The evolution of non-lethal whale science and the Southern Ocean Research Partnership

Australian Government
Department of the Environment and Heritage
Australian Antarctic Division

AUSTRALIAN MARINE MAMMAL CENTRE

Southern Ocean Research Partnership

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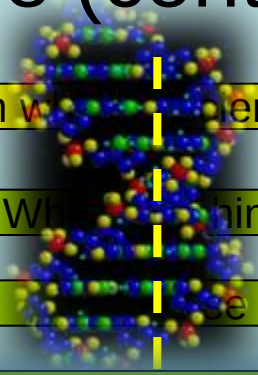
Talk structure

- The context and origins of our science
- The drivers of change (new technologies and need)
- The Southern Ocean Research Partnerships
- Our challenges

Changing influences on, and motivations for, applied cetacean science (context)



Comm. whaling science

Post-moratorium w ence (RMP)

Wh hing science

e science

Fisheries science (operational)

nce (trophic)

Eco nate change)

ulation monitoring of (recovering) populations

Disease studies

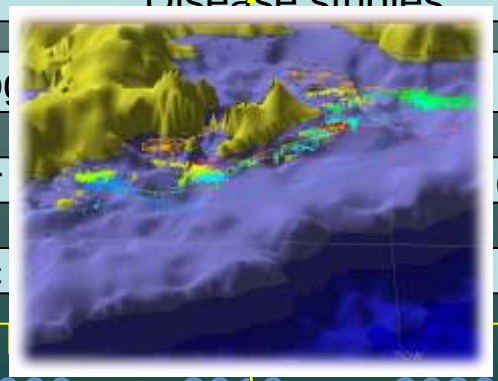
Life History/biolo

Behaviour ce

Museum science: Taxonomic

Threat science

Single species science



1950 1960 1970 1980 1990 2000 2010 2020 2030

The origins of our science… emerging from a bloody past

- Whaling science post WW2 established the foundations of what we know today:
  - ‘knife and bucket’ descriptive biology – reproduction, anatomy, diet, parasitology
  - ‘Discovery marks’ provided evidence of population structure in some species
  - Sighting surveys and catch statistics estimated population size and changes (and predicted the demise of populations)
  - This was state of art at that time

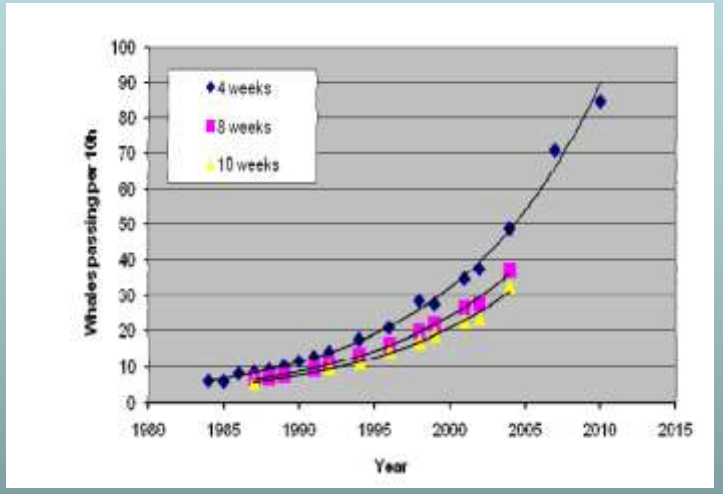
The collapse of populations, the moratorium and Comprehensive Assessments

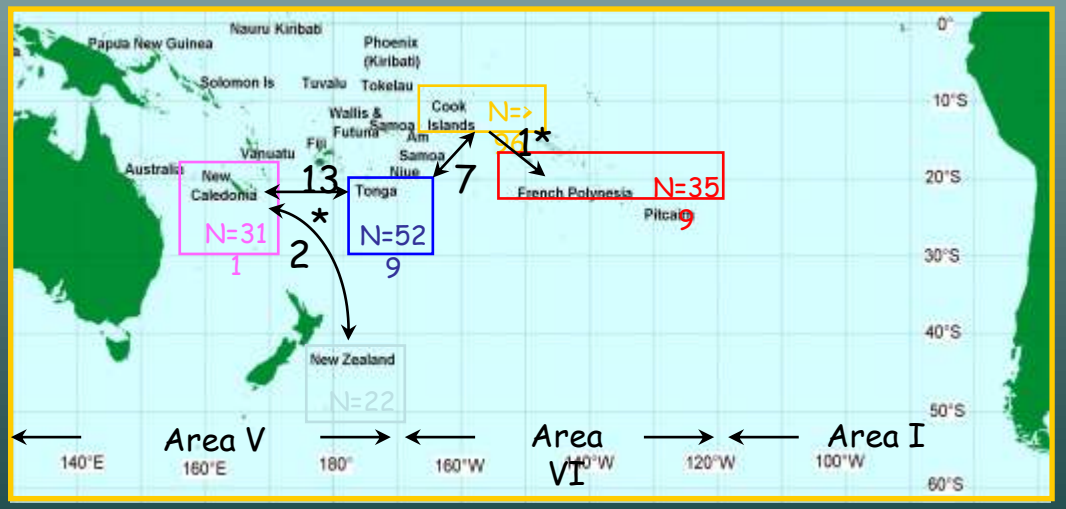
- Cascade of population collapses in the Southern Ocean through the 20th Century
- Staggered protection of species, and finally the moratorium on commercial whaling in 1986
- Comprehensive Assessments (established as an IWC science tool to study the effects of the moratorium)
- Major need for non-lethal science to monitor recovery of depleted whale populations

The pioneers of non-lethal science

- Little encouragement for early non-lethal whale science (expensive, hard to find, poor research models, funding-limited)
- Led by imaginative, dedicated scientists (with and without an IWC focus)
- Focus on near-shore, accessible species (humpbacks, right whales, killer whales, gray whales)
- Long-term surveys and the development of photo-identification led the research

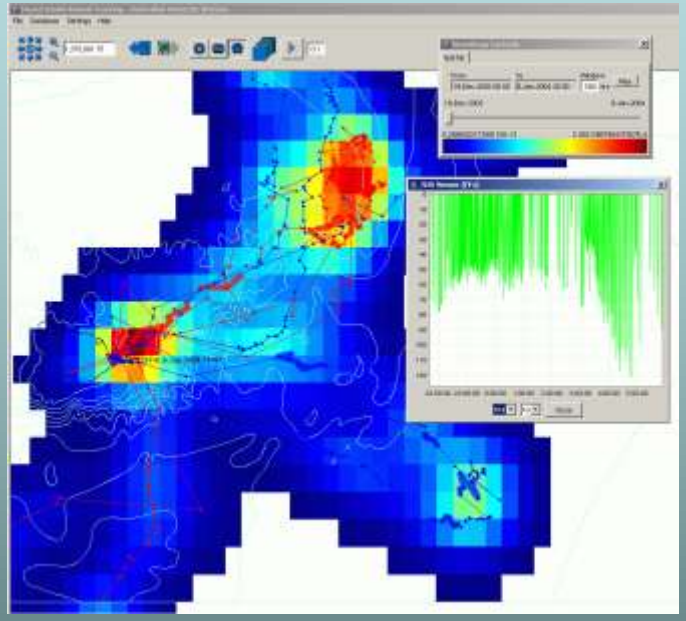
Whale recovery science: the era of the counter and the camera

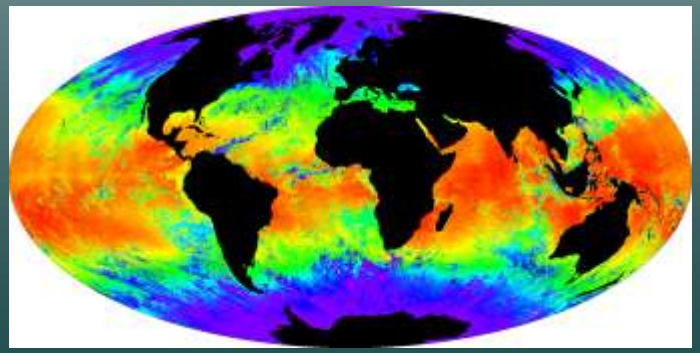




The technological era: a rapid expansion of non-lethal research opportunities

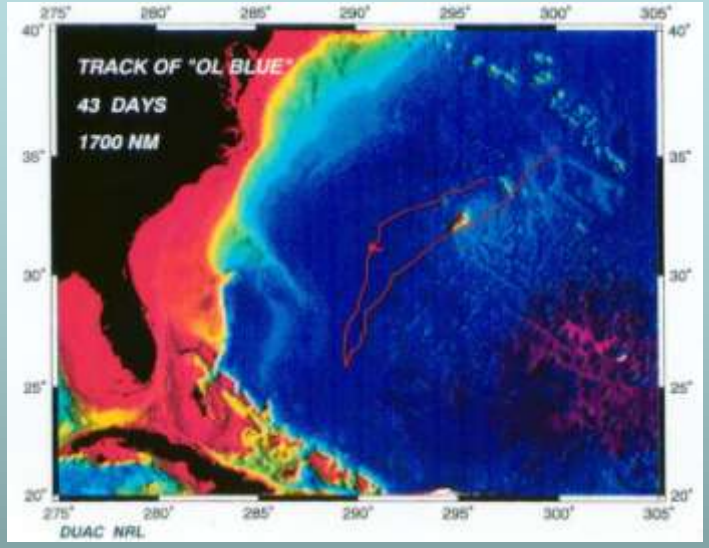
- Advances driven by developments in:
  - Whales and sound
  - Electronics and Biotelemetry
  - Molecular science
  - Statistics, maths and computer power
  - Remote sensing

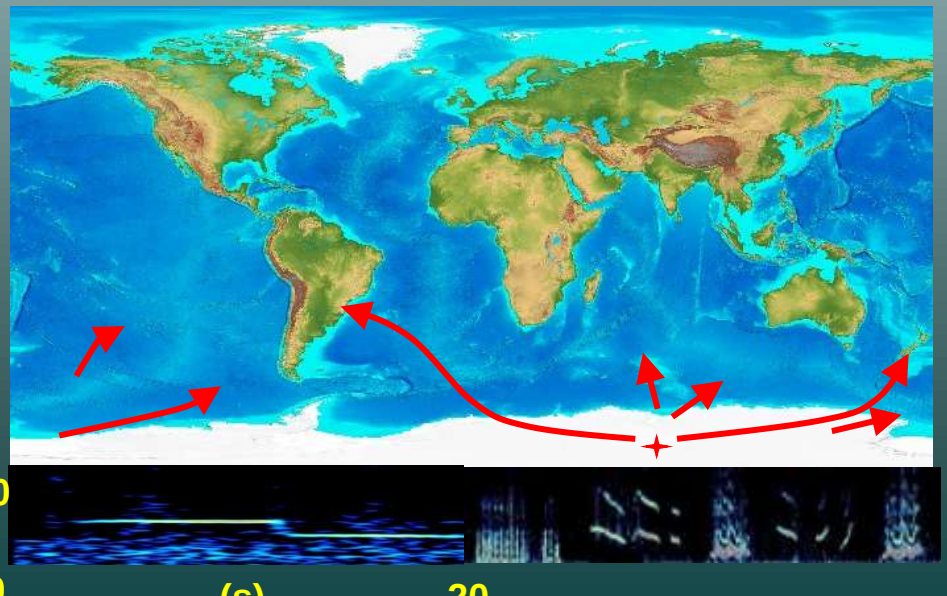




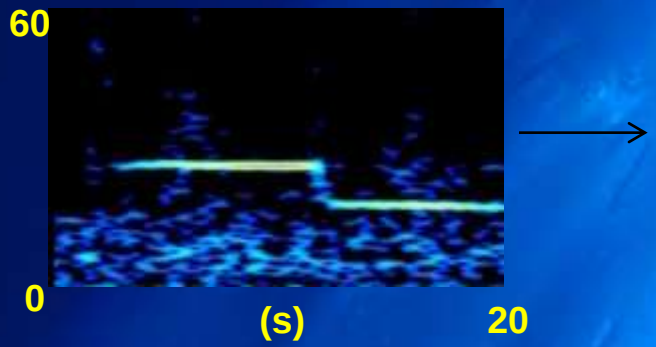
Whales and sound: the era of acoustics

- Developed from Navy submarine tracking technology
- Recognition that whales make unique sounds, heard over huge distances





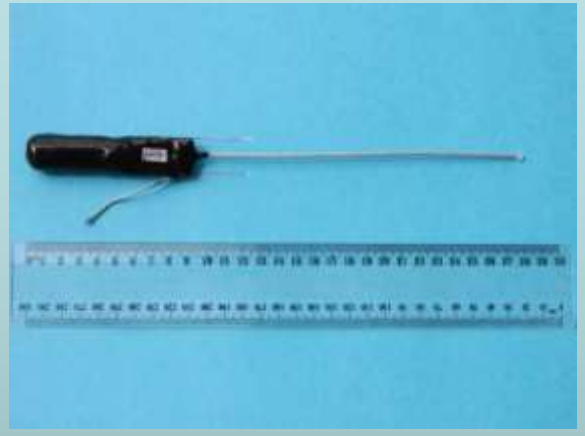
The realities and promise of acoustics



- Detection, tracking and location of individual whales (e.g. rare species)
- Infer population structure
- Track relative population trends
- Estimate relative abundance (maybe)
- Measure patterns of habitat use
- Infer behavioural states
- Insights into foraging behaviour (especially odontocetes)
- Measure other elements of the environment.....

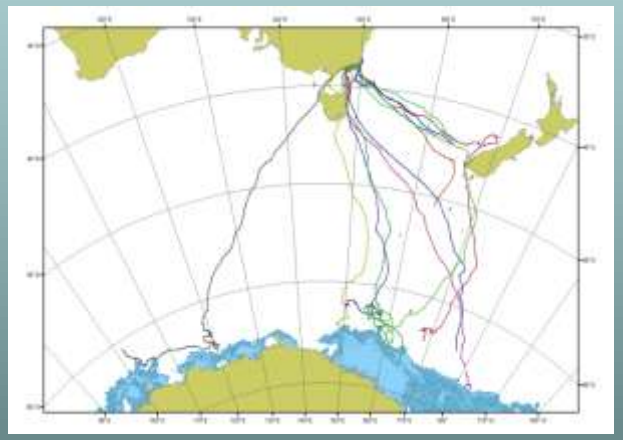
A revolution in electronics and telemetry

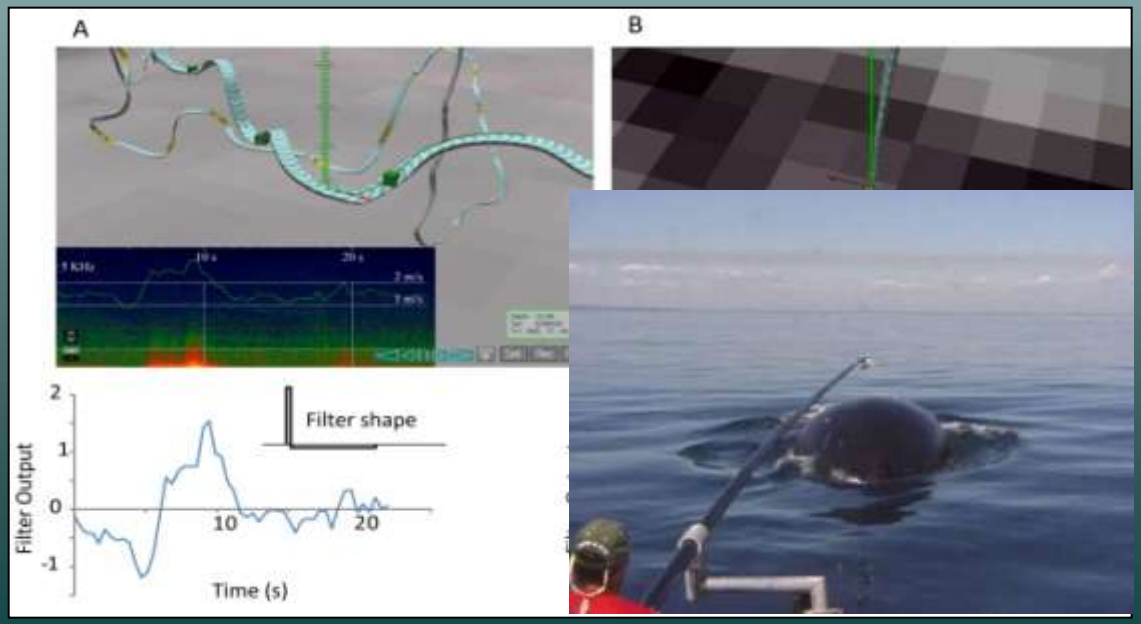
- Miniaturisation of electronics + enhanced data storage/transfer
  - Data-logging
  - Telemetry
- Techniques developed on other marine mammals and applied to whales

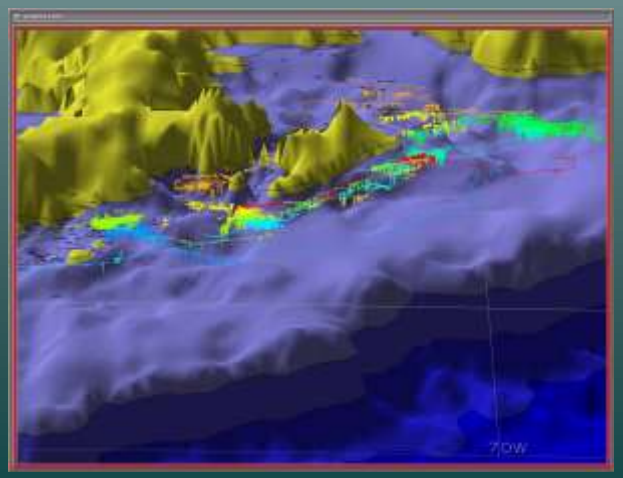


A whale's eye view of their world

- Whales tracked at scales from metres to ocean basins; from hours to years
- Multiple sensors (and growing)







The realities and promise of biologging

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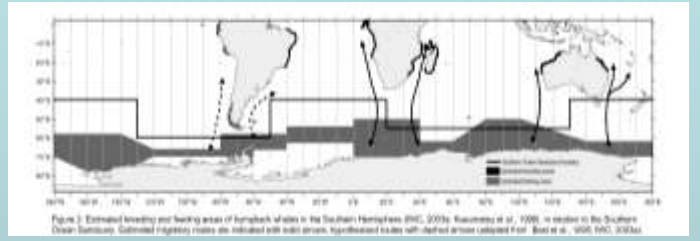
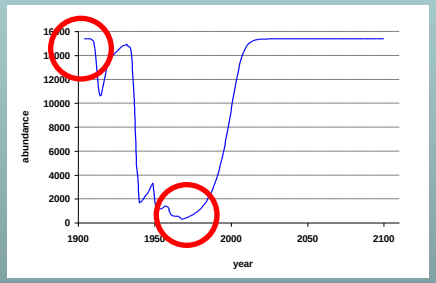
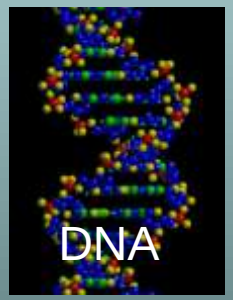
- Extraordinary insights into habitat use in 4 dimensions and across multiple scales
- Insights into foraging ecology
- Unique behavioural insights
- Interactions with the physical environment

Molecular science: the world from within the whale

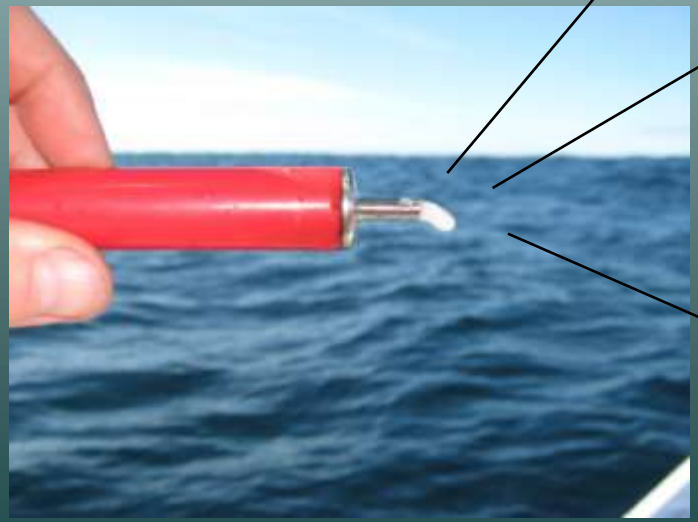




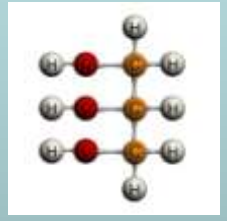


Immune status
Toxin load

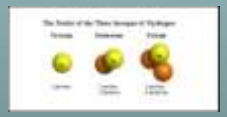
Molecular science: the world from within the whale



Fatty Acids



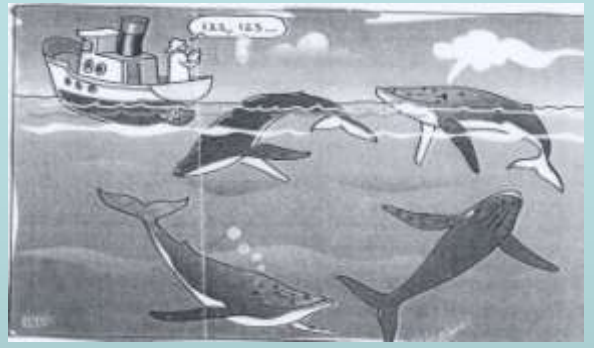
Isotopes

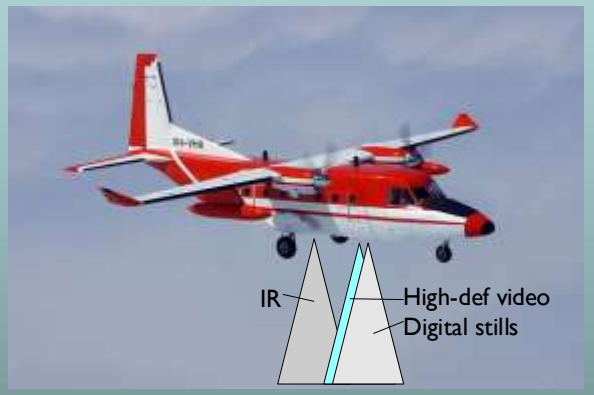


Hormones

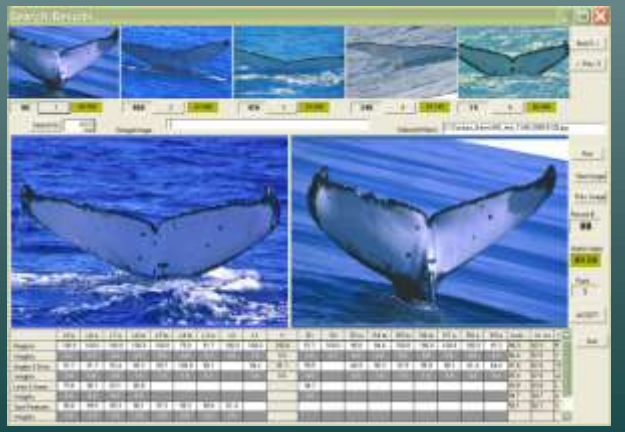
Statistics, Maths and Computer power

- Population estimation
  - Survey techniques
  - Mark-recapture studies
- Data processing, exploration and visualisation
- Statistical modelling





$$L(\underline{\beta},\underline{\theta};\underline{l},\underline{y}) = \left[\prod_{i=1}^{n} D(x_i)\right] \exp\left[-2\mu \sum_{i=1}^{n+1} \int_{x_{i-1}}^{x_i} D(x)dx\right] \left[\prod_{i=1}^{n} g(y_i)\right]$$



Large integrated cetacean studies in the Southern Ocean

- IDCR/SOWER
  - 3 decades of surveys
  - Unlikely to be repeated
  - Huge legacy
- SORP
  - Has to be clever in strategic deployment of multiple tools against important questions
  - Research developed to respond to science needs of IWC, its members and broader needs

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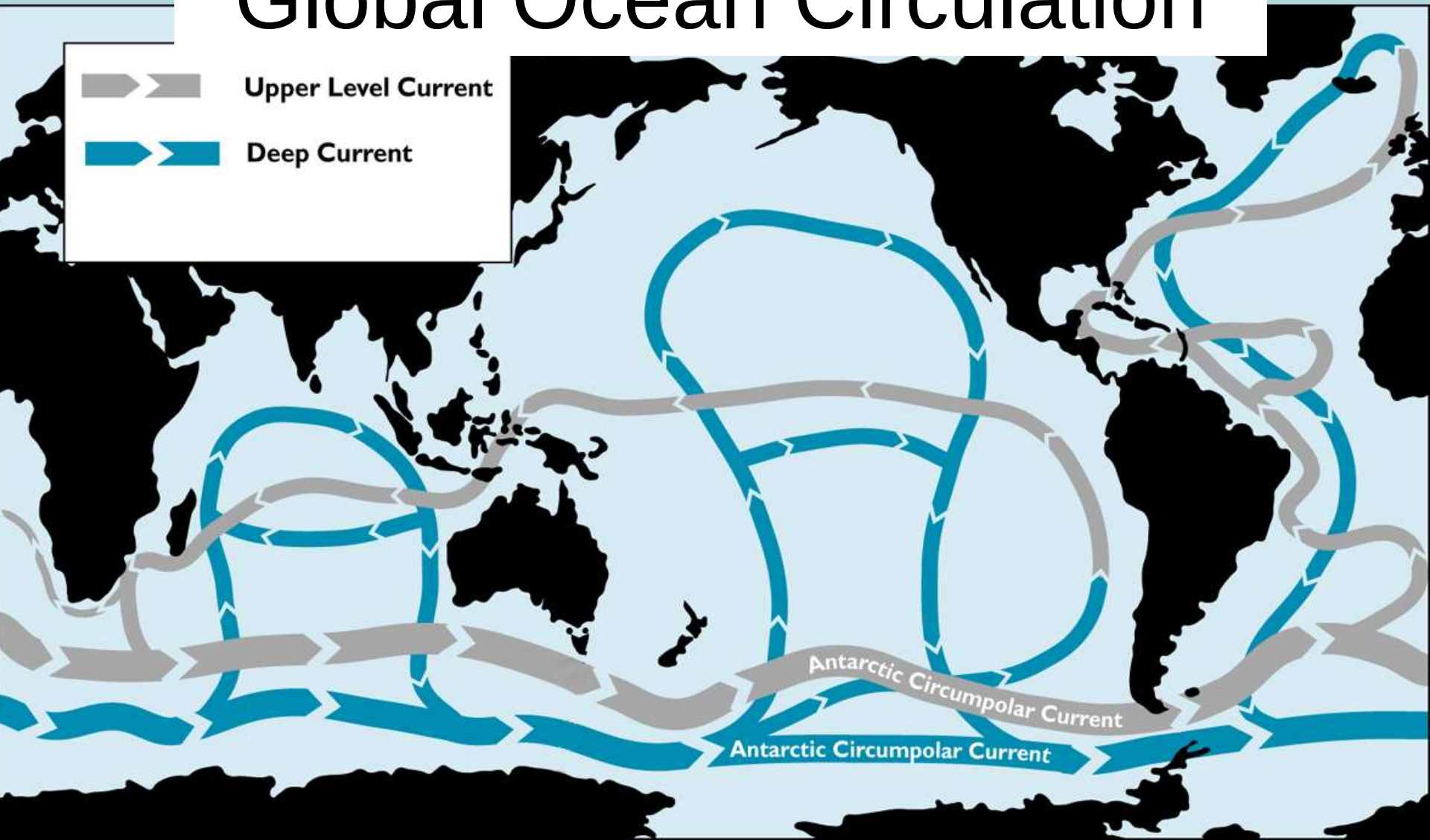
Global Ocean Circulation



The Southern Ocean Research Partnership:

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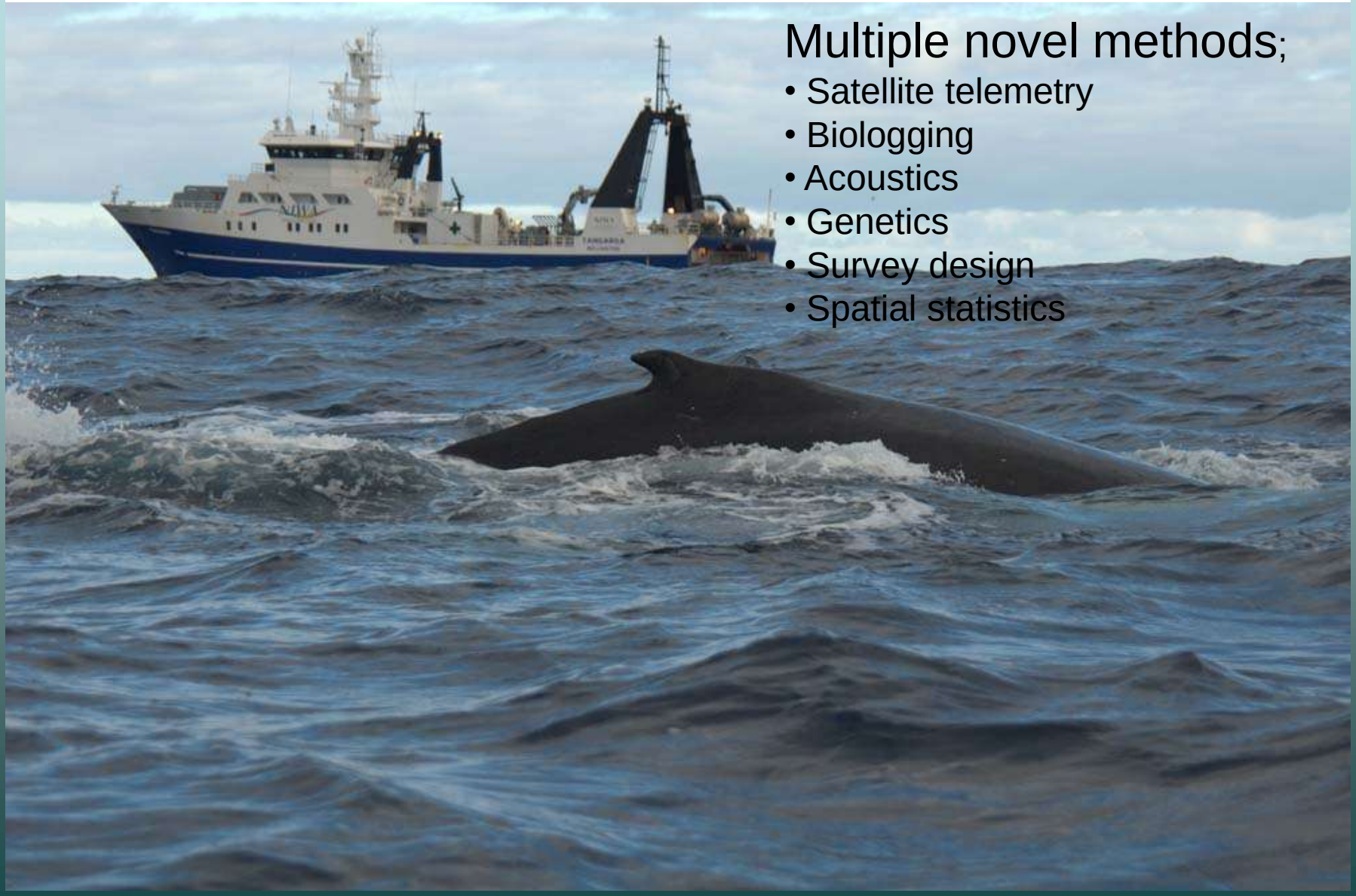
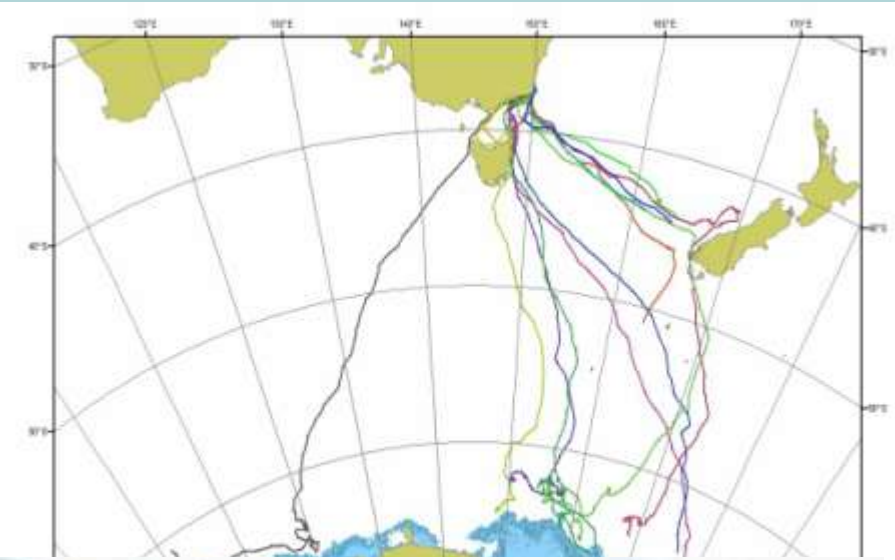
Multinational (10+ countries) Projects: Focus on 4 key research projects

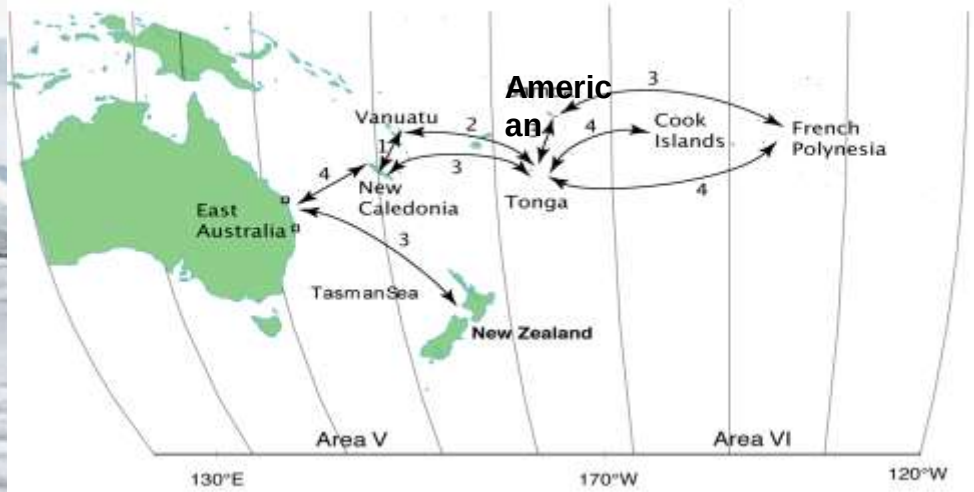


Multiple novel methods;

- Satellite telemetry
- Biologging
- Acoustics
- Genetics
- Survey design
- Spatial statistics

Breeding to feeding: habitat utilisation by humpback whales (Australia, Brazil, France, NZ, USA,)





Baleen whales and krill; niche partitioning between minke and humpback whales (USA, Australia)

Ecology of the three Antarctic killer whale ecotypes (USA, France, Australia)

The Antarctic Blue Whale Project (Australia, Argentina, Chile, Brazil, NZ, France, South Africa, USA, Germany, Norway)

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The Antarctic Blue Whale Project

A Flagship of the Southern Ocean Research Partnership

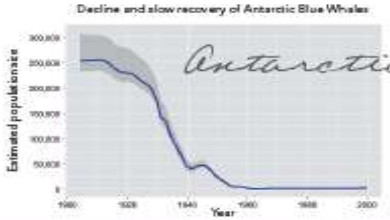
The Antarctic blue whale project is the flagship collaborative research effort of the Southern Ocean Research Partnership. By combining shipping, logistics and scientific resources, the partners will learn how the blue whales have fared after half a century of protection.

The particular objectives of this project are to:

- Estimate circumpolar abundance
- Improve understanding of population structure
- Improve understanding of linkages between breeding and feeding grounds, and
- Characterise the behaviour on the feeding grounds

A blue whale and whalers at Grytviken whaling station, South Atlantic. Shackleton expedition 1914-1917. Image by Frank Hurley

A blue whale being hauled up a ramp for flensing at Grytviken whaling station, South Atlantic - 1960.



Antarctic Blue Whale Project

Half a century ago the Antarctic blue whale was perilously close to extinction. About a third of a million blue whales were killed during the industrial whaling era before the remaining few whales were finally protected. About a decade ago it was estimated that the population of blue whales remained at less than 5% of its original size.

In order to succeed in such an ambitious project, participating scientists will develop and apply new, powerful acoustic techniques to find these rare whales, and will then utilise the most sophisticated available techniques in genetics, photography and satellite tracking to address the objectives.

The project requires substantial support from the Partnership members, with levels of engagement ranging from the *ad hoc* collection of high quality photographs of blue whales through to dedicated, multi-method research voyages.

The Antarctic blue whale project will commence in 2013, and run for at least three years. As well as advancing our knowledge of this iconic species, the project will provide a legacy from which future monitoring and understanding of blue whales can build.

A fully structured research proposal will be presented at IWC64. In order to conduct the necessary detailed planning of the coordinated, regional research efforts required for this project it is imperative that Partnership members begin the formal process of committing to their participation in this exciting work.

Current Partnership members include – Argentina, Australia, Brazil, Chile, France, Germany, New Zealand, Norway, South Africa and United States.

Images: • Underwater blue whale © Michelle Jenner – Centre for Whale Research (WA) • Two blue whales in fog © Peter Gill – The Blue Whale Study • Graph - Figure adapted from Branch (2006)

"... it is *imperative* that Partnership members begin the formal process of committing to their participation in this exciting work."

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Australian Government

Further information is available from:
Email: SORP@aad.gov.au
Web: www.marinemammals.gov.au/iwc-initiatives/bluewhale-sorp

Take home messages

- Current research tools allow cetaceans to be considered along with other SO predators
- SORP offers a framework to conduct large scale cetacean research that requires multi-national cooperation, focused application of research tools and addresses priority questions
- SORP needs you NOW! Implementation Phase.
- International cetacean science needs to be engage beyond the IWC;
  - Linked to national polar programs (e.g. SCAR; CCAMLR)
  - linked into multi-disciplinary programs
- Importance of targeted monitoring (national)

The Challenge: Cetaceans as sentinels of ecological and climate change

- Cetaceans can provide a near-Century scale signal
  - Combine historic data, long term monitoring and novel techniques
- We must become part of multi-disciplinary programs (ICED; SOOS)
  - Linked to national polar programs
- Importance of targeted monitoring (national)
- Open data