Study Plan for Assessing the Brown Trout Sport Fishery Below The Shawmut Hydroelectric Project Kennebec River, Maine

INTRODUCTION

During the mid- to latter part of the 20th century, extremely poor water quality in lower sections of the Kennebec River (i.e. south of Skowhegan) prevented the establishment of a recreational coldwater fishery. During the mid-1980's, upgraded water quality standards and improved waste treatment led to dramatically improved water quality conditions throughout the Kennebec River watershed. As a result, an experimental brown trout (*Salmo trutta*) stocking program was instigated in 1983 in the lower Kennebec to test "survivability, growth, and catchability of browns in the "cleaned up" river. Stocking rates and the corresponding year-class for brown trout (and rainbow trout, *Oncorhynchus mykiss*) in Fairfield, ME at the Shawmut Project from 1983-2012 are listed (Table 1). Spring-yearling brown trout stockings ranged between 1,000 and 2,000 fish, and averaged 1,959 fish, while rainbow trout were stocked privately between 1992 and 2007 by the Kennebec Valley Chapter of Trout Unlimited at either 1,000 or 2,000 fish annually. Brown trout fry, fall-yearlings, and adults were also infrequently stocked below the Shawmut Project over this same timeframe (Table 1).

There are limited data to analyze brown trout catch rates specifically below the Shawmut Project prior to 1993; however, data from 1993 to 2008 indicate moderate to excellent brown trout catchability (0.10-0.18 legal brown trout / angler hour) between 1993 and 1998 (and presumably between ~1985-1992). In fact, during this timeframe (1993-2008), the tailwaters of the Shawmut Hydroelectric Project (known to locals as "Shawmut") supported a nationally renowned brown trout fishery in the Kennebec River. However, this was short-lived, and beginning in 1999, catch rates on legal (and even trophy) brown trout have declined dramatically (Figure 1), and to date the fishery has essentially collapsed. The reasoning behind this collapse is currently unknown, as there are limited fieldwork and supporting data to properly analyze the Shawmut fishery. Brown trout are still stocked at Shawmut at a rate of 2,000 spring-yearlings annually. Based on the low volume of volunteer angler log books, communication with members of the Kennebec

Valley Chapter of Trout Unlimited, and observations by regional biologists and wardens, both angler use and harvest are very low.

The Shawmut brown trout stocking program once provided an important recreational fishery for Kennebec anglers, and an economic boom to local businesses. Therefore, it is important that the reasoning behind the demise of the Shawmut brown trout fishery be investigated with the specific objectives to 1) monitor and quantify seasonal brown trout movement, mortality, and growth post-stocking and throughout the Shawmut tailwater, 2) compare movement, mortality, and growth between stocked New Gloucester and Sandwich River brown trout genetic strains, and 3) determine the relative importance of physical, environmental, and biotic variables to brown trout movement, mortality, and growth.

METHODS

Study Area

The Shawmut Hydroelectric Project, owned and operated by NextEra Energy Resources (NextEra), is located on the Kennebec River in Fairfield and Benton, Maine is located at the south-central portion of the Kennebec watershed (44°37'22"N, 69°34'03"W). The study area will encompass the entirety of the Kennebec River beginning at the tailrace of the Shawmut Project and extend downstream to the Lockwood Hydroelectric Project (Waterville, ME) (Figure 2).

Radio Telemetry

This brown trout radio telemetry study will be conducted from the fall of 2013 to the fall of 2015. MDIFW biologists will monitor brown trout movement and mortality in the Kennebec River between the Shawmut Project and Lockwood Project. Telemetry receivers from Advanced Telemetry Systems (ATS), and Yagi directional antennas will be used for all brown trout location monitoring over the course of the study. A stationary telemetry receiver will monitor brown trout movement at the Hydro Kennebec Hydroelectric Project; located between Shawmut and Lockwood. Any study fish that drop below Hydro Kennebec will be effectively out of the study area because they have no means of upstream passage. Their out-migration and loss from the fishery will be recorded.

Mobile tracking will be performed twice per week on land and by boat during fall 2013 to determine the location(s) of tagged brown trout. The frequency of active location monitoring beyond fall 2013 will be determined by the occurrence of brown trout movements. It is suspected that this frequency will change on a seasonal basis and range between two times per week and once every other week. Weekly and seasonal movements will be tracked and mapped using handheld GPS units and ArcGIS 9.3.

Brown Trout Tagging and Marking

A total of 2,000 fall-yearling brown trout/year will be stocked from the New Gloucester and Palermo hatcheries (MDIFW). The Palermo hatchery will supply 1,000 Sandwich River strain brown trout/year, and the New Gloucester hatchery will supply 1,000 New Gloucester strain brown trout/year. All fish will be stocked simultaneously at the boat launch just downstream of the Shawmut Project in Fairfield, ME. An additional 3,000 Sandwich River strain brown trout will be stocked in Skowhegan each year of the study. Prior to the annual stockings, both brown trout strains stocked at Shawmut and the Sandwich strain stocked upstream at Skowhegan will be marked with specific fin clips in 2013 and 2014 (Table 2). Additionally, a minimum of twenty (20) fall-yearling brown trout ($\geq$ 10 New Gloucester strain and $\geq$ 10 Sandwich River strain) from the 2013 Shawmut stocking, will be anesthetized and surgically implanted with 24-hour non-programmable body implant, trailing whip radio antennas (model F1800) made by Advanced Telemetry Systems, Inc. The study trout will be tagged at least one week prior to stocking; allowing tags to be recovered from mortalities, and subsequently implanted in other fish. Each transmitter will be assigned a unique frequency, allowing biologists to identify individual study fish.

The radio transmitters are equipped with a mortality switch and a minimum battery life of approximately 967 days. If any radio antennas are reacquired during the study as a result of trout mortalities, we will attempt to collect a brown trout of the same strain and year-class, surgically implant the tag into the individual, and release the fish back into the same river reach.

Potential Causes of Movement and Mortality

There are many physical and biotic factors that have the potential to contribute to brown trout movement and mortality during this study including but not limited to inter- and intraspecific competition, predation (fish, mammalian, and bird), angling (i.e. hooking mortalities, harvest), temperature, dissolved oxygen, river flow, and outmigration (i.e. downstream departure out of the study area).

Smallmouth bass (*Micropterus dolomieu*) and fallfish (*Semotilus corporalis*) are both well established in the lower Kennebec River and American shad (*Alosa sapidissima*) and alewives (*Alosa pseudoharengus*) have been stocked at and above the Shawmut Project (Table 3). All cohabiting fishes likely compete and/or predate upon salmonines (Rieman 1991; Angela 1997). Additionally, avian and mammalian predators such as cormorants, bald eagles, osprey, and river otters have the potential to prey upon brown trout, likely contributing to overall mortality (Britton et al. 2006; Stewart et al. 2005). Beyond visual observation and quantifying angler harvest of competitor fishes, this study will not measure direct inter- and intraspecific competition. Sources of predation will be estimated through radio tag recollection of brown trout mortalities (e.g. in bird nests, along river banks, etc.).

Angling pressure in and around the Shawmut Project will likely contribute to brown trout mortality. Creel surveys will be conducted to estimate catch rates, harvest rates, and potential hooking mortalities for all stocked brown trout and provide a means by which differences between the New Gloucester and Sandwich River strains can be analyzed and evaluated. Signage will be posted in and around the Shawmut Project to encourage angler release of radio-tagged trout.

Temperature is the master regulator for salmonine feeding and growth (Fry 1971; Armstrong et al. 2003), and may greatly affect brown trout movement, mortality, and overall persistence during this study (Young et al. 2006; Almodovar et al. 2012). Therefore, water temperature will be recorded from October 2013 to October 2015 at 30-minute intervals at three preselected station sites downstream of Shawmut (one just below the Shawmut Project, one near the I-95 overpass, and one just upstream of the Hydro Kennebec Project) using remote data loggers

(Onset HOBO Tidbit v2 Temperature Loggers or similar). Additionally, salmonines require suitable dissolved oxygen content (≥ 5 ppm) in order to grow and survive (Wagner et al. 2001); for that reason, dissolved oxygen profiles will be measured monthly (twice per month during July and August) at preselected stations downstream of the Shawmut Project.

Precipitation events (i.e. floods and droughts) affect water flow and have the potential to impact survival and movement of brown trout populations in riverine systems (Young et al. 2010). NextEra measures water discharge at the Shawmut Project, and these data will be obtained in order to analyze brown trout mortality and movement in relation to changes in river flow.

Resident brown trout in lotic systems exhibit various degrees of movement behavior, with some populations staying relatively inactive (Burrell et al. 2000) and others dispersing long distances and maintaining expansive home ranges (Saraniemi et al. 2008). Long distance movement may displace study brown trout downstream of Lockwood Dam and outside the study area. Emigrating brown trout will be detected and monitored at Hydro Kennebec with a stationary model R2000 receiver. Those brown trout that enter the Shawmut Project fishery from the upstream Skowhegan stocking will be distinguishable by a specific marking scheme. Anecdotally, it is suspected that brown trout drop-downs from Skowhegan contribute approximately 25% to the Shawmut brown trout fishery.

Creel Surveys

Creel surveys will be conducted three times per week (two weekdays and one weekend day) during May and June of 2013-2014 from 1600h until dark. Historically, angling pressure at the Shawmut Project is greatest during May and June and creel survey data will provide pertinent information with regards to angling effort, angling methods, catch rates, harvest rates, weight and length distribution of brown trout (and that of competitor/predator fish species), and year class structure of stocked brown trout.

Data collected through angler creel census will be used to determine the overall success of the stocking program of both brown trout strains below Shawmut. This analysis will allow some

insight into brown trout strain performance (including holdover success), angler success, and an estimate of angler use. These data will be used to assist in the Department's brown trout genetic strain evaluation.

Electrofishing & Additional Analyses

In September 2014 and 2015, we will boat electrofish select reaches within the study area in order to collect stocked brown trout (and competitor/predator fishes). All fishes will be measured for total length and weight, and released back into the reach after sampling. These data will provide annual growth data for stocked brown trout by strain and quantify the size structure of the fish assemblage within the study area.

We will use a temperature-dependent, allometric bioenergetics model for brown trout to generate a PGI (Potential Growth Index). Assuming maximum consumption of a generalized invertebrate/fish prey and zero mortality, the modeling software (Fish Bioenergetics 3.0; Hewett and Johnson 1987; Hanson et al. 1997) will simulate maximum brown trout growth during the period(s) from stocking to sampling from the mean daily temperature regime at the study area reach for both field seasons. The ratio of observed brown trout mass at the time of sampling to maximum potential brown trout mass will yield the PGI.

Furthermore, we will conduct a one-way analysis of variance (ANOVA) to determine if there are differences in performance between Sandwich River and New Gloucester brown trout strains. This will provide a means to comparatively evaluate brown trout strain performance in the study area.

Management Implications

The findings from this research will provide fisheries managers with empirical evidence to better understand the movement and mortality of stocked brown trout downstream of the Shawmut Project. This study will also provide a means by which different genetic strains of riverine brown trout can be comparatively evaluated with regards to overall performance. Ultimately, this research may allow the Maine Department of Inland Fisheries & Wildlife to make more

comprehensive management decisions with regards to future stocking strategies in the tailwaters of Shawmut Dam, a once renowned brown trout fishery.

LITERATURE CITED

Almodovar, A., G.N. Graciela, D. Ayllon, and B. Elvira. 2012. Global warming threatens the persistence of Mediterranean brown trout. Global Change Biology 18: 1549-1560.

Angela, S.A. 1997. Abundance and food habits of smallmouth bass and distribution of crayfish in Lower Granite Reservoir, Idaho-Washington. Master's thesis. University of Idaho, Moscow.

Armstrong, J.D., P.S. Kemp, G.J.A. Kennedy, M. Ladle, and N.J. Milner. 2003. Habitat requirements of Atlantic salmon and brown trout in rivers and streams. Fisheries Research 62:143-170.

Britton, J.R., J. Pegg, J.S. Shepherd, and S. Toms. 2006. Revealing the prey items of the otter *Lutra lutra* in South West England using stomach analysis. International Journal of Vertebrate Zoology 55: 167-174.

Burrell, K.H., J.J. Isely, D.B. Bunnell, D.H. Van Lear, and C.A. Dolloff. 2000. Seasonal movement of brown trout in a southern Appalachian River. Transactions of the American Fisheries Society 129: 1373-1379.

Fry, F.E.J. 1971. The effect of environmental factors on the physiology of fish. Fish Physiology: 6: 1-98.

Hanson, P.C., T.B. Johnson, D.E. Schindler, and J.F. Kitchell. 1997. Fish Bioenergetics 3.0. University of Wisconsin, Sea Grant Institute.

Hewett, S.W. and B.L. Johnson. 1987. A generalized bioenergetics model of fish growth for microcomputers. University of Wisconsin Sea Grant Institute, Madison, Wisconsin.

Rieman, B.E., R.C. Beamesderfer, S. Vigg, and T.P. Poe. 1991. Estimated loss of juvenile salmonids to predation by northern squawfish, walleyes, and smallmouth bass in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120: 448-458.

Saraniemi, M., A. Huusko, and H. Takhola. 2008. Spawning migration and habitat use of adfluvial brown trout, Salmo trutta, in a strongly seasonal boreal river. Boreal Environment Research 13: 121-132.

Stewart, D.C., S.J. Middlemas, W.R. Gardiner, S. Mackey, and J.D. Armstrong. 2005. Diet and prey selection of cormorants (Phalacrocorax carbo) at Loch Leven, a major stocked trout fishery. Journal of Zoology, London 267: 191-201.

Wagner, E.J., R.E. Arndt, and M. Brough. 2001. Comparative tolerance of four stocks of

cutthroat trout to extremes in temperature, salinity, and hypoxia. Western North American Naturalist 64: 434-444.

Young, R.G., J. Wilkinson, J. Hay, and J.W. Hayes. 2010. Movement and mortality of adult brown trout in the Motupiko River, New Zealand: effects of water temperature, flow, and flooding. Transactions of the American Fisheries Society 139: 137-146.

Table 1. Brown trout and rainbow trout stocking history at Shawmut Hydroelectric Dam, Kennebec River in Fairfield, ME (1983 – 2012).

	Brown trout			Rainbow trout	
Year	Spring-Yearling	Other	Strain	Spring-Yearling	Strain
1983	2,000	-	-	0	-
1984	2,000	-	-	0	-
1985	2,000	-	-	0	-
1986	2,000	50,000 (FRY)	-	0	-
1987	2,000	-	-	0	-
1988	2,000	-	-	0	-
1989	2,000	-	-	0	-
1990	2,000	-	011	0	-
1991	2,000	48,650 (FRY)	011	0	-
1992	2,000	-	011	1,000	-
1993	2,000	-	011	0	-
1994	2,000	-	011	1,000	-
1995	2,000	-	011	2,000	-
1996	1,756	-	011	2,000	-
1997	2,000	-	011	2,000	063
1998	2,000	-	011	2,000	-
1999	2,000	-	011	2,000	-
2000	2,000	-	011	2,000	-
2001	2,000	-	011	2,000	064
2002	2,000	-	011	2,000	064
2003	2,000	-	011	2,000	064
2004	2,000	-	011	2,000	064
2005	2,000	-	011	2,000	064
2006	2,000	1,000 (FY), 10 (AD)	011	2,000	064
2007	1,000	-	011	1,000	064
2008	2,000	-	080	0	-
2009	2,000	-	080	0	-
2010	2,000	-	080	0	-
2011	2,000	-	080	0	-
2012	2,000	-	080	0	-

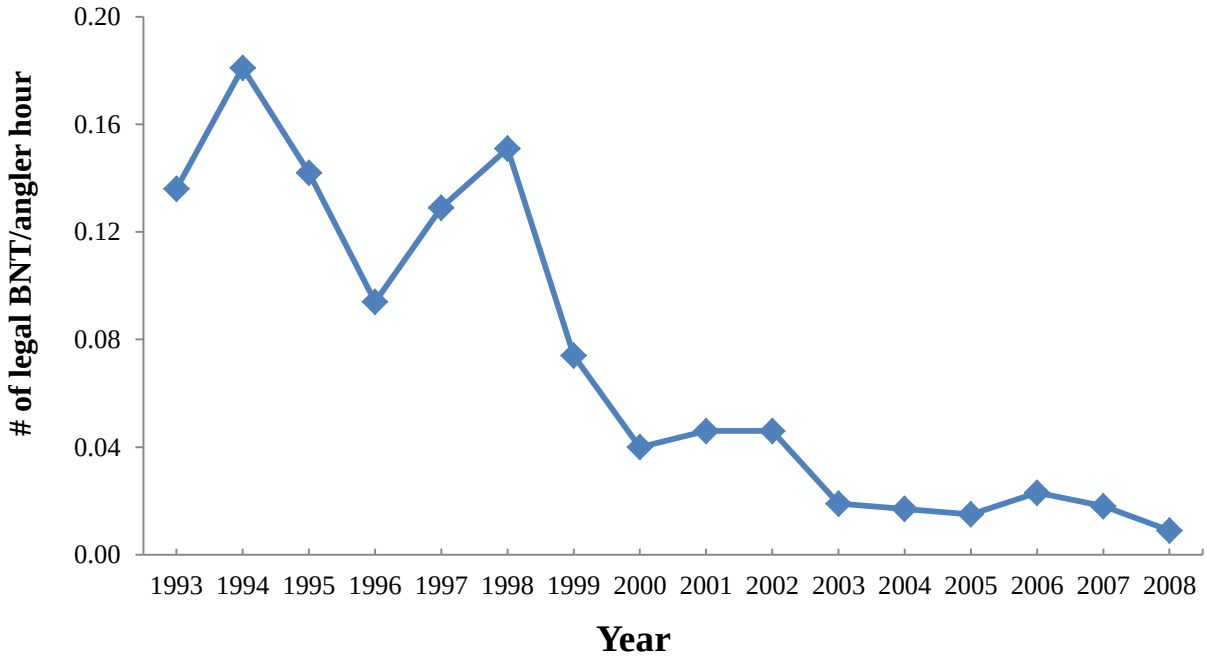

Figure 1. Hourly catch rates, from volunteer angler books and creel surveys, of legal sized brown trout in tailwaters of Shawmut Hydroelectric Dam, Kennebec River (1993 – 2008).

Table 2. Proposed brown trout fin marking strategy for Sandwich River and New Gloucester strains at the Shawmut Project and Skowhegan boat launch for 2013 and 2014.

Location and strain	Brown trout fin markings	
	2013	2014
Shawmut Dam		
Sandwich (SR) - Fall-Yearlings	left ventral (LV)	left ventral (LV) & adipose (AD)
New Gloucester (NG) – Fall-Yearlings	right ventral (RV)	right ventral (RV) & adipose (AD)
Skowhegan		
Sandwich (SR) – Spring Yearlings	both ventral (BV)	both ventral (BV) & adipose (AD)

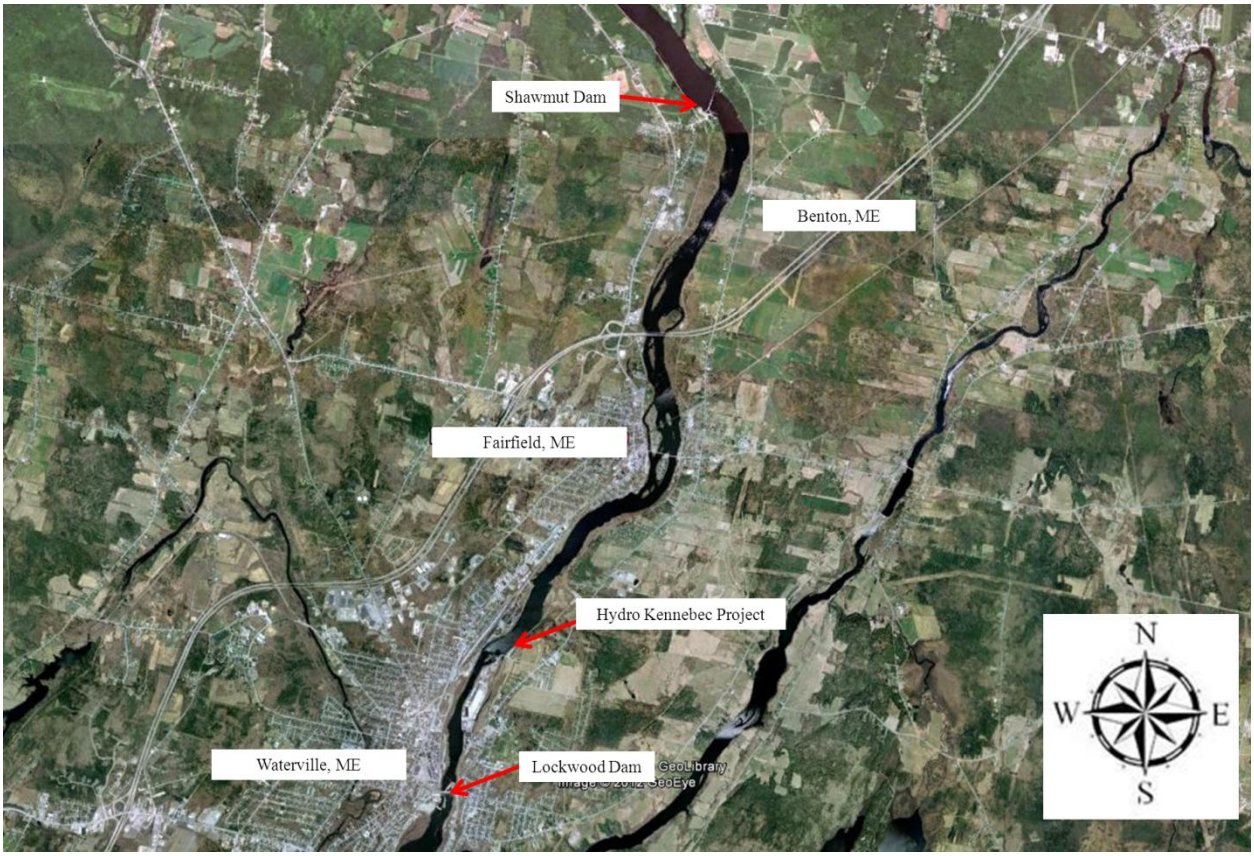

Figure 2. Study area reach located on the Kennebec River between Shawmut Hydroelectric Dam (Fairfield, ME) and Lockwood Dam (Waterville, ME).

Table 3. American shad and alewife stockings at and upstream of the Shawmut Dam project (1999-2009).

	Shawmut Dam - Fairfield		Shawmut Dam Impoundment - Skowhegan	
Year	American Shad	Alewife	American Shad	Alewife
1999	1,557,327 (fry); 13,141 (fingerling)	-	-	-
2000	1,909,682 (fry)	-	-	-
2001	1,489,713 (fry)	-	-	-
2002	1,571,856 (fry)	-	-	-
2003	2,421,121 (fry)	-	-	-
2004	4,548,957 (fry)	-	-	-
2005	1,900,663 (fry)	-	-	-
2006	262,131 (fry)	-	-	-
2007	7,937,841 (fry); 37 (adult)	23 (adult)	-	-
2008	3,283,136 (fry)	-	-	37,041 (adult)
2009	-	-	-	12,946 (adult)
2010	28 (adult)	12,043 (adult)	-	9,000 (adult)
2011	-	4,000 (adult)	-	8,078 (adult)
2012	-	10,250 (adult)	-	52,380 (adult)