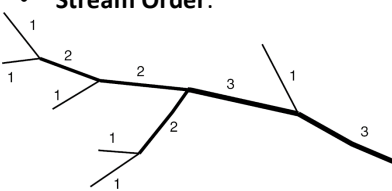
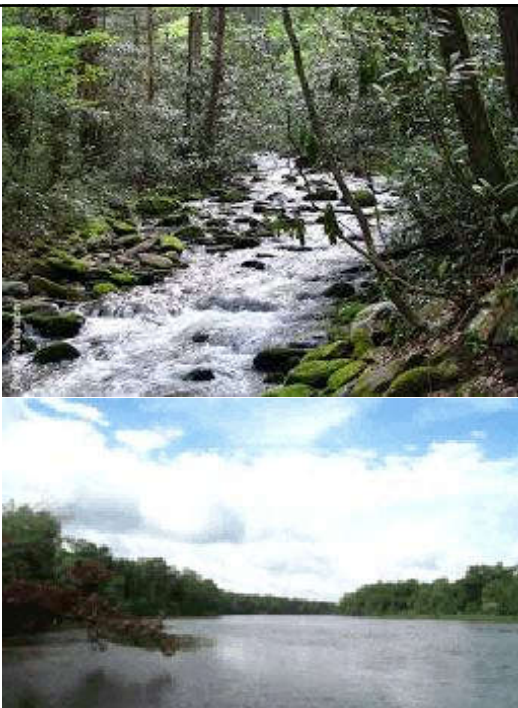


- River continuum gradients consistent throughout freshwater ecosystems globally.
- **Stream Order:**

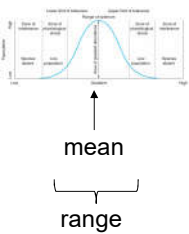
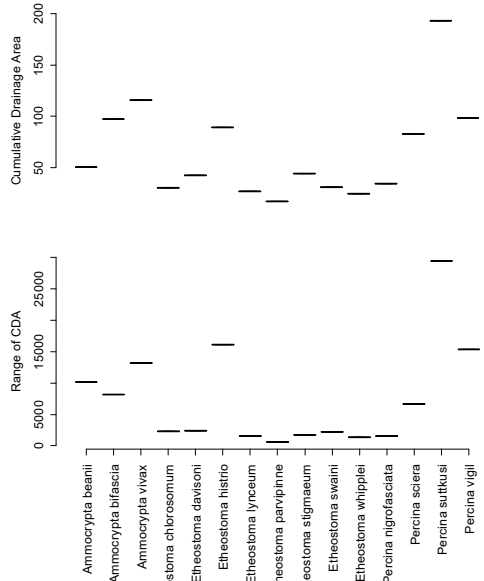


- Other metrics of size: **Cumulative Drainage Area** or **River Discharge.**



Defining Species Niche by Stream Size

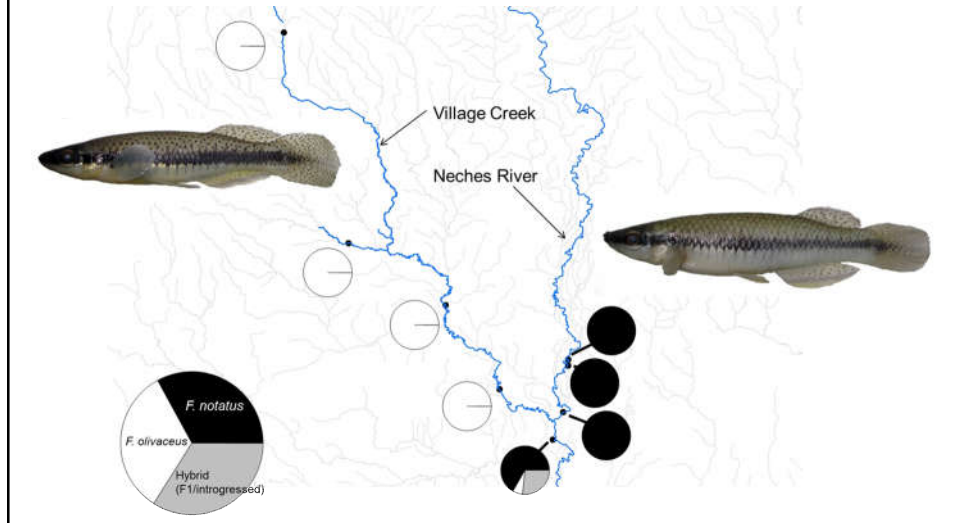
- Recall our definition of niche...
- Compiled occurrence data for all darters, calculated the mean (geometric) and variance in stream size occupied.

Species	Approximate Range of CDA
<i>Ammocrypta beanii</i>	10 - 15
<i>Ammocrypta bifascia</i>	25 - 35
<i>Ammocrypta vivax</i>	40 - 50
<i>ostoma chlorosomum</i>	55 - 65
<i>Etheostoma davisoni</i>	70 - 80
<i>Etheostoma histrio</i>	85 - 95
<i>Etheostoma lyecum</i>	100 - 110
<i>theostoma parvirinne</i>	115 - 125
<i>hecostoma stigmaeum</i>	130 - 140
<i>Etheostoma swaini</i>	145 - 155
<i>Etheostoma whipplei</i>	160 - 170
<i>Percina nigrofasciata</i>	175 - 185
<i>Percina sclera</i>	190 - 200
<i>Percina suttkusi</i>	205 - 215
<i>Percina vigli</i>	220 - 230

Partitioning Habitats

- *Fundulus* “coexistence” facilitated by *F. notatus* living downstream, *F. olivaceus* living upstream.
- True coexistence only near confluences – rapid shifts from one habitat type to another



Life History

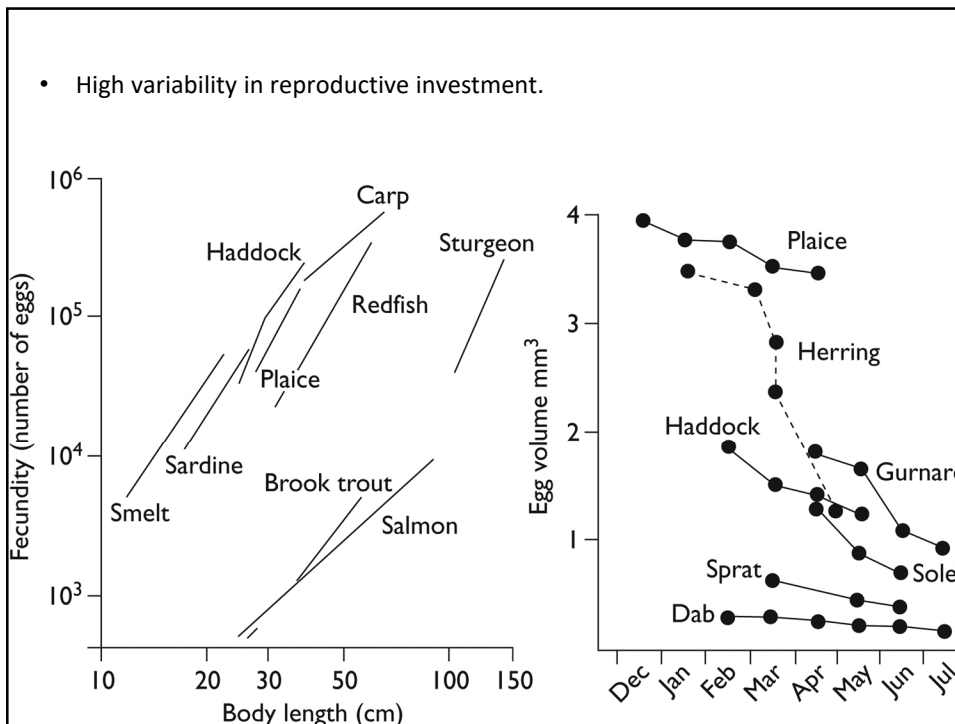
- The schedule and duration of various **ontogenetic** stages.
- Patterns of **energy allocation** to growth vs. reproduction throughout life.
- Selection should favor sets of traits that maximize **fitness**, why do we see such dramatic differences in life history?



r-selected

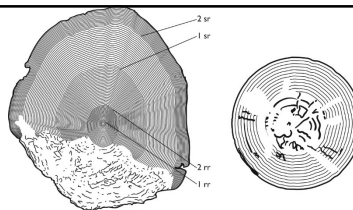


K-selected



Life History

- Assessment of population demographic structure.
- Collection and ageing of individuals
- Individual reproductive capacity.

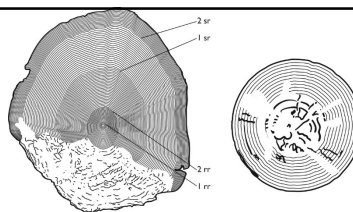


Age	n_x	l_x	d_x	q_x	s_x	m_x	$l_x m_x$	$x l_x m_x$
0	500	1.00	482.00	0.96	0.04	0	0	0
1	18	0.04	13.00	0.72	0.28	20	0.72	0.72
2	5	0.01	4.00	0.80	0.20	100	1	2
3	1	0.00	1.00	1.00	0.00	100	0.2	0.6
4	0	0						
R							1.92	3.32
T_c								1.73

- n_x - number of each age class
- l_x - probability of survival to age
- d_x - number of mortalities at each age
- q_x - age specific mortality
- s_x - age specific survivorship
- m_x - age specific fecundity

Life History

- Assessment of population demographic structure.
- Collection and ageing of individuals
- Individual reproductive capacity.



Age	n_x	l_x	d_x	q_x	s_x	m_x	$l_x m_x$	$x l_x m_x$
0	500	1.00	482.00	0.96	0.04	0	0	0
1	18	0.04	13.00	0.72	0.28	20	0.72	0.72
2	5	0.01	4.00	0.80	0.20	100	1	2
3	1	0.00	1.00	1.00	0.00	100	0.2	0.6
4	0	0						
						R	1.92	3.32
						T_c	1.73	

- $l_x m_x$ - product of age specific mortality and fecundity
- R – sum of $l_x m_x$ = rate of population increase
- T_c - sum of $x l_x m_x$ divided by R = generation time

Life History

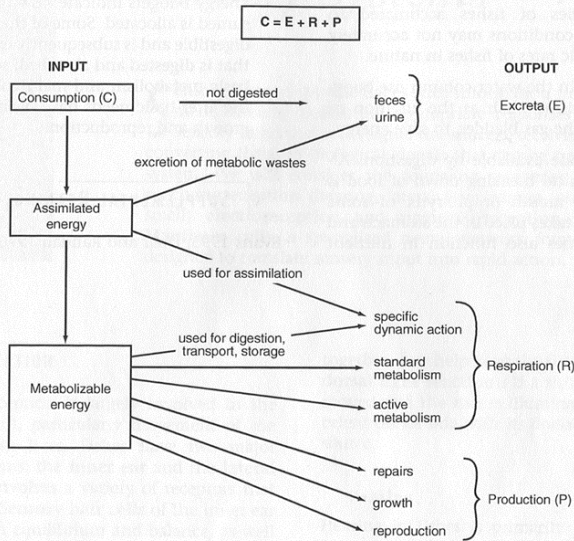
Age	n_x	l_x	d_x	q_x	s_x	m_x	$l_x m_x$	$x l_x m_x$
0	500	1.00	482.00	0.96	0.04	0	0	0
1	18	0.04	13.00	0.72	0.28	20	0.72	0.72
2	5	0.01	4.00	0.80	0.20	100	1	2
3	1	0.00	1.00	1.00	0.00	100	0.2	0.6
4	0	0						
						R	1.92	3.32
						T_c	1.73	

Age	n_x	l_x	d_x	q_x	s_x	m_x	$l_x m_x$	$x l_x m_x$
0	100	1.00	30.00	0.30	0.70	0	0	0
1	70	0.70	30.00	0.43	0.57	0	0	0
2	40	0.40	20.00	0.50	0.50	2	0.8	1.6
3	20	0.20	20.00	1.00	0.00	3	0.6	1.8
4	0	0						
						R	1.4	3.4
						T_c	2.43	

Energetics

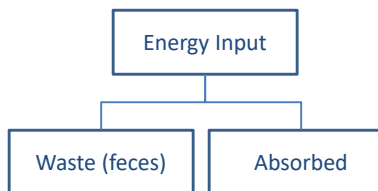
- Respiration
 - Standard (maintenance)
 - Active
 - Specific dynamic action
- Production
 - Growth/Repair
 - Reproduction
- Selection should favor strategies to maximize reproduction

FIGURE 5.9. Partitioning of energy consumed by a fish. Only energy not required to meet basic physiological needs (digestion, standard metabolism, repairs) or needed for activity is available for growth and gametes.



Sources of Energy

- **Assimilation efficiency** – ratio of calories absorbed to calories ingested
- General SDA costs
 - Lipids 5%
 - Carbohydrates 8%
 - Protein 30%
- Quality of food



Feeding habit	Consumer	Food	Assimilation/consumption (% absorption efficiency)
Herbivory	Ectotherms, aquatic	Algae	30-70
	Ectotherms, aquatic	Macrophytes	30-60
	Ectotherms, land		40-50
	Endotherms, land		60-70
Grazivory	Ectotherms, land		75-80
	Endotherms, land		70-77
Nectarivory	Ecto- or endotherms, land		95+
Carnivory	Ectotherms, aquatic	Invertebrates	65-85
	Ectotherms, aquatic	Fish	80-90
	Ectotherms, land	Flesh	85
	Endotherms, land	Flesh	85
	Endotherms, land	Milk	96
	Various	Blood	85+
Detritivory	Ectotherms, aquatic		40-45
	Ectotherms, land		10-20
Endoparasitism	Ectotherms		70-80

Reproductive Investment

- Production calories split between reproductive and somatic growth
 - Somatic – assess through condition index (mass/length³)
 - Reproductive – gonad mass/somatic mass



- *Campostoma anomalum* gonadosomatic index (GSI) values for spring 2014
- Individual females as high as 50%, males as high as 4-5%

