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What we're learning from acoustic surveys of euphausiids in the Bering Sea, the Gulf of Alaska, and the Barents Sea
# (a tale of the once and future ping)

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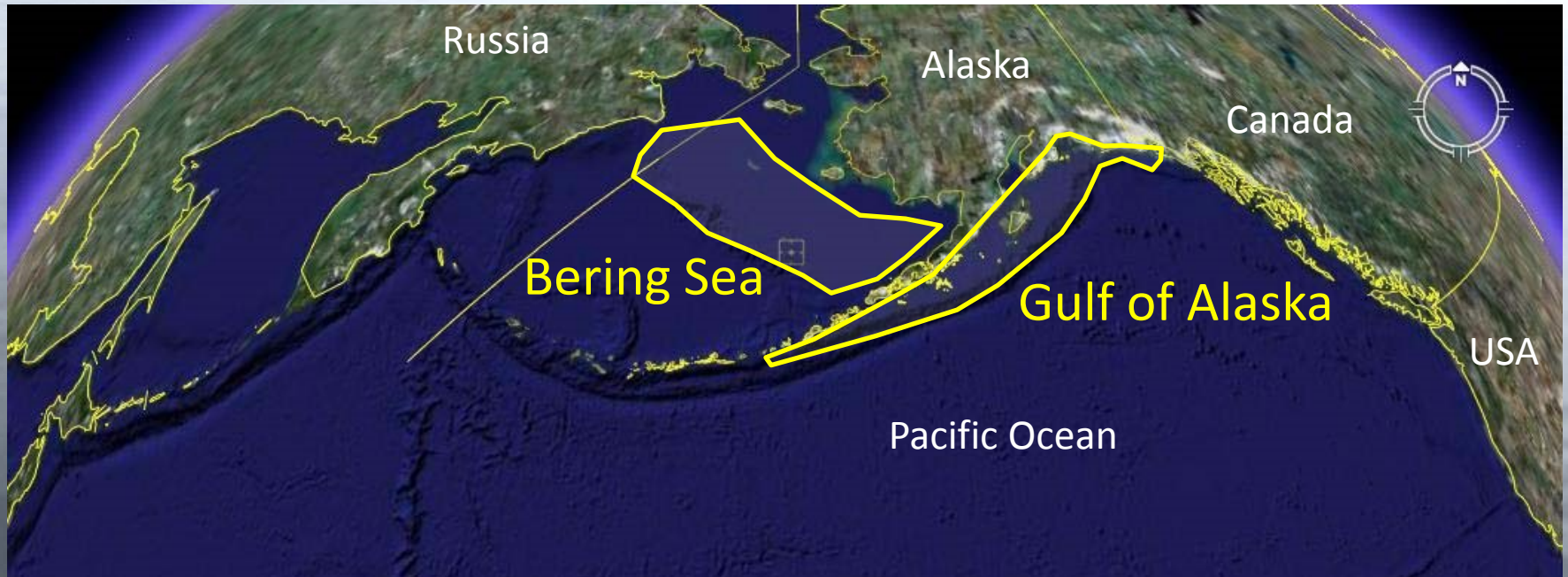
Why acoustic surveys of euphausiids?

- Important trophic link

- Distribution and abundance data useful for both ecological studies and resource management

- Acoustic surveys are tractable and can be built into/onto acoustic surveys of midwater fish (long time series with stable support)

Thysanoessa inermis
Hopcroft/UAf/NOAA/CoML

euphausiid s_A, DY1407 (preliminary)
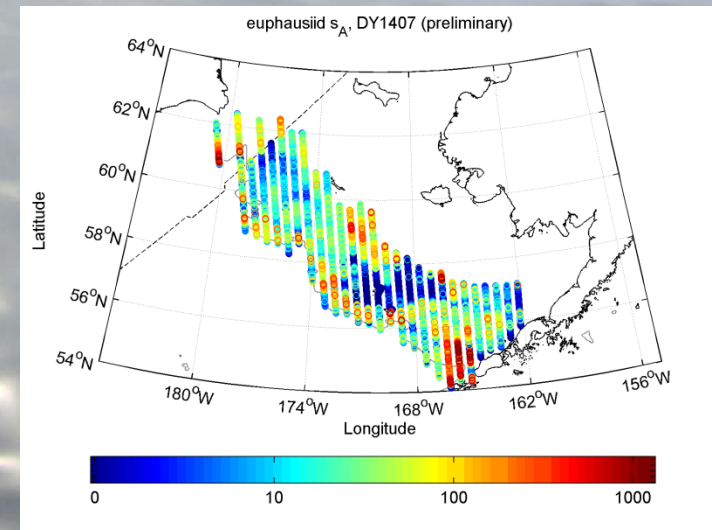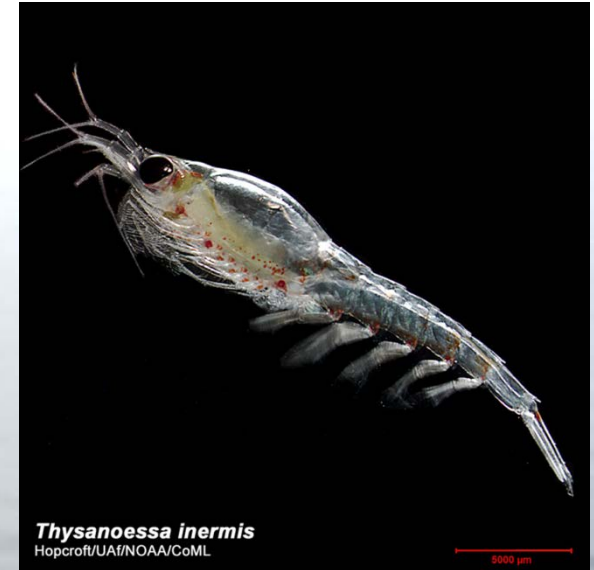
What we do and how we do it

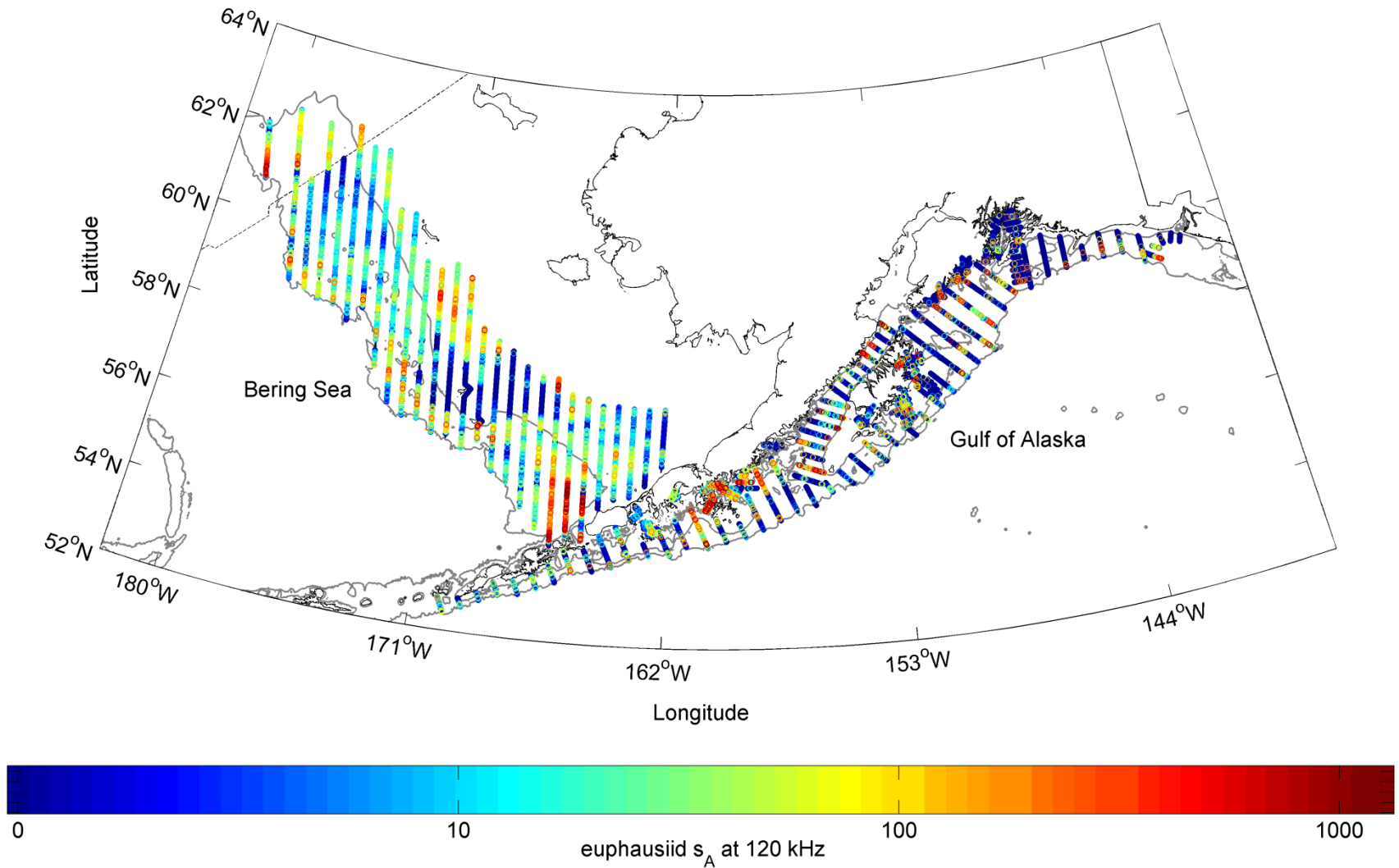# Use data from acoustic-trawl surveys of walleye pollock in Alaska

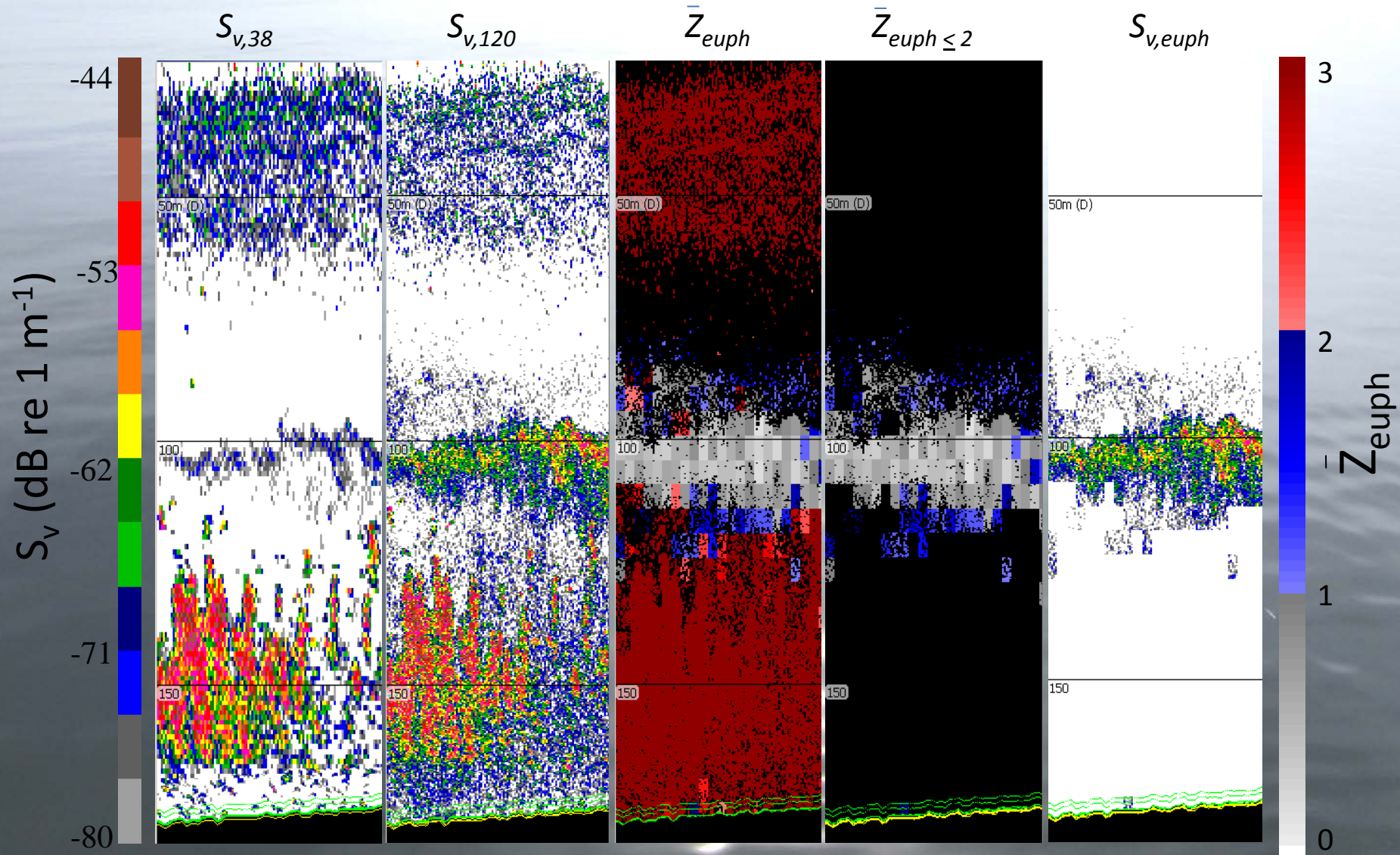*De Robertis, McKelvey, Ressler, 2010, CJFAS*
Ressler, De Robertis, Warren, Smith, Kotwicki, 2012, Deep-Sea Res II
Simonsen, Ressler, Rooper, Zador, 2016, ICES JMS

Use data from acoustic-trawl surveys of walleye pollock in Alaska

Classify euphausiid backscatter using frequency response

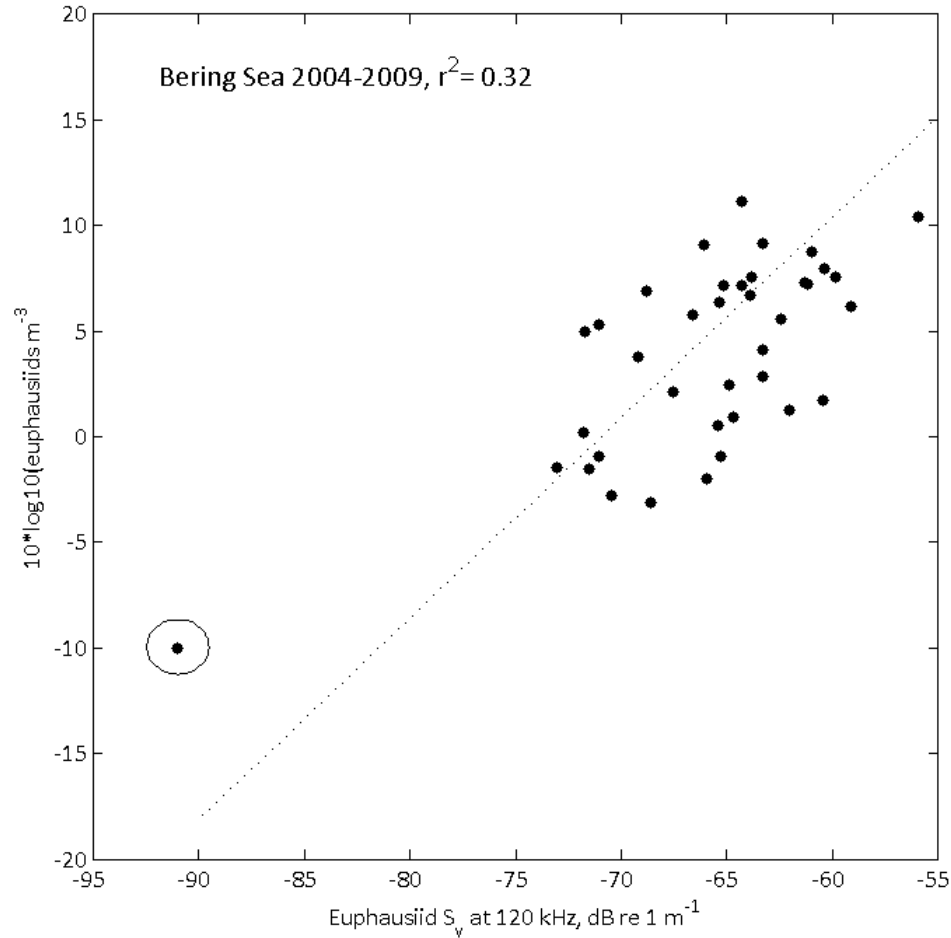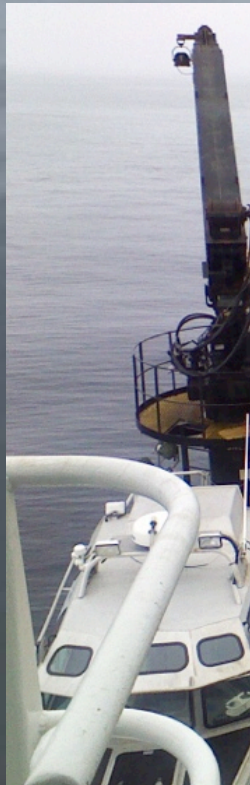# Sample euphausiid backscatter with nets

- Methot trawl
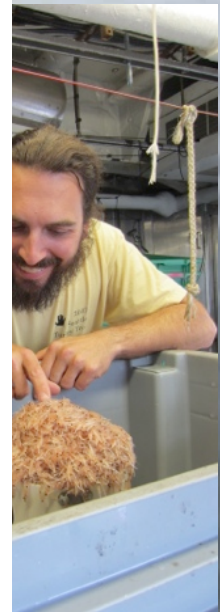 - 5 m² frame trawl with 2 mm x 3 mm mesh in body, 1 mm mesh in codend, towed at 2 – 3 knots (Methot, 1986)

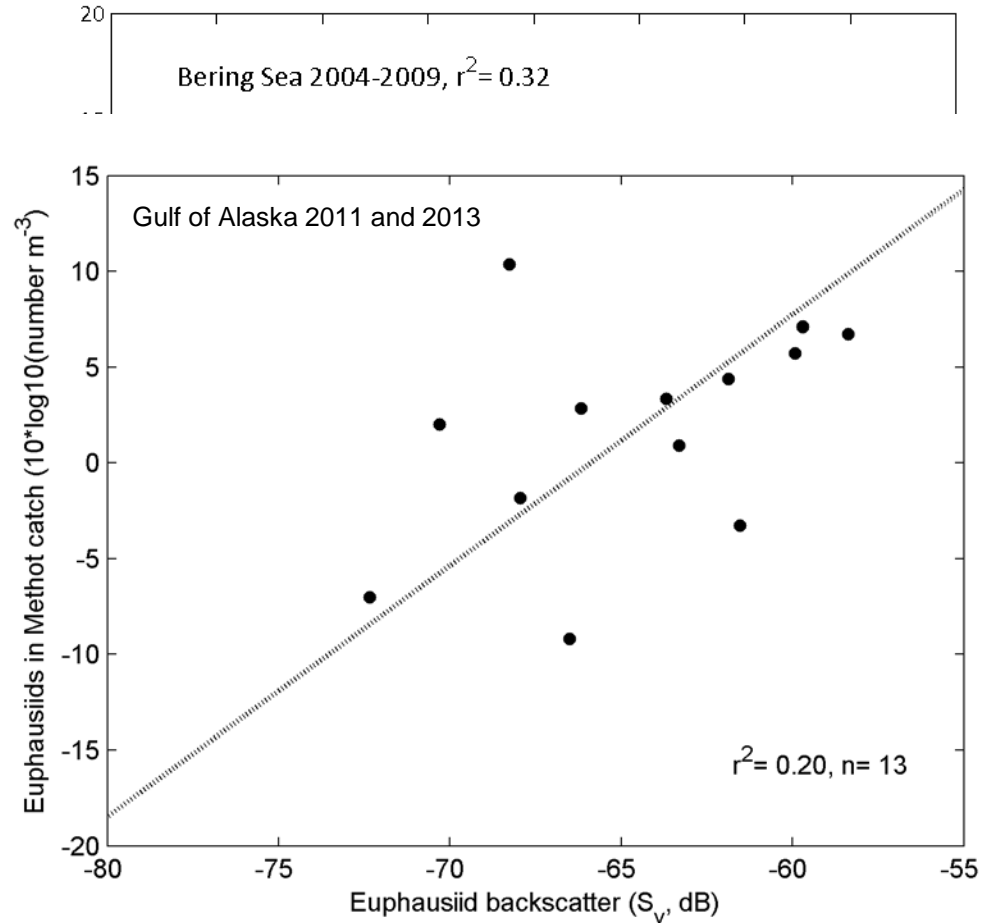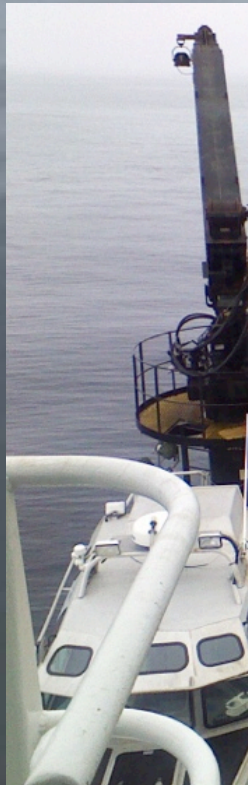# Sample euphausiid backscatter with nets

- Methot
  - 5 m² fra...   ...m mesh in
    codend

Bering Sea 2004-2009, $r^2 = 0.32$

y-axis: $10*\log10(\text{euphausiids m}^{-3})$

x-axis: Euphausiid S_v at 120 kHz, dB re 1 m^{-1}

Sample euphausiid backscatter with nets

- Methot
  - 5 m² fra...   ...m mesh in codend

Bering Sea 2004-2009, $r^2 = 0.32$

Gulf of Alaska 2011 and 2013

$r^2 = 0.20$, n = 13

Euphausiids in Methot catch ($10 \cdot \log_{10}$(number m^{-3}))
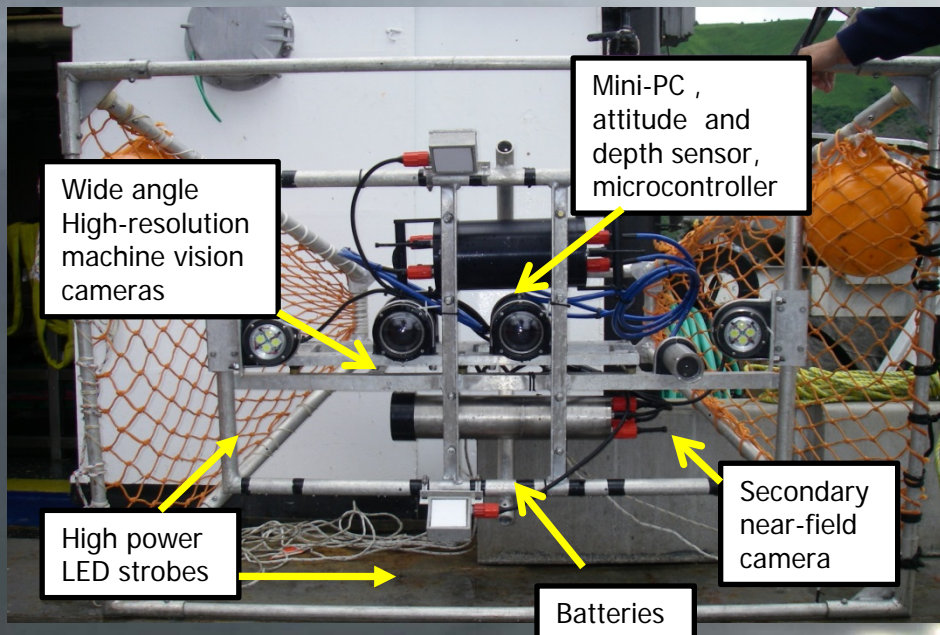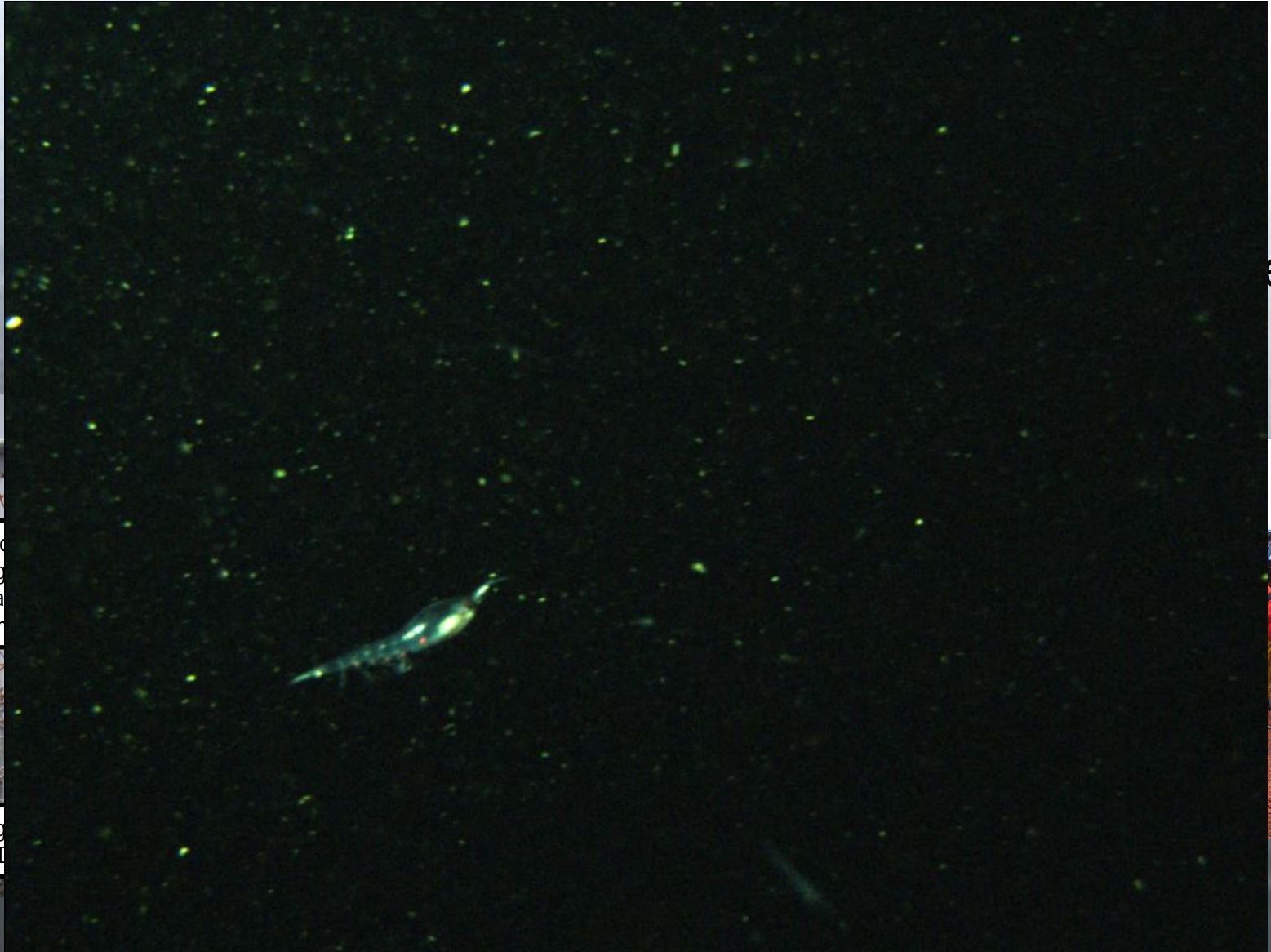
Euphausiid backscatter (S_v, dB)
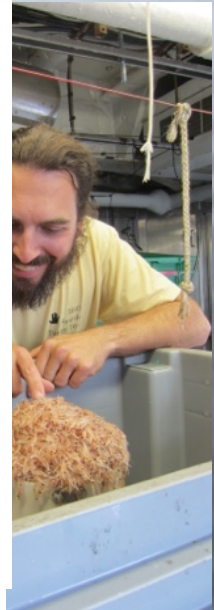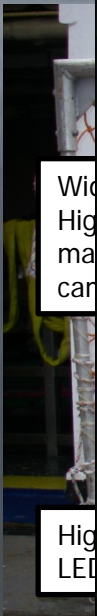
Additional 'sea-truthing' with cameras

- Camtrawl
  - Stereo camera system (Williams et al. 2010)
  - mounted in large midwater trawl for sampling fish
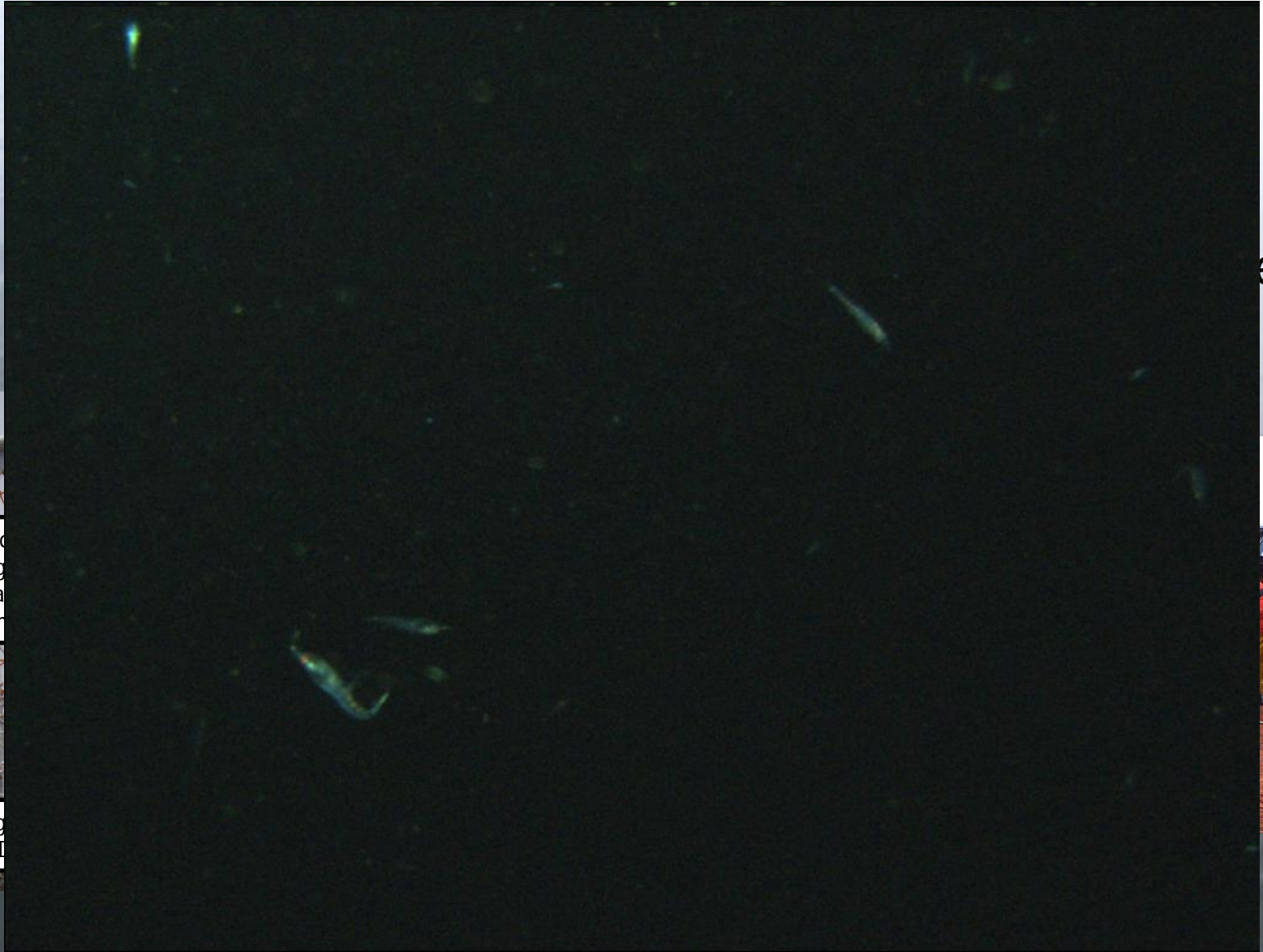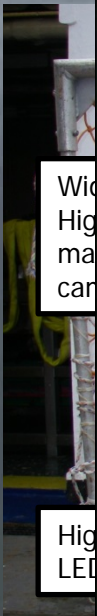 - also see euphausiids in footage as net is set/retrieved

Mini-PC , attitude and depth sensor, microcontroller

Wide angle High-resolution machine vision cameras

Secondary near-field camera

High power LED strobes

Batteries

Additional 'sea-truthing' with cameras

Additional 'sea-truthing' with cameras

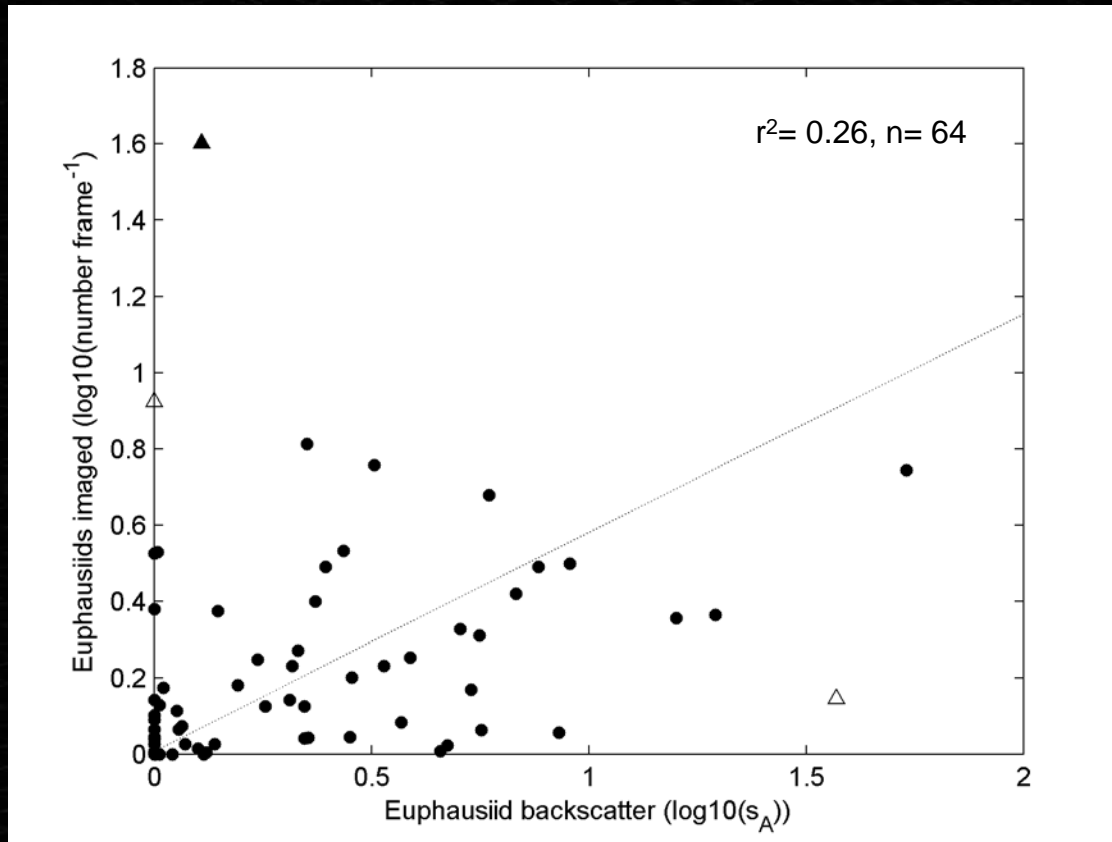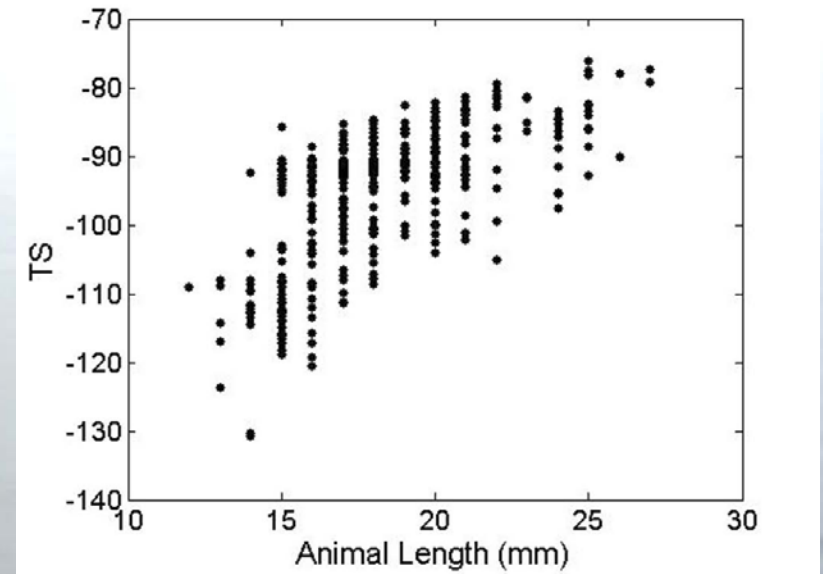# Additional 'sea-truthing' with cameras

Additional 'sea-truthing' with cameras
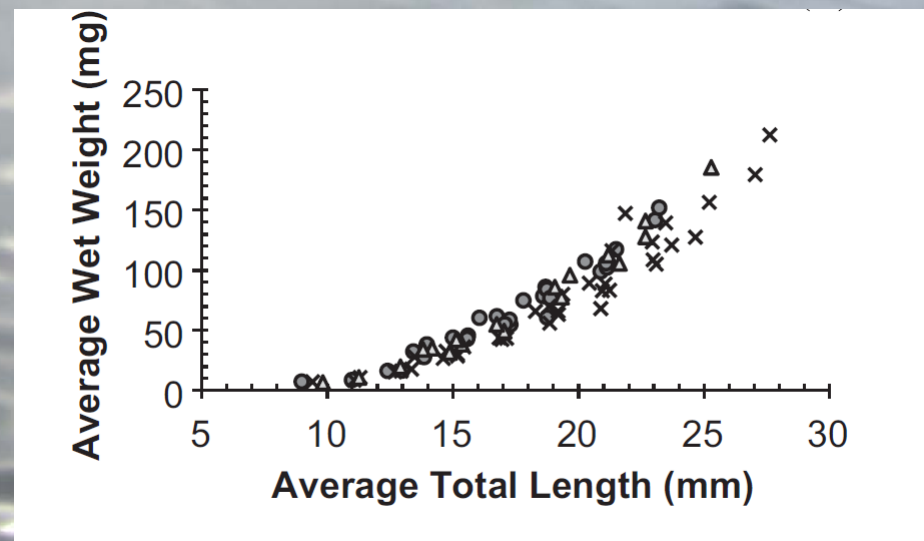
Convert backscatter to abundance and biomass

- Physics-based target strength (TS) model
  (Smith, Ressler, and Warren, IJMS 2012)

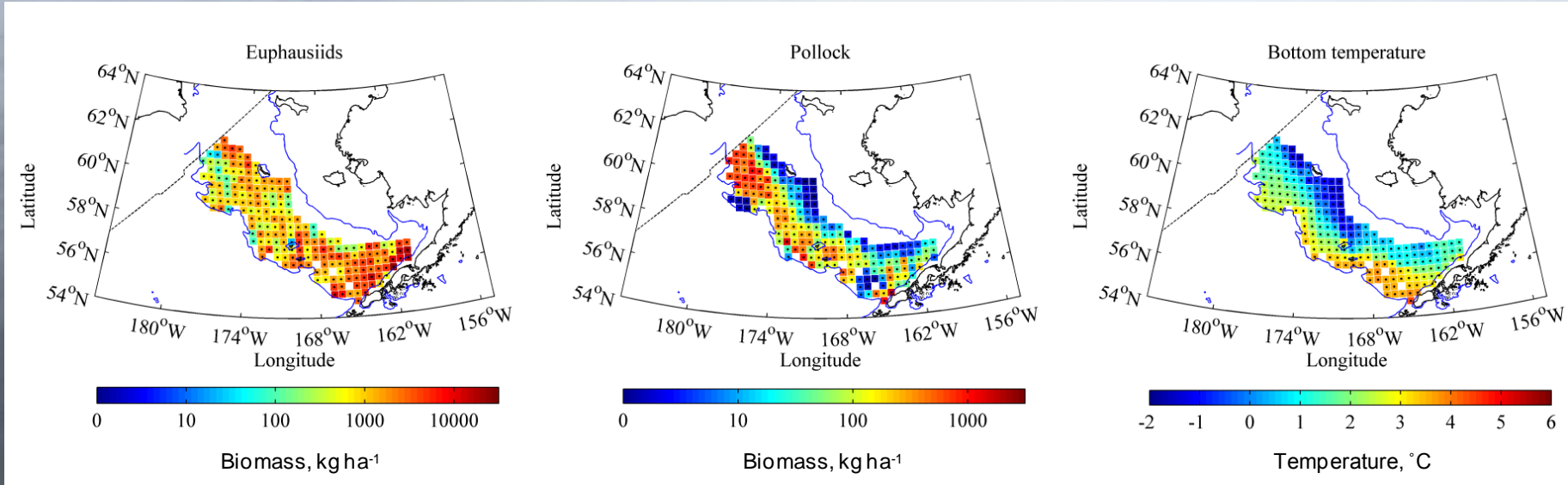
- Length-weight regression
  (Harvey et al., DSRII 2012)

How we've used it

# Bering Sea and Gulf of Alaska euphausiids: prey and predators, bottom-up or top-down control?
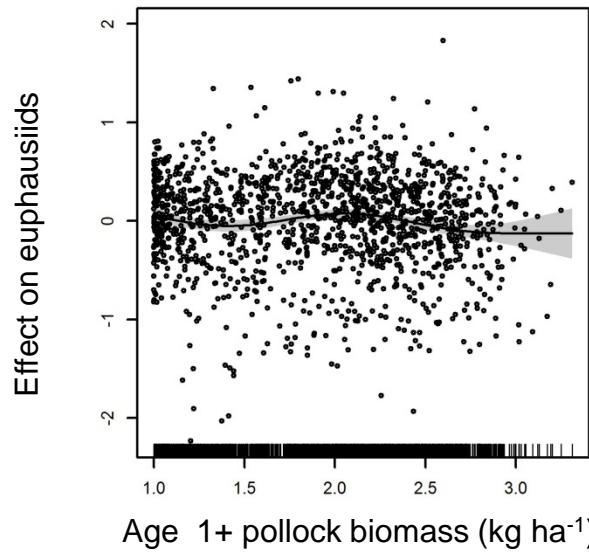
- Euphausiids = pollock + bottom temp + average surface temp + primary production + location + error

8 summer surveys, 2004-2014

Ressler, De Robertis, and Kotwicki, 2014, Marine Ecology Progress Series
Hunt, Ressler, Gibson, et al. 2015, Deep-Sea Research II
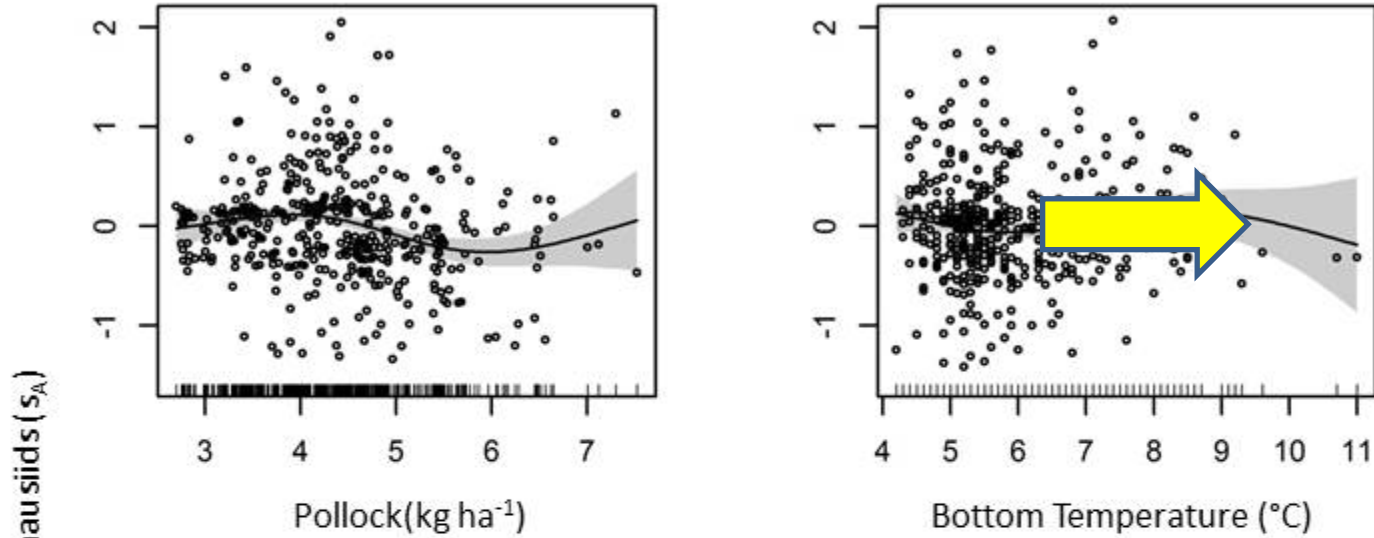*Simonsen, Ressler, Rooper, Zador, 2016, ICES JMS*
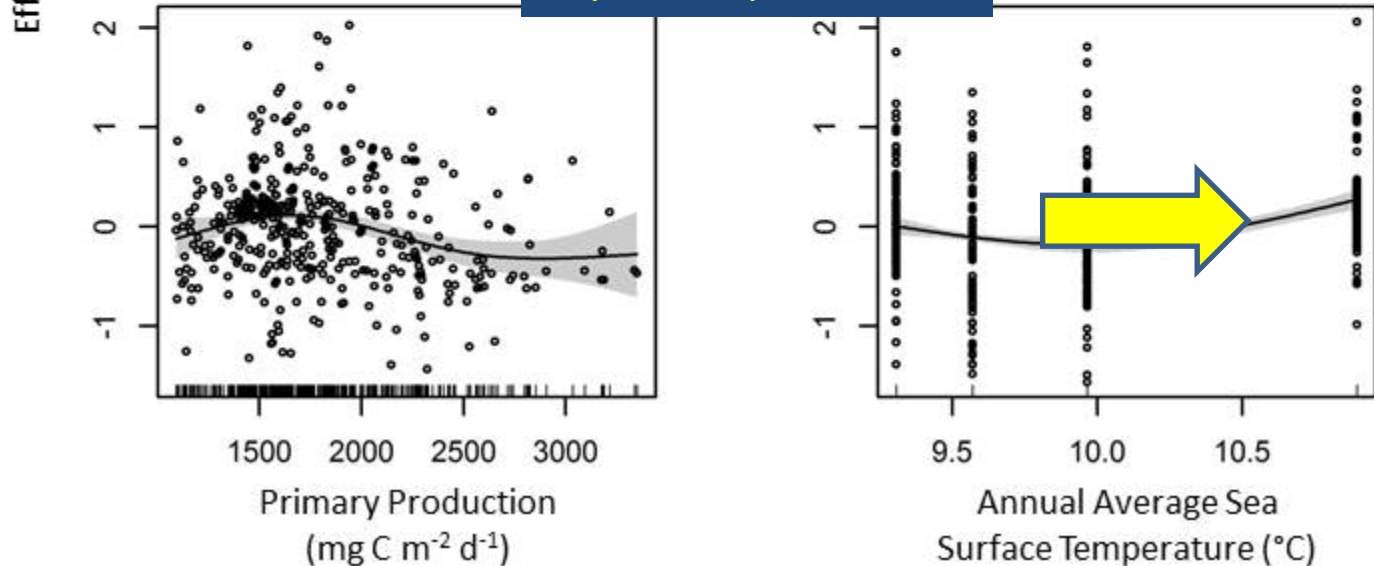
Bering Sea, 8 surveys 2004-2014; variance explained 37.2%
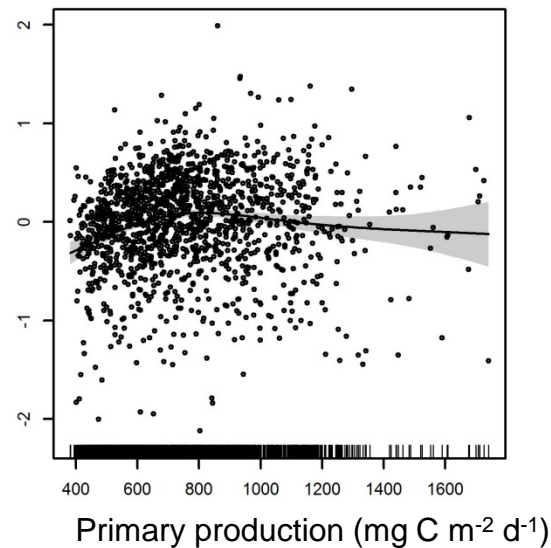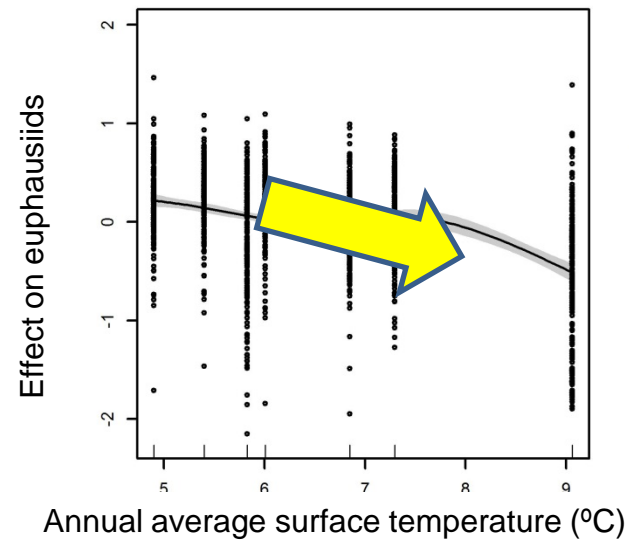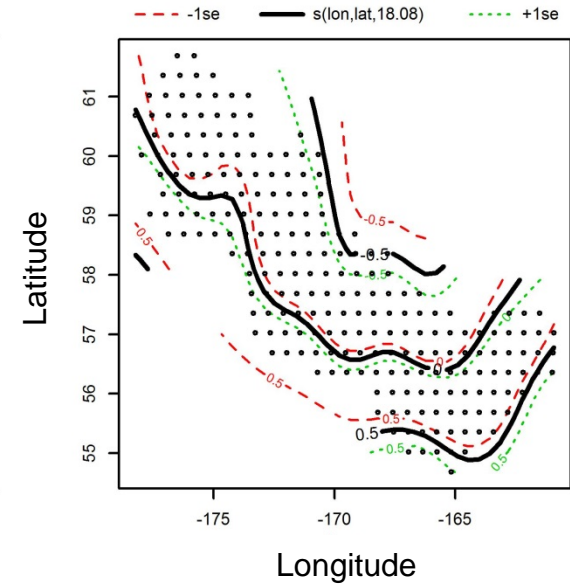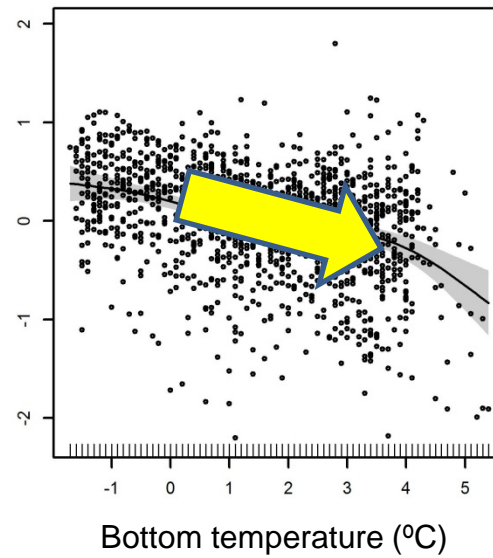
All things considered, euphausiid biomass is best predicted by temperature

In the Gulf of Alaska? 4 surveys 2003-2013, var. explained 26.4%

Effect on Euphausiids (s_A)

Pollock(kg ha^{-1})

Bottom Temperature (°C)

temperature does not appear to be an important predictor

Primary Production (mg C m^{-2} d^{-1})

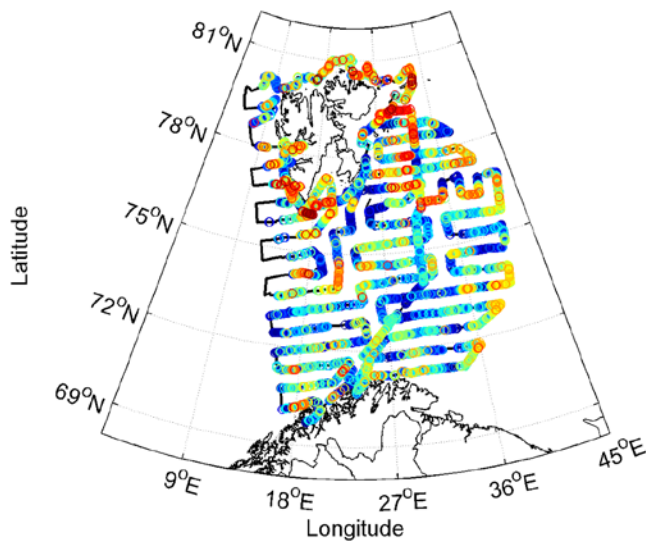Annual Average Sea Surface Temperature (°C)

Frequency response of similar euphausiid species is consistent among ecosystems

- Bering Sea

- Gulf of Alaska

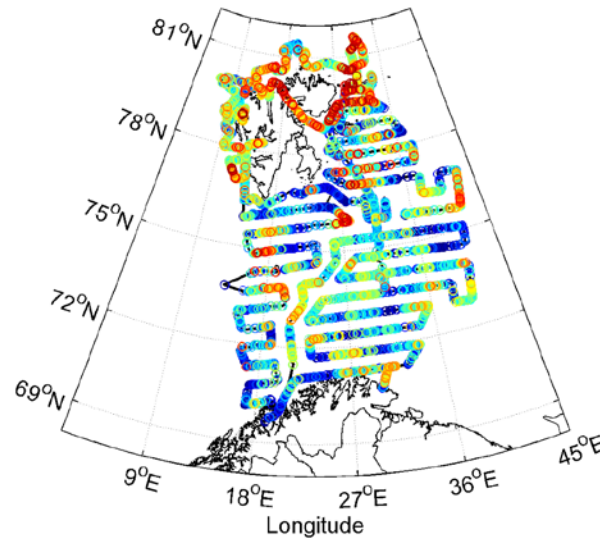- Barents Sea
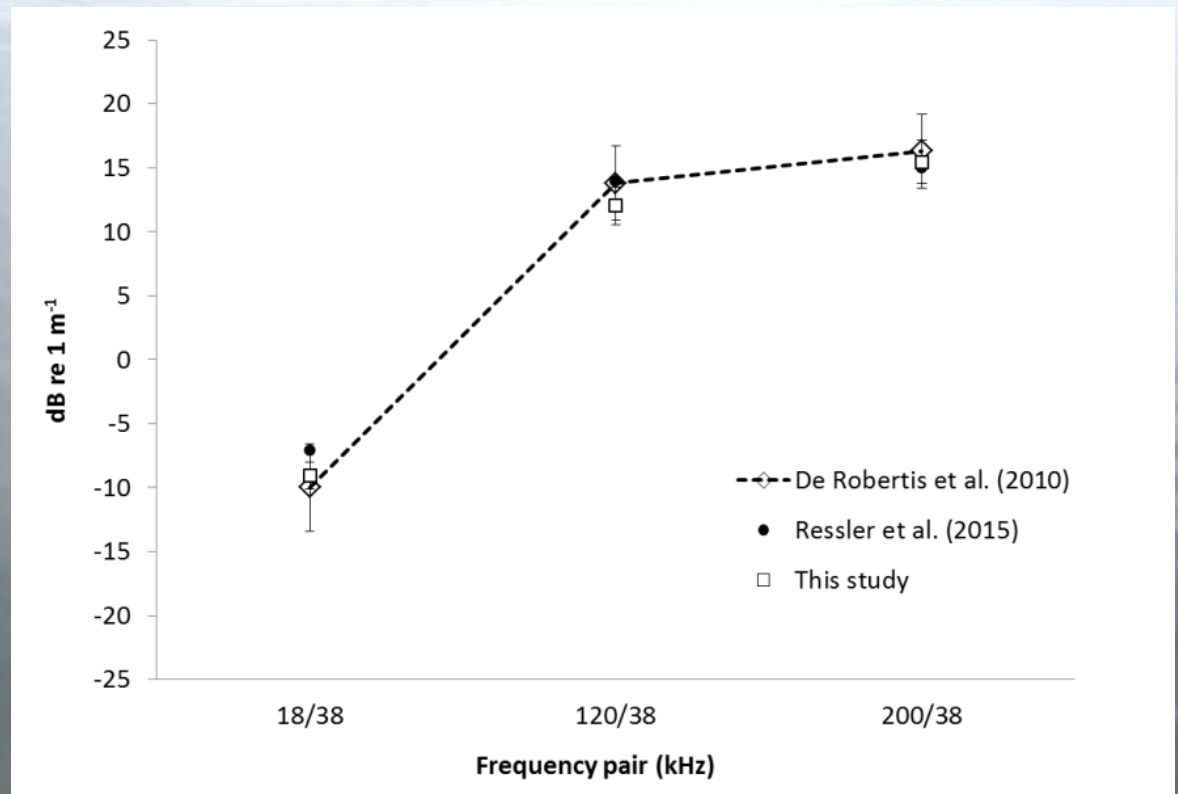
Baleen whales are associated with euphausiid backscatter in the *Barents Sea*
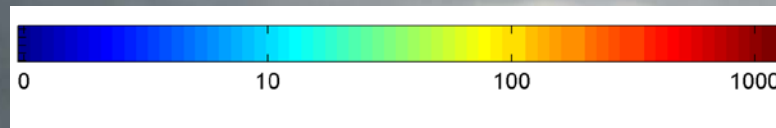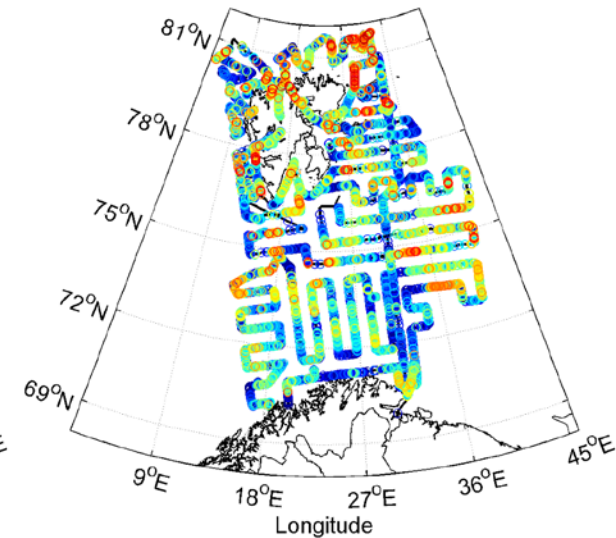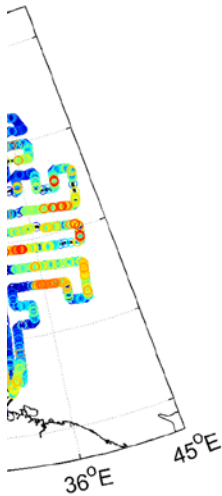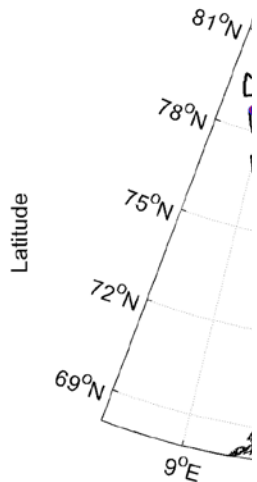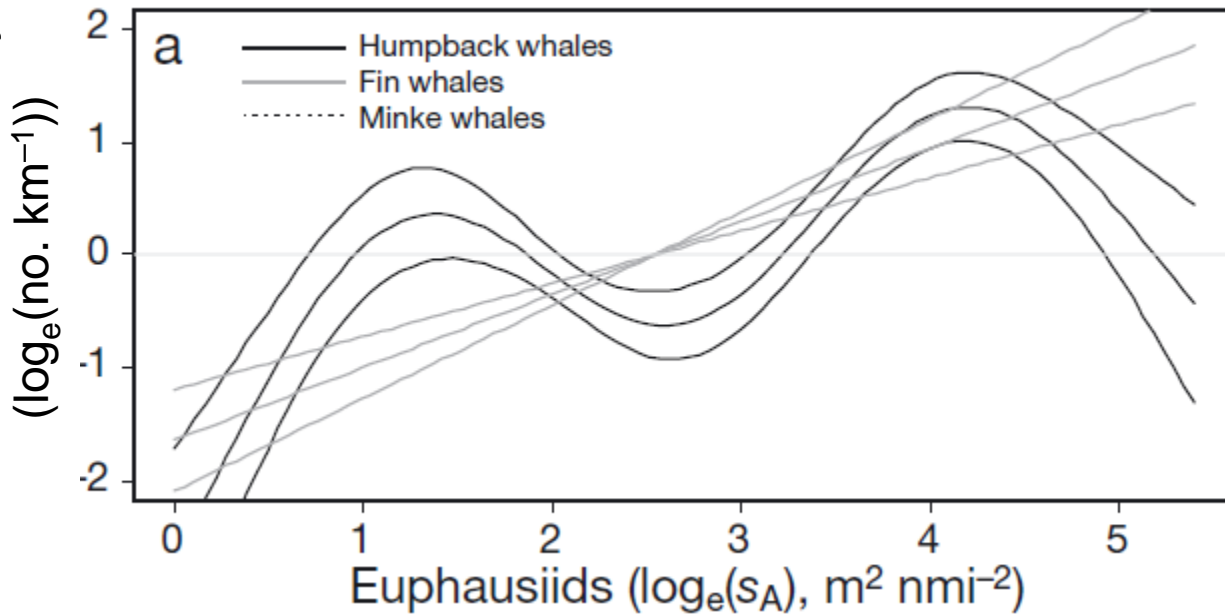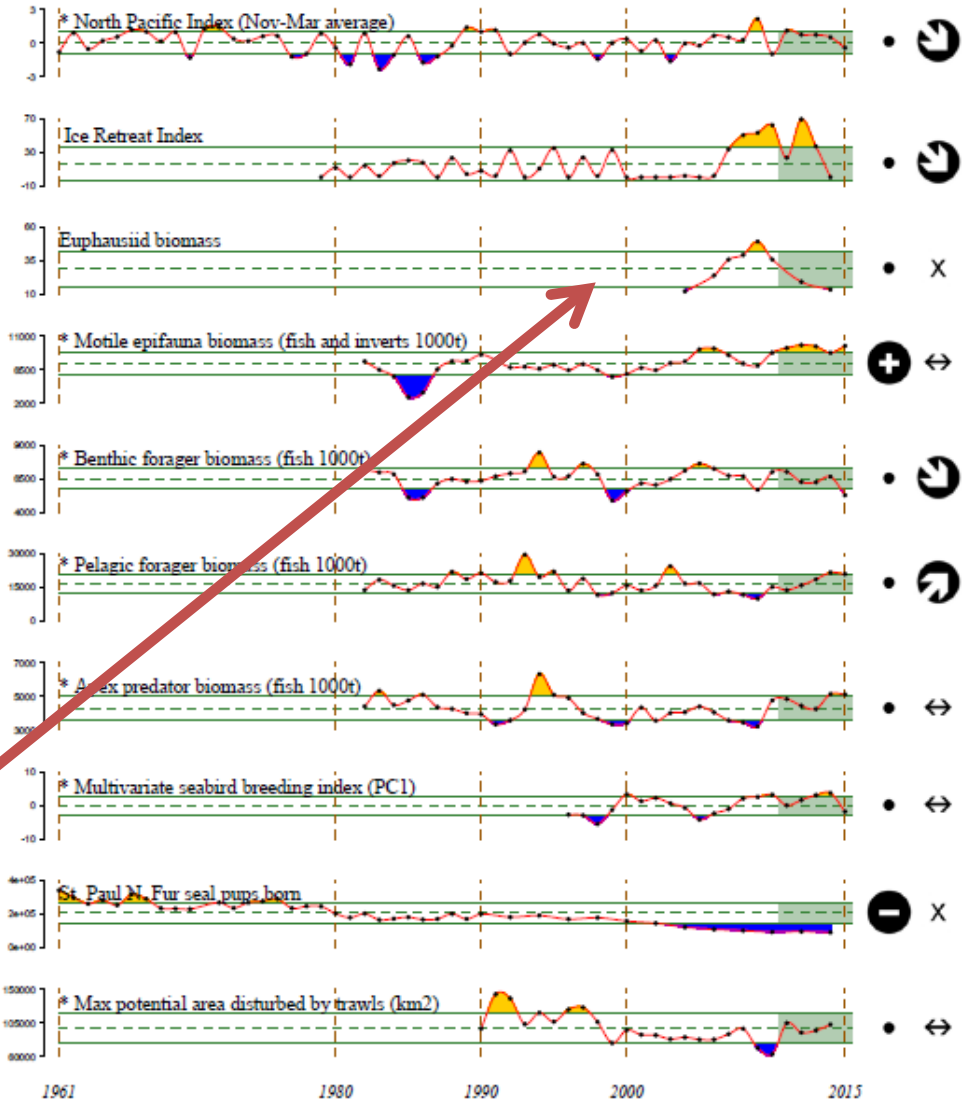

2010   2011   2012

s_A, m^2 nmi^{-2}

Ressler, Dalpadado, Macaulay, Handegard, Skern-Mauritzen, 2015. MEPS

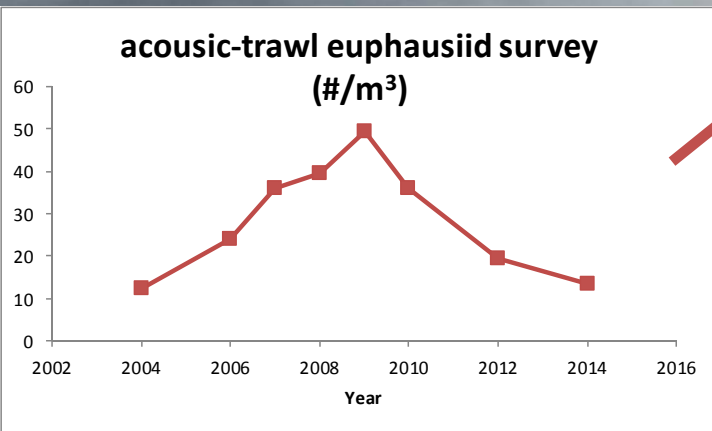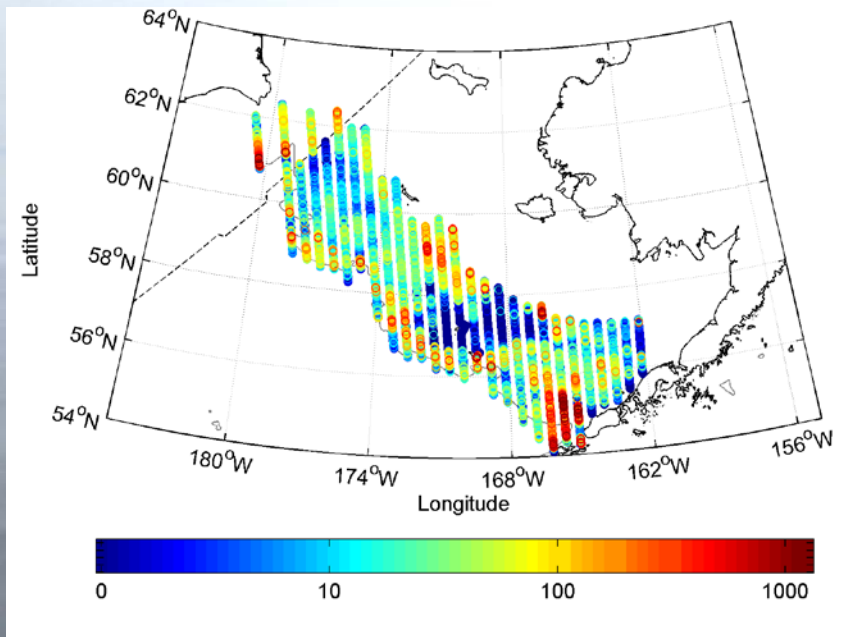# Baleen whales are associated with euphausiid backscatter in the *Barents Sea*

Ressler, Dalpadado, Macaulay, Handegard, Skern-Mauritzen, 2015. MEPS

Management application: ecosystem 'report card'

Remaining questions and summary

Fish condition may be related to euphausiid prey availability

pollock condition (AT survey)
n= 5 surveys, 2003-2015

$R^2 = 0.53$

Barnabas
Chiniak
Shelikof

Pollock condition factor, ln(LW resid)

Euphausiid density, s_A (m^2 nmi^{-2})
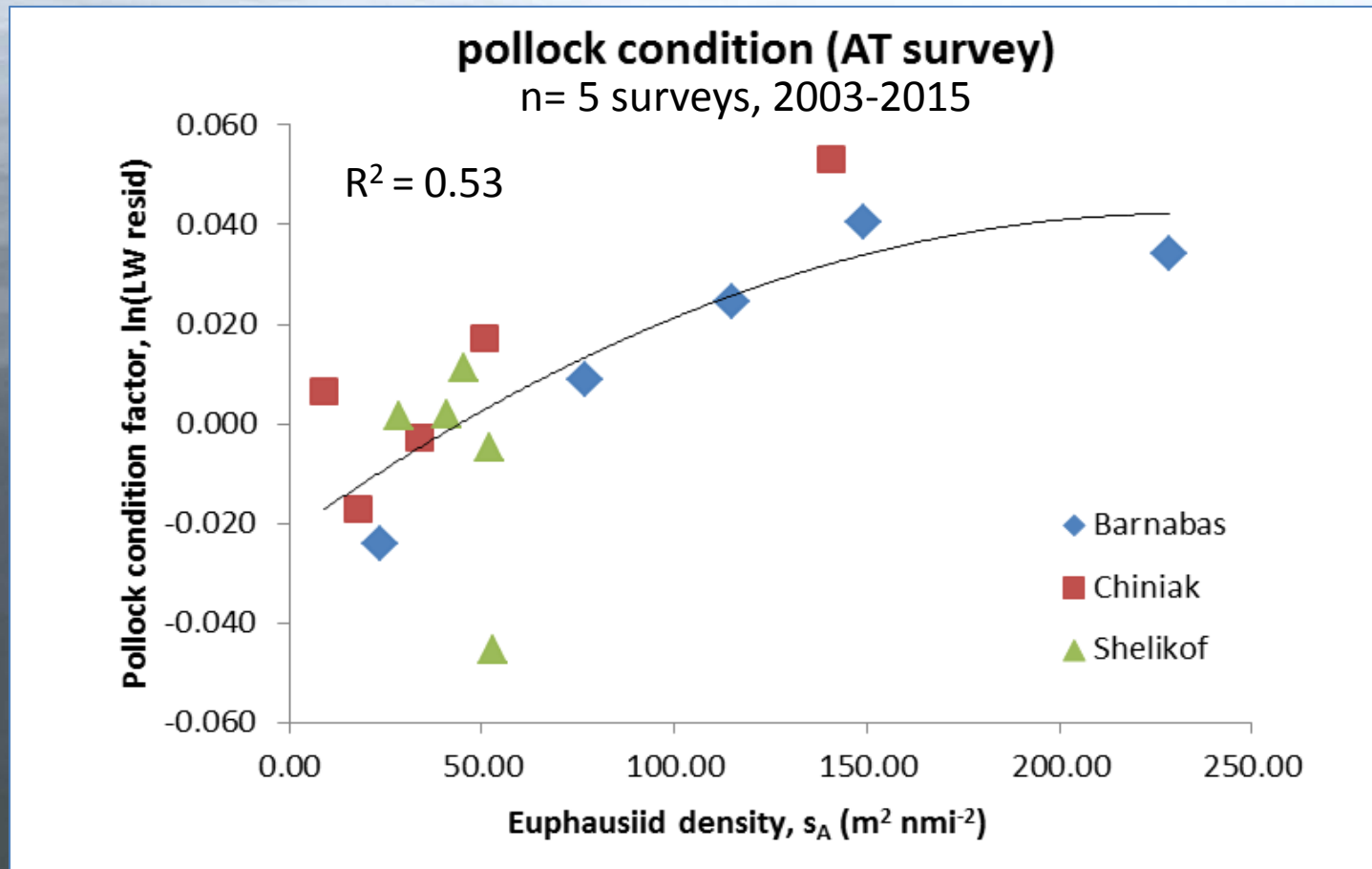
How many euphausiids are there…really?

- Comparing euphausiid abundance from net capture, acoustic surveys, ecosystem models

- Uncertainty is quite substantial - more work remains in this area

- How long is a piece of string?

RAPPORTS ET PROCÈS-VERBAUX DES RÉUNIONS
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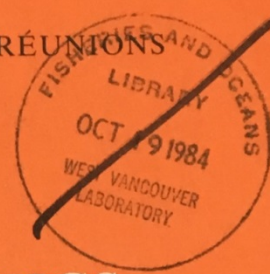
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Edited by

R. E. CRAIG

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Août 1984

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Measure euphausiid target strength this summer

with Joe Warren (SBU), Rodger Harvey (ODU), Georgina Gibson (UAF), Kresimir Williams (AFSC**)**

- Capture live animals, measure length, species, g/h

- Measure TS of tethered animals

- Compare with DWBA model predictions

- Deploy Methot trawl with strobe lights to observe effect on catch

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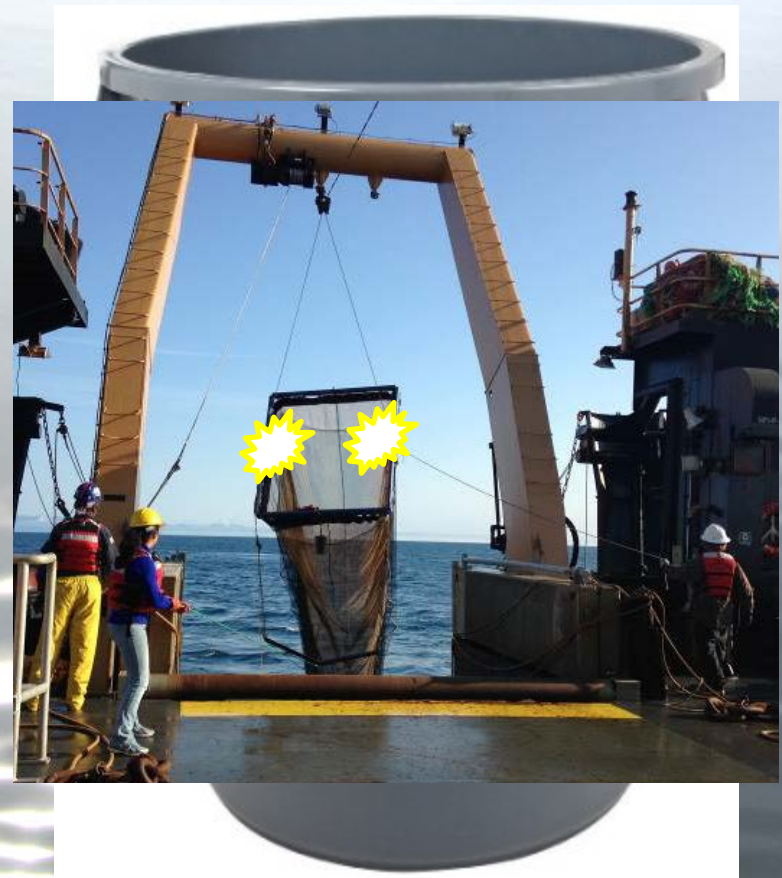
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Use stereo cameras to determine *in situ* orientation

with Mike Levine (OA), Kresimir Williams (AFSC)

Mean= -4.6°
SD= 39.2°
N= 874
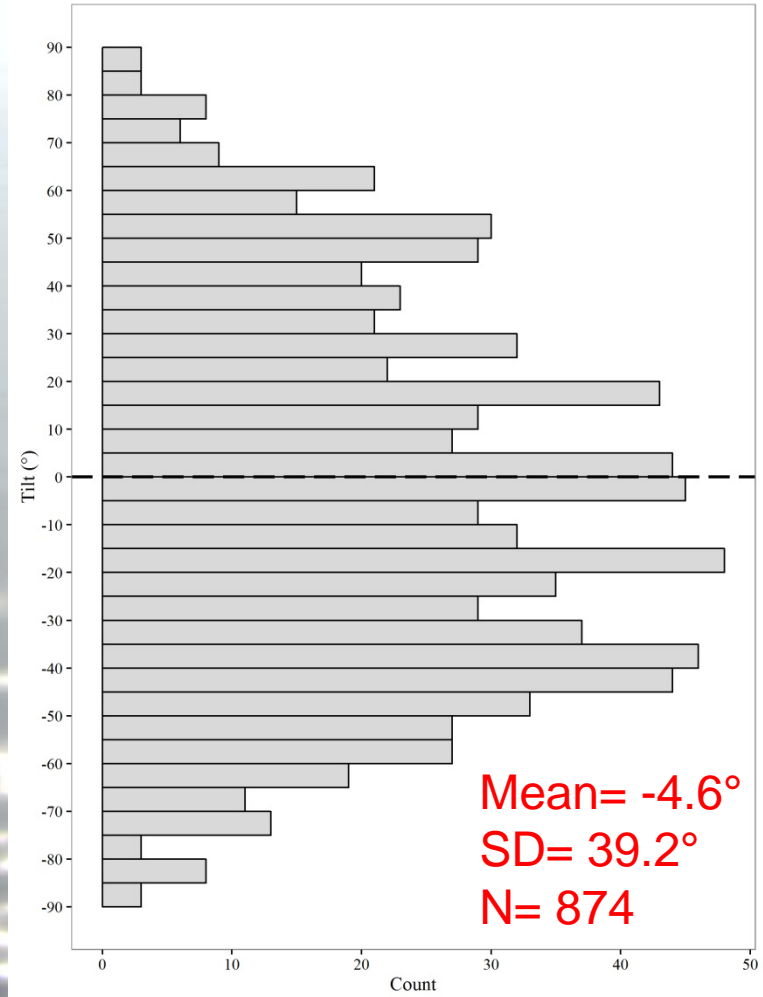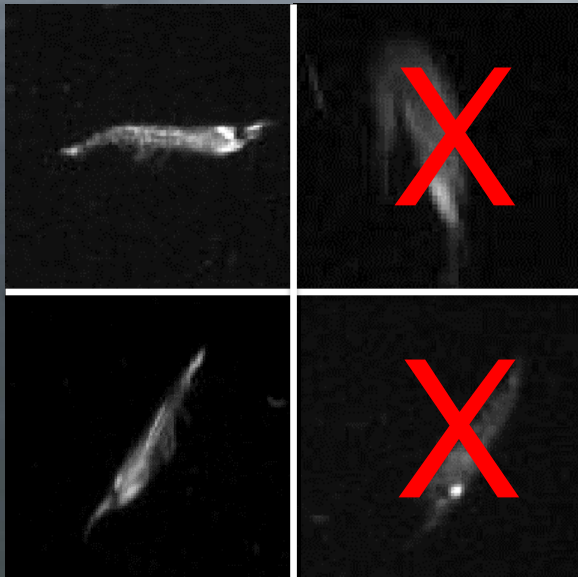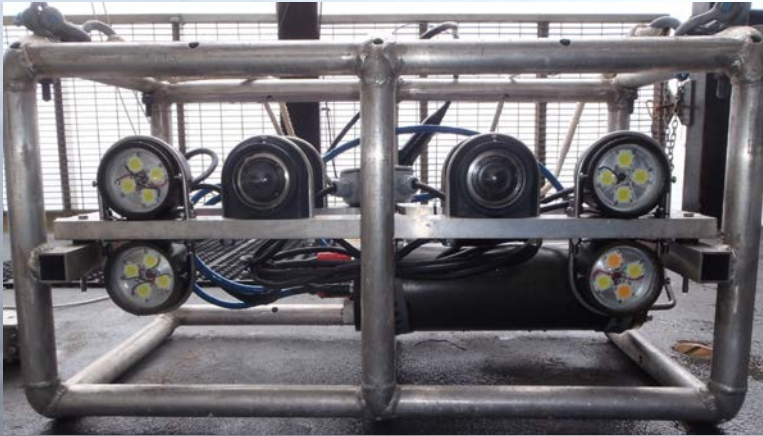
Summary

- Acoustic surveys of euphausiids are tractable and cost-effective combinations with acoustic-trawl surveys of fish

- Results have many applications: long-term monitoring, ecological studies, resource management

- 'The once and future ping'...still room for improvement and research questions to be explored

Acknowledgments

Questions?