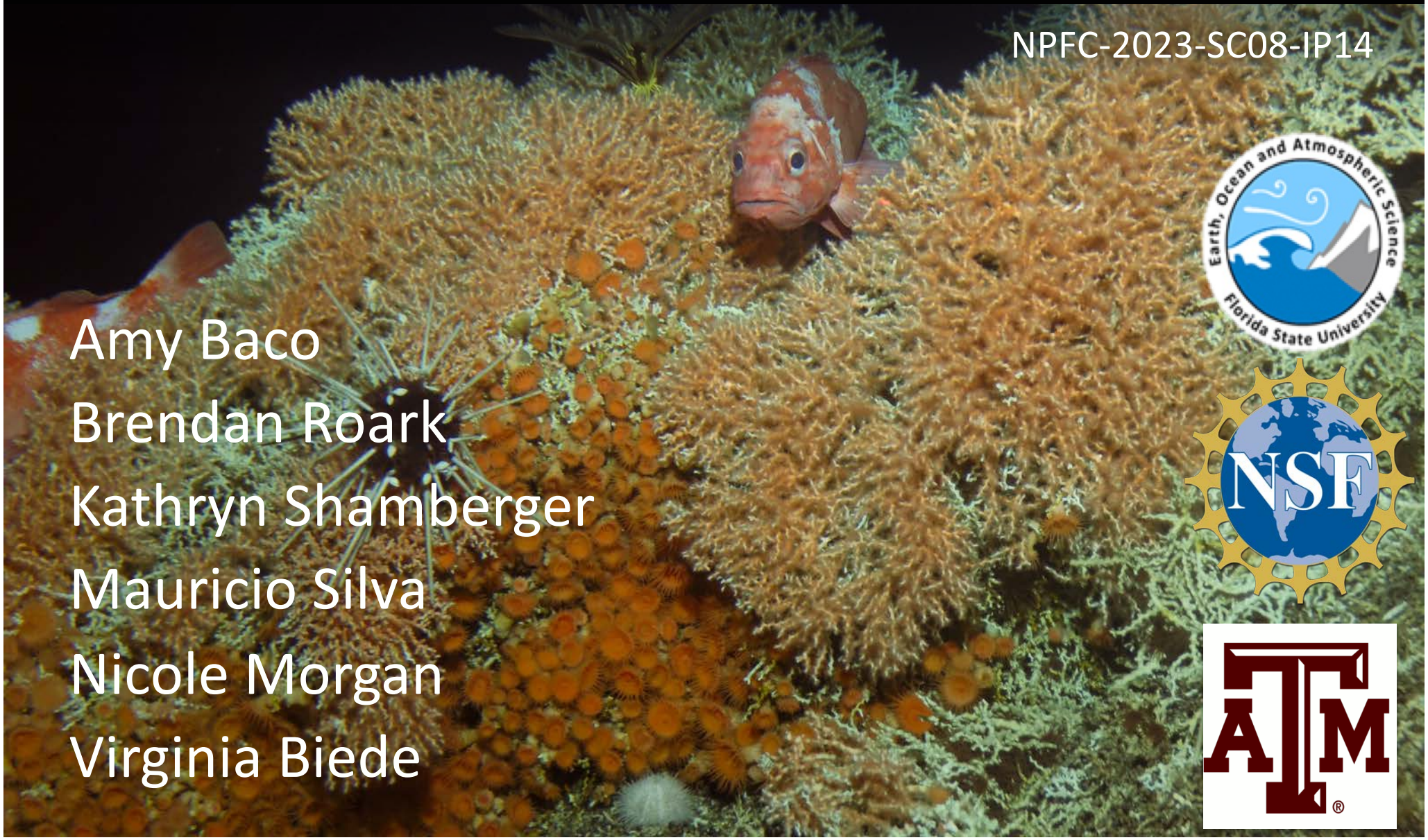
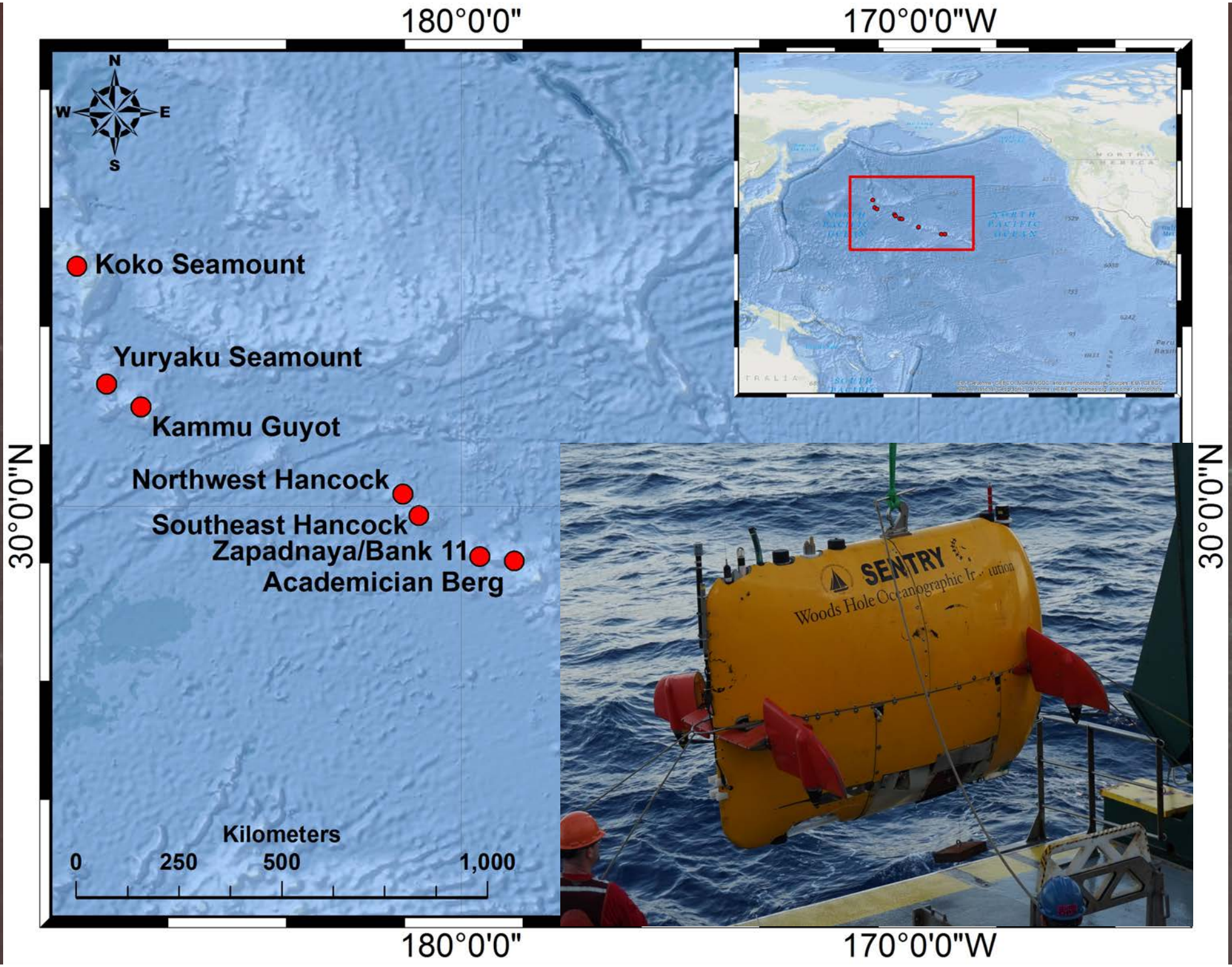
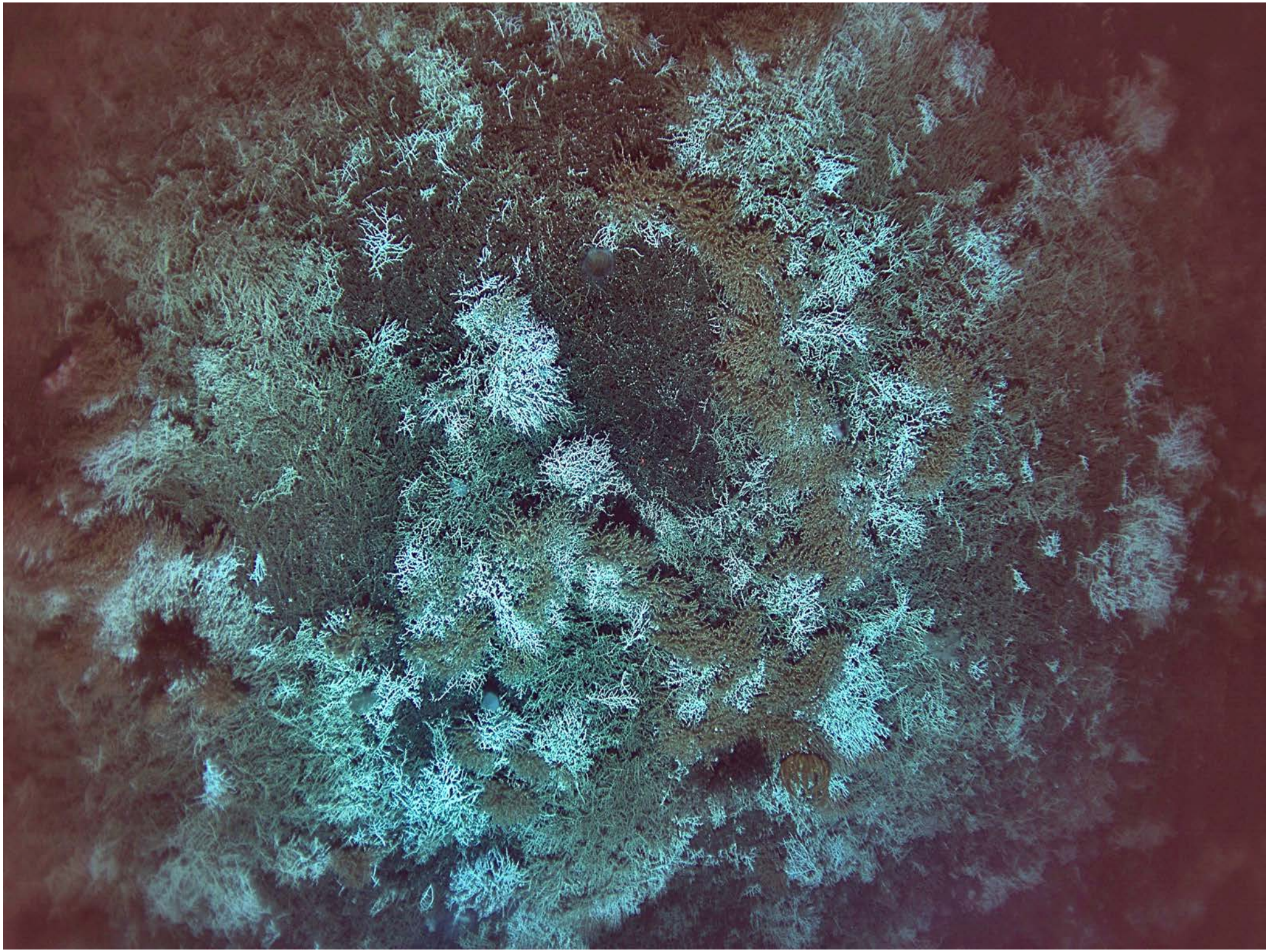
Defying Dissolution: Deep-Sea Scleractinian Reefs in the North Pacific



NPFC-2023-SC08-IP14

Amy Baco
Brendan Roark
Kathryn Shamberger
Mauricio Silva
Nicole Morgan
Virginia Biede


180°0'0"
170°0'0"W
30°0'0"N
N
W
E
S
Koko Seamount
Yuryaku Seamount
Kammu Guyot
Northwest Hancock
Southeast Hancock
Zapadnaya/Bank 11
Academician Berg
Kilometers
0
250
500
1,000
SENTRY
Woods Hole Oceanographic Institution



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Defying Dissolution: Discovery of Deep-Sea Scleractinian Coral Reefs in the North Pacific

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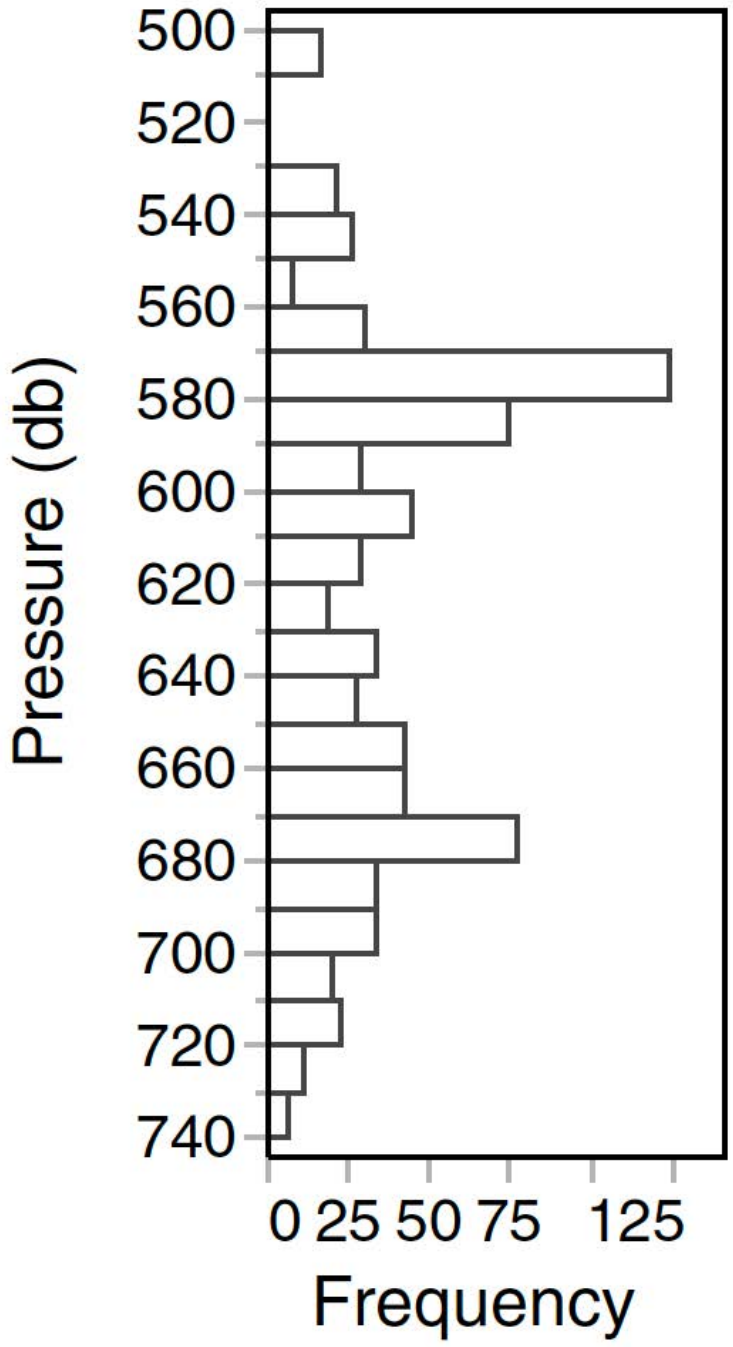
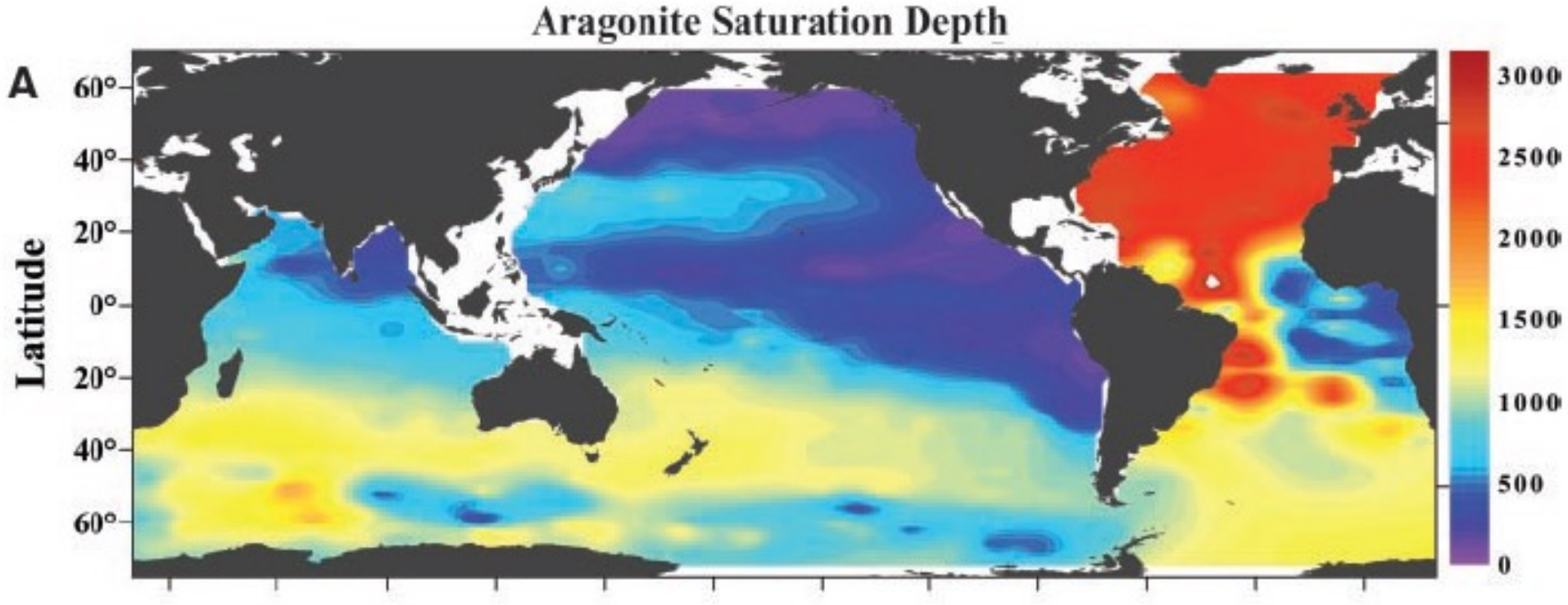
Deep-sea scleractinian coral reefs are protected ecologically and biologically significant areas that support global fisheries. The absence of observations of deep-sea scleractinian reefs in the Central and Northeast Pacific, combined with the shallow aragonite saturation horizon (ASH) and high carbonate dissolution rates there, fueled the hypothesis that reef formation in the North Pacific was improbable. Despite this, we report the discovery of live scleractinian reefs on six seamounts of the Northwestern Hawaiian Islands and Emperor Seamount Chain at depths of 535–732 m and aragonite saturation state (Ω_{arag}) values of 0.71–1.33. Although the ASH becomes deeper moving northwest along the chains, the depth distribution of the reefs becomes shallower, suggesting the ASH is having little influence on their distribution. Higher chlorophyll moving to the northwest may partially explain the geographic distribution of the reefs. Principle Components Analysis suggests that currents are also an important factor in their distribution, but neither chlorophyll nor the available current data can explain the unexpected depth distribution. Further environmental data is needed to elucidate the reason for the distribution of these reefs. The discovery of reef-forming scleractinians in this region is of concern because a number of the sites occur on seamounts with active trawl fisheries.


Pressure (db)
500
520
540
560
580
600
620
640
660
680
700
720
740
0 25 50 75 125
Frequency

Species and Chemistry

- *Solenosmilia variabilis*
- *Enallopsammia rostrata*
- Aragonitic skeletons
- Should not form reefs below aragonite saturation horizon (ASH)

Carbonate Chemistry



ASH in N Pacific <500m depth

Feely et al 2004

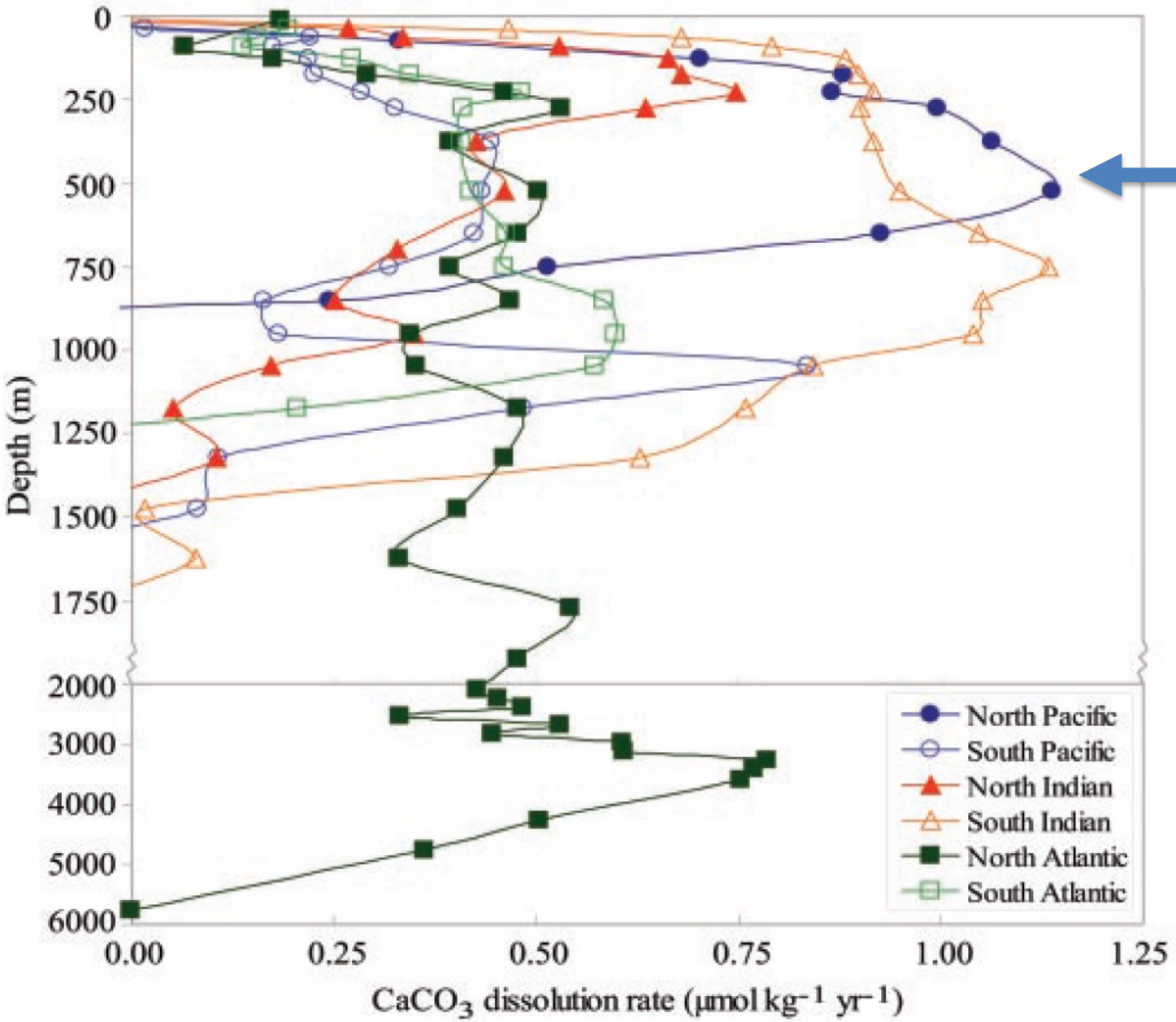
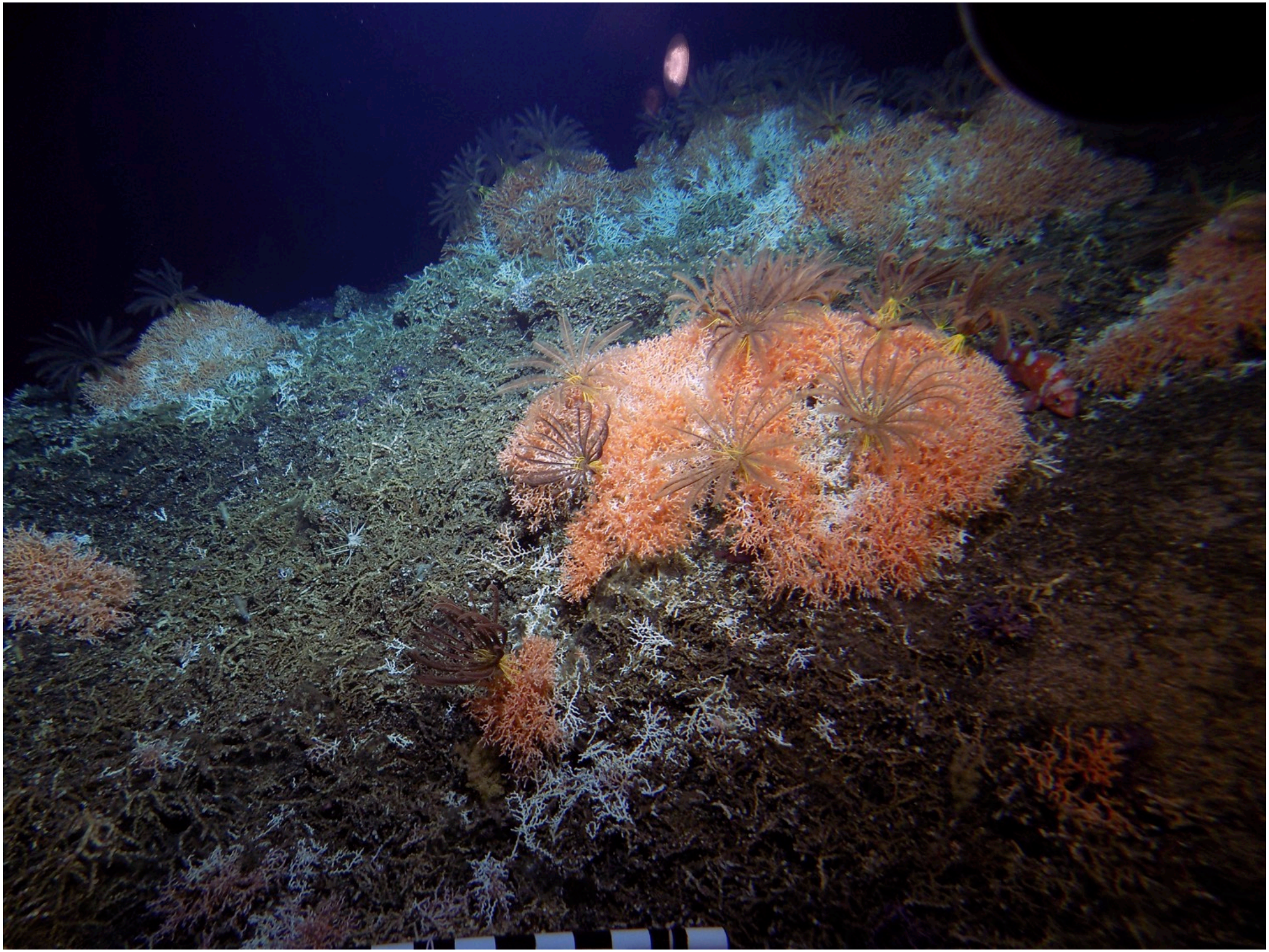
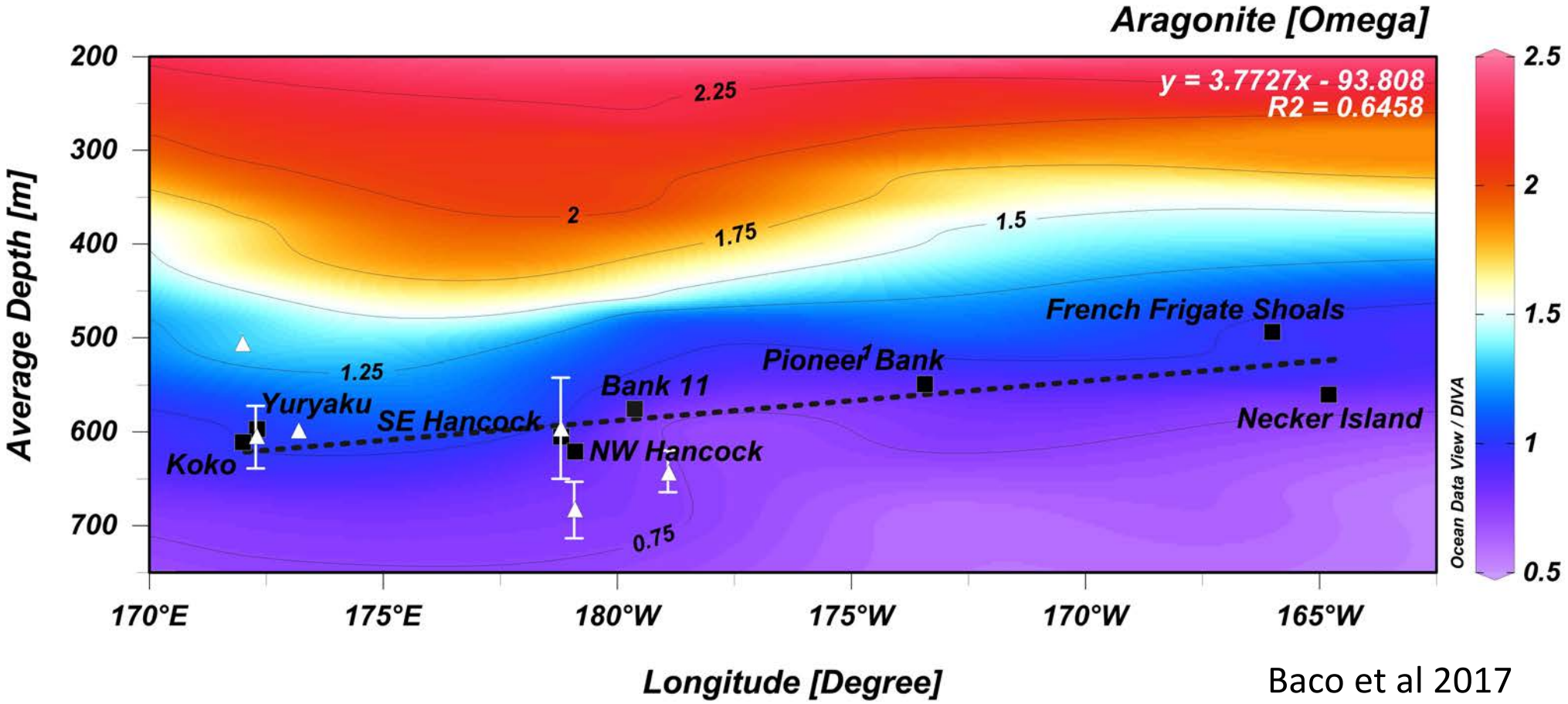


Fig. 4. In situ $CaCO_3$ dissolution rates plotted as a function of depth in the three major ocean basins.

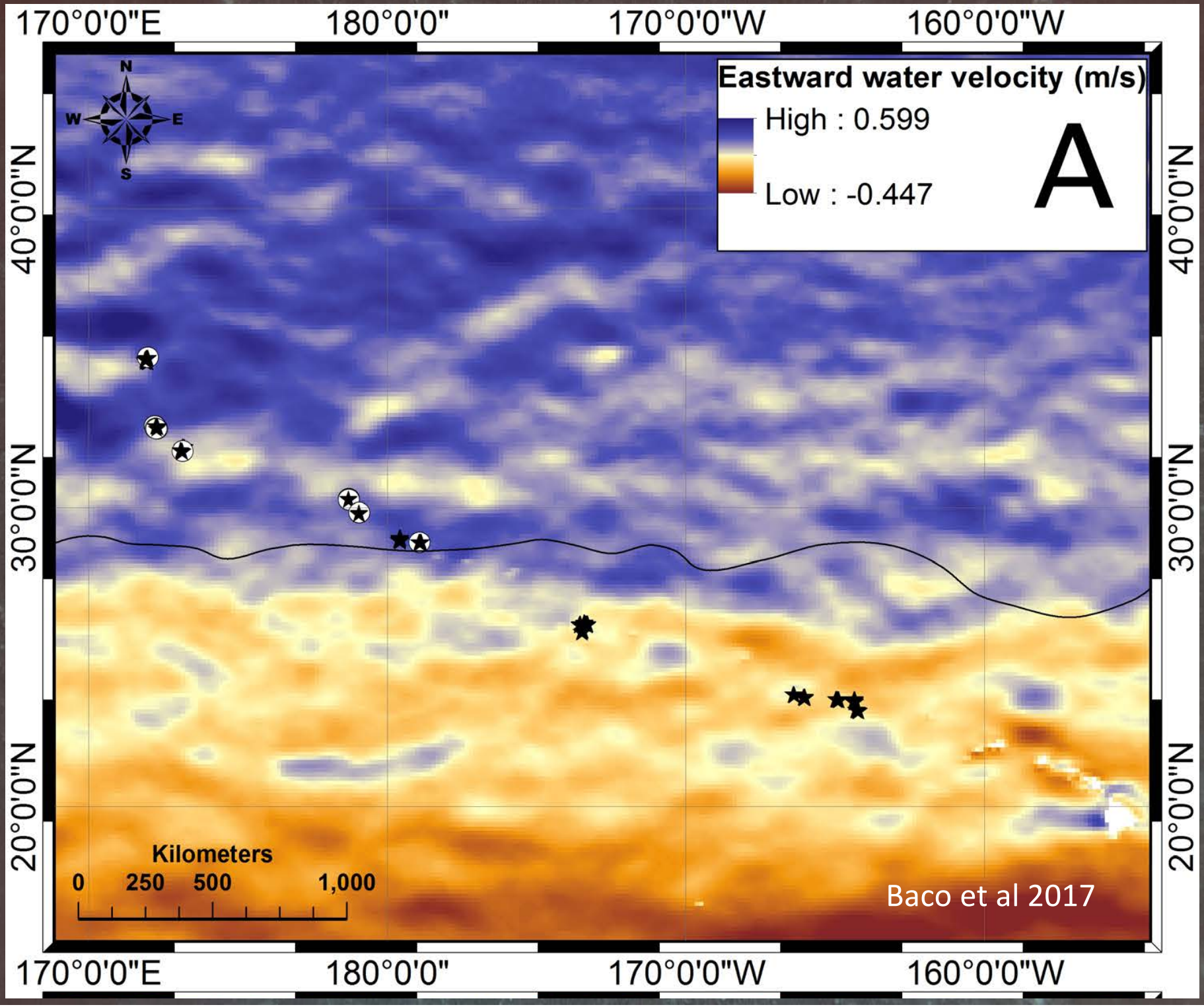
Feely et al 2004

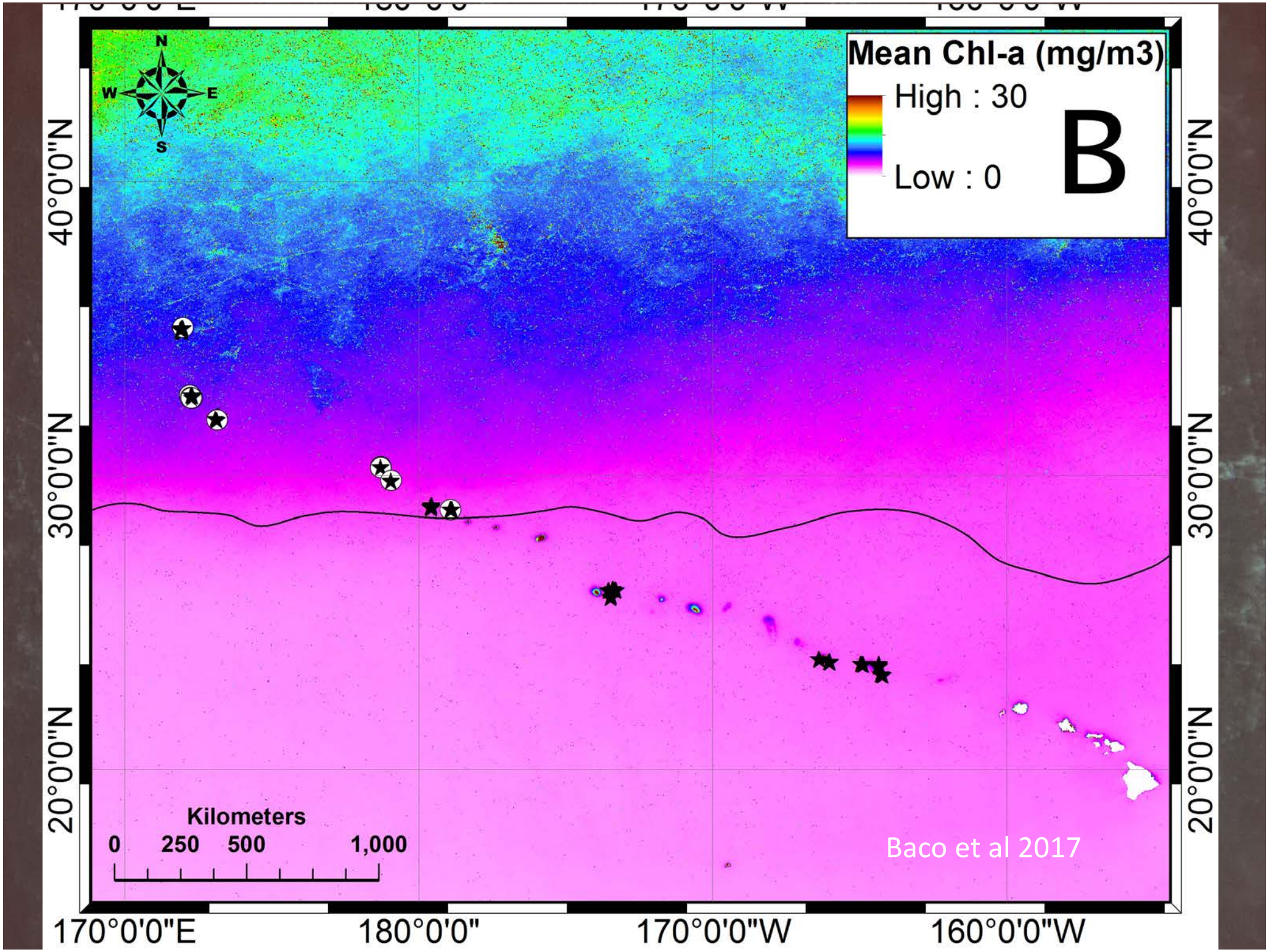


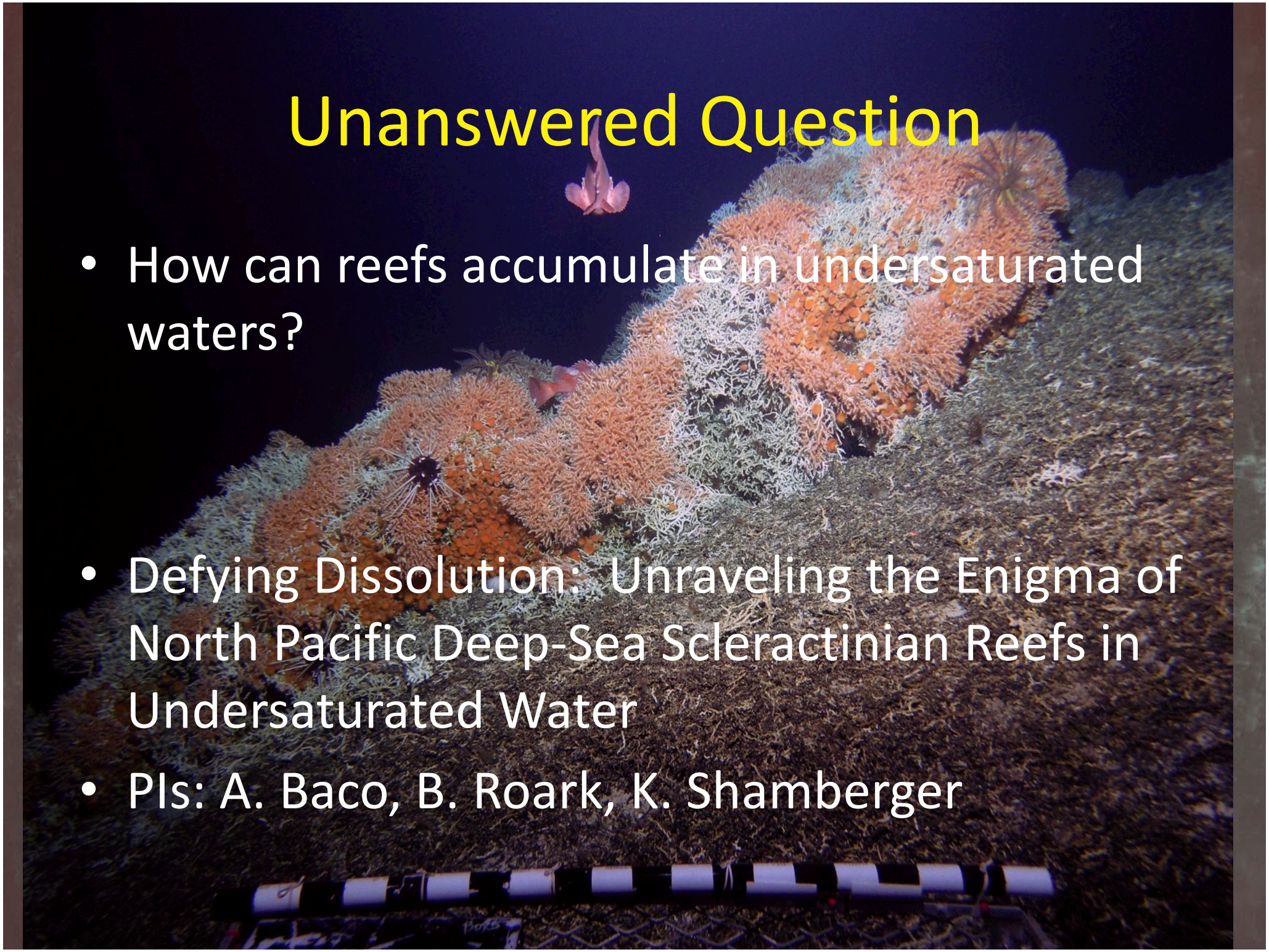


Baco et al 2017

- Sites below the ASH
- Range 0.71-1.33
- Distribution gets shallower as ASH gets deeper


170°0'0"E
180°0'0"
170°0'0"W
160°0'0"W
40°0'0"N
30°0'0"N
20°0'0"N
N
W
E
S
Eastward water velocity (m/s)
High : 0.599
Low : -0.447
A
Kilometers
0 250 500 1,000
Baco et al 2017


Mean Chl-a (mg/m3)
High : 30
Low : 0
B
N
W
E
S
40°0'0"N
30°0'0"N
20°0'0"N
Kilometers
0 250 500 1,000
Baco et al 2017
170°0'0"E
180°0'0"
170°0'0"W
160°0'0"W



Unanswered Question

- How can reefs accumulate in undersaturated waters?

- Defying Dissolution: Unraveling the Enigma of North Pacific Deep-Sea Scleractinian Reefs in Undersaturated Water
- PIs: A. Baco, B. Roark, K. Shamberger

Possible Explanations

- The Aragonite Saturation Horizon has shoaled since formation

Defying Dissolution

- Cruise 1 Fall 2021
- Cruise 2 Fall 2022

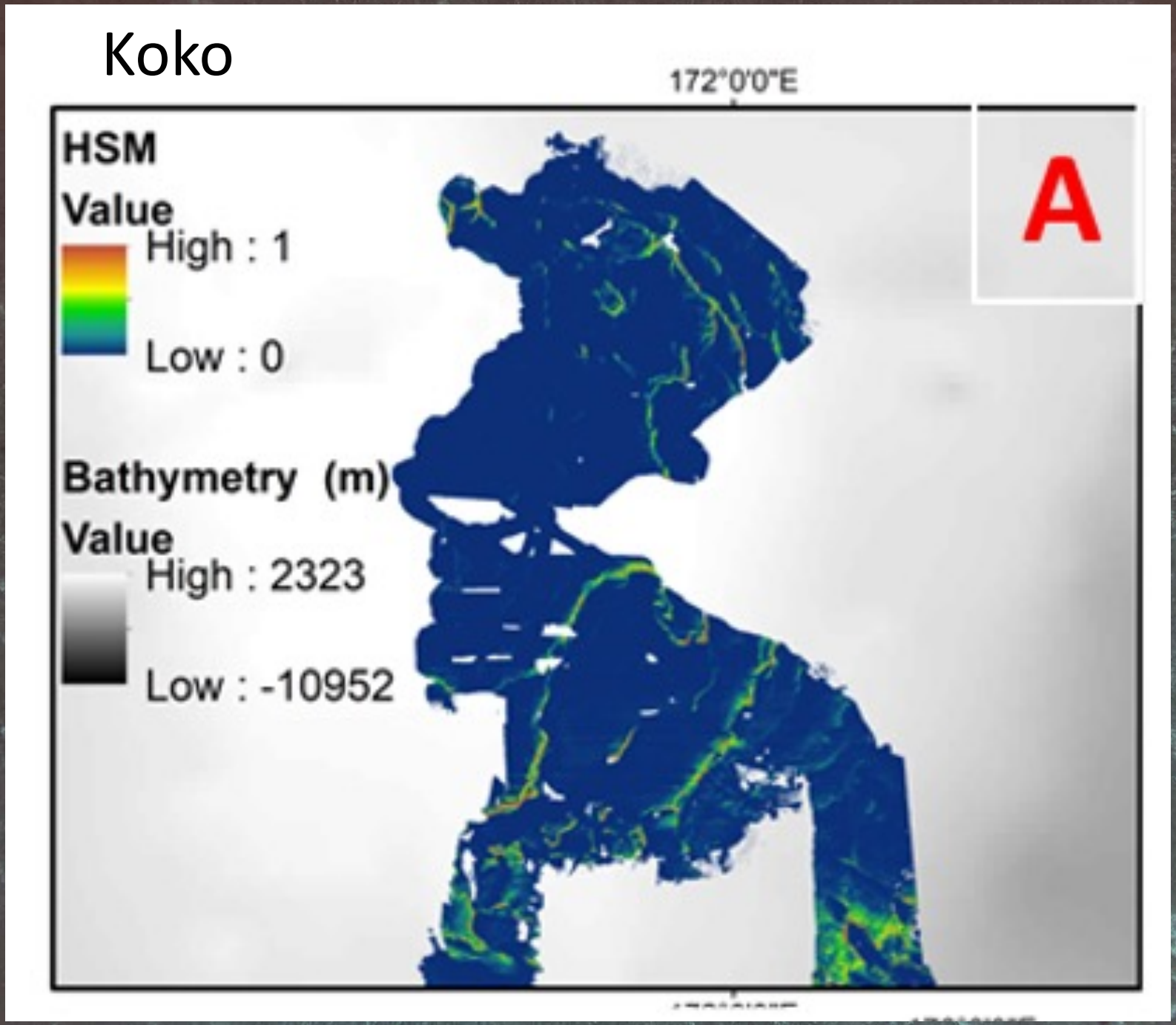
- Species Distributions, Modeling
- Carbonate Chemistry, Dissolution Experiments
- Isotopes to examine prior carbonate chemistry
- Telepresence and Whale Times Inc.

Species

- *Enallopsammia cf. pusilla*
- *Madrepora oculata*
- *Solenosmilia variabilis*
- *Desmophyllum (Lophelia) pertusa*
- *Enallopsammia rostrata* – arborescent
- *Enallopsammia rostrata* – reef-forming
- Undetermined

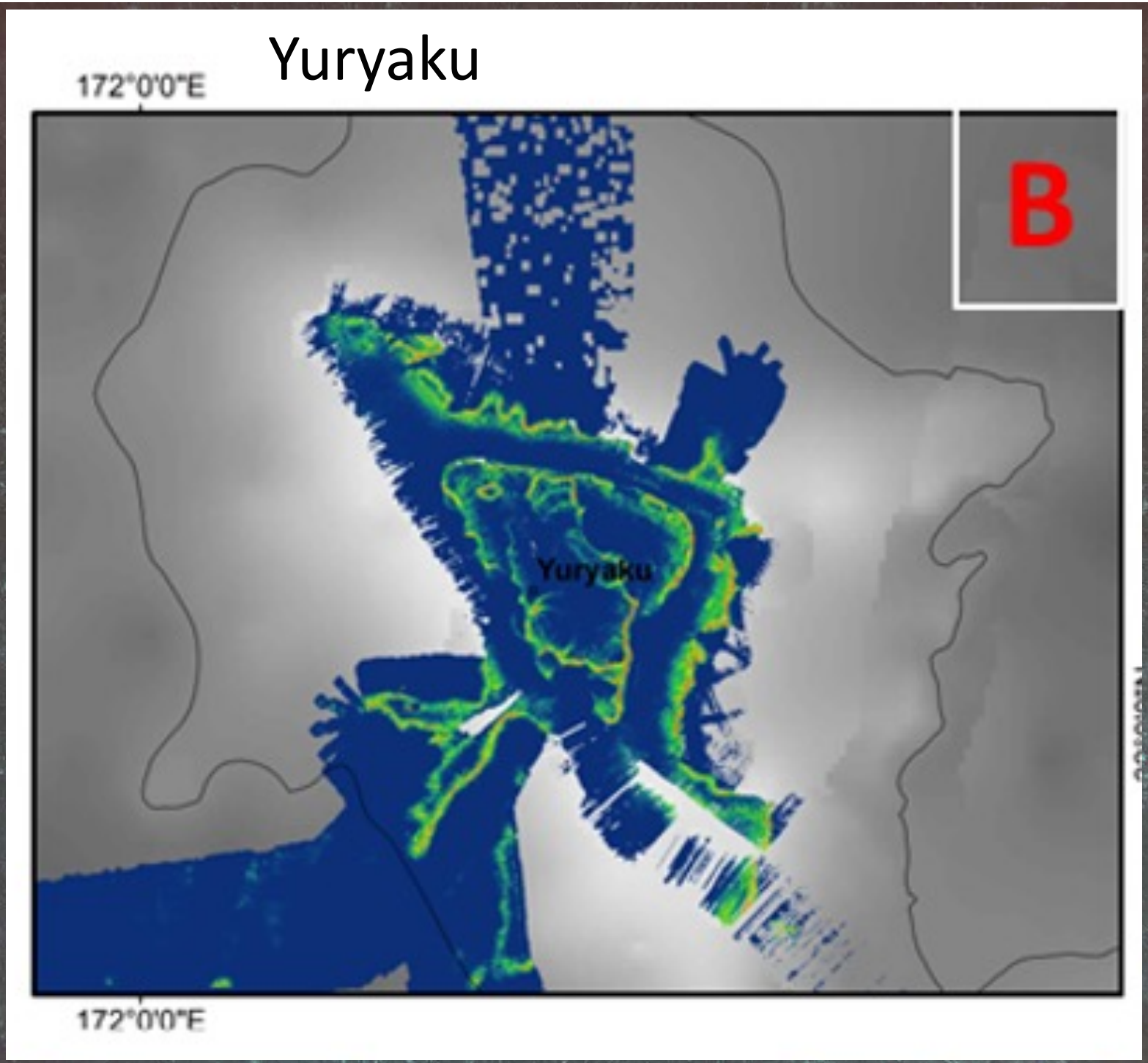
- *Hemicorallium laauense* - co-occurs

Koko



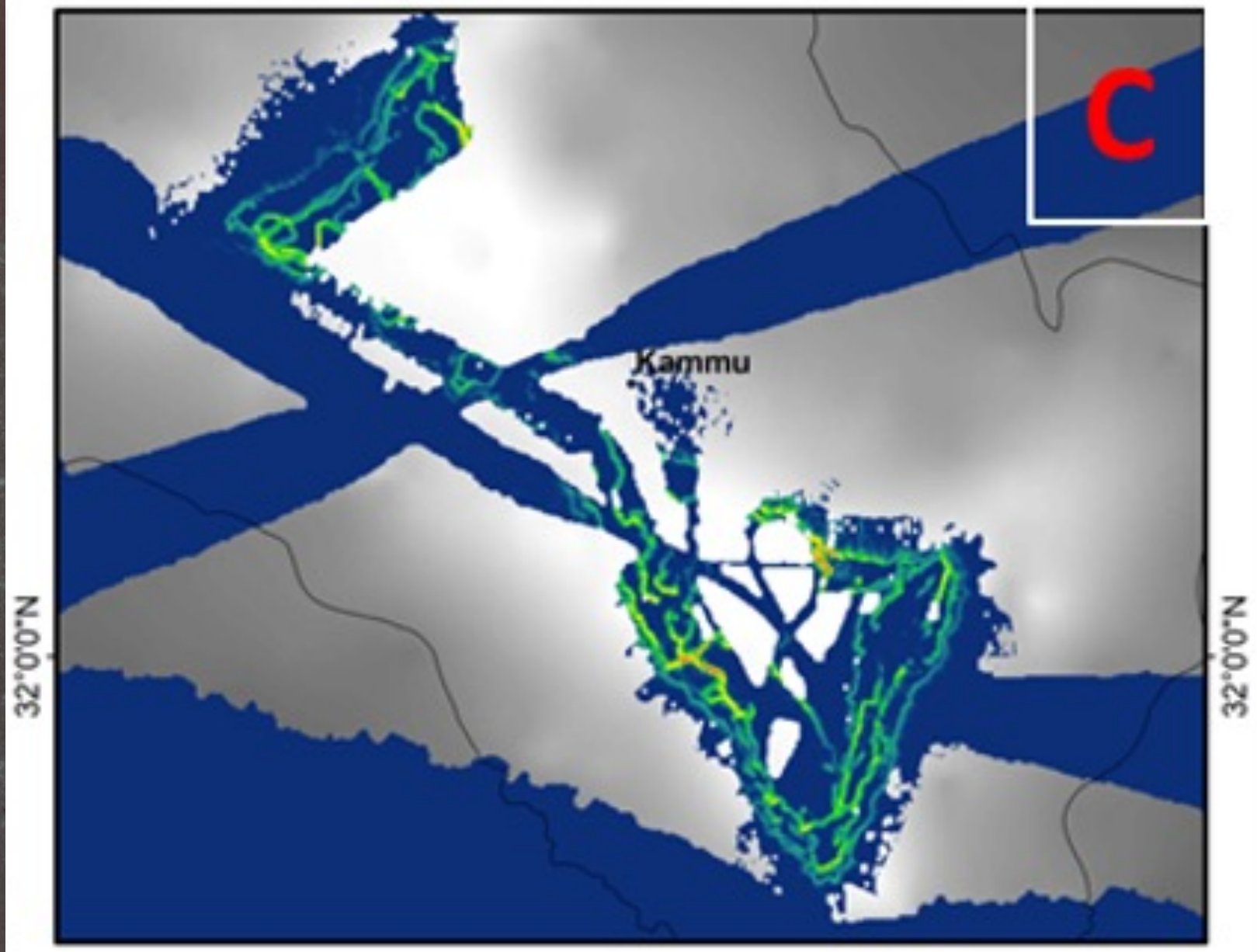
Silva et al submitted

Yuryaku



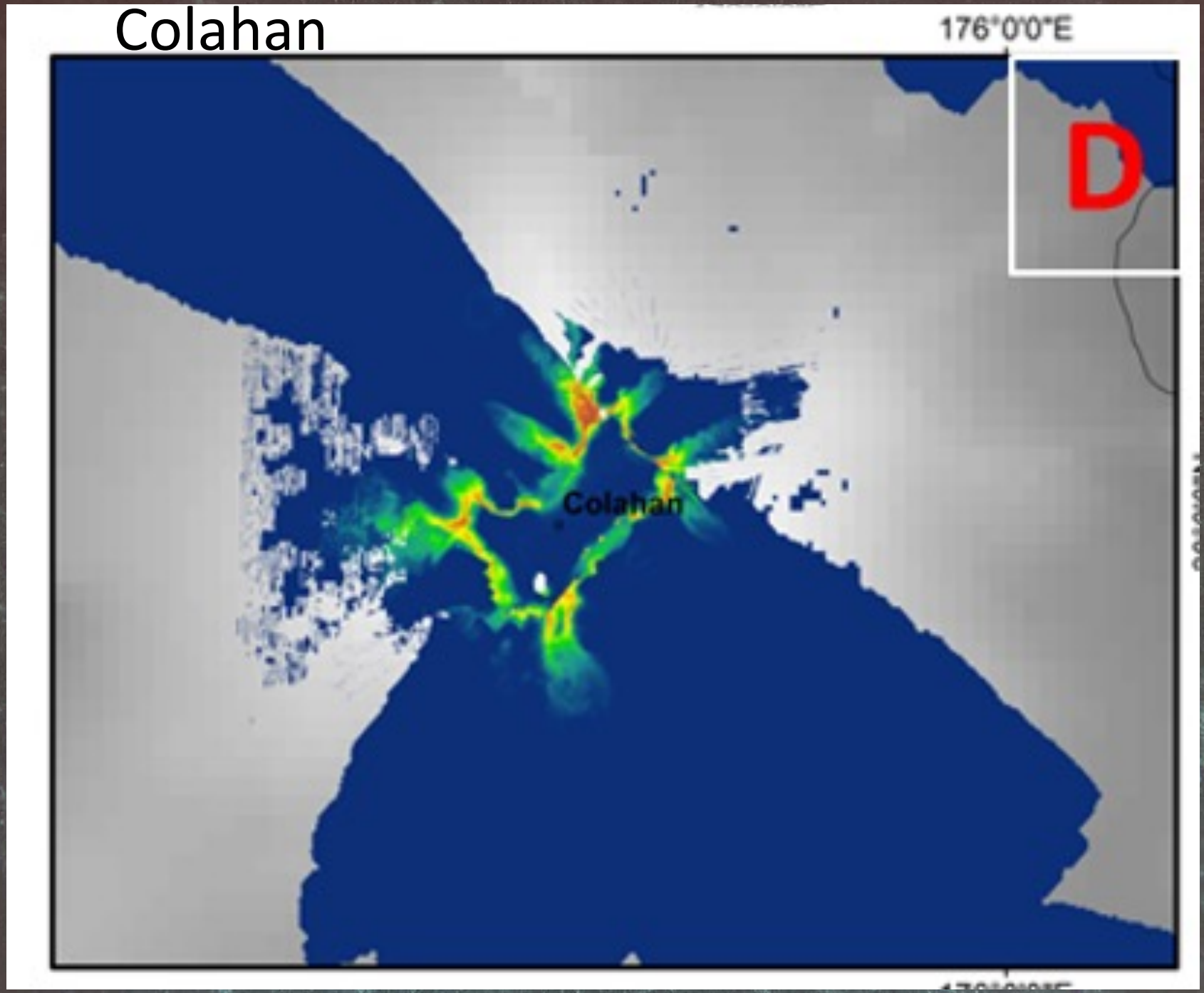
Silva et al submitted

Kammu



Silva et al submitted

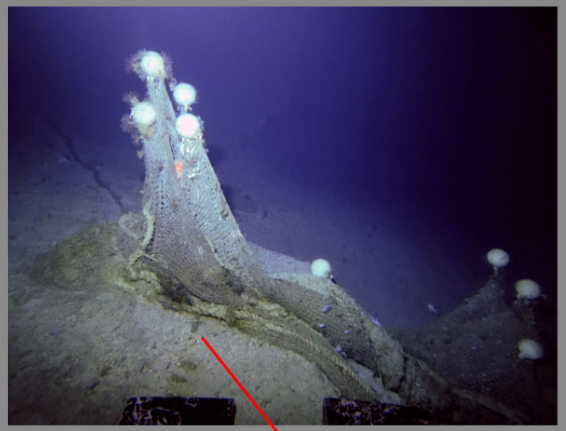
Colahan

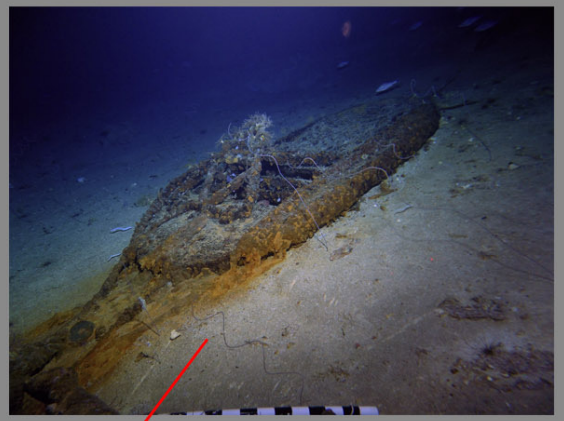


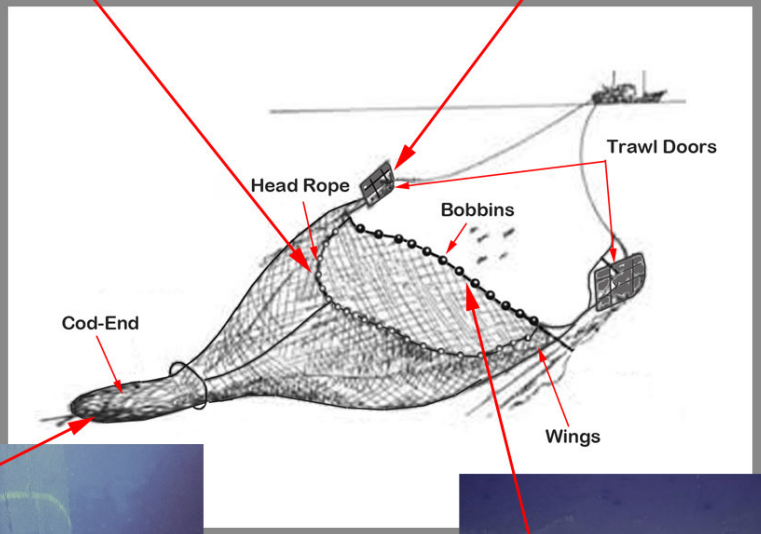
Silva et al submitted

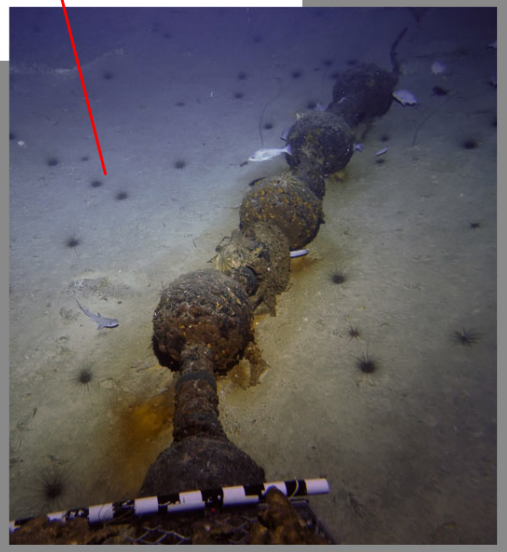
Challenges

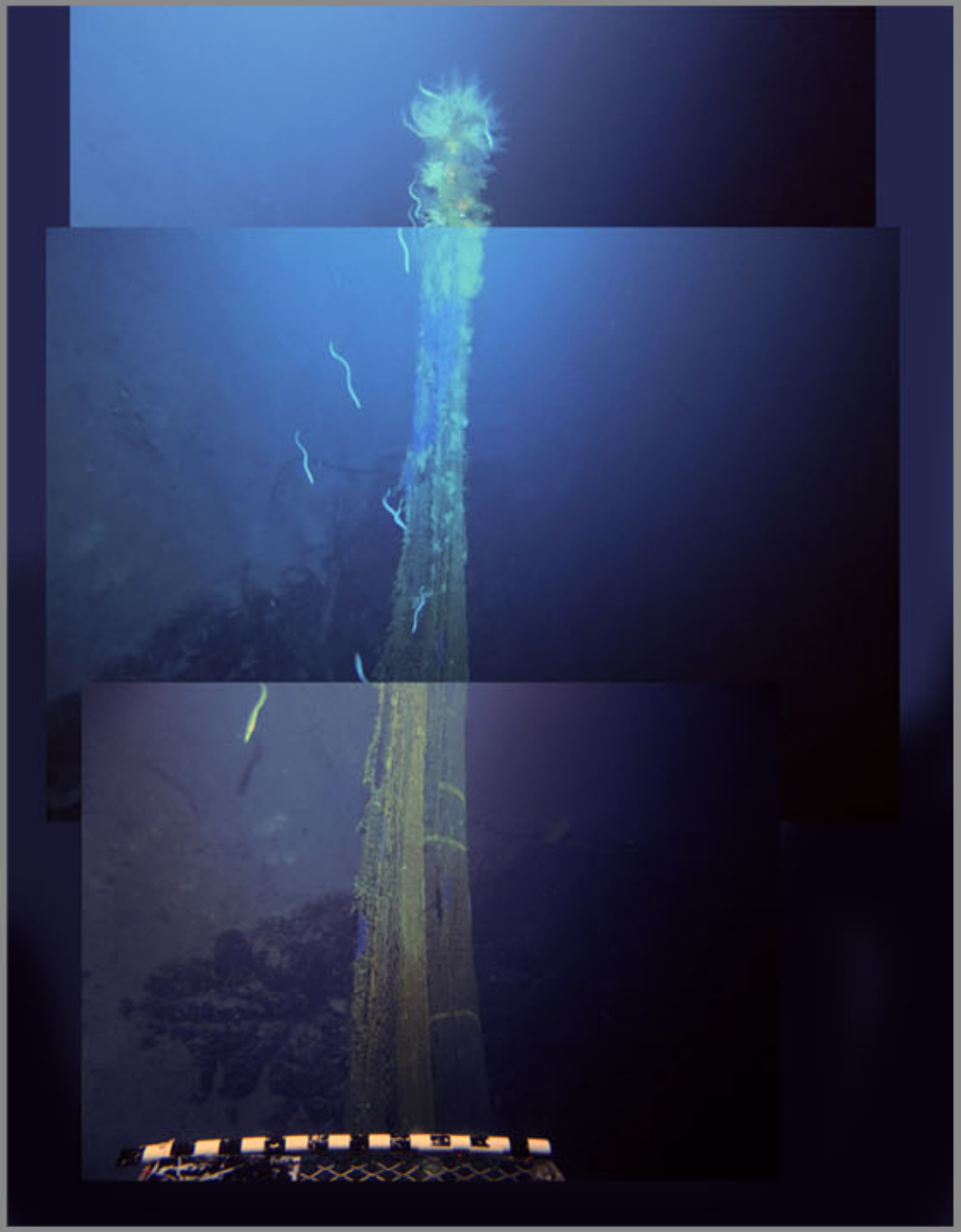
- COVID delays, lack of high-resolution bathymetry
- Lost fishing gear and lines
- Many reef areas reduced to rubble

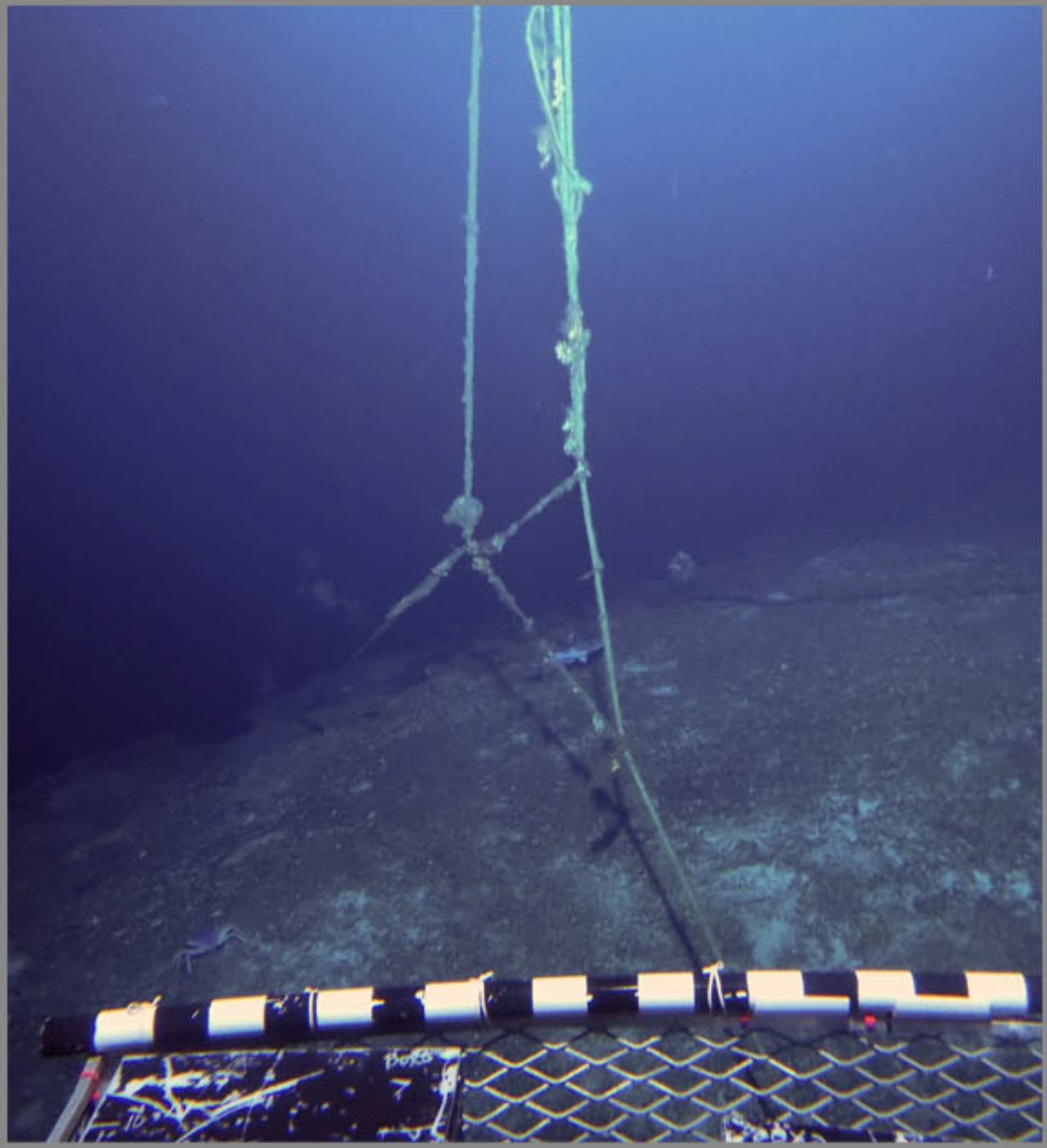


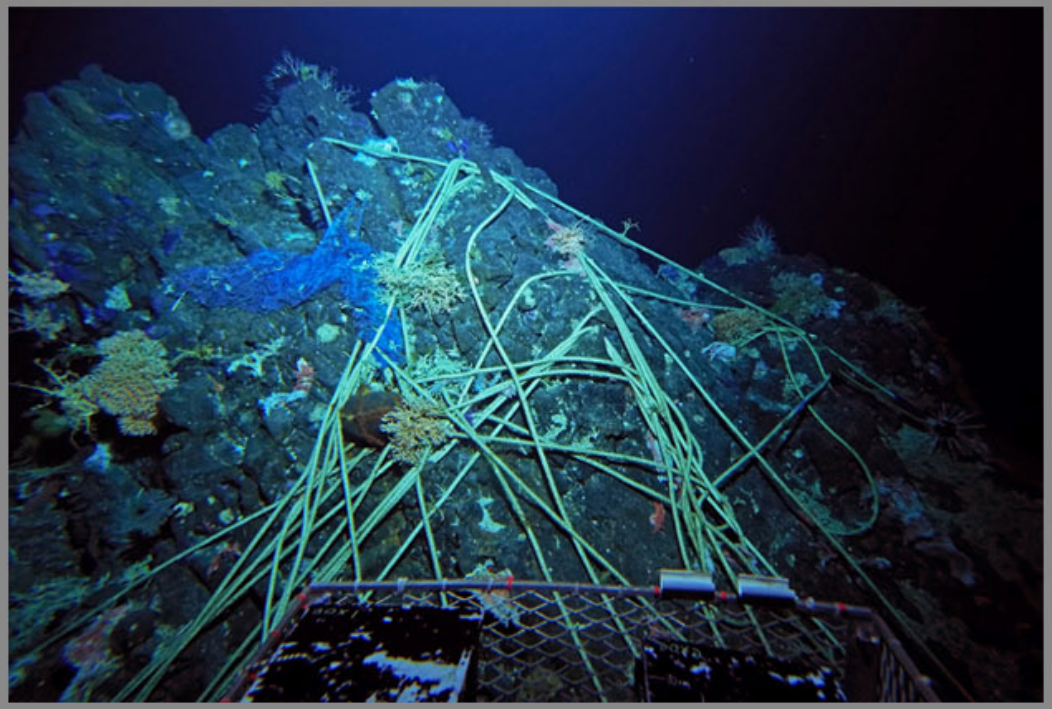


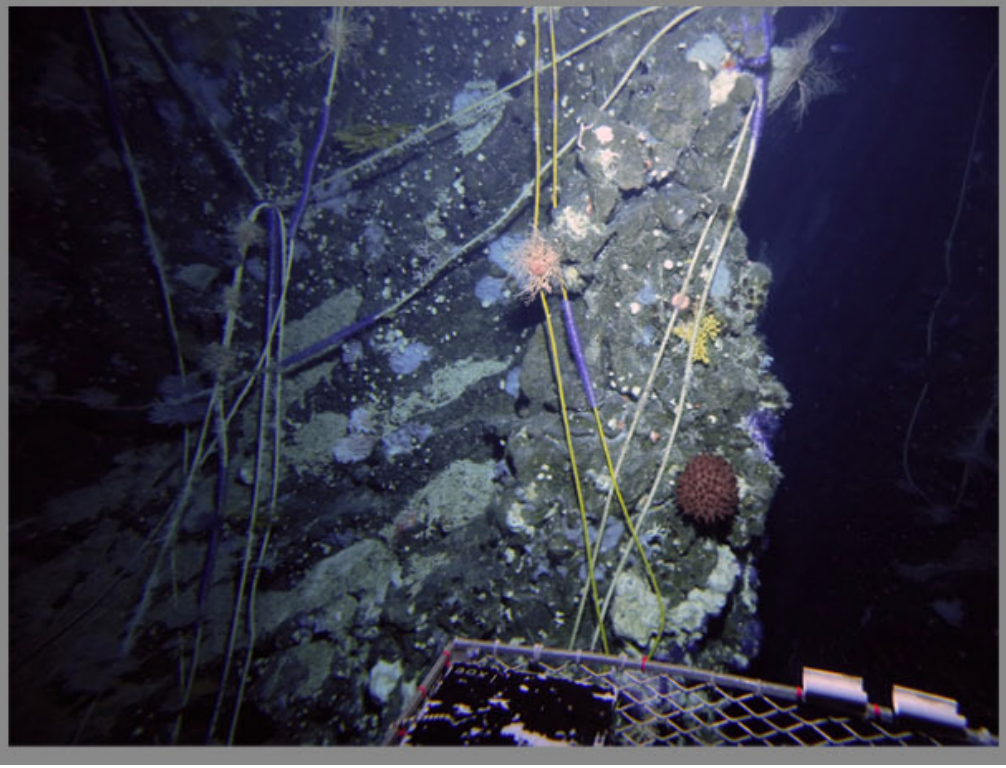

Trawl Doors
Head Rope
Bobbins
Cod-End
Wings

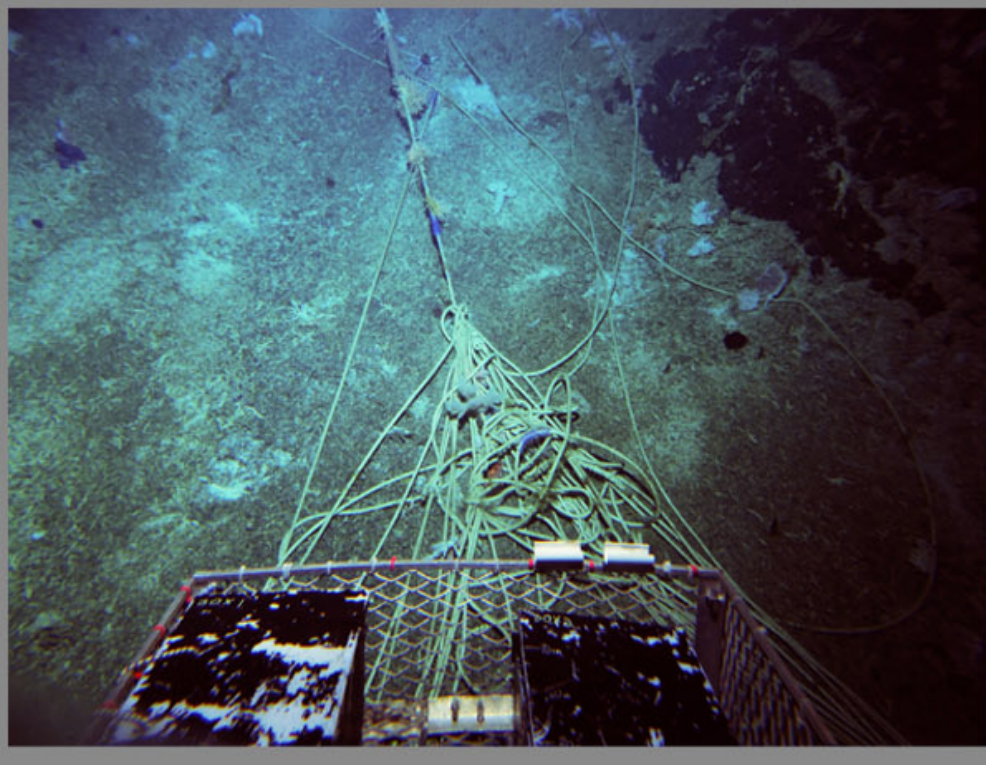


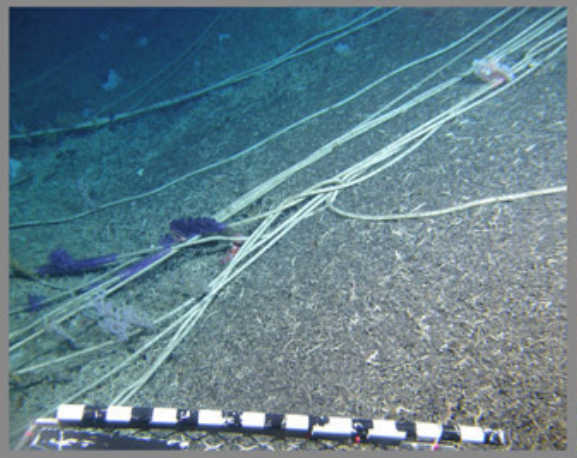
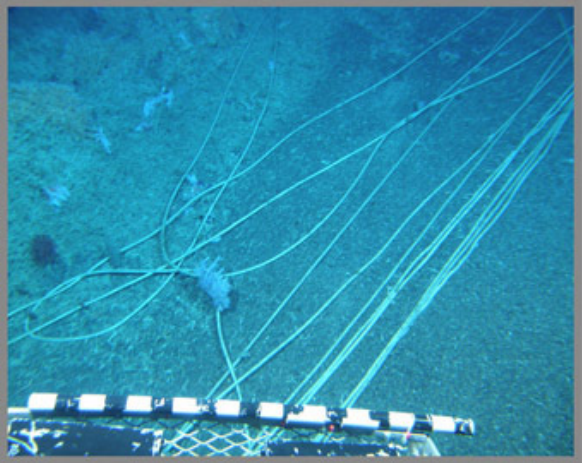
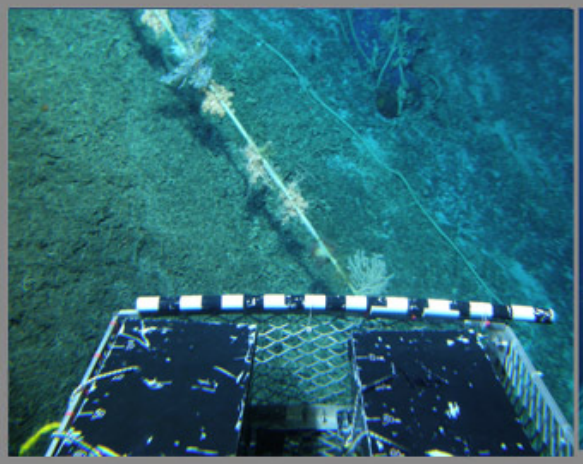
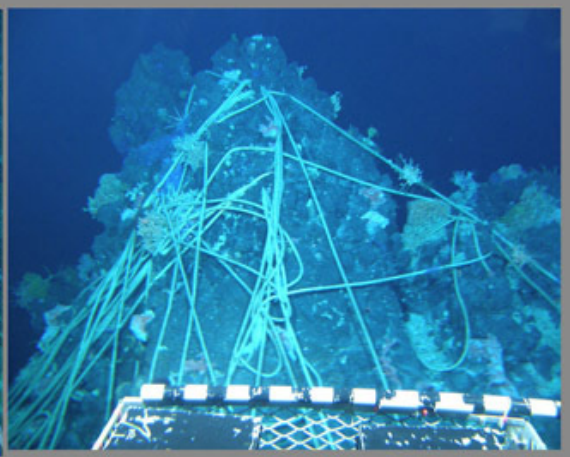
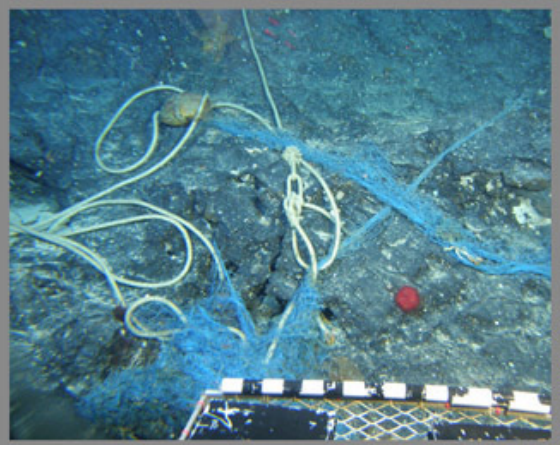
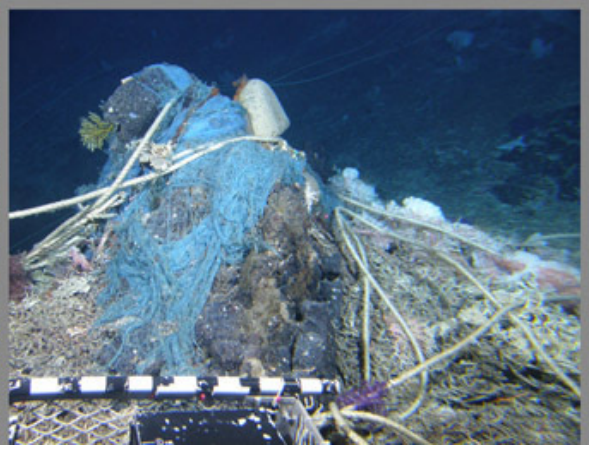


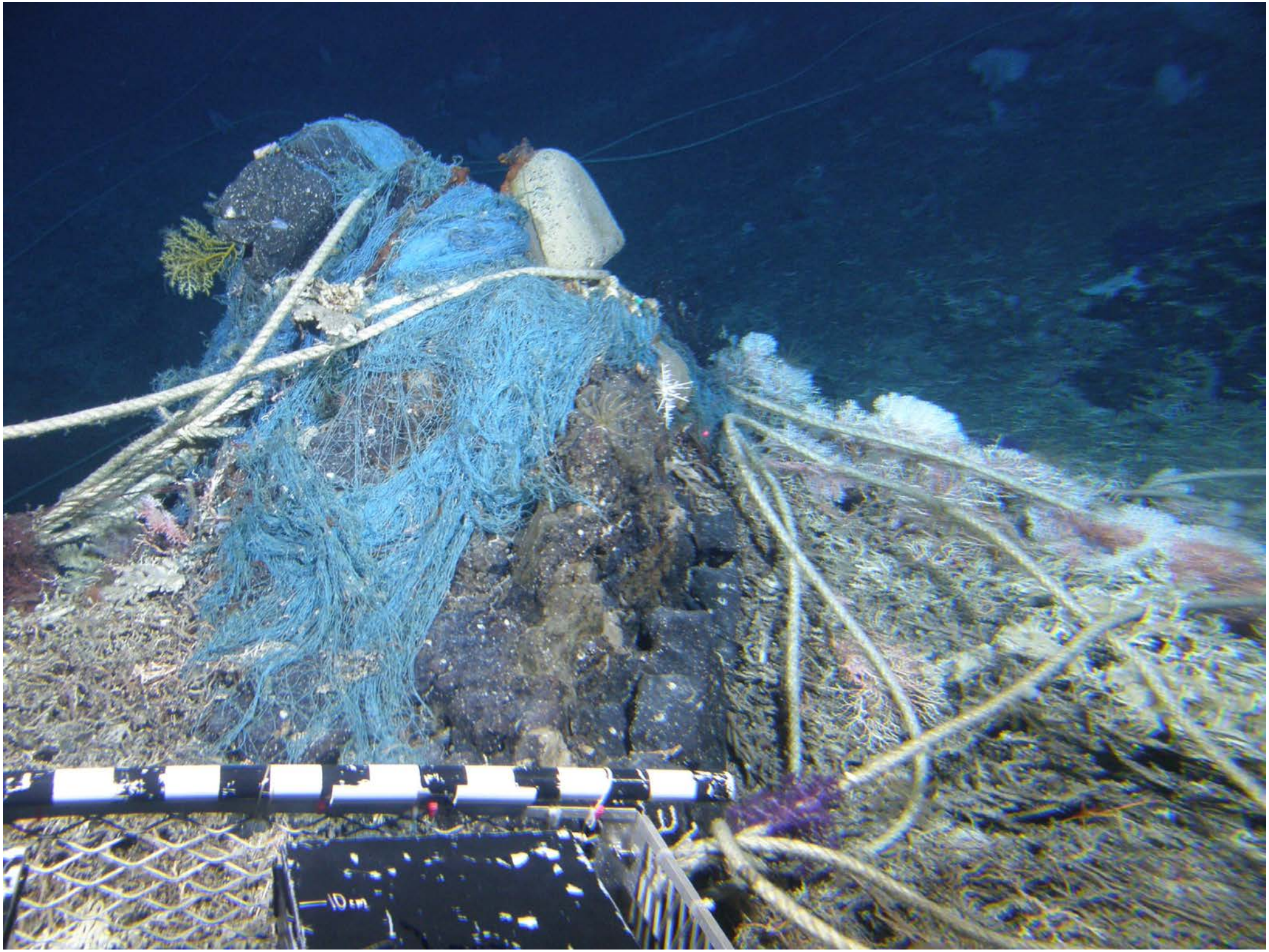


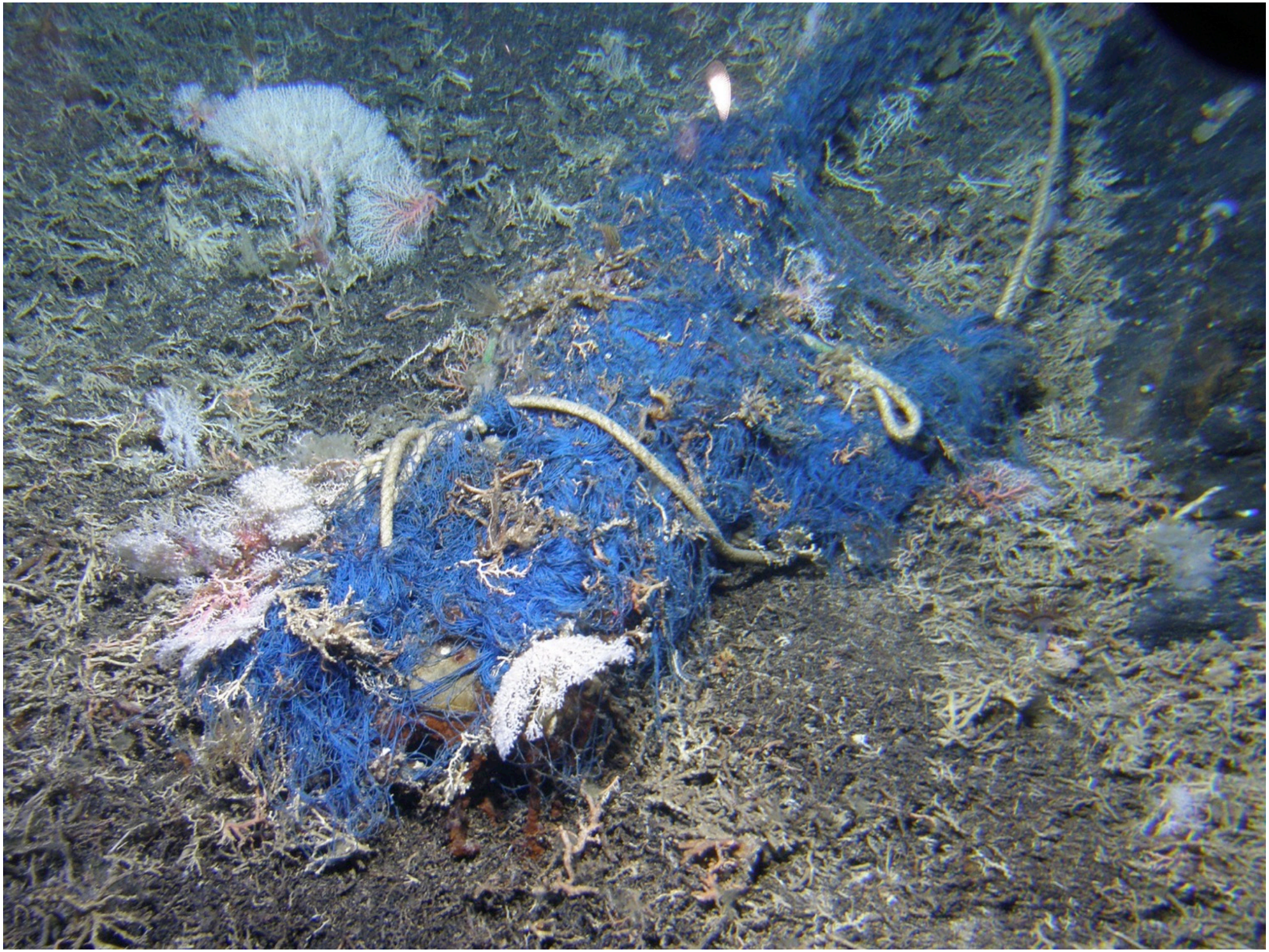


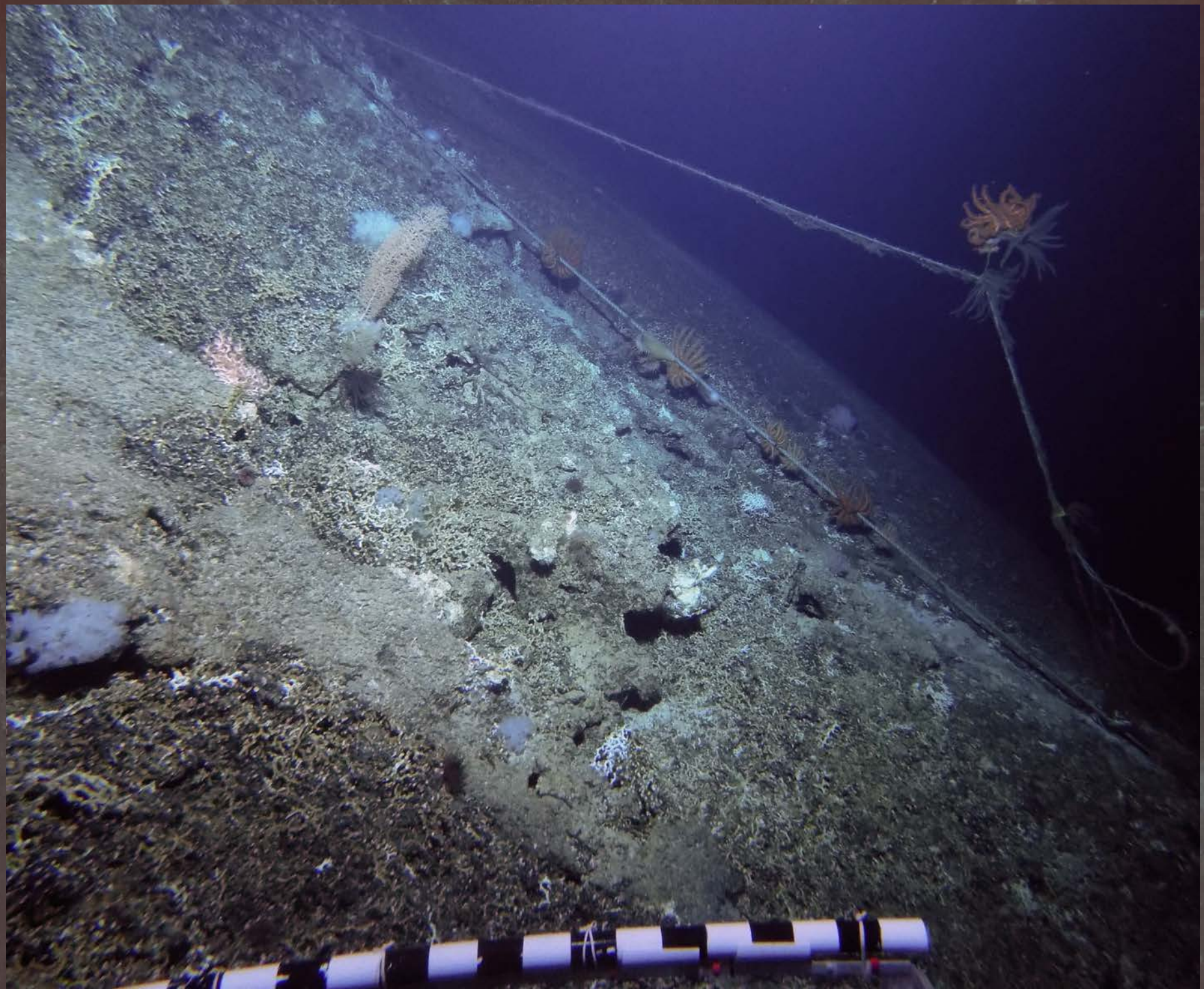


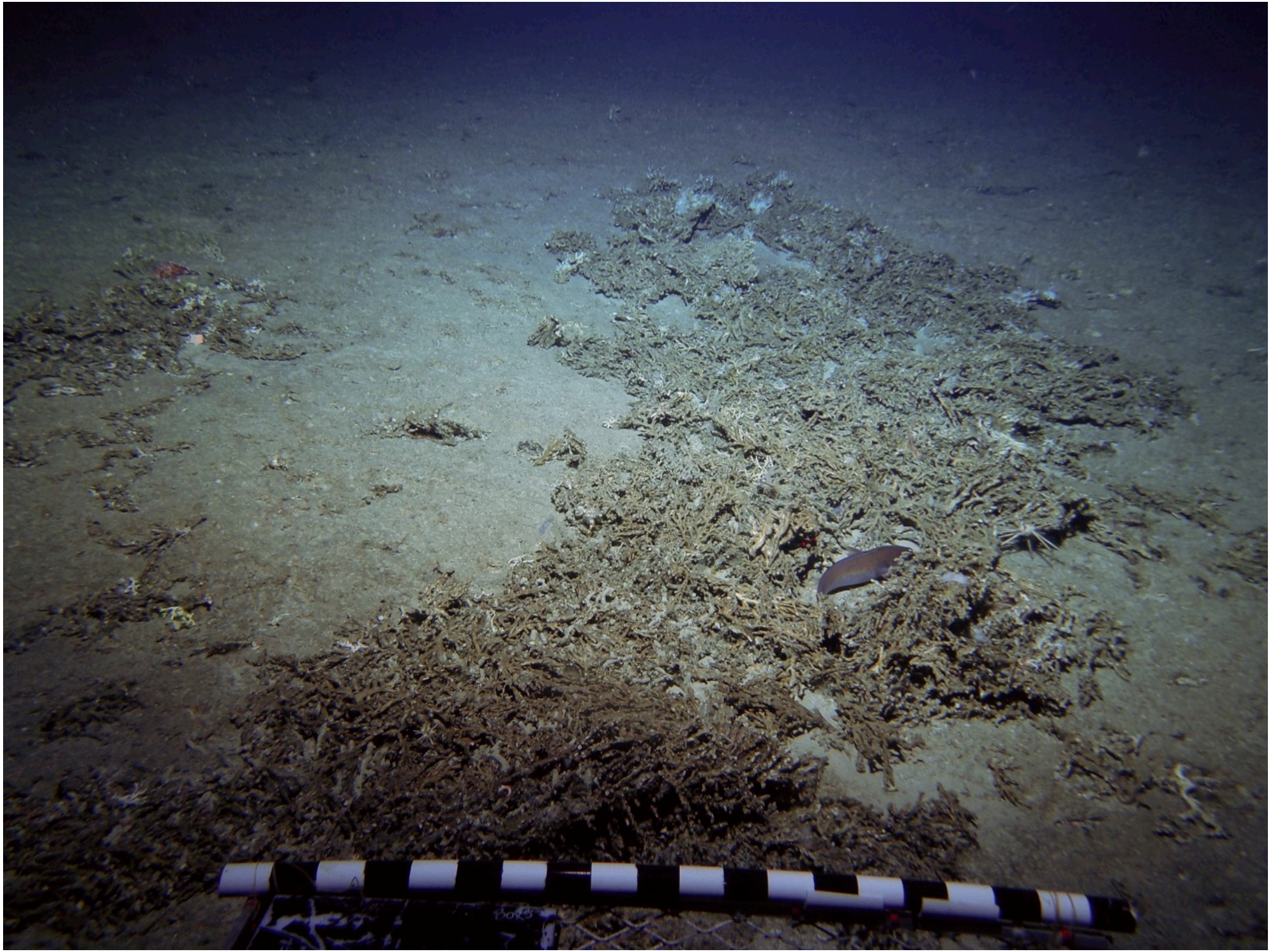


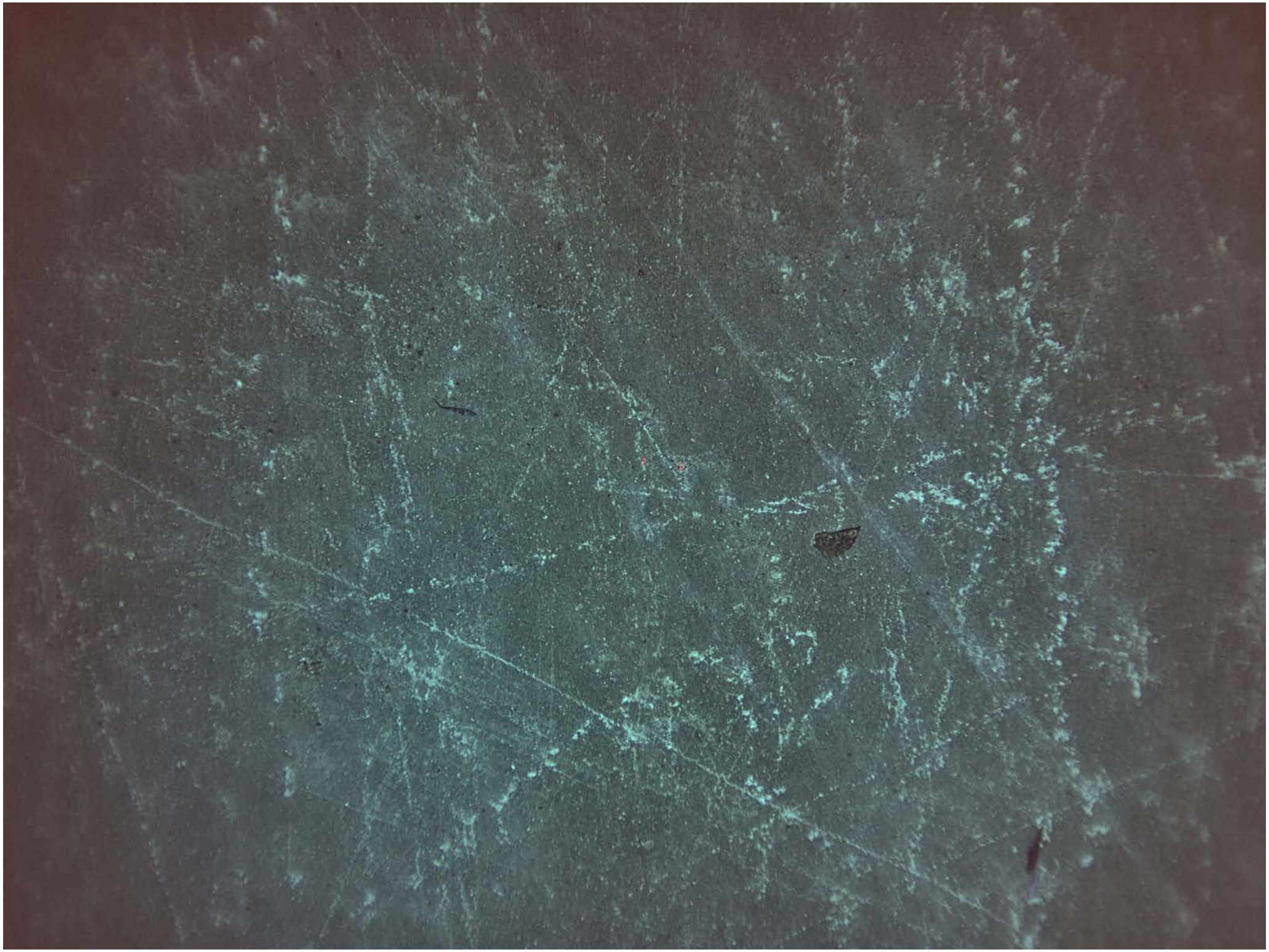








10cm









Impacts to Reefs

- ASH getting shallower because of Ocean Acidification – Loss of Habitat
- Continued Fishing Pressure
- Temperature exacerbates OA effects
- Synergistic Effects

=> Urgently need protection

Acknowledgments

- NSF OCE-1334652 and NSF Grant OCE-1851365 to ARB and OCE-1334675 to EBR, OCE-1851378 to EBR and KS
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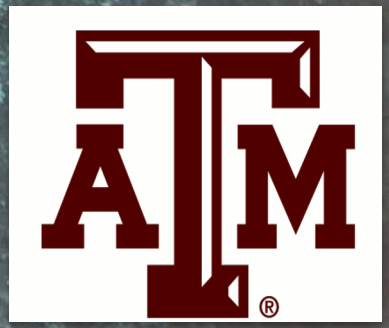
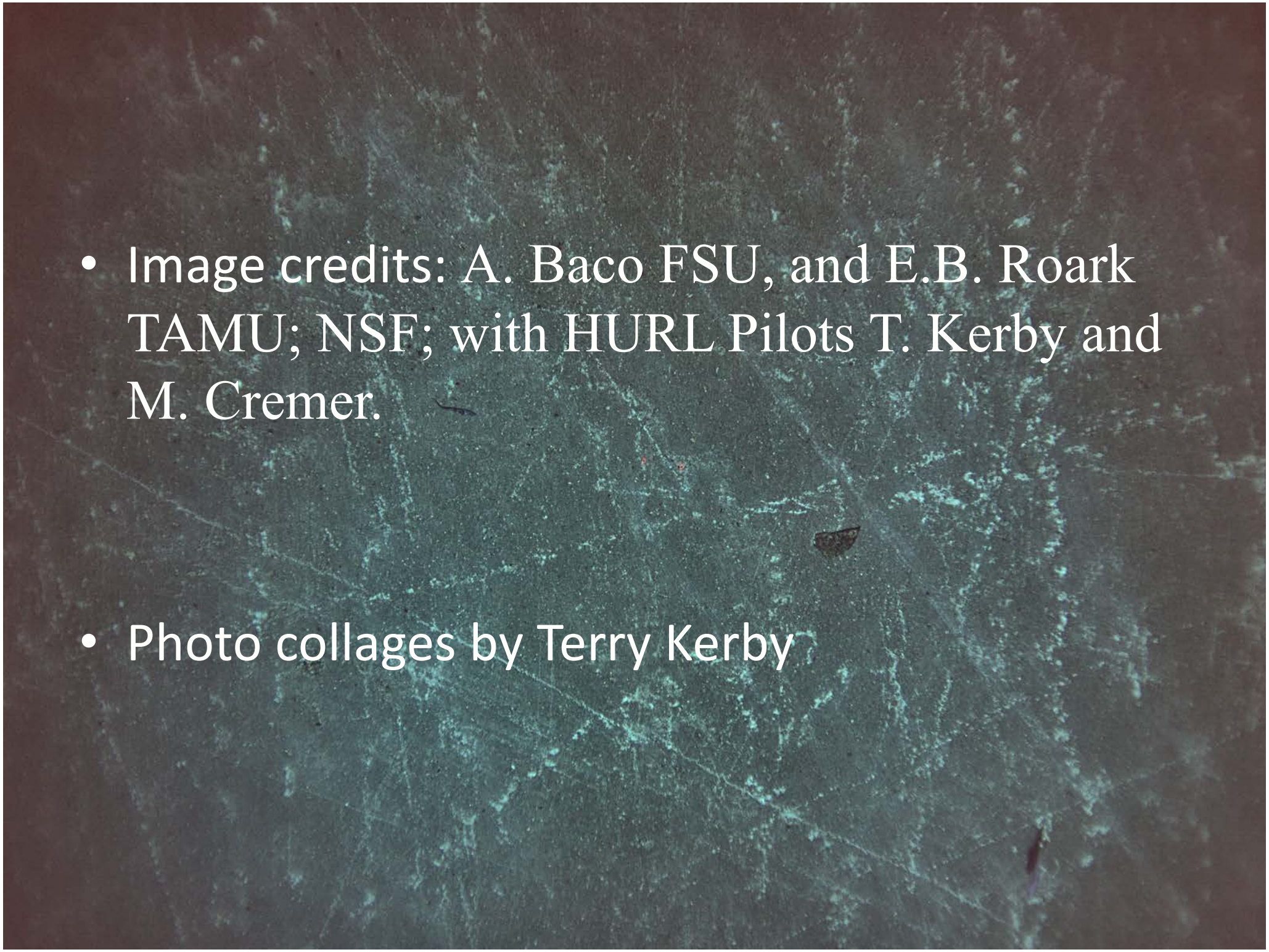
- Sikiliuaq, Kilo Moana, Sentry, KOK, Pisces, Lu`u`kai, Jason Teams
- B. Mejia, A. Shantharam, K. Miller, M. Schoemann, J. Schift, A. Metcalf, M. Betters, J. Andrews
- S. Goode, T. Ferguson, A. Rentz, T. Whitehead





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- Photo collages by Terry Kerby