

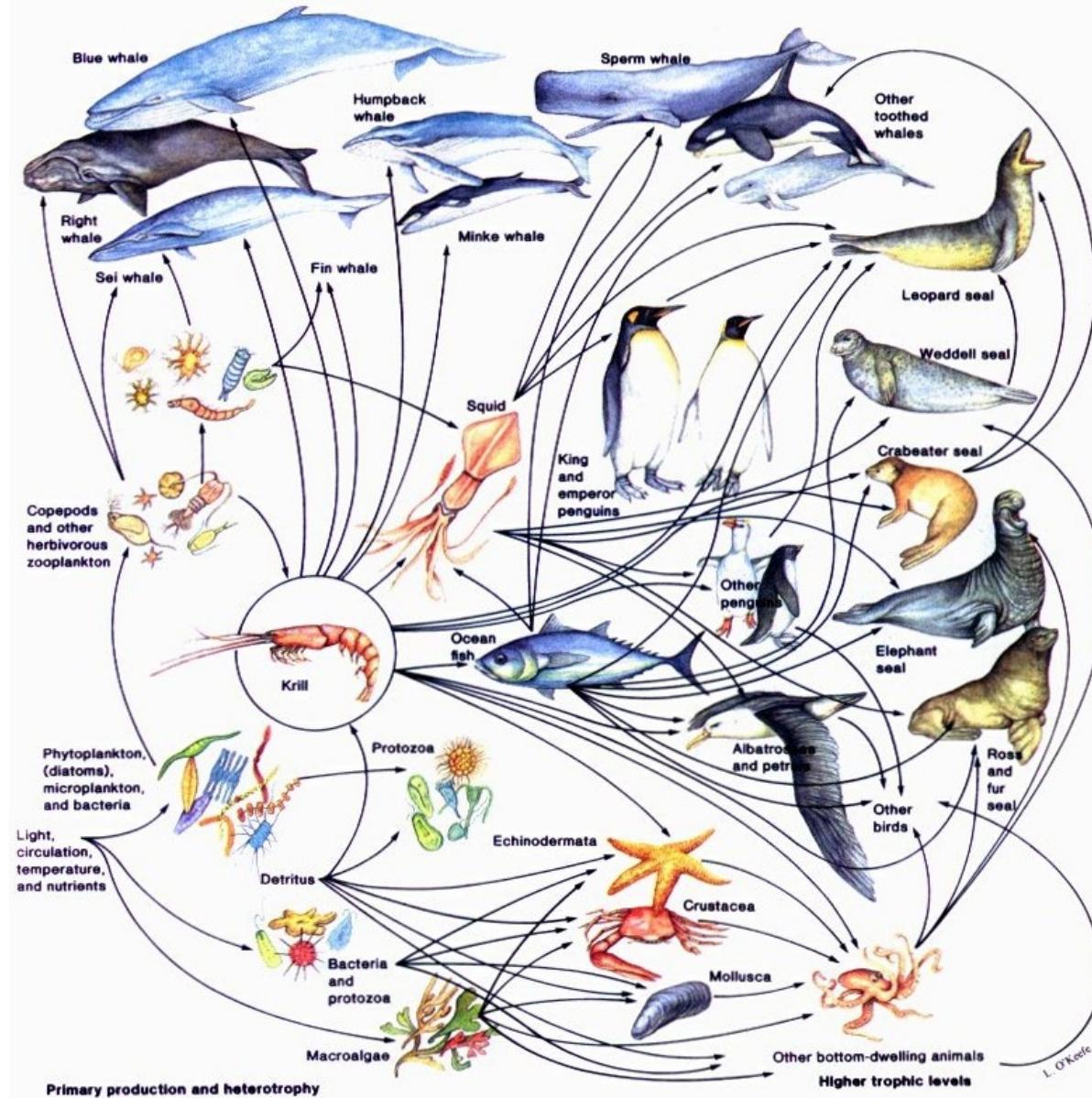


PSPM als Werkzeug zur Wirkungsabschätzung des Klimawandels für aquat. Populationen

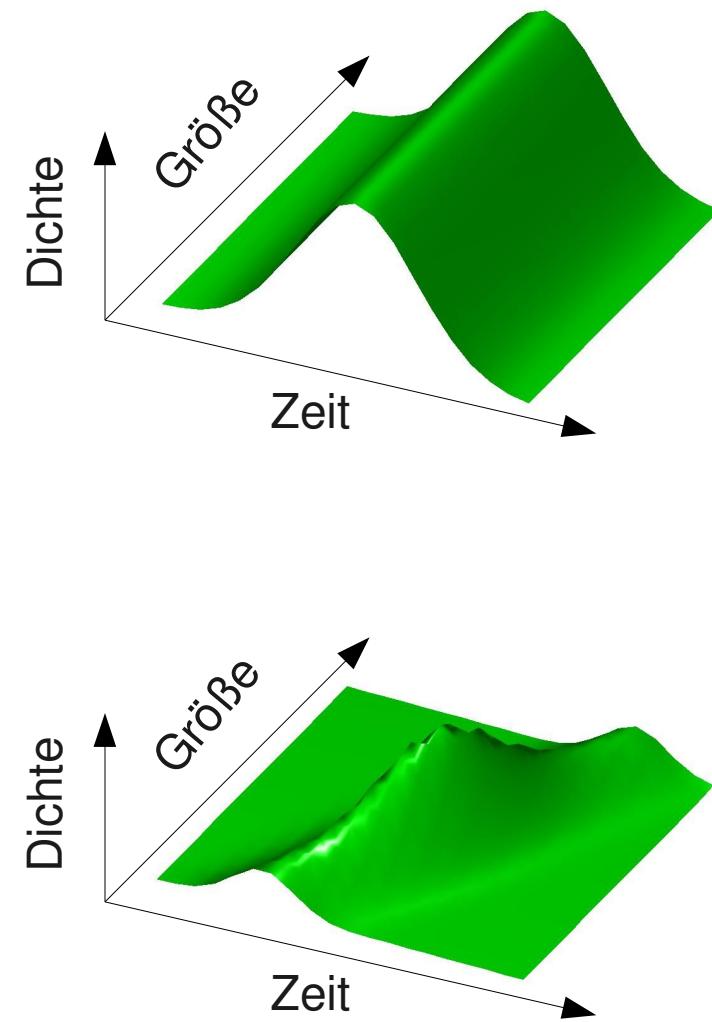
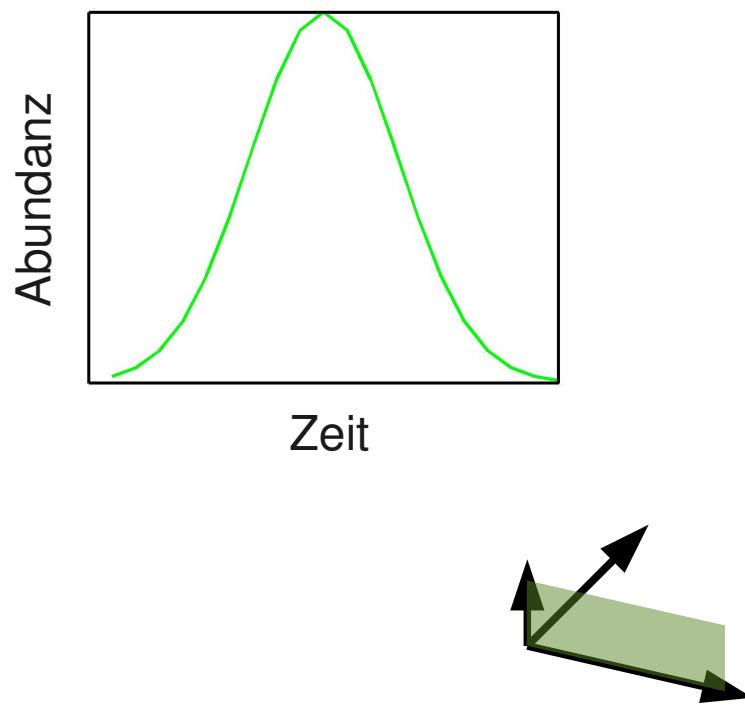
Sylvia Moenickes

Frank Suhling, Otto Richter, Anne Schneider, Rieke Frassl,
Moritz Kupisch, Lena Rohe, Leslie Mühle, Gunnar Petter

Warum PSPM?



Warum PSPM?



Wie PSPM?

Abundanz $u(t)$

$$\text{Änderung der Abundanz} = - \text{ Mortalität} + \text{ Reproduktion} + \text{ Migration}$$

Wie PSPM?

Abundanz $u(t)$

$$\frac{du(t)}{dt} = -\mu \cdot u(t) + b \cdot u(t) \pm f_{\text{Migr.}}(u(t), t, \dots)$$



Wie PSPM?

Abundanz $u(t)$

$$\frac{du(t)}{dt} = -\mu \cdot u(t) + b \cdot u(t) \pm f_{\text{Migr.}}(u(t), t, \dots)$$

$$\frac{du(t)}{dt} = -\mu(T, \dots)u(t) + b(T, \dots)u(t) \pm f_{\text{Migr.}}(u(t), t, \dots)$$



Wie PSPM?

Abundanz $u(t)$ [1]

$$\frac{du(t)}{dt} = -\mu \cdot u(t) + b \cdot u(t) \pm f_{\text{Migr.}}(u(t), t, \dots)$$

$$\frac{du(t)}{dt} = -\mu(T, \dots)u(t) + b(T, \dots)u(t) \pm f_{\text{Migr.}}(u(t), t, \dots)$$

Dichte $n(x, t)$ [1/mm]

$$\frac{\partial n(x, t)}{\partial t} = -\mu(x, T, \dots)n(x, t) + b(n(x, t), x, t, T, \dots) \pm f_{\text{Migr.}}(n(x, t), t, \dots)$$

Änderung
der
Dichte

=



Wie PSPM?

Abundanz $u(t)$ [1]

$$\frac{du(t)}{dt} = -\mu \cdot u(t) + b \cdot u(t) \pm f_{\text{Migr.}}(u(t), t, \dots)$$

$$\frac{du(t)}{dt} = -\mu(T, \dots)u(t) + b(T, \dots)u(t) \pm f_{\text{Migr.}}(u(t), t, \dots)$$

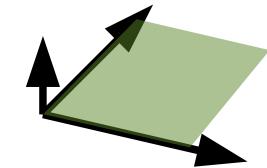
Dichte $n(x,t)$ [1/mm]

$$\frac{\partial n(x,t)}{\partial t} = -\frac{\partial g(x)n(x,t)}{\partial x} -\mu(x, T, \dots)n(x, t) + b(n(x, t), x, t, T, \dots) \pm f_{\text{Migr.}}(n(x, t), t, \dots)$$



Wie PSPM?

- Wahl des Wachstumsmodells

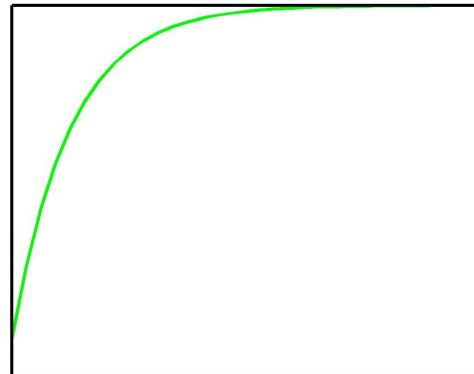


$$\frac{dx}{dt} = r_b(x_{\max} - x)$$

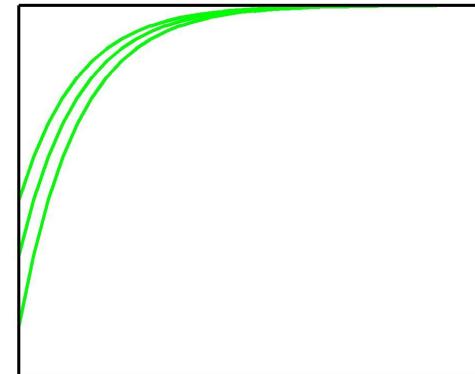
&

$$x(t) = x_{\max}(1 - e^{-r_b(t-t_0)})$$

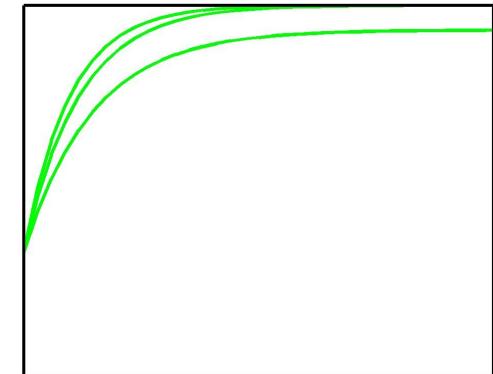
Größe



Zeit



Zeit



Zeit

Wie PSPM?

- Wahl des Wachstumsmodells

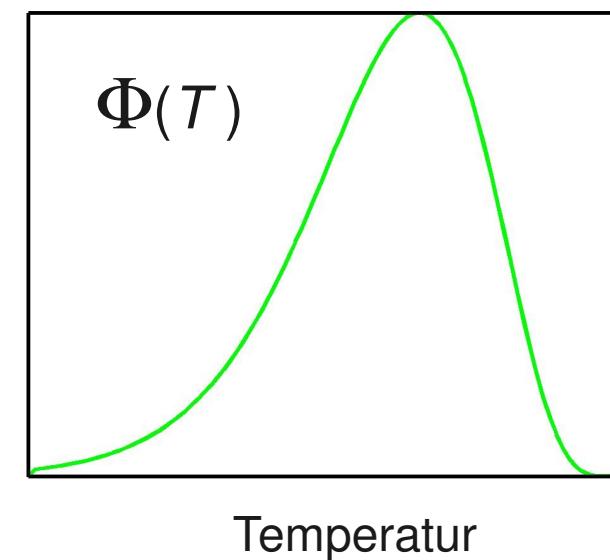
$$\frac{dx}{dt} = r_b(x_{\max} - x)$$

&

$$x(t) = x_{\max}(1 - e^{-r_b(t-t_0)})$$

- Beschreibung der Temperaturabhängigkeit

$$\frac{dx}{dt} = \underline{\Phi(T)} \cdot \underline{r_b(x_{\max} - x)}$$



Wie PSPM?

- Wahl des Wachstumsmodells

$$\frac{dx}{dt} = r_b(x_{\max} - x) \quad \& \quad x(t) = x_{\max}(1 - e^{-r_b(t-t_0)})$$

- Beschreibung der Temperaturabhängigkeit

$$\frac{dx}{dt} = \Phi(T) \cdot r_b(x_{\max} - x)$$

- Beschreibung einer Futterabhängigkeit

$$\frac{dx}{dt} = \Phi(T) \cdot r_b(f(F) \cdot x_{\max} - x)$$

Warum PSPM?

- Temperatur-Response:
Parametrisierbarkeit als sine qua non

Gammarus pulex



2

- Verknüpfung mit weiteren Klimaeffekten

Asellus aquaticus



3

- Verknüpfung mit Nahrungs dynamik

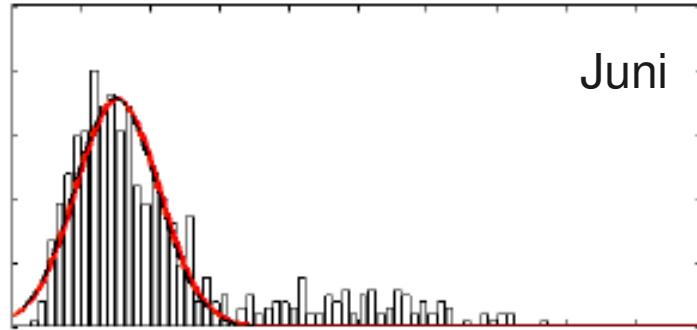
Gammarus pulex

Corbicula fluminea

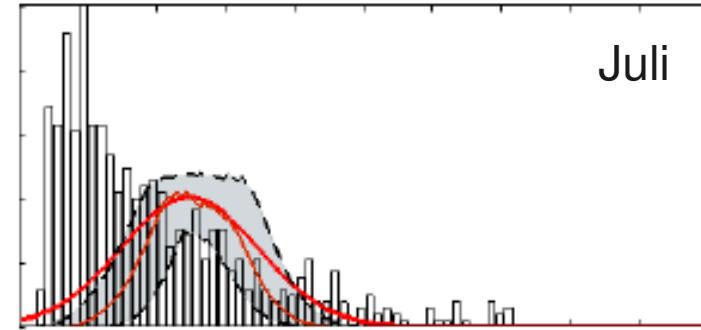


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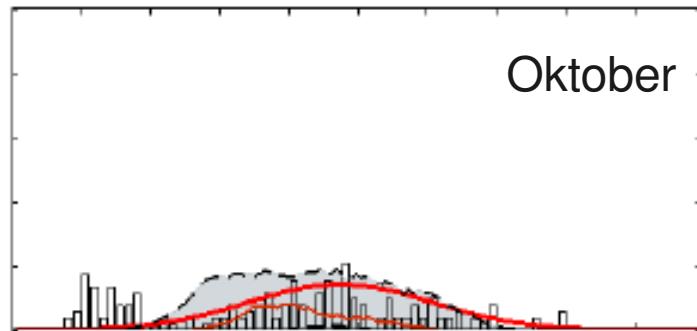
Parametrisierung



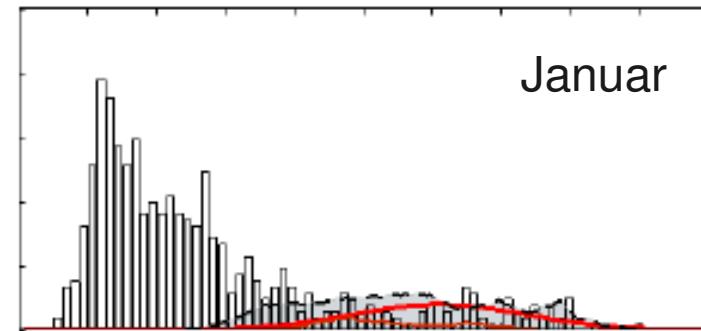
Juni



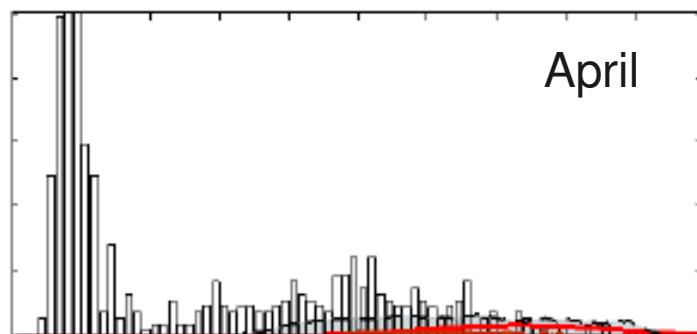
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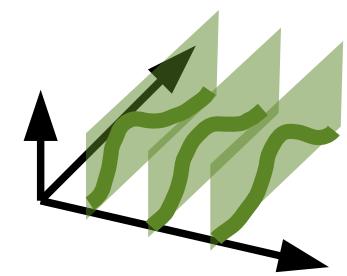
Oktober



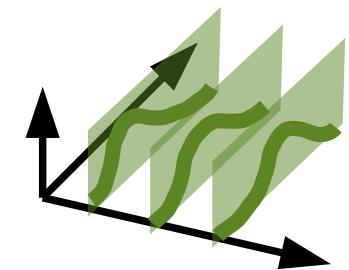
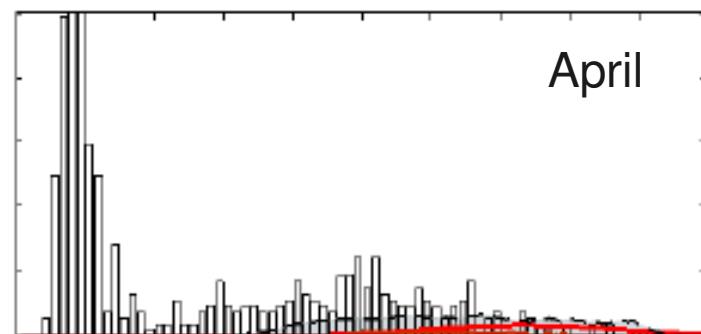
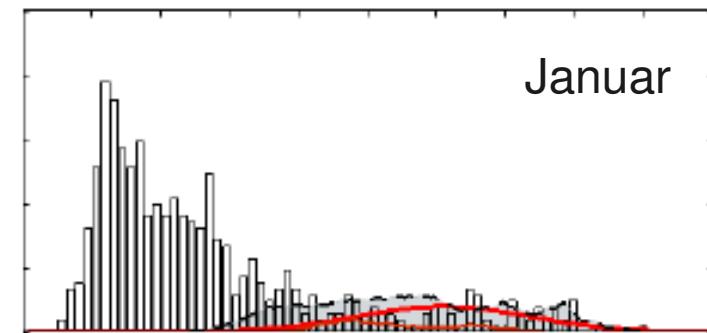
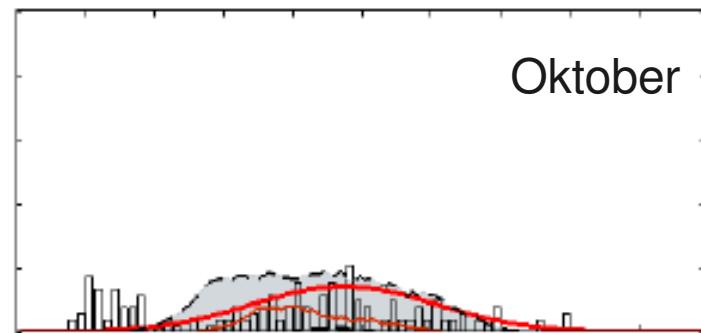
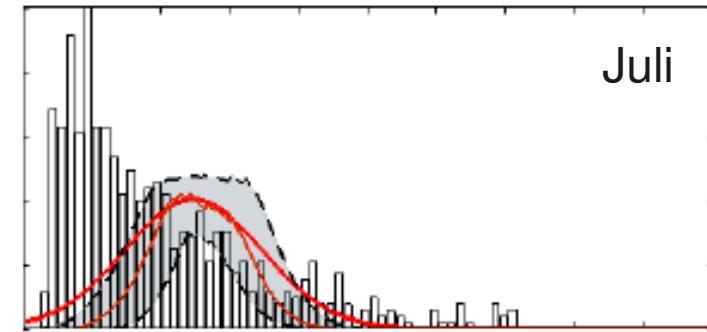
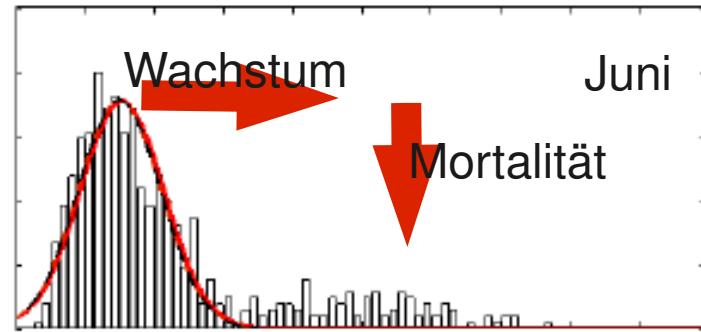
Januar



April



Parametrisierung



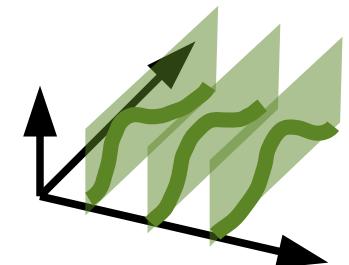
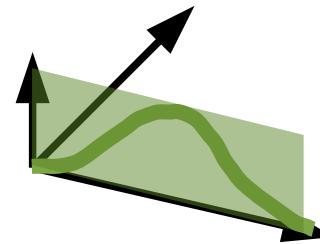
Parametrisierung

- Lab

5 konstante Temp.s

je 60 Tiere individualisiert

Gewicht und Länge an 6 Terminen

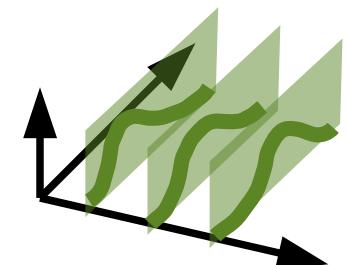


- Mesokosmen

aktuelle Temp. sowie $+2^{\circ}\text{C}$, $+4^{\circ}\text{C}$, $+6^{\circ}\text{C}$

48 Gruppen je 10 Tiere

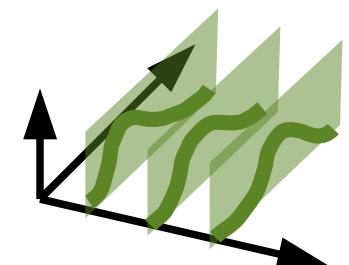
gruppenweise Gewicht



- Feldmonitoring

Flussentnahmen, Temperaturmessung

Längen an 5 Terminen



Lena Rohe
Leslie Mühle

I: Lab

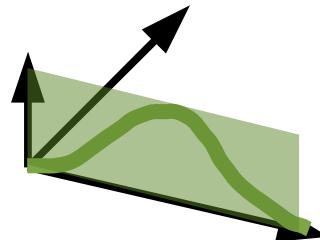
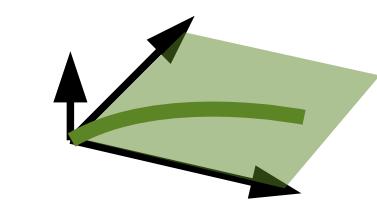
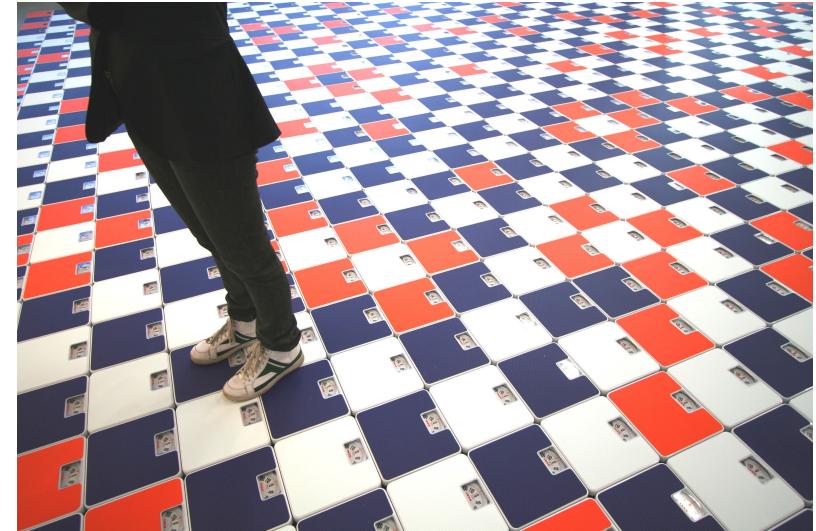
I individuell



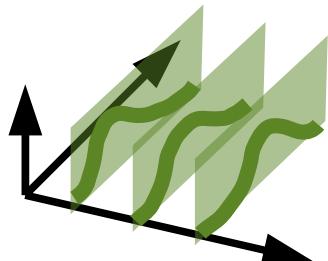
II temperaturgruppiert

III temperaturgruppiert inklusive Tote

5



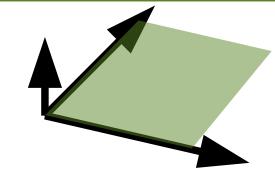
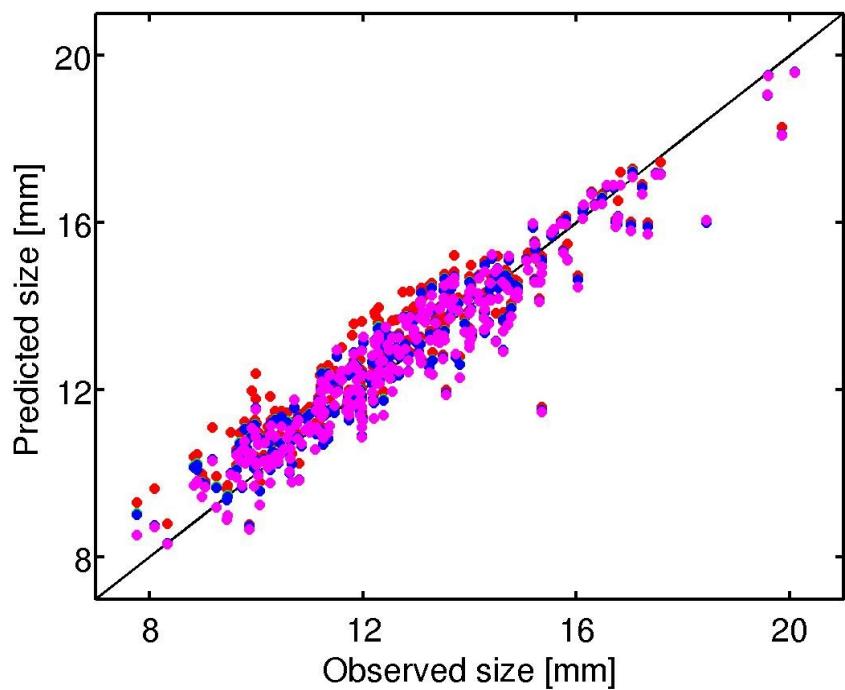
IV strukturierte Kohorten



6



Lab – Güte der Anpassung



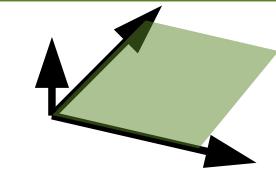
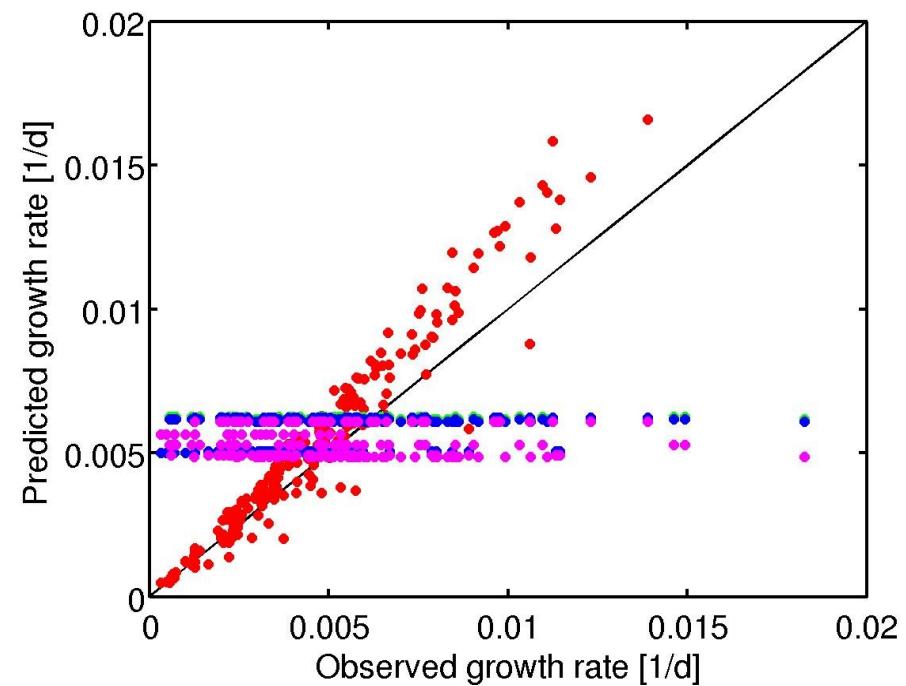
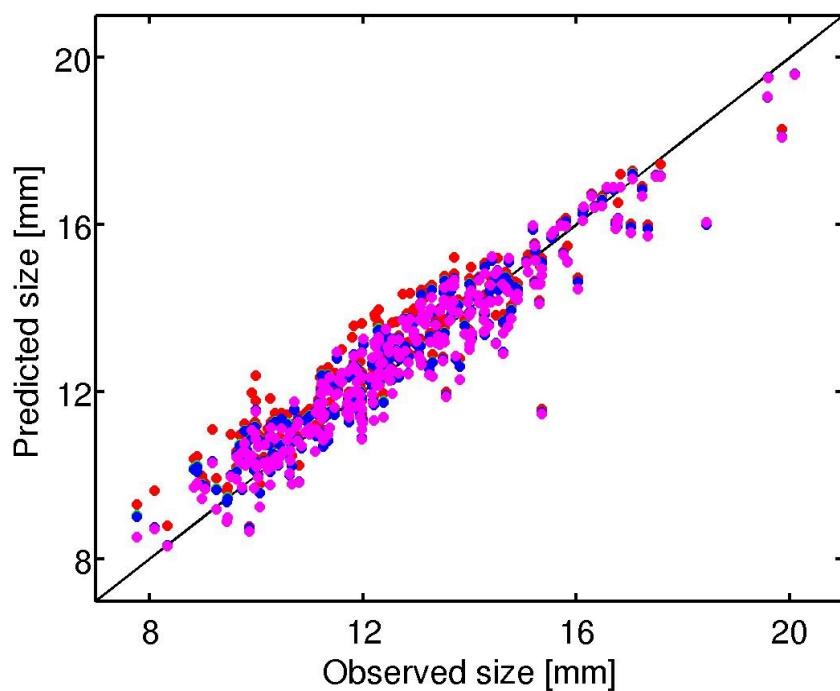
I individuell

III temperaturgruppiert+Tote

II temperaturgruppiert

IV strukturierte Kohorten

Lab – Güte der Anpassung



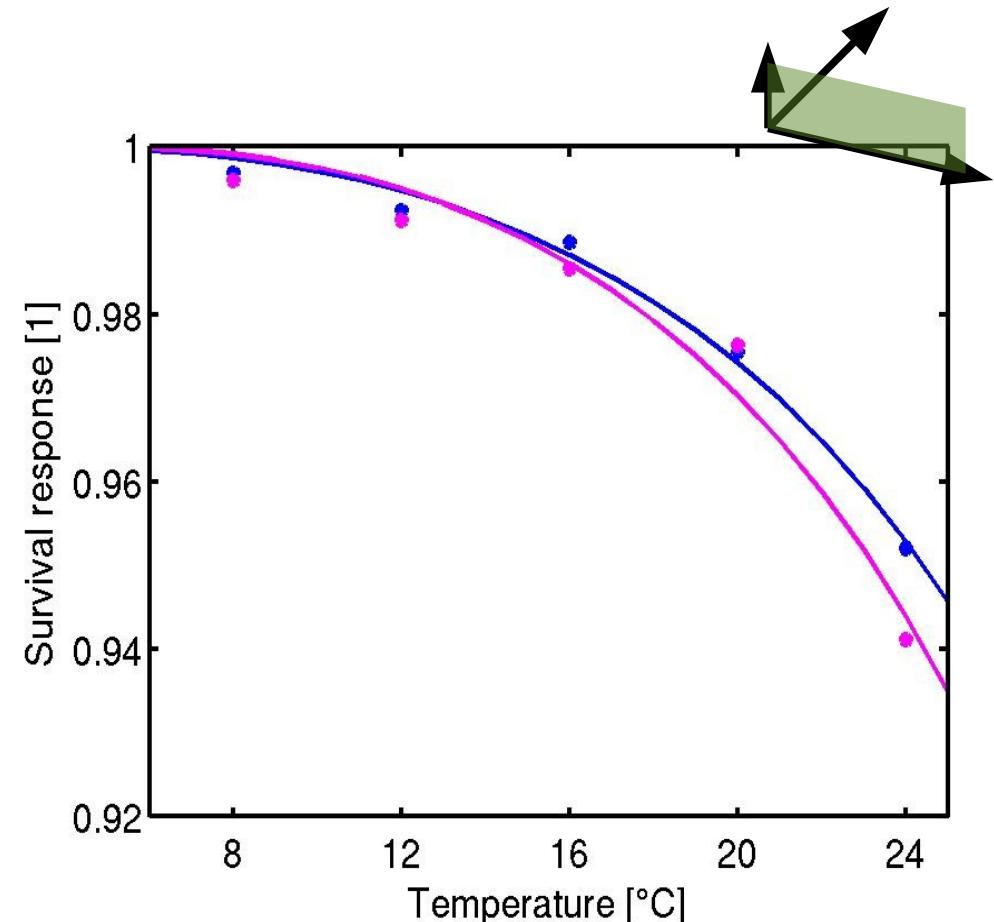
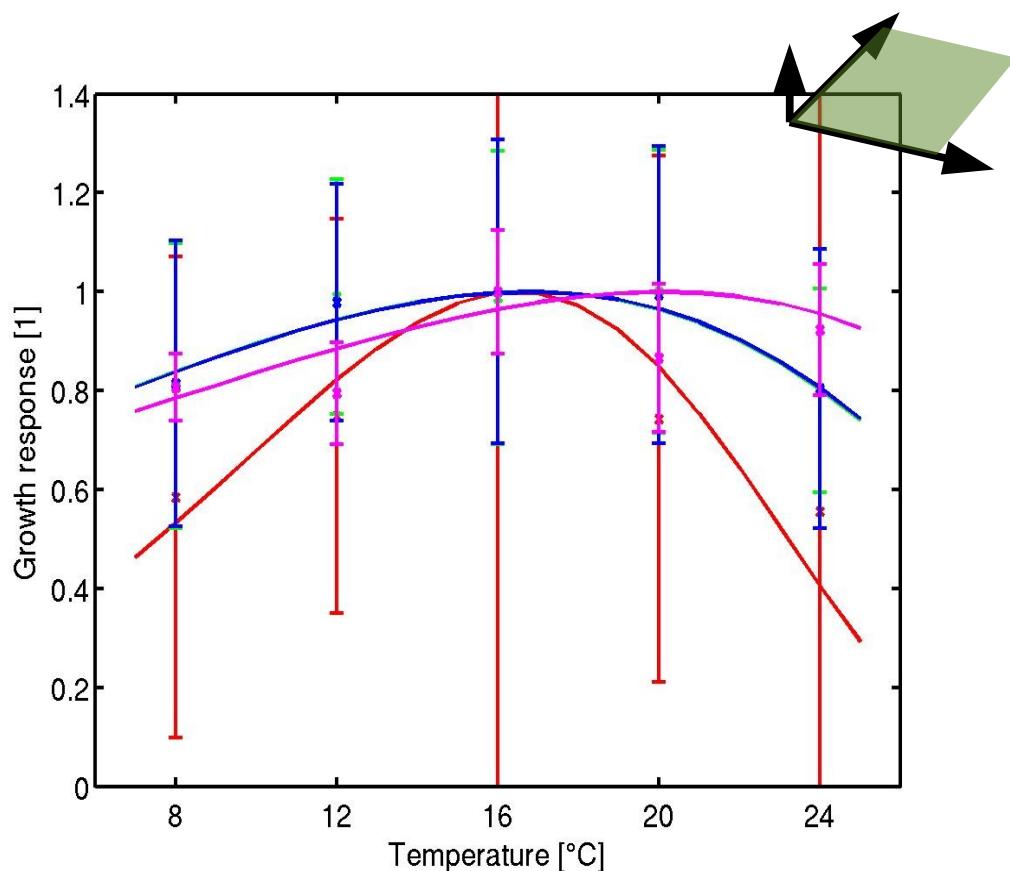
I individuell

III temperaturgruppiert+Tote

II temperaturgruppiert

IV strukturierte Kohorten

Lab - Temperatureffekte



I individuell

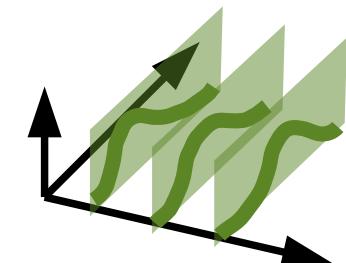
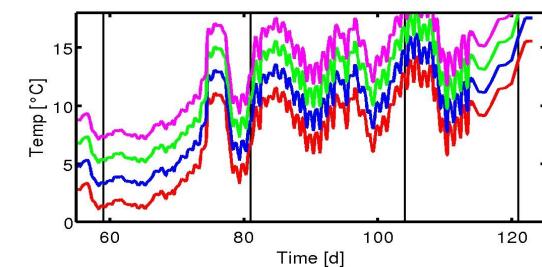
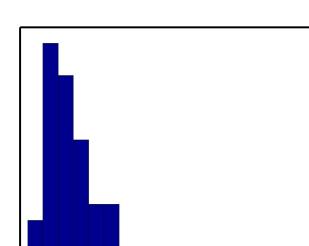
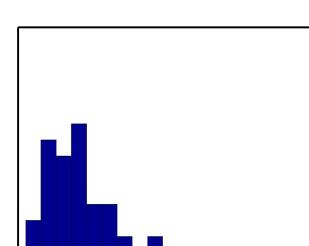
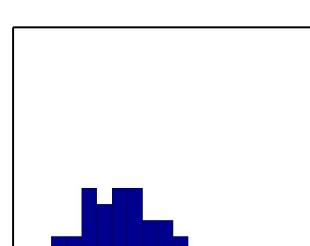
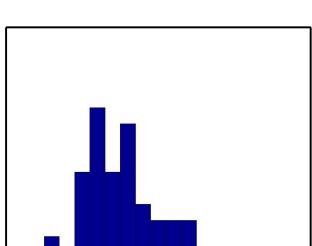
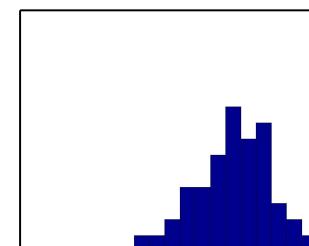
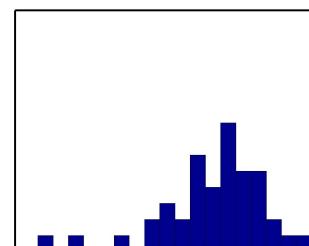
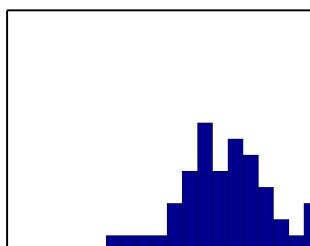
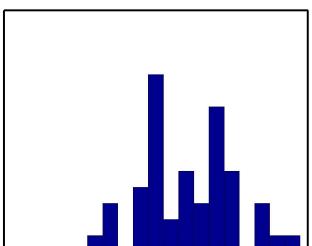
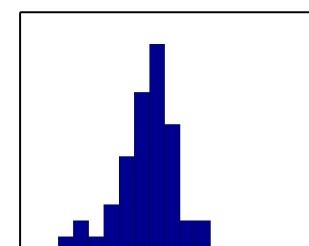
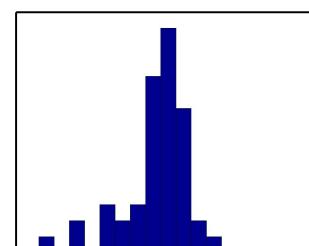
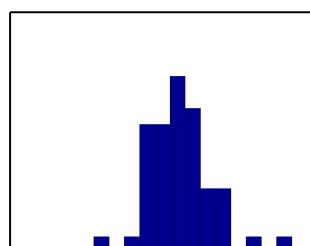
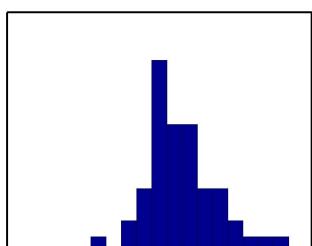
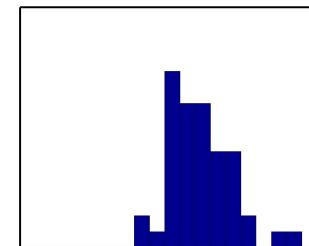
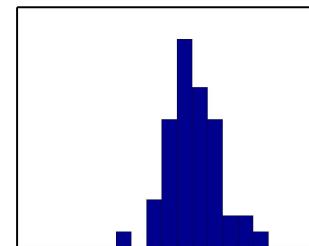
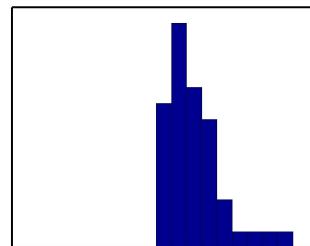
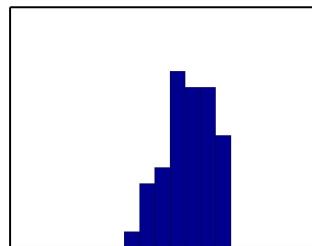
III temperaturgruppiert+Tote

II temperaturgruppiert

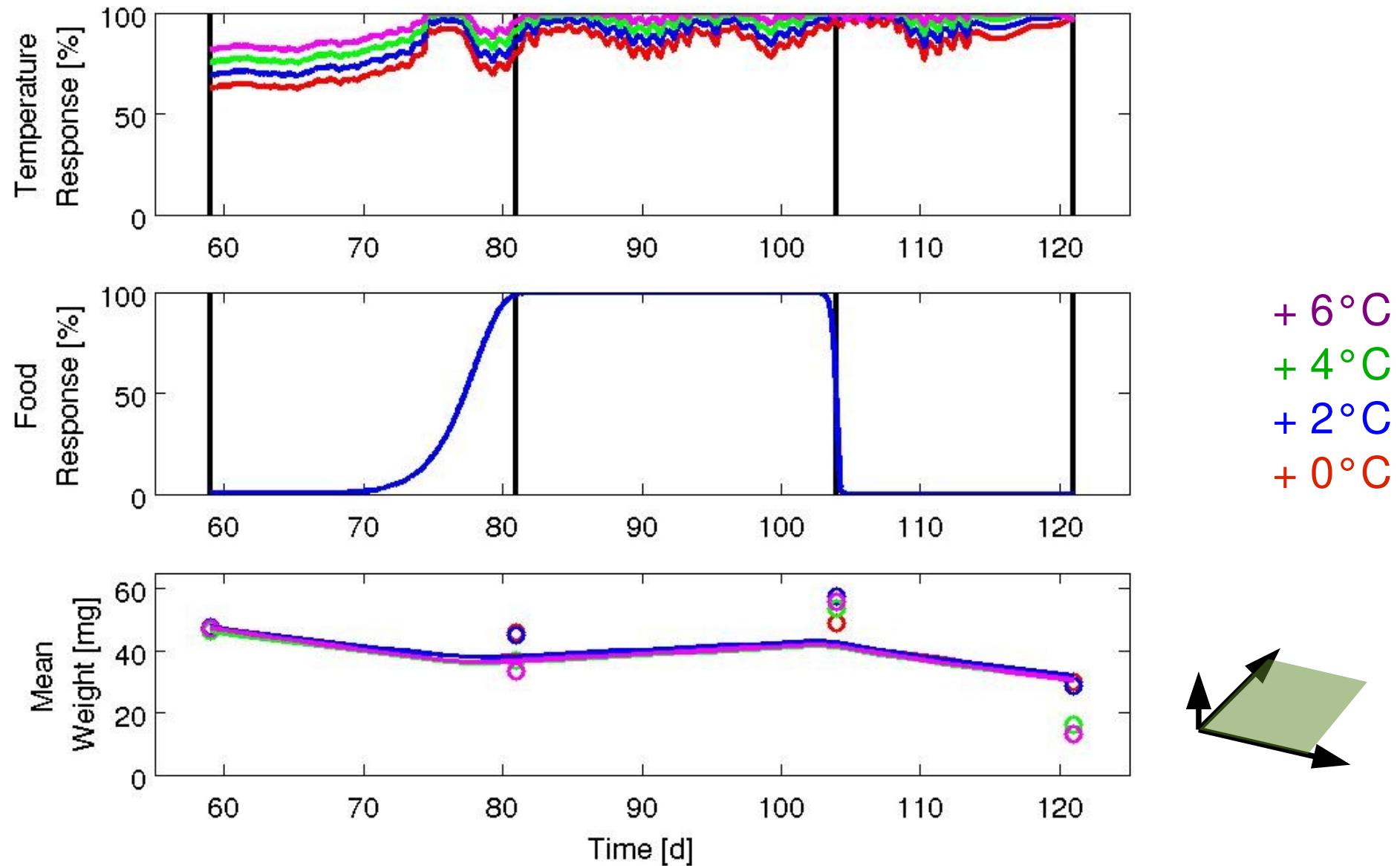
IV strukturierte Kohorten

Frank Suhling

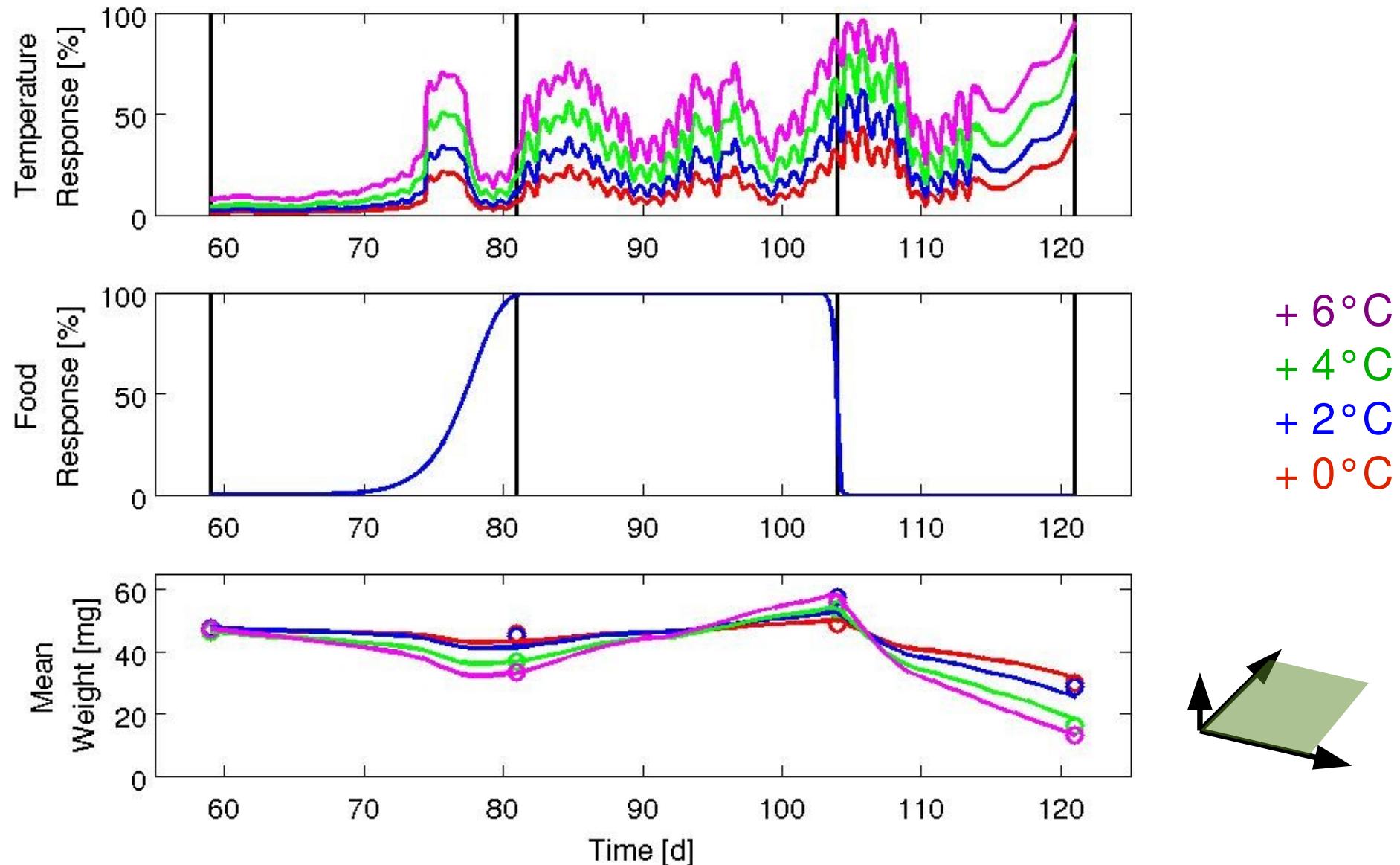
II: Mesokosmen

 $+ 0^{\circ}\text{C}$ $+ 2^{\circ}\text{C}$ $+ 4^{\circ}\text{C}$ $+ 6^{\circ}\text{C}$ 

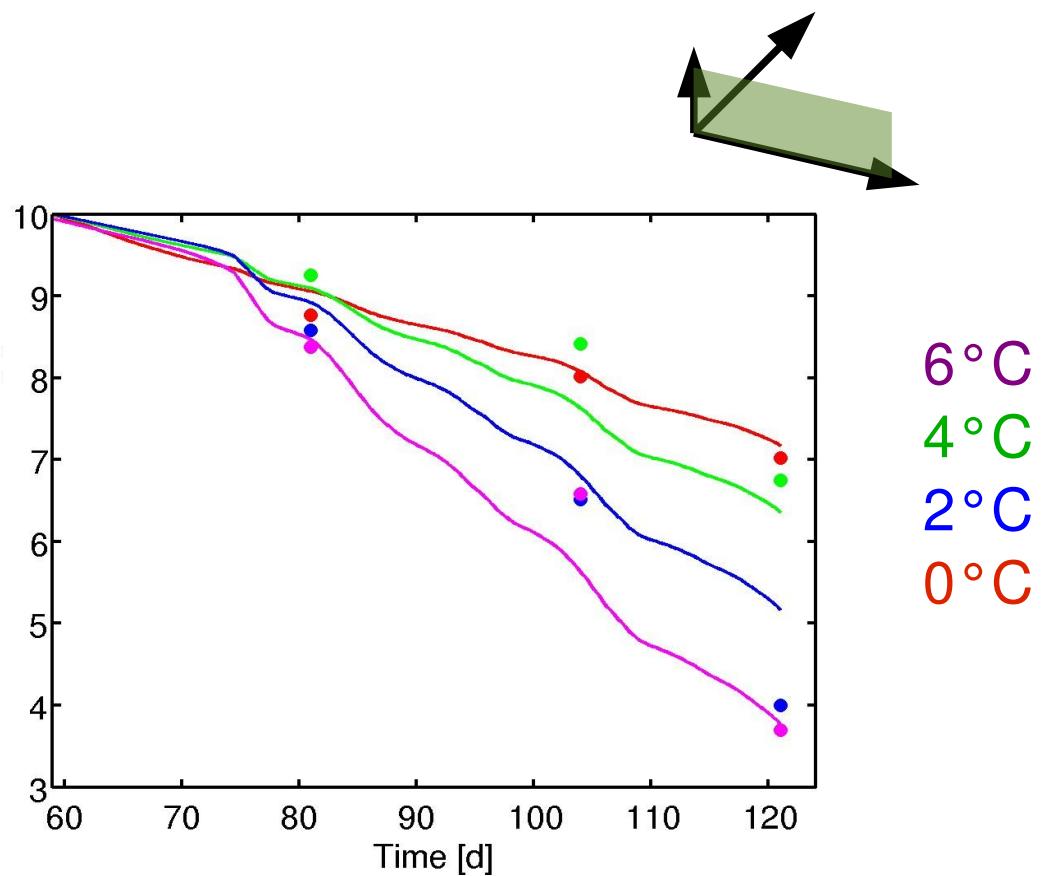
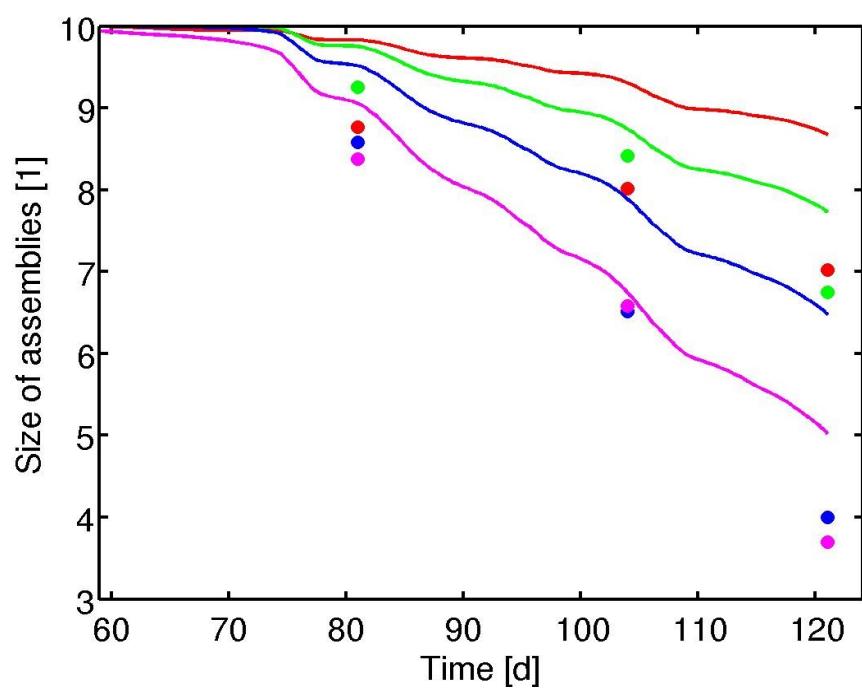
Mesokosmen – Labparameter



Mesokosmen – Parametrisierung

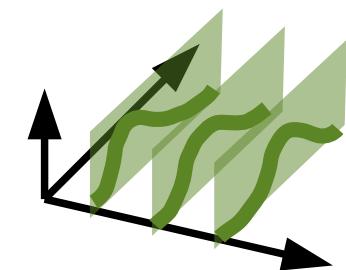
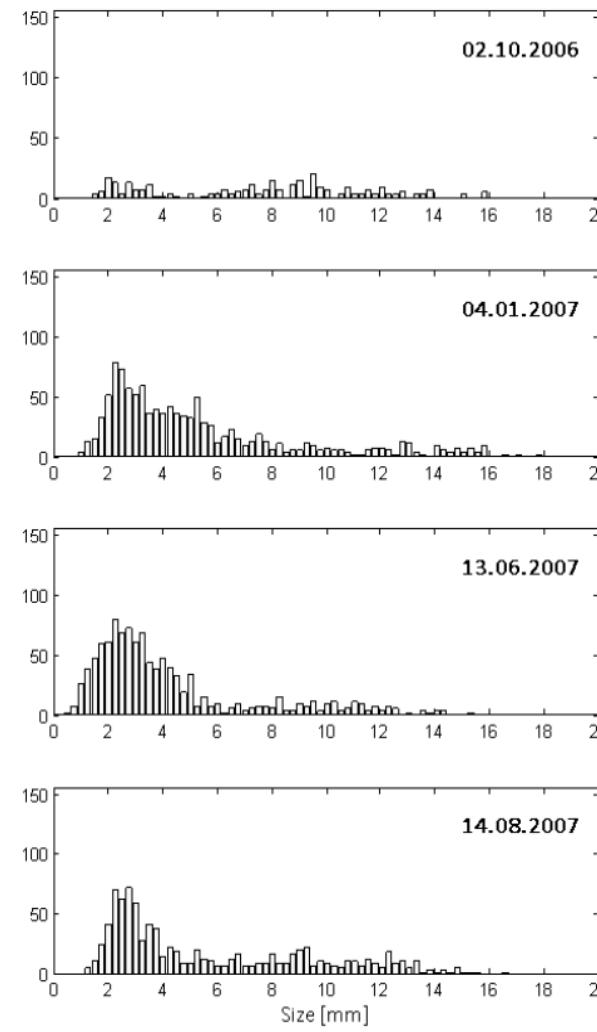
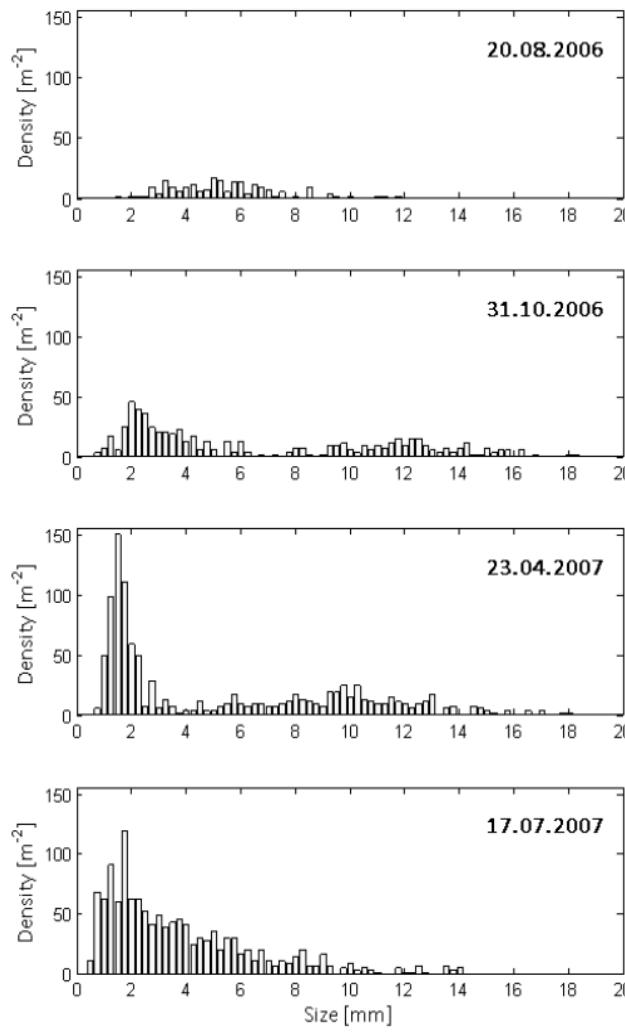


Mesokosmen - Mortalität

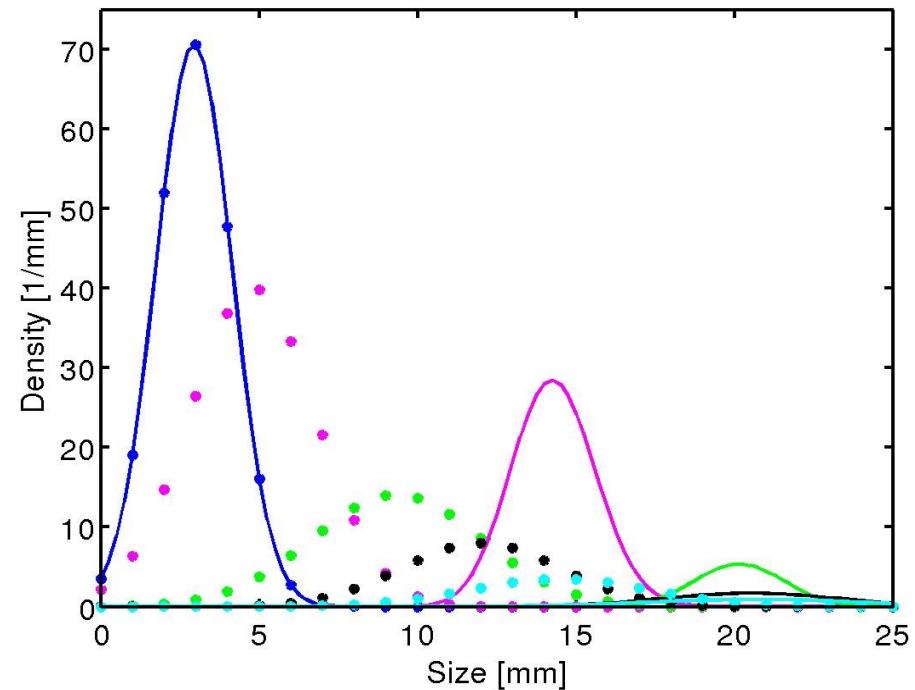
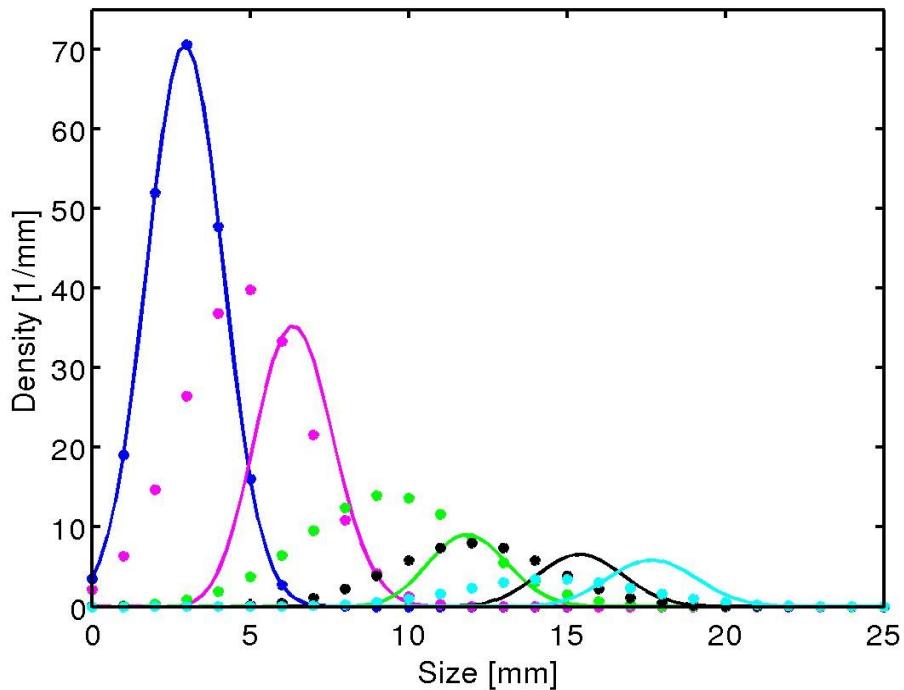


Anne Schneider
Frank Suhling

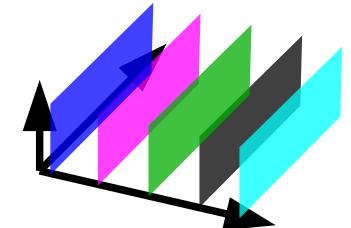
Feld



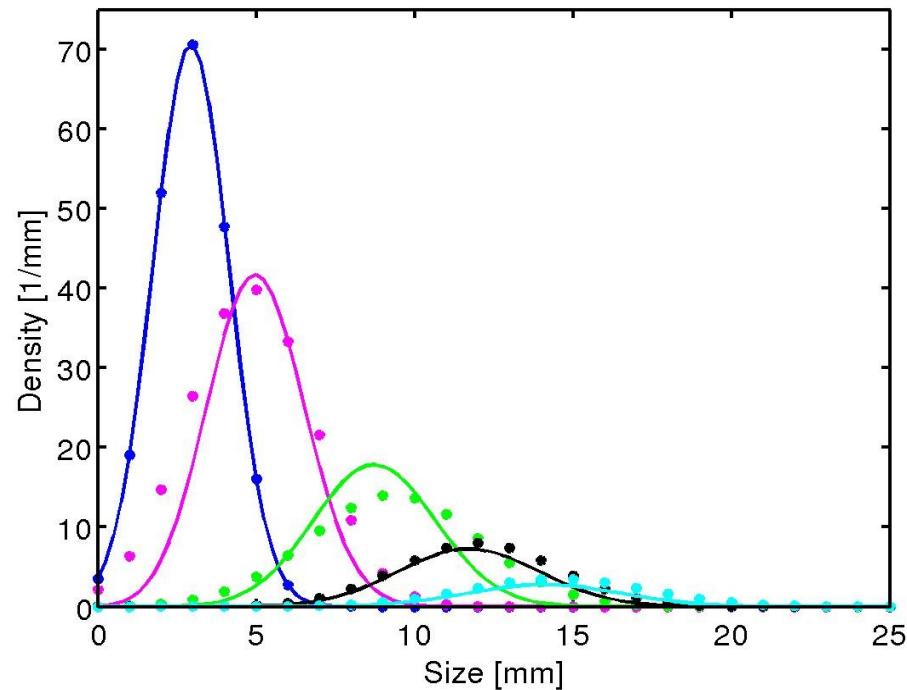
Feld – Lab und Mesokosmen



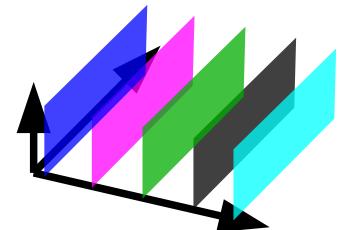
Messtermine [d nach 12. Juni]:
0 35 122 206 315



Feld - Feldparametrisierung



Messtermine [d nach 12. Juni]:
0 35 122 206 315



Feld versus Mesokosmen versus Lab

		Lab	Mesokosmen	Feld
Wachstum	rb [1/d]	0.0062	0.0454	0.0035
	$Toptr$ [°C]	16.80 (20.1)	21.6	16.80
	$q10r$	1.45 (1.35)	2.5	1.45
Mortalität	$Toptm$ [°C]	4.3	5.82	-
	$q10m$	1.04	1.05	-
	$m0$ [1/d]	0.00	0.0031	0.008
Güte	Lab: R^2 (x)	0.90		
	Mk: R^2 (x)	0.52	0.97	
	Feld: R^2 (n)	0.77	0.42	0.98

Beispiele

- *Asellus aquaticus*
weitere Klimaeffekte



- *Gammarus pulex*
Verknüpfung mit Nahrungs dynamik



- *Corbicula fluminea*
Verknüpfung mit Energiedynamik

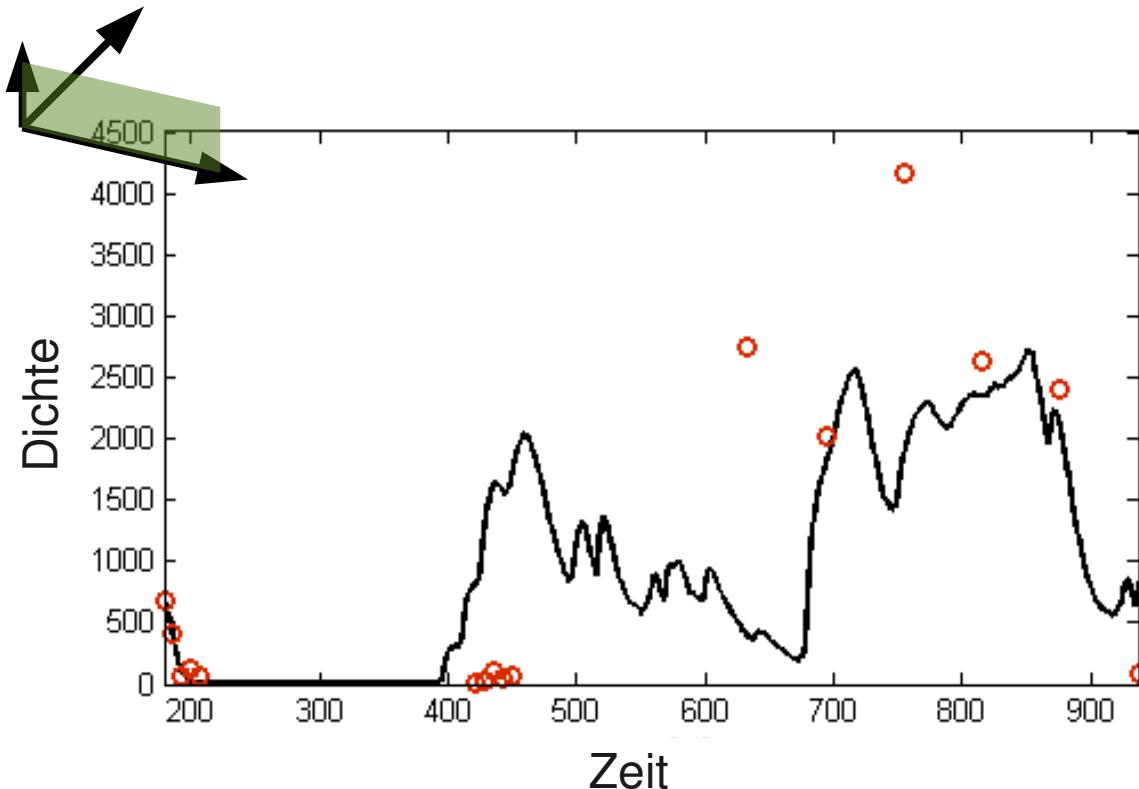


Marieke Frassl
Jeanette Schlierf

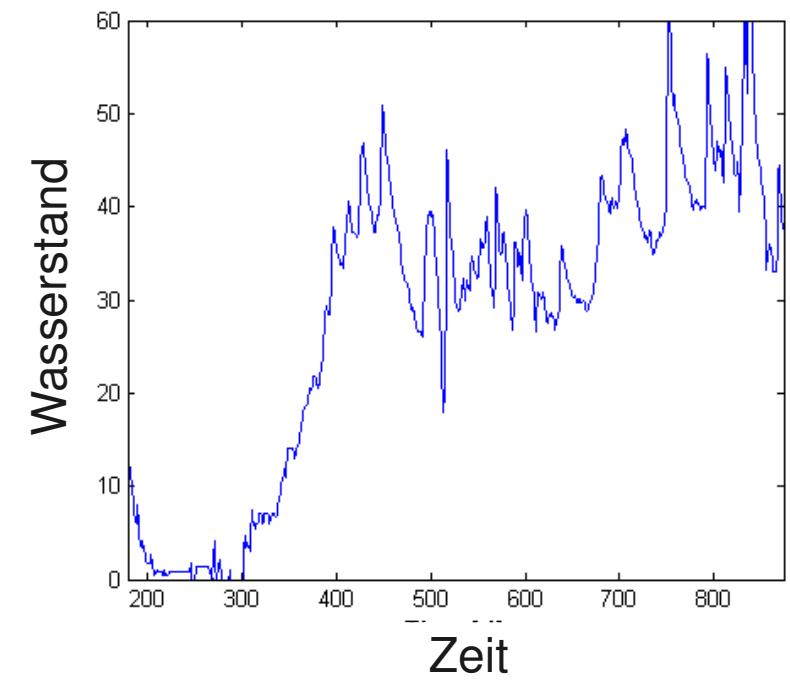
Bsp: *Asellus aquaticus* und Wasserstand

- $\mu(x, T, t) = 1 - (1 - \mu_x(x))(1 - \mu_T(T))(1 - \mu_H(t))$
- gelöst für mehrere Populationsfraktionen

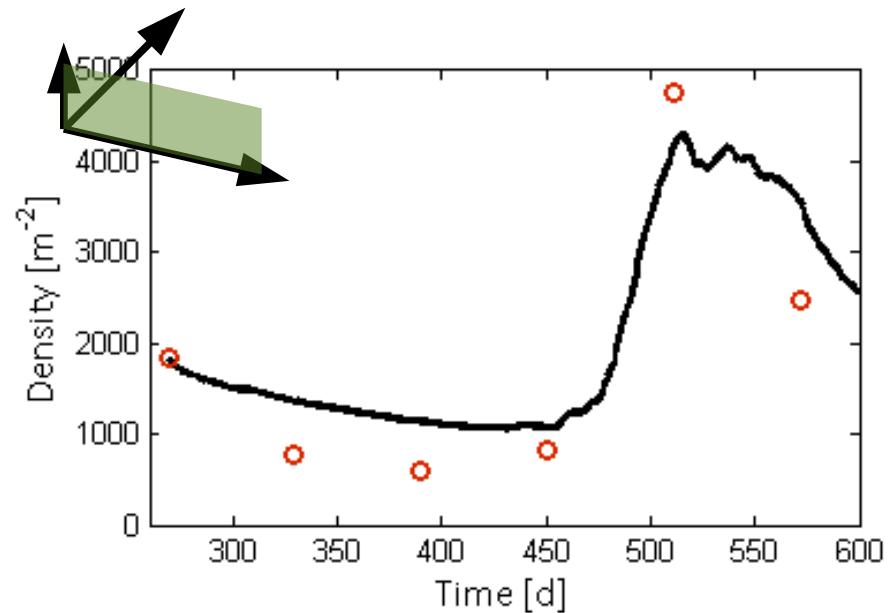
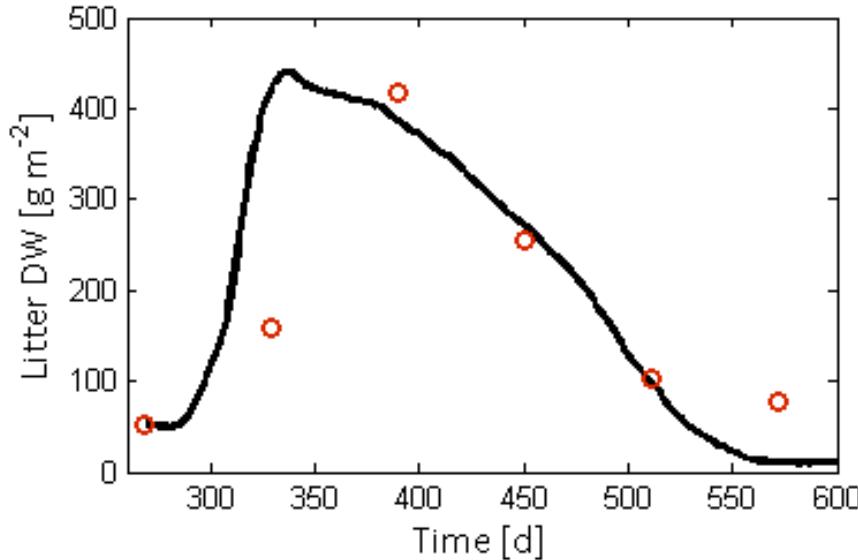
n_1, n_2, n_3



7

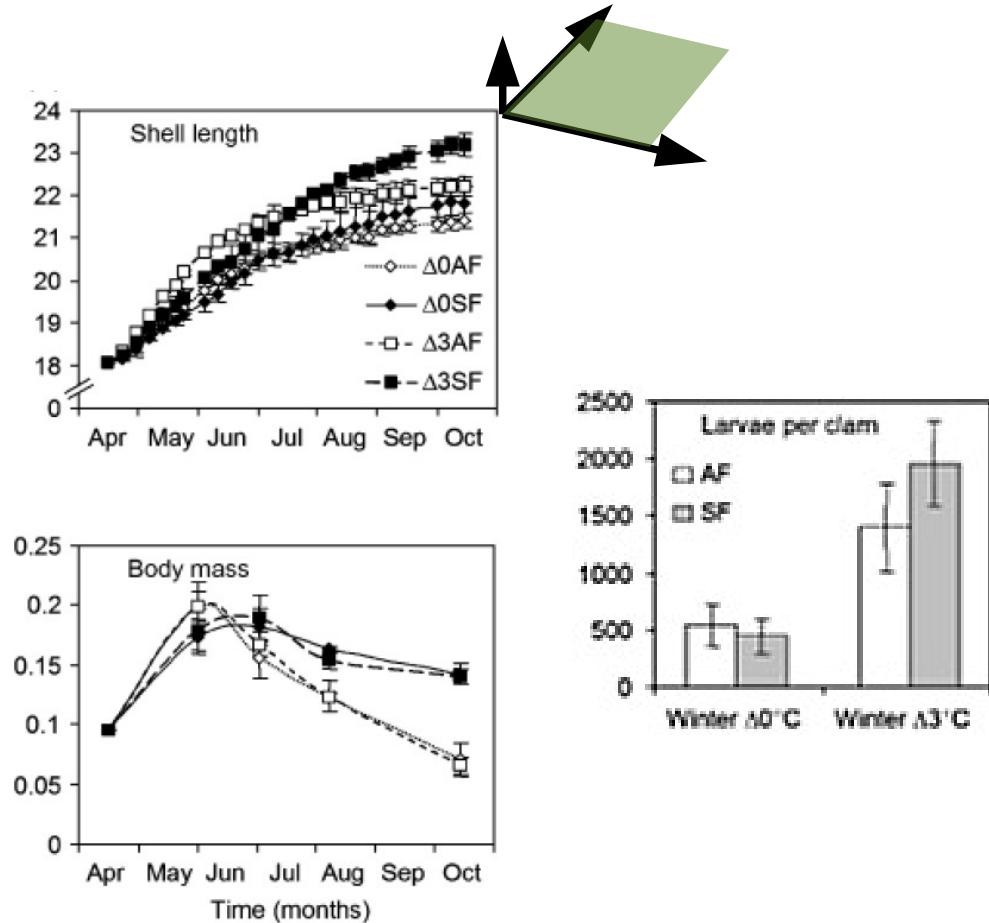


Bsp: Gammarus pulex und Streudynamik



Bsp: Corbicula fluminea und Energiedynamik

Gunnar Petter
Markus Weitere



Markus Weitere et al, Global Change Biology 2009

Gunnar Petter
Markus Weitere

Bsp: Corbicula fluminea und Energiedynamik

$$\frac{dE}{dt} = pa(T, F, l) - pc(T, E, l)$$

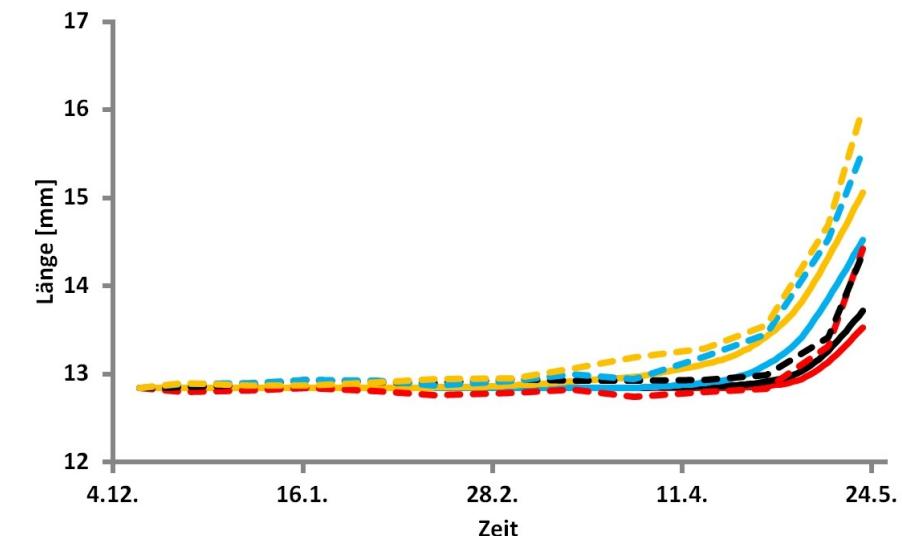
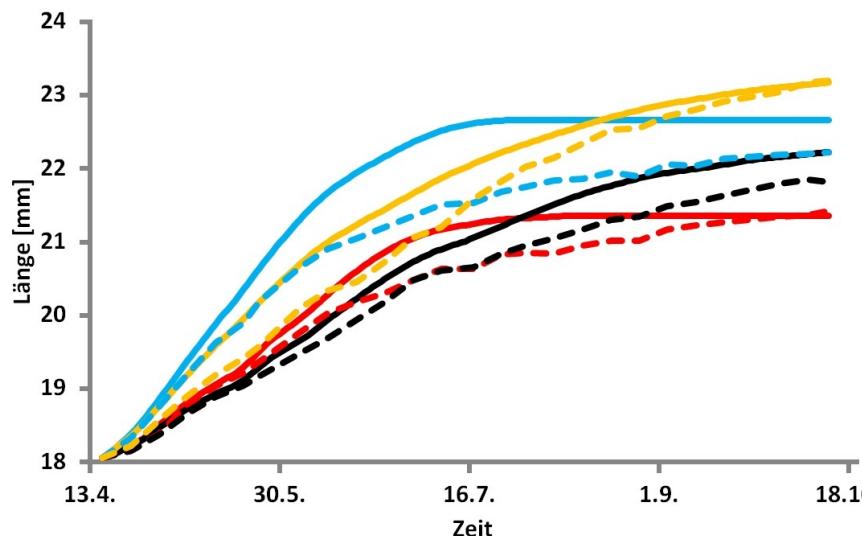
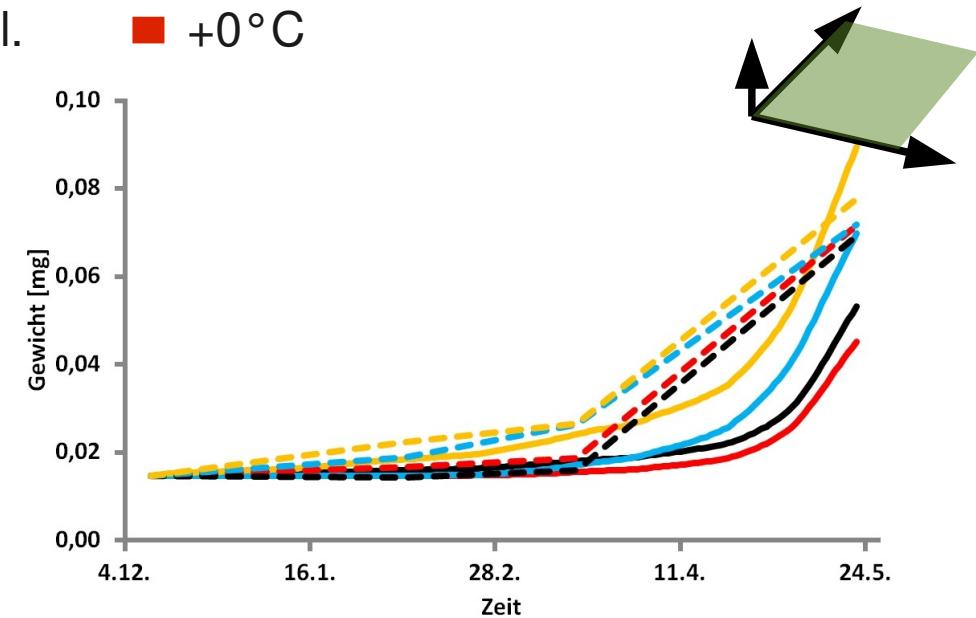
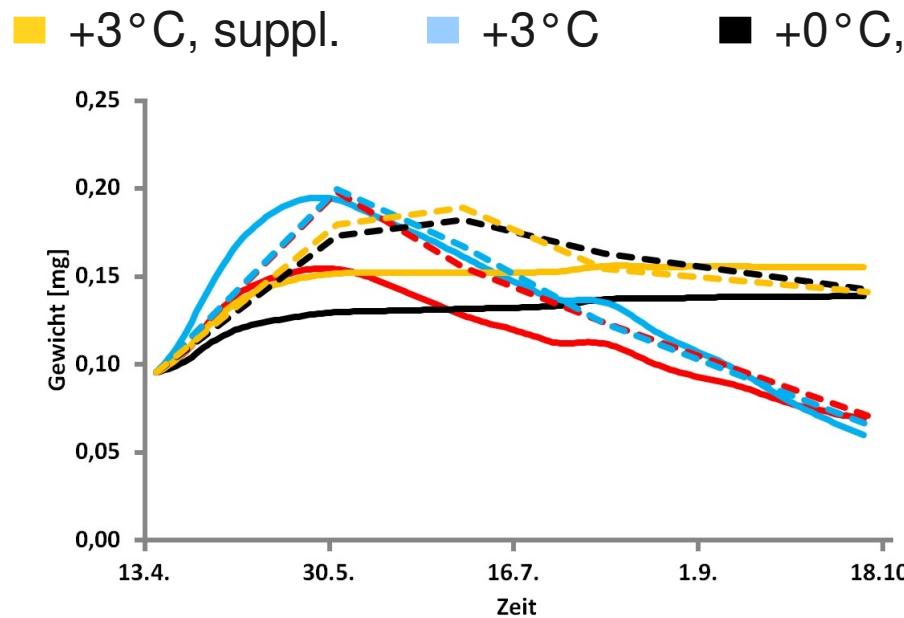
$$\frac{dl}{dt} = \frac{K \cdot pc(T, E, l) - pm(T, l)}{[E_G]} \cdot \frac{1}{3 \cdot \delta^3 \cdot l^2}$$

$$\frac{dE_R}{dt} = (1 - K) \cdot pc(T, E, l) - pj(T, l)$$



Bsp: Corbicula fluminea und Energiedynamik

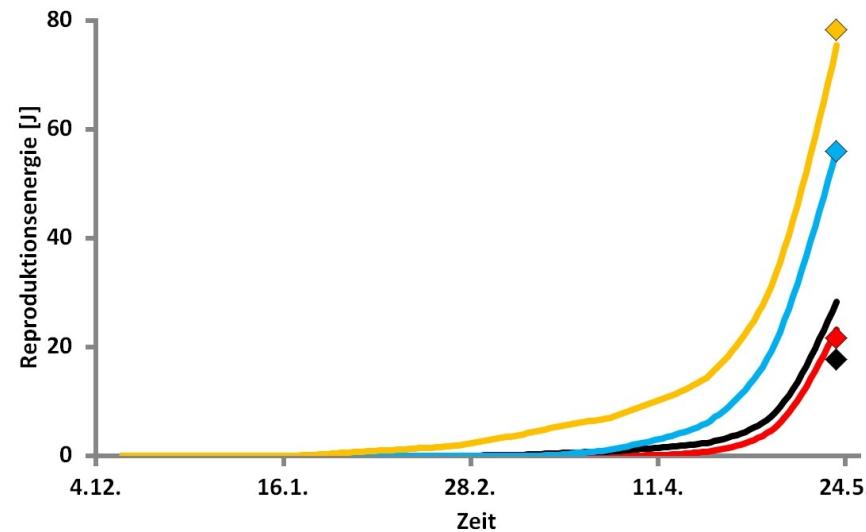
Gunnar Petter
Markus Weitere



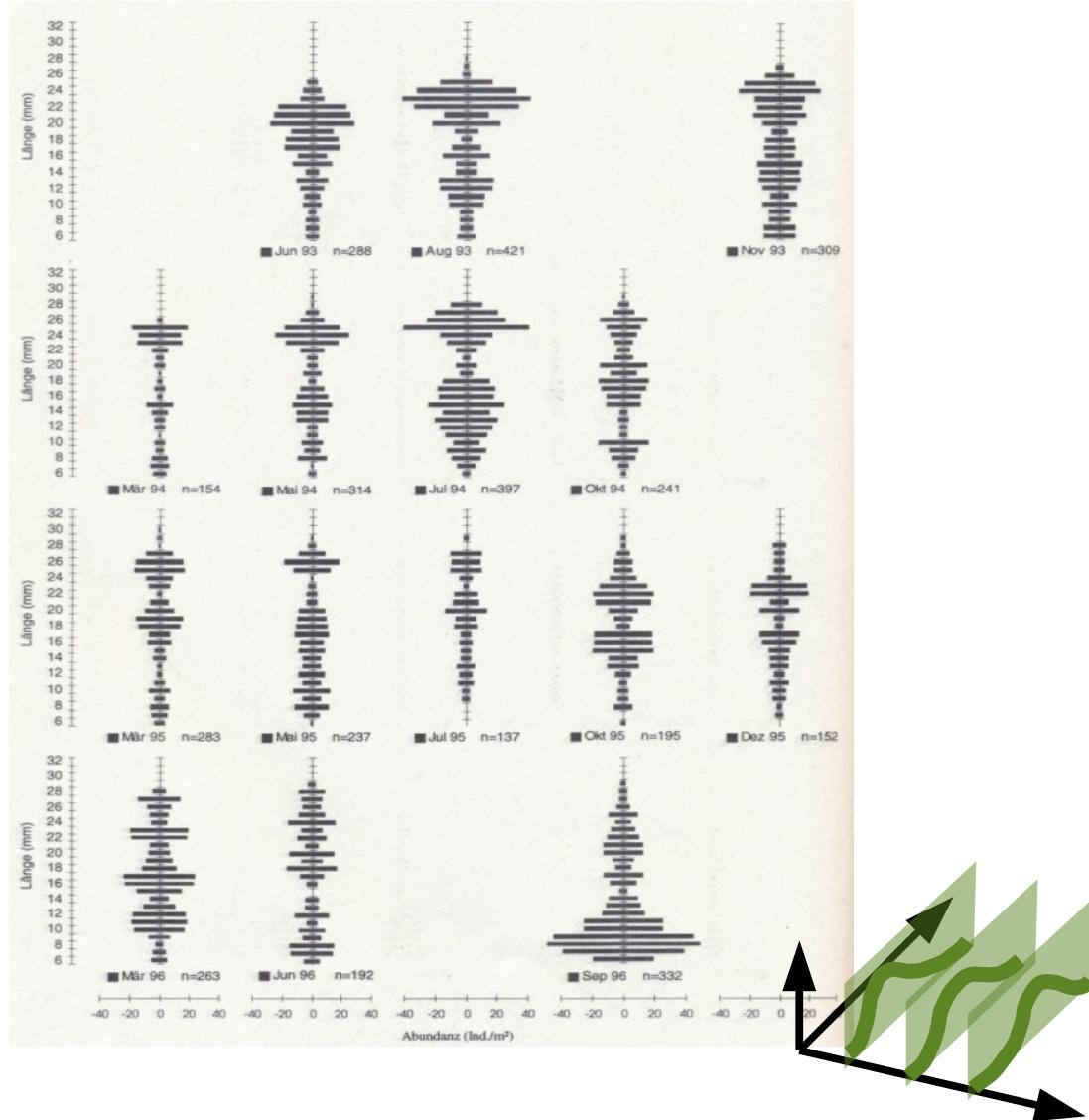
Gunnar Petter
Markus Weitere

Bsp: Corbicula fluminea und Energiedynamik

■ +3°C, suppl. ■ +3°C ■ +0°C, suppl. ■ +0°C



Bsp: Corbicula fluminea und Energiedynamik

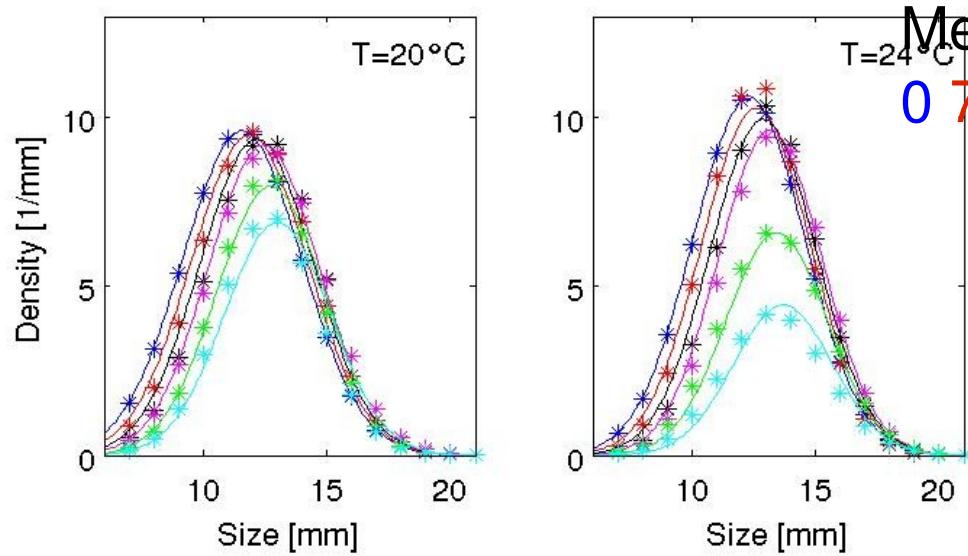
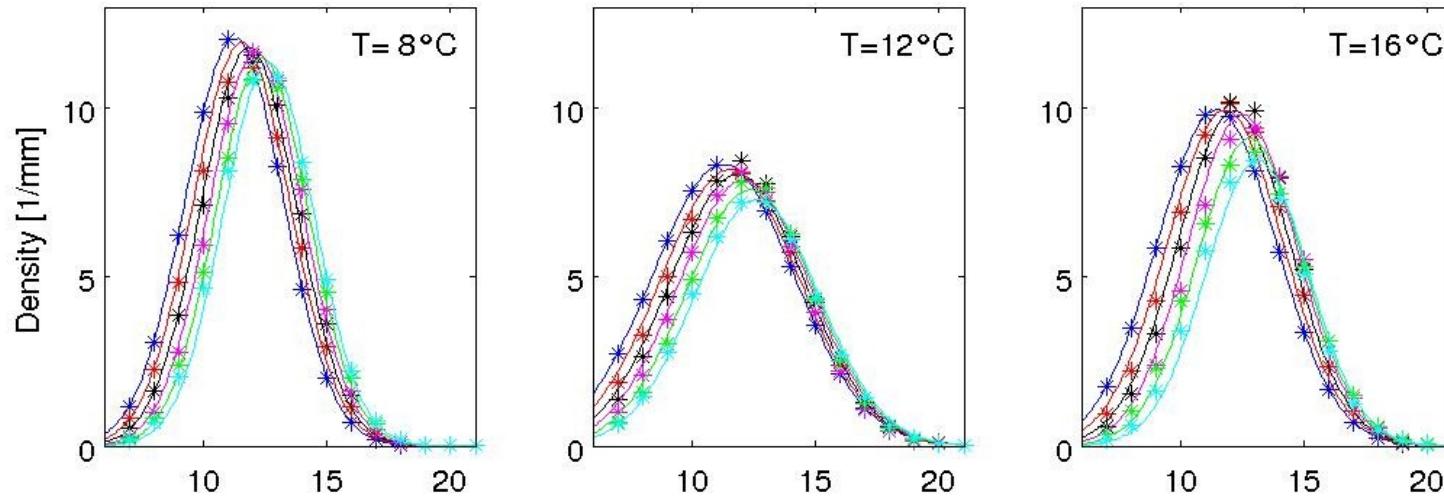


Anja Meister, Dissertation, 1997

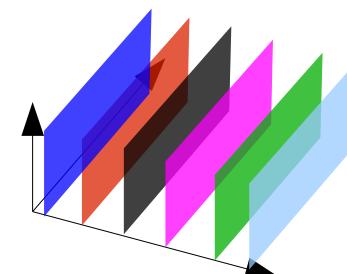
Bildnachweis

- cms.uni-konstanz.de/fileadmin/biologie/forschungstauchen/Bildarchiv
- flickr.com
- nathistoc.bio.uci.edu/crustacea/Isopoda
- eol.org
- pride2.org/NewPrideSide/Asia+
- wikipedia.de

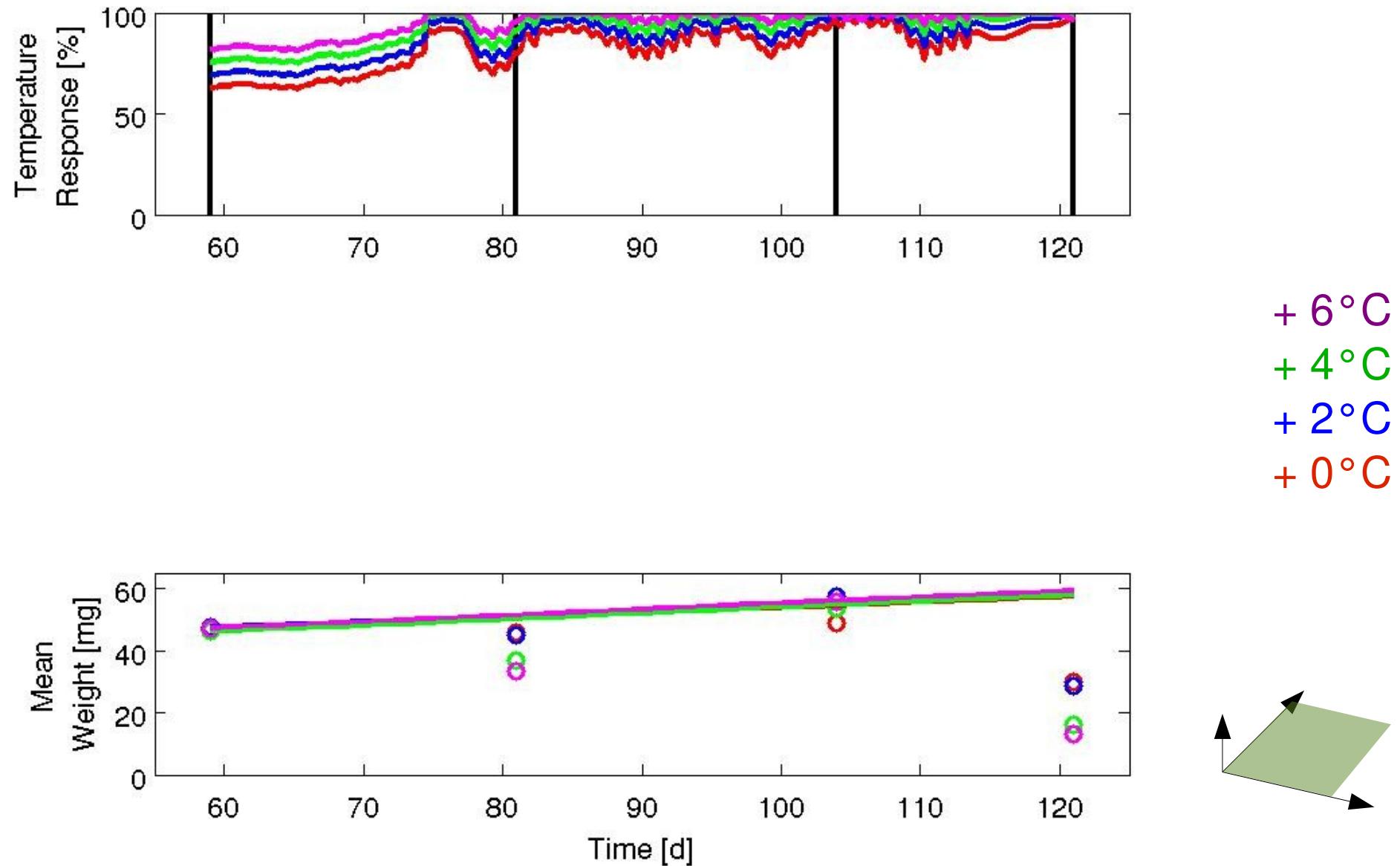
Lab – Güte der Anpassung



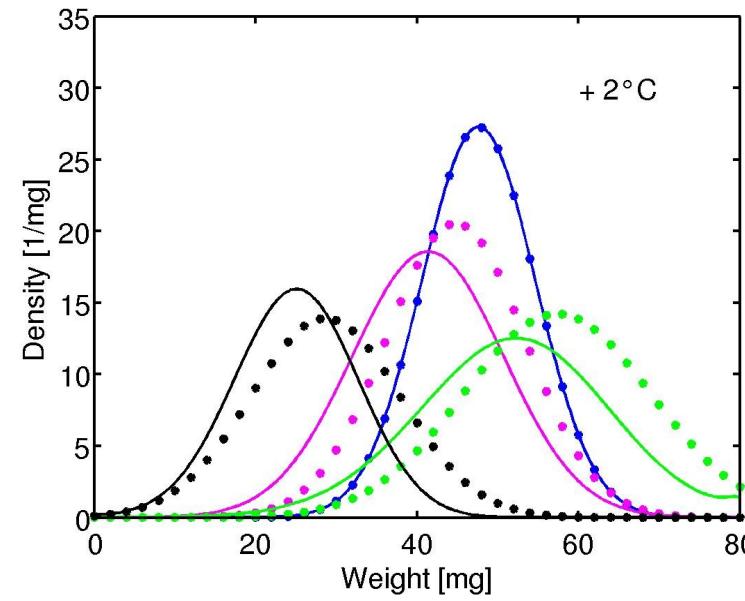
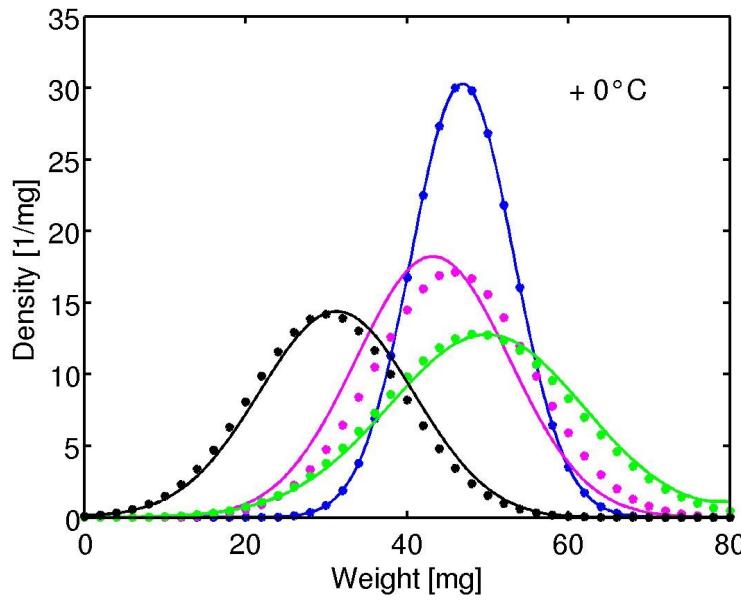
Messtermine [d]:
0 7 14 21 28 35



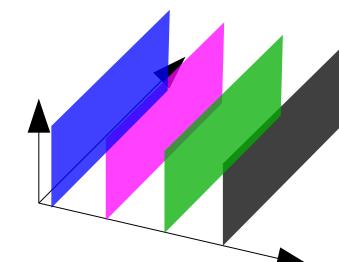
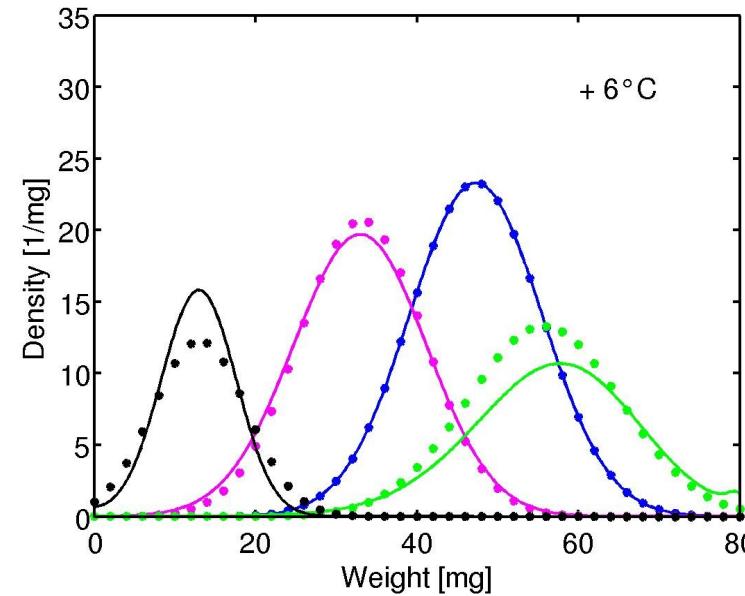
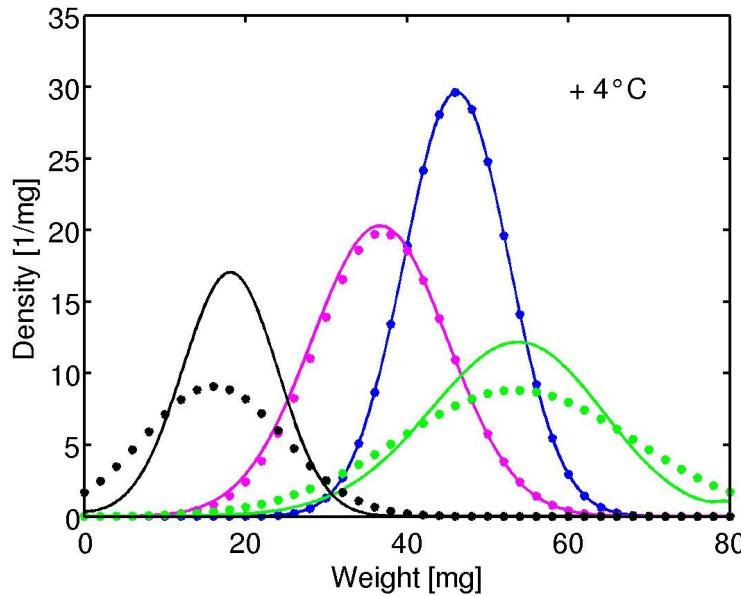
Mesokosmen – Labparameter



Mesokosmen



Messtermin:
Tag dJ 59
81
104
121



Lab - Temperatureffekte

	I	II	III	IV
rb [1/d]	0.0910 ± 0.019	0.0062 ± 0.002	0.0062 ± 0.002	0.0061 ± 0.001
$Toptr$ [°C]	16.46 ± 0.43	16.74 ± 0.15	16.80 ± 0.13	20.14 ± 0.00
$q10r$	2.11 ± 0.10	1.46 ± 0.01	1.45 ± 0.01	1.36 ± 0.00
$Toptm$ [°C]	-	-	3.63 ± 1.67	5.00 ± 3.02
$q10m$	-	-	1.03 ± 0.004	1.04 ± 0.01
$R^2(x)$	0.860	0.899	0.899	0.902
$R^2(rb)$	0.4049	0.0142	0.0154	0.0044

I individuell

III temperaturgruppiert+Tote

II temperaturgruppiert

IV strukturierte Kohorten

Lab versus Mesokosmen

	Lab	Mesokosmen
rb [1/d]	0.0062	0.0454
T_{optr} [°C]	16.80	21.6
$q10r$	1.45	2.5
T_{optm} [°C]	4.3	5.82
$q10m$	1.04	1.05
$m0$ [1/d]	0.00	0.0031
$R^2(x)$	0.52	0.97