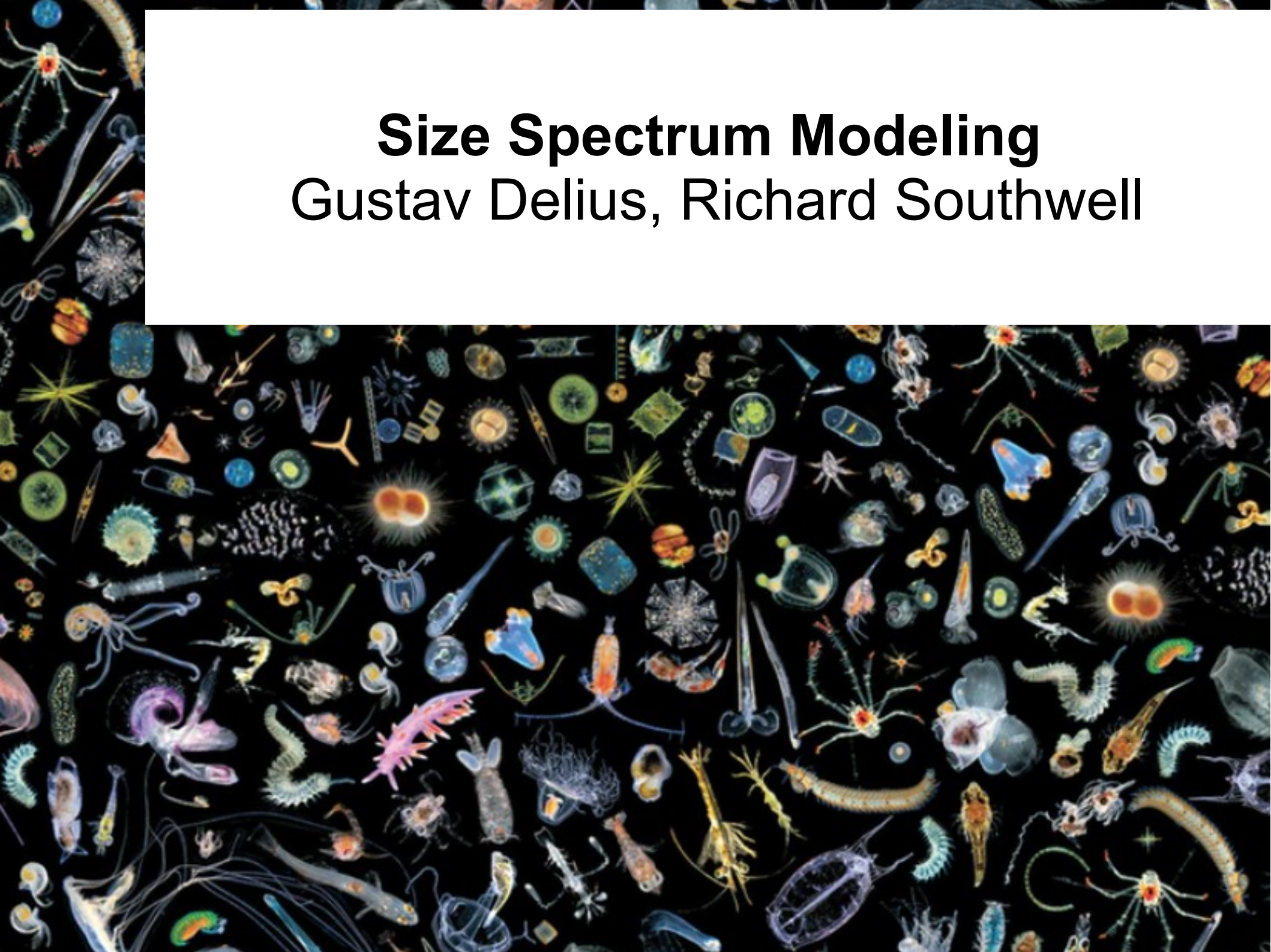
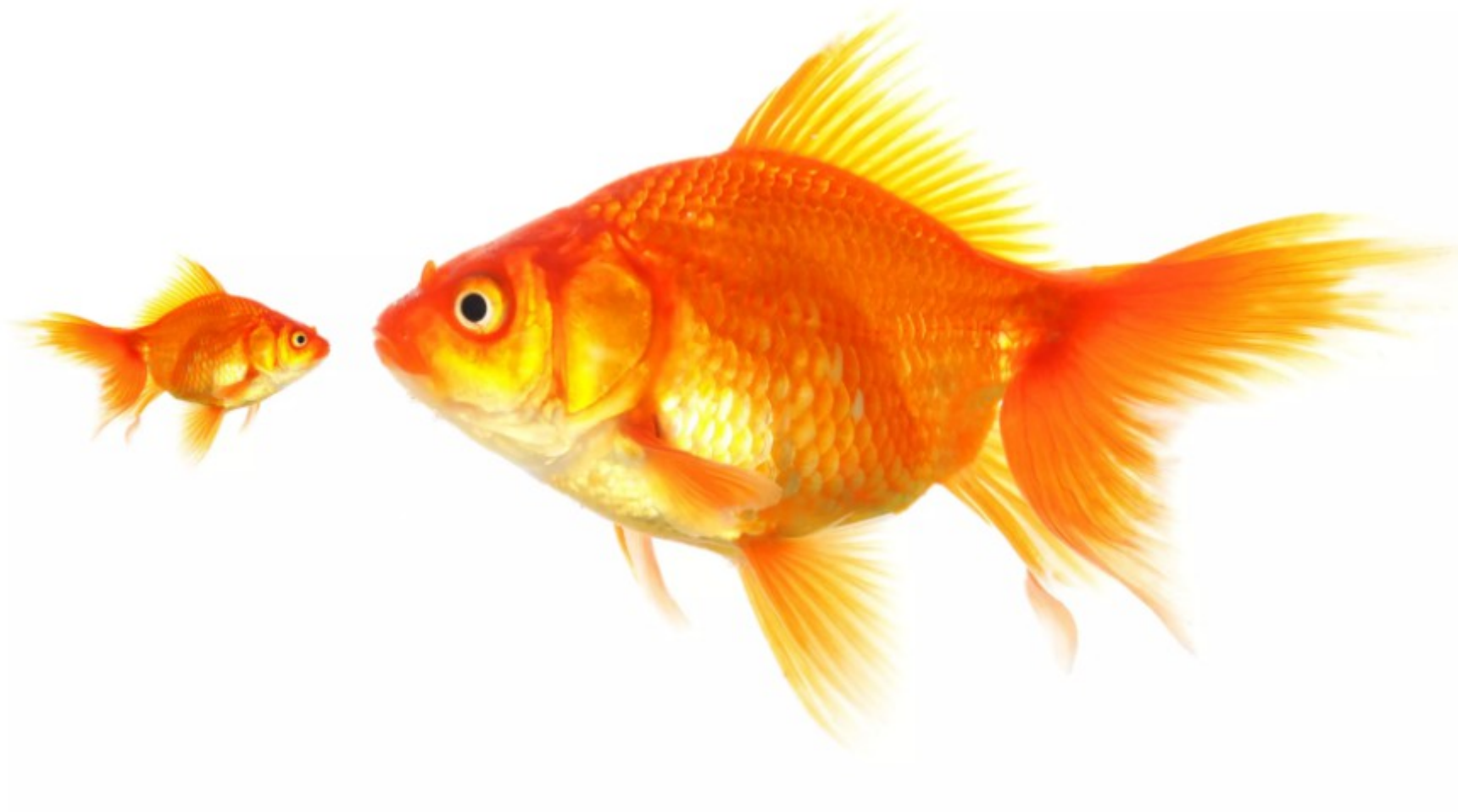
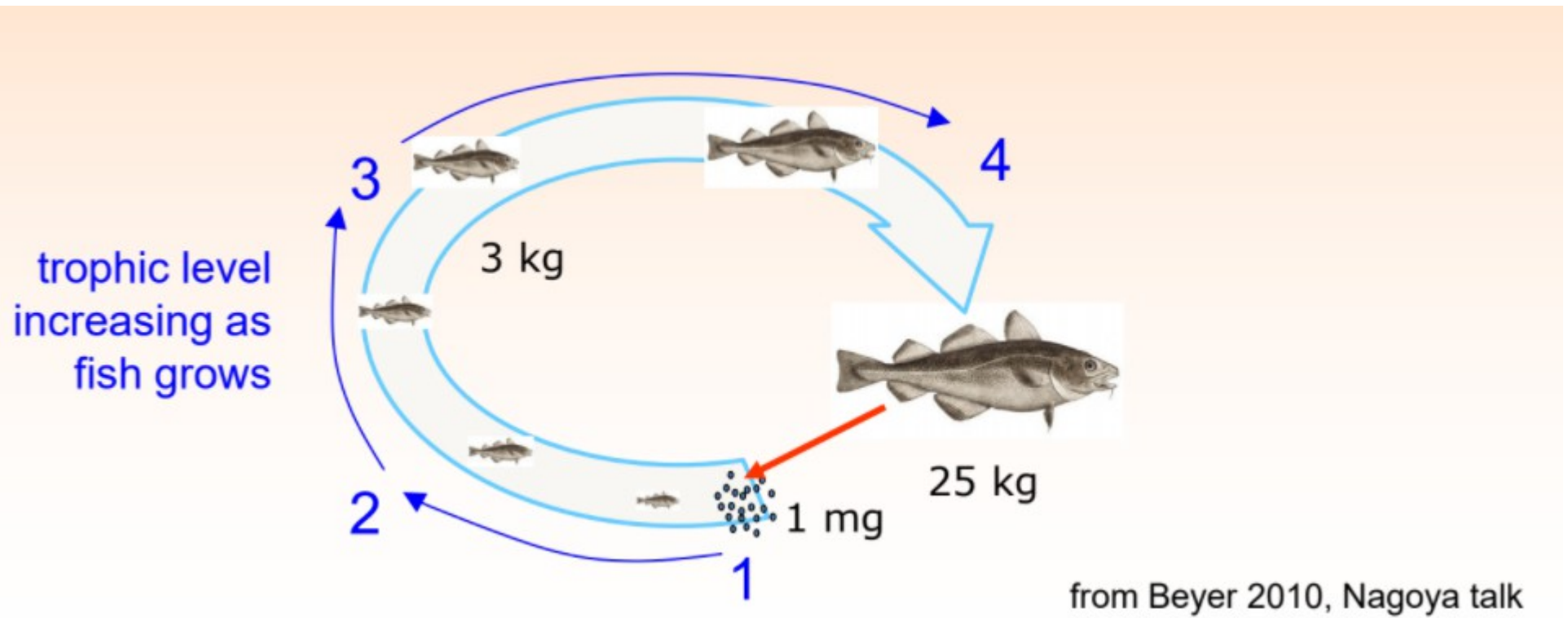


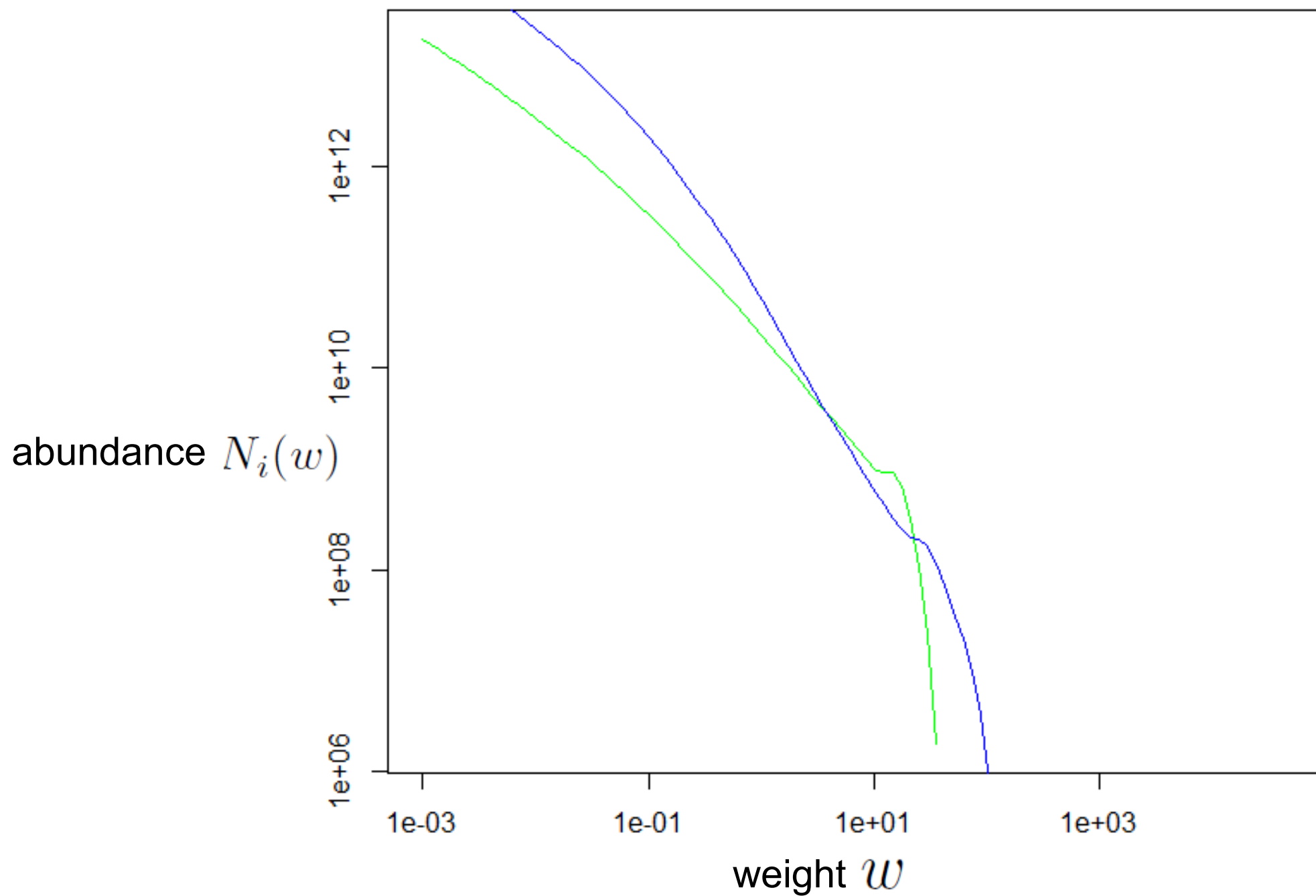
Size Spectrum Modeling

Gustav Delius, Richard Southwell



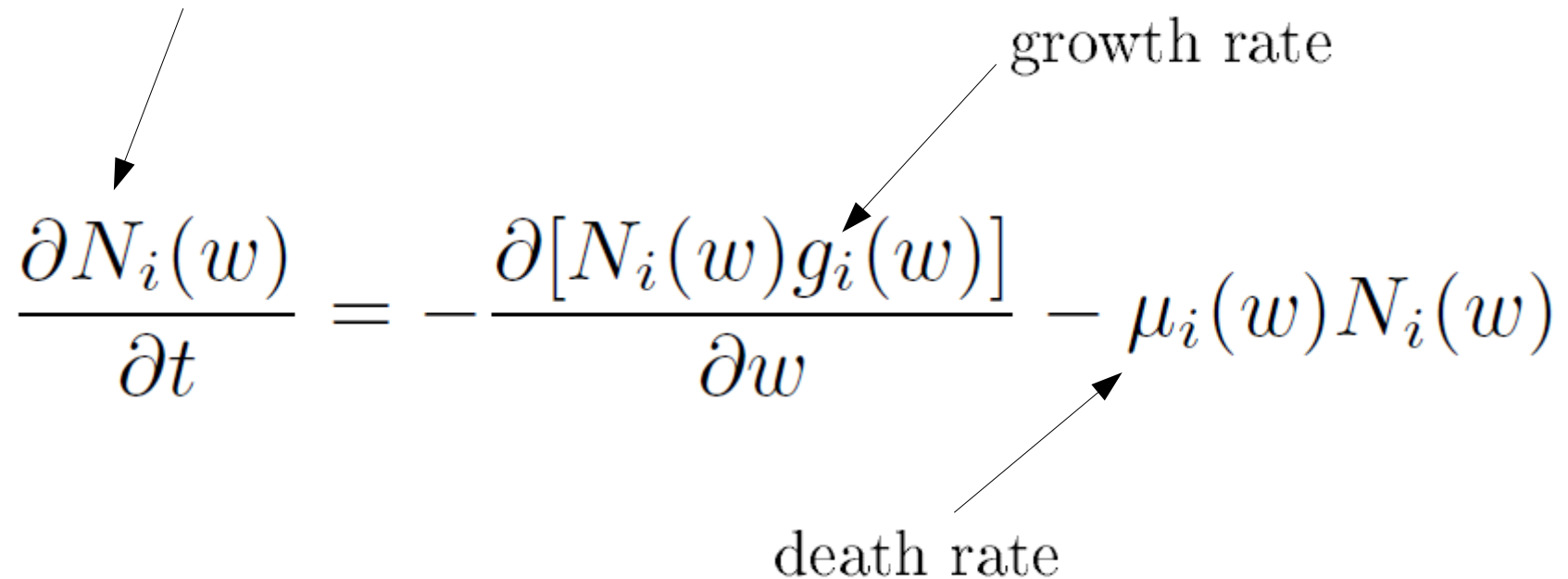






McKendrick-von Foerster equation

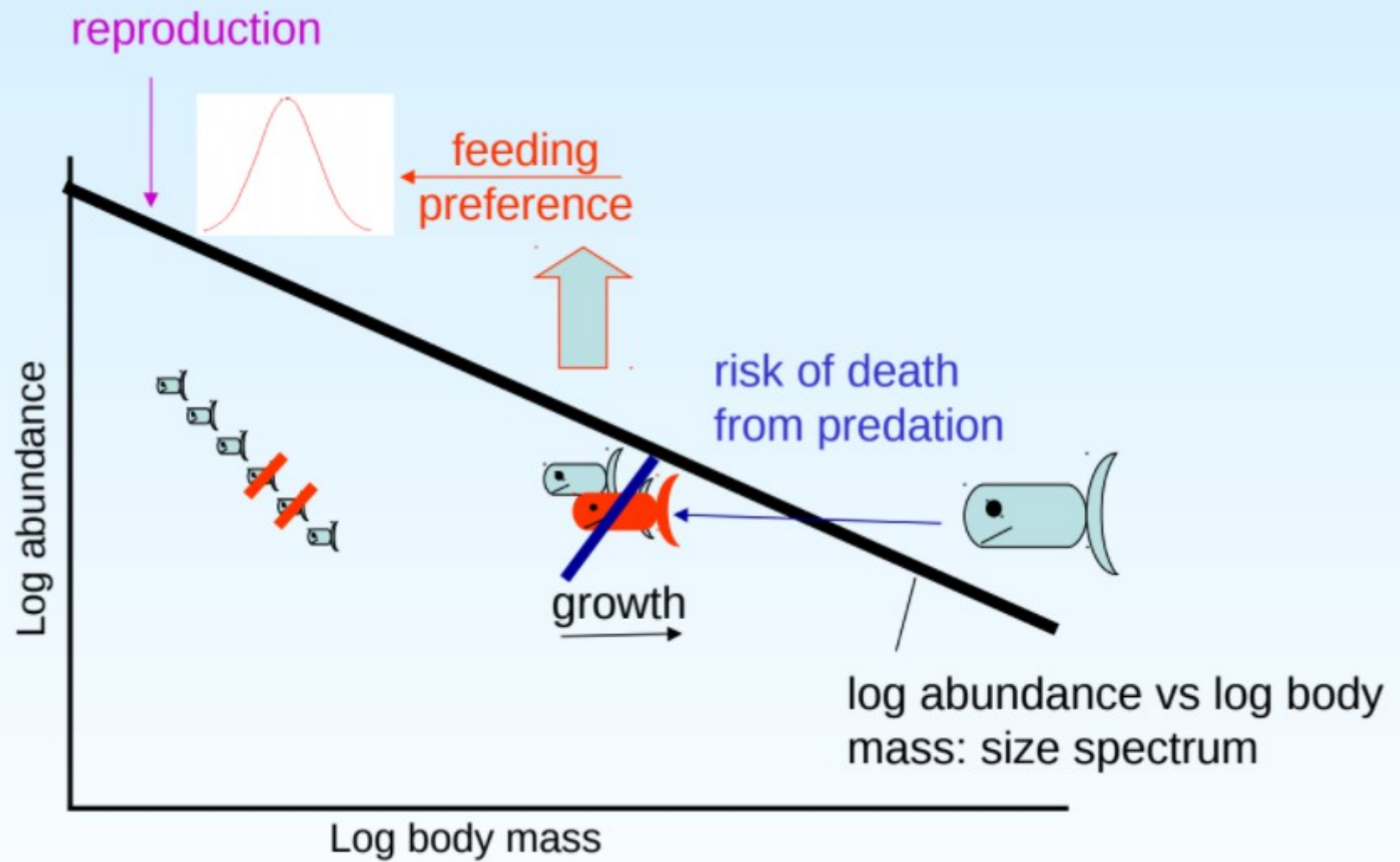
density of weight w individuals of species i

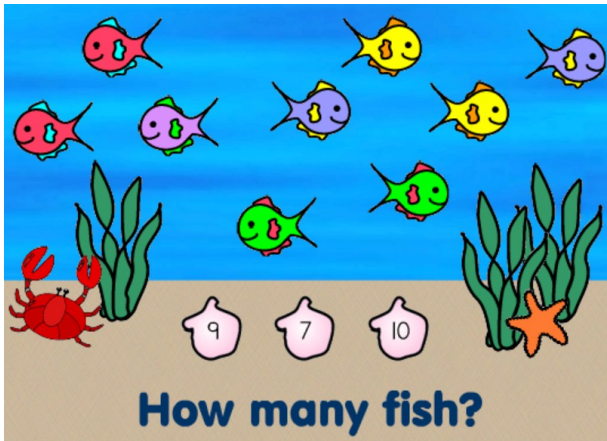


The diagram shows the McKendrick-von Foerster equation with three arrows pointing to its components:

- An arrow from the text "density of weight w individuals of species i " points to the term $\frac{\partial N_i(w)}{\partial t}$.
- An arrow from the text "growth rate" points to the term $g_i(w)$ inside the derivative.
- An arrow from the text "death rate" points to the term $\mu_i(w)$.

$$\frac{\partial N_i(w)}{\partial t} = - \frac{\partial [N_i(w) g_i(w)]}{\partial w} - \mu_i(w) N_i(w)$$

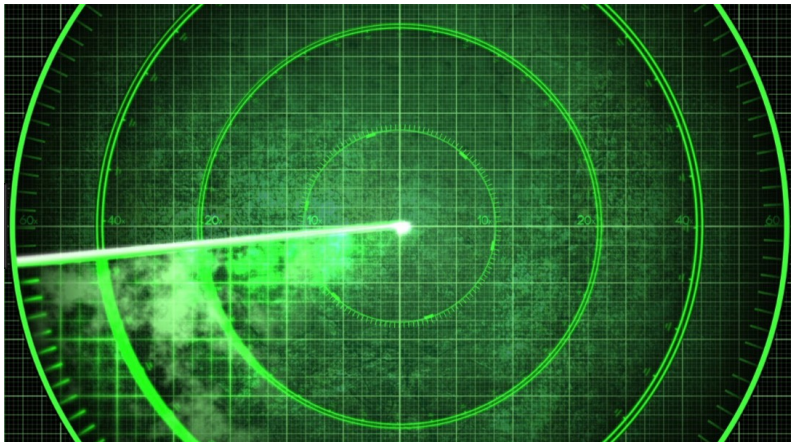




sum over prey



weight by preference



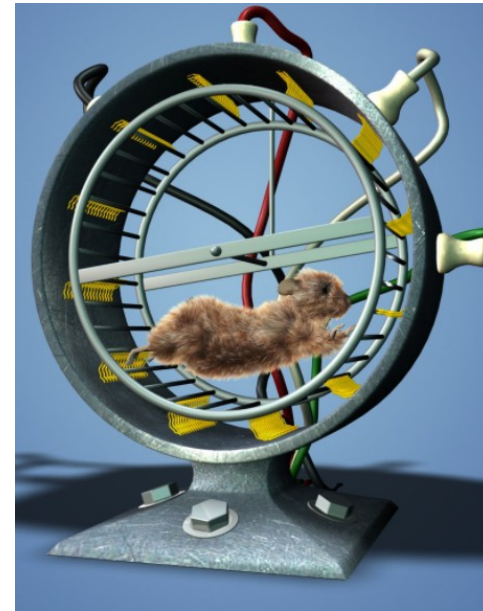
multiply by search rate of predator



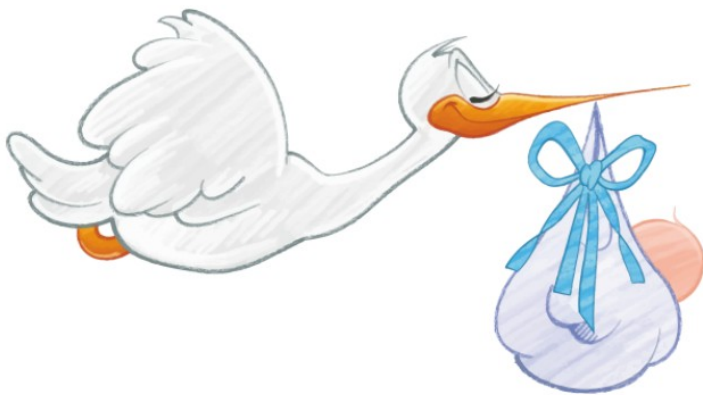
energy encountered



limited eating rate



energy costs for movement
and metabolism



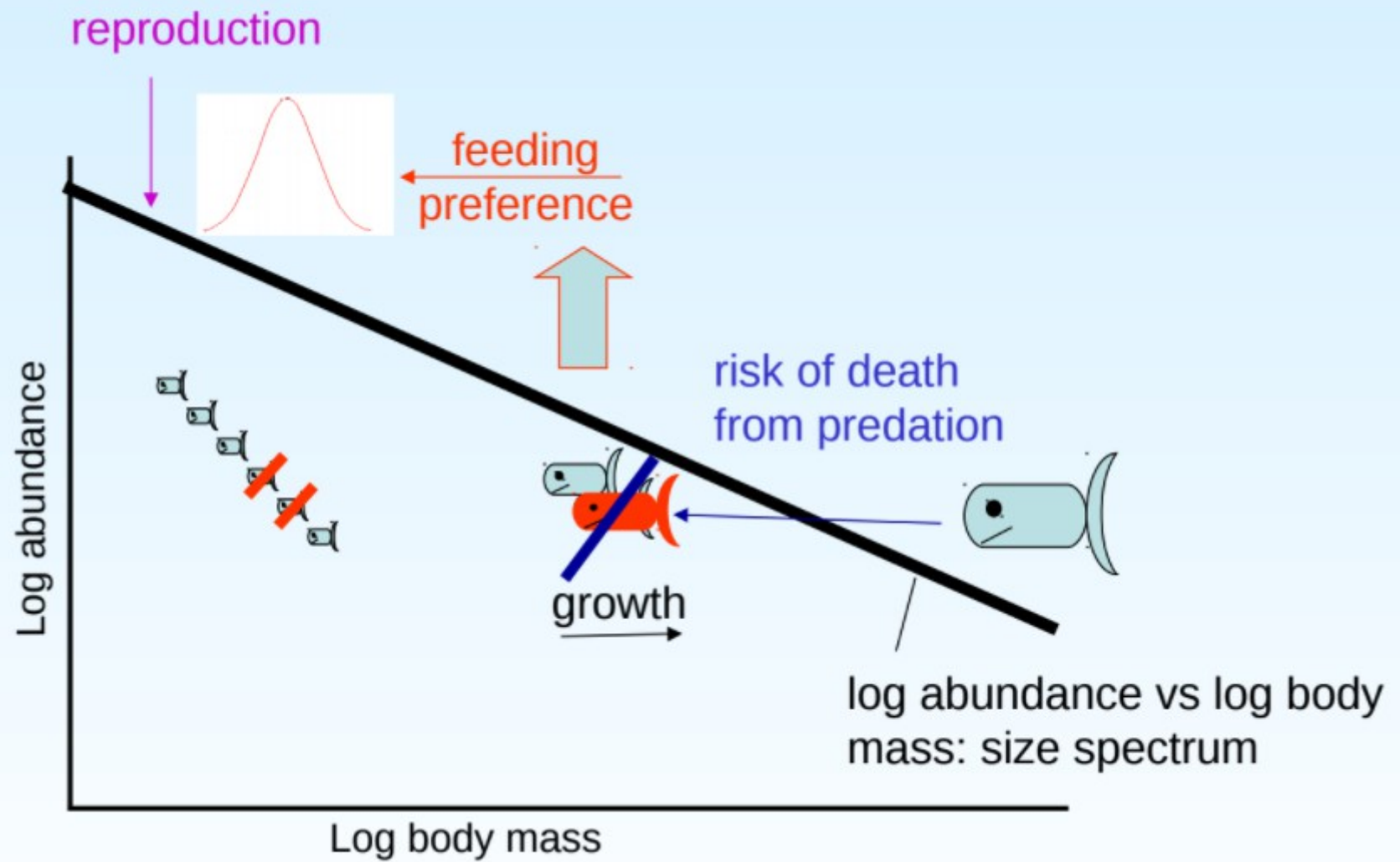
energy for reproduction



growth



?



energy available for growth and reproduction

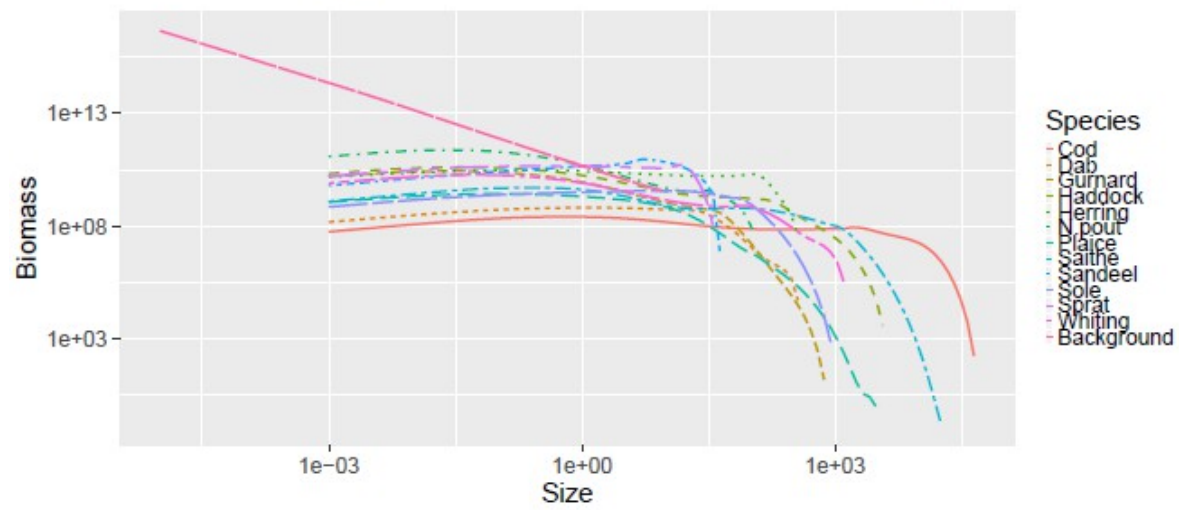
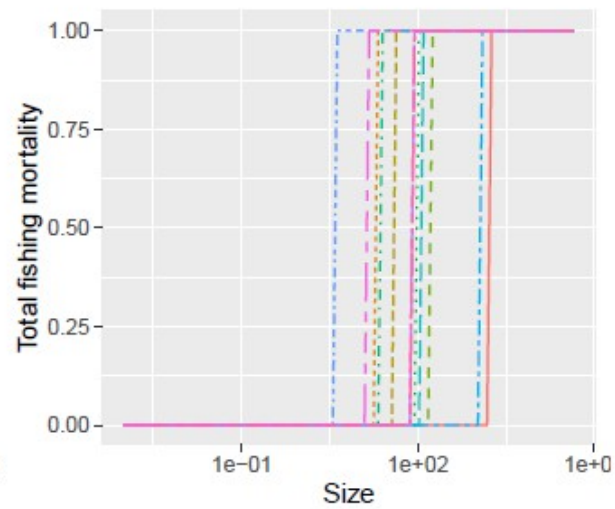
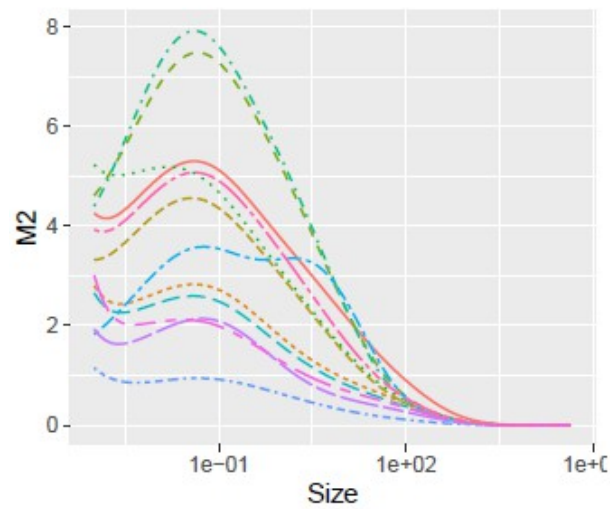
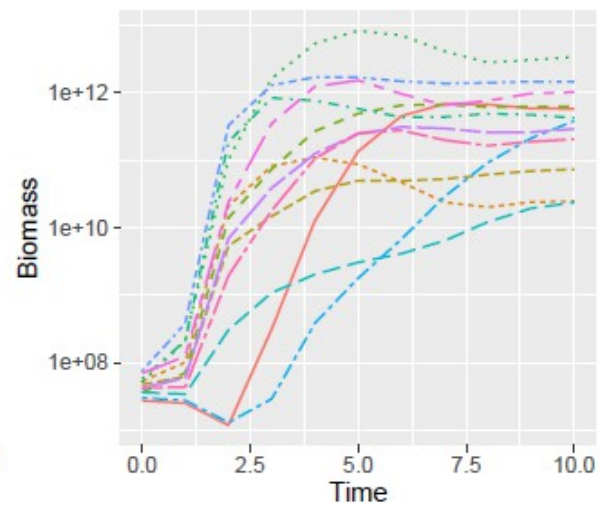
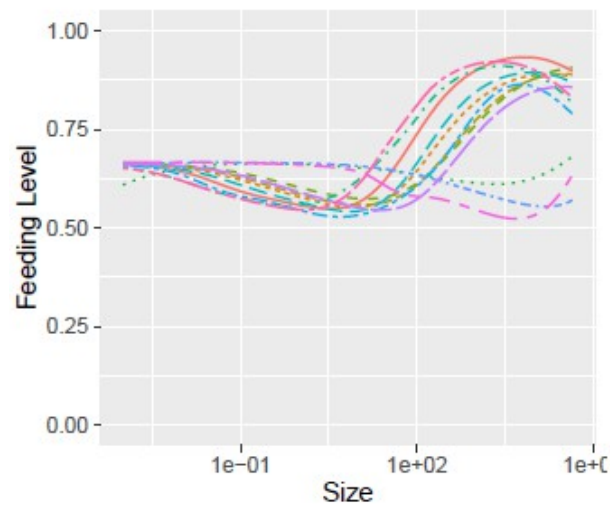
reproductive efficiency

$$g_i(w_{e.i})N_i(w_{e.i}) = \frac{\epsilon_i}{2w_{e.i}} \int_0^\infty N_i(w)E_{r.i}(w)\psi(w).dw$$

egg size for i th species

fraction of energy diverted into reproduction





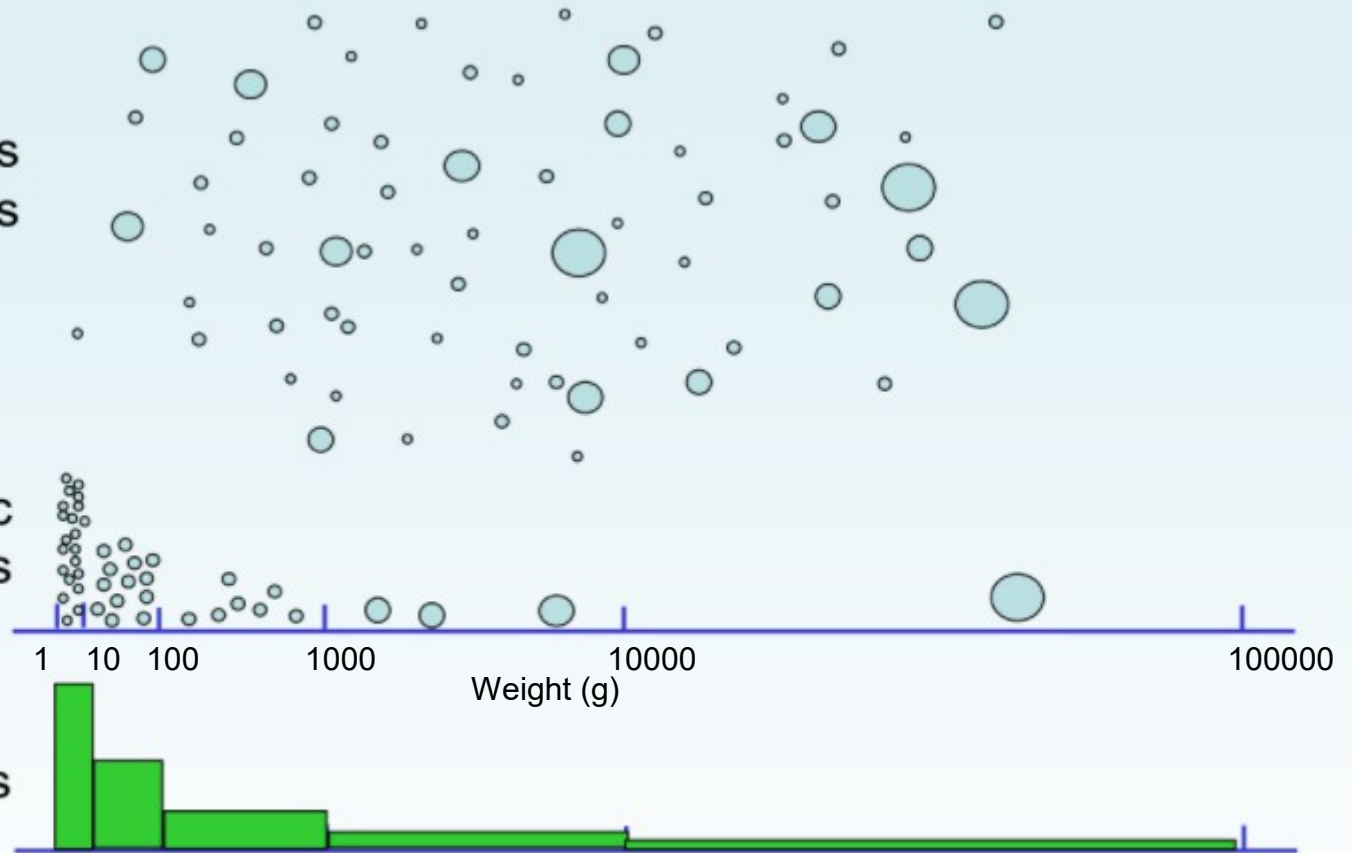


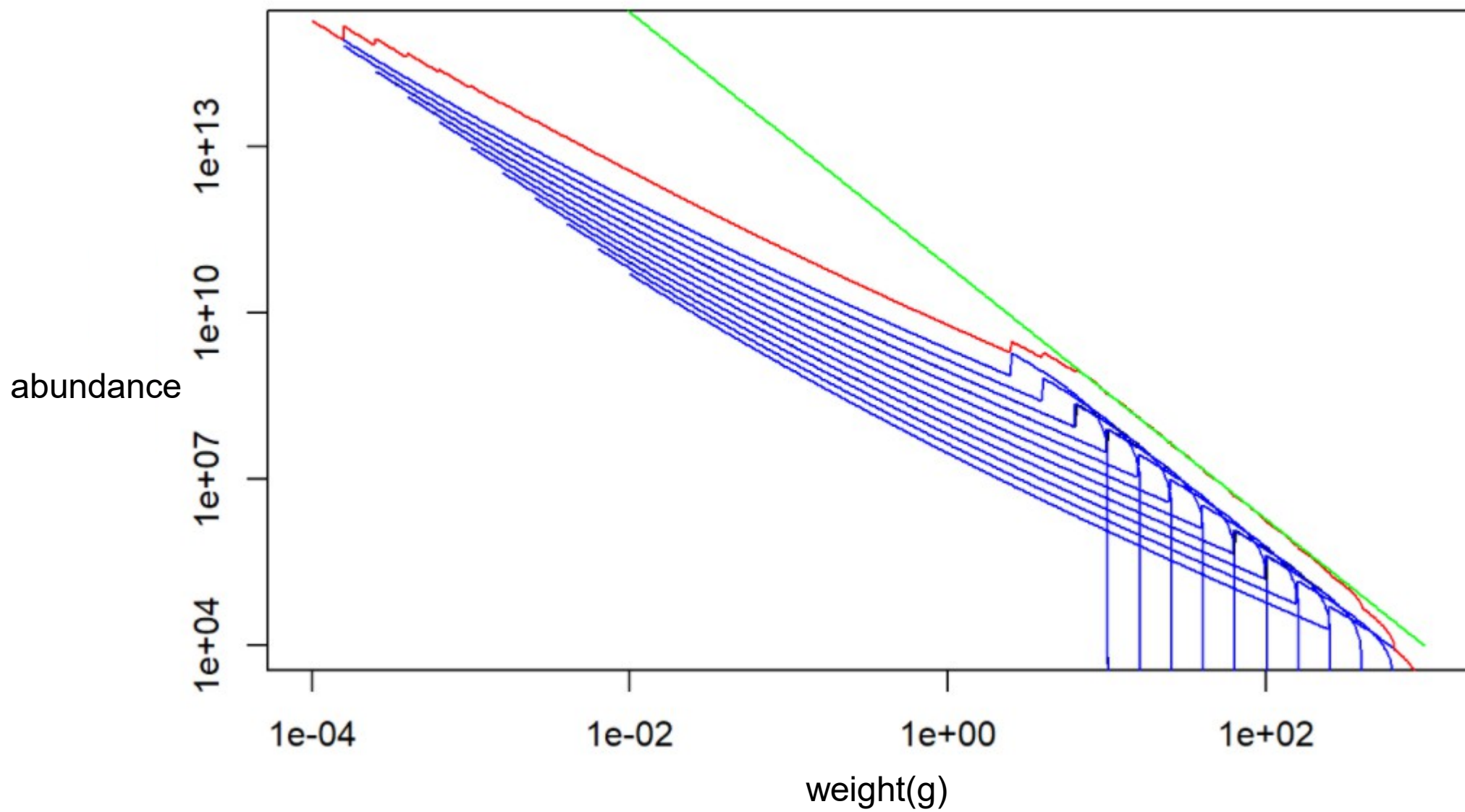
organisms as particles
of different sizes

bin into logarithmic
size intervals

sum the biomass

biomass in log bins is approximately constant





preference level

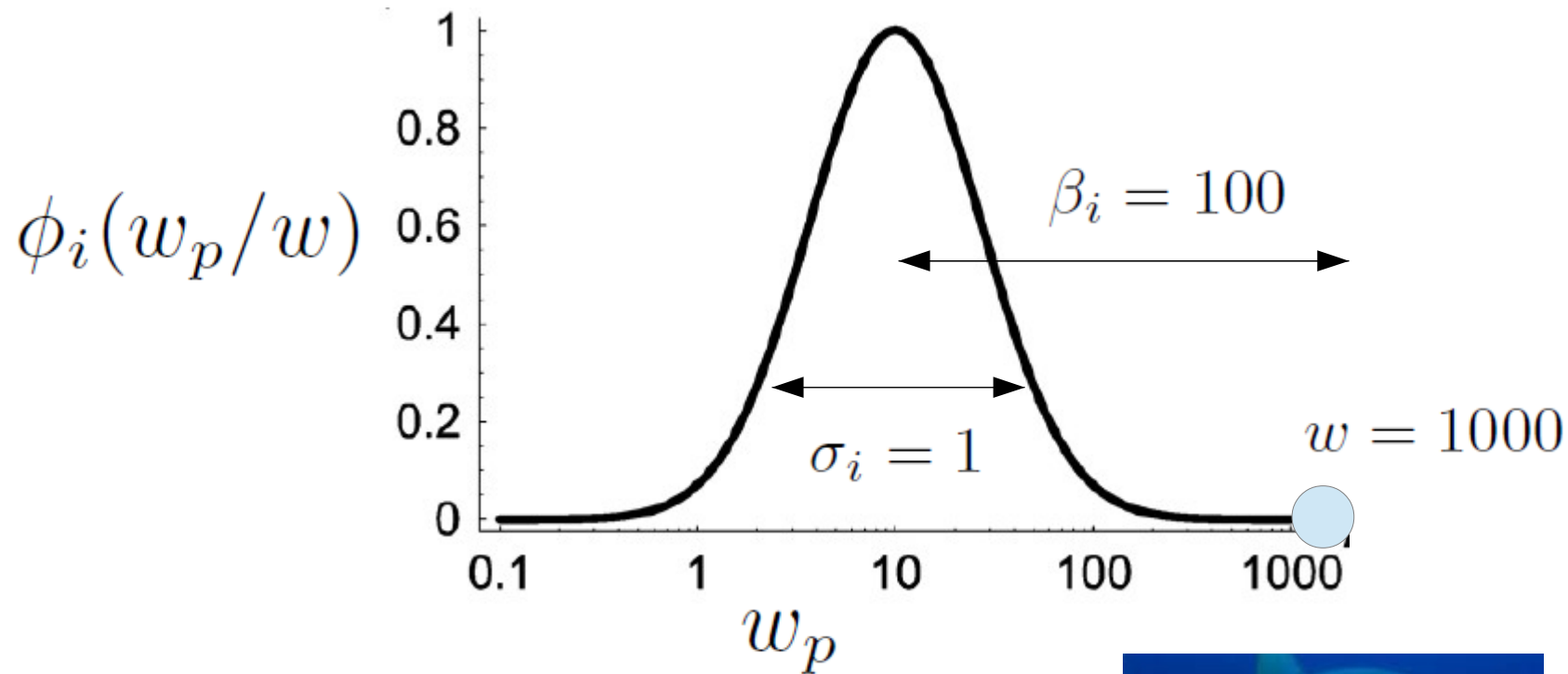
prey size

preferred predator-prey mass ratio

$$\phi_i(w_p/w) = \exp \left[\frac{-(\ln(w/(w_p\beta_i)))^2}{2\sigma_i^2} \right]$$

predator size

width of prey distribution



energy encountered

predator weight

preference level of species i for species j

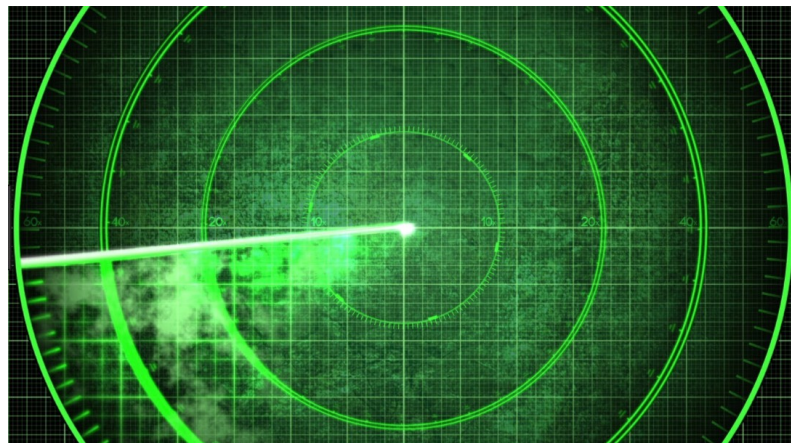
prey weight

$$E_{e.i}(w) = \underbrace{\gamma}_{\text{volumetric search rate}} w^q \int_0^\infty \left(\underbrace{N_R(w_p)}_{\text{abundance of background resources at weight } w_p} + \sum_j \underbrace{\theta_{ij}}_{\text{preference level of species } i \text{ for species } j} \underbrace{N_j(w_p)}_{\text{prey weight}} \right) \underbrace{\phi_i\left(\frac{w_p}{w}\right)}_{\text{preference level of weight } w \text{ predator for weight } w_p \text{ prey}} w_p dw_p$$

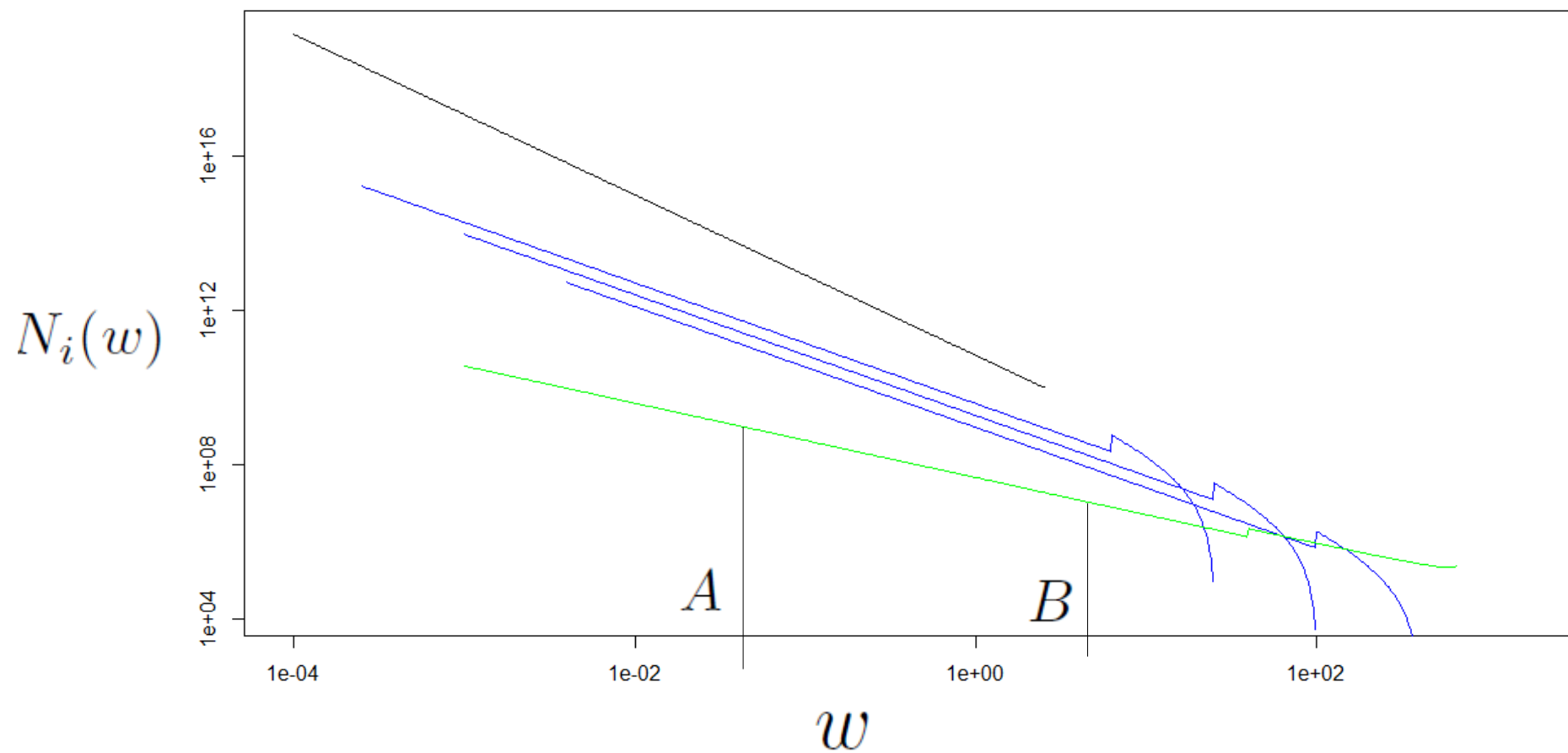
volumetric search rate

abundance of background resources at weight w_p

preference level of weight w predator for weight w_p prey



$N_i(w)$ = density of weight w individuals of species i



$\int_A^B N_i(w)dw$ = number of individuals with weight between A and B

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