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Brook Trout

- Keystone species
- Distribution limited to headwaters
- Sensitive to environmental changes
- Lack of knowledge of populations in Pennsylvania's ~64,500 streams.
Summer 2011

Worked with PFBC to document trout populations 82 previously unassessed tributaries to Loyalsock Creek

- Volunteers from Loyalsock Creek Watershed Association
- Collected trout population data, trout weights, trout diets, and benthic macroinvertebrate samples
- Recorded baseline data for 82 streams
Total precipitation (in) in Pennsylvania from 7:00 am September 5, 2011 to 7:00 am September 8, 2011. (NOAA data). Study area outlined in yellow.
Rainfall Data: Loyalsockville, PA

Daily discharge (cfs) of the USGS stream gage at Loyalsockville, PA from August 28-September 14, 2011.

Peak stage exceeded 20.4 ft, the point at which the gage flooded. Flow estimated to have reached an excess of 69,000 cfs (NOAA).
Rainfall Data: Loyalsockville, PA

Historical mean Daily discharge (cfs) of the USGS gaging station on Loyalsock Creek at Loyalsockville, PA.
Research opportunity

• Unique opportunity to observe population response across a watershed to natural stochastic event

• Pre-flood data recorded less than 3 months prior

• Re-sampled for trout in early Oct. 2011 in 5 streams
  – Lick, Rock, Mill, Streby, and Yellow Runs
  – Trout populations severely depressed
  – Streams scoured and redirected
Introduction

• Few studies of short-term stochastic events on salmonid populations

• Catastrophic flooding may remove year classes and reduce standing crops (Elwood and Waters 1969)

• Population recovery may take 3-5 years. Densities can exceed pre-flood within 5 years (Roghair et al. 2002, Roghair and Dolloff 2005)
Questions

• How long will recolonization take? (If at all)

• Will population estimates and densities exceed pre-flood levels?

• Will population age structures be altered?

• How long until populations are able to restabilize?
Methods

- 30 sites
- 1<sup>st</sup> and 2<sup>nd</sup> order streams
- 100 m length
- Triple pass collection
- Total length (mm)
- Weight (g)
Study Sites
Average population estimates: all Brook Trout from all sites during summers 2011-2019.
Average population estimates: YOY Brook Trout from all sites during summers 2011-2019.
Average population estimates: adult Brook Trout from all sites during summers 2011-2019.
Average population estimates: all Brook Trout, young of the year Brook Trout, and adult Brook Trout from all sites during summers 2011-2019.
Average Total Brook Trout densities (m$^2$) from all sites during summers 2011-2019.
Average Brook Trout Density

Average YOY Brook Trout densities (m²) from all sites during summers 2011-2019.
Average Adult Brook Trout densities (m²) from all sites during summers 2011-2019.
Average Brook Trout densities (m²) from all sites during summers 2011-2019.
2011 Flood Conclusions

- Flooding in 2011, had an impact on fish less than 150 mm in size.

- In most cases, brook trout were able to immediately recolonize stream reaches, suggesting brook trout are resilient to late summer floods.

- Mortality was pretty high for adults, but large year class in the year following the storm made up for it.

- Density dependent mechanisms evident
  - Large increase in YOY density in 2012 (1 year post flood)
  - Decrease in Age 1+ in 2012 (1 year post flood)
  - YOY decrease after 2012
  - Overall densities then reach an equilibrium
2011 Flood Conclusions

• Age structures greatly altered and susceptible
  – Age 0-1 brook trout nearly eliminated across all sites
  – Some age 2-4 trout were able to survive and spawn fall 2011

• Timing is important
  – Seasonality of flooding

• Angler pressure
  – ?
  – Temporary regulations

• Climate change
  – Is this a new norm?
October 2016 Flood
October 2016 Flood
October 2016 Flood
October 2016 Flood

USGS 01552000 Loyalsock Creek at Loyalsockville, PA

Discharge, cubic feet per second

- Median daily statistic (92 years)
- Measured discharge
- Discharge at floodstage
- Period of approved data
Rainfall Pattern

Total precipitation (in) in Loyalsock Creek area on October 21, 2016. (NOAA data). Mainstream Loyalsock Creek in light blue.
Average densities: all Brook Trout, young of the year Brook Trout, and adult Brook Trout at Fall Run during summers 2011-2019.
Average densities: all Brook Trout, young of the year Brook Trout, and adult Brook Trout at Weed Creek during summers 2011-2019.
Average density: all Brook Trout, young of the year Brook Trout, and adult Brook Trout at Dry Run during summers 2011-2019.
• Insect diversity

Inverse Simpson diversity by year for benthic macroinvertebrates
Dry Run

- Insect diversity

Inverse Simpson diversity by year for benthic macroinvertebrates
Dry Run

- *Epeorus* dominant
- Clinger
- Univoltine

Inverse Simpson diversity by year for benthic macroinvertebrates
Dry Run

- *Baetis* dominant
- Swimmer
- Multivoltine

**Inverse Simpson diversity by year for benthic macroinvertebrates**
Average densities: all Brook Trout, young of the year Brook Trout, and adult Brook Trout at Swamp Run during summers 2011-2019.
2016 Flood Conclusions

• 7 West Side streams saw between a 61 and 96% decrease in Brook Trout densities from 2016 to 2017 immediately after flood.

• Did not see the large increase in YOY density in 2017 like in 2012 (1 year post flood).

• This fall 2016 event during spawning likely wiped out redds in addition to other year classes.

• Very slow recovery post flood (2017-2019) of Brook Trout densities compared to post flood (2012-2014).

• Timing of events matters.
2016 Flood Conclusions

- Increases in mid-fall rainfall events like these could lead to population decreases, genetic isolation, and population loss.

- Post flood BMI community different post flood (2012 and 2017) vs. non-flood years.

- Decrease in diversity after 2012 and 2016 floods.

- 2012 and 2017 dominated by *Baetis* (Multivoltine, swimmer species)

- Most other years without floods dominated by *Epeorus* (Univoltine, clinger species).
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Questions?

www.susqu.edu/freshwater