2015-2016)

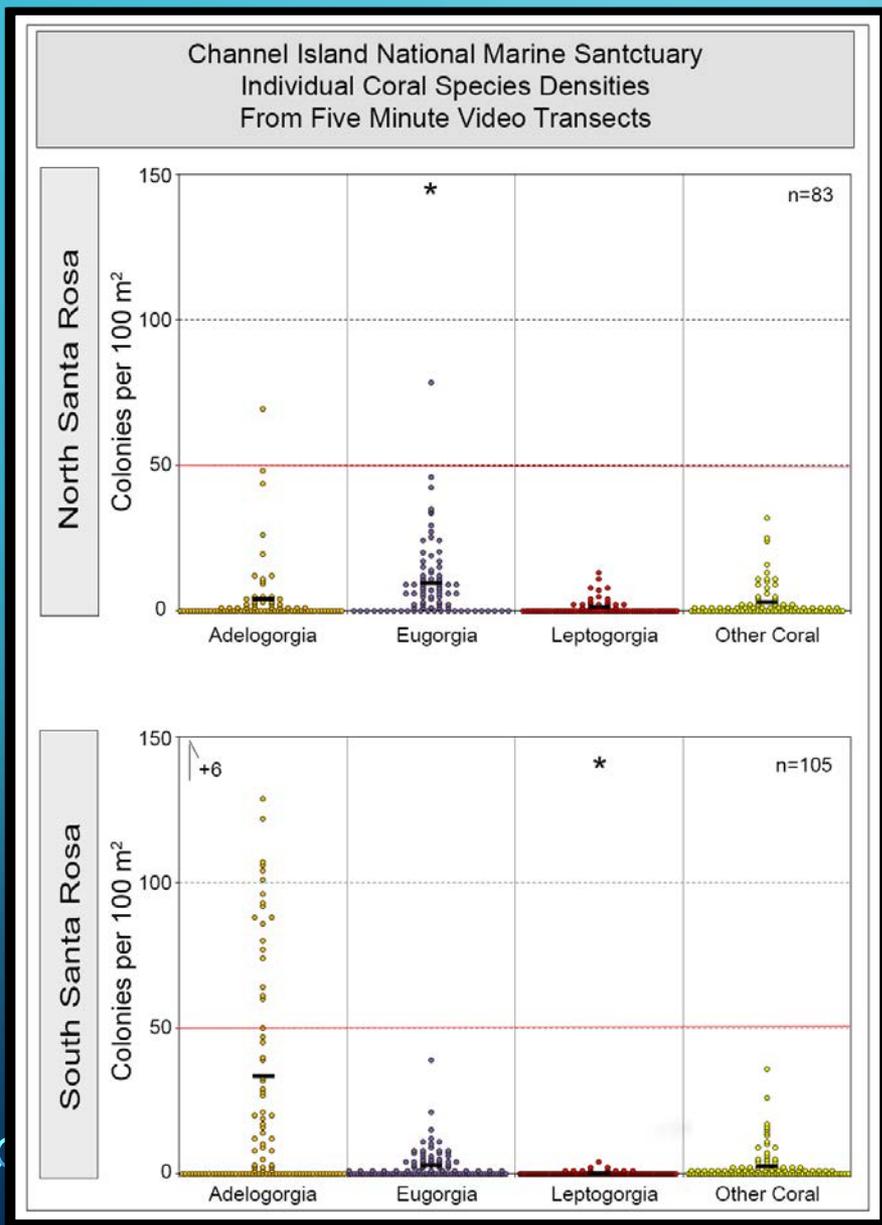


'Coral gardens' on both sides of Santa Rosa  
More 'gardens' on the South side  
Mean values between 30 – 40 corals/ 100 sq m

# Summary of Aggregate Coral Density Data from Five Minute Video Transects

	All Santa Rosa	North Santa Rosa	South Santa Rosa
Mean	28.9	17.2	38.2
Median	10.3	10.3	10.2
Std Dev.	48.1	20.3	60.3
3rd quartile	33.1	24.5	48.7
Max	343.1	99.6	343.1
IQR	31.2	20.4	48.1

# Single-species Densities, Framegrabs & Video (2015-16)



Video counts yield similar means when compared to photos, but higher maximum abundance

	Adelogorgia		Eugorgia		Leptogorgia	
	Video Counts	Framegrabs	Video Counts	Framegrabs	Video Counts	Framegrabs
Max	154	70	60	55	4	11
Mean	10	9	11	8	1	1
std. dev	27	15	15	14	1	2

- No significant difference in densities of 15 minute transects by photo and video methods
- 15 min transects are 270 m long on average

# Summary of Single Species Density Data from Five Minute Video Transects

North Santa Rosa				
	Adelogaorgia	Eugorgia	Leptogorgia	Other Coral
Mean	3.8	9.5	1.0	2.8
Median	0.0	5.8	0.0	0.4
Std Dev.	10.8	13.0	2.4	5.9
3rd quartile	2.0	12.0	0.6	2.0
Max	69.2	78.5	12.9	32.5
IQR	2.0	11.7	0.6	2.0

South Santa Rosa				
	Adelogaorgia	Eugorgia	Leptogorgia	Other Coral
Mean	33.4	2.8	0.2	2.5
Median	1.8	0.5	0.0	0.5
Std Dev.	58.5	5.2	0.5	5.4
3rd quartile	45.6	3.9	0.0	1.7
Max	335.2	38.8	3.5	36.2
IQR	45.6	3.9	0.0	1.7

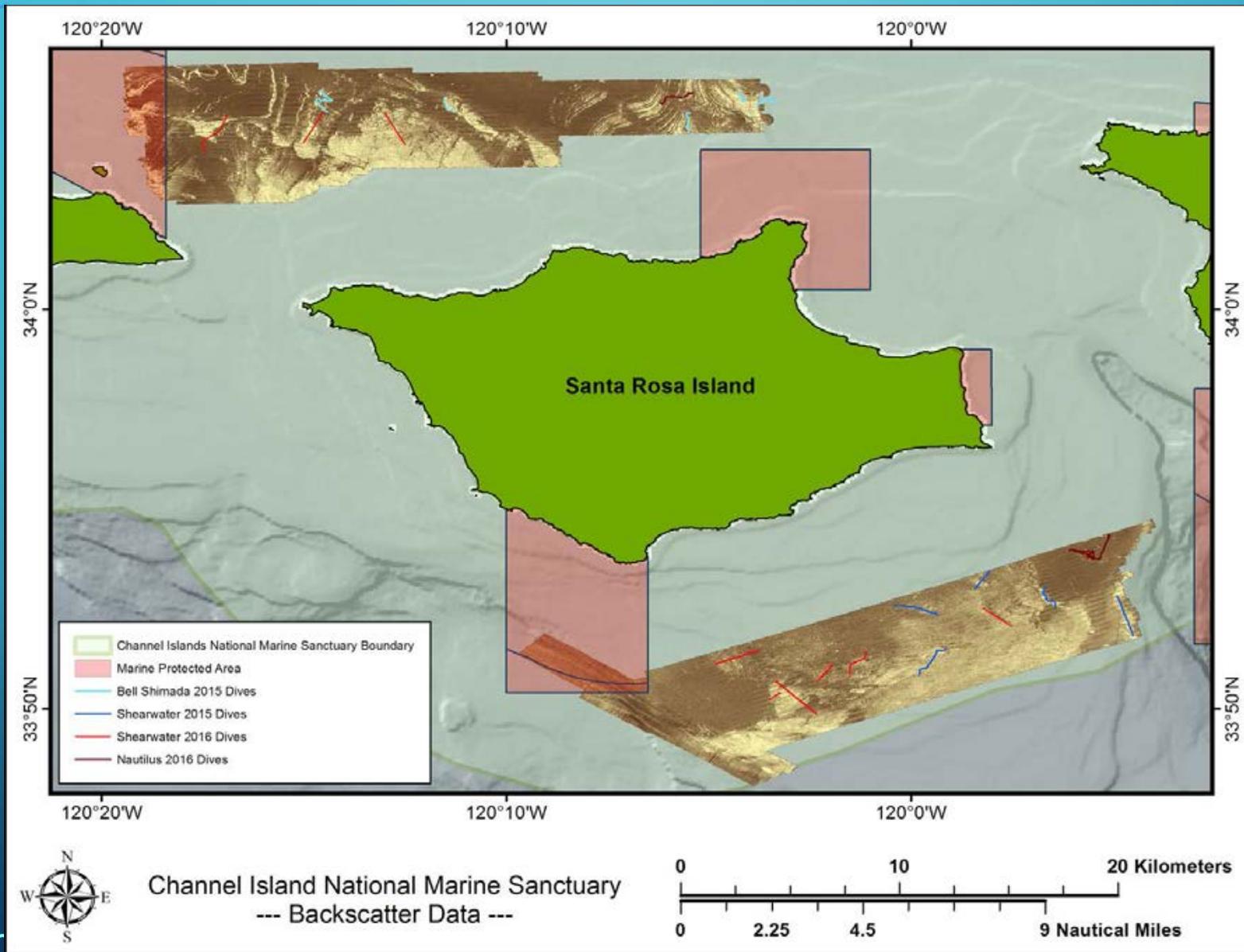
# Part I: Conclusions on Methods

- Shorter transects yield more 'coral gardens' and finer spatial resolution for habitat suitability models
- 5 min transect method provides 100 m resolution
- 15 min transect yields about 300 m resolution
- 5 min. transects yield higher densities than 15 min. transects because distribution is patchy
- High densities over small areas

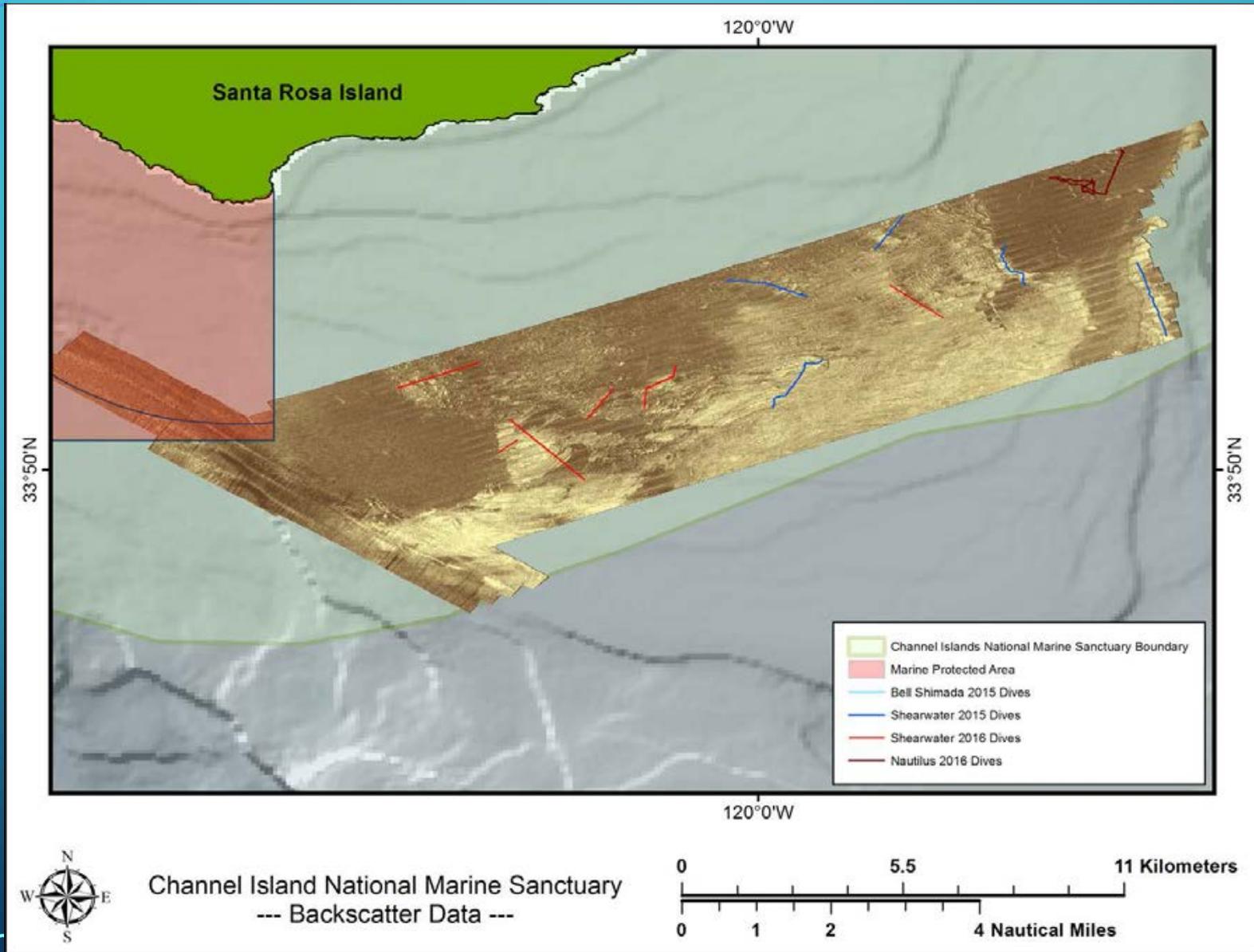
# Part I: Conclusions on Coral Gardens

- Mean densities of gorgonian octocorals in CINMS is lower than OSPAR thresholds (30 corals/ 100 m<sup>2</sup>)
- *Multispecies* densities of octocorals can exceed OSPAR threshold for a 'coral garden' (100 total corals/100 m<sup>2</sup>)
- *Single species* densities can exceed OSPAR threshold in both North and South Santa Rosa (50 corals/100 m<sup>2</sup>)
- The extent of the 'coral gardens' in CINMS may be large, because extent of hard bottom in backscatter is large.

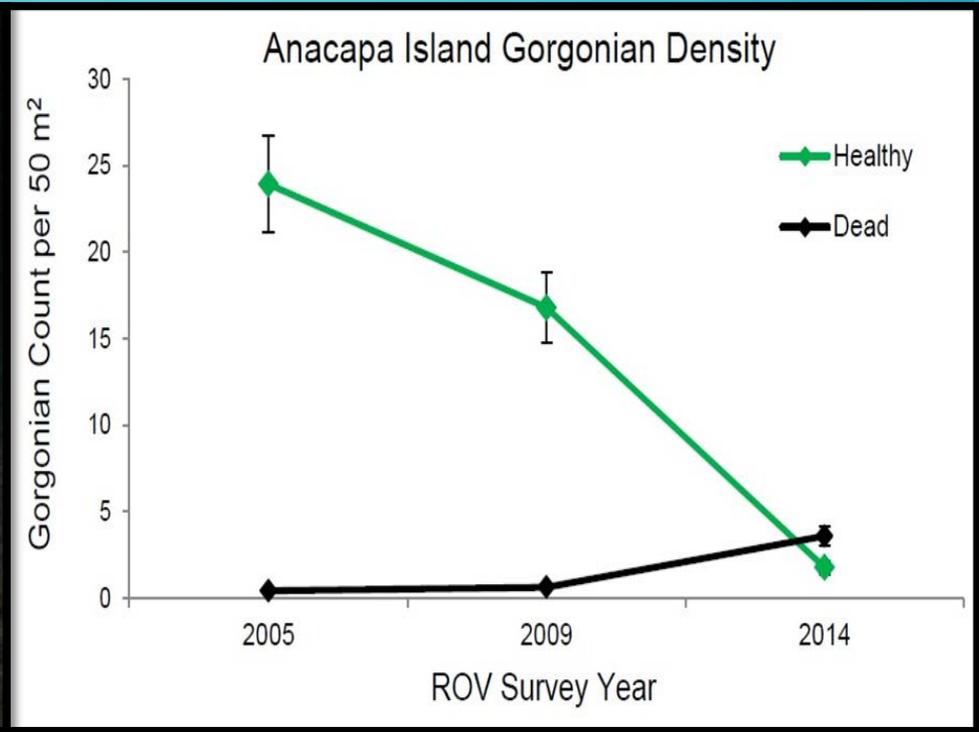
# Multibeam on Santa Rosa from NOAA Bell Shimada 2015 "Patterns in Deep Sea Corals Expedition"



Multibeam on Santa Rosa from NOAA Bell Shimada 2015 "Patterns in Deep Sea Corals Expedition"



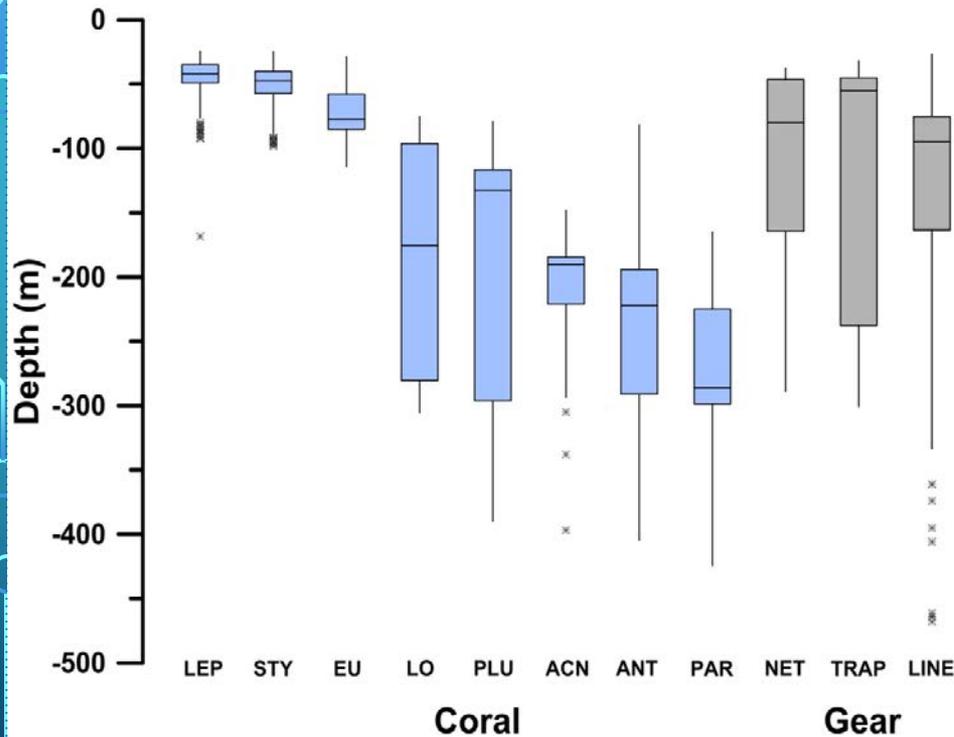
# Part II: Demise of a Coral Garden



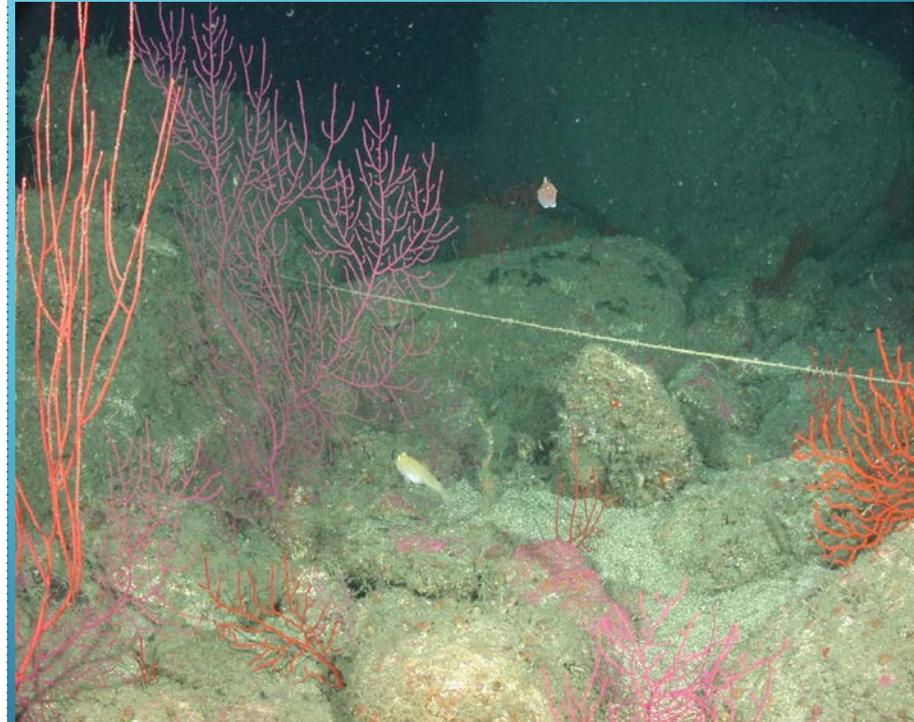
Most gardens off Santa Rosa island are pristine  
Some shallow (~30 m) declines from 2005 - 2014.  
Possible culprits: fishing or temperature?

# Fishing debris occurred in coral habitat

DEPTH RANGES OF SPECIES AND FISHING GEAR



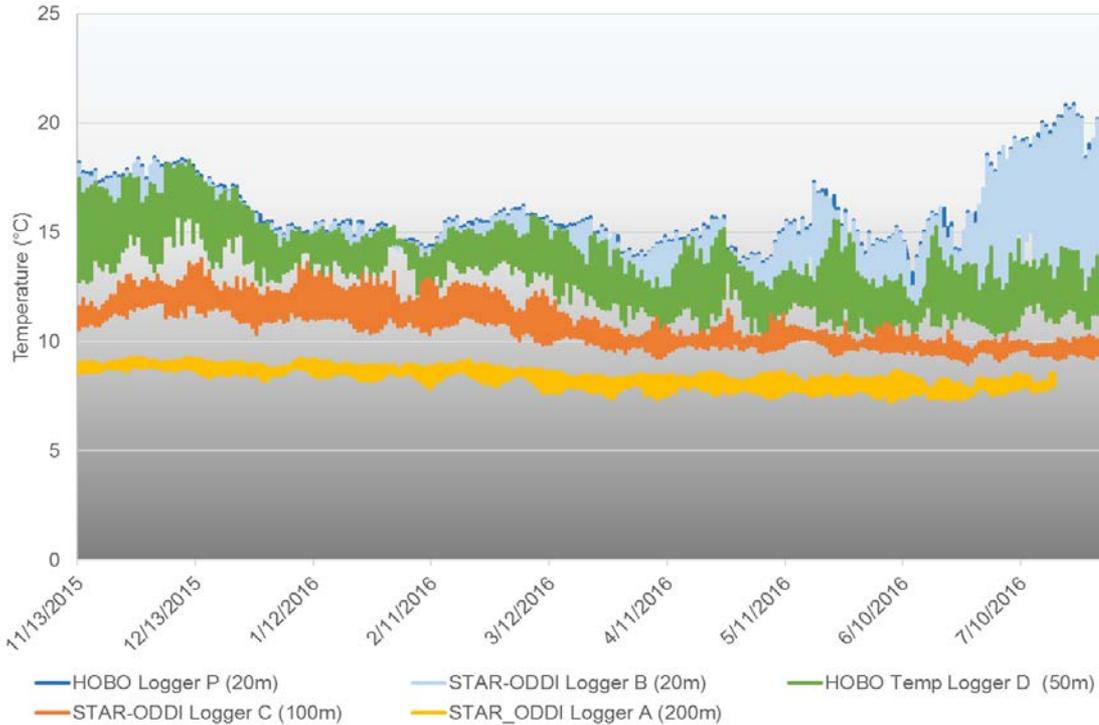
South Catalina Island at 82 m



Corals and sponges were more common than debris  
Lines were the most commonly observed debris type  
Depth distribution of debris was similar to depth distribution of corals

# Temperature varied considerably in coral habitat

Temperature Logger Data from  
Channel Islands National Marine Sanctuary



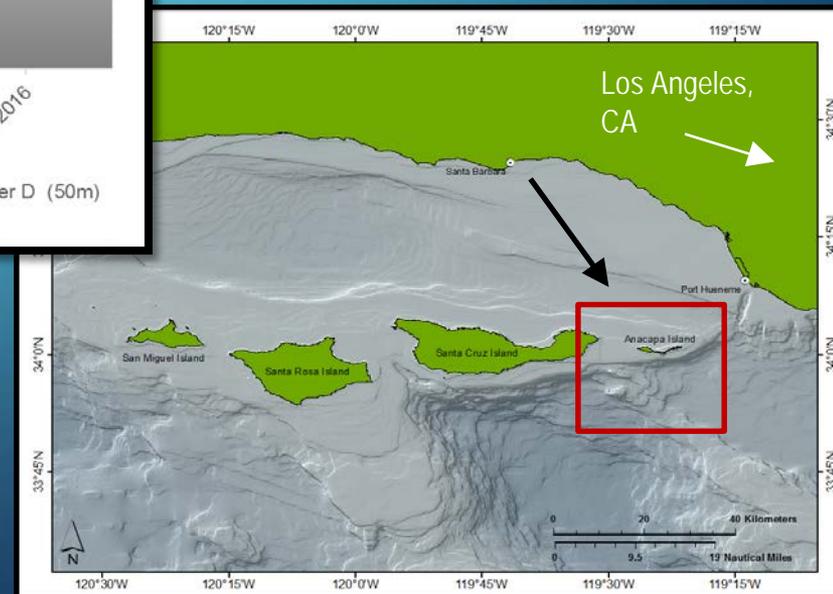
Temp loggers deployed at 20, 50, 100, and 200 meters depth

Avg temp at 20 m was 14-15 C.

Temps at 200 m were < 10 C.

Temps at 20 m depth reached 19 C for 4 weeks in July.

TEMPERATURE LOGGERS  
WERE DEPLOYED AT  
ANACAPA ISLAND



# Live corals were collected for challenge experiments



What temperatures are fatal?

Can corals recover?

How deep does an anomaly go?

How long can it last?



# Thank you!!

## Questions?

Contact:  
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- **Special thanks for support from:**
  - NOAA National Centers for Coastal Ocean Science
  - NOAA Deep Sea Coral Research and Technology Program
  - NOAA Channel Islands National Marine Sanctuary staff

