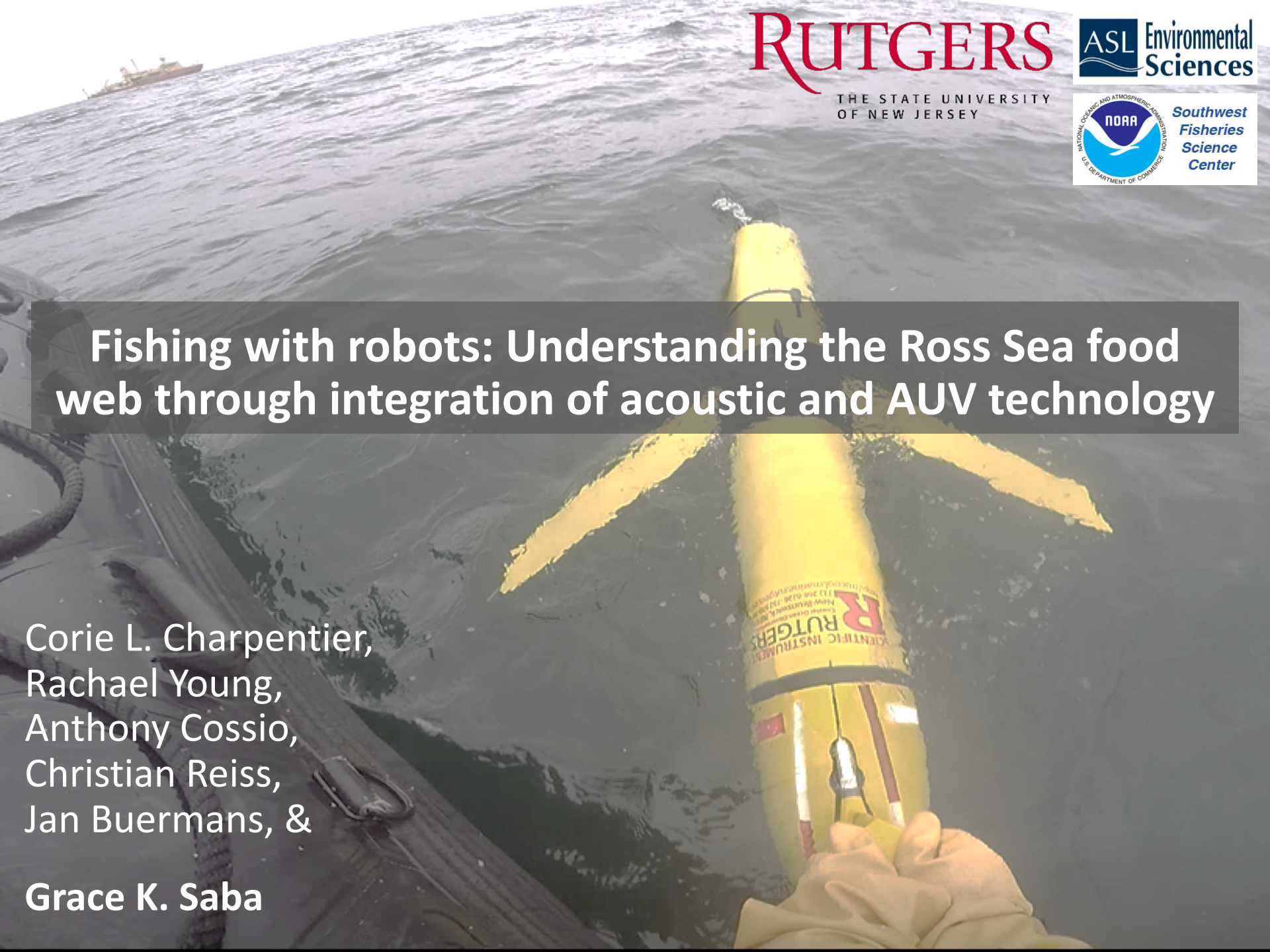


Fishing with robots: Understanding the Ross Sea food web through integration of acoustic and AUV technology

Corie L. Charpentier,
Rachael Young,
Anthony Cossio,
Christian Reiss,
Jan Buermans, &

Grace K. Saba

The Ross Sea

The Ross Sea

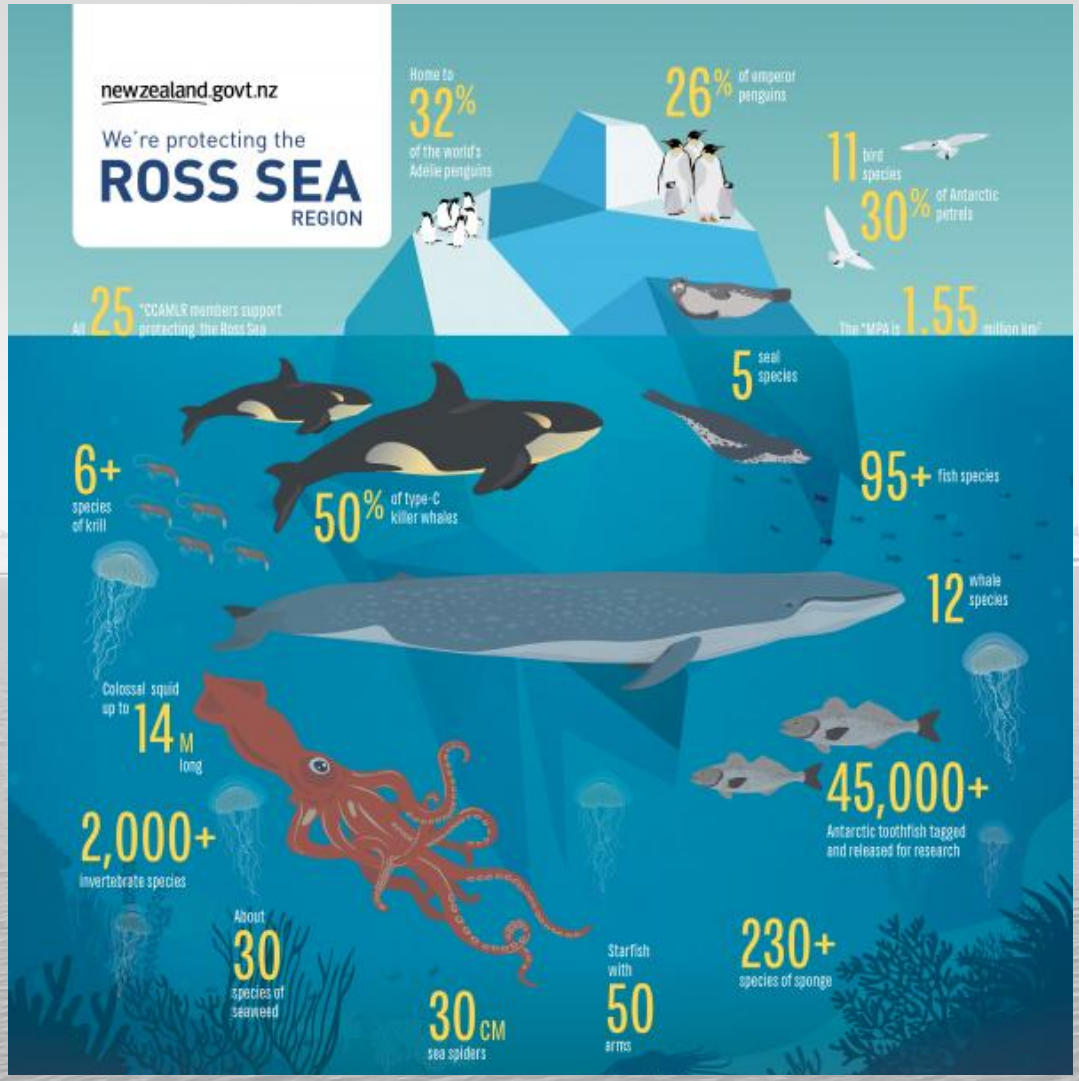
~26% of Southern Ocean primary production (Arrigo et al. [2008] J. Geophys. Res.)

The Ross Sea

~26% of Southern Ocean primary production (Arrigo et al. [2008] J. Geophys. Res.)

Supports a pristine polar ecosystem

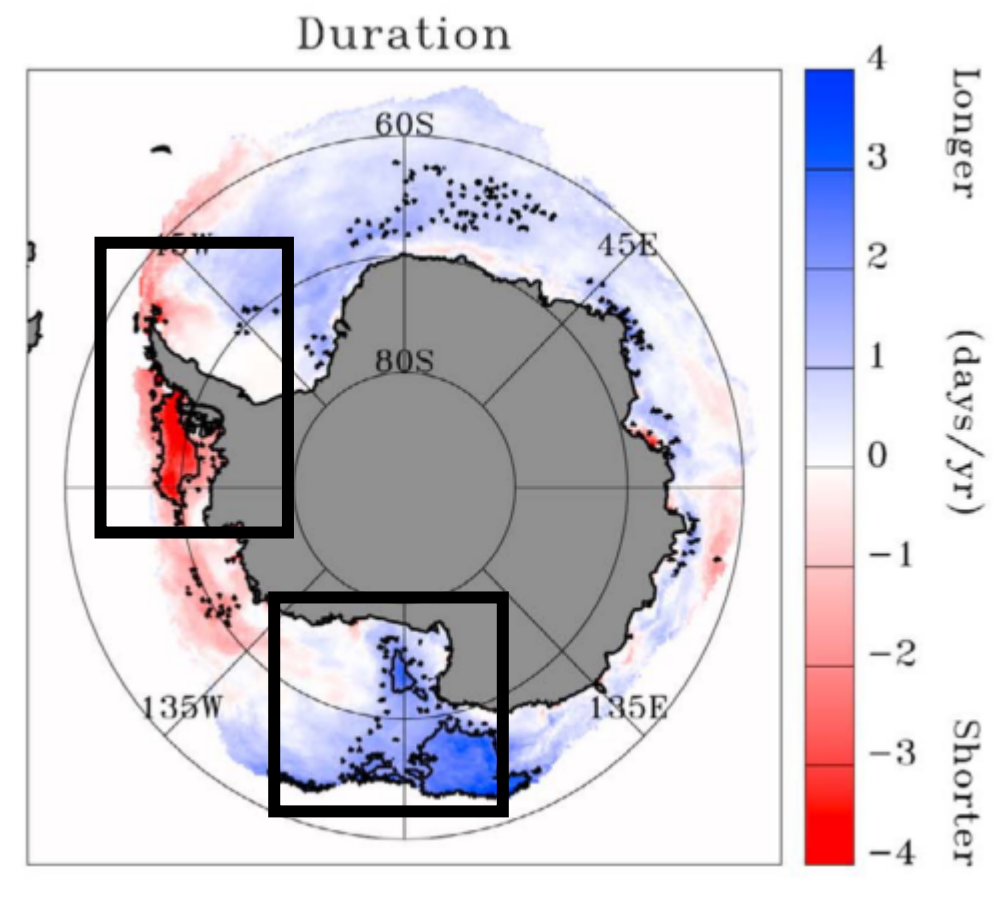
Marine Protected Area (Dec. 2017)



Modified from CCAMLR

The Ross Sea Climate

Ice season (1979/80 – 2010/2011)



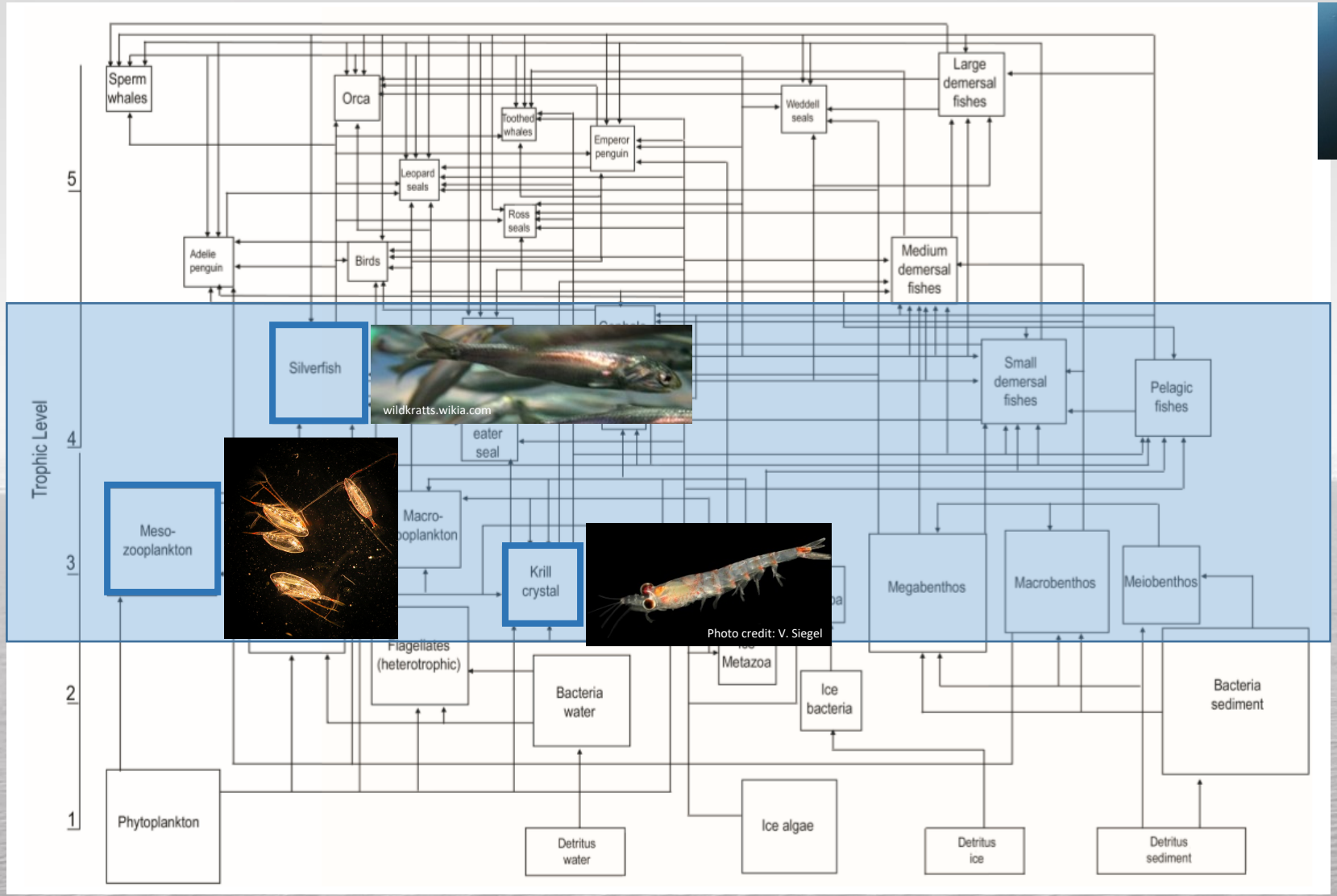
(Stammerjohn et al. [2012] Geophys. Res. Lett.)

Sea ice trend will likely reverse within 50 years in the Ross Sea
(Smith et al. [2014] Geophys. Res. Lett.)

Warming altered food web dynamics in the Western Antarctic Peninsula.

How will future climate affect the Ross Sea ecology?

The Ross Sea food web



?

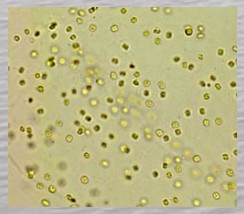


Photo credit: Jack DiTullio

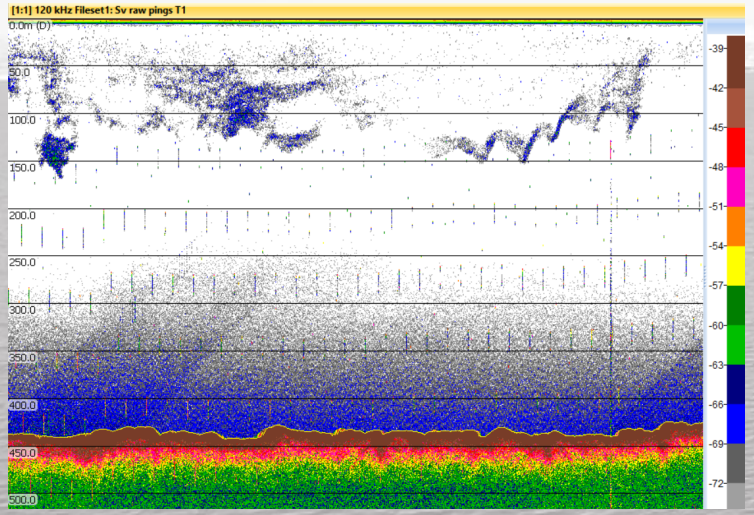
Modified from Pinkerton et al. (2010) CCAMLR Science

What regulates the abundance and dynamics of the middle trophic levels?

Ship-based methods

Net tows

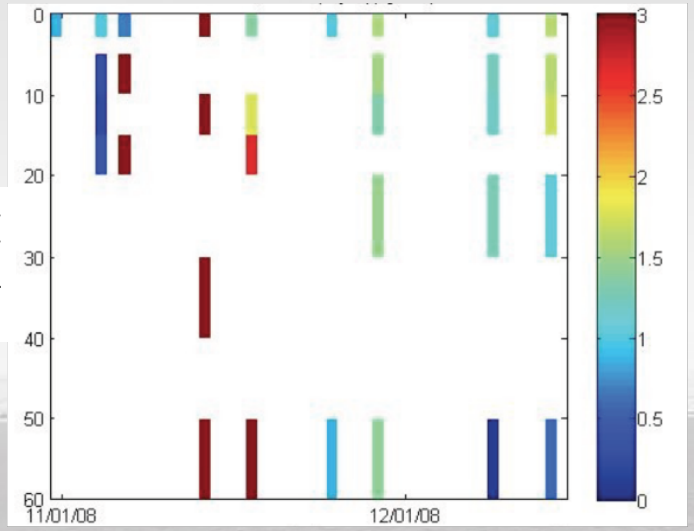
Hull-mounted acoustics



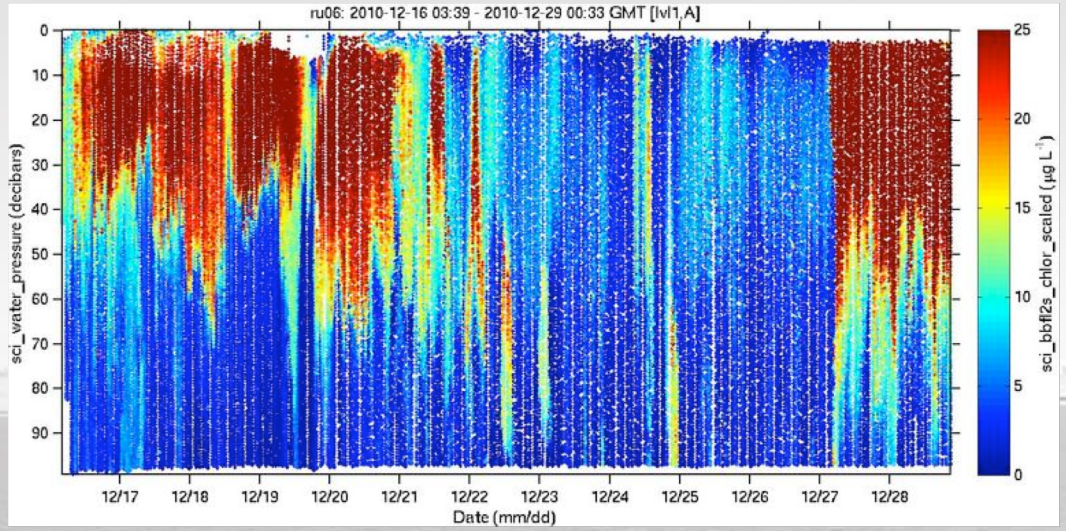
Standard ship-based methods are **costly** and provide **low spatial and temporal resolution**.

An AUV approach: Increasing resolution

Ship

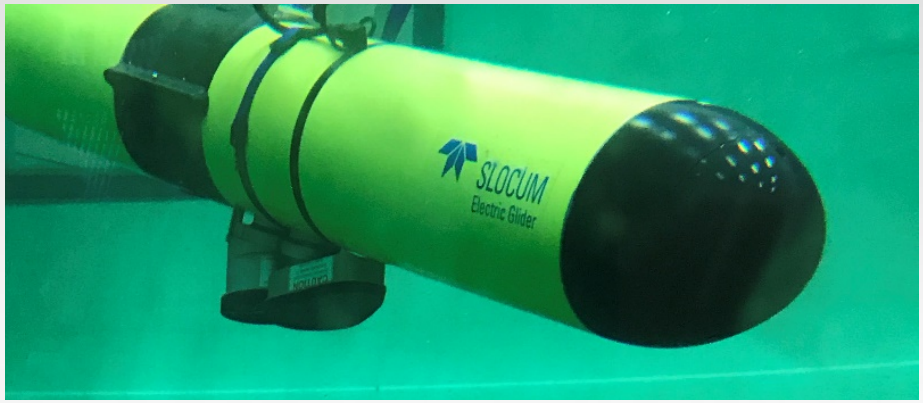


Glider



Glider technology offers a **cost-effective**, **high-resolution** alternative.

An AUV approach

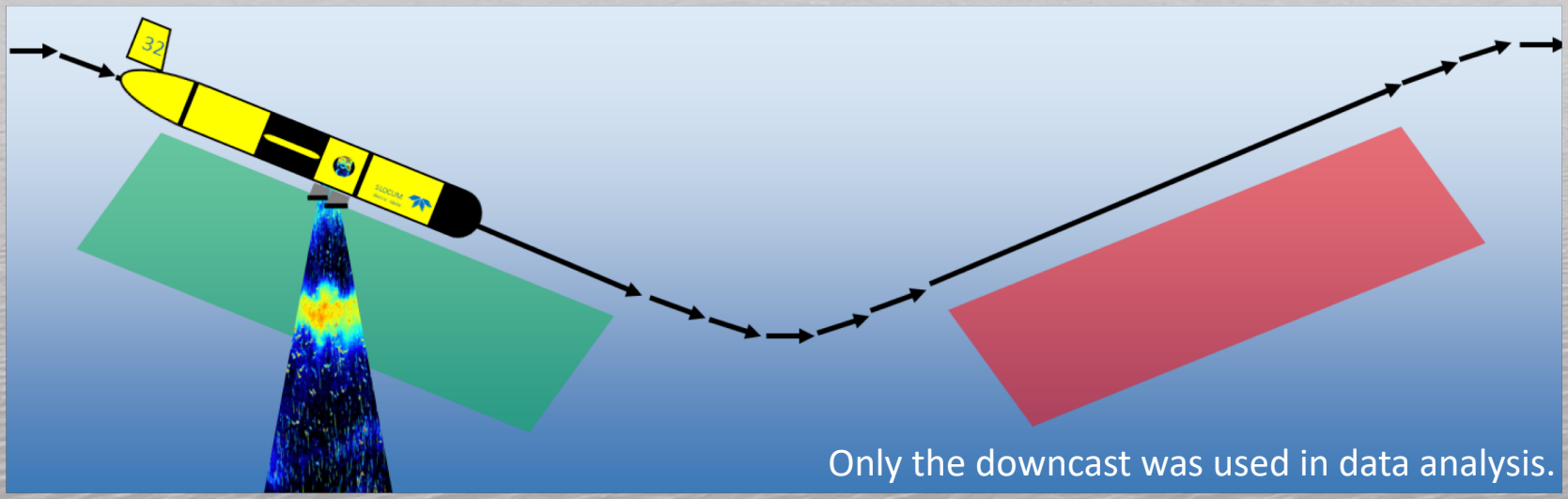


Slocum Webb G2 Glider

- CTD, WET Labs BB2FL ECO puck (chlorophyll fluorescence, optical backscatter), Aanderaa Optode (dissolved oxygen)

Acoustic Zooplankton Fish Profiler (AZFP)

- 38, 125, and 200 kHz

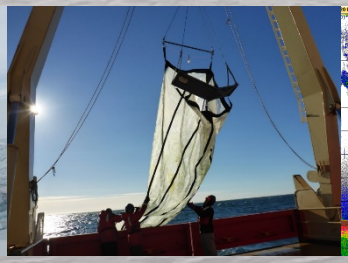
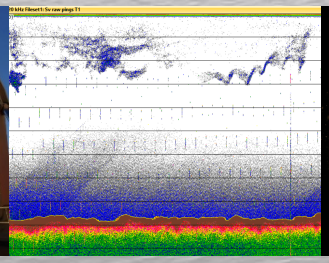


Testing our AUV approach

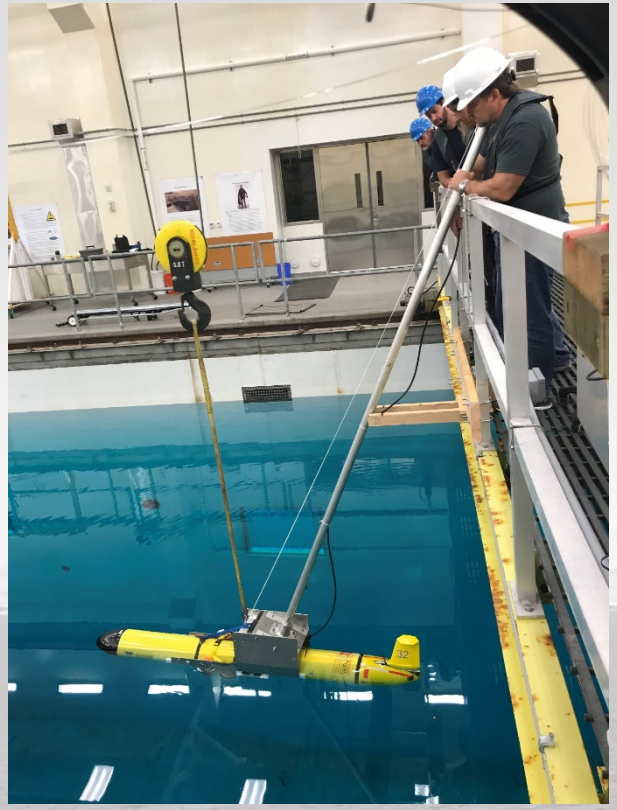
1. Calibrate glider acoustics and deploy glider in the Ross Sea

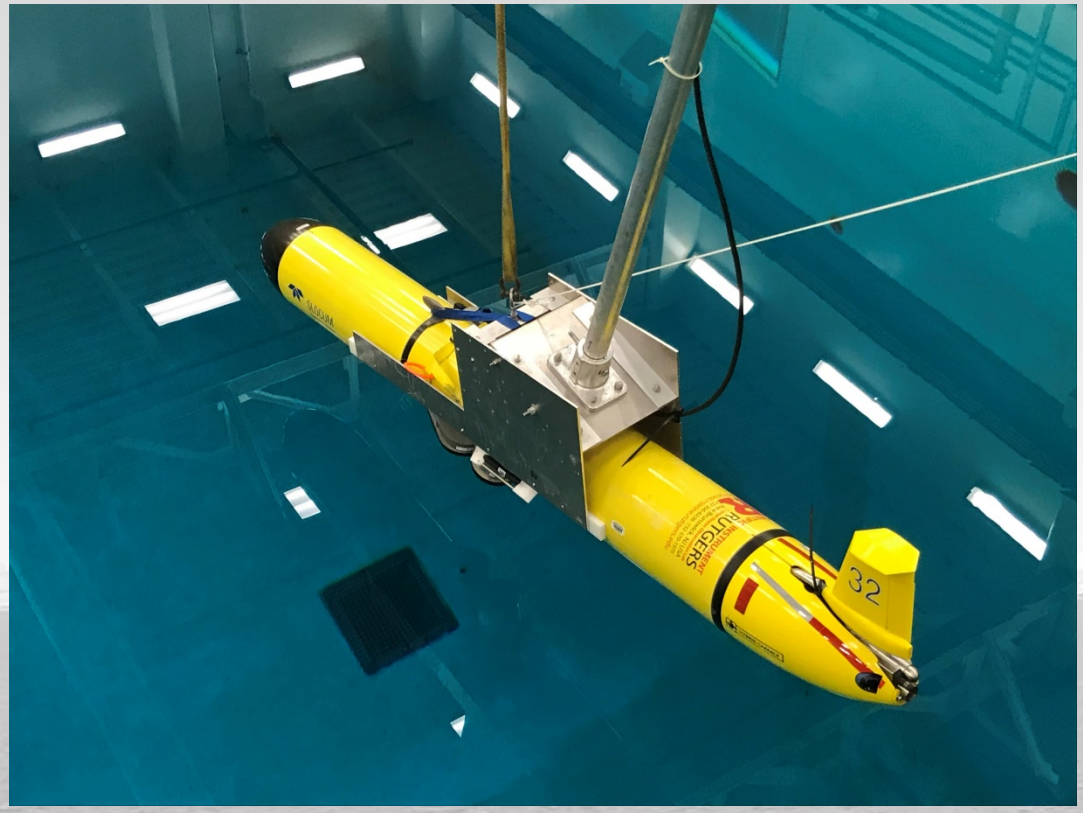
2. Ground truth glider acoustics with ship-based methods

3. Using integrated glider platform, develop methodology to assess food web dynamics in the Ross Sea


Acoustics calibration

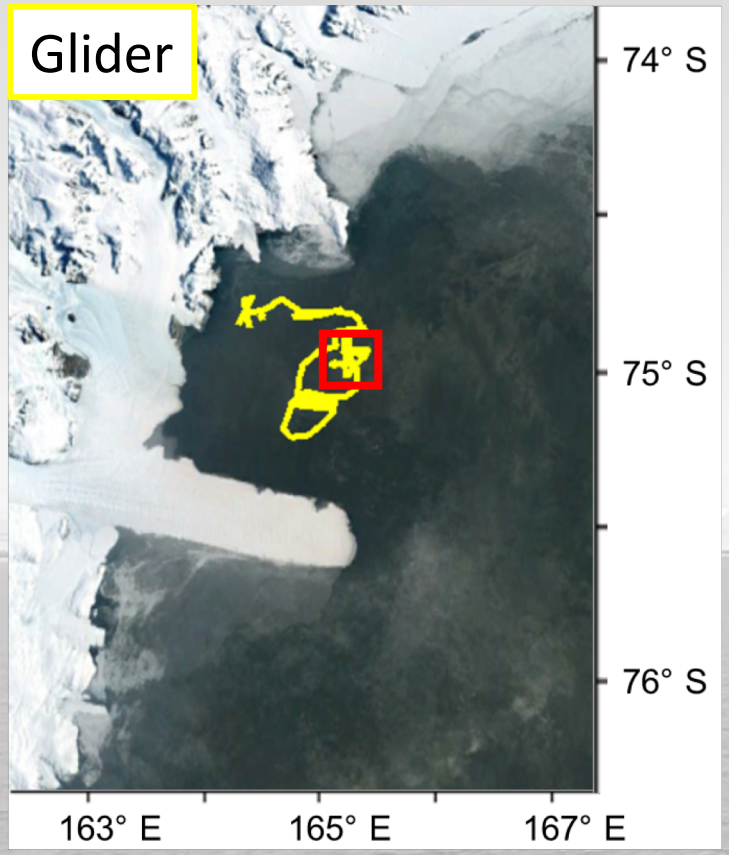


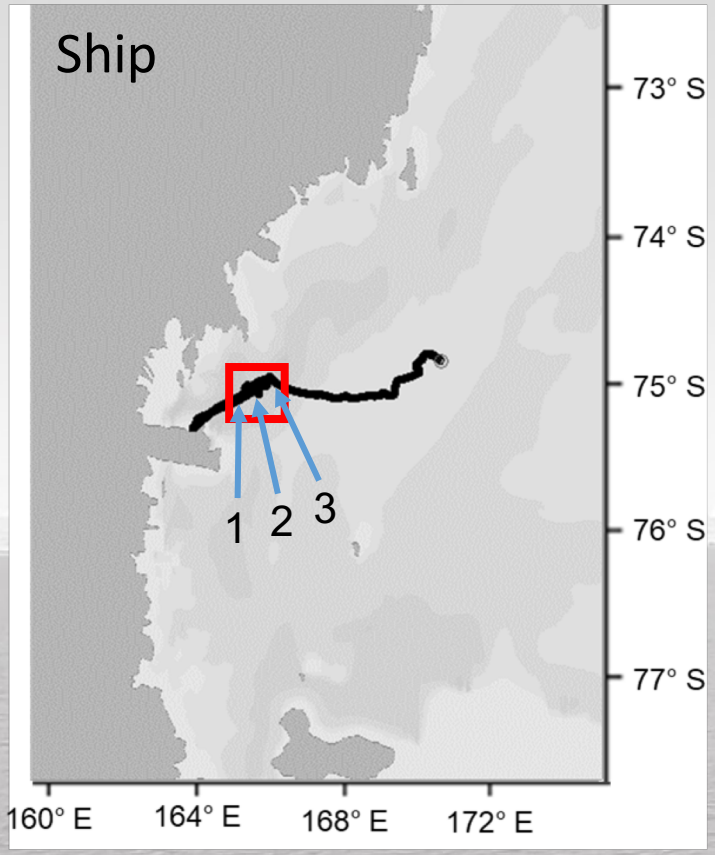


Frequency (kHz)	Sphere type (size)	Depth of sphere (m)	Offset (dB)
38	Tungsten carbide (33.2 mm)	4.5	-1.08
125	Tungsten carbide (33.2 mm)	8.5	+1.27
200	Tungsten carbide (38.1 mm)	4.5	+1.40

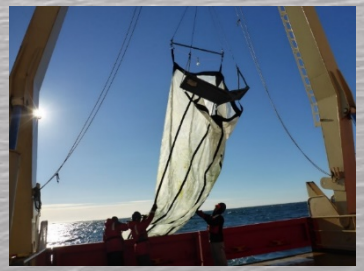
**Sensor at a salinity of 33.08, temperature of 20.3 C, pressure of 0.21 atm

Glider deployment in the Ross Sea

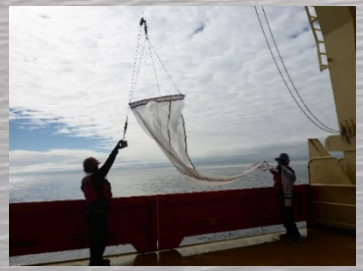




Net tows (3 locations): Isaacs-Kidd Midwater Trawl

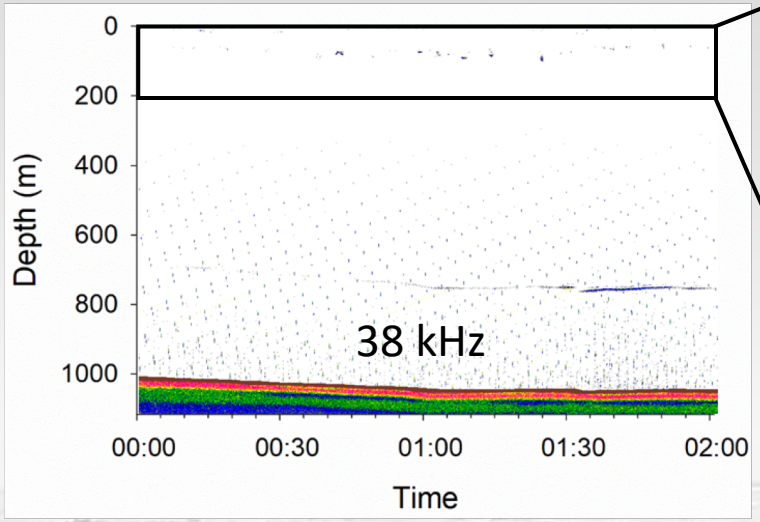


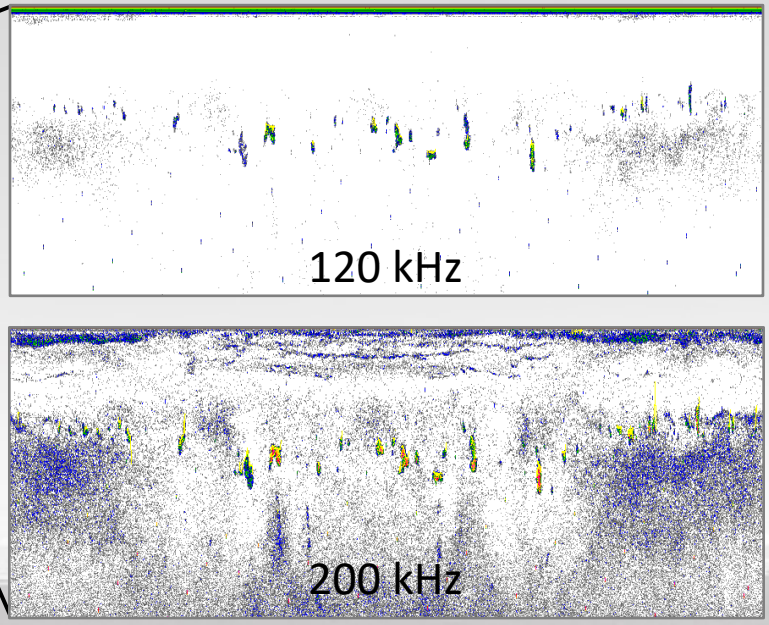
1-m^2 Plankton Net



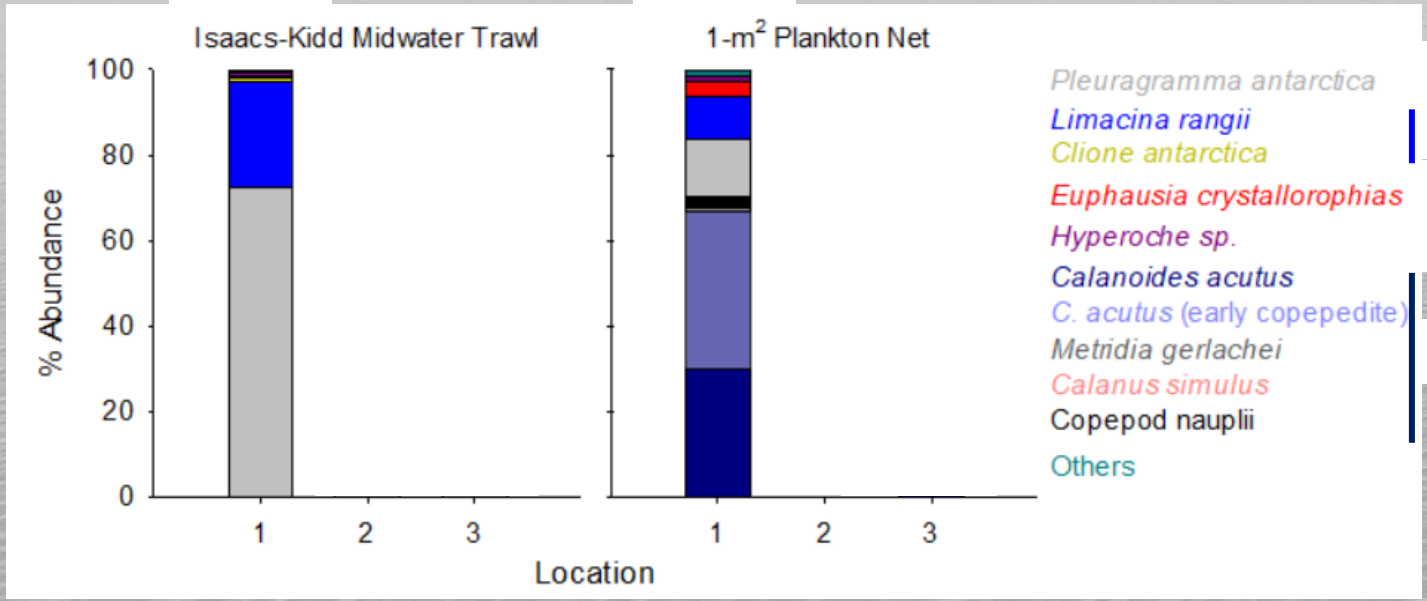
Ground truthing (Location 1)

Ship's acoustics (EK60)



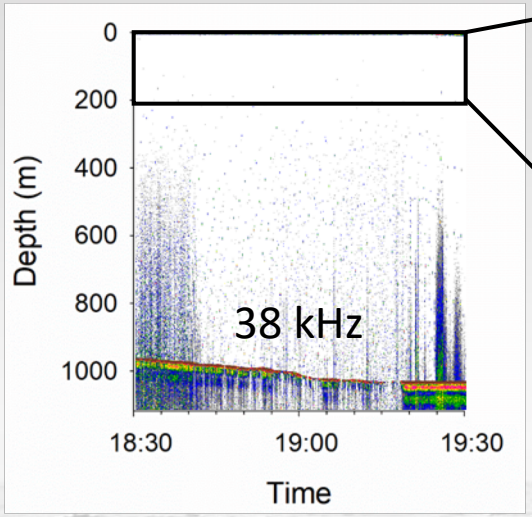


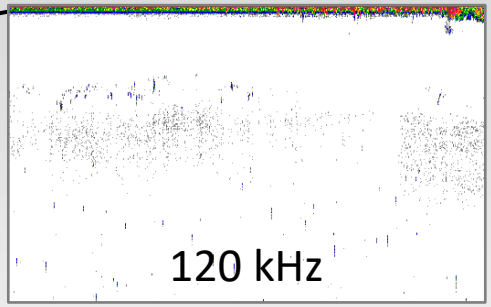
Net tows 100 m 110 m

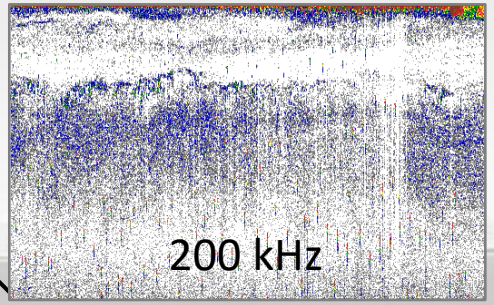


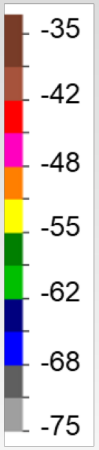
Ground truthing (Location 2)

Ship's acoustics (EK60)



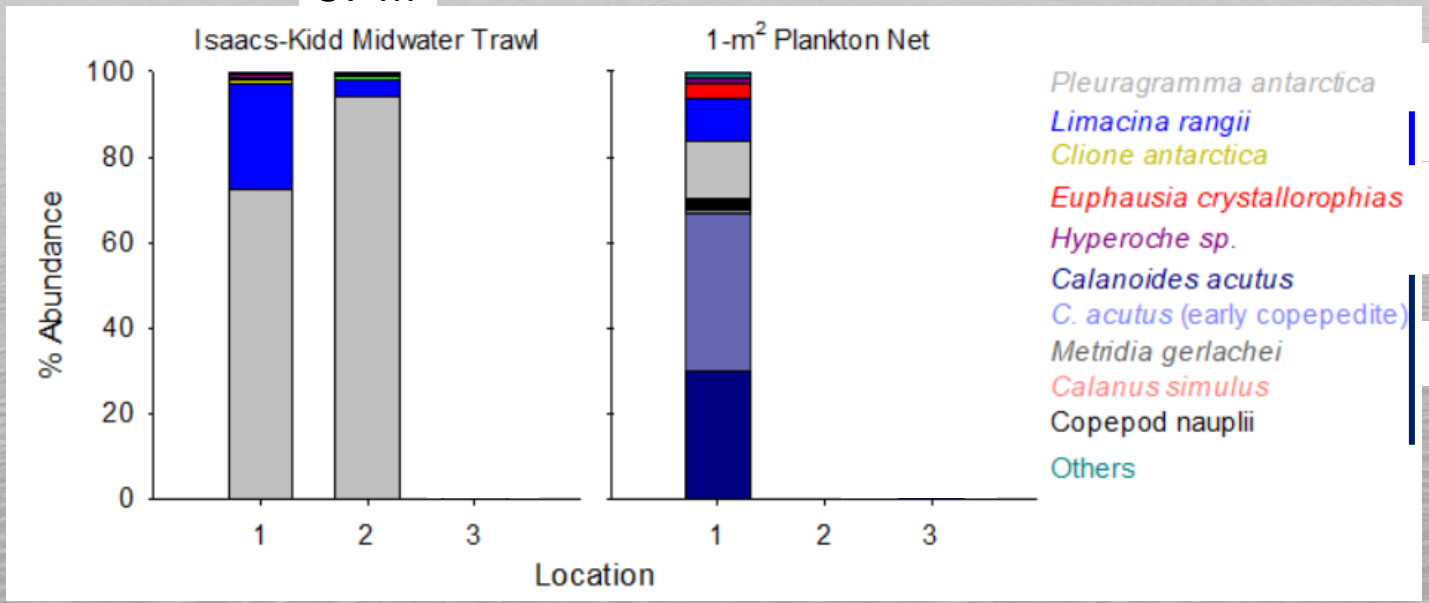






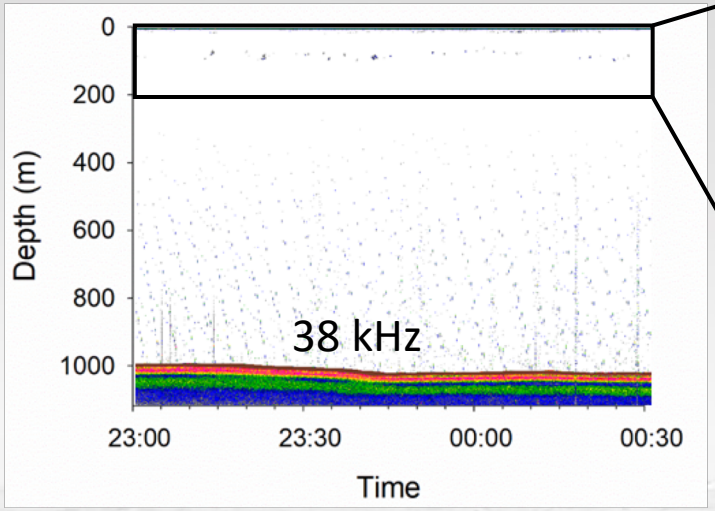
Net tows

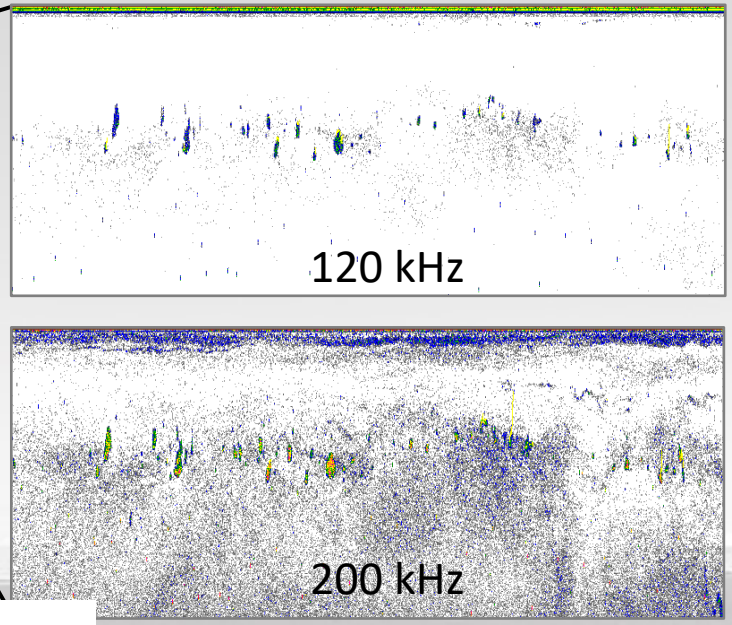
57 m

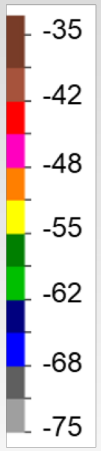


Ground truthing (Location 3)

Ship's acoustics (EK60)



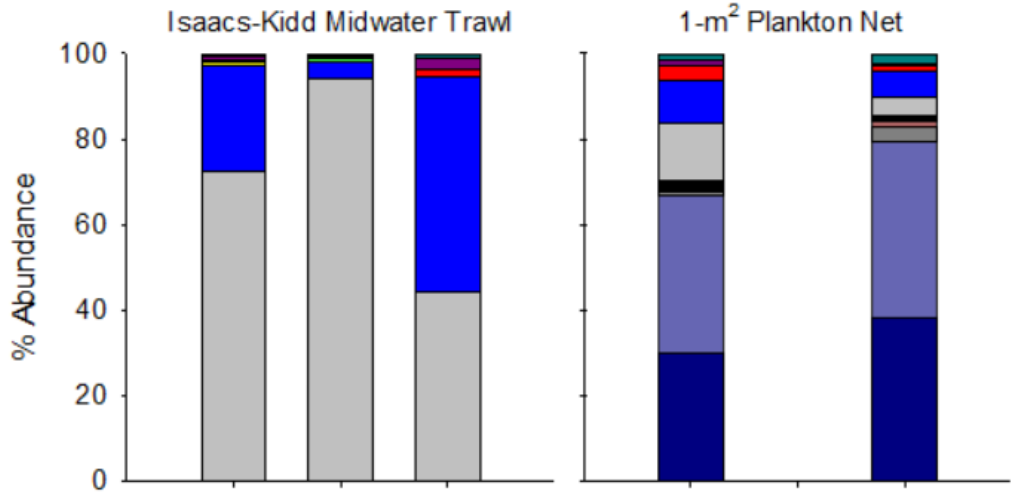




Net tows

100 m

124 m



Pleuragramma antarctica — Silverfish larvae

Limacina rangii — Pteropods

Clione antarctica — Pteropods

Euphausia crystallorophias — Krill

Hyperoche sp. — Amphipods

Calanoides acutus — Copepods

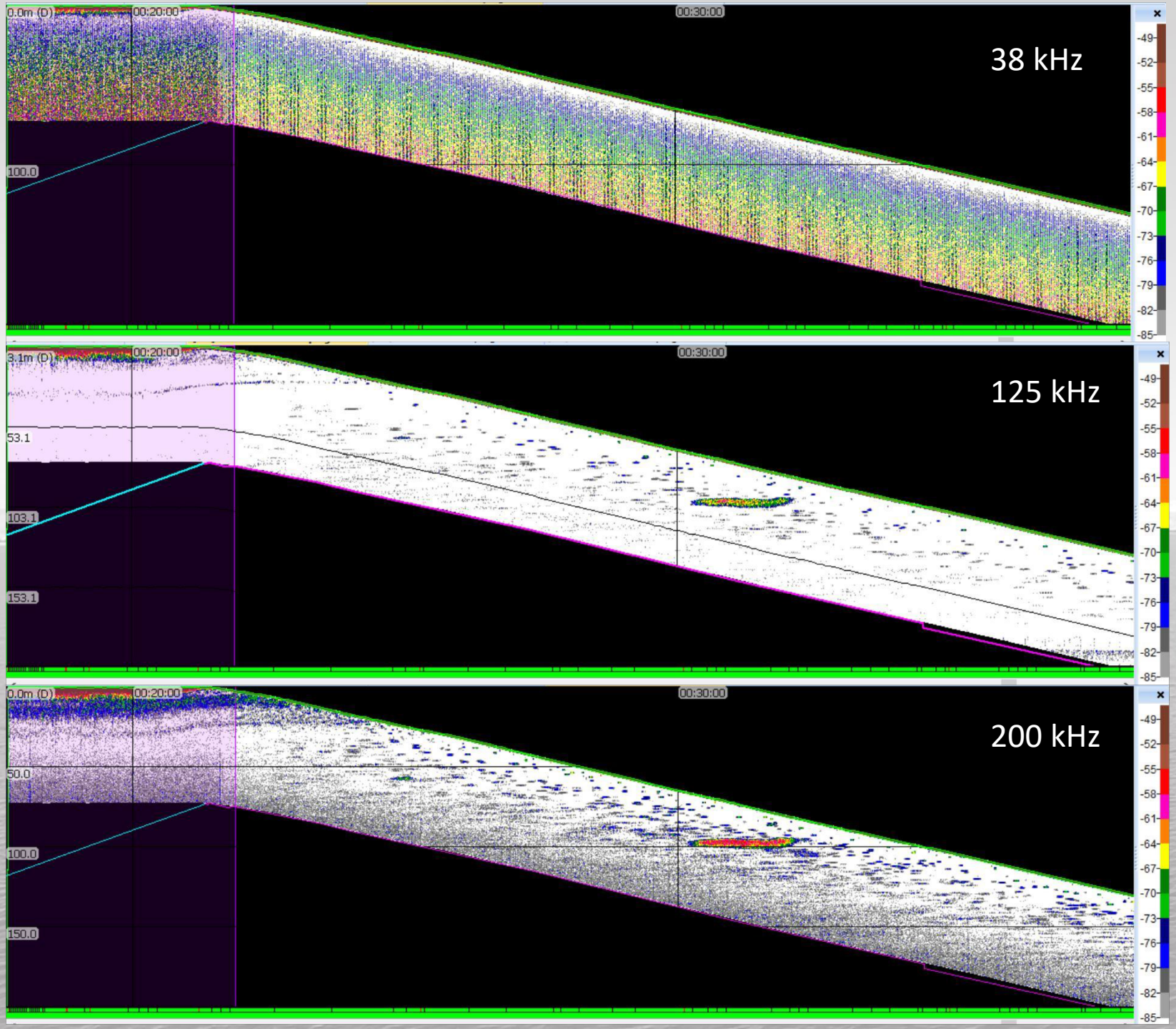
C. acutus (early copepedite) — Copepods

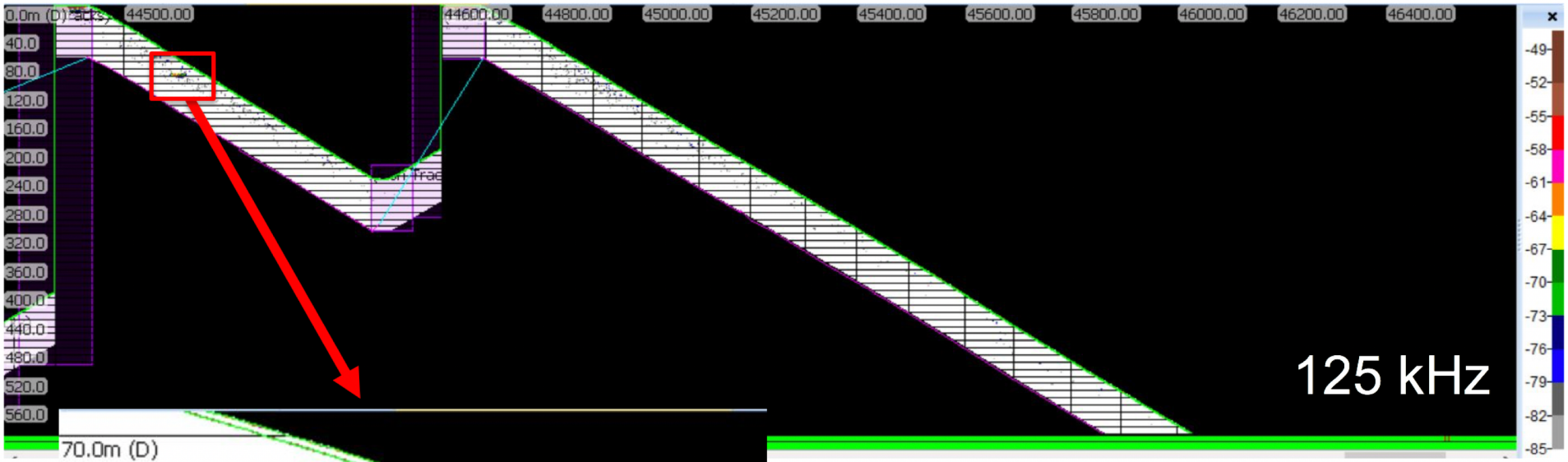
Metridia gerlachei — Copepods

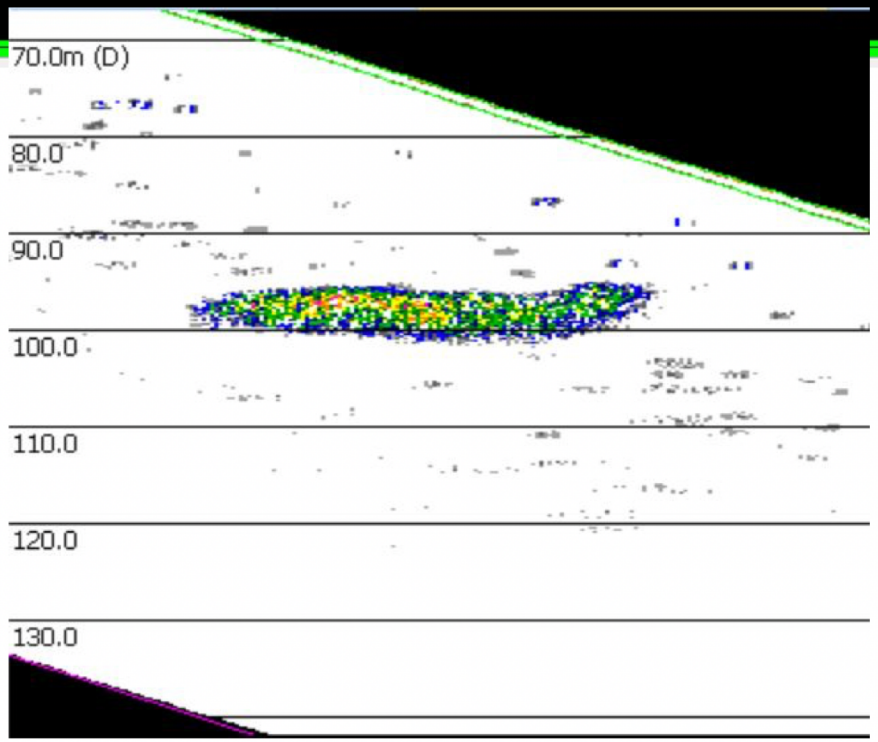
Calanus simulus — Copepods

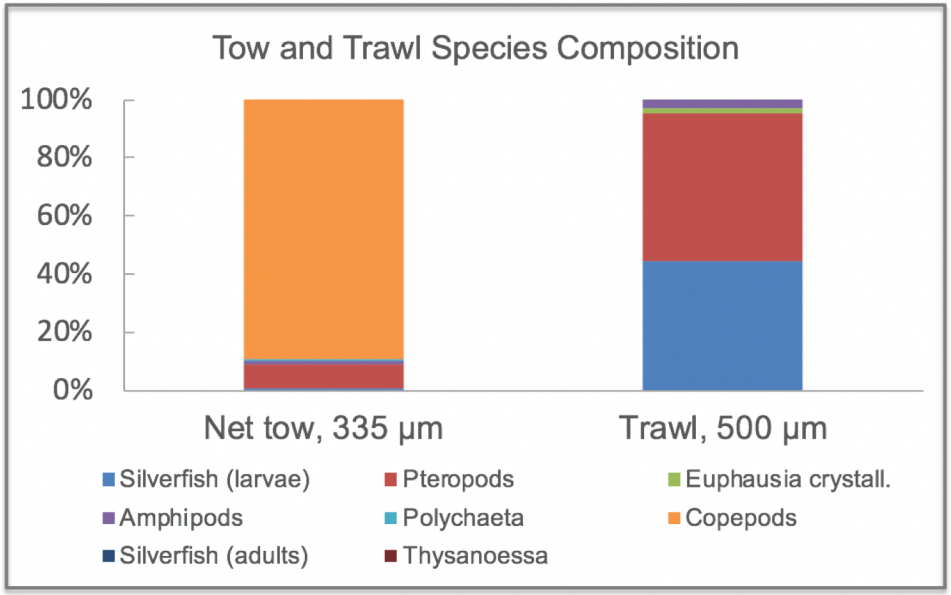
Copepod nauplii — Copepods

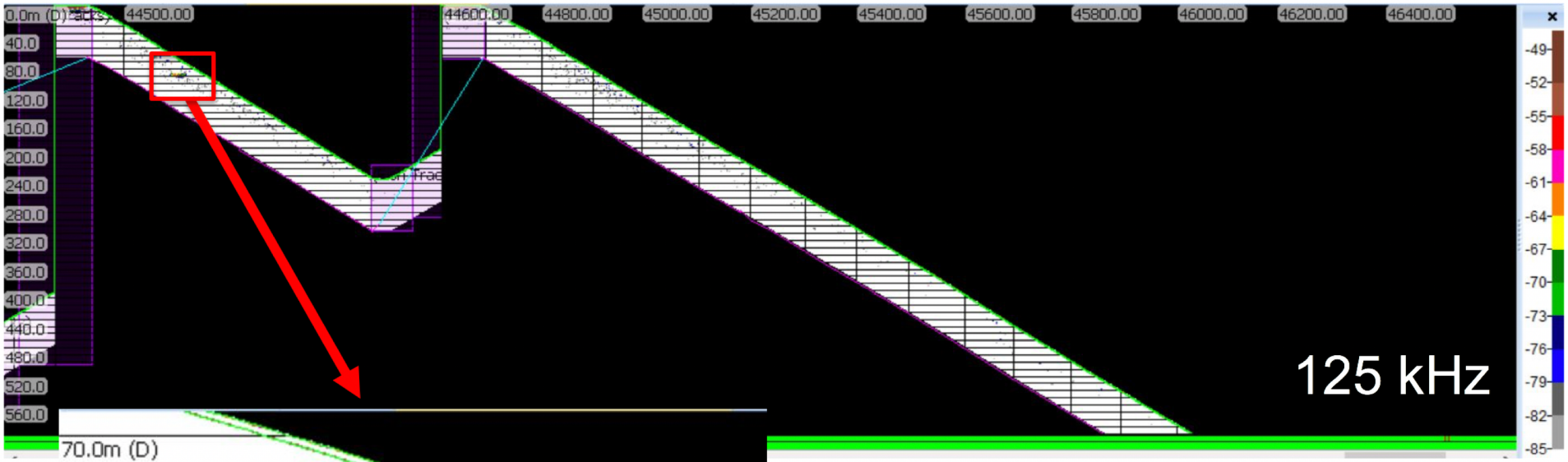
Others

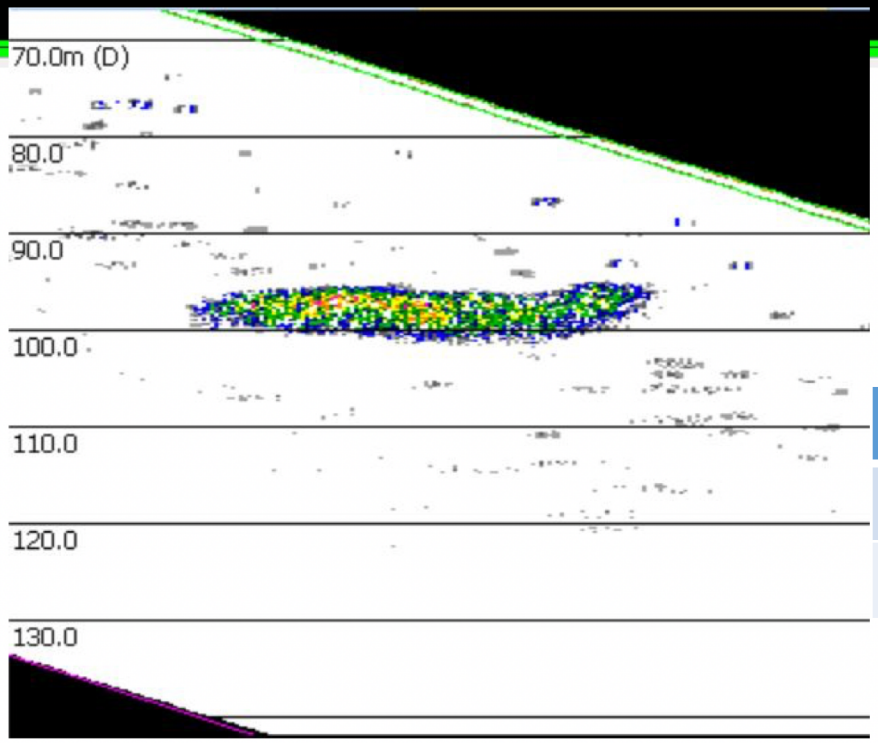

38 kHz
125 kHz
200 kHz
00:20:00
00:30:00
100.0
53.1
103.1
153.1
50.0
150.0


44500.00
44600.00
44800.00
45000.00
45200.00
45400.00
45600.00
45800.00
46000.00
46200.00
46400.00
40.0
80.0
120.0
160.0
200.0
240.0
280.0
320.0
360.0
400.0
440.0
480.0
520.0
560.0
-49
-52
-55
-58
-61
-64
-67
-70
-73
-76
-79
-82
-85
125 kHz

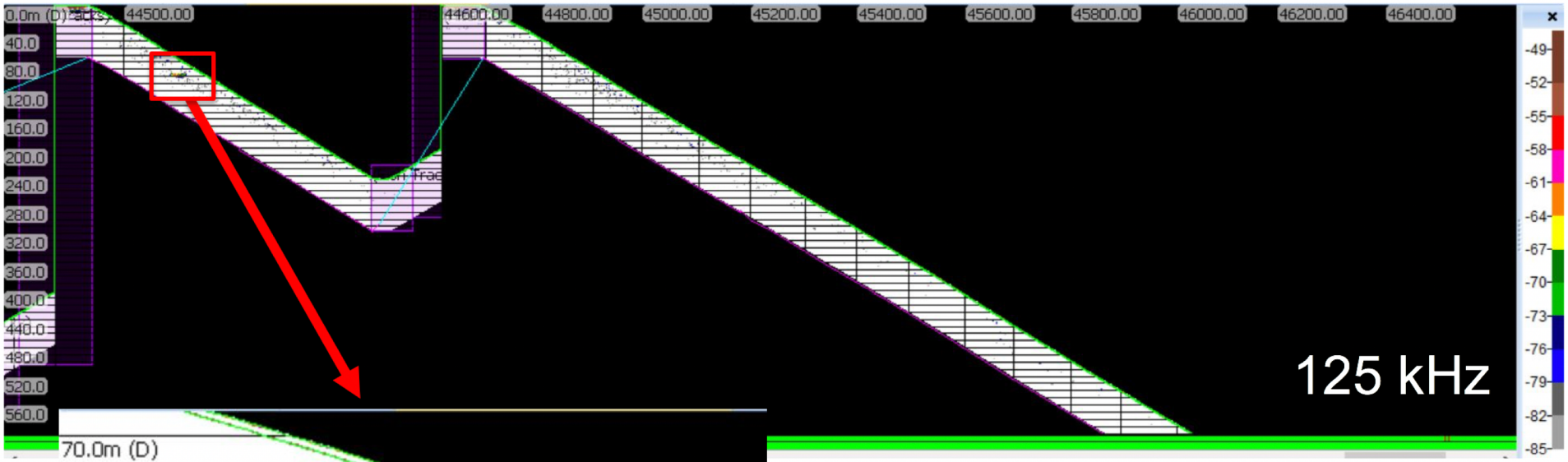

70.0m (D)
80.0
90.0
100.0
110.0
120.0
130.0

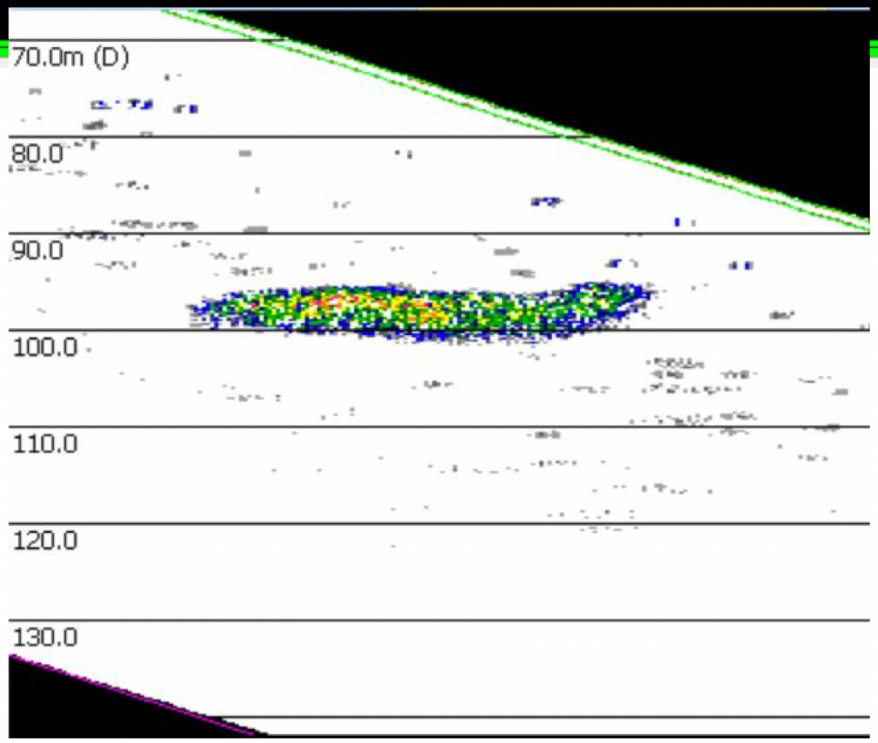

Tow and Trawl Species Composition
100%
80%
60%
40%
20%
0%
Net tow, 335 µm
Trawl, 500 µm
Silverfish (larvae)
Pteropods
Euphausia crystall.
Amphipods
Polychaeta
Copepods
Silverfish (adults)
Thysanoessa

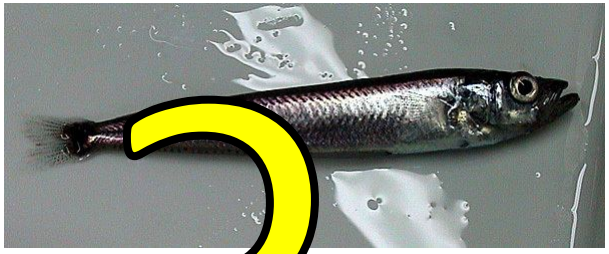




Method	Crystal krill density (g/m^2)
Tows/Trawls	10.9 - 11.37
AZFP estimate (SDWBA)	10.23


0.0m (D)
44500.00
44600.00
44800.00
45000.00
45200.00
45400.00
45600.00
45800.00
46000.00
46200.00
46400.00
40.0
80.0
120.0
160.0
200.0
240.0
280.0
320.0
360.0
400.0
440.0
480.0
520.0
560.0
-49
-52
-55
-58
-61
-64
-67
-70
-73
-76
-79
-82
-85
125 kHz


70.0m (D)
80.0
90.0
100.0
110.0
120.0
130.0

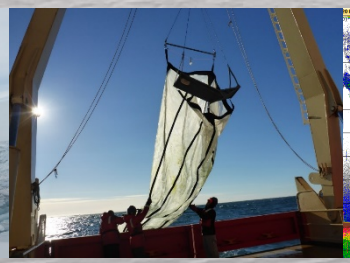
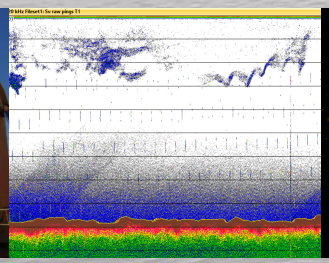


Testing our AUV approach

1. Calibrate glider acoustics and deploy glider in the Ross Sea ✓

2. Ground truth glider acoustics with ship-based methods ✓

3. Using integrated glider platform, develop methodology to assess food web dynamics in the Ross Sea


Just the tip of the *iceberg*: What's next?

1. Determine the physical drivers of zooplankton and silverfish size and distribution

2. Investigate the relationships between phytoplankton, zooplankton, and fish distributions

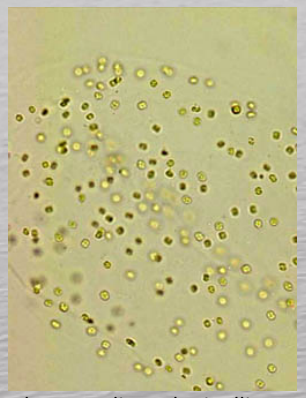




Photo credit: Jack DiTullio

David Aragon, Nicole Waite, Chip Haldeman, Schuyler Nardelli, Camille Adkison

David Lemon, Matt Stone, Rene Chave

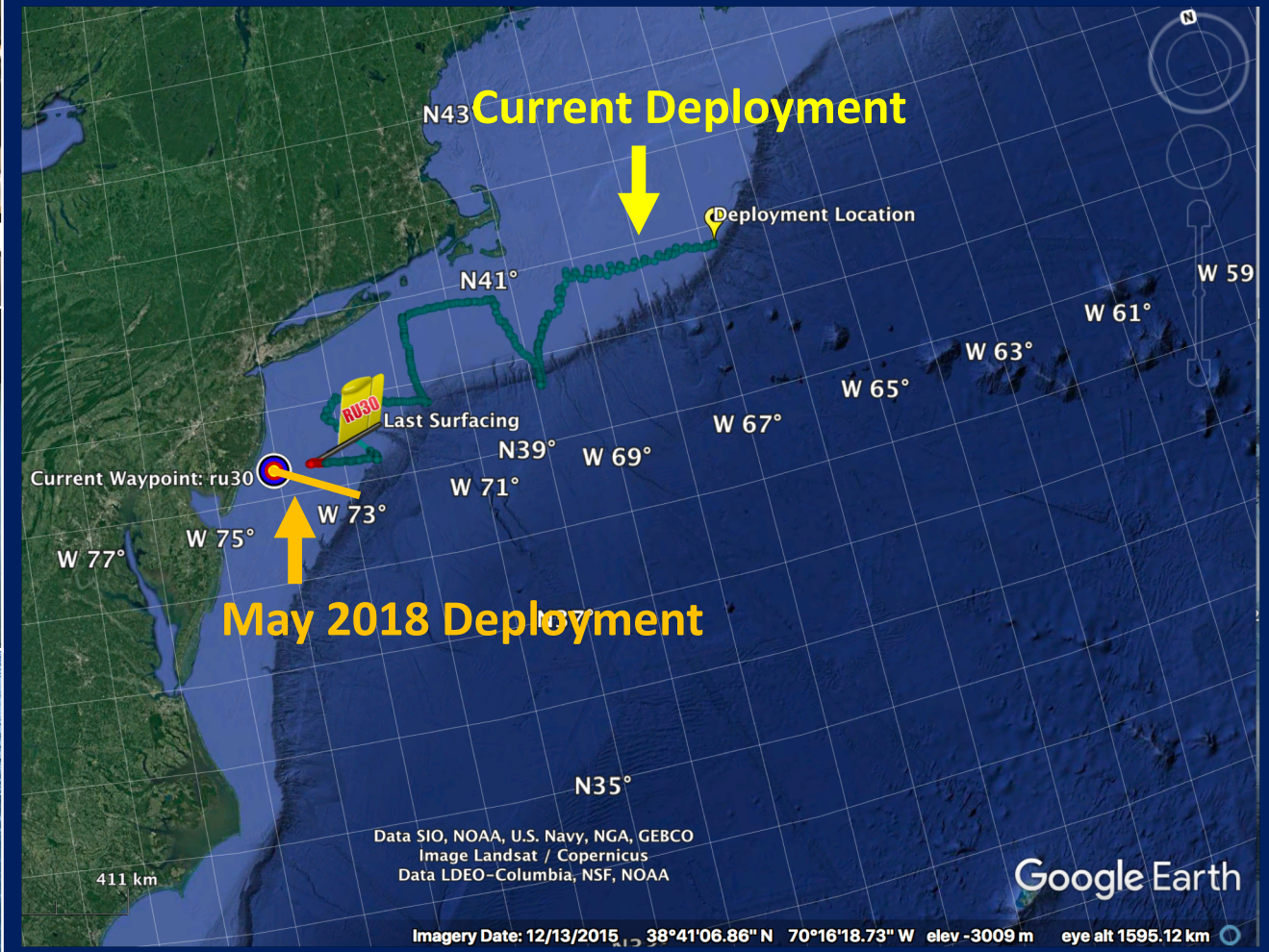
Antarctic companions: Crew of the R/V Nathaniel B Palmer, Jack Ditullio, Mak Saito, Rob Dunbar, Jamee Johnson, Linnah Neidel, Matt Louis, Shannon Zellerhoff, Nikki Chatelain, Bryan Chambers

Thank you!

Developing a profiling glider pH sensor for high resolution coastal ocean acidification monitoring

NSF OTIC Program (OCE #1634520)

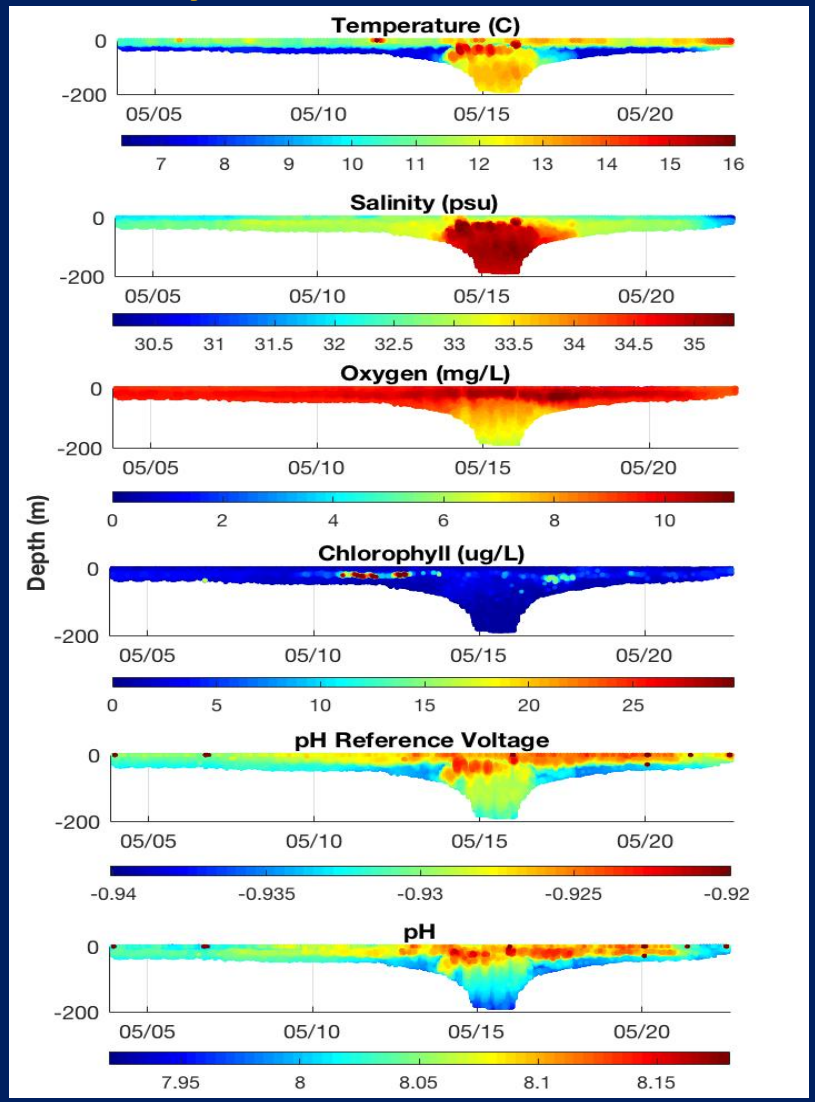
Developing a profiling glider pH sensor for high resolution coastal ocean acidification monitoring



NSF OTIC Program (OCE #1634520)

Developing a profiling glider pH sensor for high resolution coastal ocean acidification monitoring

May 2018 – NJ cross-shelf



NSF OTIC Program (OCE #1634520)