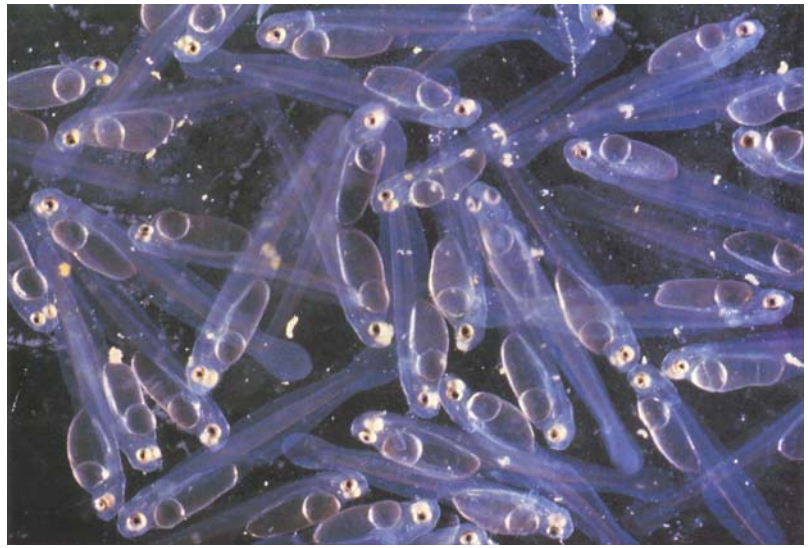


Nutrition of Hybrid Striped Bass

Importance of nutrition

- Maximize growth
- Maintain health & avoid deficiency diseases
- Minimize lipid deposition in product
- Minimize "off-flavor"
- Reduce cost of production

General comments on proximate composition and energy

- Live-weight composition of fish
  - Water (60-80%), protein (15-30%), lipid (2-12%) on a wet matter basis
  - Carbohydrates minimal, ~1%
  - Composition varies within and between
    - species, size, sex, genetics, reproductive stage, temperature, diet composition, activity regime, etc…

Proximate composition and energy cont....

HSB whole-body composition (900 g)

	Water	C. lip.	C. prot.	CHO	Ash
Wet (%)	68	10.2	17.3	0.3	4.2
Dry (%)	--	32	54	1	13
Kcal		871	746	12	

Partitioning of dietary energy

- energy ingested must convert one form or another
- Basic energy budget is:

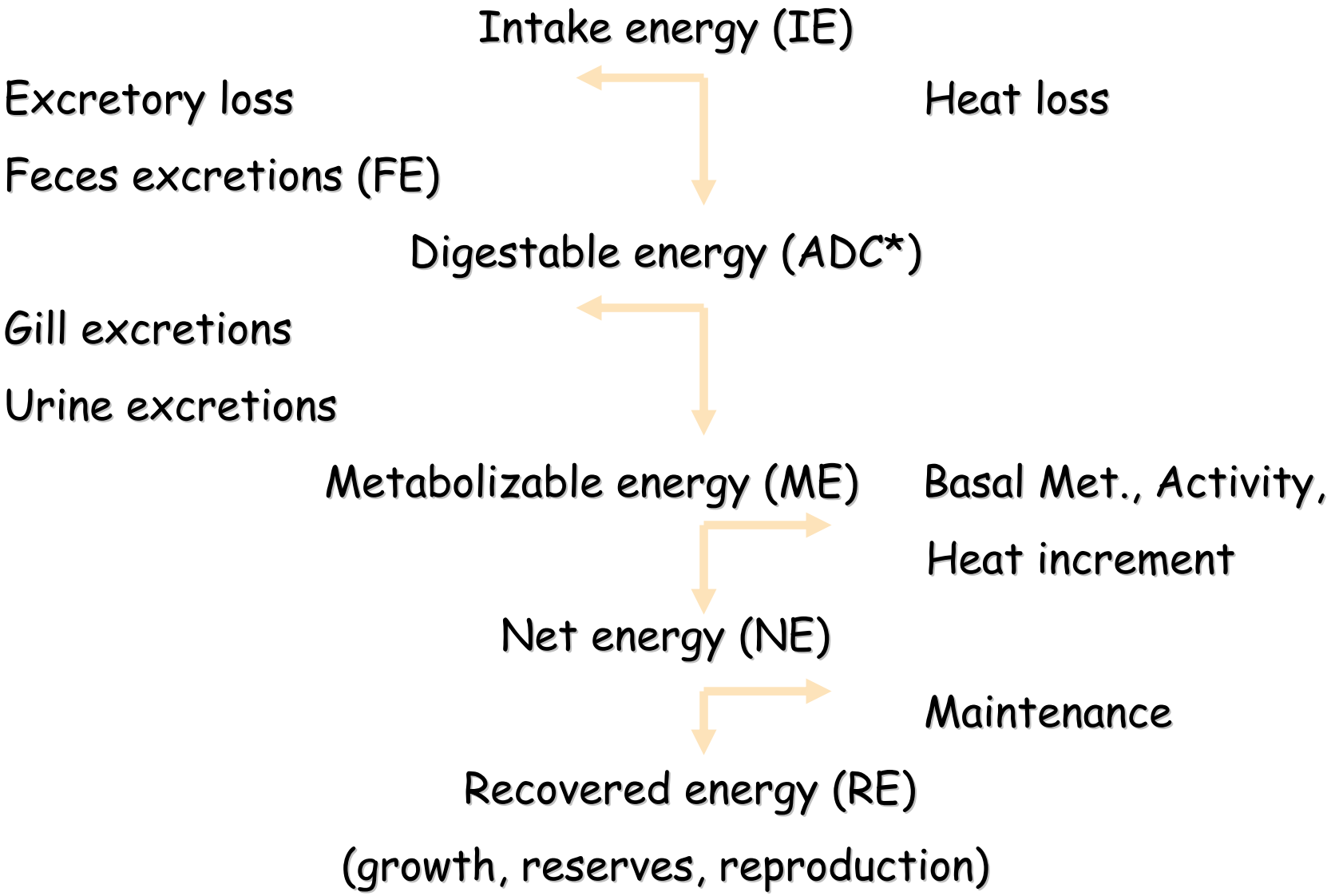
$$I = M + G + E$$ where

M includes standard, active, and feeding metabolism

G includes somatic and gonadal growth

E includes losses of urea, ammonia, feces, mucus, sloughed skin cells, etc.

Schematic of the "fate of dietary energy"



Development of fish feeds

- major fish culture advancement
- Started feeding natural foods, slowly progressed to prepared diets
  - Natural aquatic foods still important – e.g., plankton for juveniles and filter feeders

Early diets nutritionally deficient

- a lot of waste byproducts used
- used to supplement natural foods
- knew little about balanced diets for fish
- nutrition now most rapidly advancing specialty

Nutrient Groups

- Protein
  - Protein:energy ratio
  - Amino acids
- Lipids
- Carbohydrates
- Vitamins
- Minerals

Protein requirement

- Dietary protein that most closely approximates the amino acid requirements of the fish has the highest physiological protein "value"
- In general, animal better than plant
- Synthetic (crystalline) amino acids can be added
  - Question usability
  - Synthetics not absorbed from gut at same rate
  - Must be incorporated in diets at lower levels
- Fish meal usually needed to provide optimal diet

Protein

- Essential levels required to ensure:
  - Amino acid requirement
  - growth and metabolic processes
- Energy:protein ratio important for protein synthesis (growth)
- Very costly part of feed, esp. fish meal

- HSB requirement
  - 40-41% of diet dwb
  - 8-9 kcal/g protein

Essential amino acids

Fish cannot produce 11 of necessary 23 amino acids
Ten are essential

Arginine (4.3%)	Phenylalanine
Histidine	Threonine (2.8%)
Isoleucine	Tryptophan
Leucine	Lysine (4%)
Methionine (2.9%)	Valine

Total sulfur amino acids (2-2.9%)

(% of protein, dwb)

Amino acid premixes used to supplement protein

Lipids & EFA

- Needed for energy, growth and assist in absorption of fat-soluble vitamins

- HSB requirements
  - Readily utilize dietary lipid
  - 5-17% (7-10% appears optimal) menhaden oil
  - E/P must be correct
  - 1% HUFA of n-3 series essential (20% of dietary lipid)
  - Lecithin – not required
  - Cholesterol – not required

Carbohydrates (C,H,O)

- Used for energy in mammals, but fish do not have a specific requirement
- Carnivorous fishes have more limited ability to use, but HSB have a simpler GI tract
- Energy mostly from proteins or lipids, but CHO can be used for protein sparing to some extent
- Some omnivores have intestinal microflora that allow them to use cellulose (e.g., chan. cat up to 40%)
- HSB appear similar to CC, utilizing up to 25% dextrin (as lipid replacement) in diets

Vitamins

- 15 considered essential
- 11 water soluble:
  - ascorbic acid (C), biotin, choline, folic acid, inositol, niacin, pantothenic acid, pyridoxine, riboflavin, thiamin, and B_{12}
- 4 fat soluble:
  - Retinol (A), cholecalciferol (D), tocopherol (E), and K
- Vitamins C, E and choline quantified
- Supplementation* based on several spp.

Vitamin	Amount/kg
A	4,400 IU
D	2,200 IU
E	55 mg
K	11 mg
C	376 mg
Choline chloride (70%)	550 mg
B^{12}	0.09 mg
Folic acid	2.2 mg
Niacin	88 mg
Pantothenic acid	36 mg
Pyridoxine	11 mg
Riboflavin	13 mg
Thiamin	11 mg

Minerals

- Up to 22 may be required for tissue formation, metabolic functions…
- Dissolved minerals and basic feedstuffs may contribute considerably, thus supplementation* may be minimal
- Macro
  - Calcium, chloride, magnesium, phosphorus, potassium, sodium, and sulfur (same as terrestrials)
  - Phosphorus typically limiting in water
    - HSB reqt is about 0.43% of dry diet

Minerals

- Micro
  - Aluminum, chromium, cobalt, copper, fluorine, iodine, iron, manganese, molybdenum, nickel, selenium, tin, vanadium, and zinc
  - Selenium and zinc important for other fishes
  - Typically add trace mineral premix* to ensure adequacy

Mineral levels suggested for diets based on estimated or established requirements

Mineral	Amount
Available phosphorus	0.5%
Copper	5 mg/kg
Iodine	2 mg/kg
Iron	30 mg/kg
Manganese	25 mg/kg
Selenium	0.1 mg/kg
Zinc	200 mg/kg

Summary of chemically defined requirements for HSB

Protein		40–41%
- Amino acids	T. sulfur aa	2-2.9% of prot
	Lysine	4.0% "
	Threonine	2.8% "
	Arginine	4.3% "
Energy:protein		8-9 kcal/g prot.
Lipids	EFA	1% hufa n-3
	Lecithin	NR
	Cholesterol	NR
Vitamins	C	26 mg/kg
	E	28 mg/kg
	Choline	300 mg/kg
Minerals	Avail. Phos.	0.43%

Summary

- Nutrient values obtained for chemically defined diets for small fish (20-150 g) under controlled conditions
- Current model diet formulations suffice for PI & PII*
- Specific nutrient requirements & additives for larval and broodstock diets are lacking

Feed manufacturers & distribution equipment

- www.aquafeed.com