

Optimal life-histories in seasonal environments

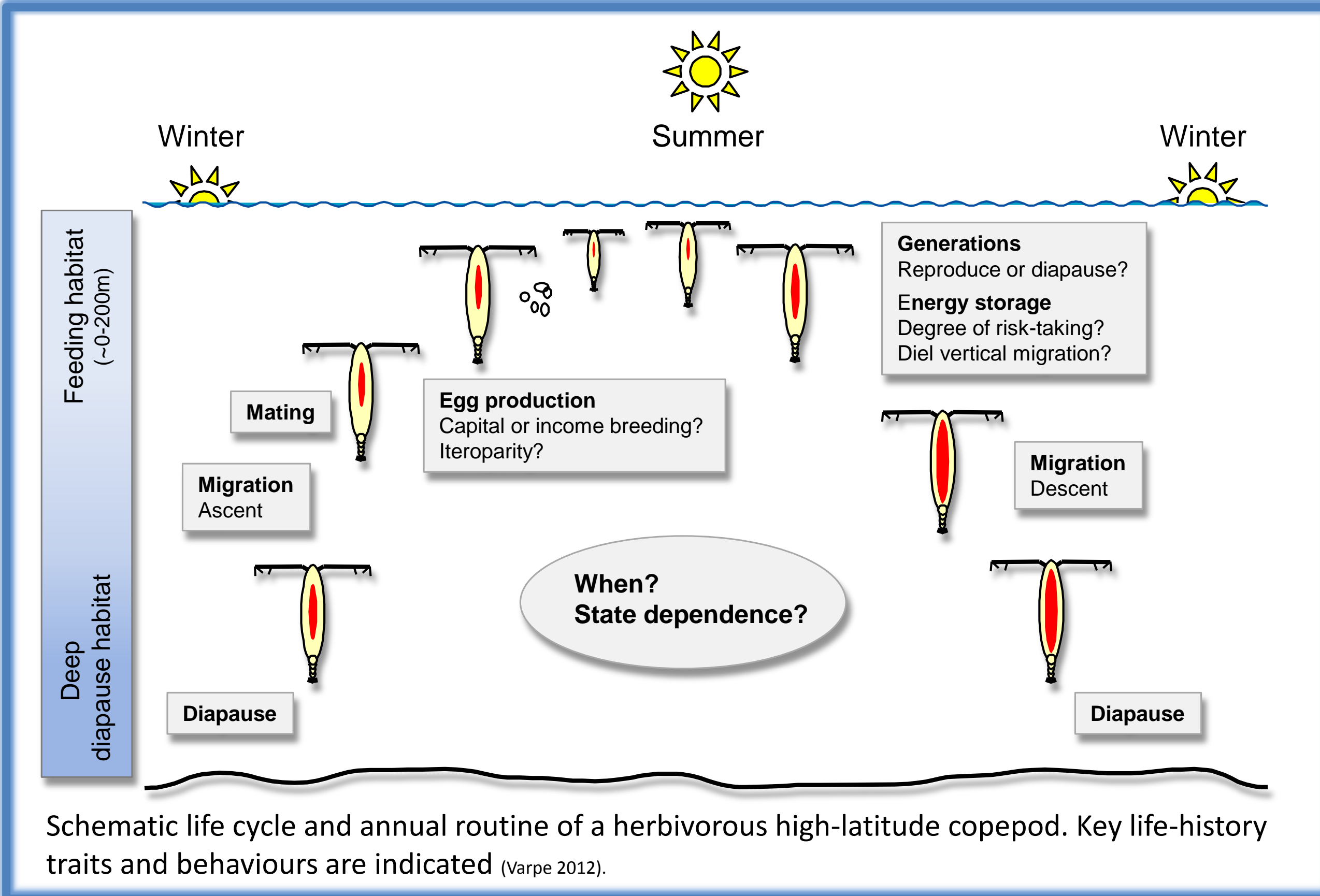
Modeling copepod strategies

Øystein Varpe - Akvaplan-niva and University Centre in Svalbard (UNIS)

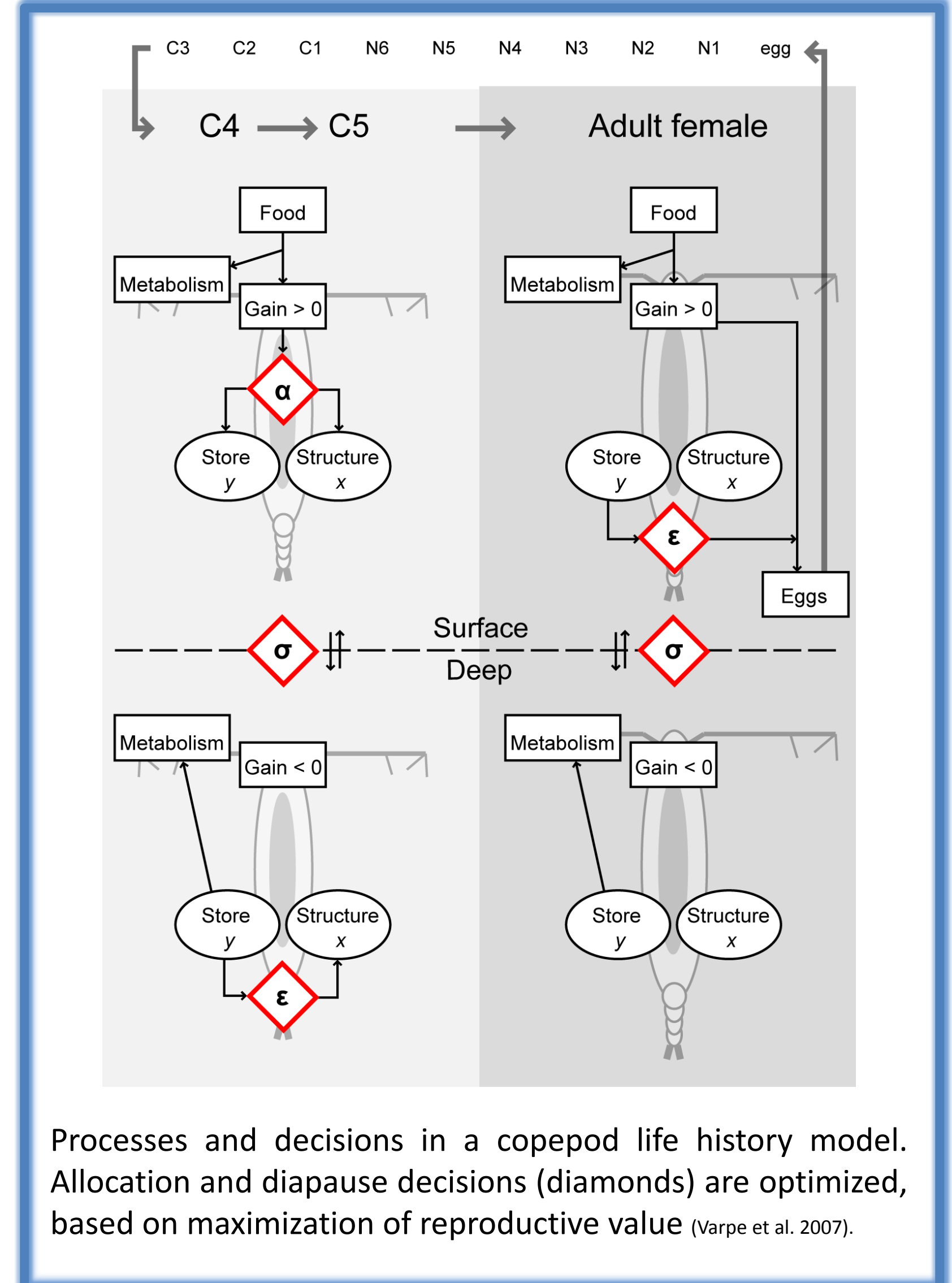
Introduction

Behavior and life-history strategies of zooplankton have evolved in response to seasonal cycles in food availability, predation risk and abiotic conditions. How are the different activities over the year linked and what are their optimal schedule? Here I present a state-dependent life history model for a herbivorous high-latitude copepod as well as some recent empirical studies developing methods and testing predictions.

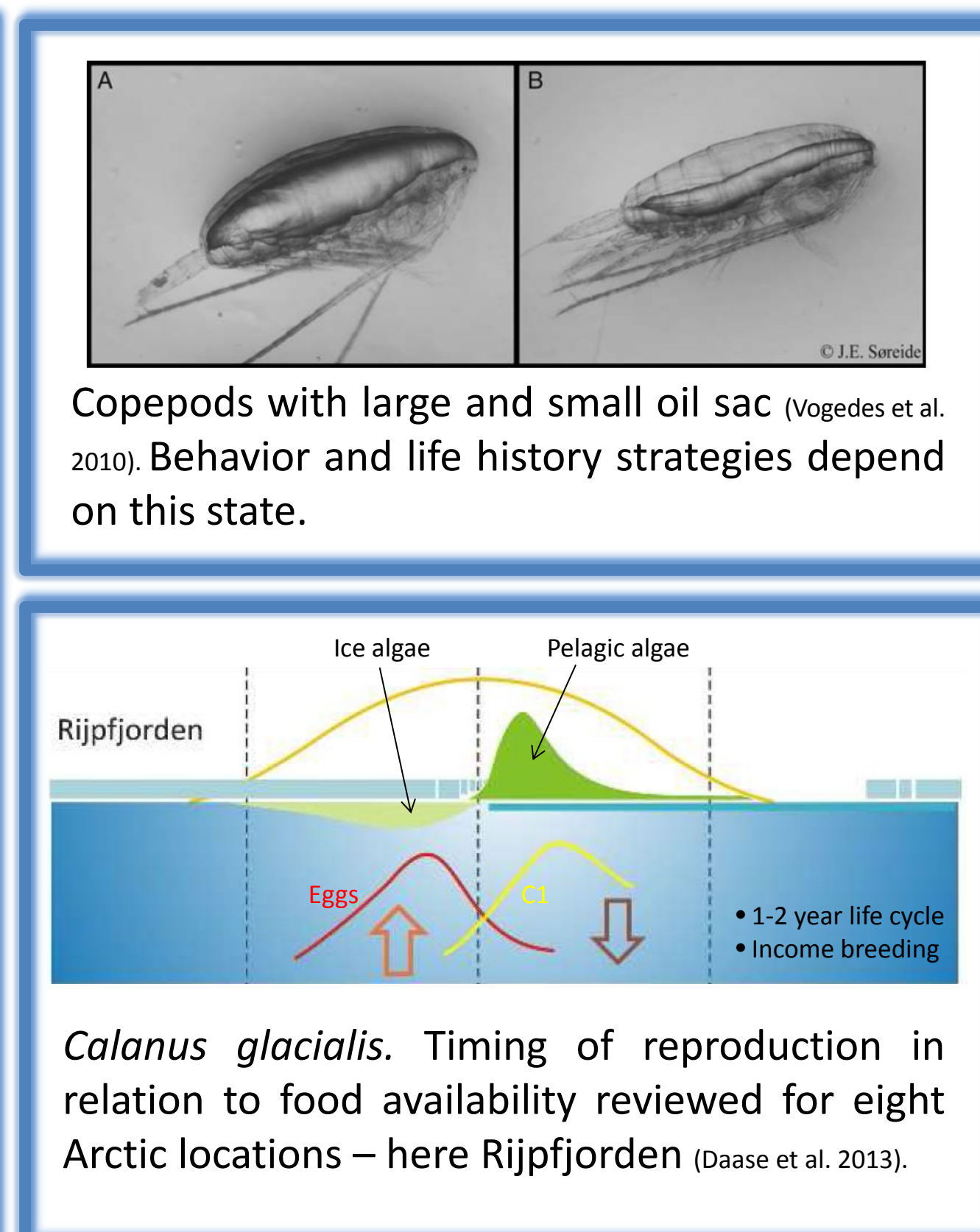
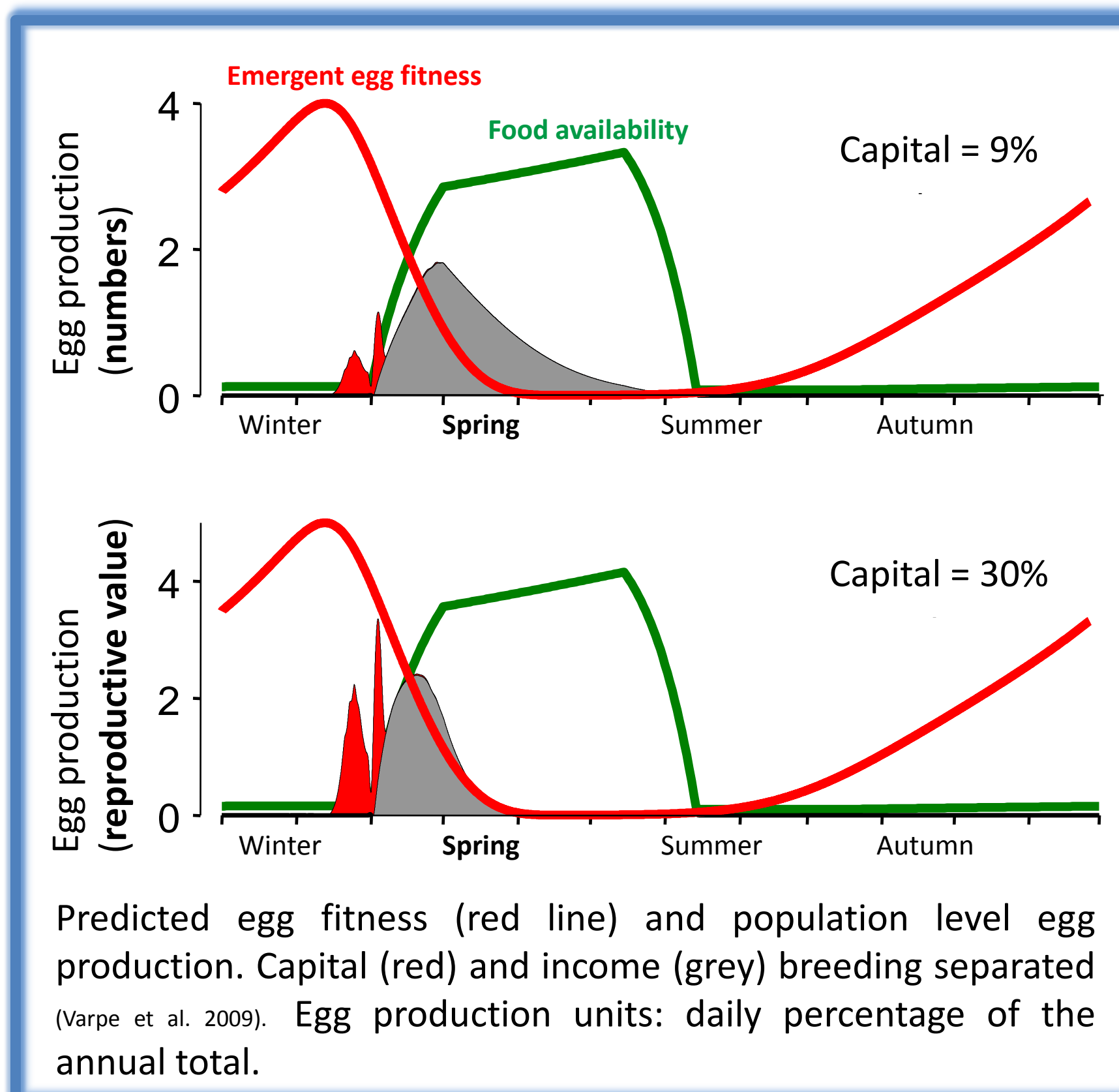
Background and research questions



Model



Results



Conclusions

The **reproductive value** of an egg is predicted to be highly seasonal. Time of peak egg fitness depends on the interaction between food availability and predation risk. Most eggs were produced later than the time of peak egg fitness - an **internal life history mismatch**. Knowing the seasonality in offspring fitness is essential to appreciate evolutionary and population-level consequences of **capital breeding**.

Field studies need to consider state-dependent behaviour and strategies. The pronounced regional and **intra-specific variability** in *Calanus glacialis* life history and phenology is partly explained by the dynamics of the bimodal food source (ice algae followed by pelagic algae).

Thanks

This work would not have been possible without the valuable collaboration with **Christian Jørgensen** and **Øyvind Fiksen** on modelling and **Janne E. Søreide** and **Malin Daase** on empirical studies.

References

MODELS: Varpe Ø., Jørgensen C., Tarling G.A. & Fiksen Ø. (2007). Early is better: seasonal egg fitness and timing of reproduction in a zooplankton life-history model. *Oikos*, 116, 1331-1342. Varpe Ø., Jørgensen C., Tarling G.A. & Fiksen Ø. (2009). The adaptive value of energy storage and capital breeding in seasonal environments. *Oikos*, 118, 363-370. **REVIEW AND LOOKOUT:** Varpe Ø. (2012). Fitness and phenology: annual routines and zooplankton adaptations to seasonal cycles. *J. Plankton Res.*, 34, 267-276. **EMPIRICAL TESTS AND METHODS:** Vogedes D., Varpe Ø., Søreide J.E., Graeve M., Berge J. & Falk-Petersen S. (2010). Lipid sac area as a proxy for individual lipid content of arctic calanoid copepods. *J. Plankton Res.*, 32, 1471-1477. Daase M., Falk-Petersen S., Varpe Ø., Darnis G., Søreide, J. E. et al. (2013). Timing of reproductive events in the marine copepod *Calanus glacialis*: a pan-Arctic perspective. *Can. J. Fish. Aquat. Sci.*, 70, 871-884. Bailey A., Søreide J.E. & Varpe Ø. (in prep). State-dependent seasonal migrations of a high-latitude copepod.