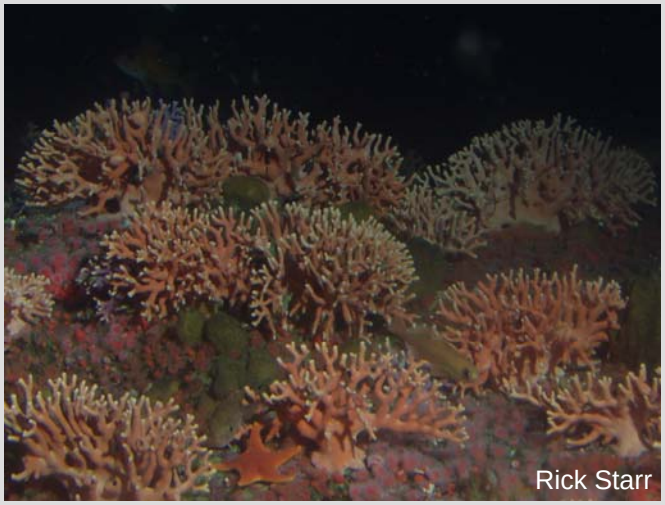
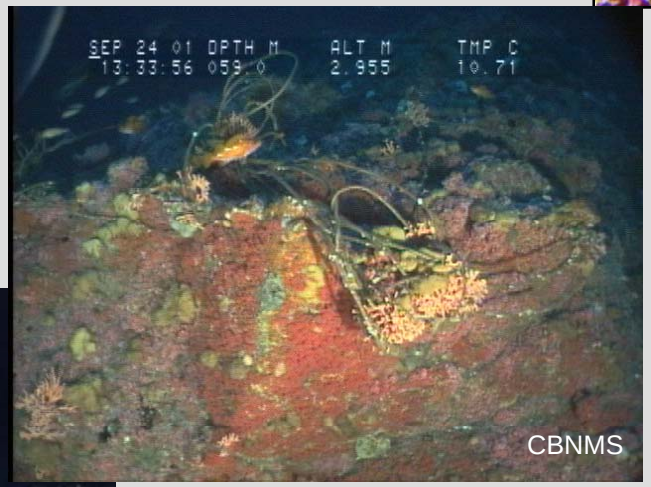
Explorations of cold water coral-habitat relationships on Cordell Bank, CA

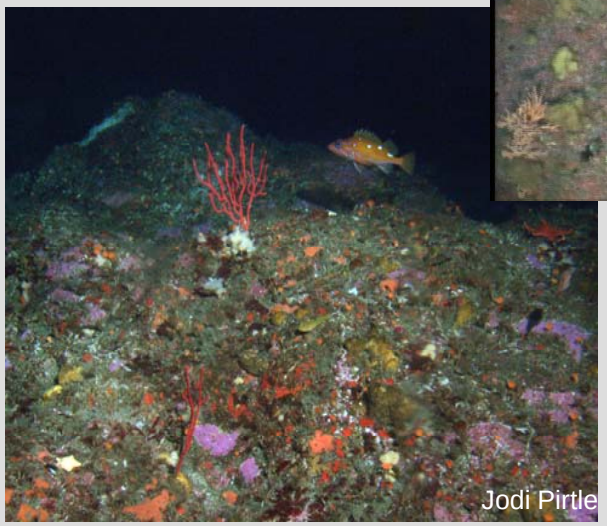
Using submersible visual data and multibeam sonar data

Lisa Etherington, Pamela van der Leeden, Dale Roberts
NOAA, Cordell Bank National Marine Sanctuary



- Cold water coral communities unique and vulnerable to disturbance
- Add structure and provide biogenic habitat for fishes and invertebrates
- Indicate environmental conditions
  - currents, food supply, sedimentation
  - regions of high biodiversity





- Need for in-situ information on coral-habitat relationships
- Coupled with seafloor mapping data - assessment of habitat relationships and allow predictions of species occurrence

Seamounts and Banks

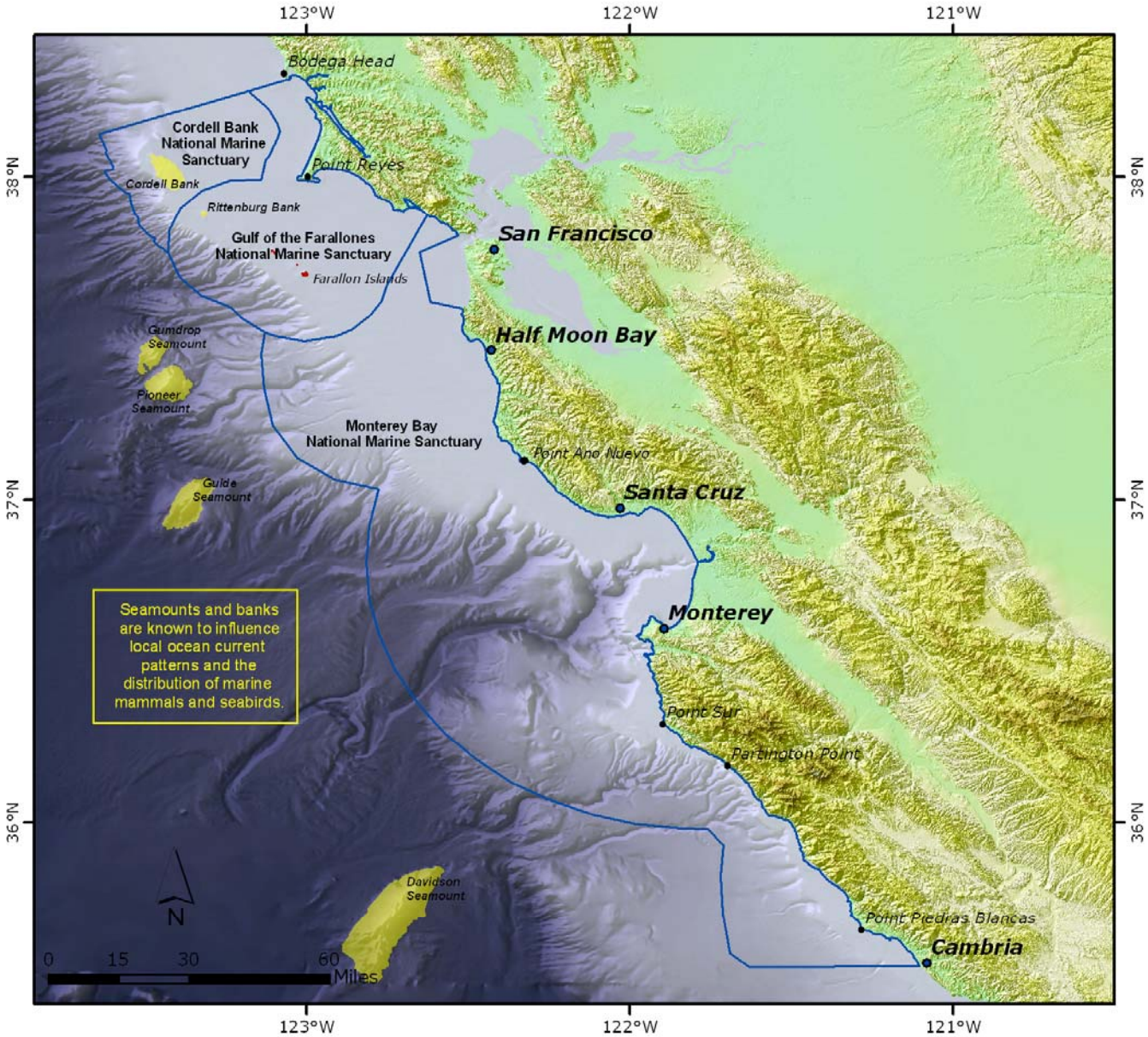


Image: Pam van der Leeden, Chad King

Cordell Bank

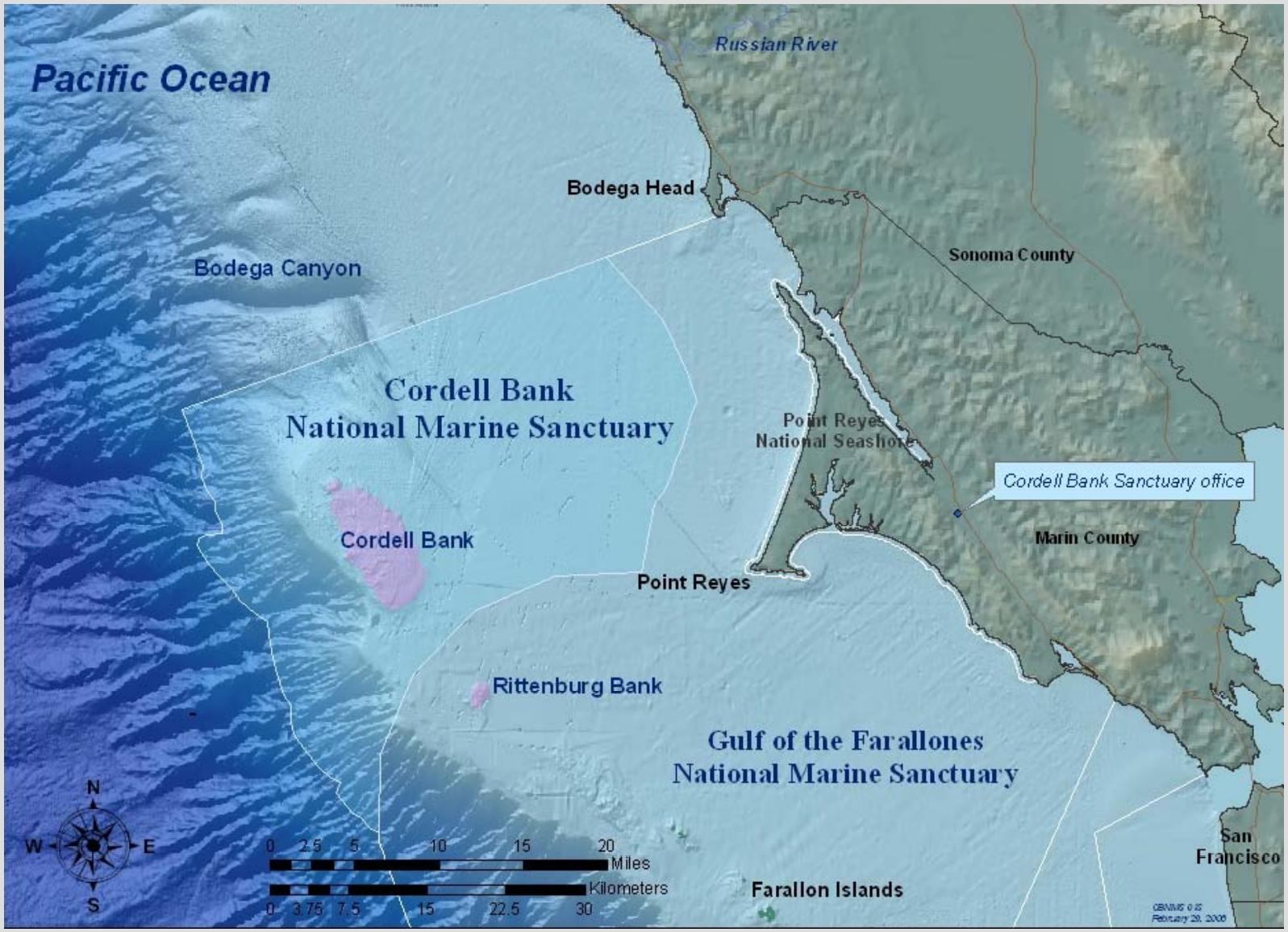
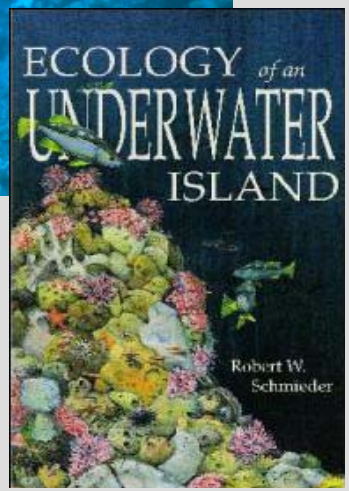


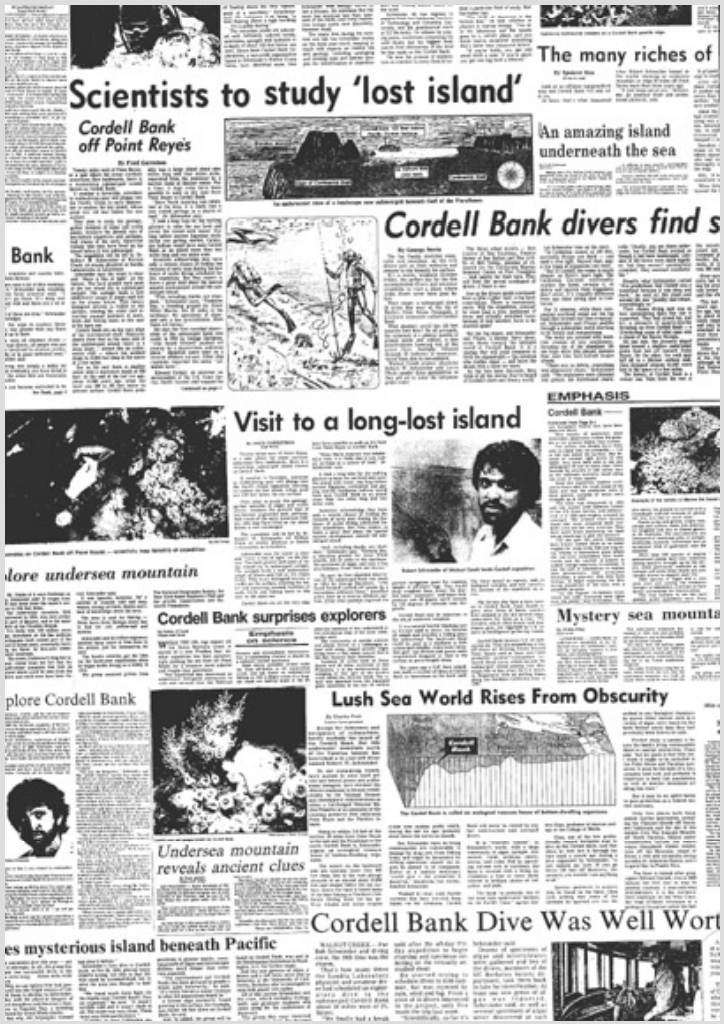
Image: Pam van der Leeden

First modern explorations of Cordell Bank

CORDELL EXPEDITIONS

1977-1988





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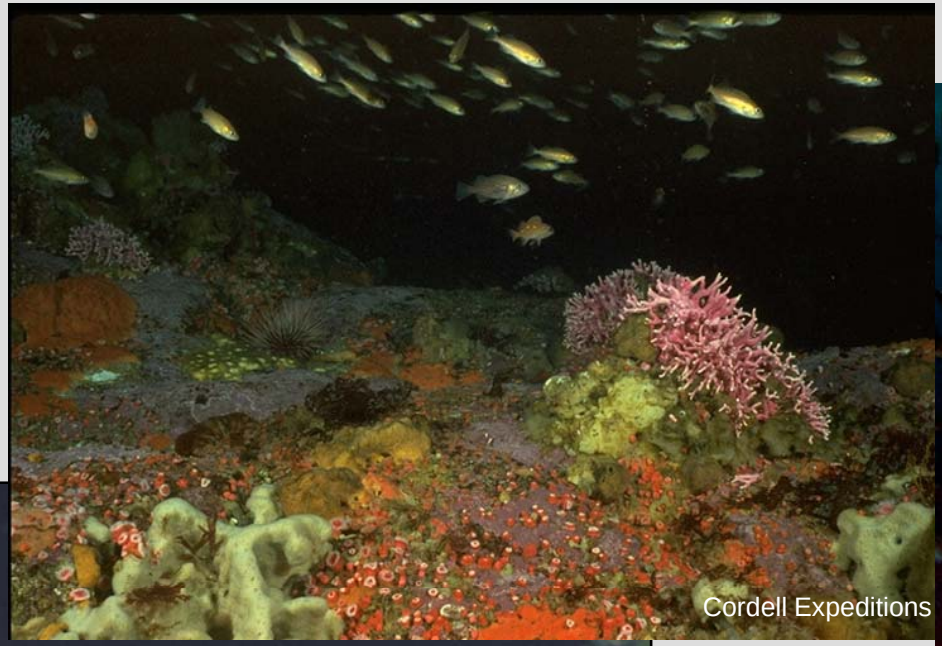

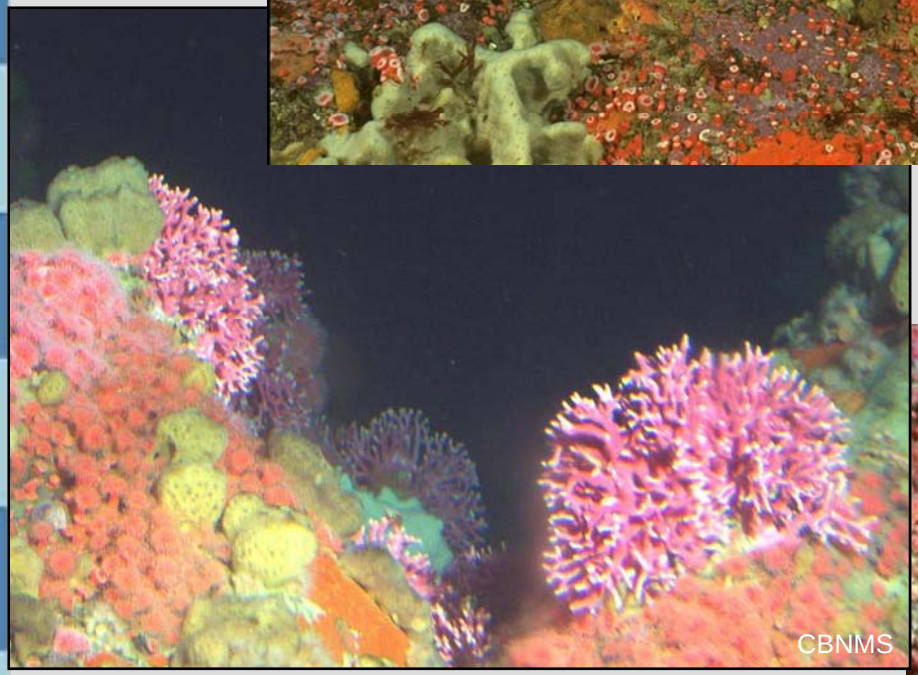

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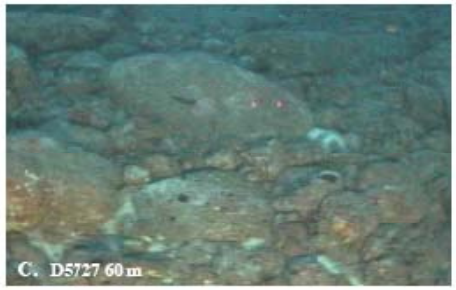
Cordell Bank habitats

rock

rock
with boulders

boulders

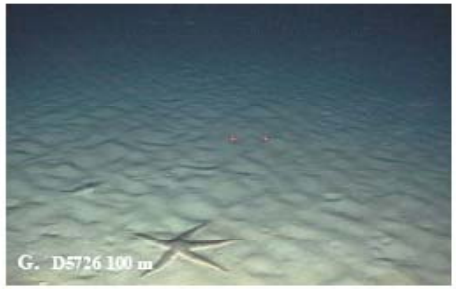


sand
with boulders

sand
with gravel

mud
with rock

sand



mud

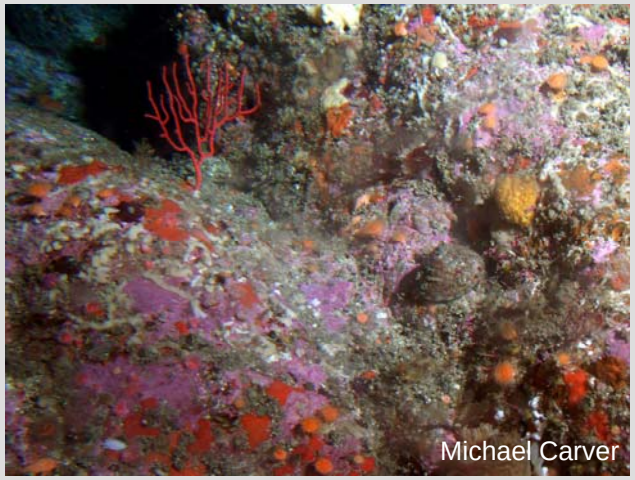
Figure: Pirtle 2005; Photos: CBNMS

Objectives

- Describe the distribution of corals (*Stylaster californicus* and *Swiftia spp*.) on Cordell Bank

- Examine the relationships between corals and habitat features of Cordell Bank using in-situ observational data and multibeam mapping data

- Predict coral presence across Cordell Bank



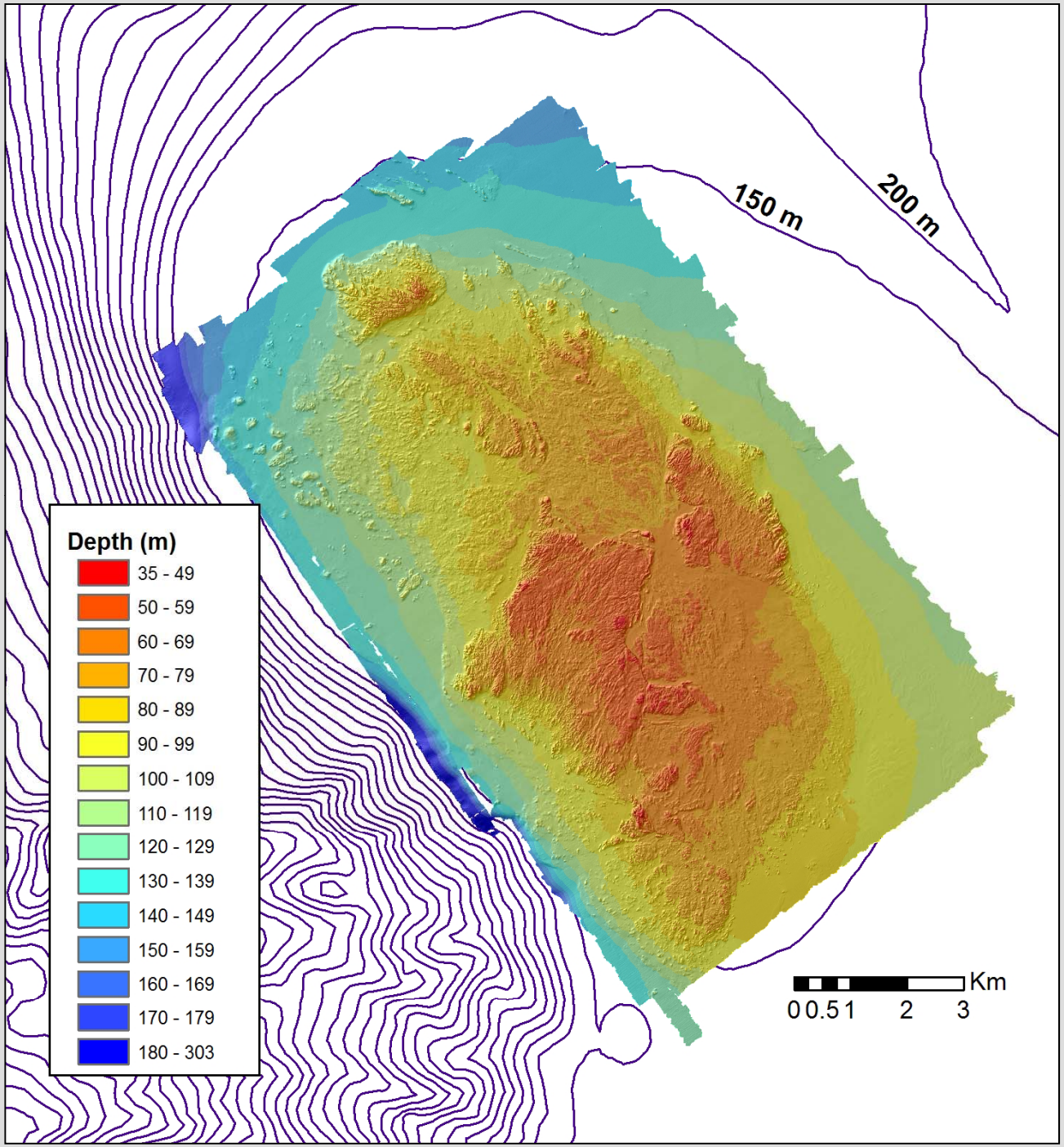
Cordell Bank Quantitative Submersible Surveys

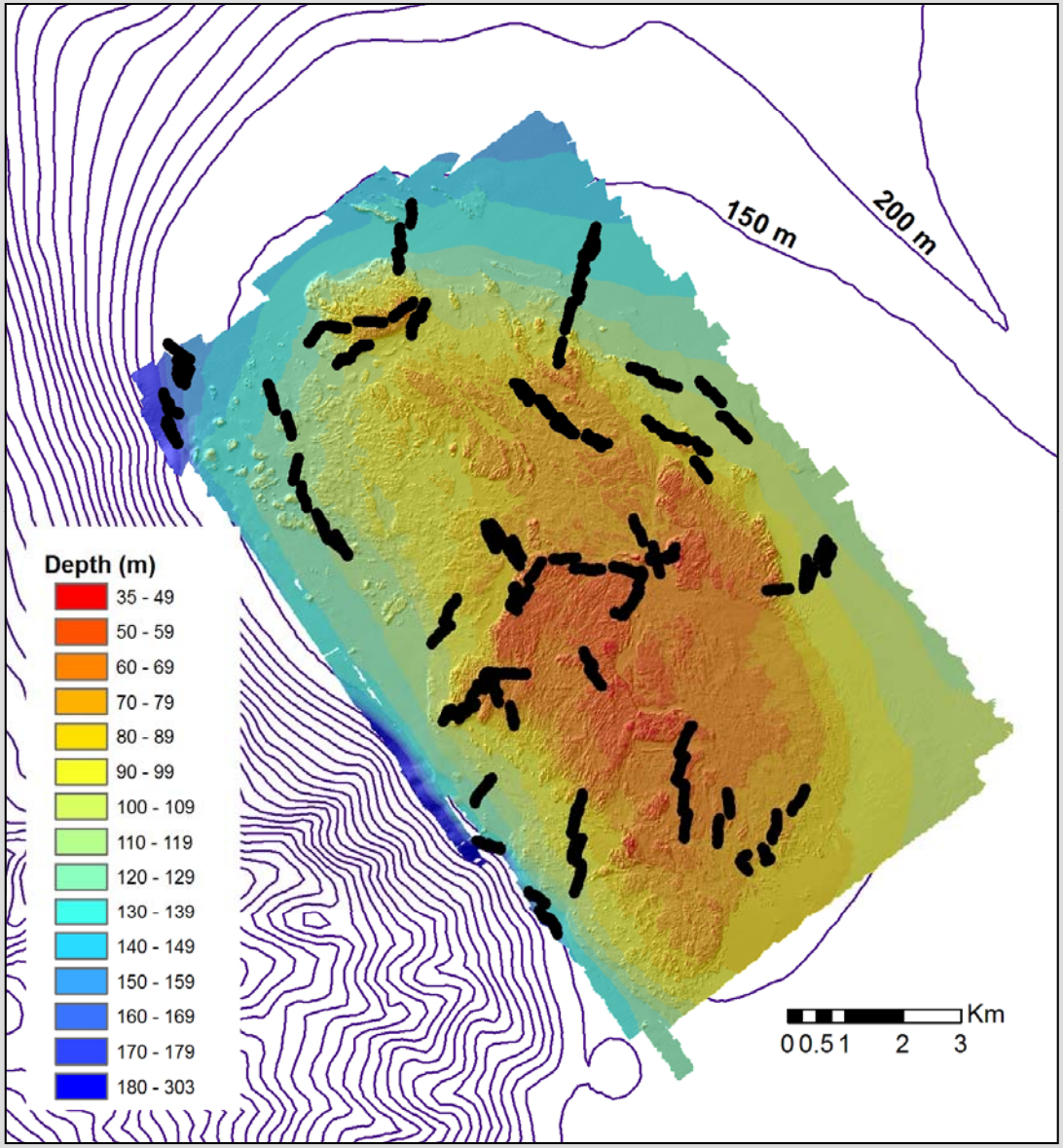
- Original objective: Describe benthic environment and groundfish assemblage over spatial extent of Bank; sample annually to assess temporal change
- 2001-2005
- Delta submersible–video with 20cm lasers
- Transects: 2m wide by 15 min. (~400-600m)
- Fish and macroinvertebrates (> 5cm) counted, sized; habitat measured visually (substrate)
- Focus to date:

- Fish/habitat relationships using video (Anderson et al. In Prep)
- Fish/macroinvertebrate/habitat relationships using video (Pirtle 2005)
- Fish/habitat relationships using video and multibeam (Young 2007)

Cordell Bank Seafloor Mapping

- Multibeam sonar sampling of Cordell Bank in 2005
- Seafloor Mapping Lab, California State University, Monterey Bay (Rikk Kvitek, Mary Young)
- Bathymetric products produced by Mary Young:
  - Depth, slope, rugosity, aspect, topographic position index (30m, 60m, 120m, 240m) – 3m resolution
- Substrate analyses conducted by Mary Young and Guy Cochrane (USGS):
  - 3 class substrate (hard, mixed soft) using rugosity and backscatter


150 m
200 m
Depth (m)
35 - 49
50 - 59
60 - 69
70 - 79
80 - 89
90 - 99
100 - 109
110 - 119
120 - 129
130 - 139
140 - 149
150 - 159
160 - 169
170 - 179
180 - 303
Km
0 0.5 1 2 3



Transect videos viewed for corals

2001: 2 exploratory dives

2002: 50 transects

2003: 35 transects

2004: 5 transect

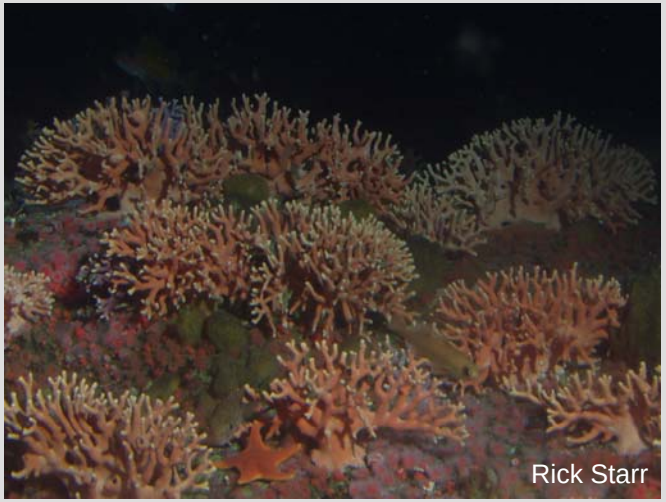
2005: 11 transects

Total: 101 transects + 2 dives (over 50 km)

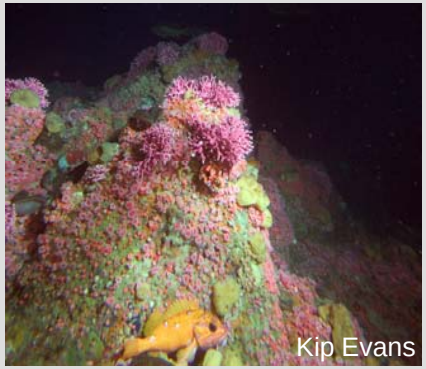
Methods

- Resampled seafloor data to 18m resolution (account for uncertainty in submersible position data)
  - Depth, slope, rugosity, aspect, topographic position index (30m, 60m, 120m, 240m), substrate
- Intersection of presence and absence points with habitat variables (2 species independently)
- Logistic regression models for *Stylaster* and *Swiftia* independently
  - Second order variables used to describe non-linear relationships
  - Stepwise model selection

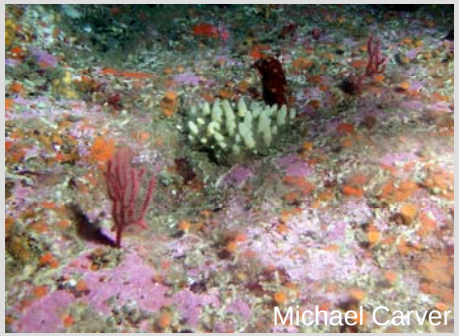
Stylaster californicus



Swiftia spp.



Stylaster californicus



Swiftia spp.

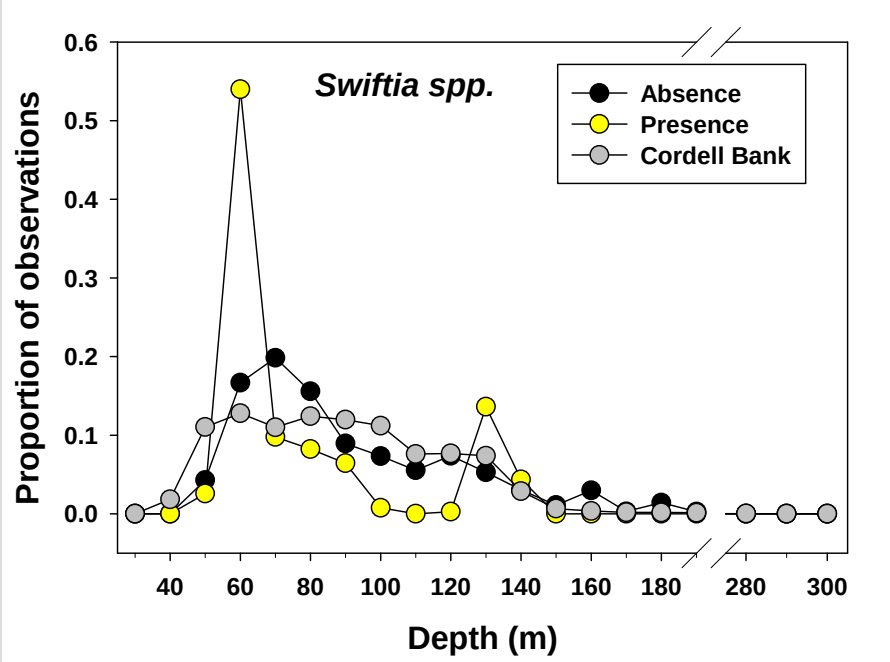
$R^2 = 0.31$	$p<0.0001$
Depth (nl)	$p<0.0001$
Slope (nl)	$p<0.0001$
TPI_240 (nl)	$p<0.0001$
Aspect	$p<0.0001$
Substrate	$p=0.0007$
TPI_120 (nl)	$p<0.0001$
TPI_30 (nl)	$p<0.0001$
Rugosity	ns
TPI_60	ns

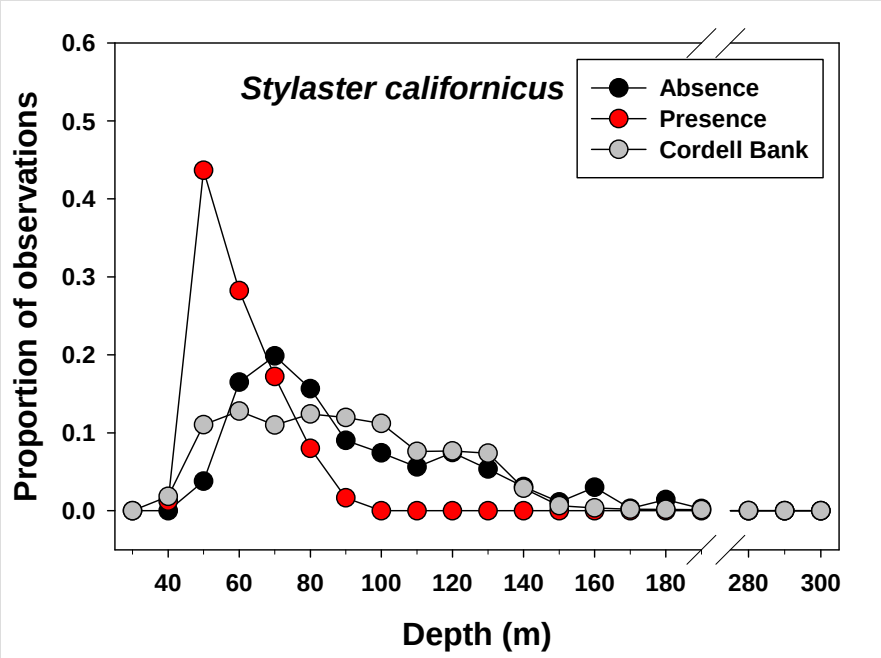
Decreasing Influence

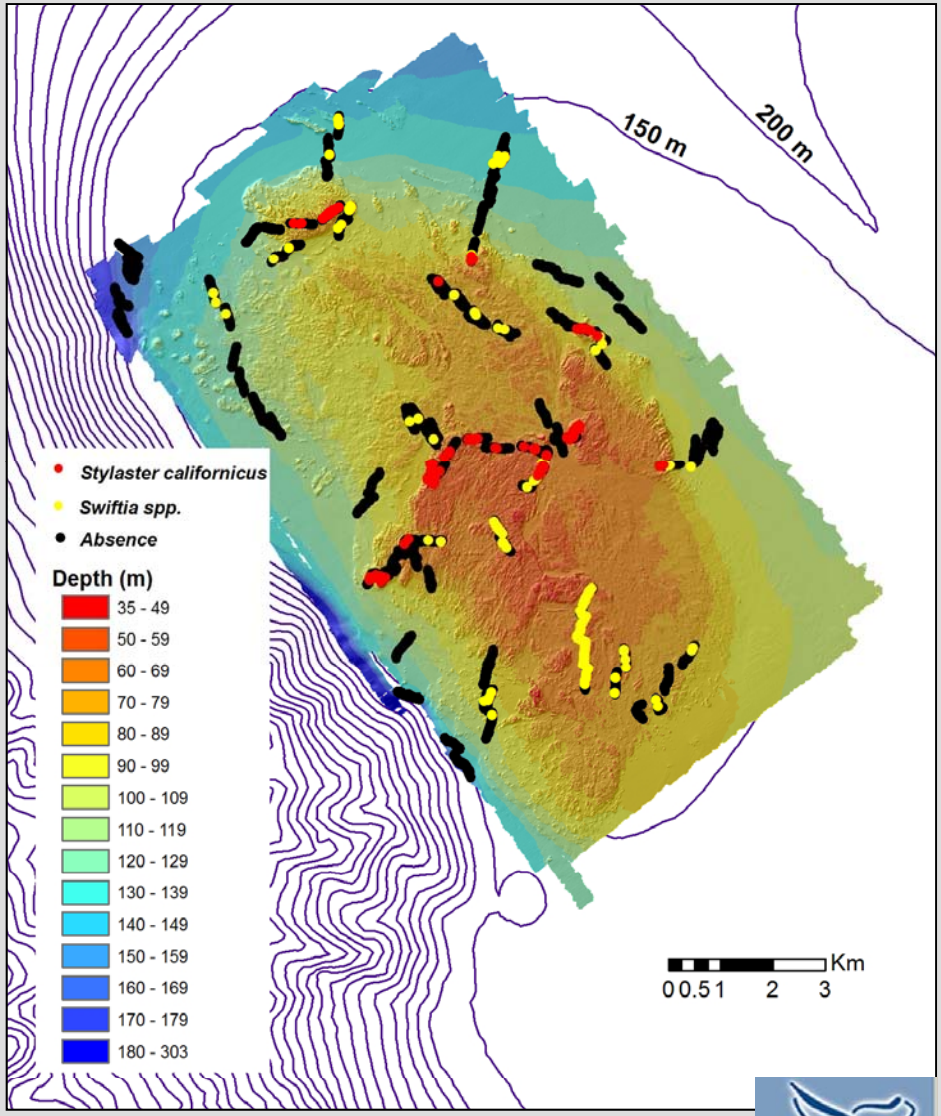
$R^2 = 0.08$	$p<0.0001$
Depth (nl)	$p<0.0001$
Slope (nl)	$p<0.0001$
TPI_240 (nl)	$p<0.0001$
TPI_120	$p=0.0014$
TPI_60	$p<0.0001$
Substrate	$p<0.0001$
Aspect	$p<0.0001$
Rugosity	ns
TPI_30	ns

- Difference between species in levels of factors significant
- Difference between species in shapes of relationships

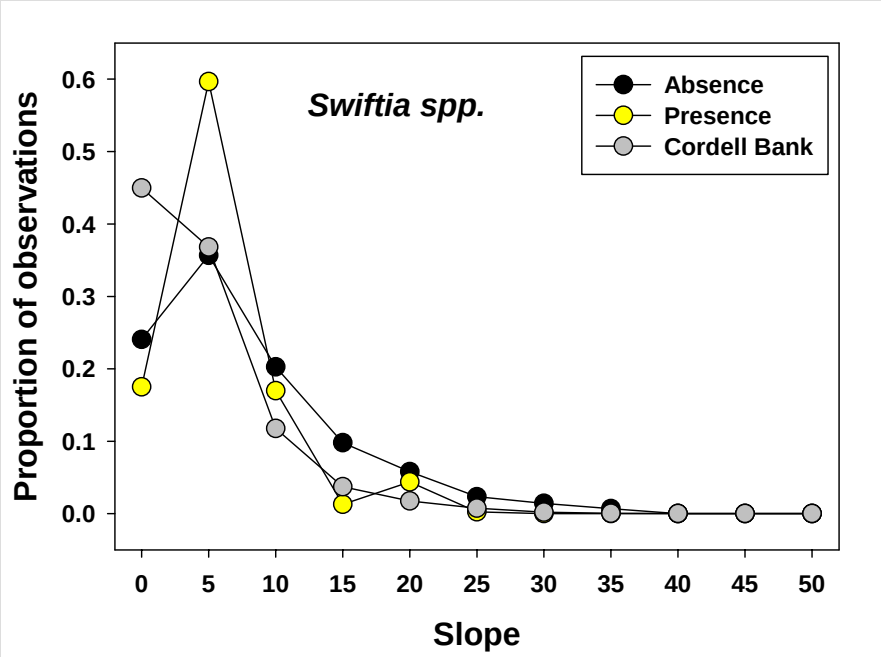
Depth

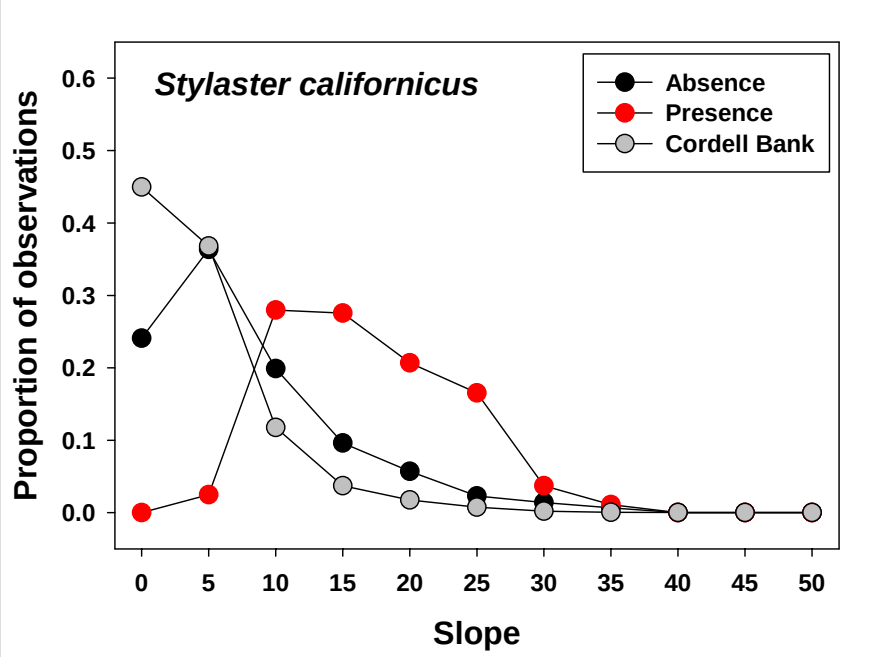

Swiftia spp.
Absence
Presence
Cordell Bank
Proportion of observations
0.0
0.1
0.2
0.3
0.4
0.5
0.6
40
60
80
100
120
140
160
180
280
300
Depth (m)

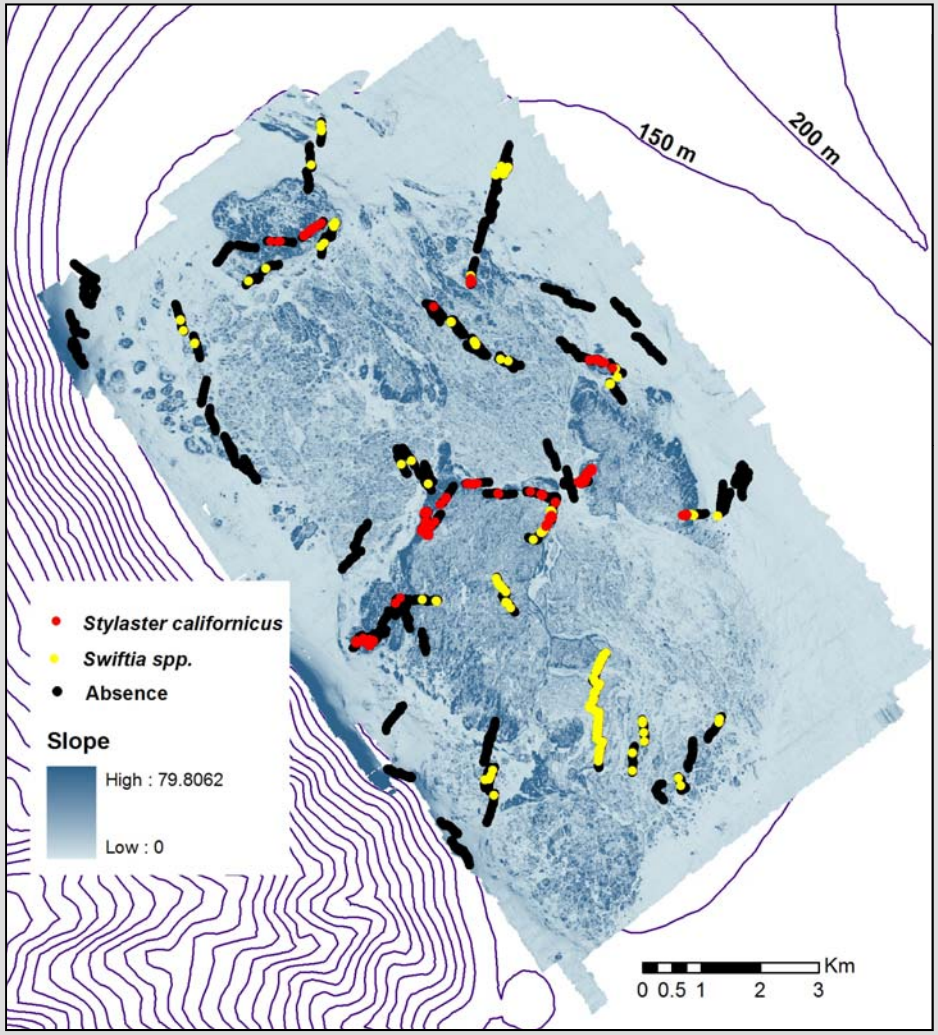

Stylaster californicus
Absence
Presence
Cordell Bank
Proportion of observations
0.0
0.1
0.2
0.3
0.4
0.5
0.6
40
60
80
100
120
140
160
180
280
300
Depth (m)


150 m
200 m
Stylaster californicus
Swiftia spp.
Absence
Depth (m)
35 - 49
50 - 59
60 - 69
70 - 79
80 - 89
90 - 99
100 - 109
110 - 119
120 - 129
130 - 139
140 - 149
150 - 159
160 - 169
170 - 179
180 - 303
Km
0 0.5 1 2 3

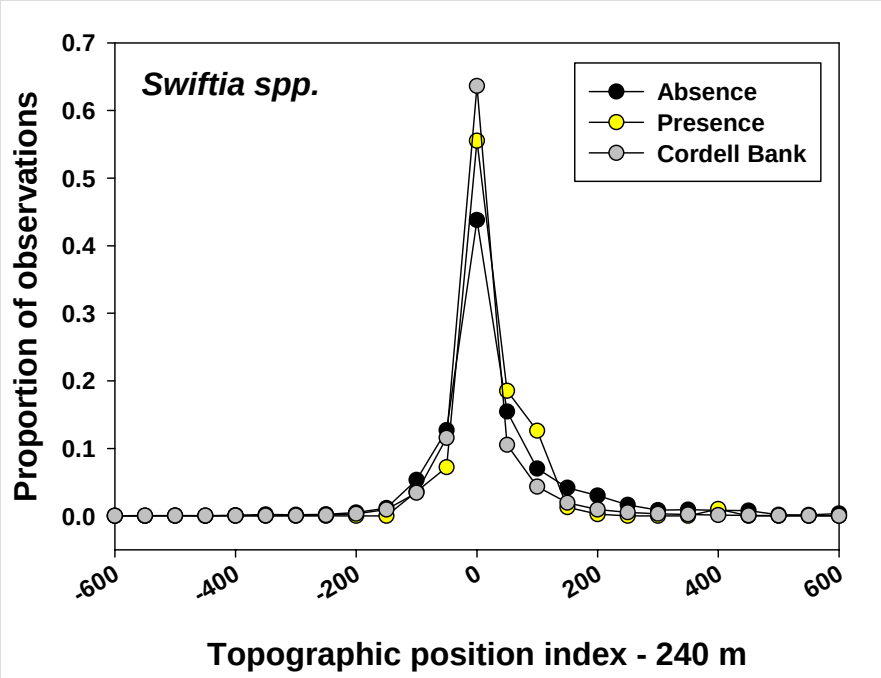
Slope

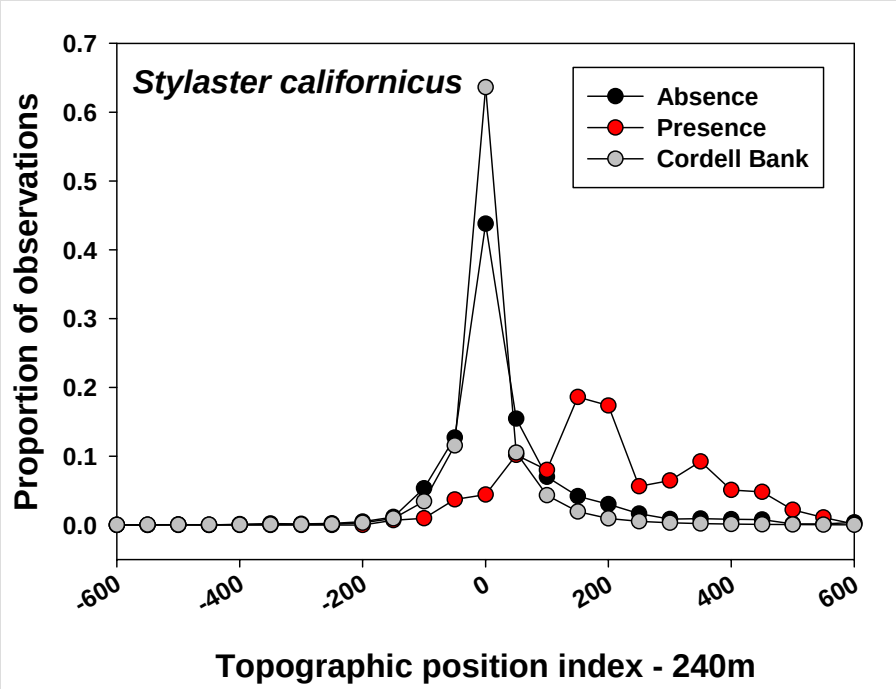

Swiftia spp.
Absence
Presence
Cordell Bank
Proportion of observations
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0
5
10
15
20
25
30
35
40
45
50
Slope

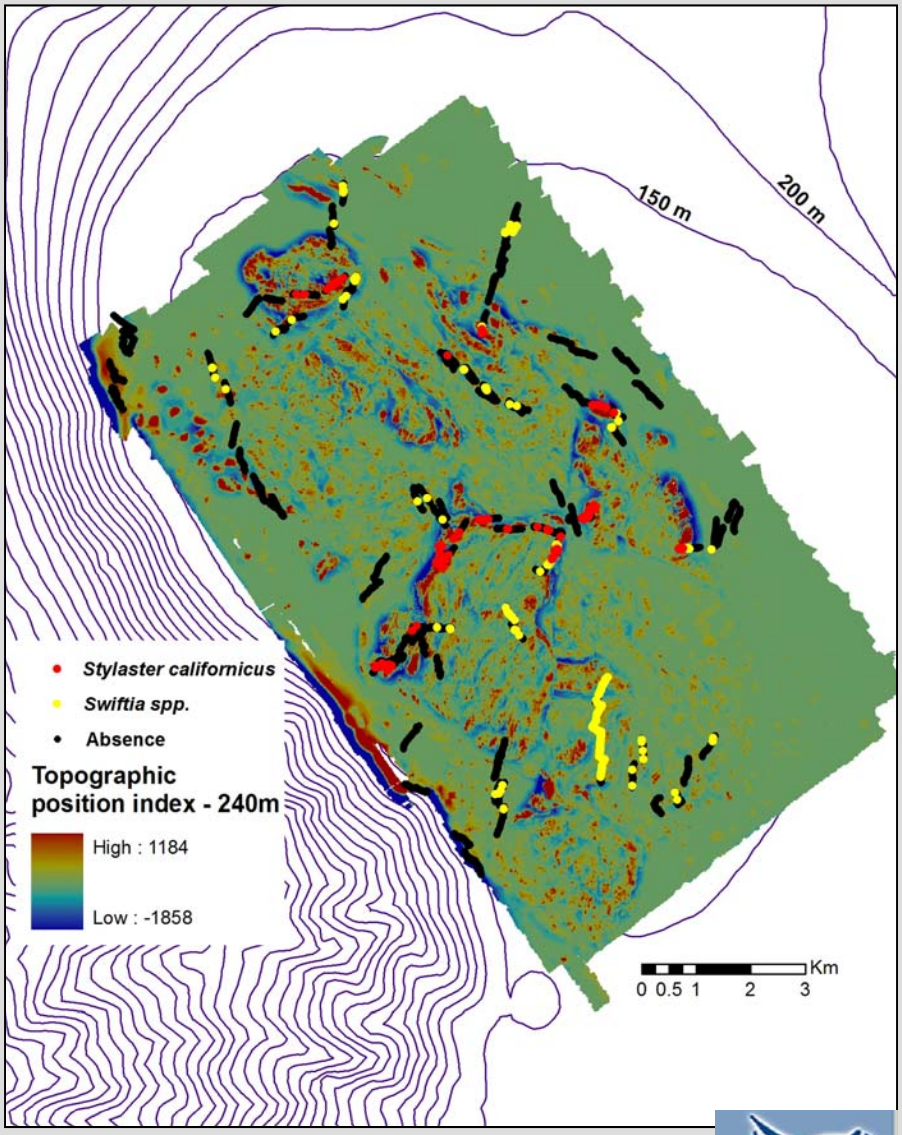

Stylaster californicus
Absence
Presence
Cordell Bank
Proportion of observations
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0
5
10
15
20
25
30
35
40
45
50
Slope


150 m
200 m
Stylaster californicus
Swiftia spp.
Absence
Slope
High : 79.8062
Low : 0
Km
0 0.5 1 2 3

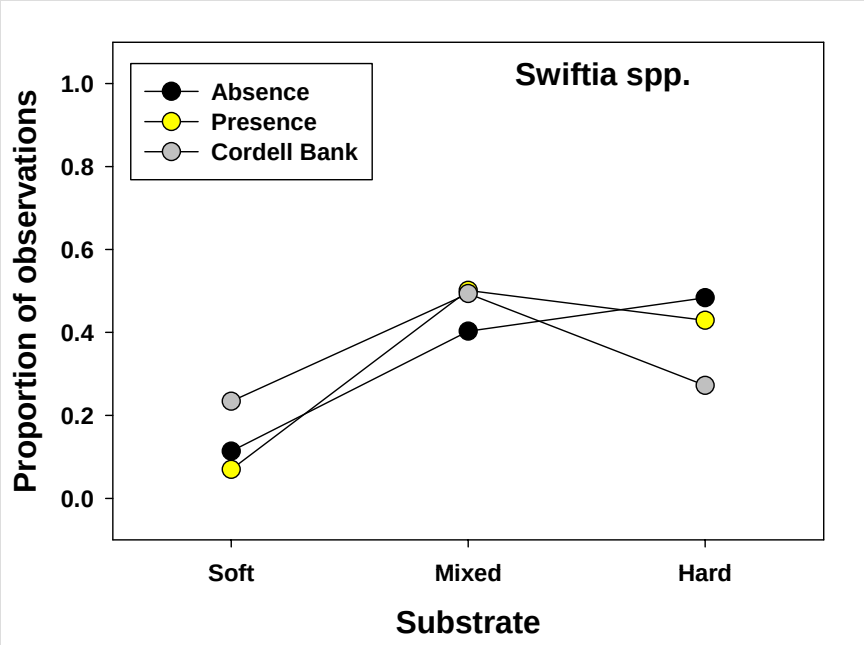
Topographic position index - 240m

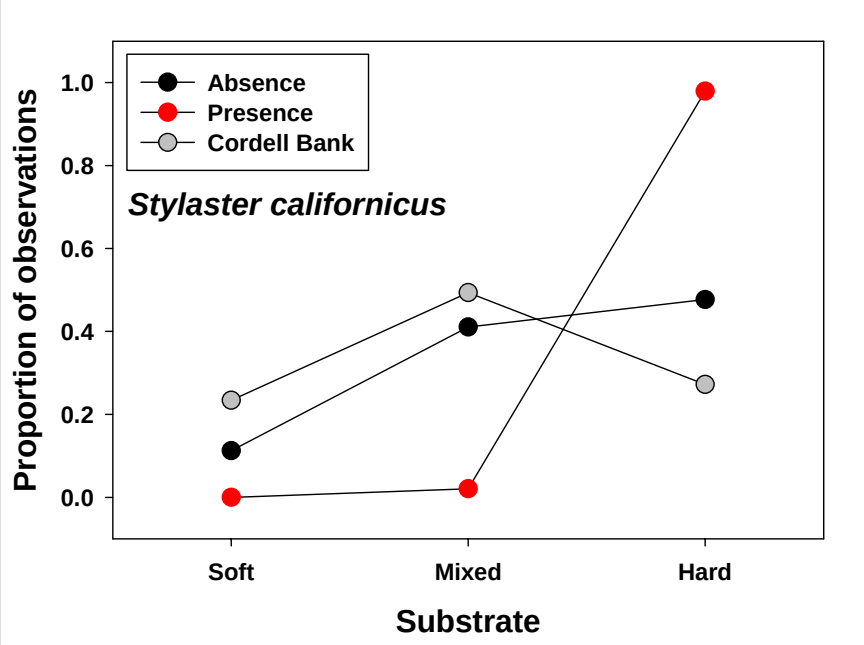


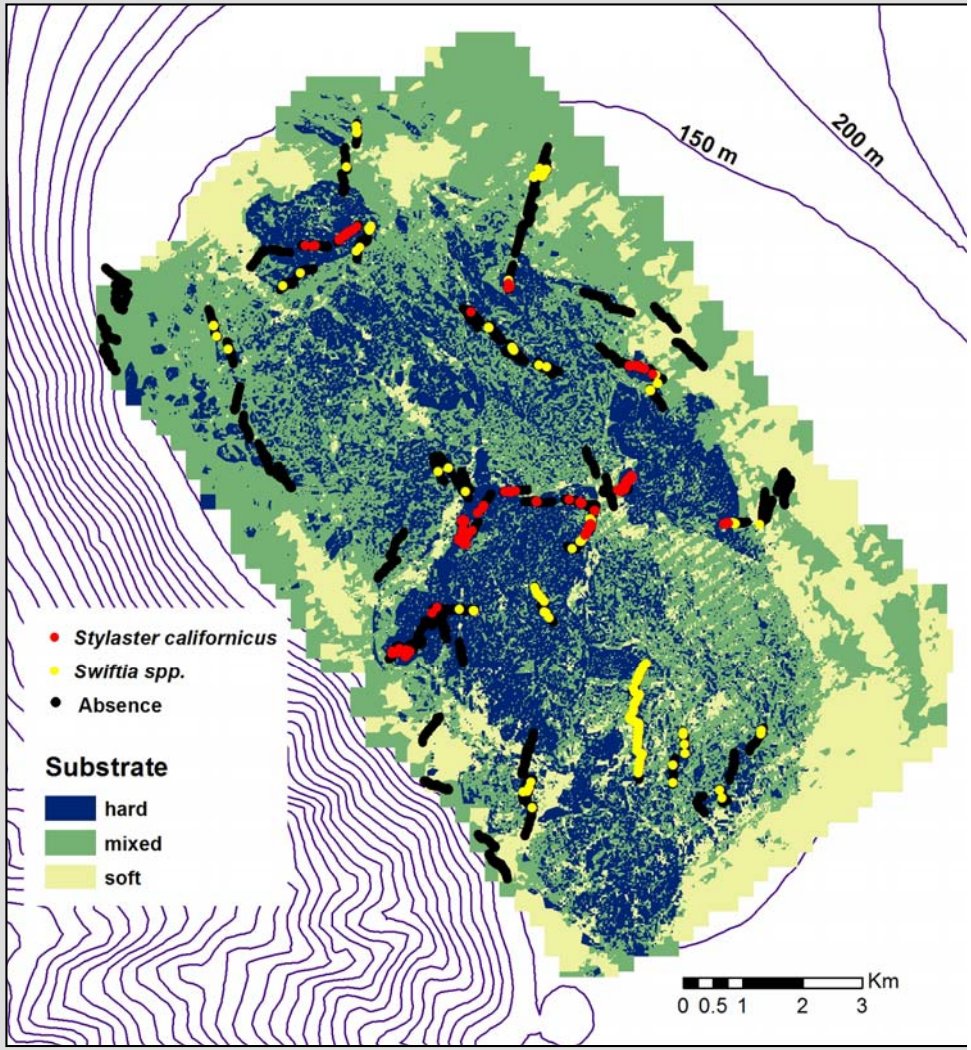




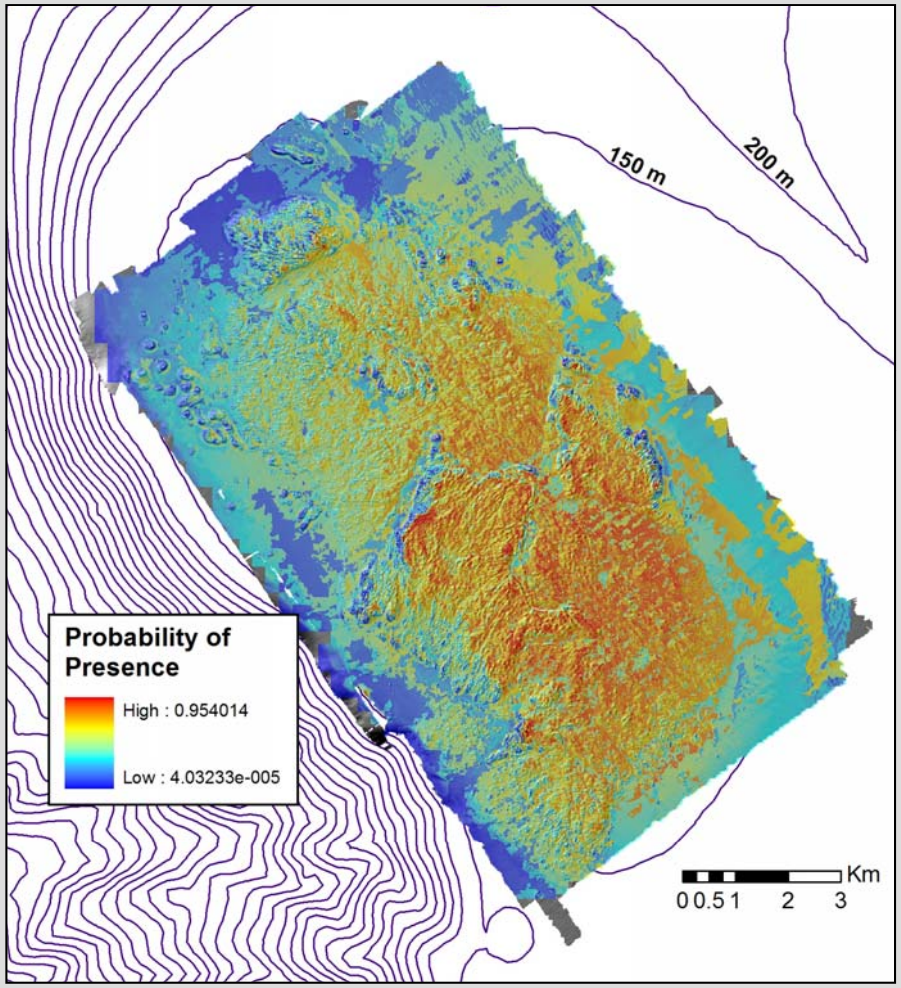
Substrate


Swiftia spp.
Absence
Presence
Cordell Bank
Proportion of observations
1.0
0.8
0.6
0.4
0.2
0.0
Soft
Mixed
Hard
Substrate

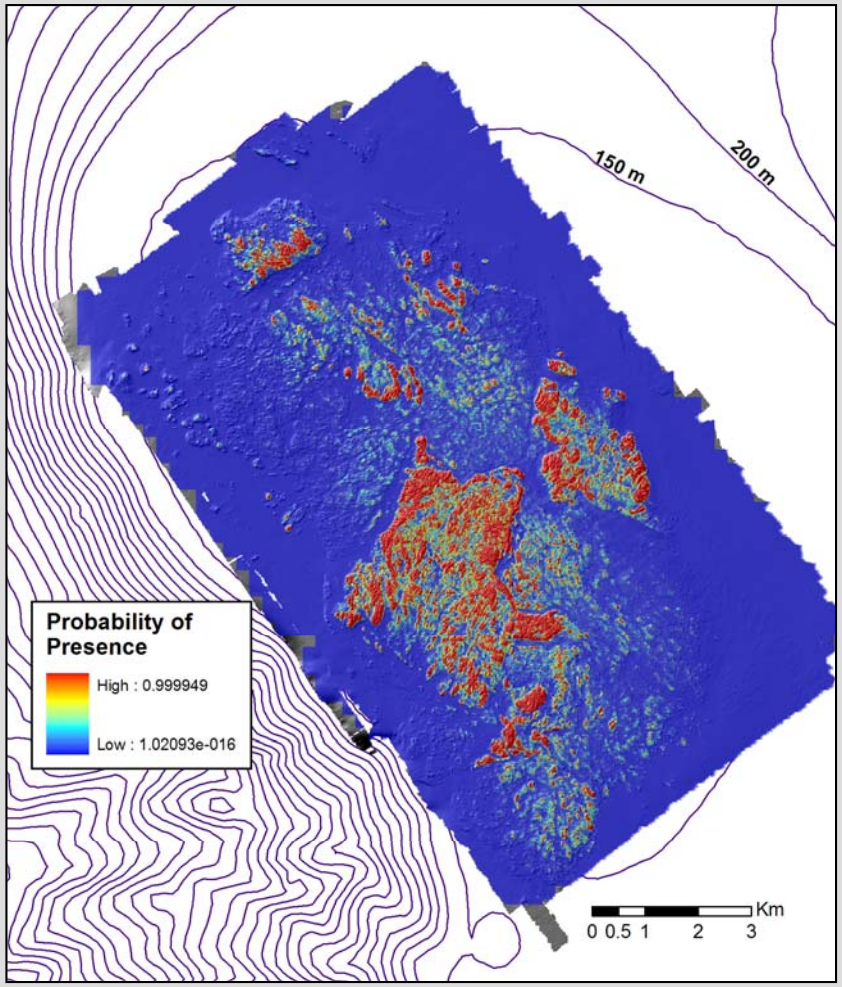

Absence
Presence
Cordell Bank
Stylaster californicus
Proportion of observations
1.0
0.8
0.6
0.4
0.2
0.0
Soft
Mixed
Hard
Substrate


150 m
200 m
Stylaster californicus
Swiftia spp.
Absence
Substrate
hard
mixed
soft
Km
0 0.5 1 2 3

Swiftia spp.



Stylaster californicus



ArcRstats GLM model prediction

Best, B.D., S. Loarie, S. Qian, P. Halpin, D. Urban. 2005. ArcRstats – multivariate habitat modeling with ArcGIS and R statistical software. Available at http://www.nicholas.duke.edu/geospatial/software.

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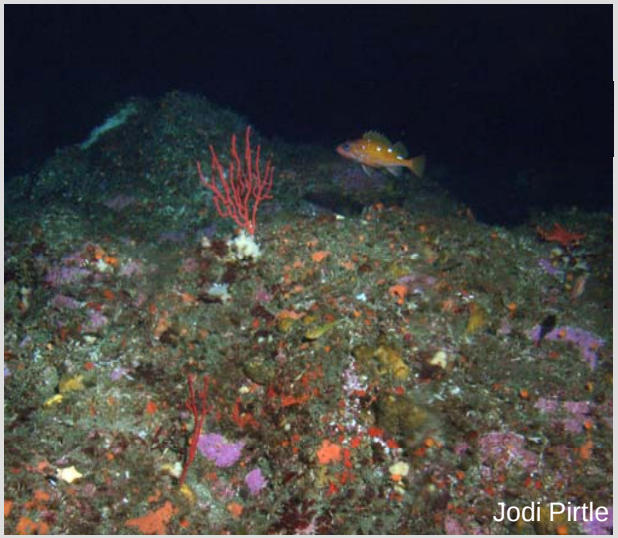
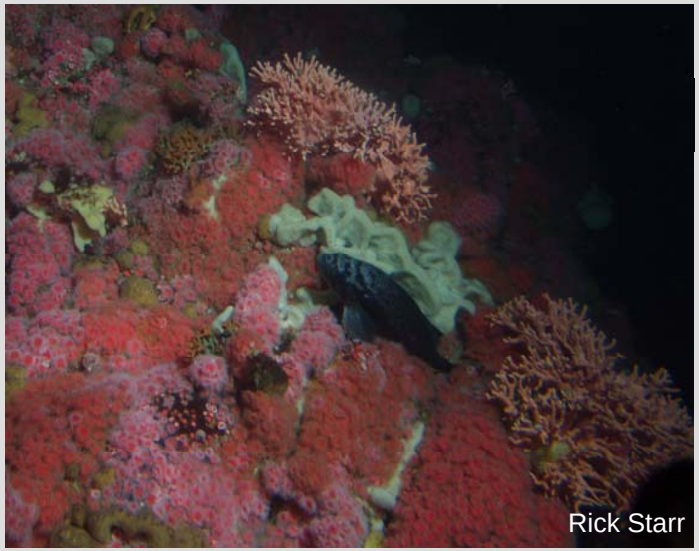
Conclusions

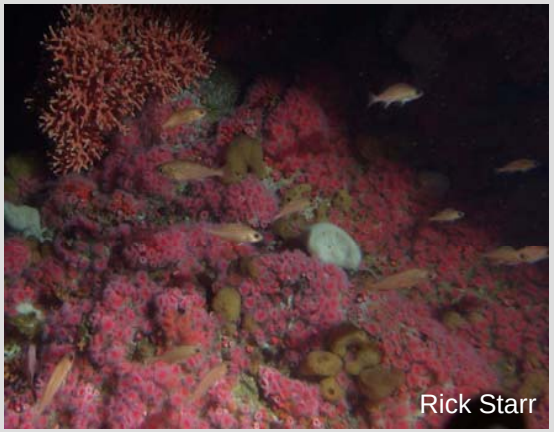
- *Stylaster californicus* restricted to small proportion of Bank; *Swiftia spp.* more broadly distributed
- Depth, slope, and broad-scale topographic position index are best predictors of *S. californicus* and *Swiftia* presence
- Hydrocorals and gorgonians occupy different niches - based on preference for different current flow patterns
- Future work will refine models and prediction maps; further sampling to evaluate models





Implications

- Highlight need for protection of these habitats, communities
  - current EFH conservation area closure to bottom contact gear on Cordell Bank need to remain in place
- Suggest differences in fine-scale current patterns across Bank
  - retention of prey, recruitment
- Extend documented northern range of *Stylaster californicus*; Cordell Bank is northern range of *Labyrinthocyathus quaylei*
  - limiting factors: habitat? dispersal? available data?
- Provide framework for monitoring habitats, communities
  - impacts of climate change, fishing closures



Acknowledgments

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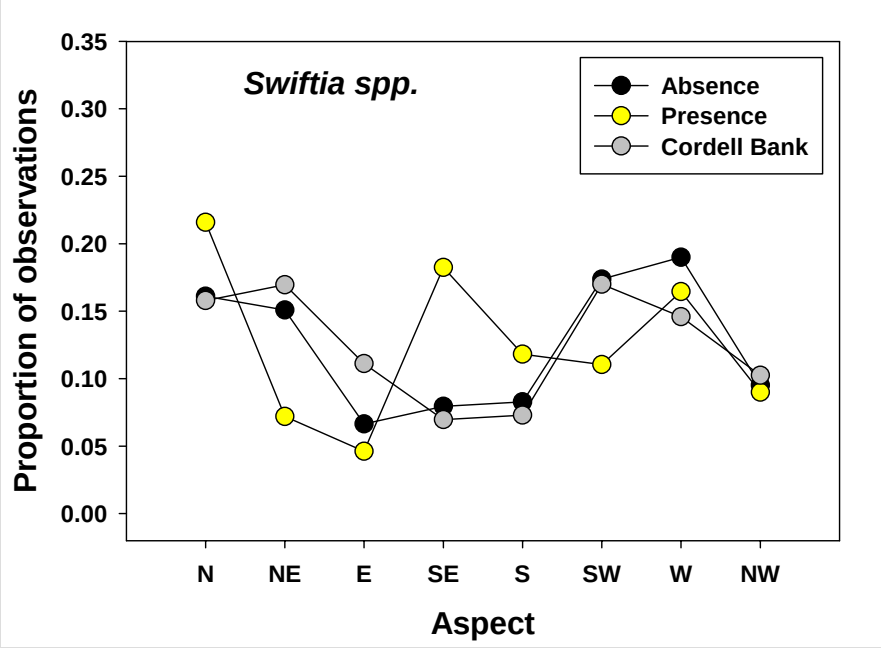
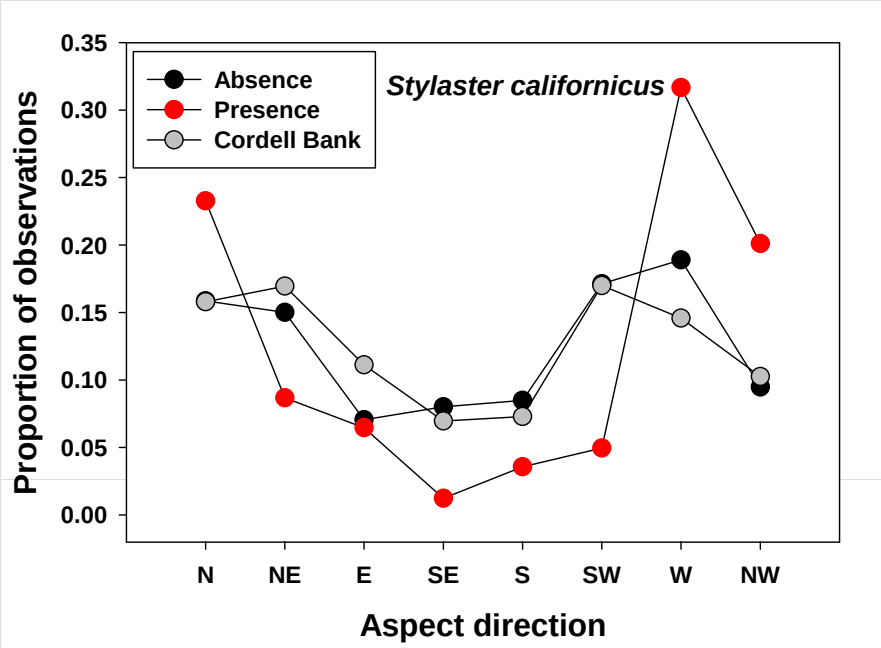
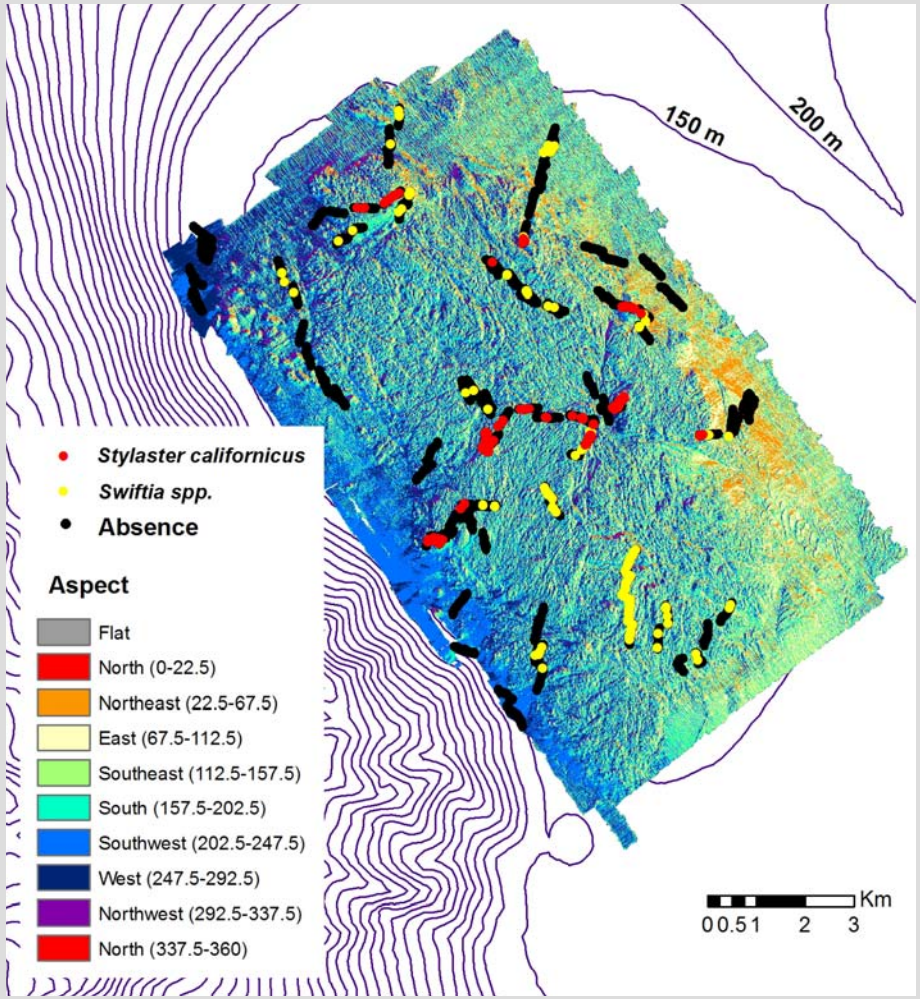
- Mark Amend, Tara Anderson, Jill Baltan, Michael Carver, Jean de Marginac, Kip Evans, Dan Howard, Tom Laidig, Bob Lea, Jodi Pirtle, Dale Roberts, Linda Snook, Rick Starr, Jennifer Stock, Brian Tissot, Ed Ueber, Mary Yoklavich (program development and submersible observers)
- Mary Young, Rikk Kvitek, Guy Cochrane, Carrie Bretz, Pat Iampietro (seafloor data processing and analysis)
- Jodi Pirtle (invertebrate observations)
- Dave Minard, Kate Thomas, Mary Young, Saori Zurita (seafloor data collection)
- Dave Slater, Chris Ijames, Joe Lilly (Delta Oceanographics)
- Crew of Velero
- Barry Nickel (additional GIS expertise)

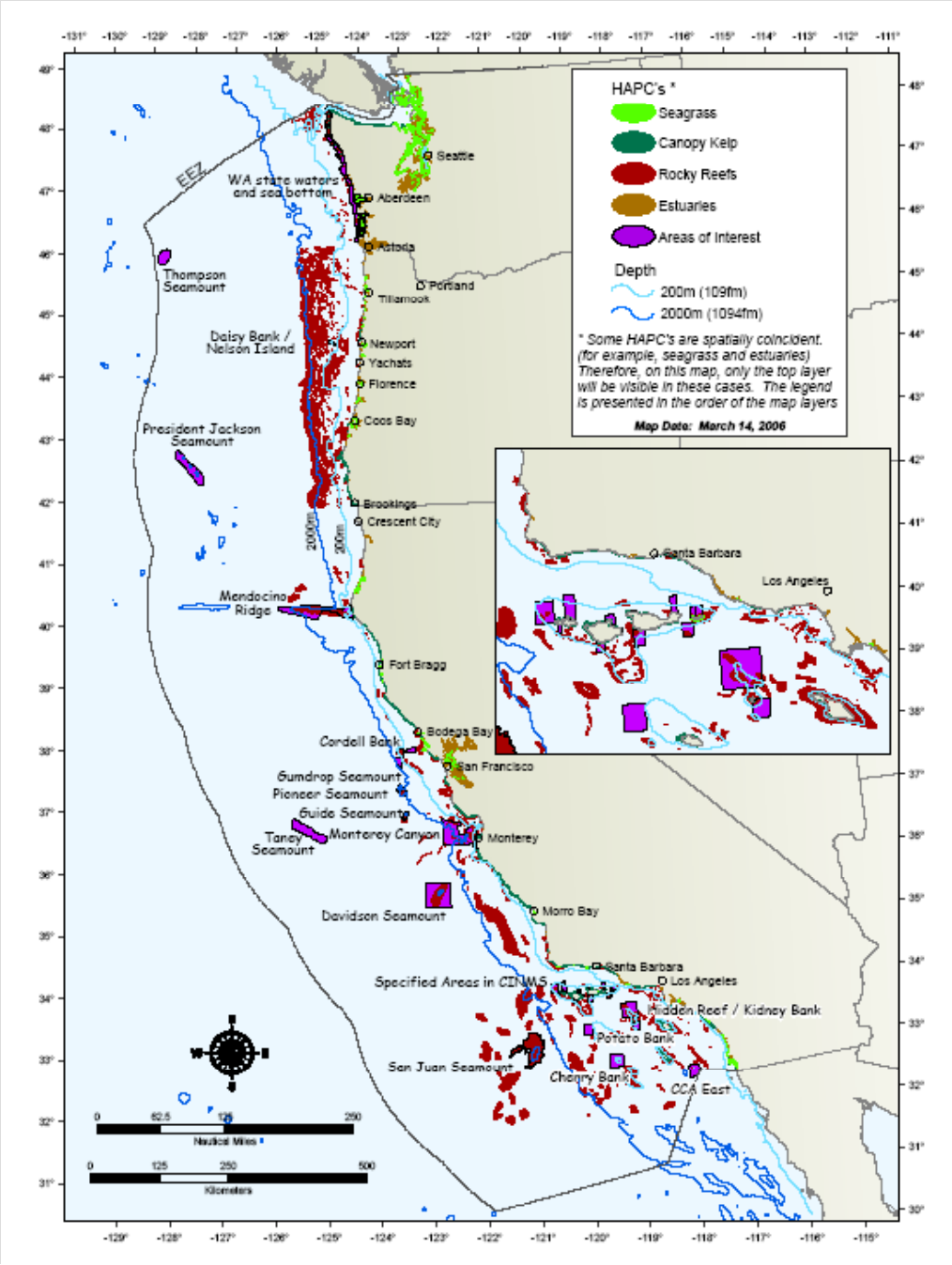
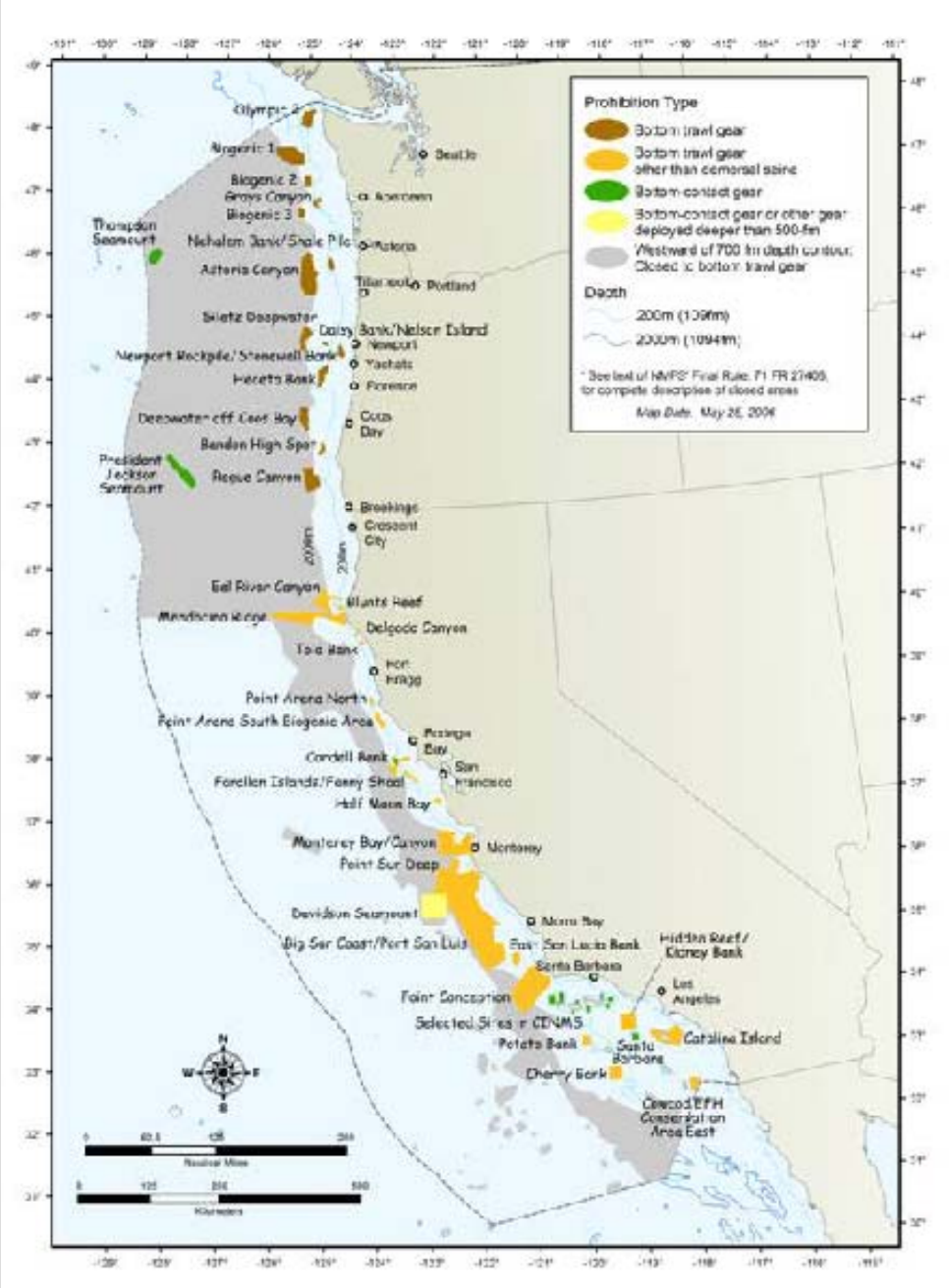
Aspect


Swiftia spp.
Absence
Presence
Cordell Bank
Proportion of observations
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
N
NE
E
SE
S
SW
W
NW
Aspect


Absence
Presence
Cordell Bank
Stylaster californicus
Proportion of observations
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
N
NE
E
SE
S
SW
W
NW
Aspect direction


150 m
200 m
Stylaster californicus
Swiftia spp.
Absence
Aspect
Flat
North (0-22.5)
Northeast (22.5-67.5)
East (67.5-112.5)
Southeast (112.5-157.5)
South (157.5-202.5)
Southwest (202.5-247.5)
West (247.5-292.5)
Northwest (292.5-337.5)
North (337.5-360)
Km
0 0.5 1 2 3

Habitat Areas of Particular Concern (HAPC)



Essential Fish Habitat (EFH) conservation areas