Food and foodwebs in freshwater

FAFU

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Outline

Energy sources for aquatic food webs

Kinds of organisms: plants, invertebrates, fishes

Freshwater food webs
Types of energy – 2 general categories – based on where the carbon is “fixed”

**Allochthonous** (fixed outside the system) – organic matter, *detritus*
- Leaf litter (deciduous, conifer)
- Wood (large and small)
- Flowers, fruits, seeds, etc.
- salmon

**Autochthonous** (fixed within the system) – primary production (3 primary types)
- Algae → Phytoplankton - suspended
- Periphyton - attached
- Vascular plants or macrophytes
- Animals

River continuum concept

Organic matter inputs change with width (size) – relative to stream area

Light (for primary production) related to stream width

Consumer types depend on kinds of food sources

1. Organic matter – detritus (allochthonous)

CPOM includes leaf litter (deciduous and coniferous), wood, flowers, fruits, seeds, etc.

FPOM includes fragments of leaves & wood, faeces, algae cells, etc.

Leaf processing sequence

Leaf fall and blow in → Wetting in stream → Microbial colonization → Invertebrate colonization → Conversion to FPOM

- Physical abrasion and softening
- Continued microbial activity and breakdown
- Mineralization by microbial respiration to CO₂
- Increasing protein content
- Further microbial conversion
- Animal feeding

Amount of weight loss:
- 5-25% (1 day)
- 5% (10 days)
- 20-35% (100 days)
- 15-25% (~30%)

Time (days):
1 → 10 → 100 → 250
A generalised aquatic food web

**Primary producers** (algae, plants)

**Detritus** (dead leaves, dissolved organic compounds, faeces, salmon carcasses)

**Grazers**
- Mostly invertebrates, scrapers

**Predators** (invertebrates, fish, birds, mammals)
- Feed on other predators, including invertebrates, fish, etc.

**Predators (piscivores)**
- Feed on invertebrates (or other primary consumers): drift feeders, etc.

**Detritivores**
- Mostly invertebrates
- Shredders, collectors, filter feeders

**Primary producers**

**Grazers**

**Predators**

**Predators (piscivores)**
DOM ("dissolved" organic matter)

Possibly the quantitatively most important source to aquatic environments (streams, lakes, wetlands, oceans) – mostly from groundwater

A = western redcedar
B = vine maple
C = red alder
D = western hemlock
Biofilms in streams

The *microbial loop* in streams is important too.

Layers of algae and bacteria develop on surfaces of rocks, wood, etc.

2. Primary producers (autochthonous)

“Algae” – several classes (Chlorophyta, Bacillariophycae, Cyanobacteria, Chrysophyta, Rhodophyta, etc.)

Vascular plants (Typha, Potamogeton, Nuphar, Nymphaea, Lemna, etc.) – “macrophytes”

Mosses
“Algae” blooms – mostly filamentous Cyanobacteria ("blue-green algae") - not easily consumed by most animals due to hard cell walls and toxins
Summary

2 main energy sources based on where the carbon is “fixed”: allochthonous - detritus (organic matter), animal bodies, etc., and autochthonous - primary production – algae, moss, macrophytes (vascular plants)

Detritus – leaf litter, particulate organic matter, dissolved organic matter

Primary production – algae (phytoplankton, periphyton) and macrophytes

Secondary productiton – animals (invertebrates, fish, amphibians, etc.)
Food webs of freshwater systems

Ways of describing food webs of freshwaters

Kinds of consumers

The basic food web

Trophic cascades

photo: courtesy Dr. Mark Wipfli, U of Alaska
A biomass pyramid

Predators
Predators are animals that feed on other live animals. They can be placed into three trophic levels: bottom, middle, and top. Bottom level predators include many small animals that feed on insects and other small plant eaters. They are usually very numerous and preyed upon by larger...
East River, Colorado, USA
A general aquatic food web

- **Primary producers** (algae, plants)
- **Grazers**
  - Mostly invertebrates
  - Planktivores, scrapers
- **Predators** (invertebrates, fish, birds, mammals)
  - Feed on invertebrates (or other primary consumers): planktivores, drift feeders, etc.
- **Detritivores**
  - Mostly invertebrates
  - Shredders, collectors, filter feeders
- **Detritus** (dead leaves, dissolved organic carbon)
  - CPOM
  - FPOM
  - DOM
Importance only appreciated within the past 15 years.
Sockeye salmon, and its food web

Streams
(eggs, alevins, fry)

lake
(juveniles)

ocean & spawning
Coastal: lower nutrients, and more DOM
- Competition
- Facilitation and Mutualism
- Indirect effects (BMII, TMII)

Change prey behaviour or use of resources
Cutthroat – stonefly interactions

No differences in survival rate of trout.

Change in mean body mass (%) - growth

With stoneflies
Without stoneflies

Predatory stonefly larvae scare prey into the water, and they are easier for trout to capture, i.e., facilitation.

**Trophic cascades**

Proposed by Steve Carpenter and colleagues in early 1980s

Trophic structure (length especially), can have influences on more than one trophic level away (mediated by intervening species)

Bluegill sunfish

Feed on *Daphnia* and other small crustaceans in the water

Fry (babies) may hide from bigger bluegills

In absence of other predators they are mostly where the food is (up in the water)

Largemouth bass (piscivore)

Bluegill sunfish

e.g. Carpenter, Kitchell, et al.
Biomass (g / m²)

Phytoplankton

Herbivorous zooplankton

Planktivore (fish or invertebrate)

Piscivore

Phytoplankton

Herbivorous zooplankton

Planktivore (fish or invertebrate)

Assumptions

All algae equally edible

Trophic levels discrete (little omnivory, mixotrophy, etc.)

Turnover rates don’t change much

Remember!! Biomass is not equivalent to productivity!!
*A trophic cascade in a stream*

**A food web diagram showing interactions among organisms in a stream ecosystem.**

- **Cladophora, epiphytic diatoms, Nostoc**
- **Tuft-weaving chironomids**
- **Predatory insects (damselfly larvae)**
- **Roach fry**
- **Stickleback fry**
- **Steelhead**
- **Large roach**

**Eel River, California**

Summary

Productivity depends on the rates of growth (algae or plants) or input rates (detritus) of basal resources.

Interactions can be complex, including the possibility of indirect effects (including trophic cascades and facilitation) through the food web.

A manager of the land or water needs to be careful.