Energy Balance in Fish

- Energy flow in fish is similar to that in mammals and birds
- fish are more efficient in energy use
- energy losses in urine and gill excretions are lower in fish because 85% of nitrogenous waste is excreted as ammonia (vs. urea in mammals and uric acid in birds)
- heat increment (increase) as a result of ingesting feed is 3-5% ME in fish vs. 30% in mammals
- maintenance energy requirements are lower because they don't regulate body temp
- they use less energy to maintain position

Factors Affecting Energy Partitioning

- Factors either affect basal metabolic rate (e.g., body size) or affect other changes
- those affecting BMR are the following:

1. **body size**:non-linear, $y = ax^b$, for most physiological variables, b values usually range between 0.7 and 0.8
2. **oxygen availability**: have conformers (linear) and non-conformers (constant until stressed)

Factors Affecting Energy Partitioning

3. **temperature:** most aquaculture species are poikilotherms, significant effect, acclimation required, aquaculture situation may mean rapid temp changes
4. **osmoregulation:** changes in salinity result in increased cost of energy
5. **stress:** increased BMR resulting from heightened levels of waste, low oxygen, crowding, handling, pollution, etc. (manifested by hypoglycemia)
6. **cycling:** various animal processes are cyclic in nature (e.g., reproduction, migration)

Factors Affecting Energy Partitioning

- Those factors ***not*** affecting BMR are:

1. **gonadal growth:** most energy diverted from muscle growth into oogenesis, deposition of lipid, can represent 30-40% of body weight, implications????
2. **locomotion:** major part of energy consumption, varies due to body shape, behavior and size, aquatic vs. terrestrial issues

Energy and Growth

- Dietary excesses or deficiencies of useful energy can reduce growth rate
- this is because energy must be used for maintenance and voluntary activity before it is used for growth
- dietary protein will be used for energy when the diet is deficient in energy relative to protein
- when the diet contains excessive energy, feed intake is typically reduced…fish don't want to be fat????
- this also reduces intake of protein and other nutrients needed for growth

Energy and Growth

- Consumption of diets with low protein to energy ratios can lead to fat deposition (fatty acid synthetase)
- this is undesirable in food fish because it reduces the dress-out yield and shortens shelf life
- undesirable in shrimp due to build-up in hepato-pancreas (midgut), ultimately affecting cooking
- low protein:energy diets can be useful for maturation animals, hatchery animals raised for release

Energy Requirments of Fish

- Determining the energy requirement of fish has been a difficult task, slow in coming
- most research has been devoted to identifying protein requirements, major minerals and vitamins
- in the past, feeds were formulated letting energy values "float"
- excess or deficiency of nutritional energy does not often lead to poor health

Energy Requirements of Fish

- Further, if feeds are formulated with practical feedstuffs (ingredients), their energy levels are not likely to be off
- it is really a matter of cost: protein is the most expensive component of the diet, COH sources are cheap, why use protein as an energy source????
- In terrestrials, feed is consumed to meet energy requirements
- thus, as energy level of the feed goes up, protein level is also designed to go up

Energy Requirements of Fish

- Fish are fed on a feed allowance basis (we estimate feed fed)
- various studies have shown that the digestible energy (DE) requirement for channel catfish and carp was around 8.3-9.7 kcal DE/100 g fish/day
- in terms of age, dietary level of DE and protein typically drop with age