

The Coltrane copepod model

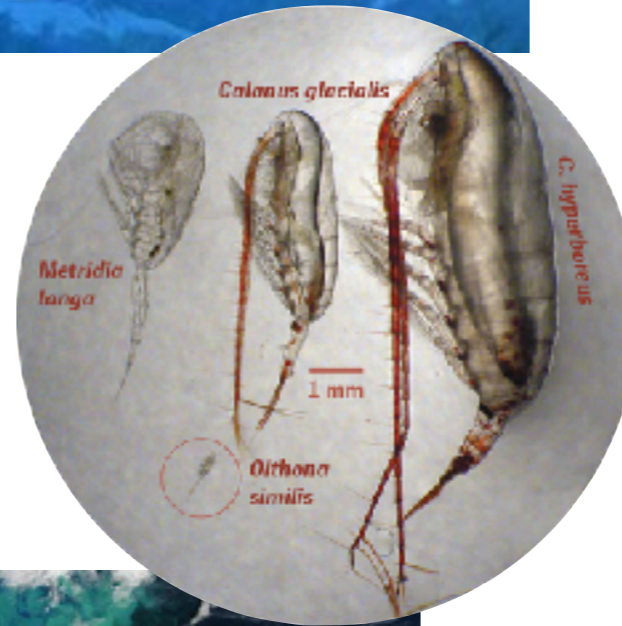
DIAPOD WP5 + PRIZE WP4

Neil Banas (Strathclyde) + a cast of thousands

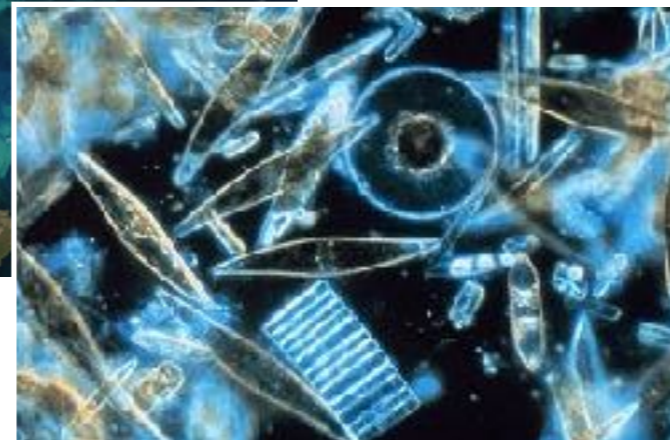
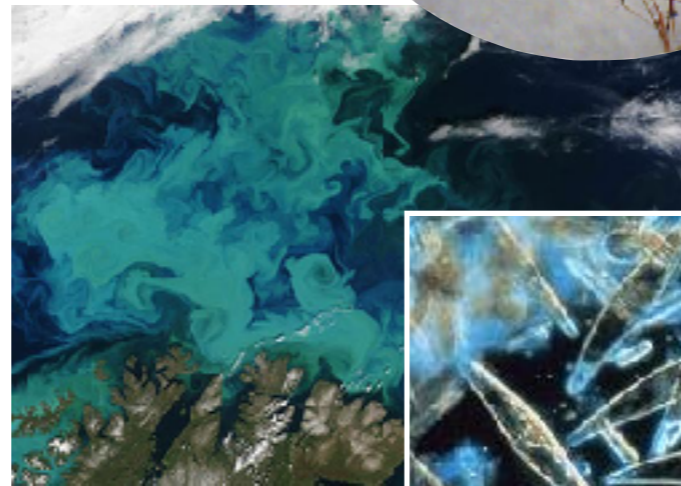


life history
 seasonal migrations
 individual bioenergetics
 foraging behaviour
 predation, competition

...



?



?

total primary productivity
 community metabolism

Where does life history strategy come into this problem?

Past approaches

Optimal annual routines

(Varpe et al. 2007, 2009; Houston & McNamara 1999, Clark & Mangel 2000)

focus on reserves
and timing

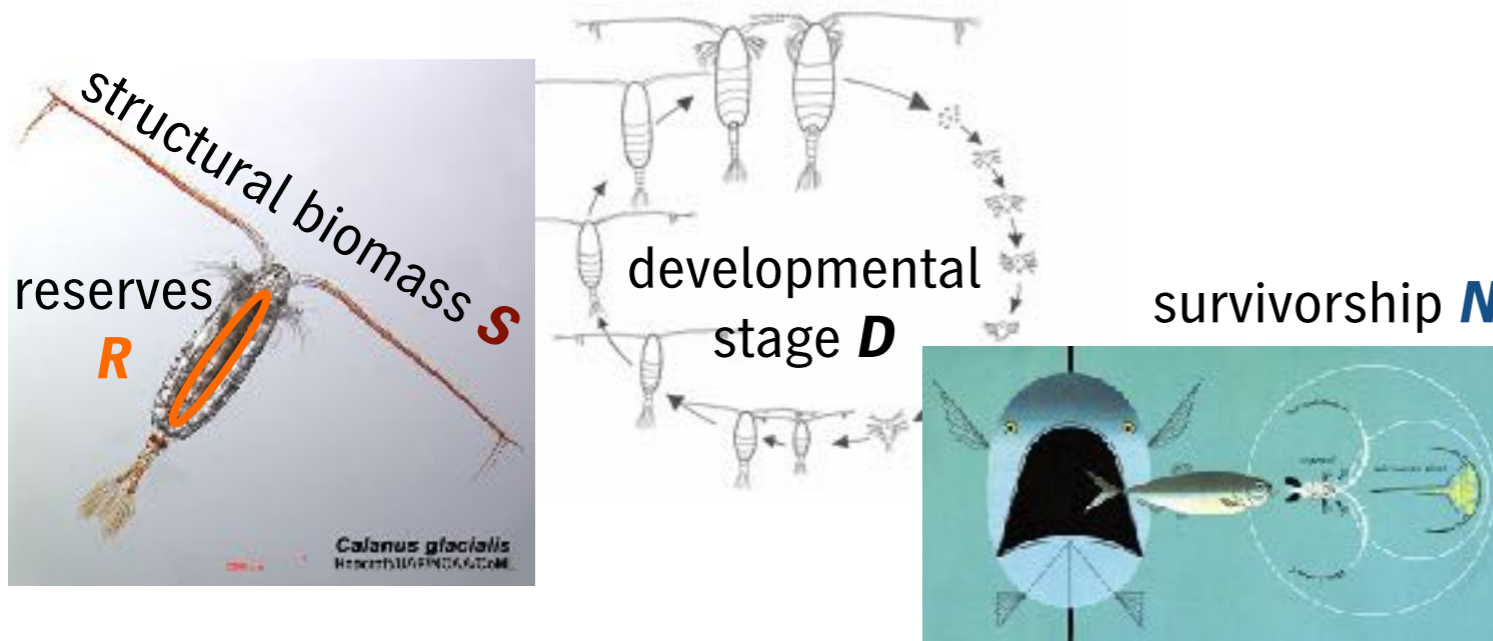
Emergent copepod communities

(Record et al. 2013)

trait-based
metacommunity

Coltrane (Copepod Life-history traits and adaptation to novel environments)

(Banas et al. *Front. Mar. Res.*, 2016)



population:
annual cycle,
net growth rate



small number of variable traits



community
associated with a
given environment

Steps

Define or assume an annual cycle of **activity level**.

Data comparisons

- Explicable in terms of prey, or prey + risk?



Steps

Define or assume an annual cycle of **activity level**.

Calculate **development** sequence, for all possible spawning dates.

Data comparisons

- Explicable in terms of prey, or prey + risk?
- Abundance by stage
- Generation length

Thresholds

Diapause-capable by winter

(cf. Ji et al. 2011, Feng et al. 2017)



Steps

Define or assume an annual cycle of **activity level**.

Calculate **development** sequence, for all possible spawning dates.

Calculate **net energy gain** (ingestion minus metabolism), **body size**, and **egg production**.

*(During development, gain = growth;
In adulthood, gain = income egg production;
Capital egg prod. \leq adult body size)*

Data comparisons

- Explicable in terms of prey, or prey + risk?
- Abundance by stage
- Generation length
- Adult body size, or size vs. stage

Thresholds

Diapause-capable by winter

Overwintering without starving



Steps

Define or assume an annual cycle of **activity level**.

Calculate **development** sequence, for all possible spawning dates.

Calculate **net energy gain** (ingestion minus metabolism), **body size**, and **egg production**.

Integrate predation mortality: timeseries of **survivorship**.

Calculate **fitness** (eggs egg^{-1}).

Data comparisons

- Explicable in terms of prey, or prey + risk?
- Abundance by stage
- Generation length
- Adult body size, or size vs. stage
- Lifetime egg prod.
- Direct mortality est.

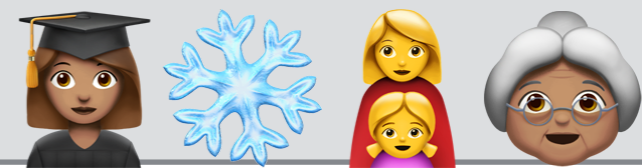
Thresholds

Diapause-capable by winter

Overwintering without starving

Reproduce at replacement rate

VIABLE!



Steps

Define or assume an annual cycle of **activity level**.

Calculate **development** sequence, for all possible spawning dates.

Calculate **net energy gain** (ingestion minus metabolism), **body size**, and **egg production**.

Integrate predation mortality: timeseries of **survivorship**.

Calculate **fitness** (eggs egg⁻¹).

Repeat fitness calculation over 2+ generations, to find **spawning timing** that is able to repeat.

Data comparisons

- Explicable in terms of prey, or prey + risk?

- Abundance by stage
- Generation length

- Adult body size, or size vs. stage

- Lifetime egg prod.
- Direct mortality est.

- Lost generations?
- **Correlations among response traits**

Thresholds

Diapause-capable by winter

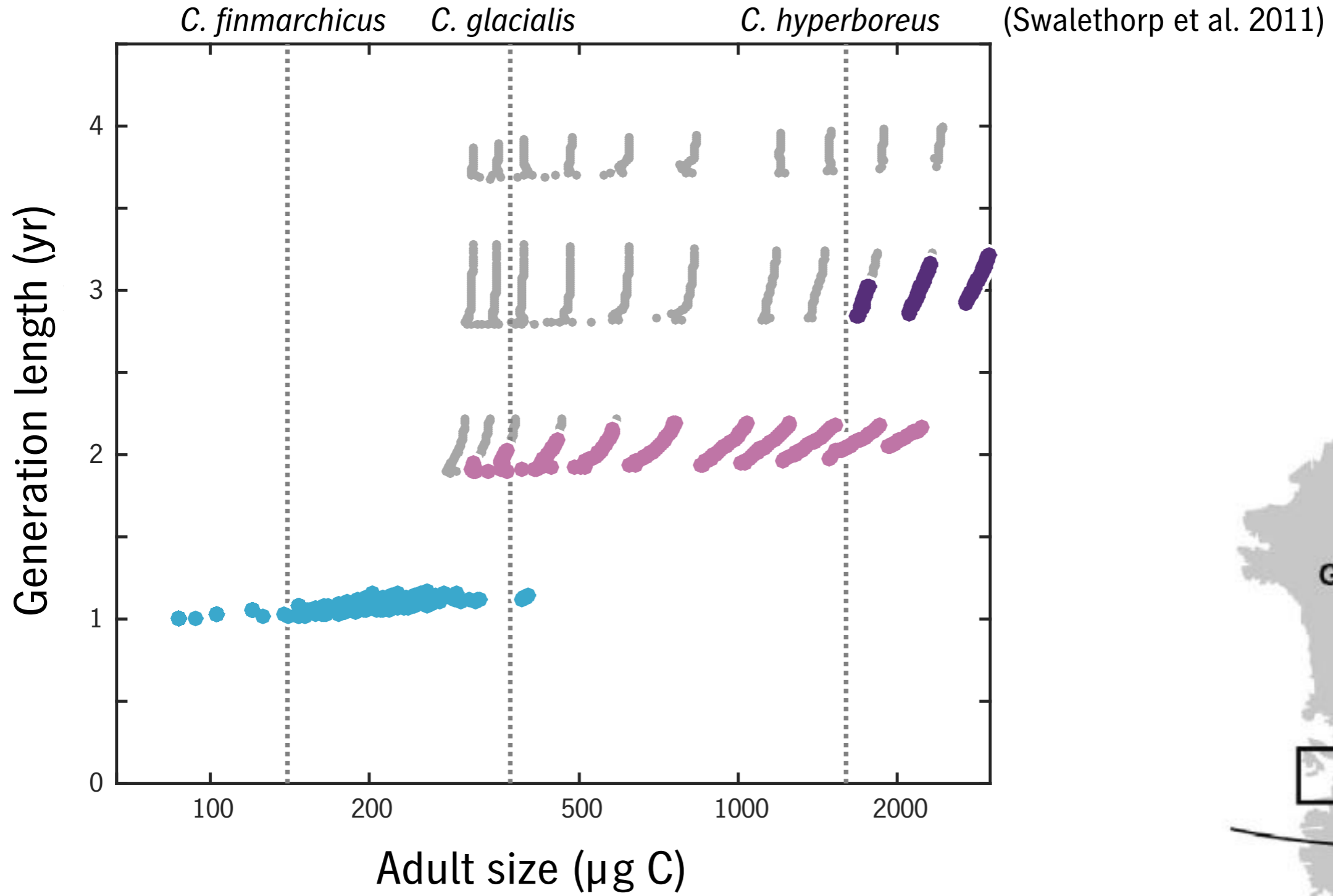
Overwintering without starving

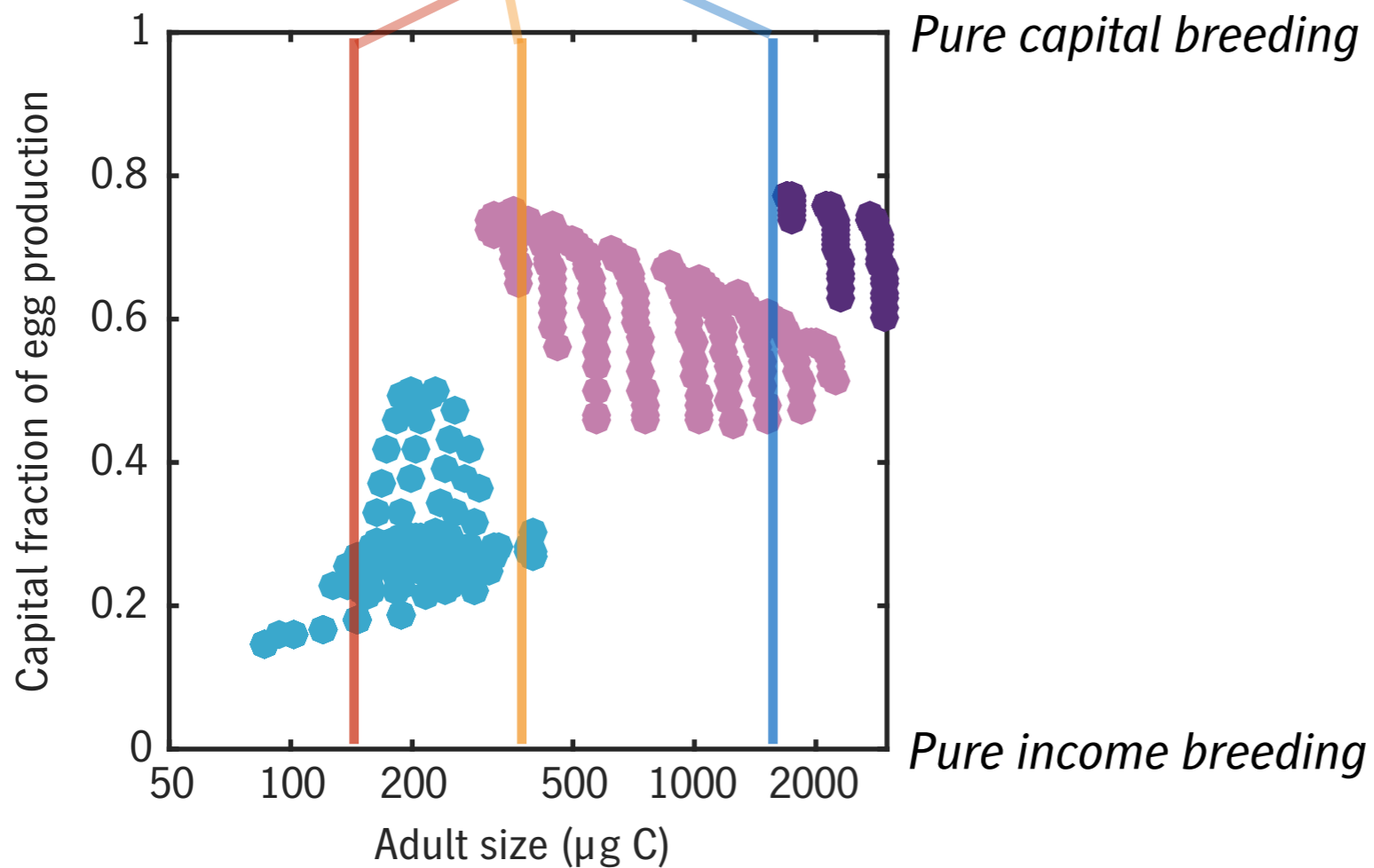
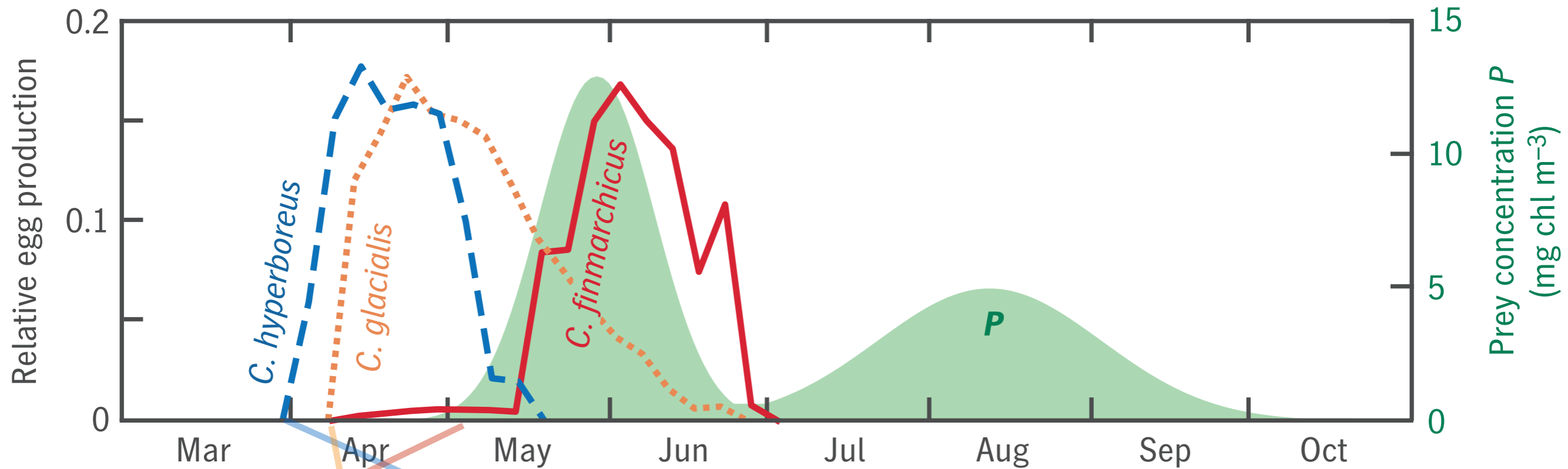
Reproduce at replacement rate

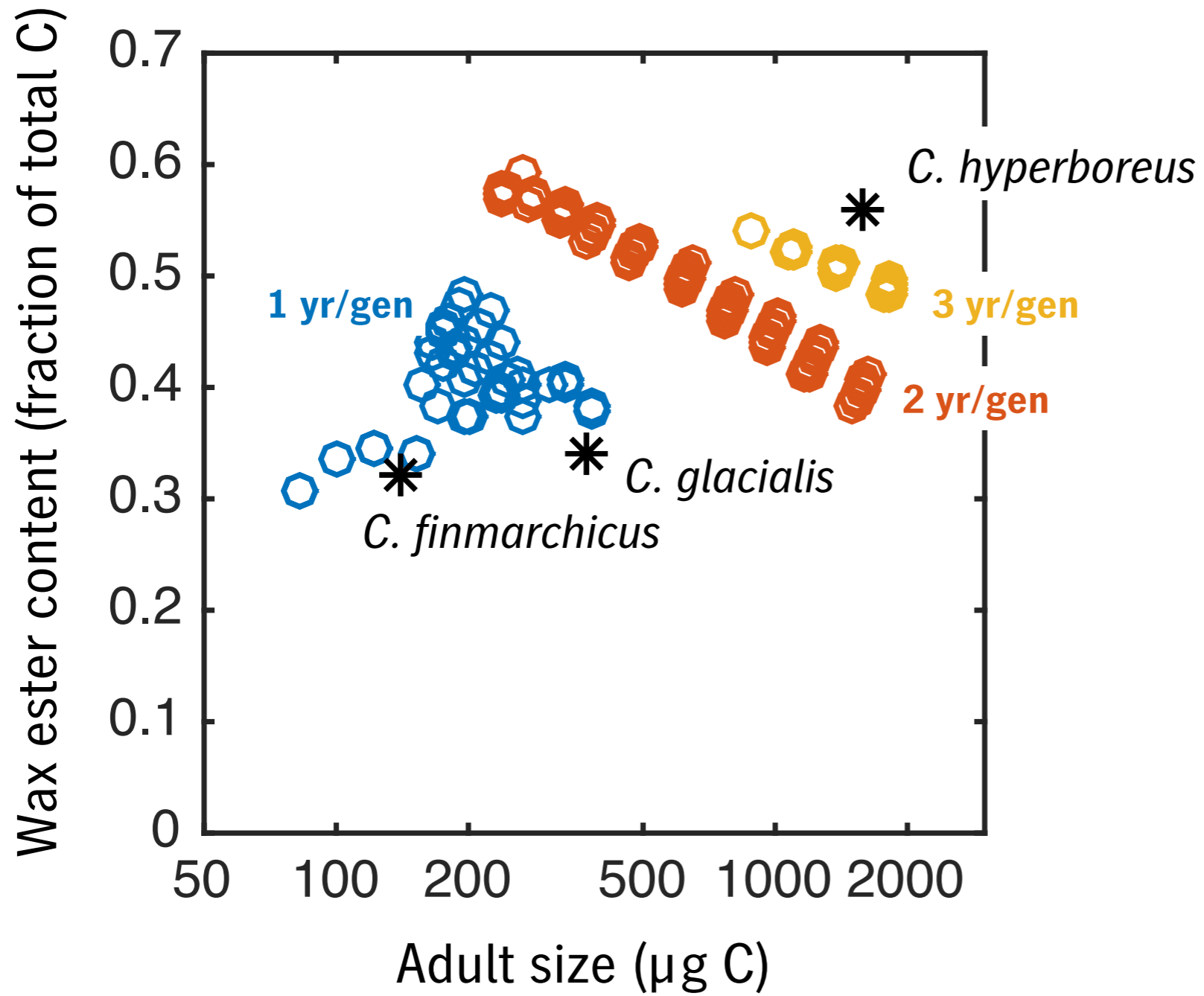
Solve internal life-history mismatch

Disko Bay, 1996–97 annual cycle

Banas et al., *Front. Mar. Res.*, 2017



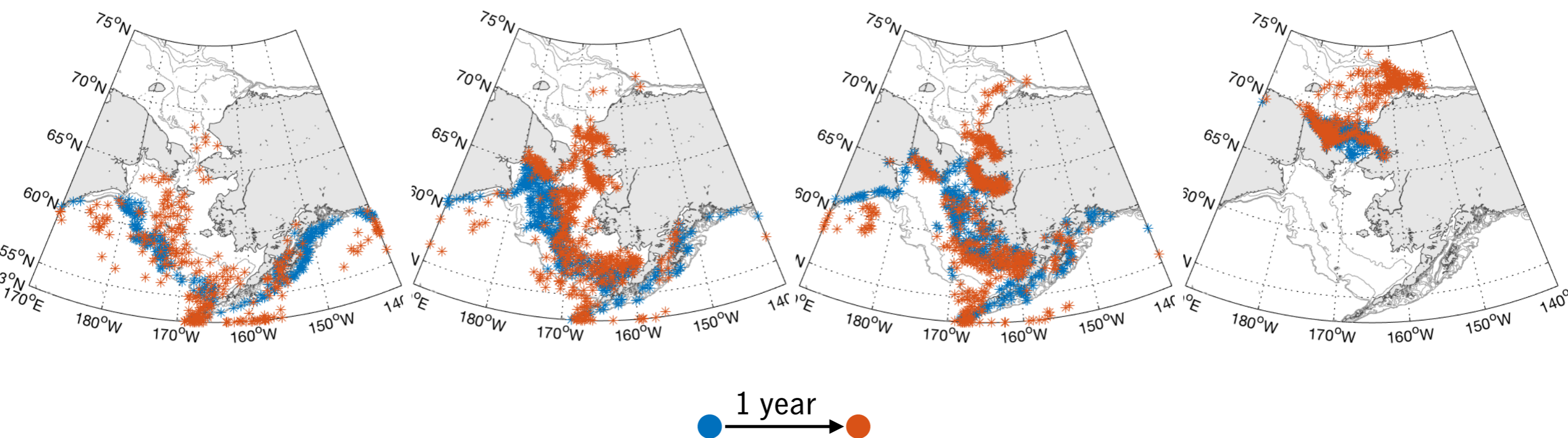




(* = Swalethorp et al. 2011)



Next step: life history along transport pathways



BIOMAS (Zhang et al. 2015)