The Patagonian Right Whales

Photo-identification and response to climate change

Nat Geog 1976(v149:p296

Benign Techniques

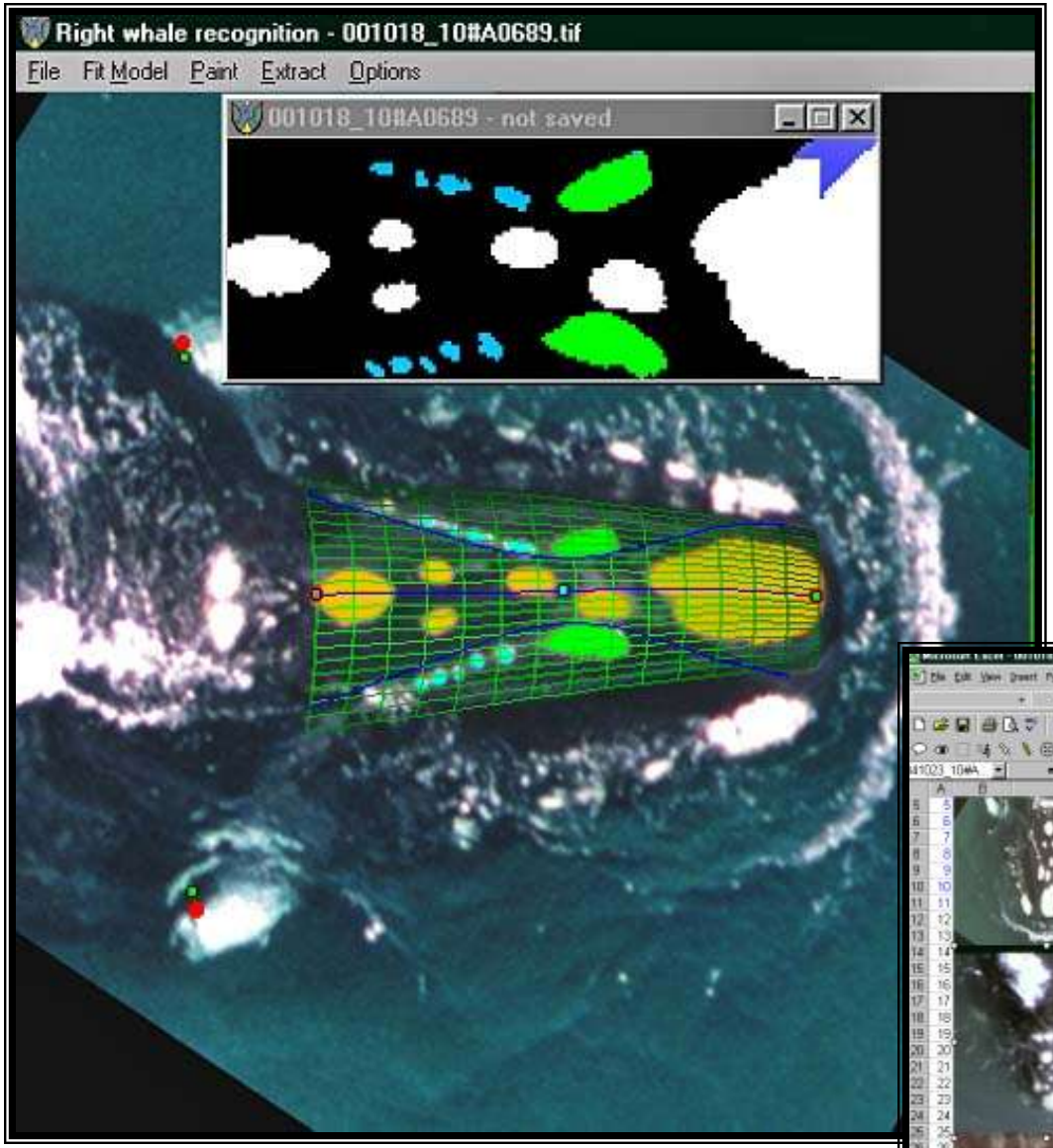
- Aerial Surveys to document individuals present in a year, locations companions, particularly presence of a calf

- Cliff top observations
  - Surveyor theodolite – swimming speeds, individual movement patterns, response to boats

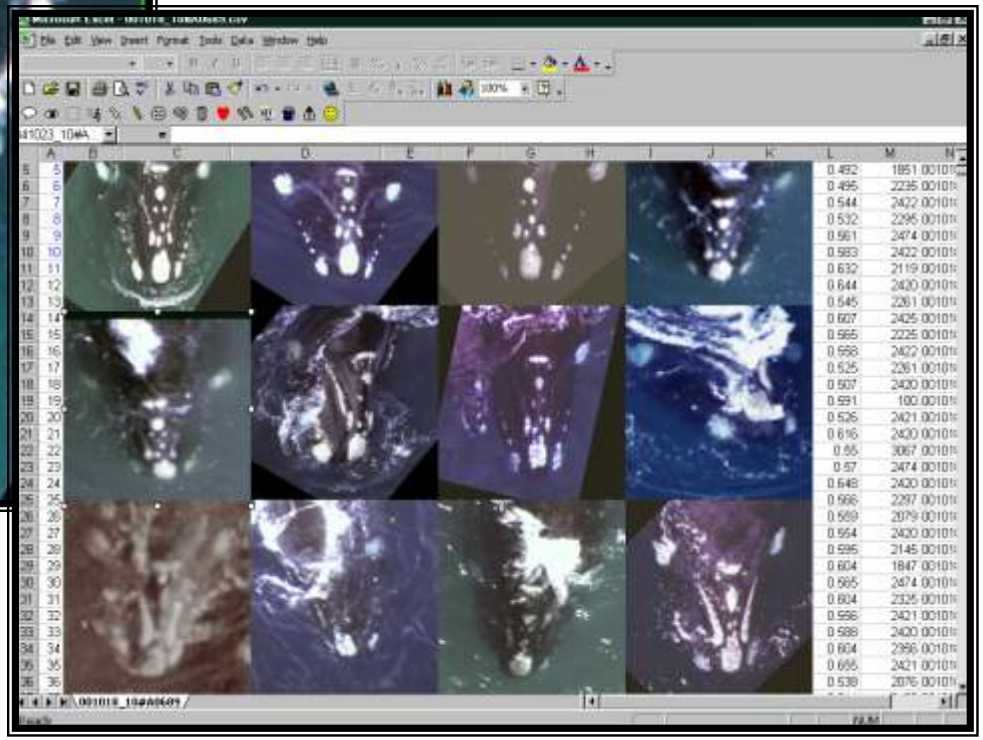
  - Focal animal follows – behavioral patterns by age group, and location, proportion time spent resting, traveling, surface active – calf development, gull harassment

  - Hydrophones -Interpret behavioral responses to sounds of different individuals

  - Document body condition by recording respiratory frequencies (blow intervals)



Survey photos are now analyzed using a computer-based system designed and implemented by Lex Hiby and Phil Lovell.



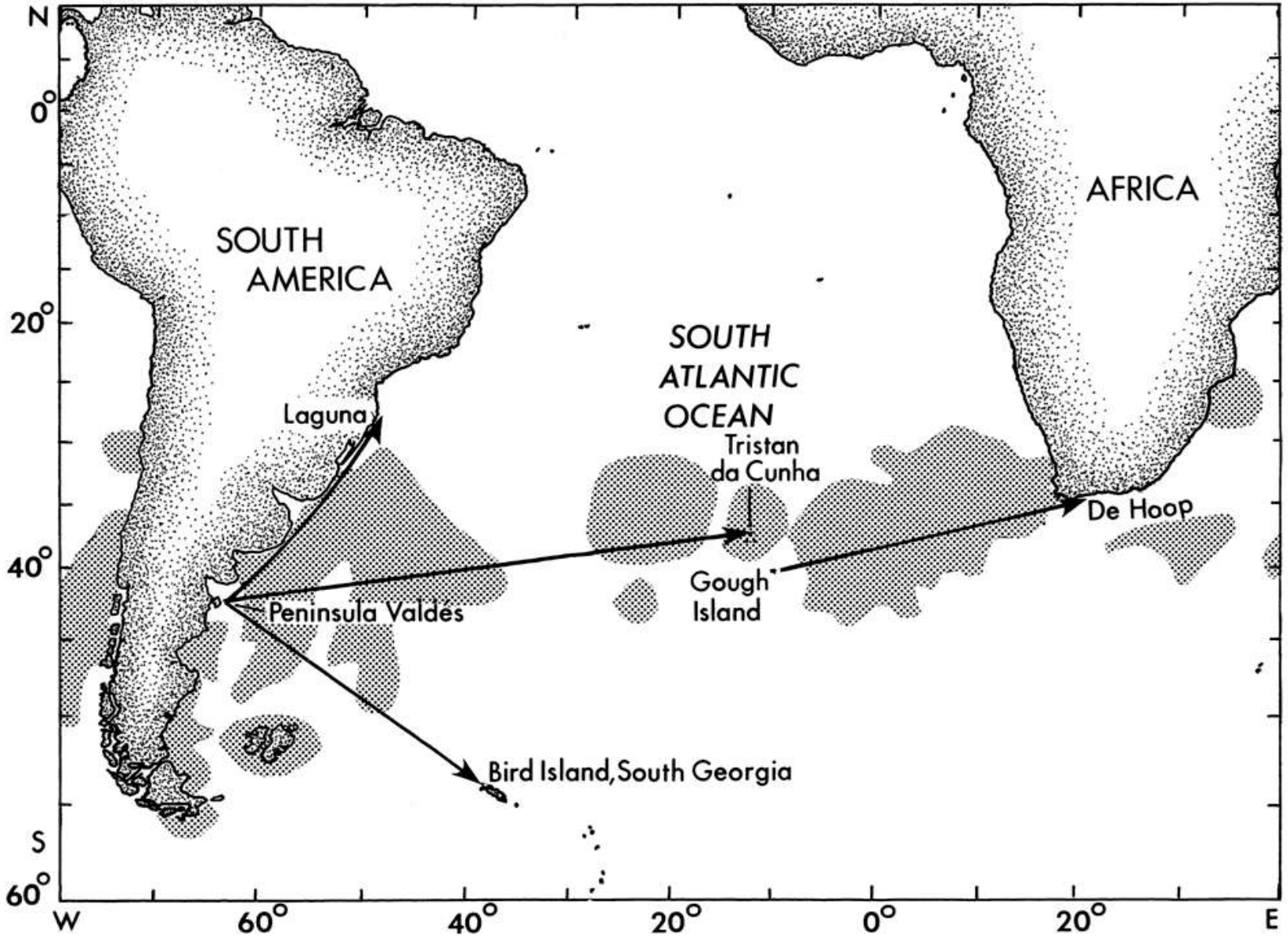


Figure 1. South Atlantic Ocean, showing movements of six right whales and shaded areas corresponding to Townsend's (1935) plots of nineteenth-century catches.

Best et al., 1993

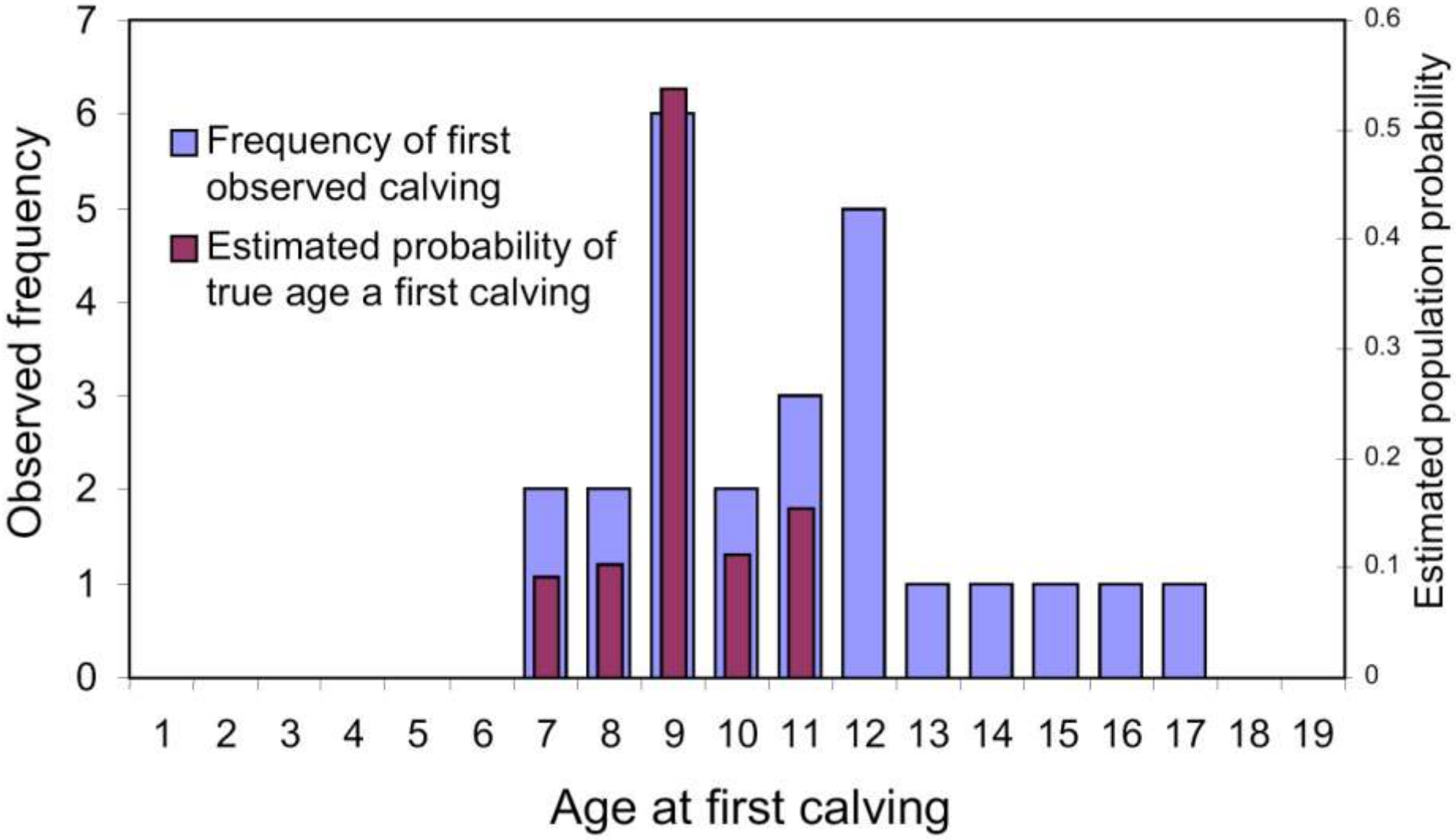
Most females have a calf once every 3 years

Longest reproductive history whale 143 with 11 calves over 36-year period.

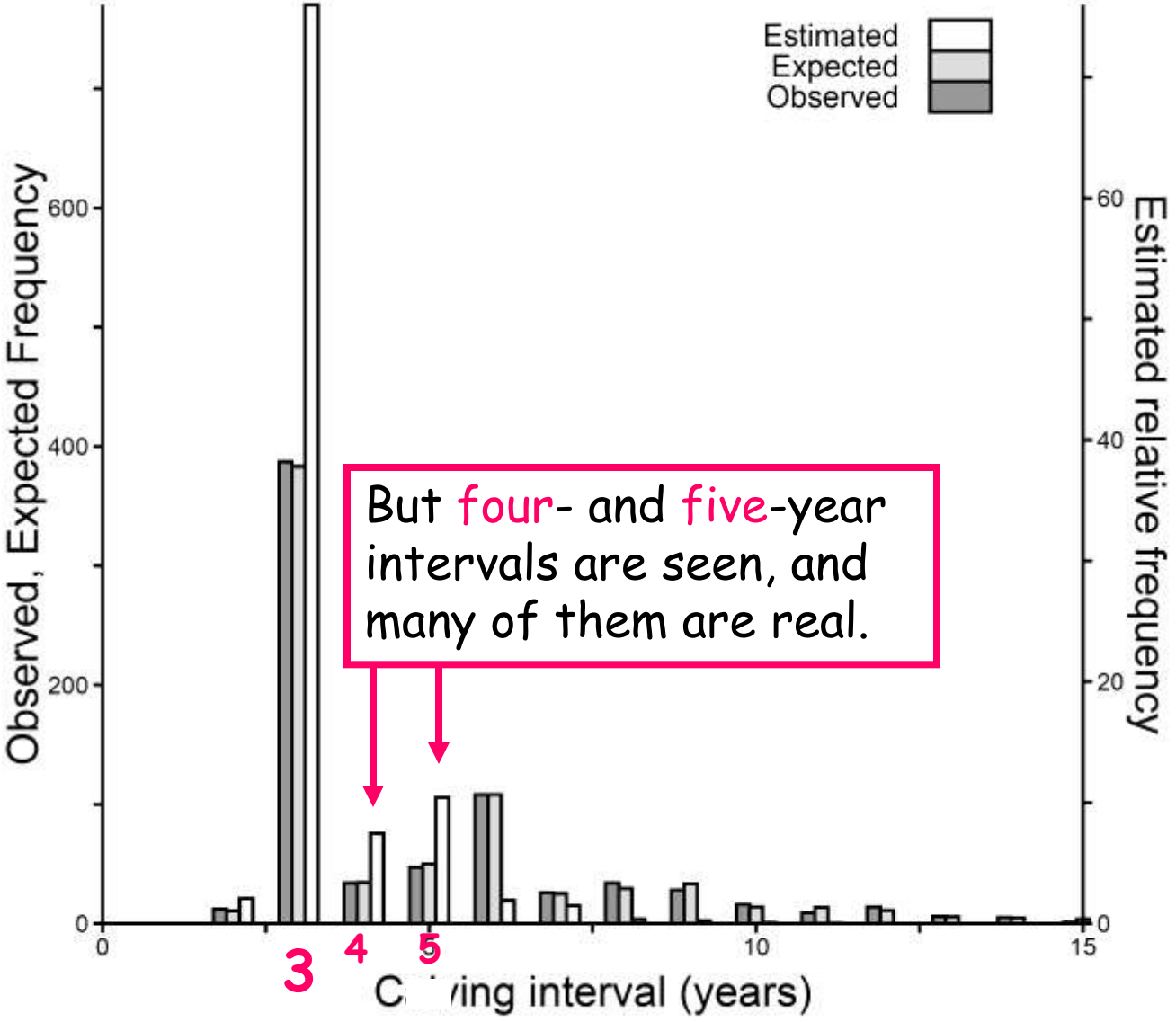
Whale 13-71 through four decades

Calf year 1984 1994 2008

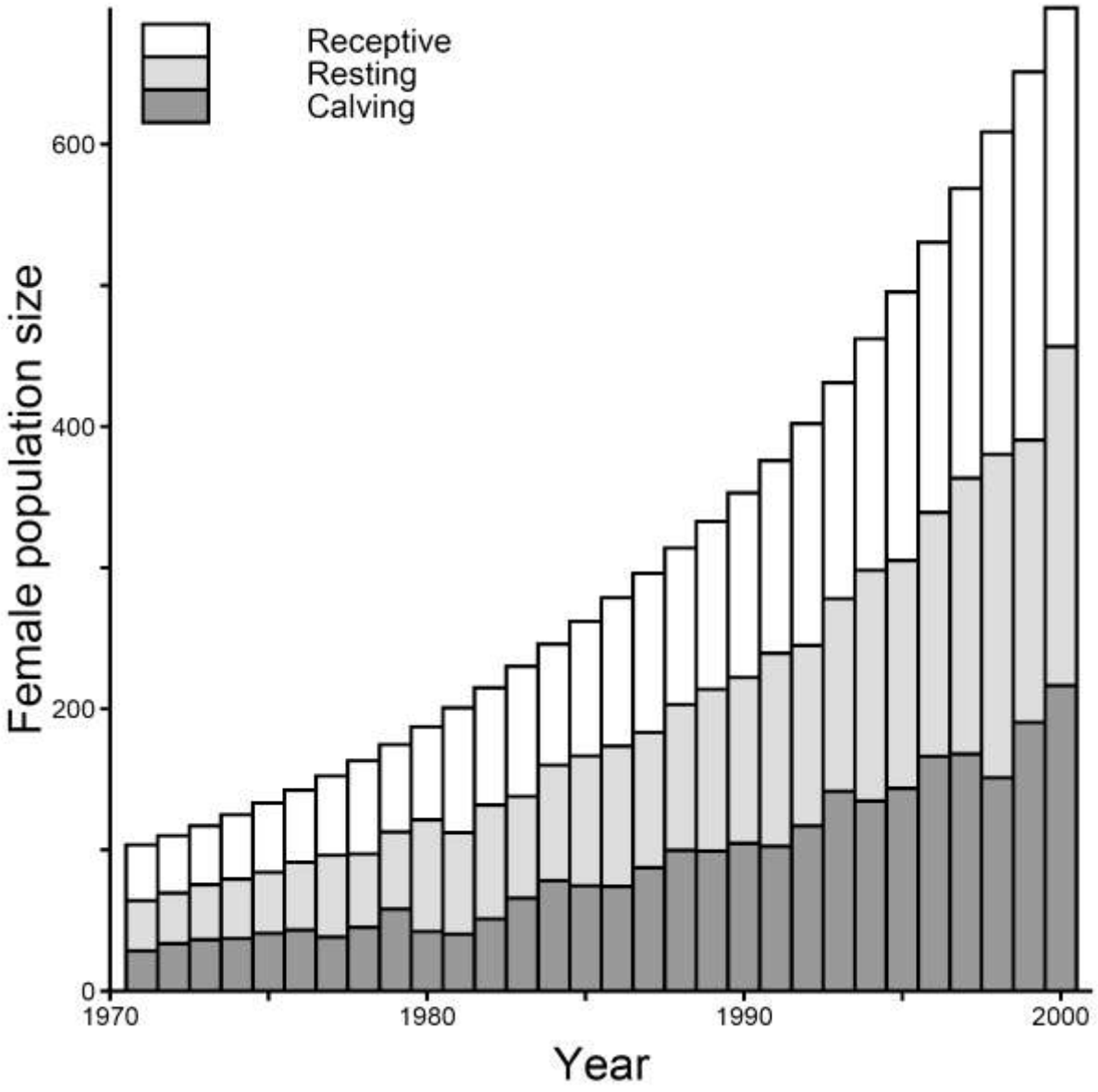
The average age of first reproduction is nine years



The normal calving interval is three years



The population increased at 6.9% per year through yr 2000



In some years, many females who are *expected* to calve fail to do so.

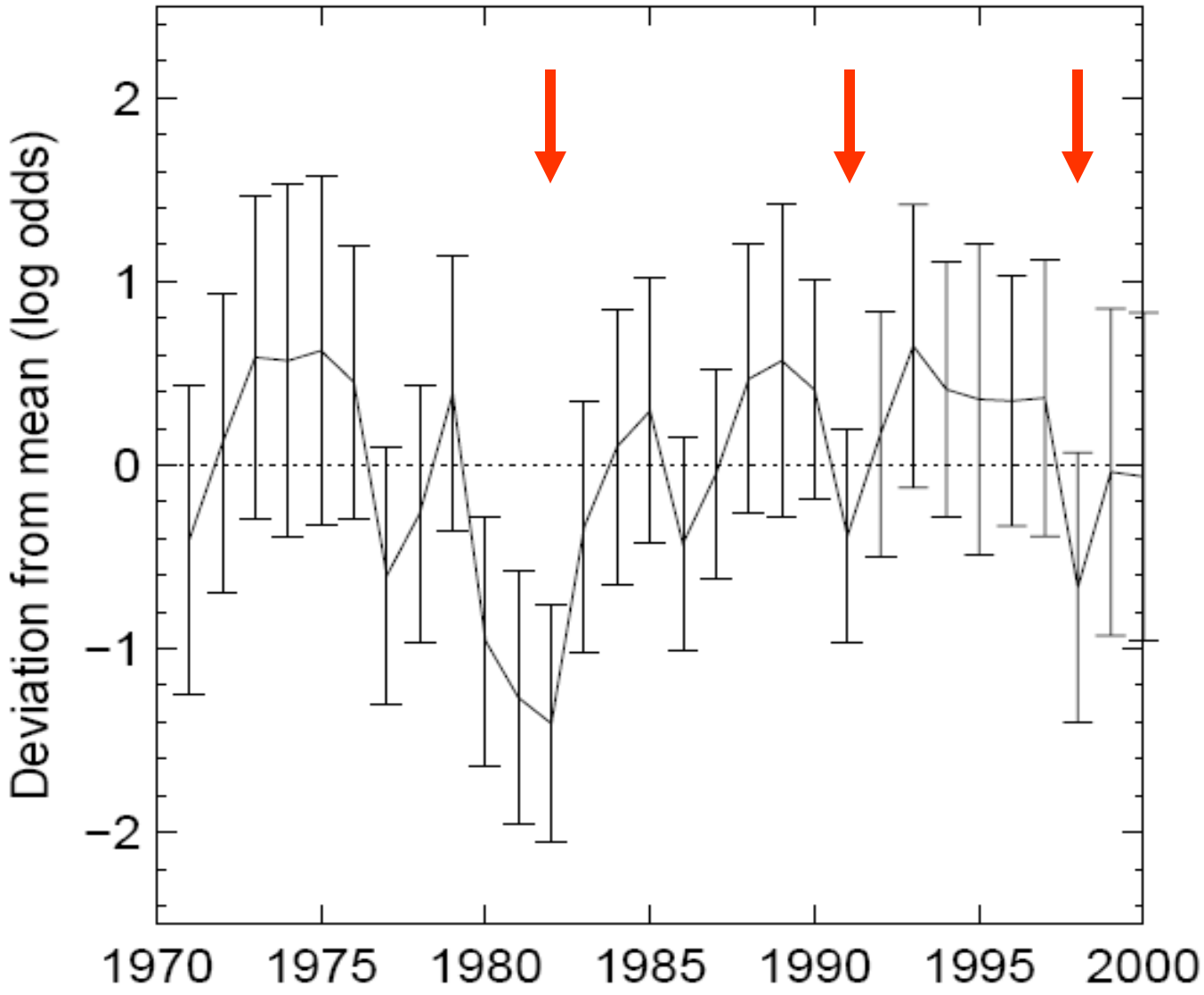


Fig. 7. Annual deviations from mean of minus log-odds ratio for Receptive to Resting transitions. Negative deviations indicate poor calving years and vice versa.

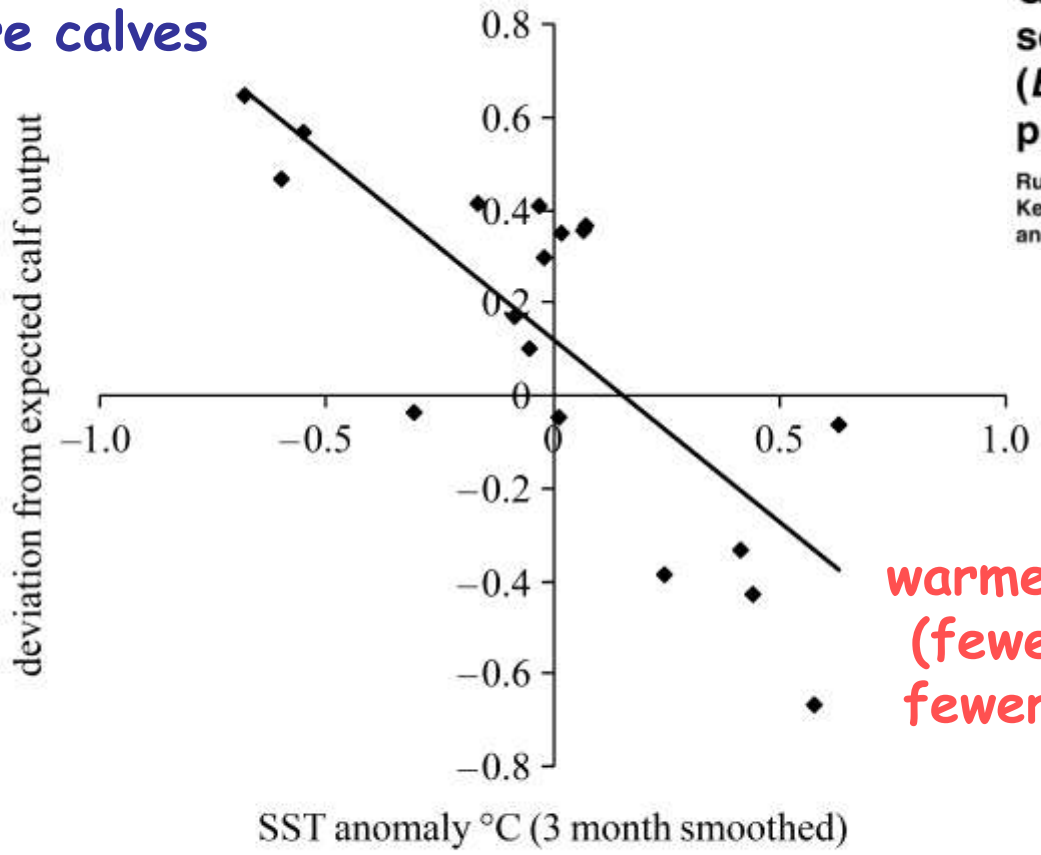
And these years tend to *follow* warm SST anomalies at South Georgia.

cooler water
(more krill)
more calves

biology letters
Biol. Lett. (2006) **2**, 289–292
doi:10.1098/rsbl.2005.0431
Published online 10 January 2006

Global climate drives southern right whale (*Eubalaena australis*) population dynamics

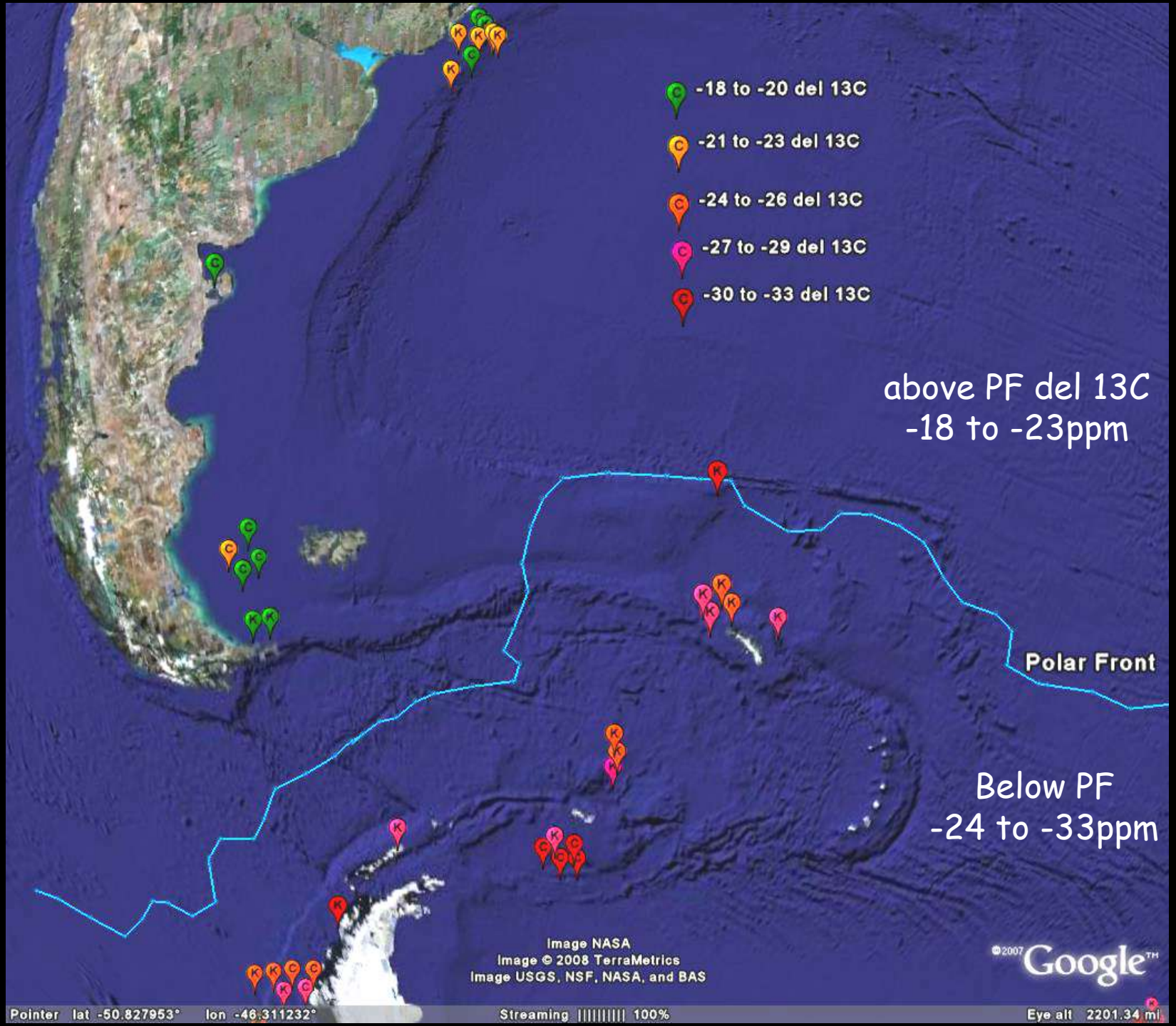
Russell Leaper[1,*], Justin Cooke[2], Phil Trathan[3], Keith Reid[3], Victoria Rowntree[4] and Roger Payne[5]



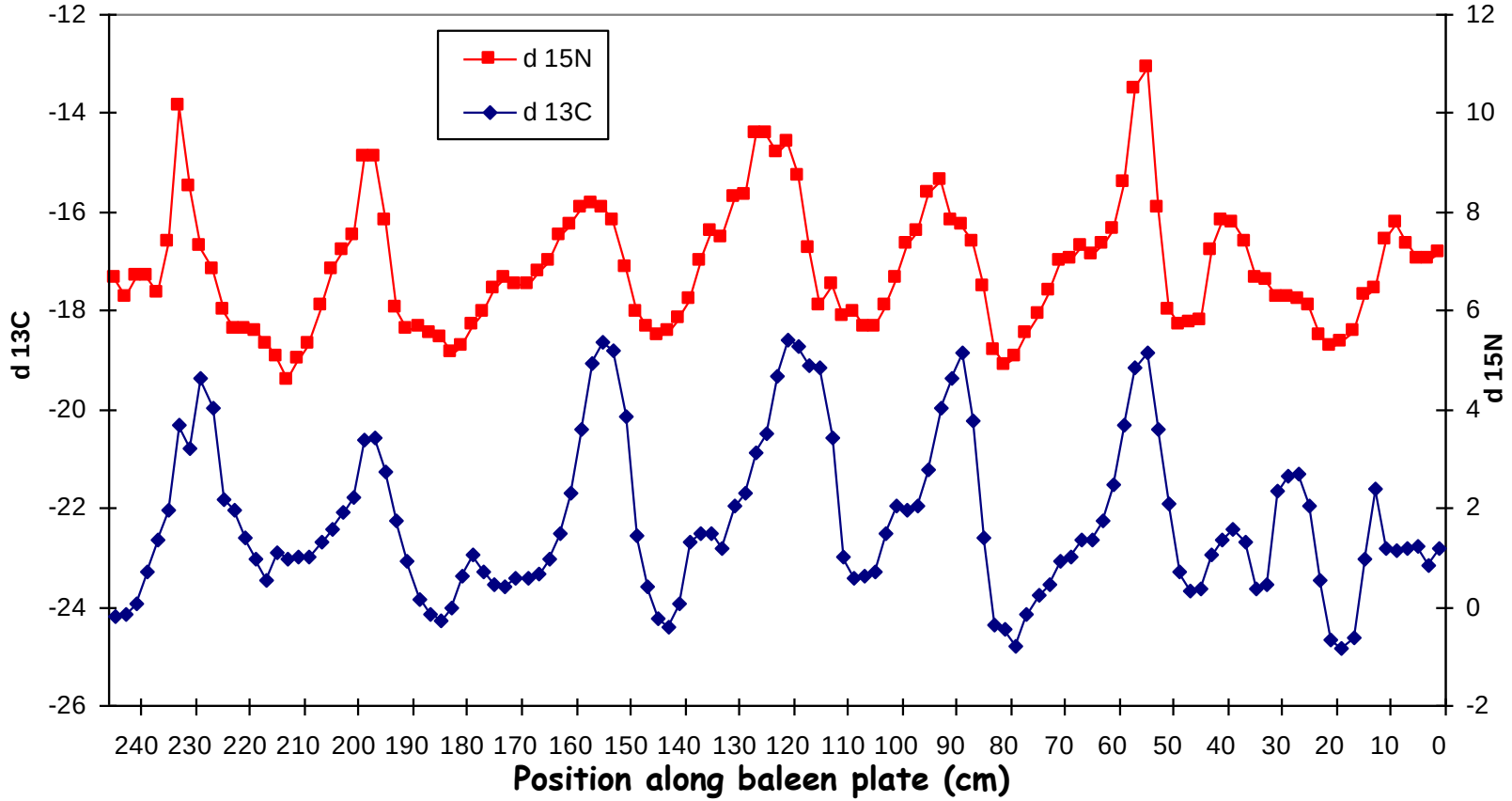
warmer water
(fewer krill)
fewer calves

Figure 1. Deviation from expected calf output against sea surface temperature (SST) anomalies at South Georgia in April of previous year for calving years 1983–2000.

Why did 482 whales die over the past 7 years?


-18 to -20 del 13C
-21 to -23 del 13C
-24 to -26 del 13C
-27 to -29 del 13C
-30 to -33 del 13C
above PF del 13C
-18 to -23ppm
Polar Front
Below PF
-24 to -33ppm
Image NASA
Image © 2008 TerraMetrics
Image USGS, NSF, NASA, and BAS
©2007 Google™
Pointer lat -50.827953° lon -46.311232°
Streaming 100%
Eye alt 2201.34 mi

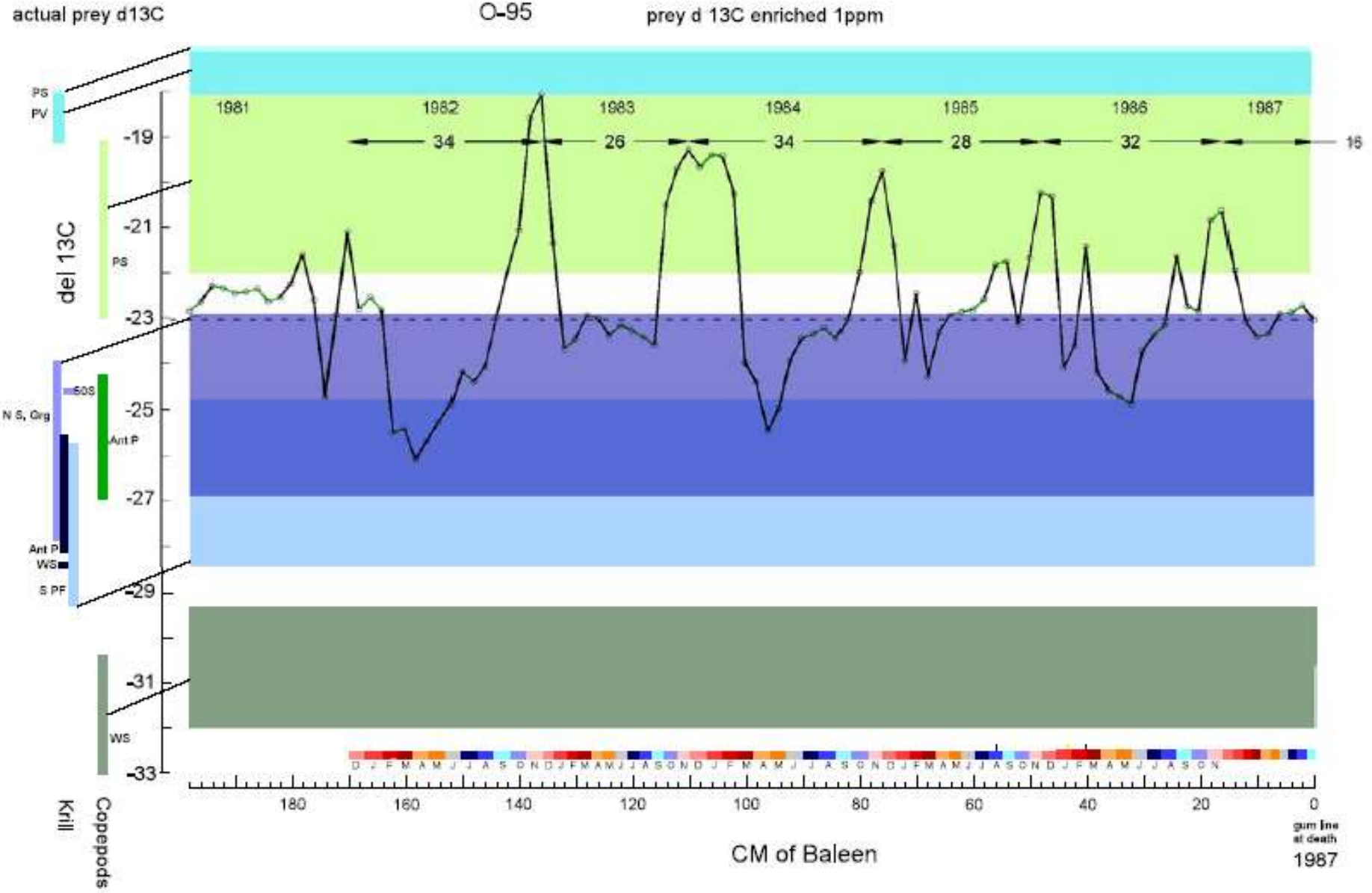
Right whales carry multi-year isotopic histories in their baleen



Tip of plate where baleen was wearing away, eight years after growth (yr 0)

time →

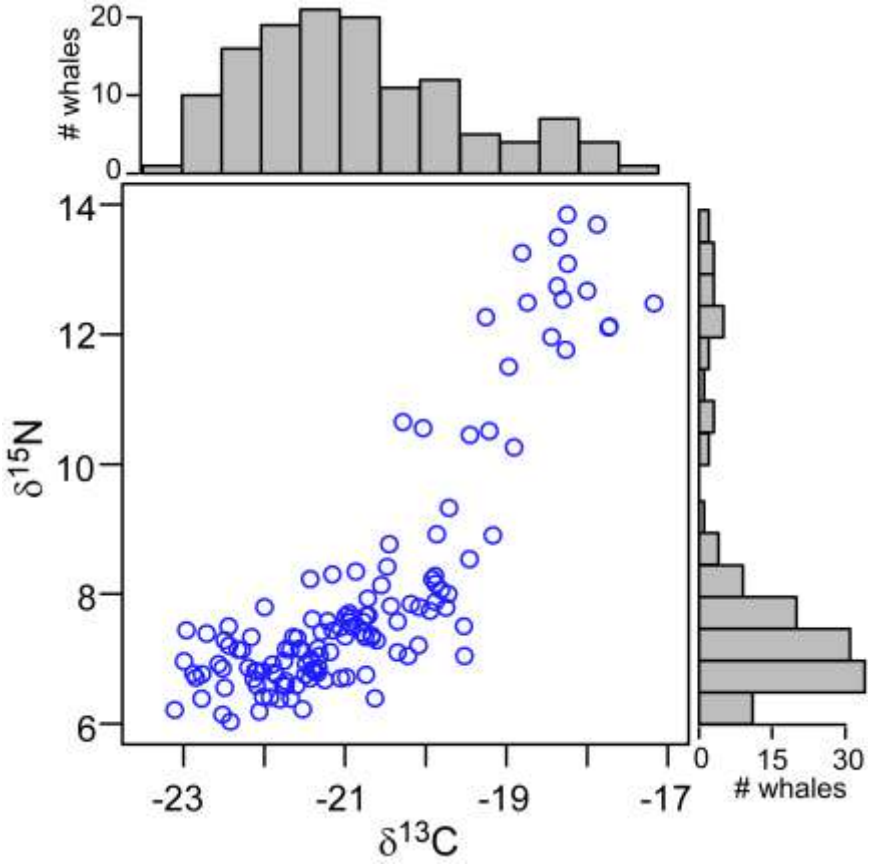
Base of plate (at gum line) = current growth when whale died at Península Valdés (yr 8)


actual prey d13C
O-95
prey d 13C enriched 1ppm
PS
PV
1981
1982
1983
1984
1985
1986
1987
34
26
34
28
32
16
-19
-21
-23
-25
-27
-29
-31
-33
del 13C
PS
60S
N S, Org
Ant P
Ant P
WS
S PF
WS
180
160
140
120
100
80
60
40
20
0
CM of Baleen
gum line at death
1987
Krill
Copepods

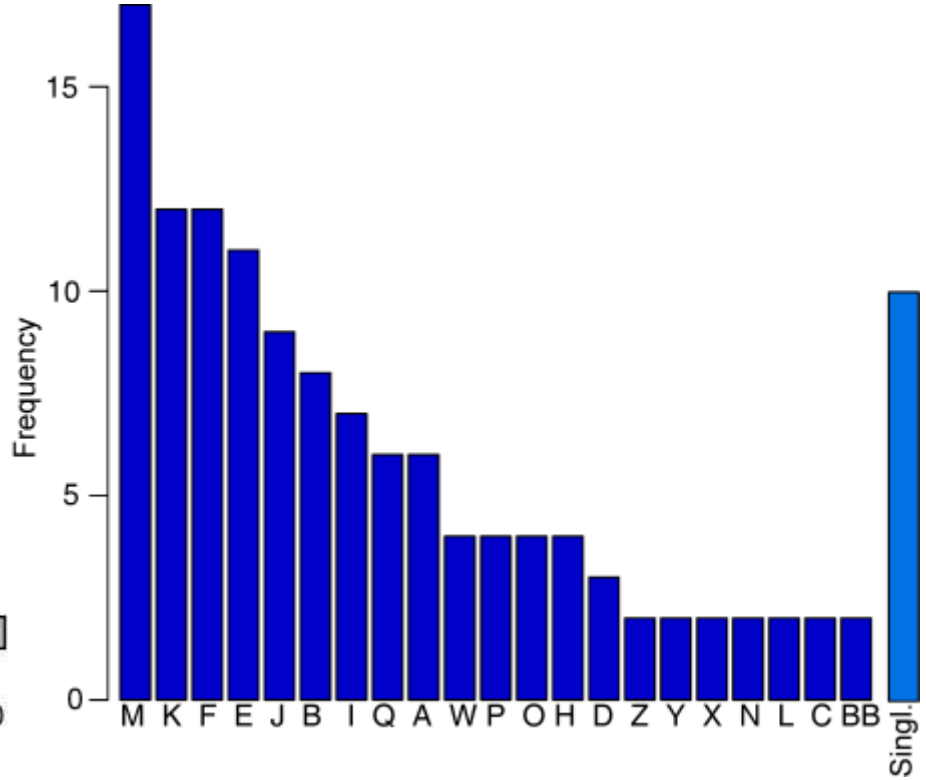
Luciano photo-identified and collected skin biopsies from 131 mothers from 2003 - 2006

1) Site fidelity to feeding grounds

Stable isotope values of 131 mothers



mtDNA analysis of the same 131 mothers

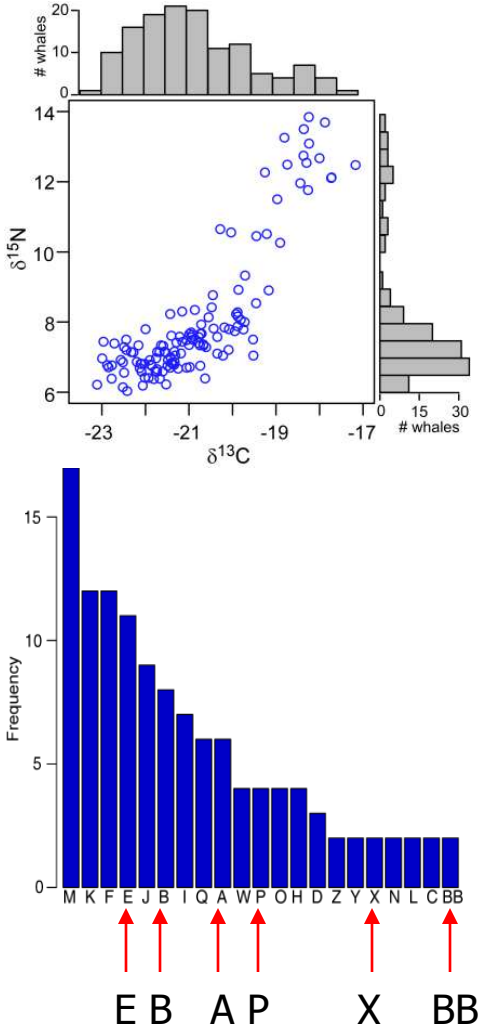


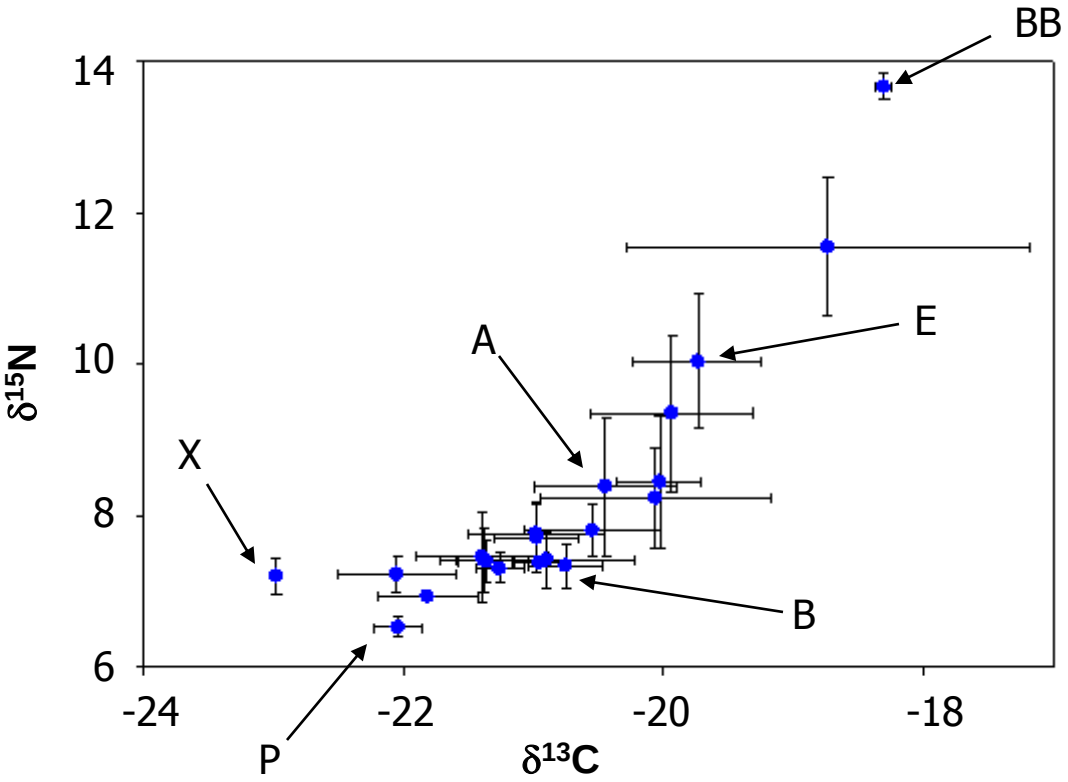
wide range of feeding locations

31 maternal lineages

1) ite fidelity to feeding grounds

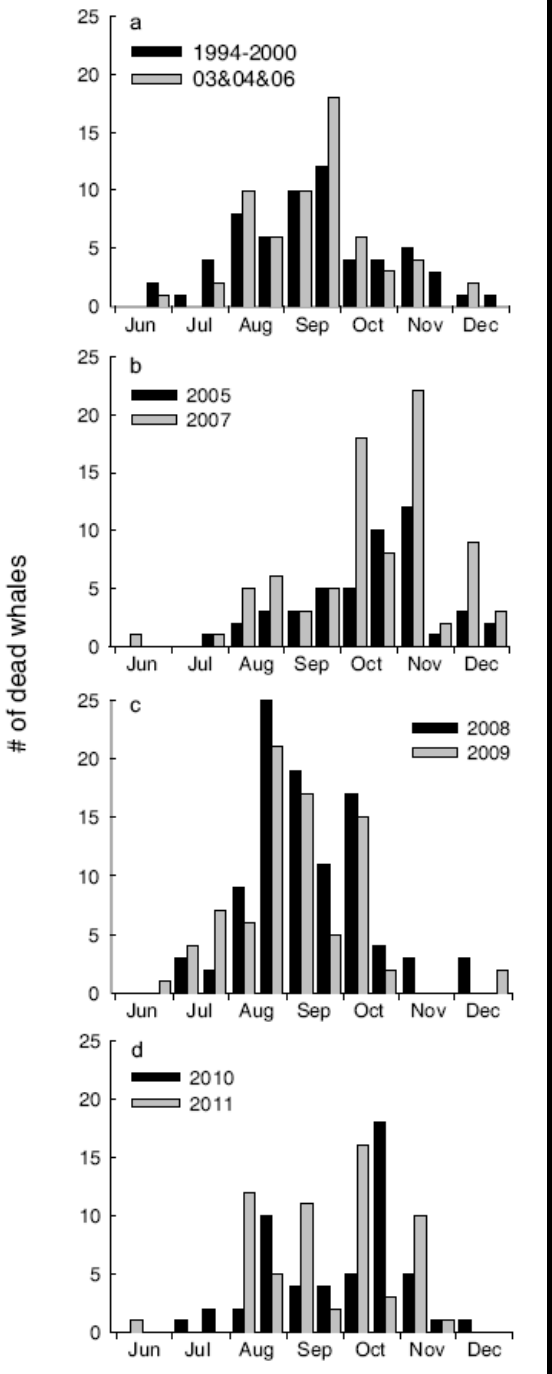
Isotopic values of individual haplotypes

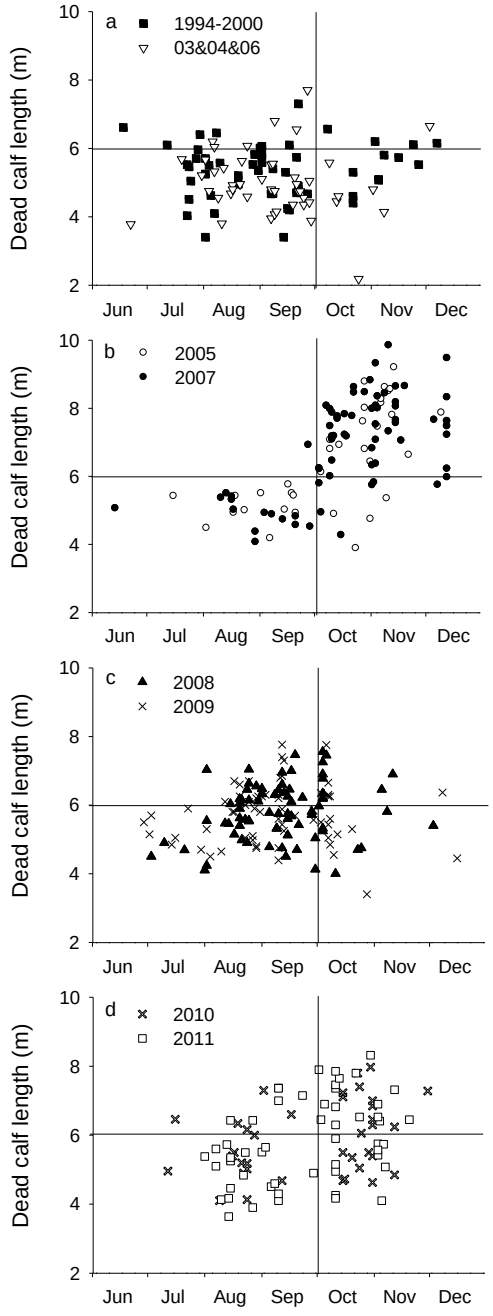


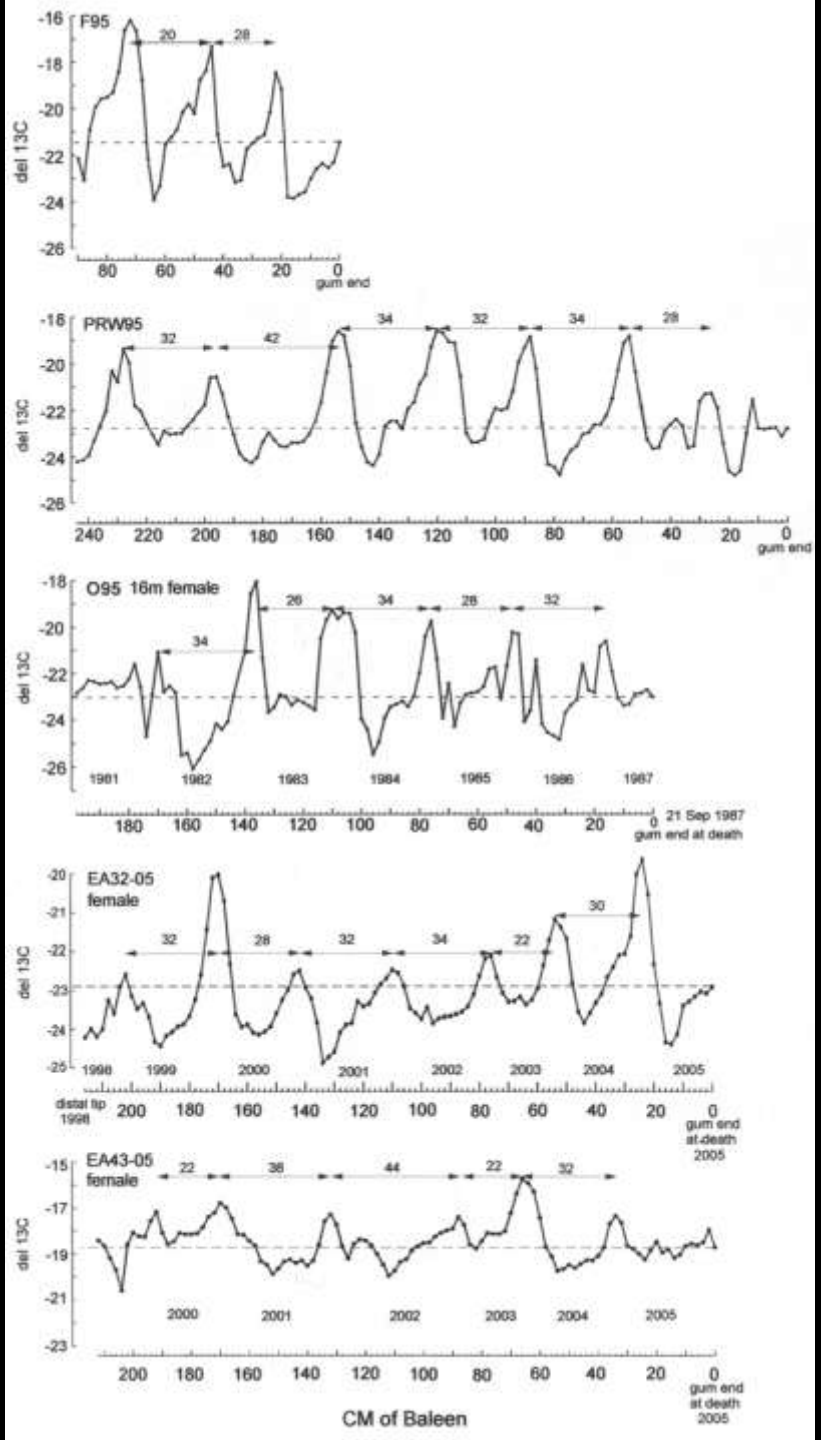


mtDNA is structured with respect to stable isotope values

Whales from the same matriline have improbably similar isotope ratios


a
1994-2000
03&04&06
b
2005
2007
c
2008
2009
d
2010
2011
# of dead whales
0
5
10
15
20
25
Jun
Jul
Aug
Sep
Oct
Nov
Dec


a
1994-2000
03&04&06
b
2005
2007
c
2008
2009
d
2010
2011
Dead calf length (m)
10
8
6
4
2
Jun
Jul
Aug
Sep
Oct
Nov
Dec


F95
20
28
del 13C
-16
-18
-20
-22
-24
-26
80 60 40 20 0
gum end
PRW95
32
42
34
32
34
28
240 220 200 180 160 140 120 100 80 60 40 20 0
gum end
O95 16m female
34
26
34
28
32
1981 1982 1983 1984 1985 1986 1987
180 160 140 120 100 80 60 40 20 0
21 Sep 1987
gum end at death
EA32-05
female
32
28
32
34
22
30
1998 1999 2000 2001 2002 2003 2004 2005
distal tip
1998
200 180 160 140 120 100 80 60 40 20 0
gum end
at death
2005
EA43-05
female
22
38
44
22
32
2000 2001 2002 2003 2004 2005
200 180 160 140 120 100 80 60 40 20 0
gum end
at death
2005
CM of Baleen