

The recovery rate of Brook Trout populations in the Loyalsock Creek watershed following catastrophic flooding.

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Abstract

In early September 2011, Tropical Storm Lee deposited over twelve inches of rain in the Loyalsock Creek watershed (north central Pennsylvania). Trees were uprooted, new substrate material was deposited and stream biota were decimated in this flooding event with peak flows reaching (69,100 cfs). As part of the PFBC Unassessed Waters Initiative, pre-flood brook trout populations were sampled in summer 2011 at 30 headwater stream study sites. Post flood samples were collected each summer at these sites between 2012 and 2015. After the September 2011 flood, results show the removal of most trout below 150mm in size across most of the study sites. 2012 yielded a large age-0 class, with low numbers of fish between 100 and 150mm in size. Results from 2013 show high recruitment of age-0 into age-1 year class, but continued low numbers of older fish. 2014 and 2015 yielded larger adult populations than previous years as young fish are recruited into older age classes. Results also show a decrease in the amount of age-0 fish since 2012. Results indicate that the age structure is recovering to pre-flood levels.

Introduction

Headwater streams are subject to natural disturbances that can alter in-stream habitat and communities. There are few studies on the effect of natural stochastic events such as flooding on salmonid populations, because these events are unpredictable. Brook trout assemblages in low-order headwater streams have been shown to be severely effected by extreme flooding. Floods can significantly reduce the abundance of brook trout in headwater streams, even though floods serve important ecological functions (Roghair and Dolloff 2005). Catastrophic flooding may cause population crashes by removing year classes from streams or reducing standing crops, thus severely affecting the future brood (Elwood and Waters 1969).

Roghair and Dolloff (2005) found that brook trout were able to completely recolonize a reach of the Staunton River, Virginia within 3 years of a massive flood event. Five years after the flood the reach was completely recolonized by adult brook trout, and the population density increased to above pre-flood levels (Roghair et al. 2002).

As part of another project (Pennsylvania Fish and Boat Commission's Unassessed Waters Initiative) we collected pre-flood data on 30 streams in June and July 2011 in the Loyalsock Creek drainage in north central Pennsylvania. In September 2011, two events converged on Loyalsock Creek in rapid succession: Hurricane Irene and Tropical Storm Lee. Rainfall from Hurricane Irene saturated soils in the watershed. Tropical Storm Lee deposited over eighteen inches of rain. A catastrophic flood occurred throughout the watershed on September 7-8, 2011 with peak flows (69,100 cfs) exceeding the previous record flow (55,800 cfs). Population estimates collected 1 month post-flood from a subset of 5 streams showed that most of the streams had a severely reduced population of brook trout from summer sampling. This provided a great opportunity to explore the impacts a catastrophic flooding event has on brook trout populations. We then collected post-flood data on these 30 streams in late June in 2012 thru 2015 to determine the long-term effects of catastrophic flooding on brook trout populations.

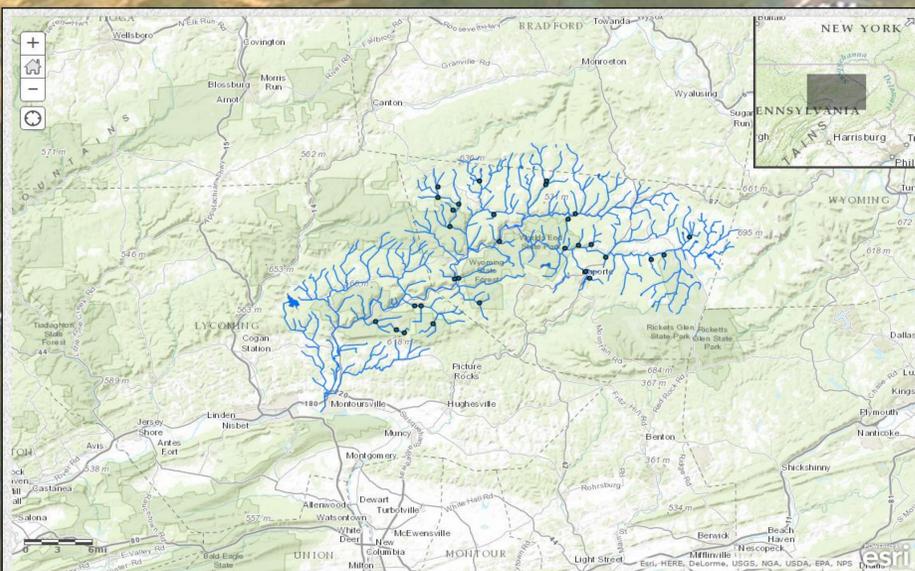


Figure 1. Map of the Loyalsock Creek watershed along with our sample locations

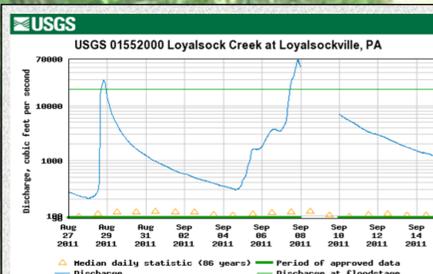


Figure 2. Daily discharge (cfs) of the USGS stream gage at Loyalsockville, PA from August 27-September 14, 2011.

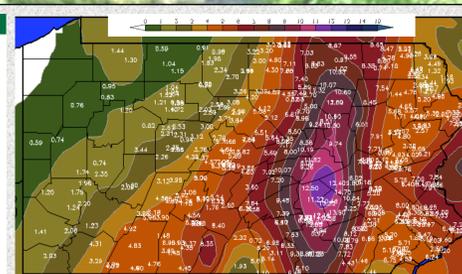


Figure 3. Total precipitation (in) in Pennsylvania from 7:00 am September 5, 2011 to 7:00 am September 8, 2011. (NOAA data).



Figure 4. Overhead view of flooding near the mouth of Loyalsock Creek. The normal creek bed is over 500m away.



Figure 5. Loyalsock Creek flooding along Route 87.(DCNR)

Methodology

- Pre-flood data on brook trout populations was collected from 30 streams within Loyalsock Creek watershed (PA) during June & July 2011 as part of the Pennsylvania Fish and Boat Commission's Unassessed Waters Initiative.
- 100 meter study reach sampled using 3-pass backpack electrofishing methods.
- September 5-8th 2011, Tropical Storm Lee deposited over 12 inches of rain locally causing catastrophic flooding.
- Post-flood data (brook trout populations) was collected at same 100m reach on 30 sites during late June 2012, 2013, 2014, & 2015.
- Fish identified to species.
- Total length (mm) and weight (g) taken of each trout species.
- Densities calculated to determine changes in Young-of-Year and adult brook trout.
- The lengths were then sorted into size classes of 25 mm. and length frequency histograms constructed to determine changes in size structure.

Results

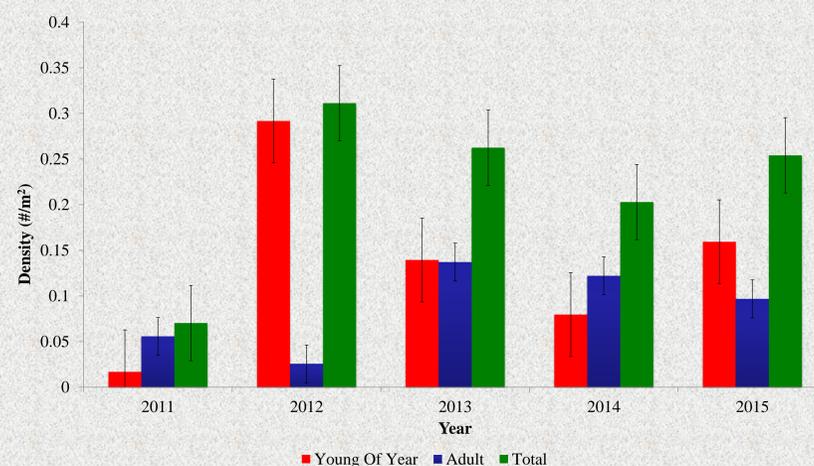


Figure 6. Density of Young-of-Year, Adult and all brook trout across all 30 sites from 2011-2015.

Results

- Total brook trout population has increased.
- Density has increased.
- Young of year make up most of the density in immediate years following flood.
- Many size classes were wiped out but are now returning.
- Slow recruitment into larger size classes.

Relative Frequencies of Brook Trout Size Classes from 2011-2015

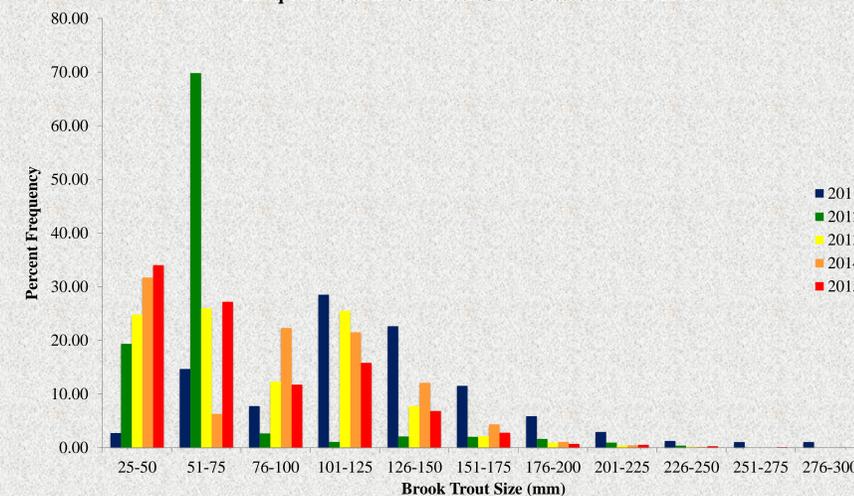


Figure 7. Brook trout size class structure hierarchy between 2011 and 2015

Conclusions

2012

- Density increase was largely contributed to by the young of the year.
- Little competition which allowed a majority of the YOY to make it to year 1.
- Age classes between 75 and 150 mm were essentially eliminated.
- Majority of the population was young of the year.

2013

- Density shifted towards adult trout.
- Many YOY recruited into the next size class.
- Some of the other size classes began to appear again.

2014

- Density shifted towards adult trout again.
- The larger size classes became more prevalent in the population.

2015

- Density shifted toward YOY.
- Most fish that survived after the flood are able to spawn, contributing to increased population.
- The size class distribution is continuing to shift back to the larger size classes.

Further analysis

- Location on watershed
- Amount of rainfall
- Changes in Age class size

Sponsors and Support

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References

Elwood, J. W. and Waters, T. F. 1969. Effects of floods on food consumption and production rates of a stream brook trout population. *Transactions of the American Fisheries Society*, 98: 253-262.
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