

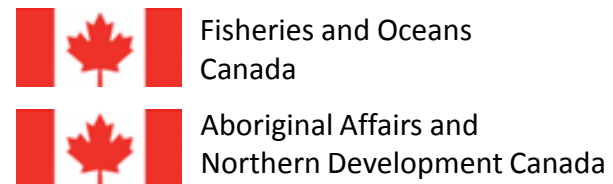
Active acoustic mapping of fish: the offshore distribution of arctic cod in the Canadian Beaufort Sea

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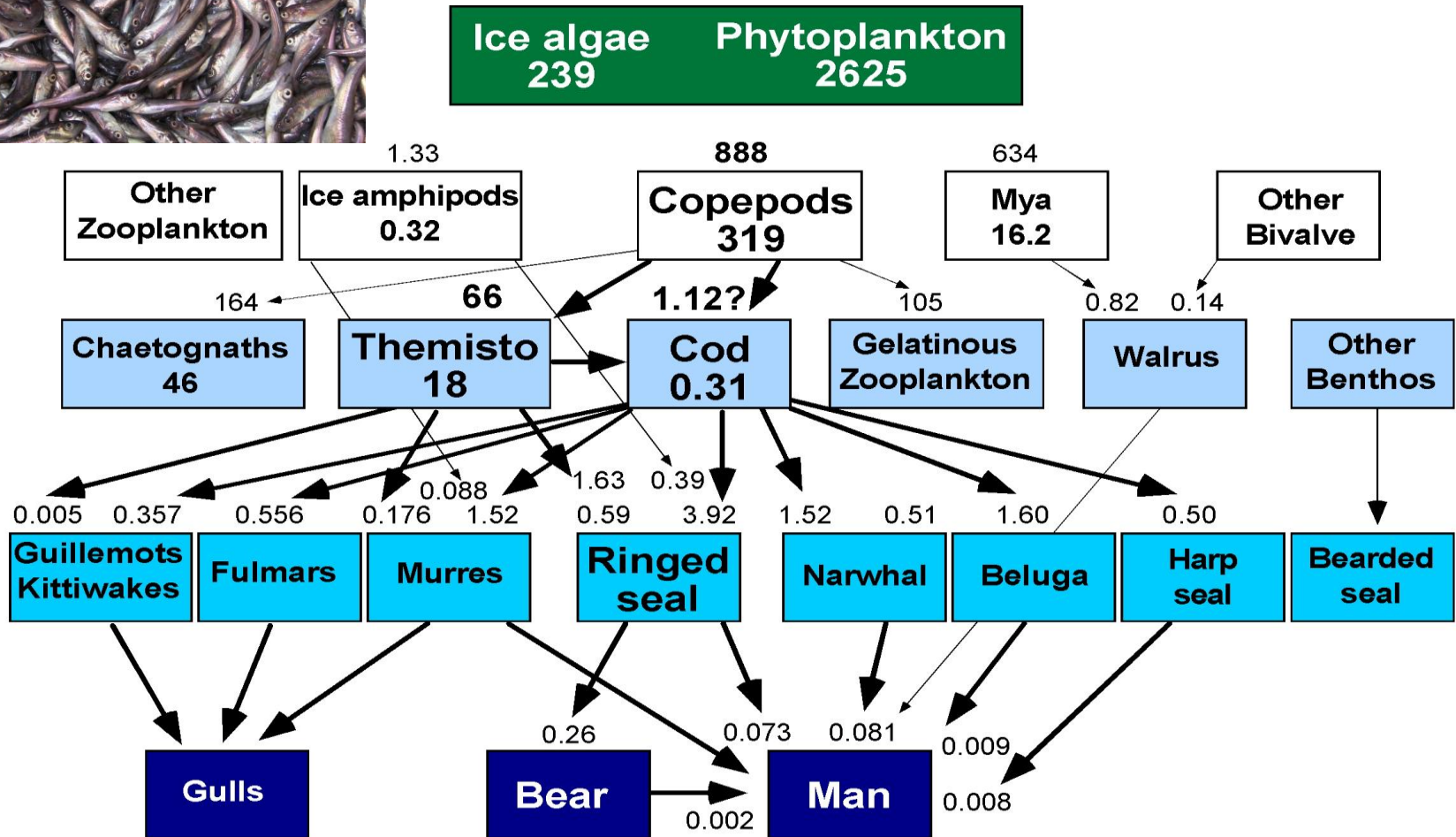
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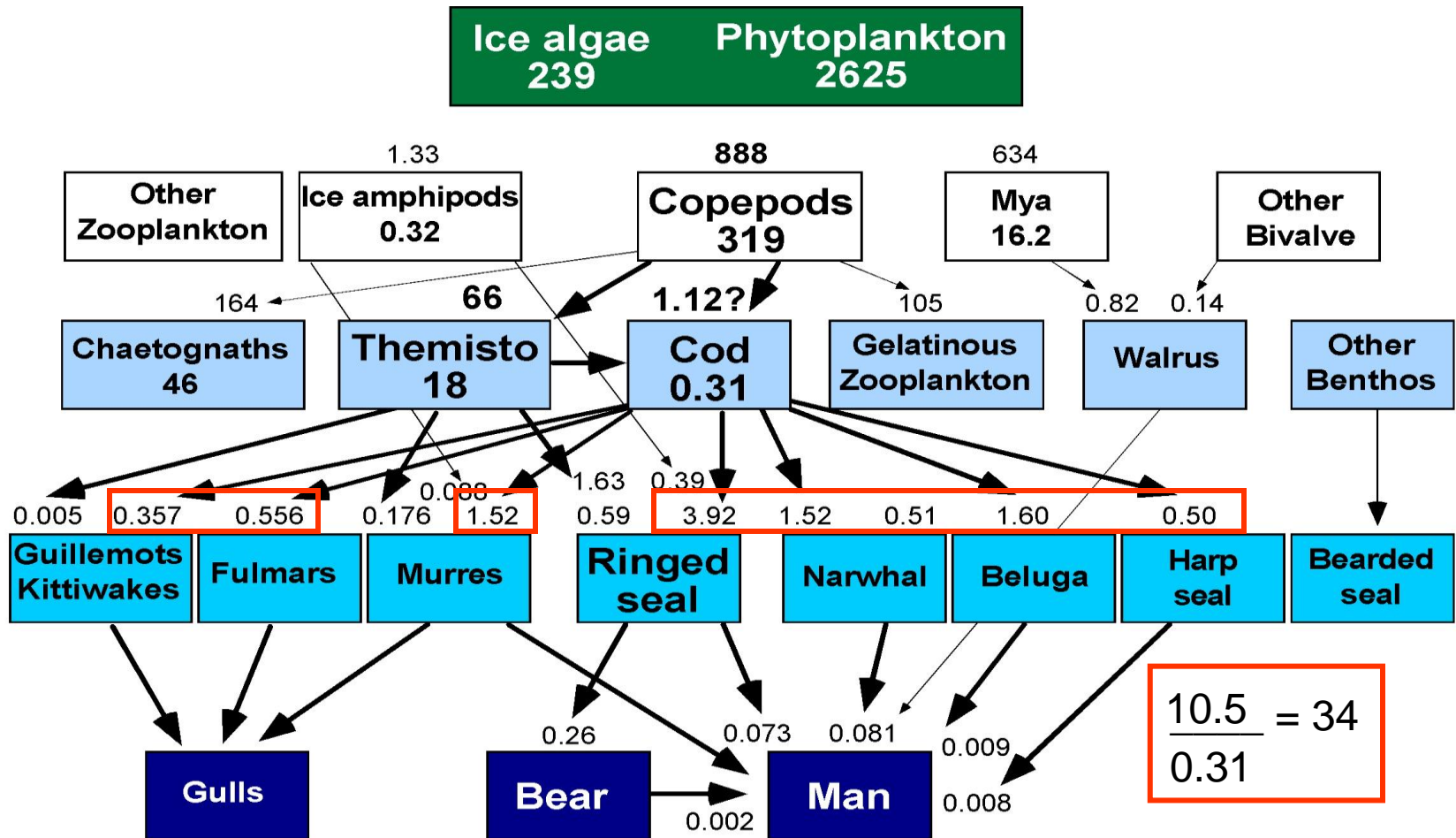


The pivotal role of the arctic cod



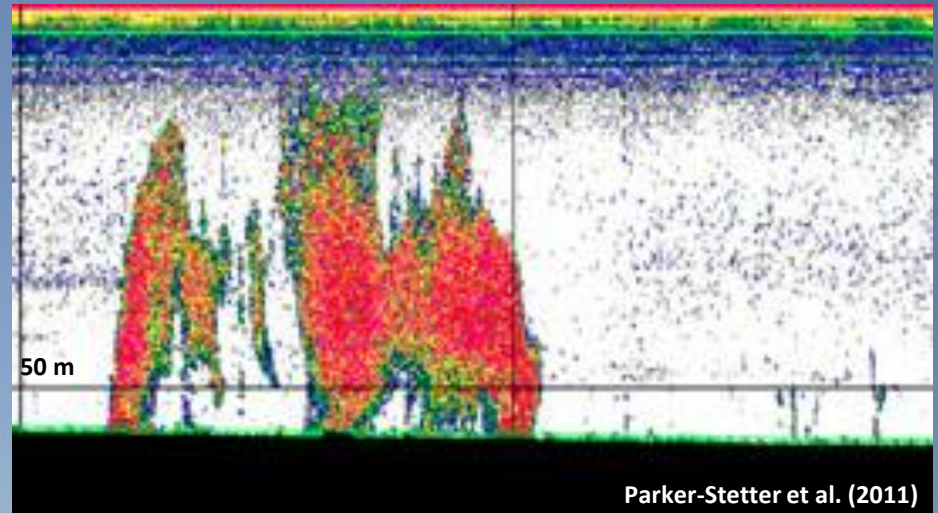
Carbon stocks (g m⁻²) and fluxes in Lancaster Sound (Welch et al. 1992)

The mystery of the missing arctic cod



Carbon stocks (g m⁻²) and fluxes in Lancaster Sound (Welch et al. 1992)

The low biomass estimate of arctic cod likely originates in the initial rare observations of surface coastal schools in the Canadian Archipelago and the U.S. Beaufort Sea



What about the offshore distribution?

Could most of the arctic cod biomass be located offshore?

BREA fisheries acoustics program

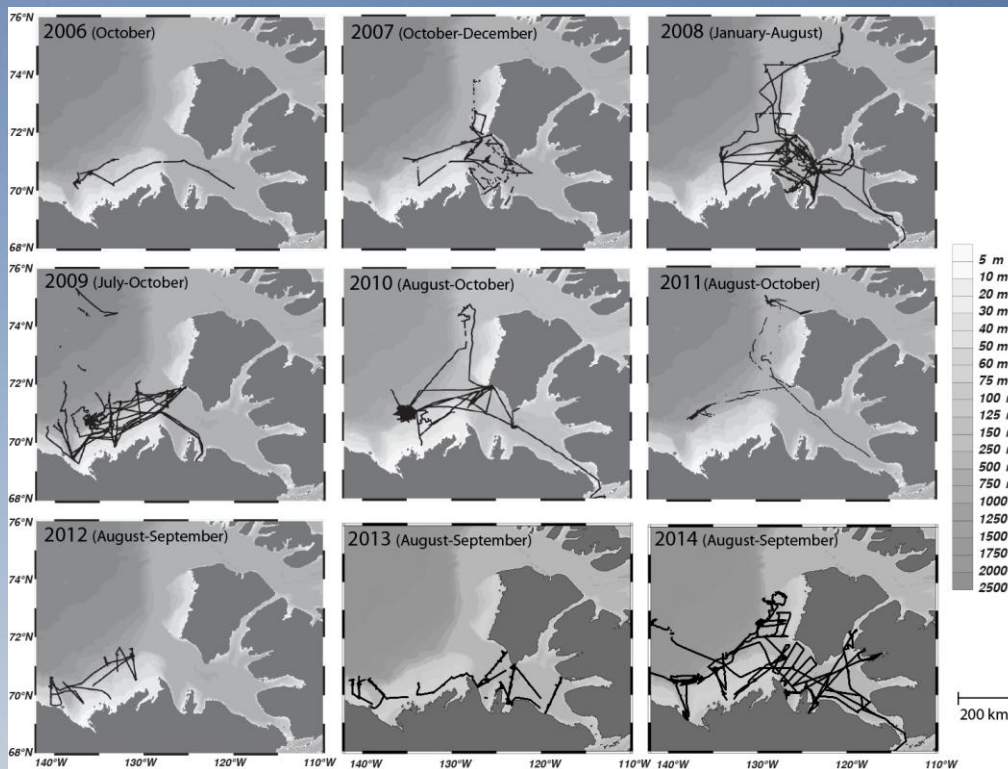
Main objectives:

Detect pelagic fish (mainly arctic cod) in the Canadian Beaufort Sea and document their distribution, size, and migration patterns

Link BREA data to previous observations to document the annual cycle and ontogenic migrations

Acoustic surveys (2006-2014)

- Amundsen Gulf and Canadian Beaufort Sea
- From 20 m to >1000 m bottom depth areas – total of 628 days



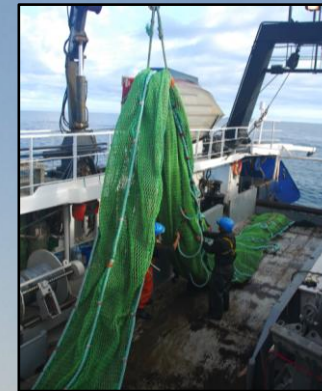
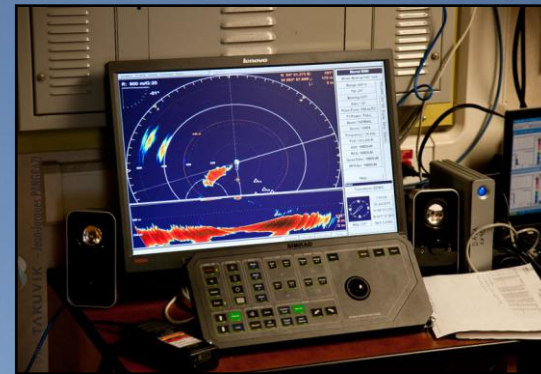
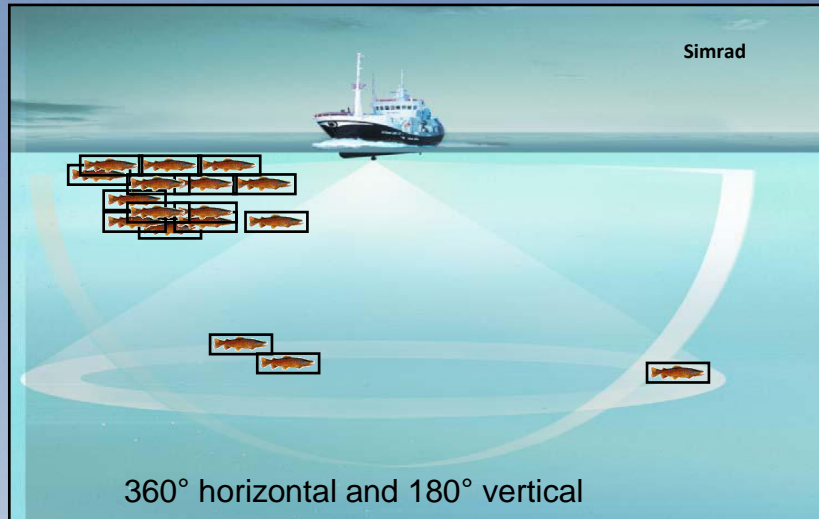
Year	Start date	End date	Vessel
2006	10 October	16 October	CCGS <i>Amundsen</i>
2007	15 October	31 December	CCGS <i>Amundsen</i>
2008	1 January	8 August	CCGS <i>Amundsen</i>
2009	16 July	16 October	CCGS <i>Amundsen</i>
2010	14 August	8 October	CCGS <i>Amundsen</i>
2011	12 August	3 October	CCGS <i>Amundsen</i>
2012	6 August	3 September	F/V <i>Frosti</i>
2013	31 July	12 September	F/V <i>Frosti</i>
2014	02 August	25 September	F/V <i>Frosti</i> CCGS <i>Amundsen</i>

BREA

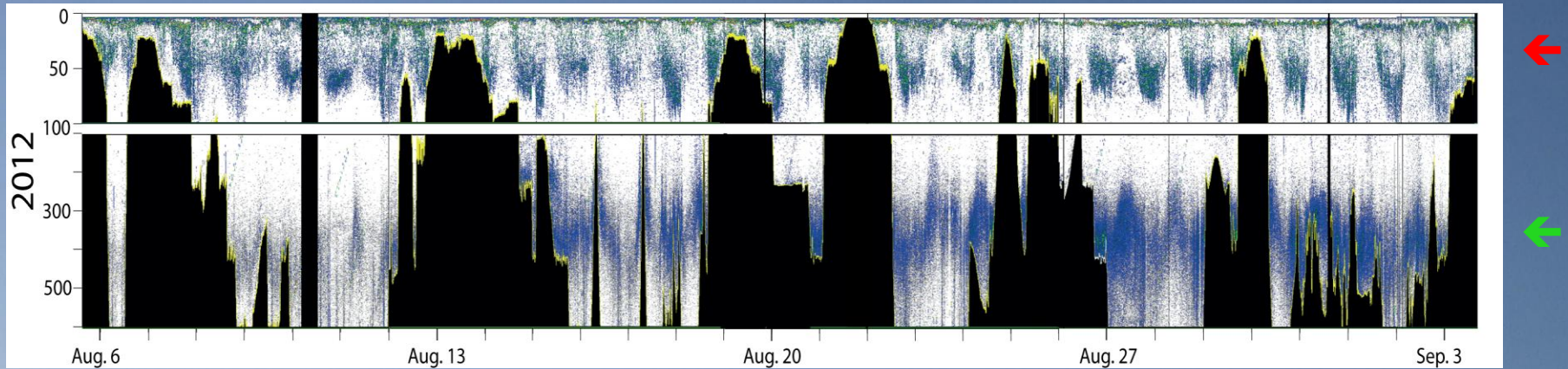


Acoustic surveys (2006-2014)

- Multifrequency (38, 120, 200 kHz) Simrad EK60 echosounder
- Simrad SX90 fisheries sonar (20-30 kHz)
- Net deployments for echo-validation



Results: ontogenic segregation



Epipelagic layer (<100m) : 88% YOY polar cod
(n=10613)



Mesopelagic layer (200-400m) : 95% polar cod > 2.5 cm
(n=800)

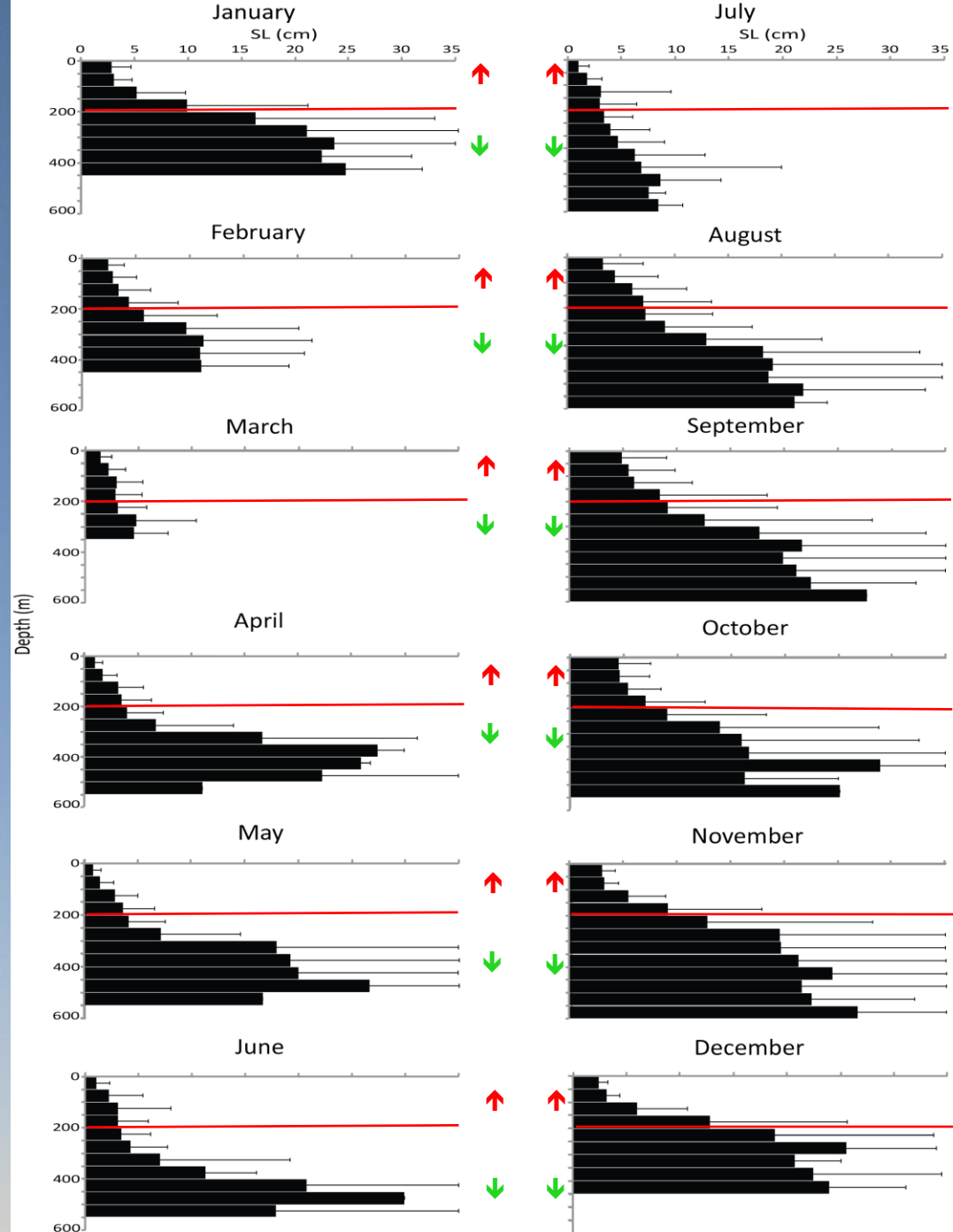


Stratified mean length by month

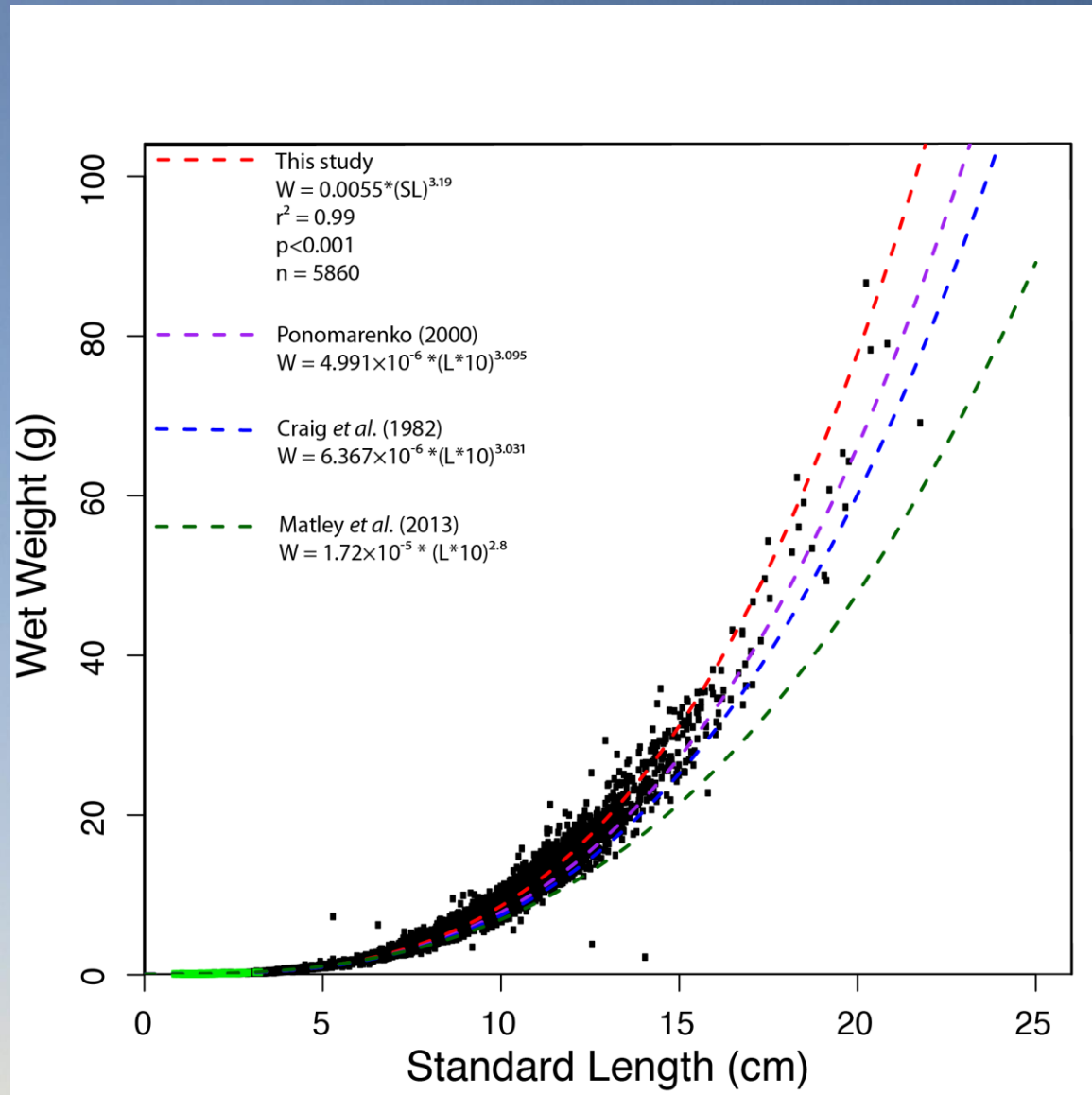
Larger fish at depth > 200 m throughout the year

Acoustic lengths coherent with net lengths

Confirms ontogenic segregation throughout the year



Numbers can be transformed into biomass

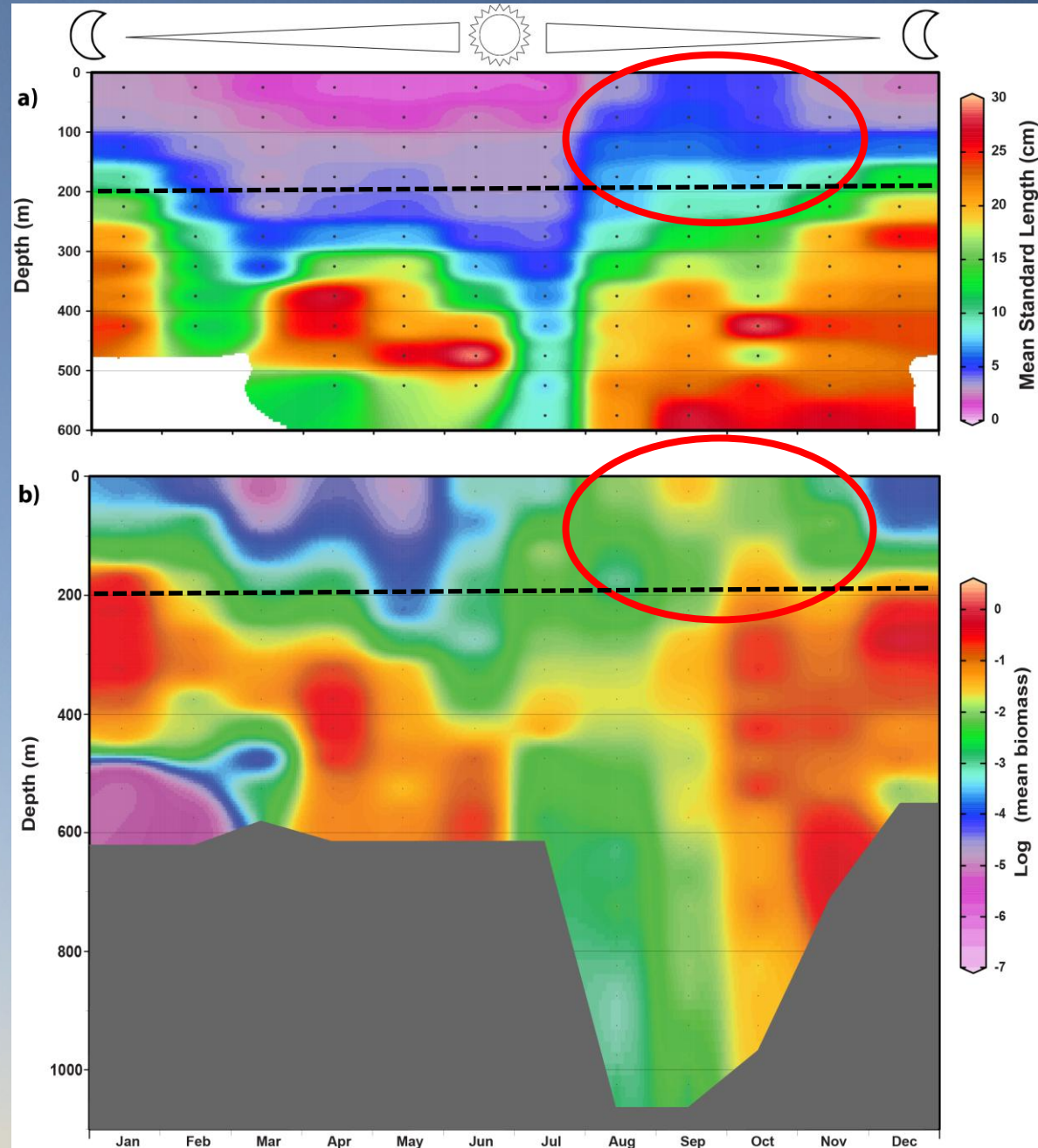


Variations in length and biomass throughout the year

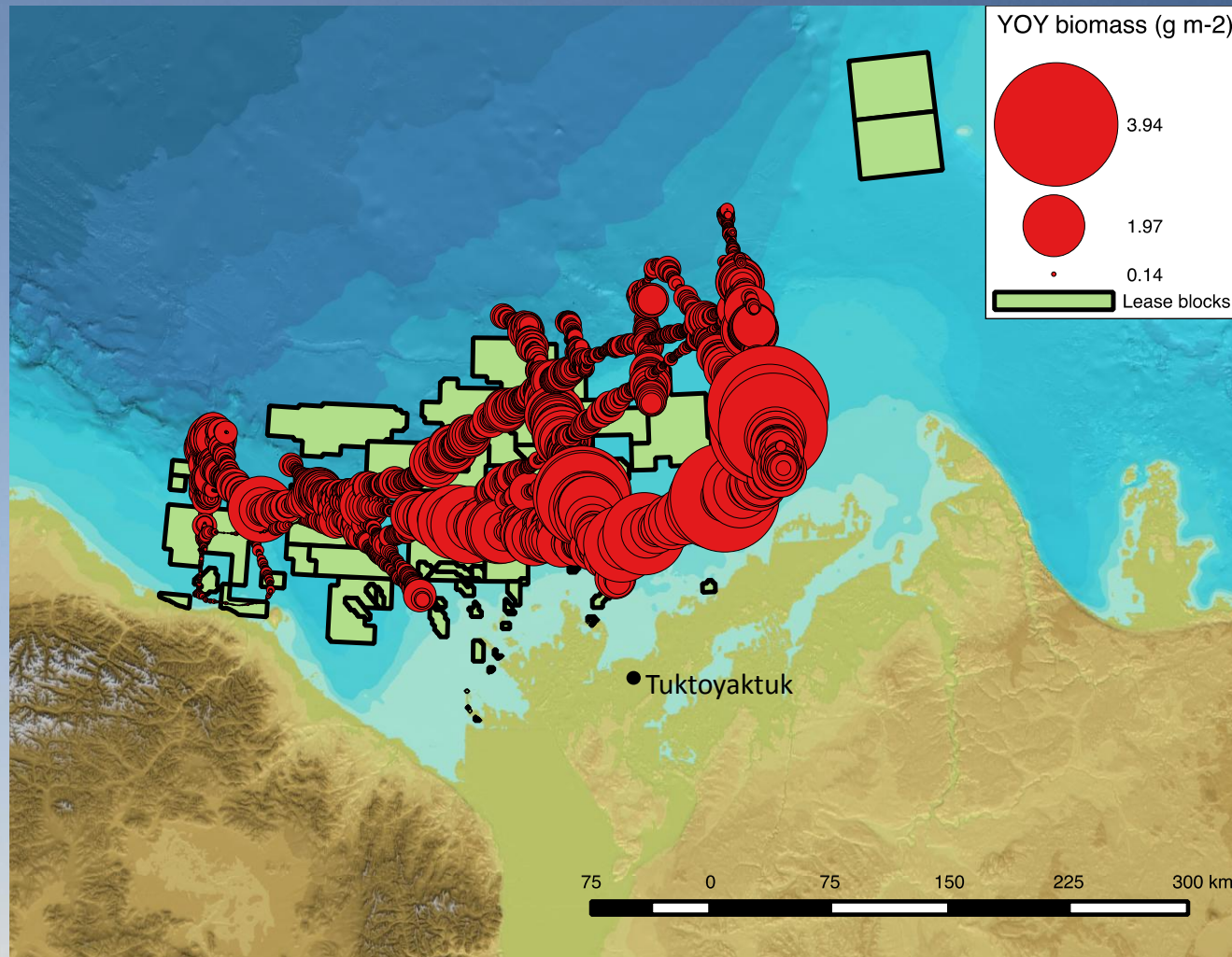
Fish >10 cm (adults) and core biomass concentrated >200 m throughout the year.

No surface schools observed over the 9 years or the 1418 km of SX90 sonar survey.

YOY hatch at the surface and descend when they reach a size between 3 and 5.5 cm, from July to November.

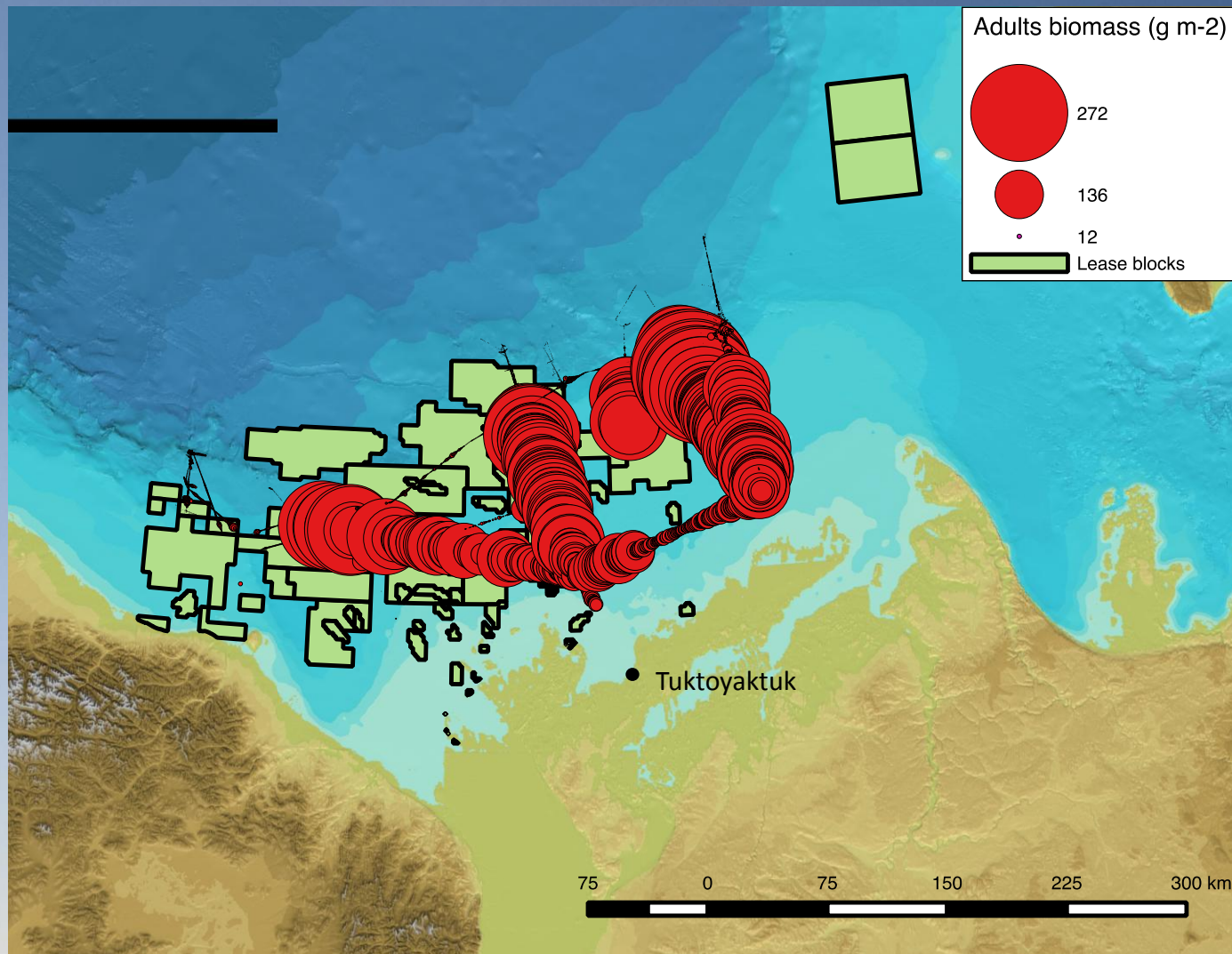


YOY arctic cod spatial distribution during the ice-free season (2012)



- Quasi-uniform distribution of YOY over the continental shelf and slope, from 20 to 1400 m.
- Overlaps oil and gas lease blocks.

Adult arctic cod spatial distribution during the ice-free season (2012)



- High biomass over the slope.
- Overlaps several oil and gas lease blocks.

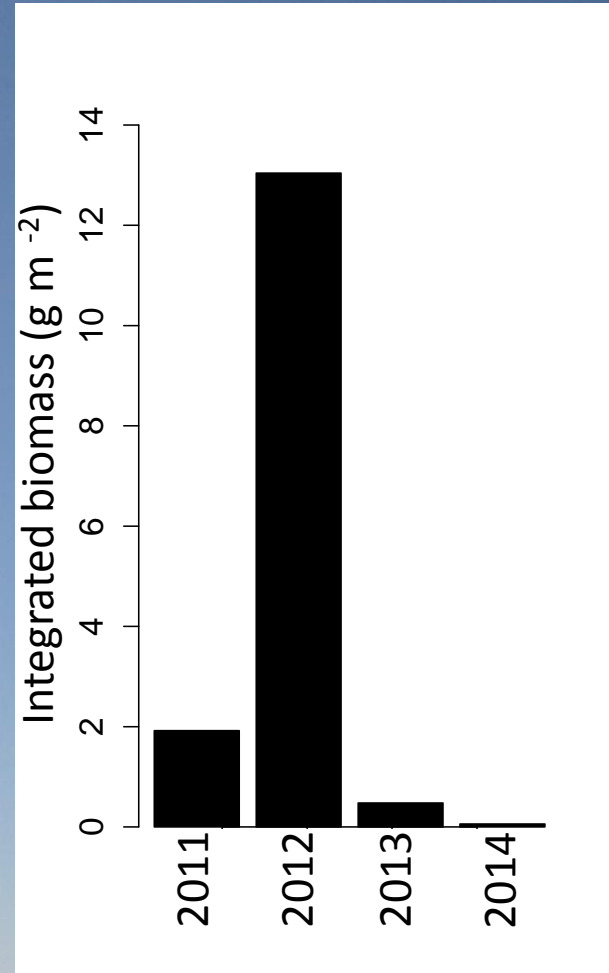
Mean annual integrated biomass of arctic cod during BREA

Strong variability

High biomass in 2012

Low biomass in 2014

Ongoing analyses to try to understand what causes the variability



Summary and conclusions

- In the Canadian Beaufort Sea, most adult arctic cod remain over the slope at depths >200 m throughout the year.
- Represent an important source of prey for seals and belugas and possibly answer the missing cod mystery. Total abundance calculations are ongoing.
- Most YOY arctic cod descend in fall before the freeze-up.
- The distribution of YOY and adult arctic cod overlaps with oil exploration lease blocks.

Acknowledgements

- Officers and crew of the CCGS *Amundsen* and F/V *Frosti*.
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- The NOAA graciously lent the transducers used during the 2012-2014 surveys.