Bioenergetics

PhD. student

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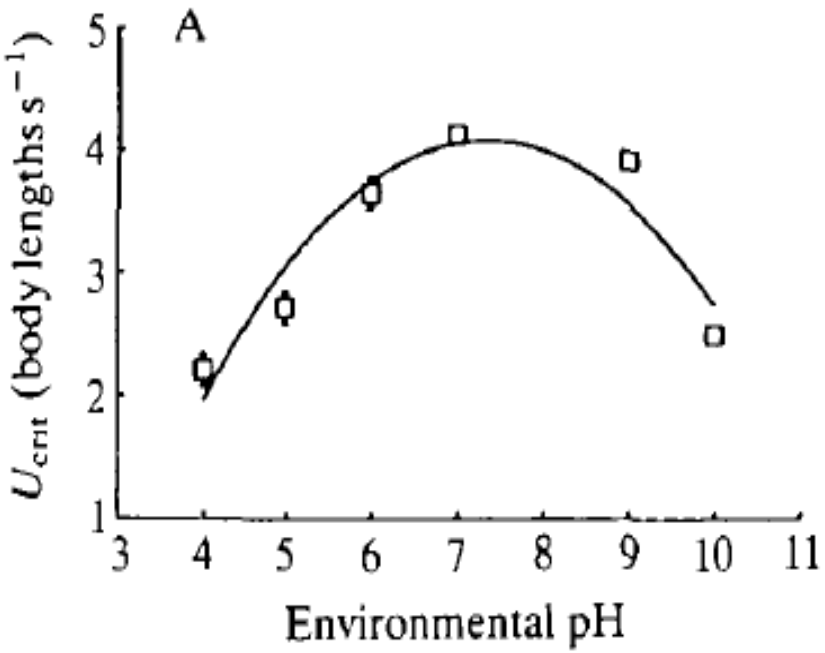
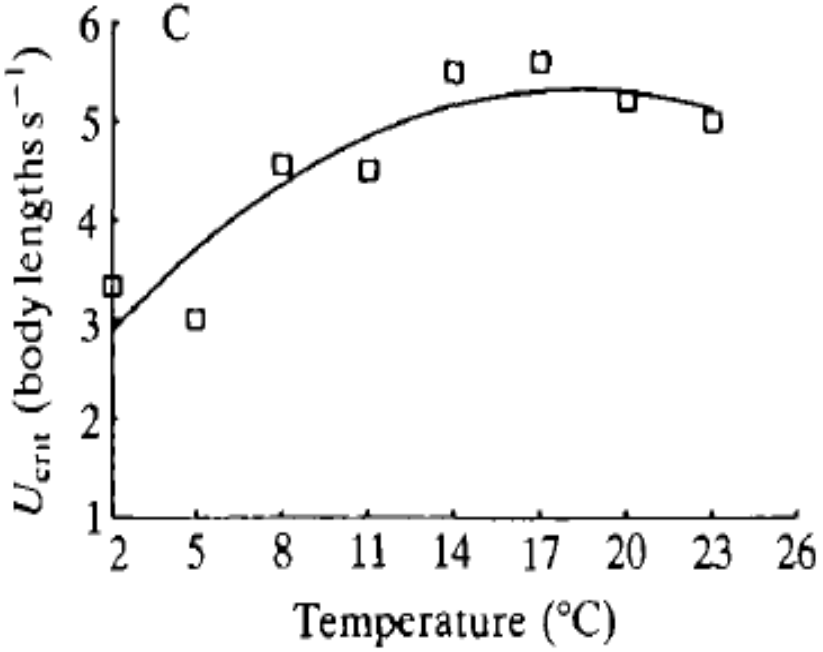
5- Bioenergetics models 1

What affects energetics?

1. Temperature
2. Body size
3. Activity levels
4. D.O., pH, or other stressors
5. Prey type and other exp. Set up.





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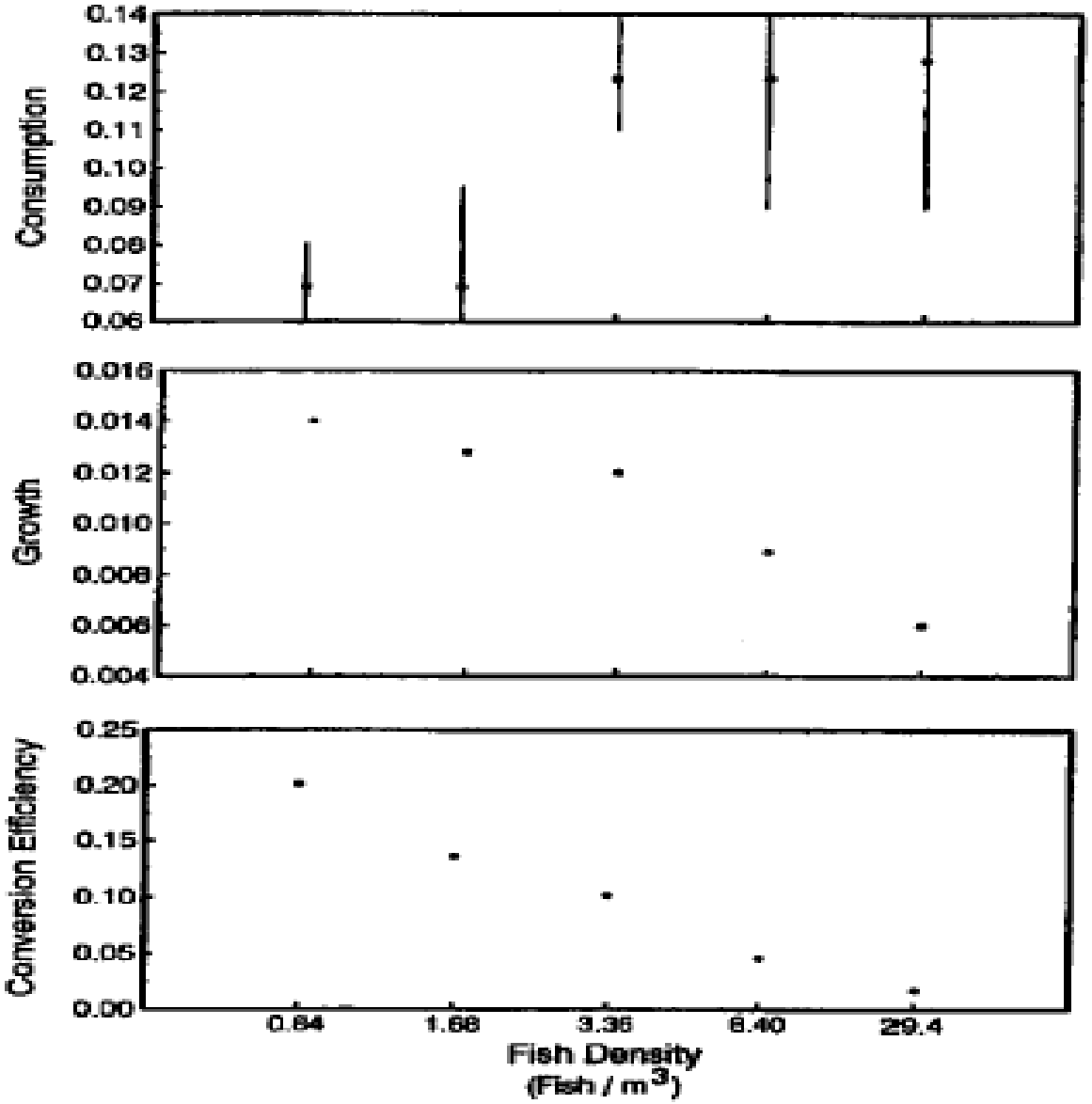


What affects energetics?

5. Prey type and other exp. Set up.

Young striped bass fed live age-0 spot, polychaetes, or chopped bay anchovy did not differ in maximum consumption rates ($P > 0.05$)

Cmax spot = 0.089 g/g/d

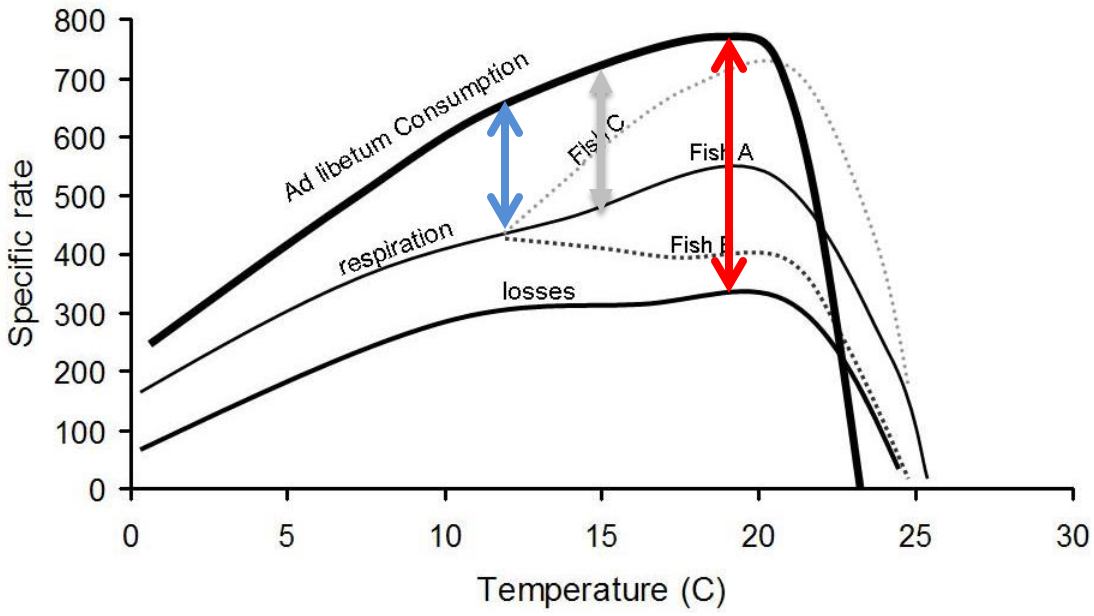
Cmax polych. = 0.080 g/g/d

Cmax anchovy = 0.071 g/g/d

Is individual variability important?

Scope for growth for a 3 hypothetical fish illustrating how changes in behavior (activity) can result in different growth potential and temperatures for optimum growth.

Fish A maintains constant activity levels with temperature and has an optimum temperature for growth (G-opt) of 14.5°C.
Fish B responds to increasing temperatures by decreasing activity resulting in a G-opt of 20°C.
Fish C increases activity with temperature resulting in a G-opt of 12°C.



Bioenergetics models

- Metabolism = respiration + active metabolism+ SDA specific dynamic action
- • Waste = egestion + excretion
- • Growth = somatic growth + gonad production + repairs
- • C = (R + A + S) + (F + U) + (B + G)

Consumption=Metabolism (Respiration) + Wastes (Excreted) + Growth (Production)

$$C = M + W + G$$

For Carnivores 100 = 44 + 27 + 29
For Herbivores 100 = 37 + 43 + 20

- What can we see?

1) Herbivores have lower growth rates and higher waste-loss rates – makes sense
2) Both fishes have higher rates of growth efficiency than birds and mammals

Respiration = amount of energy used for routine metabolism; Dependent on fish size, water temperature and activity

Consumption = proportion of the maximum daily ration for a fish at a particular mass and temperature (g prey per g body mass per day)

*** Allometric function of mass from ad libitum feeding experiments at optimum temperatures**

Waste Losses (Egestion= fecal waste and Excretion=nitrogenous waste) = constant proportion of consumption or as functions dependent on water temperature and consumption

Bioenergetics models

Types of Models in Fisheries

- **Organismal**
  – Behavior, physiology, genetics, pathology, etc.

- **Trophic Interactions**
  – Feeding, predation, competition, growth, nutrient recycling, growth, carrying capacity

- **Fish-Habitat Relations**
  – Predict fish presence, density or growth based on physical, chemical, biological factors

- **Population dynamics & assessment**
  – Predict abundance/biomass from growth, mortality, spawner-recruit, fishing, etc.

Bioenergetics models

Fish are good subjects for bioenergetics models

*__Cold-Blooded__: Temperature affects metabolism and feeding rate directly

*

Indeterminant growth –Large differences in size-at-age for the same species across different populations. More food, better food, or favorable thermal conditions translate into better growth.

*__Growth__ provides an Integrative History of environmental conditions & foraging success

Bioenergetics models

Fish Bioenergetics Models are connected to other types of fish models

- **Organismal** - Physiological rates for metabolism, consumption, growth, waste
- **Trophic Interactions** - Feeding, predation, competition, growth, nutrient recycling, growth, carrying capacity, Ecosystem models
- **Fish-Habitat Relations –** habitat quality from ambient environmental conditions, food availability & quality (growth potential)
- **Population dynamics & assessment**-Estimate population-level impacts by consumers on food resources (predation mortality, carrying capacity)

Bioenergetics models

Bioenergetics Model: An Energy Balance Equation

- Consumption = Waste + Metabolism + Growth
- INPUT = OUTPUT
  - Consumption must balance costs plus Growth

- Most common application of the model is to **Estimate the Consumption needed to satisfy observed Growth over a specified period**
- MUCH easier to measure growth than consumption in field (Hatcheries are an exception)