Comparative observations of flow around Hawaiian deep-sea corals.

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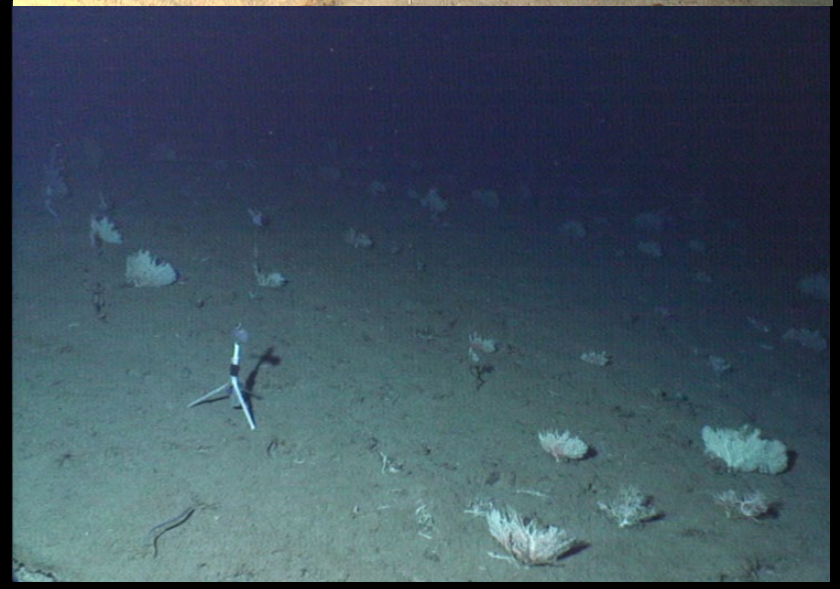
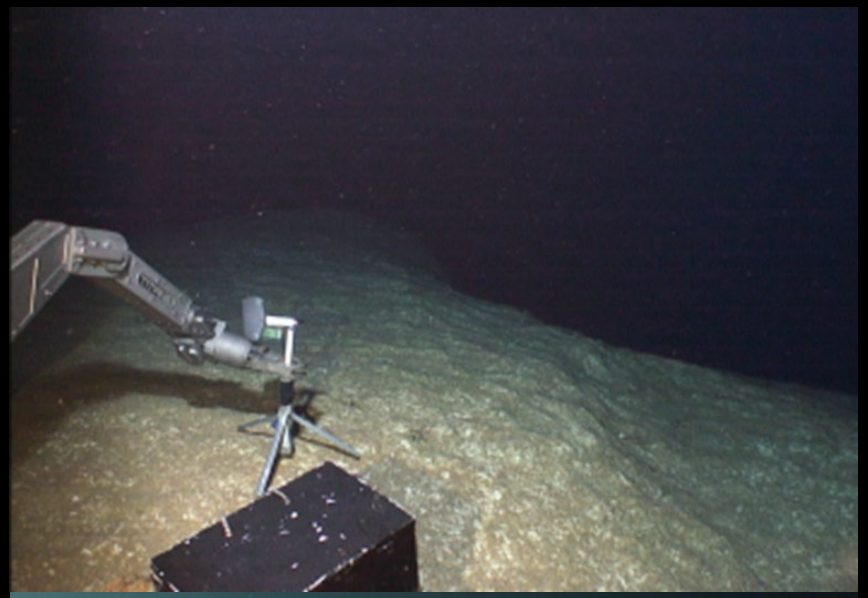
National Marine Fisheries Service
Pacific Islands Fisheries Science Center

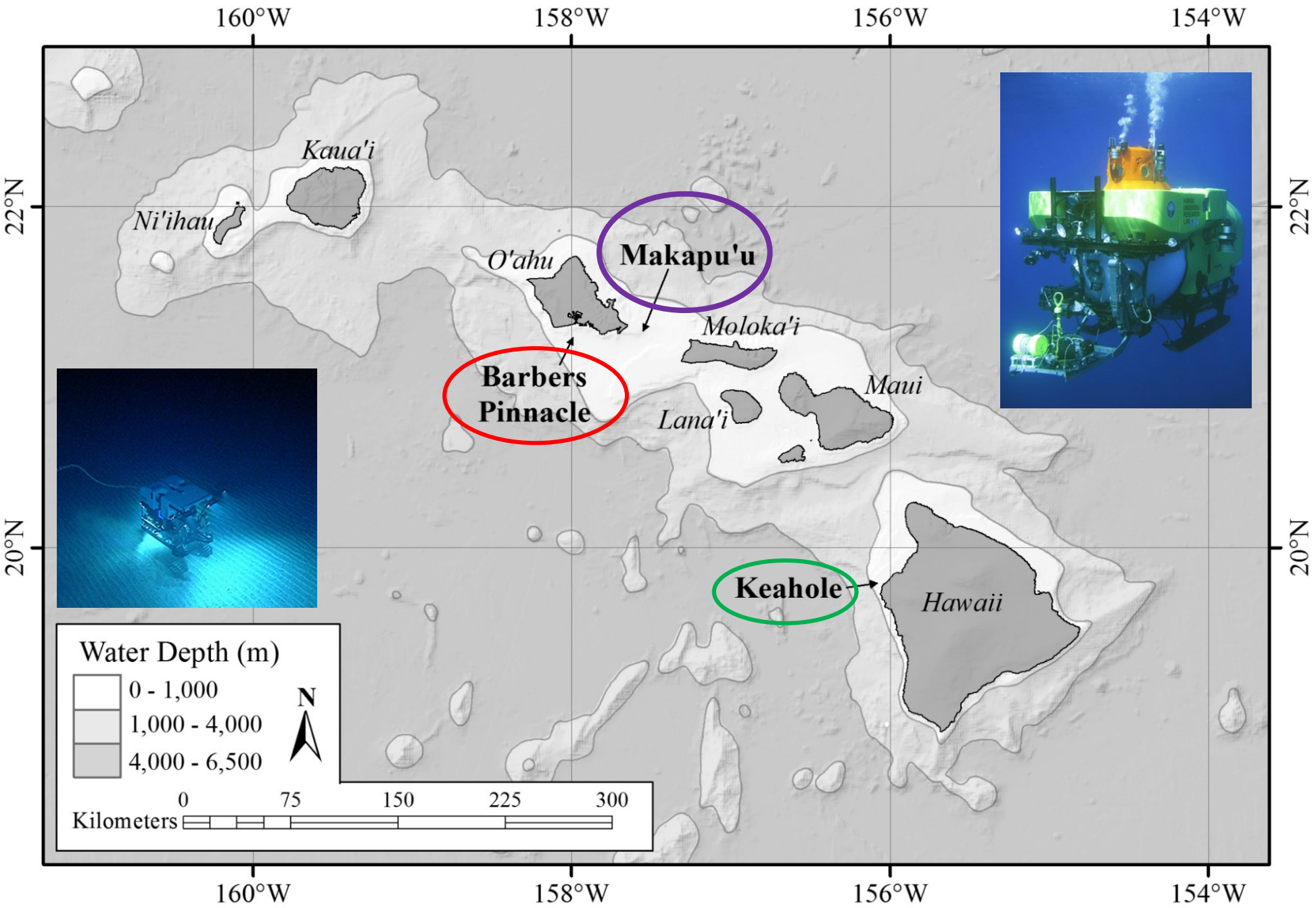
In the patch



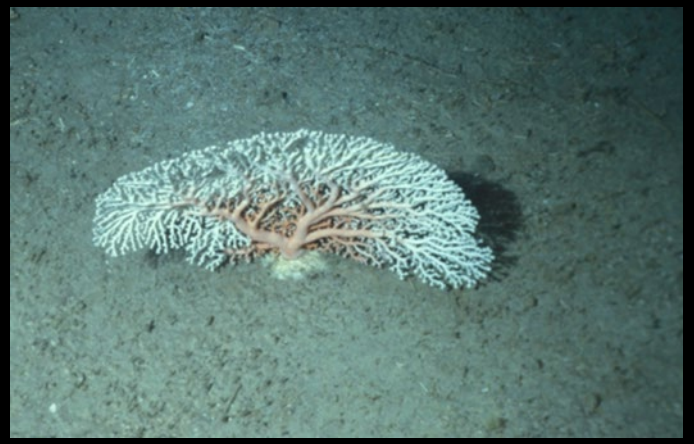
Adjacent to the patch



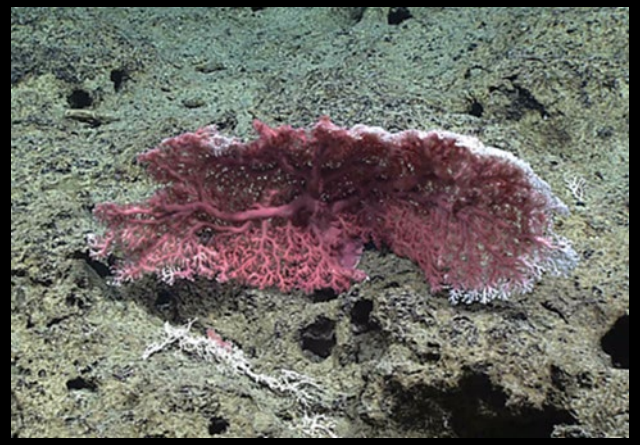
Depth
Temp
Flow rate
Tidal spectra
Suspended mat.


160°W
158°W
156°W
154°W
22°N
20°N
Kaua'i
Ni'ihau
O'ahu
Makapu'u
Moloka'i
Barbers Pinnacle
Maui
Lana'i
Keahole
Hawaii
Water Depth (m)
0 - 1,000
1,000 - 4,000
4,000 - 6,500
N
0
75
150
225
300
Kilometers

Commercially harvested precious corals



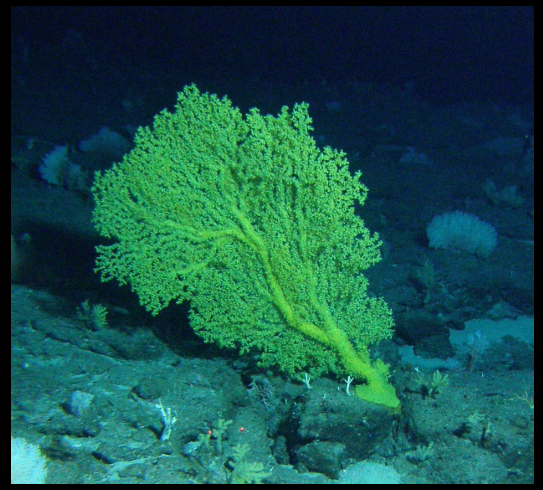
Pink



Red

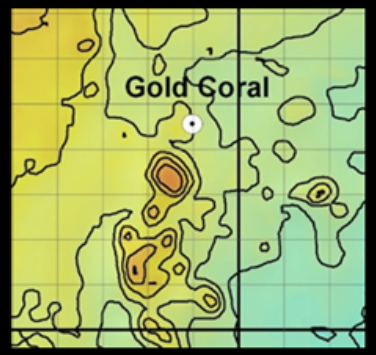
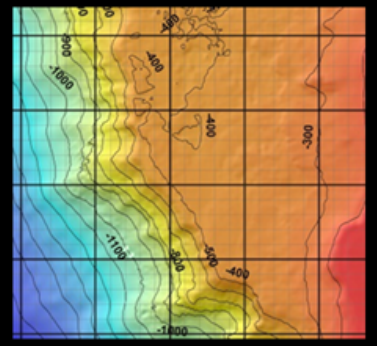
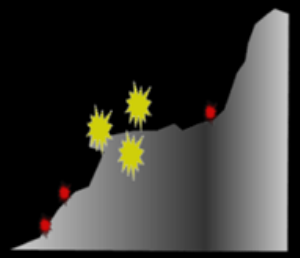
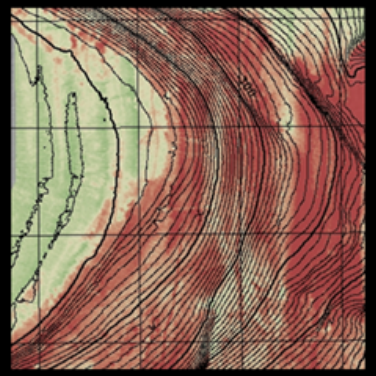
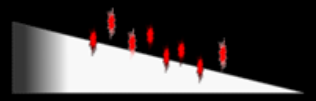
Bamboo

"*midas*"

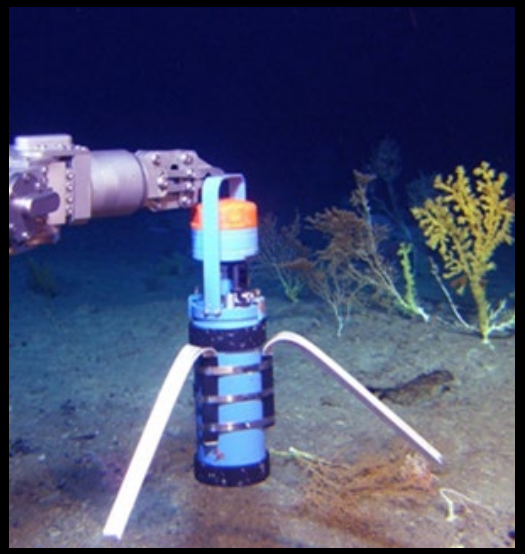


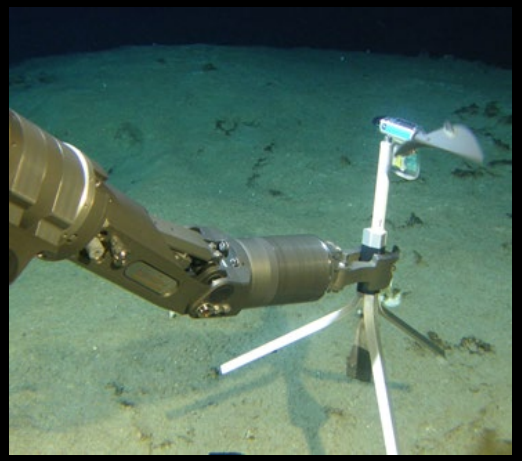
Gold

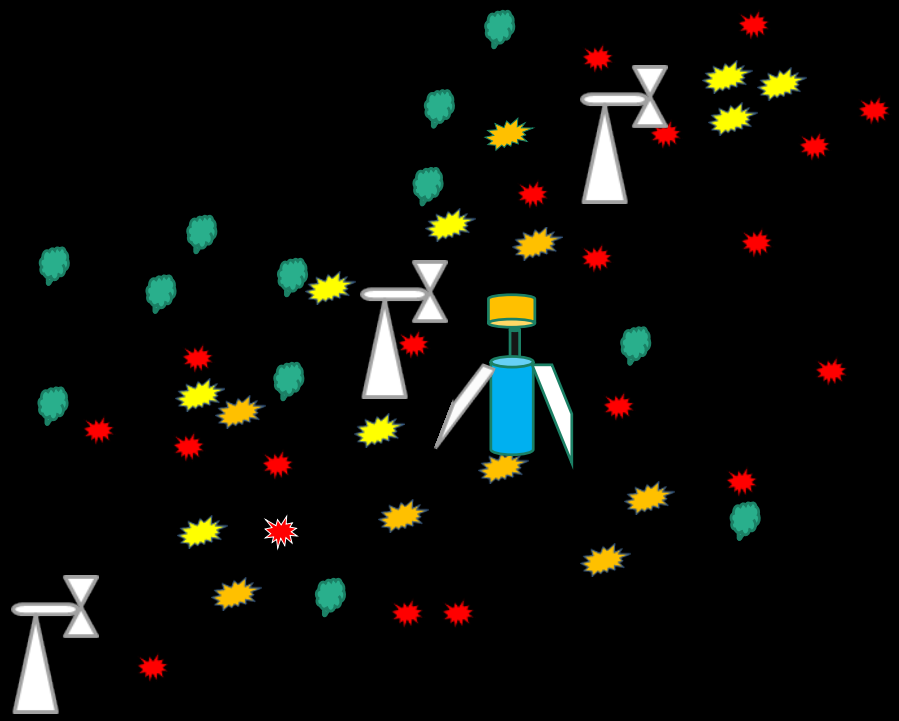
Physiography of coral patches

	Topography/size		Depth	Common precious coral taxa	
Barbers Pinnacle		0.05 square km	330 m	Gold coral Bamboo	Kulamanamana haumeaae Acanella dispar
Keahole Pt.		 2.7 square kms	379 m	Gold coral Bamboo Red coral	Kulamanamana haumeaae Acanella dispar Hemicorallium laauense
Makapuu Pt.		 12.5 square kms	415 m	Gold coral Bamboo Red coral Pink coral	Kulamanamana haumeaae Acanella dispar Hemicorallium laauense Pleurocorallium secundum

Instruments – all 3 sites



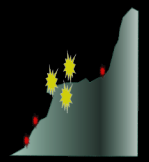




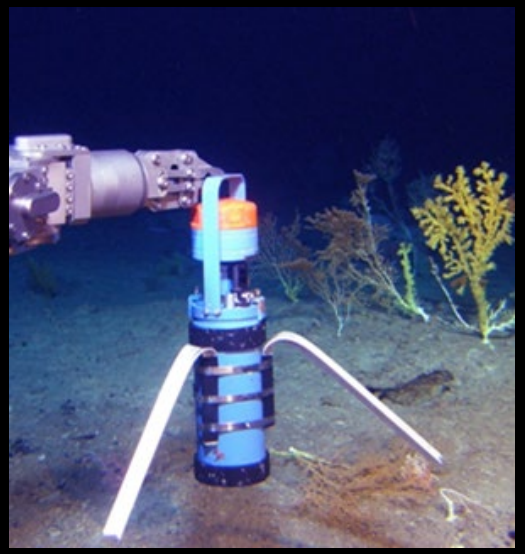
2007 Nov-Apr

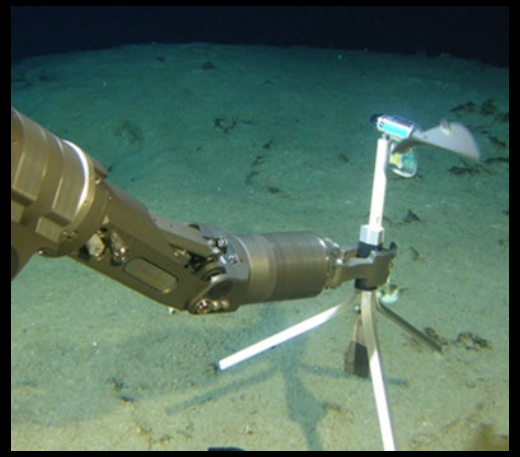
2013 Dec-July

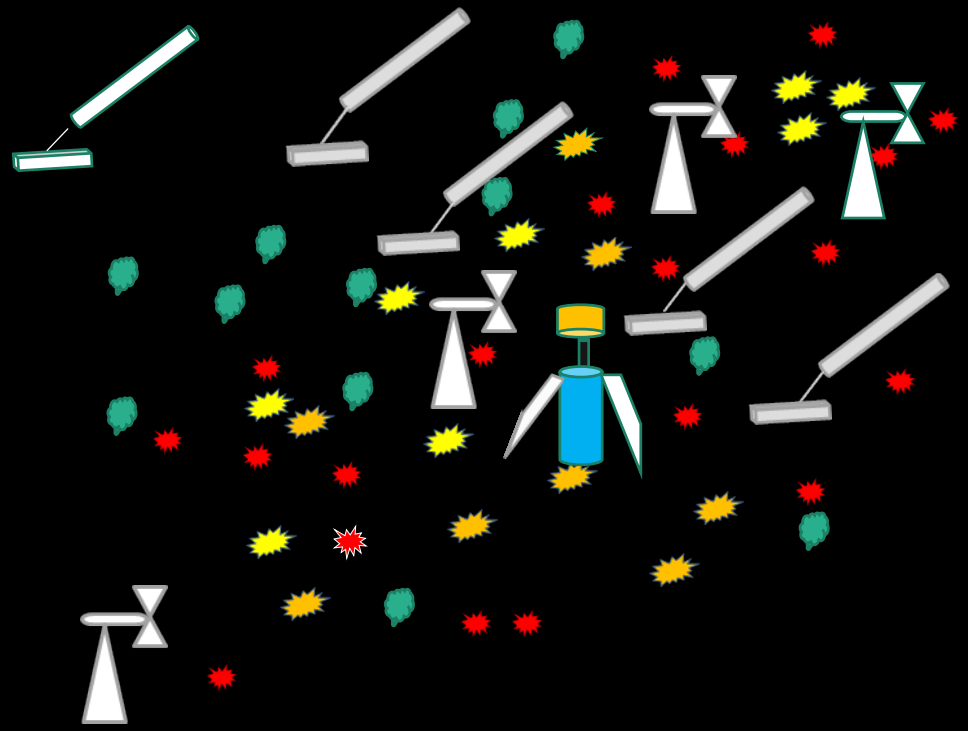
2012-2015



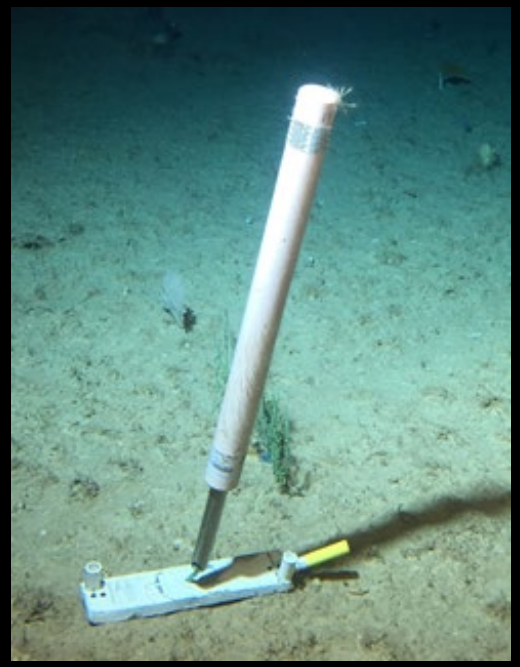
Instruments - Makapuu



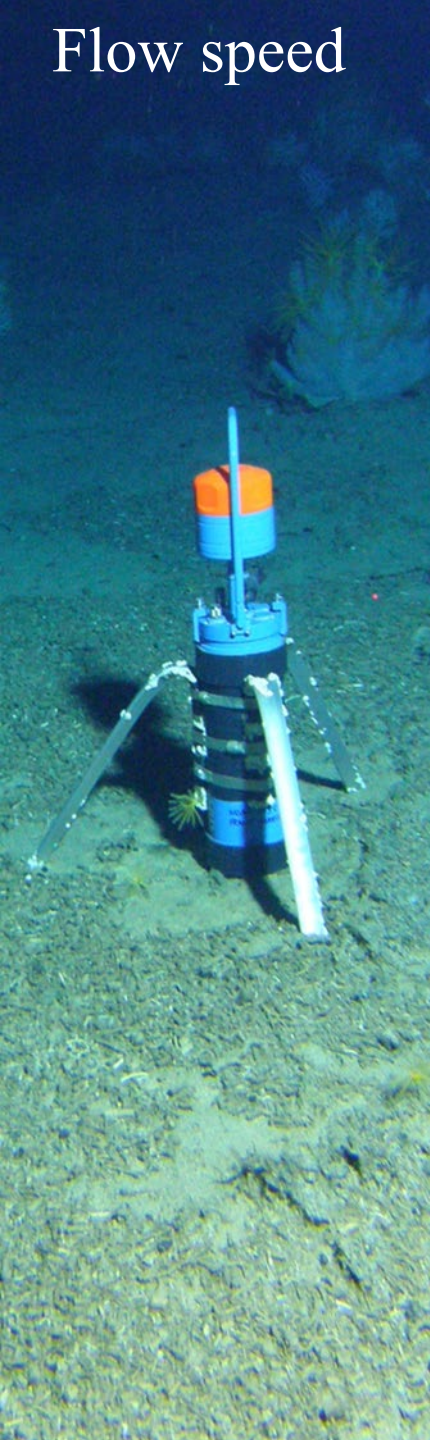


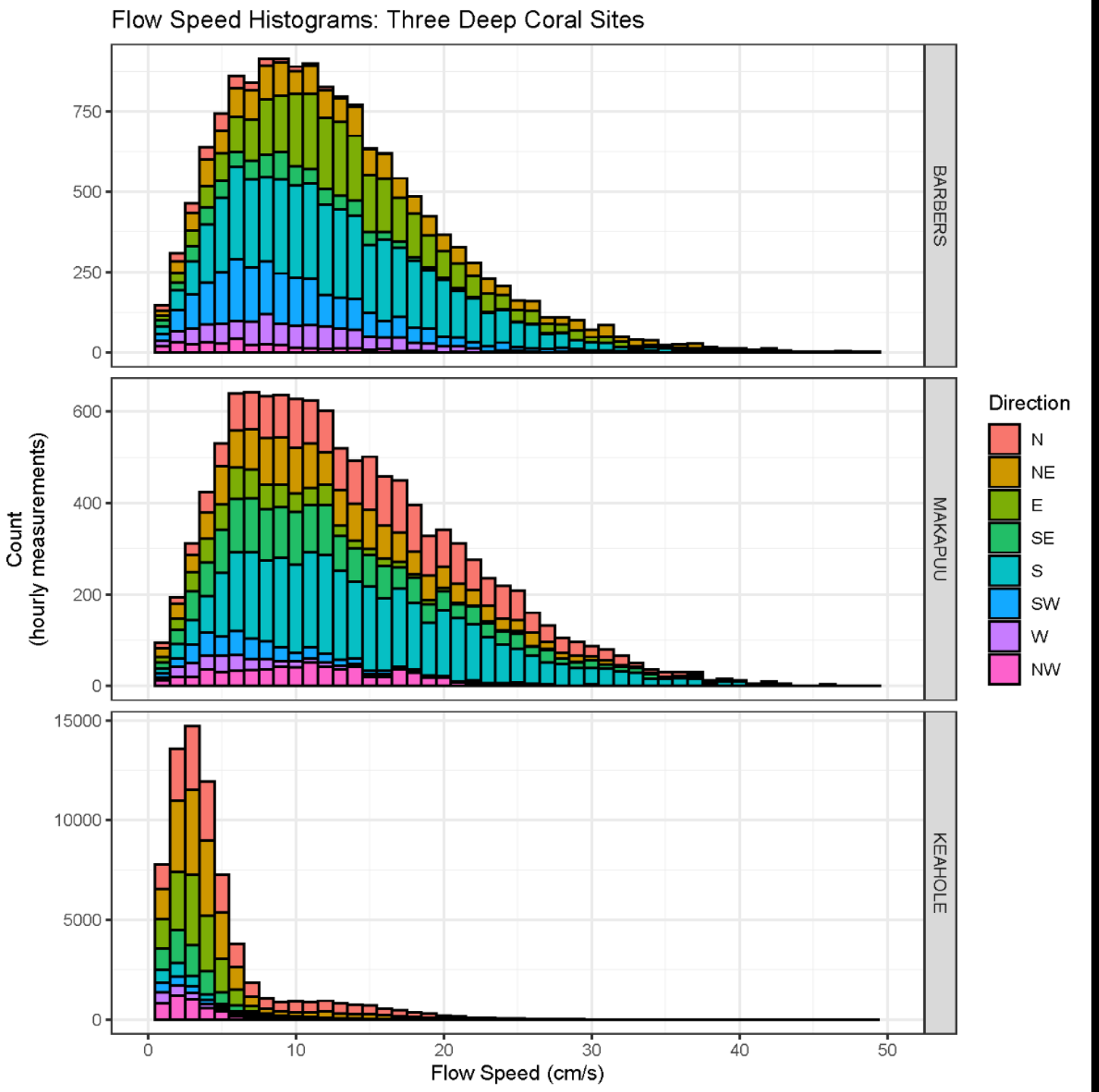


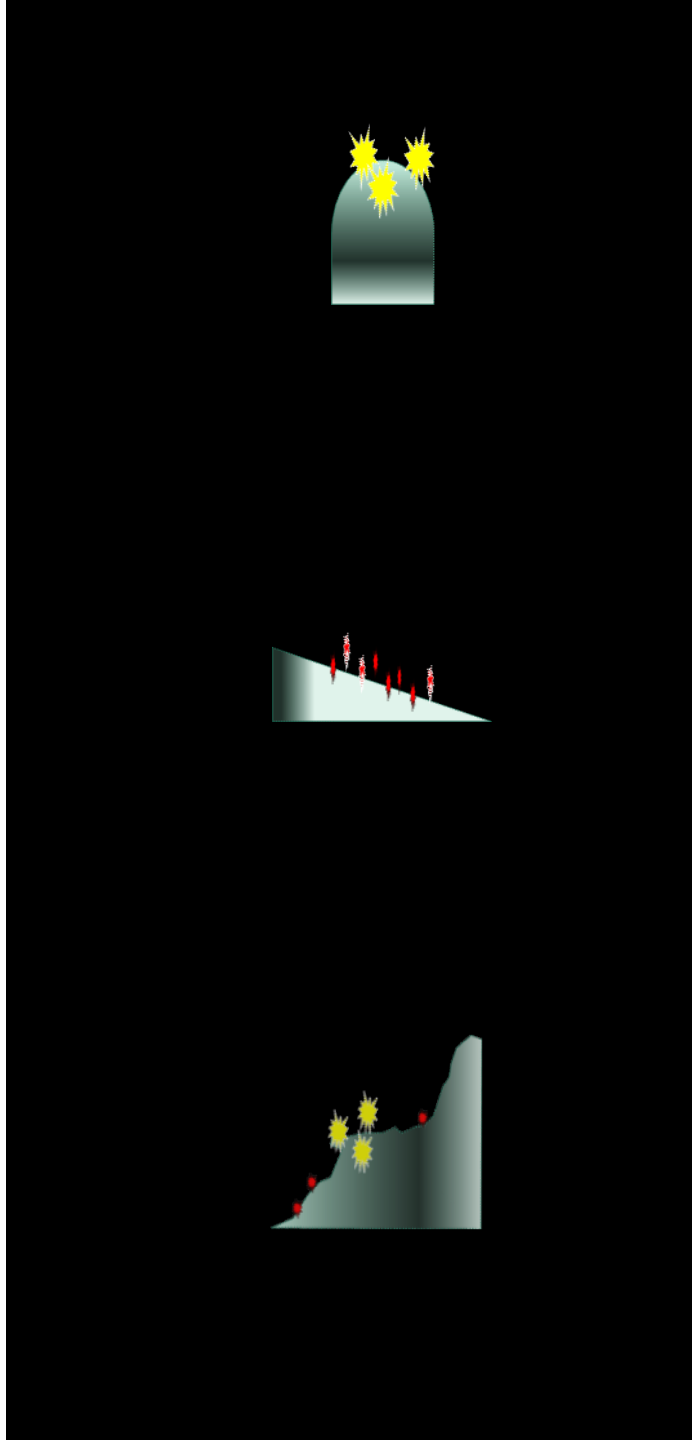
2016-2017



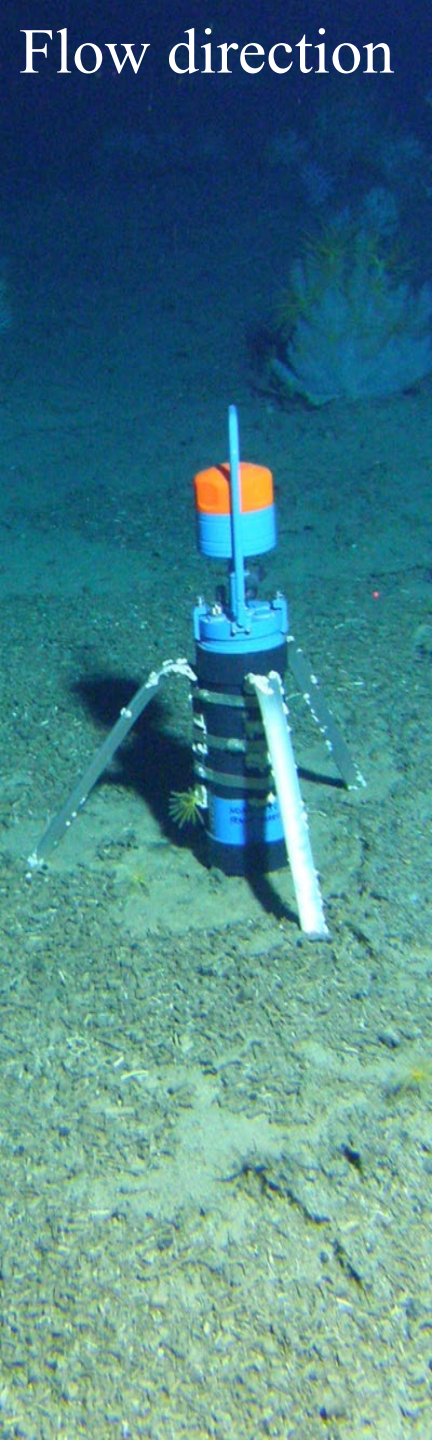
Flow speed

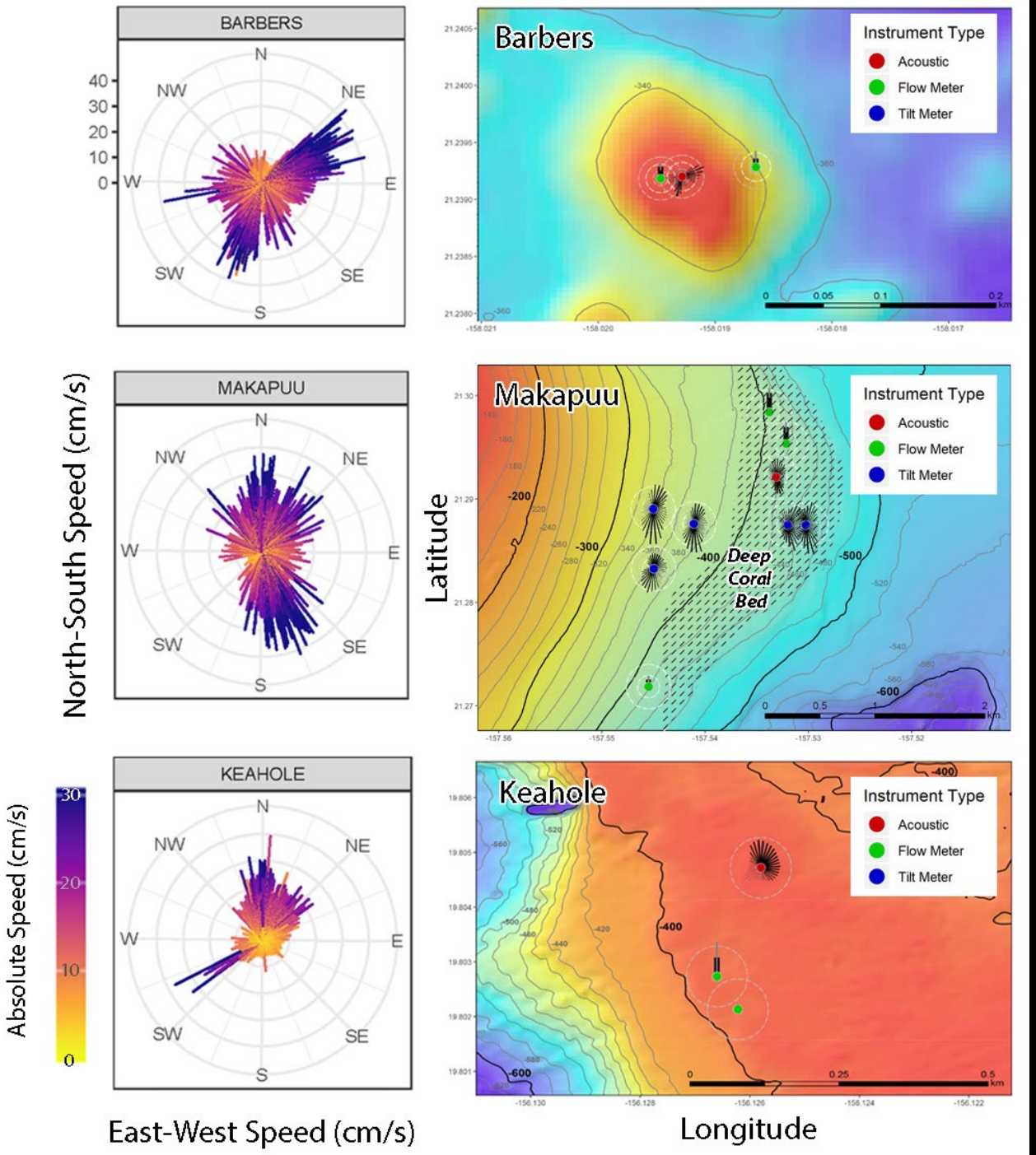


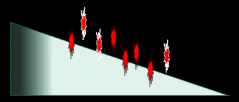

Flow Speed Histograms: Three Deep Coral Sites
BARBERS
MAKAPUU
KEAHOLE
Count
(hourly measurements)
Flow Speed (cm/s)
Direction
N
NE
E
SE
S
SW
W
NW

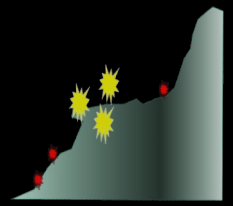


Flow direction

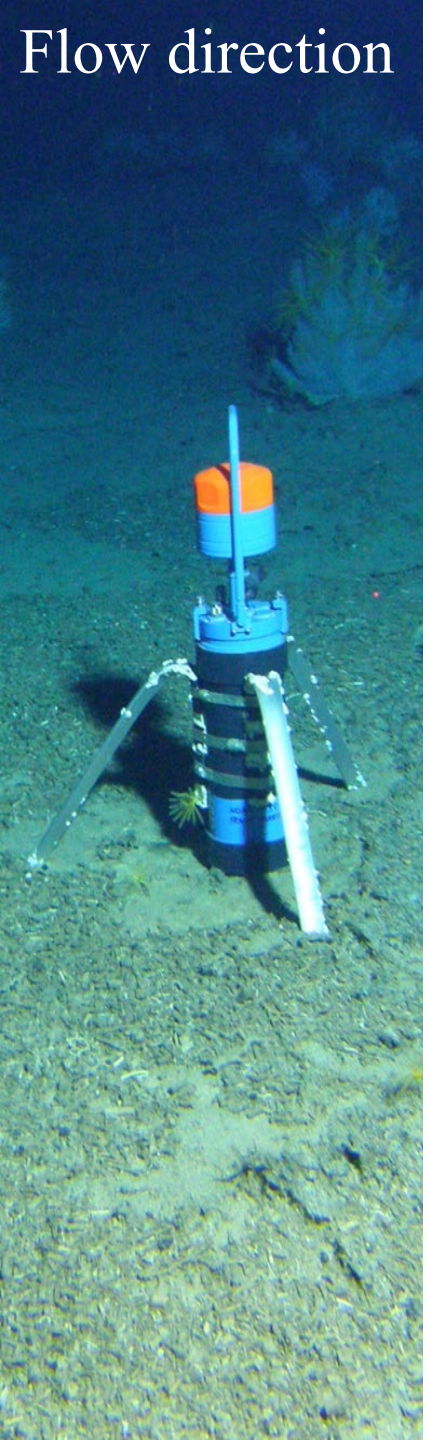


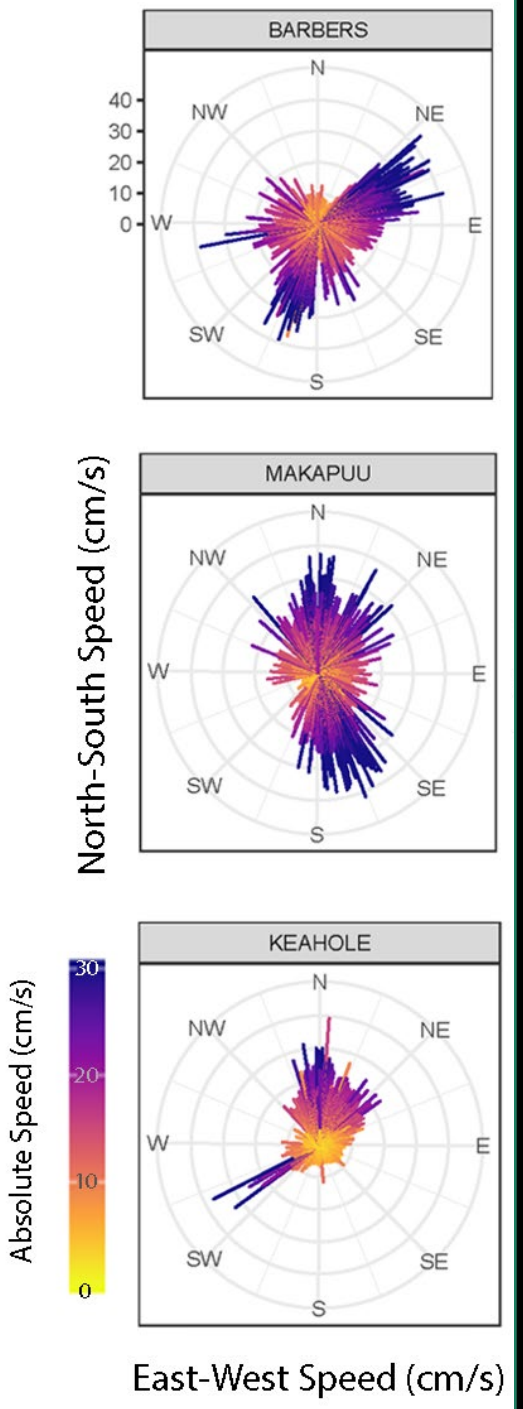


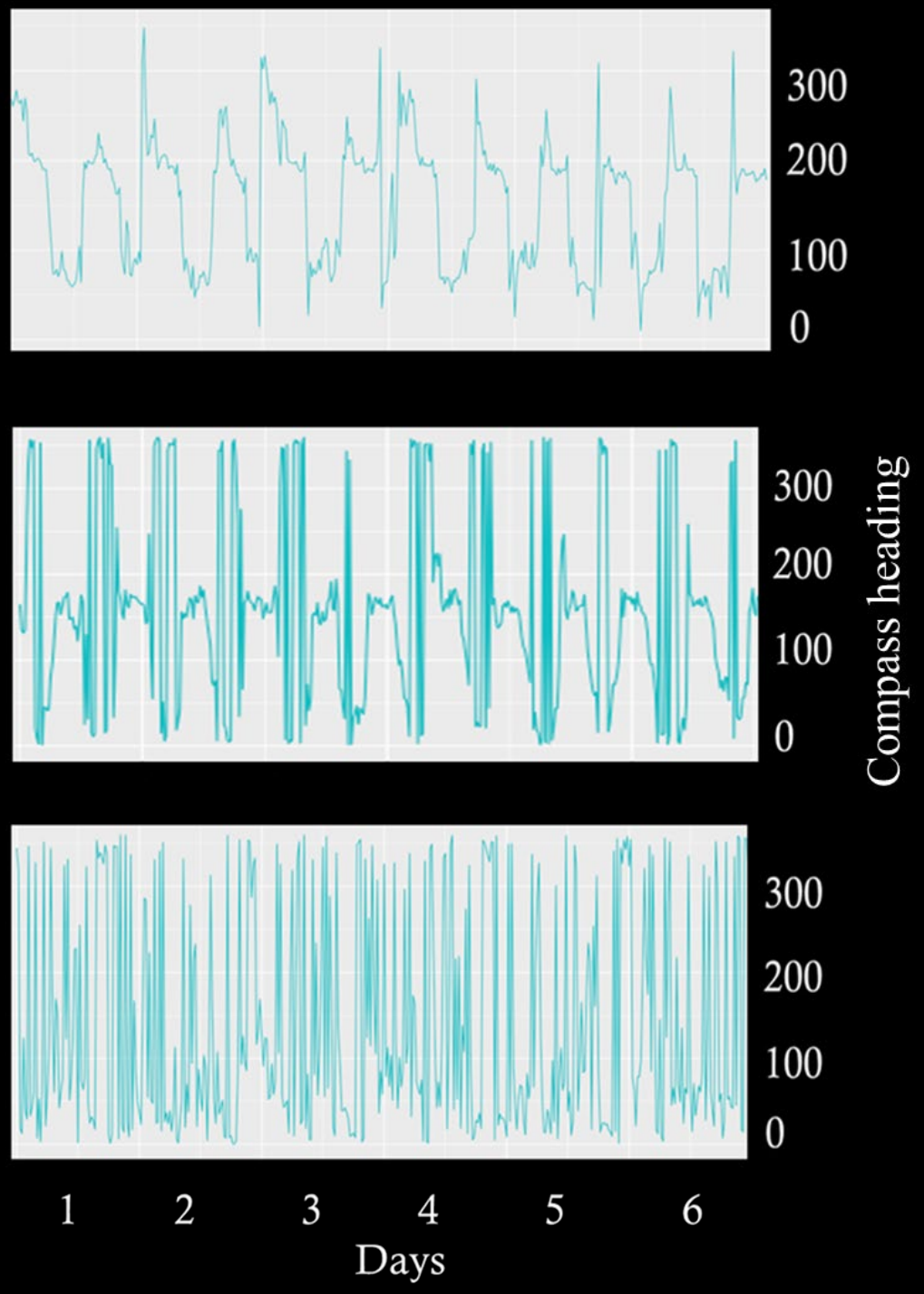


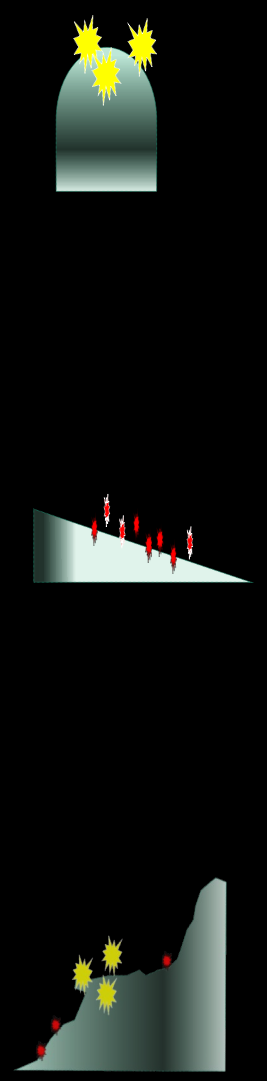


Flow direction

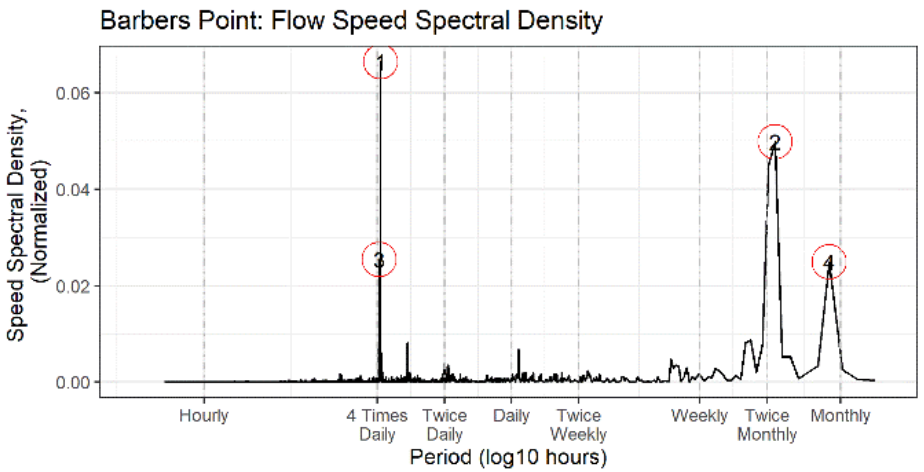


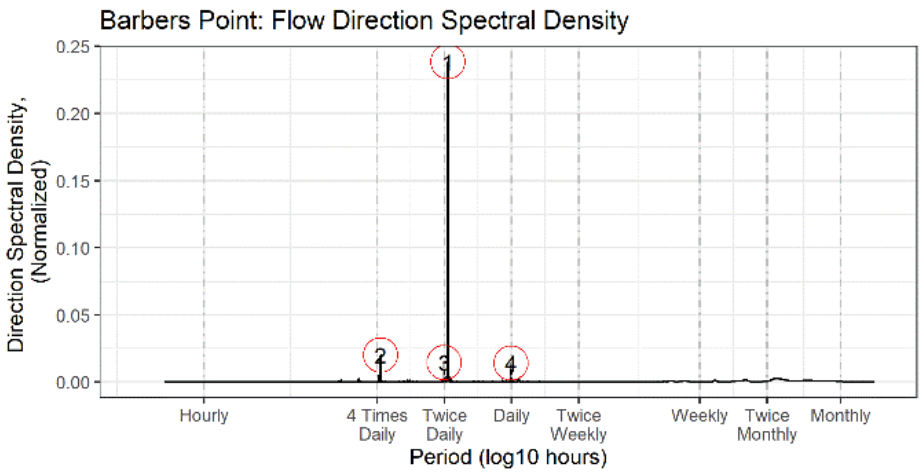


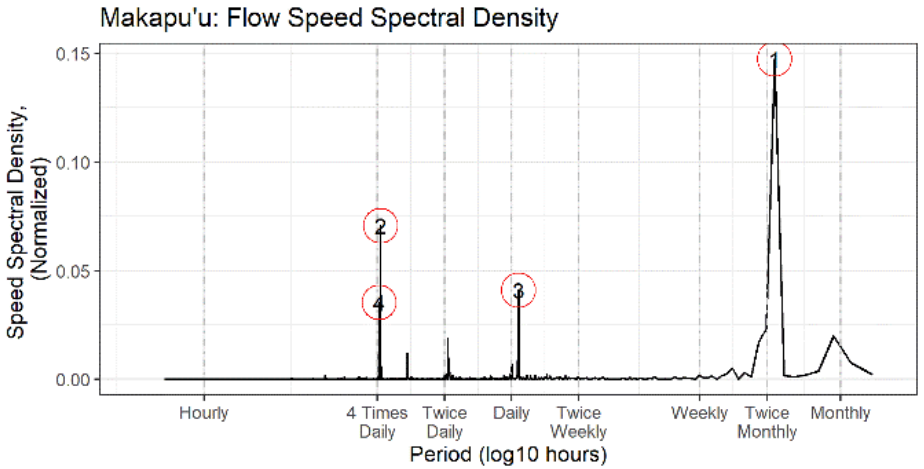


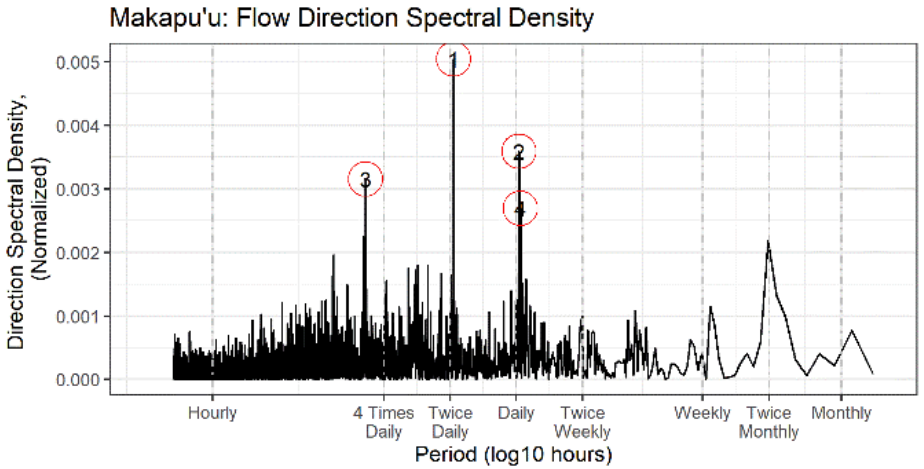


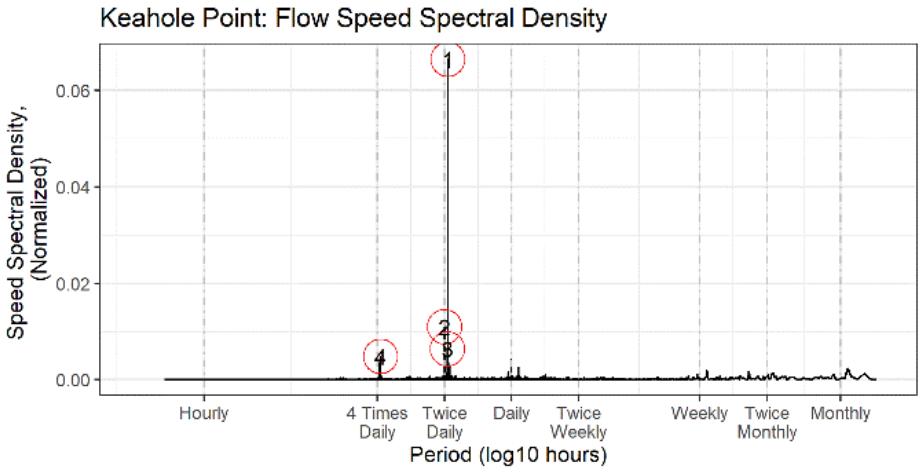
Spectra

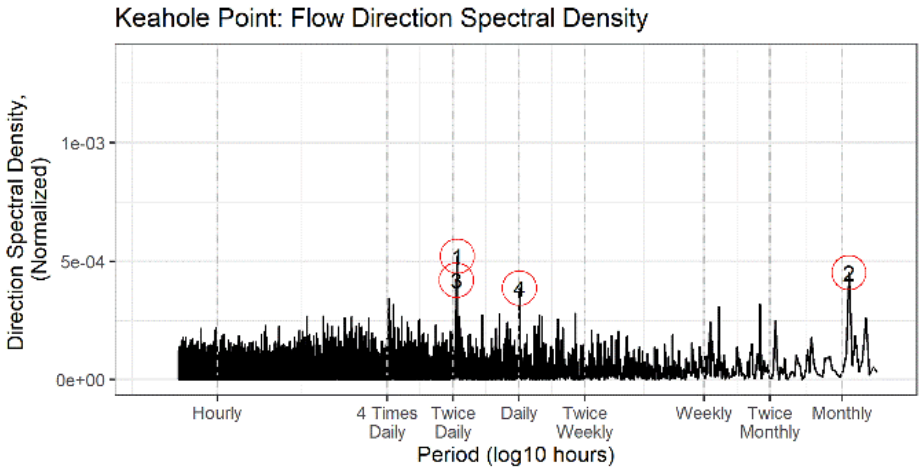

Barbers Point: Flow Speed Spectral Density
Speed Spectral Density, (Normalized)
0.06
0.04
0.02
0.00
1
2
3
4
Hourly
4 Times Daily
Twice Daily
Daily
Twice Weekly
Weekly
Twice Monthly
Monthly
Period (log10 hours)

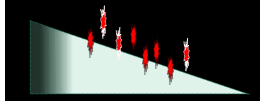

Barbers Point: Flow Direction Spectral Density
Direction Spectral Density, (Normalized)
0.25
0.20
0.15
0.10
0.05
0.00
1
2
3
4
Hourly
4 Times Daily
Twice Daily
Daily
Twice Weekly
Weekly
Twice Monthly
Monthly
Period (log10 hours)

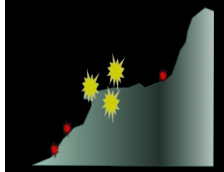

Makapu'u: Flow Speed Spectral Density
Speed Spectral Density, (Normalized)
0.15
0.10
0.05
0.00
1
2
3
4
Hourly
4 Times Daily
Twice Daily
Daily
Twice Weekly
Weekly
Twice Monthly
Monthly
Period (log10 hours)


Makapu'u: Flow Direction Spectral Density
Direction Spectral Density, (Normalized)
0.005
0.004
0.003
0.002
0.001
0.000
1
2
3
4
Hourly
4 Times Daily
Twice Daily
Daily
Twice Weekly
Weekly
Twice Monthly
Monthly
Period (log10 hours)

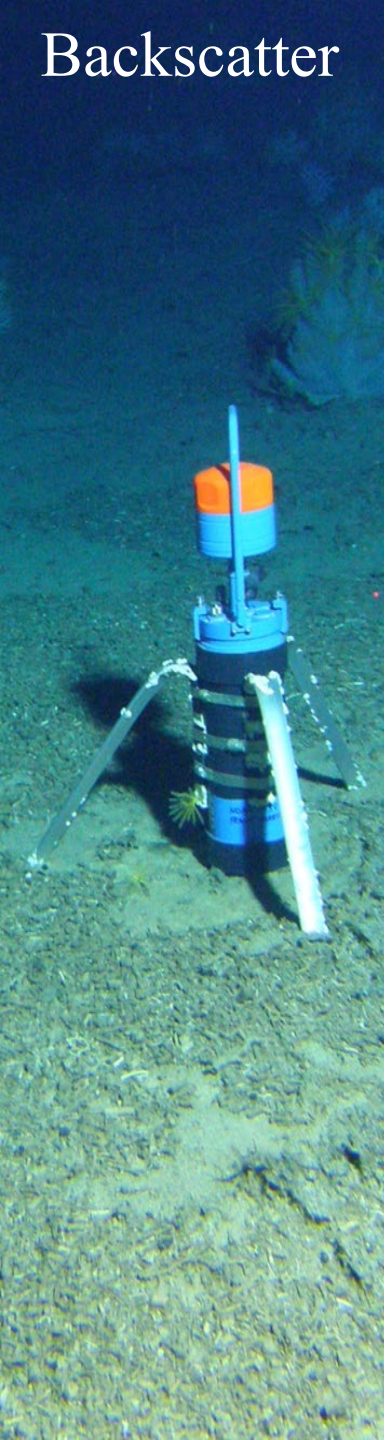

Keahole Point: Flow Speed Spectral Density
Speed Spectral Density, (Normalized)
0.06
0.04
0.02
0.00
1
2
3
4
Hourly
4 Times Daily
Twice Daily
Daily
Twice Weekly
Weekly
Twice Monthly
Monthly
Period (log10 hours)

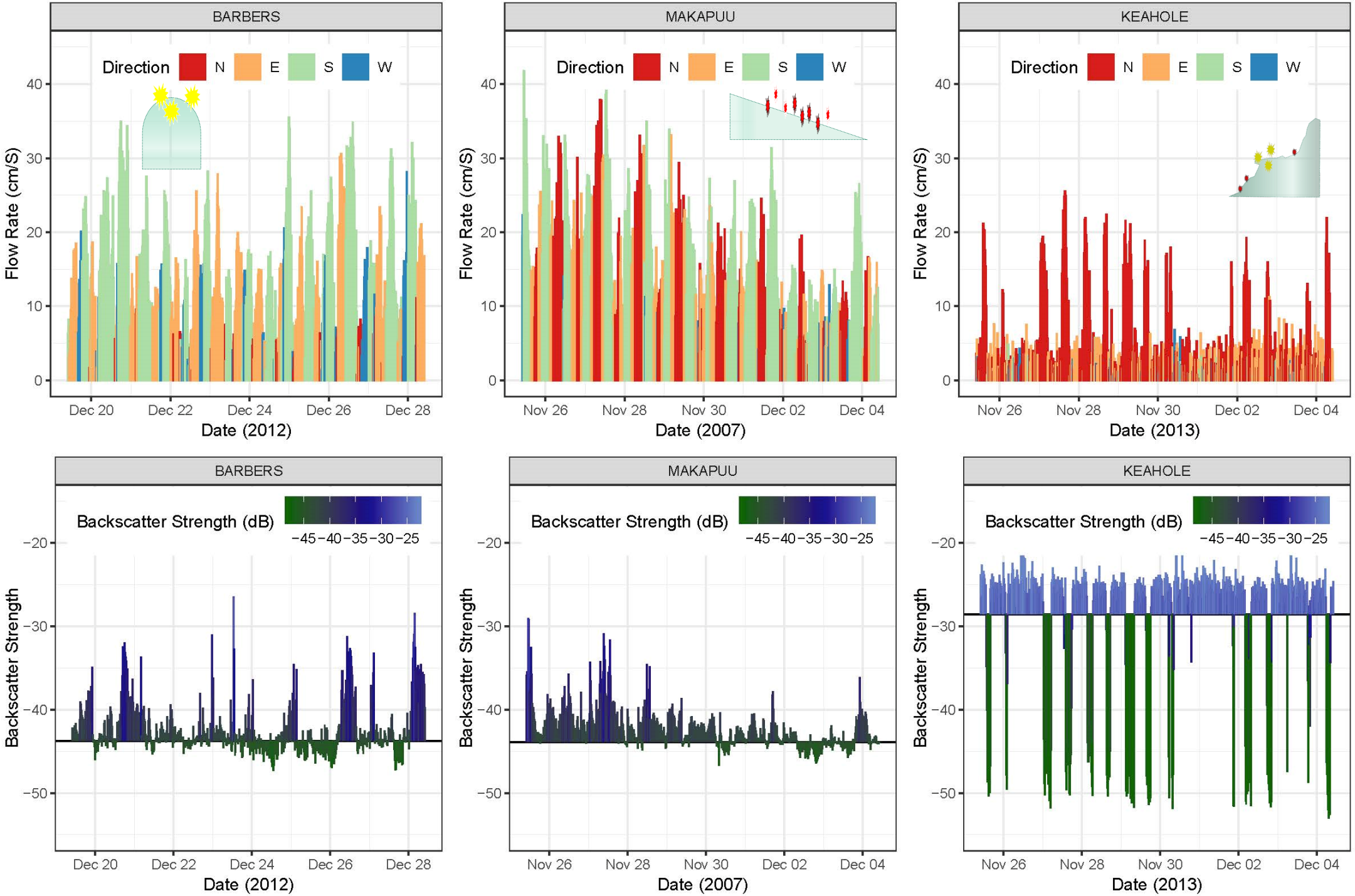

Keahole Point: Flow Direction Spectral Density
Direction Spectral Density, (Normalized)
1e-03
5e-04
0e+00
1
2
3
4
Hourly
4 Times Daily
Twice Daily
Daily
Twice Weekly
Weekly
Twice Monthly
Monthly
Period (log10 hours)

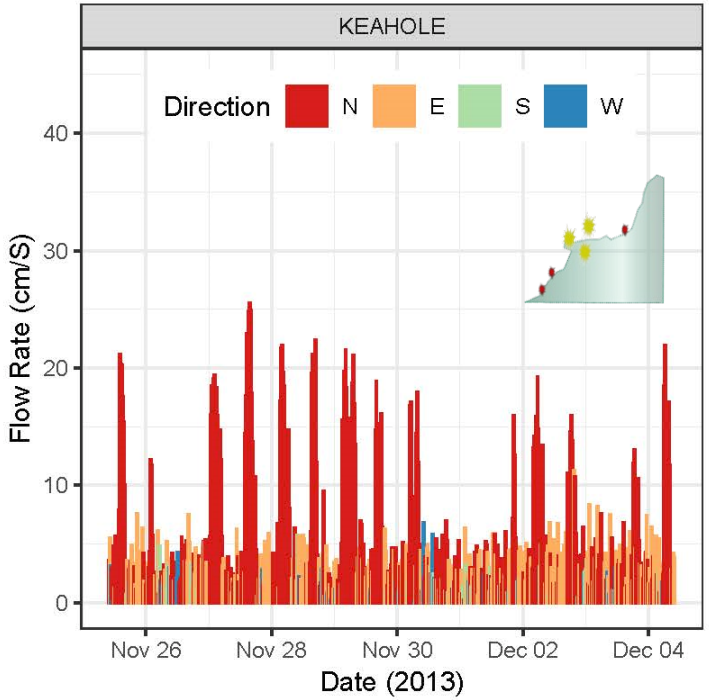


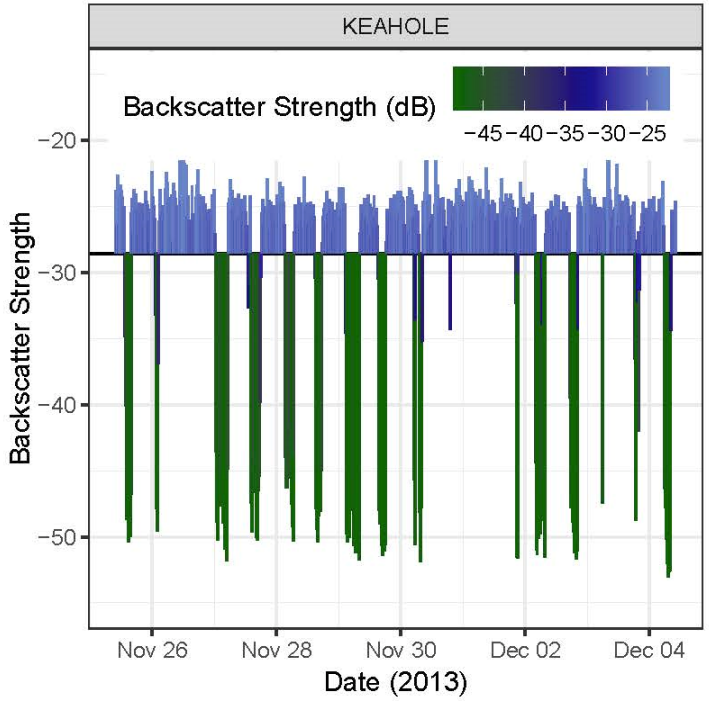


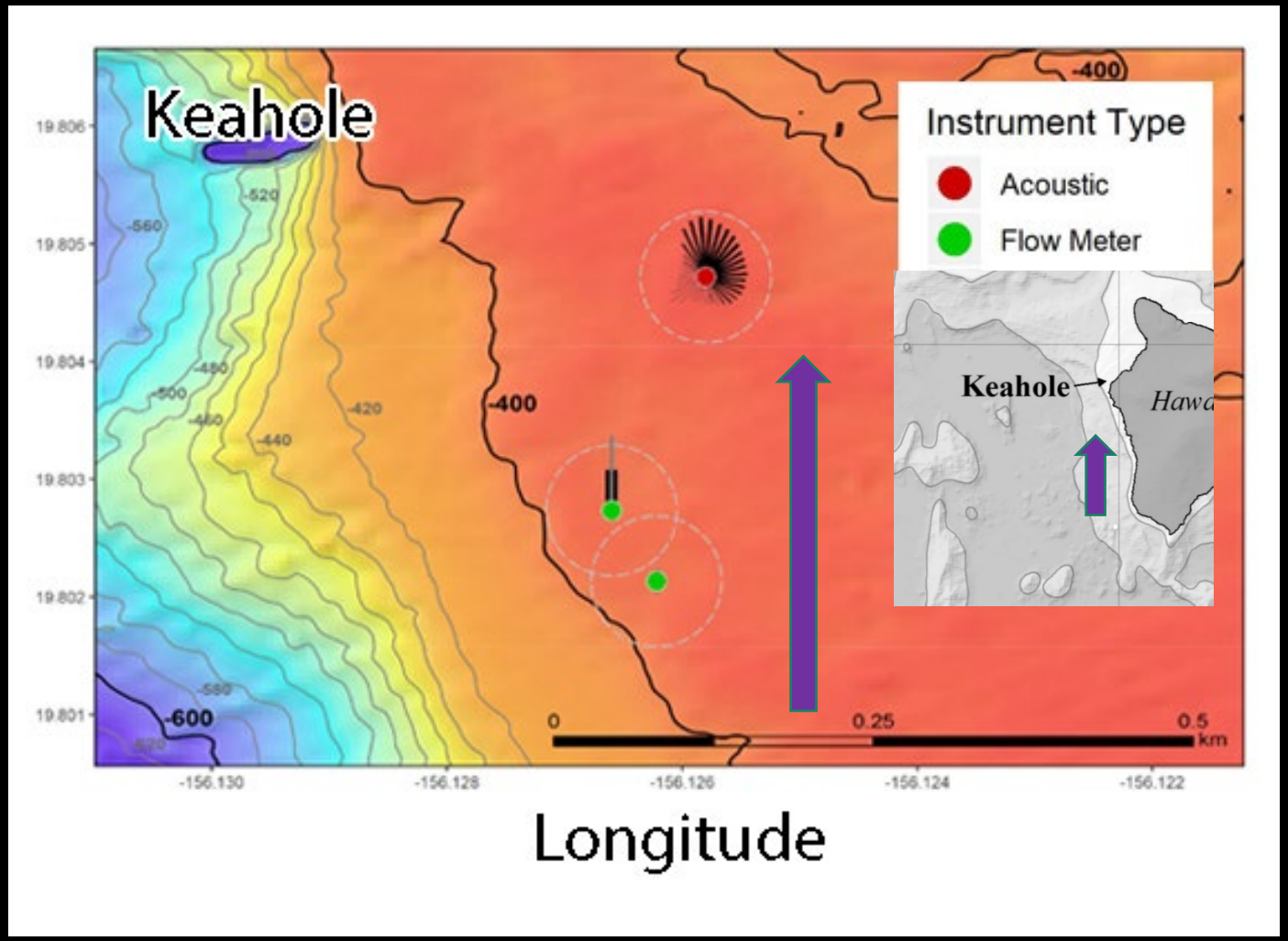
Backscatter



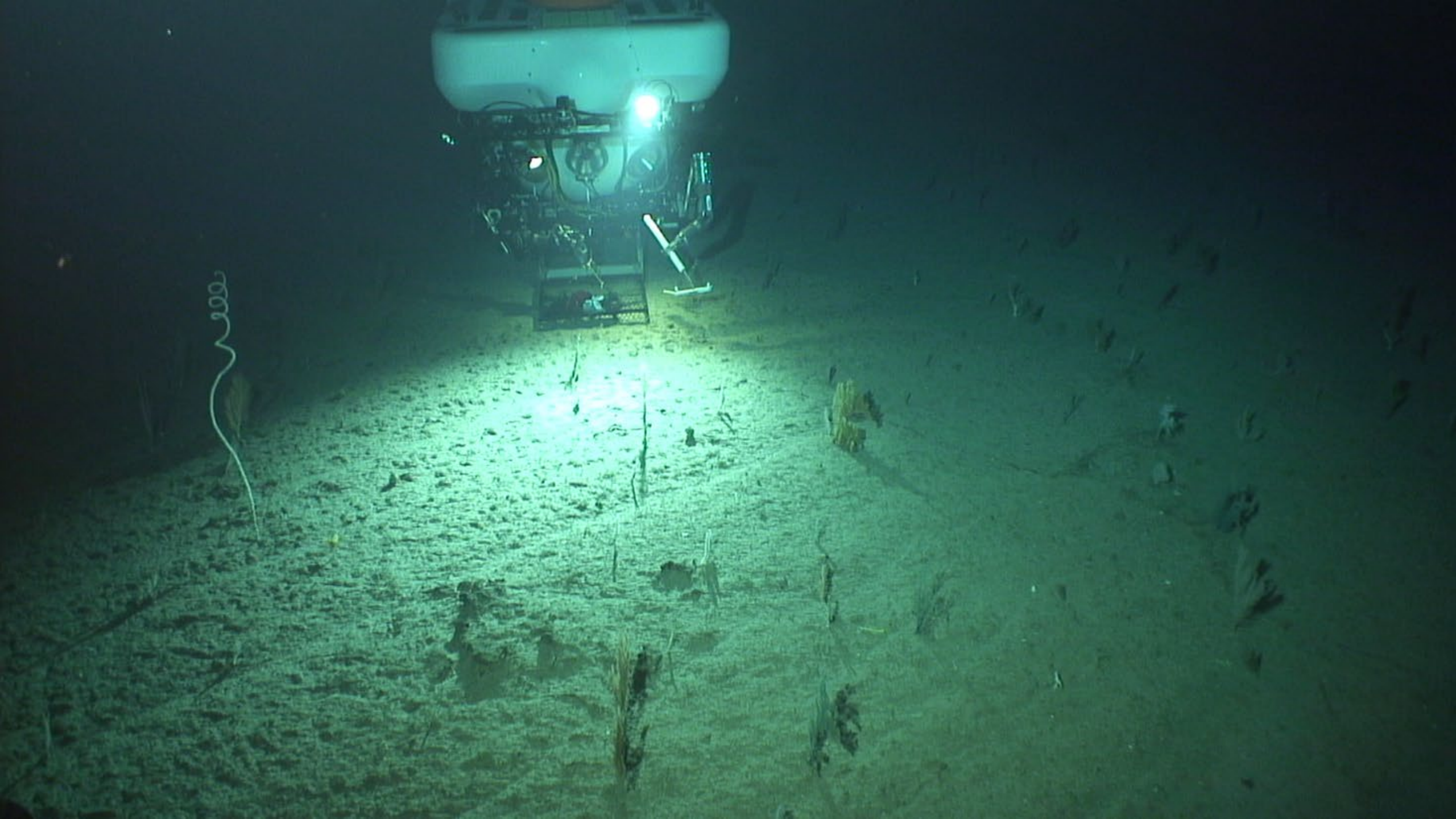


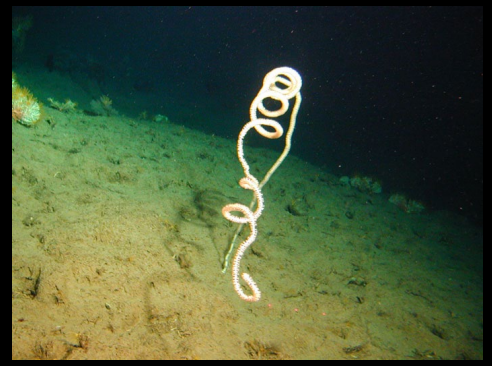






Northern pulse of water from deep colder water biogenic?

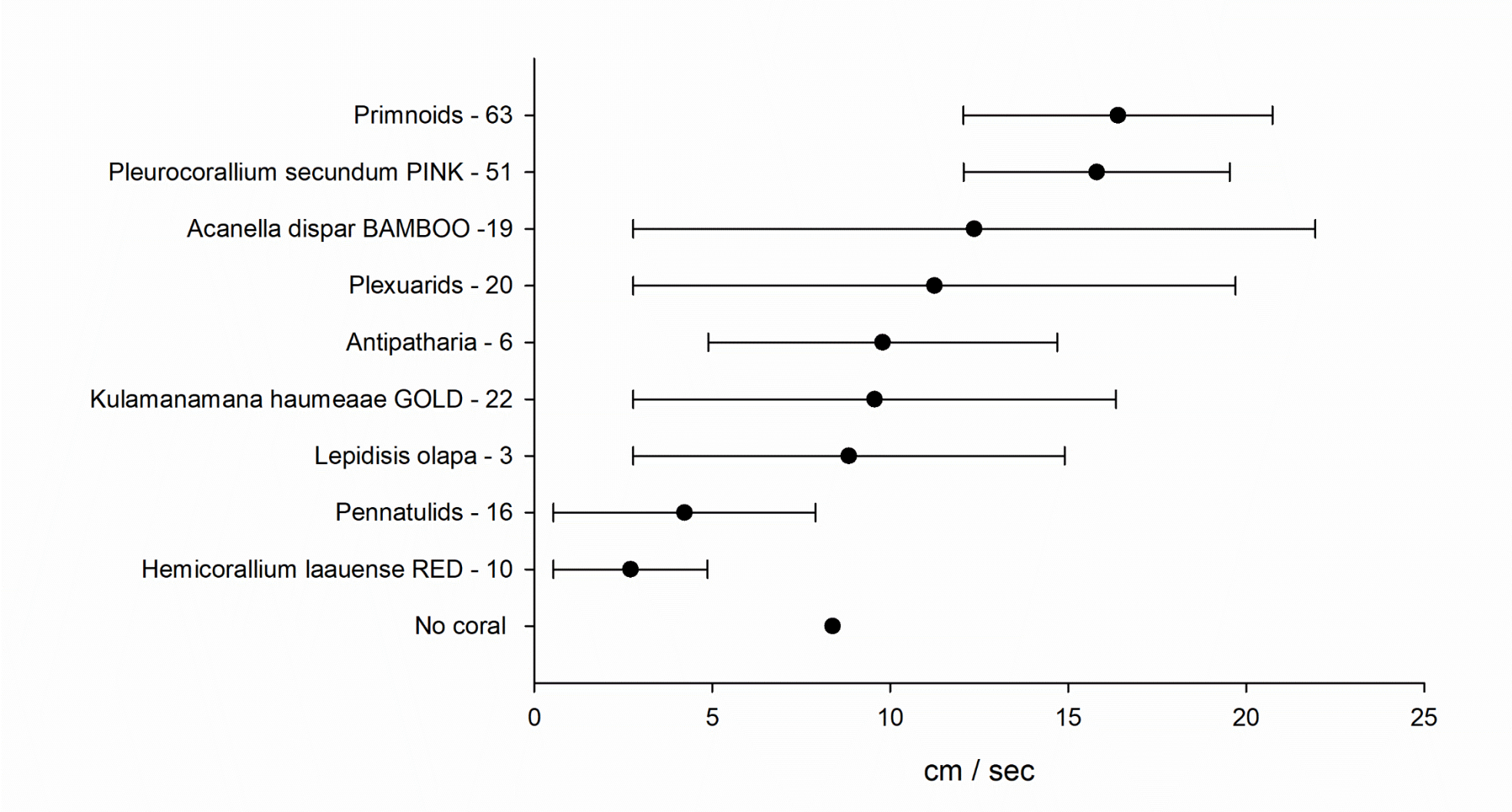




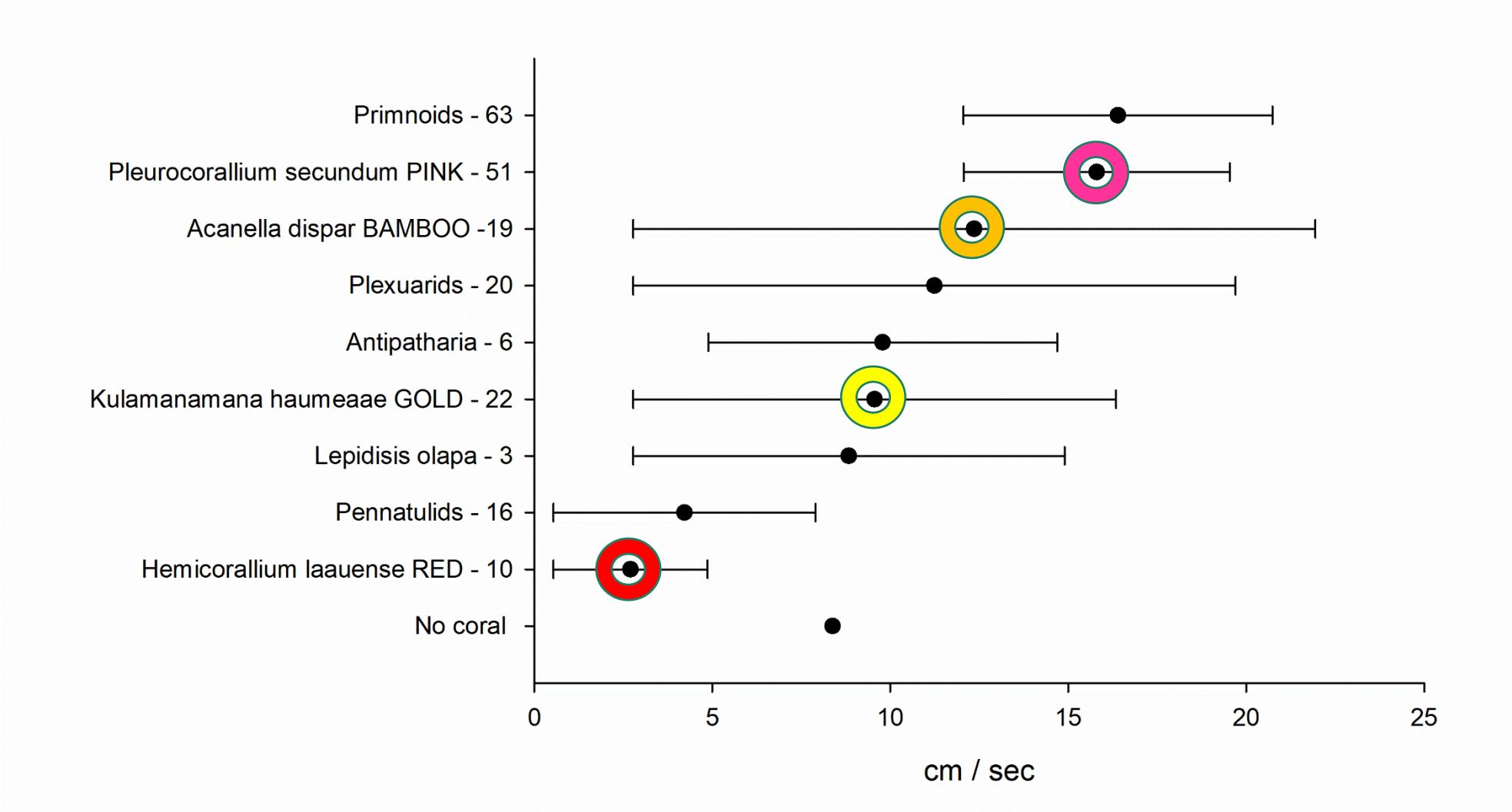
a

Taxa	No.	Observed mean flow cm/s (std)
Acanella dispar	19	2.78 (3.98) - 18.89 (10.36)
Acanthogorgia sp.	17	4.89 (5.23)
Antipatharia sp.	2	9.6 (10.7) - 18.4 (10.1)
Dendropathes bacotaylorae	6	4.89 (5.23) - 14.9 (8.59)
Equchipsammia sp.	11	9.6 (10.7) - 13.5 (13.8)
Eunicella sp	1	14.92 (8.59)
Halipteris sp.	16	0.54 (1.91) - 7.94 (7.24)
Hemicorallium laauense	10	0.54 (1.91) - 4.89 (5.23)
Kulamanamana haumeaae	22	2.78 (3.98) - 17.07 (9.05)
Lepidisis olapa	3	2.78 (3.98) - 14.9 (8.59)
Narella gigas	5	18.89 (10.36)
Narella muzikae	11	18.4 (10.1) – 21.7 (11.93)
Paracalyptrophora sp.	1	18.4 (10.1)
Pleurocorallium secundum	51	12.6 2 (10.61) – 18.4 (10.1)
Plexaurid	9	2.78 (3.98)-18.4 (10.1)
Plexaurid blue	10	14.92 (8.59)-18.89 (10.36)
Plexaurid gold	3	14.92 (8.59)-18.89 (10.36)
Telopathes sp.	1	12.7 (7.44)
Thourella hilgendorfi	1	16.8 (9.25)

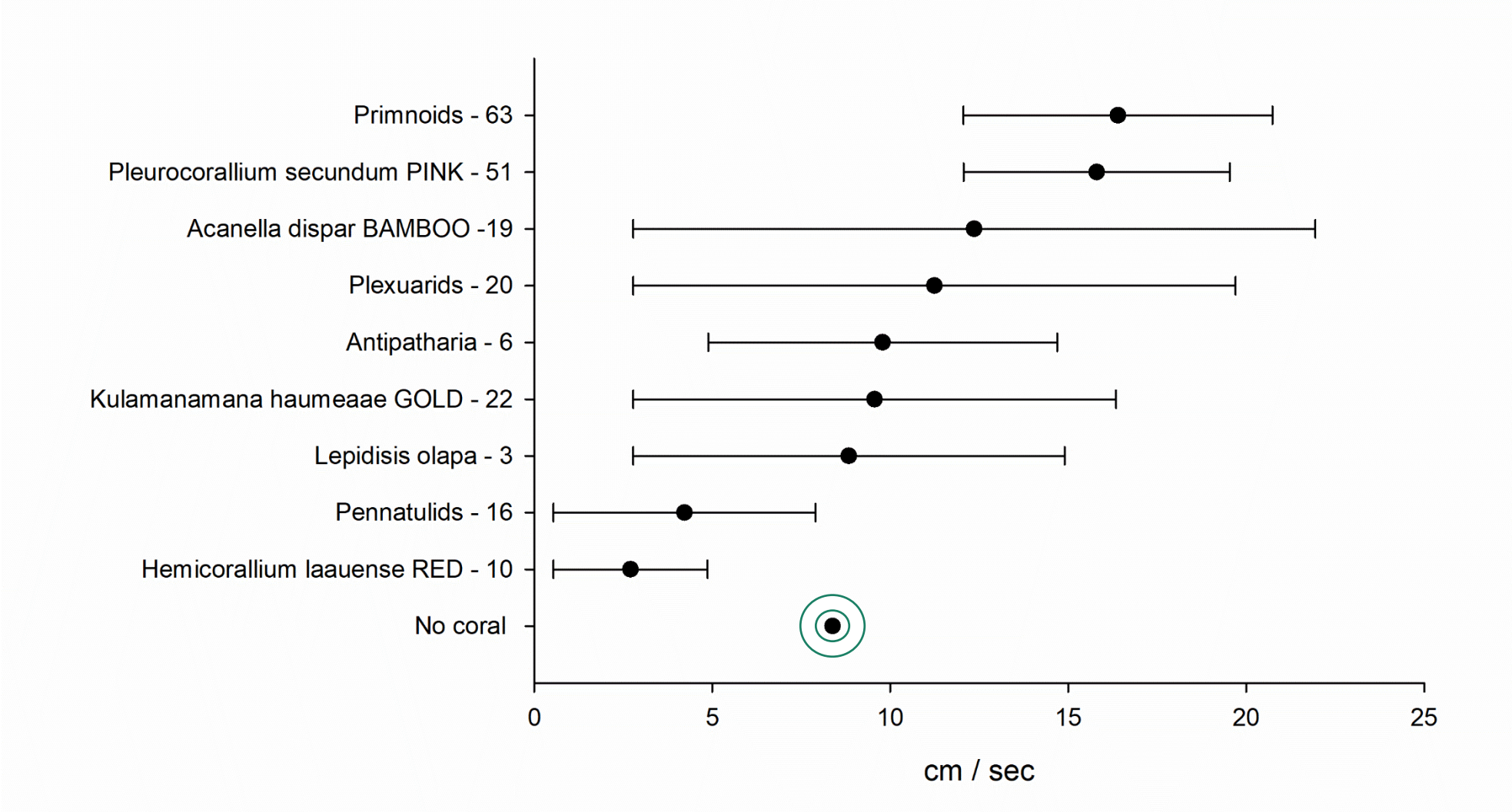
Range of mean flow by coral type



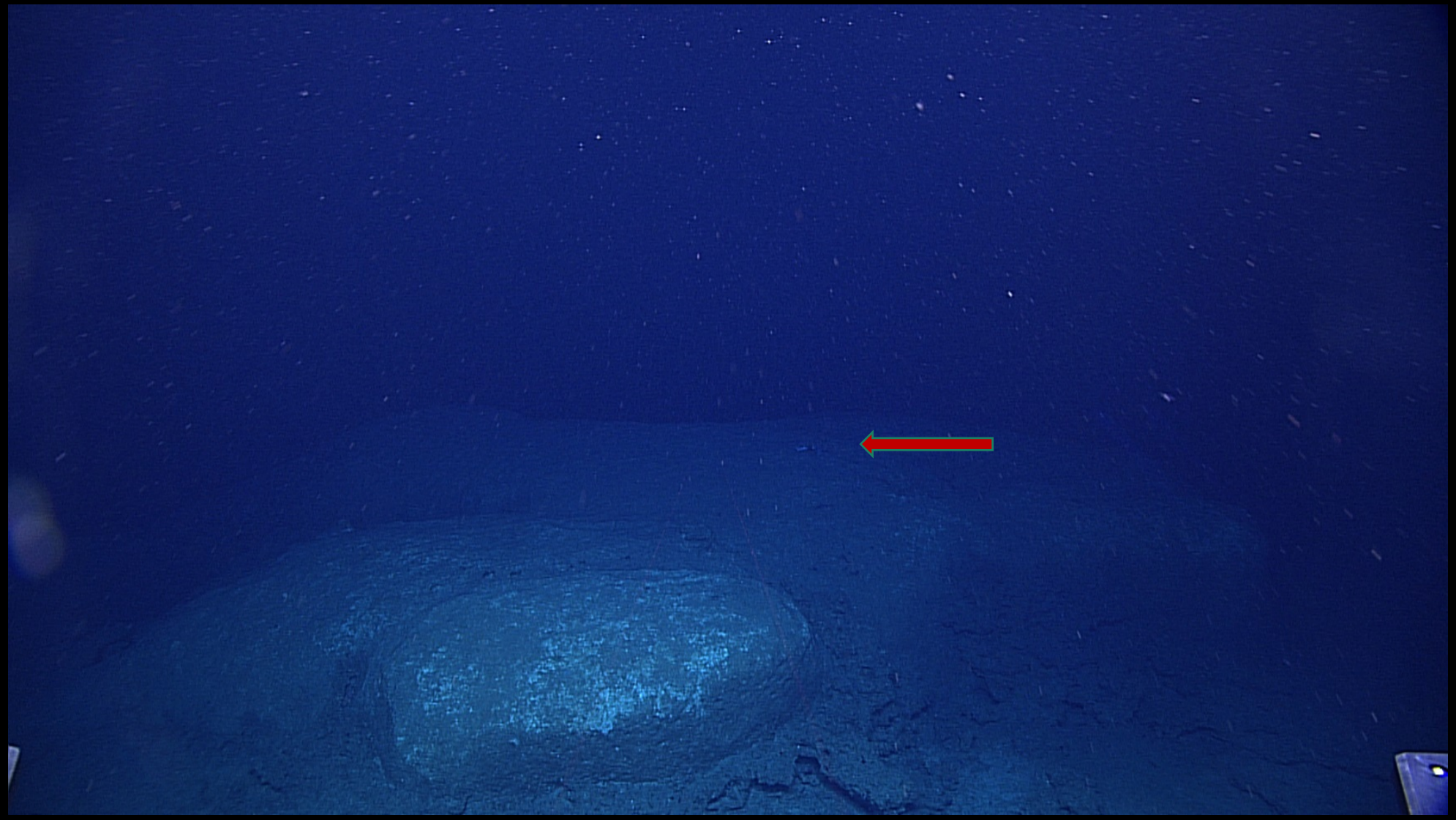
Range of mean flow by coral type

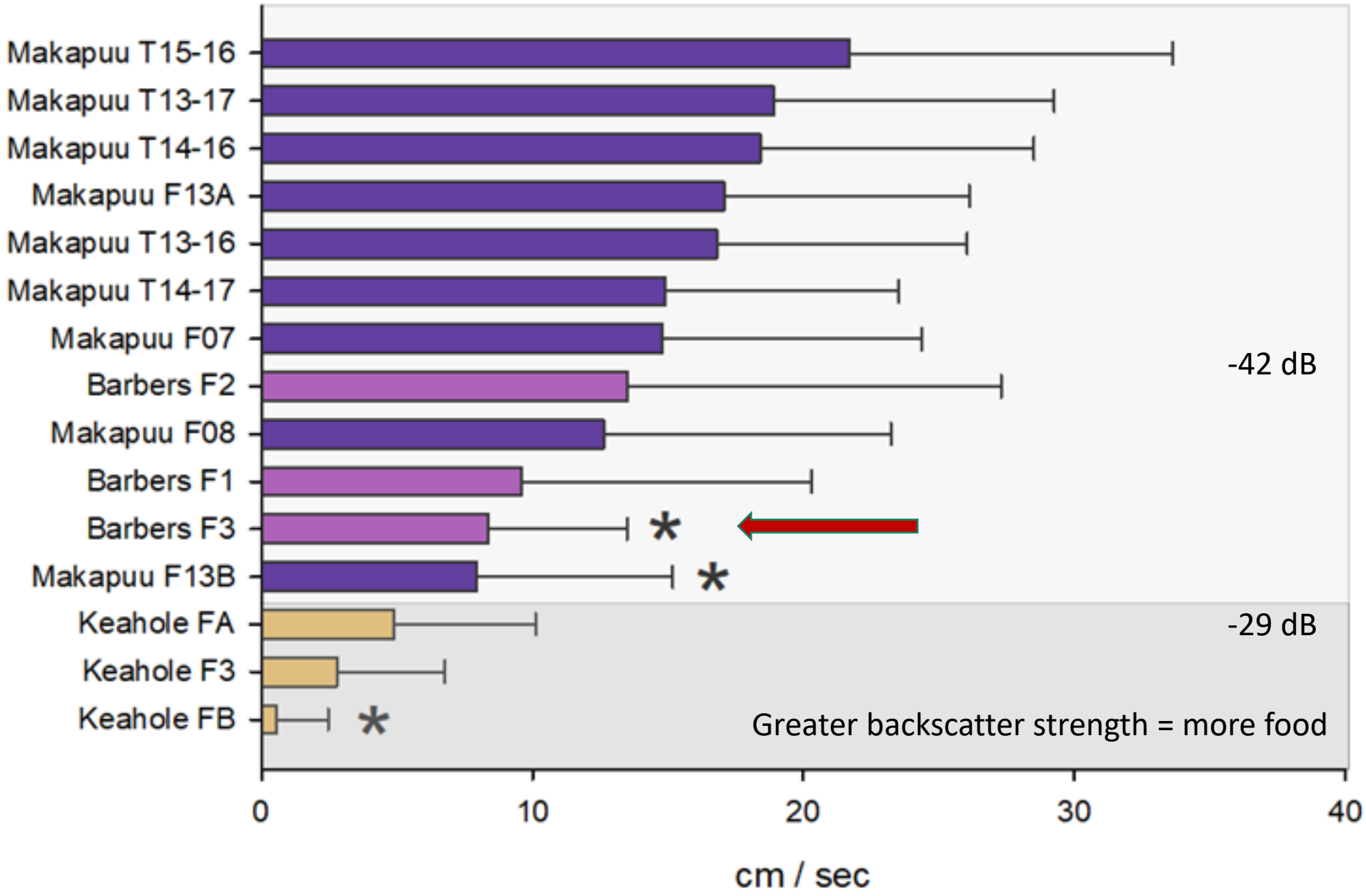


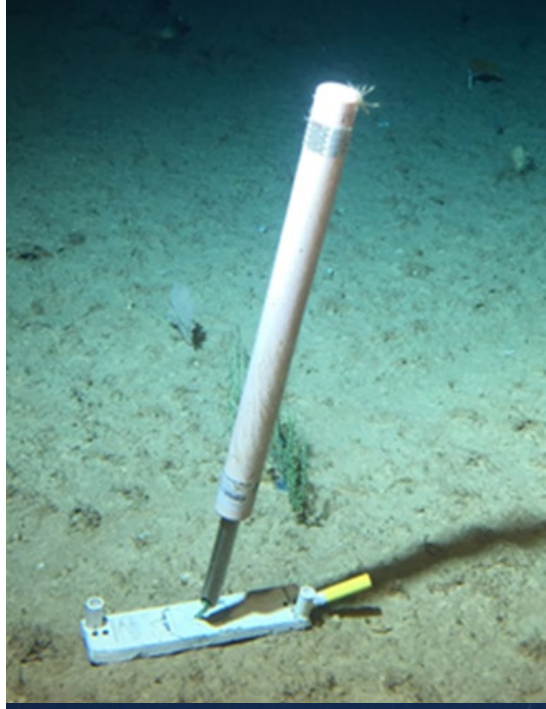
Range of mean flow by coral type

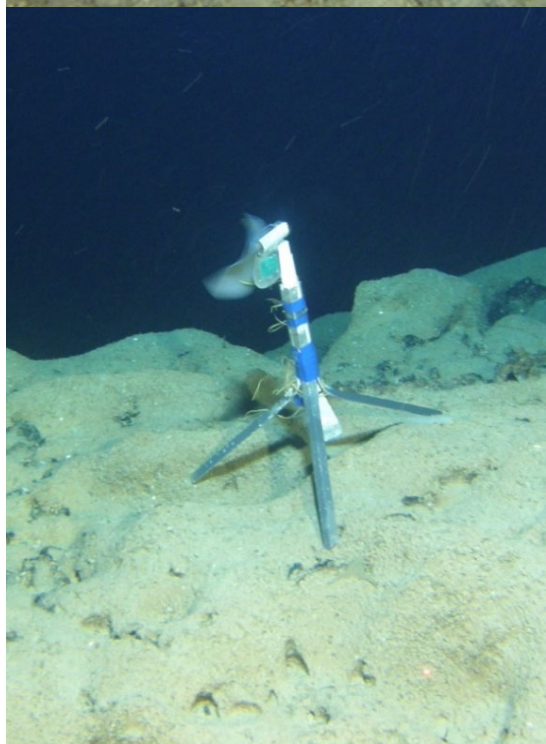


Edge of Barbers patch

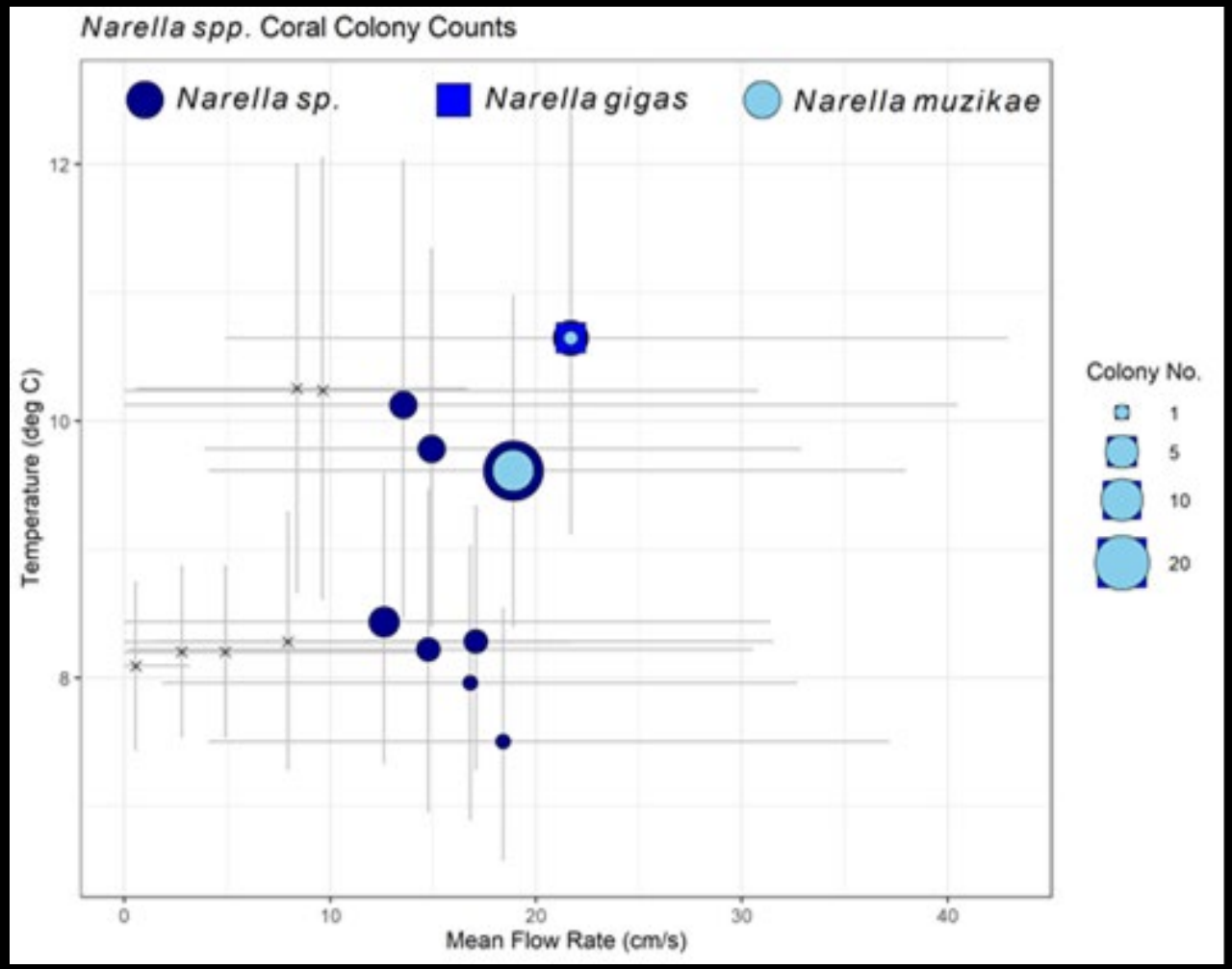



Makapuu T15-16
Makapuu T13-17
Makapuu T14-16
Makapuu F13A
Makapuu T13-16
Makapuu T14-17
Makapuu F07
Barbers F2
Makapuu F08
Barbers F1
Barbers F3
Makapuu F13B
Keahole FA
Keahole F3
Keahole FB
-42 dB
-29 dB
Greater backscatter strength = more food
0
10
20
30
40
cm / sec



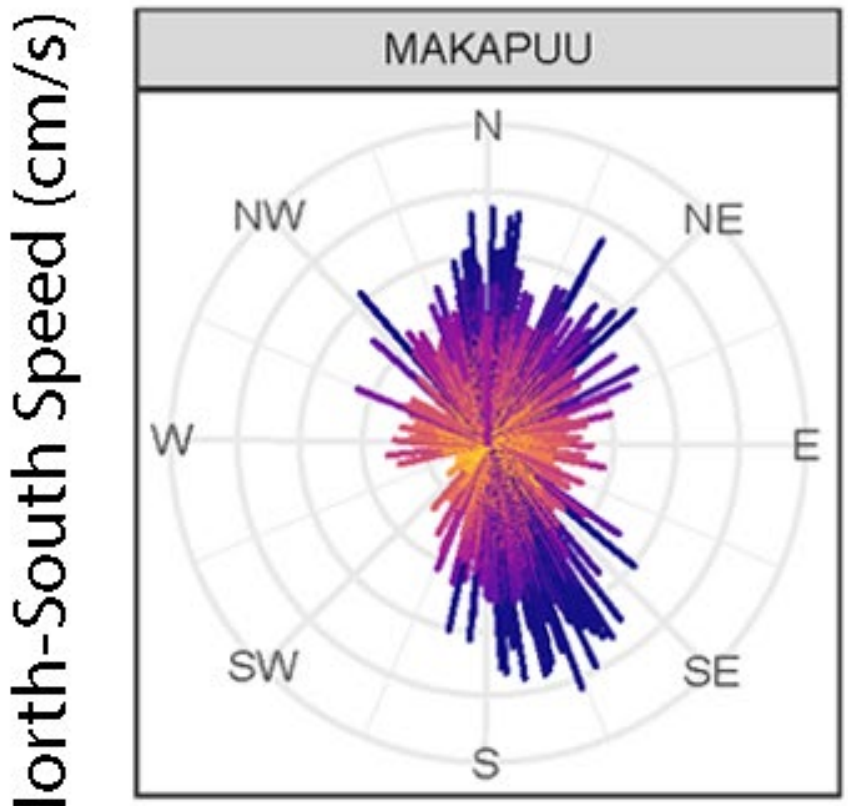


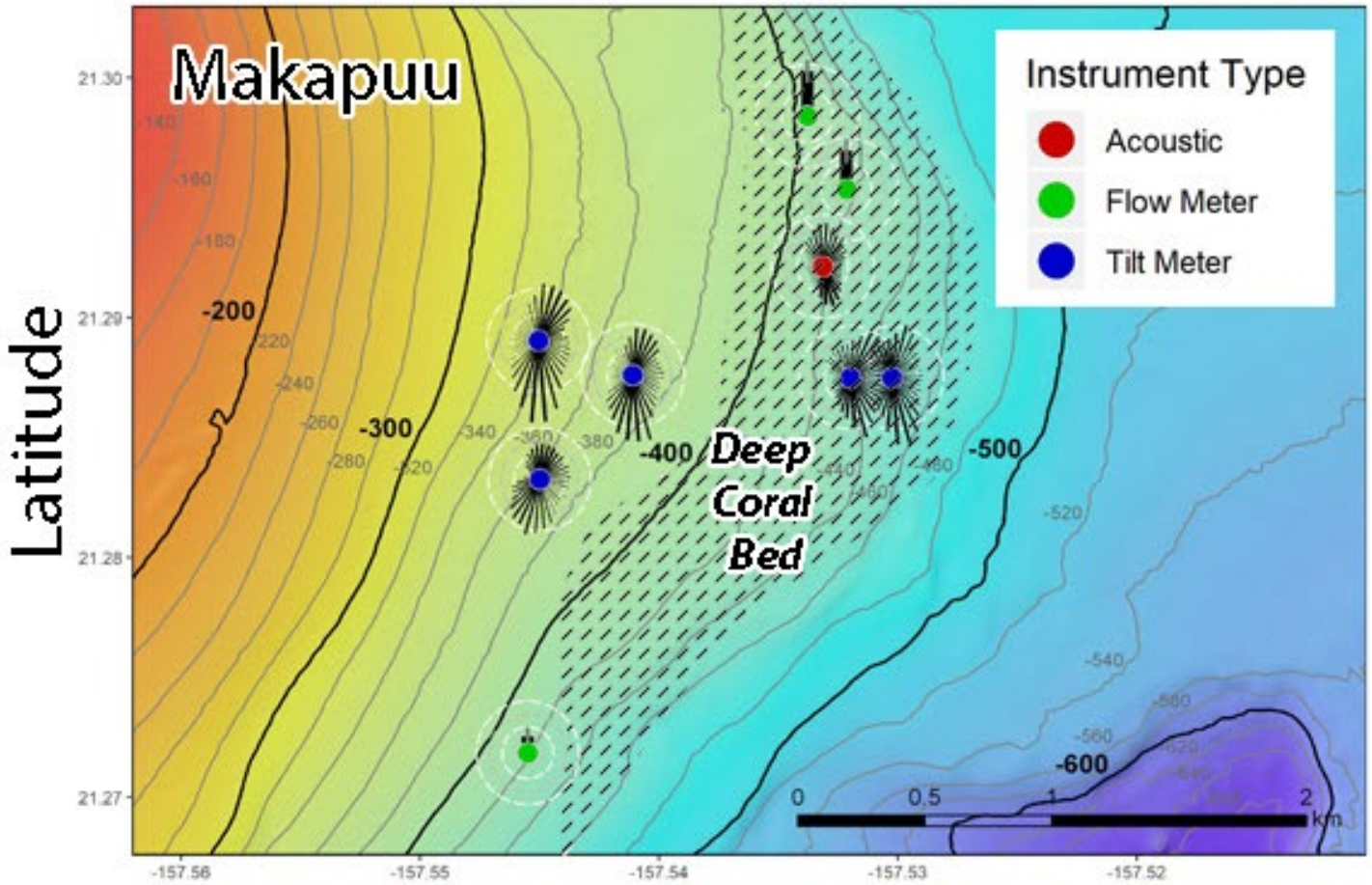
Primnoids



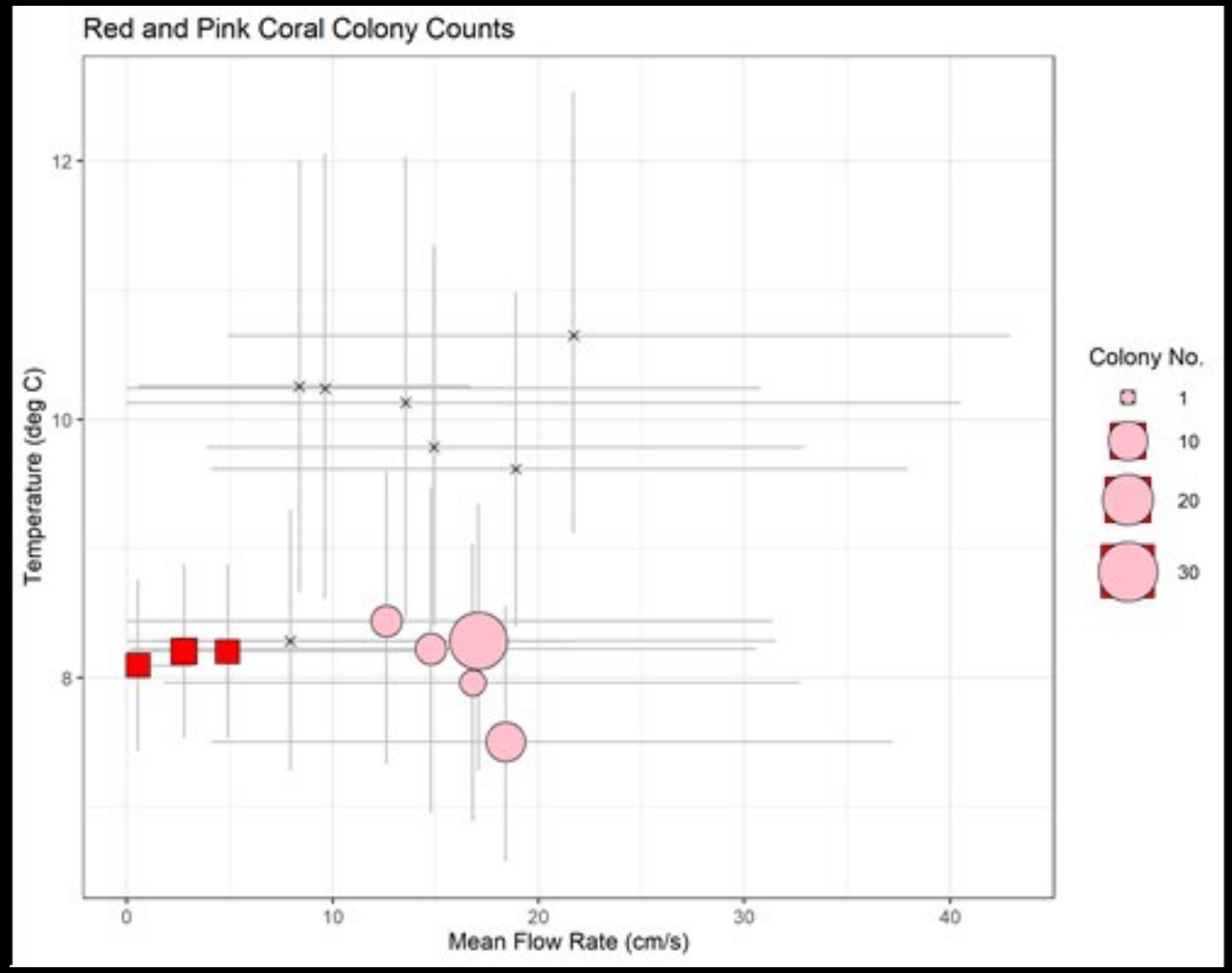
Narella gigas

Narella muzikae


North-South Speed (cm/s)
MAKAPUU
N
NE
E
SE
S
SW
W
NW


Makapuu
Latitude
Instrument Type
Acoustic
Flow Meter
Tilt Meter
-200
-300
-400
-500
-600
Deep Coral Bed
0
0.5
1
2
km
21.30
21.29
21.28
21.27
-157.56
-157.55
-157.54
-157.53
-157.52

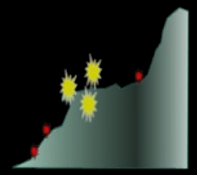
Corallids



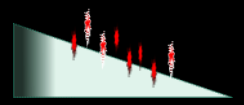
Hemicorallium laauense

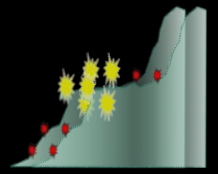
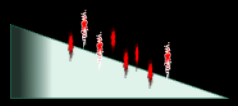
Pleurocorallium secundum

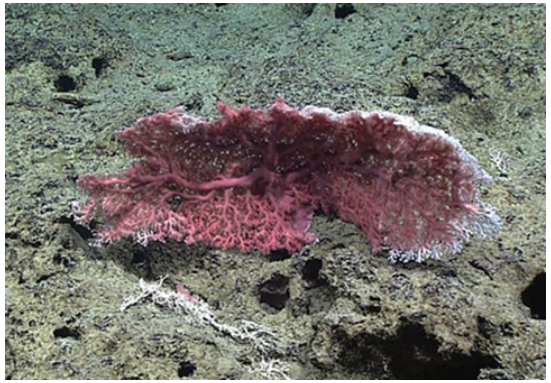
Red Keahole

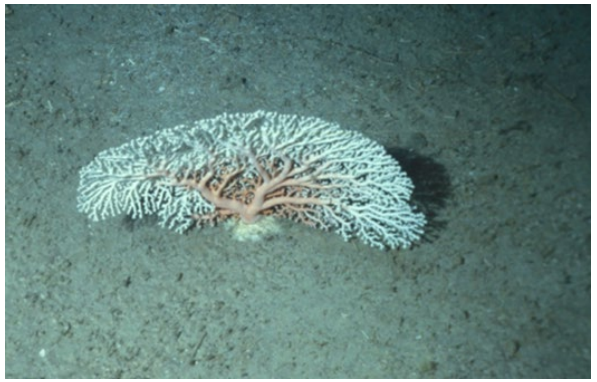


Pink Makapuu

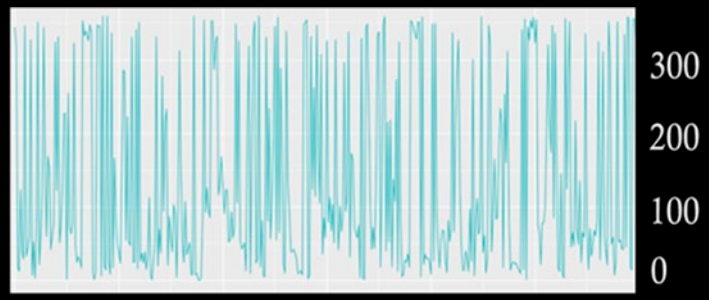


Red Keahole  Pink Makapuu 

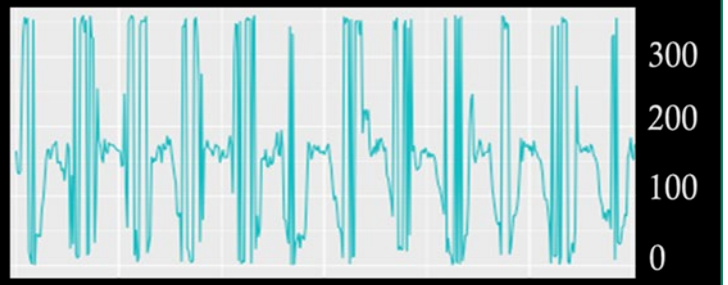




Face multiple directions – low flow



Face same direction – high flow



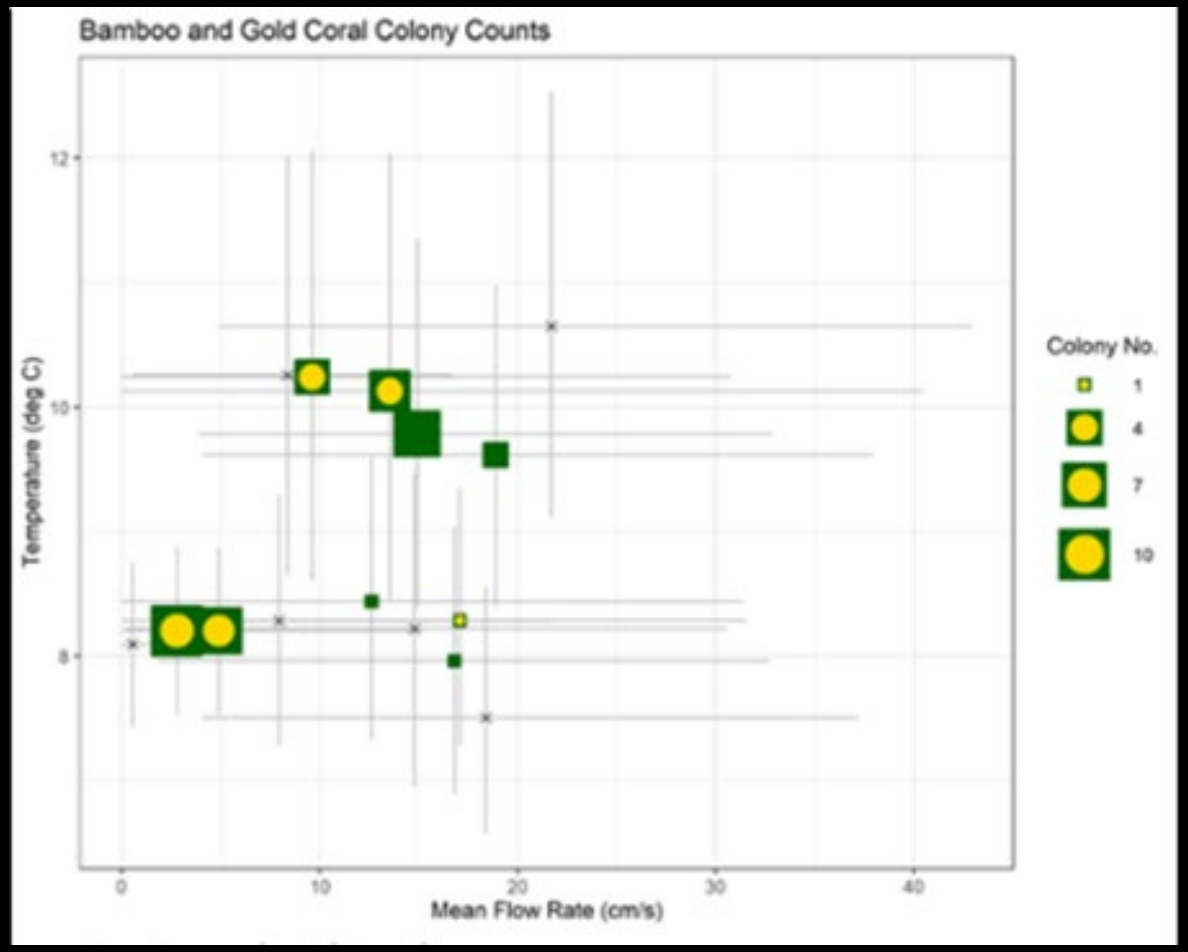
Mean °C

12
10
8
6

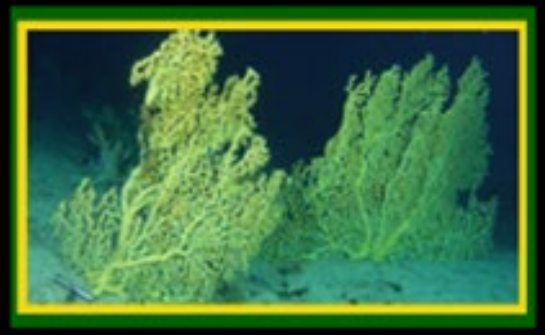
-10
0
10
20
30

Mean flow cm/s

Bamboo and Gold - all sites

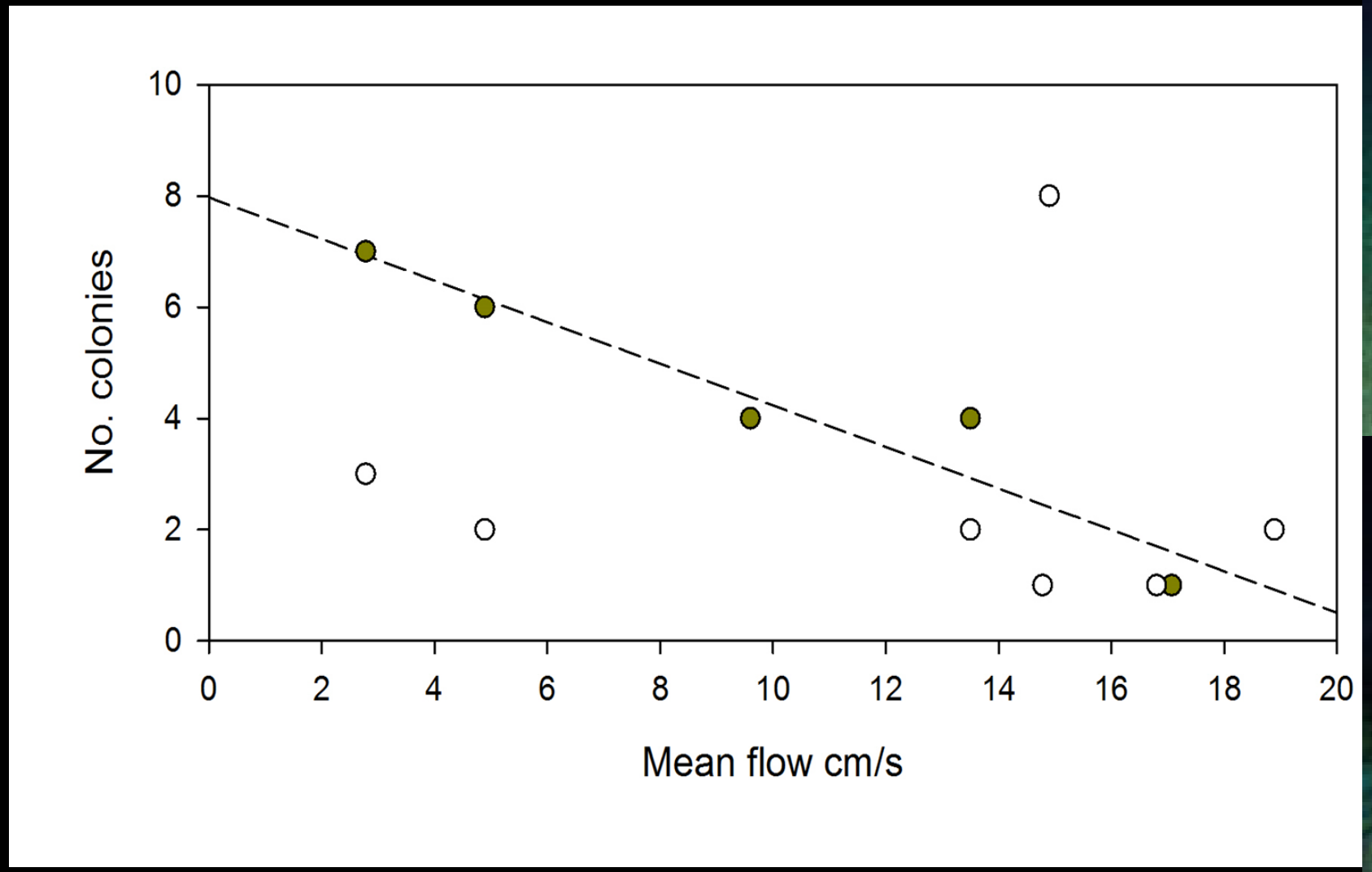


Acanella dispar



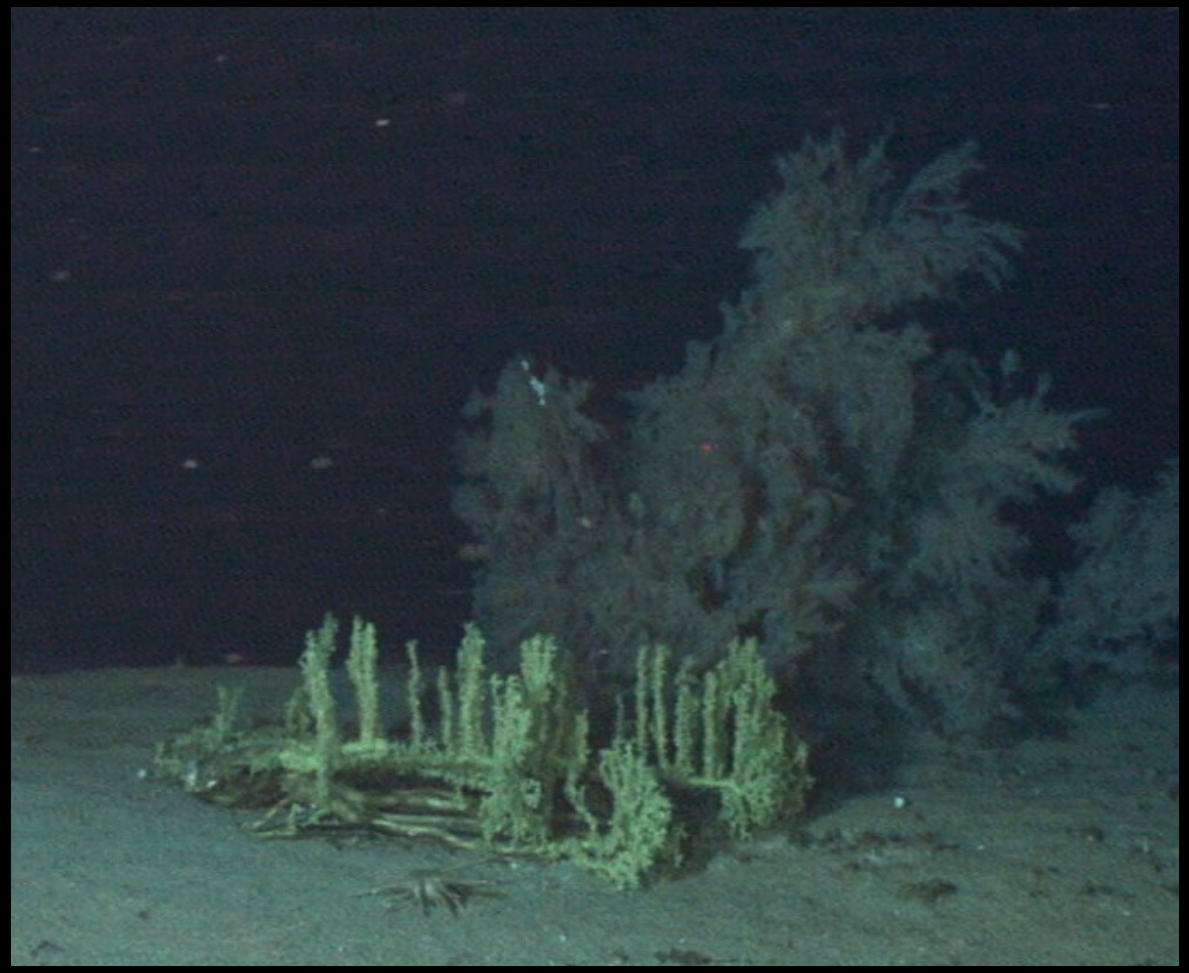
Kulamanamana haumeaae

More golds at lower flow



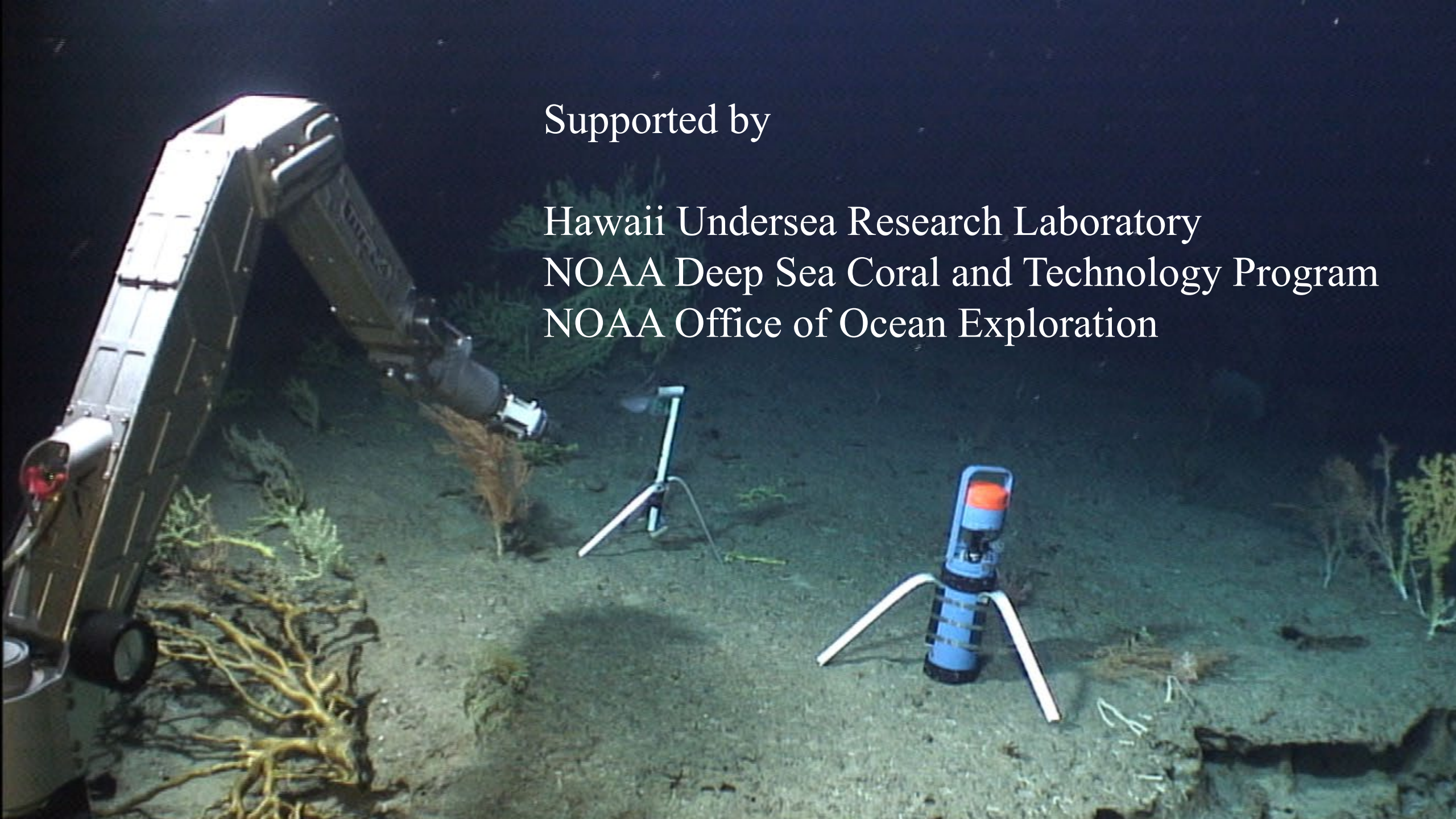
Height of gold colonies differs among sites

$P<0.05$



Summary

- Within depth/temp envelopes for deep coral flow is an important variable
- Difference in backscatter can shift the scale of flow suitable for corals
- Different taxa have different flow preferences
  - Intensity
  - Spatial and temporal spectra
- Able to put some numbers on expected relationships



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