Maternal size and body condition determine calf growth rates in Southern right whales:

repeated individual sampling using unmanned aerial vehicles

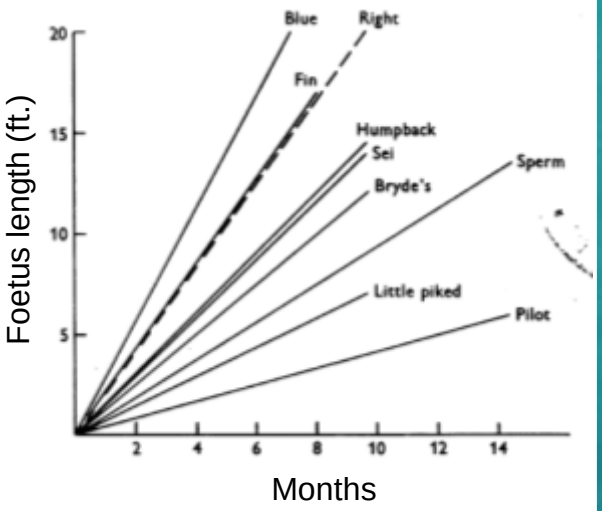
Fredrik Christiansen

Fabien Vivier, Claire Charlton, Rhianne Ward, Stephen Burnell, Alicia Amerson & Lars Bejder

Email: f.christiansen@murdoch.edu.au

Reproduction in baleen whales

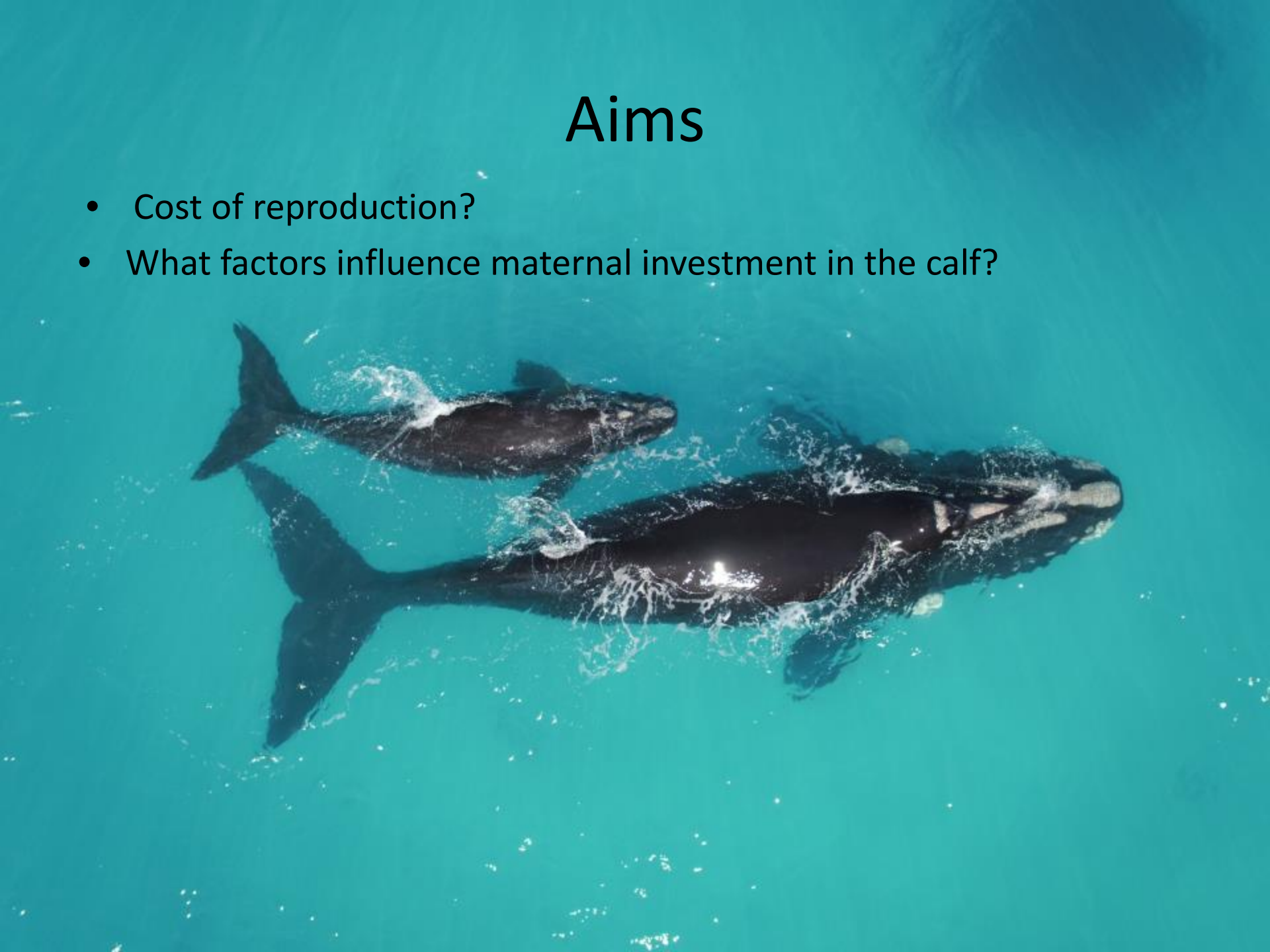
- Capital breeder
- Reproductive cycle tied to migratory cycle
- High offspring growth rates
- Energetically demanding (early lactation)
  - Sufficient energy stores critical
- Body condition important
  - Pregnancy rate (Williams et al. 2013)
  - Foetus growth (Christiansen et al. 2014)
  - Calf condition (Christiansen et al. 2016)



Frazer and Huggett 1959

Aims

- Cost of reproduction?
- What factors influence maternal investment in the calf?



UAV Aerial Photogrammetry

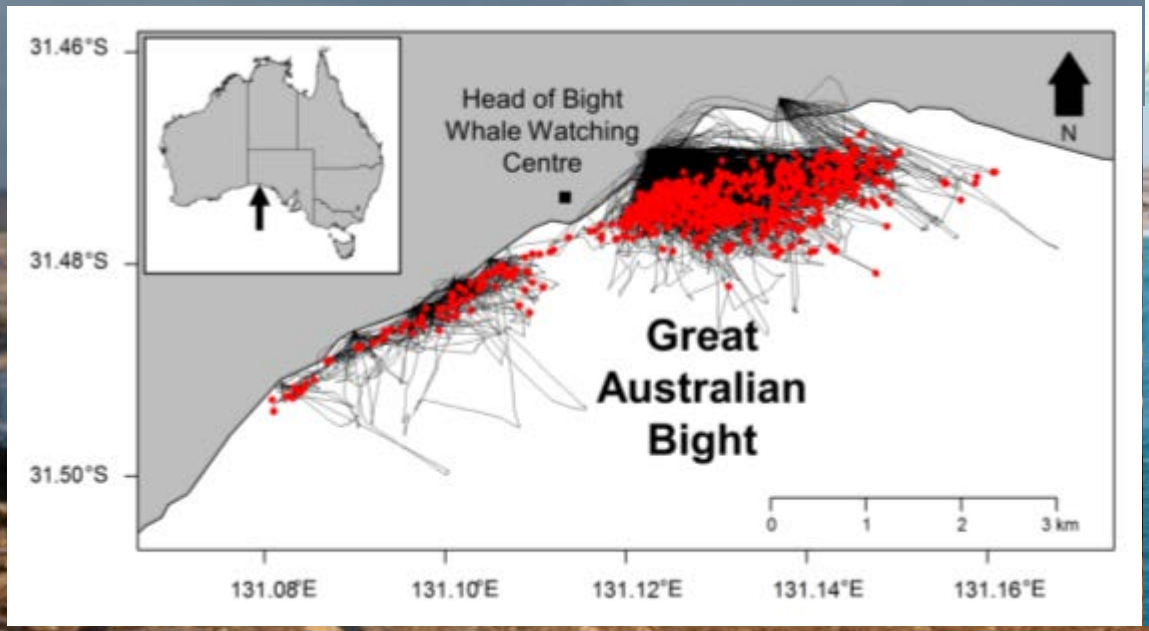
- Aerial photogrammetry (Miller et al. 2012, *MEPS* 459:135-156)
- UAV photogrammetry (Christiansen et al. 2016a, *Ecosphere* 7:e01468)
- Non-invasive (Christiansen et al. 2016b, *Front. Mar. Sci.* 3:277)
- Cost effective
- Safe
- Remote locations

Repeated individual sampling of mother /calf pairs throughout breeding season

Study species and area

Study species and area

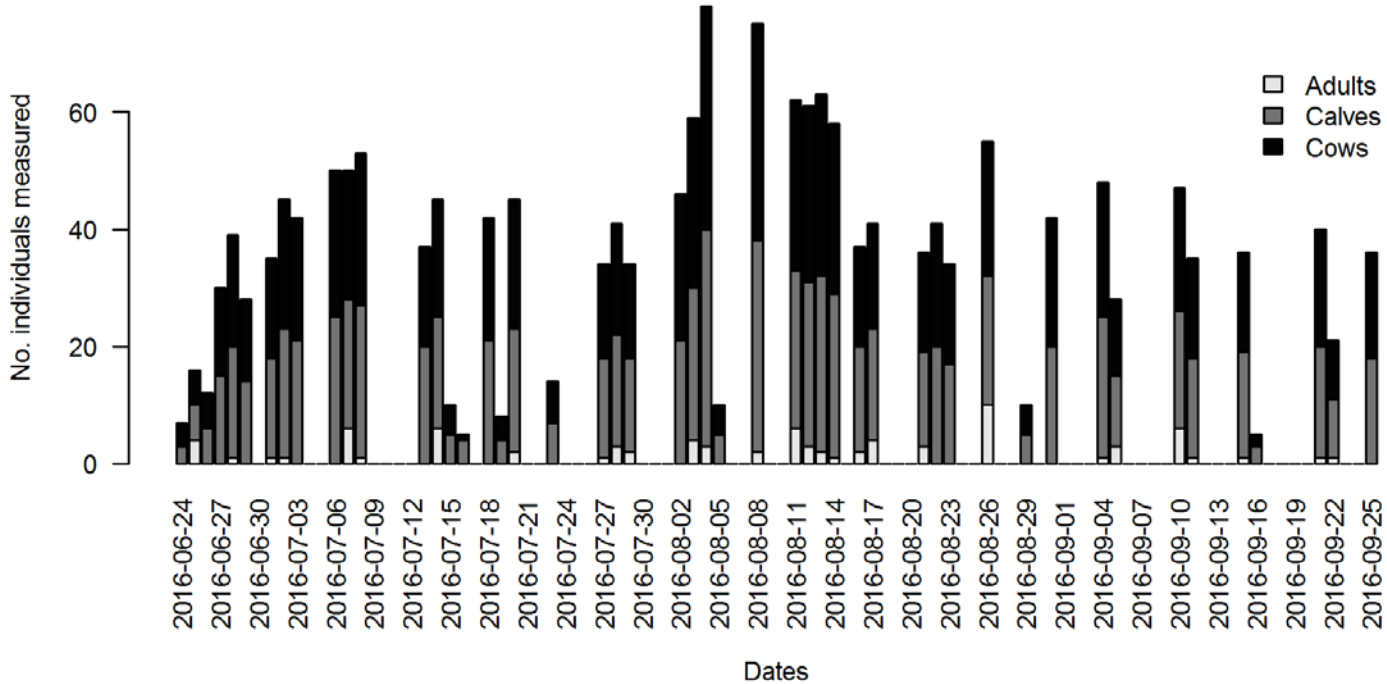
- Southern right whale (*Eubalaena australis*)
- Head of Bight breeding ground
- Population size: ~2500 (Australia)
- Fieldwork: June 24 – September 25 2016

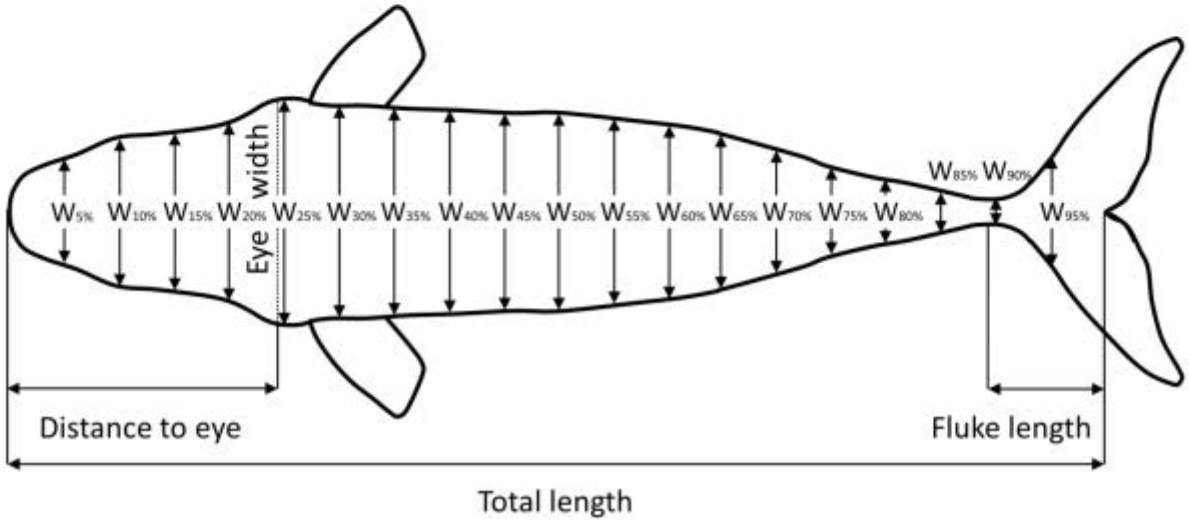


Results – Sample size

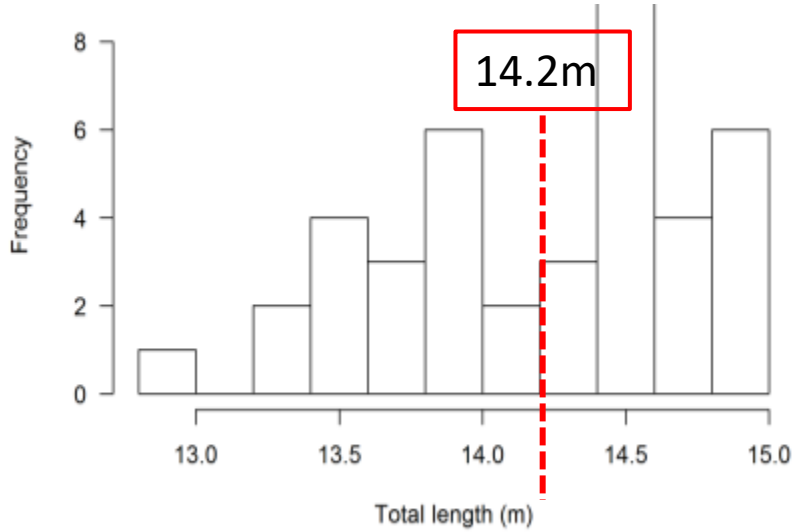
- 878 flights
- 2,897 measurements
- 238 whales measured
  - 89 lactating cows
  - 89 calves
  - 60 unaccompanied adults

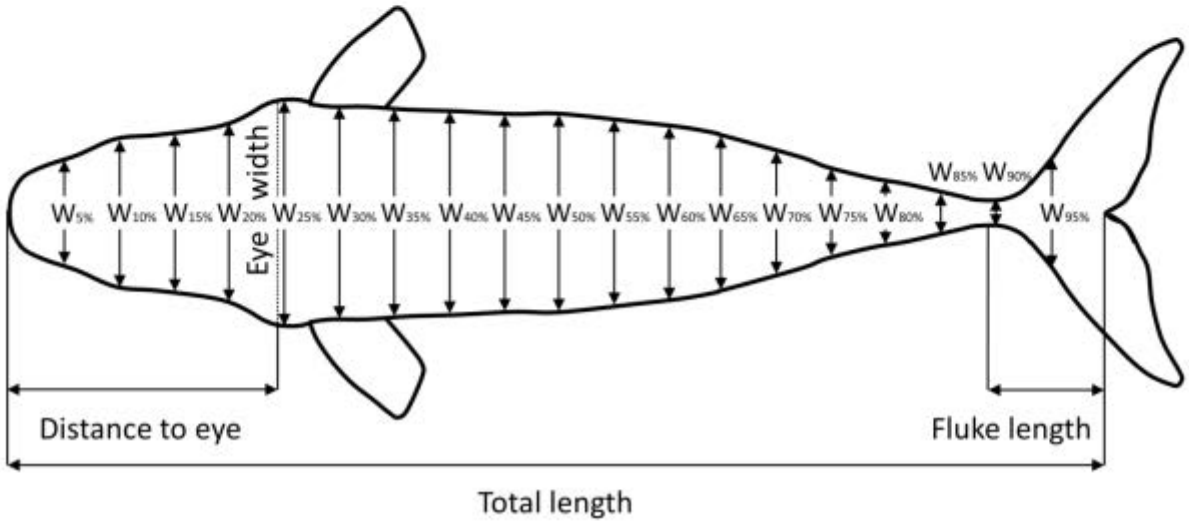
  } average 10 times (SD=5.7)



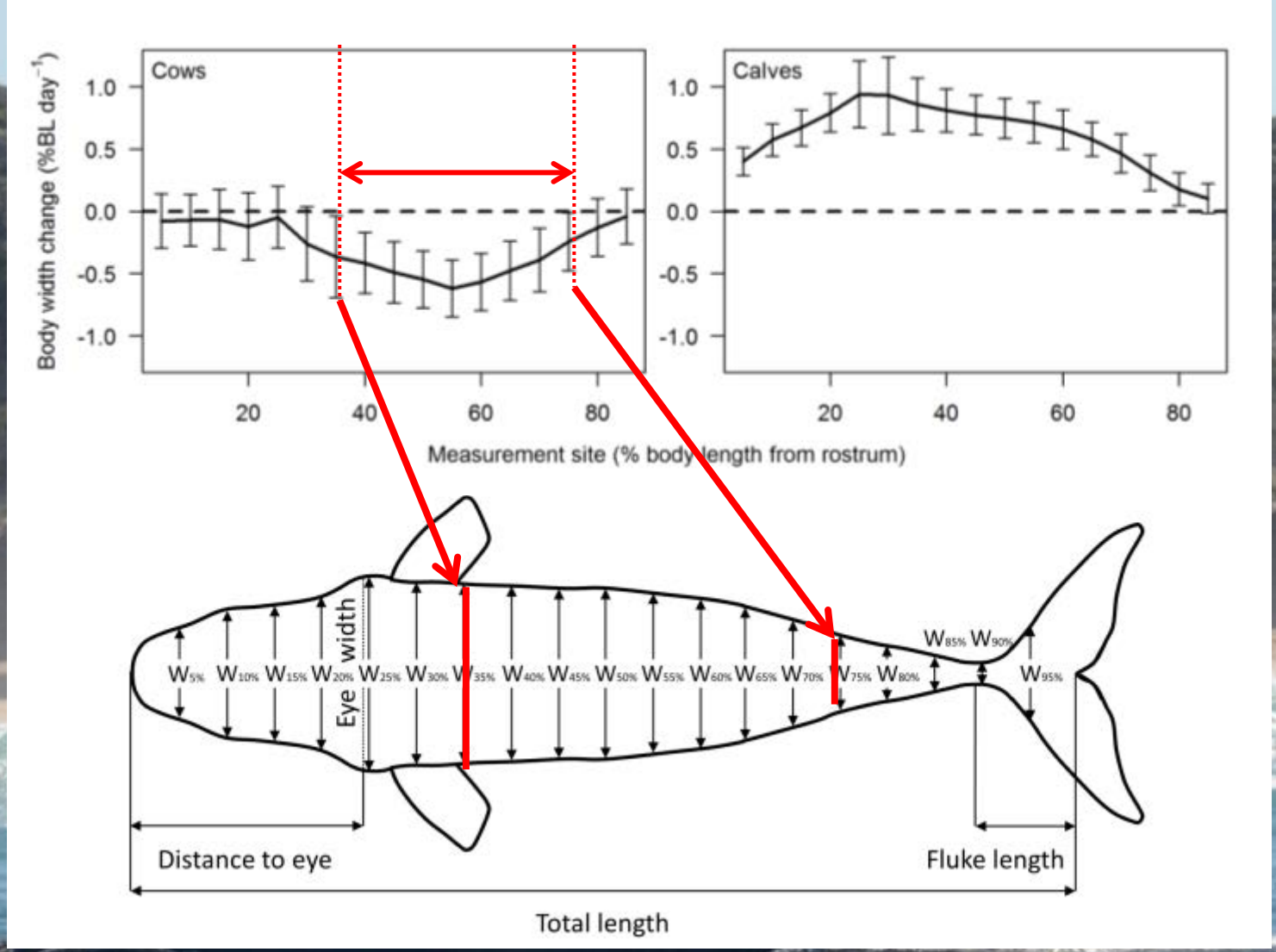

W5%
W10%
W15%
W20%
Eye width
W25%
W30%
W35%
W40%
W45%
W50%
W55%
W60%
W65%
W70%
W75%
W80%
W85%
W90%
W95%
Distance to eye
Fluke length
Total length

Body length

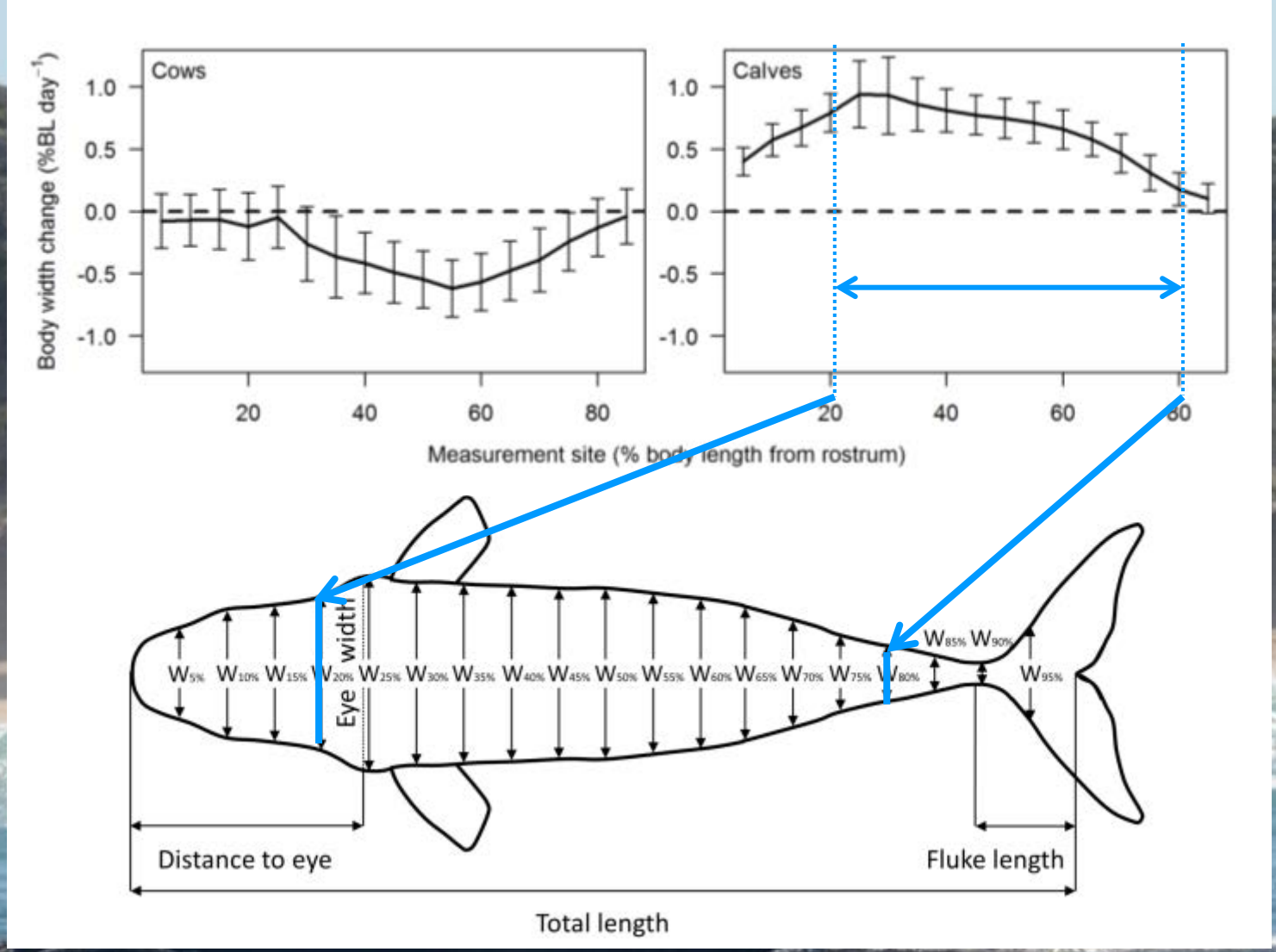

14.2m
Frequency
0
2
4
6
8
13.0
13.5
14.0
14.5
15.0
Total length (m)


Eye width
W5% W10% W15% W20% W25% W30% W35% W40% W45% W50% W55% W60% W65% W70% W75% W80%
W85% W90%
W95%
Distance to eye
Fluke length
Total length

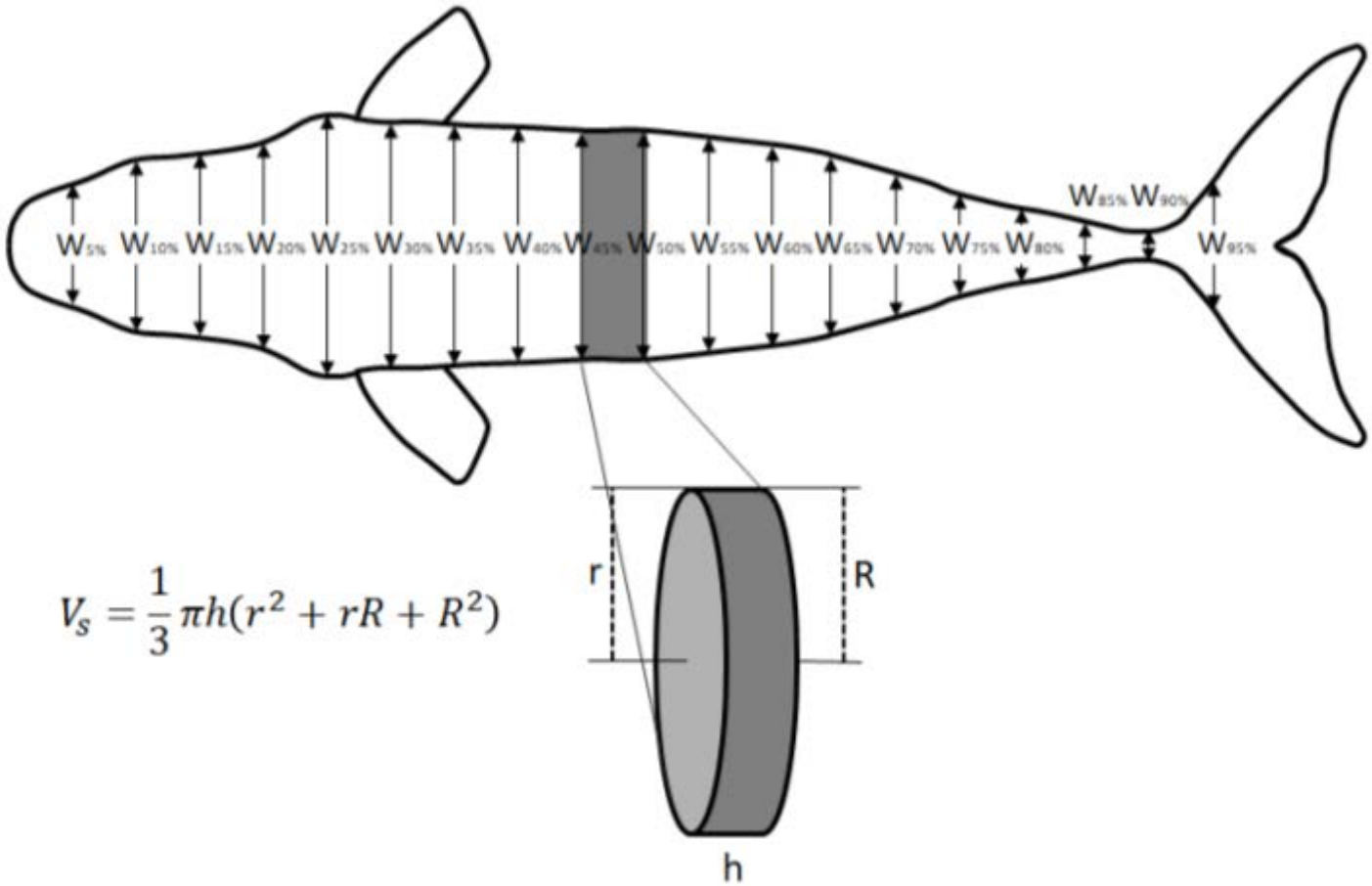
Body width


Cows
Calves
Body width change (%BL day⁻¹)
1.0
0.5
0.0
-0.5
-1.0
20
40
60
80
Measurement site (% body length from rostrum)
Eye width
W5% W10% W15% W20% W25% W30% W35% W40% W45% W50% W55% W60% W65% W70% W75% W80%
W85% W90%
W95%
Distance to eye
Fluke length
Total length

Body width

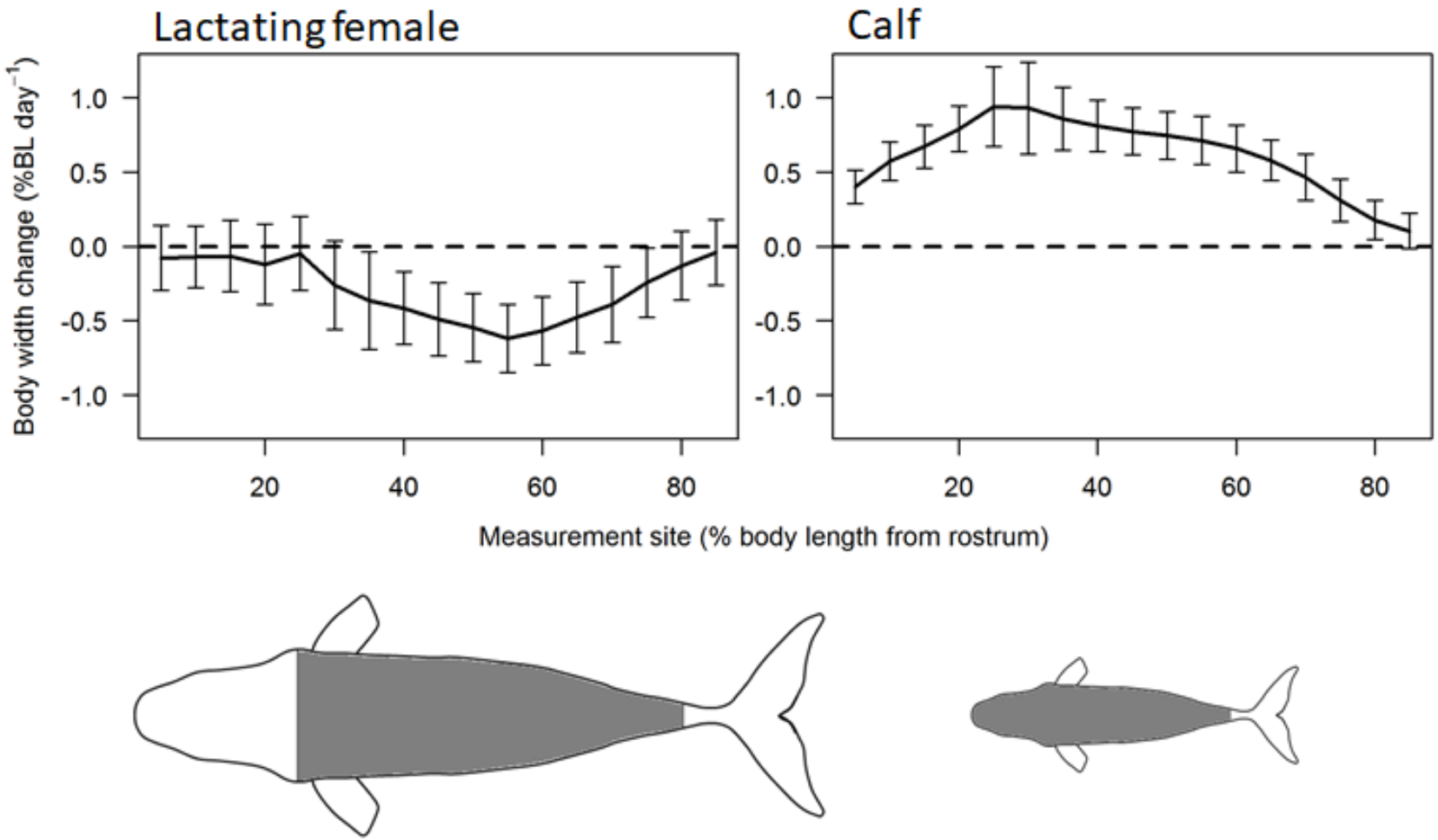

Cows
Calves
Body width change (%BL day^{-1})
1.0
0.5
0.0
-0.5
-1.0
20
40
60
80
Measurement site (% body length from rostrum)
Eye width
$W_{5\%}$ $W_{10\%}$ $W_{15\%}$ $W_{20\%}$ $W_{25\%}$ $W_{30\%}$ $W_{35\%}$ $W_{40\%}$ $W_{45\%}$ $W_{50\%}$ $W_{55\%}$ $W_{60\%}$ $W_{65\%}$ $W_{70\%}$ $W_{75\%}$ $W_{80\%}$ $W_{85\%}$ $W_{90\%}$ $W_{95\%}$
Distance to eye
Fluke length
Total length

Body volume

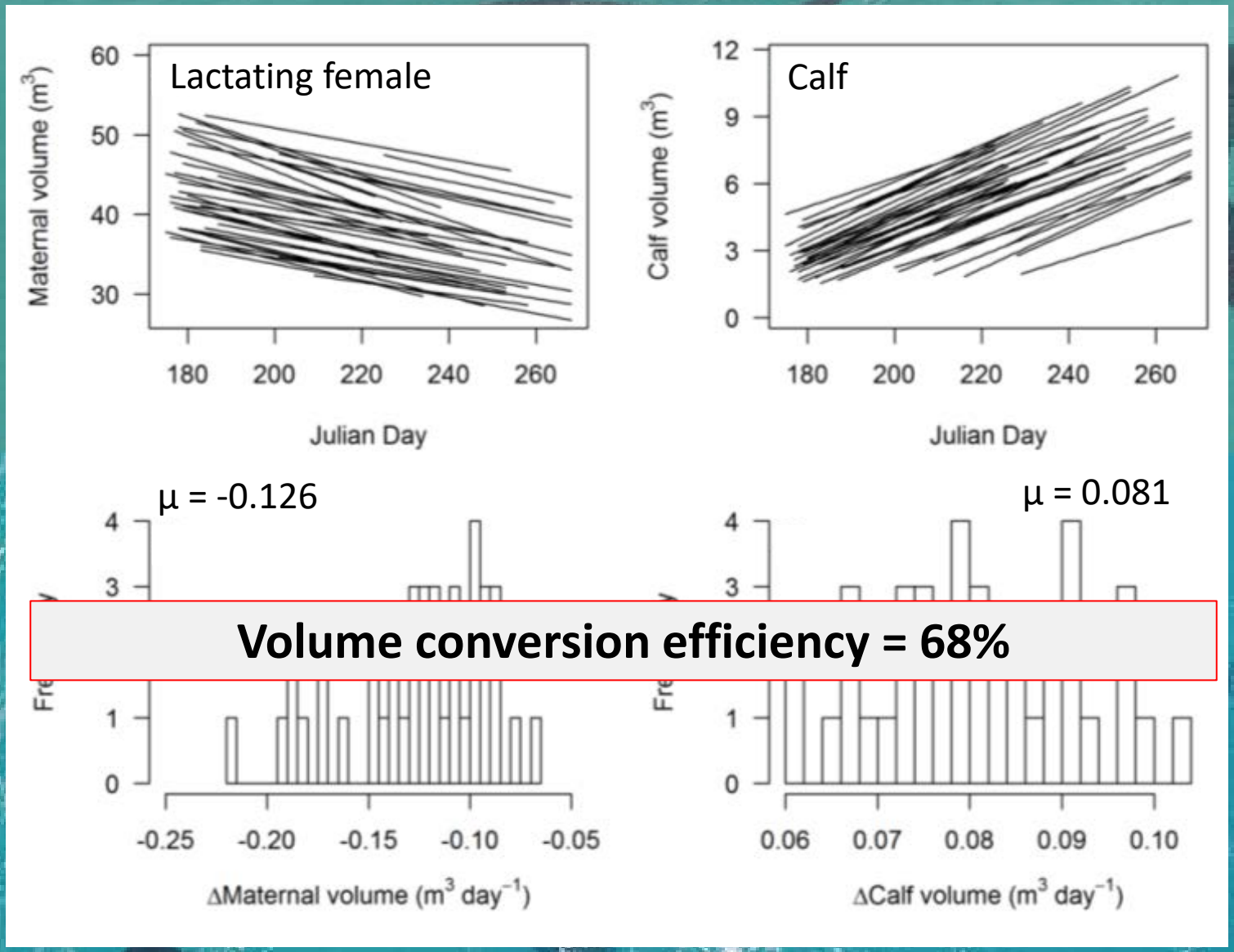


$$V_s = \frac{1}{3}\pi h(r^2 + rR + R^2)$$

Body volume

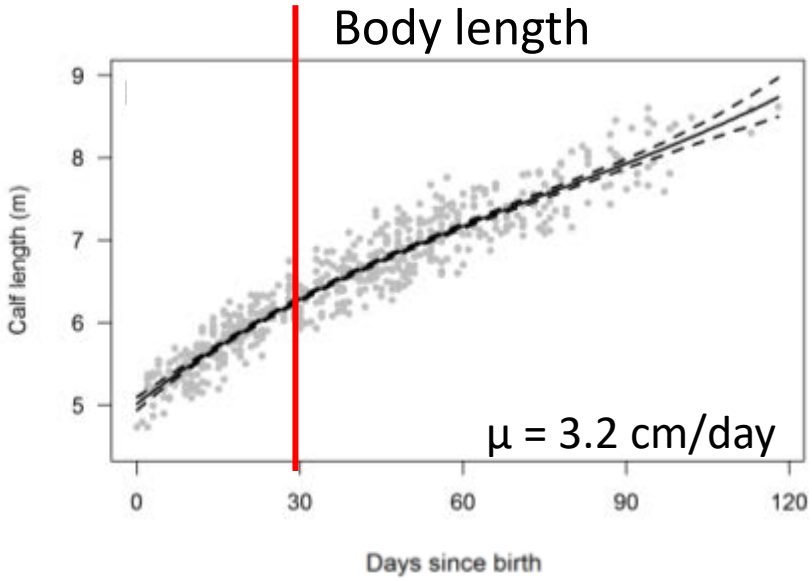

Lactating female
Calf
Body width change (%BL day^{-1})
1.0
0.5
0.0
-0.5
-1.0
20
40
60
80
Measurement site (% body length from rostrum)

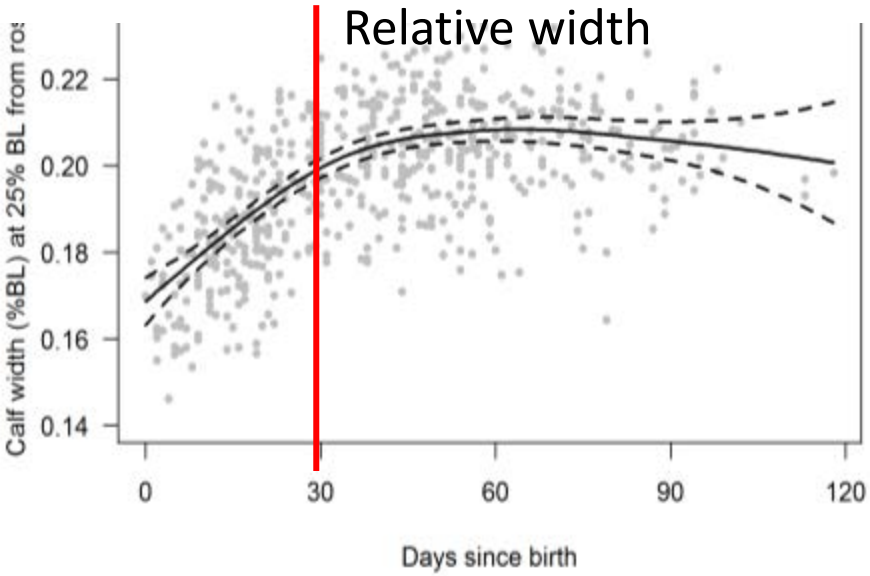
Calf growth vs. maternal condition



Volume conversion efficiency = 68%

Calf growth


Body length
Calf length (m)
9
8
7
6
5
0
30
60
90
120
Days since birth
μ = 3.2 cm/day


Relative width
Calf width (%BL) at 25% BL from ro
0.22
0.20
0.18
0.16
0.14
0
30
60
90
120
Days since birth

Calf growth vs. maternal condition

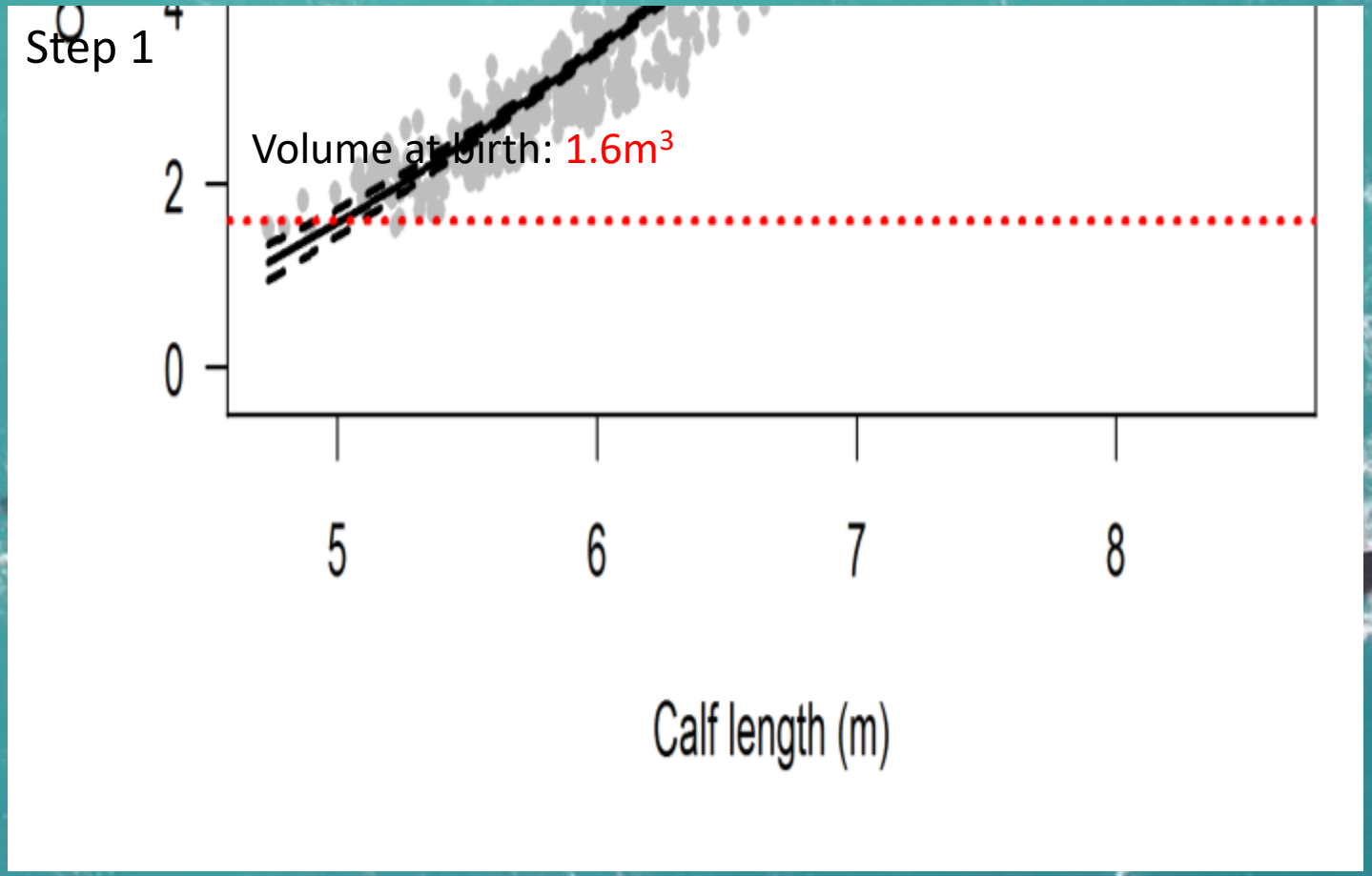
What factors determine maternal investment in calf?

- Maternal body length
- Maternal body condition

Maternal volume at time of birth?

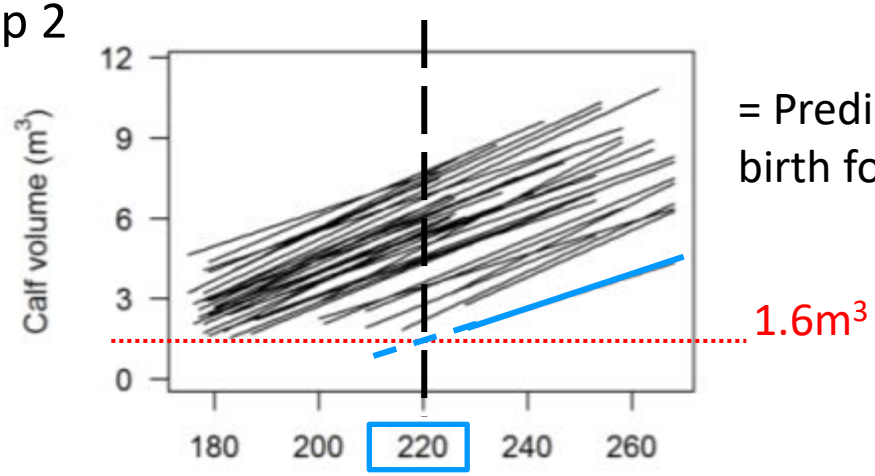
= Date of calf birth?

Body volume at day of birth



Body volume at day of birth

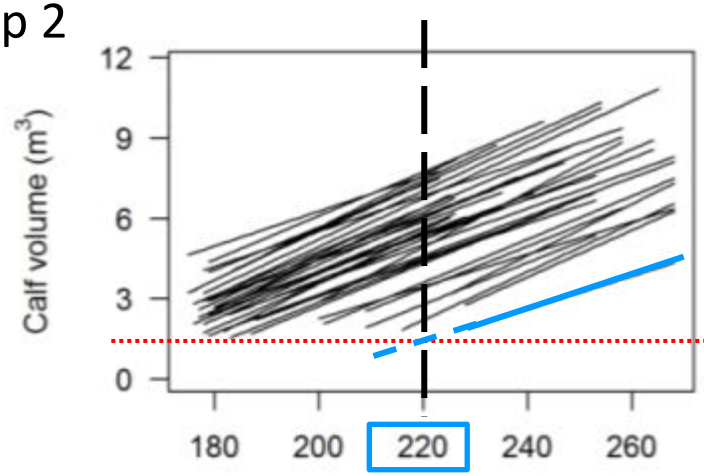
Step 2



= Predicted date of birth for each calf

Body volume at day of birth

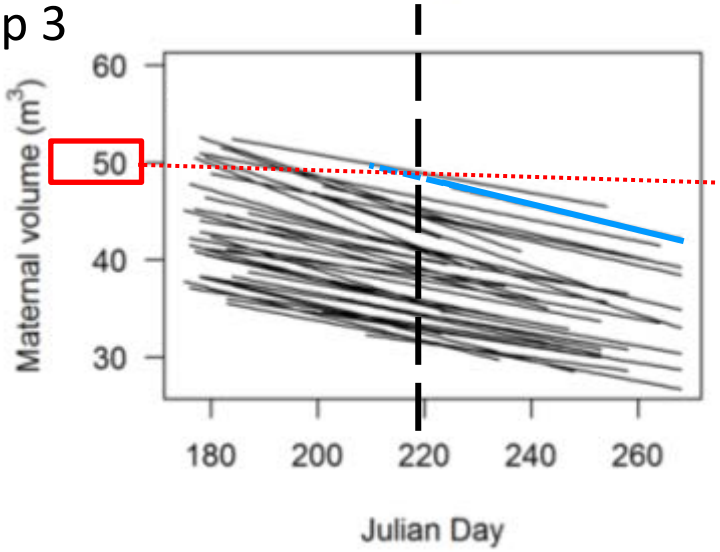
Step 2



= Predicted date of birth for each calf

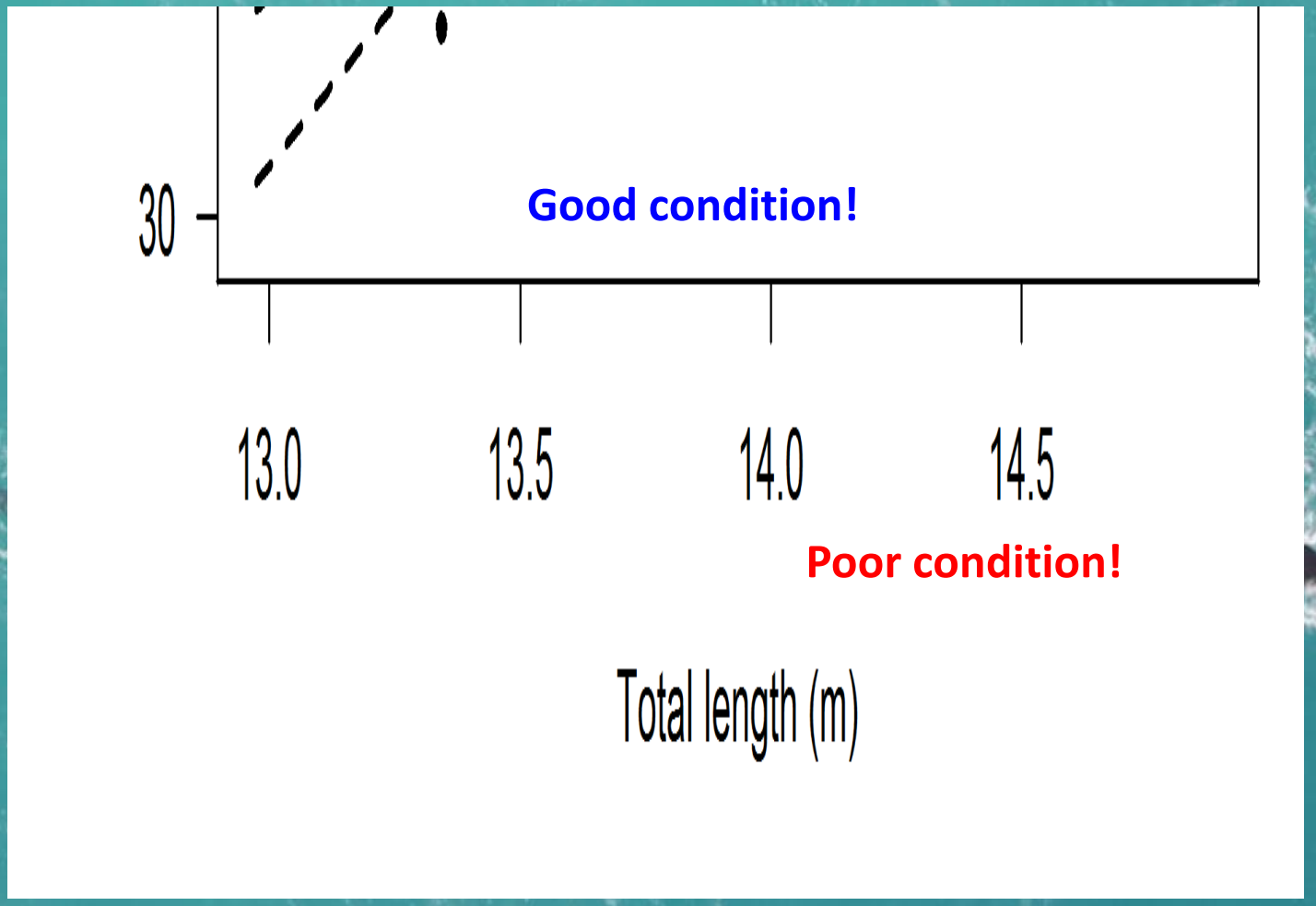
1.6m^3

Step 3



= Predicted maternal volume at date of birth

Body condition at time of birth



Gray whales in Laguna San Ignacio, Mexico

15 Jan – 15 April 2018:
- 452 flights
- 675 measurements
- 63 mother / calf pairs
- 254 single animals

16 Jan – 15 April 2019:
So far (16jan-02mar):
- 393 flights
- 285 measurements
- 24 mother / calf pairs
- 132 single animals

Thank you for listening!

Thanks to:

Aboriginal Lands Trust
Yalata Land Management
Far West Coast Aboriginal Cooperation
U.S. Office of Naval Research
World Wide Fund for Nature, Australia.
Global Unmanned Systems
Interspatial Aviation Services Pty Ltd.

Find out more:
Web: www.mucru.org
Twitter: @FChristiansen83
Email: f.christiansen@murdoch.edu.au

Gracias por su atención

Find out more visit:
www.sanignaciograywhales.org

Murdoch University

CETACEAN RESEARCH UNIT

UABCS

PRIMMA UABCS 1988

The Ocean Foundation

Ecoturismo Kuyima

Laguna San Ignacio ecosystem science program
a project of The Ocean Foundation in Baja, Mexico