Federal Aid in Sport Fish Restoration
F16AF00354
F-57-R-35
Annual Performance Report

2016-17

Connecticut Fisheries Division

Inland Fisheries Research and Management

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

Grant Title: INLAND FISHERIES RESEARCH AND MANAGEMENT

Study 1: **Coldwater Fisheries Program**

Study 2: **Warmwater Fisheries Program**

Study 3: **Inland Fisheries Coordination and Administration**

Period Covered: **April 1, 2016 – March 31, 2017**

Project Personnel: Robert Jacobs, Supervising Fisheries Biologist, Project Leader
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September 4, 2017

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Bureau of Natural Resources
September 4, 2017

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Grant Title: INLAND FISHERIES RESEARCH AND MANAGEMENT

Study 1: Coldwater Fisheries Program

Job 1: Monitoring Fish Populations in Streams
Job 2: Stream Angler Surveys
Job 3: Trout Stocking
Job 4: Wild Trout Management
Job 5: Farmington River Management
Job 6: Housatonic River Management
Job 7: Coldwater Lakes Management

Study 2: Warmwater Fisheries Program

Job 1: Monitor Warmwater Fish Populations in Lakes and Large Rivers
Job 2: Lake and Large River Angler Surveys
Job 3: Bass Research and Management
Job 4: Reservoir Bass Studies
Job 5: Northern Pike Management
Job 6: Walleye Management
Job 7: Channel Catfish Management

Study 3: Inland Fisheries Coordination and Administration

Job 1: Inland Fisheries Operations

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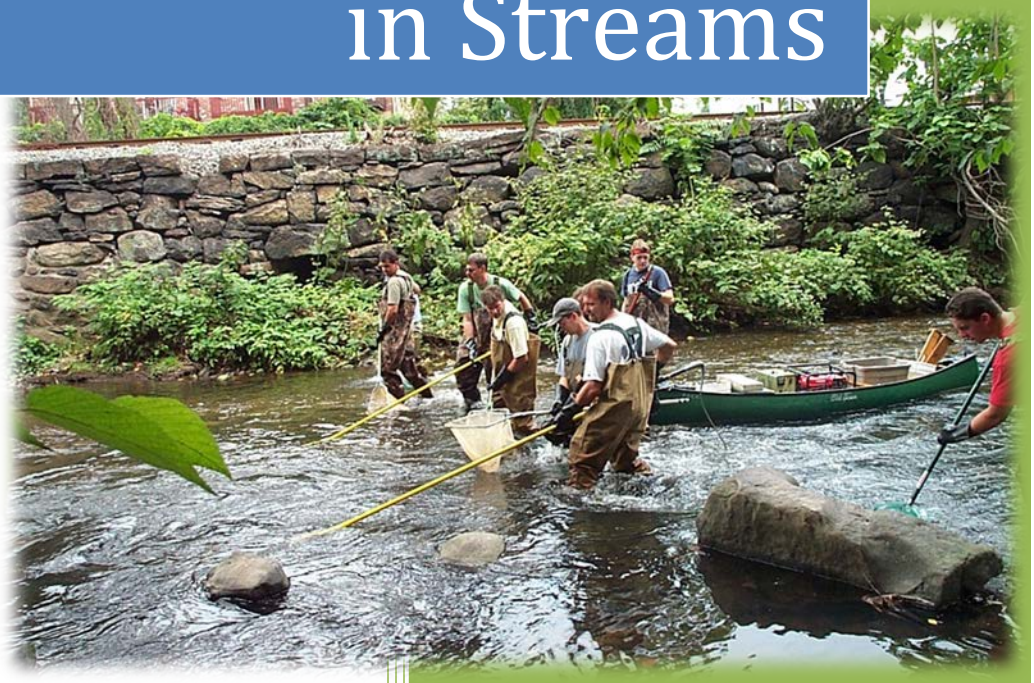
Connecticut Fisheries Division

Monitoring Fish Populations in Streams



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Grant Title: Inland Fisheries Research and Management
Study 1: Coldwater Fisheries Program
Project: Coldwater Monitoring
Job 1: Monitoring Fish Populations in Streams

Period Covered: April 1, 2016 to March 31, 2017

Report Prepared by: Edward Machowski and Neal Hagstrom

Job Personnel: Edward Machowski, Job Leader
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Timothy Barry, Program Coordinator
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Date Submitted: September 4, 2017

Approved by: Peter Aarrestad
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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

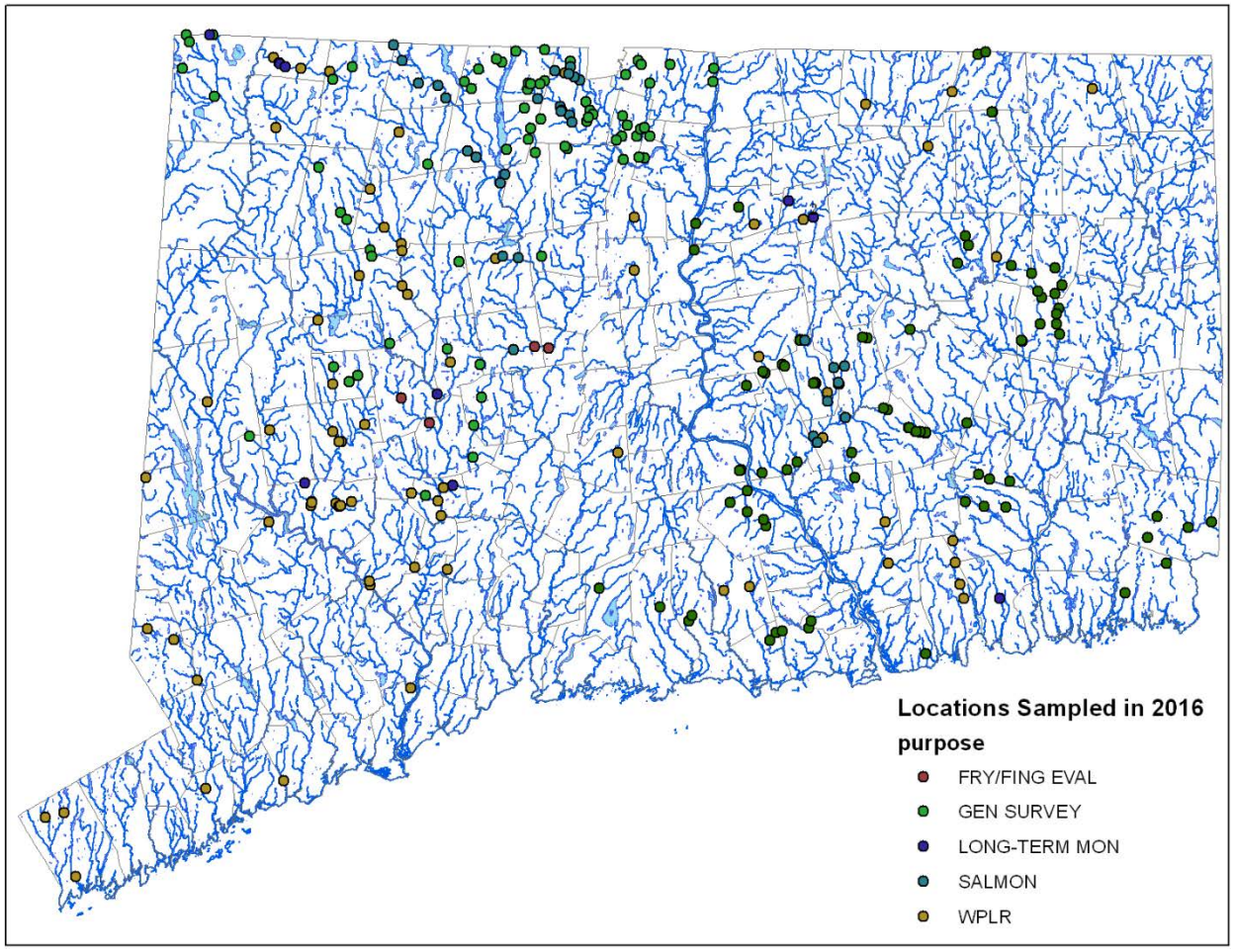

***Figure 1**. Locations of the 168 streams sampled by FD in 2016 and 70 streams sampled by WPLR personnel.*

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).

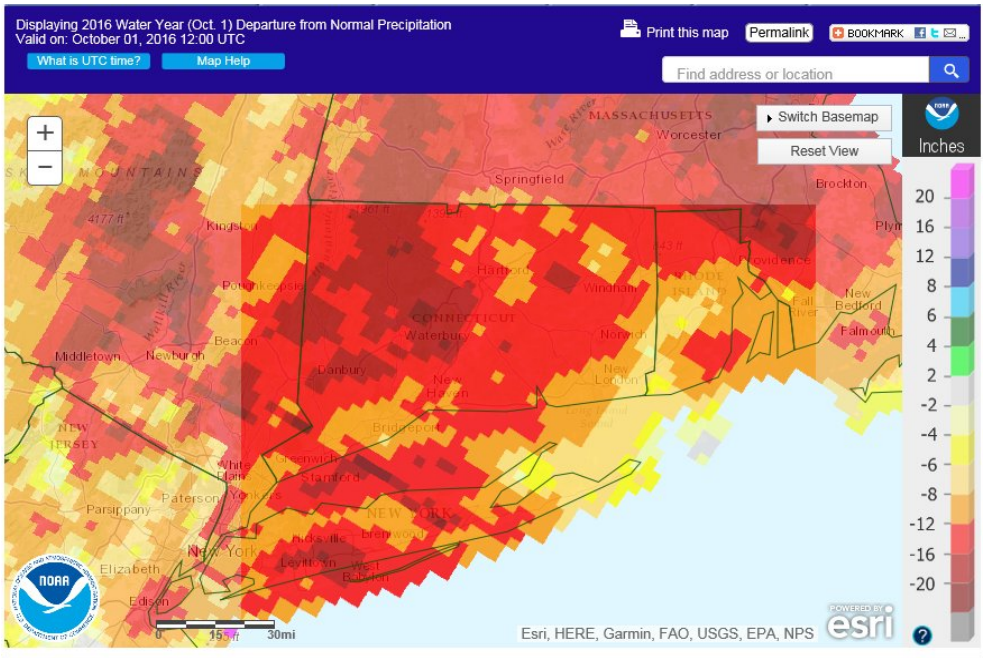

***Figure 2**. Statewide precipitation deficit for the 2016 water year. Figure provided by National Weather Service.*

- 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°F (typical for Bradley Airport is 14.6 days over 90°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.

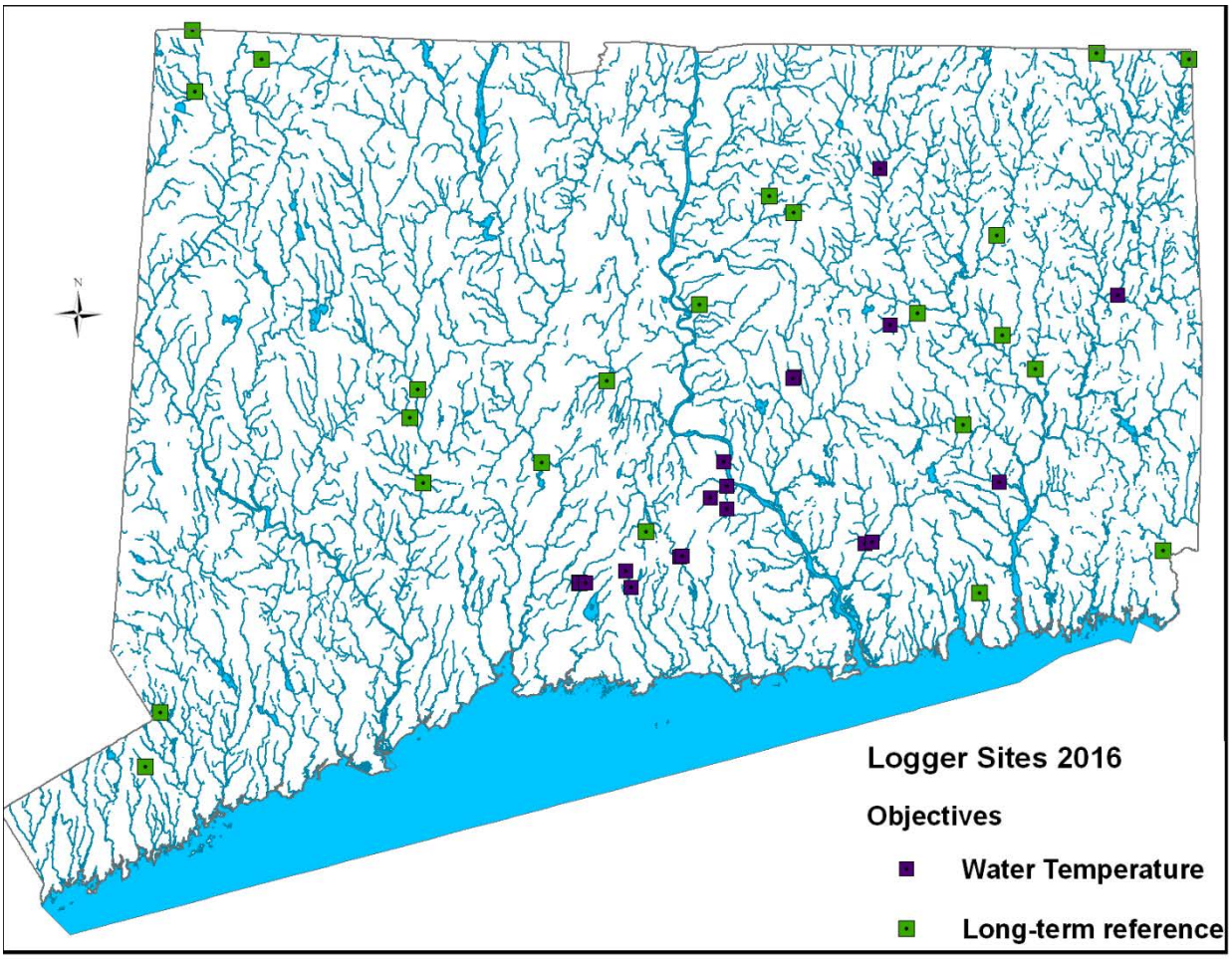

Figure 3. *Locations of the 23 long-term reference streams (green squares), and the 16 streams where thermographs were deployed statewide in 2016.*

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.

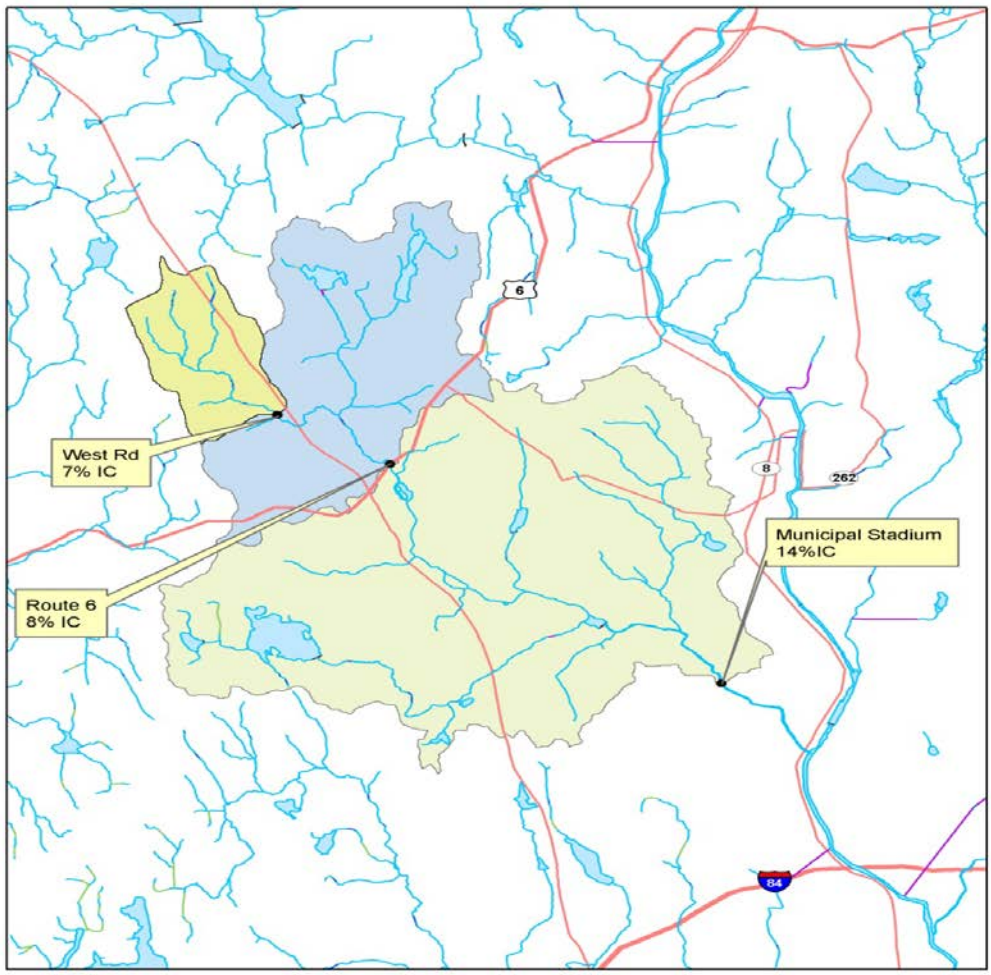

Figure 4*. Percent impervious cover at two stocked locations on Steele Brook, Watertown.*

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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Report Prepared by: Neal Hagstrom and Edward Machowski

Job Personnel: Neal Hagstrom, Job Leader /Project Leader
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Timothy Barry, Program Coordinator
Robert Jacobs, Assistant Program Coordinator

Date Submitted: September 4, 2017

Approved by: Peter Aarrestad
Director, Fisheries Division

William Hyatt
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Cover photo: Large river trout fishing in a popular pool, DEEP staff photo.

Summary

In this document, we reviewed and compared the results of 2016 rapid assessment angler surveys conducted on Opening Day (OD) of trout fishing season (2nd Saturday in April). Trout stocking sites at 68 locations around the state were visited by Fisheries staff on the morning of OD 2016. These surveys provided timely data on usage of these water bodies on OD, the busiest trout fishing day of the entire year. These data were analyzed and, where data from other years were available or where similar trout management regulations exist between different sites, trends are presented. Potential performance metrics that had been previously evaluated for the efficiency of trout stockings were used in the review. While not definitive, data appear to indicate that for ponds with predominately shore fishing access, regardless of management type and regulations, stocking higher densities of fish resulted in greater angler usage, at least on OD.

In the last report two metrics, effort/stocked trout and catch/stocked trout for the trout season were reviewed as indices of stocking efficiencies using catch/effort data from 45 past angler surveys conducted between 1988-1994 . Rapid assessment methodology is usually a short-duration endeavor and focuses on angler effort and assessing if specific angling access/stocking locations are being utilized. In most cases catch data arenot collected during rapid assessment surveys. Thus, only the effort/stocked trout metric could be calculated and used for review for the OD 2016 data. The effort/stocked trout metric value from this rapid assessment is from a single hour, the first hour (6:00AM) of OD. The last review used total effort for the entire fishing season. Additional work is needed to see if a correction factor can be developed to equate the observed effort during the first hour of the fishing season with the seasonal totals.

Background

Sound fisheries management of streams relies upon a combination of angler survey and biological data. This job provides a coordinated and standardized means of assessing recreational fishing on Connecticut's streams using accepted methodology. Angler surveys conducted under this job will expand our knowledge of the State's stream fisheries resources, and help to determine the effectiveness of current fishing regulations and trout stocking regimes. Improved fishing quality and angler satisfaction, resulting from informed management decisions, may lead to greater angler interest and participation in river and stream fishing. In

the case of the State's trout stocking program, current angler effort/catch information on stocked rivers/streams should help optimize the finite trout production from state fish hatcheries. By providing a central depository for data storage and guidance in creating statistically valid, standardized survey methods, this job will increase efficiencies for other fisheries management jobs requiring stream angler survey data.

Angler surveys can be used to collect economic information for a fishery that includes the cost to go fishing, the impact of purchases related to fishing trips on local economies and the willingness of anglers to pay for their recreation opportunities. A significant body of baseline fisheries economic data has been collected during several past studies in Connecticut: the Farmington River (Hyatt, 1986), the Housatonic River (Barry 1988), and for 60 streams across the state during the 1988-1994 stream survey (Hagstrom et al., 1996). Economic information helps managers make informed decisions. It can be used to evaluate a particular fisheries value to anglers, compare the cost-benefit of various management options and place monetary values on the deeded fishing rights of a specific water body. This report summarizes work performed during April 1, 2016 to March 31, 2017.

Objectives

- Develop and implement standard survey methods.
- Coordinate implementation for angler surveys (assessing angler effort, catch, and attitudes) on requested stream resources.
- Maintain stream angler survey databases and archive all raw data to provide technical support to management projects.
- Provide economic information to support fisheries management decision making.

Approach

Three different types of angler surveys are typically used for streams and rivers to gather quantitative estimates of angler effort (hours of fishing), catch (numbers of fish caught), harvest (number of fish taken), and catch rates (the total number of fish caught per hour) for all fish species.

- Roving angler surveys with a stratified, random design (Malvestuto et al. 1978) are best suited for streams with many access points that are easy to walk or drive between.
- Bus stop angler surveys (Pollack et al. 1994) are useful for larger rivers that have

many well defined, but widely dispersed access points.

- Rapid assessments (Orciari et al. 2011) are useful when rough estimates of fishing are desired from many places, or when staff is not available to survey for the whole season (e.g., only the period on and immediately following Opening Day (OD)). This survey method allows only a relative comparison of fishing pressure between streams where data were collected during a similar time period.

For collecting data away from stream-side, alternative survey methods such as electronic, phone, mail, and canvas surveys will be evaluated for their usefulness in collecting non-resource specific or off-site resource specific angler attitudes.

The methodology for the Roving and Bus Stop Surveys are presented in Hagstrom et al. 2016.

Rapid Assessments

The rapid assessment method is a series of counts at locations where only a relative index of angler usage is needed (Orciari et al. 2011). These data are used to assess whether stocking rates for specific streams or stocking locations match current angler usage. Generally no individual angler interviews are done with this method.

For all methods, information collected during individual angler interviews can include: angler effort, catch, expenditures, home town and angler opinions related to management activities and resource values. Depending on project needs, this information can be used to generate economic impact, and service areas. Economic impact is the monetary value that a fishery adds to local business. The Service Area analysis is used to determine the towns that are serviced by an individual resource or particular management area. It could also be used to imply how far anglers will travel based on the perceived value of the fisheries. Annual catch and effort statistics are presented in this report with more detailed analysis in individual job reports. All job specific opinion questions will be summarized in that job's report.

Field Activities

Opening Day-Rapid Assessments

Single-count Rapid Assessments were conducted Opening Day (OD) of trout season at 68 streams (or sections of streams) and ponds (April 9, 2016). See Figure 1 for the spatial distributions of locations. There were a total of 22 separate streams and 33 ponds visited. Counts were done at 16 locations for the first time in 2016, while the remaining 52 locations were sites that had been assessed on past OD's. The availability of data to compare OD locations over time is mixed. Some waterbodies have several years of data, while others have

no data or only data collected later in the day that may not be representative of site usage. For the majority of locations checked on OD the greatest angling effort occurs during the first hour (6:00-7:00 AM).

Table 1. Management category, number of ponds, lakes and stream sections surveyed for angler effort on Opening Day of Trout fishing Season 2016

Regulation Type	**Number of Waterbodies**	**Regulations**
Community Waters (CW)	8	Small urban ponds with Standard season and variable limits
Lakes	16	Standard season, 5-trout/day limit
Trout Management Lakes (TML)	2	Larger lakes, special seasons for trout fishing. Size and harvest limits vary
Trout Parks	8	Small ponds with standard season and 2-trout/day limit
Streams	28	Standard season and statewide trout regulations.
Trout Management Areas (TMA)	4	Catch and Release stream sections with Year round Seasons
Trophy Areas (TA)	2	Rivers stocked with large trout, 2-trout/day and minimum size limits
Wild Trout Management Areas (WTMA)	1	Single artificial terminal tackle, and catch and release only. Not stocked.

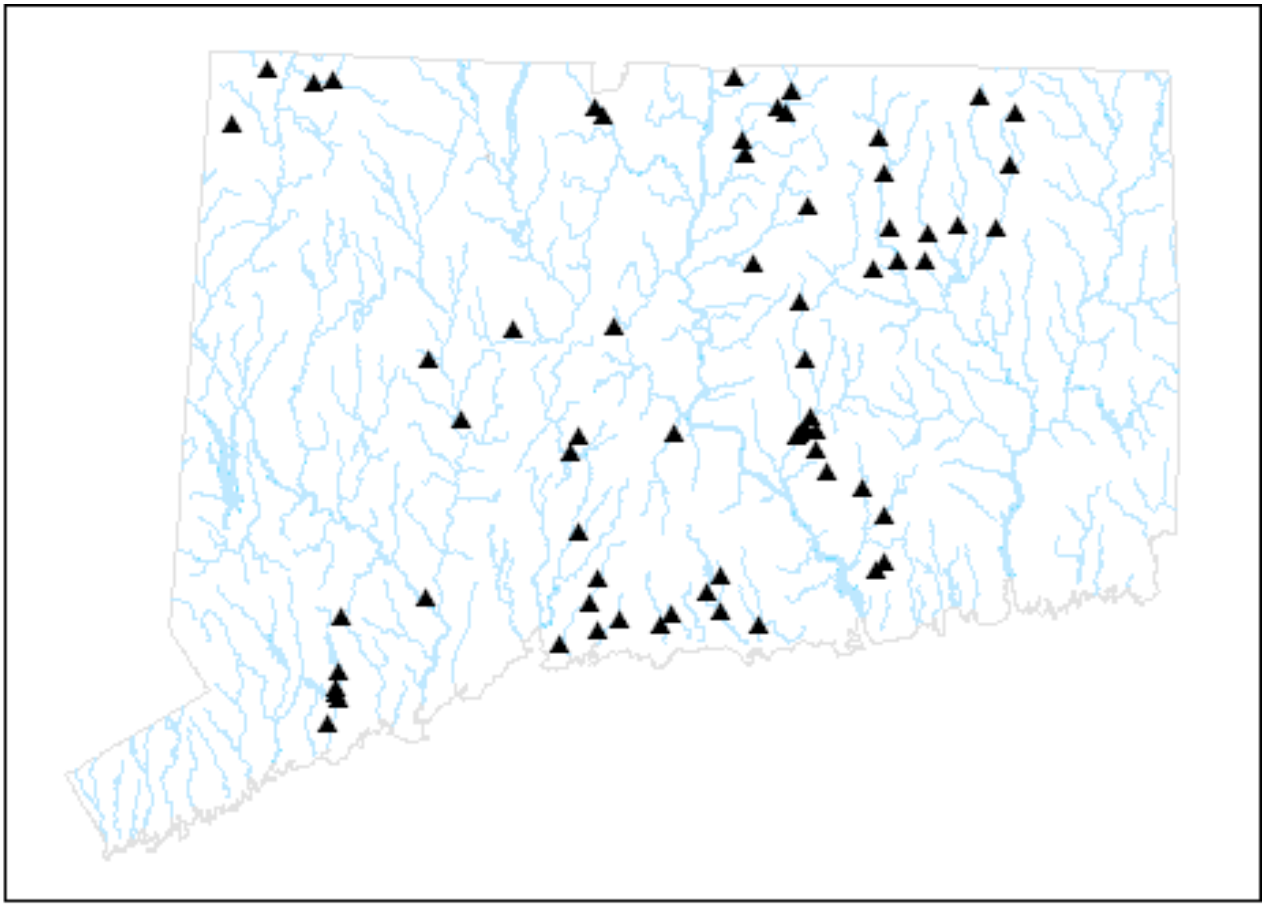

Figure 1. Distribution of Opening Day rapid assessment locations during 2016. Three locations were part of season long assessment of fishing: Moodus Reservoir, Pickerel Lake and Wangumbaug Lake. (See Lake Angler Survey job for additional details).

Opening Day counts/Rapid assessments:

These counts provide feedback on the usage of specific stocking sites as well as an overview of angler usage along individual rivers and stream systems and at ponds and lakes for our Trout Stocking Program (See Trout Distribution Report). As a result of past counts on OD, and the observed low or lack of usage by anglers, it was recommended to stop or reduce stockings at several streams or specific stocking sites on streams.

Angler usage at a site on OD is the result of weather, and in the case of streams, flow conditions, continued public access to the specific location or waterbody, the angler's past experiences and current expectations from the site, in this case specifically on OD, what information they have learned about stocking this year (was the location stocked or not?) and often on what they observe (re: visible, swimming trout) in the water. The number of anglers

at a site usually decreases during the course of OD morning. This is based on many years of observations and count data from previous OD rapid assessments. The highest counts are usually at 6:00 am and drop over the next several hours. In stocked rivers, non-uniform probabilities of use for the entire Opening Day morning period were determined for Connecticut streams by Hyatt (1986) and confirmed during Angler Surveys done during 1988-1994 (Hagstrom et al. 1996). These value could be used to correct all angler counts to a 6:00 am equivalent count.

When compared to the best available data from prior OD counts, there was a general trend of lower angler counts in the majority of stream locations (29 of 35). These declines were usually in the range of 50% lower than in past counts. Only a couple of places had an increase in usage compared to past data (Natchaug River Trout Park, Bigelow Brook and Wonoskopomuc Lake). Nine of the 33 ponds counted had lower angler counts. Weather (cold to cool air temperatures) and flow conditions were reasonably mild on OD of 2016, so it would appear that these were not factors in this observation.

Angler counts and number of trout stocked were compared across management types (Figure 2). As would be expected, a general relationship was found for both lakes and streams where more fish meant more effort (Figure 2 and 3). It was interesting to note that ponds and lakes with similar management regulations tended to cluster together. The sites that had higher effort levels were heavily used Trout Parks for ponds and the Trophy Areas (TA) on streams that are stocked with a percentage (~50%, >12 inches TL) of larger fish. Where good, shore-based fishing access, or an opportunity to potentially catch larger fish (TA's) exists it appears that denser stocking rates (on a fish/acre basis) attracts more anglers. The one very high outlier for ponds was Schreeder Pond (TP- Figure 4) which is stocked OD and where there has been an effort to cultivate angler participation as a social event. This location generated ~200 angler

hours of effort during the first hour of OD and is stocked with a moderate number of trout/acre for OD (~250 fish/acre), when compared to other locations.

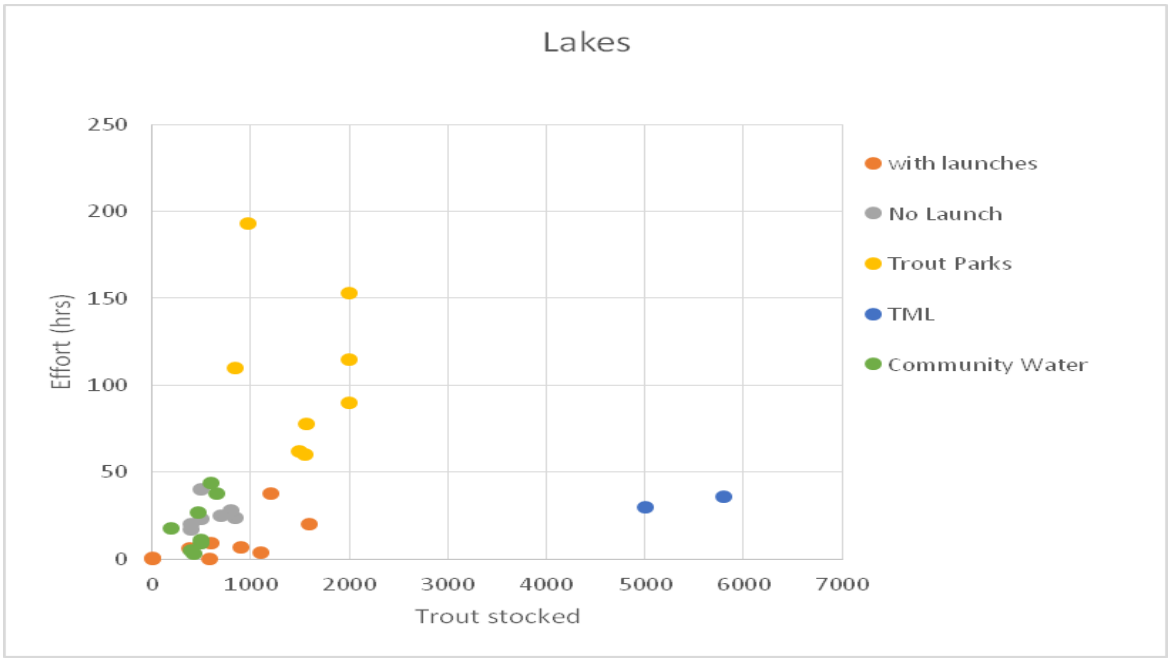

Figure 2. Number of fish stocked for Opening Day vs Anglers counted in one hour on Opening Day (effort) in selected Connecticut lakes and ponds in 2016.

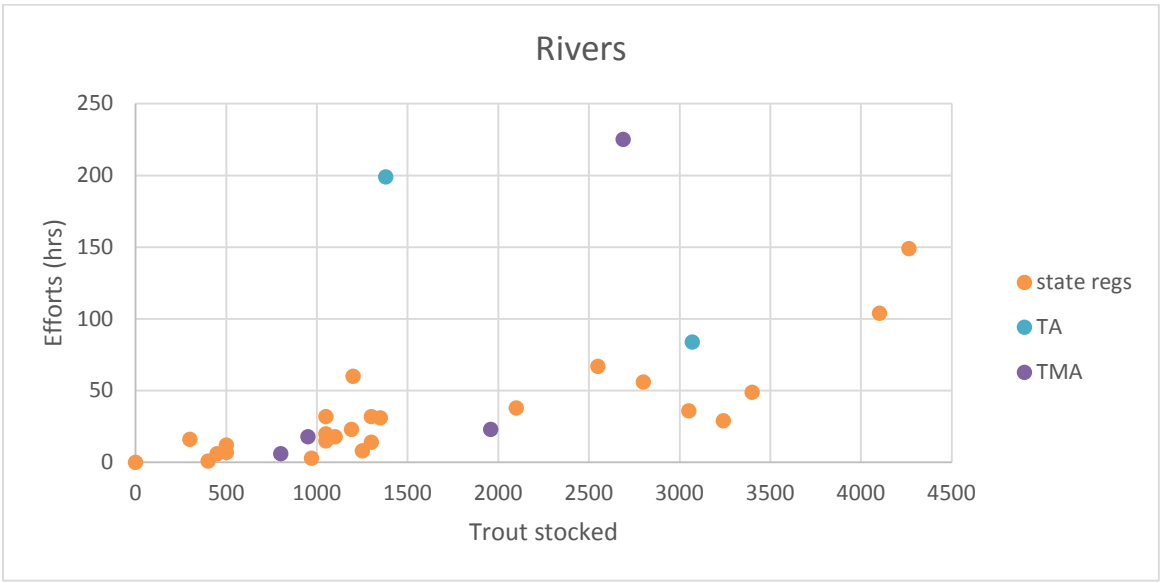

Figure 3. Angler effort vs number of trout stocked for selected Connecticut streams by management types

For ponds, when values are compared on a per acre basis, the different management types clustered together and a general effort vs stocking density relationship could be seen (Figure 4). The data in Figure 4 appear to indicate stocking smaller ponds with good shore fishing access

(i.e. ~50% or more of the shoreline is accessible for fishing) is more effective at attracting angler activity and may be more efficient from a fish distribution prospective, at least for OD

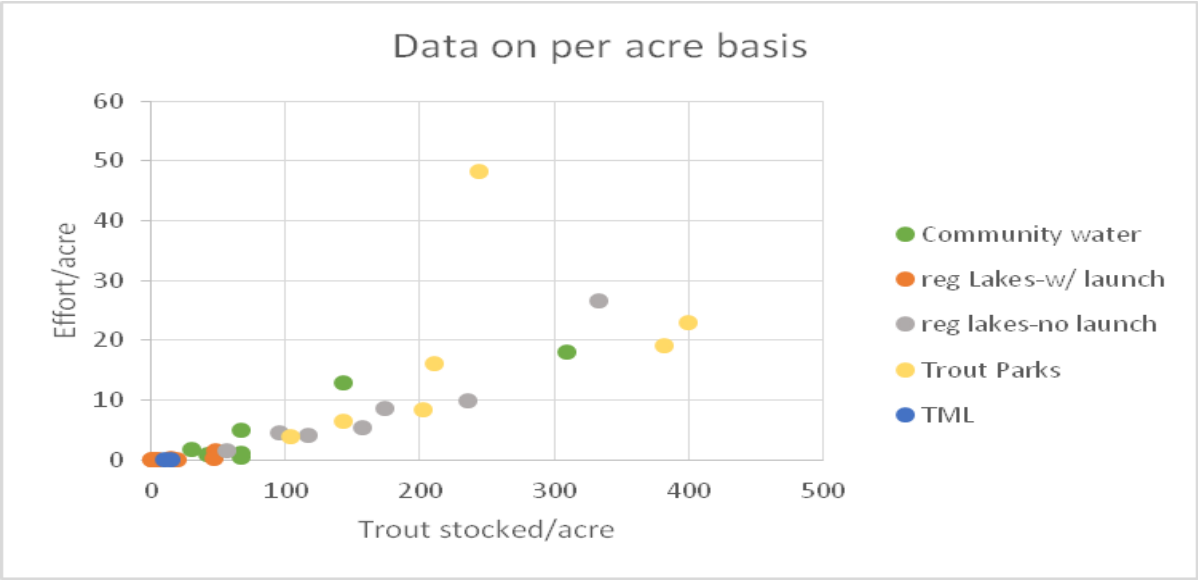

Figure 4. Number of trout/acre stocked vs Opening Day Angler count/ acre for selected Connecticut Lakes & Ponds in 2016

An attempt was made to use the performance metric as suggested in the last final report. However, those comparison metrics were derived from data collected on season or year-long angler surveys. Because the rapid assessment survey protocol only collects effort data, only the angler effort/stocked trout metric could be used for comparison purposes. The analysis for the 2016 report (Hagstrom and Machowski 2016) was done using season long effort totals, where in the current case we have only a single hourly counts (done by Fisheries staff in a number of different locations but all at the exact same start time, re: 6:00AM OD). It will be necessary to rescale the performance metrics to compare an hourly counts against seasonal effort totals. Unfortunately, there is no one-to-one correspondence between the two approaches. The same effort/acre versus trout stocked/acre metric appears to indicate that stocking more trout in streams does not result in more angler effort on OD (Figure 5). For ponds, the data indicate that more effort is gained as the density of stocking increase up to about 250 trout/acre, above which the added benefits starts to decline (Figure 6). This may represent a shoreline or boat access saturation point for these waterbodies.

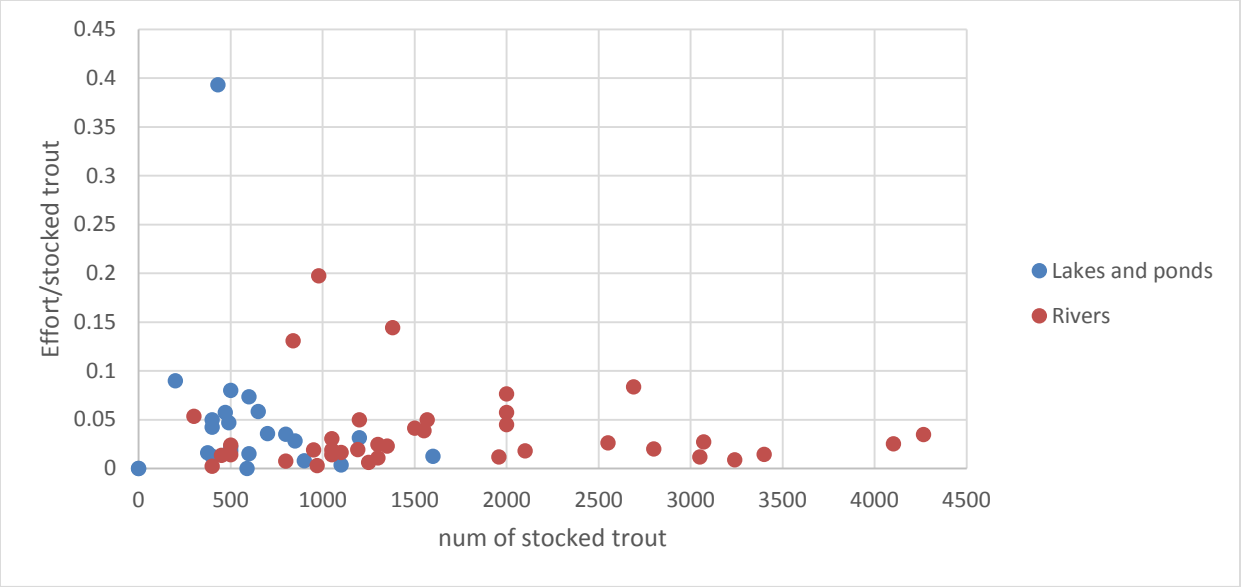

Figure 5. Stocking performance metrics compared to total trout stockings.

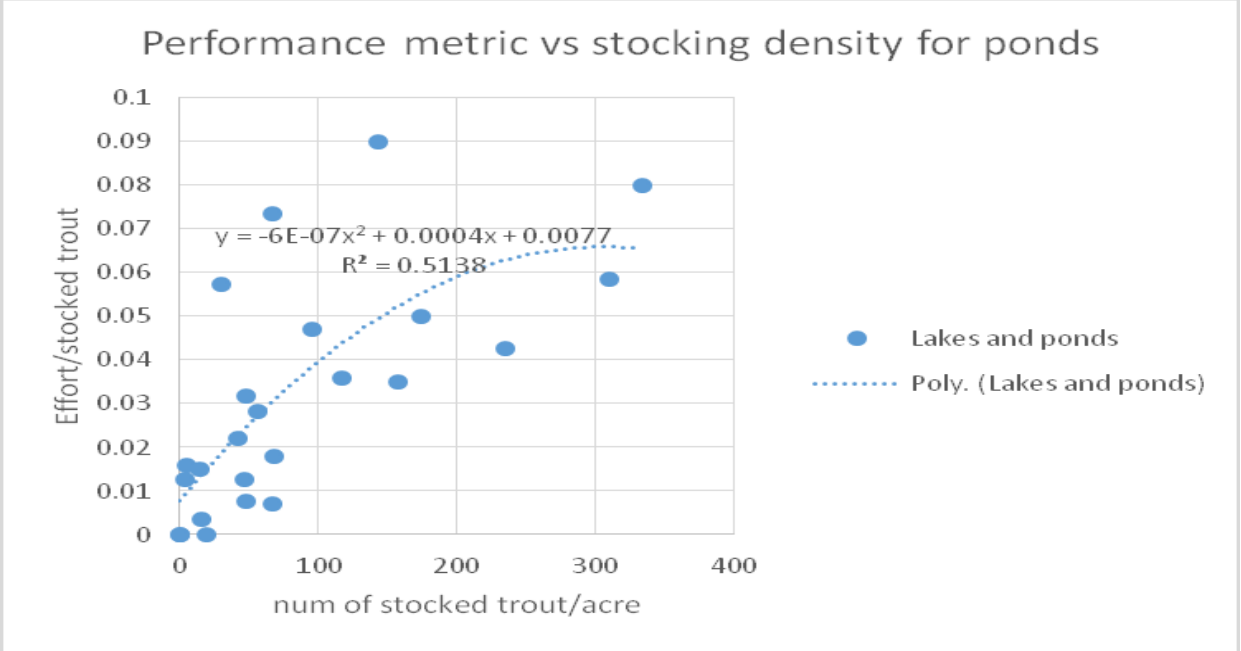

Figure 6 Angler effort generated by increased trout stocking density in Connecticut lakes and ponds

For next years' report, a similar analysis will be completed for rivers and streams by putting stocking rates on a per kilometer basis.

Recommendations

Develop set of Opening Day survey loops that can be done on a rotational basis to establish additional time series information on general usage and angler participation.

Develop more detailed metrics that use the single Opening Day count to evaluate statewide trout stocking.

Opening Day angler usage appears to be related to pond stocking density. Preliminary discussions have been initiated to examine if setting Opening Day stocking densities to optimize angler usage of available water bodies could provide better utilization of the State's limited hatchery trout production.

Expenditures

Total Cost:	$54,538
Federal Share:	$40,903
State Share:	$13,634

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2016-17

Federal Aid in Sport Fish Restoration
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Annual Performance Report

Connecticut Fisheries Division

Trout Stocking

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

Grant Title: Inland Fisheries Research and Management
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Project: Coldwater Management
Job 3: Trout Stocking

Period Covered: April 1, 2016 to March 31, 2017

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Date Submitted: September 4, 2017

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Cover photo: A pair of beautiful Rainbow Trout and streamside fiddleheads by chashcc.

Summary

Recreational fishing is a healthy outdoor experience that is important to the quality of life for many of Connecticut's residents and is beneficial to the state's economy. Trout anglers annually enjoy over 1.2 million days fishing in Connecticut. These same anglers (approximately 109,000 adult anglers older than 16 years of age), spend roughly $30.00/day pursuing trout, which contributes around $36 million annually to the State's economy (U.S. Department of Interior et al. 2013 (revised 2014)). With this in mind, a major objective of the Connecticut Department of Energy and Environmental Protection's (DEEP) Fisheries Division (FD) is to enhance and diversify recreational fishing opportunities. To support high-quality fishing experiences, the FD's hatchery system stocks approximately 900,000-1.3 million salmonids (trout fry, fingerling/yearling trout, catchable size trout, Atlantic Salmon broodstock, and Kokanee Salmon fry) that are reared at three State fish hatcheries. Currently, Brown, Brook, Rainbow, and Tiger Trout (a Brown Trout X Brook Trout hybrid), along with Atlantic Salmon and Kokanee Salmon (a landlocked form of the anadromous Pacific Sockeye Salmon) are raised for stocking in waters open to public fishing. This year work continued on refining the trout stocking assessment (RASTA) protocol. Public stocking maps were updated and made available via the DEEP FD website. As part of the continuing program to update and replace the aging fleet of hatchery trucks, a fifth new stocking truck (purchased with state funded capital improvement monies) will be housed at Kensington hatchery.

Background

The primary purpose of the Trout Stocking job is to maintain and enhance Connecticut's trout fisheries in areas that are accessible to the general public. A goal of the FD is to provide reasonable accessibility and trout fishing opportunities throughout the year, in all regions of the State. This job has great importance because trout are a highly sought-after gamefish, and generate ~ 1.2 million fishing trips (days)/year in recreational activity in Connecticut (U.S. Department of Interior et al. 2013). Additionally, 109,000 trout anglers spent an average of $30.00/day and generated over $36 million per year to the State's economy (dollar amount based on U.S. Department of Interior et al. 2013). These estimates of fishing activity and economic value must be viewed as conservative, in that data from anglers under the age of 16 were not included.

The majority of this fishing activity can be attributed to hatchery production of trout and stocking by FD. Three species of trout (Brook (*Salvelinus fontinalis*), Brown (*Salmo trutta*), and Rainbow (*Oncorhynchus mykiss*), one hybrid trout ("Tiger" which is a Brown Trout and Brook Trout cross), and two species of salmon (Atlantic (*Salmo salar*) and Kokanee (*Oncorhynchus nerka*) – a landlocked form of the anadromous Sockeye Salmon) are raised in the hatchery system. Special strains of Brown Trout (i.e. Cortland, Iijoki, Survivor, and Seeforellen) are also

raised for specific management objectives and programs (i.e. the Coldwater Lakes Management, Farmington River, Housatonic River, Wild Trout, and Sea-run Trout Jobs). Each year, nearly 650,000 catchable-sized trout are produced, which includes approximately 2,000 broodstock trout (2 - 10 lbs. each). An additional 1,000 -1,500 broodstock Atlantic Salmon (3 - 20 lbs. each), 400 - 500 broodstock Seeforellen Brown Trout (3 - 5 lbs. each), 300,000-400,000 Brown Trout fry, and 150,000-200,000 Kokanee Salmon fry are also provided by the State's hatchery system for annual distribution. Over 400 truck-runs are required annually to stock these fish into approximately 200 rivers and streams, and 100 lakes and ponds; the vast majority of which are done within a short, three month window (March-May). Stocking of trout and salmon (Atlantic and Kokanee) requires determining proper allocation of fish, logistical planning, timely scheduling, extensive coordination, and accountability. The large commitment of personnel and high level of coordination (between fish management, hatchery, and environmental law enforcement staff) required to complete this Job has necessitated high levels of oversight and development of efficiencies. Computerization of stocking schedules, stocking location maps, annual distribution reports, and historical stocking records have further improved efficiencies and centralization of all of these components have helped to standardized the statewide process. The use of the internet and social media outlets have vastly improved the FD's ability to disseminate this information, in a timely manner, to the angling public.

Trout are transported to stream side via hatchery truck and in some instances volunteers help distribute the fish by float stocking fish throughout high quality habitat. Photo by: FD staff

Continued improvements to existing procedures for scheduling and distribution are on-going. As was reported by Orciari et al. (2011), an experimental protocol (formerly known as the CT R_x method) to quantitatively rank the relative importance of all of Connecticut's stocked waters

was developed. This ranking system, now called the "Ranking of All Stocked Trout Areas" (RASTA), is currently being refined. This tool should serve as a means for assessing current trout stocking allocations but more importantly, it should allow for making better informed allocation decisions moving forward. Additionally, it will provide a documentable means of determining future changes to trout stocking allocations at specific locations/regions around the State.

Six objectives currently exist for the Trout Stocking job:

1. Distribute trout and salmon produced at State hatcheries to areas that can support salmonids, promote fishing opportunities, and are accessible to the general public.

2. Produce the Annual Fish Distribution Report, an annual report listing the allocation of all fish stocked by location, and maintain a continual allocation record for each stocked area (Historical Stocking Record).

3. Update stocking maps and provide to public through the DEEP website.

4. Utilize angler usage data obtained from the Stream Angler Survey (F57-R35, Study 1, Job 2), and Lake Angler Survey (F57-R35, Study 2, Job 2) to make informed management decisions regarding trout allocations.

5. Develop and continually refine a quantitative means of ranking the relative importance of each stocked area, and use this to guide allocation of fish.

6. Work cooperatively with hatchery staff to ensure all coldwater/trout Fish Management objectives are met.

Atlantic salmon being stocked in the Shetucket River. Photo by: Chris McDowell

The purpose of Job 3 is to provide an accurate, historical record of trout stocking, enhance fishing opportunities by continually assessing allocations of stocked salmonids (trout, Kokanee Salmon, and broodstock Atlantic Salmon), and improve the trout distribution process statewide. This report summarizes the work involved in distributing those fish during 2016.

Approach

Trout and broodstock Atlantic Salmon stocking is planned, coordinated, and scheduled for all suitable inland waters of the State (Orciari et al. 2011). The number of broodstock Atlantic Salmon is apportioned evenly between the eastern and western halves of the state to provide a

limited, but popular recreational, sport fishery. See the Wild Trout (F57-R35, Study 1, Job 4), Coldwater Lakes Management (F57-R35, Study 1, Job 7), and Sea-run Trout Job (F50-D36 Job 4) reports for stocking practices of Brown Trout fry, Kokanee Salmon fry, and Sea-run trout, respectively. Special management areas (Figure 1) receive prescribed allocations of trout, specifics of which can be found in Orciari et al. (2011).

Trout being stocked by FD's Burlington State Fish Hatchery staff.

A nice Kensington Hatchery-raised broodstock Atlantic Salmon caught from the Shetucket River by Brandon Belair in 2013.

The annual fish distribution report is produced and made available through the DEEP FD website:

http://www.ct.gov/deep/lib/deep/fishing/general_information/fishdistributionreport.pdf

Stocking maps are updated as needed to reflect the most current stocking locations. Changes in locations and access for the general public are now available through the DEEP FD website for all river/stream locations where catchable trout are stocked (www.ct.gov/deep/troutstockingmaps).

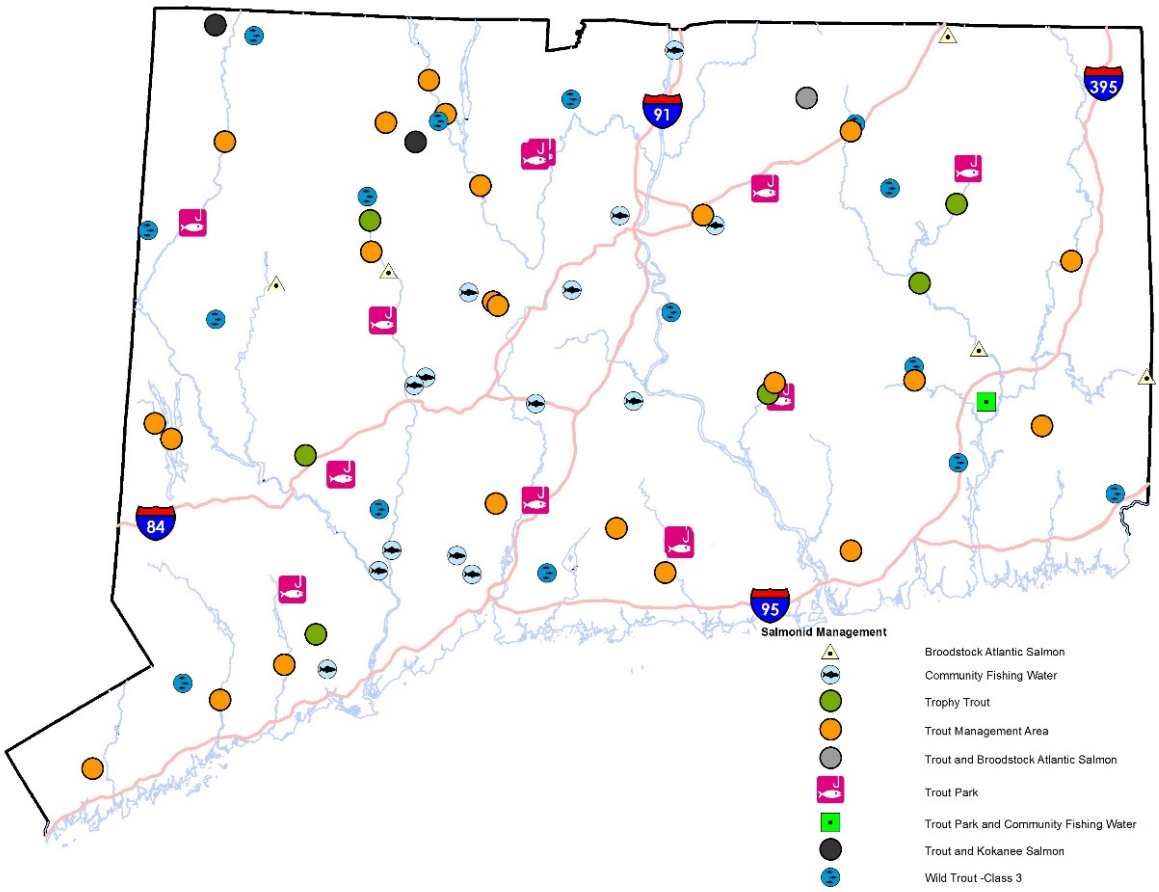

Figure 1. Locations of specialty areas stocked with trout and salmon. Refer to the 2017 Angler's Guide for specific regulations for each area.

The RASTA system was previously developed to assess the current allocations of trout stocked in lakes and ponds, and to help determine future allocations based on quantifiable and "best professional judgment" parameters (see Orciari et al. 2011 for scoring of qualitative factors). A similar assessment was also used by Orciari et al. (2011) to evaluate trout allocations in a handful of Connecticut's rivers and streams, but is currently being refined. Measurable parameters such as length of stream section stocked, and number of stocking points are updated using ArcGIS. Additional parameters such as census information, population density and proximity to other stocked trout resources will be evaluated and incorporated. In addition, stream trout stocking locations throughout the State were evaluated and ranked to assess fishing opportunities and angling access. Stocking sites were evaluated by visiting stocking locations with a team of fish management staff (minimum of 2) and ranking each site under the following categories: 1) Land ownership (public, open space, or private), 2) Stocking Difficulty/Safety (the ease or difficulty of physically carrying/moving nets and buckets of trout,

by staff, from the stocking truck, and safely releasing them into the water). Traffic volume/control, road crossings, bank steepness and substrate, and distance from the parking location to the edge of the stream are taken into consideration), and 3) Public Access for the fishing community (parking availability, approximate number of safe parking locations, proximity of the waterbody to parking, ease or difficulty of accessing the water or shoreline fishing area, ease or difficulty of recognition by anglers, of each individual site, as a publically accessible fishing area, FD signage designating the area for standard or special management, etc.).

Key Findings

Approximately 688,725 catchable-size (>6 inches) trout, 265,750 Brown Trout fry and 138,900 Kokanee Salmon fry were stocked in 2016 (follow the link given in the "Approach" section of this document to the 2016 Fish Distribution Report). The number of catchable trout was 4.9% lower compared to the five year average (2011-2015 average = 724,368). Of the total catchable-size trout stocked, 34% were released into lakes and ponds, and 66% were released into rivers and streams. Size composition for catchable trout was 9.5% yearlings (6-9 inches), 80.3% adults (9-12 inches), 9.7% large-size trout (>12 inches), and <1% specialty trout (i.e. broodstock >16 inches). Species composition was 48.7% Brown Trout, 35.2% Rainbow Trout, 15.4% Brook Trout, and <1% "Tiger" Trout.

Low water/flow conditions at all three state hatcheries were related to an ongoing statewide drought (which began in the fall of 2015) and reduced flow capacity in the well systems. These reduced flow conditions required calculated reductions in the production poundage capabilities and thus, a reduction in the total numbers of trout that the hatcheries were capable of safely producing. This condition precipitated an "emergency stocking" in late fall 2015 where 13 waterbodies (Appendix 1) were stocked with 30,000 adult trout (Brown and Rainbow) to reduce the total biomass at Quinebaug Hatchery. From mid-January through mid-February, a "contingency stocking" (these fish would have normally been stocked out 1-2 months later) of an additional ~ 40,000 adult trout (Brook, Brown, and Rainbow) were stocked into lakes and ponds throughout the State due to the continued low flow conditions from pumped wells at both the Kensington and Quinebaug hatcheries.

In anticipation of Opening Day (OD) 2016, the normal, pre-season trout stocking began on February 22nd in lakes and ponds. All stocking of waterbodies was completed by OD and in-season (after OD) stocking was successfully completed by May 24th. Approximately 59.1% of the 2016 catchable-size trout allotment was stocked during pre-season (January 20th to before OD; 2nd Saturday in April), 33.8% was stocked in-season (OD to end of May), and 7.1% during

late-season (June through early January); excluding fry, a total of ~ 829,000 trout were stocked in 2016. Due to the late fall "emergency stocking" and the earlier than normal "contingency stocking", many waterbodies did not receive their typical in-season allotments. In most cases these locations received allotment numbers similar to other years, however the period or season (pre- vs. in-season) when they were stocked varied by as much as 3-4 months (mid-Jan to mid-April of May). Only one waterbody was not stocked in 2016, Bashan Lake, because the lake had yet to refill after dam repairs made in 2014-2015. Statewide, 22 waterbodies (or sections of waterbodies) were removed from the stocking list due to reduced access, reduced usage, or insufficient stream flows.

During fall 2016, 1,731 broodstock Atlantic Salmon raised at the Kensington State Fish Hatchery (Berlin, CT) were stocked into the following waterbodies: Naugatuck River (366 fish), Shetucket River from the Scotland Dam to Occum Dam (365 fish), Mount Tom Pond (500 fish), and Crystal Lake-Ellington (500 fish). Due to a prolonged drought in Connecticut, more broodstock Atlantic salmon were stocked into lakes rather than the normally stocked rivers. Low streamflow conditions during early fall, coupled with warmer than average water temperatures, required staff to make the decision to stock locations where these fish had a reasonable chance of surviving, as least for several months. Stream conditions improved enough to warrant stocking by mid-October. Also of note was the October stockings of broodstock Brook Trout (avg. weight of 3-5lbs.) into Mohawk Pond and Black Pond, Woodstock; see the Coldwater Lakes Management report (Study 1, Job 6) for more detail. For specific information regarding Brown Trout, Kokanee Salmon fry and Sea-run Trout stocking, see the reports for Wild Trout (F57-R35, Study 1, Job 4), Coldwater Lakes Management (F57-R35, Study 1, Job 6) and Sea-run Trout (F50-D36 Job 4), respectively.

In late December 2016 and early January 2017, the last of Connecticut reared broodstock Seeforellen Brown Trout (avg. weight of 3-5lbs.) were stocked equally into each of Crystal and Highland lakes; 500 total. Due to fiscal constraints, the decision was made in 2016 to discontinue production of the Seeforellen strain from the Kensington Hatchery facility. The plan is to stock the remaining Seeforellen fry (~100,000 total) into rivers and streams during spring 2017 under the direction of the Wild Trout and Stream Monitoring jobs, after which this strain will no longer be available in Connecticut. The State of Maine has received fertilized eggs from Connecticut's Seeforellen strain with the intention of starting a production program. It is the FD's hope that, once the State's fiscal climate improves, the Division might potentially be in a position to re-establish production of the Seeforellen strain, with eggs supplied from the State of Maine.

The annual Fish Distribution Report was completed and was made available to the public in February 2017. This report not only includes the distribution of salmonids, but also includes information regarding the release of other fish species managed by the FD (i.e. Walleye,

Channel Catfish, Northern Pike, clupeids, Sea-run trout, and Kokanee and Atlantic Salmon) throughout the State.

Other noteworthy accomplishments during 2016 included updates to the majority of FD stocking and public stocking maps. Trout stocking coverages in ArcGIS were updated as well. All of these updates were the outcome of the recent stocking site assessments that were conducted in 2014-2015. It was found during this process that there were questions regarding ownership rights for several stocking locations. Research into those locations, where property ownership is in question, will require further property and easement reviews. In addition, work continued to refine and update the stream and lake RASTA protocol by taking a cursory look at OD angler survey data. Analysis of the OD angler survey data is on-going and it is anticipated that this information, collected over the next several years as part of the Stream Angler Survey project (Study 1, Job 2), will begin to help quantify where stocking can be improved for OD anglers and the potential to optimize the use of our hatchery production.

There is growing concern that the FD may be stocking some rivers/streams too early and that an unknown percentage of trout stocked into these waterbodies during the pre-season schedule (prior to OD) might not be available to anglers on OD (and the two week period afterwards, the minimum amount of time before most locations receive a second stocking) due to a variety of possible factors including: 1) fish leaving the system or stocking area, 2) predation, 3) natural mortality, and 4) poaching. Potential factors for fish leaving the system could be related to cold water conditions at the time of stocking, high, early-spring flood/flow events, stream pH, and/or poor trout habitat. Anecdotal evidence (phone contact, comments on fish forums, and the CT DEEP Facebook page https://www.facebook.com/CTFishAndWildlife/) appear to suggest that poor OD catch may be more frequent than in the past. It is recommended that the Connecticut FD develop a protocol for assessing current stocking practices to determine if we are providing the best OD and early-spring fishing opportunities available.

Finally, in 2016 another new hatchery truck was purchased. This truck was purchased using State funded capital improvement monies, and has a higher carrying capacity than the previously used 15 year old truck. The tanks have a greater holding capacity due to their larger size/weight rating, better insulation and use of a bottled oxygen aeration system. The truck was first used during fall 2016, and will be available for use during the spring 2017 stocking season. This new truck will be housed at Kensington State Fish Hatchery.

Discussion

In an effort to assess current allocations and potentially improve trout stocking and angling, the FD continued a detailed evaluation of ways to improve the process and ensure that stocked trout are distributed equitably and are accessible for all of the state's anglers. This year, the majority of public trout stocking maps were updated to address angler concerns and changes in access. Ongoing refinements to the RASTA protocol have been beneficial in improving stocking efficiencies. Results from site evaluations completed in both eastern and western CT in 2014-15 suggest that land ownership has changed substantially along some rivers and streams, especially in the lower counties of western Connecticut, and certain streams in eastern Connecticut. These changes indicate that many of these sites/locations may no longer warrant the stocking of publicly supported resources, such as trout. FD staff needs to research DEEP files for information on permanent angling easements and fishing lease agreements, and review property ownership at many of these locations. This research will help guide future decisions on whether to discontinue stocking at specific sites or in some cases along entire stretches of rivers, and whether to re-allocate stocking numbers within a given river system or to other areas.

Because of the growing concern that the FD may be stocking some streams too early prior to OD, it is recommended that the Connecticut FD develop a protocol(s) for assessing current stocking practices to determine if we are providing the best OD and early spring fishing opportunities available. This assessment could include conducting short term, but intensive angler surveys, marking/tagging fish prior to stocking and electrofishing afterwards to determine stream residency, and potentially radio-telemetry, or some combination of all three. It is also recommended that the FD review relevant literature from other states and countries to determine how other agencies have evaluated their stocking practices and what were the outcomes/management decisions developed from these studies.

Also, preliminary results from OD angler counts suggest that there is a general relationship for both lakes and streams where greater numbers of stocked fish resulted in greater fishing effort. Furthermore, effort appears to be higher in some riverine special management areas such as Trophy Trout Areas. Additional data from subsequent years will be useful in helping to determine trends and improve stocking efficiency. The FD should consolidate and review all pertinent angler data that has been collected in prior years and summarize all trout angler effort, catch, and catch rate data for each waterbody where trout are stocked. This information could be useful when determining if waterbodies are stocked appropriately and will be helpful when assessing and determining allotments for currently stocked areas.

Recommendations

* Review DEEP files to research permanent easements and angler access lease agreements.

* Research property ownership and public access of stocking sites where there is some level of uncertainty.

Brook trout fishing on a quite stream in the northwest corner. Photo submitted by: Timothy Sheffield.

* In selected locations, review past stocking practices along with angler survey information to determine appropriate trout stocking allocations.

* Develop a protocol for evaluating current stocking practices and its overall effectiveness in generating the best possible fishing success.

* Review and evaluate all individual river/stream stocking sites in both eastern and western CT once every five years.

Expenditures

Total Cost:	$53,751
Federal Share:	$40,313
State Share:	$13,438

References

Orciari, R.D., T. Barry, N. Hagstrom, G. Leonard, E. Machowski, C. McDowell, K. Vensel, and J. Bender. 2011. Study 1 Coldwater fisheries management, Job 4 Trout Stocking. Connecticut Department of Environmental Protection, Bureau of Natural Resources, Inland Fisheries Division, Hartford, CT. 50 pp.

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Acknowledgements

Many thanks go to the hatchery staff for their efforts in producing, transporting, and stocking this important product. Additional thanks goes to all DEEP Fisheries permanent staff as well as our Seasonal Resource Assistants, and the many volunteers that assisted with the distribution of the trout.

Appendices

Appendix 1. Waterbodies "emergency" stocked* in late fall 2015.

Waterbody	Town	Number Stocked Fall 2015
Beach Pond	Voluntown	2,500
Black Pond	Middlefield, Meriden	2,500
East Twin Lake	Salisbury	3,000
Gardner Lake	Salem, Bozrah	2,500
Long Pond	N. Stonington, Ledyard	2,500
Mashapaug Lake	Union	2,500
Squantz Pond	New Fairfield	3,000
Stillwater Pond	Torrington	1,000
Tyler Pond	Goshen	1,000
Waumgumbaug Lake (aka Coventry Lake)	Coventry	2,500
West Branch Reservoir	Colebrook	3,000
West Hill Pond	Barkhamsted, New Hartford	3,000
West Side Pond	Goshen	1,000
Total		**30,000**

* The "emergency stocking" occurred in late fall 2015 where 13 waterbodies were stocked with 30,000 adult trout (Brown and Rainbow) to reduce the total biomass at Quinebaug State Fish Hatchery, due to low flow volumes from pumped wells.

Federal Aid in Sport Fish Restoration
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Annual Performance Report

2016-17

Connecticut Fisheries Division

Farmington River Management

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

Grant Title: Inland Fisheries Research and Management
Study 1: Coldwater Fisheries Program
Job 5: Farmington River Management

Period Covered: April 1, 2016 to March 31, 2017

Report Prepared by: Neal Hagstrom

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Date Submitted: June 7, 2017

Approved by: Peter Aarrestad
Director, Fisheries Division

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Cover photo: A yearling size wild Brown Trout from the West Branch Farmington River (photo credit Kierran Broatch).

Summary

This report covers work done during 2016 on the upper 22 miles of the West Branch (WB) and mainstem Farmington River within Connecticut. Currently this stretch is managed with a Year-round Catch &Release (C&R) area along 5.6 miles of river and a Seasonal C&R area for 17.5 miles of river.

Overall, weather conditions and associated flows were not conducive for salmonid survival and growth during 2016. Severe drought conditions that began in the fall of 2015 persisted throughout this year. Flow conditions were extremely low beginning in mid-July (2-3 months earlier than normal) and into the winter. The low inflow volume of the Farmington River (<100 cubic feet per second (cfs)/day), for a significant part of the spring resulted in a rapid drop in the Colebrook Reservoir pool height during June and July. Flows for the WB Farmington River emanate from Colebrook. By August 1st, due to the low pool conditions at Colebrook, only the mandated 50cfs daily minimum flow was released into the WB Farmington River. For the first time, it was necessary to release water from the "Fisheries Pool" in early-August to mitigate high water temperatures in the lower section of the mainstem Farmington River (New Hartford-Unionville) and especially below Collinsville Dam. As the drought conditions continued through the late summer and early fall, alternative flow scenarios needed to be weighed and critical decisions made. After weighing the potential tradeoffs between ensuring adequate winter flows and/or supporting spawning in critical riverine side-braid habitats in the fall, it was determined that there was not enough water in the "Fisheries Pool" to accomplish both alternatives. Releasing increased flows, to flood the spawning areas, even over a short duration, would likely jeopardize the overwinter survival of the river's trout populations. Upstream water releases, during the fall season, from lake draw-downs and some rains within the drainage, provided a small buffer. The slightly increased flows (60-80cfs) allowed for spawning to occur within the main river channel. This is atypical from most years when spawning has been observed primarily in side-braid habitats. Whether this 2016 natural spawning by brown trout in the main river channel was successful will not be determined for 2 years.

Population samples were not conducted in fall 2016 due to the low flows and the desire to minimize any additional stress on the remaining trout population. Broodstock fish were collected for Survivor Brown Trout production. Approximately 62,000 eggs were stripped, fertilized and incubated and will provide the Survivor Brown Trout yearlings for the 2018 stockings and the 2-year old brown trout stocking for 2019.

Background

The Farmington River is a federally designated Wild and Scenic River (14 miles) and regionally recognized trout fishery. Cold, hypolimnetic water releases from Goodwin Dam (Colebrook Reservoir) create a unique tailwater fishery that supports a sizeable trout population throughout the year. In 1988, a Trout Management Area (TMA) was designated for a 1.8 mile section of the river. Year-round catch-and-release trout fishing regulations were instituted to capitalize on this unique fishery resource (Hyatt 1986). Since it's original inception, the TMA has been expanded twice to accommodate angler demand and to reduce congestion (Hagstrom et al. 2005 & 2010). While the trout fishery has historically been supported by hatchery stockings, during the last 15 years, a wild Brown Trout population has become established and continues to increase within the year-round catch-and-release TMA. A major reason for this was the developement of a Survivor Brown Trout program. Annual stocking of different sizes (i.e. year classes) of Survivor Brown Trout has produced excellent fishing and this strain has shown an ability to prosper in the river. The selective use of river captured, "holdover" broodstock appears to have conserved desirable Brown Trout genetic traits that appear to have supported development of, and increases in, the resident wild Brown Trout population.

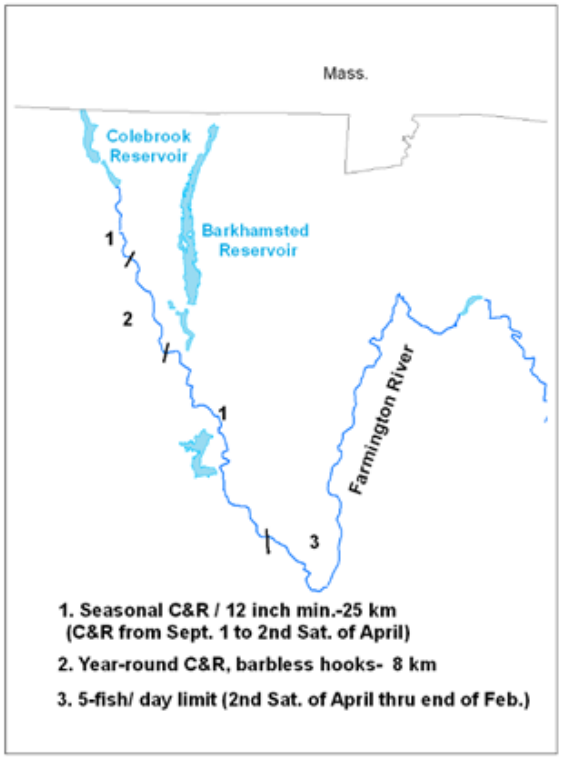


Figure 1 .Regulations that went into effect on the Farmington River in 2012.

In 1994, a Seasonal TMA (catch-and-release regulations in effect for only part of the year) was established in a downstream section of the mainstem river in Avon, Burlington and the Unionville sections of the river. Over the intervening years a variety of trout regulations

Trout population sampling in the Farmington River takes two stream electrofishing crews, several live carts and a tank truck to transport Survivor broodstock back to the hatchery. A full sampling crew can be 16-20 people per day.

have been used to manage different sections of the river including: catch-and-release, length and creel limits, as well as terminal tackle limitations (barbless hooks). Current work has focused on evaluating the effects of recently enacted, streamlined trout fishing regulations in the river above Unionville. The entire 22 miles of the upper river from Goodwin Dam to Rte 177 in Unionville can now be fished year round. This includes the 5.3 mile year-round TMA (Fig. 1- section with regulation #2) where no harvest is permitted.

The focus of this progress report concerns events and sampling that occurred during the 2016-17 study period. A severe drought and unprecedented (since the inception of the TMA's) low-flow conditions inhibited angling and eventually led to a significant late-summer, coldwater fish-kill (re: trout) in the lower Farmington River TMA. Considerable insights were gained in regards to the interrelationships between high air temperatures, water temperatures, and flow augmentation, especially on the lower Farmington River from this unfortunate situation

Approach

Standard trout stockings (numbers, species, sizes) specific to each area of the river were done each spring, summer and fall. Fin clipping and/or elastomer tagging were used to mark and later identify specific groups of stocked trout.

Brood stock collection is conducted in late summer using methods similar to the site-specific, standardized electrofishing protocols (Hagstrom et al. 2010). When broodstock are collected "holdover" Brown Trout that have over-wintered (> 1 year) are preferentially collected to serve as broodstock for the development and maintenance of the Survivor Brown Trout strain (see sidebar on pg.7); fish of wild origin are selected whenever possible. In order to meet minimum egg production numbers, some recently stocked fish (5-6 months survival in the river) may be selectively culled and can also be taken for broodstock when necessary.

Prior surveys conducted during the first week of November (2008-2012) had documented spawning locations under normal flow conditions. In most years spawning had been observed primarily in side-braid habitats. To determine the current spawning activity of trout, under extreme low flow conditions, redd surveys were conducted by Fisheries staff and volunteers on November 4th 2016. The surveys were along fixed lengths of river where previous spawning had been documented.

Key Findings

Flows and water temperatures

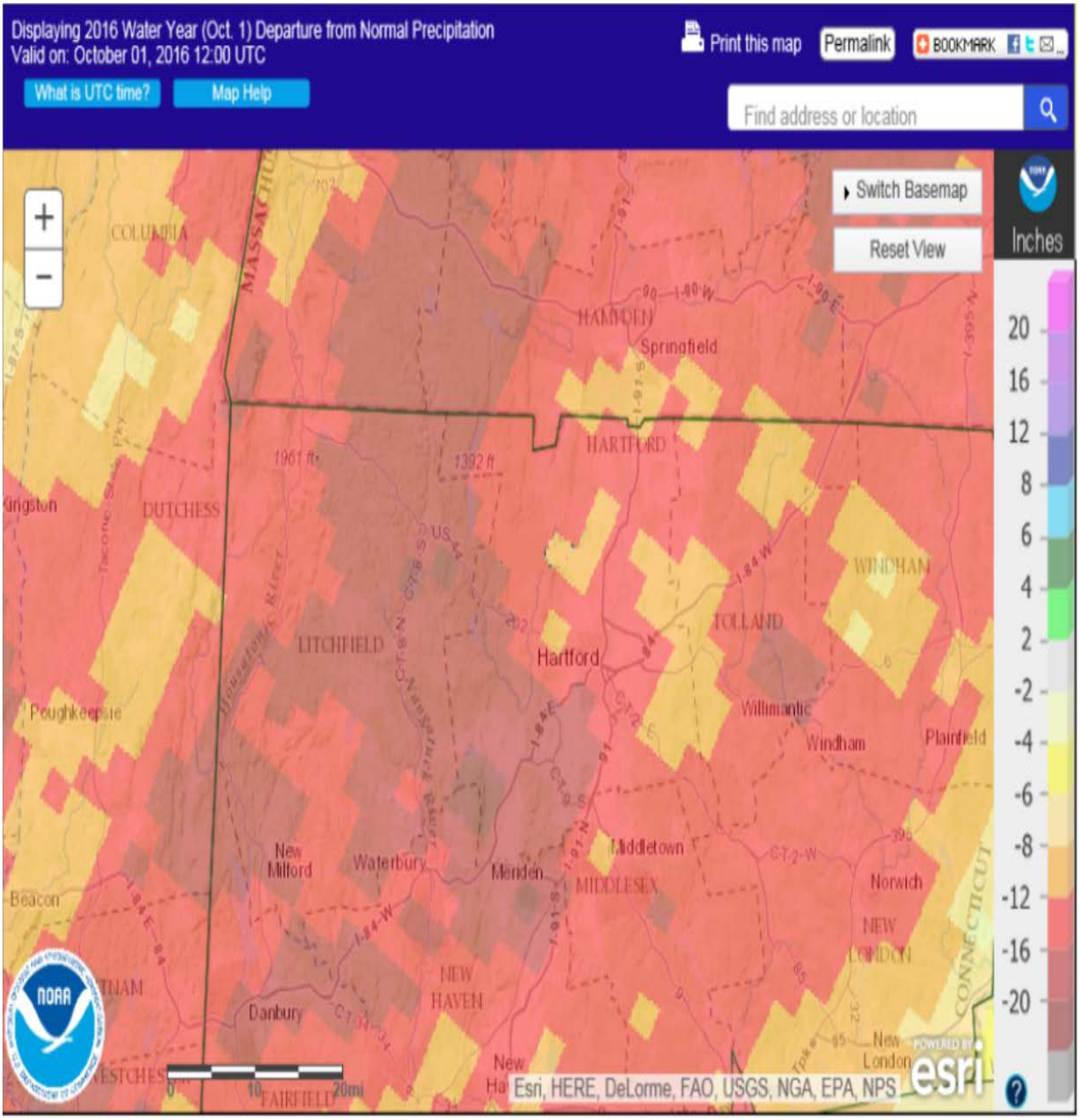
Annual changes in weather patterns can impact salmonid growth, survival and spawning success. The overall effect of weather and flows over the last 6 years is outlined in Table 1. During 2010-2015 conditions ranged from droughts during the spawn to a hurricane which produced 20,000 cubic feet second (cfs) river flows. In 2016, a drought that began in fall 2015 continued through the year. Rainfall deficits for the Farmington Basin exceeded 16-20 inches for most of the basin (Figure 2).

Due to the drought conditions and the resultant lack of inflow, Colebrook Reservoir was drained to record low levels (the standing pool was ~80ft below full levels in October of 2016). This resulted in an agreement between the MDC and the Fisheries Division to initiate a protracted water saving measure, reducing flows to 50cfs in late July (App. 2). This measure also initially necessitated augmenting flows from the Fisheries Pool at a low level (20cfs). In mid-August a period of high air temperatures and high humidity created river water temperatures above the short-term lethal limits of trout (28^{O}C or 80^{O}F). The conditions forced fish to seek thermal refuge out of the mainstem river channel in smaller, cooler stream mouths. This phenomenon was most prevalent in the lower river in the Canton/Burlington/Avon sections of the Farmington River. During this brief heat wave water temperatures as high at 28^{o}C were recorded. In an effort to protect the already highly stressed trout population in the lower river during this high temperature event, additional water/flow (50cfs) was called for from the Fisheries Pool and added to further augment the flows for several days. Thus flows were increased to 100cfs for 3 days and river water temperatures, especially in the lower river were decreased slightly. Eight thermal refuges along the Farmington River from New Hartford to Unionville were closed to Fishing from August 18th to September 15th. Trout mortality due to heat and bird predation were documented in this section of the river during several days of the high heat. By the beginning of September, air temperatures had declined and the fishing closures ended. The drought continued into the fall with scattered rain: September (2 inches), October (2.4 inches) and November (2.7 inches). This is below the normal rainfall amounts that support increased river flows for spawning.

Table 1. Historic overview of weather and flow effects on fishing and trout (White = Average/Red = negative/Green = positive). The darker the color the more intense the impacts were.

Year	Spring	Summer	Fall
2011	Average (100-300cfs)	Average (100-300cfs)	Hurricane Irene –Scour events-(~20,000 cfs)
2012	Ideal fishing conditions early spring-mild winter	Low flows (<100cfs) late summer. Some anglers stopped fishing	Average
2013	Average	Atypical high (>500cfs) early summer flows	Warmer than Average Fall with low flows (<100cfs)
2014	Average	High flows (>600cfs) in May and June made river unfishable. Cool summer temperatures meant a 3 week longer growth period for trout	Warmer than Average Fall with low flows
2105	Average	Ideal fishing; flows conditions-normal to low flows	Warmer than Average Fall with low flows
2016	Good Fishing Conditions- Flow dropped below average in April and May	Ideal Fishing conditions at first, flows dropped in late July to historic low levels. First heat related fish kill documented in the lower Farmington River.	Very low flows continue, many spawning areas dewatered.

Figure 2. ***Rainfall deficit for the Farmington River Valley during Oct 2015 and Oct 2016. Over 20 inches below normal in spots.***



Annual trout population sampling

In past years fish population sampling was typically conducted during the second week of September at fixed standard stations, (see Hagstrom et al. 2012). In 2016 there was concern that extensive sampling might further stress the trout population during these unprecedented low flows. Based on these concerns, standardized sampling was not conducted. Instead abbreviated sampling, to only collect broodstock fish, was done in three locations along the river; Morgan Brook Pool, Halford's Run and the Spring Hole.

Broodstock sampling was successful in collecting 96 sexually mature fish deemed suitable for spawning. Generally 100-120 broodstock are collected, so the 2016 collections were slightly below our normal target. FD had raised the target number of broodstock take to 150 in 2015 to expand the number of eggs and ultimately of Survivor Brown trout available for stocking to other locations. Later in the fall of 2016, approximately 62,000 eggs were taken and will provide the Survivor Brown Trout yearlings for the 2018 stockings and the 2-year old brown trout stocking for 2019.

Flows and trout spawning

As mentioned in previous reports, long-standing water rights (see sidebar in Discussion section, pg. 9) are tied to flow timing, volume and duration for the West Branch Farmington River. As part of these regulated (or statutory) water rights, there is a limited amount of water available in the Fisheries Pool (3.3 billion gals. held in Colebrook Reservoir) to augment flows should the need arise. While this reserved volume of water will allow for some flow augmentation, in most years the Fisheries Div. does not "call for" the allocated Fisheries Pool until October. Due to the extreme drought and low flows

Survivor Brown Trout Program

The concept of the Survivor program is to use fish that survive in the river (both stocked and wild fish) to produce the next generation of fish to be stocked. The rational is that the environment selects the fish with the best adapted genes to survive, and this breeding program conserves and reinforces those genes and characteristics. Since 1993 trout from the Farmington River have been used for Survivor strain broodstock. The eggs from these trout are raised to produce fish for stocking the Trout Management Area. They are stocked two years after the fish are spawned and their eggs taken. The young survivor Brown Trout are marked with a small colored tag called an elastomer tag (see circled area in picture below) in clear tissue behind the eye to distinguish how old they are and when they were stocked. The initial results from this program were a doubling of survival rates of stocked Browns to adult size. These fish survive and "holdover" far better than standard trout produced at our state hatcheries. Survivor trout can be easily identified by their missing/clipped adipose fin (fleshy fin normally located just in front of the tail on the back) and the elastomer tags.

that date needed to begin using water from the Fisheries Pool was advanced by over 2 months in the summer of 2016. In addition, later in 2016, it became evident through flow simulations that there might be further problems. Flow and water storage data from Colebrook indicated that there was not a sufficient volume of water stored in Colebrook Reservoir (re: the Fisheries Pool) to provide for minimal but adequate summer flows and to also allow for a slight flow increase, early in the fall, to cover historic spawning areas (side-braid channels) through the spawning and incubation period. Due to the drought in 2015-2016 a unique situation was presented that indicated there would need to be potential tradeoffs between providing flows that supported the trout population during the end of the summer and through the winter versus slightly increasing flows to ensure adequate conditions to maximize natural spawning. The decision was made to try to prolong minimum flows and protect the existing trout population. This decision did not come without some "costs". It meant that it would not be possible to flood the spawning areas in the fall with water from the Fisheries Pool, unless a significant and dramatic change to the prevailing weather patterns ensued and alleviated or ended the drought conditions. This did not happen.

Aside from the flow issues during the late summer and fall of 2016, there were questions as to the overall condition of the trout in the upper WB Farmington River, especially in terms of the ability of Brown Trout to spawn. Additionally, there were questions regarding whether the Browns would be able to spawn in other areas of the river, given that the preferred areas (side-braid channels) would not be flooded during the fall-winter of 2016-17. While handling fish during the broodstock collections in September, it became apparent that the trout were in suitable physical condition (re: sexually mature) to spawn.

Why DEEP can augment the Farmington River's Flow.

Farmington River flows are the result of a complex set of business and government regulated agreements. The Colebrook Dam was built by the Army Corps of Engineer and MDC and the Goodwin Dam by MDC. The dams are operated for multiple uses: flood control and hydro-electric production at two upstream locations; Colebrook Dam (Colebrook) and Goodwin Dam (Hartland) and further downstream at the Rainbow Dam (Farmington River Power Company, Windsor)

The Water Master at MDC must balance all of these requirements when determining daily releases. As part of this process, a pre-determined limited volume of water (the Fisheries Pool) was designated for use by the DEEP-FD to augment flows when necessary to improve river conditions for fish. The Fisheries Pool was established as mitigation (as allowed for by the Federal Fish and Wildlife Conservation Act) following the construction of Colebrook Dam, a federal action. This is not a large volume of water (3 billion gallons) compared to the total reservoir capacity and is only replenished if the reservoir reaches full pool height in the winter/spring. It is used only when needed such as during drought conditions.

Subsequently, redds surveys were conducted on November 4th, similar to the timing of past surveys done in 2008-2010. Three two-man crews searched sections of river where spawning activity had been observed in the past. The physical/flow condition of the side-braids, where historically the greatest observed spawning activity had occurred, were noted and any new or additional spawning

The rarely seen bridge at the upper end of Colebrook Reservoir-almost dry.

sites recorded (Appendix 4a &4b). On the day of the survey, Brown Trout were observed actively spawning throughout all mainstem river sections surveyed. Redds were located primarily in the main river channel, in areas not previously observed to support successful nest building or spawning. The braided section of the WB Farmington, between the Church Pool and Morgan Brook was the only prior, high use spawning area that was observed to be active, despite this falls low flows (60-75cfs). The remainder of the side braids were totally dry.

It remains to be seen how successful or unsuccessful the 2016 natural spawning in these new spawning locations on WB Farmington River will be. It is likely that given the flows to date that these

redds will result in a successful spawn, but that cannot be confirmed without population sampling in the fall of 2018. The eggs that were placed in these redds are not guaranteed to hatch. Flow modeling indicates that sudden increase in flows of more than 500cfs could negatively affect fry production and would likely result in the main channel redds being scoured. In addition, these new redds locations are in shallower waters than usual and therefore, these areas could be potentially damaged by freezing or anchor ice.

In an attempt to mitigate the effects of the summer mortalities, 8,000 yearling brown trout were stocked into the lower Farmington River in late September and October. These stockings were done after all threat of high water temperatures were past. The yearling-size fish should reach a catchable size by late spring 2017.

Recommendations

- Maintain current trout stockings to support the heavy recreational use of this river.
- Continue annual fall Survivor strain broodstock collections.
- Continue adherence to practices and expand timeframe for egg collection to ensure the genetic diversity of brood stock (both wild and hatchery raised fish) selected for the continuation of the Survivor program.
- Monitor fall flows to ensure adequate spawning condition for wild and holdover Brown Trout and augment flows as needed.
- Based on the numerous years of annual trout population sampling, transition to an alternate year population sampling regime (i.e. every other year).

Expenditures

Total Cost:	$36,880
Federal Share:	$27,660
State Share:	$9,220

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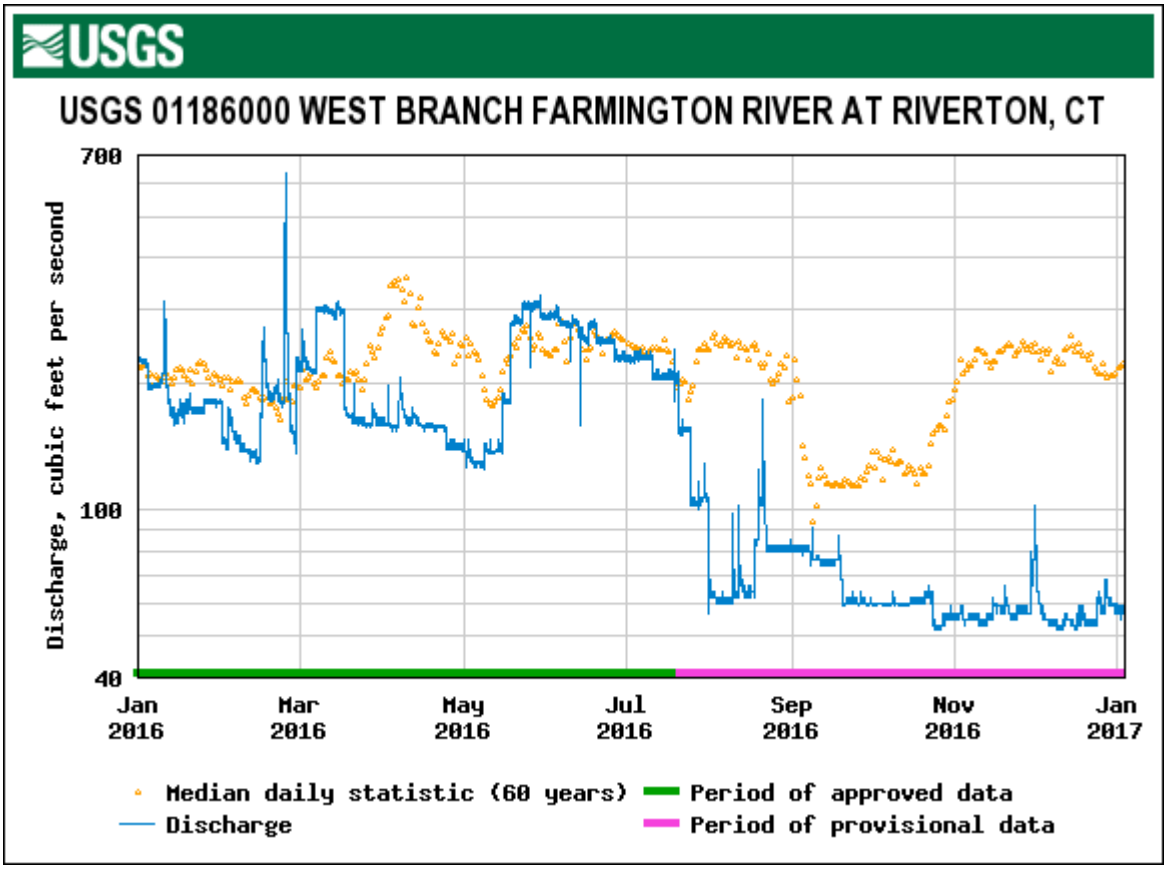
In addition, we would like to acknowledge the exceptional help from the staff of the Burlington State Fish Hatchery who maintained and spawned the brood stock as well as raising the Survivor strain Brown Trout for this project: Rick VanNostrand, Jamie Hayes, Joseph Ravita, Chris Pleil, Steve Piera and Rob Castrogiovanni.

Appendices

Appendix 1. Past and current regulations on the Farmington River with designation of angler survey zones and lengths.

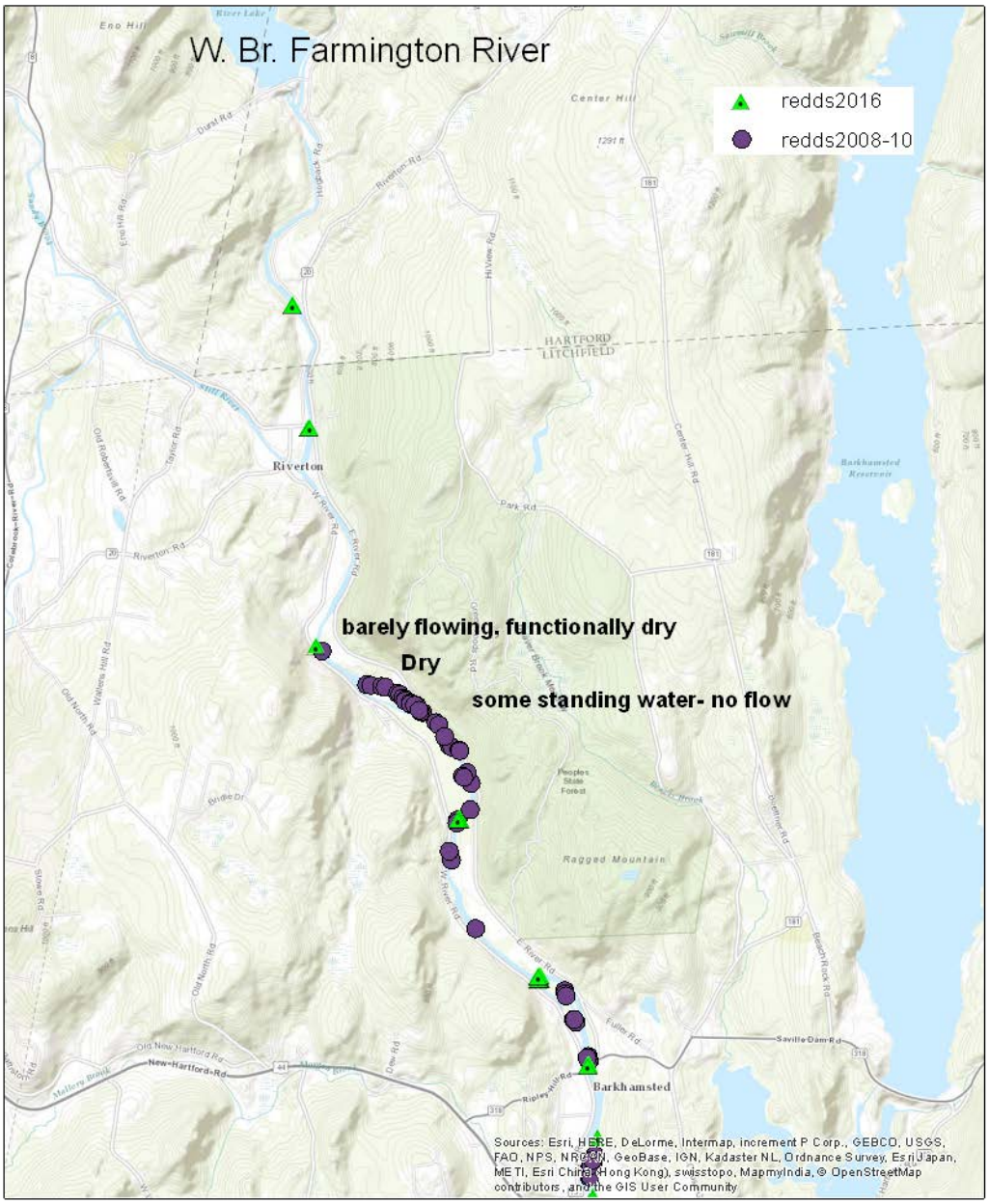
River Section	Angler Survey Zone	Pre 2012 Regulations	Approximate River Miles	New Regulation as of Jan. 2012	Approximate River Miles
Goodwin Dam downstream to the West Branch TMA	Zone 1- 3.6 mile	12"MLL, 2/day	5.8 miles	Seasonal TMA 12"MLL, 2/day 9/1-OD: C&R	3.6 miles
	Zone 2- 2.8 miles			TMA C & R only (Abutments below Whittemore pool to Route 219 Bridge)	5.3 miles
West Branch TMA	Zone 3- 2.5 miles	TMA C & R only (Power line in park to Route 219 Bridge)	3 miles		
Route 219 - Route 44 (Satan's Kingdom)	Zone 4 8.0 miles	12"MLL, 2/day	8 miles	Seasonal TMA 12"MLL, 2/day 9/1-OD: C&R	13.4 miles
Route 44 (Satin's Kingdom) downstream to Lower Collinsville Dam		12"MLL, 2/day			
Lower Collinsville Dam downstream to Route 4 Bridge in Unionville	Zone 5 5.4 miles	Seasonal TMA 12"MLL, 2/day 9/1-OD: C&R	4.3 miles		
Route 4 to Route 177 Bridge		12"MLL, 2/day	1 mile		

Appendix 2. Farmington River flows above the Still River 2016

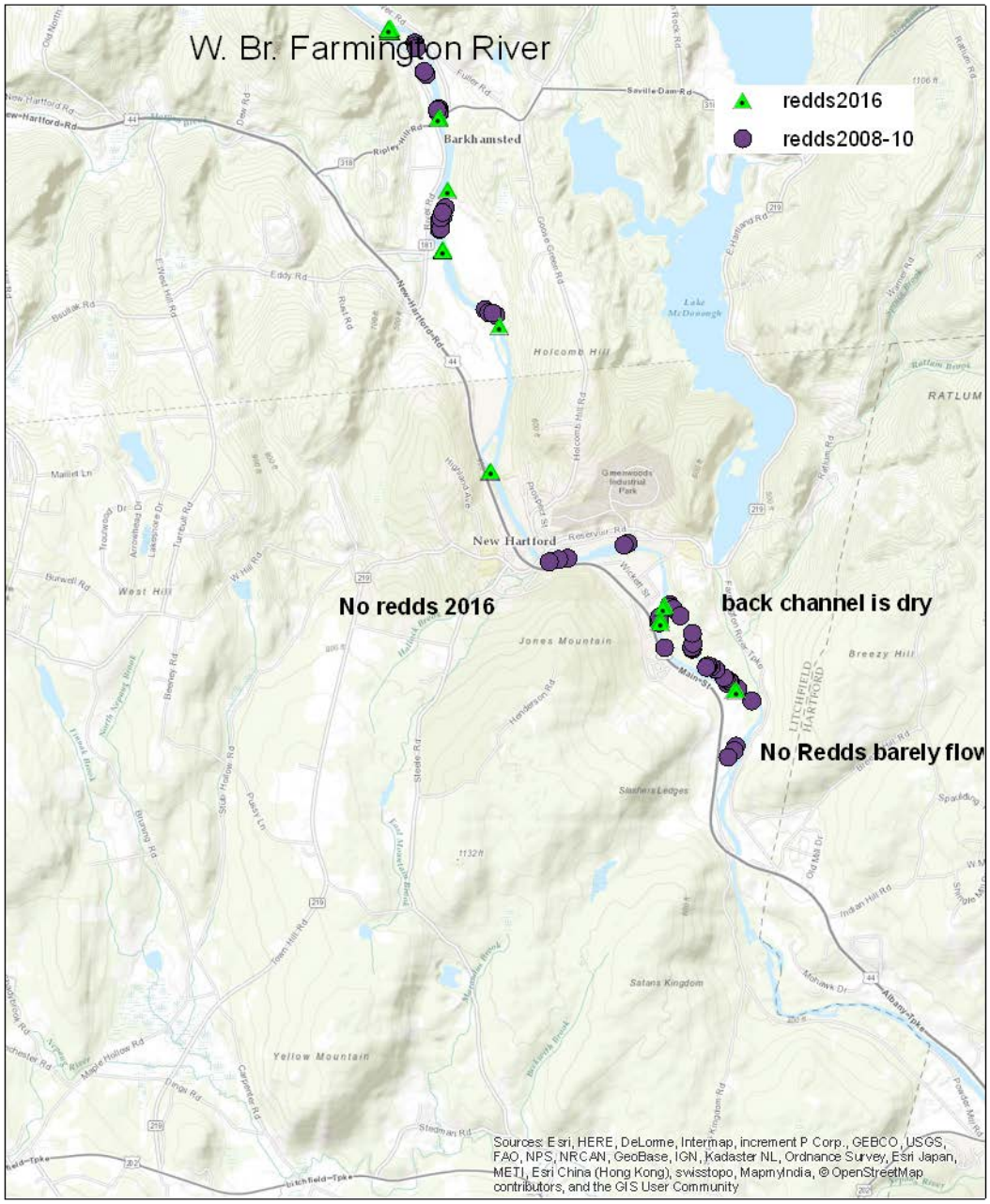


Appendix 3. List of thermal refuges closed to fishing by emergency declaration. No fishing within 100ft of the Posted signs.

1) East Mountain (Hallock) Brook - New Hartford
2) Cherry Brook - Canton
3) Rattlesnake Hill Brook - Canton
4) Burlington Brook - Burlington
5) Hyde Brook - Avon
6) Unionville Brook - Farmington (Unionville)
7) Hawley's Brook - Farmington (Unionville)
8) Pequabuck River - Farmington



Appendix 4a. Trout spawning redds observed in 2016 (Green triangles), past redds are purple circles above the Rte. 318 bridge. Comments in bold refer to conditions inside channels



Appendix 4b. Trout spawning redds observed in 2016 (Green triangles), past redds are purple circles below the Rte. 318 bridge. Comments in bold refer to conditions inside channels

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Bureau of Natural Resources
Fisheries Division

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Cover photos: (Left) Female Kokanee Salmon awaiting spawning at the Burlington State Hatchery, (Right) a deceased Rainbow Smelt specimen collected from a private lake, (Bottom) a spectacular looking male Seeforellen-strain Brown Trout prior to being stocked into Highland Lake.

Summary

During 2016 trout stocking within Connecticut's Trout Management Lakes (TMLs) and other important coldwater lakes went as prescribed by the lake categorization (See 2016 Final Report). A new trout stocking initiative, stocking of large (>16 inch; 3 -5 lbs.) broodstock Brook Trout into Black Pond (Woodstock) and Mohawk Pond (Goshen), was viewed favorably by anglers based on responses received during a winter angler survey at Mohawk Pond. A total of 117,000 Cortland strain yearling Brown Trout were stocked into Lake Wononskopomuc and Saugatuck Reservoir as part of an experimental put-grow-and-take stocking strategy. An estimated 2 million fertilized Rainbow Smelt eggs were collected in a private reservoir and transferred during 2016 to West Hill Pond in hopes of restoring an extirpated population, enhancing the forage base, and increasing angling opportunities in the future. Oxygen/Temperature profiles were obtained at coldwater lakes during the summer of 2016. Kokanee Salmon management followed standard procedures in 2016. Three lakes were stocked during the spring with Kokanee fry, and broodstock were collected from West Hill Pond and East Twin Lake in the fall for spawning at Burlington State Fish Hatchery.

Background

Over the past 30+ years, the Connecticut Department of Energy and Environmental Protection (DEEP), Fisheries Division (FD) has studied various aspects of Brown Trout (*Salmo trutta*) in many of the state's coldwater lakes (for a detailed description of historical management see Eltz and Machowski, 2016 Final Report). During this period, management efforts largely focused on maintaining and enhancing holdover Brown Trout in select lakes through size and timing of trout stocked, and also through fishing regulations (e.g., length limits, slot limits, and season closures) and forage fish assessment (i.e., Landlocked Alewife).

Management efforts worked to produce viable and in some cases, notable fisheries for trophy Brown Trout. Throughout this management history both habitat and biological changes have occurred within our Trout Management Lakes (TMLs). Data collected over the past ten years indicate that conditions in some of Connecticut's coldwater lakes have become less favorable for producing holdover trout (e.g., declines in over summer habitat and loss/fluctuations of forage base). In addition to the physical/biological changes within our TMLs, there have also been alterations in trout production within our state hatchery system which may impact trout lakes management. For example, the Seeforellen Brown Trout strain was brought into Connecticut in 1990, primarily for use it as a coldwater lake management fish due to its growth

potential and longevity. Unfortunately, due to cost-savings measure instituted in early 2016, this strain is no longer produced in our hatchery system.

In 2013 FD biologists developed a classification system (Eltz and Machowski, 2016) based on a lake's current potential for producing holdover Brown Trout and other coldwater fishes (e.g., Kokanee Salmon (*Onchoryncus nerka*) and Rainbow Smelt (*Osmerus mordax*)). Parameters used in the classification system include over summer habitat (i.e. volume of late summer cold, oxygenated water), forage abundance and availability of thermal refugia. This new classification system is now being used as a guideline in determining appropriate stocking and management options for each coldwater lake.

Historically, West Hill Pond supported a robust, holdover Brown Trout fishery until the disappearance of an important forage fish species, Rainbow Smelt in the late 1980's (Eltz and Machowski, 2016). In 2013, FD biologists embarked on a management project to restore Smelt in West Hill Pond. It was anticipated that if successful, this could provide forage for the lakes Brown Trout and also potentially restore a once popular winter fishery for Landlocked Smelt.

Kokanee Salmon have been managed in Connecticut beginning with East Twin Lake in the 1940's. Since then, this landlocked variety of salmon have been introduced in a total of 18 Connecticut lakes in hopes of generating new and unique fisheries. Unfortunately, in most of those lakes, efforts failed to produce fishable populations. Presently Kokanee Salmon are only actively managed in West Hill Pond and East Twin Lake. Lake Wononskopomuc was also actively managed through 2015 with annual stockings, but the continued presence of Landlocked Alewife (another pelagic zooplanktivore and competitor) negated Kokanee management in this lake. Connecticut is currently one of only three states east of the Rocky Mountains that provide Kokanee Salmon fisheries through active stocking and management.

The purpose of Job 7 is to evaluate and manage coldwater fisheries in Connecticut's lakes. This report summarizes work conducted during 2016 at TMLs, and other important lakes that have the potential for supporting coldwater fisheries.

Objectives

- Assess abundance and size distribution of Brown Trout and Alewives in TMLs (e.g., Crystal, East Twin, and Highland lakes), and other important coldwater lakes (e.g. Lake Wononskopomuc, and Saugatuck Reservoir) as time permits.
- Obtain temperature and oxygen profiles on Connecticut's coldwater lakes to monitor potential changes in summer coldwater habitat (the season with the most severe/restrictive habitat conditions for coldwater fisheries resources in Connecticut).
- Investigate options for producing quality trout fisheries in coldwater lakes through stocking manipulation, special regulations, or forage enhancement, and the potential for managing

other lentic coldwater fishes.

- Maintain and manage Kokanee Salmon fisheries in two of Connecticut's best coldwater lakes and continue to explore the potential for management in additional waterbodies.
- Determine the need for continuing or changing special regulations on TMLs.

Approach

- TMLs and selected coldwater lakes (Figure 1) are:
  - Stocked with trout during the spring and fall. Timing, species and size of trout stocked are determined by lake categorization and management potential.
  - Sampled by standard boat electrofishing (pulsed DC) in October or early November to assess holdover trout and Landlocked Alewife abundance (number sampled per hour of standardized electrofishing).
  - Sampled by trap nets in October or early-November to assess holdover trout. Brown Trout population size is estimated using the Schnabel mark-recapture method (Everhart et al. 1975); trout are captured, marked with unique fin clips, and recaptured using only trap nets.
  - Sampled with vertical gill nets (hereafter referred to as a "gang" of gillnets; 5 vertical gillnets each of a different mesh size, varying from 9.5mm to 22.2mm) during the summer to estimate relative abundance (number sampled per day with a standard gang of vertical gill nets) and age structure of Alewife.
  - Sampled with YSI Pro-20 oxygen/temperature meters during mid to late summer to obtain dissolved oxygen (DO) and temperature profiles.
- Enhance coldwater fishing opportunities in TMLs and important coldwater lakes by:
  - Restoring a viable Rainbow Smelt population in West Hill Pond. Fertilized smelt eggs are collected via spawning mats constructed out of PVC pipe or rebar that are wrapped with artificial substrate (Burlap fabric). Mats are placed along the shore and in tributaries of a drinking water supply reservoir that is closed to angling. Eggs that adhere to the artificial substrate are then transferred to West Hill Pond. Materials for the construction of spawning mats are donated by the Northwest Connecticut Sportsman's Council.
- Activities related to the assessment and management of Kokanee Salmon in two coldwater lakes (West Hill Pond and East Twin Lake) (Figure 1) are completed by:
  - Collecting mature kokanee for broodstock each fall (mid-October), prior to spawning, using trap nets at West Hill Pond and if necessary, at East Twin Lake.

- Sampling with trap nets in October to assess the sexually mature component of the Kokanee Salmon populations. Kokanee population size is estimated using the Schnabel mark-recapture method (Everhart et al. 1975); salmon are captured, marked with unique fin clips, and recaptured using only trap nets.
- Manually spawning mature kokanee at Burlington State Fish Hatchery, where the resulting progeny are raised to the small fingerling (2 – 3 inch) stage.
- Stocking 50,000 fingerlings into West Hill Pond, 75,000 into East Twin Lake each spring, and stocking surplus fingerlings into Beach Pond beginning in 2016.

- Roving angler surveys with a stratified random design (Malvestuto et al. 1978) are conducted as time permits in selected lakes (Study 2, Job 2) to determine angler effort, catch, harvest, and satisfaction.
- Summer fish kills in coldwater management lakes, when they occur, are investigated on an as needed basis.

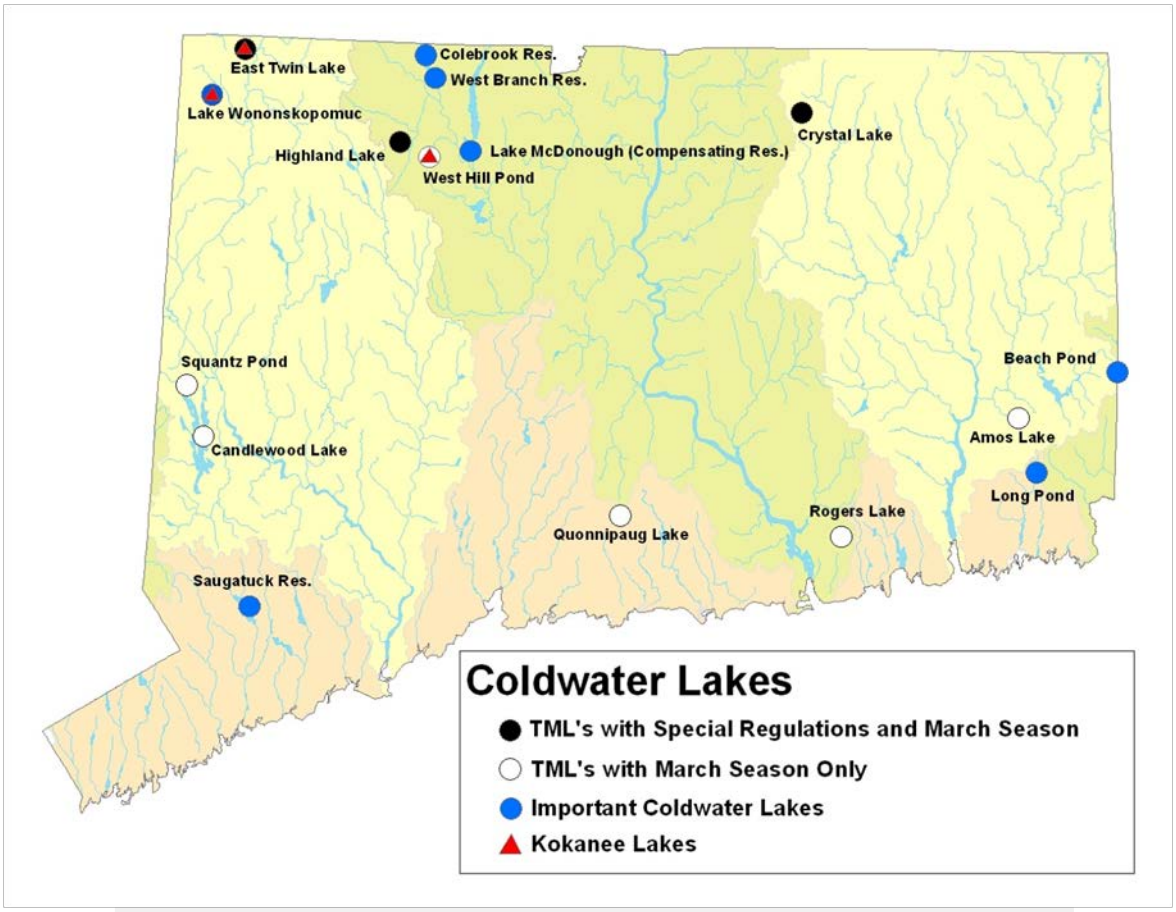

Figure 1. *Location of TMLs, important coldwater lakes, and Kokanee Salmon lakes. Major watersheds are represented by color shading.*

Key Findings

Stocking

- Seeforellen-strain Brown Trout were stocked as yearlings (> 6 in.), large adults (> 12 in.), and broodstock (avg. weight 5 lbs) in 2016 (Appendix 1). This is the final stocking of Seeforellen-strain Brown Trout in Connecticut lakes due to cost-cutting measures and the hopefully temporary elimination of this strain from hatchery production.

The State of Maine accepted 110,000 Seeforellen eggs from our hatchery into their hatchery system. Under an improved future fiscal environment, the Fisheries Division would anticipate re-establishing production of the Seeforellen strain within our hatchery system with eggs supplied back to us from the State of Maine.

- Lake Wononskopomuc and Saugatuck Reservoir received special stockings of Cortland-

strain Brown Trout yearlings (Appendix 1) in the fall of 2016. These lakes were selected to receive these fish as they have the best potential of all the State's coldwater lakes to grow and produce holdover trout.

- As part of a new trout angling initiative, two waterbodies (Black Pond, Woodstock and Mohawk Pond, Goshen) were selected as "Brook Trout Management Lakes." These lakes were chosen based on their suitable habitat, small size, and rural locations, reminiscent of back-country Adirondack or northern New England Brook Trout waters.
    - Both lakes were stocked in late October of 2015 with large surplus broodstock Brook Trout (Black Pond received 180 and Mohawk Pond received 205). These stockings and the "Brook Trout Management Lake" idea were announced on the agency's Fish and Wildlife Facebook page.
    - Additionally, both ponds will be stocked exclusively with Brook Trout beginning in the spring of 2017.

Trout and Forage Fish Sampling

- No TMLs were sampled by electrofishing or trap netting in 2016. Of note, Highland Lake was not sampled as usual due to severe drought conditions coupled with the annual fall drawdown. The combination of conditions would have resulted in an abnormal/inefficient sample (i.e. typical locations (stream mouths and spring seeps) where pre-spawn trout congregate in the fall were non-existent due to the drought) (Appendix 2).
- East Twin Lake was sampled for Alewife using a standard gang set of five vertical gill nets (one overnight set) in August 2016. No Alewife were sampled indicating that they remain absent from the lake (Alewife last sampled in 2010) or at such low levels that they are undetectable by our method of sampling (Appendix 2).
- Lake Wononskopomuc was sampled for Alewife using a gang set of vertical gill nets (two overnight sets with 5 nets) in August of 2016.

Landlocked Alewives collected from Lake Wononskopomuc in summer 2016

- In 2016, Alewife abundance in Lake Wononskopomuc had increased (16/net-day) over the average for the past 5 year period (10.6/net-day; Appendix 2). Based on length frequency of the Alewives captured there appeared to be three distinct year classes, indicating a stable population exists in the lake.

Forage Fish Enhancement in West Hill Pond

- In the spring of 2016, 22 spawning mats (9 large 1.5'X3' and 13 small 1'x1.5') were deployed in two tributaries along the eastern shoreline of a unfished drinking water reservoir in northwest, Connecticut to collect fertilized eggs from spawning Rainbow Smelt. Spawning mats were not placed in the reservoir itself, as had been done the previous 2 years, because of low water levels due to drought conditions.
  - An estimated 2 million eggs were collected and transported to the recipient stream at West Hill Pond. Three spawning mats were destroyed by bears. The eggs were consumed (along with the Burlap substrate!) shortly after the smelt had successfully spawned.
  - Prior to relocating the egg-laden spawning mats in the recipient stream at West Hill Pond, the mouth of the stream was inspected for possible adult smelt spawning activity (this would have been as a result of the egg relocations from the 2014 and/or 2015 year class(es)). Approximately 1 dozen eggs were found on moss covered rocks in the stream mouth indicating that a low level of spawning activity had occurred.
  - The use of Astroturf as an artificial spawning substrate was discontinued in 2016. Visual observations suggested that the smelt utilized the burlap mats more readily than the Astroturf mats in the previous two years.

Photos: (Top) Fisheries seasonal (Frank Beres) placing egg-filled spawning mats in mouth of recipient tributary at West Hill Pond, (Bottom-left) a close-up view of Rainbow Smelt eggs on Burlap fabric spawning mat, (Bottom-right) post-spawn smelt along shore of the donor tributary stream.

Temperature/Oxygen Profiles

- Water temperature and DO measurements taken July through September 2016 show:
  - At Highland Lake the layer of suitable coldwater habitat (≤ 19°C, with ≥ 4 mg/l of DO) deteriorated steadily from July (5 meters thickness) through September (1 meter thickness) (Appendix 3).
  - East Twin Lake, Lake Wononskopomuc, and West Hill Pond showed the greatest volumes and most persistent layer of optimum coldwater habitat throughout the summer (Appendix 3).
- Colebrook and West Branch Reservoirs can be considered flow-through riverine impoundments whereby cool/cold water entering the system via the Farmington River sinks to depths of similar temperature and essentially "pushes" cold water habitat through the system. This allowed both Colebrook Reservoir and West Branch Reservoir to maintain excellent cold/oxygenated water through July, 2016 (Appendix 3). However, this favorable condition most likely deteriorated drastically throughout the remainder of the summer/fall because of severe drought conditions. Because of the drought, water from the reservoirs was drawn from the deeper, oxygenated layers to maintain and enhance low flow conditions in the West Branch Farmington River. Due to the severity of the drought,

Colebrook Reservoir was drawn down to near record low levels by late summer.

Kokanee Salmon Management

- In the spring of 2016, Kokanee Salmon fry produced from the 2015 egg-take were stocked into East Twin Lake, West Hill Pond, and Beach Pond (Appendix 4).
    - Fingerlings (~11,000) surplus to the stocking needs of the other management lakes were stocked into Beach Pond. This was the first year since 1978 that Beach Pond was stocked with Kokanee fingerlings. The lake was chosen because alewives, considered to be a competitor of Kokanee, were still abundant in Lake Wononskopomuc; and conversely, alewife numbers have been steadily decreasing to the point of being undetectable by our sampling methods as of 2016 in Beach Pond.
- In the fall of 2016, 329 mature Kokanee (151 males, avg. length = 19.4 inches; 178 females avg. length = 18.6 inches) were captured in trap nets at West Hill Pond (Appendix 4). Both male and female kokanee combined averaged 19.0 inches which is close to 1.0 inch larger than the next largest recorded broodstock from 2015 at 18.1 inches. All adult Kokanee were brought to Burlington Hatchery to be used as broodstock.
    - This number of adult Kokanee fell short of the 225 male/female spawning pairs target, therefore it was necessary to also set nets at East Twin Lake.
- Trap nets set at East Twin Lake produced 228 mature Kokanee all of which were taken as broodstock. These adult Kokanee were much smaller (151 males, avg. length = 12.8 inches; 77 females, avg. length = 12.2 inches) than those captured at West Hill Pond.
- Of the adult salmon brought to Burlington Hatchery, 244 pairs were spawned to produce ~227,792 eggs of which ~187,855 eyed (82% eye-up; typical range for eye-up = 75 – 85%) for the 2017 fry production cycle (Appendix 4). Due to the large body size of the female kokanee, the number of eggs/female (avg. = 1,867 eggs/female) is the highest ever recorded and much higher than the average over the past ten year period (avg. 2006-2015 = 925 eggs/female; range = 678 – 1,500).
- Kokanee abundance was 10.3 fish/net-day at West Hill Pond (avg. 2006 – 2015 = 43/net-day) and 22.8 fish/net-day at East Twin Lake (avg. 2014 – 2015 = 41/net-day) (Appendix 4). East Twin Lake has only been used to augment numbers of broodstock collected from West Hill Pond twice (2014 and 2015) since the Kokanee population recovered in 2008.

Male Kokanee Salmon netted from West Hill Pond.

Mohawk Pond Creel

- Once safe ice formed (1/14/2016) a winter ice fishing angler survey was conducted on Mohawk Pond to assess catch of the recently stocked Brook Trout and also assess angler attitudes toward the idea of Mohawk Pond becoming a "Brook Trout Management Lake."
    - A total of 51 anglers were interviewed during the abbreviated (39 day; 2015-2016) ice fishing season on Mohawk Pond. Total angler effort expanded to 605 angler hours (AH) of which, 70% (429 AH) was directed toward trout (Appendix 5).
    - Total trout catch during the short ice fishing season at Mohawk Pond was 15 of which 11 were harvested. Out of that total, 7 of the 15 estimated trout caught were Brook Trout and every Brook Trout was harvested (Appendix 6).
    - As part of this angler survey, fishermen were asked their opinion of this lake becoming a "Brook Trout Management Lake." Of the anglers interviewed, 82% were "In Favor" or "Highly In Favor" of this management strategy, while eight percent were "Opposed", and 10 percent had "No Opinion".
- No fish kills were reported at any of the TMLs, or other important coldwater lakes in 2016. This despite the fact that the entire state remained in a severe drought throughout the year.
- Based on the FD Trophy Fish awards program, anglers reported catching 7 trophy Brown Trout from TMLs and important coldwater lakes in 2016.

  Kept:
    - At Crystal Lake, a 7 lb 7 oz., 23.5 inch-long and a 6 lb 2 oz., 24 inch-long Brown Trout
    - At Beach Pond, a 6 lb 4 oz., 23 inch-long Brown Trout.

  Released:

- At Wononskopomuc Lake, an 8 lb 12 oz., 28 inch-long and a 27.5 inch-long Brown Trout.
- At Saugatuck Reservoir, two 24 inch-long Brown Trout.

Discussion

Stocking

The long-term impact on trout management resulting from the loss of the Seeforellen-strain Brown Trout from Connecticut's hatchery system remains unknown. While this strain was never fully assessed and evaluated in our coldwater lakes, anecdotal evidence over the years indicated that this strain consistently produced some of the largest holdover Brown Trout ever grown in Connecticut lakes. Management strategies will now depend on the availability of Cortland-strain Brown Trout which have shown some ability to holdover (Schluntz et al., 1999) and grow in Connecticut lakes. Some information may be gleaned by assessing the Cortland yearlings that were stocked into both Lake Wononskopomuc and Saugatuck Reservoir in the fall of 2016 or spring of 2017. However, this assessment may prove difficult because the yearling trout were not marked prior to stocking.

Surplus broodstock Brook Trout were stocked into the two "Brook Trout Management Lakes" (Black Pond and Mohawk Pond) during fall 2016 but were not assessed. Based on the responses by anglers during the winter creel at Mohawk Pond in 2016, the FD will move toward stocking only Brook Trout in both waterbodies during 2017, in an attempt to create a unique and different trout fishing experience in CT.

Forage Sampling

The success of holdover Brown Trout in Connecticut lakes largely depends on the ability of fish to survive and grow, which is primarily linked to the availability of forage and suitable coldwater habitat. In most Connecticut lakes managed for trout, the primary forage is Landlocked Alewife, whose populations are known to fluctuate considerably from year-to-year. Because Landlocked Alewife population size fluctuates, so too can holdover trout numbers and growth, since predator populations often respond to available forage. Although estimation of Landlocked Alewife population size can be difficult, abundance trend data indicate numbers have increased in Lake Wononskopomuc. Prior to this sample, Landlocked Alewife abundance in the lake appeared to have been declining. While the presence of Alewives has negated management of Kokanee Salmon in this location, the consistent forage base that Landlocked Alewife provides appears to be the key to this lake's ability to support a consistent fishery for large holdover Brown Trout.

Forage Fish Enhancement in West Hill Pond

Historical Trophy Fish Awards information/records show that West Hill Pond frequently produced trophy-sized Brown Trout when Rainbow Smelt were present. As early as 1929, smelt spawned in a West Hill Pond tributary. From the 1970's through the mid-1980's, a large water pump circulated lake water for a short distance upstream into the tributary to augment spring flows and improve access to spawning habitat by Smelt. In addition, a local State Conservation Officer occasionally "trapped and transferred" Rainbow Smelt eggs from other nearby donor populations and transplanted them in the same tributary stream. After pump operations ceased, Rainbow Smelt were extirpated due to diminished flows and the inability of smelt to gain access to suitable spawning habitat. The last Rainbow Smelt was sampled by FD biologists in 1989.

A donor population of Rainbow Smelt from an unfished drinking water reservoir was identified in 2013, and utilized in 2014 - 2016. Over this 3 year period an estimated 12 million+ smelt eggs have been successfully transferred to the recipient tributary at West Hill Pond. Due to manpower constraints we were unable to fully document spawning Smelt at West Hill Pond during the spring of 2016. However, visual observations of the moss covered rocks at the mouth of the tributary stream revealed a small number of Smelt eggs, indicating that smelt from one of the previous years' egg transfers survived, reached sexual maturity and spawned. This is the first time that Smelt have spawned in the tributary of West Hill Pond since the late 1990's. Continued monitoring will be necessary at West Hill Pond to determine if these initial transplants have established a new population at any level. If successful even at low–modest levels, then possible habitat augmentation, to ensure adequate access to more spawning habitat, should be considered to further Smelt re-establishment. It is hoped that a viable smelt population will once again support a previously popular winter ice fishery, and also improve the lake's potential to grow holdover Brown Trout and increase angling opportunities.

Kokanee Salmon Management

Anecdotal angler reports during 2016 indicated that Kokanee Salmon numbers at West Hill Pond may have declined, but the size of the salmon was the largest seen in many years. This observation was confirmed during FD efforts to collect broodstock in the fall of 2016. After a week of netting at West Hill Pond, FD biologists had not collected enough broodstock to reach the target of 225 spawning pairs (ratio = 1 male:1 female). However, the size of the salmon was the largest ever recorded throughout the history of Kokanee management in West Hill Pond. It is possible that fewer salmon in the lake resulted in less intraspecific competition, allowing for increased growth.

Regardless of the shortfall in broodstock from West Hill Pond, the remaining broodstock needed were quickly obtained from East Twin Lake. Since the reestablishment of Kokanee in East Twin in 2008, the population has remained robust, but the size structure of the adult Salmon population has declined over the last two years likely due to the increase in number of Kokanee stocked, which could be causing increased competition for limited forage. Starting in 2013 the number of fry stocked into East Twin was increased from 70,000 to approximately 95,000 annually. Because of this, the FD reduced the fry stocked in 2016 back to 70,000. This practice will continue over the next few years and the size of adult salmon will be monitored for changes. It should be noted that although Landlocked Alewife remain extirpated from East Twin Lake, the lake does have a thriving population of Zebra Mussels (*Dreissena polymorpha*) which could have some competitive interaction with Kokanee, primarily for zooplankton forage.

Mohawk Pond Creel

The angler survey conducted at Mohawk Pond shows that the vast majority of anglers target trout and while only one large (16 inch) Brook Trout was actually measured during the survey, there were anecdotal reports, along with angler photographs and Facebook responses of additional large Brook Trout being caught. In addition, many anglers commented favorably on the new idea of managing the lake just for Brook Trout, and this was supported by the fact that over 80% of the anglers interviewed were in favor of this new initiative.

Recommendations

- Investigate management and stocking options/strategies based on the recent categorization of TMLs and important coldwater lakes.
  - Determine hatchery production targets of “large” Brown Trout (16 inch avg. length) for stocking recommendations to manage certain coldwater lakes with suitable habitat, but little or no holdover potential.
  - Investigate the relationships between trout stocking densities and catch rates in select management lakes and determine if improvements are possible or feasible.
  - Investigate and determine the feasibility of producing a “Survivor” strain of Brown Trout, similar to what has been done for the Farmington River (Hagstrom et al. 2011), and determine if this strain has better potential for use in Connecticut’s coldwater lakes.
  - Investigate the potential of producing or procuring sterile, triploid Brown or Rainbow trout for use in TML management. Triploid trout have higher growth rate potential because they are not expending energy producing gametes, and as such may have greater potential to achieve larger sizes in our TMLs.

- Locate, map, and assess the inflow from thermal refuges in all TMLs and important coldwater lakes.
  - Data demonstrate that Highland Lake's thermal refuges are critical for holdover production. Given possible long-term climactic changes and the potential for further declines in suitable coldwater lake habitat, the FD should evaluate the pros/cons of enacting special regulations that reduce or restrict fishing in the lake's refuges during the critical summer months.
- Begin monitoring (2017) the Rainbow Smelt population in West Hill Pond by gill netting, underwater video recording, and/or visual observation of smelt during the spring spawning run.

A male Kokanee Salmon from West Hill Pond during fall broodstock collection

Expenditures

Total Cost:	$73,760
Federal Share:	$55,320
State Share:	$18,440

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Appendices

Appendix 1. Numbers, sizes, and lakes stocked with Seeforellen-strain Brown Trout in 2016 and early 2017. Special stockings of Brook Trout (BK) into Mohawk Pond and Black Pond (Woodstock), and Cortland-strain Brown Trout yearlings into Lake Wononskopomuc and Saugatuck Reservoir are indicated.

Lake	Special Stockings	Seeforellen-strain Brown Trout Stocked		
		> 6 inches	> 12 inches	> 16 inches
Beach Pond		0	0	0
Crystal Lake		0	400	535
East Twin Lake		0	100	0
Highland Lake		0	400	505
Lake Wononskopomuc	35,000 Cortland Yrlng	1,000	0	0
Long Pond		0	100	0
Mohawk Pond	205 BK SBS[a]	0	0	0
Black Pond (Woodstock)	180 BK SBS[a]	0	0	0
Saugatuck Reservoir	82,000 Cortland Yearling	8,850	0	0
Squantz Pond		0	0	0
West Hill Pond		0	0	0
Total		9,850	1,000	1,040

[a]SBS denotes Surplus Broodstock

Appendix 2. Relative abundance of Brown Trout (number sampled per hour of standardized electrofishing) and Alewife (number sampled per day with a standard gang of 5 vertical gill nets, and per hour standardized electrofishing) in 2016. Dashes indicate no sampling occurred. [1]Net-days (shown in parentheses) equal the number of nets set in the lake times the number of days (24 hr period) the nets fished.

Lake	Brown Trout			Alewife	
	No. per electro-hr			No. per electro-hr	No. per net-day (no. net-days)[1]
	<12 inches	12-16 inches	>16 inches	All sizes	All sizes
Crystal Lake	--	--	--	--	--
Highland Lake	--	--	--	--	--
East Twin Lake	--	--	--	--	0 (5)
Lake Wononskopomuc	--	--	--	--	16 (10)

Appendix 3. Layer of optimum cold, oxygenated Brown Trout water (≤ 19°C, with DO levels ≥ 4 mg/l) and depths where they were observed for selected coldwater lakes sampled in the summer of 2016. Zeros indicate no optimum coldwater layer was detected.

Lake	Sample Date	Layer of cold oxygenated water (m)	Upper limit of cold oxygenated water (m)	Lower limit of cold oxygenated water (m)
Trout Management Lakes				
Crystal Lake	8/9/2016	2	6.5	8.5
East Twin Lake	8/16/2016	7	7.5	14.5
Highland Lake	7/28/2016	5	5.5	10.5
Highland Lake	8/12/2016	3	6.5	9.5
Highland Lake	9/8/2016	1	7.5	8.5
Other Coldwater Lakes				
Lake Wononskopomuc	8/16/2016	7	6.5	13.5
Mohawk Pond	8/11/2016	0	--	--
Colebrook Res.	7/22/2016	14	10.5	24.5
West Branch Res.	7/22/2016	22	2.5	24.5
Squantz Pond	8/23/2016	0	--	--
West Hill Pond	8/12/2016	5	6.5	11.5

Appendix 4. Numbers and locations of Kokanee fry stocked, numbers and relative abundance of Kokanee captured during trap netting efforts, and number of eggs taken for spawning in 2016. Dashes indicate no netting occurred

Lake	Number of Kokanee fry stocked	Number of Kokanee trap netted (broodstock)[1]	Number of Kokanee per net-day (no. net-days)[2]	Number of eggs taken[3]
East Twin Lake	76,000	228 (228)	22.8 (10)	0
West Hill Pond	51,000	329 (329)	10.3 (32)	227,792
Beach Pond	11,000	--	--	--

[1] Numbers in parentheses indicate the number of mature fish captured in trap nets that were taken as broodstock to Burlington Hatchery for spawning.

[2] Net-days (shown in parentheses) equal the number of nets set in the lake times the number of days nets were set.

[3] Total number of eggs taken were a mix of both West Hill and East Twin Kokanee adult.

Appendix 5. Estimated **total angler effort** (angler-hrs) at Mohawk Pond during the 2015 - 2016 ice fishing season. The ± 95% confidence limits (**CL**) around effort estimates are shown in parentheses. Estimated **Directed effort (DE)** (angler-hrs) for Brook Trout and Other fish at Mohawk Pond during the 2015 - 2016 ice fishing season. The percent of Total Effort is shown in parentheses. "Trout" directed effort includes only effort targeting trout species.

Lake	Dates	Total Days	Total Angler Effort (CL)	Trout (DE)	Other (DE)
Mohawk P.	1/14/16 - 2/28/16	39	605 (62%)	427 (70%)	178 (30%)

Appendix 6. Estimated **total catch and harvest** (All Trout and Brook Trout) at Mohawk Pond during 2015 – 2016 ice fishing season. The ± 95% confidence limits (**CL**) around catch and harvest estimates are shown in parentheses.

Mohawk Pond	Dates	Safe Ice Days	Catch (CL)	Harvest (CL)
All Trout	1/14/16 - 2/28/16	39	15 (22%)	11 (29%)
Brook Trout	" "	" "	7 (221%)	7 (221%)

Federal Aid in Sport Fish Restoration
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Annual Performance Report

2016-17

Connecticut Fisheries Division

- Monitoring Warmwater Fish Populations in Lakes and Large Rivers
- Bass Research and Management

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

Grant Title: Inland Fisheries Research and Management
Study 2: Warmwater Fisheries Program
Project: Warmwater Fisheries Monitoring
Job 1: Monitoring Warmwater Fish Populations in Lakes and Large Rivers
Job 3: Bass Research and Management
Job 4: Bass Supplemental Stocking Study - Not Active

Period Covered: April 1, 2016 to March 31, 2017

Report Prepared by: Eileen O'Donnell

Job Personnel: Eileen O'Donnell, Co-Job Leader/Project Leader
Gerald Leonard, Co-Job Leader
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Robert Jacobs, Program Coordinator
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Date Submitted: September 4, 2017

Approved by: Peter Aarrestad
Director, Fisheries Division

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Chief, Bureau of Natural Resources

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Cover photo: Lake Waramaug, Warren CT. DEEP file photo.

Summary

Boat electrofishing fish surveys were conducted at 46 sites during the spring and fall of 2016. Data were collected from six bass tournaments at Lake Zoar between May and August 2016. Tournament angler catch rate of bass was 0.35 bass/hr. Twelve Bass Management lakes were sampled during the spring and fall of 2016. The Bass Supplemental Stocking Study was completed in 2015. Seven unfished reservoirs were sampled in 2016 to improve our estimate of the numbers of fish available for a potential program of stocking bass from water supply reservoirs into public waters.

Background

The Connecticut Department of Energy and Environmental Protection Fisheries Division (FD) has regularly monitored fish populations among the state's important lakes and large rivers since 1988 via night boat electrofishing. Lakes are dynamic systems that are subject to both natural variations as well as anthropogenic influences (e.g. winter drawdowns, chemical herbicide applications, dredging, invasive species, changes in angler pressure, and climate change). Maintaining current fish population data is therefore vital for fishery biologists to make informed management decisions. Through this job, Connecticut's special management lakes (Bass, Walleye, Channel Catfish and Northern Pike) are sampled to assess potential changes in fish populations. Additionally, a variety of waterbodies are also sampled on a regular rotational basis to document overarching statewide trends among Connecticut's freshwater fish populations.

Largemouth and Smallmouth Bass combined are Connecticut's most popular gamefish (U.S. Fish and Wildlife Service 2011). In addition to their recreational importance, bass are the principal predatory fish in nearly all of the state's lakes and ponds and thus play a key role in maintaining predator-prey balance in complex fish communities. In recent decades, interest in bass fishing and the sophistication of bass angling techniques have increased as have the popularity of competitive bass tournaments. These tournaments offer biologists an opportunity to efficiently monitor angler catch rates of bass in Connecticut's Bass lakes.

Much of bass management in Connecticut over the last 30 years has focused on reducing harvest by restricting the sizes and numbers of bass that anglers may take. Recent evidence has indicated that vulnerability to angling is a genetically heritable trait (Phillips et al. 2009). It was hypothesized that decades of angling and harvest has reduced the genetic diversity of bass populations due to anglers removing bolder bass from fished populations. This phenomenon is referred to as fisheries induced evolution (FIE) (Law 2007).

Connecticut is unique in that most public water supply reservoirs are closed to angling and; therefore, their bass populations are free from the effects of FIE. A cooperative study between the University of Connecticut and the DEEP-FD "Bass Supplemental Stocking Study" was launched in 2011 to investigate the potential utility of stocking bass from unfished reservoir to improve bass fishing in Connecticut public lakes. This research revealed several key findings. Among them were that Largemouth Bass from unfished reservoirs had significantly higher resting metabolisms (a corollary of boldness in bass; Cooke et al. 2007, Hessenauer et al. 2015), that adult bass transferred from an unfished reservoir to a public lake increased angler catch rates during the spring angling season, and that transplanted bass successfully spawned and bred with resident bass in a public lake (Hessenauer 2015, Davis and O'Donnell 2016). This study concluded that supplemental stocking of reservoir bass into public lakes may have potential in mitigating the effects of FIE on heavily-fished bass populations.

The purpose of this report is to summarize the work performed during the period April 1, 2016 through March 31, 2017.

Note: The Connecticut DEEP Inland and Marine Fisheries Divisions were merged into a single Fisheries Division in January 2017. Although the majority of the work for this report was conducted while we were still Inland Fisheries, the new designation has been incorporated herein.

Approach

Warmwater fish are sampled in selected lakes by standard night boat electrofishing from late-April to the first week of June, and from the last week of September to the first week of November. All fish species sampled are identified and measured, and scales are taken from a subsample of important species for age-and-growth analyses (see Jacobs et al. 2011 for detailed methods).

Bass tournament weigh-ins are monitored on selected waterbodies between April and October. All bass brought to the weigh-in are identified to species, measured to the nearest cm and released. Anglers are also asked how many bass greater than 12 inches they released during their day's fishing (referred to as "culled" fish). The number of anglers and duration of fishing are recorded to determine angler effort (the total number of hours expended by all anglers, expressed as "angler-hrs"). Catch rates (# fish caught/angling hrs) are calculated using weighed-in bass only as well as weighed in plus reportedly released bass.

Key Findings

Monitoring Warmwater Fish Populations in Lakes and Large Rivers

Statewide Electrofishing

The FD sampled 46 sites via boat electrofishing during the spring and fall of 2016 (Figure 1 and Appendices 1a and 1b). Among the sites sampled were seven unfished water supply reservoirs, three of which had not been sampled previously; two private lakes; 19 special management lakes (for Bass, Walleye, Northern Pike or Channel Catfish); and the remaining sites were important Connecticut lakes and the Connecticut River that had not been recently sampled. All data were entered into the Statewide Lake and Pond Survey Database. Species and catch rates (electrofishing catch/hr) for all lakes, ponds and large rivers sampled by the FD between the 1980s and 2016 can be found here on our website:

http://www.ct.gov/deep/lib/deep/fishing/fisheries_management/Statewide_Lake_and_Large_River_Electrofishing_Survey.pdf

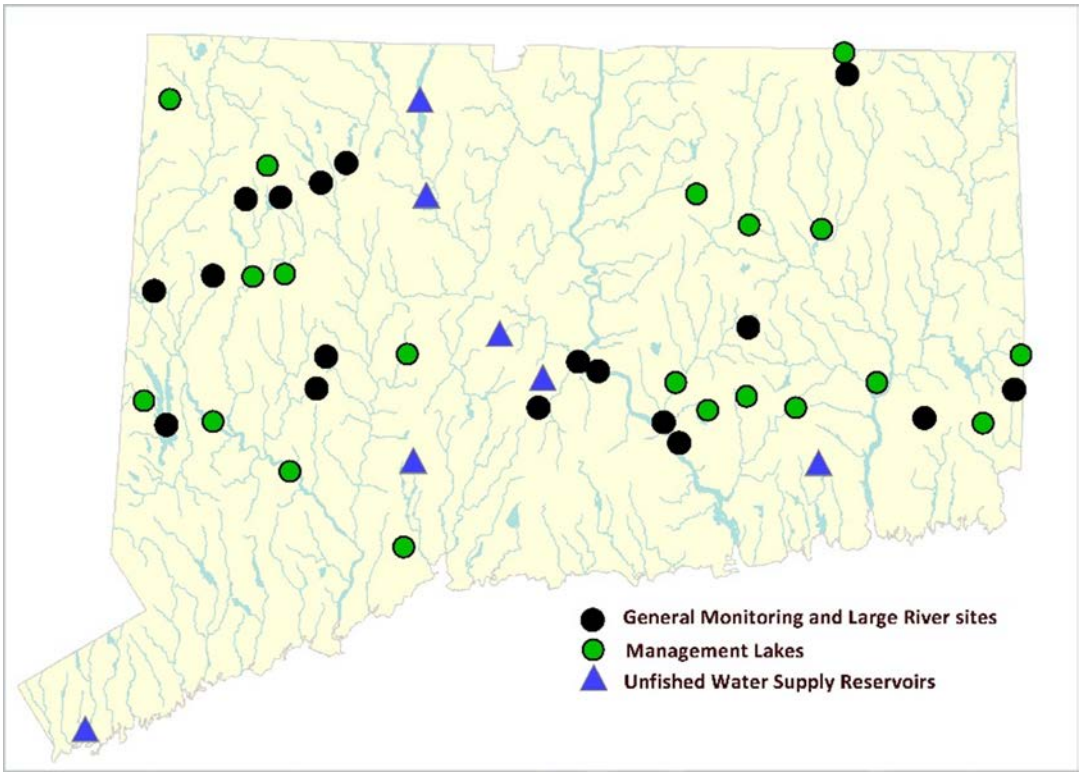

Figure 1. *Electrofishing sites sampled in the spring or fall of 2016.*

Some notable observations are:

1. Severe drought conditions extended well into the fall of 2016 limiting access to several small lakes which were due to be sampled.
2. The Tench population at Bantam Lake appears to be abundant but has stabilized. Over the last three electrofishing samples (2013, 2014 and 2016), catch rates of Tench were 65, 45 and 53 fish/hr, respectively. They appear to be much less common in Lake Winnemaug, the source of Bantam Lake's Tench population, where only one fish was sampled in 2016.
3. The Bowfin population in the Connecticut River continues to increase and expand.
4. As a result of the drought and continued low water levels in the Connecticut River during 2016, aquatic macrophytes were able to colonize shallow areas of the river that previously had been barren. As a result more warmwater fish species were sampled in the mainstem of the river than in previous years.

The seven unfished water supply reservoirs were sampled for two reasons:

1. They serve as "controls" for monitoring statewide trends in fish populations. For example, if similar trends are observed among public waterbodies and waters closed to fishing, we know that fishing is not the cause.
2. To determine the efficacy of a program of stocking bass from unfished reservoirs into public lakes, we must first have a reasonable estimate of the potential numbers of fish available for such a program among the larger water supply reservoirs.

Bass Tournaments

Six bass tournaments were monitored at Lake Zoar between May and August, 2016. Tournaments ranged from 11 to 46 anglers (average 24). Four tournaments operated under a 5-bass per boat rule (5/boat) and two under a 5-bass per angler rule (5/angler) (Table 1). Fishing under the 5/boat rule limits the number of bass that can be weighed-in by a team and results in both lower catch rates of weighed-in bass and higher culling rates (O'Donnell and Leonard 2016). Not surprisingly, the catch rate of weighed-in bass was 13% lower for the 5/boat tournaments and the percent of bass culled at the 5/boat tournaments was 27% vs. 13% at the 5/angler tournaments. When culling was accounted for (+Released row in Table 1), the catch rates between the two tournament types were similar (0.34 vs. 0.35/hr).

Tournaments were last sampled at Lake Zoar in 2004 when the catch rate of weighed-in bass was 0.28/hr (Appendix 2). This was before FD adopted a new protocol discriminating between tournament types (5 bass/boat or 5 bass/angler) as well as recording culled bass. When both types of tournaments in 2016 are combined, the catch rate for weighed-in fish is equal to that measured in 2004 (0.28/hr).

Table 1. Tournament summary data for Largemouth (LM) and Smallmouth (SM) Bass from Lake Zoar in 2016. In the column labeled "Method", "Weighed-in" indicates catch rates of only those bass brought to weigh-ins, "+Released" indicates catch rates of weighed-in bass plus those of bass ≥30 cm reportedly released by the anglers. "Combined" is the catch rate of Largemouth and Smallmouth Bass combined.

Lake Zoar Tournament Type	No. of Tourns.	Angler -hrs	Method	Bass Catch Rate LM Bass/Hr	SM Bass/Hr	Combined
5-bass per angler	2	368	**Weighed-in**	0.19	0.11	0.30
			+Released	**0.23**	**0.11**	**0.34**
5-bass per boat	4	734	**Weighed-in**	0.14	0.12	0.26
			+Released	**0.19**	**0.16**	**0.35**

Bass Research and Management

A total of 12 Bass Management Lakes were sampled via night boat electrofishing during 2016 (Appendix 1b). Catch rates fluctuated among lakes generally within normal expectations. Catch rates for Bass Management Lakes as well as all sites sampled in 2016 are on the DEEP Fisheries website:

http://www.ct.gov/deep/lib/deep/fishing/fisheries_management/Statewide_Lake_and_Large_River_Electrofishing_Survey.pdf

Bass Supplemental Stocking Study

The Bass Supplemental Stocking Study concluded in 2015 (Hessenauer et al. 2015; Davis and O'Donnell 2016). The study produced a number of findings that will assist in guiding future bass management in Connecticut; among these were the findings that transplantation of adult bass from unfished reservoirs to public lakes a) produced a substantial short-term enhancement of bass fisheries, and b) had the potential to enhance the genetic makeup of bass populations. Accordingly, the study recommended assessing the potential of regularly transplanting reservoir bass to selected public lakes. A necessary pre-requisite for such a program is determination of the number of unfished reservoirs in the State that support substantial bass populations. Sampling the seven water supply reservoirs in 2016 was in part conducted to facilitate this inventory (see website link above for results of these samples). In addition to guiding development of a possible reservoir bass stocking initiative, these samples provided

data that are valuable to the FD statewide lake monitoring program (fish communities in unfished lakes provide an important comparative benchmark for those in public lakes). FD should continue to sample unfished reservoirs in the coming years as resources permit.

Expenditures

Job 1. Monitoring Warmwater Fish Populations in Lakes and Large Rivers

Total Cost:	111,887
Federal Share:	83,916
State Share:	27,972

Job 3. Bass Research and Management

Total Cost:	90,937
Federal Share:	68,203
State Share:	22,734

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Appendix 1a. **General monitoring sites** sampled by the FD using boat electrofishing gear during 2016.[1]

Lake	Town	Date(s) Sampled (month/day)	Comments
General Monitoring			
Amston L.	Hebron/Lebanon	10/5/16	Stocked in 2015 by Lake Association with Channel Catfish and Largemouth Bass
Avery P.	Preston	11/2/16	
Barkhamsted Res.	Barkhamsted	5/17/16	Unfished water supply reservoir
Bethany L.	Bethany	5/24/16	Unfished water supply reservoir
Beseck L.	Middlefield	10/12/16	Post deep lake drawdown
Bigelow P.	Union	11/3	
Burr P.	Torrington	10/12	
Candlewood L.	Brookfield/Danbury/New Fairfield/New Milford/Sherman	5/31	Grass carp stocking
Dog P.	Goshen	11/1	
Green Falls Res.	Voluntown	10/26	Banded sunfish site
Hatch P.	Kent	10/18	
Konomuc Res.	Waterford	10/17	Unfished water supply reservoir
Mianus Res.	Greenwich	5/2	Unfished water supply reservoir
Mohawk P.	Cornwall/Goshen	10/20	
Mt. Higby Res.	Middletown	4/25	Unfished water supply reservoir
Nepaug Res.	Burlington/Canton/New Hartford	5/23	Unfished water supply reservoir
Quassapaug L.	Middlebury	5/5	
Shuttle Meadow Res.	Southington	5/18	Unfished water supply reservoir
Stillwater Res.	Torrington	10/3	
Waramaug L.	Warren/Washington	4/27	
Winnemaug L.	Watertown	10/17	Tench site
Connecticut River Sites			
Mainstem Central	Middletown/Portland	10/18	
Mainstem South	East Haddam	10/4	
Mattabassett River	Middletown	10/18	
Salmon River Cove	East Haddam	10/4	
Connecticut Yankee Channel	East Haddam	10/4	

[1] Species and catch rates (electrofishing catch/hr) for all lakes, ponds and large rivers sampled by the FD between the 1980s and 2014 can be found here on our website:

http://www.ct.gov/deep/lib/deep/fishing/fisheries_management/Statewide_Lake_and_Large_River_Electrofishing_Survey.pdf

Appendix

Appendix 2b. Special Management Lakes sampled by the FD using boat electrofishing gear during 2016.[1]

Lake	Town	Date(s) Sampled (month/day)	Comments
Bantam L.	Litchfield/Morris	4/25	Northern Pike, Tench site
Beach P.	Voluntown	5/26	Walleye
Bolton L. (Middle)	Bolton/Vernon	10/11	Bass
Coventry L.	Coventry	4/12 & 5/10	Bass/Walleye
Gardner L.	Bozrah/Montville/Salem	4/13, 5/4, 5/18, 5/31	Bass/Walleye
Hayward L.	East Haddam	10/19	Bass
Lillinonah L.	Bridgewater, Brookfield, New Milford, Newtown, Roxbury, Southbury	5/26	Northern Pike
Maltby L. #2	West Haven	5/2	Bass/Catfish
Mansfield Hollow Res.	Mansfield/Windham	4/27	Bass
Mashapaug L.	Union	5/25	Bass/Walleye
Mohegan P.	Norwich	4/26, 5/11, 5/16	Bass/Catfish
Moodus Res.	East Haddam	10/25	Bass
Mt. Tom P.	Litchfield/Morris/Washington	4/13	Walleye
Pickerel L.	Colchester/East Haddam	10/24	Bass
Scoville Res.	Wolcott	10/31	Catfish
Squantz P.	New Fairfield/Sherman	5/9	Walleye/Pre-Grass Carp Introduction
West Side P.	Goshen	10/24	Bass
Wononscopomuc L.	Salisbury	5/11	Bass
Wyassup L.	North Stonington	6/1	Bass
Zoar L.	Monroe/Newtown/Oxford/ Southbury	5/16	Walleye

[1] Species and catch rates (electrofishing catch/hr) for all lakes, ponds and large rivers sampled by the FD between the 1980s and 2014 can be found here on our website:

http://www.ct.gov/deep/lib/deep/fishing/fisheries_management/Statewide_Lake_and_Large_River_Electrofishing_Survey.pdf

Appendix 2. Bass tournament summary data from Lake Zoar from 1985 to 2004.

Lake	Year	No. Tourns.	No. Angs.	Angler -hrs	Bass/Hour LM	Bass/Hour SM	Bass/Hr Comb.
Zoar	1985	2	100	703	0.12	0.01	0.13
	1986	3	157	1,096	0.12	0.04	0.16
	1987	3	123	858	0.20	0.04	0.24
	1991	4	200	1,401	0.10	0.04	0.14
	2004	4	115	800	0.19	0.09	0.28

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Connecticut Fisheries Division

Lake and Large River Angler Surveys

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

Grant Title: Inland Fisheries Research and Management
Study 2: Warmwater Fisheries Management Job 2: Lake and Large River Angler Surveys

Period Covered: April 1, 2016 to March 31, 2017

Report Prepared by: Christopher McDowell & Brian Eltz

Job Personnel: Justin Davis, Co-Job Leader
Gerald Leonard, Co-Job Leader
Brian Eltz, Primary Staff
Christopher McDowell, Primary Staff
Eileen O'Donnell, Project Leader
Robert Jacobs, Program Coordinator
Tim Barry, Assistant Program Coordinator

Date Submitted: September 4, 2017

Approved by: Peter Aarrestad
Director, Fisheries Division

William Hyatt
Chief, Bureau of Natural Resources

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Cover photo: Cassie Ganio with a Largemouth Bass caught on the Bantam River in Torrington, CT. Photo by Christian Anderson.

Summary

The Connecticut Department of Energy and Environmental Protection Fisheries Division (FD) conducted angler surveys on seven Connecticut lakes during 2016-17: Mohawk Pond, Mount Tom Pond, Coventry Lake, Moodus Reservoir, Pickerel Lake, Lake Zoar, and Mansfield Hollow Reservoir. These surveys collected data on fishing effort, catch and harvest of various fish species, and angler opinions on FD management practices. Most open water fishing effort was by anglers targeting either bass, trout (where stocked) or "anything" they could catch. At Coventry, a Walleye Management Lake, 6% of open water anglers targeted Walleye. Periods of safe ice were relatively brief (approx. one month or less) at most lakes surveyed during both winters of 2016 and 2017, with the exception of Mansfield Hollow Reservoir, which had approximately two months of intermittent safe ice. Fisheries created by FD stockings of Northern Pike attracted the majority of ice angler participation on Mansfield Hollow Reservoir. At other lakes surveyed, ice anglers targeted either trout or "anything" the majority of the time.

Background

Angler surveys are an indispensable component of Fisheries Division (FD) management programs. These surveys provide vital information on angler use of various fisheries and angler feedback on current management practices. The FD has a long history of conducting angler surveys on lakes and large rivers, but these surveys were typically conducted under the auspices of individual management and monitoring projects. In 2011, FD initiated a centralized Lake and Large River Angler Survey Job that was charged with collecting and archiving angler survey data from lakes and large rivers using standardized survey methods that ensures comparability of data across locations and years. This report details work conducted by the Lake and Large River Angler Survey Job during the winter of 2016 through the winter of 2017.

Note: The Connecticut DEEP Inland and Marine Fisheries Divisions were merged into a single Fisheries Division in January of 2017. Although the majority of the work for this report was conducted while we were still Inland Fisheries, the new designation has been incorporated herein.

Approach

FD staff members create a prioritized list of potential survey sites annually. As many waterbodies as resources permit are surveyed within a given year. Lake surveys employ a standardized stratified random roving design (Malvestuto et al. 1978). Large river surveys are

often customized and may employ roving designs, access point designs (Pollock et al. 1994), or some combination of the two approaches. Standard open water surveys are typically conducted from Opening Day of trout season (2rd Saturday in April) until the end of October during the daylight hours between dawn and dusk. Ice season surveys are conducted from dawn to dusk during periods of safe ice, which typically occur from mid-December through the beginning of March. Open water and ice surveys are occasionally conducted after dark at lakes that support night fisheries for species such as Walleye and Channel Catfish. On a given day, survey clerks travel to the waterbody, count the number of anglers present, and then interview anglers using a standardized questionnaire. All survey data are entered into centralized databases.

All surveys quantify angler effort (expressed as "angler-hrs", or hours of fishing that occur over the course of the season; one angler-hr = one angler fishing for one hour, two anglers fishing for three hours = six angler-hrs, etc.) as well as catch (numbers of fish caught by anglers) and harvest (numbers of fish caught that are kept). Surveys also quantify directed effort (percentage and/or number of angler-hrs spent in pursuit of particular species) and catch rates (the number of a species caught per angler-hr of fishing). Anglers may also be asked questions to assess their avidity (number of fishing trips taken annually to the waterbody), monetary expenditures for their fishing trip, and opinions of current or prospective FD management programs.

Key Findings

The FD conducted angler surveys on two lakes during the 2016 ice season and five lakes during 2016-17 open water and ice seasons (Fig. 1, Appendix 1). Mohawk Pond (2016), Mount Tom Pond (2016) and Mansfield Hollow Reservoir (2016-17) were only surveyed during the ice fishing season; whereas, Moodus Reservoir, Pickerel Lake (2016) and Lake Zoar (2016) were only surveyed during the open water season. Coventry Lake was surveyed during both the open water and ice seasons of 2016-17. An attempt was made to survey Moodus during the winter of 2016-17, but safe ice never set up. Angler effort, catch and harvest, and directed effort at each lake are shown in Appendices 2-4.

Lakes surveyed during 2016-17 were chosen for varied reasons (Appendix 1), which included:

- Mohawk Pond: a survey was conducted in part to assess a new experimental initiative. Large broodstock Brook Trout were stocked into two waterbodies; Mohawk Pond and Black Pond (Woodstock). Each lake received approximately 200 fish with the intensions of providing anglers the opportunity to catch large brookies in a relatively pristine setting.

- Mount Tom Pond: a survey was conducted to assess the developing Walleye fishery (see Walleye Management Annual Performance Report: Warmwater Job 6, 2016-17) as well as assess the stocking of 125 broodstock Atlantic Salmon in the fall of 2015.
- Coventry Lake: a survey was conducted to compile more data on the Walleye fishery that has been struggling to produce legal size (18-inch) fish since stocking began in 2001 (see Walleye Management Annual Performance Report: Warmwater Job 6, 2016-17).
- For both Moodus Reservoir and Pickerel Lake, surveys were conducted to add to the long-term historical dataset for these important warmwater fisheries that are also Bass Management Lakes.
- Lake Zoar: a survey was conducted to assess the developing Walleye fishery (which began in 2011), as well as determine the extent of the pike and bass fisheries.
- Mansfield Hollow Reservoir: a survey was conducted to assess the status of the pike fishery at this lake and assess the relative performance and contribution to the fishery of two stocked pike size classes (fingerlings vs. yearlings, see Northern Pike Annual Performance Report: Warmwater Job 5, 2016-17 for details).

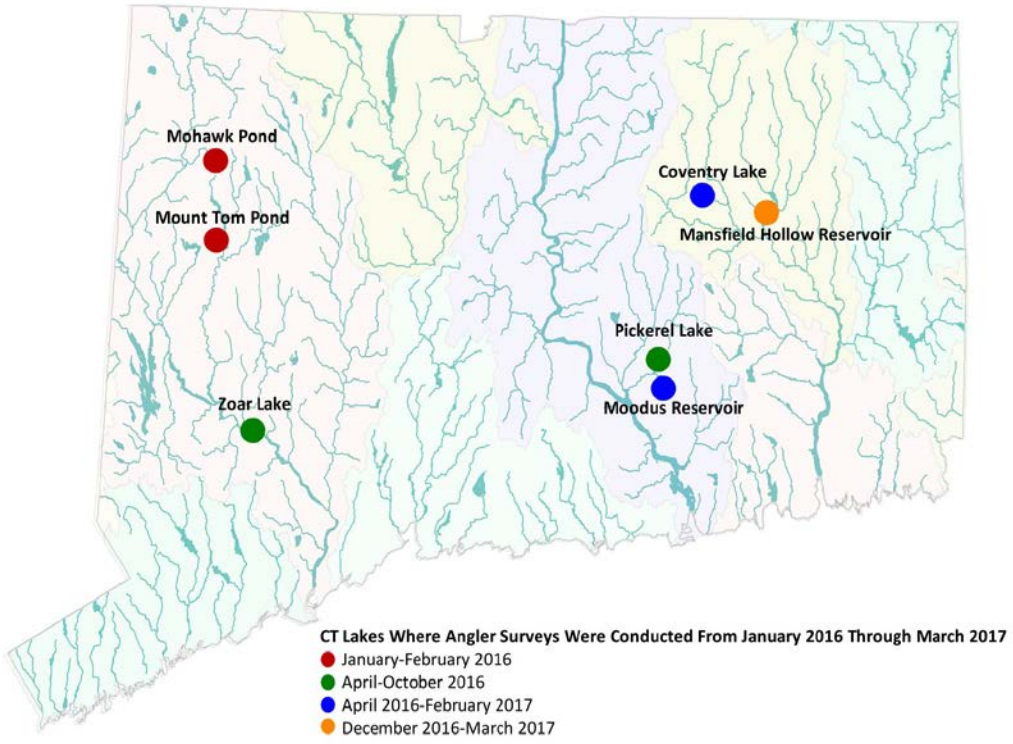

Figure 1. *Connecticut lakes where angler surveys were conducted January 2016 - March 2017.*

Total open water angler effort at lakes surveyed during 2016 ranged from 3,925 angler-hrs at Pickerel Lake to 18,993 angler-hrs at Lake Zoar (Appendix 2). Boat effort was substantially higher than shore effort at all four lakes surveyed. Bass (Largemouth and Smallmouth) were the most targeted fish during the open water season, ranging from 37% to 70% of total effort among the lakes surveyed (Appendix 4a). Open water angler effort directed toward Walleye was relatively low at Coventry and Zoar lakes (6% and <1%); however, estimated Walleye catch (121 and 198 fish) was near average for a Walleye Management Lake (WML) (Avg = 178 for nine WMLs surveyed between 2010 and 2014). Directed toward pike at Lake Zoar was low (1% of total effort). Generalist "anything" anglers accounted for a substantial portion (21-40%) of total fishing effort among the lakes surveyed during the open water season (Appendix 4a).

Periods of safe ice were relatively short during the January-February 2016 season at Mohawk Pond (38 days) and Mount Tom (36 days, however, some of the pond remained ice free throughout the season) as well as during the 2016-17 season at Coventry Lake (22 days). At Mansfield Hollow Reservoir in 2016-17, safe ice came in three disjunct periods totaling 63 days among which the ice receded and refroze twice. At Mohawk and Mount Tom ponds, salmonids were the most popular target species during the ice season (directed effort = 70% for trout at Mohawk, and 35% for trout and 20% for Atlantic Salmon at Mount Tom, Appendix 4b). Generalist anglers made up the next largest category of directed effort at Mohawk and Mount Tom (28% and 35%). At Coventry Lake, generalist anglers accounted for 91% of the directed ice effort (Appendix 4b) and despite being a WML, none of the 18 anglers interviewed targeted Walleye. Pike was the most popular target species for ice anglers at Mansfield Hollow Reservoir accounting for 92% of directed effort (Appendix 4b).

Gamefish catch and harvest rates (percentages of fish caught that are kept) varied by species among the sites during the open water surveys (see Appendix 3a). Bass (Largemouth and Smallmouth) and sunfish were the species caught most frequently in Coventry and Zoar Lakes during the open water period; whereas, Chain Pickerel and bass dominated the catch at Moodus and Pickerel Lakes. Harvest rates for Largemouth and Smallmouth Bass, Chain Pickerel and Walleye were 8% or less at most lakes. Conversely, harvest rates for trout species in aggregate ("All trout" harvest estimates in Appendix 3a) ranged from 55 to 84% among lakes. Harvest rates for "panfish" such as Yellow Perch, Black Crappie, White Perch, Rock Bass, catfish species, and sunfish species ranged from 0% to 100%, with the highest rates found at Pickerel Lake and Lake Zoar. Despite low directed effort, an estimated 121 pike were caught during the open water period at Lake Zoar. However, none of these fish were caught by anglers targeting pike.

Catch during the ice fishing season (Appendix 3b) varied among sites, but in general Yellow Perch, Largemouth Bass and Chain Pickerel were the species most caught. No Walleye were reported caught at Coventry Lake; however, this may have little significance because the short ice season resulted in only 18 anglers being interviewed during eight visits to the lake. At

Mohawk Pond, the trout catch was low during the short ice season there (of 40 trout anglers interviewed, only one brown and one brook trout were caught). At Mount Tom Pond, the Atlantic Salmon that were stocked during the fall of 2015 provided the majority of the catch, with an estimated 57 fish caught, 56% of which were harvested. At Mansfield Hollow Reservoir, Northern Pike were one of the most commonly caught species during the ice fishing season (an estimated 194 caught). Harvest rates (Appendix 3b) at the four lakes surveyed during the ice season followed the same general pattern as observed for open water (low for bass, moderate for panfish, and high for trout).

Discussion

Angler surveys conducted during 2016-17 highlight the diversity of inland fishing opportunities available in Connecticut. This Job is important to Fisheries Management in providing valuable catch, harvest and effort data to base management decisions upon. Many of the lakes surveyed during 2016-17 demonstrate the success of FD stocking programs in creating diversified fisheries throughout the state, but it has also brought to light some fisheries that require further investigation as to how to improve them. These include the Walleye program in Coventry Lake, which appears to have only a small fishable population of Walleye despite being stocked for 16 years (see Walleye Management Report Study 2 Job 6 2016-17 for specific details).

The success of the Brook Trout stocking program at Mohawk Pond is unclear based alone on the low catches encountered during the short 2016 ice fishing season. However, anecdotal reports indicate that some anglers caught fish during open water prior to the ice season as well as during the ice season. Moreover, this lake appears to have a large contingent of anglers that target trout.

It is apparent from the ice survey results at Mount Tom Pond that the salmon stocking was a success. Unlike the excellent pike fishery upstream at Lake Lillinonah (McDowell et al. 2013), pike appear to be only incidentally caught in Lake Zoar and are likely not present in high densities.

Expenditures

Total Cost:	101,510
Federal Share:	76,132
State Share:	25,377

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Appendices

Appendix 1. Lakes where the Fisheries Division conducted angler surveys during 2016-17.

Lake	Towns	Area (acres)	Public Boat Access	Public Shore Access	Special Management	Prior Angler Surveys?	Primary Rationale	Comments
Coventry Lake	Coventry	373	Paved ramp, parking for 26 cars.	Restricted to launch area	Walleye Management Lake[1]Bass Management Lake[2]	Multiple surveys dating back to 2002	Walleye assessment	6 mph speed limit from sunset to one hour after sunrise all days and on Sundays from noon to 4 pm; May 15 to September 15 and from noon to 2pm on July 4. 40 mph at other times.
Mansfield Hollow Reservoir	Mansfield, Windham	460	Paved ramp, parking for 50 vehicles.	Excellent - entire shoreline is open to public	Bass Management Lake[2], Northern Pike Management Lake[3]	Multiple surveys dating back to 1993	Northern Pike assessment	8 mph speed limit. Ice season survey only in 2016-17.
Mohawk Pond	Cornwall, Goshen	16	Parking for 8 vehicles.	Many areas inaccessible due to thick vegetation and wetland habitat	Statewide regulations apply for all species.	None	Brook Trout stocking assessment	Use of all motors prohibited. Ice season survey only in 2016.
Moodus Reservoir (upper)	East Haddam	486	Paved ramp, parking for 10 vehicles.	Limited. Access is the causeway that separates the two basins	Trophy Bass Management Lake[2]	Multiple surveys dating back to 1986	Long term warmwater fisheries monitoring	8 mph speed limit from 9:00am-8:00am, 35 mph at all other times.
Mount Tom Pond	Litchfield, Morris, Washington	56	Undeveloped. Car-top boats, parking for 9 vehicles. A parking fee charged: Memorial Day-Labor Day.	Limited to state park boundaries	Statewide regulations apply for all species.	None	Walleye and Atlantic Salmon assessment	Gas motors prohibited. Ice season survey only in 2016.
Pickerel Lake	Colchester, East Haddam	82	Paved ramp with parking for 10 cars.	Restricted to launch area	Bass Management Lake[2]	Multiple surveys dating back to 1986	Long term warmwater fisheries monitoring	8 mph speed limit except for the period June 15 to first Sunday after Labor Day 11am to 6 pm. Open water survey only in 2016.
Zoar Lake	Monroe, Newtown, Oxford, Southbury	909	Paved ramp, parking for 60 cars.	Kettletown State park on the eastern shore	Statewide regulations apply for all species.	None	Northern Pike and Walleye assessment	45mph daytime speed limit; 25 mph ½ hour after sunset to ½ hour before sunrise. Open water survey only in 2016.

[1] Walleye Management Lakes are stocked annually with Walleye fingerlings; see Walleye Management Report Study 2 Job 6 2016-17.
[2] Bass Management Lakes are managed with specialized bass regulations; see Bass Management Report Study 2 Job 3 2016-17.
[3] Northern Pike Management Lakes are stocked annually with Northern Pike fingerlings; see Northern Pike Management Report Study 2 Job 4 2016-17.

Appendix 2. Estimated **angler effort** (angler-hrs) at lakes surveyed during the 2016 ice fishing season (periods of safe ice from 1/14-2/22/16); the 2016 open water season (4/9-10/31/16) and subsequent 2016-17 ice fishing season. The ± 95% confidence limits around effort estimates are shown in parentheses, expressed as a percentage of the effort estimate (e.g. an entry of "1,000 (50%)" represents an effort estimate of 1,000 angler-hrs with a 95% confidence limit of ± 500 angler-hrs). The columns labeled "**Eff/acre**" contain the open water or ice angler effort per acre for each lake. The column labeled "**Ice Days**" contains the number of days of safe ice at each lake during the ice fishing season. Entries of "**n.a.**" indicate the lake was not surveyed during that season.

		Open Water Season				Ice Season		
Lake	**Area (AC)**	**Boat**	**Shore**	**Total**	**Eff/acre**	**Ice**	**Eff/acre**	**Ice Days**
[1]Coventry Lake	373	4,711(24%)	1,440(40%)	6,150(20%)	13	432(259%)	1	22
[2]Mansfield Hollow Res.	460	n.a.	n.a.	n.a.	n.a.	2,866(37%)	6.2	61
[3]Mohawk Pond	16	n.a.	n.a.	n.a.	n.a.	605(62%)	37	38
[4]Moodus Reservoir	486	7,816(20%)	2,222(31%)	10,038(16%)	16	-	-	No Safe Ice
[5]Mount Tom Pond	56	n.a.	n.a.	n.a.	n.a.	1506(56%)	27	36
[6]Pickerel Lake	82	2,717(25%)	1,209(68%)	3,925(26%)	33	n.a.	n.a.	n.a.
[7]Zoar Lake	909	10,391(20%)	8,542(19%)	18,933(15%)	11	n.a.	n.a.	n.a.

[1] Coventry Lake was surveyed during the 2016 open water period (4/9-10/31/16) and the 2016-17 ice fishing season (2/4/-2/25/17).
[2] Mansfield Hollow Res. was surveyed during three disjunct safe ice periods during the 2016-17 ice fishing season (12/15/16-1/22/17 & 2/4-2/25/17 & 3/17-3/18/17).
[3] Mohawk Pond was surveyed during the 2016 ice fishing season (1/14-2/21/16).
[4]Moodus Reservoir was surveyed during the 2016 open water period (4/9-10/31/16). A survey during the 2016-17 ice fishing season was attempted, but no safe ice formed.
[5]Mount Tom Pond was surveyed during the 2016 ice fishing season (1/14-2/22/16).
[6]Pickerel Lake was surveyed during the 2016 open water period (4/9-10/31/16).
[7]Zoar Lake was surveyed during the 2016 open water period (4/9-10/31/16).

Appendix 3a. Estimated **catch (number of fish), harvest (number of fish), and harvest rate (percent of fish caught that were harvested)** at lakes surveyed during the 2016 open water season (4/9-10/31/16). The ± 95% confidence interval (C.I.) around catch or harvest estimates are shown in parentheses, expressed as a percentage of the catch or harvest estimate (e.g. an entry of "1,000 (50%)" represents an estimate of 1,000 fish caught or harvested with a 95% confidence interval of ± 500 fish). Catch of individual catfish species are not reported because most anglers cannot reliably identify catfish to species. When observed by angler survey clerks, catch of various sunfish species is reported, but most time anglers cannot reliably identify individual sunfish species and so the generic category of "sunfish" is included. In lakes with relatively low estimated trout catches, catch and harvest of individual trout species are not reported separately. "**NP**" means this species is not present in the lake.

Open Water Season Catch, Harvest and Harvest Rates

	Coventry			Moodus Reservoir (upper)			Pickerel Lake			Zoar Lake		
Species	**Catch (95% C.I.)**	**Harvest (95% C.I.)**	**Harvest Rate**	**Catch (95% C.I.)**	**Harvest (95% C.I.)**	**Harvest Rate**	**Catch (95% C.I.)**	**Harvest (95% C.I.)**	**Harvest Rate**	**Catch (95% C.I.)**	**Harvest (95% C.I.)**	**Harvest Rate**
Largemouth Bass	1,933(52%)	0(0%)	**0%**	3,547(35%)	30(152%)	**8%**	1,340(36%)	49(159%)	**4%**	3,273(35%)	89(228%)	**3%**
Smallmouth Bass	764(90%)	83(206%)	**11%**	76(105%)	0(0%)	**0%**	NP	NP	**NP**	7,663(36%)	4(208%)	**5%**
Walleye	121(96%)	0(0%)	**0%**	NP	NP	**NP**	NP	NP	**NP**	198(121%)	9(200%)	**4%**
Northern Pike	NP	NP	**NP**	NP	NP	**NP**	NP	NP	**NP**	121(141%)	0(0%)	**0%**
Chain Pickerel	124(83%)	0(0%)	**0%**	5,431(36%)	163(144%)	**3%**	1,953(54%)	0(0%)	**0%**	6(204%)	0(0%)	**0%**
All trout	876(57%)	480(65%)	**55%**	NP	NP	**NP**	NP	NP	**NP**	148(110%)	124(128%)	**84%**
Black Crappie	636(132%)	209(206%)	**33%**	-	-	**-**	261(87%)	73(173%)	**28%**	459(127%)	0(0%)	**0%**
Yellow Perch	639(56%)	0(0%)	**0%**	482(77%)	20(141%)	**4%**	356(70%)	21(146%)	**6%**	615(55%)	316(96%)	**51%**
All catfish[1]	-	-	**-**	-	-	**-**	14(209%)	14(209%)	**100%**	23(166%)	5(200%)	**22%**
All sunfish[2]	4,118(122%)	47(206%)	**1%**	2,221(52%)	261(199%)	**12%**	920(62%)	39(204%)	**4%**	3,501(41%)	766(67%)	**22%**
Common Carp	2(206%)	0(0%)	**0%**	NP	NP	**NP**	NP	NP	**NP**	230(114%)	94(208%)	**41%**

[1] Anglers reported catching Channel and White Catfish, and Brown and Yellow Bullheads.
[2] Anglers reported catching Bluegills, Pumpkinseeds and "sunfish".

Appendix 3b. Estimated **catch (number of fish), harvest (number of fish), and harvest rate (percent of fish caught that were harvested)** at lakes surveyed during the 2016 ice fishing season (periods of safe ice 1/14-2/22/16) and the 2016-17 ice fishing season (periods of safe ice from 12/15/16-3/18/17). The ± 95% confidence interval (C.I.) around catch or harvest estimates are shown in parentheses, expressed as a percentage of the catch or harvest estimate (e.g. an entry of "1,000 (50%)" represents an estimate of 1,000 fish caught or harvested with a 95% confidence interval of ± 500 fish). Catch of individual catfish species are not reported because most anglers cannot reliably identify catfish to species. When observed by angler survey clerks, catch of various sunfish species is reported, but most time anglers cannot reliably identify individual sunfish species and so the generic category of "sunfish" is included. In lakes with relatively low estimated trout catches, catch and harvest of individual trout species are not reported separately. "**NP**" means this species is not present in the lake.

Ice Fishing Season Catch, Harvest and Harvest Rates

	Coventry			Mansfield Hollow Reservoir			Mohawk Pond			Mount Tom Pond		
Species	**Catch (95% C.I.)**	**Harvest (95% C.I.)**	**Harvest Rate**	**Catch (95% C.I.)**	**Harvest (95% C.I.)**	**Harvest Rate**	**Catch (95% C.I.)**	**Harvest (95% C.I.)**	**Harvest Rate**	**Catch (95% C.I.)**	**Harvest (95% C.I.)**	**Harvest Rate**
Largemouth Bass	112(270%)	0(0%)	**0%**	135(100%)	3(208%)	**2.2%**	40(163%)	0(0%)	**0%**	-	-	**-**
Walleye	-	-	**-**	NP	NP	NP	NP	NP	**NP**	-	-	**-**
Chain Pickerel	22(267%)	11(267%)	**50%**	178(81%)	10(210%)	**6%**	18(155%)	0(0%)	**0%**	15(222%)	15(222%)	**100%**
Northern Pike	NP	NP	**NP**	194(83%)	0(0%)	**0%**	NP	NP	**NP**	-	-	**-**
All trout	9(267%)	9(267%)	**100%**	NP	NP	NP	15(114%)	11(153%)	**73%**	-	-	**-**
Brook Trout	-	-	**-**	NP	NP	NP	7(221%)	7(221%)	**100%**	-	-	**-**
Atlantic Salmon	NP	NP	**NP**	NP	NP	NP	NP	NP	**NP**	57(99%)	32(155%)	**56%**
Black Crappie	11(267%)	11(267%)	**100%**	24(172%)	10(210%)	**42%**	7(221%)	0(0%)	**0%**	2(227%)	0(0%)	**0%**
Yellow Perch	232(148%)	131(326%)	**56%**	207(93%)	37(95%)	**18%**	109(134%)	6(226%)	**5%**	-	-	**-**
All catfish[1]	-	-	**-**	4(208%)	0(0%)	**0%**	-	-	**-**	-	-	**-**
Rock Bass	11(267%)	11(267%)	**100%**	NP	NP	NP	-	-	**-**			
All sunfish[2]	11(267%)	11(267%)	**100%**	24(217%)	0(0%)	**0%**	13(221%)	0(0%)	**0%**	-	-	**-**

[1] Anglers reported catching Channel Catfish, White Catfish, and Brown Bullheads.
[2] Anglers reported catching Bluegills, Pumpkinseeds, Redbreast and "sunfish".

Appendix 4a. **Directed effort** (angler-hrs) for various species at lakes surveyed during the 2016 open water season (4/9-10/31/16). "**Bass**" directed effort includes all effort targeting Largemouth Bass and/or Smallmouth Bass. "**Trout**", "**Catfish**", and "**Sunfish**" directed effort includes all effort targeting all trout species, all catfish species and all sunfish species, respectively. "**Anything**" directed effort reflects generalist angler effort not directed towards any particular species (i.e. anglers who are fishing for "anything", "whatever they can catch", etc.). "Effort (%)" columns may sum to slightly more or less than 100% due to rounding.

Open Water Season Directed Effort								
	Coventry		Moodus		Pickerel		Zoar	
Species	Effort (Hrs)	Effort (%)	Effort (Hrs)	Effort (%)	Effort (Hrs)	Effort (%)	Effort (Hrs)	Effort (%)
Bass	-	-	-	-	-	-	11,410	60
Largemouth Bass	2,356	38	7,111	71	2,657	68	-	-
Smallmouth Bass	13	<1	-	-	-	-	-	-
Walleye	409	7	-	-	-	-	25	<1
Northern Pike	-	-	-	-	-	-	134	1
Chain Pickerel	-	-	75	1	38	1	-	-
All trout	510	8	-	-	-	-	61	<1
Black Crappie	-	-	440	4	47	1	-	-
Yellow Perch	143	2	-	-	-	-	106	1
White Perch	-	-	-	-	-	-	263	1
All catfish	-	-	2	<1	-	-	100	<1
All sunfish	187	3	248	2	209	5	51	<1
Common Carp	59	1	-	-	-	-	1,405	7
Anything	2,473	40	2,161	21	973	25	5,377	28

Appendix 4b. **Directed effort** (angler-hrs) for various species at lakes surveyed during the 2016 ice fishing season (periods of safe ice 1/14-2/22/16) and the 2016-17 ice fishing season (periods of safe ice from 12/15/16-3/18/17). "**Trout**", "**Catfish**", and "**Sunfish**" directed effort includes all effort targeting all trout species, all catfish species and all sunfish species, respectively. "**Anything**" directed effort reflects generalist angler effort not directed towards any particular species (i.e. anglers who are fishing for "anything", "whatever they can catch", etc.). "Effort (%)" columns may sum to slightly more or less than 100% due to rounding.

Ice Season Directed Effort								
	Coventry Lake		Mansfield Hollow Reservoir		Mohawk Pond		Mount Tom Pond	
Species	Effort (Hrs)	Effort (%)	Effort (Hrs)	Effort (%)	Effort (Hrs)	Effort (%)	Effort (Hrs)	Effort (%)
Largemouth Bass	-	-	68	2	0.1	<1	-	-
Walleye	-	-	-	-	-	-	68	4
Northern Pike	-	-	2,630	92	-	-		
Chain Pickerel	-	-	-	-	-	-	87	6
Atlantic Salmon	-	-	-	-	-	-	294	20
All trout	-	-	-	-	437	70	529	35
Brook Trout					18	3	-	-
Yellow Perch	29	7	25	1	-	-	-	-
All sunfish	10	2	5	<1	-	-	-	-
Anything	393	91	138	5	168	27	529	35

Federal Aid in Sport Fish Restoration
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Annual Performance Report

2016-17

Connecticut Fisheries Division

Northern Pike Management

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Bureau of Natural Resources
Fisheries Division

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Project: Warmwater Fisheries Management
Job 5: Northern Pike Management

Period Covered: April 1, 2016 to March 31, 2017

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Date Submitted: September 4, 2017

Approved by: Peter Aarrestad
Director, Fisheries Division

William Hyatt
Chief, Bureau of Natural Resources

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Cover photo: Fisheries Biologist Chris McDowell holding a large female Northern Pike prior to releasing into the Haddam pike spawning marsh.

Summary

The Connecticut DEEP Fisheries Division (FD) has created a number of successful Northern Pike fisheries as evidenced by angler survey results and numerous trophy fish awards. However, variable production of pike fingerlings in managed marshes remains a challenge to effective management of Connecticut pike fisheries. In 2016, fingerlings were stocked into four Pike Management Lakes (PMLs) and the lower Connecticut River. In addition, the FD completed the final year of the pike enhancement study that involved: 1) stocking yearling pike obtained from a private hatchery into Mansfield Hollow Reservoir (MHR) and, 2) rearing pike fry acquired from the Hacketstown Fish Hatchery in New Jersey in a managed nursery marsh. Also in 2016, the FD began a third pike enhancement study at Punch Brook Pond, Burlington State Fish Hatchery where fry, also obtained from the Hacketstown Fish Hatchery, were raised to an advanced (>8 inches) fingerling stage. An ice angler survey was conducted at MHR during winter 2016-17. Safe fishable ice was intermittent throughout the season due to erratic swings in temperature through the season. Most ice fishing effort was directed towards pike and 80% of the anglers were in favor of the pike program.

Background

The Northern Pike is one of Connecticut's largest freshwater gamefish. Angler surveys conducted on Pike Management Lakes (PMLs) have documented that pike attract angling effort year-round, especially during the ice fishing season, and that a majority of anglers fishing these waters are in favor of Connecticut's Pike Management Program (Machowski et al. 2011). The pike's large size and predatory nature also makes it an effective consumer of a variety of forage fish. Predation by pike helps thin out smaller fish species, which prevents them from becoming "stockpiled" (overabundant and therefore slower growing), thereby improving the overall quality of angling in a waterbody.

Maintenance and enhancement of pike fisheries is an important component of Connecticut's overall Inland Fisheries management program. Pike populations in the PMLs are supplemented or completely supported by annual stockings of 3-6-inch pike "fingerlings". Currently, the CT DEEP Fisheries Division (FD) stocks four PMLs: Bantam Lake, Mansfield Hollow Reservoir,

Pachaug Pond and Winchester Lake (Figure 1). Stocking in Quaddick Reservoir has been discontinued because the current winter drawdown regime likely results in most of the pike emigrating downstream. A fifth lake that is not a PML, Lake Lillinonah, is not stocked by the FD, but receives annual stockings of yearling pike purchased by the Lake Lillinonah Authority. The FD also stocks pike fingerlings in the Haddam area of the Connecticut River to supplement the self-sustaining population there.

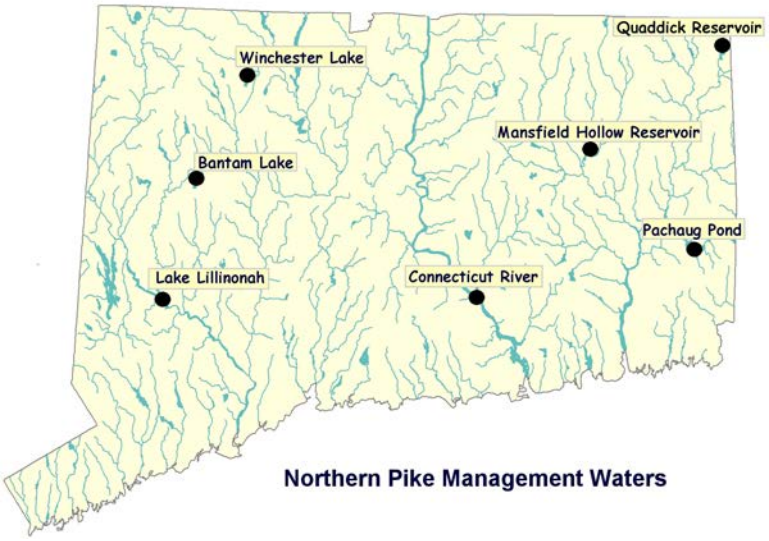

Figure 1. *Connecticut waterbodies stocked and managed for Northern Pike. Note: Quaddick Reservoir is no longer stocked with pike.*

The purpose of Job 5 is to maintain and enhance Northern Pike populations in selected Connecticut waters in order to increase and improve fishing opportunities for Connecticut anglers. This report summarizes pike-related work conducted during 2016-17.

Note: The Connecticut DEEP Inland and Marine Fisheries Divisions were merged into a single Fisheries Division in January of 2017. Although the majority of the work for this report was conducted while we were still Inland Fisheries, the new designation has been incorporated herein.

Approach

Adult pike broodstock are collected in early spring using trap nets at Bantam Lake and a fixed weir trap at the Lower Haddam Marsh on the Connecticut River. Broodstock are then stocked into managed marshes at a targeted ratio of two males to one female. The fingerlings hatched

Figure 2. *FD biologist Chris McDowell with an adult broodstock pike (top left). Adult pike are stocked into managed marshes to spawn each spring (bottom photo is the Upper Haddam Marsh). Juveniles (right) are collected in June of the same year for stocking. Photos by Chris McDowell and Eric Schluntz.*

in the marshes are collected in June by draining or "drawing down" the marshes and then stocking them into the PMLs (rates for most PMLs range from 2 to 5 pike/acre, Figure 1 and 2).

Adult pike abundance is estimated in selected lakes using the Schnabel mark-recapture method (Hayes et al. 2007). Boat electrofishing, trap nets, and gill nets are used to collect pike for abundance estimates. Scale samples are collected from a subsample of adult pike and used to estimate age and growth rates (scales have annual growth rings that can be counted).

Angler surveys are used to assess angler effort, catch and harvest of pike and other species within PMLs during open water and ice fishing seasons. Surveys employ a standardized stratified random roving design (Malvestuto et al. 1978) and are conducted in selected lakes as resources permit (see "Lake and Large River Angler Surveys" report: Study 2, Job 2, for more detailed methods).

Production Experiments

In 2013, two experiments were initiated to investigate alternative methods of pike production. A third experiment began in 2016.

1. In Mansfield Hollow Reservoir (MHR), fingerling pike stocking was discontinued for seven years (2005-11) to assess the level of natural reproduction. Additionally, stocking numbers were reduced between 2002 and 2004. The pike population declined over this time indicating that natural reproduction alone could not support the fishery (McDowell et al. 2014). Lake Lillinonah, a non-PML stocked annually by the Lake Lillinonah Authority with only 200-600 yearling (10-16-inch) pike appeared to have a thriving pike population (McDowell et al. 2013; McDowell et al. 2014). Using the yearling stocking rates from Lake Lillinonah, a study was designed to compare stocking yearlings versus 4-6-inch fingerlings at MHR. The FD purchased yearling pike from Zetts Fish Farm & Hatcheries, Inc. (Zetts Fish Farm), a commercial hatchery in Pennsylvania. Yearlings were marked with year-specific fin clips and stocked at 0.13 pike/acre (60 fish) in 2013 and 0.26 pike/acre (120 fish) in 2014. The relative performance of the two pike age classes were tracked via angler surveys and trap netting (2014-16) to assess their contribution to the fishery.
2. The second experiment compared the cost effectiveness of stocking fry as an alternative to stocking pre-spawn adults in managed marshes. Two marshes in Wyantenock State Forest (Kent, CT) were chosen as the study sites because they are not prone to flooding and have consistently produced fingerlings by the standard practice of stocking pre-spawn adult pike. Known numbers of pike fry provided gratis by the New Jersey Division of Fish and Wildlife were stocked into one of two

Figure 3. *Fry received from the Hackettstown Fish Hatchery in New Jersey that were used in the Wyantenock and Punch Brook experiments.*

Wyantenock marshes from 2013 through 2016. The other marsh was stocked with broodstock adults. Fry stocking densities were calculated to closely match typical densities produced by stocking spawning adults (10 fry/m^2, Bry and Souchon 1982). Fry stocking and stocking spawning adults were alternated between the marshes each year to reduce any within-marsh bias. Production by the two methods was then compared.

3. In 2016, the FD Fish Management and hatchery personnel began a pike culture experiment in Punch Brook Pond #6 on the Burlington State Fish Hatchery property (Figure 4). Twenty-one thousand fry obtained gratis from the State of New Jersey Hackettstown Fish Hatchery were stocked into the 0.16 acre pond during March 2016. The pond was fertilized with alfalfa meal to promote zooplankton growth prior to stocking fry and for the first four weeks following stocking. Plankton tows were conducted five days after, then again 10 days after fry stocking to determine the abundance and type of zooplankton. Pike fry grow rapidly and switch to a fish diet when approximately two inches long. To accommodate this diet change and help prevent cannibalism, the pond was stocked with forage fish (Fathead Minnows and Golden Shiners) in early May and through the summer. Further details of this experiment can be found in McDowell et al. (2016).

Figure 4. *Punch Brook Pond #6 following dredging and before it was filled with water for the pike rearing experiment during spring 2016.*

Key Findings

Fingerling Production at Pike Spawning Marshes

Statewide production during 2016 (Appendix 1, Table 1) was 7,338 fingerling pike, which was lower than both the project production goal and the 2002-15 average annual production of 10,829 and 12,555 fish. The majority (51%) of fingerlings produced in 2016 came from the Mansfield Marsh. Table 1 displays stocking statistics for the PMLs stocked in 2016.

Table 1. Stocking statistics for fingerling pike stocked into the Connecticut PMLs and the Connecticut River in 2016.

Lake	Acres	Number Stocked	Avg. Length (inches)	No./Acre	Target No./Acre[1]
Bantam	947	513[2]	5.1	0.5	2.0[3]
Mansfield Hollow	460	2,395[4]	4.5	5.2	5.0
Pachaug	841	1,710[5]	3.6	2.0	5.0
Quaddick[6]	408	0	0	0	0
Winchester	246	1,303[7]	4.5[8]/10.0[9]	1.4	5.0
Connecticut River		1,417[10]	4.5[11]/3.6[12]		
Total		**7,338**			

[1] These are "maintenance" stocking rates. Introduction rate is 10/acre.

[2] Fingerlings raised in Wyantenock #3 from Bantam Lake adult broodstock.

[3]Maintenance stocking rate for Bantam is lower than other lakes due to the occurrence of some natural reproduction.

[4]Fingerlings from Mansfield Hollow Marsh.

[5]Fingerlings from Lower Haddam Marsh.

[6]Stocking discontinued until winter drawdowns can be regulated on this lake.

[7]Fingerlings raised from New Jersey fry in Wyantenock #4 (1,185) and New Jersey fry raised to 'advanced' fingerling stage in Punch Brook Pond #6 (118) located at Burlington Hatchery.

[8]New Jersey fingerlings from Wyantenock Marsh #4.

[9]New Jersey fingerlings raised to 'advanced' fingerling stage in Punch Brook Pond #6 at Burlington Hatchery.

[10]Fingerlings from the Mansfield and Lower Haddam marshes.

[11]Fingerlings from Mansfield Hollow Marsh.

[12]Fingerlings from Lower Haddam Marsh.

Yearling vs. Fingerling Stocking Experiment at Mansfield Hollow Reservoir

The results to date of the yearling versus fingerling stocking experiment conducted from 2013 through 2016 at MHR are inconclusive. Trap netting during March and April of 2014-16 captured lower numbers of adult pike compared to historical trap net records (see Table 2 "# Caught" column). The identifying clips given to the pike purchased from Zetts were easily recognizable; however, relatively few were caught over the three netting periods (1 in 2014, 6 in 2015 and 2 in 2016). The total contribution of Zetts pike to the adult pike population at MHR will be assessed once all of the pike scales collected are aged.

Table 2. Population estimates of Northern Pike in Mansfield Hollow Reservoir 1997 through 2016. Population estimates were conducted using trap nets, and during some years a combination of trap nets, gill nets, and night boat electrofishing.

Year	# Caught (Recaptured)	All Sizes		Stock Size (>35cm)		Quality Size (>53 cm)		Preferred Size (>71cm)	
		N	95% CI	N	95% CI	N	95% CI	N	95% CI
1997	151 (21)	443	363-566						
1998	81 (14)	179	141-245						
1999	125 (8)	471	348-729						
2000	79 (3)	379	240-897						
2002	103 (6)	523	371-884						
2013	33 (6)	95	44-259	95	44-259	90	41-246	45	15-227
2015	39 (2)	282	78-2,820	224	62-2,240	138	38-1,380	48	13-485
2016	32 (3)	133	45-667	124	42-618	75	25-373	22	6-220

Fry Versus Broodstock Experiment at Wyantenock Marshes

Wyantenock #3 was stocked with fry in 2013 and 2015, and Wyantenock #4 was stocked with fry in 2014 and 2016 (Table 3). Using two-way ANOVA, the individual marsh had a significant effect on fingerlings produced per acre ($F = 38.88$; $df = 1$; $P = <0.0016$). After controlling for the marsh effect, the stocking "treatment" (fry vs. adult stocked) had no significant effect on production ($F = 0.09$; $df = 1$; $P = <0.7720$).

Cost per fingerling for fish produced by fry stocking was slightly less than that of stocking adults ($4.60/fingerling vs. $5.46/fingerling). However, cost per fingerling for both methods was slightly more expensive than the state average for all marshes combined using broodstock adults ($4.44) (McDowell et al. 2016).

Table 3. Pike fry vs. broodstock adult stocking statistics and fingerling production from the two marshes in Wyantenock State Forest, 2013-16.

	Wyantenock #3 (6 Acres)				Wyantenock #4 (2 Acres)		
Year	**# Fry Stocked**	**# Adults Stocked**	**# Fingerlings Produced/acre**		**# Fry Stocked**	**# Adults Stocked**	**# Fingerlings Produced/acre**
2013	135,000		91.2			8 female/5 male	461.0
2014		12 Female/9 male	211.0		50,000		474.5
2015	101,000		233.3			8 female/16 male	589.5
2016		14 female/28 male	91.3		45,000		629.0

Punch Brook Fry Rearing Experiment

A total of 21,000 fry were stocked into Punch Brook Pond #6 at the Burlington State Fish Hatchery on March 30, 2016. The first plankton tow revealed that only Chironomid larvae were present in the pond. Whereas, five days later (the second sample) zooplankton (Copepods and Cladocerans) were both present and abundant. At that time, fry swimming near shore appeared to have full abdomens indicating utilization of the zooplankton forage.

The pond was first seined on May 20 to determine growth and survival from fry to small fingerling. A total of 1,845 (avg. length = 2.8 inches) fingerlings (Table 4; Figure 5) was captured equating to a 9% survival rate from stocked fry to fingerling. Cost (including staff time, screening, valves, fertilizer and live forage) was calculated at $2.68/fingerling.

All fingerlings were restocked into the pond and allowed to grow to advanced fingerling size. The pond was seined again on September 9 when 118 advanced-size (avg. length = 10 inches) fingerlings were captured, equating to a 6% survival from small to advanced fingerling. Due to the increased staff time, high cost of live forage and increased mortality, the cost to produce a

10-inch fingerling was much higher ($65.16/fish) than to produce a 3-inch fingerling. The advanced fingerlings were given a fin clip and stocked into Winchester Lake.

Table 4. Calculated costs of both small (2.8 inches) and advanced (10 inches) fingerling pike raised at the Burlington State Fish Hatchery, 2016.

Punch Brook Pond #6 Pike Culture Experiment 2016			
Personnel cost and expenses to produce small fingerling pike: (*Cost calculated through May 20 – first harvest date*)	**Expenses**	**Personnel**	**Production**
Total single use item annual expenses (e.g. fertilizer):	$835.00	$3,831.50	1,845
Annual prorated expenses (e.g. durable equipment):	$288.20		
Total Annual cost including both one time and prorated expenses:	$1,123.20		**$4,954.70 total cost to produce 1,854, 3-inch fingerlings = $2.68/fingerling**
Personnel cost and expenses to produce large fingerling pike: (*Cost calculated through September 9 – second harvest date*)	**Expenses**	**Personnel**	**Production**
Total one time annual expenses:	$2,510.00	$4,891.25	118
Annual prorated expenses:	$288.20		
Total Annual cost including both one time and prorated expenses:	$2,798.20		**$7,689.45 total cost to produce 118, 10-inch fingerlings = $65.16/fingerling**

Figure 5. *Punch Brook pike fingerlings (small May fingerlings seen on left and large advanced September fingerling seen on right).*

Angler Survey

An angler survey was conducted at MHR during the ice fishing season from December 15, 2016 to March 18, 2017 (see Lake and Large River Angler Survey report: Study 2, Job 2 for details on other species caught). Safe fishable ice was intermittent throughout the season (total days of safe ice = 63) due to erratic swings in temperature. Estimated directed effort for pike was 2,674

angler-hrs (AH) making up 92% of total angler effort for the season. Anglers caught 194 (80% CI) pike and harvested none.

Catch effort of pike by anglers targeting them was 0.06/hr in 2017 (Figure 6). After pike fingerling stocking was suspended in MHR, the mean directed catch effort decreased by 73% (0.11/hr in 2001-02 vs. 0.03/hr in 2010-15 (Figure 6). There was a moderate increase in directed catch per effort in 2017, which hopefully indicates the population density began to increase.

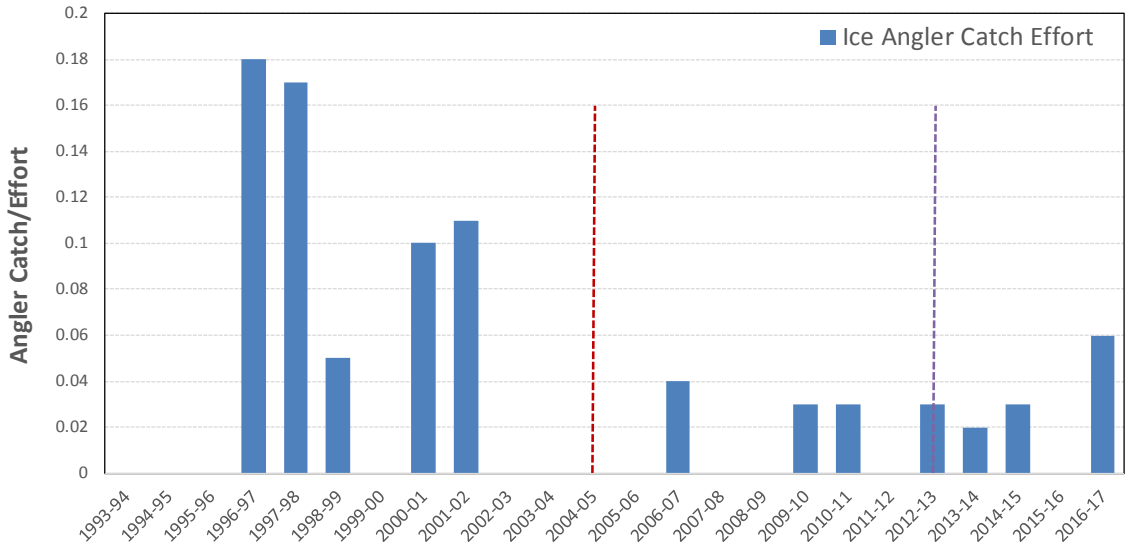

Figure 6. *Catch per effort of pike by ice anglers targeting pike in Mansfield Hollow Reservoir 1994-2017. No surveys were conducted during years with missing data. The* ***red dashed line*** *marks when fingerling stocking was suspended and the* ***purple dashed line*** *when fingerling stocking resumed.*

The length-frequency of the 2016-17 pike catch was relatively narrow (24-36 inches) compared to the length-frequency of catch prior to the cessation of stocking (Figure 7). Age-classes can be inferred by interpreting modes in length-frequencies. The 2016-17 pike length-frequency appears to include only two overlapping age-classes; whereas, length-frequencies from prior ice fishing angler surveys at MHR contain multiple age classes (Figure 7). There should have been at least four age-classes present in the 2016-17 population because restocking started at MHR in 2013. It is unclear whether this is an indication of variable survival of stocked year-classes or if

the other age-classes were somehow underrepresented due to the short safe ice fishing season of 2016-17.

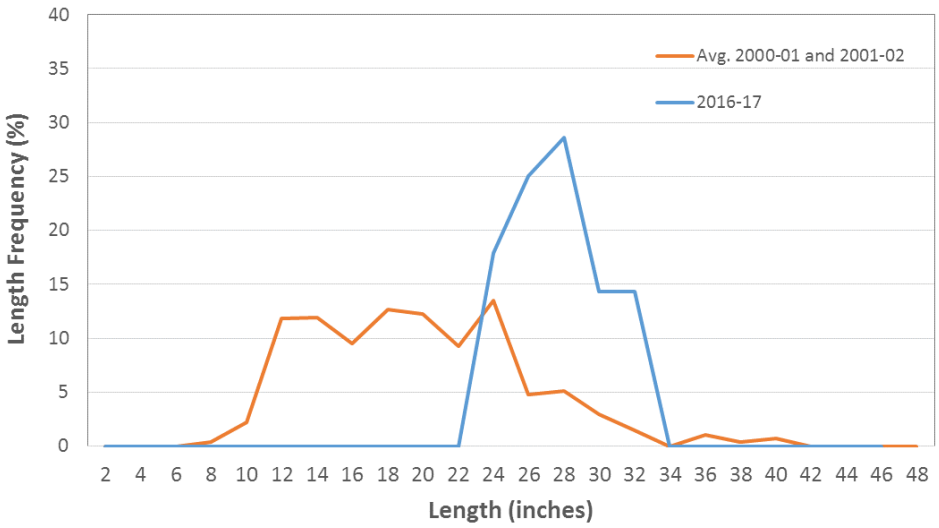

Figure 7. *Length-frequencies of Northern Pike caught during the ice fishing season at Mansfield Hollow Reservoir in 2016-17 compared to the average of ice seasons 2000-01 and 2001-02 before fingerling stocking was suspended.*

During the 2016-17 ice angler survey at MHR, angler opinion regarding the pike program remained high with 80% "In Favor" or "Highly in Favor" (1993-2015 average = 81%). Only 5% of the anglers interviewed were either "Opposed" or "Highly Opposed" (1993-2015 average = 10%). Fifteen percent of anglers said they had "No Opinion" (1993-2015 average = 9%).

Two questions were asked during the 2016-17 ice angler survey to determine angler attitudes toward harvesting pike: "How often are you likely to keep pike that you catch in this lake?" and for those who never keep pike, "Why wouldn't you keep pike?". The majority of respondents (70%) stated they "Never" kept pike. Of the remaining anglers, 12% stated they "Rarely (<10% of the time)" kept pike, 9% said "Occasionally (10-50% of the time)", 6% stated "Most of the time (>50% of the time)", and 3% stated they "Always" kept pike. Of the 55 anglers who said they rarely or never keep pike, 84% said they are catch-and-release anglers. Other less common responses were they did not like the taste (7%), the fish were too bony (5%), and they only keep trophy size fish (4%).

Discussion

Reliable production of pike fingerlings at FD managed marshes remains elusive, likely due to factors outside of staff control. This fact continues to prevent us from stocking PMLs with adequate and consistent numbers of fingerlings as had been done historically. In Connecticut, natural reproduction of pike, though present in many of the PMLs, appears inadequate to maintain long-term fishable populations (McDowell et al. 2013). Therefore, successful management hinges on the ability to consistently stock PMLs with juveniles. Alternative methods of production and sources of juvenile pike require further investigation.

The resumption of stocking pike fingerlings into MHR appears to have improved the fishery based on the increase in pike directed catch effort during the 2016-17 ice season compared to previous (2012-15) surveys. Population estimates using trap net and electrofishing, however; do not indicate an increase in numbers of adult pike between 2013 and 2016. Additionally, the number of the Zetts yearlings in the trap net catches was unexpectedly low compared to results of yearling stocking in Lake Lillinonah (McDowell et al. 2013). It is unclear whether mortality and/or emigration rates are relatively higher at MHR. MHR is a flood control impoundment and fish can easily escape through the dam. Despite these uncertainties, most anglers were in favor of the pike program at MHR such that continued stocking and monitoring of pike are warranted.

32-inch Northern Pike caught by Mike Kelley while ice fishing at Mansfield Hollow Reservoir 2017.

We anticipated that fry stocking in two of our easily controlled spawning marshes would result in better fingerling production than the standard method of stocking spawning adults because some of the early season variables that are typically out of our control can be mitigated (e.g., freezing temperatures, fertilization success and egg-to-fry survival). There was a slight cost-benefit to fry stocking; however, our sample size was very small (n = 2 for each marsh/treatment combination) so results should be interpreted with caution. Another issue that "muddies" interpretation is that the stocking density of broodstock females/acre differed between marshes, meaning there were likely more eggs/acre produced in the smaller marsh (Wyantenock #4) than the larger one (Wyantenock #3). This disparity in broodstock stocking rates occurred because of a miscalculation and miscommunication among staff. Although some variables were eliminated by fry stocking, uncontrollable environmental variables still likely play a substantial role in fry survival using either production method. Results of our hatchery rearing experiment conducted at the Burlington Fish Hatchery may shed some light on procedures which could help increase production in our marshes (e.g., fertilization, feeding, etc.) in the future.

Results of the experimental pike culture at Punch Brook Pond #6 were encouraging because we were successful in raising both small and advanced fingerlings in one of our culture ponds, which is a first for a Connecticut State hatchery. This experiment was initiated not only to assess whether pike could be raised within our hatchery system, but also to determine whether it was cost effective compared to our spawning marshes. Based on the results from this experiment, the cost of producing a 3-4-inch fingerling pike is considerably less than that for our managed spawning marshes ($2.68 vs. $4.44 respectively).

In our hatchery ponds, cost per fingerling could be reduced if survival of stocked fry could be improved. While the same argument could be made for our managed marshes, the hatchery pond is a more controlled environment, thus enhancing survival should be more attainable. One factor which may have accounted for the poor fry-to-small-fingerling survival was a lack of zooplankton forage in the pond during the first week of stocking. Zooplankton (Copepods and Cladocerans) did not become abundant until 10 days after fry stocking. Although the pond was fertilized with alfalfa meal six days prior to fry stocking, this period was rainy with persistent

cloud cover likely causing poor zooplankton production. Thus we conclude that mortality of newly-stocked fry may have been high due to lack of food during their first week in the pond.

The reason for poor survival (6%) from small to advanced fingerling is uncertain. Ample forage existed in the pond (live Golden Shiners and Fathead Minnows), but perhaps forage size was not appropriate. The Golden Shiners were smaller than the Fatheads. When the larger Fatheads were stocked we observed that fingerling pike fed heavily on them, but they did not appear to feed on the smaller Golden Shiner. Regrettably, the availability of size-appropriate forage is dependent on our vendor who is located in Arkansas. Because they are well ahead of us in growing season, we could only get what is available.

It is also possible that high cannibalism and/or predation affected fingerling survival. This set of ponds is known for their chronically high predation rates (especially by Great Blue Heron, Mink and Otter) when used to grow trout. Perhaps the pike also became an attractive meal once they began to grow larger.

Recommendations

- Evaluate fingerling production within our hatchery system for a second year and increase the number of ponds used from one to two. Allow the fingerlings to grow to 4-5 inches before being harvested and stocked into PMLs (probably early to mid-June).
- Research availability and cost of pike fingerlings and yearlings from out-of-state sources.
- Stock a suitable PML (other than MHR) or new lake to continue assessing the performance of yearling pike if Zett's Fish Farm has enough yearlings available in 2017.
- Continue to stock fingerlings and/or yearlings at MHR. Monitor periodically using angler surveys and trap nets as resources permit to determine if the pike fishery can be rebuilt.

Expenditures

Total Cost:	79,977
Federal Share:	59,983
State Share:	19,994

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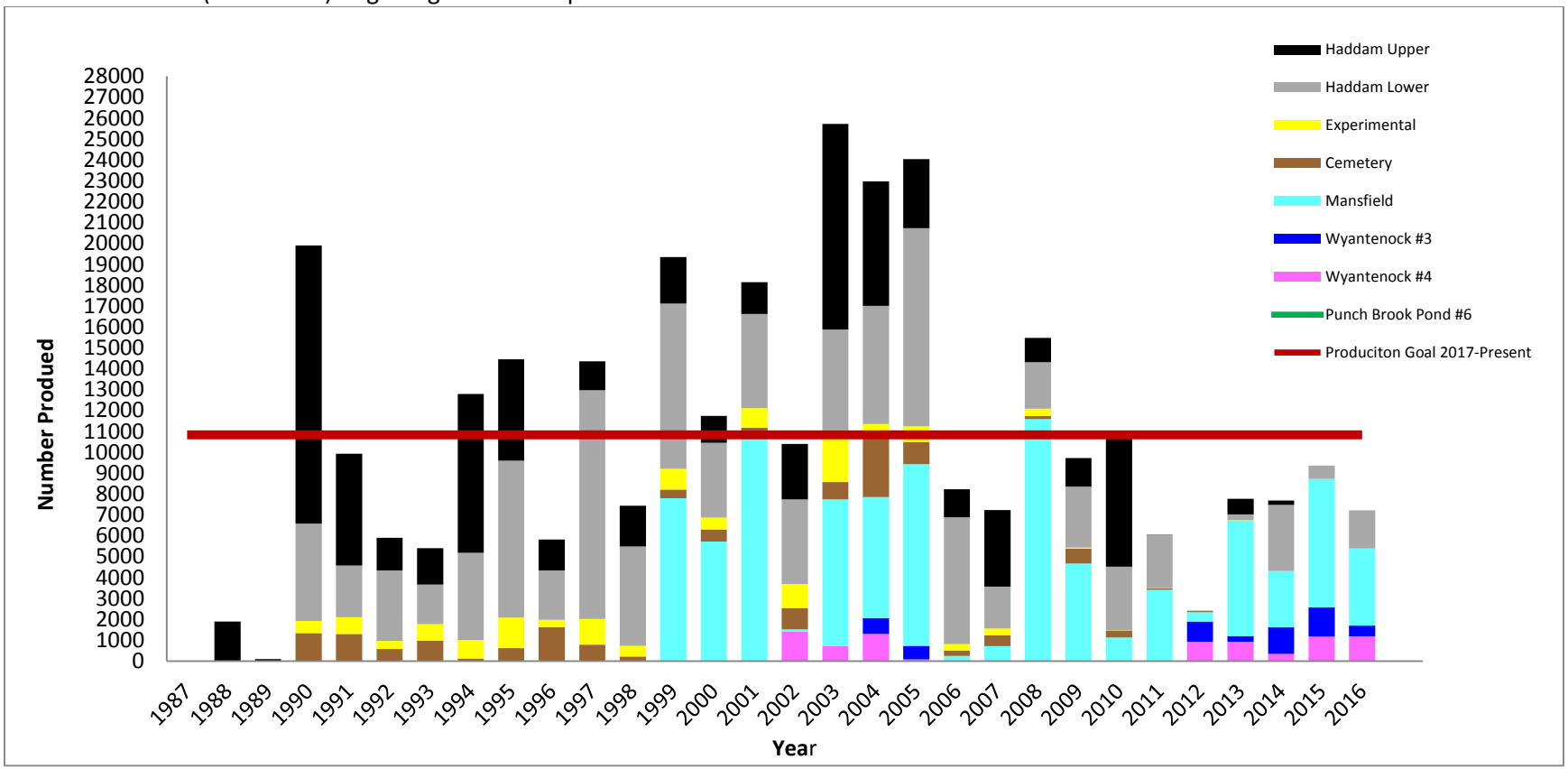
Appendix

Appendix 1. Northern Pike fingerling production from the FD managed marshes and Punch Brook Pond #6 at Burlington State Fish Hatchery, 1987 to present. Each year's production was stocked into the PMLs and the Connecticut River. Note: Punch Brook Pond #6 initially produced 1,845 small (~2.8 inches) fingerlings in 2016. These were stocked back into the pond, whereupon in September the pond was drained again and the 118 advanced (~10 inches) fingerlings that were produced were stocked into a PML.



Federal Aid in Sport Fish Restoration
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Annual Performance Report

2016-17

Connecticut Fisheries Division

Walleye Management

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

Grant Title: Inland Fisheries Research and Management
Study 2: Warmwater Fisheries Program
Project: Warmwater Management
Job 6: Walleye Management

Period Covered: April 1, 2016 to March 31, 2017

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Date Submitted: September 4, 2017

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Cover photo: Former CT FD Fisheries Biologist, Gerald Leonard, happily stocking walleye fingerlings into Gardner Lake.

Summary

Walleye fingerlings were stocked into 13 Connecticut lakes in 2016. A spring 2016 population estimate of Walleye was conducted at Mount Tom Pond, first stocked in 2012, which indicated that approximately 51 legal size (18-inches) fish were present for Opening Day of fishing. Open water angler surveys were conducted in 2016 at Coventry Lake and Lake Zoar, and ice angler surveys were conducted at Mount Tom Pond during the winter of 2015-16 and at Coventry Lake during 2016-17. An estimated 199 Walleye were caught from Zoar and 121 from Coventry during the open water season, of which only 9 were harvested; all from Zoar. No Walleye were reportedly caught during the Mount Tom or Coventry Lake ice angler surveys, most likely due to the short periods of safe ice those years. Five trophy fish awards were awarded statewide for Walleye in 2016.

Background

The Walleye is one of the most popular gamefish in North America (Scott and Crossman 1973, Eddy and Underhill 1974). They grow to large size, can be caught throughout the year using a variety of techniques, and provide excellent table fare. Walleye are also efficient predators that can utilize overabundant forage fish populations. Overall, Walleye management is an important tool that adds to the diversity and quality of Connecticut's inland fishing opportunities.

Walleye populations in Connecticut Walleye Management Lakes (WMLs, see map Figure 1) are completely supported by annual fall fingerling stockings. No successful Walleye reproduction has been observed to date in any of the WMLs. Statewide Walleye regulations in Connecticut are an 18-inch minimum size limit and a 2-fish possession limit (one site, Lake Pocotopaug, has a 20-inch minimum length limit).

Photo of a typical 5-inch fingerling Walleye stocked during the fall into Connecticut lakes.

The Connecticut Department of Energy and Environmental Protection Fisheries Division (FD) continually explores new options to increase the effectiveness and efficiency of the Walleye Management Program. One priority is the assessment of angler harvest rates

to ensure that current regulations are adequate to sustain quality Walleye fishing.

The purpose of Job 6 is to evaluate and optimize Walleye fisheries statewide. This report summarizes work conducted during 2016-17.

Approach

Walleye fisheries are maintained by stocking four- to seven-inch fingerlings during late October-early November. Fingerlings are purchased with Federal Sport Fish Restoration funds from a commercial supplier in Minnesota. Two water companies and one municipality purchase Walleye from the same vendor and fish are concurrently shipped for stocking the same day into all WMLs. Relative abundance of adult Walleye (catch per hour or CPH) is assessed by boat electrofishing during early- to mid-April. Relative abundance of sub-adult Walleye is assessed during May. Walleye population size is estimated on selected lakes using trap nets and electrofishing (March to early April) with a Schnabel mark-recapture design (Everhart et al. 1975). Stratified random roving angler surveys (Malvestuto et al. 1978, for detailed methods see Lake and Large River Angler Survey report: Study 2, Job 2) are conducted as resources permit to estimate angler effort, catch and harvest for Walleye, as well as to determine angler opinions on current management.

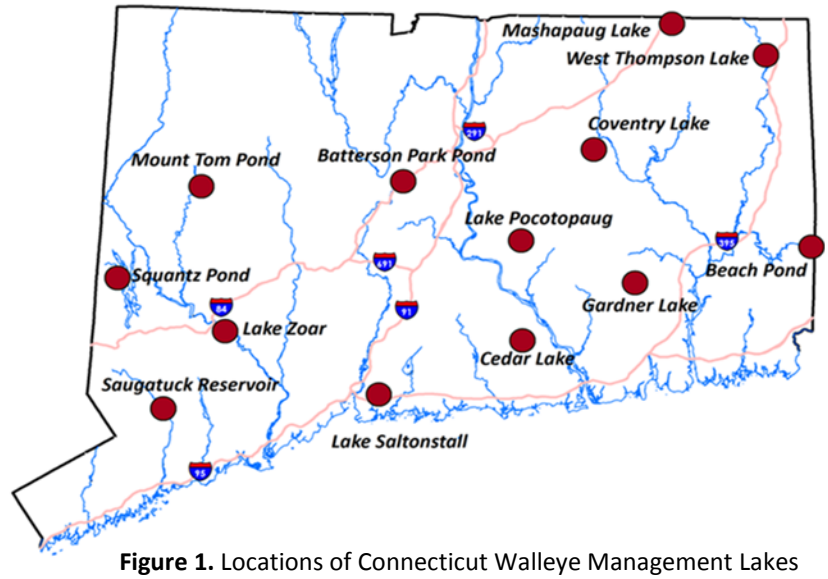

Figure 1. Locations of Connecticut Walleye Management Lakes

Note: The Connecticut DEEP Inland and Marine Fisheries Divisions were merged into a single Fisheries Division in January 2017. Although the majority of the work for this report was conducted while we were still Inland Fisheries, the new designation has been incorporated herein.

Key Findings

Stocking

Ten public WMLs, two water supply reservoirs that are open to fishing, and one semi-private lake were stocked with Walleye fingerlings in October 2016. Stocking rates ranged from three to fifteen per acre (Table 1). As in 2015, "large" fingerlings (7-inch avg.) were stocked in Gardner and Mashapaug lakes to determine if this larger size-at-stocking would improve recruitment to the fishery. All other public lakes were stocked with standard-size fingerlings averaging 5.1 inches in length. Stocking Coventry Lake with standard-size fingerlings was resumed in 2016. Stocking rates at this lake had been reduced in 2011 and then stocking was discontinued in 2013 to determine if reduced stocking rates might enhance Walleye growth rates (see Leonard et al. 2016 for more detail).

Table 1. Numbers, stocking densities (No. per acre), and average total length (inches) of Walleye fingerlings stocked statewide by FD and others in 2016.

Lake	Acres	Number	No. per acre	Length (in.)
Batterson	140	2,100	15.0	5.2
Beach	373	3,700	9.9	4.8
Cedar	69	1,035	15.0	5.2
Coventry	373	1,100	2.9	5.2
Gardner	529	2,270	4.3	**6.9***
Mashapaug	287	1,230	4.3	**7.0***
Mt Tom	56	840	15.0	5.1
Squantz	270	4,100	15.2	5.2
W. Thompson	239	3,600	15.1	4.8
Zoar	909	7,925	8.7	5.1
Sub Total		**27,900**		
Water companies and municipalities				
Pocotopaug	512	2,000	3.9	5.2
Saltonstall	422	3,135	7.4	4.9
Saugatuck	827	2,660	3.2	7.5
Sub Total		**7,795**		
Total stocked		**35,695**		5.5

*Gardner and Mashapaug lakes were experimentally stocked with "large size" fingerlings in 2015 and 2016.

Population Estimate

The 2016 Walleye population size in Mount Tom Pond was estimated using 16 days of trap netting (3/23-4/8) and one night of electrofishing (4/13). Estimated population size was 78 Walleye ≥10 inches (95% confidence interval or "CI"= 48-127) (Appendix 1), of which 51 (95% CI = 28-94) were legal size (≥18-inch). This population size equates to 1.4 fish/acre which is a lower density than that estimated for Batterson Park Pond six years after first stocking (3.6/acre in 2007), Squantz Pond three years after first stocking (2.4/acre in 1996) and Gardner Lake three years after first stocking (1.8/acre in 1996), but higher than that of Beach Pond six years after first stocking (0.71/acre in 2007).

Walleye Relative Abundance

Electrofishing was conducted at four WMLs during March and April 2016 to estimate relative abundance of adult Walleye. Electrofishing catch per hour (CPH) of ≥ 18-inch Walleye was 4.7 at Gardner Lake, 0 at Coventry Lake, 16.8 at Mt. Tom Pond, and 0 at Lake Zoar (Appendix 2). The relative abundance of adult Walleye has been generally declining at Gardner Lake since the fishery matured in the early 2000s (see Appendix 2).

Electrofishing was also conducted during May in Gardner and Mashapaug Lakes to assess the relative survival of the experimental large fingerlings (avg. 7 inches) stocked the previous fall. Encouragingly, the May 2016 fingerling catch rates were higher at both lakes than during previous years when standard-size (4-5-inch) fingerlings had been stocked (Gardner 16.3 vs. 2010-14 avg. 1.6/hr; range 0-5.2/hr and Mashapaug 2.9/hr vs. 2010-14 avg. 1.1/hr; range 1.0-1.2/hr).

Lewis Stein with an 18-inch Walleye caught at Coventry Lake through the ice during the winter of 2017.

Angler Surveys

Angler surveys were conducted at Coventry Lake and Lake Zoar during the open water season of 2016 (Opening Day 4/9 - 10/31/16), and during the ice fishing seasons at Mount Tom Pond (1/14 - 2/22/16) and Coventry Lake (2/4 - 2/25/17). Directed angler effort for Walleye was 6.5% of total effort at Coventry Lake during the open water

season, but only 0.1% at Lake Zoar (Table 2). During the ice season, directed effort was 4.5% at Mt. Tom Pond and too low to detect at Coventry Lake (due primarily to the short number of days with safe ice). Among the lakes, directed catch and directed catch rate were moderate during the open water season and low during the ice seasons (Table 2). Estimated angler catch during the open water season was 121 at Coventry and 199 at Zoar with very few harvested. Most Walleye were caught incidentally by anglers fishing for other species. No Walleye were reported caught during the ice fishing season at either Mt. Tom Pond or Coventry Lake. However, one angler at Coventry Lake stated that he had caught and harvested a legal Walleye on a previous fishing trip. Overall, 78% of ice-anglers and 46% of open-water anglers interviewed at Coventry had caught a walleye before. Catch and effort were low during the ice angler surveys because the ice fishing seasons were short during both years. Mt. Tom Pond never completely froze during the winter of 2016 and much of the pond (~50%) was not fishable. Coventry Lake had an abbreviated ice season in 2017 and most of the lake's surface area was unsafe to fish throughout the season. See Lake and Large River Angler Survey report: Study 2, Job 2 for details on other species caught.

Table 2. Angler survey statistics for Walleye during the open water fishing season at Coventry Lake and Lake Zoar in 2016, and for Coventry Lake (2017) and Mount Tom Pond (2016) during the ice season. "(CL)" indicates that 95% confidence limits are shown in parentheses. "(Percent)" indicates percent of total angler-hours targeting Walleye in parentheses. Directed effort, catch and catch rate are those for anglers targeting Walleye.

Lakes	Total Estimated Catch (CL)	Total Estimated Harvest (CL)	Directed Angler-hrs (Percent)	All Anglers Catch Rate (Catch/hr)	Directed Catch	Directed Catch Rate (Catch/hr)	Days of Safe Ice
Open Water							
Coventry	121 (96%)	0	399 (6.5%)	0.05	11	0.06	n.a.
Zoar	199 (121%)	9 (200%)	25 (0.1%)	0.01	0	0	n.a.
Ice Survey							
Coventry	0	0	0	0	0	0	22
Mt. Tom	0	0	68 (4.5%)	0	0	0	36

Table 3 compares open water angler survey statistics from Lake Zoar to other lakes with still developing fisheries (surveyed four-to-seven years after first being stocked with Walleye). Estimated Walleye catch at Lake Zoar was similar to that observed at Beach and Mashapaug lakes, but considerably lower than that at Coventry Lake. Although directed effort for Walleye only accounted for 0.13-3.0% of the total effort among the developing fisheries, these percentages approximately doubled by the time these fisheries fully matured (see Peak Directed Effort, Table 3).

Comparing ice fishing angler survey statistics from Mt. Tom Pond to other waterbodies with developing fisheries (surveyed two-to-three years after first being stocked with Walleye) reveals that the percent of total effort directed toward Walleye at Mt. Tom in 2016 was lower than that observed at any other lake except Beach Pond (Table 4.). Additionally, Walleye were being caught at all developing waterbodies except Beach and Mt. Tom ponds. In all, directed effort for Walleye accounted for 1.9-14.5% of the total effort among the developing fisheries; whereas, peak directed effort increased to 38-74% of total effort in all waterbodies except Beach Pond once these fisheries had matured (Table 4).

Table 3. Estimated catch, harvest, and directed effort (AH = angler-hrs) for Walleye during the open water season at four lakes four-to-seven years after being initially stocked. Peak directed effort is the highest percent of total effort observed among angler surveys on that waterbody.

Lake	Year First Stocked	Survey Year	Estimated Walleye Catch	95% CI	Estimated Walleye Harvest	95% CI	Directed Effort (AH)	% of Total Effort	Peak Directed Effort
Beach	2001	2007	**121**	132	**27**	187	493	3.0%	6%(2011)
Coventry	2001	2005	**660**	62	**--**	--	236	1.7%	5%(2009)
Mashapaug	2001	2008	**103**	96	**21**	212	455	2.9%	5%(2014)
Zoar	2011	2016	**199**	138	**9**	199	25	0.1%	n.a.

Table 4. Estimated catch, harvest, and directed effort (AH = angler-hrs) for Walleye during the ice fishing season at four lakes two-to-three years after being initially stocked. Peak directed effort is the highest percent of total effort observed among angler surveys on that waterbody.

Lake	Year First Stocked	Survey Year	Estimated Walleye Catch	95% CI	Estimated Walleye Harvest	95% CI	Directed Effort (AH)	Percent of Total Effort	Peak Directed Effort
Beach	2001	2004	**0**	--	**0**	--	19	1.9%	2%(2008)
Gardner	1993	1996	**63**	103	**30**	200	545	14.5%	74%(2000)
Mashapaug	2001	2005	**15**	153	**0**	--	312	9.5%	38%(2014)
Mt. Tom	2013	2016	**0**	--	**0**	--	68	4.5%	n.a.
Squantz	1993	1996	**34**	153	**6**	133	517	9.1%	53%(2007)

Despite low Walleye directed effort and catch rates, most anglers at Coventry Lake and Mount Tom Pond were 'In Favor'/'Highly in Favor' of Walleye stockings at the lakes surveyed (Table 5). Few anglers (0 to 7%) were opposed to Walleye introduction among the three lakes surveyed. Fifty-one percent of anglers at Lake Zoar were ambivalent about the Walleye program. This is

likely due to low awareness of the program coupled with low fish availability – only 42% of anglers interviewed during the open water season at Lake Zoar were aware that Walleye were being stocked vs. 72% and 100% at Coventry during the open water and ice seasons, and 60% at Mount Tom during the ice season.

Table 5. Angler attitudes toward stocking Walleye into Coventry Lake and Lake Zoar during the open water fishing season 2016, and Mount Tom Pond and Coventry Lake during the ice fishing seasons.

	Coventry (open)	Zoar (open)	Mount Tom (ice)	Coventry (ice)
In Favor/Highly in Favor	69%	43%	75%	100%
No Opinion	24%	51%	25%	0%
Opposed/Highly Opposed	7%	6%	0%	0%
Anglers Queried	190	560	56	18

Trophy Fish Awards

Five Walleye trophy fish awards were given to anglers in 2016: three from Lake Saltonstall and two from Lake Pocotopaug. To qualify for a trophy fish award, a Walleye must be larger than 23 inches for released fish and at least five pounds for kept fish. Since 1997, there have been 167 trophy fish awards given statewide for Walleye.

Marc Fontaine with a trophy Walleye from Beach Pond through the ice in 2014 (32", 13 lbs 8 oz). DEEP FD file photo.

Discussion

Available evidence (based on night boat electrofishing and angler catches) suggests that Walleye abundance at Coventry and Gardner lakes continue to fall below expectations. As mentioned in Leonard et al. (2016), possible factors for the cause(s) of these declines include: 1) increased predation on Walleye fingerlings; 2) changes in the forage base; and 3) changes in

habitat, water chemistry or temperature. These factors should be further investigated to gain insight into the observed declines at each lake. Although adult Walleye abundance remained low at Gardner in 2016, stocking larger-size fall fingerlings shows promise as spring fingerling abundance levels were higher in spring 2016 than what was observed during the springs of 2010-14 when standard-size fingerlings were stocked the falls prior to sampling. While initially promising, effectiveness of stocking large fingerlings needs to be further evaluated to determine if recruitment to the fishery improves.

Recent population estimate data suggests that Mount Tom Pond may be developing into a Walleye fishery after four years of stocking. However, at Lake Zoar, abundance sampling and angler survey data indicate that a Walleye fishery has yet to develop after five years of stocking. Therefore, further population monitoring is needed at Lake Zoar to determine if the program is going to be successful here and if the lake should continue to be stocked.

As reported by Leonard et al. (2016), the success of Connecticut Walleye fisheries varies among lakes. In order to fully understand these fisheries recent information is needed on all WMLs. For example, relative abundance sampling for Walleye at Beach Pond has not been conducted since 2011 and the only population estimate was conducted in 2007. Although State personnel resources are currently limited, regular sampling of the WMLs remains important in tracking the relative success among and changes within our state's Walleye fisheries.

Recommendations

- Investigate reasons for the declining Walleye abundance in the eastern WMLs compared to the successes in others to further hone our management strategies.
- Determine the effectiveness of stocking larger-size fingerlings.
- Determine if newly stocked Walleye lakes (Mt. Tom Pond, Cedar Lake, West Thompson Reservoir, and Lake Zoar) are developing into quality fisheries.

Expenditures

Total Cost:	111,372
Federal Share:	83,529
State Share:	27,843

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Appendix 1. – Schnabel population estimates by size category of Walleye at Mount Tom Pond (Spring 2016). Estimates are calculated from a combination of trap nets and electrofishing.

Lake	Year	No. of Year Classes	Size ≥ 10 in.	95% CI	Density #/ac	Size ≥ 15 in.	95% CI	Density #/ac	Size ≥ 18 in.	95% CI	Density #/ac	Size ≥ 20 in.	95% CI	Density #/ac
Mt. Tom (56 acres)	2016	4	78	48-127	1.4	60	36-98	1.1	51	28-94	0.9	32	9-122	0.6

Appendix 2. – Relative abundance (electrofishing catch per hour) for all sizes, quality size (≥15 inches), legal size (≥18 inches) and large size (≥20 inches) Walleye from lakes sampled during April 1995-2016. Initial year stocked with Walleye fingerlings in parentheses.

	Gardner (1993)				Coventry (2001)				Mount Tom (2012)				Zoar (2011)			
Year	All	≥15	≥18	≥20	All	≥15	≥18	≥20	All	≥15	≥18	≥20	All	≥15	≥18	≥20
1995	35.0	0.0	0.0	0.0												
1996	45.8	27.7	1.6	0.0												
1997	NS															
1998	NS															
1999	110.0	95.6	18.2	2.2												
2000	70.9	66.9	10.8	1.9												
2001	57.0	38.8	13.7	1.0												
2002	56.4	39.1	15.5	2.3												
2003	50.8	32.8	7.0	0.0												
2004	47.9	37.4	7.8	0.9	15.9	0	0	0								
2005	57.5	45.8	20.5	5.9	25.8	1	0	0								
2006	51.4	47.2	14.2	4.2	44.9	5	0	0								
2007	NS				15.3	4.7	0	0								
2008	123.9	116.7	36.1	8.4	22.5	2.6	0	0								
2009	19.2	19.2	3.6	1.2	27.6	9.2	0	0								
2010	42.6	17.0	6.4	0.0	NS											
2011	17.3	12.4	4.9	3.7	21.4	9.5	1.2	1.2								
2012	33.3	28.6	17.9	6.0	NS											
2013[a]	10.1	8.4	2.9	1.1	33.4	10.7	2.4	2.4								
2014[a]	8.0	7.5	1.8	0.0	NS											
2015	NS				14.8	9.1	0	0	19	15.8	4.7	0	3.6	1.2	0	0
2016	9.4	7	4.7	1.2	8	6.8	0	0	21	19.6	16.8	4.2	12.1	5.5	0	0

NS = Not sampled in that year

[a] Entire lake sampled at Gardner Lake, not standard sites.

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Annual Performance Report

2016-17

Connecticut Fisheries Division

Channel Catfish Management

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

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Study 2: Warmwater Fisheries Program
Job 7: Channel Catfish Management

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Report Prepared by: Neal Hagstrom

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Date Submitted: September 4, 2017

Approved by: Peter Aarrestad
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Cover photo: Edwin Stackhouse Finch with a 14lb Channel Catfish caught at Batterson Pond in 2016. Photo from Iain Sorrell.

Summary

In Connecticut, Channel Catfish occur in naturalized riverine populations and in a number of Catfish Management Lakes (CMLs) that are annually stocked with commercially raised catfish by the Connecticut DEEP Fisheries Division (FD). The naturalized catfish population in the Connecticut River has considerable untapped fishery potential; the status of populations in other large river systems in the state is unclear. The FD Channel Catfish stocking program has grown from 12 CMLs in 2007 to now include 26 managed waters. This report documents completion of annual stocking objectives and preparations for the 2017 stockings.

Background

Since the late 1970s, the Connecticut River has supported a naturalized Channel Catfish population (Jacobs et al. 2004). Angler surveys of the Connecticut River in 1997-98 (Howell and Molnar 1999) and 2007-8 (Davis et al. 2011) revealed that catfish species (predominantly Channel Catfish) supported a popular targeted fishery. In the most recent survey, anglers spent an estimated 20,000 hours annually fishing for catfish species (8% of total annual effort), caught 30,000 catfish and harvested 60% of those fish (Davis et al. 2011). Channel Catfish (hereafter referred to as "catfish") have historically not been a major component of lake and pond fisheries in Connecticut. However, some catfish caught from public lakes have been very large (including the current state record of 29 lbs 6 oz caught from Mashapaug Lake) indicating that catfish can survive and grow to substantial sizes in Connecticut waters.

FD Biologist Justin Davis with a large Channel Catfish collected from the Connecticut River in 2012. Photo by Neal Hagstrom.

Catfish stockings can create fishing opportunities in small urban ponds (Stuewe 1999), and therefore represent a promising option to expand fishing opportunities for residents living in densely populated areas (Barry et al. 2011). Recognizing this potential, the FD initiated a catfish stocking program in 2007.

The FD's catfish stocking program began in 2007 at 11 CMLs (see Fig. 1,). Four CMLs were stocked with large (14-18 inch) adult catfish to create "put-and-take" fisheries that would provide immediate opportunities for anglers to catch and

harvest large catfish. Six “put-and-grow” CMLs were stocked with smaller (9-11 inch) yearling catfish. Two CMLs (Lakewood Lake and Lake Wintergreen) were stocked with both adult and yearling fish. See Davis et al. 2016 for a detailed review of the program. The program has been expanded several times to add additional waterbodies.

The purpose of this report is to summarize catfish-related work conducted during 2016-17.

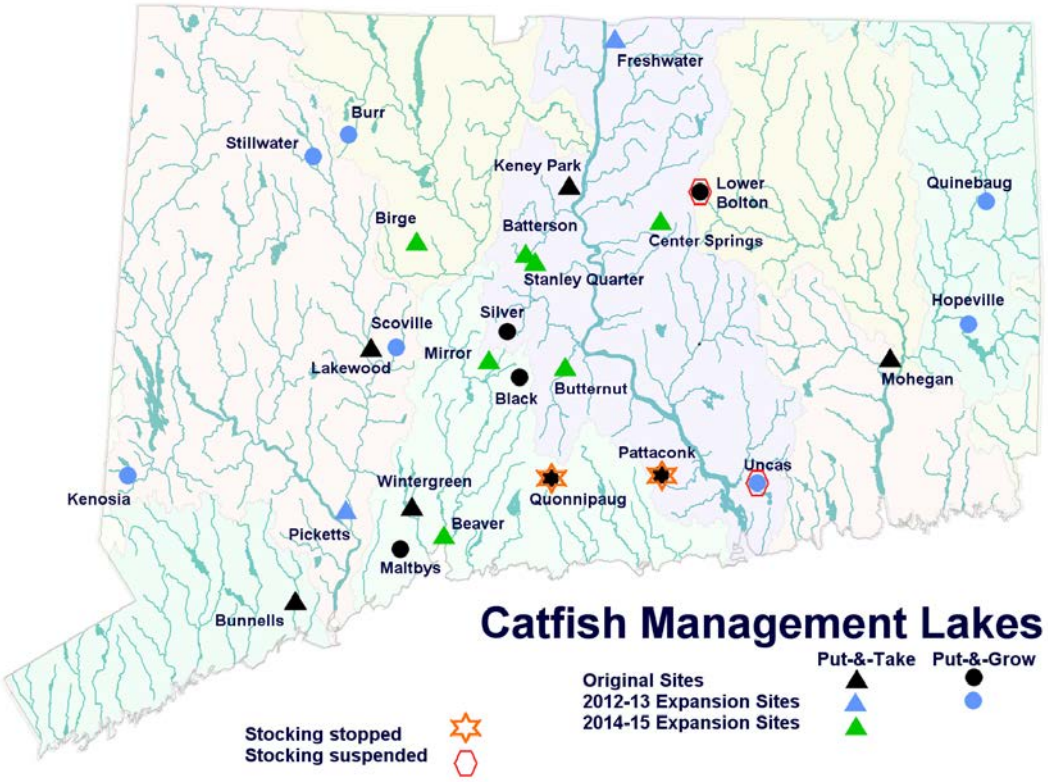

Figure 1. Locations of Catfish Management Lakes in Connecticut.

Note: The Connecticut DEEP Inland and Marine Fisheries Divisions were merged into a single Fisheries Division in January of 2017. Although the majority of the work for this report was conducted while we were still Inland Fisheries, the new designation has been incorporated herein.

Findings

Currently, there are a total of 28 CMLs; 14 Put-and-Take CMLs, 14 Put-and-Grow CMLs, and two waterbodies (Lakewood Lake and Lake Wintergreen) that are stocked with both sizes of fish. In 2016, a total of 26 CMLs were successfully stocked with catfish at rates of 3-75 adults/acre

and/or 3-11 yearlings/acre (Appendices 1 and 2). Only 30 adult catfish were stocked into Mirror Lake in 2016 due to poor water quality (dense algal bloom and recent fish kill). The remainder of fish (370 adults) scheduled for Mirror Lake were stocked into Silver Lake.

Lower Bolton Lake was not stocked with catfish again in 2016 at the request of the town of Bolton (See Davis et al. 2016 for discussion of situation).

Recommendations

- Stock Channel Catfish in Connecticut's CMLs as resources and time permits.
- Resume stocking catfish in Lower Bolton Lake in 2017.

Expenditures

Total Cost:	89,564
Federal Share:	67,173
State Share:	22,391

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Appendices

Appendix 1. Numbers of adult Channel Catfish stocked annually into Connecticut Catfish Management Lakes. Stocking rates (per acre) appear in parentheses next to numbers of adults stocked. Note that Lakewood Lake and Lake Wintergreen also received annual stockings of yearling catfish (see Appendix 2).

Lake	Acres	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Original Lakes											
Bunnells Pond	42	1,500 (36)	1,500 (36)	1,500 (36)	1,500 (36)	1,500 (36)	1,000(24)	1,080 (26)	750 (18)	800 (19)	800 (19)
Keney Park Pond	3	750(250)	500 (167)	500 (167)	500 (167)	500(167)	250 (83)	600(200)	300(100)	275 (92)	225 (75)
Lakewood Lake	60		1,250 (21)	1,250 (21)	1,250 (21)	1,250 (21)	915 (15)	1,180 (20)	800 (13)	800 (13)	900 (15)
Mohegan Park Pond	14	750 (54)	750 (54)	750 (54)	750 (54)	750 (54)	250 (18)	600 (43)	550 (39)	685 (49)	625 (45)
Wintergreen Lake	58	1,500 (26)	1,200 (21)	1,200 (21)	1,200 (21)	1,200 (21)	900 (16)	1,080 (19)	800 (14)	800 (14)	900 (15)
Silver Lake	146										370 (3)*
2012 Expansion Lakes											
Freshwater Pond	8						500 (63)	540 (68)	400 (50)	500 (63)	350 (44)
Pickett's Pond	9						500 (56)	600 (67)	400 (44)	400 (44)	450 (50)
2014 Expansion Lakes											
Beaver Park Lagoon	9								400 (44)	350 (39)	400 (44)
Birge Pond	12								550 (46)	450 (38)	450 (38)
Butternut Park Pond	3								200 (67)	200 (67)	150 (50)
Center Springs Park Pond	6									325 (54)	225 (38)
Mirror Lake	7								350 (50)	300 (43)	30 (4)*
Stanley Quarter Park Pond	6								300 (50)	275 (46)	300 (50)
SUM		**4,500**	**5,200**	**5,200**	**5,200**	**5,200**	**4,315**	**5,680**	**5,800**	**6,160**	**6,175**

* 370 adult catfish were diverted from Mirror Lake to Silver Lake due to poor water quality.

Appendix 2. Numbers of yearling Channel Catfish stocked annually into Connecticut's Catfish Management Lakes. Stocking rates (per acre) appear in parentheses next to numbers of yearlings stocked. Note that Lakewood Lake and Lake Wintergreen also received annual stockings of adult catfish (see Appendix 1).

Lake	Acres	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Original Lakes											
Black Pond	76	1,216 (16)	1,200 (16)	1,200 (16)	700 (9)	1,200 (16)	1,448 (19)	875 (12)	725 (10)	760 (10)	760 (10)
Lower Bolton Lake	175	2,836 (16)	2,800 (16)	2,800 (16)	2,800 (16)	2,800 (16)	2,667 (15)				
Maltby Lake #2	19	355 (19)	350 (18)	350 (18)	350 (18)	350 (18)	365 (19)	210 (11)	215 (11)	190 (10)	205 (11)
Maltby Lake #3	23	355 (15)	350 (15)	350 (15)	350 (15)	350 (15)	407 (18)	210 (9)	235 (10)	225 (10)	230 (10)
Pattaconk Lake	56	748 (13)	800 (14)	800 (14)	800 (14)	800 (14)	839 (15)	700 (13)	720 (13)		
Quonnipaug Lake	99	1,233 (12)	1,250 (13)	1,250 (13)	1,250 (13)	1,250 (13)					
Silver Lake	146	2,419 (17)	2,400 (16)	2,400 (16)	2,400 (16)	2,400 (16)	2,251 (15)	1,750 (12)	1,500 (10)	1,500 (10)	1,365 (9)
Wintergreen Lake	58	758 (13)	750 (13)	750 (13)	750 (13)	750 (13)	750 (13)	700 (12)	720 (12)	580 (10)	615 (11)
2012 Expansion Lakes											
Hopeville Pond	137						2,138 (16)	1,050 (8)	1,285 (9)	1,370 (10)	1,385(10)
Lake Kenosia	60						1,516 (25)	875 (15)	695 (12)	600 (10)	545 (9)
Quinebaug Lake	88						1,662 (19)	1,050 (12)	1,290 (15)	880 (10)	545 (6)
Stillwater Pond	100						1,731 (17)	875 (9)	930 (9)	1,000 (10)	1,200 (12)
2013 Expansion Lakes											
Batterson Park Pond	140							875 (6)	285 (2)	425 (3)	410 (3)
Burr Pond	85							1,225 (14)	825 (10)	850 (10)	900 (11)
Lakewood Lake	60							2,835 (47)	627 (10)	600 (10)	680 (11)
Scoville Reservoir	121							1,575 (13)	1,147 (9)	1,200 (10)	1,180 (10)
Uncas Lake	69							1,050 (15)			
SUM		**9,920**	**9,900**	**9,900**	**9,400**	**9,900**	**15,774**	**15,855**	**11,199**	**10,180**	**10,700**

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Annual Performance Report

2016-17

Connecticut Fisheries Division

Inland Fisheries Coordination and Administration

Connecticut Department of Energy & Environmental Protection
Bureau of Natural Resources
Fisheries Division
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SPORT FISH RESTORATION

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

Grant Title: Inland Fisheries Research and Management
Study 3: Inland Fisheries Coordination and Administration
Job 1: Inland Fisheries Operations

Period Covered: April 1, 2016 to March 31, 2017

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Cover photo: Connecticut's fisheries offer quality and diversity to the anglers who partake in recreational fishing.

Purpose

Fisheries Division (FD) staff must provide services to the angling public to ensure the proper protection and management of Connecticut's fishery resources. These activities are necessary so that current knowledge and the results of research and management projects can be broadly applied. Included in these activities are; public outreach, access development, planning, and permit review.

The FD is frequently required to administer projects and collect information due to unforeseen circumstances (ex. fish needed for contaminant analysis, investigation of fish kills). In addition, opportunities to collect valuable information often arise. It is important that the FD be able to meet these demands and take advantage of opportunities.

Objectives:

- Provide general fisheries information to the public.
- Ensure that data can be collected where needed to evaluate programs and to take advantage of opportunities.

Approach

- Prepare press releases, fishing advisory reports and articles for circulation to the media
- Create and share administration of social media
- Update web pages to reflect current FD programs, reports, and other outreach materials
- Serve on the editorial board of Connecticut Wildlife Magazine
- Encourage anglers to submit digital photos for FD publications and electronic media, including Angler's Guide photo contest
- Respond to public inquiries for fisheries information (telephone, emails, and letters)
- Give presentations on fisheries issues to school groups and organizations (angler clubs, Scouts, The Nature Conservancy, etc.)
- Provide guidance for the use of ezFile, an on-line permit application and review system, for submission and processing of permits (Fishing Tournament, Fish Importation/Liberation, Scientific Collectors) to promote proper management and to facilitate public enjoyment of fisheries resources.
- Plan and coordinate operations, personnel and equipment so that data can be collected where needed
- Participate in hunting and fishing fairs, shows, days, etc.
- Provide clerical support on all F-57-R projects

Key Findings

- Press releases (18) and fishing reports (30 weekly reports) were prepared and distributed to the media, providing information on fisheries enhancement programs
- Interviews were provided to radio and television (approximately 20)
- Provided editorial review or authored six fisheries related articles in Connecticut Wildlife Magazine
- Shared angler posts and questions on the Facebook page with all CT Fish and Wildlife members (currently 20,713 likes)
- Hosted 15 Facebook Live sessions (averaged approximately 4,000 views each)
- "Tweeted" fishing related info over 100 times (currently 311 followers)
- Established account and posted 15 times on FishBrain (most popular fishing app in the world).
- Approximately 50 presentations were made to school groups and organizations requesting information on fisheries issues
- Responses to public inquiries for fisheries information were provided upon request
- Compiled quarterly "News and Updates" reports for the Fisheries Advisory Council and distribution to the public
- Published the Annual Fish Stocking Report
- Guidance was provided 1) to anglers participating in 872 fishing tournaments, 2) to individuals making 198 requests to import and 337 requests to liberate fish, 3) to approximately 35 individuals or organizations requesting authorization to collect scientific data on fish populations, and 4) 288 requests to import bait (retail bait dealers)
- Published monthly e-newsletter, *CT Fishin' Tips* and *The Weekly Fishing Report*, using Constant Contact (6,653 and 5,650 subscribers respectively)
- Facilitated two Free Fishing License Days on June 19 and August 13, 2016 (459 and 546) participants respectively. A post-event survey of participants was compiled for each of the days.
- Developed and staffed public exhibitions including; The Northeast Hunting and Fishing Show, Connecticut Hunting and Fishing Day, Free Fishing Day, and the annual Saltwater fishing event.
- Facilitated the annual Trophy Fish Program award ceremony

Conclusions

- Ongoing efforts to communicate fisheries information to anglers and the general public were accomplished
- Fisheries Management (inland) operations were scheduled and completed.
- Electronic distribution of information is timely, convenient, and cost effective

Recommendations

- Continue ongoing efforts to communicate fisheries information to anglers and the general public, especially through the development of interactive maps and smartphone applications
- Continue scheduling and coordinating Inland Fisheries Management operations
- Continue to utilize electronic media as a tool to deliver interesting and educational material to engage constituents, especially through live streaming like Facebook Live.
- Increase effort to maintain and update current information on our web pages

Estimated Costs

Total Cost:	74,693
Federal Share:	56,020
State Share:	18,673