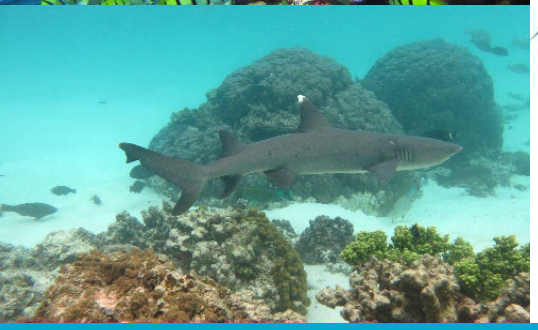


ningaloo outlook

BHP

CSIRO

Environmental effects on energetics of Ningaloo green turtles

Jessica Stubbs, Nicki Mitchell, Mat Vanderklift, Sabrina Fossette-Halot, Richard Pillans, Nina Marn, and Starrlight Augustine

Ningaloo Outlook – A partnership between BHP and CSIRO

WESTERN COASTAL/OCEAN & ATMOSPHERE
www.csiro.au

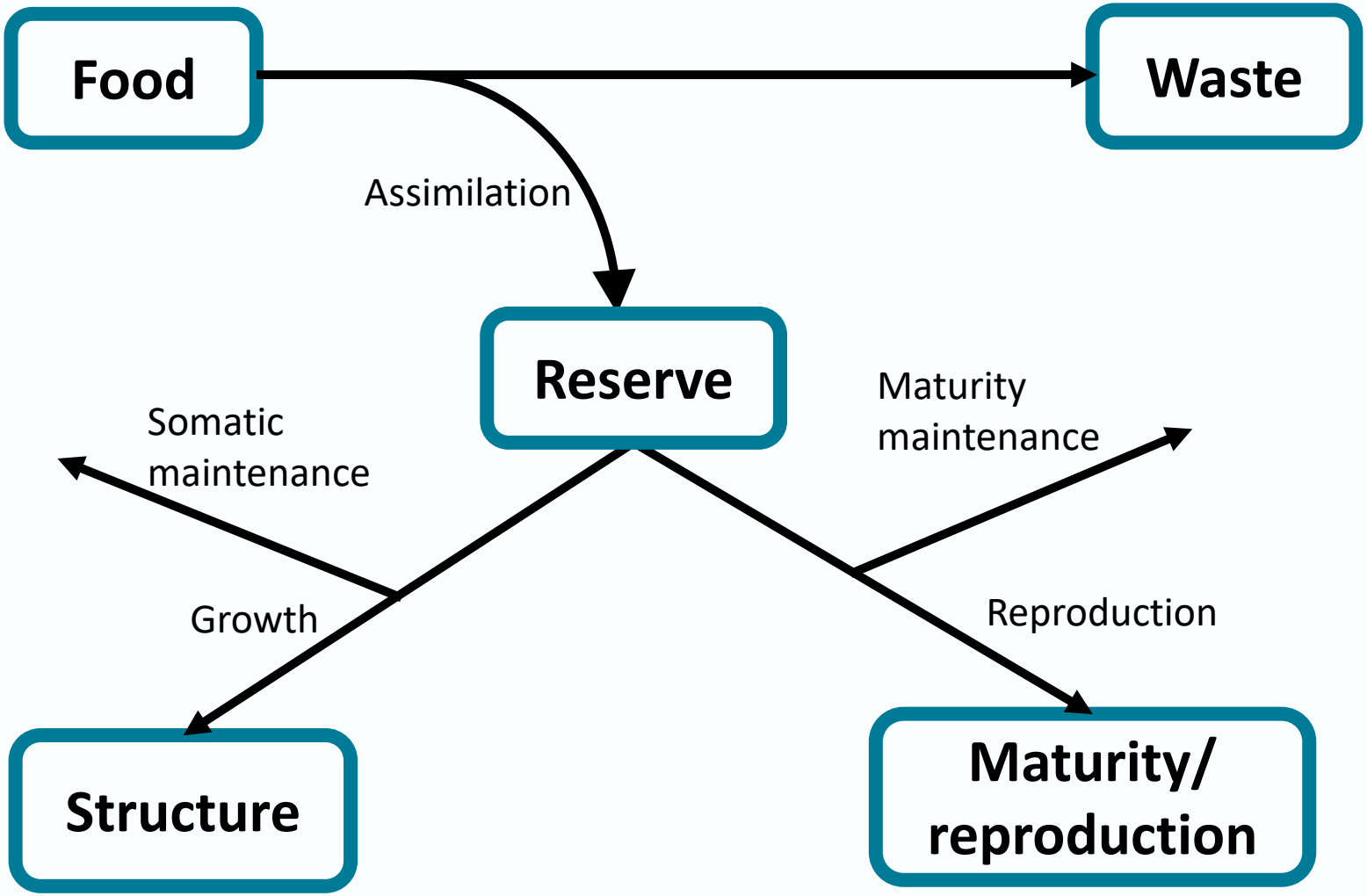
CSIRO

Ningaloo Outlook is a BHP-CSIRO Industry-Science Marine Research Partnership investing A$5.4 million over five years to gather new knowledge on the Ningaloo reef and its important ecological values

Green turtles at Ningaloo

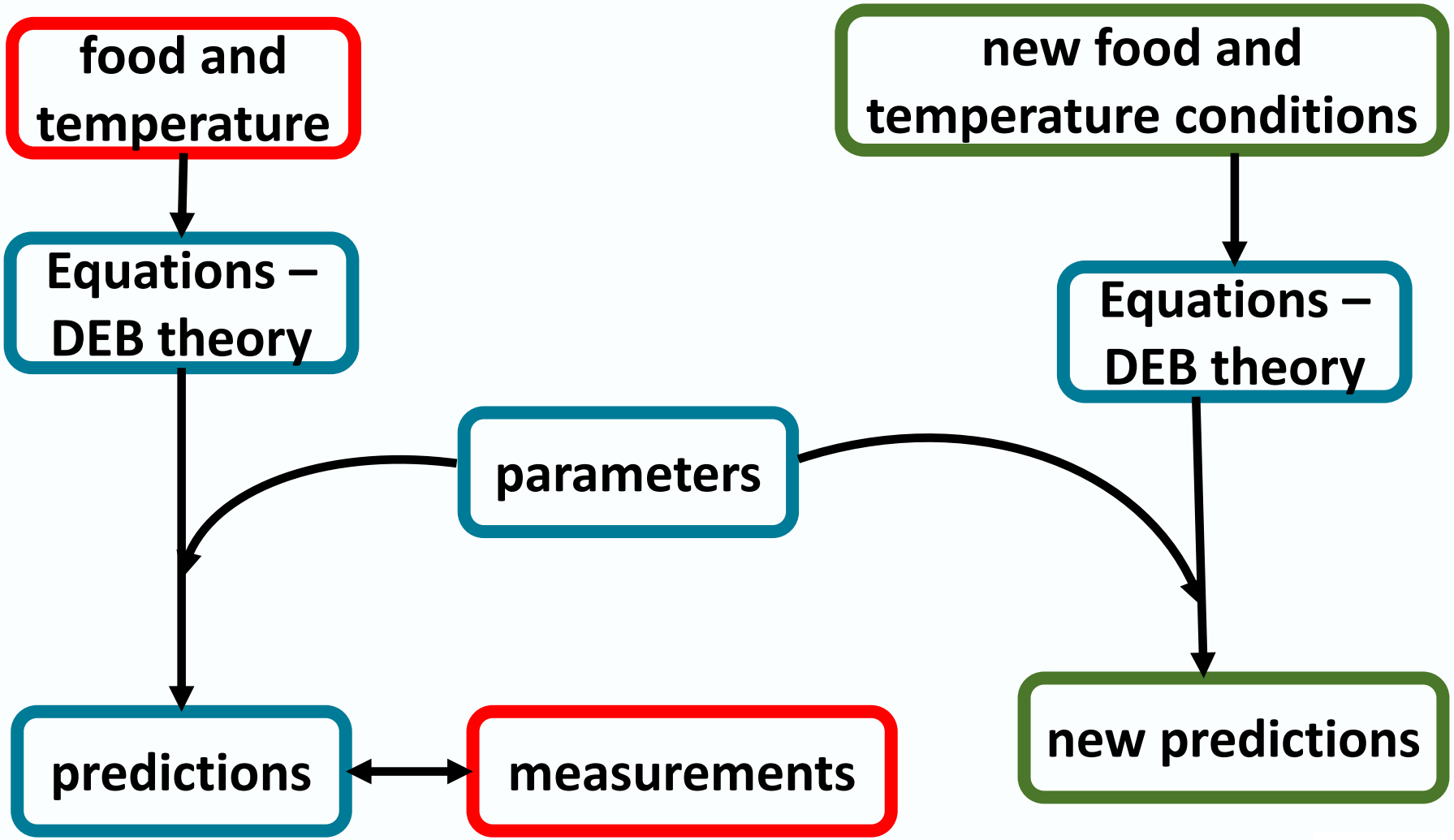
- **Slow growing** and **long lived**
- **Models** allow us to look at **whole life cycle**
- **Dynamic Energy Budget** model
  - Model **energetics** of Ningaloo population
  - Response to **changing conditions**

Dynamic Energy Budget (DEB)



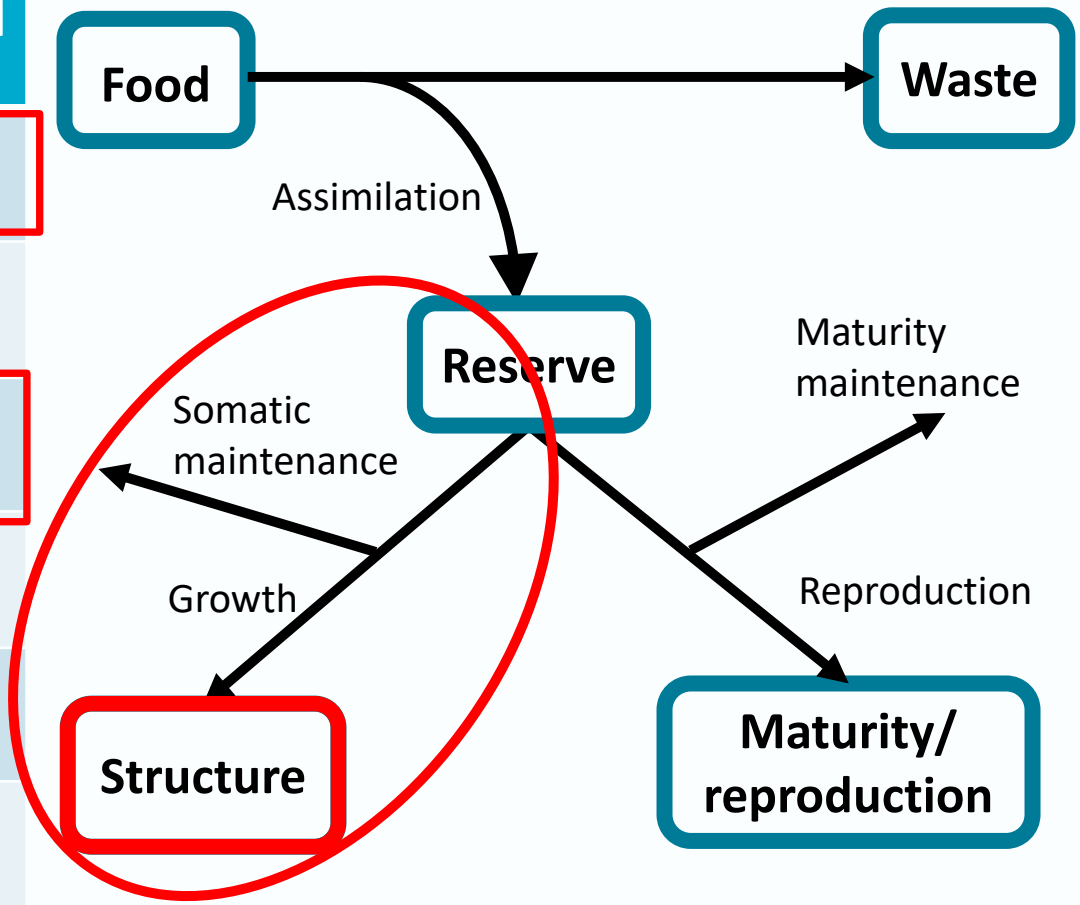
modified from Kooijman 2010

DEB – building and using a model



Parameters

Parameter	Symbol
Allocation fraction to soma	κ
Volume specific somatic maintenance (J d^{-1} cm^{-3})	$[\dot{p}_M]$
Specific cost for structure (J cm^{-3})	$[E_G]$
Maximum specific assimilation rate (J d^{-1} cm^{-2})	$\{\dot{p}_{Am}\}$
Maturity at hatching (J)	E^h_H
Maturity at puberty (J)	E^p_H

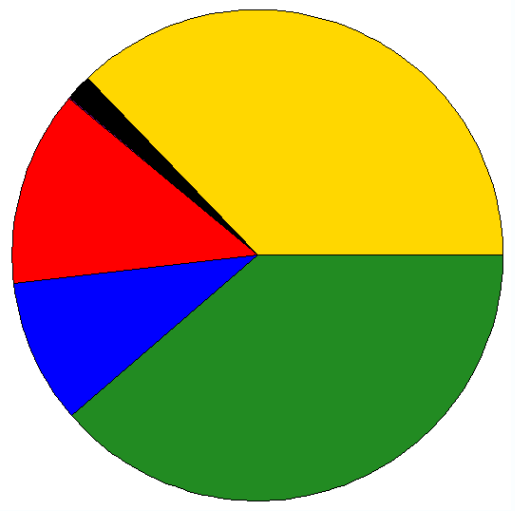


modified from Kooijman 2010

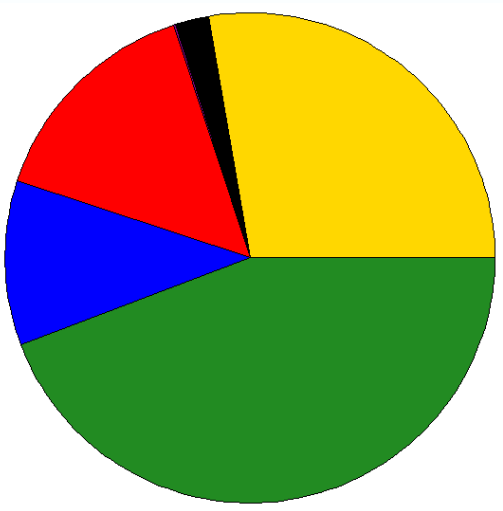
Parameters – green turtle

Parameter	Symbol	Value
Allocation fraction to soma	κ	0.7931
Volume specific somatic maintenance (J d^{-1} cm^{-3})	$[\dot{p}_M]$	11.05
Specific cost for structure (J cm^{-3})	$[E_G]$	7815
Maximum specific assimilation rate (J d^{-1} cm^{-2})	$\{\dot{p}_{Am}\}$	720.4
Maturity at hatching (J)	E^h_H	2.71×10^4
Maturity at puberty (J)	E^p_H	4.90×10^8

Maternal effect



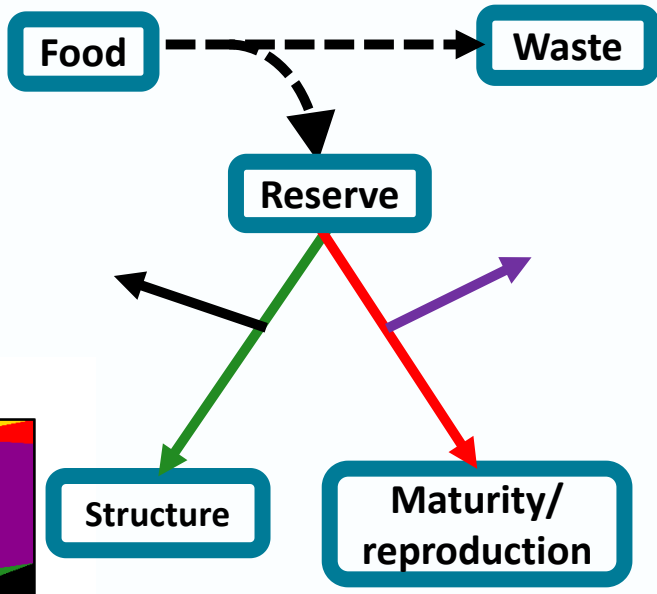
Abundant food

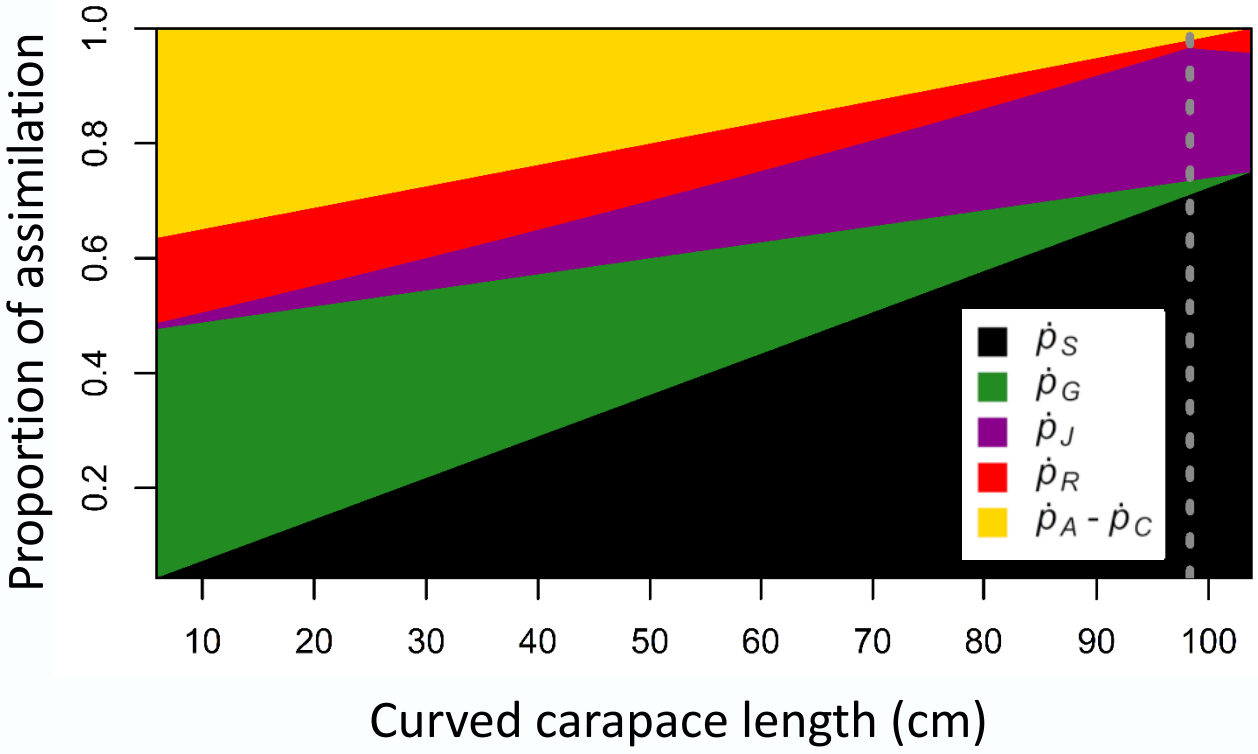


Food limited

- Reserve
- Somatic maintenance
- Maturity maintenance
- Maturity
- Growth overhead
- Structure

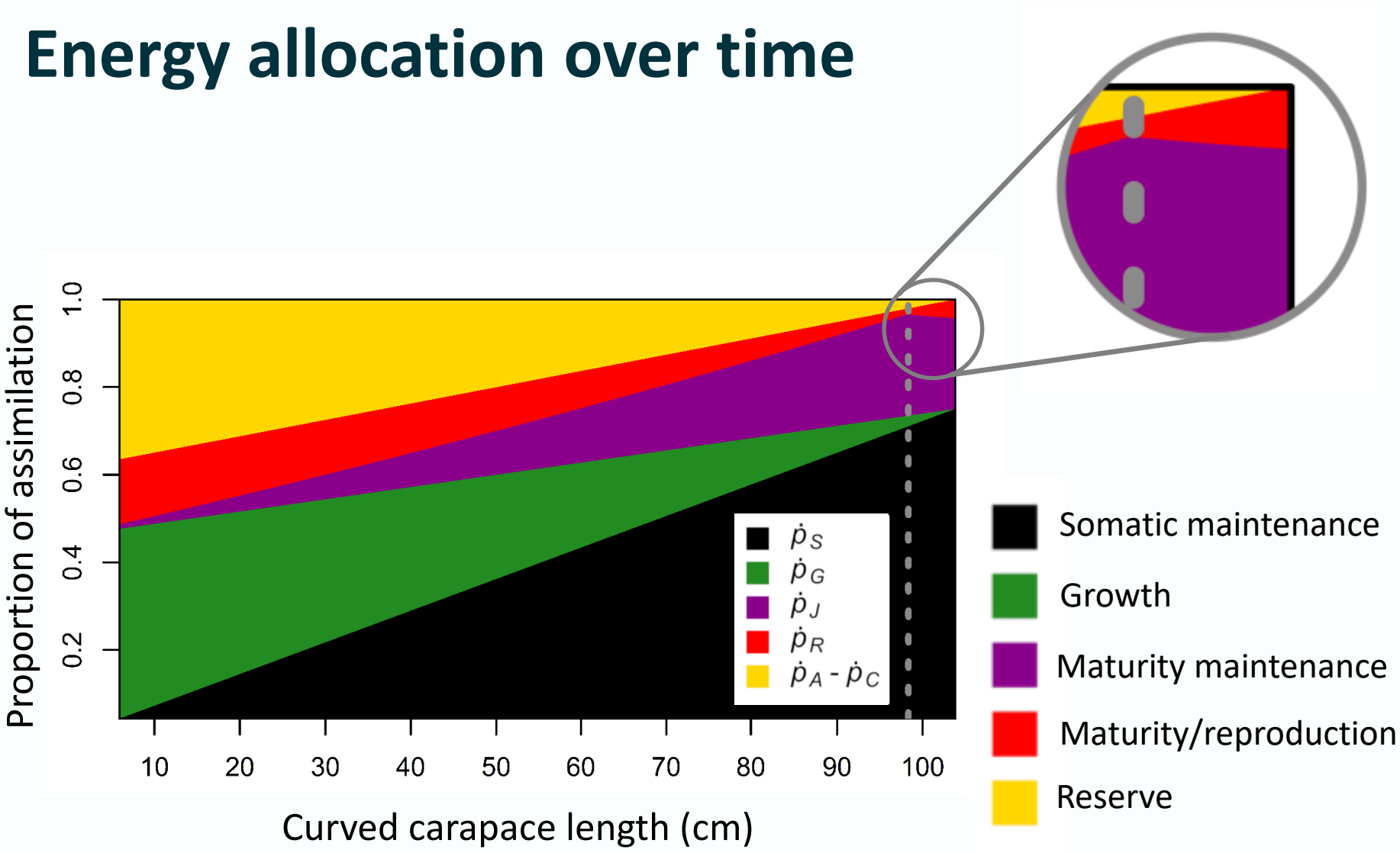
Energy allocation over time





- Somatic maintenance
- Growth
- Maturity maintenance
- Maturity/reproduction
- Reserve

Energy allocation over time



Effects of food and temperature

- **Food** influences **total** amount of **energy** in the system
  - Ultimate size
  - Reproductive output
- **Temperature** influences the **rate** of metabolic processes
  - Growth
  - Rate of egg formation

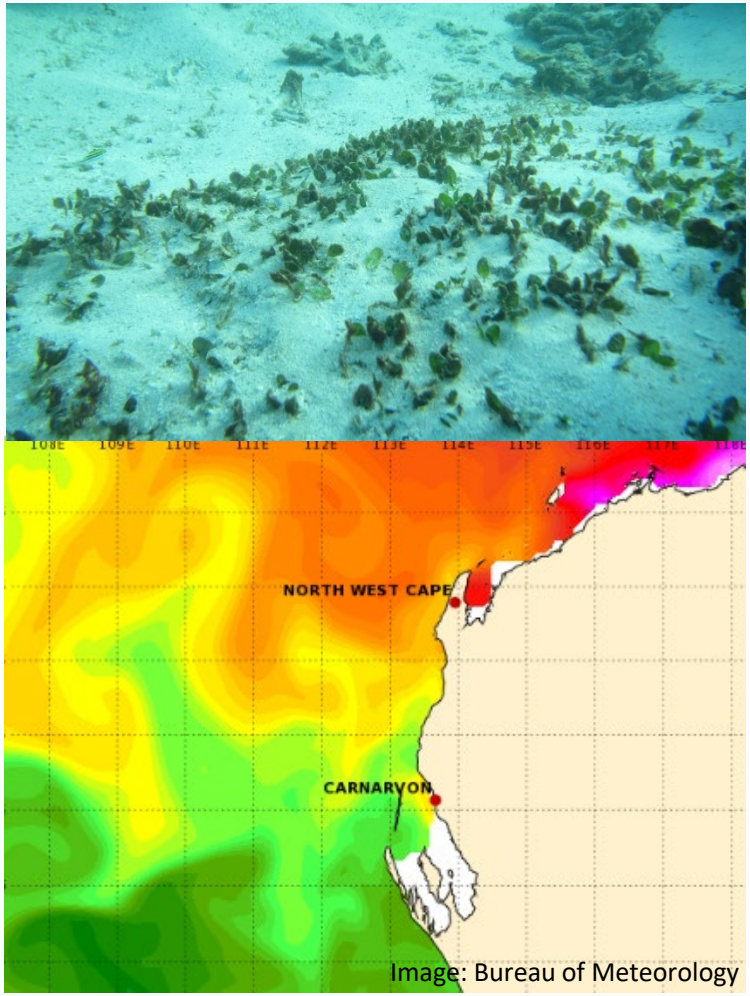
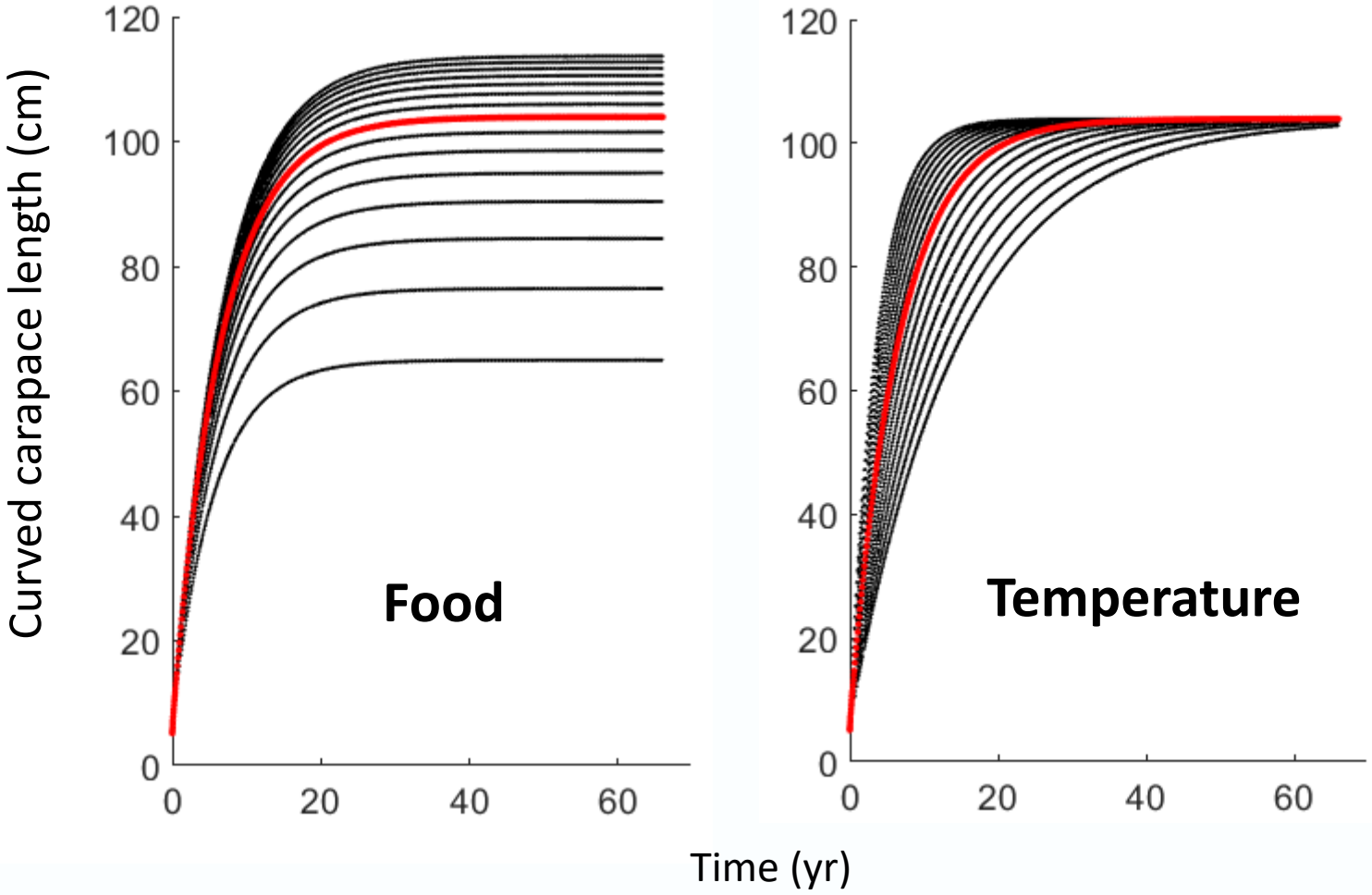
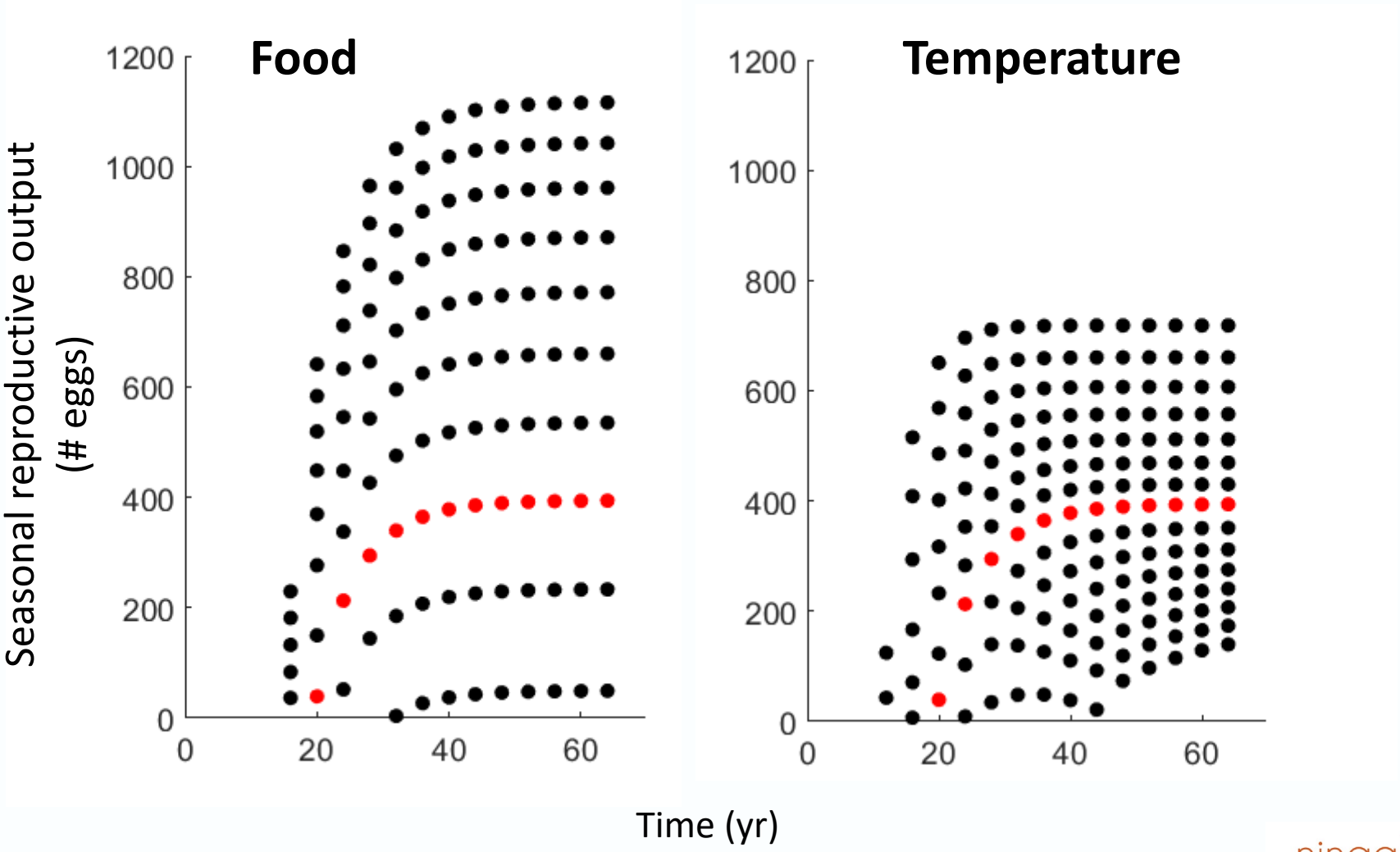


Image: Bureau of Meteorology

Effects of food and temperature - size



Effects of food and temperature - reproduction



Age at puberty

Temperature

Temperature (°C)	Age at puberty (yr)
30	10
29	11
27	13
25	16
23	19
21	21
19	26
17	33
15	38

Food

Change in food (%)	Age at puberty (yr)
+54	14
+32	15
+21	16
+11	17
0	19
-11	22
-21	31
-32	n/a
-54	n/a

Next steps

- Model **variable food** and **temperature** scenarios
- **Variable** time between **breeding seasons**
- Could be **coupled** with an **Individual based model**
  - Simulate **population** level **responses**
  - Could indicate **trends** in the **population before** they become evident in the **breeding** individuals

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CSIRO Oceans and Atmosphere
UWA School of Biological Sciences
Jessica Stubbs
PhD Candidate

e jessica.stubbs@research.uwa.edu.au
t 08 9333 6261