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Connecticut Inland Fisheries

Housatonic River Research and Management



Connecticut Department of Energy &
Environmental Protection
Bureau of Natural Resources
Inland Fisheries Division
79 Elm Street, Hartford, CT 06106
860-424-3474

www.ct.gov/deep/fishing
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Inland Fisheries Division



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Report Prepared by: Michael Humphreys and Brian Eltz

Job Personnel: Michael Humphreys, Job Leader
Brian Eltz, Job Leader
Neal Hagstrom, Primary Staff
Timothy Barry, Program Coordinator
Robert Jacobs, Assistant Program Coordinator

Date Submitted: May ??, 2015

Approved by: Peter Aarrestad
Director, Inland Fisheries Division

William Hyatt
Chief, Bureau of Natural Resources



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Cover photo: Sampling trout in the upper Housatonic TMA at the Furnace Brook thermal refuge.

Summary

Water temperatures in the Housatonic River during the past five summers (2010-2014) have varied considerably, regularly exceeded short-term lethal levels for trout in some years, while remaining suitable in others. In 2014, water temperatures remained cool and flows remained high throughout the summer, and trout survival in the mainstem of the river was better than usual. For the past four years, most Brown Trout stocked by the Inland Fisheries Division (IFD) into the two year-round catch-and-release Trout Management Areas (TMAs) on the Housatonic River have been double marked with an adipose fin clip and a variety of colors and placements of visible implant "elastomer" tags. This has allowed long-term tracking of survival and growth of twenty different strain/size/stock date combinations of Brown Trout. Results show some highly significant differences among groups of stocked fish: 1) short-term survival differences among strains (Cortland and Survivor) have been inconsistent among TMAs, and may be dependent on the degree of size-selective predation in thermal refuges vs. the open river. 2) Survivor-strain fish have consistently shown better long term survival, producing more "holdovers" in the years following stocking. Marked holdover Brown Trout sampled in 2013 (N = 80) were all Survivors, and individuals from all six groups of Survivors stocked in 2011 and 2012 were present in 2013 samples. Marked holdover Brown Trout sampled in 2014 (N = 21) were all Survivors, with the exception of one Cortland-strain fish sampled from the Tenmile River, and individuals from all nine groups of Survivors stocked in 2011, 2012, and 2013 were present in 2014 samples. 3) Larger Survivors stocked in the fall produce more holdovers than Survivors stocked in the spring. Fry-stocked and wild Brown Trout, and occasionally naturally spawned Rainbow Trout are contributing to the Housatonic trout fisheries.

Recruitment of non-game species in 2013 and 2014 was very low; poor recruitment of five minnow species apparently corresponds to high late spring and summer flows.

In 2014, as in previous years, all Smallmouth Bass were netted and measured during sampling, and scale samples were collected and aged. Analyses of all smallmouth data will be presented in the final segment report.

Some NRD grant funds allocated for increased law enforcement in 2011-2013 were not spent; remaining funds were used to enhance patrolling efforts again in 2014. Ten Connecticut Environmental Conservation Police officers (ECP) patrolled 195 hours on the Housatonic in 2014. Between May 13 and September 27, a total of 231 contacts were made, and 61 violations were addressed resulting in 11 arrests. As in 2011, 2012, and 2013, fishing without a license was the most common violation (39 violations, 64% of the total). The New Milford Section and the Bulls Bridge Trout and Bass Management Area (TBMA) were the river sections with the highest number of violations (48% and 21% of all violations, respectively).

Background

Despite contamination by PCB's, the Housatonic River supports important trout and Smallmouth Bass fisheries in its upper free-flowing reaches (Falls Village to New Milford). From 1981 to the present, considerable research has been conducted by the Connecticut Inland Fisheries Division (IFD) on trout and Smallmouth Bass populations in two Trout Management Areas (TMAs), two Bass Management Areas (BMAs), and several other free-flowing sections of the upper river. In addition, angler surveys have been conducted to help answer management questions, and to quantify angler usage, catch rates, opinions, and expenditures.

The IFD currently stocks Brown Trout and Rainbow Trout into two, year-round catch-and-release TMAs. The Housatonic River-Cornwall TMA and the Bulls Bridge TBMA require assessment of the stocked trout (by species, strains, sizes, and seasons) to determine best management practices for providing strong populations that include some holdover fish.

The Housatonic River supports one of the most abundant populations of relatively large-size (>12 inch) riverine Smallmouth Bass in Connecticut. Due to strong evidence of Smallmouth Bass overharvest in the Bulls Bridge TBMA (severely truncated length-frequency distribution), the State's first catch-and-release regulations on riverine Smallmouth Bass were implemented on this section of river in 2003. Results from annual assessments of the bass population and an angler survey conducted in 2006 indicated that documented poaching has impaired the area's bass (and trout) fisheries. The IFD received a grant from the General Electric Natural Resource Damages Settlement Agreement (NRD) to fund increased law enforcement within the upper river to discourage poaching. IFD is coordinating activities with Connecticut Environmental Conservation Police officers (ECP), and will determine the success of the catch-and-release regulations concurrent with increased law enforcement. This has required a follow-up angler survey on the entire upper river in 2013. The angler survey was also conducted to assess recent changes in trout stocking, status of the Smallmouth Bass fisheries, and need and potential for active management of fisheries outside of the TMAs.

Although the Housatonic River becomes warm in the summer, trout can survive in thermal refuges (cool areas located at mouths of tributaries) during hot spells. Previously, "pond-and-release" flows from the Falls Village and Bulls Bridge power plants disrupted thermal refuges, and occasionally caused fish kills. In 2005, the flow regime of the river was changed from pond-and-release to "run-of-river", by ruling of the Federal Energy Regulatory Commission (FERC). Assessment of the potential changes to the river's fish community in response to this change in the flow regime is on-going. Additionally, habitat improvements to enhance thermal refuges for trout are on-going. These efforts seek to provide trout with a larger volume of coldwater habitat and overhead shelter as protection against predatory birds.

Year-round catch-and-release regulations in both Housatonic River TMAs provide an opportunity to determine whether the "Survivor strain" of Brown Trout (see Study 1, Job 5) may perform better than the IFD's standard domestic hatchery strain of Brown Trout (Cortland). Multiple, "head-to-head" performance tests between the Survivors and Cortlands are being conducted in both TMAs. Brown Trout fry stocking in tributaries has shown promise for producing additional high-quality semi-wild trout for river fisheries. Stocking of Survivor-strain fry in the lower reaches of 14 Housatonic River tributaries is being evaluated. Some limited natural reproduction by Rainbow Trout has recently been documented in the lower reaches of nine tributaries to the upper river. Rainbow Trout reproduction on this scale has not previously been documented in Connecticut, and warrants further investigation.

More information is needed on some sections of the river. Three free-flowing segments of the upper Housatonic River, totaling 15 miles, are not currently stocked with trout by the IFD; however, some of these sections are regularly stocked with thousands of trout by a private group in spring and fall. The potential value of stocking and managing trout in these public areas needs to be fully explored. Also, very little information has been collected on Smallmouth Bass in some areas of the river. Basic abundance, population structure, and growth rate data are needed to assess current status and management potential. A better understanding of Smallmouth Bass populations throughout the river will help to select optimal management strategies for all areas. Northern Pike are expanding in certain sections of the river. Assessment of developing pike fisheries and expanding pike populations are yet other reasons for taking a comprehensive look at all sections of the upper Housatonic River.

The purpose of Job 6 (Housatonic River Research and Management) is to optimize angling quality for trout and Smallmouth Bass in the upper portions of the Housatonic River, and to better understand the dynamics of the entire fish community. This is addressed via the following objectives:

- ◆ In the TMAs, maintain trout abundance and size distributions at levels that provide quality fishing by maximizing trout survival over multiple years.
- ◆ Maximize angler catch rates and satisfaction by determining best trout stocking practices (species, strains, size composition, and timing).
- ◆ Enhance thermal refuges.
- ◆ Assess the performance of Farmington Survivor-strain Brown Trout in the Housatonic TMAs, and investigate the potential for developing a strain of Brown Trout best suited for extended survival, in seasonal, thermally stressed environments.
- ◆ Assess Smallmouth Bass and the rest of the fish community throughout all sections of the river, and determine the most appropriate management options.

- ◆ Complete assessment of catch-and-release regulations for Smallmouth Bass and trout in the Bulls Bridge TMA under increased law enforcement.
- ◆ Monitor variations in river water temperature via temperature data loggers deployed at standard sites along the river and at thermal refuge streams.
- ◆ Assess natural Rainbow Trout reproduction and supplemental Brown Trout fry stocking in Housatonic tributaries in conjunction with Study 1, Job 4, Wild Trout Management.

This report summarizes trout and bass sampling information, angler survey analyses, and law enforcement records collected during 2011, 2012, 2013, and 2014.

Approach

- ◆ Standardized numbers, sizes, species, and strains of trout are stocked into TMAs each spring and fall.
- ◆ Trout cohorts are marked with different combinations of fin clips and elastomer tags, and measured for total length prior to stocking.
- ◆ Trout, Smallmouth Bass, and other fish species are sampled by standardized electrofishing in late summer.
- ◆ Samples of trout, bass, and other species are provided to a private General Electric contractor for PCB contamination monitoring. Elastomer tags are used to determine PCB exposure time of trout samples.
- ◆ Scale and occasionally otolith samples are collected from smallmouths at each sample site each year, and fish ages and growth rates are determined.
- ◆ Thermal refuge enhancement work is coordinated with volunteers and completed in late spring or early summer.
- ◆ Water temperature data loggers are deployed spring to fall at thermal refuges and mainstem standard sites, to monitor summer water temperatures.
- ◆ Brown Trout fry are stocked into Housatonic tributary streams in the spring, and assessed by backpack electrofishing in conjunction with Job 4, Wild Trout Management.
- ◆ Natural reproduction of Rainbow Trout is monitored in tributary streams by backpack electrofishing in conjunction with Job 4, Wild Trout Management.
- ◆ A roving angler survey with a stratified, random design (Malvestuto et al. 1978) was

conducted on the entire upper river during 2013, to determine angler effort, catch, harvest, catch rates, opinions, and habits.

- ◆ Angler compliance with fishing regulations is assessed using ECP records and angler survey data.
- ◆ Presentations are regularly given to organized angling clubs to update them on progress and findings.

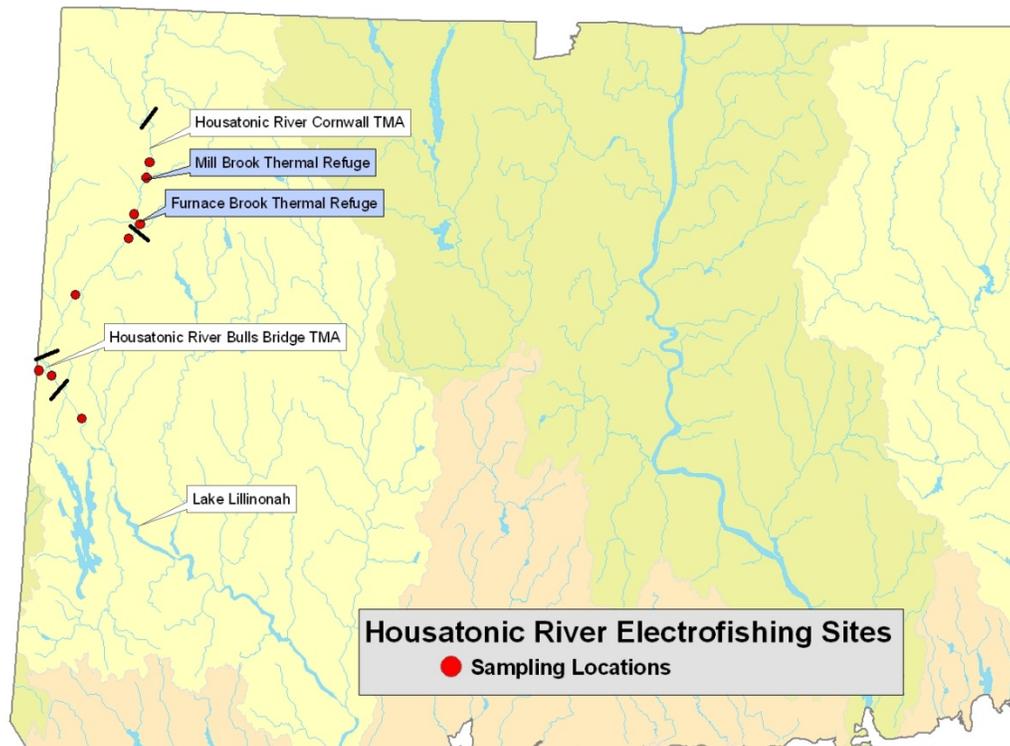
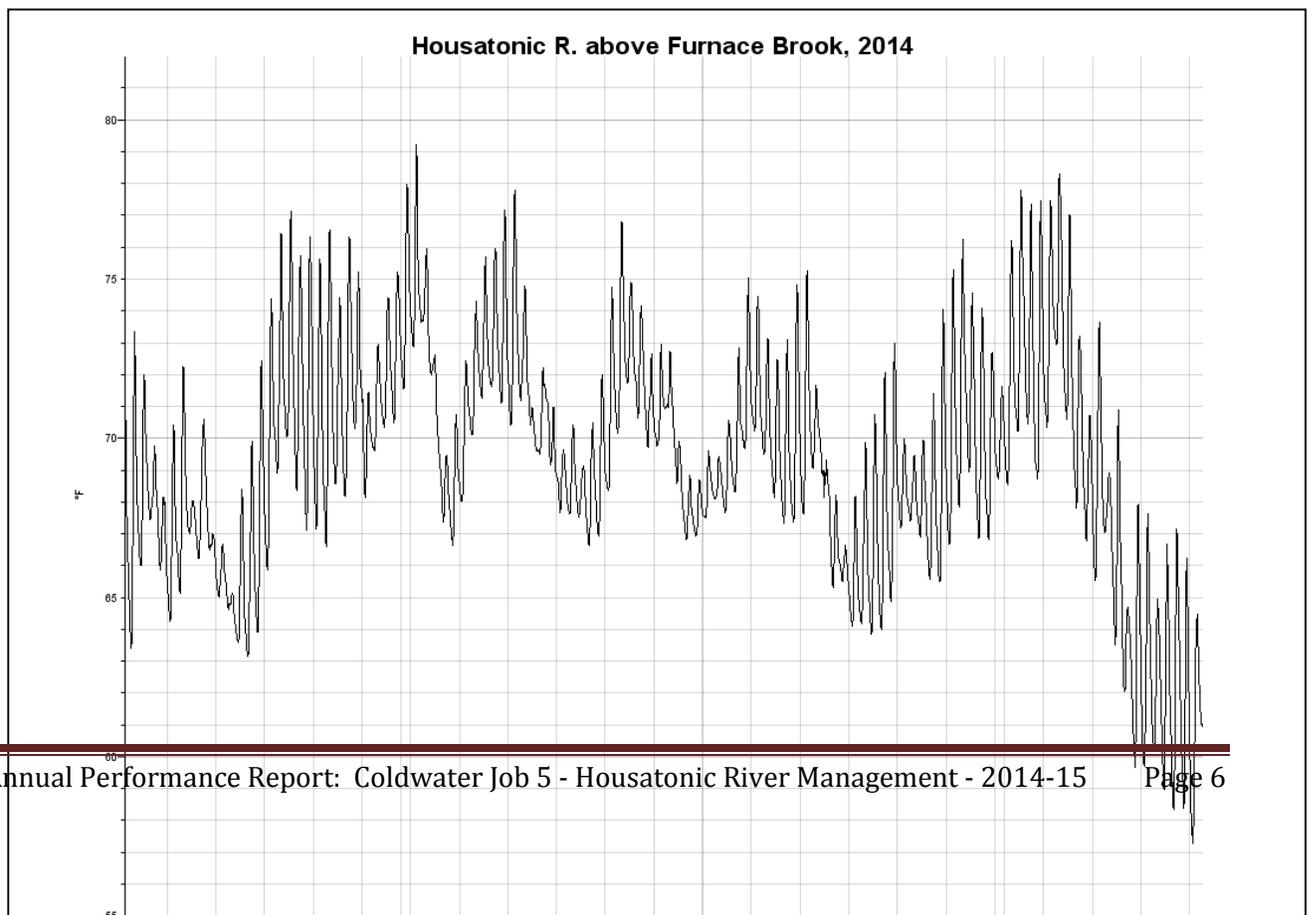


Figure 1. Standard Housatonic River sample sites sampled annually 2011-2014.

Key Findings

- ◆ A number of past weather events negatively affected the population structures of trout, Smallmouth Bass, and other species present in the Housatonic River at sampling time in late summer 2014.
 - Conditions for over-summer survival of trout in 2010, 2011, and 2012 had been poor due to low flows and high temperatures. Summer trout kills occurred in all three years on days when air temperatures exceeded 95-100°F, and maximum water temperatures reached 85 – 88°F in the TMA and TBMA. During the summer of 2013, water temperatures spiked to lethal levels during a brief period in mid-July (Maximum water temperatures were 85.6°F in the Cornwall TMA, and 85.8°F in the Bulls Bridge TBMA) which caused a minor trout kill, but flows were high in the mainstem and cold tributaries, and consequently trout survival proved to be fairly good overall. During the summer of 2014, water temperatures remained unusually cool (Figure 2) and flows were unusually high (Figure 3). Air temperature never reached 90°F all summer, and the maximum water temperature at the Cornwall TMA was only 79.2°F. During visual checks of thermal refuges, only a few trout were observed on rare occasions. During several summer high-flow events, the water became unusually turbid, which may have affected some species.



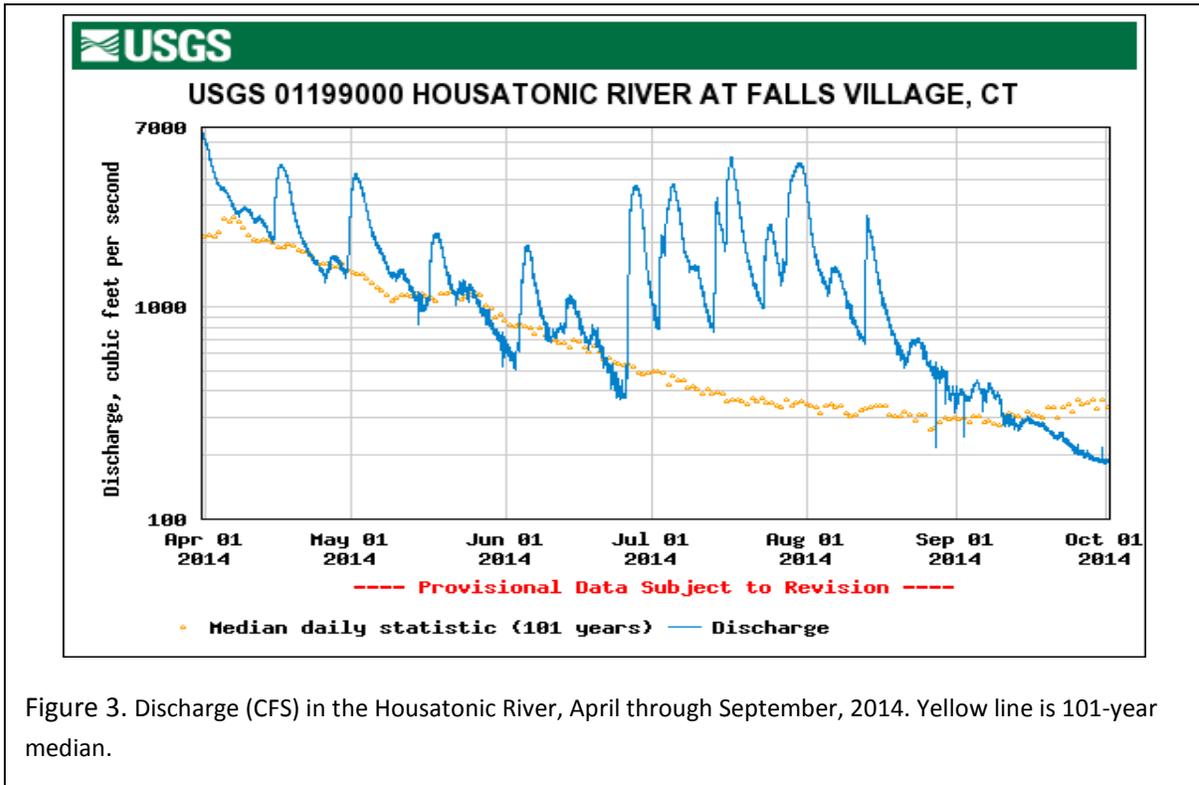


Figure 3. Discharge (CFS) in the Housatonic River, April through September, 2014. Yellow line is 101-year median.

- ◆ Summer water temperatures remained below 77.5°F in thermal refuges during the past five summers.
- ◆ In the spring and fall of 2014, standard numbers and strains of Brown Trout and Rainbow Trout were stocked into the two TMAs (Appendix 1). Spring rainbows were reduced in the Cornwall TMA (from 3,000 to 1,860) due to a shortage of available fish. Fall rainbow adults at Bulls Bridge (2,500) were replaced with large Cortland-strain fingerling Brown Trout (2,000), and >12 inch Cortland browns (500) due to poor fall rainbow catch documented in the 2013 angler survey and very few if any rainbows in late summer samples.
- ◆ In 2014, not all Brown Trout cohorts were adipose-fin-clipped and elastomer tagged as in 2011-2013 (Appendix 1 and Appendix 2). Only spring-stocked yearlings and fall-stocked large Survivors stocked into the Cornwall TMA, were clipped and tagged. Of the 1,500 large adult Brown Trout stocked in fall of 2014, 500 were Survivor strain (Avg. 11.9 inches, all stocked into the Cornwall TMA); the other 1,000 were slightly larger, Cortland strain Brown Trout (Avg. 13.1 inches; 500 stocked into the Cornwall TMA and 500 stocked into the Bulls Bridge TBMA). Spring yearlings stocked into the Bulls Bridge TBMA were all unmarked Survivors (4,000 at 8.6 inches). Spring yearlings stocked into the Cornwall TMA were all clipped and tagged (1,525 Survivors at 8.6 inches; 1,570 Cortlands at 8.3 inches). Spring-stocked adults were all Cortland strain (3,000 stocked into the Cornwall TMA; 2,000 stocked into the Bulls Bridge TBMA; no length measurements were taken). The new fall stocking of 2,000 fingerlings (7.4 inches) in the Bulls Bridge TBMA were all Cortlands. For the first time a

small number of brown trout fry (11,000) were experimentally stocked into the Tenmile River portion of the Bulls Bridge TBMA).

- ◆ In 2014, tag retention was high (99-100%) in two groups tagged at a larger size prior to stocking (7 days post tagging), and much lower (71%) for the one group tagged at a small size and 154 days prior to stocking (Appendix 2).
- ◆ In 2014, sampling in the main stem was conducted approximately one month later than usual due to high flows, and not all standard sites (Figure 1) were sampled due to a staffing shortages:
 - Three of four standard sites were sampled in the upper Cornwall TMA: two mainstem sites- “Turnip Island” and “Push'em Up”, and one thermal refuge- “Furnace”. “Mill” refuge was not sampled in 2014.
 - Both standard sites were sampled in the Bulls Bridge TBMA: “Gunns Eddy” and the Tenmile River.
 - None of the three sites outside of the TMAs (“Swifts Bridge”, “Gravestone”, and “Squash Hollow”) were sampled in 2014.
- ◆ The possible need for scheduling volunteer thermal refuge enhancement work during 2014 was assessed as each spring/summer weekend approached. Because flows were high and temperatures were cool from late June through August, there was no need or opportunity to work in refuges.

Trout Populations

- ◆ Of 443 trout sampled in standard Housatonic River sample sites during 2014, 152 (34%) were from the Cornwall TMA, and 291 (66%) were from the Bulls Bridge TBMA. The vast majority of trout sampled from the Cornwall TMA (116; 76%) were found at the two mainstem sites, not in Furnace Refuge. Cornwall’s Mill refuge was not sampled, but no trout were observed congregated there at any time during the summer of 2014. At the Bulls Bridge TBMA, trout were sampled throughout the mainstem Housatonic (110) and Tenmile (181). In 2011, 2012, and 2013, a total of 415, 775, and 383 trout were sampled, respectively, in both TMAs combined.
- ◆ A total of 412 Brown Trout were sampled in the Housatonic River in September 2014:
 - Sixty-one fin-clipped Brown Trout were netted and examined under ambient light conditions; of those, 54 (89%) retained their elastomer tag. Tag retention observed in the field during August of 2011, 2012, and 2013 was 92%, 88%, and 84%, respectively.
 - In 2014, stocking-to-first-summer growth increments were 1.9 inches for Survivor yearlings, and 1.6 inches for Cortland yearlings **in the Cornwall TMA** (recall that clipped/tagged yearlings were only stocked in the Cornwall TMA in 2014; Appendix 3).

The growth increment of Survivor yearlings was similar to that found in 2013 (2.0 inches), but higher than those found in 2012 (1.3 inches) and 2011 (1.6 inches). Similarly, Cortland yearling stocking-to-first-summer growth was less than what was observed in 2013 (2.0 inches), but greater than in 2012 (0.9 inches); no Cortland yearlings were stocked in spring 2011. Long-term growth comparisons between strains for trout stocked in the springs of 2012 and 2013 were not possible because too few holdovers were sampled (2012- 4 Survivors and 0 Cortlands; 2013- 3 Survivors and 1 Cortland). However, growth of Survivors stocked spring 2011, 2012, and 2013 in the Cornwall TMA was high (Average 10.3 inches (124%), 9.3 inches (107%), and 6.4 inches (79%), respectively).

- Survivor yearlings stocked in September 2011 at 11.4 inches, grew to 18.9 inches (range 18.3-19.4 inches) by September 2014, an increase of 7.4 inches (65%) in 3 years.
- Long-term growth comparisons of large Cortlands and Survivors stocked at similar sizes in September 2011-2013 were not possible because no hold-over Cortlands and only three Survivor strain fish were recaptured in September 2014 (from the previous 3-years stockings).
- Survivor yearlings stocked in September 2012 at 10.9 inches, grew to 18.0 inches (N = 2; range: 17.5 – 18.5 inches), by September 2014, an average increase of 7.1 inches in two years.
- Growth of Survivor yearlings stocked in September 2013 at 10.9 inches was negligible by September 2014 (0.71 inches) based on only two recaptures (11.1, 12.0 inches).
- Head-to-head strain comparisons of 2014 spring stocked yearlings in the Cornwall TMA show similar survival four months after stocking (Appendix 4). Too few fish were sampled from stockings prior to 2014 to make additional within-year head-to-head comparisons.
- Survivors stocked at different sizes and dates into the Cornwall TMA in 2013 were examined for relative ability to produce "holdover" trout in September samples the year following stocking. Too few fish were recovered from the three groups of Survivors stocked in 2013 (three spring stocked yearlings, two fall stocked yearlings, and one fall stocked large adult) to make conclusions regarding survival between the three groups of



Large 21-inch wild or fry-stocked Brown Trout from the Cornwall TMA.

fish.

- Twenty-one of 54 (39%) Brown Trout sampled with intact elastomer tags were holdovers that had been stocked prior to winter 2013-14. This percentage is slightly higher than what was observed in 2013 (31%) and 2012 (37%), possibly due to not tagging the spring-stocked adult Cortlands or any of the yearlings stocked in the Bulls Bridge TBMA in 2014. Eighteen of the holdovers were found in the Cornwall TMA, and three were sampled from the Bulls Bridge TBMA; all but one were of Survivor strain origin. No additional tagged brown trout were found during tributary sampling in 2014.
- Of all Brown Trout sampled, 26 (6%) were over 16 inches, 18 (4%) were over 18 inches, and 3 (0.7%) were over 20 inches. The largest Brown Trout sampled in 2014 was 21.6 inches, and was of wild or fry-stocked origin.
- Using interval mortality calculations (Guy and Brown 2007), mortality estimates for Brown Trout stocked during the spring of 2013 were calculated. Mortality of 2013 spring-stocked Brown Trout from time of sampling in August 2013 to time of sampling in September 2014 was high (75% - 100%) for all three cohorts (Survivor yearlings, Cortland yearlings, and Cortland adults) in both TMAs. Spring Cortland yearlings in the Tenmile River section of the Bull's Bridge TMA exhibited the lowest mortality (75%), but few were sampled during each year (four in 2013 and one in 2014). Spring Survivor yearlings exhibited high mortality in each TMA (96-97%), and no 2013 spring stocked adult Cortlands were observed in either TMA (100% mortality). Mortality calculations of this nature assume that the sample sites and sampling conditions are the same from year to year. Conditions in 2013 and 2014 were similar enough to have some value, however river flows and temperature profiles during these two summers were different enough to significantly affect trout distribution, trout sampling, and validity of calculations (In 2013, warm temperatures caused more trout to leave the mainstem and congregate in thermal refuges where they were more effectively sampled. In 2014, more trout were sampled in mainstem samples, and Mill Refuge was not sampled).
- Of all Brown Trout sampled, 36 (9%) were of wild or fry-stocked origin (4.1 to 21.6 inches). However, 28% of Brown Trout over 18 inches (five of 18) were determined to be of wild or fry-stocked origin.
- Seven of the 15 wild Brown Trout sampled from the Tenmile River were likely of fry stocked origin from the experimental spring stocking in 2014.
- ◆ A total of 31 Rainbow Trout were sampled in September 2014:
 - All (100%) were collected from within the Cornwall TMA (in 2011, 2012, and 2013, 93%, 98%, and 81% of all rainbows were from the Cornwall TMA, respectively). Of these, 29 were collected from mainstem sites, and two were collected from Furnace refuge. The

Swift's Bridge site, which was not sampled in 2014, usually contributed to the number of rainbows sampled in past years. This area of the river is stocked annually with Rainbow Trout by a private source.

- No adipose-clipped adult rainbows, stocked in the Cornwall TMA during the spring of 2012, were sampled.
- All rainbows were unmarked fish of hatchery origin. Two likely sources of these fish include direct stockings into the Cornwall TMA by IFD and fish stocked into the upper portion of the Cornwall TMA and below the TMA by a private group. Additionally, some may have been stocked in tributaries by IFD to support put-and-take fisheries, though these numbers are extremely low.
- In 2014, no rainbows in mainstem or refuge samples were identified as being wild spawned. In 2013, four (8%) were identified as wild spawned. In 2014, Rainbow Trout reproduction was documented in the lower reaches of one tributary (Kent Falls Brook), where 19 young-of-year were netted and more were observed.
- ◆ In 2013, an additional 139 Housatonic Project Brown Trout (elastomer-tagged and adipose-fin-clipped) were sampled from five tributary streams (Furnace Brook, Guinea Brook, Kent Falls Brook, Reed Brook, and Salmon Creek) and one additional thermal refuge (Kent Falls) of the Housatonic. Of those, the majority of clipped/tagged trout were found in Furnace Brook (127); the largest tributary entering the Cornwall TMA. In 2014, all of these same sites were sampled, but no stocked Brown Trout were collected. These data again confirm the substantially different trout distribution during these two years.
- ◆ 20,000-35,000 Survivor Brown Trout fry stocked into the lower reaches of 13 tributary streams in the spring of each of the past four years (2011-2014), generally survived well (see Wild Trout progress report, Job 6). However only seven fingerlings were recovered from the Tenmile River in 2014, indicating only a minor contribution from the fry experimentally stocked that spring.

Smallmouth Bass Populations

- ◆ In 2014, Smallmouth Bass were sampled from the three aforementioned mainstem Housatonic River sites, and from the Tenmile River, Bulls Bridge TBMA site. Data and analyses from these samples will be included in the final segment report.

Additional River/Species Sampling

- ◆ At the Cornwall TMA and the Bulls Bridge TBMA, abundance of minnow species along the margins of the river dropped to very low levels in 2013. Again in 2014, abundance of minnows along the margins was very low at sample time, however minnow larvae were observed to be very abundant on May 21, 2014. It appears that high summer flows may

limit minnow recruitment, as has been observed with smallmouth bass.

Enhanced Law Enforcement

- ◆ The original NRD Enhanced Law Enforcement grant was awarded to provide increased patrolling in 2011, 2012, and 2013. Allocated funds were not fully expended; consequently, the increased patrolling was extended at a reduced level, through summer 2014. ECP patrol records for 2014 were entered into a spreadsheet and summarized along with 2011, 2012, and 2013 data (Appendix 3).
 - Ten officers patrolled approximately 195 hours in 2014, compared to 337 hours in 2011, 504 hours in 2012, and 305 hours in 2013.
 - In 2014, the highest patrolling effort was in the New Milford Section (48 hours), and the Bulls Bridge TBMA (48 hours in the mainstem Housatonic River portion, and 0.5 hours in the Tenmile River section).
 - Between May 13 and September 27, 2014 a total of 231 contacts were made, and 61 violations (26% of contacts) were addressed resulting in 11 arrests.
 - In 2014, as in 2011, 2012, and 2013, fishing without a license was the most common offence (39 violations, 64% of the total). This violation, as well as the total number of violations per section was highest in New Milford (48% of all violations) and Bulls Bridge TBMA (21% of all violations).
 - Illegal harvest of trout was observed during patrols only in the Bulls Bridge TBMA in 2014. Illegal harvest of bass was observed in the Bulls Bridge TBMA in 2013 and 2014, and in New Milford in 2014.

Discussion and Conclusions

Trout Populations

- ◆ For the first time since 2009, flows and water temperatures during the summer of 2014 were conducive to trout survival in the mainstem Housatonic River through the entire summer. Trout remained in the mainstem, and very few used the thermal refuges for only very brief periods.
- ◆ The total number of trout sampled in the Housatonic River in 2014 (443) was similar to what was sampled in 2013 (398) and 2011 (415), but lower than what was observed in 2012 (775). Trout are less effectively sampled when dispersed in the open river than they are

when concentrated in a refuge. Consequently, trout data collected largely in the mainstem river in 2014 indicate that trout were likely less stressed from the intense heat of a normal summer and good survival of trout is anticipated moving into the fall of 2014 and spring of 2015. In contrast, in 2012 more trout were sampled, but mostly from the thermal refuges. These fish were likely subjected to greater thermal stress and thus did not survive as well into the fall and following year. Numbers sampled in 2014 may also reflect sampling fewer standard sample sites that regularly held small numbers of trout (Mill Refuge and Swifts Bridge standard sites were not sampled in 2014).

- ◆ Over 55,000 Brown Trout have been fin-clipped and elastomer tagged during the four years of this project. Elastomer tag retention observed in the field remained high (89%) during 2014. Josephson et al. (2008) found that long-term (400 days) elastomer tag retention in stocked juvenile Brook Trout was lower (50–72%) than in our study. Our tagging efforts have proven to be suitable for long-term batch marking of catchable-size stocked Brown Trout.
- ◆ Head-to-head strain comparisons consistently show that Survivor strain Brown Trout outperform Cortlands in the Housatonic River. Very few, if any, Cortlands are seen during late summer sampling following the year of stocking. In 2013 samples, all 80 tagged holdover Brown Trout were Survivors, and all six marked groups of Survivors from previous years were represented in samples. In 2014, 20 of 21 tagged holdover Brown Trout were Survivors, and all nine marked groups of Survivors from previous years were represented in samples, the oldest of which had been in the river for 3.4 years. Based on these results, the Survivor strain clearly has a genetically based survival advantage over the Cortland strain when stocked into the Housatonic River, and possibly other streams that may or may not become too warm for trout during the summer months. However it is possible that wild fish naturalized in other streams may have genetically determined traits that could perform even better. Preliminary consideration of logistics indicates feasibility of initiating additional strain testing with Brown Trout produced from wild broodstock.
- ◆ Based upon the numbers and sizes of wild or fry-stocked trout sampled in 2011-2014, continued stocking of Brown Trout fry, possibly raised from wild broodstock, could continue to contribute to the abundance and quality of trout available in the TMAs.
- ◆ Natural Rainbow Trout reproduction occurred in most Housatonic tributaries in 2010 under ideal spring conditions. Reproduction was very limited in 2011, and 2012 and no rainbow reproduction was documented in 2013. In 2014, rainbow reproduction was documented in only one tributary, the lower reaches of Kent Falls Brook. It appears that all of the Rainbow Trout reproduction was supported by large rainbows stocked in the spring by a private entity. As long as these fish are privately stocked into the Housatonic River in spring and fall,

it is reasonable to assume that some of these fish could spawn successfully in tributaries on an irregular basis. A few wild-spawned rainbows could continue to recruit to the river fishery from time to time when flows and temperatures are suitable and if the private stockings continue.

Smallmouth Bass Populations

- ◆ The Smallmouth Bass population in the Housatonic and Tenmile rivers is a valuable fishery resource, but is highly vulnerable to overharvest and year class failures which can significantly impact fishing quality. Population data, as well as age and growth analyses will be presented in the final segment report. These analyses will provide information necessary to guide decisions regarding future Smallmouth Bass management in the Housatonic and Tenmile rivers.

Additional River Sampling

- ◆ It appears that spring river conditions (flows, temperature, and turbidity) may strongly influence reproduction and consequently abundance of most or all fish species in the river. Continued sampling of all species at selected standard sites within and outside of management areas will provide further insights into the dynamics of this complex and ever-changing ecosystem.

Enhanced Law Enforcement

- ◆ The NRD grant has markedly increased ECP presence on the river during the past four years, and has resulted in positive feedback from the law-abiding angling public. However high flow conditions and reduced angling during much of the spring and summer of 2013 and 2014, as well as a reduction in the number of officers available to patrol, and reduced funds in 2014, resulted in fewer patrols, fewer contacts, and fewer arrests than during 2011 and 2012.
- ◆ Records of illegally harvested fish were low in 2011, moderate in 2012, and low in 2013 and 2014. Quantifying illegal harvest remains difficult and problematic.
- ◆ The results of the angler survey assessment of the benefits of the NRD grant remain equivocal due to the atypical spring and summer river conditions in 2013 and 2014, and resulting altered angling patterns and success.

Modifications/Recommendations

- ◆ Based on a finding that wild salmonids have a genetically determined physiological basis for heat tolerance (Cassinelli and Moffitt, 2010), discussions were held with hatchery staff to determine resources needed to raise yearling Brown Trout from wild, fall-caught broodstock captured from other streams. Rough plans for a small-scale pilot project were deemed feasible. If resources permit, collect wild broodstock Brown Trout in the fall of 2015, to produce potentially genetically superior trout for stocking into the TMAs. Careful consideration of possible broodstock sources will be necessary.
- ◆ Fully explore the potential ramifications of continued natural reproduction of privately stocked Rainbow Trout, especially in regards to possible impacts to wild brook trout in tributary streams.
- ◆ As resources permit, restore sampling of all standard sites, and consider sampling additional braided channels to assess their importance as nursery areas.
- ◆ If resources permit, conduct a follow-up angler survey in order to determine Housatonic River recreational fishery parameters during flow conditions that are closer to average.

Expenditures

Total Cost:	\$86,963
Federal Share:	\$65,222
State Share:	\$21741

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Appendices

Appendix 1. Number, strain, size, and timing of trout stocking in the Housatonic River TMAs in 2011-2014. Numbers in parentheses are mean lengths (mm Total Length) at stocking.

2011	Stocked late April				Stocked mid-late September					Total
	Survivor brown yearlings	Cortland brown yearlings	Rainbow adults	Cortland brown adults	Survivor brown yearlings	Cortland brown large adults	Survivor brown large adults	Rainbow yearlings	Cortland Brown fingerlings	
Cornwall TMA	3,000 (212)	0	3,000 (324)	3,000 (296)	3,000 (290)	500 (336)	500 (339)	5,000 (240)	0	18,000
Bulls Bridge TMA	4,000 (212)	0	0	2,000 (296)	0	0	0	2,500 (240)	0	8,500

2012	Stocked early May				Stocked mid-late September					Total
	Survivor brown yearlings	Cortland brown yearlings	Rainbow adults	Cortland brown adults	Survivor brown yearlings	Cortland brown large adults	Survivor brown large adults	Rainbow yearlings	Cortland Brown fingerlings	
Cornwall TMA	2,010 (219)	1,280 (266)	3,000 (348)	3,000 (271)	3,100 (277)	500 (337)	500 (314)	5,000 (240)	0	18,390
Bulls Bridge TMA	2,600 (219)	1,670 (266)	0	2,000 (271)	0	0	0	2,500 (240)	0	8,770

2013	Stocked early May				Stocked mid-late September					Total
	Survivor brown yearlings	Cortland brown yearlings	Rainbow adults	Cortland brown adults	Survivor brown yearlings	Cortland brown large adults	Survivor brown large adults	Rainbow yearlings	Cortland Brown fingerlings	
Cornwall TMA	3,260 (207)	920 (201)	3,000 (302)	3,230 (270)	3,670 (276)	630 (329)	520 (298)	5,000 (241)	0	20,230
Bulls Bridge TMA	4,350 (207)	920 (201)	0	2,150 (270)	0	0	0	2,500 (241)	0	9,920

2014	Stocked early May				Stocked mid-late September					Total
	Survivor brown yearlings	Cortland brown yearlings	Rainbow adults	Cortland brown adults	Survivor brown yearlings	Cortland brown large adults	Survivor brown large adults	Rainbow yearlings	Cortland Brown fingerlings	
Cornwall TMA	1,525 (219)	1,570 (212)	1,860 (NA)	3,000 (NA)	3,300 (271)	500 (334)	500 (301)	5,000 (250)	0	17,255
Bulls Bridge TMA	4,000 (219)	0	0	2,000 (NA)	0	500 (334)	0	0	2,000 (189)	8,500

Appendix 2. Elastomer tag color, location, length at tagging (\pm 95% Confidence Interval: CI) and hatchery retention rates of different cohorts of Brown Trout that were adipose-fin-clipped, injected with elastomer in the clear adipose eye tissue posterior to the left or right eye, and stocked into the Housatonic River TMAs in 2011, 2012, 2013, and 2014.

Strain/group/year	Length (and CI) at tagging (mm TL)	Number tagged	Tag color/side	Days after tagging	Percent tag retention (N)
2011					
Fall Survivor large adults	217 (6)	500	Red-left	185	87 (86)
Fall Survivor yearlings	212 (5)	3,000	Yellow-right	128	89 (55)
Spring Cortland adults	296 (5)	5,000	Yellow-left	21	98 (59)
Spring Survivor yearlings	212 (5)	7,000	Red-right	18	98 (53)
Fall Cortland large adults	336 (7)	500	Orange-right	8	100 (44)
2012					
Fall Survivor large adults	193 (10)	500	Green-left	216	82 (100)
Spring Survivor yearlings	219 (8)	4,600	Red-left	13	100 (158)
Spring Cortland yearlings	266 (6)	2,950	Orange-left	11	100 (88)
Fall Survivor yearlings	277 (7)	3,100	Pink-right	7	100 (80)
Spring Cortland adults	271 (8)	5,000	Pink-left	7	100 (114)
Fall Cortland large adults	337 (7)	500	White-left	6	100 (39)
2013					
Fall Survivor large adults	298 (6)	520	Orange-left	17	98 (115)
Fall Survivor yearlings	276 (6)	3,670	Red-right	14	98 (108)
Spring Cortland adults	270 (5)	5,380	Yellow-left	13	98 (86)
Spring Survivor yearlings	207 (5)	7,610	Yellow-right	17	98 (115)
Spring Cortland yearlings	201 (4)	1,840	Orange-right	8	100 (130)
Fall Cortland large adults	329 (8)	630	Green-right	11	98 (107)
2014					
Fall Survivor large adults	189 (11)	500	Orange-left	154	71 (35)
Spring Survivor yearlings	219 (9)	1,527	Pink-left	7	100 (126)
Spring Cortland yearlings	212 (4)	1,570	White-right	7	99 (108)

Appendix 3. Growth of twenty marked cohorts (different size-strain-stocking season combinations) of Brown Trout and Rainbow Trout stocked into Housatonic River TMAs in Spring or Fall of 2011, 2012, 2013, or 2014, and recaptured in August 2011, August 2012, August 2013, and September 2014. Asterisks indicate Furnace Brook was not directly stocked with trout; trout stocked into the mainstem Housatonic River actively migrated into this tributary.

Cohort	TMA/section	Number stocked	Date sampled	Length (mmTL)	No. recaps	Growth (mm)
2011 Spring Survivor yearlings	Cornwall	3,000	April 2011 (at stocking)	212	-	-
			Aug 2011	253	45	41 (19%)
			Aug 2012	347	11	135 (64%)
			Aug 2013	444	4	232 (109%)
			Sept 2014	474	3	262 (124%)
	BB- Gunn's Eddy (entire BB TMA)	4,000	April 2011 (at stocking)	212	-	-
			Aug 2011	245	10	33 (16%)
			Aug 2012	-	0	-
			Aug 2013	-	0	-
			Sept 2014	-	0	-
	BB- Tenmile R.		April 2011 (at stocking)	212	-	-
			Aug 2011	241	37	29 (14%)
			Aug 2012	307	1	95 (45%)
Aug 2013			-	0	-	
Sept 2014			-	0	-	
2011 Spring Cortland Adults	Cornwall	3,000	April 2011 (at stocking)	296	-	-
			Aug 2011	307	98	11 (4%)
			Aug 2012	347	1	51 (17%)
			Aug 2014	-	0	-
			Sept 2014	-	0	-
	BB- Gunn's Eddy (entire BB TMA)	2,000	April 2011 (at stocking)	296	-	-
			Aug 2011	301	7	5 (2%)
			Aug 2012	-	0	-
			Aug 2013	-	0	-
			Sept 2014	-	0	-
	BB- Tenmile R.		April 2011 (at stocking)	296	-	-
			Aug 2011	311	6	15 (5%)
			Aug 2012	-	0	-
Aug 2013			-	0	-	
Sept 2014			-	0	-	
2011 Fall Survivor Yearlings	Cornwall	3,000	Sept 2011 (at stocking)	290	-	-
			Aug 2012	359	54	69 (24%)
			Aug 2013	425	15	135 (47%)
			Sept 2014	479	3	189 (65%)
			2011 Fall Large Survivor Adults	Cornwall	500	Sept 2011 (at stocking)
Aug 2012	390	30				51 (15%)
Aug 2013	445	7				114 (34%)
Sept 2014	506	1				167 (49%)
2011 Fall Large Cortland Adults	Cornwall	500				Sept 2011 (at stocking)
			Aug 2012	393	3	57 (17%)
			Aug 2013	-	0	-
			Sept 2014	-	0	-

Appendix 3. (continued)

Cohort	TMA/section	Number stocked	Date sampled	Length (mmTL)	No. recaps	Growth (mm)
2012 Spring Survivor yearlings	Cornwall	2,010	April 2012 (at stocking)	219	-	-
			Aug 2012	252	62	33 (15%)
			Aug 2013	368	7	149 (68%)
			Sept 2014	454	4	235 (107%)
	BB- Gunn's Eddy (entire BB TMA)	2,600	April 2012 (at stocking)	219	-	-
			Aug 2012	256	45	37 (17%)
			Aug 2013	-	0	-
			Sept 2014	-	0	-
	BB- Tenmile R.		April 2012 (at stocking)	219	-	-
			Aug 2012	252	85	33 (15%)
			Aug 2013	-	0	-
			Sept 2014	-	0	-
2012 Spring Cortland yearlings	Cornwall	1,300	April 2012 (at stocking)	266	-	-
			Aug 2012	288	37	22 (8%)
			Aug 2013	-	0	-
			Sept 2014	-	0	-
	BB- Gunn's Eddy (entire BB TMA)	1,700	April 2012 (at stocking)	266	-	-
			Aug 2012	291	8	25 (9%)
			Aug 2013	-	0	-
			Sept 2014	-	0	-
	BB- Tenmile R.		April 2012 (at stocking)	266	-	-
			Aug 2012	274	19	8 (3%)
			Aug 2013	-	0	-
			Sept 2014	-	0	-
2012 Spring Cortland Adults	Cornwall	3,000	April 2012 (at stocking)	271	-	-
			Aug 2012	304	68	33 (12%)
			Aug 2013	-	0	-
			Sept 2014	-	0	-
	BB- Gunn's Eddy (entire BB TMA)	2,000	April 2012 (at stocking)	271	-	-
			Aug 2012	307	8	36 (13%)
			Aug 2013	-	0	-
			Sept 2014	-	0	-
	BB- Tenmile R.		April 2012 (at stocking)	271	-	-
			Aug 2012	286	25	15 (6%)
			Aug 2013	-	0	-
			Sept 2014	-	0	-
2012 Spring Adult Rainbows (adipose clipped)	Cornwall	3,000	April 2012 (at stocking)	348	-	-
			Aug 2012	366	109	18 (5%)
			Aug 2013	429	5	81 (23%)
			Sept 2014	-	0	-
2012 Fall Survivor Yearlings	Cornwall	3,100	Sept 2012 (at stocking)	277	-	-
			Aug 2013	354	23	77 (28%)
			Sept 2014	457	2	180 (65%)
2012 Fall Large Survivor Adults	Cornwall	500	Sept 2012 (at stocking)	314	-	-
			Aug 2013	382	17	51 (15%)
			Sept 2014	436	1	122 (39%)
2012 Fall Large Cortland Adults	Cornwall	500	Sept 2012 (at stocking)	337	-	-
			Aug 2013	-	0	-
			Sept 2014	-	0	-

Appendix 3. (continued)

Cohort	TMA/section	Number stocked	Date sampled	Length (mmTL)	No. recaps	Growth (mm)	
2013 Spring Survivor yearlings	Cornwall	3,260	April 2013 (at stocking)	207	-	-	
			Aug 2013	257	33	50 (24%)	
			Sept 2014	370	1	163 (79%)	
	Furnace Brook*	**		April 2013 (at stocking)	207	-	-
				Aug 2013	255	63	48 (23%)
				Sept 2014	-	0	-
	BB- Gunn's Eddy (entire BB TMA)	4,350		April 2013 (at stocking)	207	-	-
				Aug 2013	245	38	38 (18%)
				Sept 2014	367	1	160 (77%)
	BB- Tenmile R.			April 2013 (at stocking)	207	-	-
				Aug 2013	239	28	32 (15%)
				Sept 2014	309	1	102 (49%)
2013 Spring Cortland yearlings	Cornwall	920	April 2013 (at stocking)	201	-	-	
			Aug 2013	252	8	51 (25%)	
			Sept 2014	-	0	-	
	Furnace Brook*	**		April 2013 (at stocking)	201	-	-
				Aug 2013	245	10	44 (22%)
				Sept 2014	-	0	-
	BB- Gunn's Eddy (entire BB TMA)	920		April 2013 (at stocking)	201	-	-
				Aug 2013	247	2	46 (23%)
				Sept 2014	-	0	-
	BB- Tenmile R.			April 2013 (at stocking)	201	-	-
				Aug 2013	231	4	30 (14%)
				Sept 2014	280	1	79 (39%)
2013 Spring Cortland Adults	Cornwall	3,230	April 2013 (at stocking)	270	-	-	
			Aug 2013	294	42	24 (9%)	
			Sept 2014	-	0	-	
	Furnace Brook*	**		April 2013 (at stocking)	270	-	-
				Aug 2013	285	33	15 (6%)
				Sept 2014	-	0	-
	BB- Gunn's Eddy (entire BB TMA)	2,150		April 2013 (at stocking)	270	-	-
				Aug 2013	271	2	1 (0.4%)
				Sept 2014	-	0	-
	BB- Tenmile R.			April 2013 (at stocking)	270	-	-
				Aug 2013	274	4	4 (1%)
				Sept 2014	-	0	-
2013 Fall Survivor Yearlings	Cornwall	3,670	Sept 2013 (at stocking)	276	-	-	
			Sept 2014	294	2	18 (7%)	
2013 Fall Large Survivor Adults	Cornwall	520	Sept 2013 (at stocking)	298	-	-	
			Sept 2014	354	1	56 (19%)	
2013 Fall Large Cortland Adults	Cornwall	630	Sept 2013 (at stocking)	329	-	-	
			Sept 2014	-	0	-	
2014 Spring Survivor yearlings	Cornwall	1,525	April 2014 (at stocking)	219	-	-	
			Sept 2014	266	20	47 (21%)	
2014 Spring Cortland yearlings	Cornwall	1,570	April 2014 (at stocking)	212	-	-	
			Sept 2014	252	13	40 (19%)	

* Not directly stocked with trout

Appendix 4. Number and percent composition by strain, of Brown Trout stocked into and recaptured from Housatonic River TMAs in 2011, 2012, 2013, and 2014. Chi Square tests indicate the probability that the difference between observed and expected ratios of Brown Trout cohorts (size-strain-stock date combinations) in river samples occurred by chance alone.

Sampling in 2011								
TMA/section	2011 Spring Survivor yearlings		2011 Spring Cortland adults		Total recaps	χ^2	df	p
	Number (%) at stocking	Number (%) at recapture	Number (%) stocking	Number (%) at recapture				
Cornwall TMA	3,000 (50%)	45 (31%)	3,000 (50%)	98 (69%)	143	19.64	1	<.00001
Bull's Bridge TMA:	4,000 (67%)		2,000 (33%)					
Gunn's Eddy		10 (59%)		7 (41%)	17	0.51	1	0.47
Tenmile R.		37 (86%)		6 (14%)	43	7.06	1	<.01
Sampling in 2012								
TMA/section	2012 Spring Survivor yearlings		2012 Spring Cortland yearlings		Total recaps	χ^2	df	p
	Number (%) at stocking	Number (%) at recapture	Number (%) at stocking	Number (%) at recapture				
Cornwall TMA	2,010 (61%)	62 (63%)	1,280 (39%)	37 (37%)	99	0.11	1	0.74
Bull's Bridge TMA:	2,600 (61%)		1,670 (39%)					
Gunn's Eddy		45 (85%)		8 (15%)	53	12.73	1	<.001
Tenmile R.		86 (80%)		21 (20%)	107	16.88	1	<.0001
TMA/section	2011 Fall large Survivor adults		2011 Fall large Cortland adults		Total recaps	χ^2	df	p
	Number (%) at stocking	Number (%) at recapture	Number (%) stocking	Number (%) at recapture				
Cornwall TMA	500 (50%)	30 (91%)	500 (50%)	3 (9%)	33	22.09	1	<.00001
TMA/section	2012 Spring Survivor yearlings		2012 Spring Cortland adults		Total recaps	χ^2	df	p
	Number (%) at stocking	Number (%) at recapture	Number (%) stocking	Number (%) at recapture				
Cornwall TMA	2,010 (40%)	62 (48%)	3,000 (60%)	68 (52%)	130	3.08	1	0.079
Bull's Bridge TMA:	2,600 (57%)		2,000 (43%)					
Gunn's Eddy		45 (85%)		8 (15%)	53	17.13	1	<.0001
Tenmile R.		86 (77%)		25 (23%)	111	19.45	1	<.0001
TMA/section	2012 Spring Cortland yearlings		2012 Spring Cortland adults		Total recaps	χ^2	df	p
	Number (%) at stocking	Number (%) at recapture	Number (%) stocking	Number (%) at recapture				
Cornwall TMA	1,280 (30%)	37 (35%)	3,000 (70%)	68 (65%)	105	1.37	1	0.24
Bull's Bridge TMA:	1,670 (46%)		2,000 (54%)					
Gunn's Eddy		8 (50%)		8 (50%)	16	0.012	1	0.72
Tenmile R.		21 (46%)		25 (54%)	46	0.00005	1	0.99
TMA/section	2011 Spring Survivor yearlings		2011 Fall Survivor yearlings		Total recaps	χ^2	df	p
	Number (%) at stocking	Number (%) at recapture	Number (%) stocking	Number (%) at recapture				
Cornwall TMA	3,000 (50%)	11 (17%)	3,000 (50%)	54 (83%)	65	28.45	1	<.00001
TMA/section	2011 Fall Survivor yearlings		2011 Fall large Survivor adults		Total recaps	χ^2	df	p
	Number (%) at stocking	Number (%) at recapture	Number (%) stocking	Number (%) at recapture				
Cornwall TMA	3,000 (86%)	54 (64%)	500 (14%)	30 (36%)	84	32.90	1	<.00001
TMA/section	2011 Spring Survivor yearlings		2011 Fall large Survivor adults		Total recaps	χ^2	df	p
	Number (%) at stocking	Number (%) at recapture	Number (%) stocking	Number (%) at recapture				
Cornwall TMA	3,000 (86%)	11 (27%)	500 (14%)	30 (73%)	41	119.23	1	<.00001

Appendix 4. (continued)

Sampling in 2013									
TMA/section	2013 Spring Survivor yearlings		vs.	2013 Spring Cortland yearlings		Total recaps	χ^2	df	p
	Number (%) at stocking	Number (%) at recapture	Number (%) at stocking	Number (%) at recapture					
Cornwall TMA	3,260 (78%)	33 (80%)		920 (22%)	8 (20%)	41	0.15	1	0.70
Bull's Bridge TMA:	4,350 (82%)			920 (18%)					
Gunn's Eddy		38 (95%)			2 (5%)	40	4.58	1	<.05
Tenmile R.		28 (88%)			4 (13%)	32	0.66	1	0.42
2012 Fall large Survivor adults									
TMA/section	2012 Fall large Survivor adults		vs.	2012 Fall large Cortland adults		Total recaps	χ^2	df	p
	Number (%) at stocking	Number (%) at recapture	Number (%) stocking	Number (%) at recapture					
Cornwall TMA	500 (50%)	17 (100%)		500 (50%)	0 (0%)	17	17.00	1	<.0001
2013 Spring Survivor yearlings									
TMA/section	2013 Spring Survivor yearlings		vs.	2013 Spring Cortland adults		Total recaps	χ^2	df	p
	Number (%) at stocking	Number (%) at recapture	Number (%) stocking	Number (%) at recapture					
Cornwall TMA	3,260 (50%)	42 (56%)		3,230 (50%)	33 (44%)	75	1.08	1	0.30
Bull's Bridge TMA:	4,350 (67%)			2,150 (33%)					
Gunn's Eddy		38 (95%)			2 (5%)	40	14.18	1	<.0001
Tenmile R.		28 (87%)			4 (13%)	32	6.08	1	0.01
2013 Spring Cortland yearlings									
TMA/section	2013 Spring Cortland yearlings		vs.	2013 Spring Cortland adults		Total recaps	χ^2	df	p
	Number (%) at stocking	Number (%) at recapture	Number (%) stocking	Number (%) at recapture					
Cornwall TMA	920 (22%)	8 (16%)		3,230 (78%)	42 (84%)	50	1.05	1	0.31
Bull's Bridge TMA:	920 (30%)			2,150 (70%)					
Gunn's Eddy		2 (50%)			2 (50%)	4	-	-	-
Tenmile R.		4 (50%)			4 (58%)	8	-	-	-
2012 Spring Survivor yearlings									
TMA/section	2012 Spring Survivor yearlings		vs.	2012 Fall Survivor yearlings		Total recaps	χ^2	df	p
	Number (%) at stocking	Number (%) at recapture	Number (%) stocking	Number (%) at recapture					
Cornwall TMA	2,010 (39%)	7 (23%)		3,100 (61%)	23 (77%)	30	3.10	1	0.08
2012 Fall Survivor yearlings									
TMA/section	2012 Fall Survivor yearlings		vs.	2012 Fall large Survivor adults		Total recaps	χ^2	df	p
	Number (%) at stocking	Number (%) at recapture	Number (%) stocking	Number (%) at recapture					
Cornwall TMA	3,100 (86%)	23 (58%)		500 (14%)	17 (42%)	40	26.99	1	<.00001
2012 Spring Survivor yearlings									
TMA/section	2012 Spring Survivor yearlings		vs.	2012 Fall large Survivor adults		Total recaps	χ^2	df	p
	Number (%) at stocking	Number (%) at recapture	Number (%) stocking	Number (%) at recapture					
Cornwall TMA	2,010 (80%)	7 (29%)		500 (20%)	17 (71%)	24	38.76	1	<.00001
Sampling in 2014									
TMA/section	2014 Spring Survivor yearlings		vs.	2014 Spring Cortland yearlings		Total recaps	χ^2	df	p
	Number (%) at stocking	Number (%) at recapture	Number (%) at stocking	Number (%) at recapture					
Cornwall TMA	1,525 (49%)	20 (61%)		1,570 (51%)	13 (39%)	33	7.78	1	0.18

Only tagged spring Survivor and Cortland Yearlings in 2014
 All other Chi Square comparisons had expected values <5, so not reported here

Appendix 5. Summary of 2011, 2012, 2013, and 2014 ECP enforcement activities on the upper Housatonic River by river/management section. The patrol season ran from March 23 through September 29.

Section No., Name/ Management Zone	Section Length (km)	Hours Patrolled	Number of			Contacts		Written Warning	Verbal Warning	Violations				All violations		
			Hours/km	Patrols	Patrols/km	(no violation)	Arrests			No license	Not carrying license	Illegal harvest trout (N)	Illegal harvest bass (N)		Boating reg. and PFD's	Illegal netting
2011																
1- Falls Village-north	15.7	34	2	35	2.2	70	1		1	1	1					2
2- Cornwall TMA, all-tackle	10.2	48	5	57	5.6	129	3	3	3	4	2			3		9
3- Cornwall TMA, fly-only	5.5	79	14	87	15.8	262	3	3	8	11	1			1	8	21
4- Stanley Tract	14.0	52	4	59	4.2	117	7	0	1	3				1	4	8
5- Kent Impoundment	7.7	24	3	26	3.4	75	1	1	0	2						2
6- BB TMA, (Hous)	5.2	42	8	37	7.1	168	6	3	1	8	2					10
7- BB TMA, (Tenmile)	1.0	1	1	1	1.0	11	0	0	0							0
8- New Milford	13.4	57	4	40	3.0	105	5	12	6	23		4				27
2011 Total	72.7	337	5	342	4.7	938	26	22	20	52	6	0	4	5	12	79
2012																
1- Falls Village-north	15.7	54	3	42	2.7	87	1	2	4	2	1			4		7
2- Cornwall TMA, all-tackle	10.2	86	8	69	6.8	214	11	3	4	9	7	1 (1)	1 (1)		1	19
3- Cornwall TMA, fly-only	5.5	94	17	90	16.4	202	8	4	4	7	1	4 (?)	1 (11)	1	7	21
4- Stanley Tract	14.0	81	6	62	4.4	155	2	1	3	5	1		1 (?)		2	10
5- Kent Impoundment	7.7	73	9	56	7.3	154	6	6	4	14	2		4 (25)	1	4	25
6- BB TMA, (Hous)	5.2	64	12	50	9.6	146	6	3	3	7		1 (1)	7 (20)	1	2	18
7- BB TMA, (Tenmile)	1.0	0.5	1	1	1.0	0	0	0	0							0
8- New Milford	13.4	51	4	37	2.8	99	4	1	5	10						10
2012 Total	72.7	504	7	407	5.6	1,057	38	20	27	54	12	6	14	7	4	110
2013																
1- Falls Village-north	15.7	28	2	28	1.8	7	0	0	1	1						1
2- Cornwall TMA, all-tackle	10.2	42	4	43	4.2	67	2	0	2	3	1					4
3- Cornwall TMA, fly-only	5.5	56	10	56	10.2	47	3	2	3	5					5	10
4- Stanley Tract	14.0	77	6	69	4.9	51	5	1	3	6					3	9
5- Kent Impoundment	7.7	41	5	35	4.5	30	2	5	1	1	4			6	1	12
6- BB TMA, (Hous)	5.2	42	8	42	8.1	79	5	8	6	14	1	1 (1)	5 (?)		3	24
7- BB TMA, (Tenmile)	1.0	1.5	2	1	1.0	16	0	0	0							0
8- New Milford	13.4	17	1	19	1.4	10	2	1	0	3						3
2013 Total	72.7	305	4	293	4.0	307	19	17	16	33	6	1	5	6	12	63
2014																
1- Falls Village-north	15.7	9	1	7	0.4	13	0	0	0							0
2- Cornwall TMA, all-tackle	10.2	14	1	16	1.6	19	0	0	0							0
3- Cornwall TMA, fly-only	5.5	29	5	26	4.7	29	5	1	1	5					6	11
4- Stanley Tract	14.0	32	2	24	1.7	22	0	0	2						2	2
5- Kent Impoundment	7.7	14	2	14	1.8	6	1	2	1	2				2	2	6
6- BB TMA, (Hous)	5.2	48	9	42	8.1	43	3	3	5	9		2 (2)	2 (2)			13
7- BB TMA, (Tenmile)	1.0	0.5	1	1	1.0	0	0	0	0							0
8- New Milford	13.4	48	4	33	2.5	49	2	3	21	23	3		2 (2)	1		29
2014 Total	72.7	195	3	163	2.2	181	11	9	30	39	3	2	4	3	10	61
2011-2014																
1- Falls Village-north	15.7	125	8	112	7.1	177	2	2	6	4	2			4	0	10
2- Cornwall TMA, all-tackle	10.2	190	19	185	18.1	429	16	6	9	16	10	1 (1)	1 (1)	3	0	32
3- Cornwall TMA, fly-only	5.5	258	47	259	47.1	540	19	10	16	28	2	4 (?)	1 (11)	2	0	63
4- Stanley Tract	14.0	242	17	214	15.3	345	14	2	9	14	1		1 (?)	1	2	29
5- Kent Impoundment	7.7	152	20	131	17.0	265	10	14	6	19	6		4 (25)	9	0	45
6- BB TMA, (Hous)	5.2	196	38	171	32.9	436	20	17	15	38	3	4 (4)	14 (?)	1	2	65
7- BB TMA, (Tenmile)	1.0	4	4	4	4.0	27	0	0	0	0	0			0	0	0
8- New Milford	13.4	173	13	129	9.6	263	13	17	32	59	3		6	1	0	69
2011-2014 Total	72.7	1,340	18	1,205	16.6	2,483	94	68	93	178	27	9	27	21	4	313

*Other violations included: trespass, fishing in thermal refuges, littering, fishing with more than two lines, spin fishing in fly-only area, fishing during the closed season, and illegal harvest of Northern Pike and sunfish.