

An overview of, and future opportunities for, large whale research in the “African Sector” of the Southern Ocean

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An estimated two million whales were removed in species directed serial bouts of whaling from the Southern Hemisphere in last three hundred years.

125 000 – 151 000 southern right whales

210 000 humpback whales

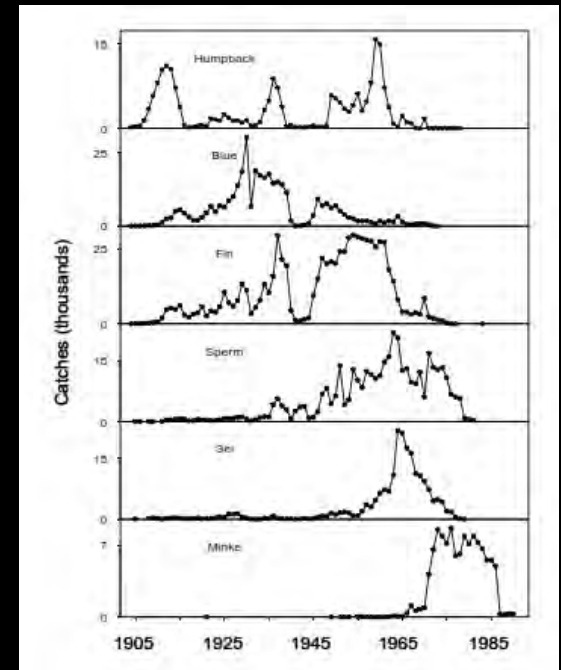
360 000 blue whales

725 000 fin whales

203 000 sei whales

402 000 sperm whales

116 000 minke whales



“greatest human-induced perturbations of a marine ecosystem anywhere in the world” - sealing and whaling
Mori and Butterworth, (2006)

Some 70% of these estimated to feed within the SO krill ecosystem



Krill declines in SW Atlantic Ocean

Considerable debate on relative roles of Top-Down and Bottom-Up Forcing in krill ecosystem shaping in the literature.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY BIOLOGICAL SCIENCES

Southern Ocean Environmental Changes: Effects on Seabird, Seal and Whale Populations [and Discussion]

J. P. Croxall, T. Callaghan, R. Cervellati and D. W. H. Walton

Phil. Trans. R. Soc. Lond. B 1992 **338**, 319-328
doi: 10.1098/rstb.1992.0152

Antarctic Science 19 (3), 291-295 (2007) © Antarctic Science Ltd 2007 Printed in the UK

DOI: 10.1017/S0954102007000491

Opinion

Paradigm misplaced? Antarctic marine ecosystems are affected by climate change as well as biological processes and harvesting

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PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY BIOLOGICAL SCIENCES

Environmental forcing and Southern Ocean marine predator populations: effects of climate change and variability

P.N. Trathan, J. Forcada and E.J. Murphy

Phil. Trans. R. Soc. B 2007 **362**, 2351-2365
doi: 10.1098/rstb.2006.1953

MARINE MAMMAL SCIENCE, **(*)**: ***_**** (*** 2009)

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DOI: 10.1111/j.1748-7692.2009.00337.x

Impacts of cetaceans on the structure of Southern Ocean food webs

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INSIGHT REVIEW

NATURE [Vol. 437] 15 September 2005 | doi:10.1038/Nature04161

Polar ocean ecosystems in a changing world

Victor Smetacek¹ and Stephen Nicol^{2,3}

Polar organisms have adapted their seasonal cycles to the dynamic interface between ice and water. This interface ranges from the micrometre-sized brine channels within sea ice to the planetary-scale advance and retreat of sea ice. Polar marine ecosystems are particularly sensitive to climate change because small temperature differences can have large effects on the extent and thickness of sea ice. Little is known about the interactions between large, long-lived organisms and their planktonic food supply. Disentangling the effects of human exploitation of upper trophic levels from basin-wide, decade-scale climate cycles to identify long-term, global trends is a daunting challenge facing polar bio-oceanography.

Global Change Biology (2008) **14**, 2473-2488, doi: 10.1111/j.1365-2486.2008.01678.x

Life history buffering in Antarctic mammals and birds against changing patterns of climate and environmental variation

JAUME FORCADA, PHILIP N. TRATHAN and EUGENE J. MURPHY
British Antarctic Survey, Natural Environment Research Council, Madingley Road, Cambridge CB3 0ET, UK

Variability in krill biomass links harvesting and climate warming to penguin population changes in Antarctica

Wayne Z. Trivelpiece^{a,1}, Jefferson T. Hinke^{a,b}, Aileen K. Miller^a, Christian S. Reiss^a, Susan G. Trivelpiece^a, and George M. Watters^a

^aAntarctic Ecosystem Research Division, Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, La Jolla, CA, 92037; and ^bScripps Institution of Oceanography, University of California at San Diego, La Jolla, CA 92093

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PROCEEDINGS OF THE ROYAL SOCIETY

Proc. R. Soc. B (2007) **274**, 3057-3067
doi:10.1098/rspb.2007.1180
Published online 17 October 2007

Climatically driven fluctuations in Southern Ocean ecosystems

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Forcing Mechanisms in Southern Ocean systems

Top-Down (Biologically driven) Forcing

1. Predation Switching
2. Competitive Release and the “krill surplus hypothesis”

Conflicting evidence of effects of 150 m tonne surplus

With the removal of top-down forcing, krill should reach a level where bottom-up forcing would be expected to be in control.

Bottom-Up (Environmentally driven) Forcing

Krill Declines - resulting from warming air and water temperatures and winter ice cover decreases



“Disentangling the effects of **human exploitation of upper trophic levels from basin-wide, decade-scale climate cycles** to identify long-term, global trends is a daunting challenge facing polar bio-oceanography.”

Smetacek and Nicol (2005)

“The extent of the krill decline and the underlying factors are under vigorous debate, mainly because of **difficulties in unravelling the effects of industrial whaling and fishing from those of sea ice retreat.**”

Constable (2005)

On a broader system scale.....

Environmental conditioning by whales ?

Growing body of evidence showing that marine mammals play a significant role in the nutrient dynamics of marine ecosystems.

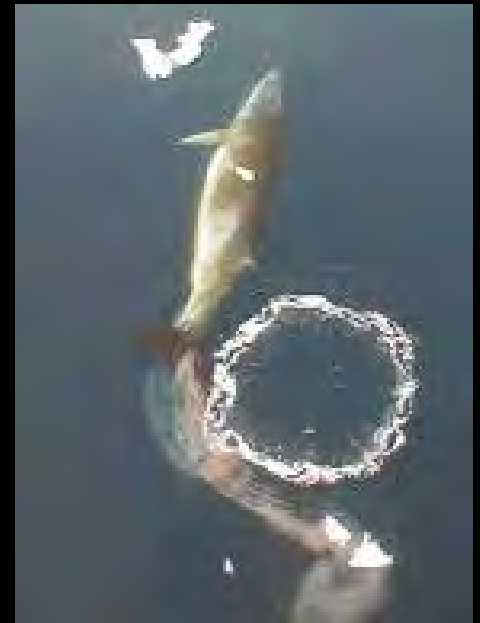
Surplus yield models

Smetacek and Nicol (2005)

Smetacek (2008)

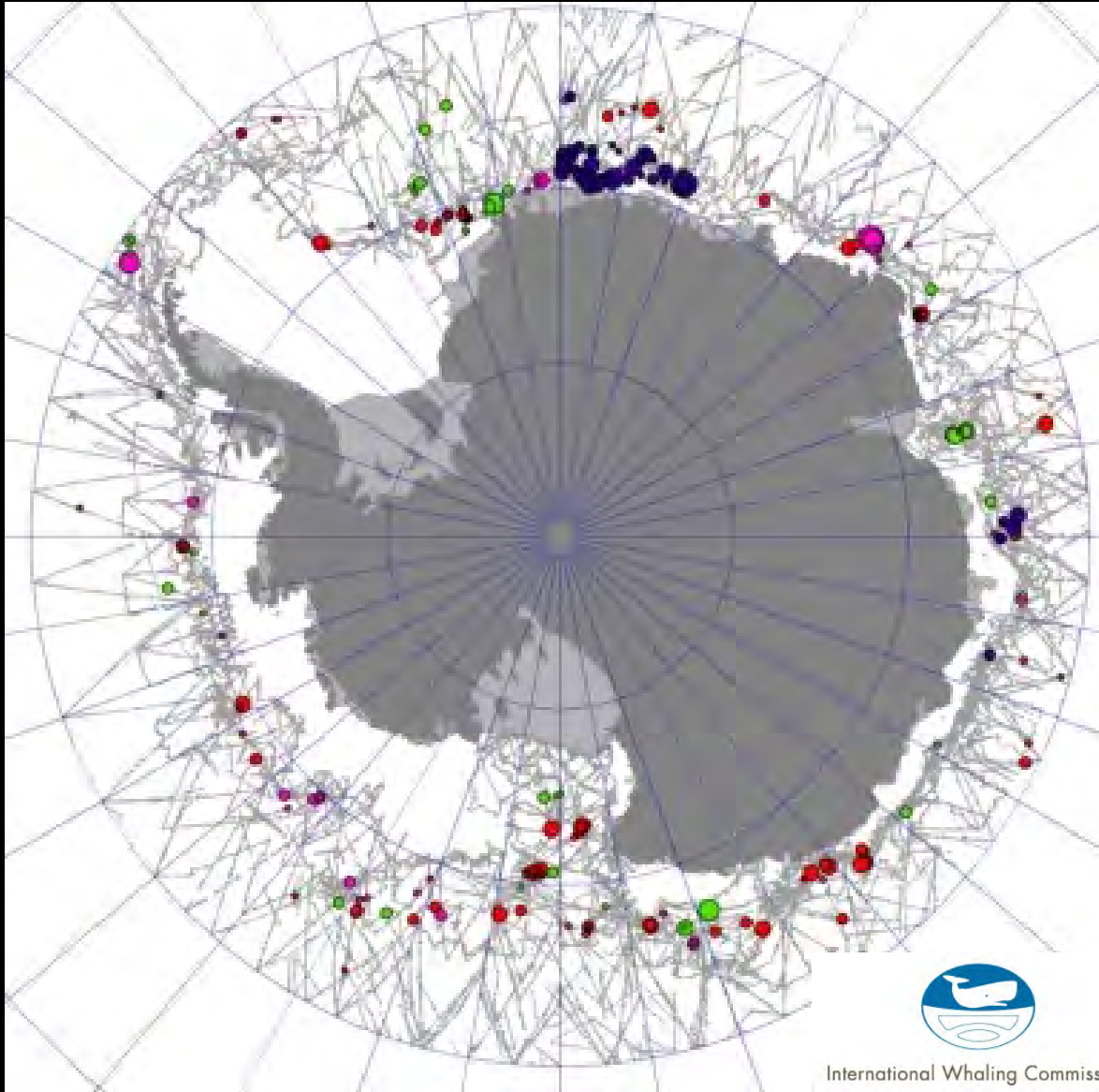
Nicol et al.. (2010)

Lavery et al. (2010, 2012, 2014)



SO Cetacean Research

Discovery Programme of the Modern Whaling Era
IWC IDCR and SOWER Surveys (1978 – 2010)



International Whaling Commission

Two whale species that feed sympatrically within this krill ecosystem are:

Antarctic blue whales

Catches of some 345,000
last century

Protected in 1964



Humpback whales

Catches of some 210,000 last century

Protected in 1963



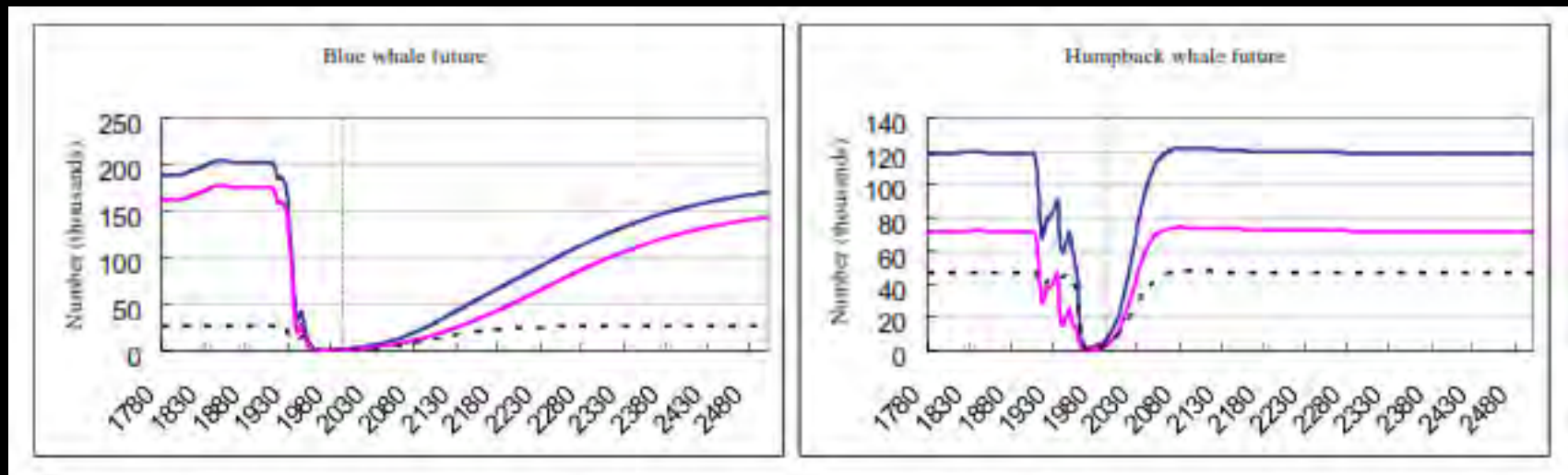
Antarctic blue whales

Increasing at 7% per annum (wide CV)- very low current numbers (2,200 to 3,500).

Humpback whales

Many populations increasing at 10% per annum.

SA East coast population (C1) may be at about 65-98 % of K_{1904} .



Interesting Ecosystem Questions

What is driving differential recovery rates?

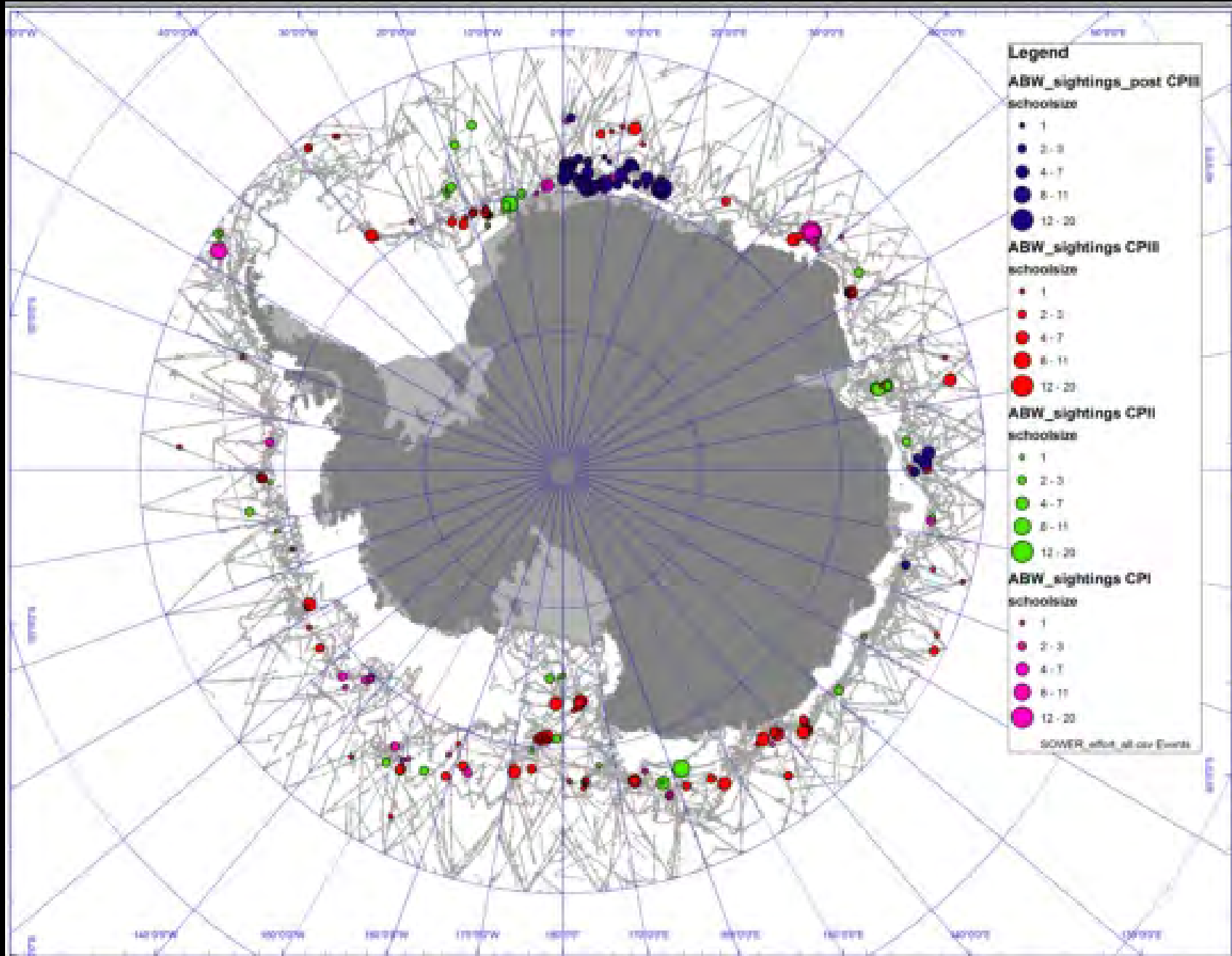
Why have some species “recovered” and others not?

Resource partitioning of sympatric species ?

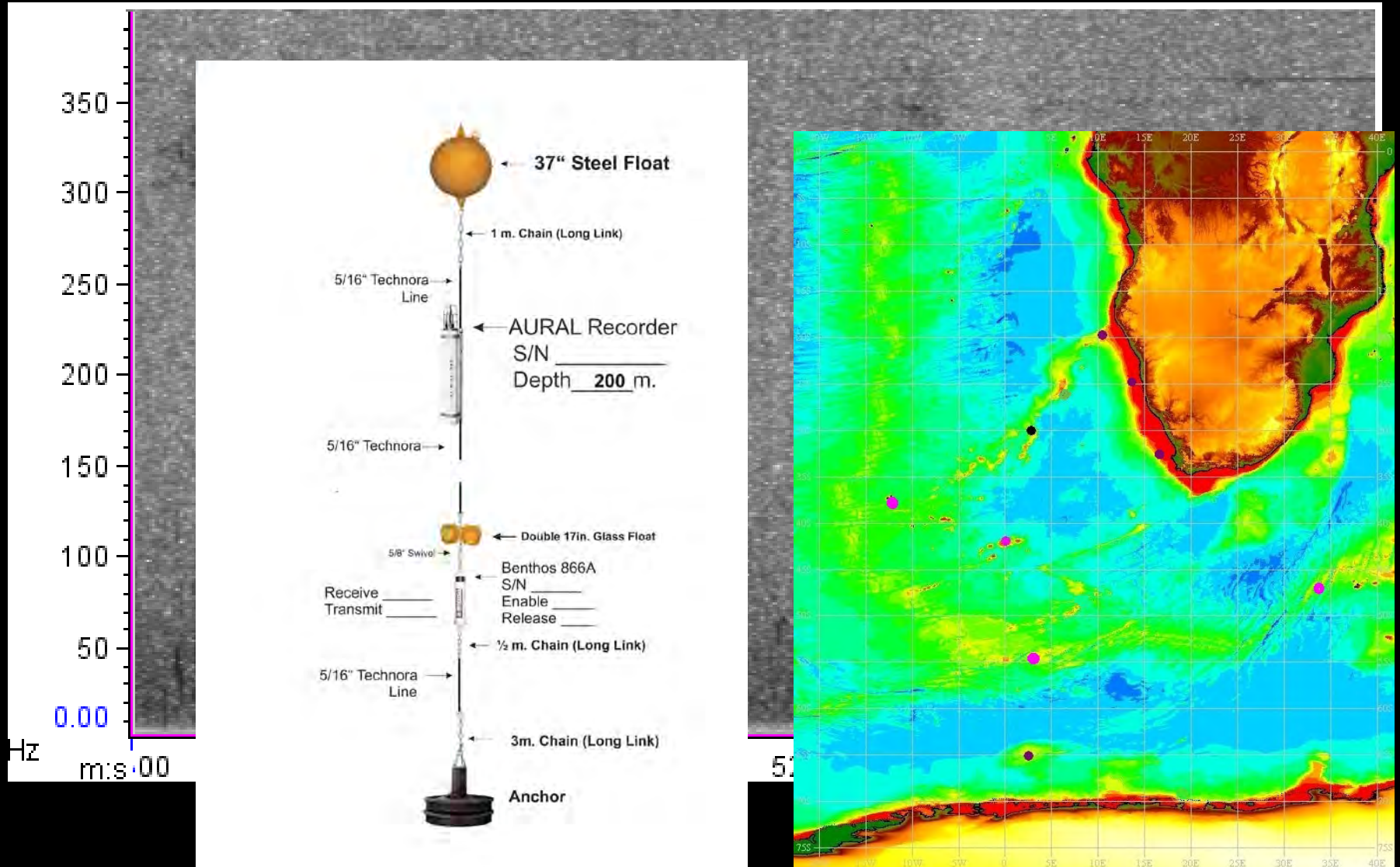


Need to get a handle on
blue whales - The South
African Blue Whale
Project

Better understanding of
trophic dynamics of these
two species (and minke
whales)

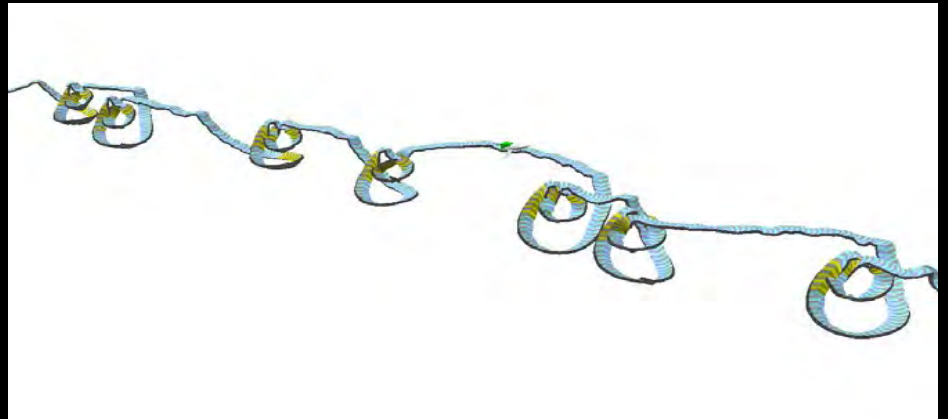
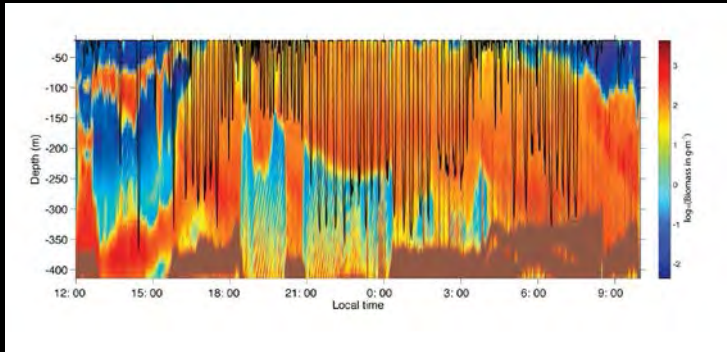
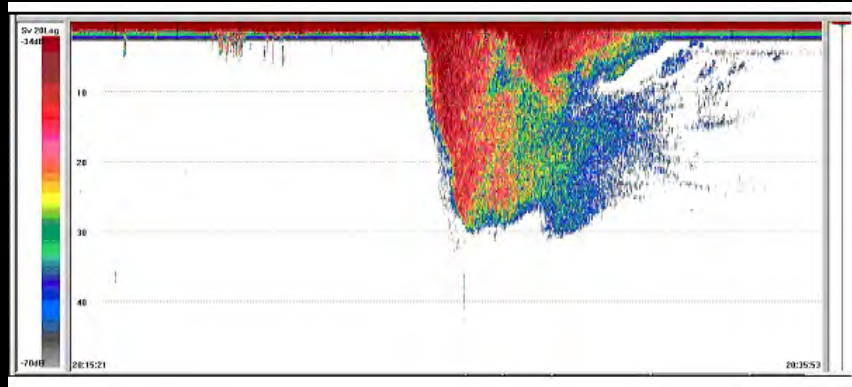


Autonomous Acoustic Recorders





SA blue whale cruise 2013/14 - A number of sighted blue whales appeared to be feeding - Ecological niche modelling and resource partitioning of sympatric krill consumers.



Advocate a shift from a species approach towards systems research of ice-edge krill system

Multi - Disciplinary (Biogeochemistry to Top Consumers)

Multi - Institutional

Multi - National (IWC – SORP)



International Whaling Commission



**Southern
Ocean
Research
Partnership**