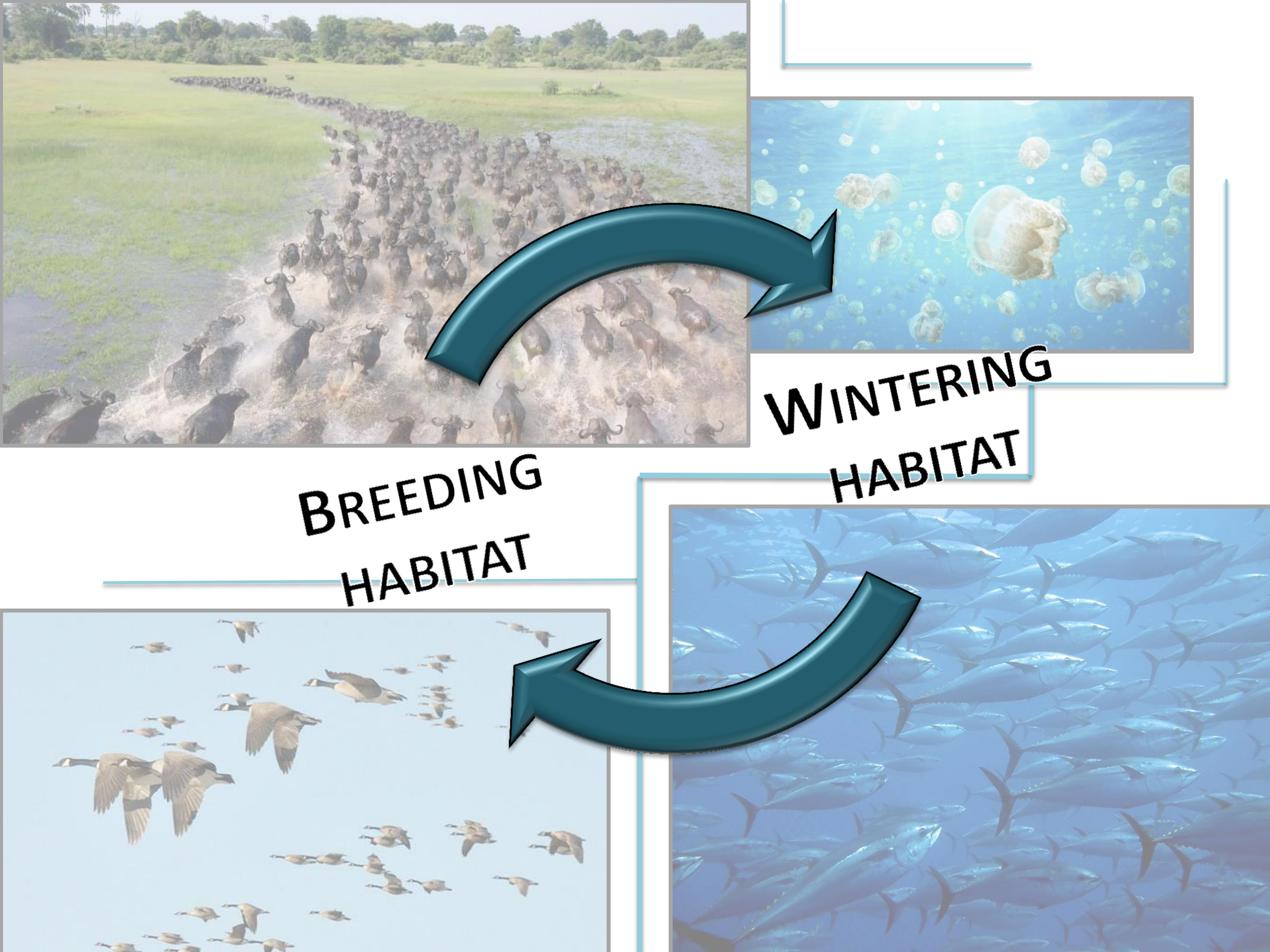
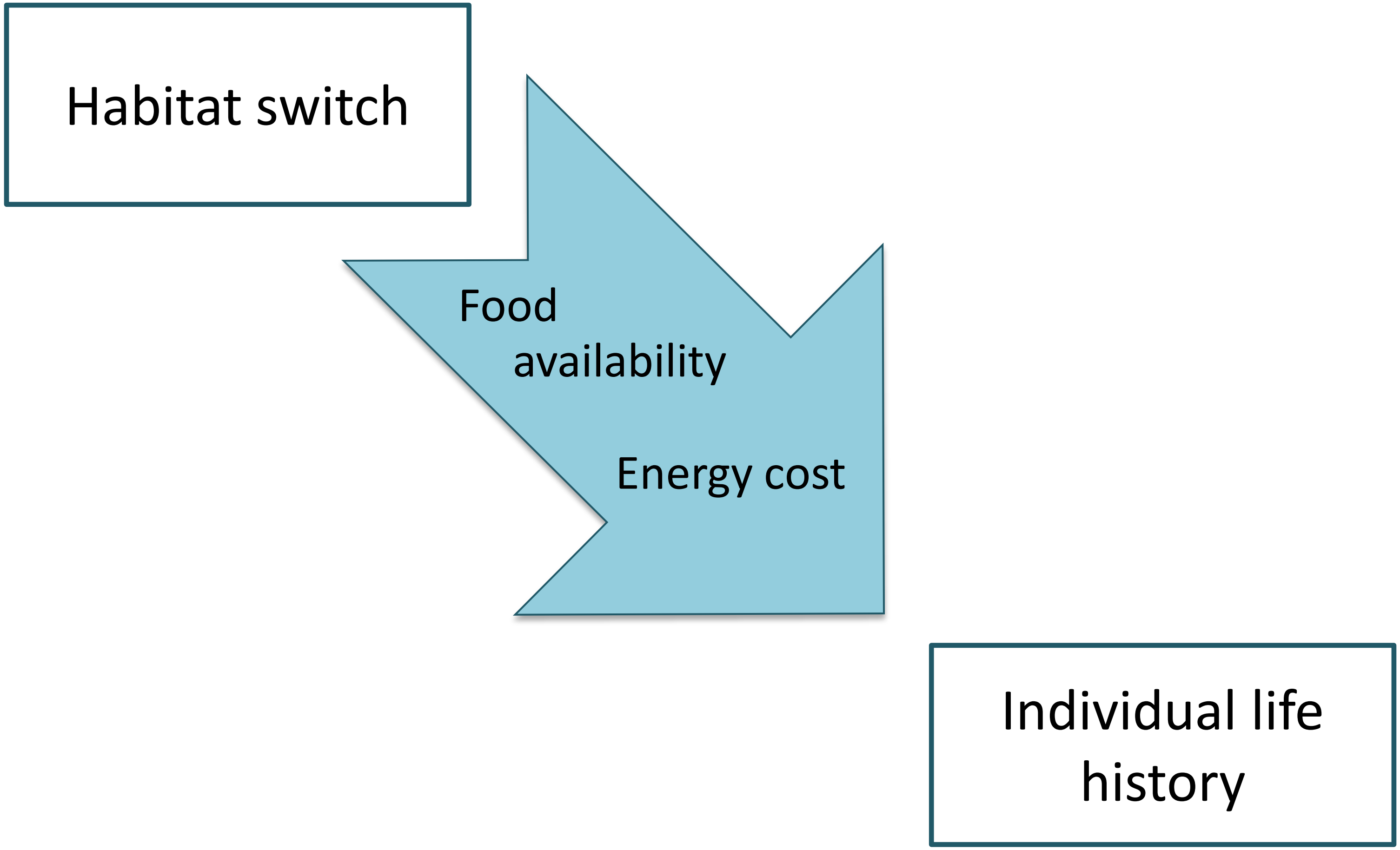
A decline of food abundance in the non-breeding habitat may increase resilience of migratory populations

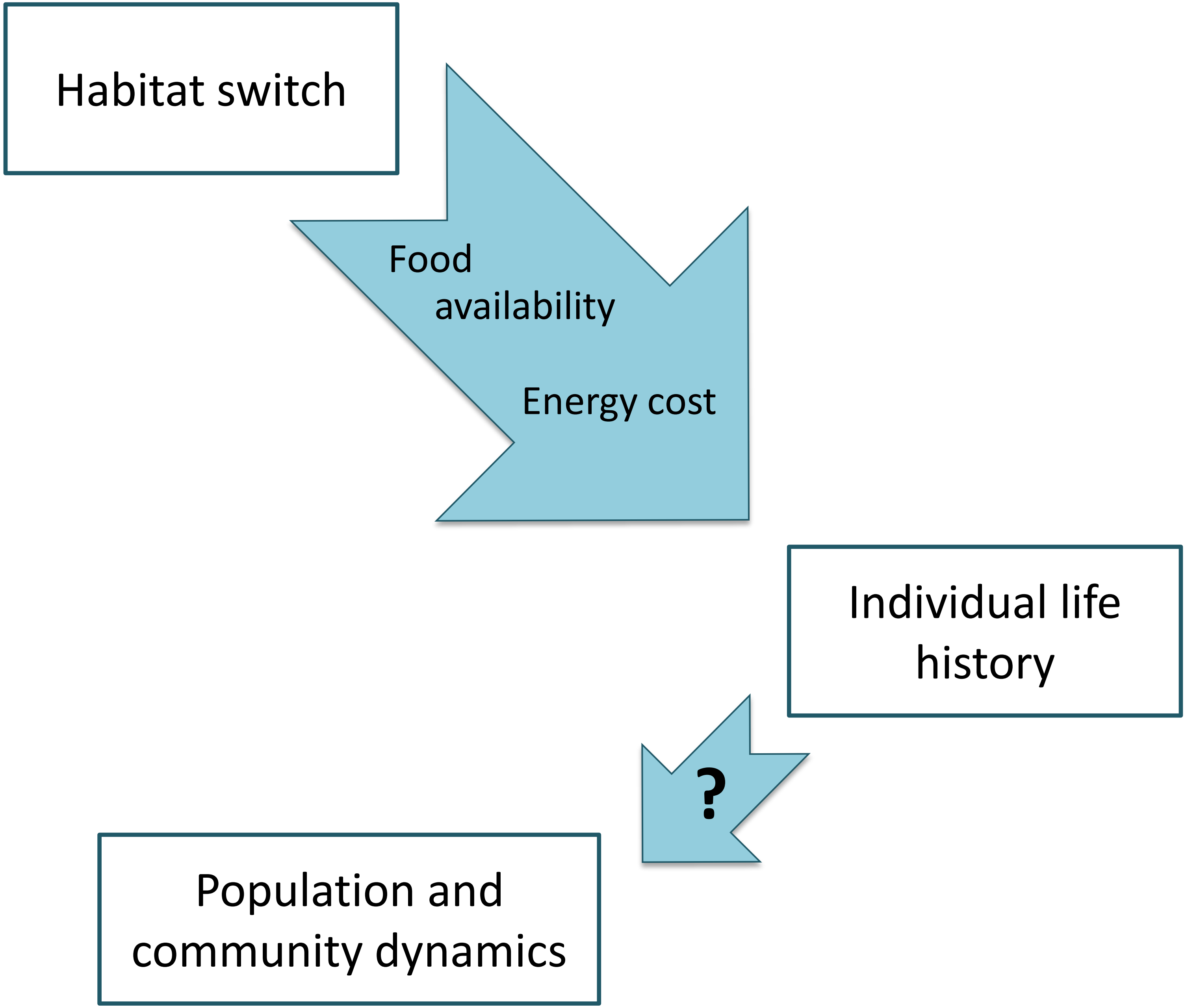
European Research Council

Catalina Chaparro
André de Roos



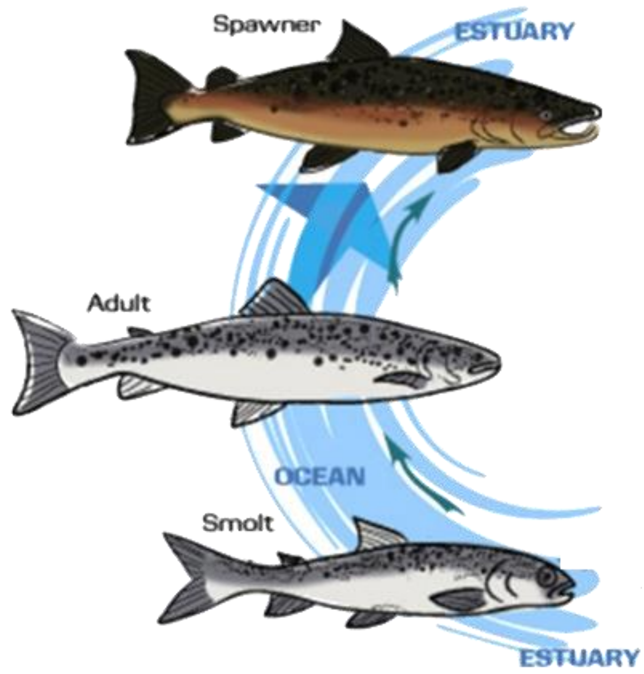


Wintering habitat
Breeding habitat


Habitat switch
Food availability
Energy cost
Individual life history

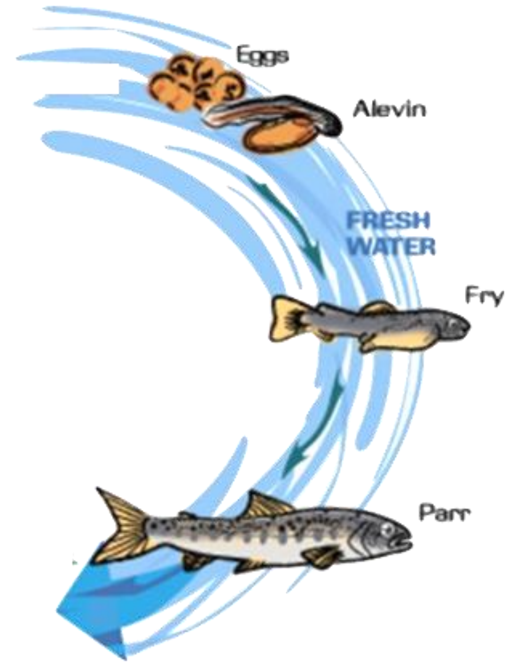

Habitat switch
Food availability
Energy cost
Individual life history
?
Population and community dynamics

Salmon life cycle

Ocean



River



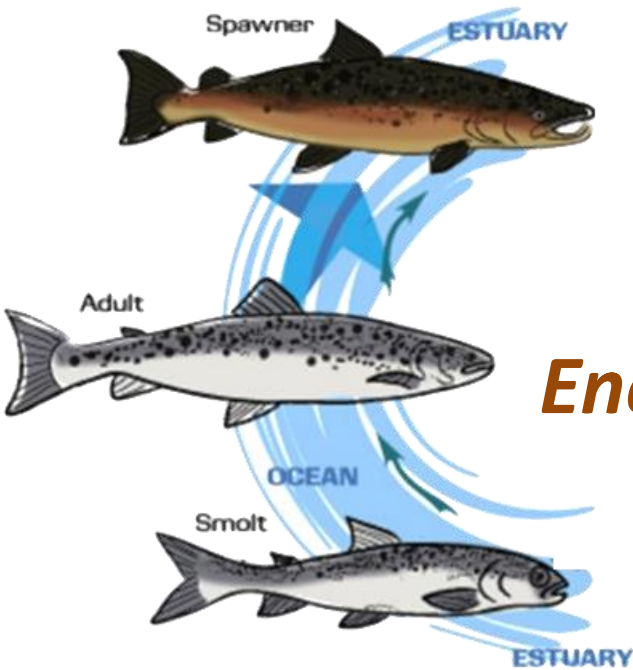
Low survival
No competition

High survival
Competition

Salmon life cycle

Ocean

River



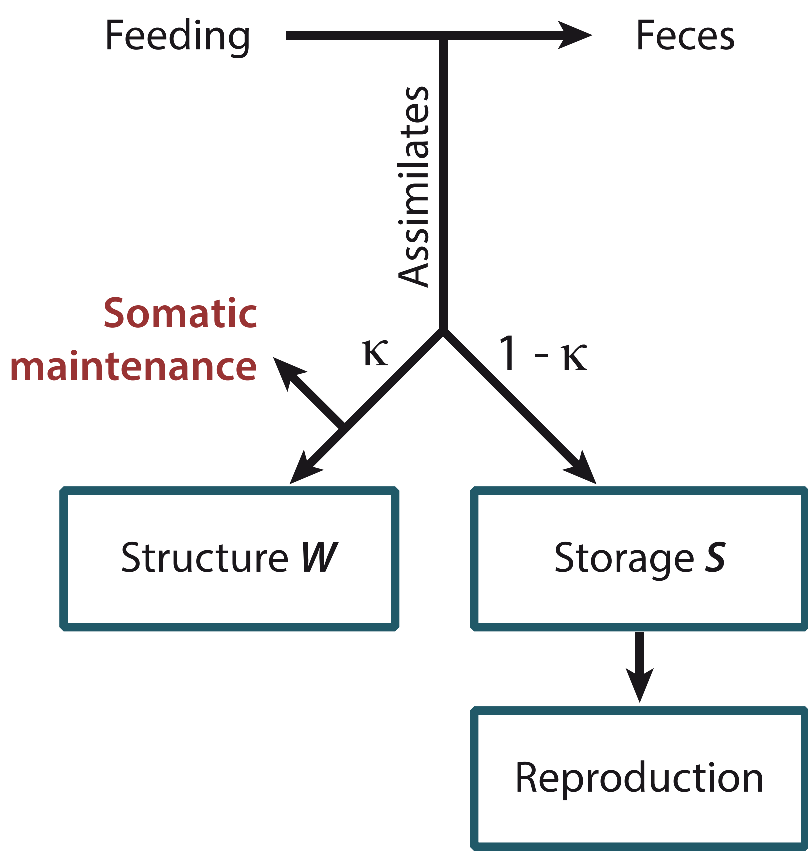
Migration

Energetic costs

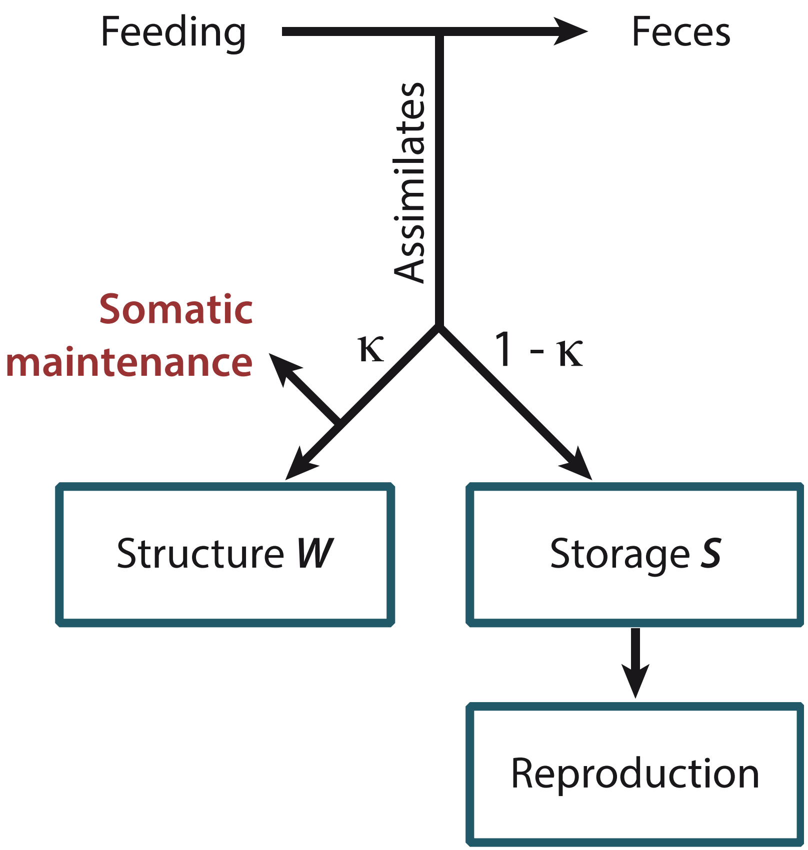
Low survival
No competition

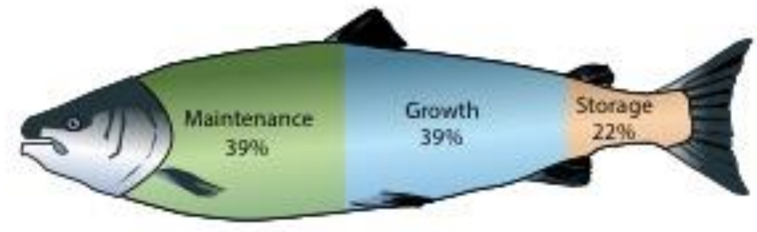
High survival
Competition

How is energy used?

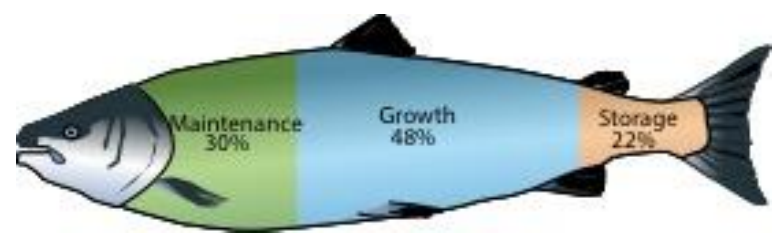


How is energy used?

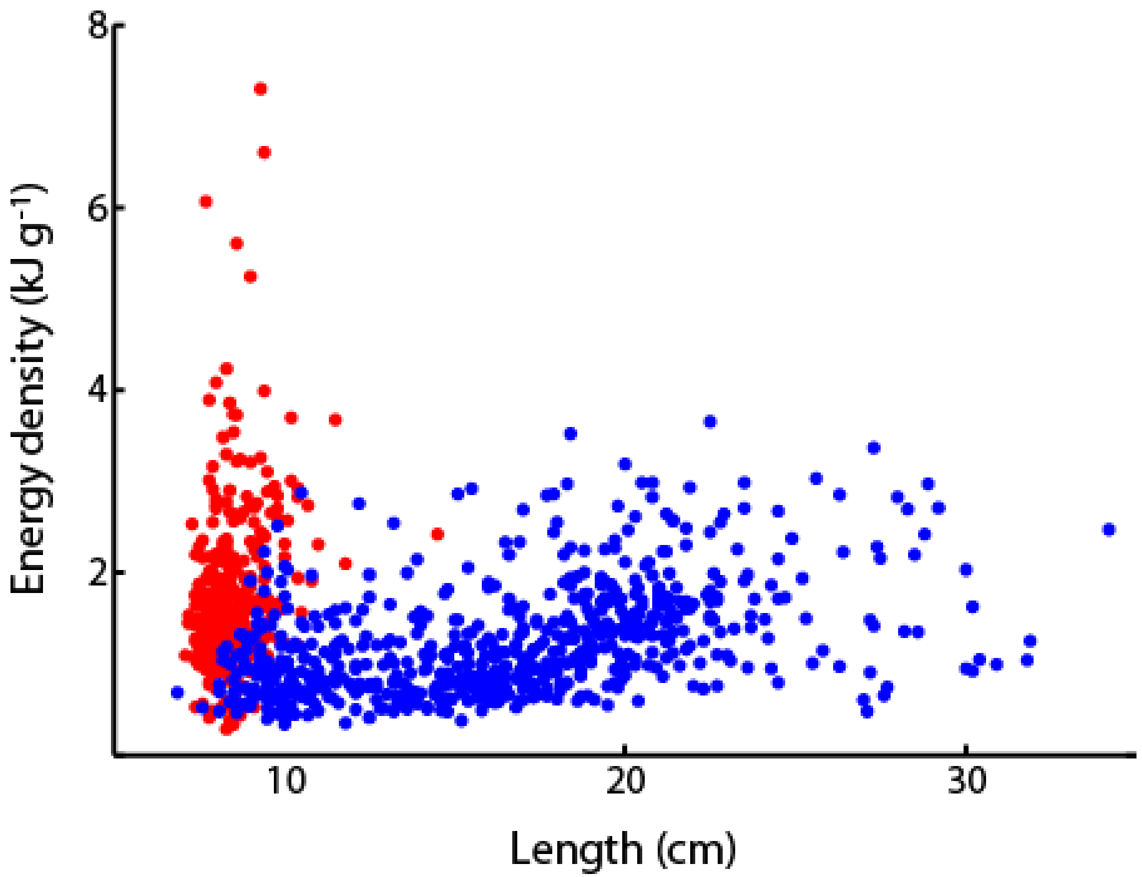




Habitat switch
Increase food



The change in food experienced when they switch habitat affects the allocation between structure and storage



MacFarlane, 2010. Energy dynamics and growth of Chinook salmon (Oncorhynchus tshawytscha) from the Central Valley of California during the estuarine phase and first ocean year. Can. J. Fish. Aquat. Sci. 67:1549–1565.

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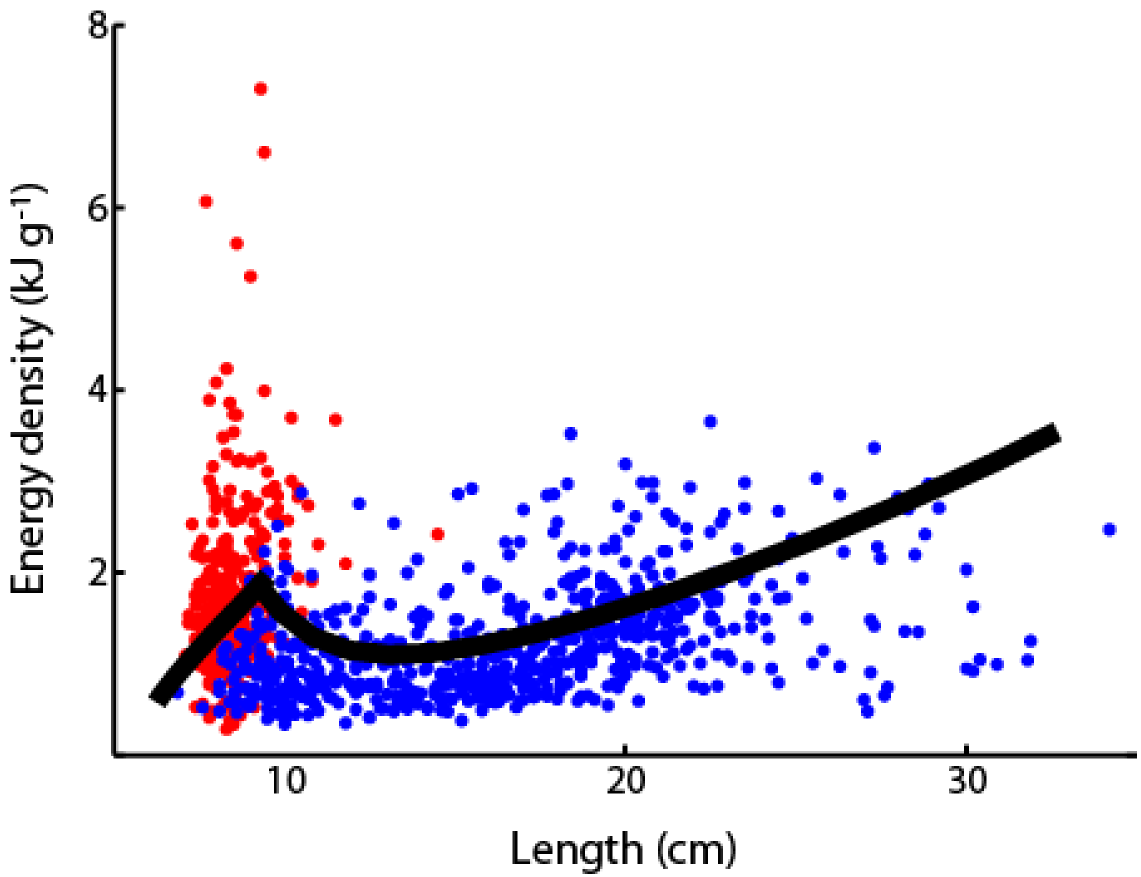

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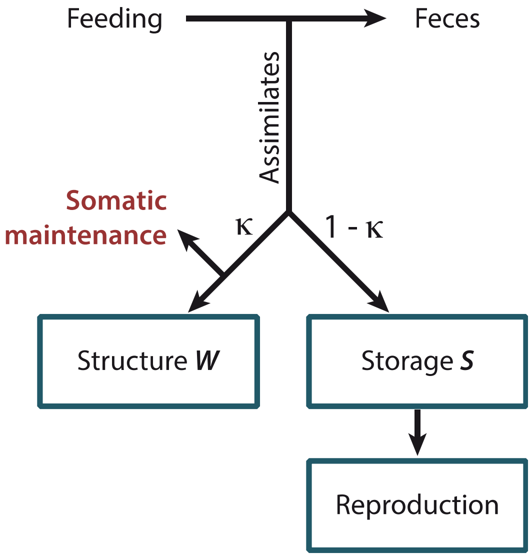

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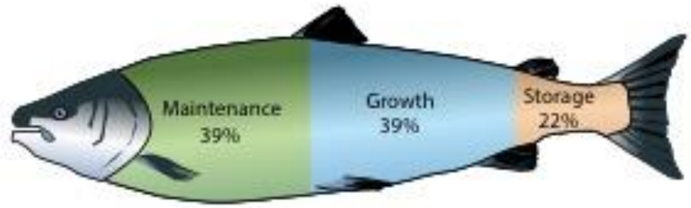
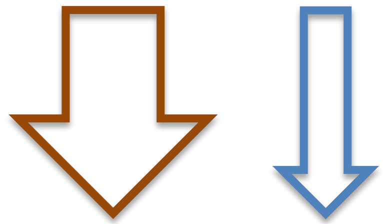
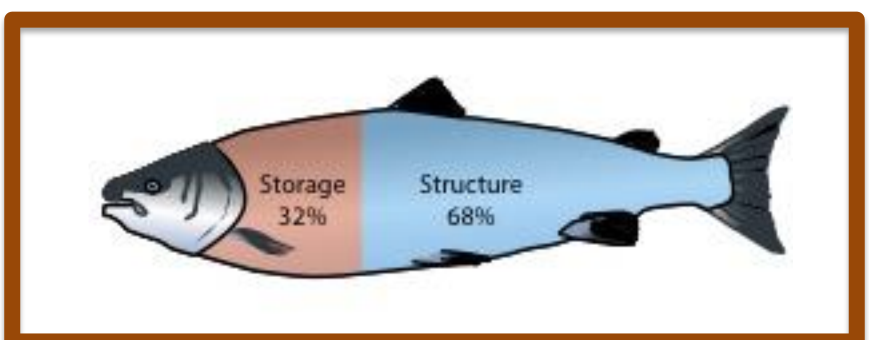
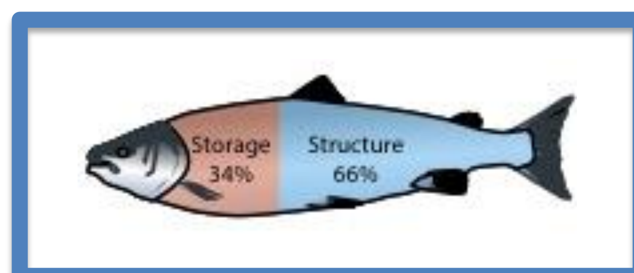




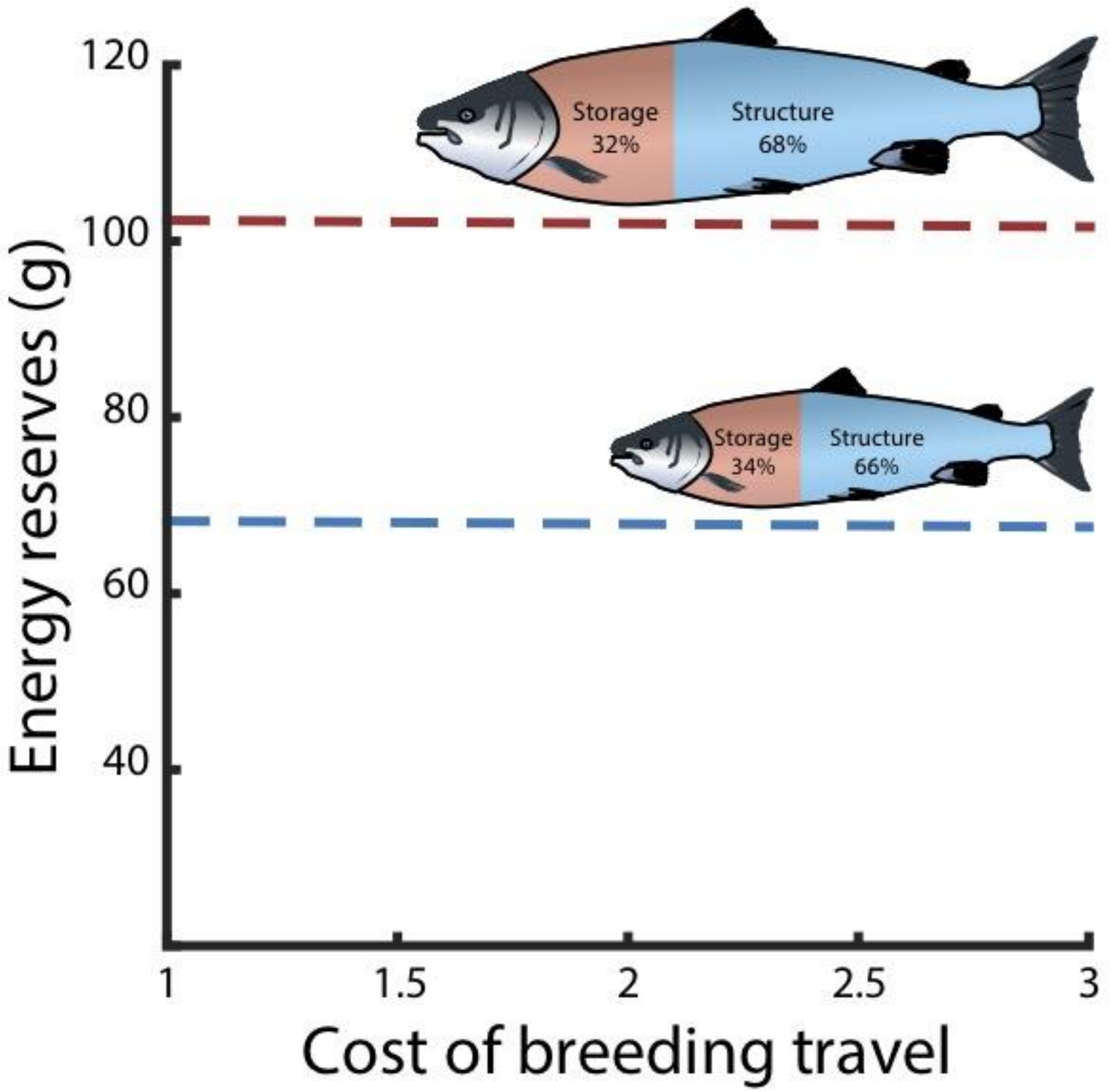
Habitat switch

Increase food

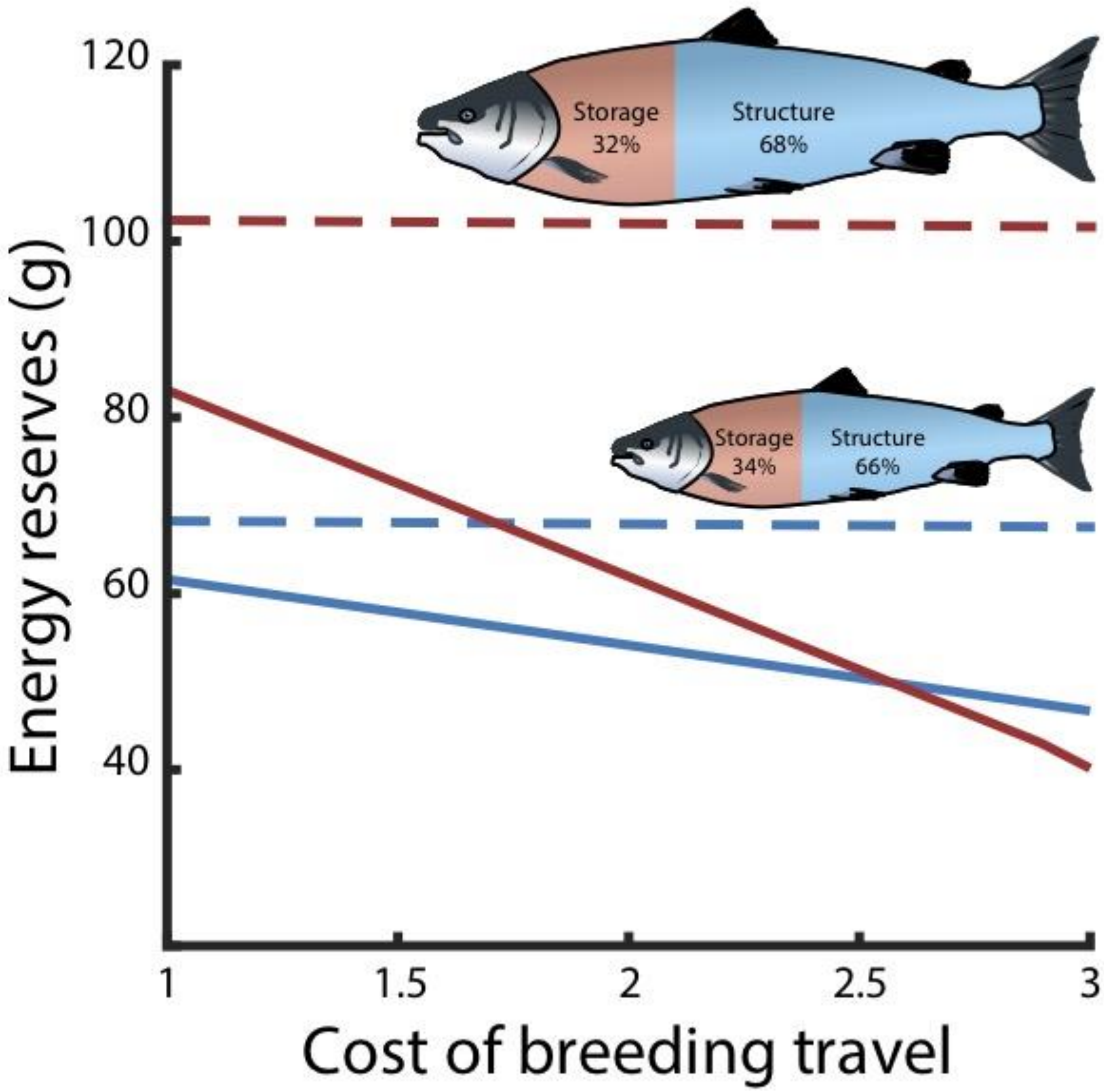




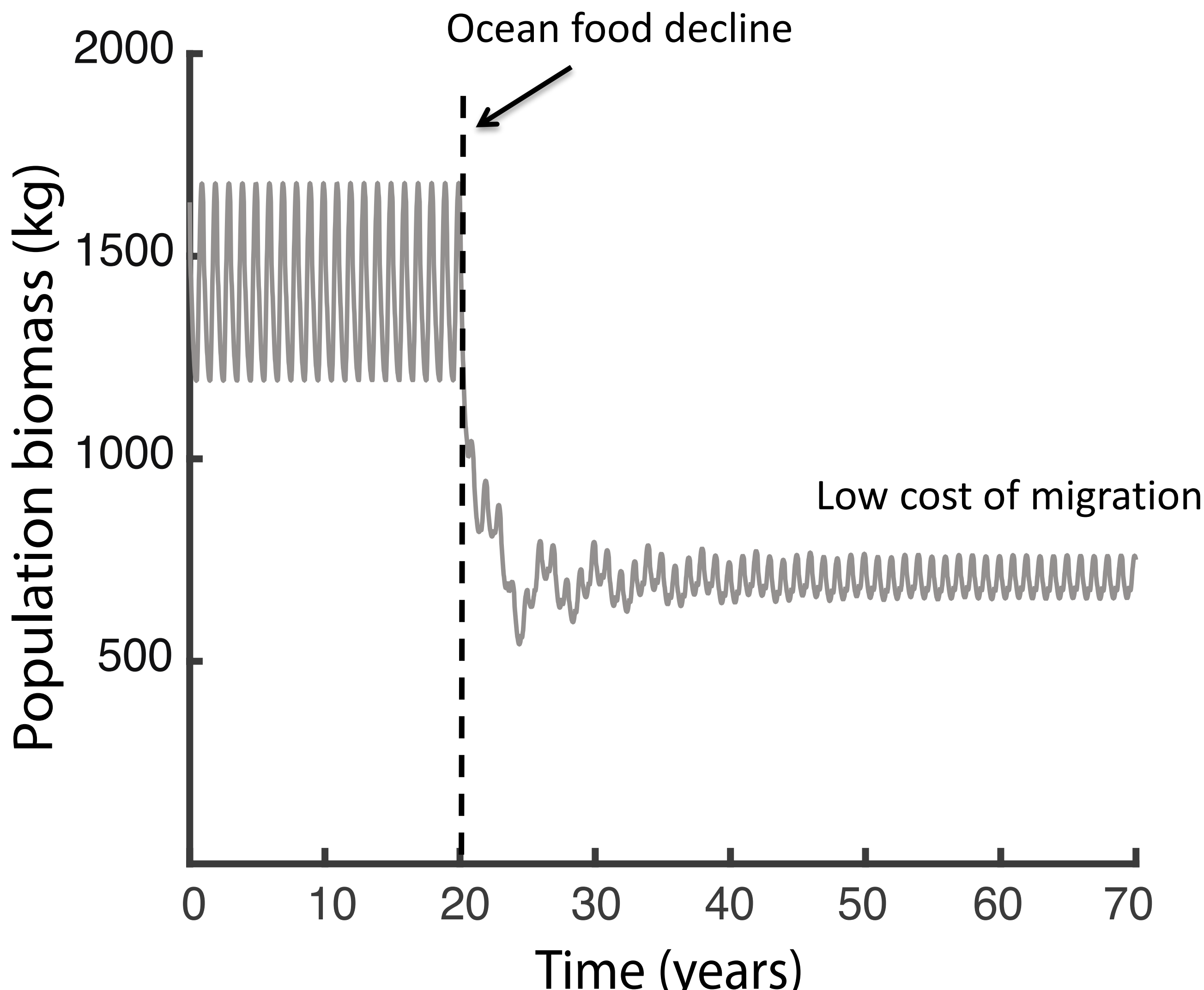
How is the energy reserves before migration?



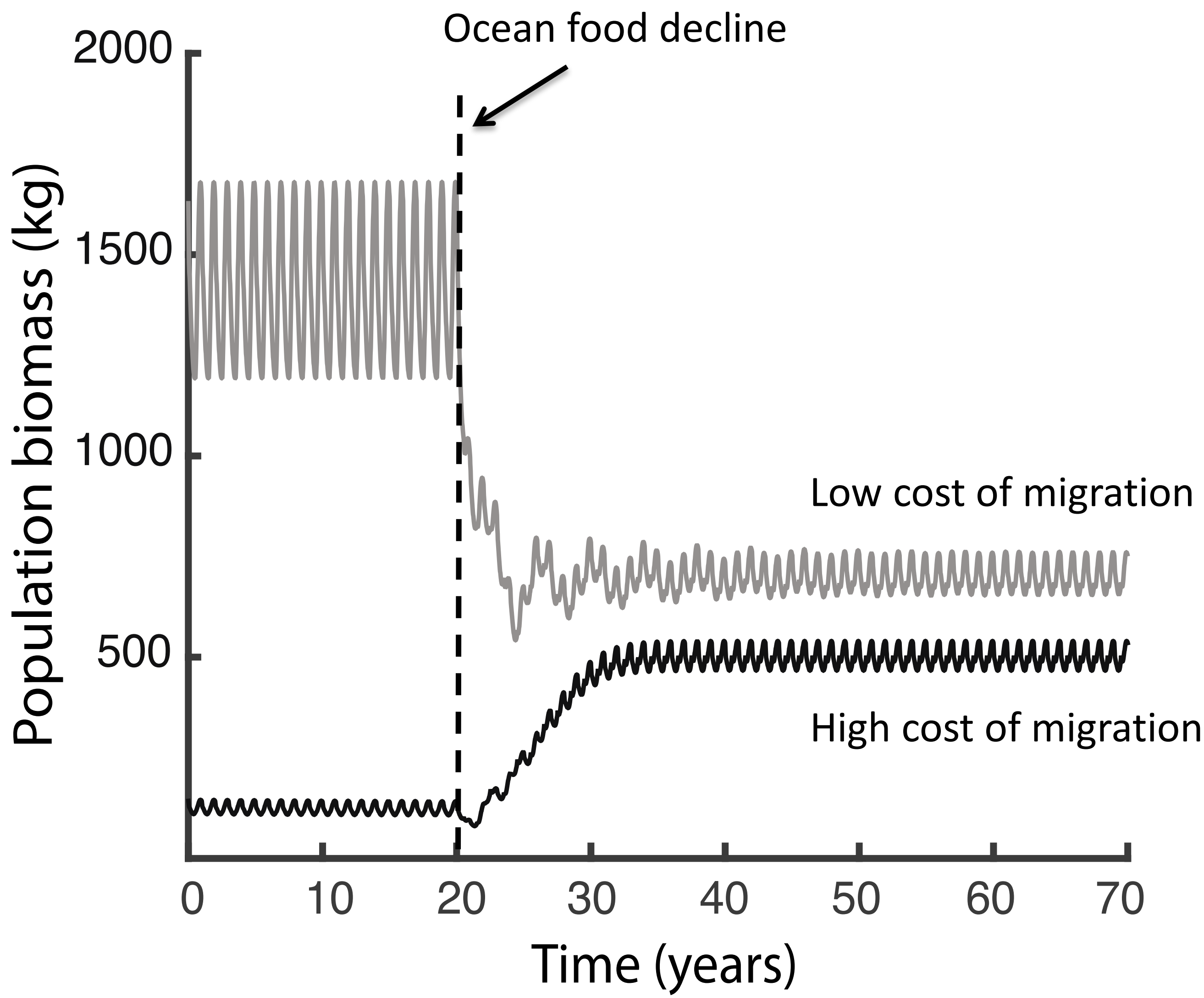
And after migration?



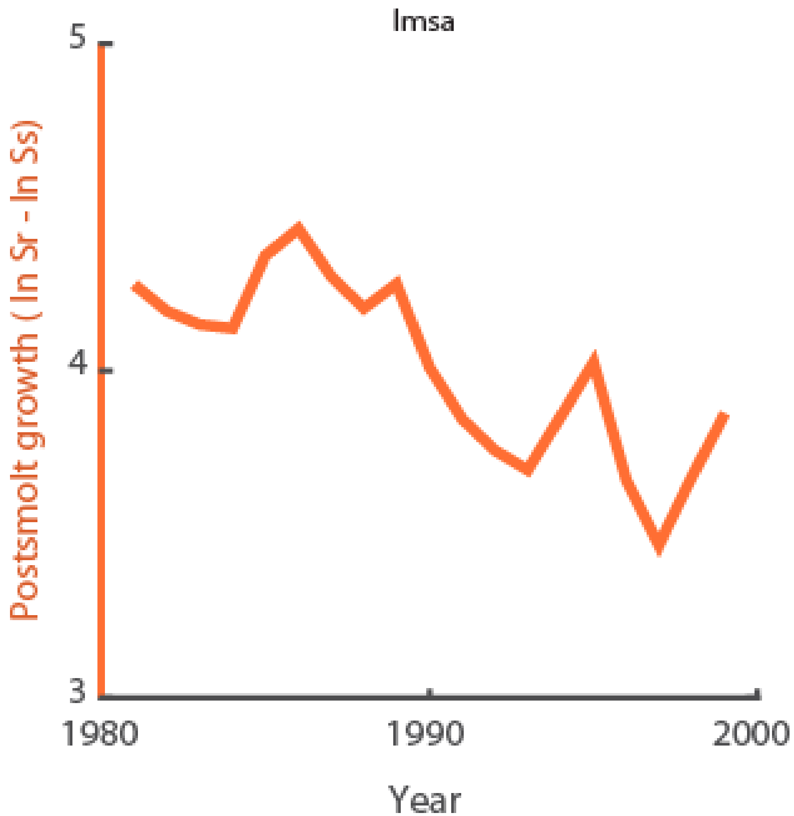
Population consequences of ocean food decline

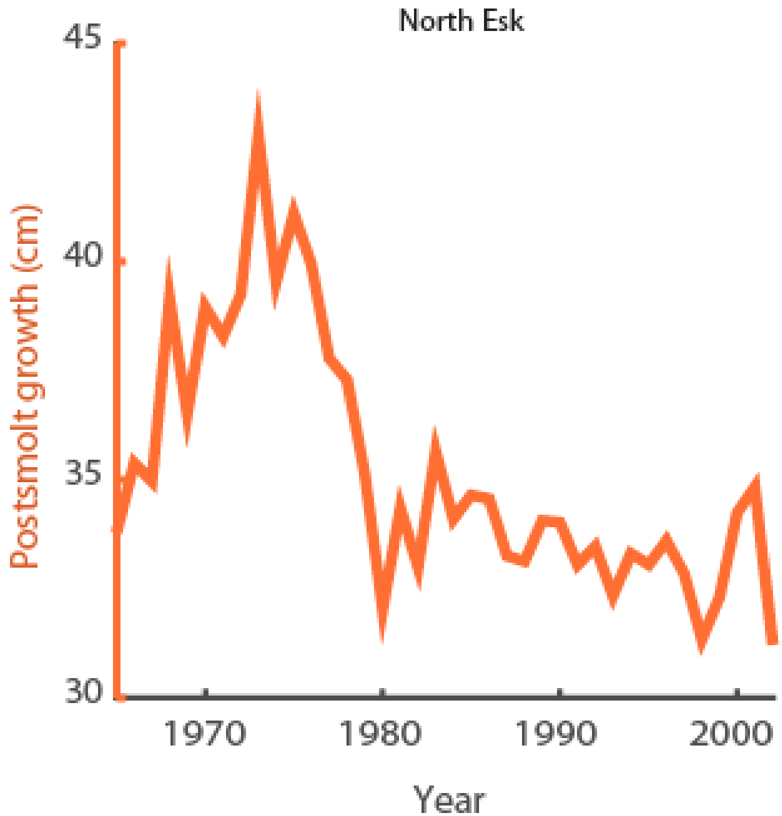


Population consequences of ocean food decline



Growth and dynamics in the field

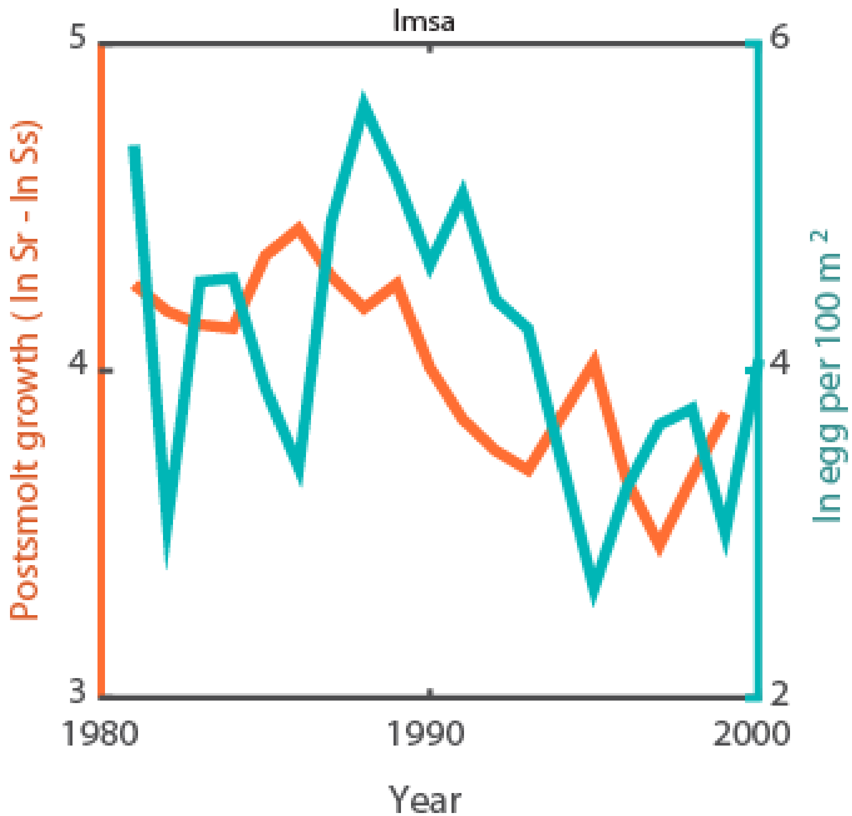


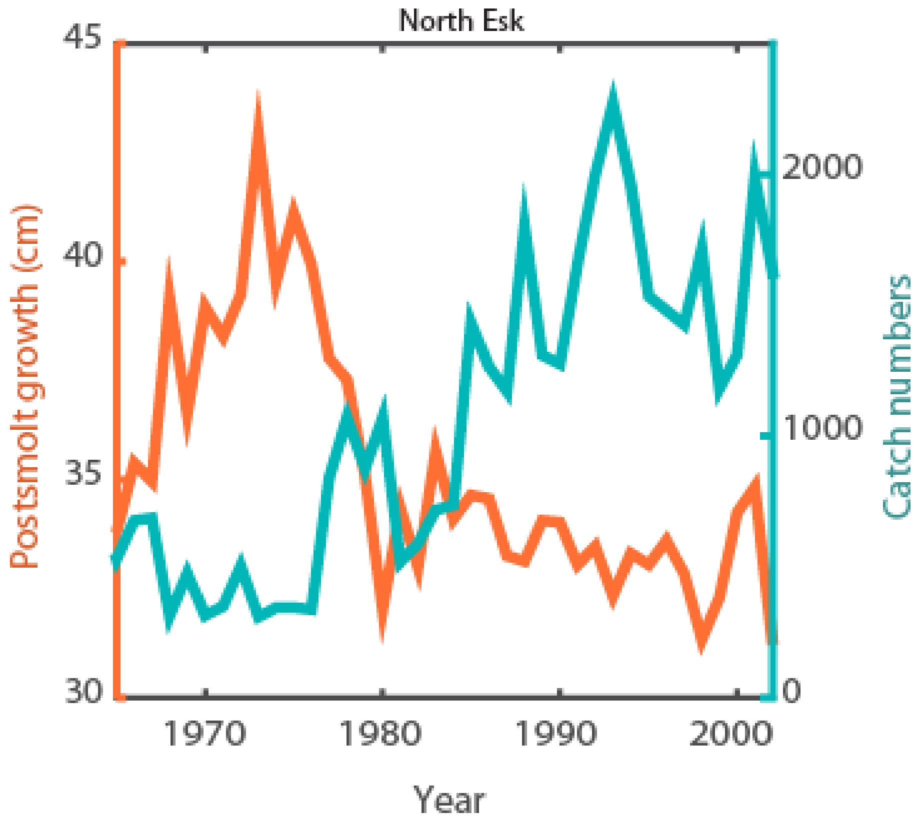


Migration distance:
~ 3 km

Migration distance:
> 100 km

Growth and dynamics in the field





Migration distance:
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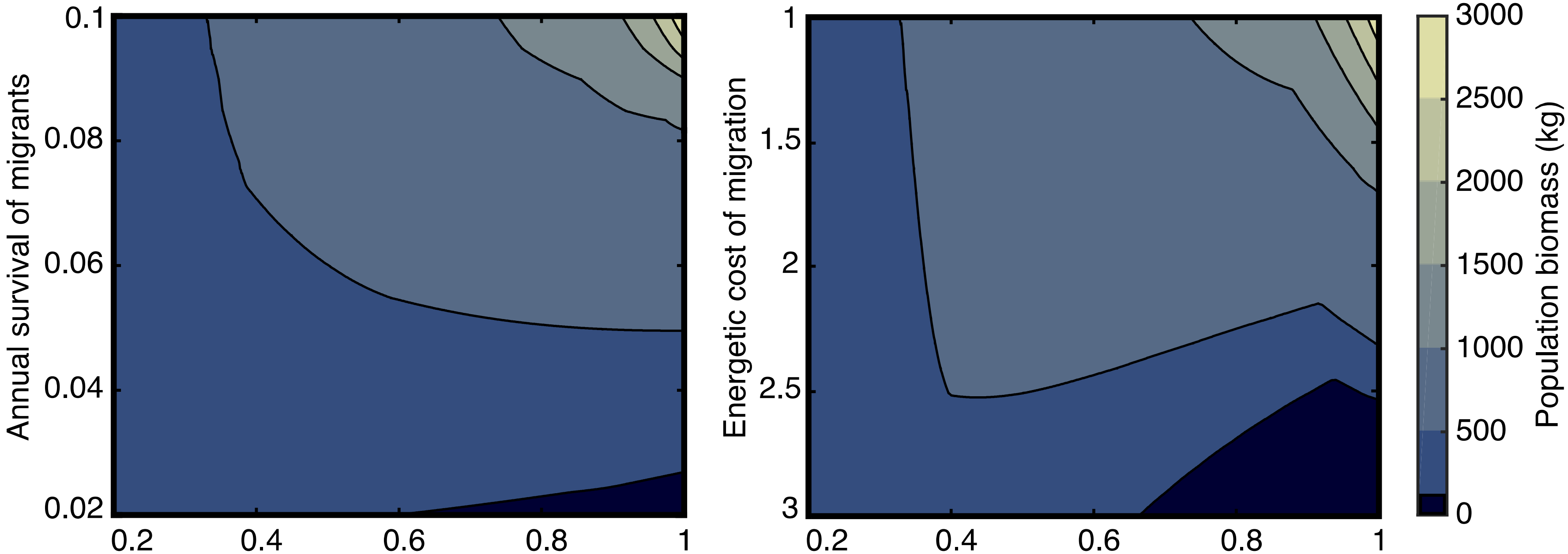
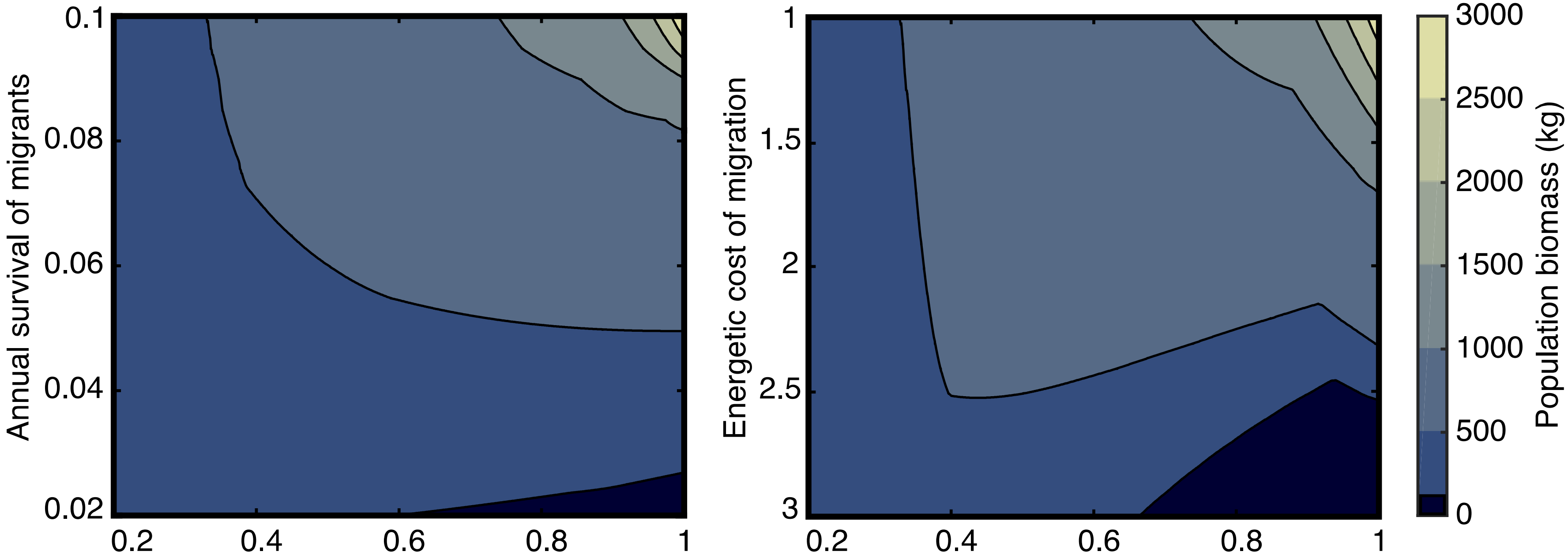
Migration distance:
> 100 km

High food availability in the ocean causes extinction when the cost of migration high



Food availability in the ocean

High food availability in the ocean causes extinction when the cost of migration high

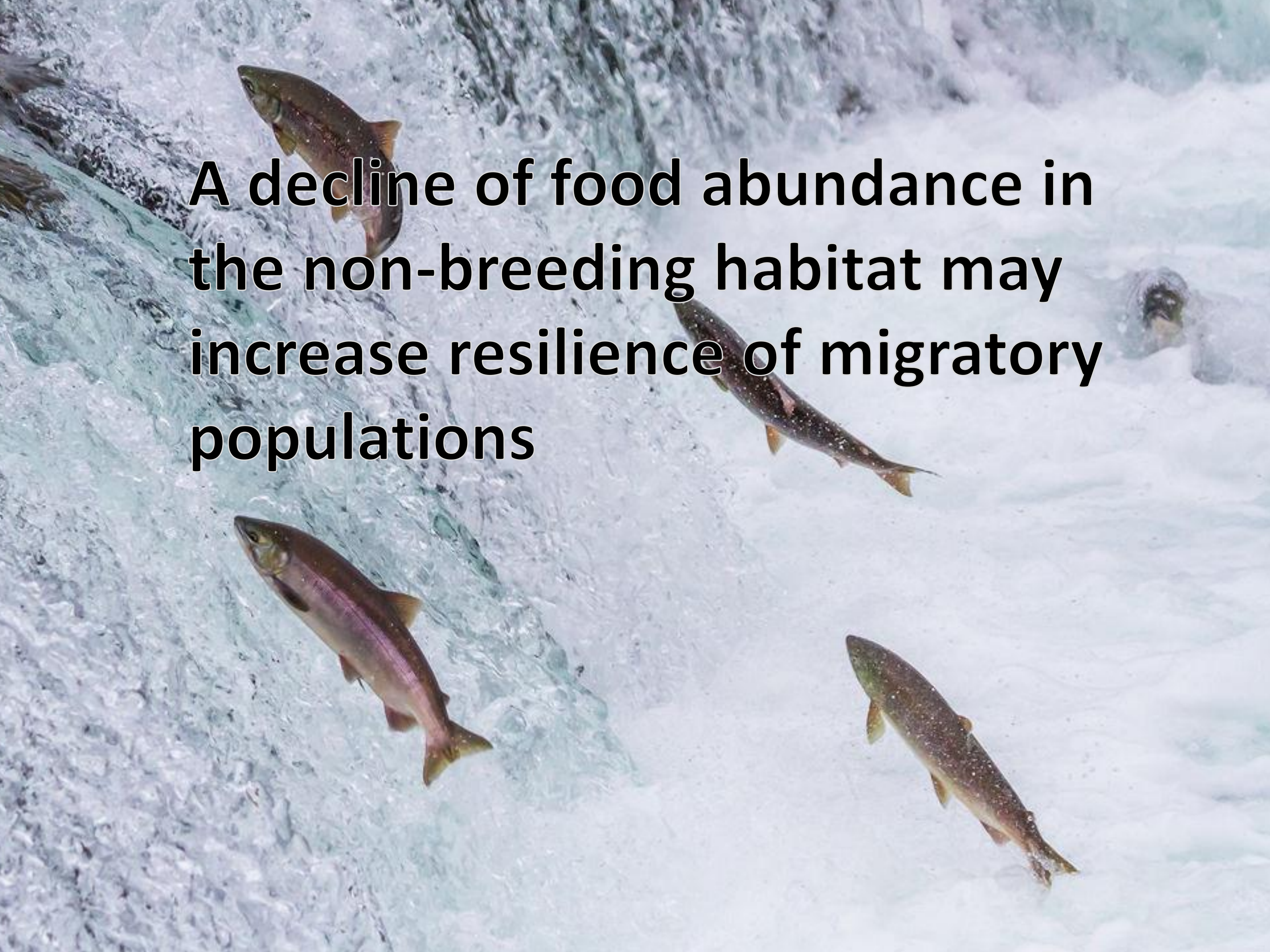


Food availability in the ocean

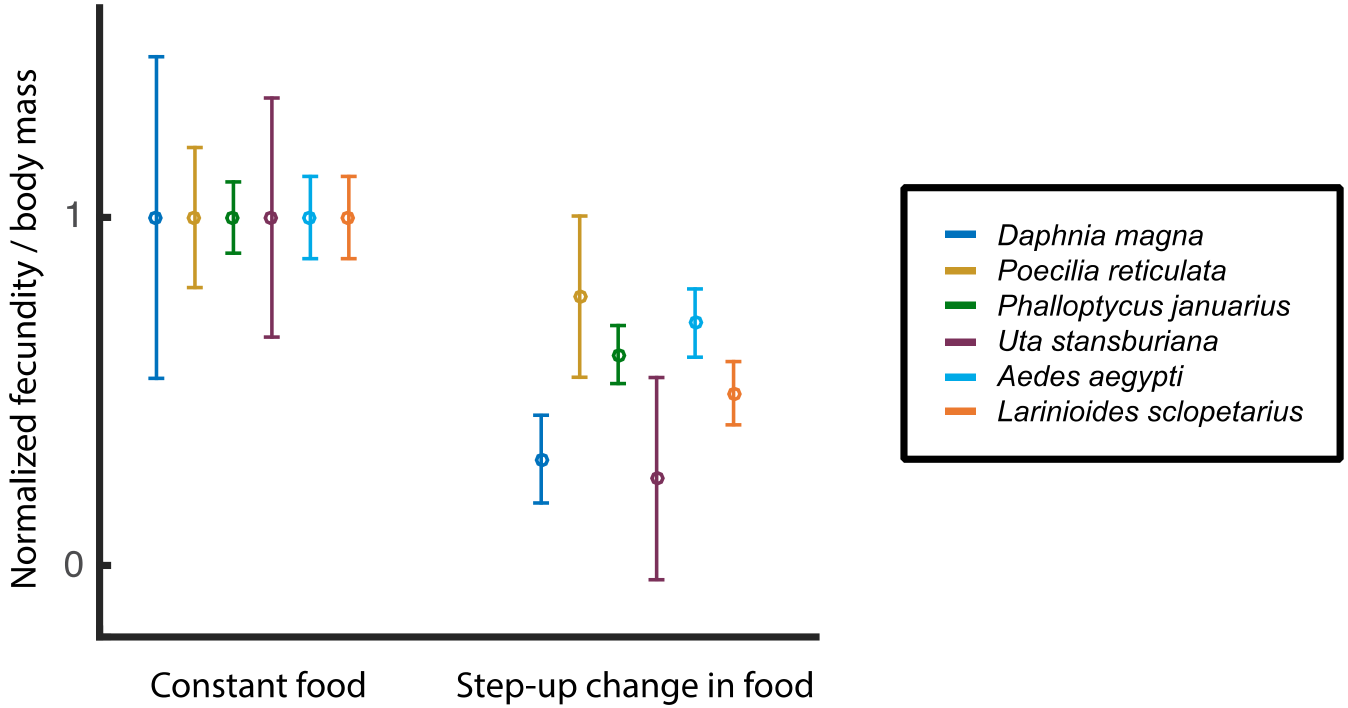
Unless… evolution select for smaller sizes

- We build dams in short period of time
  - Is that time enough for selection to act?
- The peak of dams building coincide with the decline in food abundance in the ocean
  - This decline may have prevented a larger collapse of populations
- Climate change predict declining in ocean productivity
  - Good for persistence, bad for fisheries

A decline of food abundance in the non-breeding habitat may increase resilience of migratory populations




Thank you
Questions?



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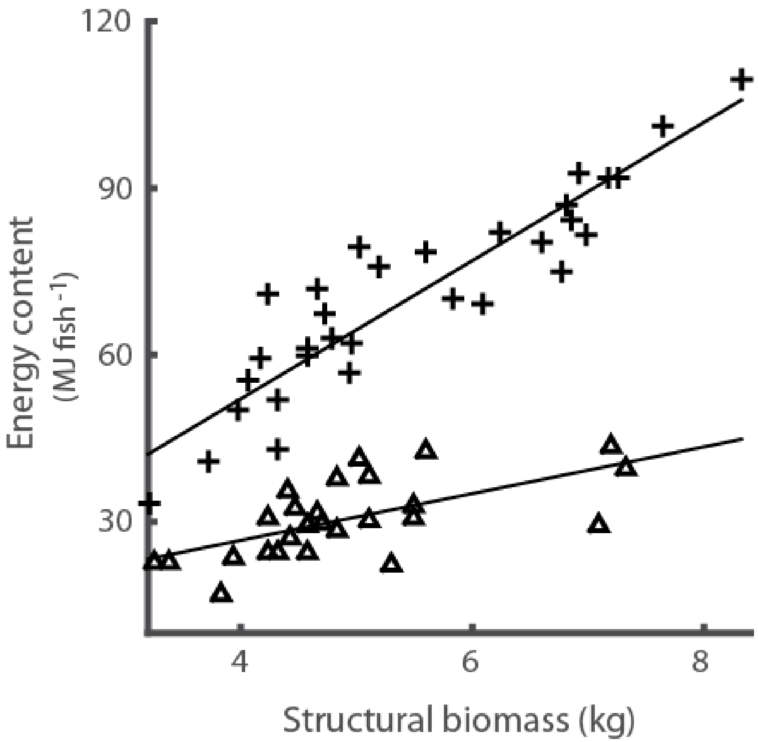
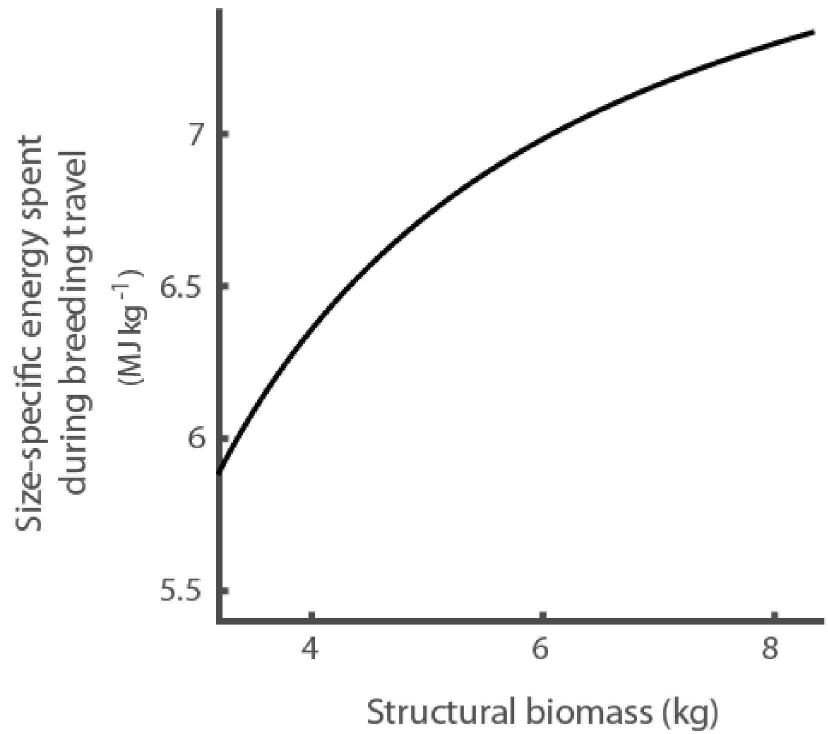
Larger fish requires more energy per g





MODEL

○ Population level

Size structured population model

Breeding habitat (river)

Density-dependence

$$\frac{dR_r}{dt} = \rho(R_{max} - R_r) - f_r\, J_a \sum_{i=1}^{c} n_i\; W_i^{2/3}$$

$$f_r = \frac{R_r}{K + R_r}$$

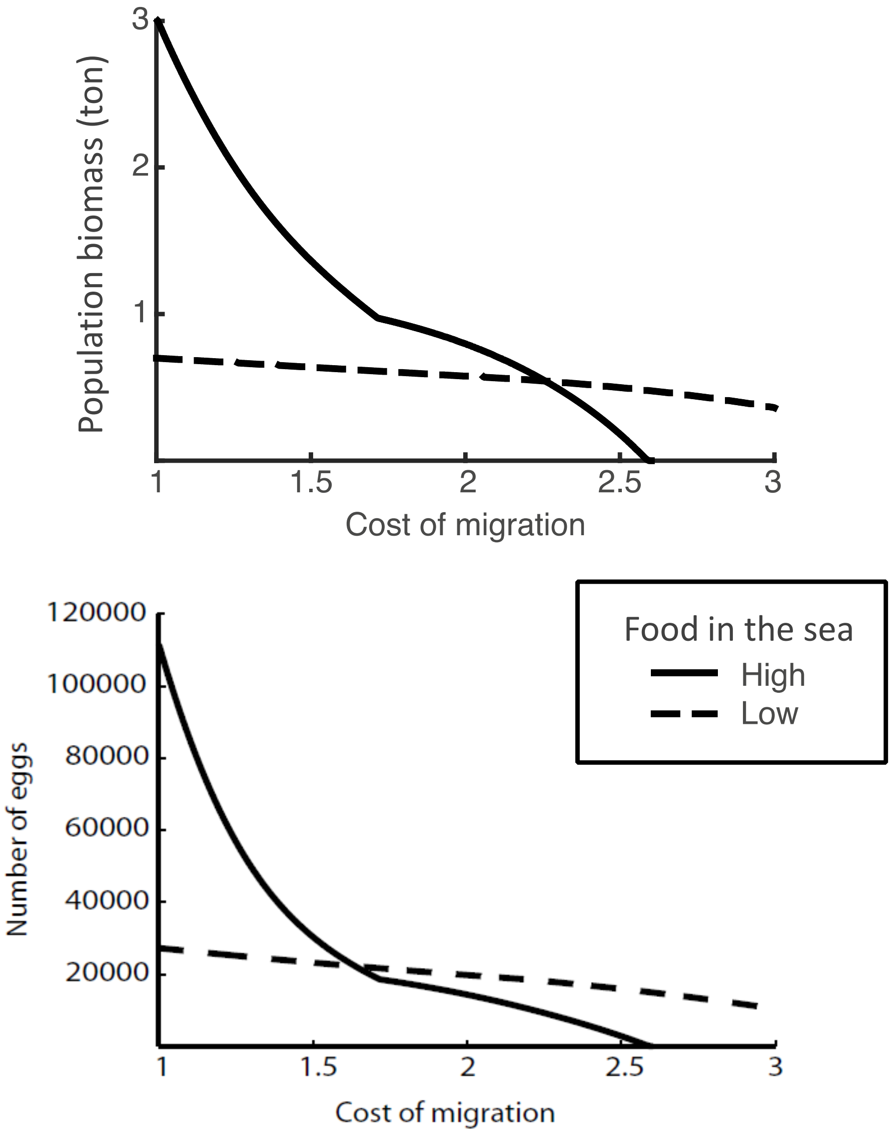
Wintering habitat (sea)

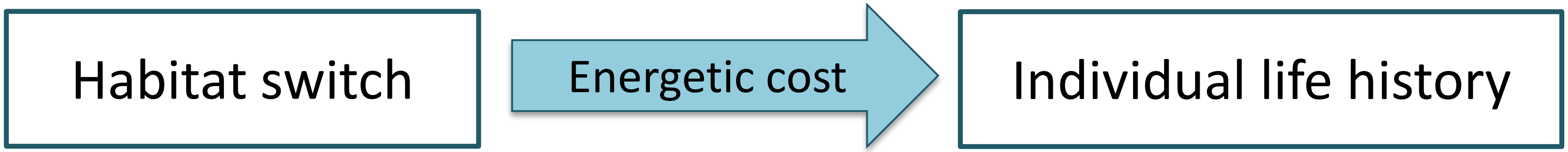
No density-dependence

R_s is constant

f_s is constant

RESULTS Impact on reproduction





Journal of Fish Biology (1993) **42,** 485–508

Fecundity and egg size variation in North American Pacific salmon (*Oncorhynchus*)

T. D. Beacham and C. B. Murray

Journal of Fish Biology (2006) **69,** 860–869
doi:10.1111/j.1095-8649.2006.01160.x, available online at http://www.blackwell-synergy.com

Life-history effects of migratory costs in anadromous brown trout

B. Jonsson* and N. Jonsson

RESULTS ○ Why does low food allow persistence?

Aquaculture Research, 2001, **32**, 963–974

Weight gain and lipid deposition in Atlantic salmon, *Salmo salar*, during compensatory growth: evidence for lipostatic regulation?

S J S Johansen*, M Ekli, B Stangnes & M Jobling
Norwegian College of Fishery Science, University of Tromsø, N-9037 Tromsø, Norway

tested in two trials in which feed-restricted or -deprived postsmolt Atlantic salmon, *Salmo salar*, became hyperphagic after transfer to excess feeding. At the end of the first trial, previously feed-restricted fish had fully compensated for their lost weight gain compared to continuously fed control fish, but had a leaner body composition (i.e. reduced energy stores) and were still showing signs of compensatory growth. In the second trial, feed deprivation drained body lipids and caused a stronger hyperphagic response than restrictive feeding, although it took

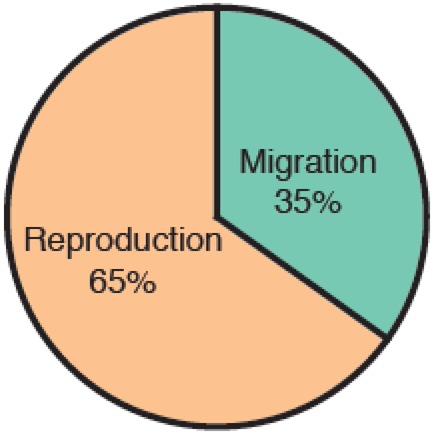
RESULTS Why does low food in the sea allows persistence?

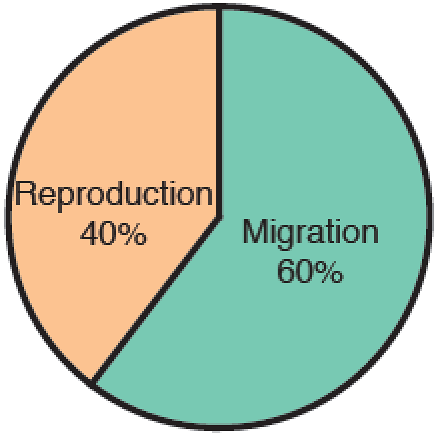
Storage use during the breeding season

When the cost of migration is low

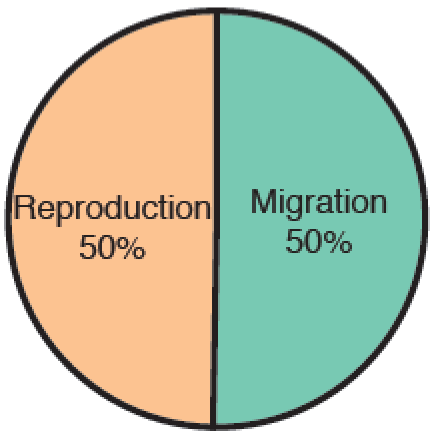
When the cost of migration is high

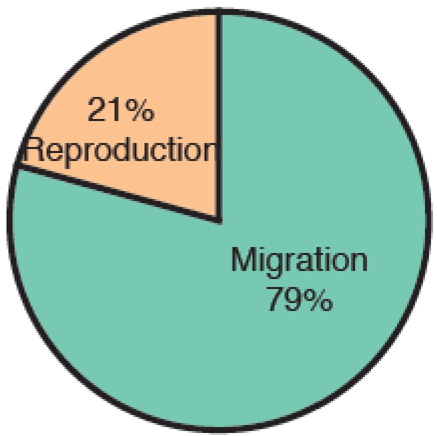
Low food in the sea





High food in the sea





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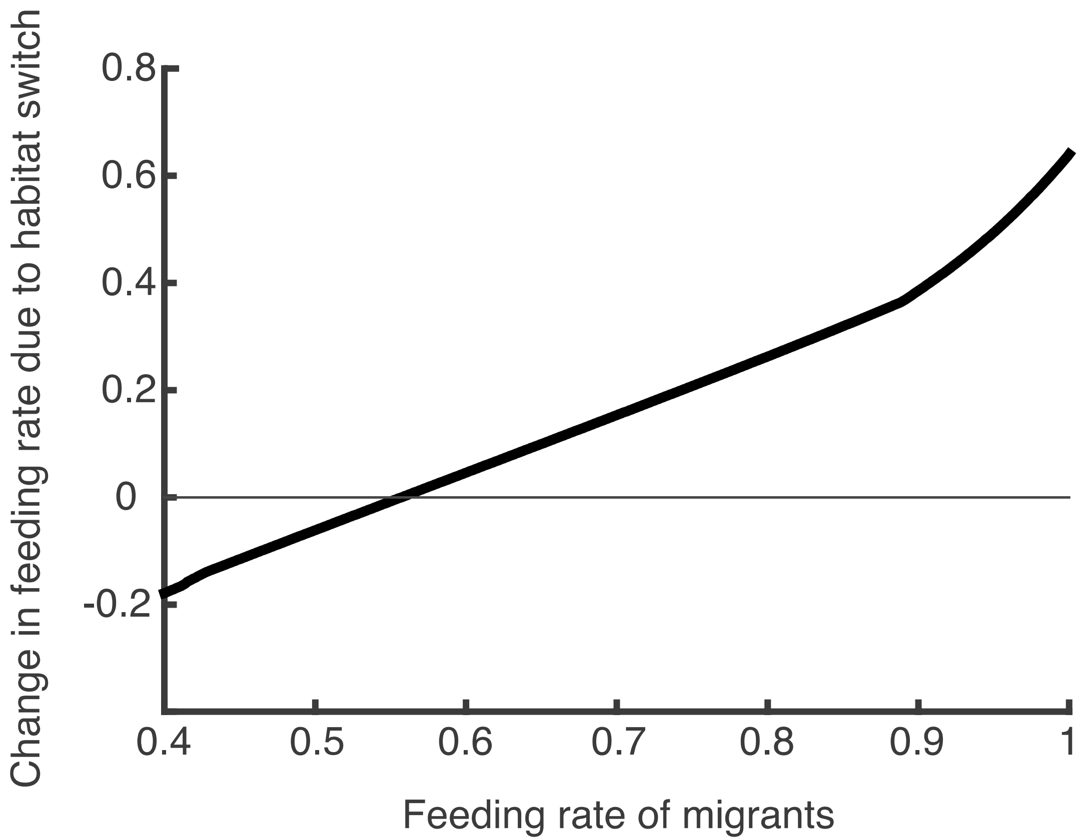

RESULTS

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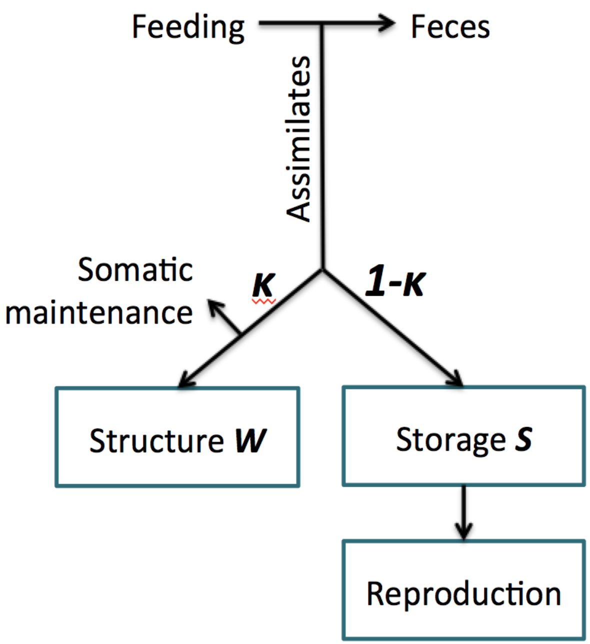

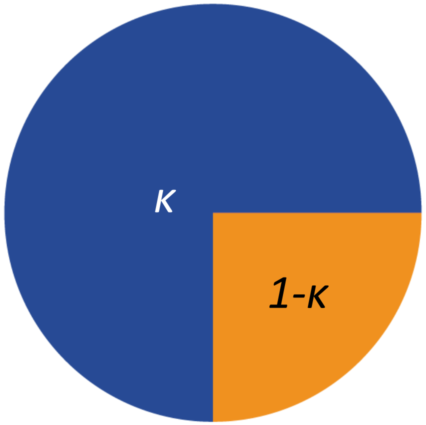

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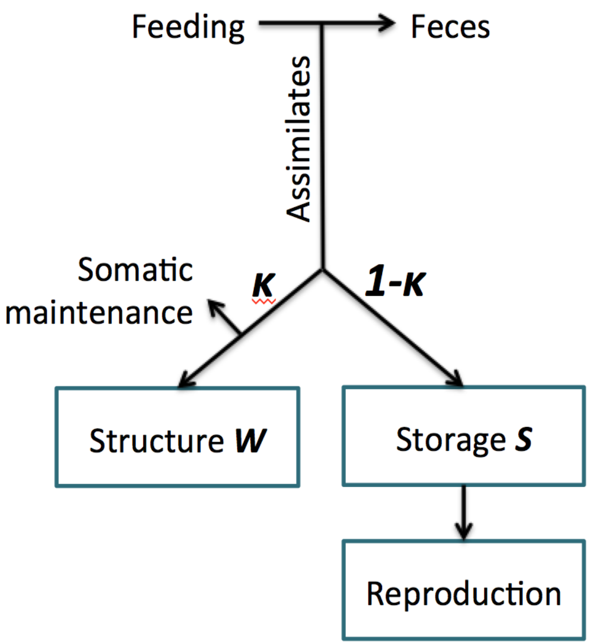

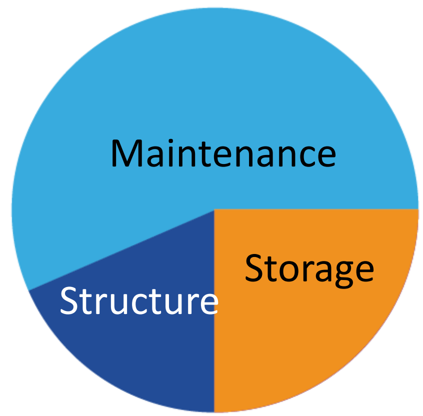

$$\frac{dW}{dt} = \kappa\,(f\,J_a\,W^{2/3}) - J_M^v\,W$$

$$\frac{dS}{dt} = (1-\kappa) f\,J_a\,W^{2/3}$$

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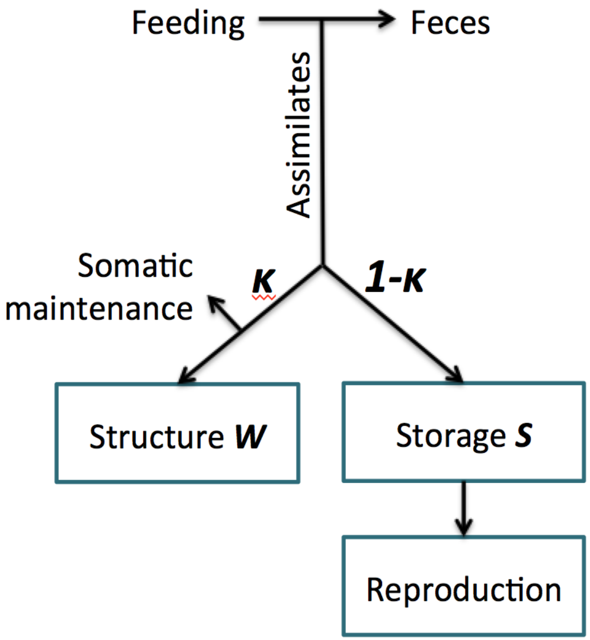

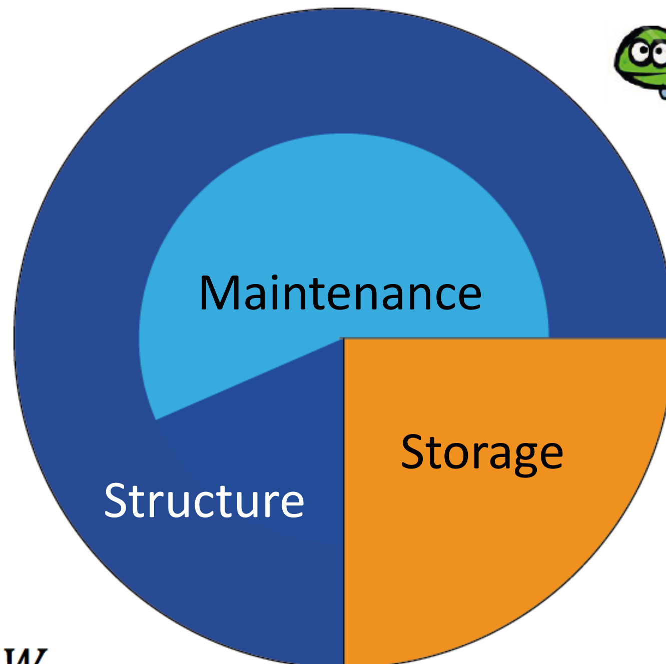

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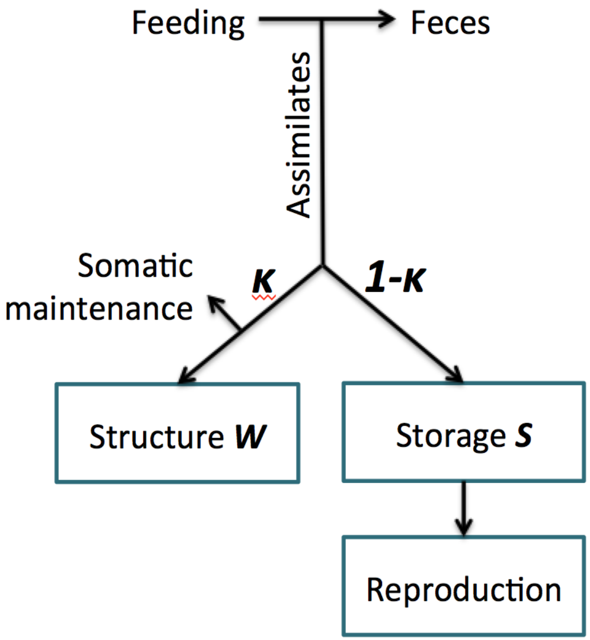

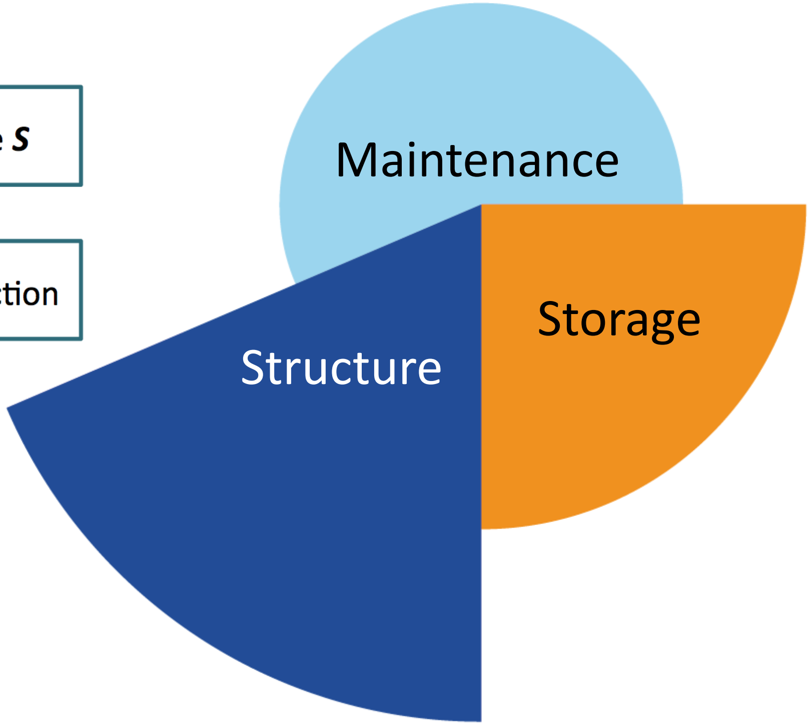

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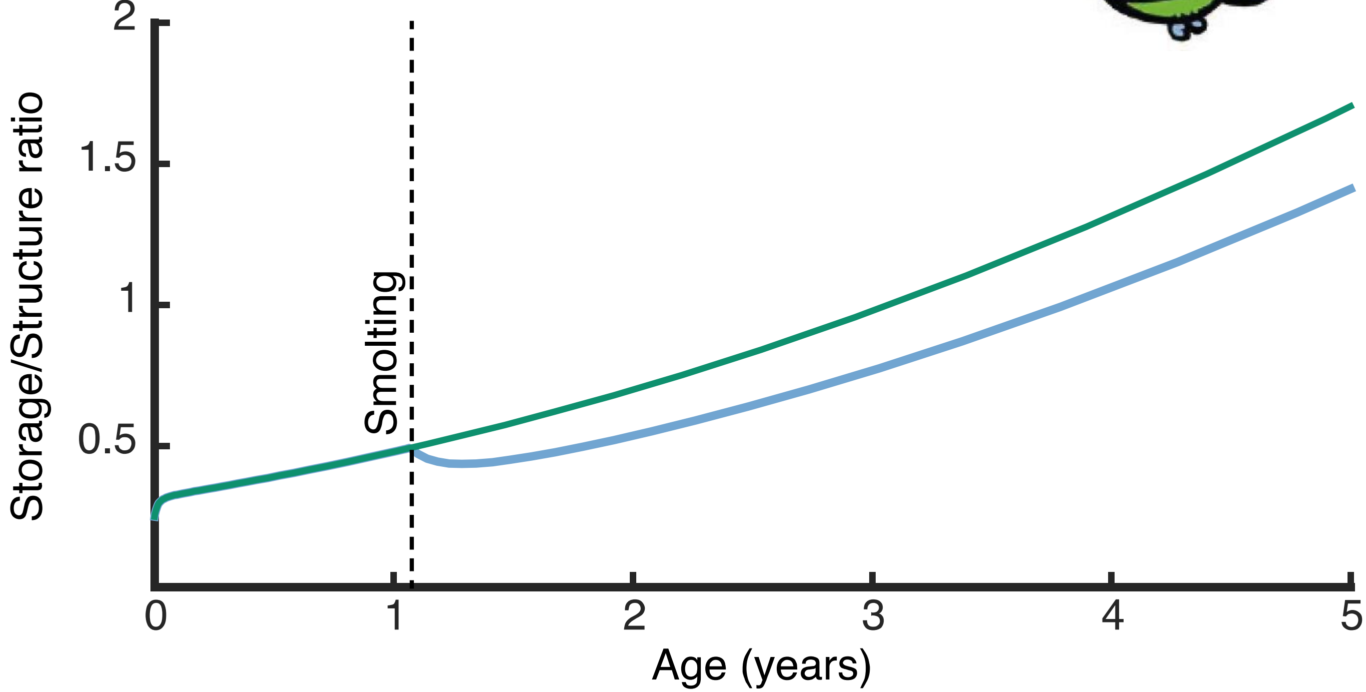

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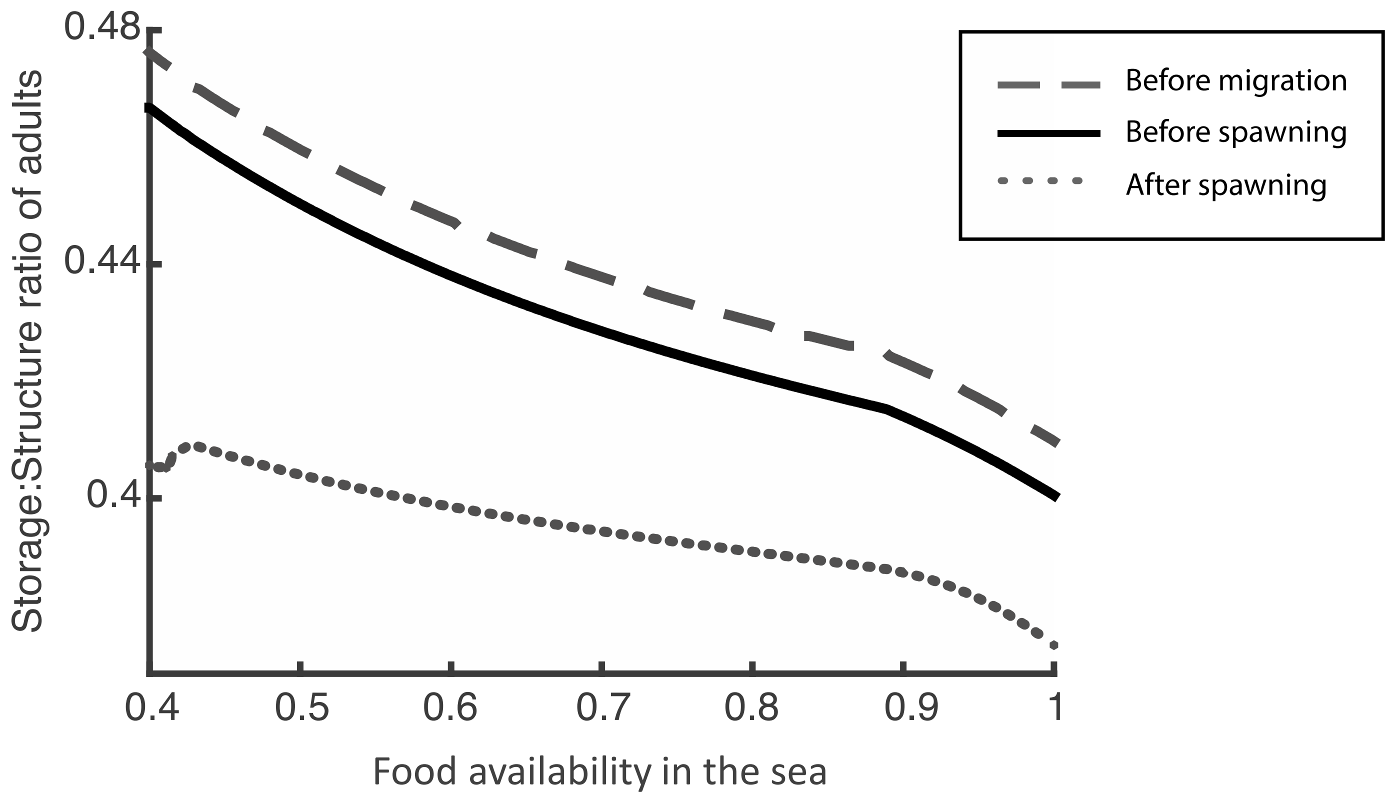

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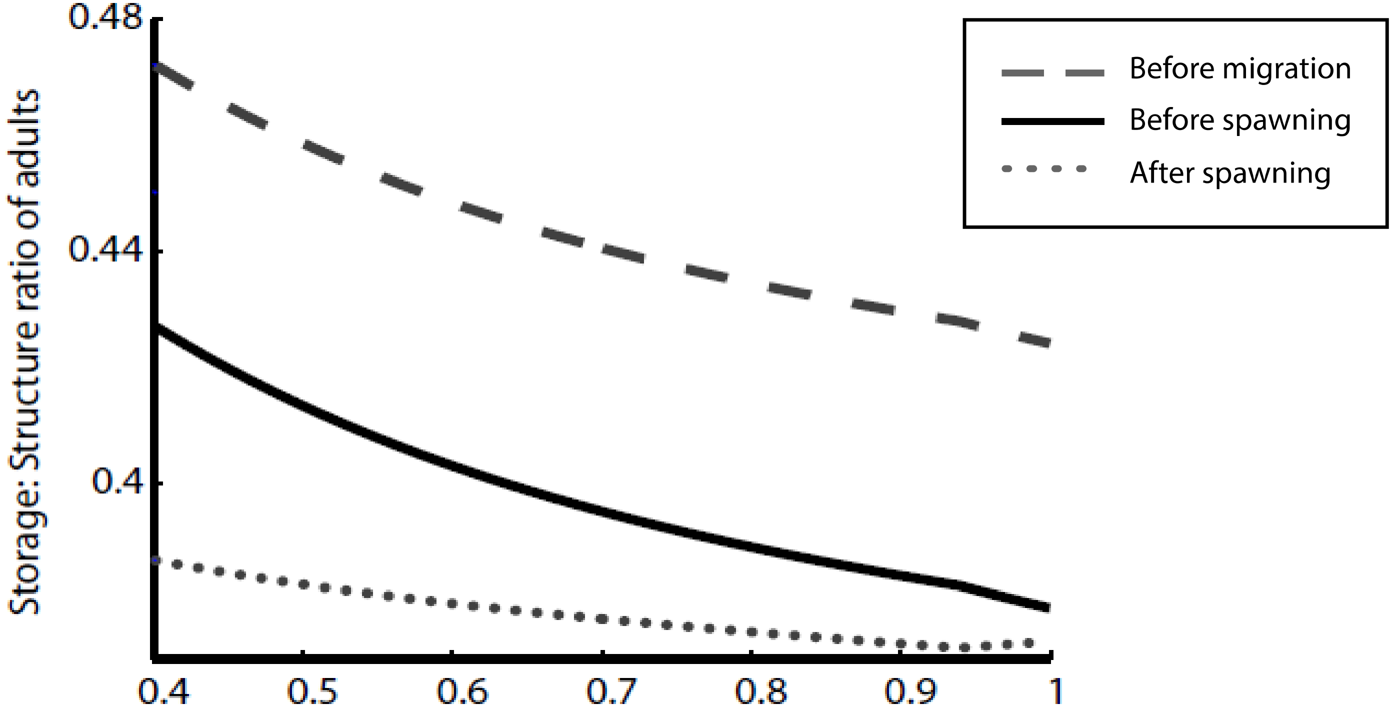

Food availability in the sea