Lecture 15: Streams and Rivers

I. Introduction

Flowing = lotic = fluvial
>3M mi of permanent streams in US

A. Objectives

1. Summarize key processes/features of lotic habitats and ecosytems
2. Summarize consequences for lotic fishes
3. Summarize key patterns for lotic fish assemblages
4. Summarize major human impacts on lotic fish assemblages

B. Contrast lotic vs lentic ecosystems

1. Differences
   a. permanence (geologic time)
   b. stability (ecological time)
   c. boundedness (hierarchical vs discrete)
   d. spatial/temporal variation, organizational complexity
   e. fish diversity, fish migration

2. Similarities
   a. influence of aridity, temperature, watershed vegetation and soil
   b. fish diversity reflects species pool, water-body size, habitat diversity, environmental harshness

C. Factors controlling lotic fish communities

1. 5-class framework
   Flow regime
   Water chemistry
   Habitat structure
   Production pathways/levels
   Biotic interactions

   Other conceptual models represent processes and mechanisms causing variation in these factors

II. Features of lotic systems

A. Terms

1. Water body size: brook, creek, stream, river

2. Position in stream network: headwater, tributary, mainstem, confluence

3. Near-stream zones
   a. Riparian zone (area bordering stream, contributes organic matter)
   b. Floodplain (wider area inundated during floods, contributes nutrients, organic matter)

4. Land areas: watershed, catchment, drainage, basin (contribute water, ions, sediment, etc)

B. Flow regime

1. Major effects of flowing water
   a. fish must deal with force of current
   b. chemical/temperature cues conveyed long distances
   c. primary agent of habitat formation
      - water + gravity (force) = channel-scouring
      - path of least resistance is meandering, not tubular (straight)

d. hydraulic vs hydrologic factors
- hydraulic: force of flowing water (velocity, turbulence
- hydrologic: source, amount, temporal variation of flow; more relevant to flow regime

C. Consequences for fishes
1. Stream-types reflect variation in intermittency, flashiness, and source of flow

2. Fish communities reflect flow regimes
a. ecological correlates in MI streams
b. seasonality and patterns of tropical fish movement, abundance

D. Consequences of flow for water chemistry (DO, temperature, pH, [nutrients])
Conditions relatively homogenous via mixing

1. Fish responses to water chemistry
a. limited physiological tolerance to extremes, temporal variation
b. less temporal variation downstream
c. geographic variation in temperature tolerance
eg, minnows in prairie streams more tolerant than minnows in upland streams (benign)
greater tolerance for high temperature, low DO

E. Consequences of flow for habitat
1. Basics of fluvial geomorphology
a. stream power related to energy expended by flowing water
- useful index of erosive capacity
- function of discharge and channel slope

b. at bankfull discharge, flow resistance reaches minimum
- BFD usually controls/maintains form of alluvial channels; 1-2-yr recurrence interval

2. Interactions between flowing water, features that resist force of flow → "habitat" for fishes
a. riffles: shallow, swift, turbulent, coarse substrate
absent in low-slope channels

b. pools: deep, slow, "flat" water, fine-coarse substrate
riffle vs pool differences diminish during floods

c. runs – intermediate

d. miscellaneous: cascades, side channels, etc

e. reaches or segments (homogenous sections between tributary confluences

3. Spatial patterns
a. Stream size as a pervasive correlate
- habitat volume, diversity, stability ↑ downstream
- species richness generally increases downstream
- wider array of fish sizes downstream
- wider array of reproductive tactics (eg, more migratory spp)

b. effects of network position
- tributaries as key junctures (punctuated environmental change)
- complicating effects of stream juxtaposition
abrupt changes in water size → shifts in local species composition

4. Similarity between riffle-pool habitat gradient and upstream-downstream habitat gradient

5. Multi-scale, hierarchical perspectives
   a. understanding fish and habitats as riverscapes

6. Other major disturbances
   a. landscape disturbances influence instream conditions regardless of water flow

F. Consequences of flow for biotic production
   1. Spatial variation in trophic composition reflects climate, productivity of watershed

   2. River continuum concept
      a. focus on downstream changes in channel form, water quantity, production processes
         - influence of riparian ↓
         - influence of floodplain ↑
         - influence of local offstream conditions ↓ (river becomes more integrative)

      b. looking downstream: production goes from allochthonous to autochthonous and back again
         - primary production limited by canopy shade in headwaters
         - primary production limited by turbidity in large rivers

      c. invertebrate production (fish food) reflects seasonality of flow, temperature
         - in temperate streams, peaks in late spring-early summer and late autumn
         - fish-food shortages in non-peak periods promote density-dependent controls on fish populations

      d. sources, timing of production reflected in trophic composition of fish community
         - downstream addition of piscivores, planktivores, food specialists

      e. discontinuities in the continuum
         - springs, caves, beaver dams

   3. Flood-pulse production in large rivers
      a. food, nutrient, organic inputs controlled by flooding
      b. dependent on connection to floodplain
      c. production pulses

G. Consequences of flow for biotic interactions
   1. Predation threat
      a. terrestrial predators most effective in shallow water
      b. aquatic predators most effective in deep water
         - large aquatic predators avoid shallow water
         - small fishes often prefer pools but restricted to shallows to avoid aquatic predators
      c. predation threat can intensify competition among small fishes

   2. Seasonal, annual variation in flow → variation in resources availability, intensity of competition

III. Human impacts
   A. Simplification of channel morphology via channelization

   B. Simplification/truncation of river flow regimes via dams
      1. Major effects on diadromous species, obligate riverine species, flood-dependent species
      2. ↑ in lentic and exotic species

   C. Landscape alteration (deforestation, agriculture, urbanization)
      - greater flashiness of flow regimes

   D. Homogenization of faunas (purposeful and accidental introductions)