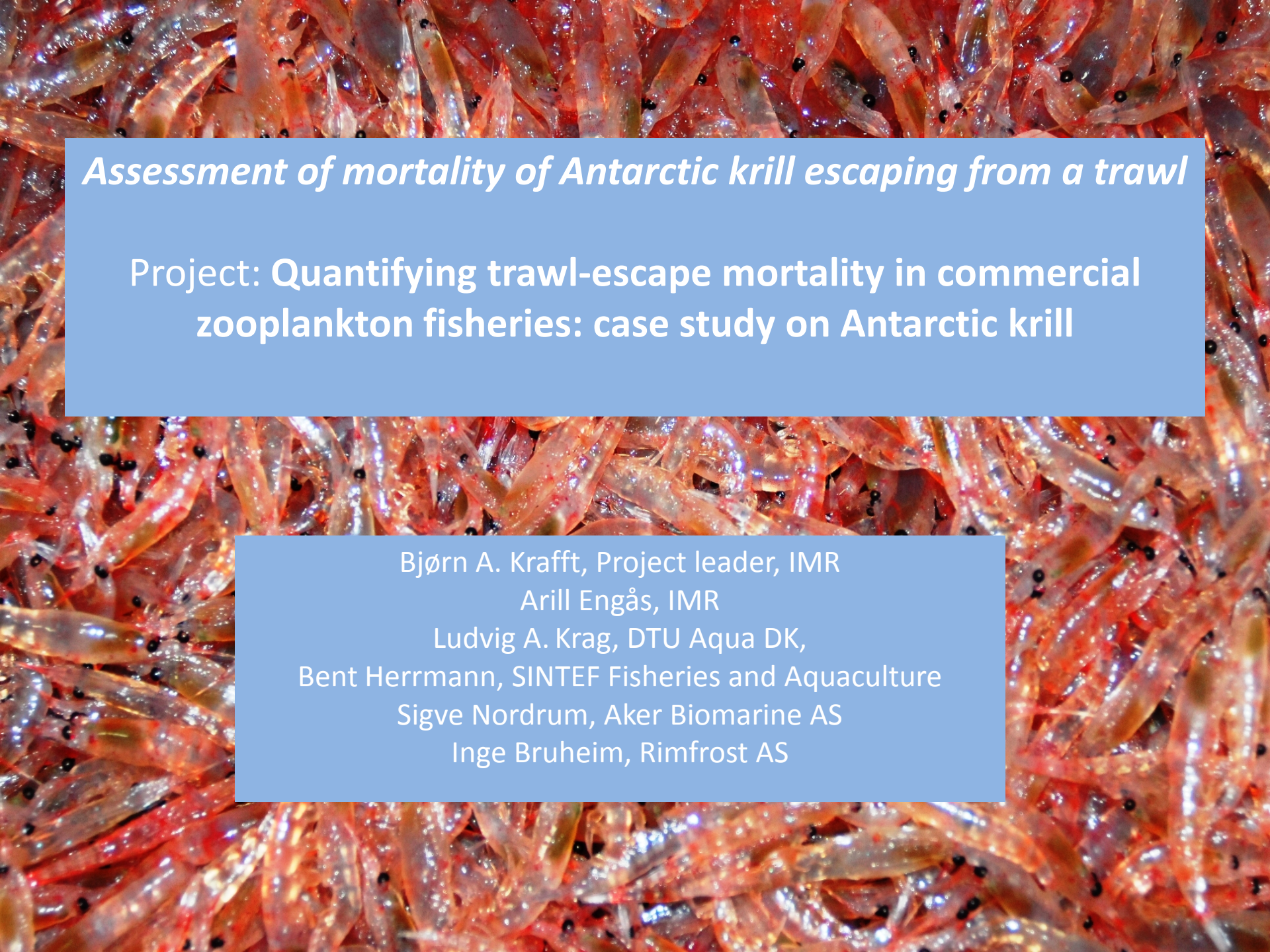
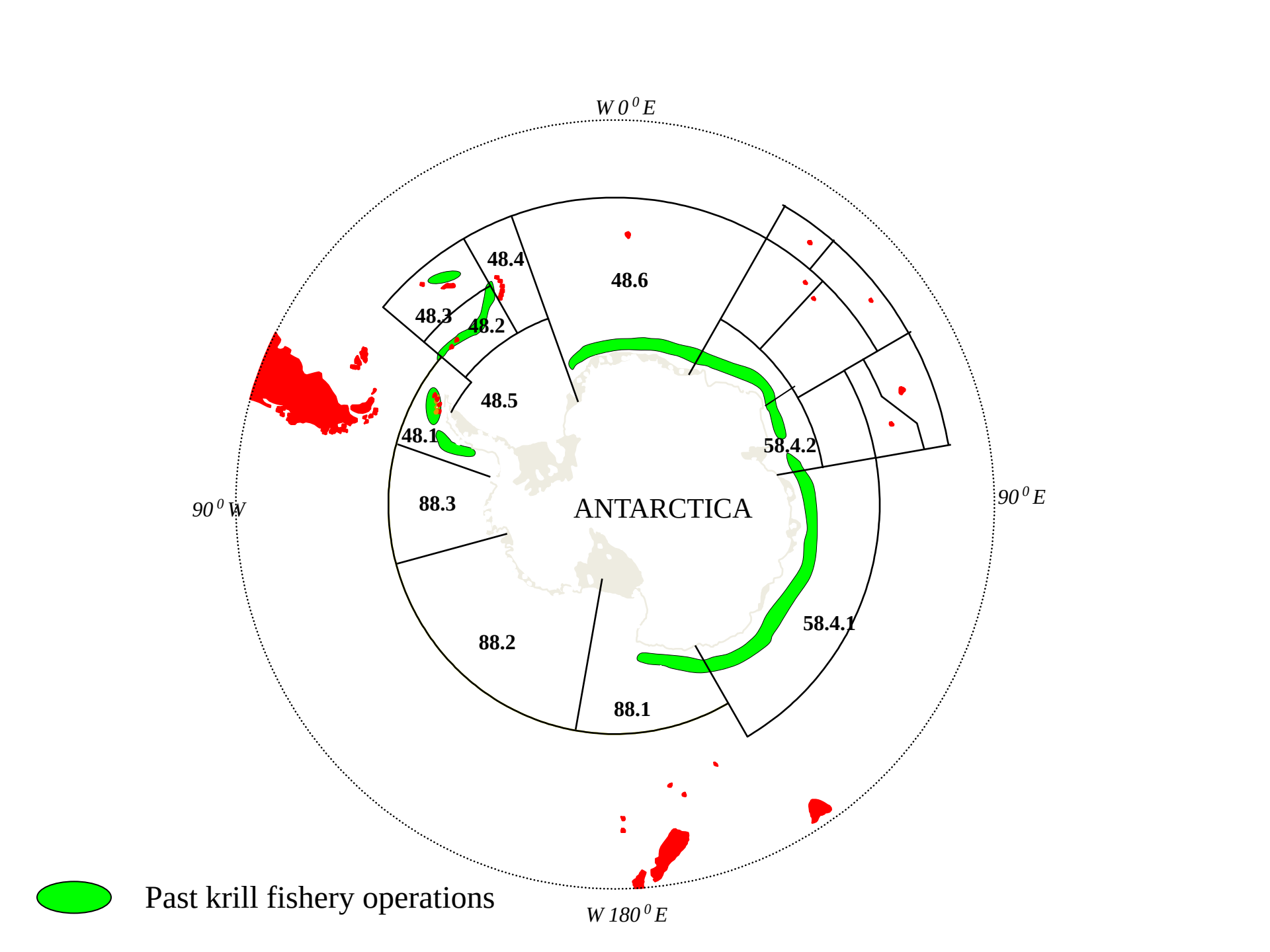


Assessment of mortality of Antarctic krill escaping from a trawl

Project: **Quantifying trawl-escape mortality in commercial zooplankton fisheries: case study on Antarctic krill**

Bjørn A. Krafft, Project leader, IMR
Arill Engås, IMR
Ludvig A. Krag, DTU Aqua DK,
Bent Herrmann, SINTEF Fisheries and Aquaculture
Sigve Nordrum, Aker Biomarine AS
Inge Bruheim, Rimfrost AS


W 0 0 E
90 0 W
90 0 E
W 180 0 E
48.4
48.6
48.3
48.2
48.5
48.1
58.4.2
88.3
ANTARCTICA
58.4.1
88.2
88.1
Past krill fishery operations

CCAMLR (Commission for the Conservation of Antarctic Marine Living Resources) Trigger levels for krill

<u>South Atlantic</u>

Trigger: 620,000 tonnes

48.1: 155,000 tonnes

48.2: 279,000 tonnes

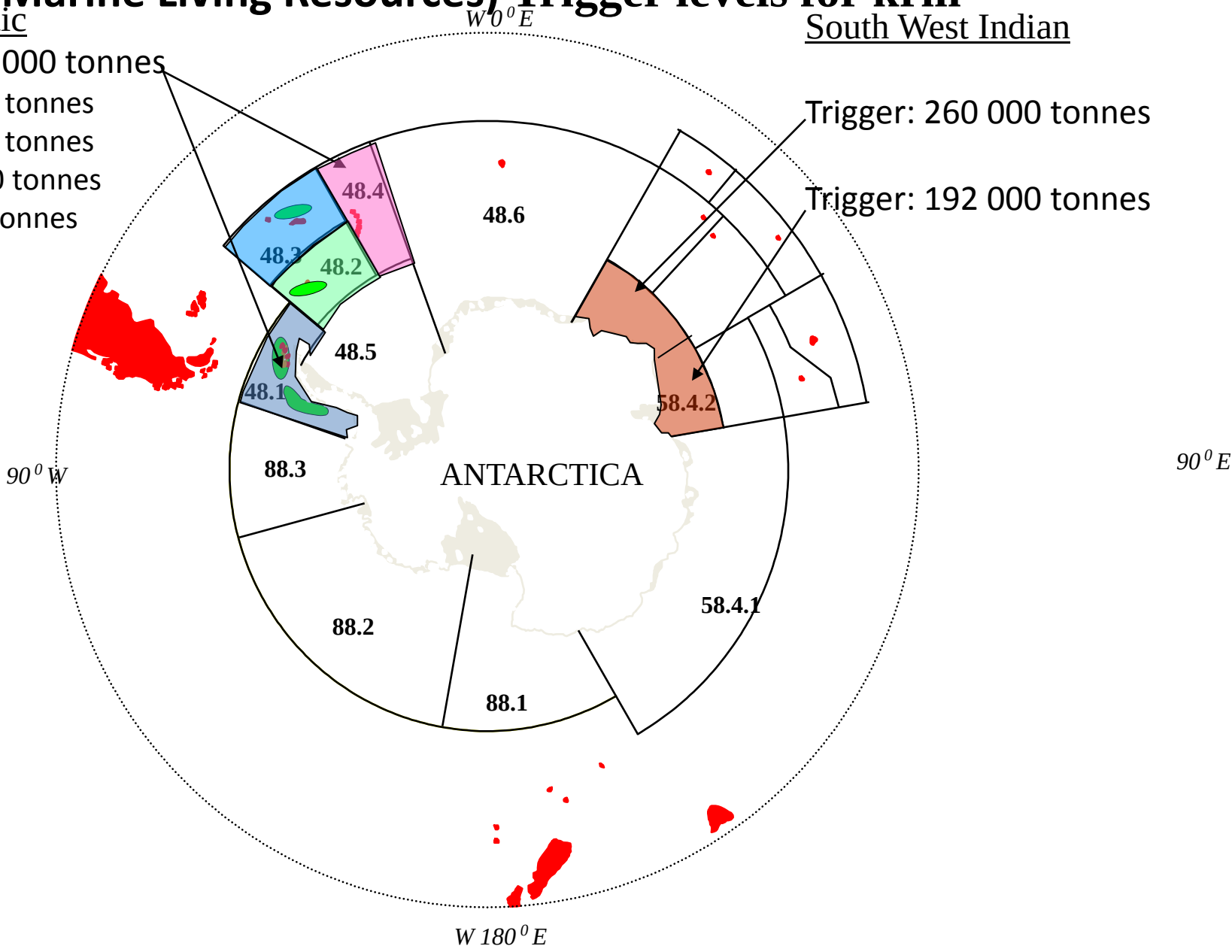
48.3: 279, 000 tonnes

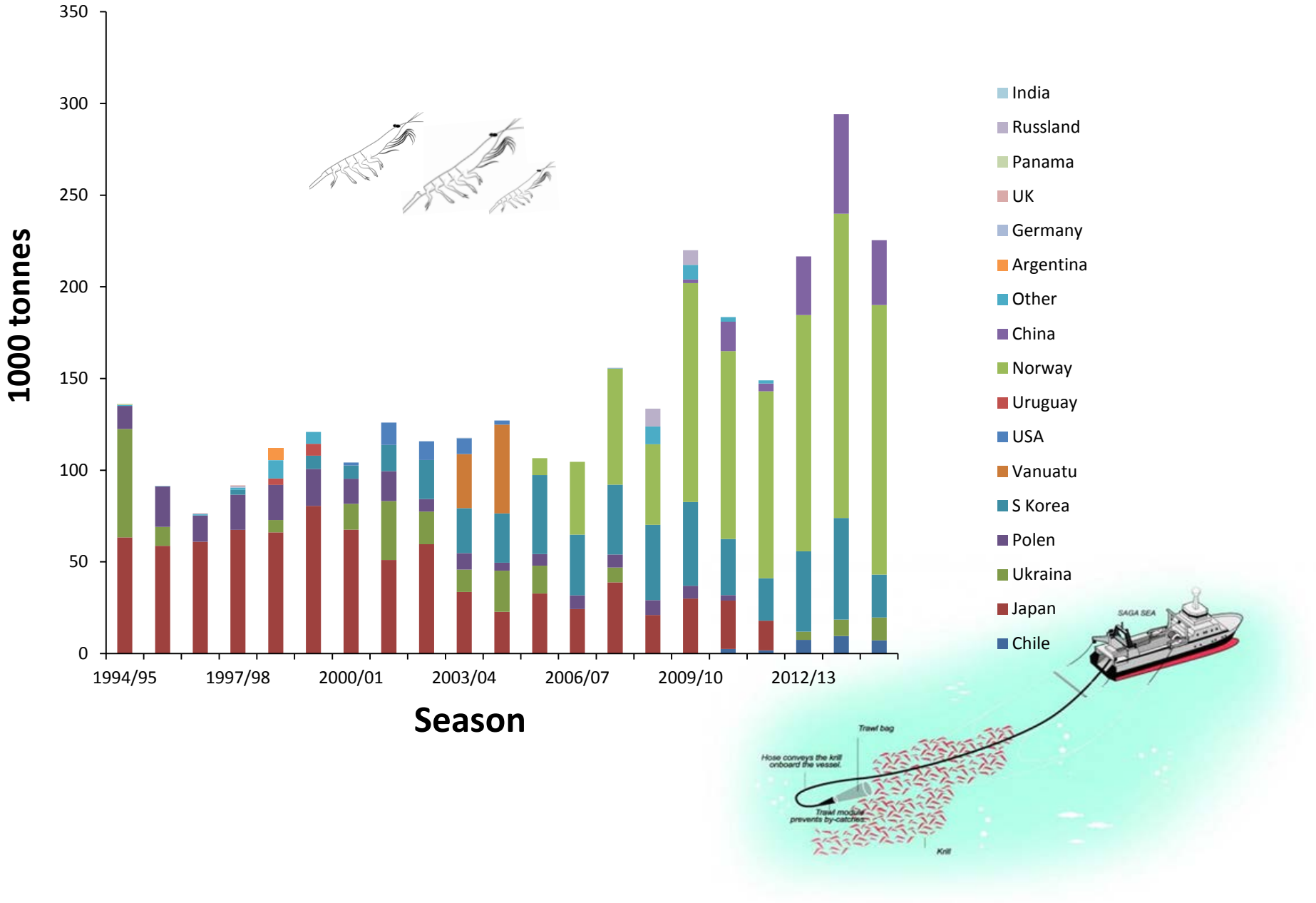
38.4: 93,000 tonnes

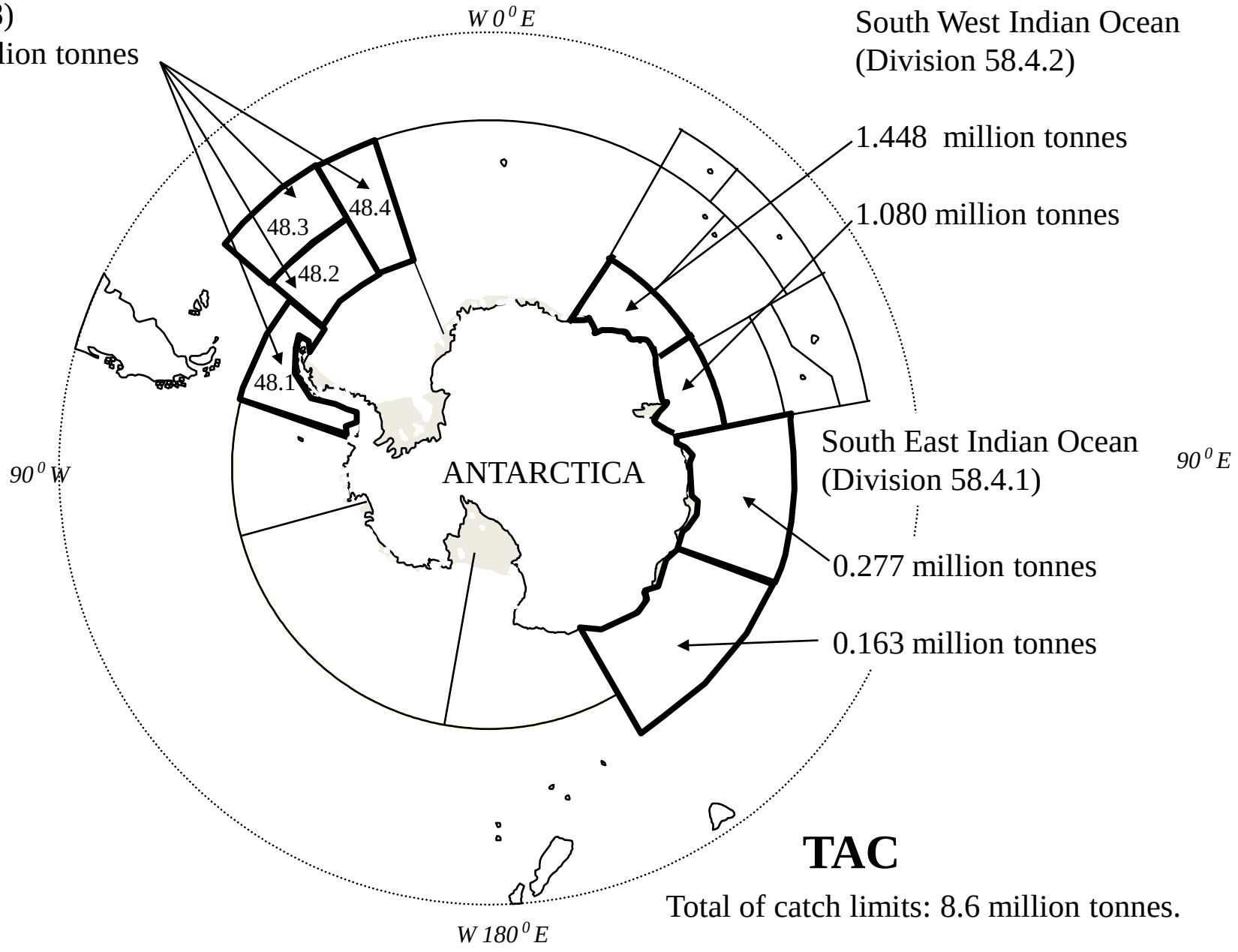
<u>South West Indian</u>

Trigger: 260 000 tonnes

Trigger: 192 000 tonnes




1000 tonnes
350
300
250
200
150
100
50
0
1994/95
1997/98
2000/01
2003/04
2006/07
2009/10
2012/13
Season
India
Russland
Panama
UK
Germany
Argentina
Other
China
Norway
Uruguay
USA
Vanuatu
S Korea
Polen
Ukraina
Japan
Chile
SAGA SEA
Trawl bag
Hose conveys the krill onboard the vessel.
Krill

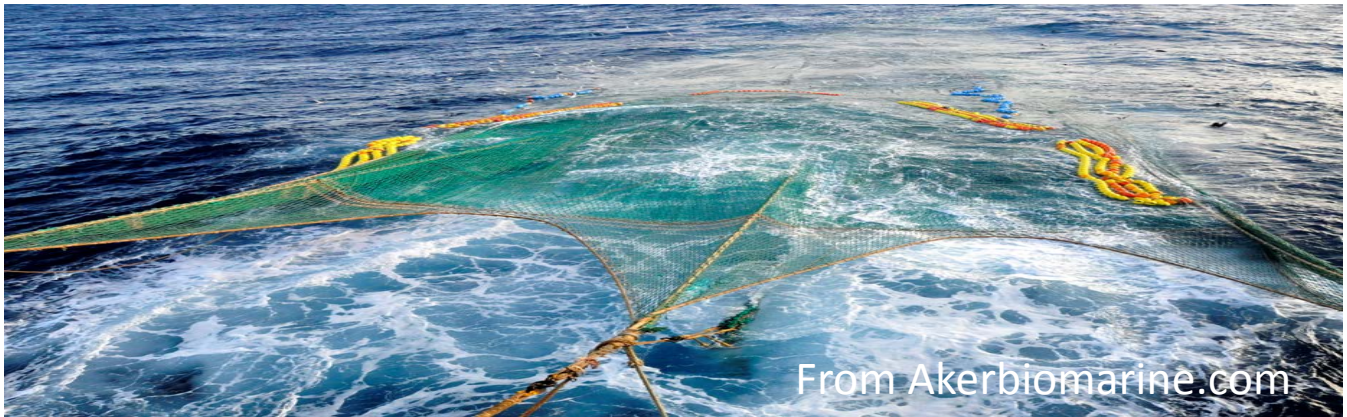


TAC

Total of catch limits: 8.6 million tonnes.

Escape/unaccounted mortality

- Unaccounted mortality includes the deaths that occur after escaping the fishing gear, due to physiological damage, stress or trauma – factors which may also increase vulnerability to predators.
- Estimating unaccounted mortality is vital for the overall estimation of total fishing mortality.
- The distribution and level of the krill harvest is expected to expand, but the methods for estimating unaccounted fishing mortality in krill remain poorly understood.



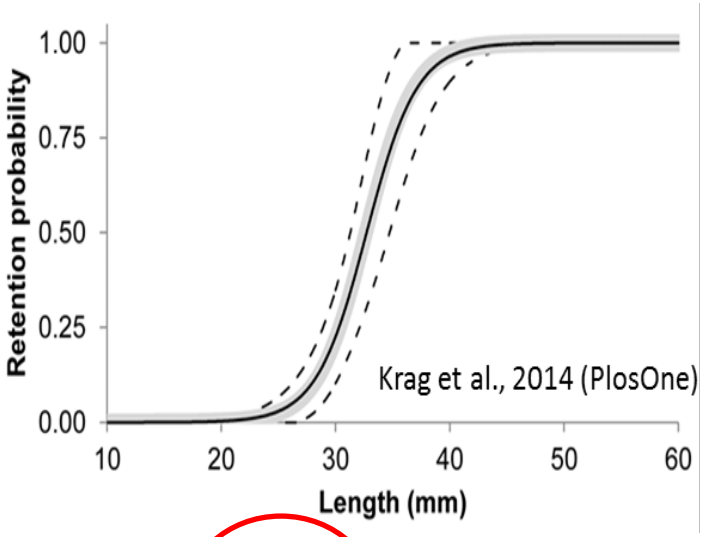
OPEN ACCESS Freely available online

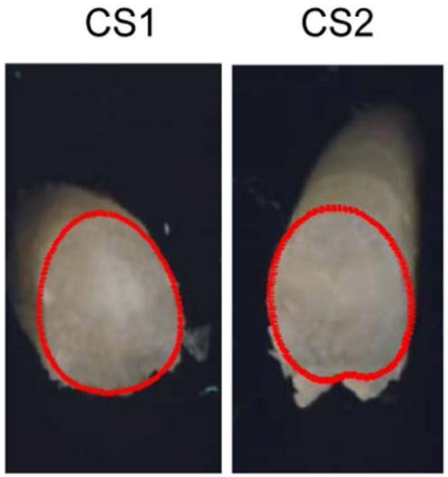
PLOS | ONE

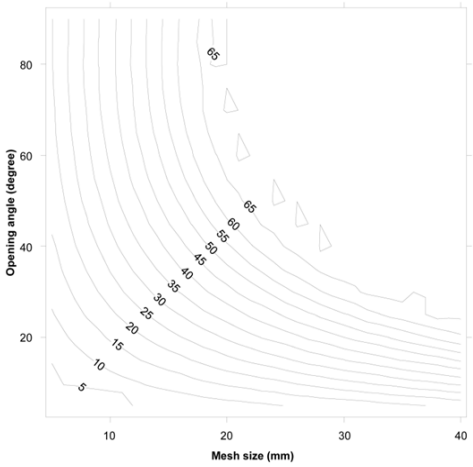
Size Selection of Antarctic Krill (*Euphausia superba*) in Trawls

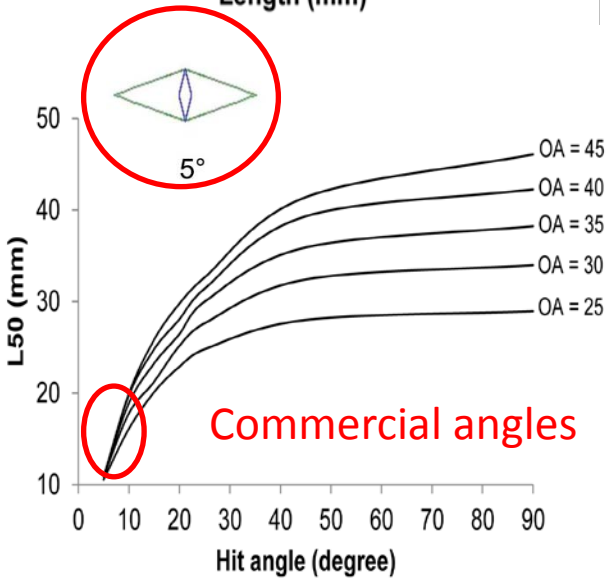
Ludvig A. Krag[1]*, Bent Herrmann[2], Svein A. Iversen[3], Arill Engås[3], Sigve Nordrum[4], Bjørn A. Krafft[3]

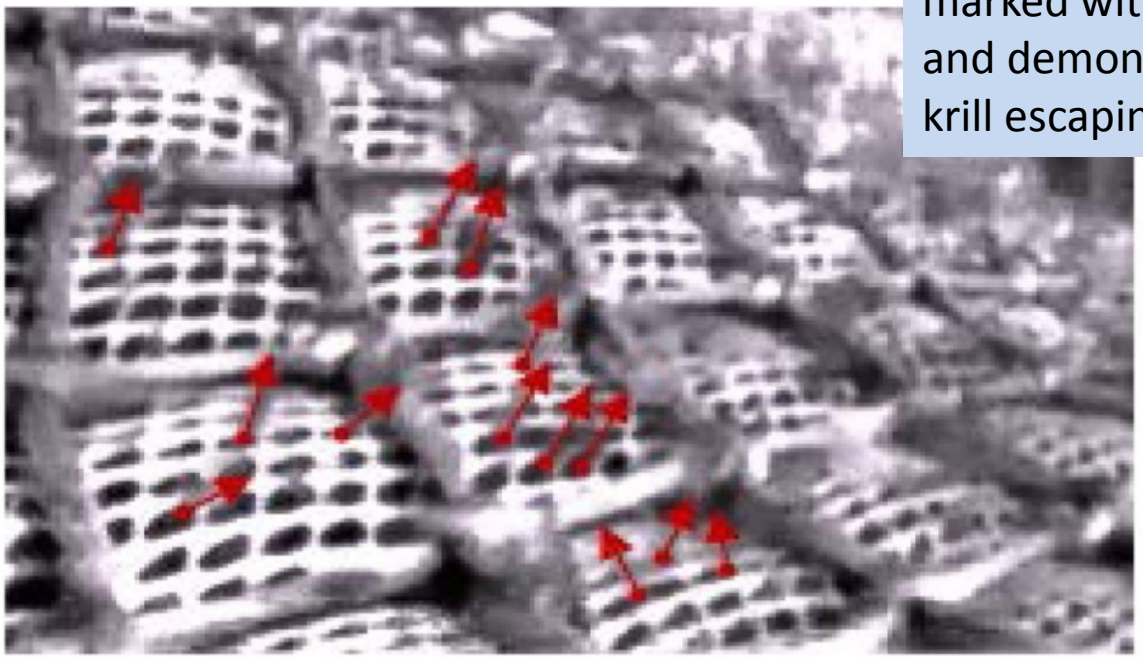
- Many of the length classes of krill can escape through the commonly used commercial mesh sizes
- Video recordings indicate that the orientation of the animals escaping the meshes usually exit head first and relatively perpendicular to the netting wall.





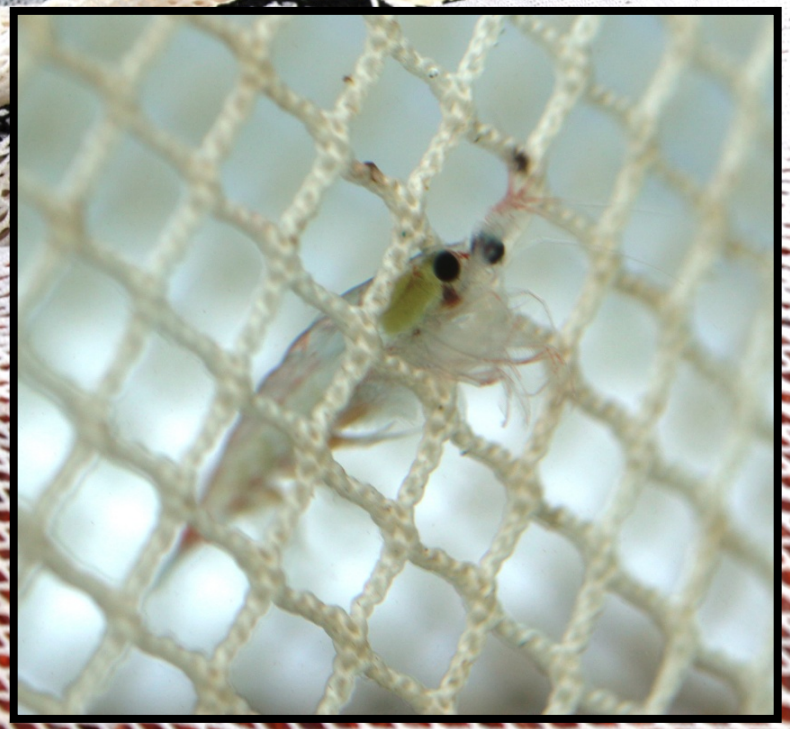






Underwater video captured during fishing indicating escaping krill. The escapees are marked with red arrows in the lower photo and demonstrate an optimal orientation of the krill escaping.

”Stickers” in the codend of research trawl (16 mm mesh size)

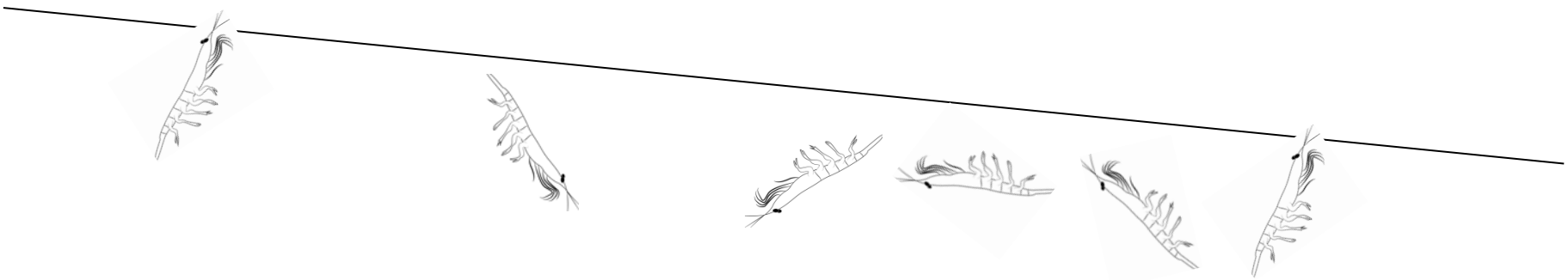


Laboratory study shows that krill escapes mesh head first.

Krill may be able to orientate themselves optimally in relation to the trawl.
Alternatively, the escape process may be more random,
since a >200 m long trawl provides many opportunities for krill to contact the netting during their journey to the codend and at some point individuals may meet the netting at an optimal orientation purely by chance.

Trawl dimensions: L: 230m

H: 16m



Fisheries Research 170 (2015) 102–105

Contents lists available at ScienceDirect

Fisheries Research

journal homepage: www.elsevier.com/locate/fishres

Short Communication

Assessment of mortality of Antarctic krill (*Euphausia superba*) escaping from a trawl

Bjørn A. Krafft[a,*], Ludvig A. Krag[b]

[a] Institute of Marine Research, 5870 Bergen, Norway
[b] DTU Aqua, Natl Inst Aquat Resources, DK-9850 Hirtshals, Denmark

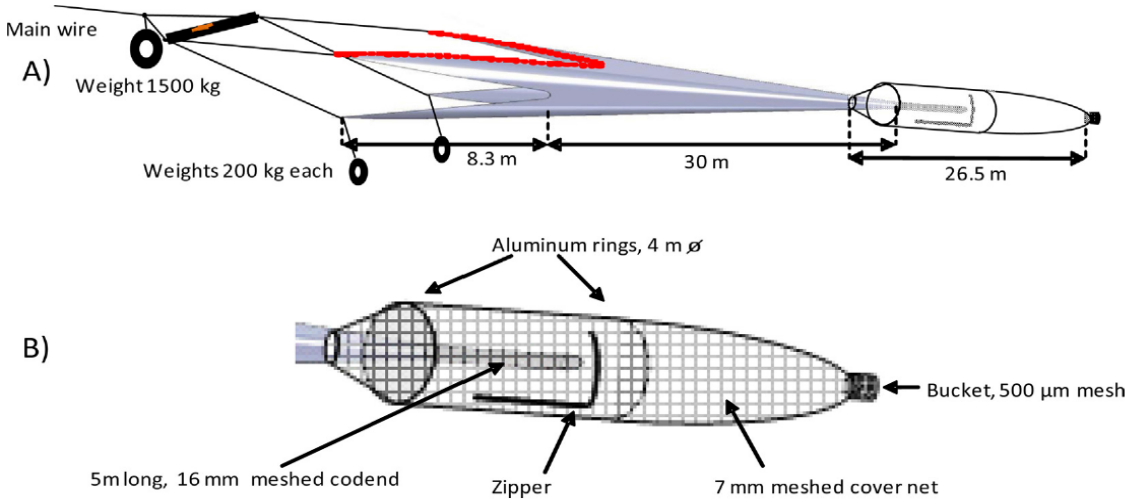


Fig. 1. (A) covered codend sampling technique, (B) cover net system.

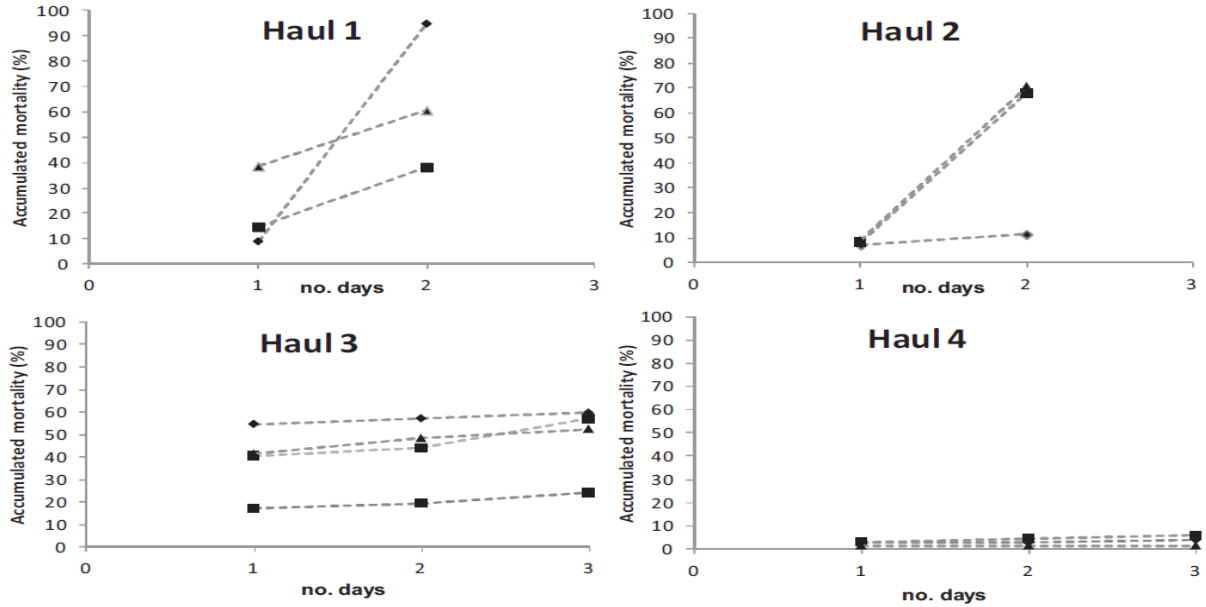


Fig. 2. Accumulated mortality for escaped krill caught in a covered codend after 24–72 h in the holding tank.

Quantifying the escape mortality of trawl caught Antarctic krill (*Euphausia superba*)

Krafft BA, Krag LA, Engås A, Nordrum S, Bruheim I, Herrmann B.

Submitted to PLOS ONE, April 2016.

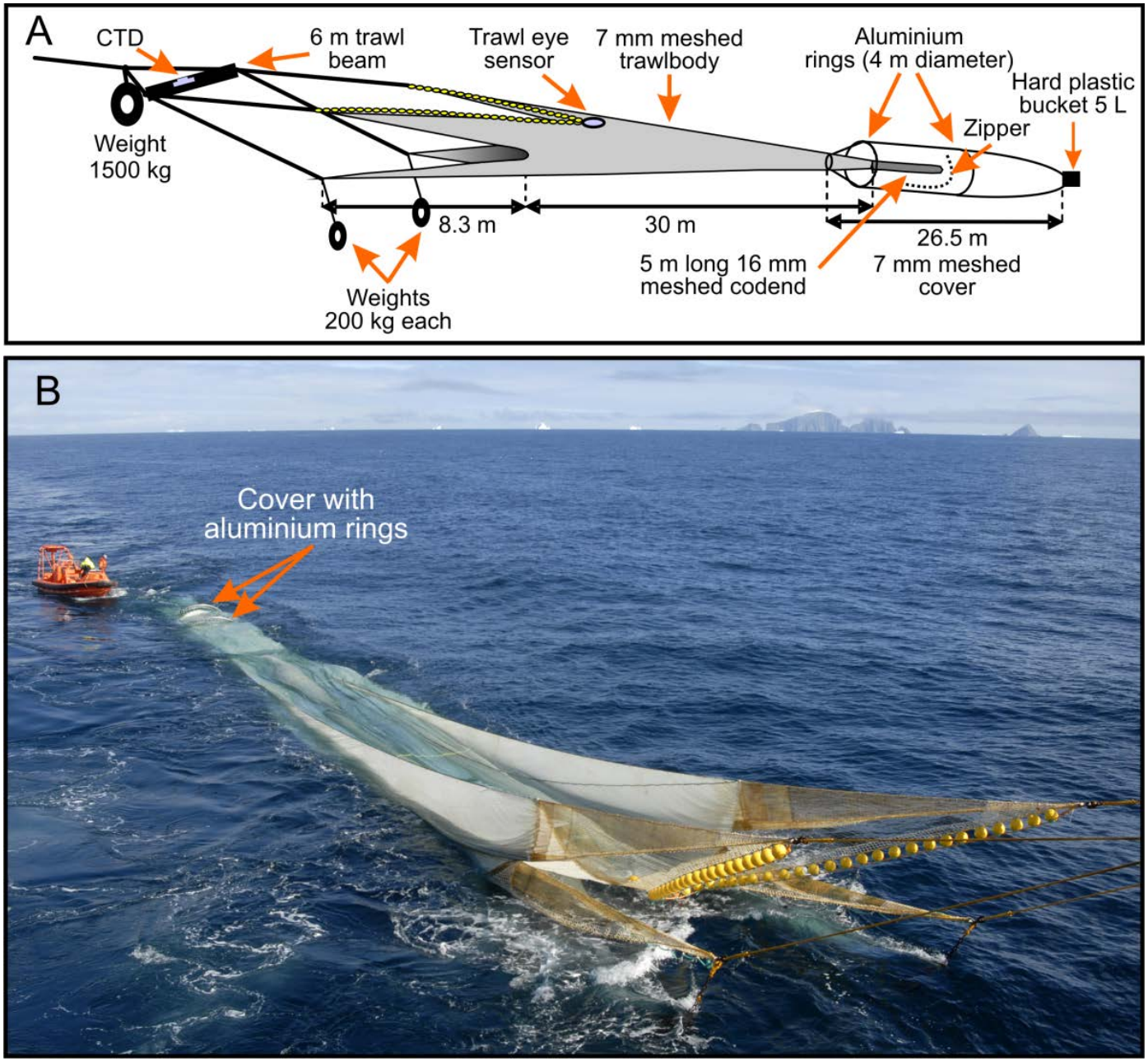
This study set out to quantify the escape mortality of trawl caught krill, following the study design and recommendations for methodological improvements given in Krafft and Krag (2015):

i) increased number of replicates

ii) establishment of adequate experimental control groups

iii) optimized holding facilities to mimic natural conditions as closely as possible.

In addition, we provide a formal statistical approach to investigate mortality rates of escapees against time, applying a non-parametric Kaplan Meier (KM) model to the data.



Covered codend sampling system used to collect krill trawl escapees (A and B).

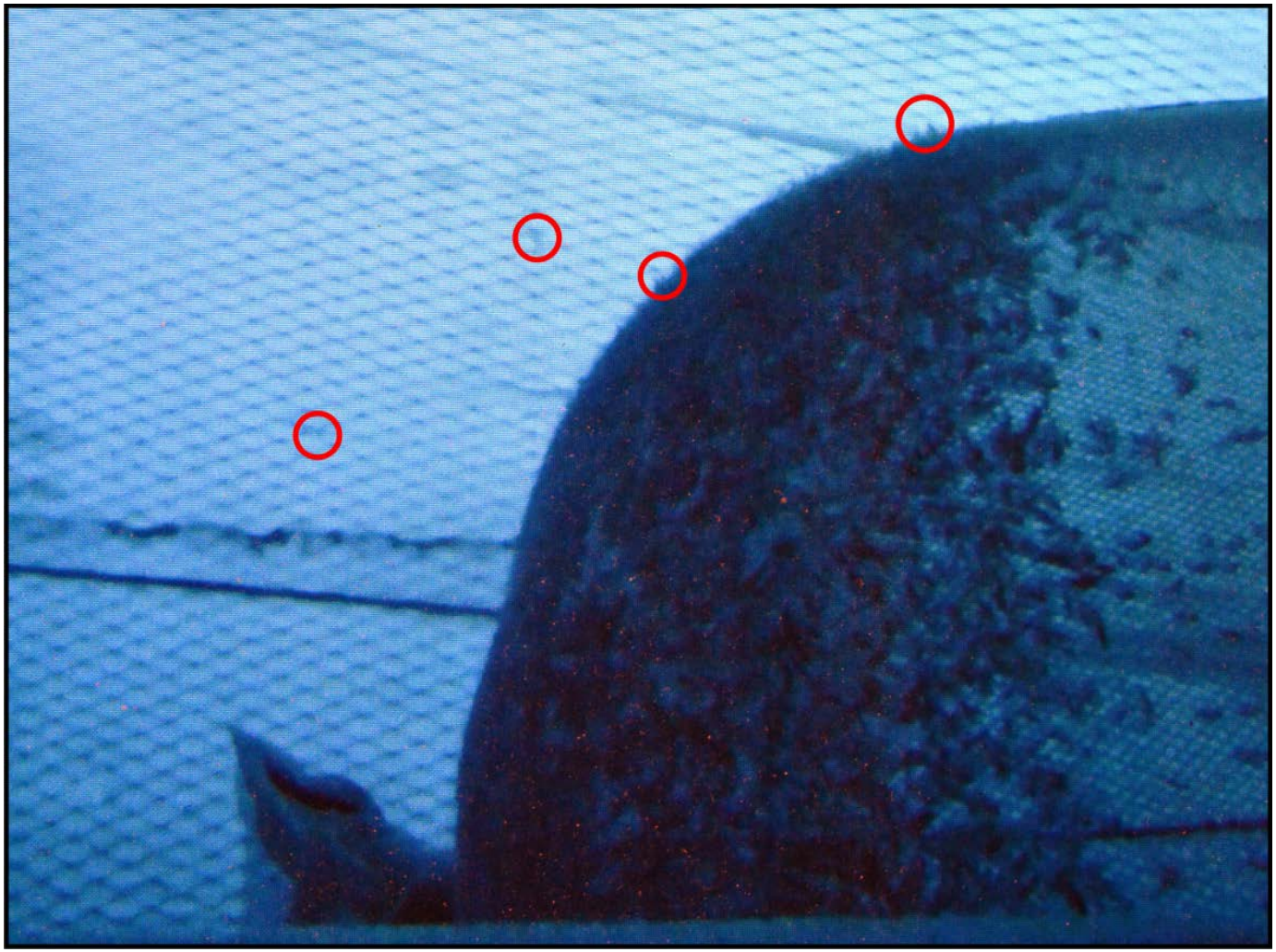
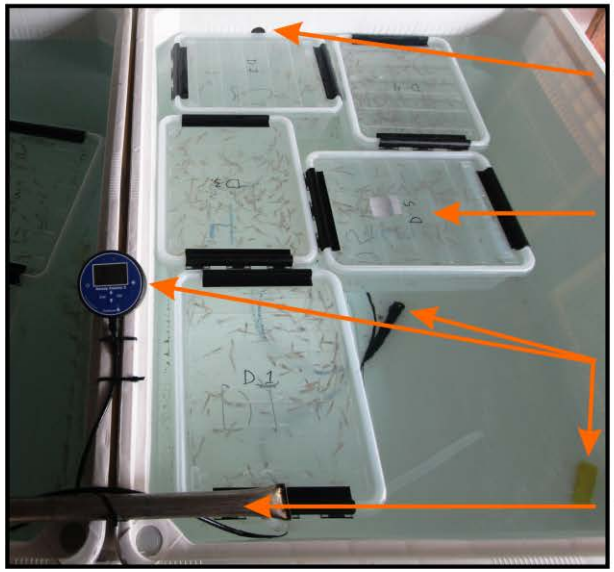


Image captured inside the cover facing the codend during fishing, using underwater video cameras, red circles indicate krill penetrating 16 mm meshes in the codend and escapees within the cover. The cover mesh was 7 mm supported by a 200 mm protection net.

Experimental holding tank set-up
with krill control groups and trawl caught escapees to monitor escape mortality.

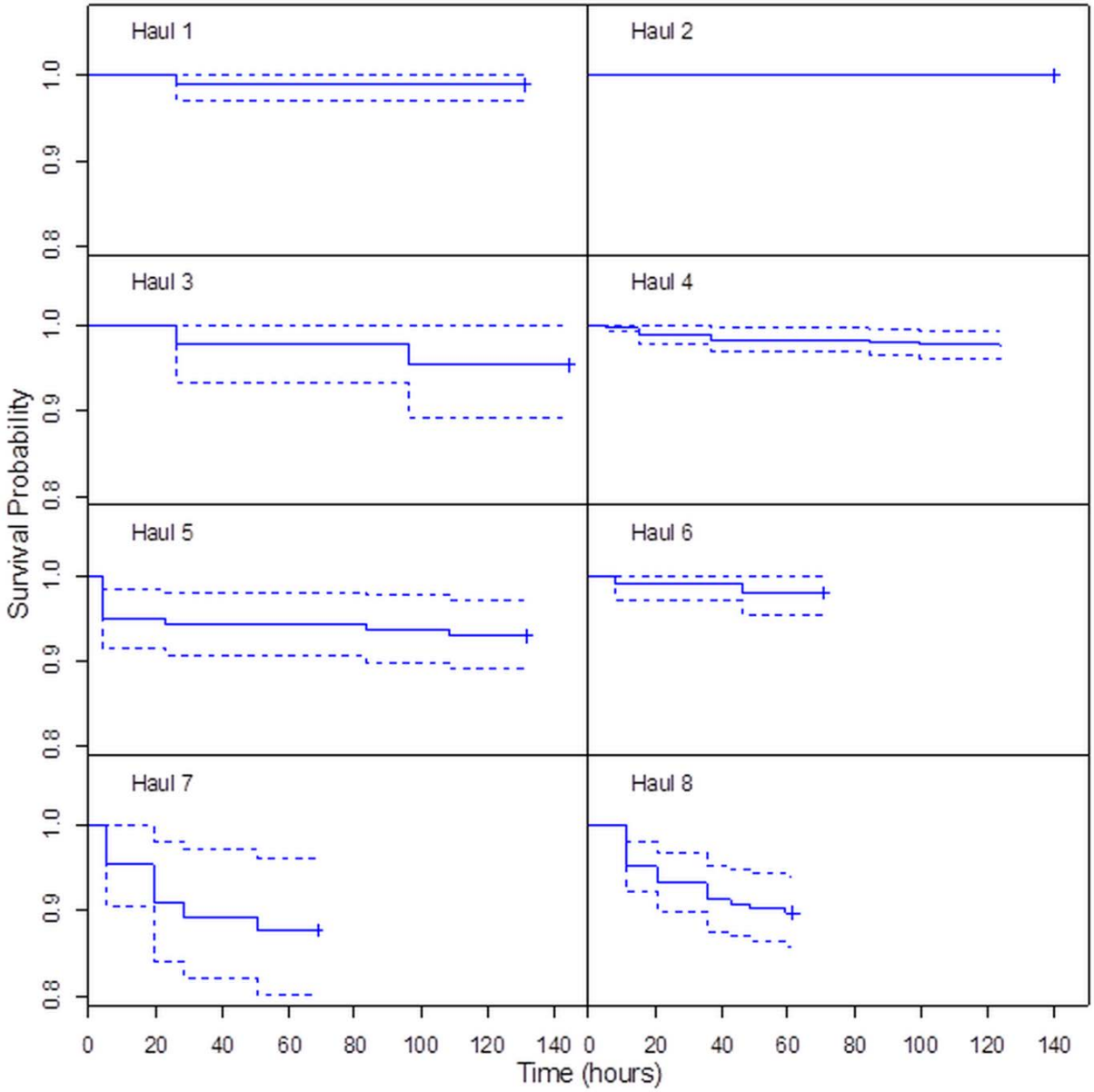


Water drain (diameter = 4 cm)

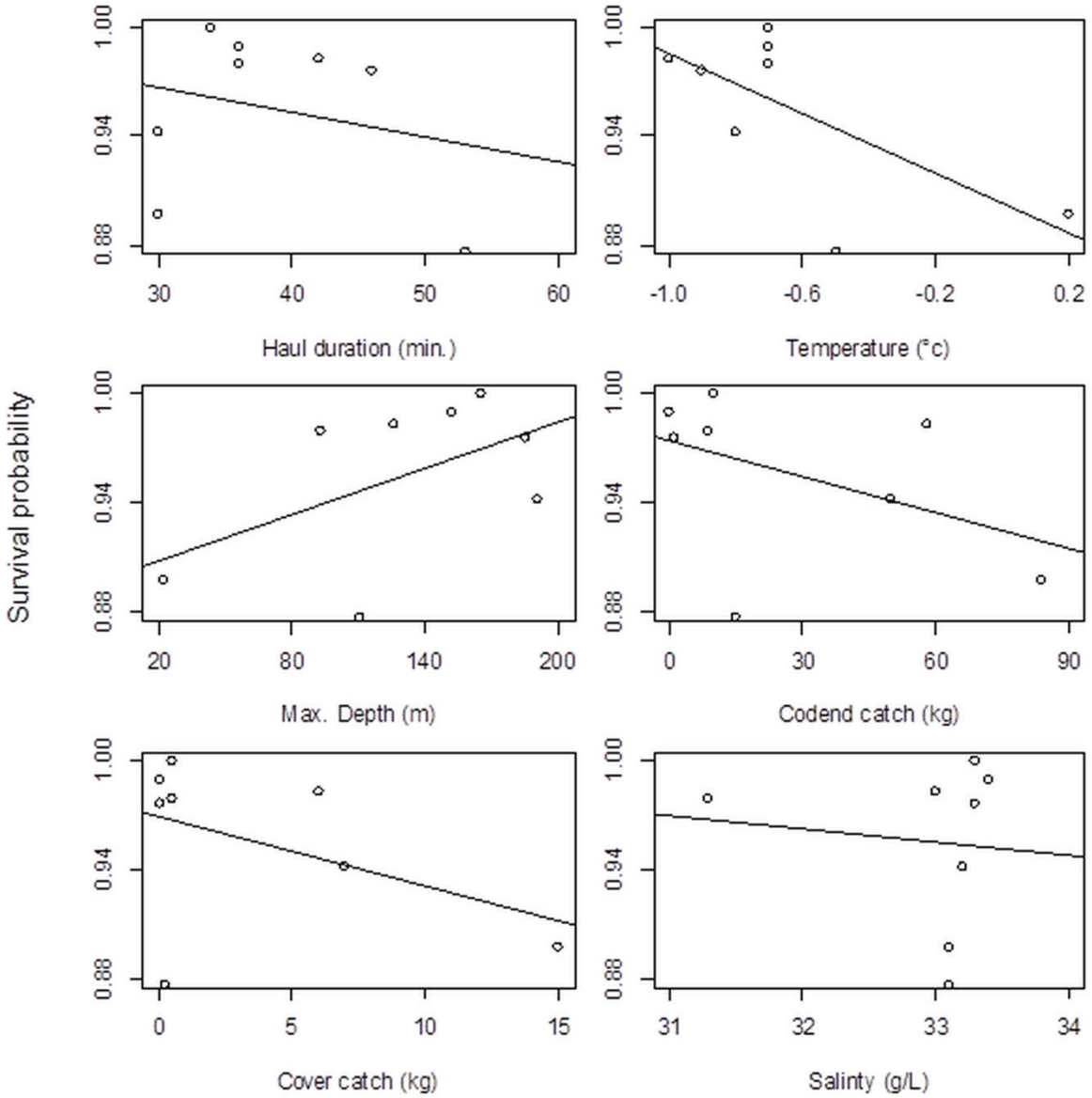
15 L aquariums

Oxygen and temperature sensors

Water supply

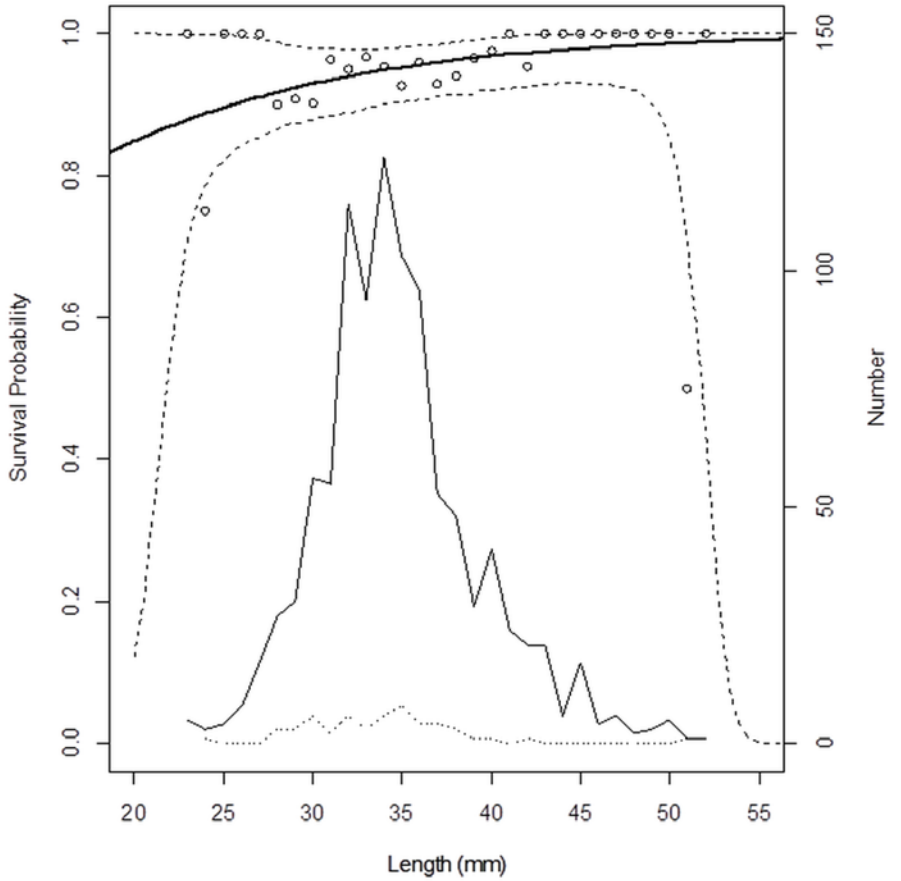


Kaplan-Meier survival probability curves for individual codend escapement hauls. Dashed lines represent 95 % confidence bands. Time on x-axis is given in hours from arrival of the catch on deck.

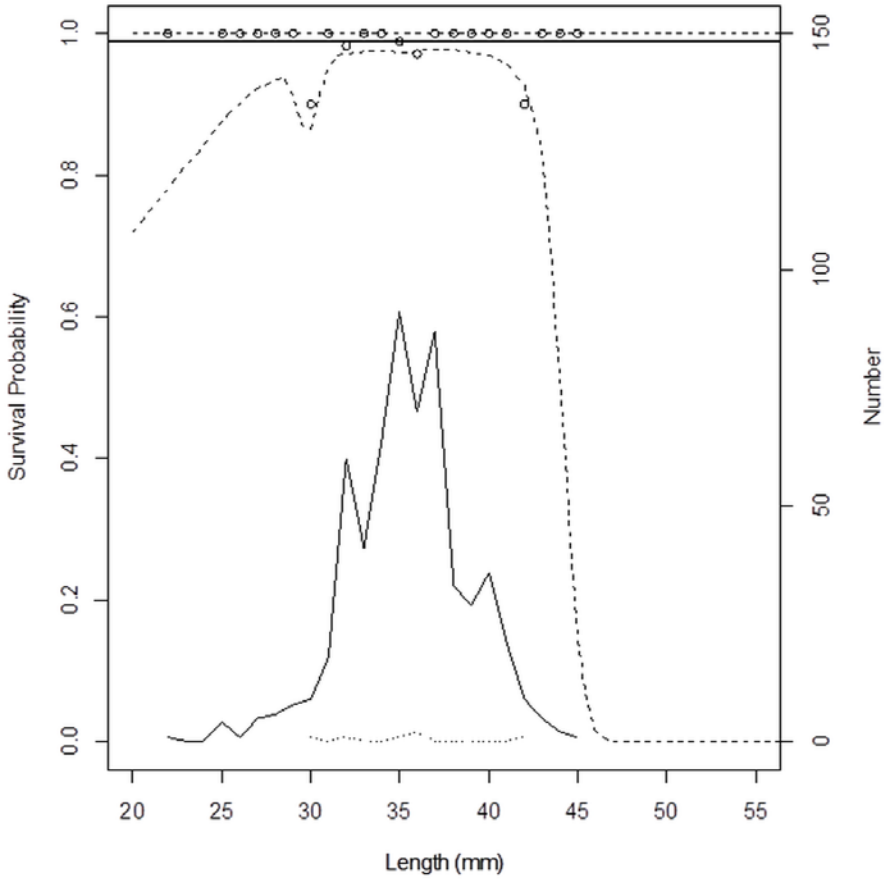


Survival probability in individual hauls 60 hours after the catch arrived on deck against different operational parameters: haul duration, sea temperature, max. fishing depth, codend catch weight, cover catch weight, seawater salinity. The lines in the plots represent the fit of the individual single parameter models

Pooled hauls



Control groups



Length-dependent survival probability .

Circles represent experimentally observed survival probability.

Solid thick line represents the modelled length-dependent survival rate at the end of observation period.

Dashed lines represent 95 % confidence limits for the survival probability.

Thin solid line shows the number of surviving krill of each length.

Dotted line shows the number of dead krill of different sizes.

Conclusion

- No significant effect on mortality was associated with the holding tank conditions. This shows that we succeeded in providing stable, high quality holding conditions throughout the study.
- Haul duration, hydrological conditions, maximum fishing depth and catch composition all had no significant effect on mortality of krill escaping 16 mm mesh size nets
- We found low between-haul mortality variations in the escape experiment hauls, and some of this variation could be explained by stresses induced post-heaving and between holding conditions (air exposure, gravitation).
- The three first bullet points indicates that the mortality that we observed during the study is associated with the escapement.
- The non- parametric Kaplan-Meier analysis used to model the relationship between mortality rates of escapees and time showed there was a weak tendency, though not significant, for smaller individuals to suffer higher mortality than larger individuals. .
- The mortality of krill escaping the trawl nets in our study was 4.4 ± 4.4 %, suggesting that krill are fairly tolerant of the capture-and-escape process in trawls.
- This knowledge is valuable for the adoption of gear based management measures and for future fishing gear development to reduce escapement and unaccounted mortality, which in turn will also increase the long term economic profitability of the fishery.
- This also provides knowledge and methods relevant for the development of also other new and exploratory fisheries on resources lower in the food chain.

Future work coming from the project:
Escapees vulnerability to predators?
Active or passive selection process?
Selection process in the entire trawl body?

Thanks for listening !

Thanks to:
Norwegian Research Council for funding SILF
(P. no 243619) and to
Aker Biomarine and Olympic Seafood for
supplying vessel time for the project