The Effects of Impoundments on Streams

Region 4 Wetlands/401 Conference
November 2, 2016
Summary of 2012 Work

- Temp increased downstream
- Chl-a increased downstream
- Invertebrate community more tolerant (BI about 1.5 greater) downstream
- Possible invertebrate community shifts
Why Another Study?

• Can impacts be recreated?
• Better quantification of biological impairment
• How far downstream to recover from these impacts?
Study Design

- 13 Lakes (8 Small, 5 Large, 7 Mountain, 5 Piedmont, 1 Sandhills, 1 Urban)
- 5 sampling locations/ lake/stream
- Small streams (site 1 < 3 mi² watershed) sampled May – June using Qual 4 method
- Large streams sampled July – Aug using Full Scale
- Chl-a sampled as well as usual parameters (DO, Temp etc)
Location of Study Sites

Legend

Ecoregions
- Blue Ridge Mountains
- Piedmont
- Sand Hills
- Coastal Plain

Project sites

NC county boundaries

Overview of North Carolina. Boxed area shown in detail above.
Results - Temperature

Mean Temperature by Distance Downstream (mi2)

- Small Stream
- Large Stream
Results – Chlorophyll-a

Chlorophyll-α (µg/l)

Chl-α (µg/l)

1 2 3 4 5

50
45
40
35
30
25
20
15
10
5
0

Large Piedmont
Mtns & Small Pied
Biotic Index Changes

Change in Biotic Index by Distance Downstream (mi²)

- Upstream
- Dam
- 0.25
- 0.5
- 1
- 2
- 3
- 10

Change in Biotic Index

- Piedmont
- Mountain
Results - EPT Taxa Richness

- 7 streams EPTS declined 60-75%
- 3 declined 85%, 2 only declined 33%
- 4 streams never recovered
- 5 streams recovered in 1 mi²
- Other 3 streams recovered at 3.5, 4 and 9.5 mi²
Bioclassification Recovery

- 7 streams dropped 2 bioclasses, be dam, 3 streams dropped 1 bioclass, 1 dropped 3, 1 dropped 4
- 6 streams recovered in < 1 mi². 2 in 1-5 mi², Recovery occurred in > 9 mi² in 4 streams.
- Many with the fastest recovery were below smallest impoundments.
The RCC predicts how biological communities are modified because of catchment size and energy input. This concept has been tested worldwide and seems to hold true.

Headwaters dominated by shredders and few grazers, mid-order streams dominated by grazers, few shredders
Predictions

- Ponds should cut off flow of leaves so shredders should decline be dam
- Grazers should be low above the dam and increasing as go downstream
- Filter feeders should spike below the dam eating periphyton from pond, then decline
Reality - Shredders

% Shredders by Site

1 2 3 4 5

% Shredders

Small streams
Large Streams
Reality – Filter Feeders

% Filter Feeders by Site

1 2 3 4 5

% Filter Feeders

Small streams
Large Mountain
Large Piedmont
Reality – Filter Feeders

% Filter Feeders by Site 2015

- Small streams
- Large Mountain
- Large Piedmont
- Impaired
Filter Feeders – More Data

% Filter Feeders by Site 2015 + 2016

- Small streams
- Large Mountain
- Large Piedmont
- Impaired
Filter Feeders vs Chlorophyll

Chlorophyll-α (μg/l)

% Filter Feeders by Site 2015 + 2016
Water Quality impairment at work?

- Large Piedmont sites 2, 3 and ½ of 4 Not Supporting
- Filter Feeders are a relatively intolerant group – mean TV 3.91
- Only 5 FF make up impaired community mean TV 6.5
- Range 4.9 (Simulium) to 7.9 (Hydropsyche betteni)
Conclusions

- Are there downstream impacts of impoundments? YES!
- How far downstream do the impacts go? It depends
- Temperature – 5-8° jump be dam, cools by ½ mi² to warmer normal
- Chlorophyll-α – slight increase in Supporting streams, big spike in Not Supporting for 2-5 mi² downstream
- Bugs BI – 1.5-3 unit increase be dam. P streams recover in 3 mi², M streams drop ½ spike in 0.25 mi² then stays
Conclusions (Cont)

- Bugs EPTS – declined 24-88% be dam, 5 recover in 1mi²
- Bugs Bioclassification – declined 1-4 bioclass be dam ½ streams recovered >1mi², 1/3 unrecovered at 9mi²
- Shredders - drop to 5% be dam, slight, incomplete recovery
- Grazers - respond to reach specific light not impound
- Filter Feeders – Mountain streams small Piedmont peaked be dam, grazed down pool phyto. Large Pied behaved like impaired, little grazing lots of chl-α
Recommendations

• Dams are bad for streams. Don’t permit any you don’t have to.
• Consider requiring mitigation for impaired functions below dam. Maybe for ½ - 1 mi²
• Dam removal companies will want extra mitigation credits. Should they get them?