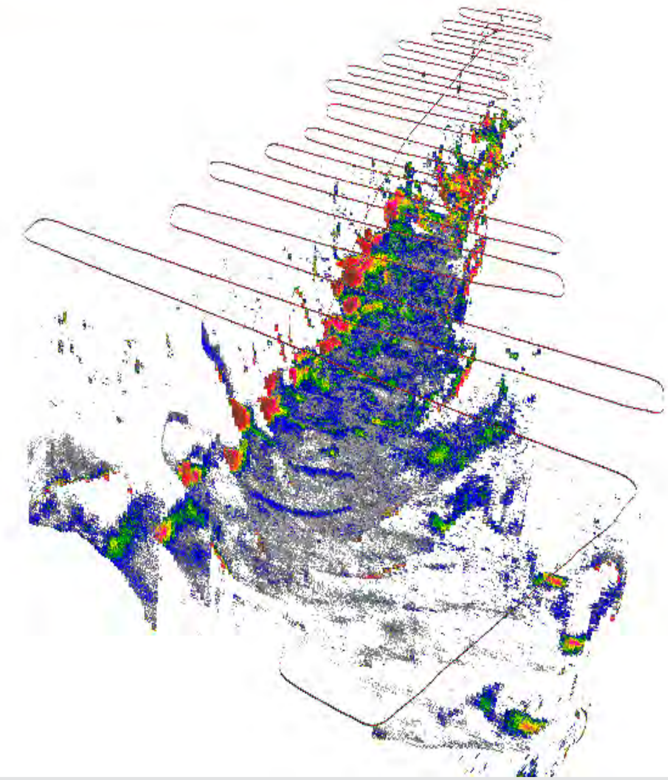

www.csiro.au

# Using commercial vessels to monitor deep-water fisheries and basin scale ecosystems

Rudy Kloser:

Tim Ryan, Gordon Keith, Mark Lewis, Caroline Sutton, Ryan Downie, Liza Gershwin

National Research FLAGSHIPS Wealth from Oceans

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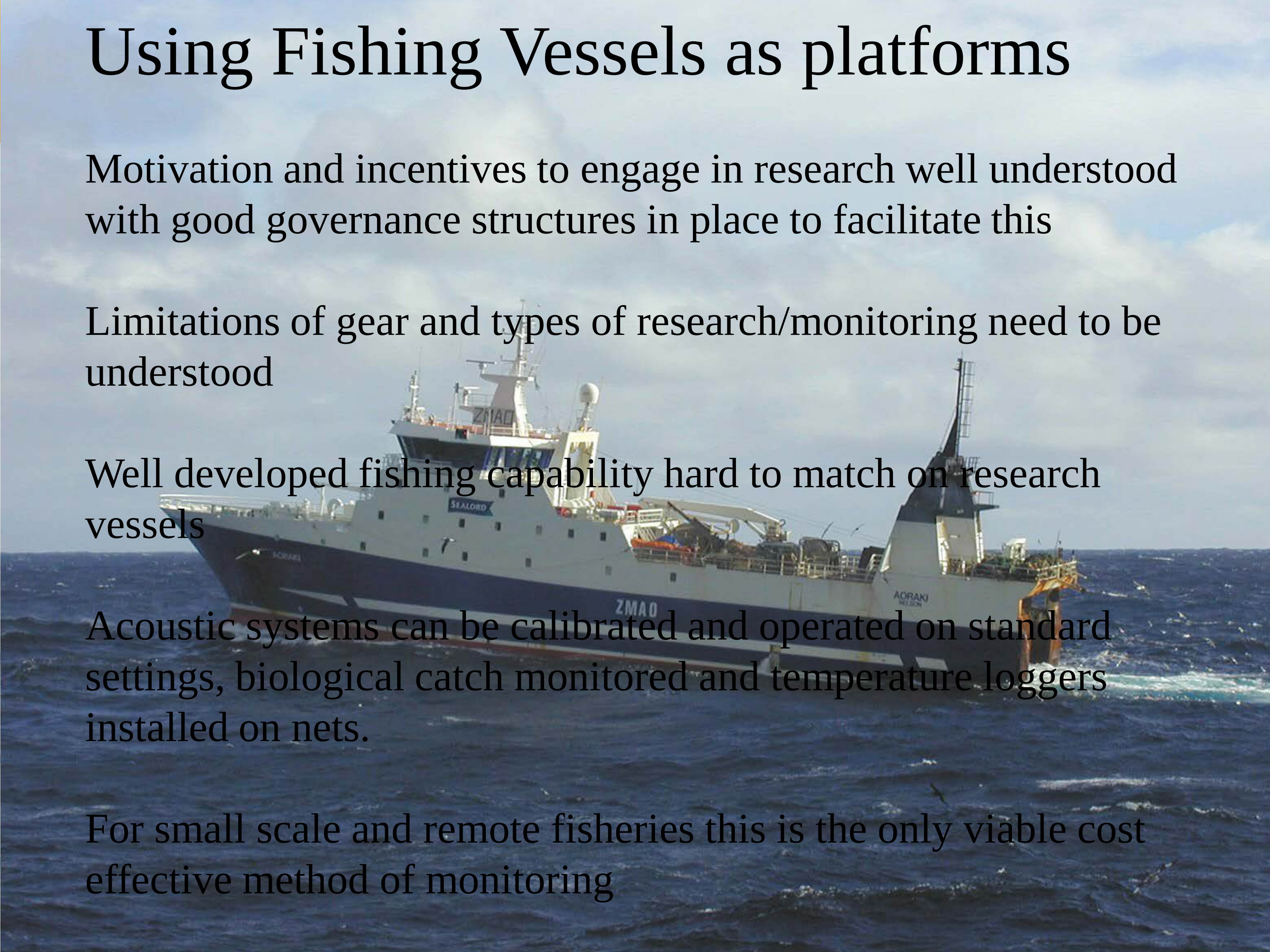
# Using Fishing Vessels as platforms



Motivation and incentives to engage in research well understood with good governance structures in place to facilitate this

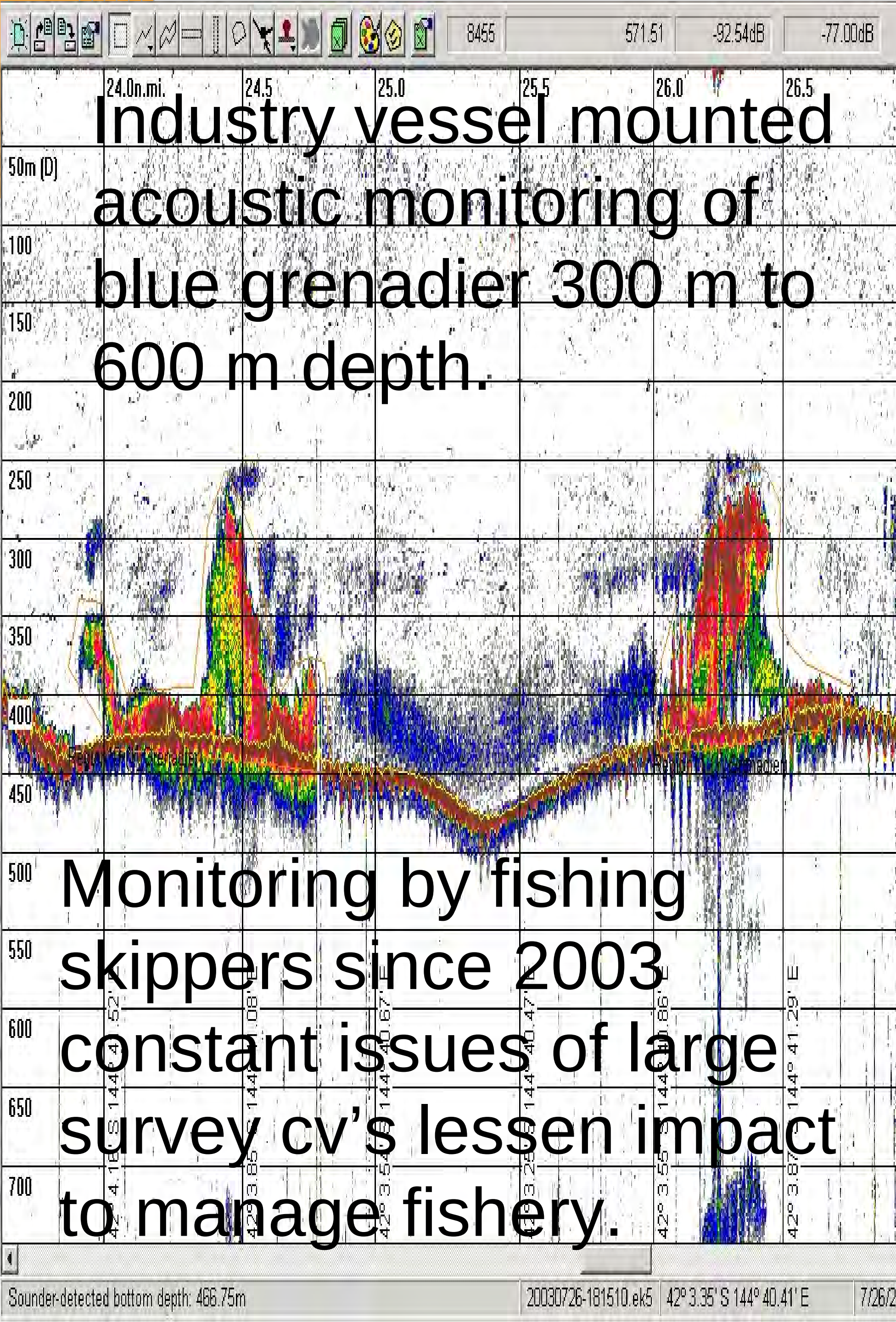
Limitations of gear and types of research/monitoring need to be understood

Well developed fishing capability hard to match on research vessels

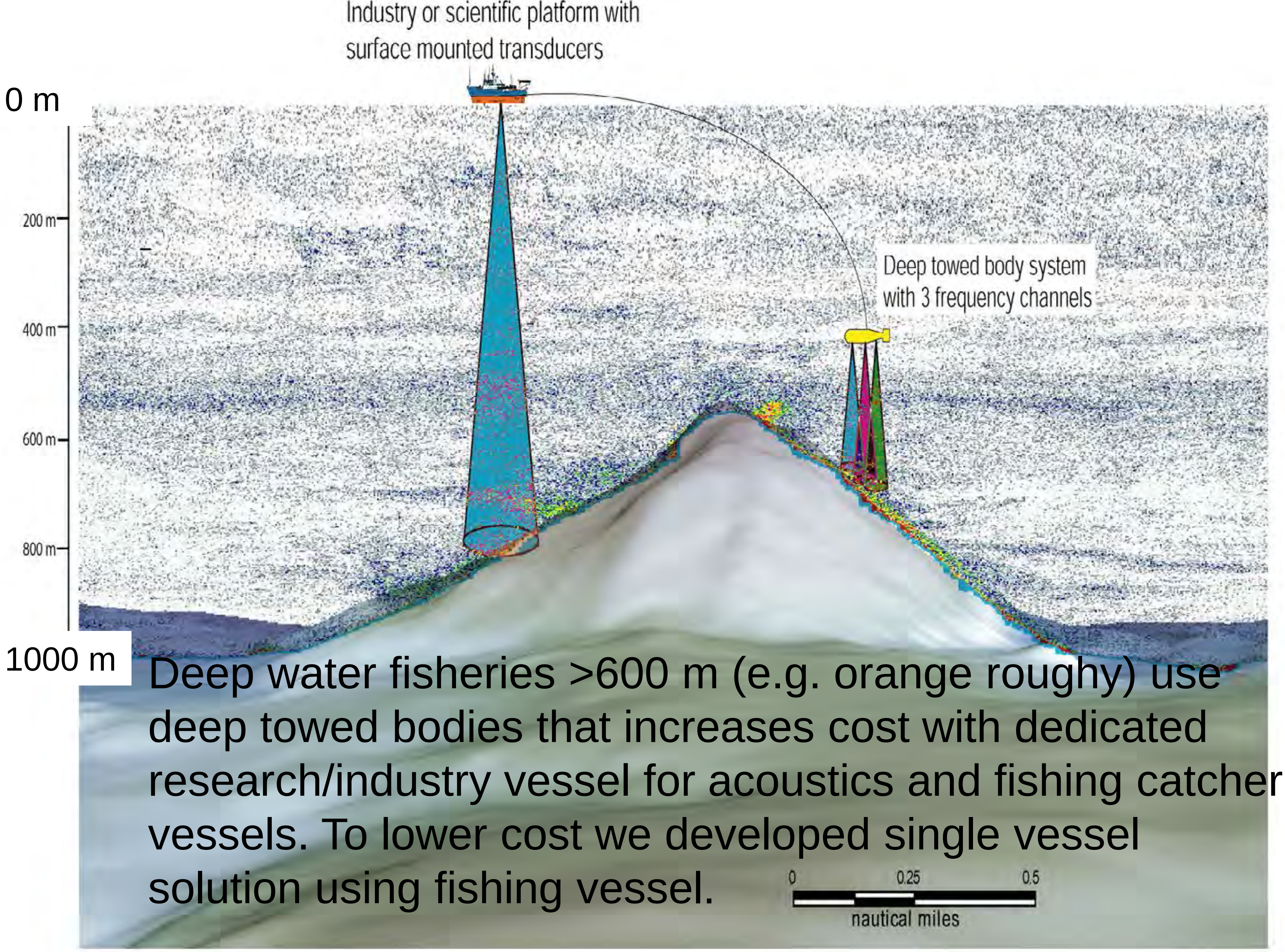
Acoustic systems can be calibrated and operated on standard settings, biological catch monitored and temperature loggers installed on nets.

For small scale and remote fisheries this is the only viable cost effective method of monitoring

Industry vessel mounted acoustic monitoring of blue grenadier 300 m to 600 m depth.



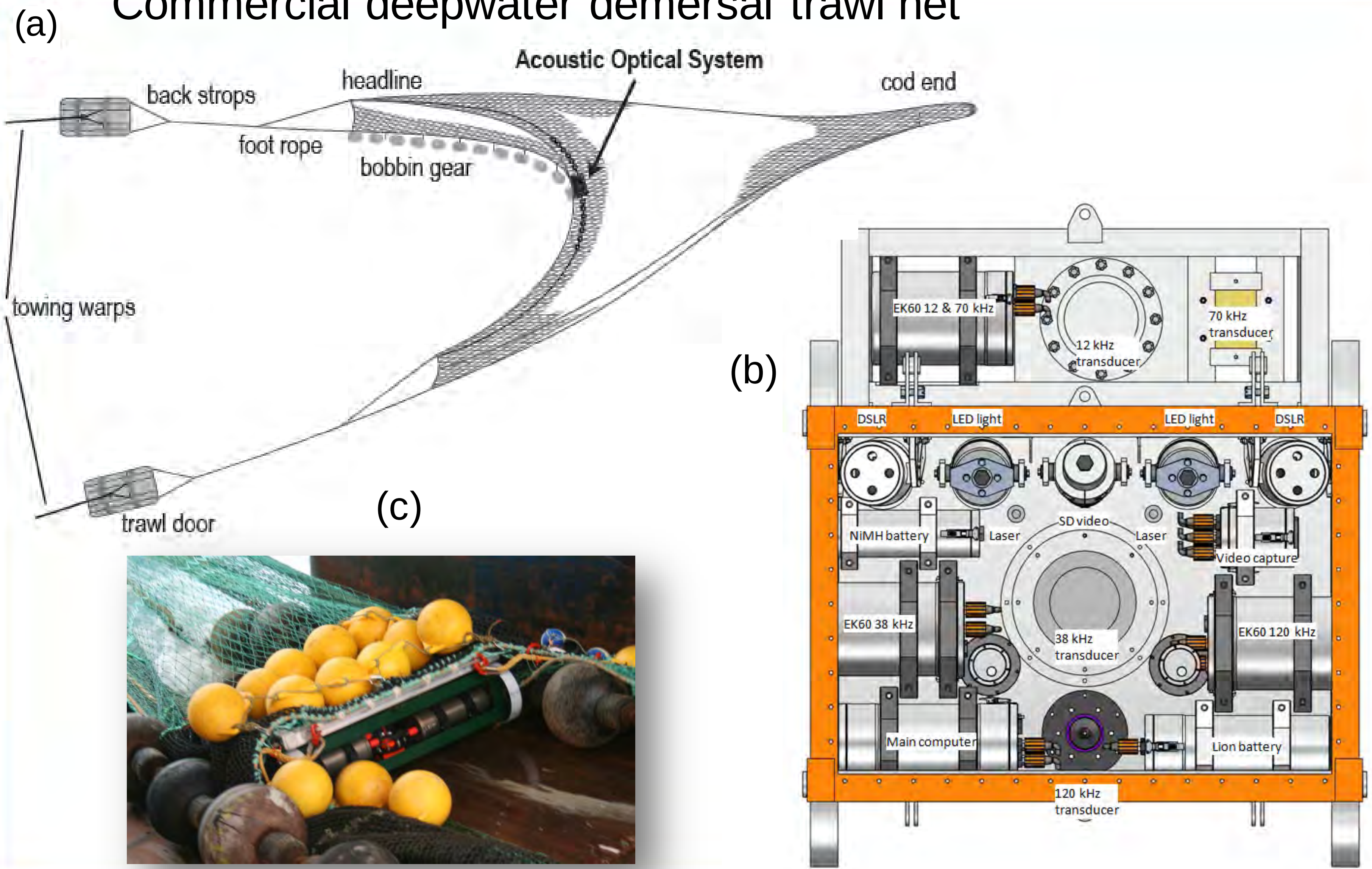

Monitoring by fishing skippers since 2003 constant issues of large survey cv's lessen impact to manage fishery.



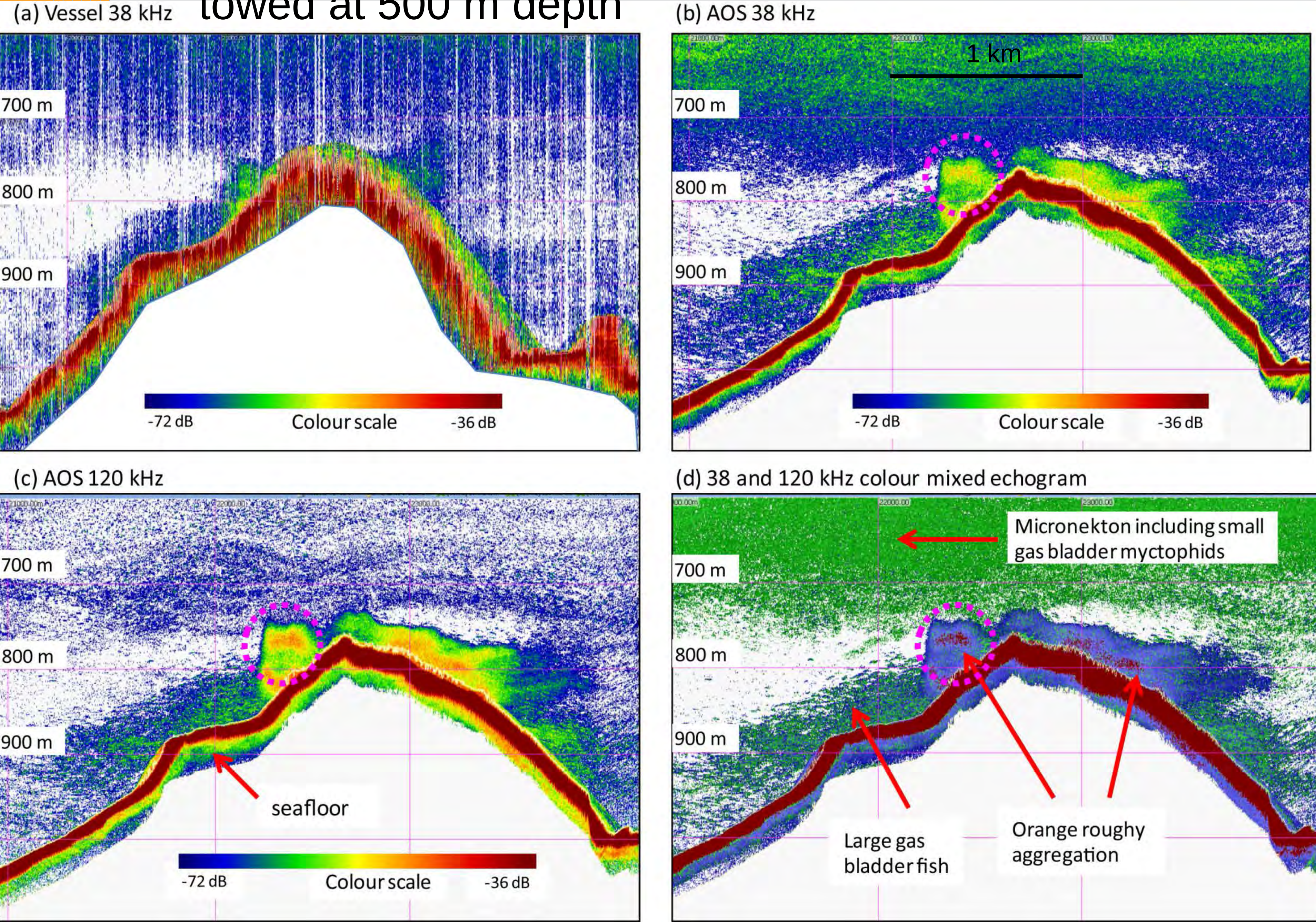

Deep water fisheries >600 m (e.g. orange roughy) use deep towed bodies that increases cost with dedicated research/industry vessel for acoustics and fishing catcher vessels. To lower cost we developed single vessel solution using fishing vessel.

# Net attached Acoustic Optical System (AOS) designed for acoustic surveys from fishing vessel

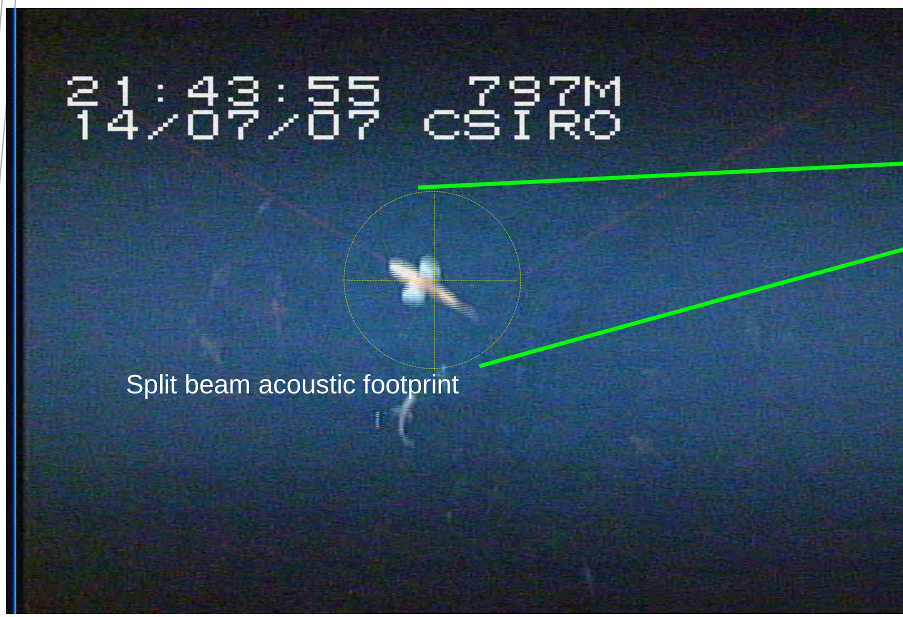
## Commercial deepwater demersal trawl net



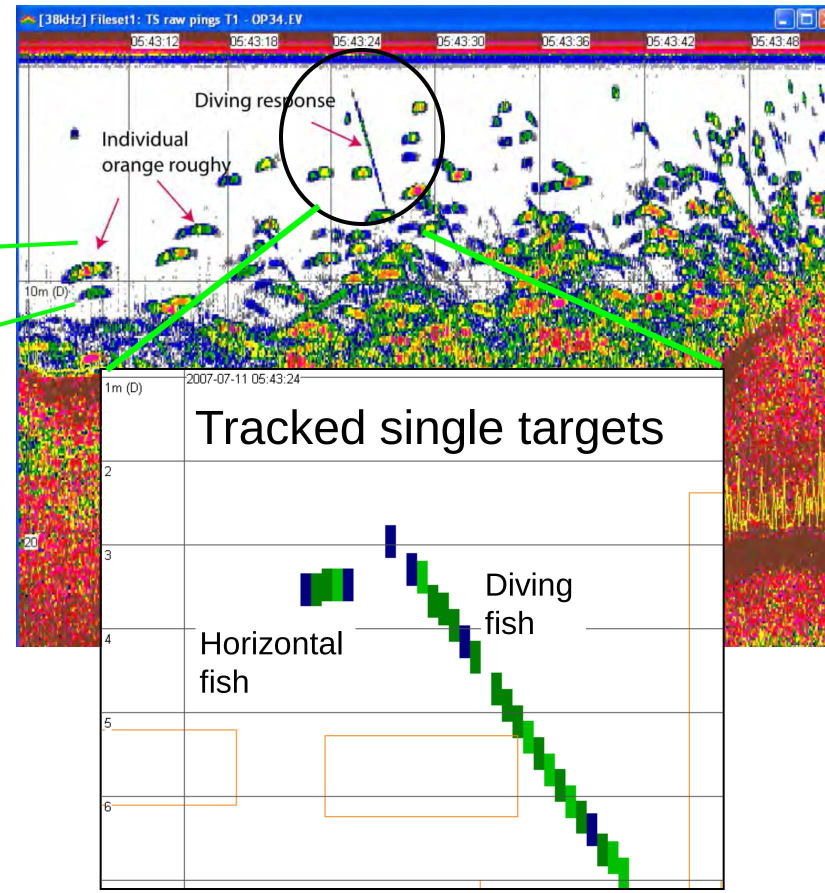
# Acoustic survey of orange roughy 2010 with AOS towed at 500 m depth



# Linkage with net attached acoustics and video for visually verified in situ target strengths

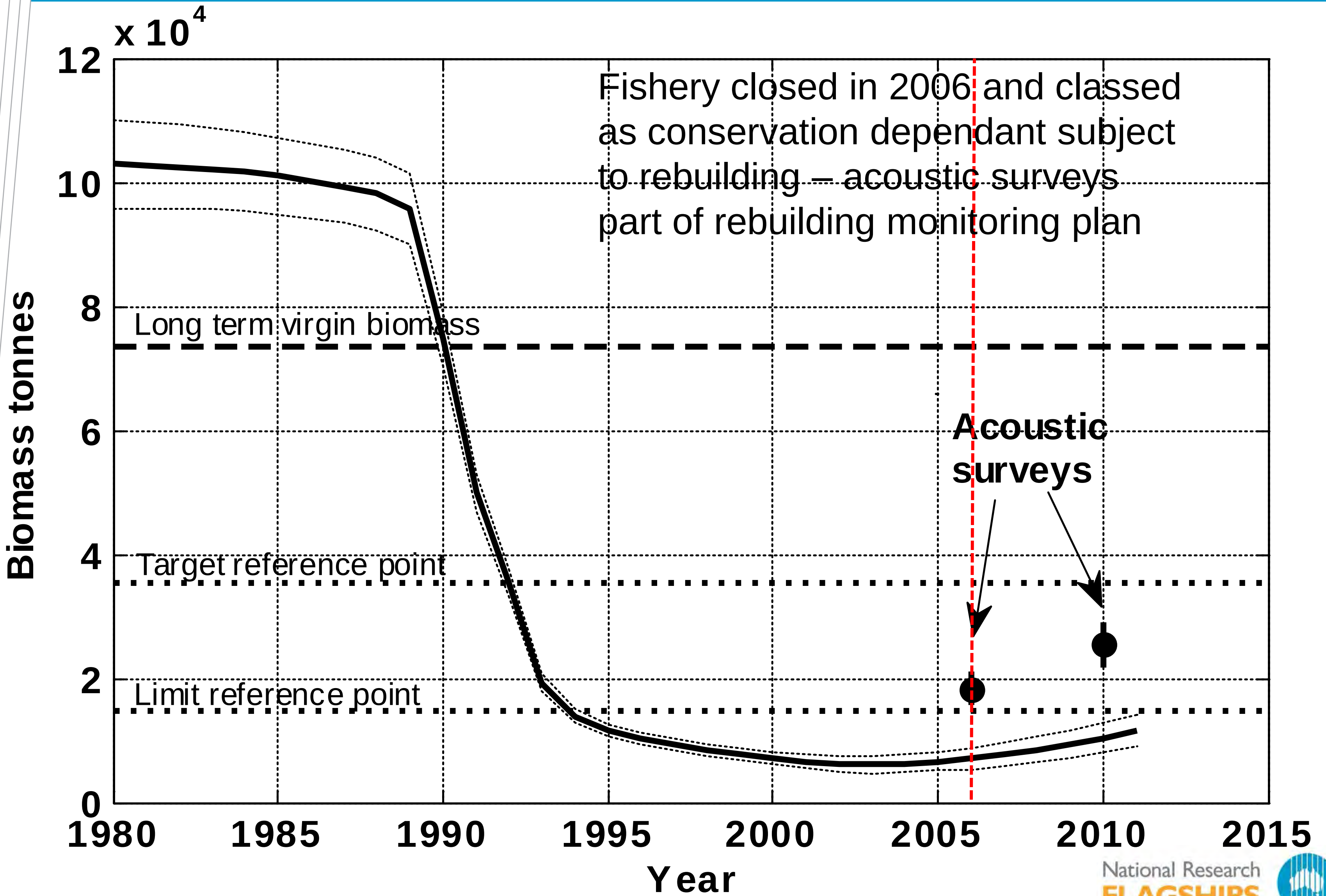



Frame grab from AOS video

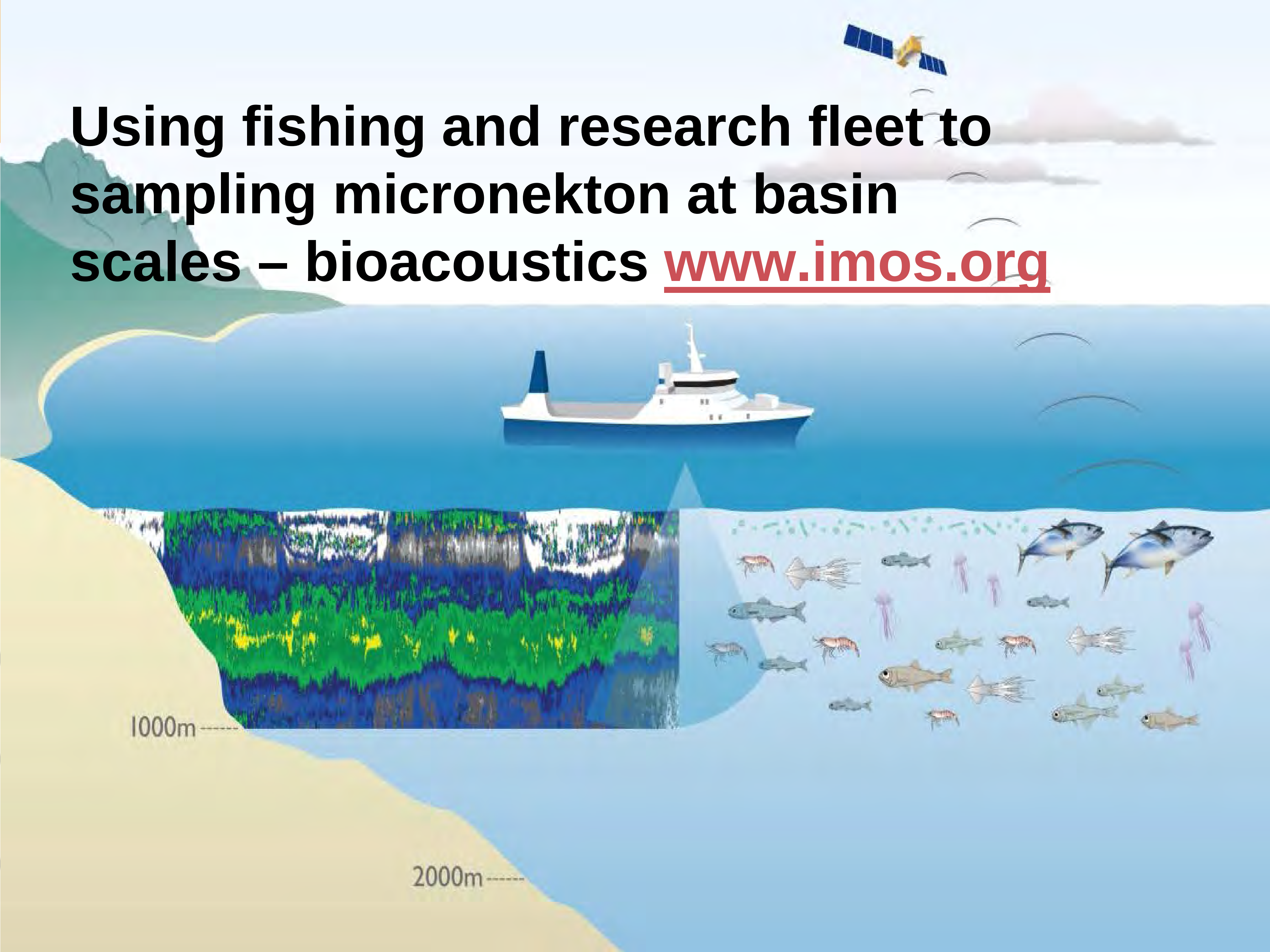



Macaulay, Kloser and Ryan (2012) IJMS

# New Industry Acoustic Survey Results are challenging the perception of the fishery status and recovery rate



# Using fishing and research fleet to sampling micronekton at basin scales – bioacoustics www.imos.org

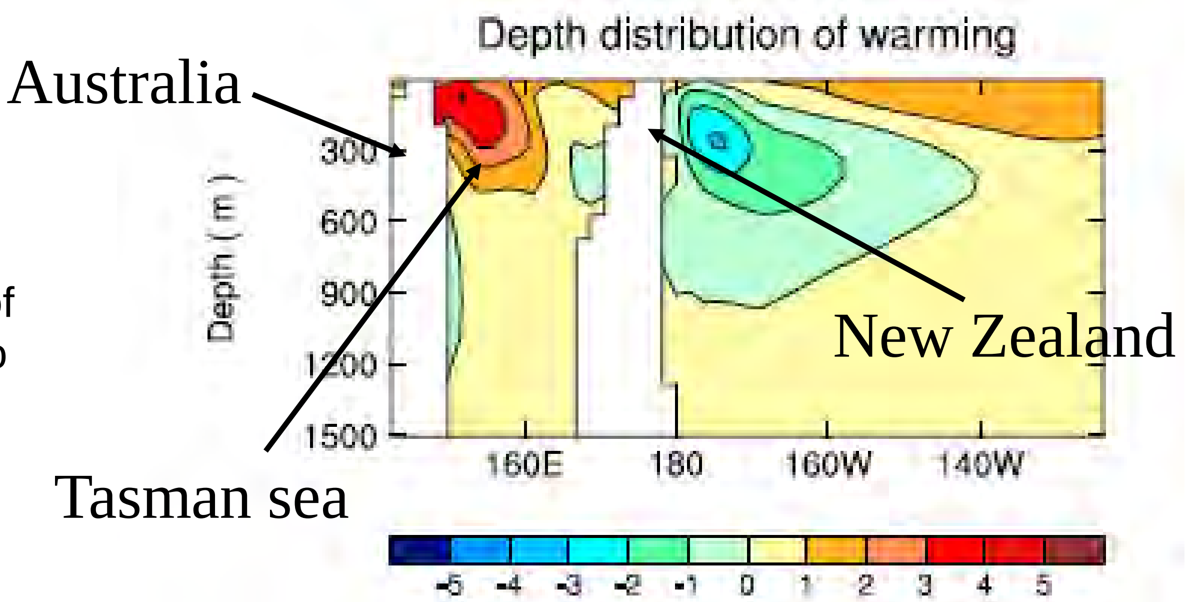


# The biology (micronekton) being monitored

# Missing link ….. **mid-trophic organisms**
# Need …what…where…**biomass**…**change …**

- Monitoring of large ecosystems for fisheries, marine planning and climate change.
- Predict shifts in communities – distribution of top predators (e.g. Fish (Tuna), Mammals and birds)
- Basin scale changes around Australia (e.g. Tasman Sea is predicted to have the largest change in temperature in the Southern Ocean)
- Need biological baseline and monitoring indicators

Predicted ensemble-mean changes in temperature (C) along the 36S section of the South Pacific due to global warming 2035-2055. Cai et al. 2005.



# Example of ecosystem model that needs initialisation and assimilation of mid-trophic data

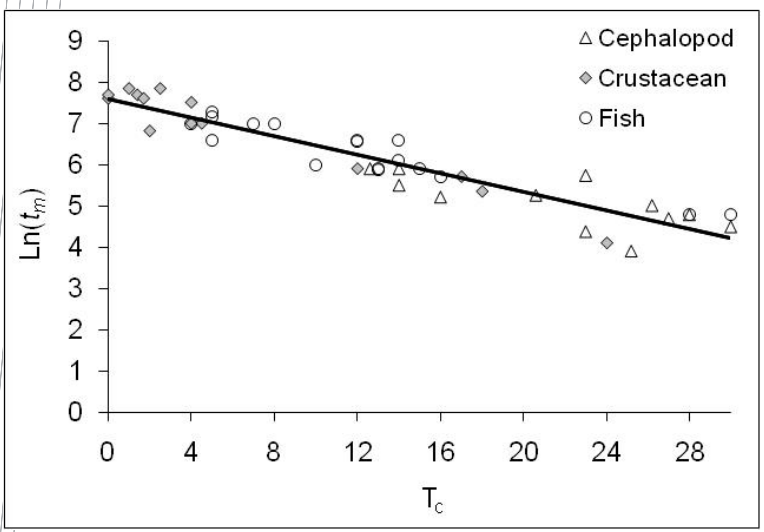


ELSEVIER
Progress in Oceanography
2010, **84**: 69–84
journal homepage: www.elsevier.com/locate/pocean

Bridging the gap from ocean models to population dynamics of large marine predators: A model of mid-trophic functional groups

Patrick Lehodey [a,*], Raghu Murtugudde [b], Inna Senina [a]

[a] MEMMS (Marine Ecosystems Modeling and Monitoring by Satellites), CLS, Space Oceanography Division, 8-10 rue Hermes, 31520 Ramonville, France
[b] ESSIC, Earth Science System Interdisciplinary Center, University of Maryland, USA



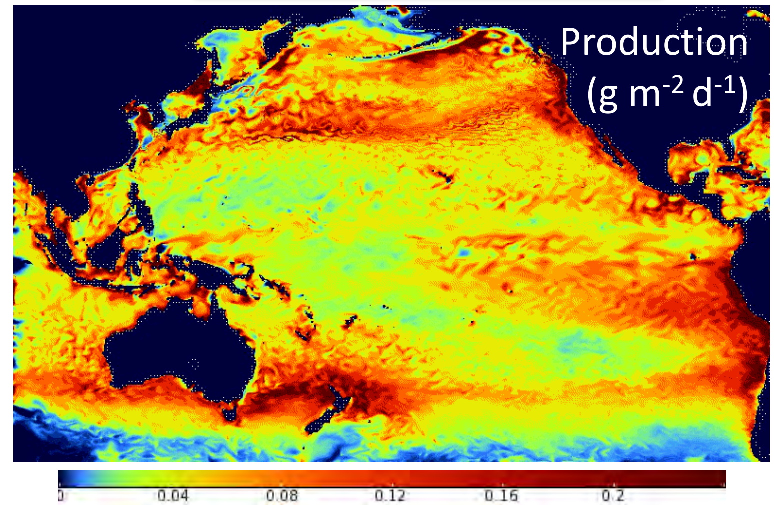

Time of development in days (Log scale) of mid-trophic (micronekton) organisms until age at maturity ($t_m$) in relation to their ambiant habitat temperature Tc

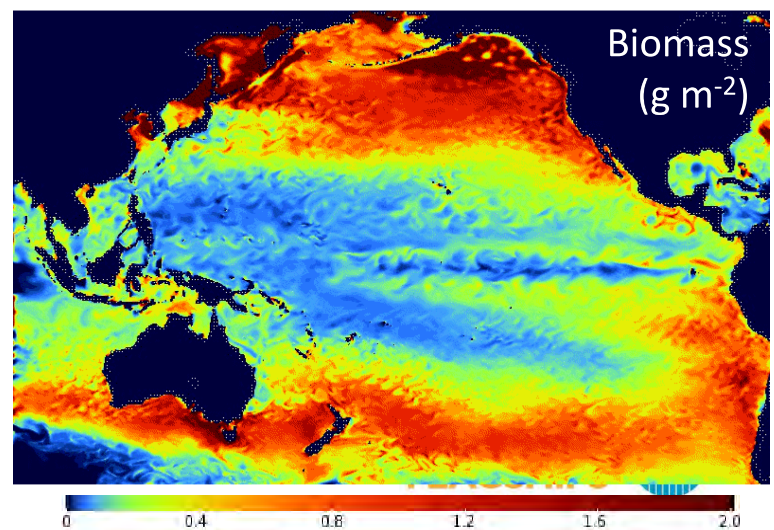
¼ deg x 6 day (2005)

Physical fields from MERCATOR (http://www.mercator-ocean.fr/)
Satellite derived Primary production

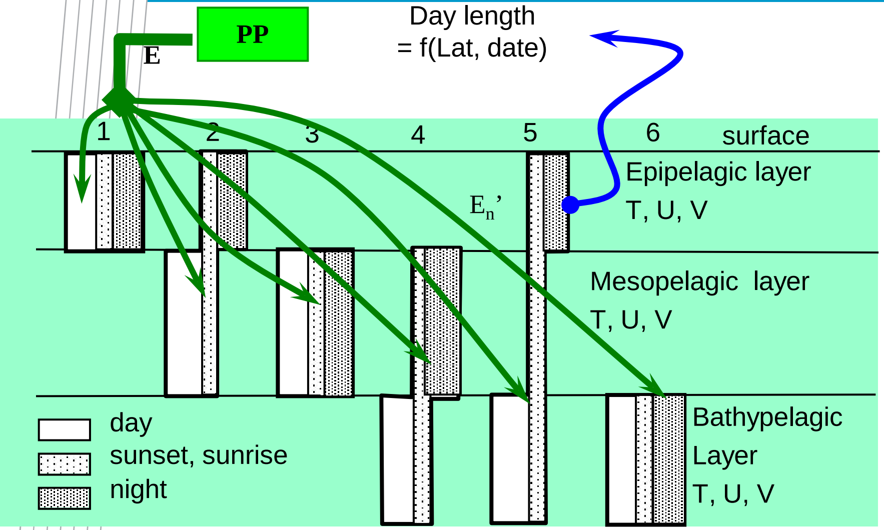
Basin scale monitoring

**Ex: Component 1 Epipelagic (daytime)**



# SEPODYM MTL model (Lehodey et al. 2008)

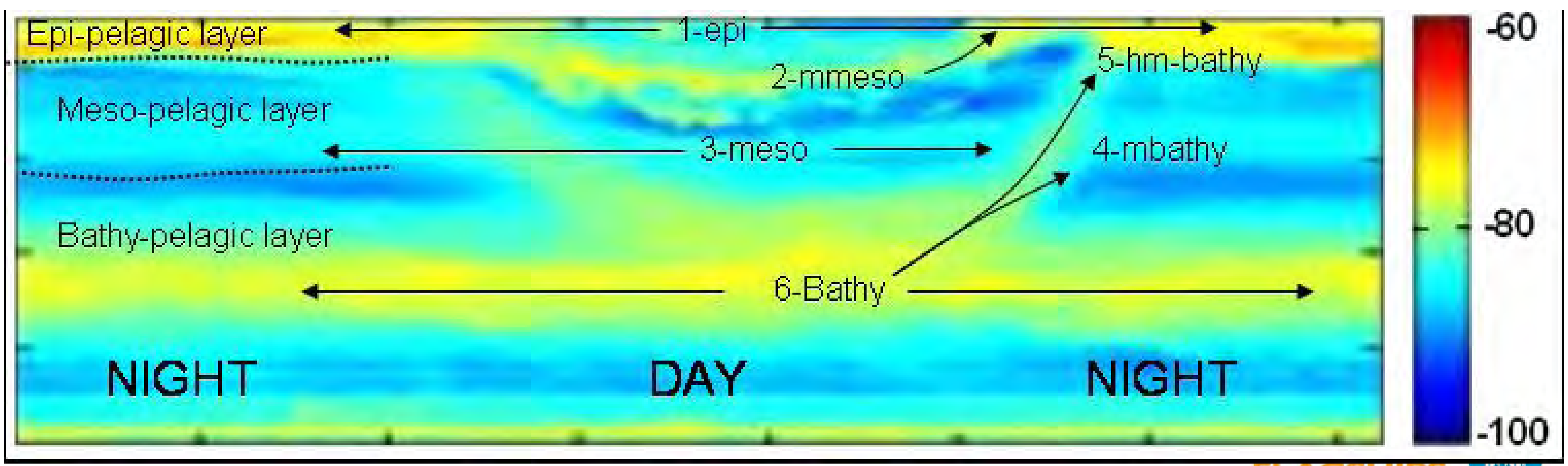



A model of micronekton
(small prey organisms)

The MODEL: 6 functional groups in 3 vertical layers. Three components exhibit diel vertical migrations, transferring energy from surface to deep layers.

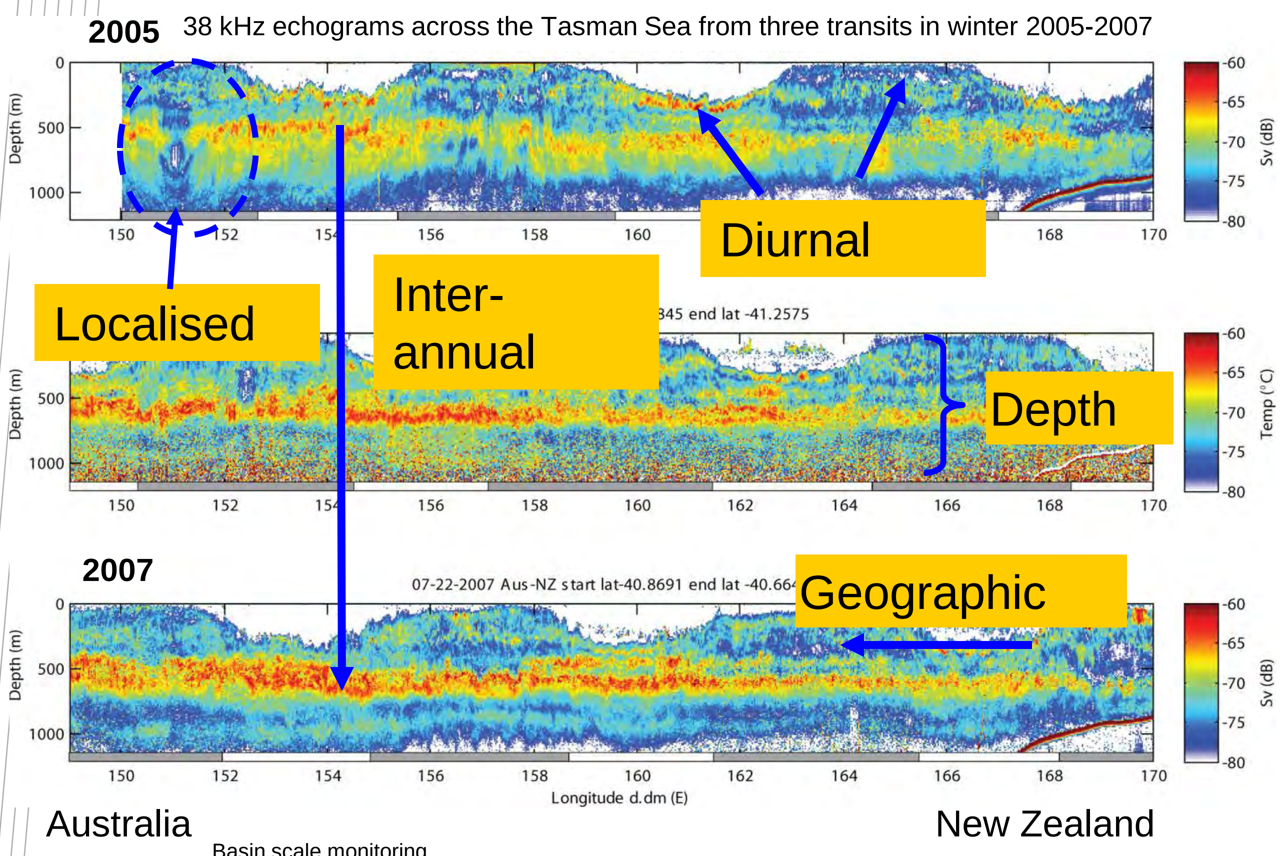
The source of energy is the primary production PP.

Mar-ECO station North Atlantic, (IMR, Bergen Norway) showing acoustic detection of micronekton



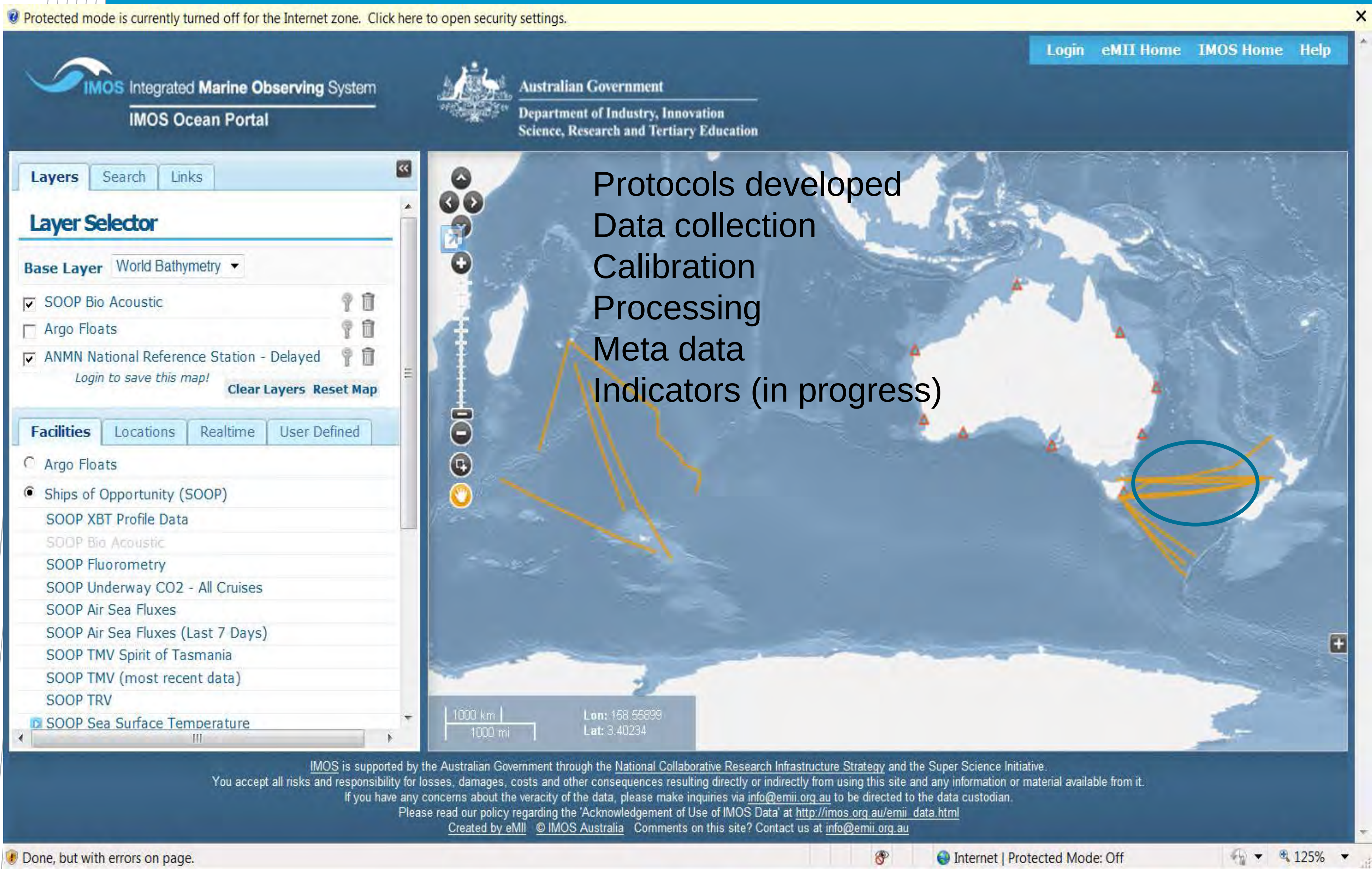
# Ocean scale acoustics – using Ships Of Opportunity (SOOP) Kloser et al. 2009

Commercial and Research vessels with calibrated digital echosounders
- rapid, cost effective sampling through range of depths and geographic locations during transits

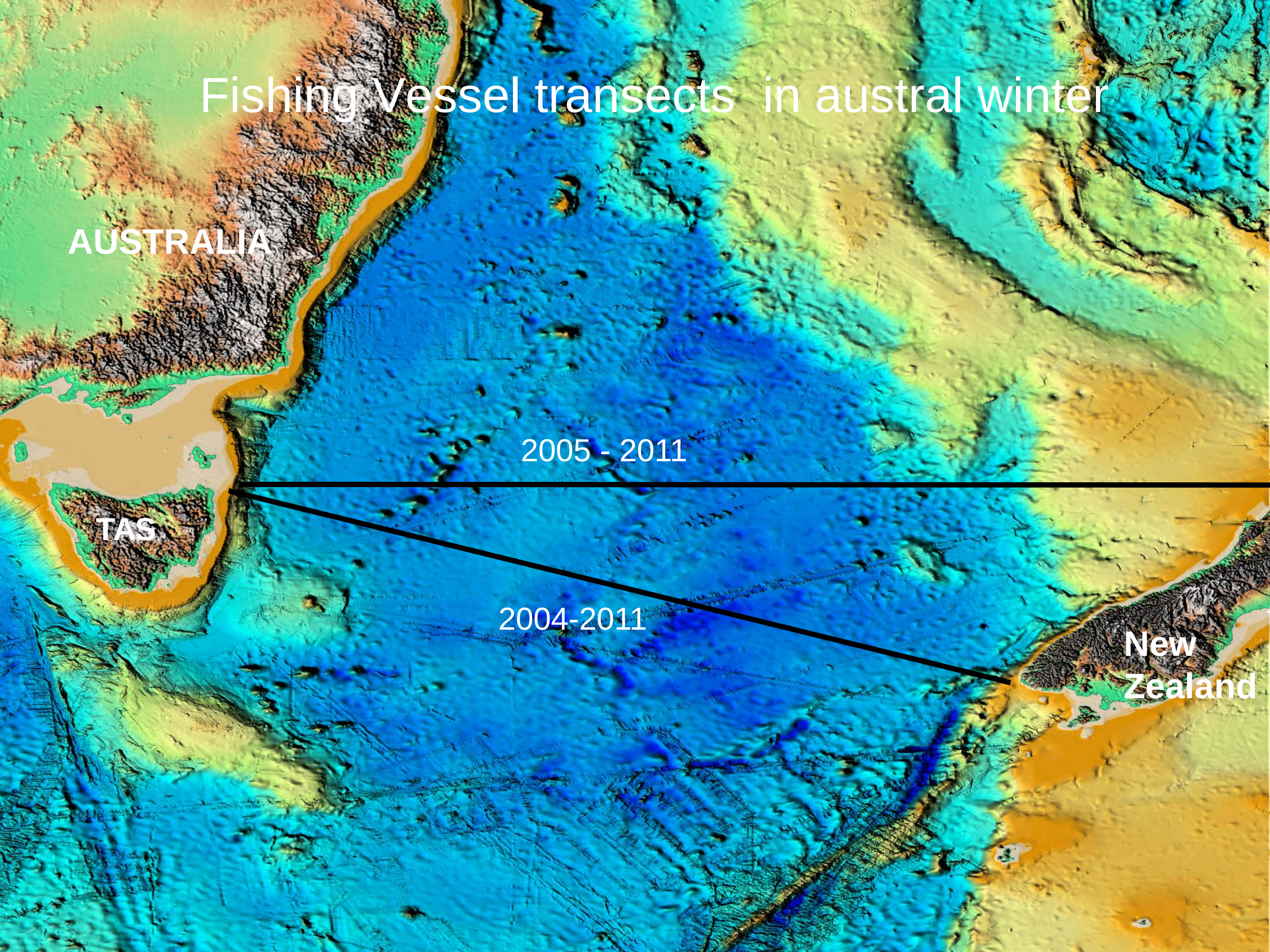


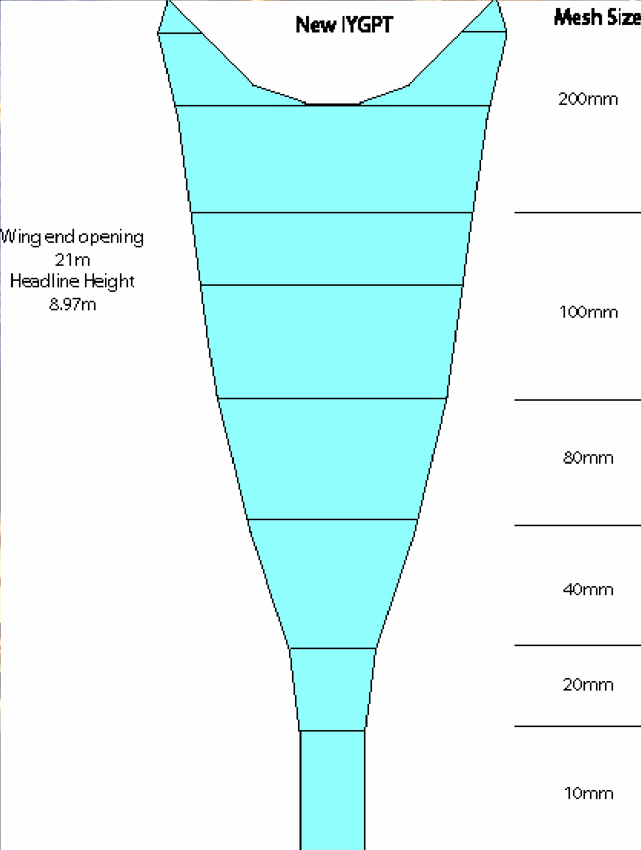

- Small gas bladder myctophids may dominate the acoustic signal at 38 kHz?
- Other species groups include jellies, squid, small crustaceans
- Need to quantify ensemble weight and acoustic reflectivity of dominant species groups to convert backscatter to biomass at the basin scale

# Data posted to web portal www.imos.org.au and publically available transects have a summary graphic since 2010




- Protocols developed
- Data collection
- Calibration
- Processing
- Meta data
- Indicators (in progress)


Fishing Vessel transects in austral winter
AUSTRALIA
TAS
2005 - 2011
2004-2011
New
Zealand



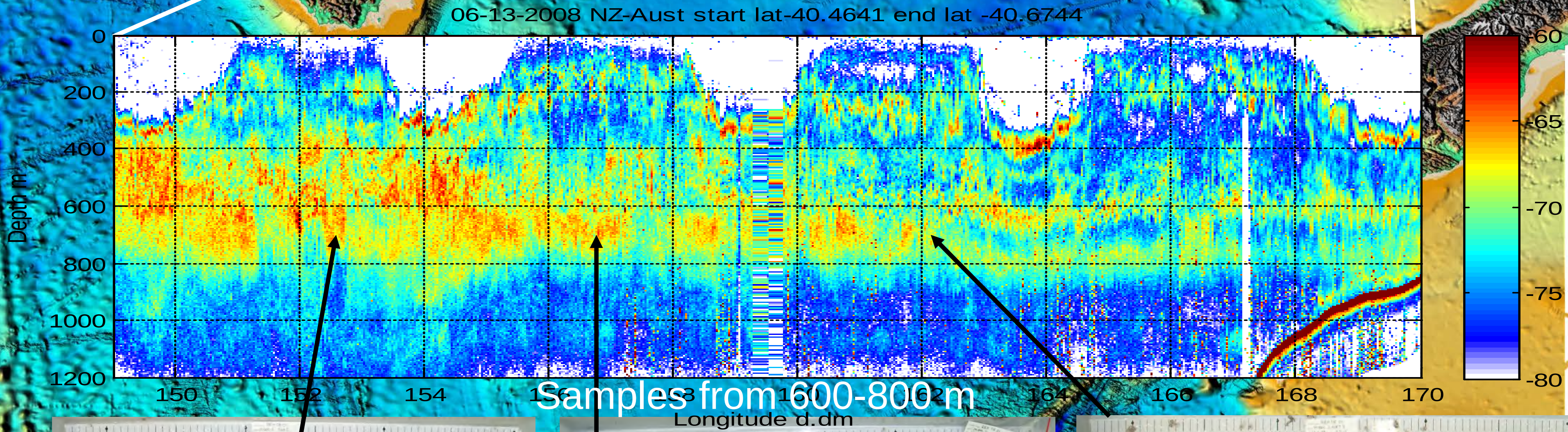

# Net, acoustic and optical sampling gear used from a fishing vessel during 2008 and 2009

Mid-water opening and closing net (MIDOC)

Codend device – 5 codends that have preset drop times.

Attached to end of demersal and pelagic fishing nets and research vessel IYGPT .

# Net and Acoustic depth stratified (200 m day night strata) sampling along Trans Tasman transect in June 2008




Samples from 600-800 m

Dominant fish family Myctophidae with 32 species recorded and 2-4 species at each depth making > 70% of biomass

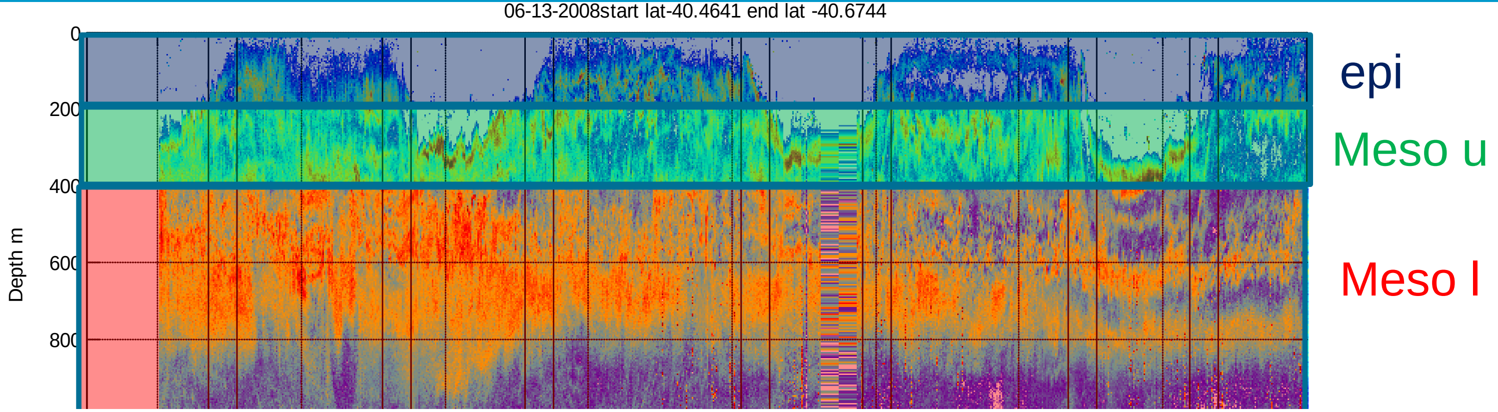
# Based on biological sampling in 2008 on trans-Tasman sea transect derive acoustic conversion factors for fish energetics

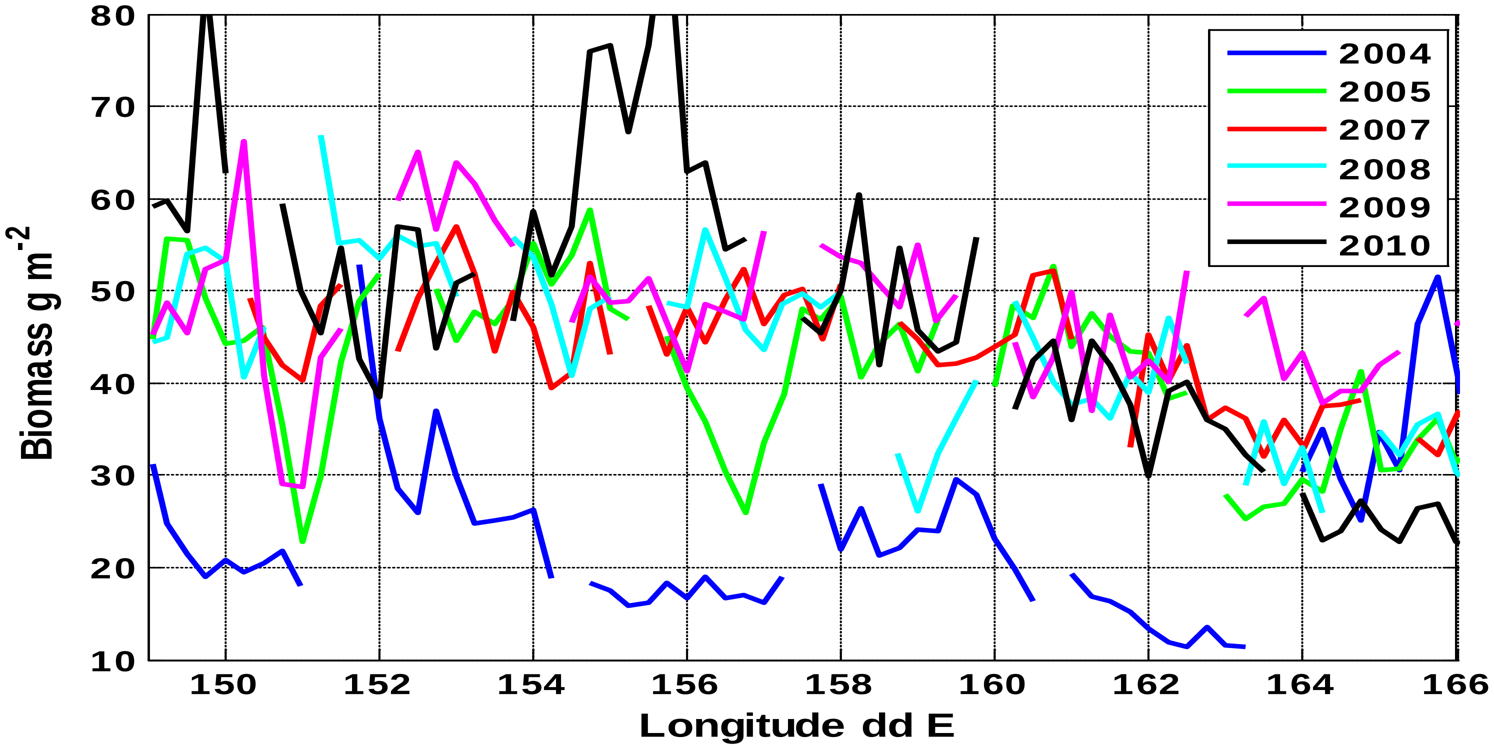
Conducted 6 tows – 3 day 3 night – depth stratified at 200 m with 5 nets 1000 m to 0 m

Epi 0-200 m
Meso upper 200 -400 m
Meso Lower 400 – 1000 m

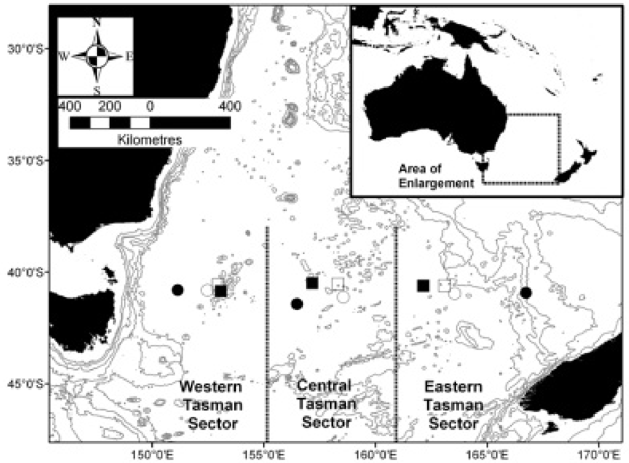
| | Layer | | |
|---|---|---|---|
| | epi | meso u | meso l |
| Biomass ratio day | **0.03** | **0.23** | **0.74** |
| Biomass ratio night | **0.20** | **0.34** | **0.46** |
| ***TS day dB*** | *-58.0* | *-53.0* | *-46.0* |
| **weight day kg** | 0.0021 | 0.0023 | 0.0093 |
| ***TS night dB*** | *-54.0* | *-50.0* | *-47.0* |
| **weight night kg** | 0.0061 | 0.0079 | 0.0085 |

# Preliminary spatial biomass and energetic exchange of micronekton fish biomass across Tasman Sea 2008

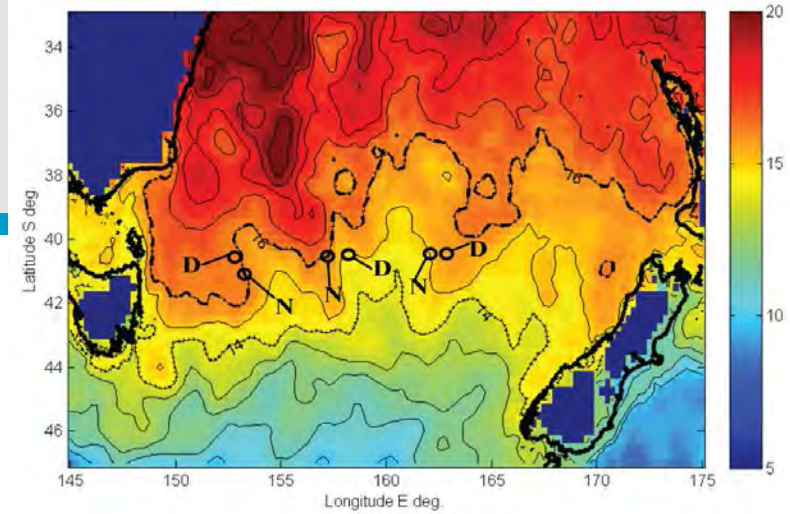


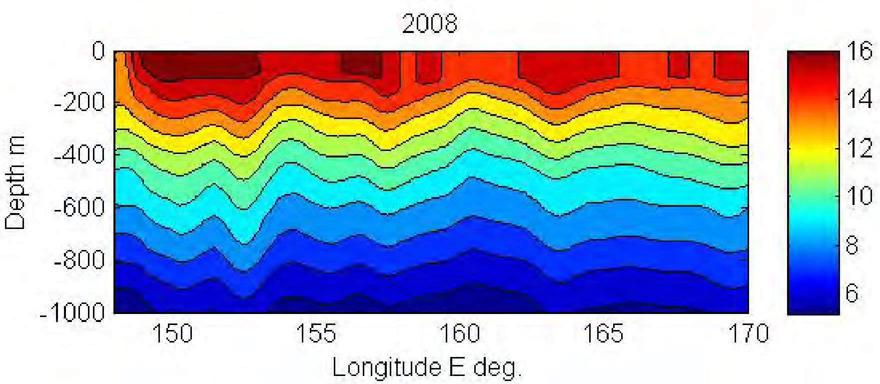



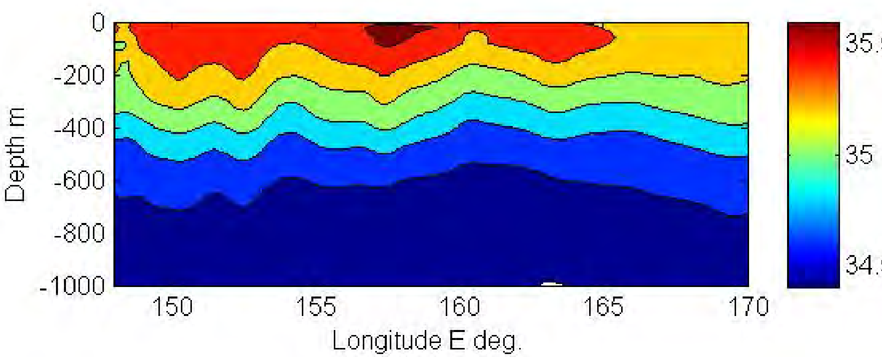
# Lantern fish catch




| | Western | Central | Eastern |
|---|---|---|---|
| Year | Mean | Mean | Mean |
| 2008 | 10.6 | 8.2 | 6.6 |

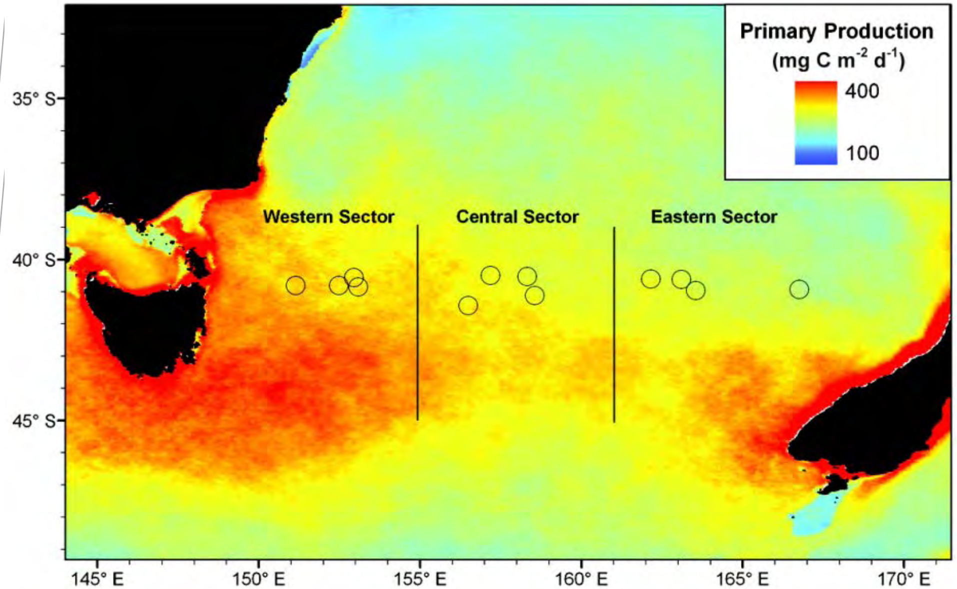


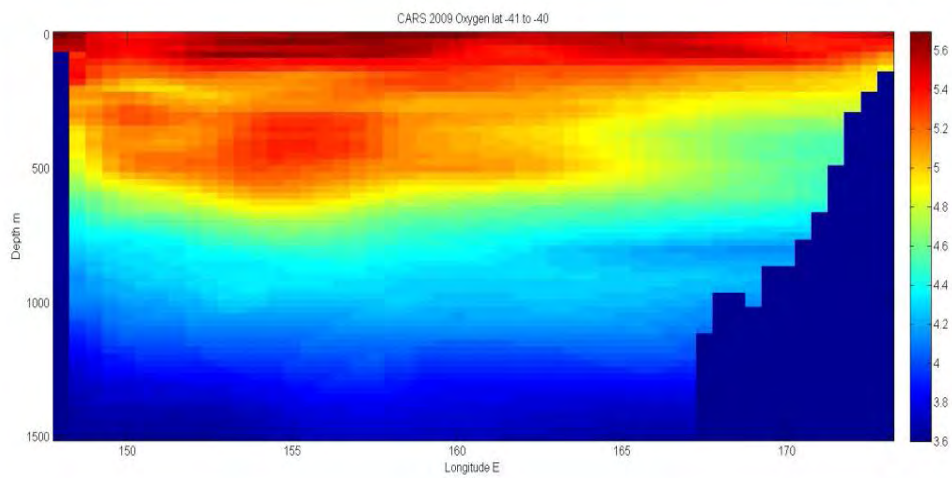




Flynn and Kloser (2012)

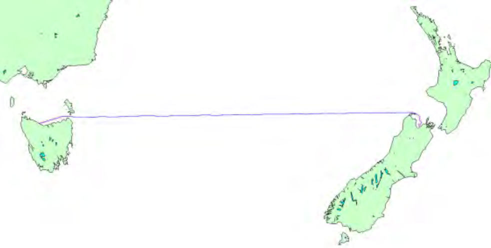
# Long term co-variates – primary production and oxygen content – agree with acoustic and trawl trend



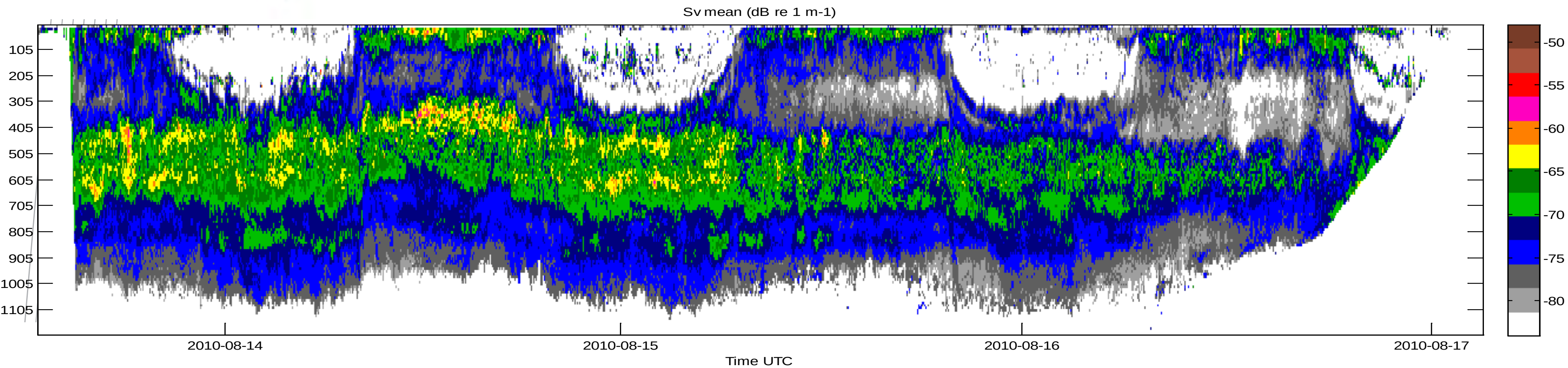

- Long term annual production derived from ocean colour
  - Flynn and Kloser (2012)

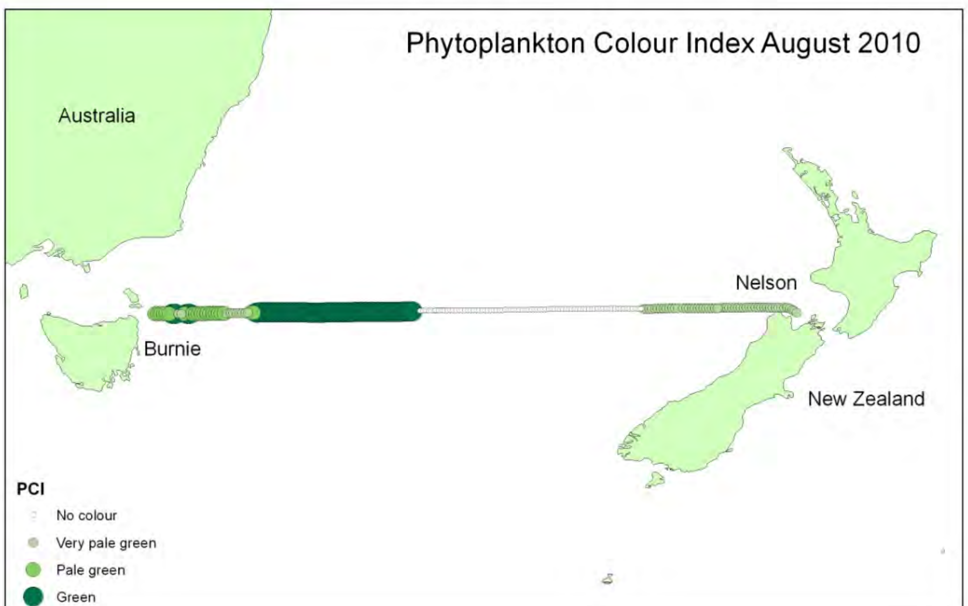


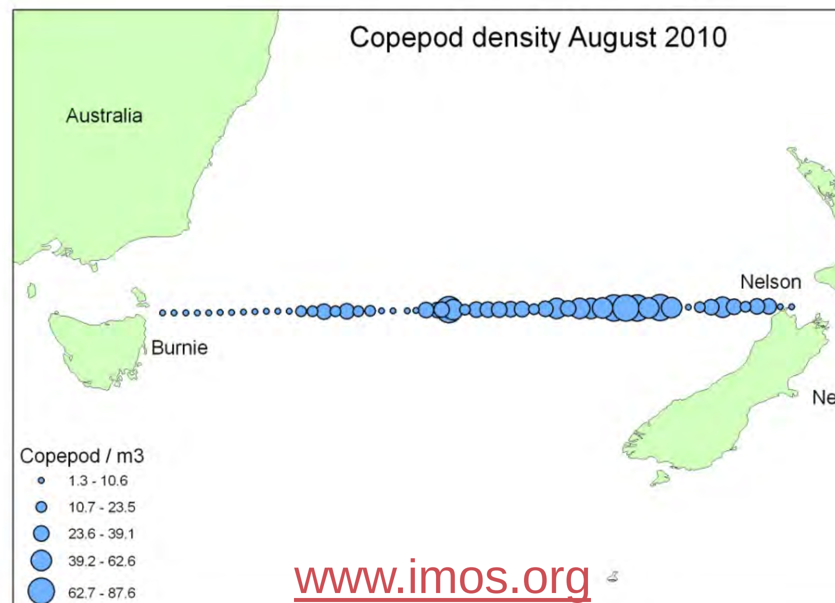

Long term oxygen content derived from CARS



# Linkages between trophic groups – bioacoustics, continuous plankton recorder from fishing vessel

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# Global Estimates of mid-water fishes

The global estimate of mesopelagic fish that is commonly referred to in the scientific literature amounts to 948 × $10^6$ t wet weight (Gjøsæter & Kawaguchi 1980).

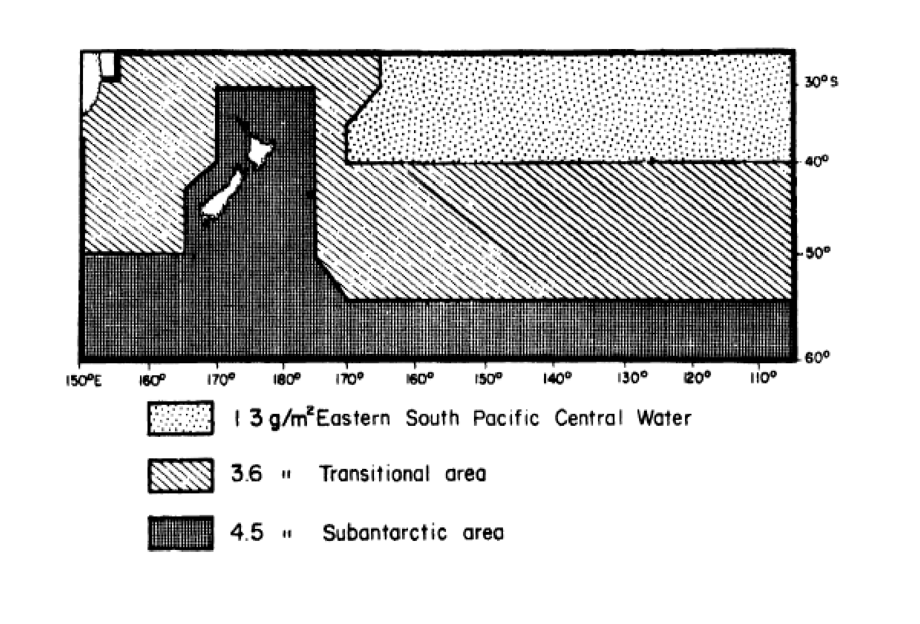



Fig. 19.1 The three subareas and values used for the total biomass estimation in the Southwest Pacific.

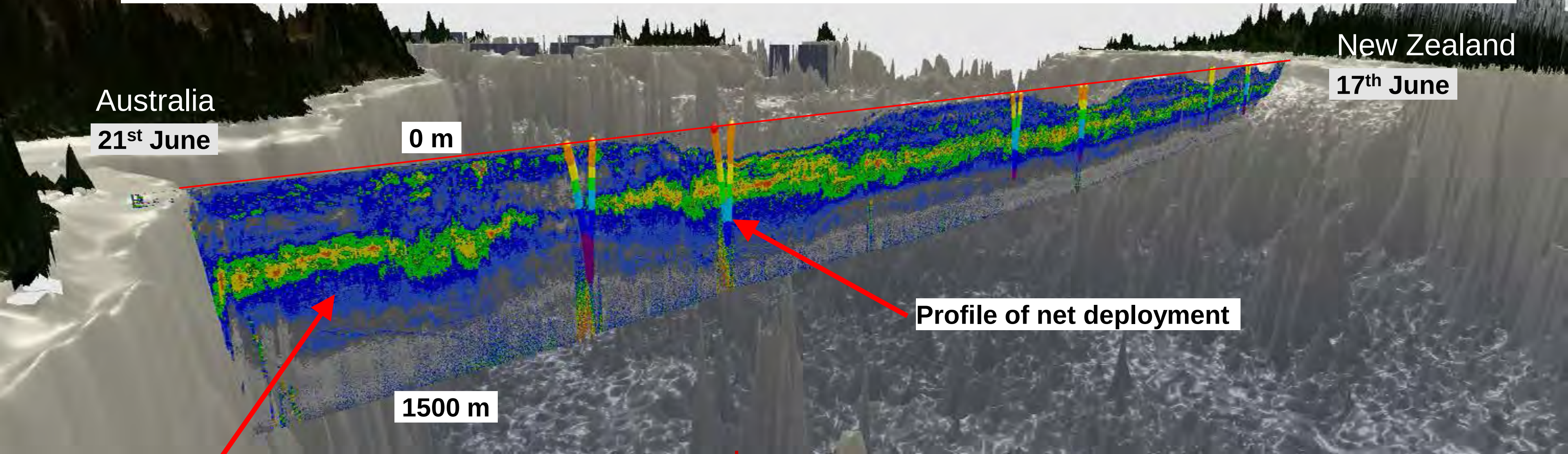
Our estimates are order of magnitude higher with acoustics and 2-3 times higher for nets.

# Issues with net, acoustic and optical sampling for estimating biomass

| | Nets | Acoustics | Optics |
| --- | --- | --- | --- |
| Catchability | organisms avoid net (e.g. squids fast swimming fish) | low target strength<br>frequency dependant | low sample volume<br>organisms avoid platform. |
| Selectivity | different sizes are selected depending on mesh size | bias to higher scatterers and gas bladdered species in particular.<br>resonance scattering frequency and depth dependant | bias to targets that can be easily seen. Depending on lighting different objects identifiable |

# Ocean basin studies using fishing vessels

Density, biodiversity and biogeography of micronekton at the scale of an ocean basin with nets, acoustics and optics

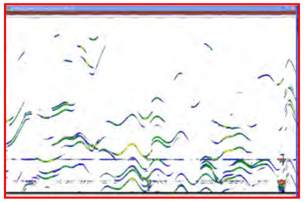



**Integrated Marine Observing System 38 kHz vessel of opportunity acoustic data**

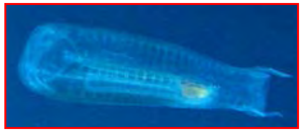
**Validation experiments**

- Midwater nets with attached acoustic-optical system

**MIDOC net**



**AOS 38 kHz**



**AOS DSLR**

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# Bio-acoustic basin scale summary

http://imos.org.au/

- Started a program of monitoring acoustic backscatter for decadal trends – includes fishing and research vessels as part of IMOS.
- Commenced integration with ecosystem models
- Validation research with detailed multi-frequency, optical and net measurements under way
- Historic analysis of acoustic and trawls for testing metrics and regional differences underway internationally
- To get global coverage need more countries to incorporate into their ocean observing systems using international agreed metadata protocols.

Special thanks to:

Sealord  Australian Longline Marine National Facility

| | |
|---|---|
| IMOS | CSIRO Wealth from Oceans flagship |
| CSIRO | CPR Anthony Richardson, Marine Instrumentation Matt Sherlock, Jeff Cordell and Andreas Marouchos |
| PICES | Steven Barbeaux for the invitation to present in this session. |

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# Thank you

**Rudy Kloser CSIRO**
**rudy.kloser@csiro.au**

IMOS Integrated Marine Observing System

IMOS_logo-wide_new.png

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