Passive acoustic monitoring of large whales in the Southern Ocean

Marine mammals rely on sound for:

- Navigation
- Communication
- Foraging
- Individual or group identification
- Reproductive display
- Group cohesion

Cetacean vocal frequency ranges

Different species make distinctly different sounds

- Sounds produced include clicks and whistles from odontocetes
  - Sperm whales
- The “song” of bowhead whales
- Very low-frequency moans and pulses
  - Fin whales
- Truly bizarre sounds
  - Minke whales

Sounds can be heard at long distances

- Depending upon frequency, signals can be heard a 100s m to 100s of km
- Low-frequencies attenuate less than high frequency
- Most baleen whales produce relatively low frequency sound (<1000 Hz)
- Animals can be heard farther than seen, in poor weather* and visibility - i.e. year-round

Tools

Getting the data

- Dipping hydrophone
- Sonobuoys
- Towed arrays
- Moored hydrophone*
- Cabled hydrophone

Processing the data

- Long-term spectrograms
- Automatic detection methods
- Detection and classification

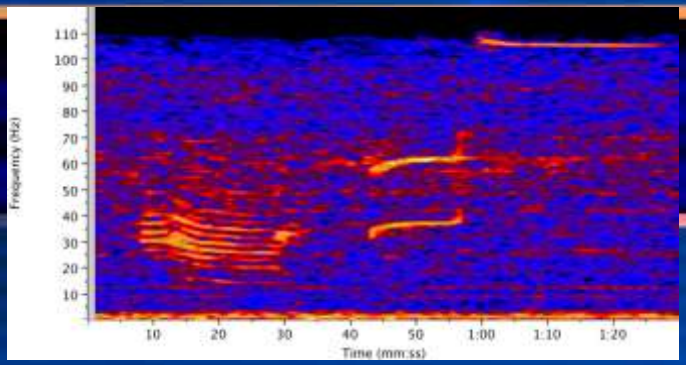
Examples of how PAM can be used to study marine mammals

- Geographic variation among populations
- Broad-scale population migrations
- Changes in relative population over time
- Searching for rare species

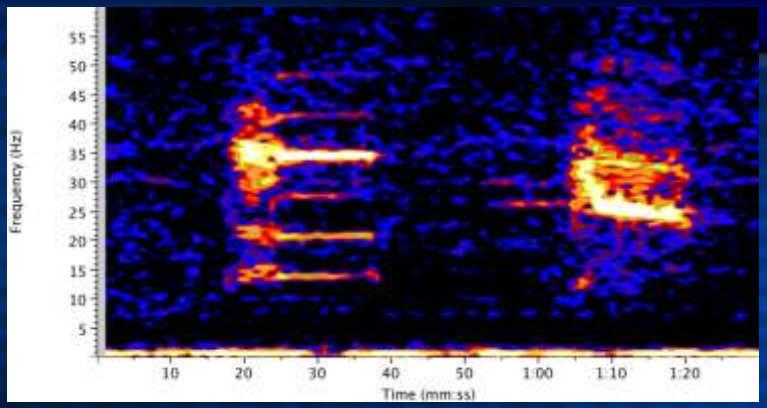
Geographic variation

- Southern Hemisphere blue whales
  - Same signal from blue whales circum-Antarctic (28 Hz)
  - Many different “pygmy” blue whale call types - all ~geographically distinct
- SH Fin whales
  - High frequency pulse that may be indicative of “acoustic population”
  - No clear differences in interpulse interval

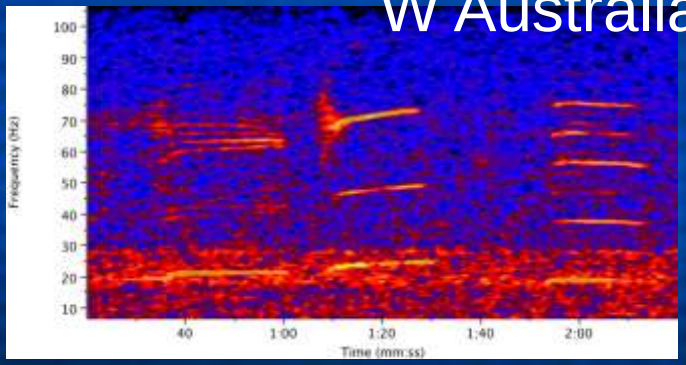
Sri Lanka



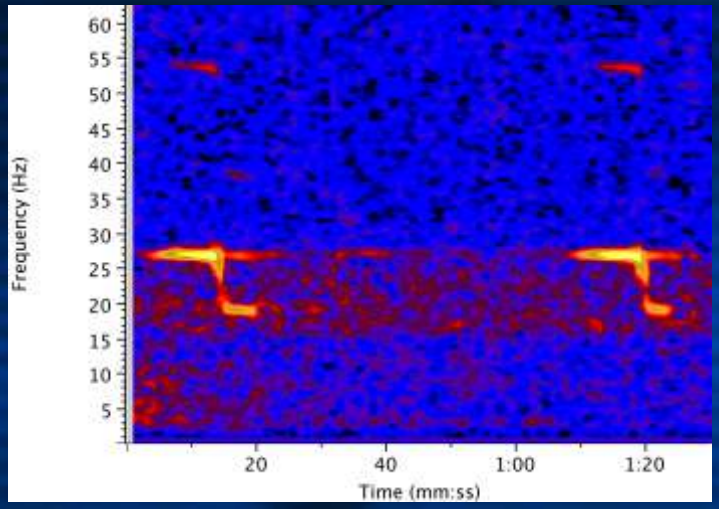
Madagascar

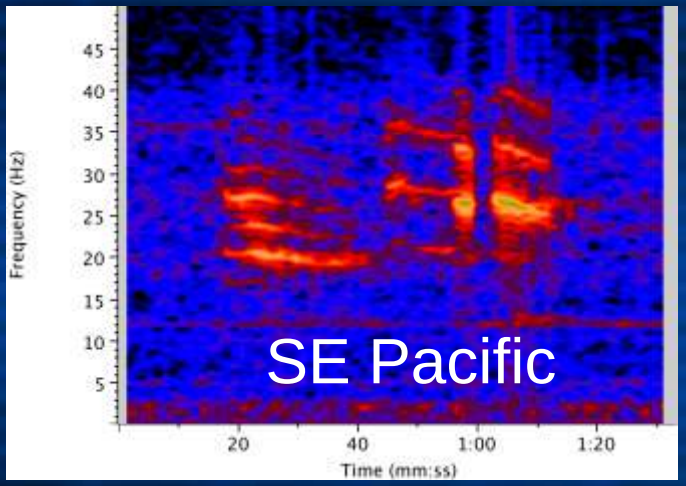


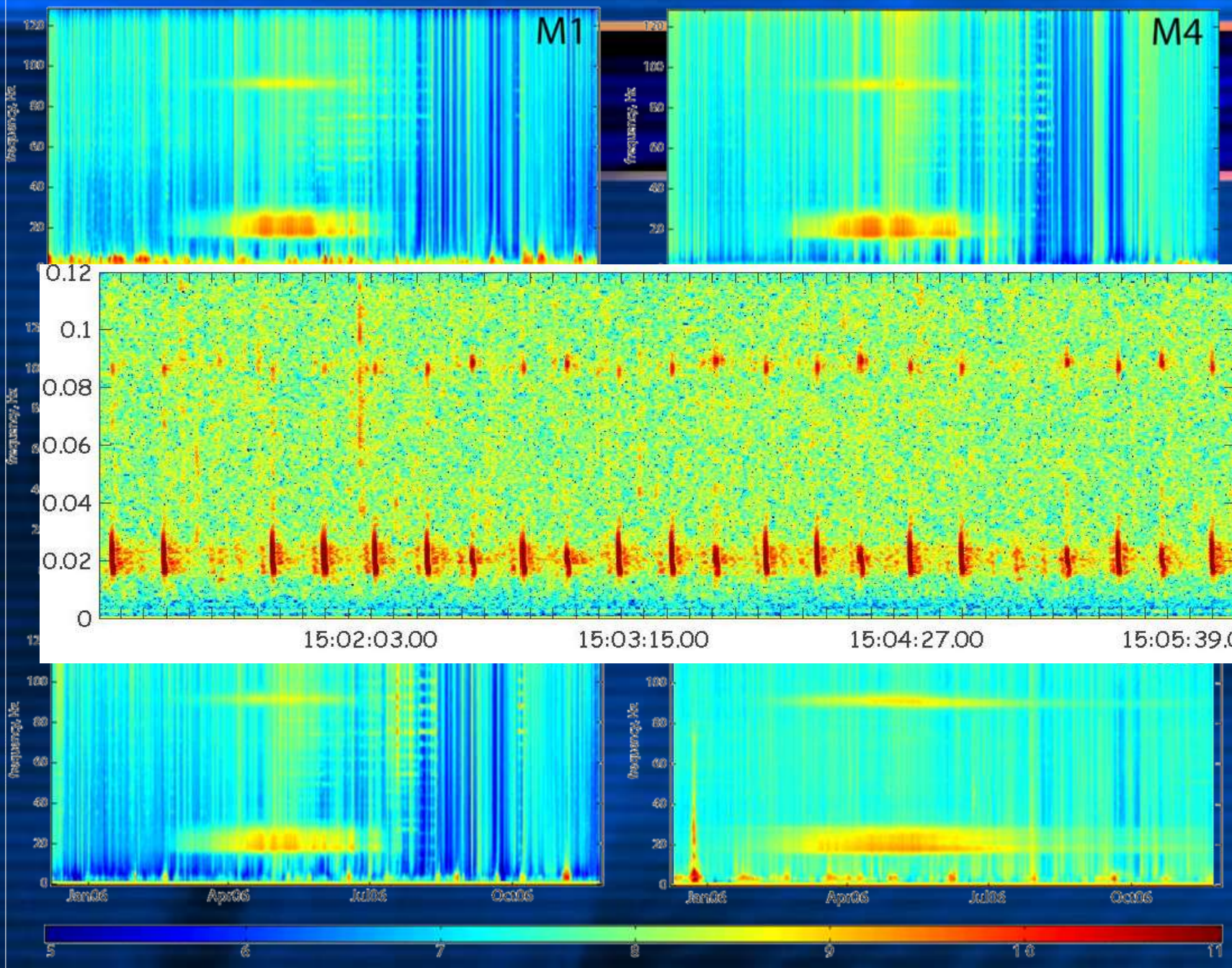
W Australia



Antarctic



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M4
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0.1
0.08
0.06
0.04
0.02
0
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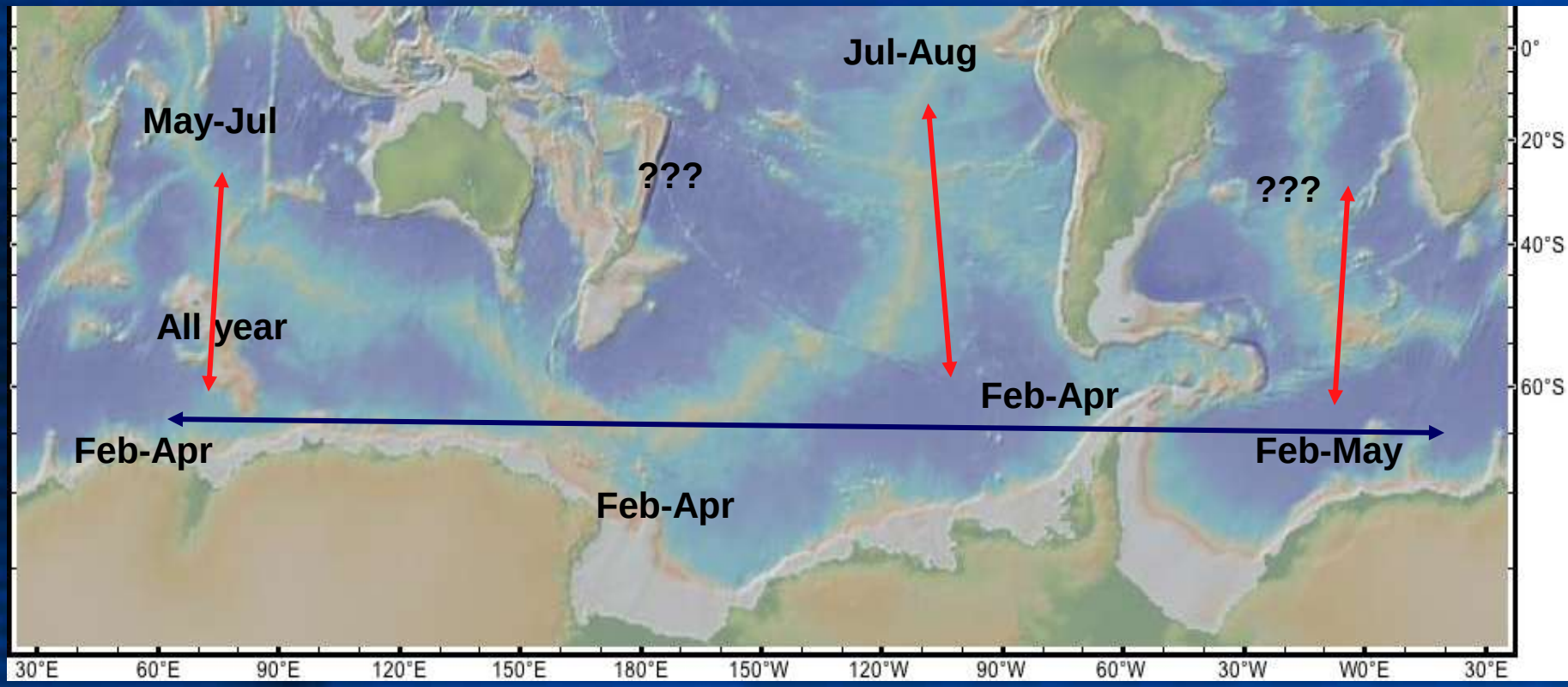
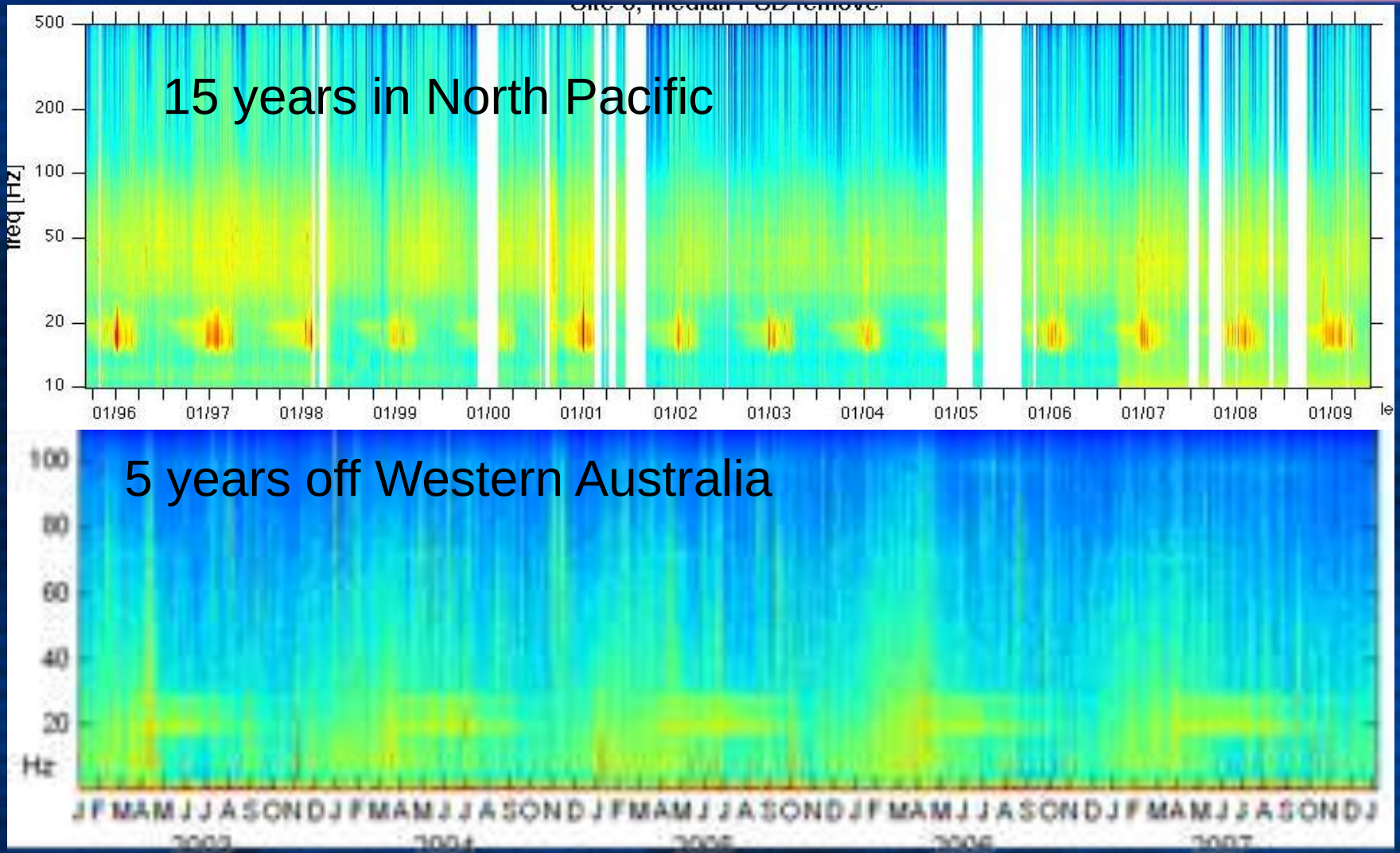
15:03:15.00
15:04:27.00
15:05:39.00
Jan06
Apr06
Jul06
Oct06
5
6
7
8
9
10
11

Tracking movements

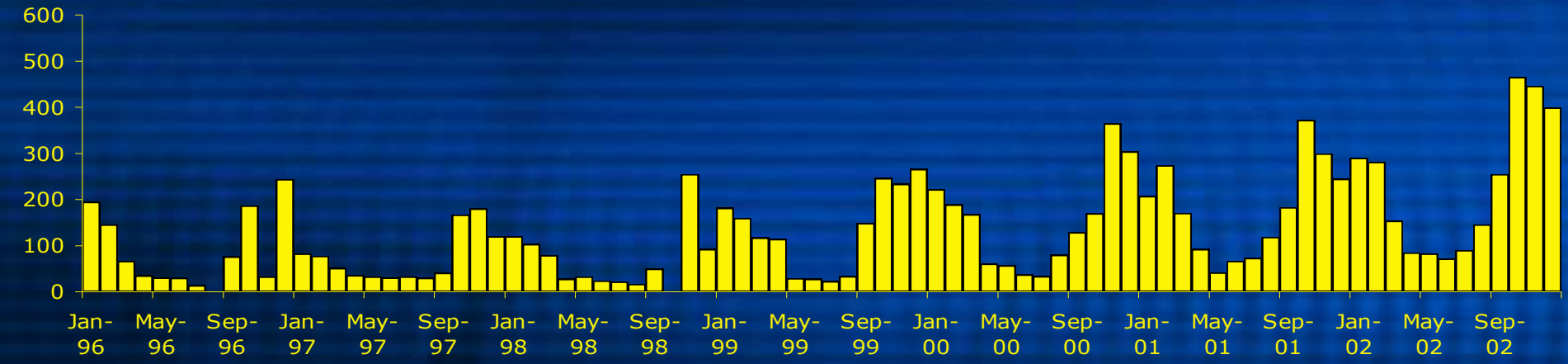
- Where do Antarctic blue whales go in winter?

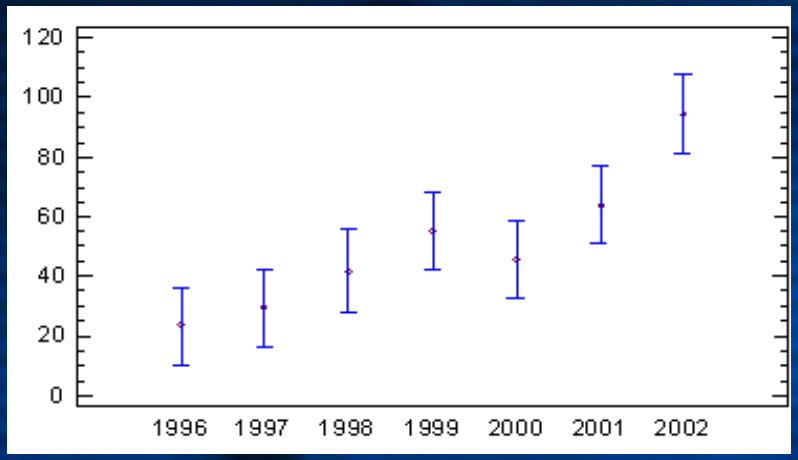


Long-term monitoring

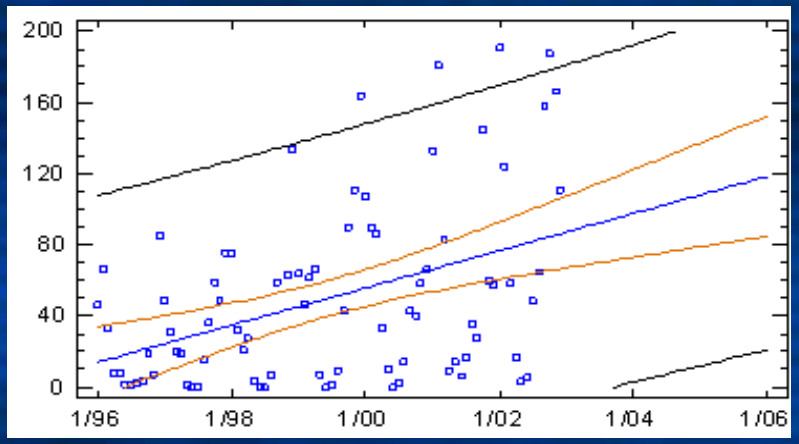


Relative change in abundance





Year



Date

Needle in a haystack

- Use sonobuoys to localize for photo-ID, Biopsy
  - N P right whales
  - Antarctic blue whales
- Deploy moorings in former habitat when very low densities of animals are expected
  - NP Right whales
  - Spitsbergen bowheads
  - Antarctic blue whales

Caveats

- We can't say anything about silent animals
- For baleen whales, we don't know who vocalizes, how often, what proportion of the population, WHY?
- Different sounds used for different purposes
- Animals may vocalize more during some seasons than others
- Environment influences detection distance

PAM can tell you a lot, but is best when part of a multi-disciplinary approach

SORP blue and fin whale acoustics project

- Analyse extant moored hydrophone data around the Antarctic for blue and fin whale calls
  - Seasonal and diel variation, calls and call types
  - Geographic variation (fin whales)
  - Best techniques for analysis of Terabytes of data?
- Determine locations, instrument configuration, and partners for long-term acoustic monitoring
- Use DiFAR sonobuoys during cruises to help find blue whales for biopsy/photo-ID/satellite tagging

Acknowledgments

Data presented here were from a variety of published and unpublished sources

Bob Dziak

Jason Gedamke*

Don Ljungblad

Rob McCauley

Shannon Rankin

Flore Samaran*

Ana Sirovic

Ilse van Opzeeland*