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Annual Performance Report

2016-17

Connecticut Fisheries Division

Monitoring Fish Populations in Streams

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State of Connecticut
Department of Energy and Environmental Protection
Bureau of Natural Resources
Fisheries Division

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Study 1: Coldwater Fisheries Program
Project: Coldwater Monitoring
Job 1: Monitoring Fish Populations in Streams

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Cover photo: DEEP Fisheries Division stream sampling crew. FD file photo.

Summary

The DEEP Fisheries Division (FD), in cooperation with the Bureau of Water Protection and Land Reuse (WPLR), electrofished a total of 238 streams in 2016. Of the 168 streams electrofished by FD staff, 21 samples were paired with in-stream water temperature data (these include 9 long-term reference streams). These data will be used to document inter-annual and long-term changes in fish populations produced by climate, weather and various man-made effects. In Connecticut, severe drought conditions persisted statewide throughout 2016 and at year's end some regions of the state were 20 inches deficit in rainfall. These conditions resulted in many small/mid-size streams going dry (~68% of headwater streams that were visited by FD biologists could not be sampled due to dry streambeds). While weather conditions were generally not favorable for many stream fish populations, the warm stable flows in late spring may have had positive effects on species such as Smallmouth Bass where ideal flows and temperature provided excellent spawning conditions.

Background

Throughout the State's history many Connecticut streams became impaired by a variety of anthropogenic factors (e.g., industrialization, impoundment, flow diversion, pollution (including thermal), agriculture, development, and urban sprawl). In recent years, and largely due to the Clean Water Act (1972) along with general environmental awareness, many of those impacted streams have experienced improvements in water quality through flow naturalization or enhancement, upgrades of sewage treatment plants, and reductions in harmful industrial discharge. But, even with these in-stream improvements, most Connecticut streams are still faced with a multitude of impairments.

For example, developmental pressures have not only caused habitat fragmentation due to dam and road construction, but have also exacerbated anthropogenic warming. Damming or ponding of stream water, loss of vegetation from stream banks ("riparian areas"), filled wetlands, increased impervious surfaces, effluent from wastewater treatment plants (WWTPs), and discharge from hydroelectric plants are all potential causes of warming ("thermal loading") in Connecticut streams. Recent studies (Beauchene et al, 2014 and Lyons et al, 2009) reported on the deleterious impacts/importance of water temperature to stream fish communities. Regardless of the cause(s) of warming water temperature, the changes need to be identified and the effects monitored so they can be quantified and understood.

Additionally, artificial barriers cause stream habitat fragmentation, often inhibiting or prohibiting the free movement of fish throughout a stream system. Documenting and mapping the locations of artificial barriers will enhance the FD's ability to restore connectivity and instream habitat in many of Connecticut's streams. Information collected can also be used to identify potential new fishing opportunities produced by improved water quality or habitat.

Many of the changes in habitat and stream fish communities that have occurred in Connecticut over the past 20 years could not have been quantified, or even documented, if not for the 1988-1994 Statewide Stream Survey which collected baseline data on many of the State's stream fish populations (Hagstrom et al. 1996). This information is now over 20 years old, and many streams have not yet been re-surveyed. Re-sampling of historic survey sites, coupled with long-term sampling of selected reference streams and collection and analysis of water temperature data, will document if range shifts of fish species has occurred due to man-made or environmental/climatic changes. Data collected under this Job, along with time-series data collected under the Wild Trout Job (Coldwater Management Project, Job 4) and fish community assessments done by WPLR staff, will provide a robust data set that will aid in making future management decisions.

Objectives

- Monitor streams where water quality or physical habitat has been improved or has become degraded.
- Assess resident fish populations in both the Shepaug and Housatonic rivers to document if flow alterations produce changes in fish populations.
- Assess fish populations of headwater streams, with emphasis on temperature-sensitive coldwater species.

Slimy sculpin, a core member of many coldwater fish communities. Photo by R. Jacobs

- Conduct water temperature mapping of stream networks to locate sources of thermal loading (e.g., cleared riparian stream corridors, instream impoundments, surface or ground water influences), identify key thermal refuge areas, and assign a thermal classification to streams.
- Inventory and map manmade or natural barriers/obstructions to fish movement utilizing the North Atlantic Aquatic Connectivity Collaborative (NAACC) protocol. All data are entered and stored in the NAACC database.

- Assess short and long term environmental trends by regularly sampling reference (sentinel) streams (cold, cool and warm water) and by re-sampling selected 1988-1994 Stream Survey sites.
- Standardize and archive stream survey data, and make information available to the HCE program, other divisions within the DEEP, town land use commissions, and the public upon request. Additionally, share these important data for use in regional planning for adaptive measures to climate change, aimed at mitigating potential threats to stream dwelling, cold-water specialist species.

Approach

- Abundance and size distributions of stream fish are monitored by electrofishing following standard sampling protocols outlined by Hagstrom et al. 1996. Beginning in 2016, the FD switched from Cofelt backpack electrofishing units to Smith Root LR-24 electrofishing backpacks. The Smith Root shockers allow for more control over the electrical wave form than the Cofelt units. The Smith Root units were set with a 25% duty cycle, and then voltage was increased or decreased until the unit was delivering 0.3Amps.
- Long term reference sites selected by water temperature-habitat type [based on average hourly summer (June – August) water temperature metrics derived by Beauchene et al, 2014 as: cold (< 64.9^{o}F), cool (64.9^{o}F – 71.1^{o}F), warm (>71.1^{o}F)] and geographic location are periodically (each stream is sampled on a 3 year rotation; to avoid possible bias imposed by annual electrofishing) sampled for fish species composition and abundance, and monitored year-round for water temperature.
- Sites from the 1988-1994 Stream Survey are selected for re-surveying based on the following criteria: 1) length of time since last sample, 2) specific requests for sampling by agency personnel, 3) opportunity to obtain fish population data that can be paired with current water temperature data, and 4) the need to assess recent habitat changes.
- Water temperatures are continuously recorded from May through October (in some cases year-round) using Onset data loggers in selected streams.
- Stream crossings are assessed to identify man-made barriers (e.g. culverts, bridges) to fish movement. Each crossing is mapped, measurements and photographs are taken of each barrier, and the data are then stored in Geo Referenced databases and viewed through a limited access portal.
- Appropriate statistical techniques (e.g., multivariate cluster analyses, TITAN analyses (Baker and King 2010) are used to classify and describe changes in stream fish communities.

Key Findings

- During 2016, fish population data were collected from 168 streams sampled by FD staff, and an additional 70 streams sampled by WPLR staff (Figure 1) and all data were compiled and entered into a centralized database. Streams were separated into the following categories:
    - Water quality altered streams including fish contaminant analysis: 2
    - General survey streams including water temperature monitoring streams: 155
    - Trout fry/fingerling stocked streams: 2
    - Long-term water temperature monitoring and reference streams: 9
    - WPLR streams (streams sampled solely by WPLR personnel): 70

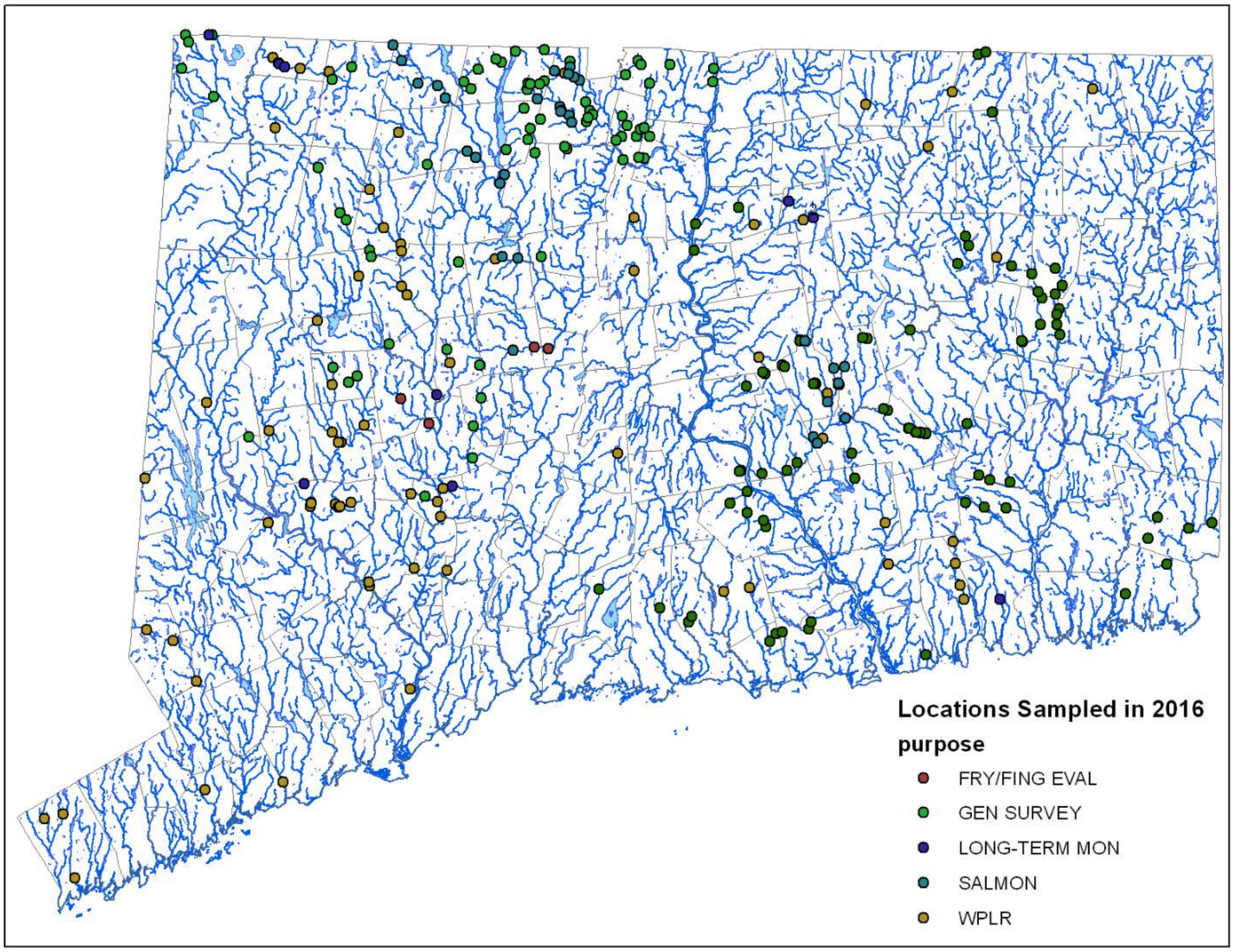

Figure 1. *Locations of the 168 streams sampled by FD in 2016 and 70 streams sampled by WPLR personnel.*

Weather Conditions:

Local and regional weather (temperature and precipitation) can play a very important role in spawning success, survival and growth of stream fishes. Even in a state as small as Connecticut, weather can vary greatly from one geographic location to another and the resulting effects on stream fishes can be difficult to document. The following is an overall account of the weather from 2016 taken from the National Weather Service at Bradley International Airport.

** The term "normal" is used repeatedly in the following weather description and refers to the average of long term data collected daily, monthly and annually from the weather reporting station at Bradley International Airport. Deviations in precipitation or temperature can then be compared to what is considered to be normal or average for that period of time in Connecticut.*

- Southern New England has been the epicenter of dryness in the northeast, with Connecticut having the fourth driest year on record in 2016, and each of the last five years have been drier than average for Connecticut. This persistent dryness rivals the drought of record during the 1960s.
- Throughout all of Connecticut, 2016 began the year in a precipitation deficit. According to NOAA National Weather Service – Bradley International Airport data, average statewide precipitation was well below normal at the end of 2015 (-12.18 inches).
- Drought conditions were greatly exacerbated during the 2016 calendar year where, by December of 2016, the statewide average was well below normal (-8.99 inches). The most pronounced precipitation deficit occurred in the western/north western portion of the state, while the south eastern region experienced less severe conditions in 2016 (Figure 2).

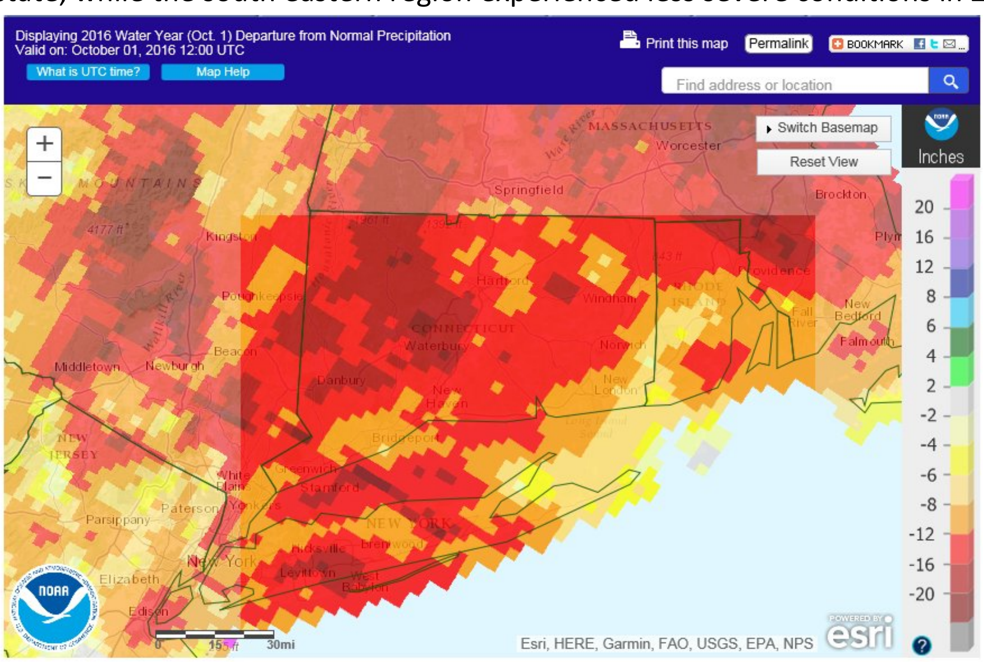

***Figure 2**. Statewide precipitation deficit for the 2016 water year. Figure provided by National Weather Service.*

- In addition to the drought conditions, NOAA National Weather Service (Bradley International Airport data) indicated that summer temperatures (June – August) were the 5th warmest on record with 18 days exceeding 90^{o}F (typical for Bradley Airport is 14.6 days over 90^{o}F annually).
- The lack of precipitation had a deleterious effect on stream conditions statewide, most notably the smaller headwater streams where sampling crews encountered numerous dry streams (45 out of 66 = 68%). Even in larger streams where flows persisted but were drastically reduced, fall spawning Brown and Brook Trout may not have been able to reach traditional spawning areas due to low flow conditions. In contrast, spring spawning riverine Smallmouth Bass were able to successfully spawn due to the stable (lower flow) warm stream conditions during May and June. For example, in the standard Naugatuck River (Frost Bridge) site which has been sampled 7 times since 2002, the number of young-of-year smallmouth bass in 2016 was far greater than the average of all past samples (1,542 fish/mile in 2016 vs. 250 fish/mile avg. 2002 – 2014).

Water Temperature Monitoring

A total of 41 thermographs were deployed in Connecticut during 2016 (Figure 3). Out of those, 25 were part of FD's long term reference streams (see next report section). Paired water temperature/fish abundance data were collected from the remaining 16 streams. These data are being used to evaluate water diversion permits, and develop seasonal indices based on water temperature to help predict fish community changes due to changes in temperature. All temperature data were uploaded to the *Echosheds.org* website for long term data storage and public access to the data.

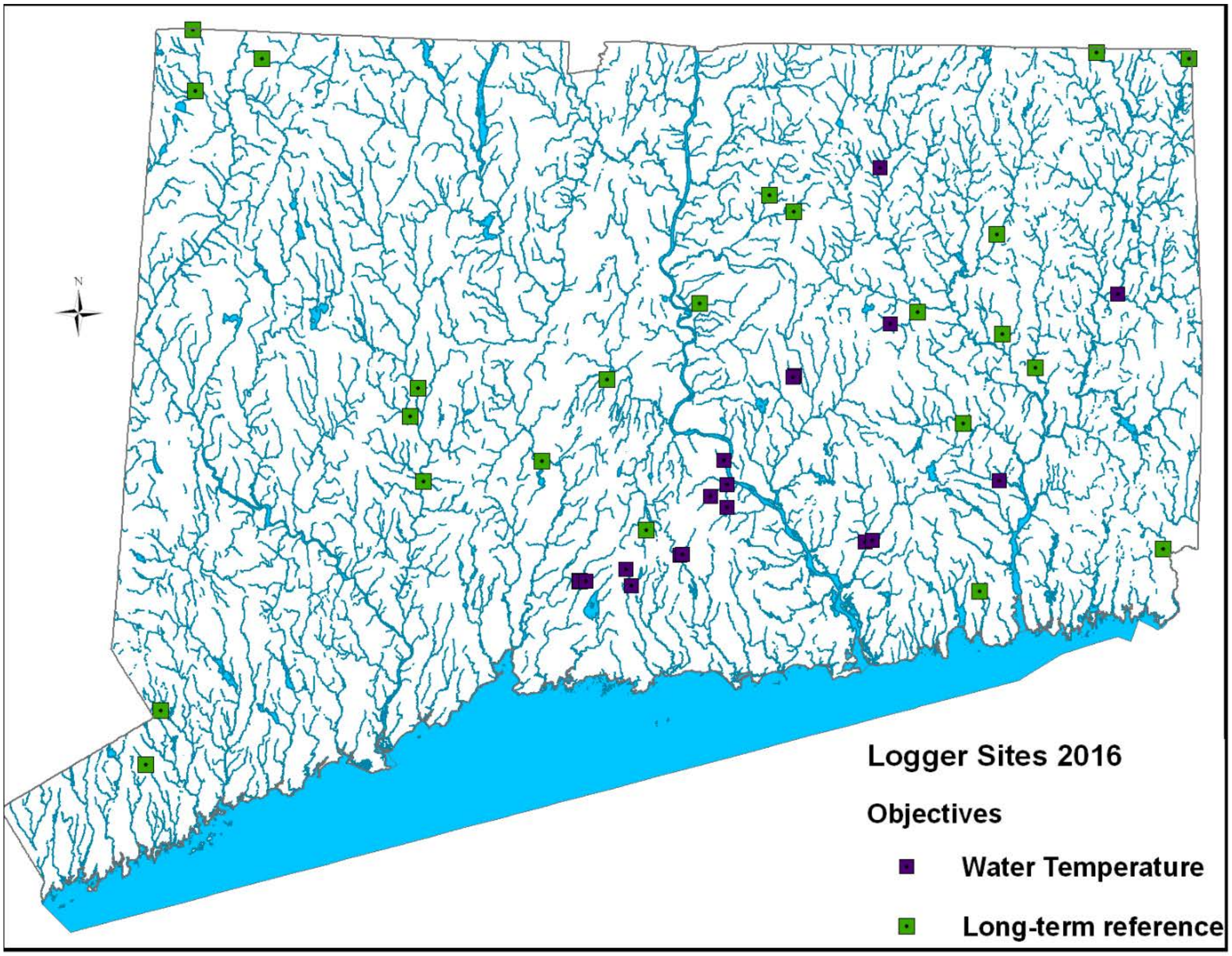

***Figure 3**. Locations of the 23 long-term reference streams (green squares), and the 16 streams where thermographs were deployed statewide in 2016.*

Long-term Reference Streams:

Beginning in 2013, a suite of 23 streams was selected (based on known habitat type "cold, cool, warm") statewide as "long-term reference" streams (Figure 3). Thermographs were deployed in some of the streams in 2013 and the remainder in 2014. Fish community data are being collected in these streams on a 3 year rotational basis (i.e. each stream is sampled every 3 years), and in 2016 fish population data were collected in 9 out of the 23 streams. Data are being used to monitor trends in fish distribution and community structure as they are related to stream water temperature and potential future changes.

In addition, the FD has sampled two long-term reference streams (Mattabesset River, Berlin and Valley Brook, Hartland) for trout almost every year since 2000. Data from these streams/stream sections, which are closed to angling, allows FD to assess year-to-year fluctuations in trout abundance produced solely by variation in environmental conditions.

However, due to extreme drought conditions in 2016, the Mattabesset River was not sampled in the fall (first time in over 20 years) to avoid disrupting resident trout already stressed from environmental conditions (Table 1).

Table 1. Abundance (fish/mile) of both spring and fall Brown Trout sampled by electrofishing a standard 208yd site of the Mattabesset River, Berlin (2007 – 2016).

2007		2008		2009		2010		2011		2012		2013		2014		2015		2016	
Spr	Fall	Spr	Fall	Spr	Fall	Spr	Fall	Spr	Fall	Spr	Fall	Spr	Fall	Spr	Fall	Spr	Fall	Spr	Fall
25	93	85	195	203	195	161	195	85	178	144	118	76	110	68	296	169	93	84	NS

Brook Trout abundance could not be assessed in Valley Brook in 2016 due to severe drought conditions (Table 2). The lower 151yd stretch of stream was predominately dry with the exception of a few shallow, isolated pools. The reach of stream above this standard site had more water and was sampled revealing that Brook Trout were present in the stream.

Table 2. Abundance of Brook Trout (fish/mile) sampled by electrofishing in a standard 151yd stretch of Valley Brook, Hartland (2007 – 2016).

2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
221	128	35	501	105	828	NS	548	128	NS

NS = Not sampled. In 2013 Valley Brook was not sampled due to time constraints, and in 2016 the lower portion of Valley Brook was not sampled due to severe drought conditions.

Stream Crossing Assessments

Stream crossing evaluations began in eastern Connecticut in 2006 and in western Connecticut in 2014. This work is currently being coordinated with staff in the FD's Habitat Conservation and Enhancement (HCE) program. All data collected to date has been absorbed into a larger, regional effort currently under the heading of the North Atlantic Aquatic Connectivity Collaborative (NAACC). Through 2016, FD/HCE staff have collected data on 4,355 stream crossings (culverts, bridges, etc.) statewide (565 for 2016) and all survey data have been entered into the NAACC database.

In Connecticut, FD is working closely with other state agencies (e.g., Department of Transportation) as well as non-governmental organizations (NGO's) (e.g., Housatonic Valley Association and Farmington River Watershed Association) to not only inventory crossings, but also to develop priorities for specific culvert/bridge replacements. While this information is primarily being presented to town commissions/transportation staff to address infrastructure safety, there are direct implications for the FD with respect to fisheries management; specifically potential unrestricted/free passage of fish throughout a stream system.

Fry Stocking Evaluation:

Steele Brook (Watertown) has been stocked with Brown Trout fry since 2005 in two standard stream sections Table 3.). In April 2016, a total of 7,000 Seeforellen fry were stocked between the two sites (4,000 in the Upper area and 3,000 in the Lower area). Densities (#/Acre) of stocked fry (0+) sampled in September of 2016 was well below the average of the past 10 years for both locations (Upper Area - 110 vs. 10 year average = 564; Lower Area – 8 vs. 10 year average = 146). In addition, 6/Ac yearling (1+) and no older (2+) Brown Trout were sampled in the Upper Area.

Table 3. Stocking and sampling density of Brown Trout stocked as fry in two standard sections of Steele Brook, Watertown (2005 – 2016).

Location/Year	# Stocked	Stocking Density (#/Ac)	0+ Sampling Density (#/Ac)	0+ Percent Survival	1+ Sampling Density (#/Ac)	1+ Percent Survival	2+ Sampling Density (#/Ac)	2+ Percent Survival
Upper Area								
2005	6,000	11,037	393	0.04	--	--	--	--
2006	6,000	11,037	462	0.04	41	0.004	--	--
2007	6,000	11,037	722	0.07	58	0.005	0	0
2008	6,000	11,037	740	0.07	35	0.003	0	0
2009	6,000	11,037	1,115	0.10	41	0.004	29	0.003
2010	8,000	14,716	665	0.05	64	0.004	58	0.005
2011	8,000	14,716		NS				
2012	6,000	11,037	197	0.02	41	0.004	41	0.003
2013	6,000	11,037	410	0.04	0	0	23	0.002
2014	6,000	11,037	480	0.04	17	0.002	12	0.001
2015	6,000	11,037	451	0.04	6	0.001	12	0.001
2016	4,000	7,358	110	0.01	6	0.001	0	0
Lower Area								
2005	4,000	8,890	32	0.01	--	--	--	--
02006	6,000	13,333	178	0.03	0	0	--	--
2007	6,000	13,333	146	0.03	0	0	0	0
2008	6,000	13,333		NS				
2009	6,000	13,333	554	0.10	8	0.002	4	0.001
2010	7,000	15,555	113	0.02	4	0.001	16	0.003
2011	7,000	15,555		NS				
2012	6,000	13,333	8	0.0006	0	0	0	0
2013	6,000	13,333	69	0.01	0	0	0	0
2014	4,000	8,890	93	0.03	0	0	0	0
2015	4,000	8,890	121	0.03	0	0	0	0
2016	3,000	6,667	8	0.0006	0	0	0	0

Discussion

Severe drought conditions statewide had potentially serious negative effects on many stream fish populations. Numerous small to mid-size streams went totally or partially dry if they were not well buffered with ample groundwater inputs. Fish that reside in these streams may be able to seek refuge in isolated pools throughout the summer, but these refugia are not always available. The full impacts of the 2016 drought may not be known for some time. Sampling many of the long term reference streams and select headwater streams in 2017 may help document the impacts of the previous year's drought.

While conditions for some stream fish were unfavorable, others, such as the spring spawning Smallmouth Bass greatly benefited from the stable, lower flows and suitable temperatures allowing for ideal spawning conditions. Unfortunately, the Housatonic River (Connecticut's premiere Smallmouth Bass stream) was not sampled during 2016 so FD biologists could not document the level of natural reproduction in that river. However, as mentioned previously in this report, the number of young-of-year Smallmouth Bass sampled in our long term reference site within the Naugatuck River was exceptional (1,542/mile in 2016 vs. 250/mile avg. 2002-2014). These data and stream flow data suggest that spawning conditions for other CT populations of riverine Smallmouth Bass were favorable.

Overall, trout survival in the two standard sections of Steele Brook was very poor and likely the result of extremely low flow conditions especially in the upper site which has more suitable trout habitat than the lower stocked area of this stream. There also remains a disparity in Brown Trout fry survival between the two fry-stocked sections due to habitat stability and quality differences. The upper stream section of Steele Brook (above the Route 6 crossing) is above the influence of dams, has cooler (Avg. June 15th - Sept 15th = 66^{o}F) water temperatures and more stable habitat (less impervious surface (~7%) in the upper drainage and less prone to flash flooding). Whereas the lower stocked location (Municipal Stadium) is below two dammed impoundments, is warmer (Avg. June 15th – Sept 15th = 70^{o}F), and more urbanized with a higher percentage (~14%) of impervious cover in the contributory drainage (Figure 4). The higher percentage of impervious cover within the drainage area of the Municipal Stadium stream reach makes this area very prone to flash floods. Consequently, the in-stream habitat is in constant flux. Annual shifts in stream channel following high flow events are not uncommon.

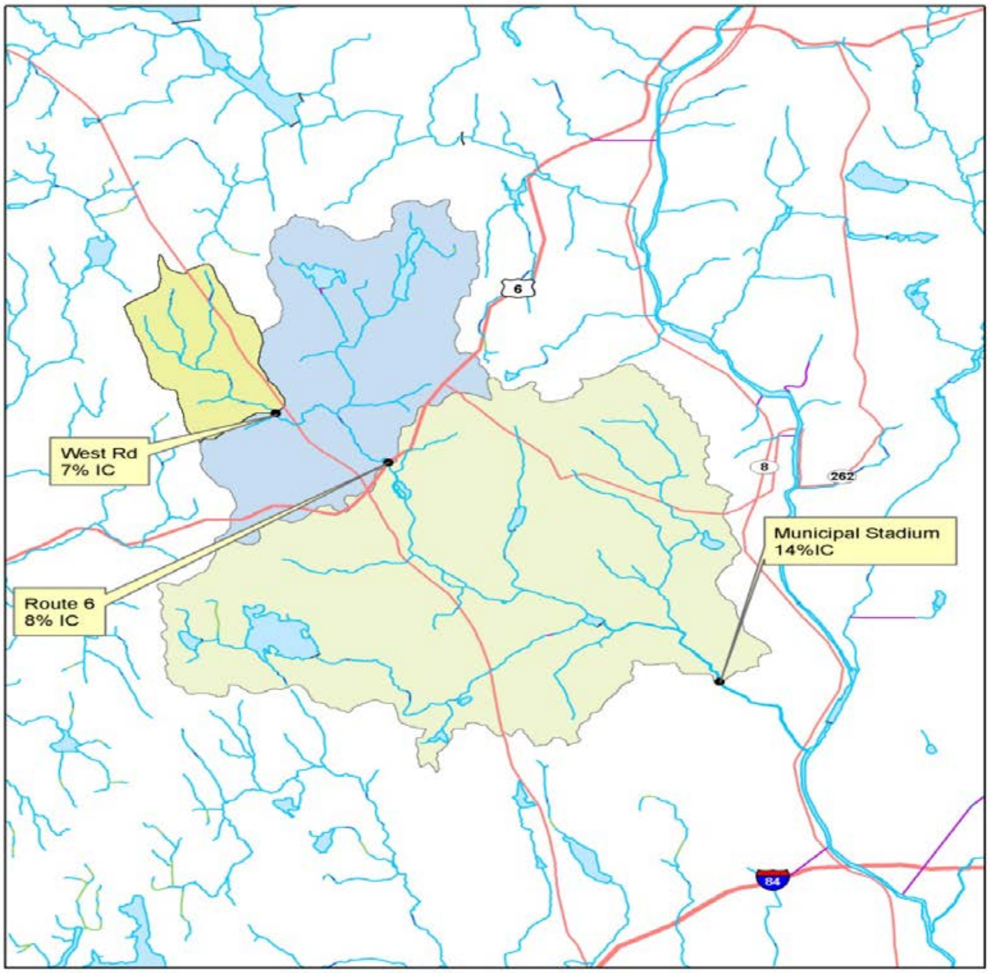

Figure 4*. Percent impervious cover at two stocked locations on Steele Brook, Watertown.*

As stream habitat improves with anticipated dam removal, it may be possible to develop a viable trout fishery in this metropolitan stream. Interestingly, local anglers who frequent the upper stream location have reported catching Brown Trout up to 16 inches.

Further analysis of water temperature data, assessment of flow alterations on both the Shepaug River and Housatonic River, stream crossing assessments, riverine smallmouth bass management assessment, and a full review of species distribution in Connecticut streams will be presented in the 2017 Annual Report.

Recommendations

- Evaluate paired stream crossing and fish population data to determine effects of small stream barriers on fish populations.
- Select and revisit a subset of the streams that were documented as dry in 2016.
- Sample standard sites in the Housatonic River to determine 2016 Smallmouth bass population year class strength.
- Apply thermal classifications to all previously sampled streams where water temperature data exist.

Expenditures

Total Cost:	$86,474
Federal Share:	$64,856
State Share:	$21,619

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