Supplementary data (Tables S1, S2 and S3)

Table S1: Variables and model parameters. Values are the same for the example involving the equilibrium and the cyclic ecological dynamics unless two are given (values for the cyclic dynamics are then included in parentheses).

Table S2: Individual-level equations used in the simulations. These equations apply to individuals older than 1 year for the equilibrium dynamics and to all individuals for the cyclic ecological dynamics. Population-level equations are presented in Table S3 (see also Persson *et al.* (1998) and de Roos & Persson (2001)).

Table S3: Population-level equations used in the simulations of the ecological dynamics. Notice that in case of the Ricker stock-recruitment relationship, newborn individuals are assigned reversible and irreversible mass values at birth that correspond to the length at which they are recruited to the population (l=50mm). This newborn cohort (with index 0) is not taking part in the population dynamics until reaching age 1 and is hence neither harvested nor included into the resource foraging of the total population (summation term in the resource dynamic equation). Without a stock-recruitment relationship the newborn cohort follows the dynamics as prescribed by the within-season equations for all cohorts and is also harvested and included into the population foraging rate. In simulations based on the quantitative genetics approach, the newborn cohort is subdivided into a number of different sub-cohorts, which are characterized by their respective maturation sizes l_{mat}. Population dynamics follow the same systems of equations as in the absence of any phenotypic variability; the population is now made up by a larger number of smaller sub-cohorts with their own body sizes (x and y) and maturation size parameters.

References

Persson, L., Leonardsson, K., de Roos, A. M., Gyllenberg, M. & Christensen, B. 1998 Ontogenetic scaling of foraging rates and the dynamics of a size-structured consumer-resource model. *Theor. Pop. Biol.* **54**, 270-293.

de Roos, A. M. & Persson, L. 2001 Physiologically structured models - from versatile technique to ecological theory. *Oikos* **94**, 51-71.

Table S1

subject	symbol	value	unit	interpretation
Consumer	N	-	#	cohort size
	x	-	g	irreversible mass
	y	-	g	reversible mass
Seasonality	Y	90 (120)	days	growth season
Resource	R	-	g L^{-1}	resource density
	r	0.1	d^{-1}	population growth rate
	K	0.003 (0.01)	g L^{-1}	carrying capacity
	V	10^9	L	habitat volume
Consumer ontogeny	w_b	$1.4 \cdot 10^{-3}$	g	total egg mass
	l_{exp}	0.29	-	allometric exponent
	l_c	58.9	mm $g^{-l_{exp}}$	allometric scalar
	l_{mat}	varied	mm	maturation size
	q_j	0.74	-	juvenile max. condition
	q_a	1.0	-	adult max. condition
	k_r	0.5	-	gonad-egg conversion efficiency
Planktivory	α	1.0 (0.6)	-	allometric exponent
	A_{max}	$*1.0 \cdot 10^5$ ($1.5 \cdot 10^5$)	L d^{-1}	maximum attack rate (* = at 95 mm length)
	x_0	28.7	g	optimal foraging size (irreversible mass)
Handling	ξ_1	3.8	d $g^{-(1+\xi_2)}$	allometric scalar
	ξ_2	-0.81	-	allometric exponent
Metabolism	ρ_1	0.033	$g^{(1+\rho_2)}$ d^{-1}	allometric scalar
	ρ_2	0.77	-	allometric exponent
	k_e	0.61	-	conversion coefficient
Natural mortality	μ_0	0.014 (0.02)	d^{-1}	background mortality rate
	q_s	0.2	-	starvation condition threshold
	s	0.2	d^{-1}	starvation mortality threshold

Table S2

Subject	Equation
Body length	$L(x) = l_c x^{l_{\exp}}$
Attack rate	$A(x) = A_{\max}\left(\frac{x}{x_0}\exp(1-\frac{x}{x_0})\right)^{\alpha}$
Handling time	$H(x) = \xi_1 x^{\xi_2}$
Food intake rate	$I(x,R) = \frac{A(x)R}{1 + A(x)H(x)R}$
Assimilated energy	$E_a(x,R) = k_e I(x,R)$
Maintenance requirements	$E_m(x,y) = \rho_1 (x+y)^{\rho_2}$
Energy balance	$E_g(x,y,R) = E_a(x,R) - E_m(x,y)$
Fraction of net energy E_g allocated to growth in irreversible mass	$\kappa(x,y,R) = \begin{cases} \frac{y}{(1+q_j)q_j x} & \text{if } L(x) \le l_{mat} \text{ and } E_g > 0 \\ \frac{y}{(1+q_a)q_a x} & \text{if } L(x) > l_{mat} \text{ and } E_g > 0 \\ 0 & \text{otherwise} \end{cases}$
Starvation mortality rate	$\mu_s(x,y) = \begin{cases} s\left(q_s \frac{x}{y} - 1\right) & \text{if } \frac{y}{x} \le q_s \\ 0 & \text{if } \frac{y}{x} > q_s \end{cases}$
Total natural mortality rate	$\mu(x,y) = \mu_0 + \mu_s(x,y)$
Harvested fraction of cohort	$h(x) = \frac{h_{\max}}{1 + e^{0.15(T - L(x))}}$
Fecundity (eggs spawned)	$F(x,y) = \begin{cases} k_r (y - q_j x)/w_b & \text{if } L(x) > l_{mat} \text{ and } y > q_j x \\ 0 & \text{otherwise} \end{cases}$

Table S3

Subject	Equation
Resource dynamics	$\frac{dR}{dt} = r(K-R) - \sum_i I(x_i, R)\frac{N_i}{V}$
Within-season dynamics of (sub-)cohorts	$\begin{cases} \frac{dN_i}{dt} = -\mu(x_i, y_i)N_i \\ \frac{dx_i}{dt} = \kappa_i(x_i, y_i, R)E_g(x_i, y_i, R) \\ \frac{dy_i}{dt} = (1-\kappa_i(x_i, y_i, R))E_g(x_i, y_i, R) \end{cases}$
Reproduction (Ricker stock-recruitment relationship)	$\begin{cases} N_0 = 0.01Ee^{-2\cdot 10^{-9}E} \quad \text{with } E = \sum_i F(x_i, y_i)(1-h(x_i))N_i \\ x_0 = 0.57 \\ y_0 = 0.42 \end{cases}$
Reproduction (no stock-recruitment relationship)	$\begin{cases} N_0 = \sum_i F(x_i, y_i)(1-h(x_i))N_i \\ x_0 = \frac{1}{1+q_j}w_b \\ y_0 = \frac{q_j}{1+q_j}w_b \end{cases}$
Between-season changes of older cohorts (harvesting, aging, reproduction)	$\begin{cases} N_{i+1} = (1-h(x_i))N_i \\ x_{i+1} = x_i \\ y_{i+1} = \begin{cases} q_j x_i & \text{if } F(x_i, y_i) > 0 \\ y_i & \text{otherwise} \end{cases} \end{cases}$