Rainbow Trout Genetic Strain Evaluation in the Eleven Point River

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Executive Summary

The Eleven Point River's Blue Ribbon Trout Area (BRTA) contains a small, naturally reproducing population of Rainbow Trout (*Oncorhynchus mykiss*) that is supplemented through annual stockings. In 2010 and 2011 a project proposal was developed to evaluate the BRTA's stocking regime and increase first-year survival of stocked fish from <4% to 10%. Approximately 1,500 of four genetic strains of Rainbow Trout (McConaughy, Eagle Lake, Fish Lake, and a North Fork/MO Hatchery Strain cross) were stocked into the BRTA each July from 2012 through 2014. Boat electrofishing was used to assess survival of stocked fish at 6 months, 9 months and 14 months post stocking. Relative weights were also collected to evaluate body condition. The Fish Lake strain showed the highest mean percent survival over the 3 year evaluation (54% at 6 months, 30% at 9 months, and 8% at 14 months) and statistically outperformed the other three strains at the 6 and 9 month sampling periods. Mean relative weights of all stocked strains, declined for the first 6 months and considerable variations existed between individuals. At the 14 month sample, mean relative weight values of surviving stocked fish resembled values of fish initially stocked and those observed in the naturally reproduced population. Relative weight of wild trout also fluctuated during the year with low mean values being recorded in the winter months. Body condition of the Fish Lake strain was the most similar of the four strains to the wild trout with only the April sample revealing a statistically significant difference in body condition. Prey selection and feeding efficiency appear to be factors limiting survival of stocked rainbow trout. Future management steps include exclusively stocking Fish Lake strain Rainbow Trout, increasing annual stockings from 6,000 to 8,000, and splitting the one-time annual stockings into a spring and fall stocking trip. These steps specifically address goals one and four of "A Plan for Missouri Trout Fishing" and should improve overall angler experience.

Introduction

The nationally designated, Eleven Point Scenic River System is a popular river for floaters and anglers in the southcentral Ozarks of Missouri. Rainbow Trout (*Oncorhynchus mykiss*), along with Smallmouth Bass (*Micropterus dolomieu*), Shadow Bass (*Ambloplites ariommus*) , Walleye (*Sander vitreus*) , and Chain Pickerel (*Esox niger*) are commonly pursued game fish on the river. A 2013 angler survey indicated that 5,607 anglers spent 36,478 days fishing on the river (Reitz 2016). A percentage of those anglers are trout anglers that frequent the river's two adjoining trout areas. According to statewide figures, trout angling accounts for 14% of all angling effort in Missouri (2003 Kruse, et. al).

Trout Stocking and Management History

Historical records indicate that Rainbow Trout were first stocked in the Eleven Point River in 1911. Over the next 50 years, Rainbow Trout were stocked periodically with limited verifiable records (Turner 1974). From 1962 until 1992, stocking records indicate Rainbow Trout were stocked nearly annually (Miller and Wilkerson 2003) when new statewide trout regulations were adopted (Appendix A). These regulations resulted in creating two separate management areas on the Eleven Point, a 5.5 mile Wild

Trout Management Area (WTMA) with restrictive regulations and a 14.2 mile Trout Management Area (TMA) with liberal harvest. The WTMA existed from the confluence of Greer Spring to Turner Mill Access while the TMA existed downstream of Turner Mill. The stated purpose of the WTMA designation was to "provide an opportunity for anglers to catch wild, naturally reproduced, rainbow trout" (Kruse 2003). As a result, regular stockings of this area stopped. Eventually, because trout numbers remained low within the WTMA after the regulation change, different stocking strategies were implemented to augment the population over the next two decades (Ackerson 2010).

In 1997, the daily limit was reduced from 3 to 1 trout ≥18 inches (Ackerson 2005). And statewide in 2005, special management area designations became known as Blue Ribbon Trout Areas (BRTA) and White Ribbon Trout Areas (WRTA). This is the current designation on the river (Figure 1).

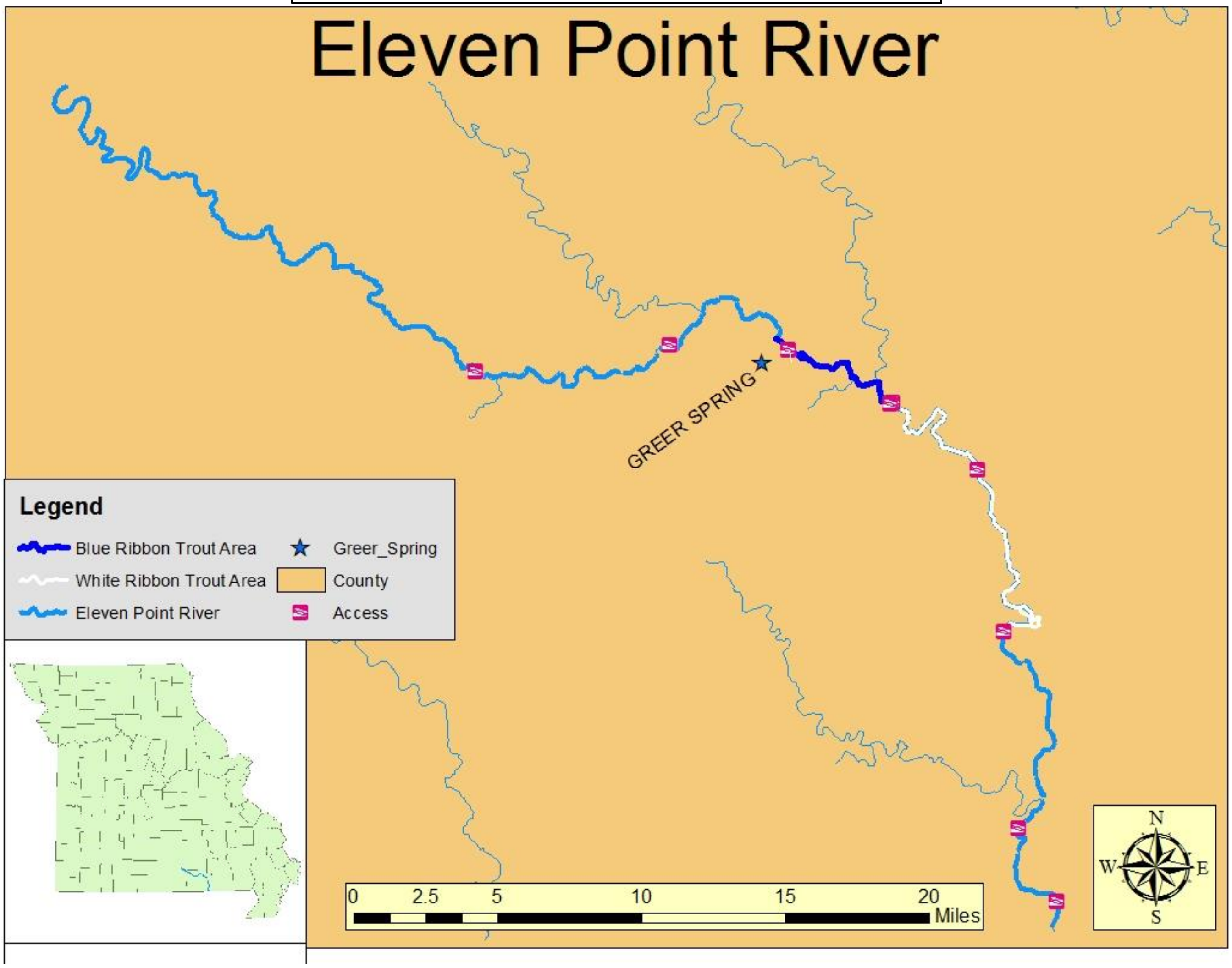
Table 1: Trout Regulations from Greer Spring to Turner Mill Access (1992 – Present)

Time Period	Pre 1992	1992-1996	1997-2004	2005 - Present
Management Area Title	none	Wild Trout Management Area	Wild Trout Management Area	Blue Ribbon Trout Area
Minimum Length Limit	none	18"	18"	18"
Daily Possession Limit	5	3	1	1
Bait Restrictions	none	artificial lures & flies only	artificial lures & flies only	artificial lures & flies only
Gigging permitted	Yes	No	No	No

Study Site and Project Justification

The Eleven Point's BRTA stands in a unique position within Missouri's trout management network. It is located on a large river (6th order within the BRTA) and exists immediately downstream from Greer spring, the state's 2nd largest spring. The only BRTA on a river of comparable size is found on the North Fork of the White River, but this fishery differs from the Eleven Point in that it is also supplemented with Brown Trout (*Salmo trutta*).

Figure 1: Trout Areas and River Accesses along the Eleven Point River



The Eleven Point's WTMA/BRTA trout populations have been monitored annually by the Missouri Department of Conservation since 1992. Rainbow Trout population estimates between 1992 and 2004 varied widely depending on the time of the sample, frequency of stocking, and the proximity of the sample to a stocking event (Ackerson 2005). From 2007-2010 samples were conducted at 6 months and 9 months, post-stocking to calculate trout population estimates within the BRTA as angler reports and observations suggested that a large number of stocked fish may be absent from the BRTA within a year. This initial assessment showed cohort numbers decreased rapidly following stocking, with the highest 6 and 9 month survival being 31% and 10%, respectively. Survival at 9 and 12 months for the period 2004-2009 for annually stocked fish, ranged from 2-8% (Ackerson 2010).

While natural reproduction occurs in the river, it is not at a level that sustains high numbers of catchable size trout. Comparatively, young-of-the-year (YOY) fish/mile estimates on the Eleven Point and North Fork vary greatly. From 1994-1998 the Eleven Point averaged 17 YOY fish/mile in comparison to 110 YOY fish/mile on the North Fork. Fall/Winter flood events often correlate with strong year classes, but record flooding in 1993 didn't improve YOY numbers in the Eleven Point when the same year produced a record year class on the North Fork (Ackerson 2003). Thus, supplemental stockings have been necessary in the Eleven Point. These stockings of catchable sized trout provide an excellent fishery for about 6 months, but fail to produce a quality long-term fishery or trophy sized fishery.

In 2010 & 2011, staff from Fisheries and Resource Science divisions created a proposal to evaluate the Eleven Point's trout stocking regime (Appendix B). This project sought to improve the efficiency and productivity of supplemental stockings to enhance the fishery and meet trout plan goals. Specifically the goal would be to increase stocked fish survival to at least 10% over the first year.

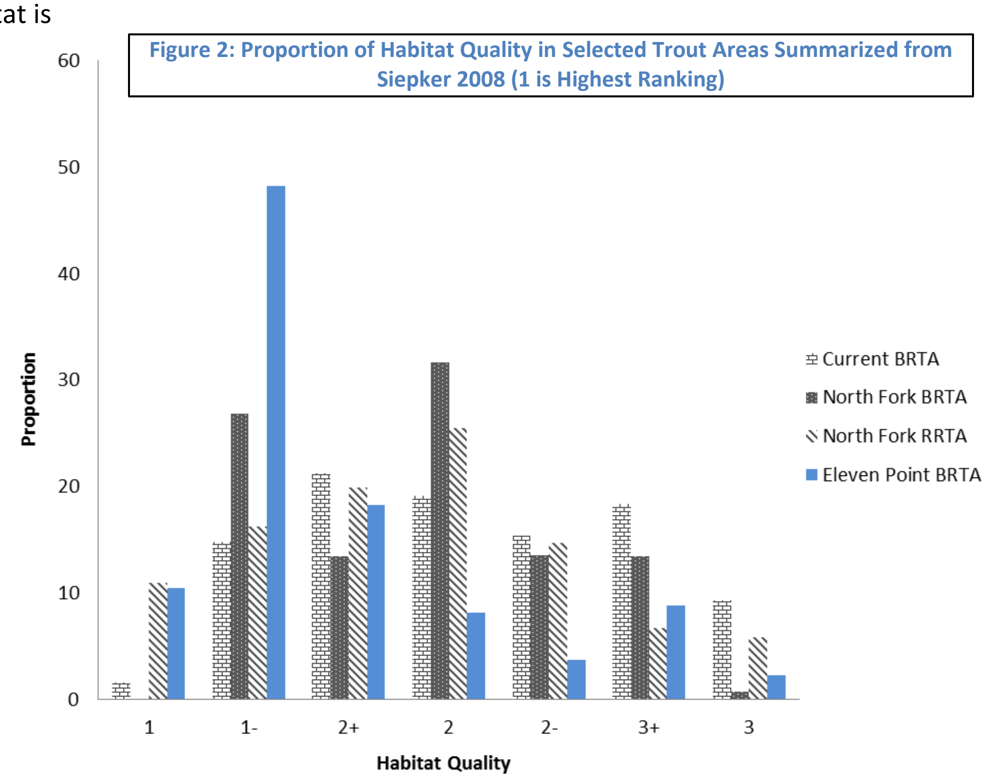
Potential Factors Impacting Survival

Long-term survival of stocked Rainbow Trout in any water body depends on a variety of abiotic and biotic factors. For example, water temperature, flow regime, physical habitat conditions, size and condition at stocking, number of predators, behavioral considerations and food availability can all significantly impact the success of stocking efforts and the survival of individual trout within the river. For the Eleven Point's BRTA some of these potential factors can be easily rejected.

First, the BRTA has the coldest summer water temperatures of any large section of the river. Water temperature loggers placed in the area just below Greer spring during summer months between 2001 and 2010 did not record any trout stress days. (Whittier et al. 2015)

Greer Spring also eliminates the potential for low flow conditions as it adds an average daily discharge of 342 cubic feet per second into the river (Miller and Wilkerson 2003). It in effect doubles the river's size and volume at the BRTA's upper end.

A lack of appropriate physical habitat is also an unlikely culprit as an exhaustive statewide trout habitat evaluation ranks the Eleven Point BRTA as some of the very best in the state. Siepker (2008) designates 59% of the BRTA in the highest numerical ranking (1 or 1-). A graphical comparison of other nearby trout management areas clearly illustrates the superior quality of habitat for the Eleven Point BRTA. (Figure 2) (Turner 2012)



The condition of stocked trout in this section of river has never been a concern as previous efforts recorded relative weights of fish at the time of stocking to range from 99-113 (MDC notes 2009). Although body condition was not specifically measured at stocking (measured at 2 months post-stocking), visually trout appeared healthy and in excellent condition.

Methods

Strain Production, Marking and Stocking

Four distinct Rainbow Trout strains were selected for this project (Table 2). These strains were selected because of consistent egg availability from federal hatcheries and in the case of the North Fork cross (NFMO), because of “wild” genetics. McConaughy (MC), Eagle Lake (EL) and Fish Lake (FL) strain eggs were sent to Missouri to be hatched and raised to stockable size. EL and FL strains were hatched and raised at Montauk hatchery. MC strains were hatched and raised to fingerling size at Shepherd of the Hills hatchery and then transported to Montauk to complete the rearing process. For the NFMO strain, eggs from the Missouri hatchery strain were fertilized by males from the North Fork of the White River. These fish were also entirely raised at Montauk hatchery. Each strain was kept separate from the other three strains and the Missouri hatchery strain fish that are stocked at Montauk State Park. Feeding rates varied for each strain due to when the strains arrived at the hatchery and to help produce similar size, stockable fish.

Table 2: Rainbow Trout Strains Selected for Evaluation

Strain	Abbreviation	Origin
McConaughy	MC	Ennis National Fish Hatchery, Montana
Eagle Lake	EL	Ennis National Fish Hatchery, Montana and Erwin National Fish Hatchery, Tennessee
Fish Lake	FL	Erwin National Fish Hatchery, Tennessee
NFMO	NFMO	Milt collected from males in the North Fork of the White River and crossed with MO hatchery stock strain females

During the rearing process, NFMO, EL, and FL strain behaved similarly to the Missouri hatchery strain. However, the MC strain exhibited a wilder type of behavior, spending most of the time on the bottom of the raceway and often exhibiting a frightful response to movement outside the raceway. This behavior is similar to what is observed of brown trout raised in the hatchery setting.

Table 3: Method of Differentiating the Four Stocked Strains

	Method of Marking		
Strain	2012	2013	2014
McConaughy	Right Caudal Peduncle CWT	Post-Ocular Elastomer	Post-Ocular Elastomer
Eagle Lake	Right Pelvic Fin Clip	Post-Ocular Elastomer	Post-Ocular Elastomer
Fish Lake	Snout CWT	Post-Ocular Elastomer	Post-Ocular Elastomer
NFMO	Dorsal Fin CWT	Post-Ocular Elastomer	Post-Ocular Elastomer

In the study's first year (2012) the trout strains were differentiated prior to stocking using a combination of coded-wire tags (CWT) and fin clips (Table 3). However, in the evaluation's second and third years, visible implant elastomer (VIE) tags were used to differentiate the strains. A tag retention evaluation was completed prior to utilizing the VIE tags for the last 2 years of the evaluation. Elastomer injected post ocular had a 93% retention rate for a 12 month period. Tag retention longer than 12 months was not examined. (Appendix C)

The evaluation outlined a three year stocking plan (2012-2014), annually stocking similar numbers of fish from each strain into the BRTA (Table 4). Each year, a minimum of 1,500 fish of each strain were stocked during July, downstream of the Greer Access located in the BRTA's upper section.

Table 4: Numbers and Size Information of Fish Stocked

Strain	# Fish Stocked	# Pounds Stocked	Avg. Length Inches	Avg. Weight Pounds
2012				
NFMO	1,500	1,200	12.6	0.80
Eagle Lake	1,621	1,266	12.4	0.76
Fish Lake	1,500	1,147	12.4	0.76
McConaughy	1,500	846	11.2	0.56
2013				
Strain	# Fish Stocked	# Pounds Stocked	Avg. Length Inches	Avg. Weight Pounds
NFMO	1,750	1,190	11.9	0.68
Eagle Lake	1,689	1,164	12.0	0.69
Fish Lake	1,661	1,019	11.5	0.76
McConaughy	1,500	603	10.0	0.40
2014				
Strain	# Fish Stocked	# Pounds Stocked	Avg. Length Inches	Avg. Weight Pounds
NFMO	1,625	973	11.4	0.60
Eagle Lake	1,625	973	11.4	0.60
Fish Lake	1,625	650	10.1	0.40
McConaughy	1,625	562	9.5	0.35

Sampling

Mark and recapture electrofishing surveys were conducted utilizing two similarly equipped stream boats. At least 1 day, but not more than 4 days separated each marking and recapture run. These mark and recapture samples took place at 2 months (September), 6 months (January), 9 months (April) and 14 months (September) post-stocking (Table 5), avoiding the hottest time of the year to minimize handling stress. The winter sample for the 2013 cohort had to be pushed into February because of a significant rain event in mid-January. Population estimates from the September sample (2 months post-stocking) were used as the initial stocking numbers of each strain and to calculate 14-month post-stocking survival, from the previous year's sample. An additional sample was taken in 2013 upstream of the BRTA to check emigration out of the BRTA.

Table 5: Sampling Schedule

Date		Activity	
Year	Month	Stock Trout	Sample Trout
2012	July	X	
	September		X
2013	January		X
	April		X
	July	X	
	September		X
2014	February*		X
	April		X
	July	X	
	September		X
2015	January		X
	April		X
	September		X

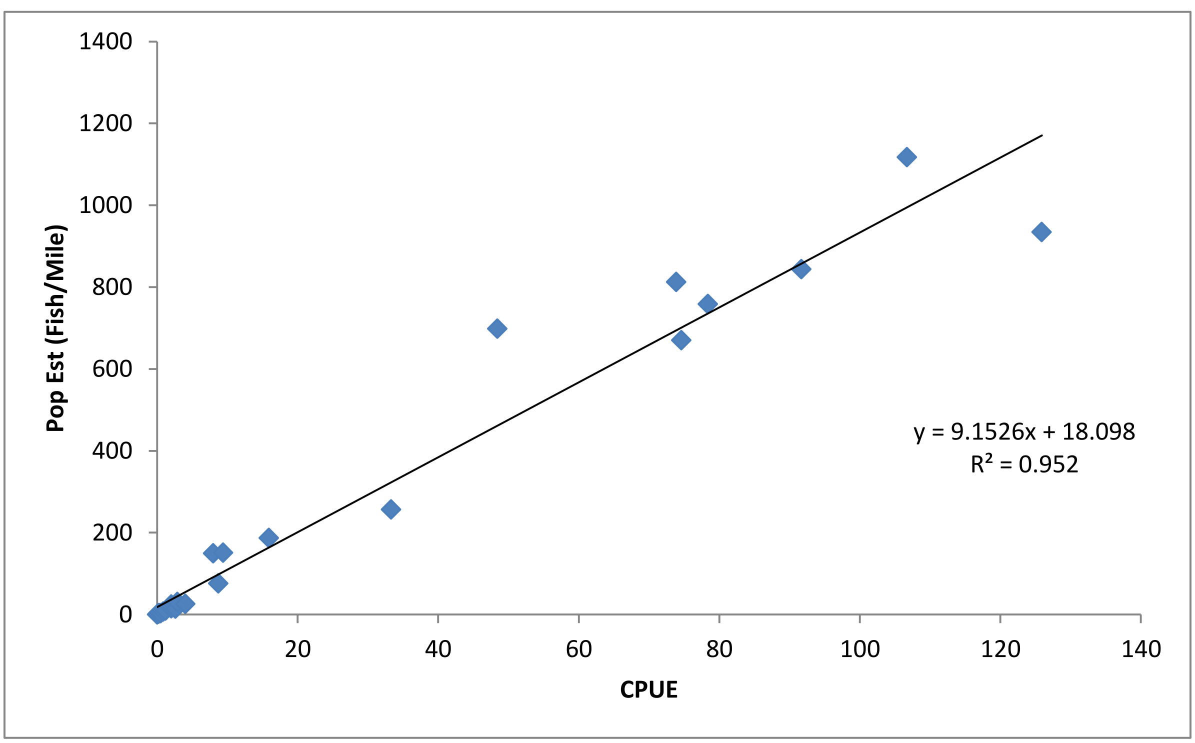
* = The first sample in 2014 was achieved in February

Data Analysis

Initially, percent survival was calculated from estimates of a modified Lincoln-Peterson, single-pass, mark and recapture population model. However, after catch per unit effort (CPUE) (fish/hour) showed strong correlation to population estimates (fish/mile) (Figure 3), CPUE comparisons were used to determine strain percent survival over time and between strains. The percent survival of all three years was combined to determine the average (mean) percent survival over the entire study period. A one-tail t-test of significance was completed between the best performing strain and the rest of the strains at each of the three sample periods.

Body condition of stocked and wild trout was also determined by taking lengths and weights of all captured fish at each sample and assessing relative weights (W_r) based off of techniques described in Wege and Anderson 1978 and Anderson and Neumann 1996. Ranges of relative weights were noted and mean relative weights for each cohort group were determined and analyzed. Two-tailed t-tests of significance were used to compare mean relative weights of stocked strains and wild trout throughout the year.

Figure 3: Relationship between CPUE and Modified Lincoln-Peterson Population Estimates (Fish/Mile) of BRTA Samples between September 2007 and January 2014

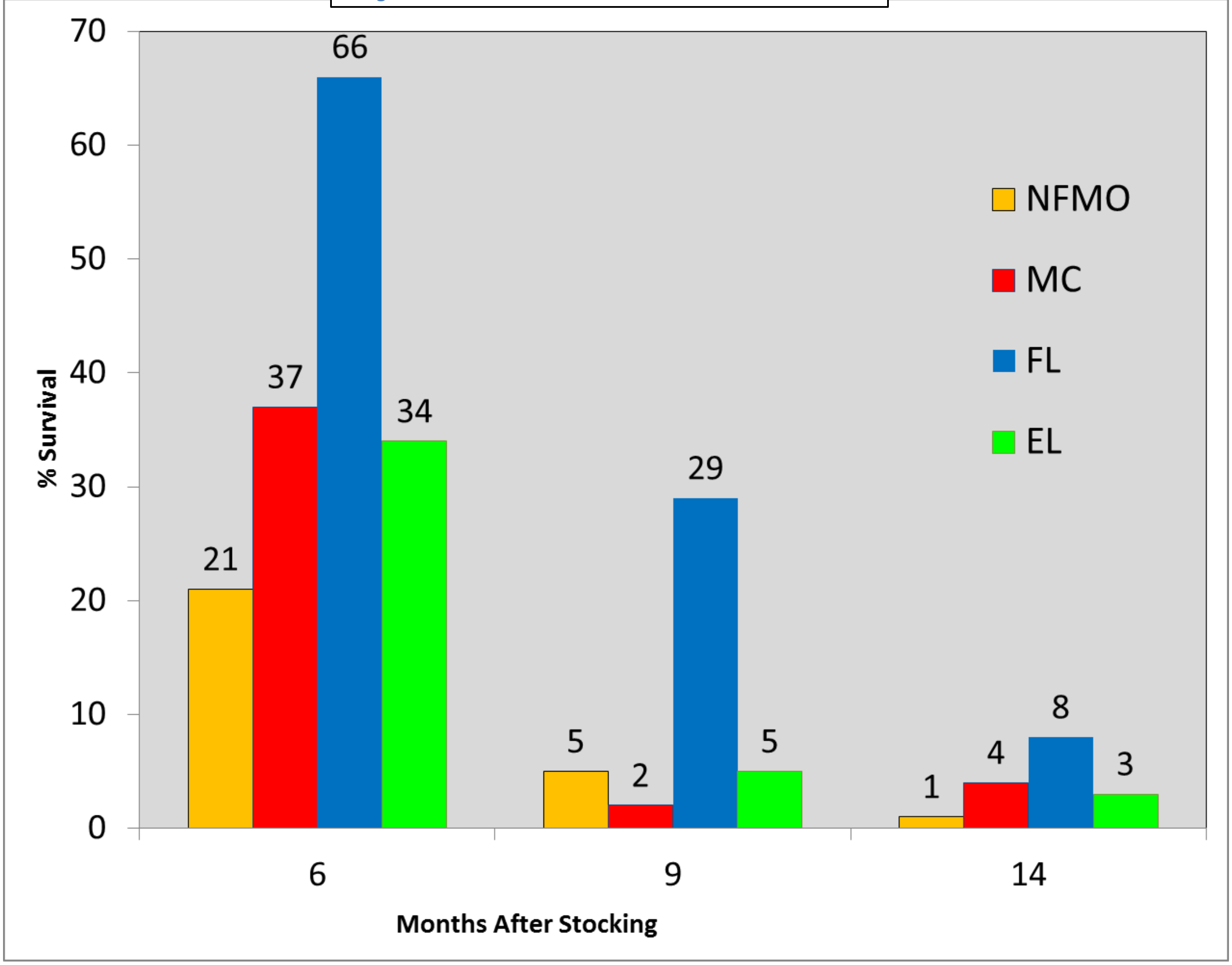


Results

Percent Survival 2012 Stocking Cohort

Six-month survival of 2012’s stocked trout ranged from 21-66% depending on the strain. Nine and 14 months post-stocking survival ranged from 2-29% and 1-8%, respectively. The Fish Lake strain had the highest overall survival at all 3 sampling time periods based off of CPUE. (Figure 4).

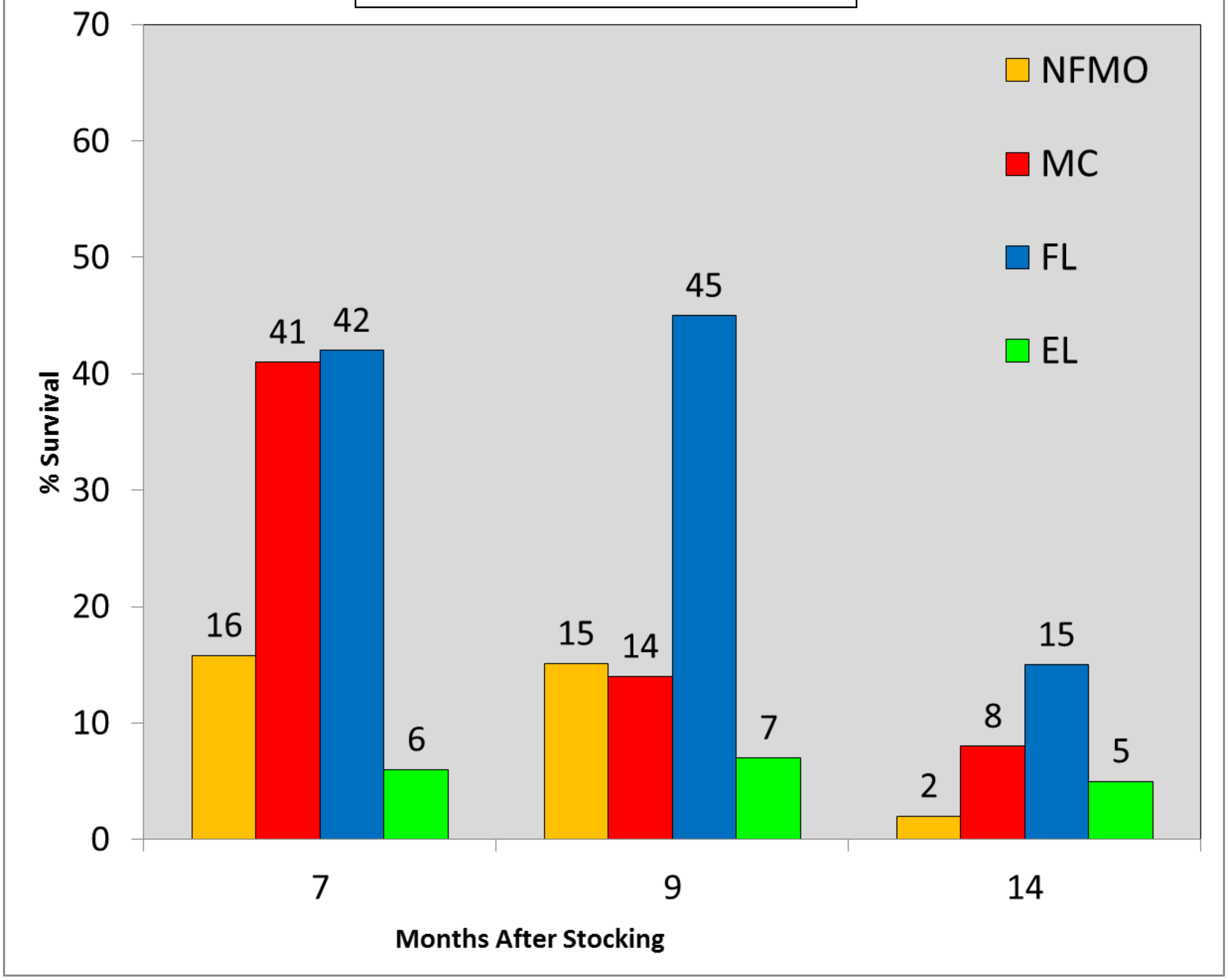
Figure 4: 2012 Percent Survival of Stocked Rainbow Trout



Percent Survival 2013 Stocking Cohort

Seven-month survival of 2013 stocked trout ranged from 6-42% survival, depending on the strain. For this period, survival rates for both the McConaughy and Fish Lake strains exceeded 40%. Nine and 14 months post-stocking survival ranged from 7-45% and 2-15%, respectively. The Fish Lake strain had the highest overall survival at all 3 sampling time periods, based off of CPUE (Figure 5).

Figure 5: 2013 Percent Survival of Stocked Rainbow Trout



Percent Survival 2014 Stocking Cohort

Six-month survival of the 2014 cohort ranged from 30-53% survival, depending on the strain. Nine and 14 months post-stocking survival ranged from 4-19% and 0-4%, respectively. The Fish Lake strain had the highest six month survival and the North Fork of the White River cross had the highest survival at the 9 and 14 month sampling time periods based off of CPUE. (Figure 6).

Figure 6: 2014 Percent Survival of Stocked Rainbow Trout

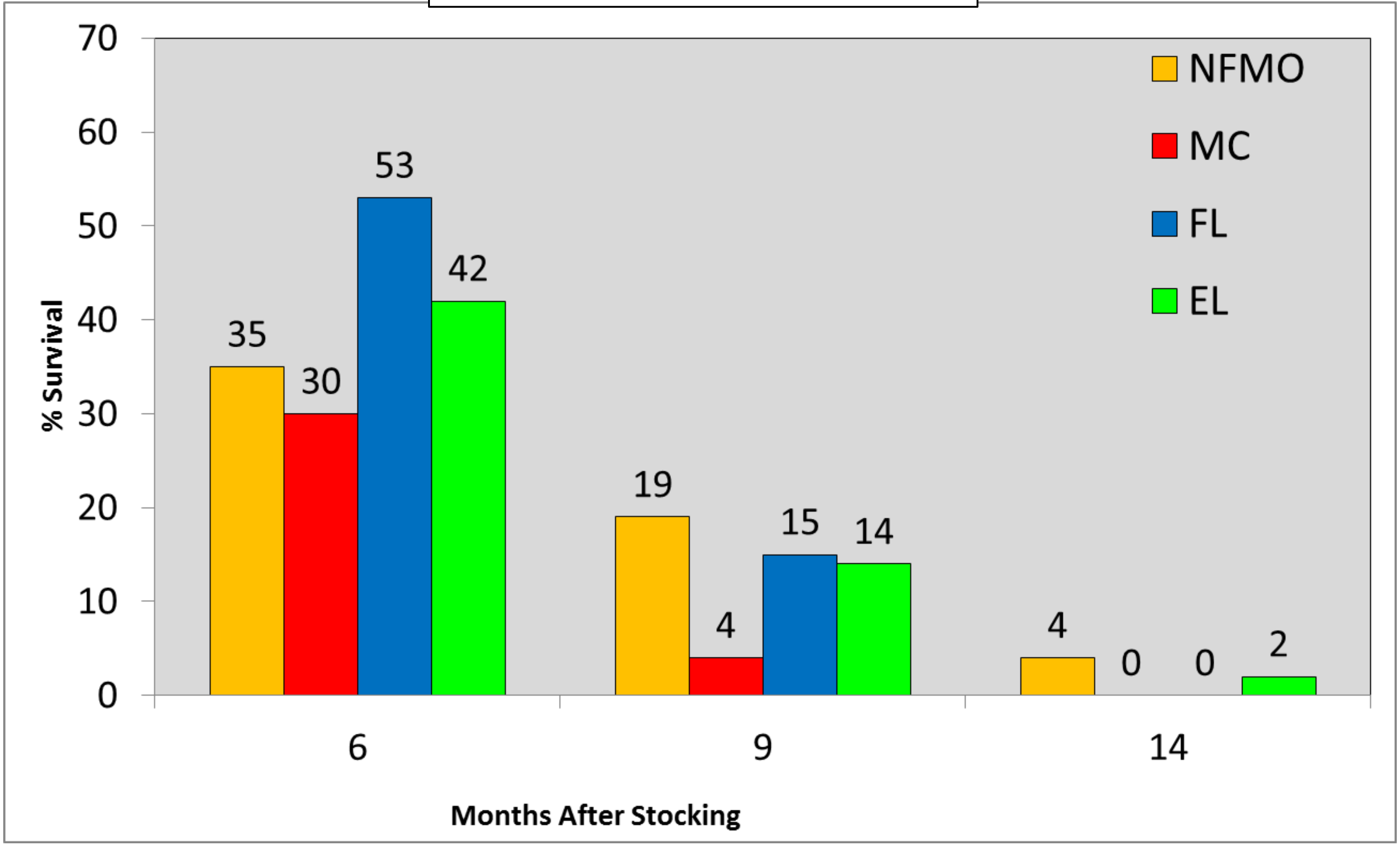
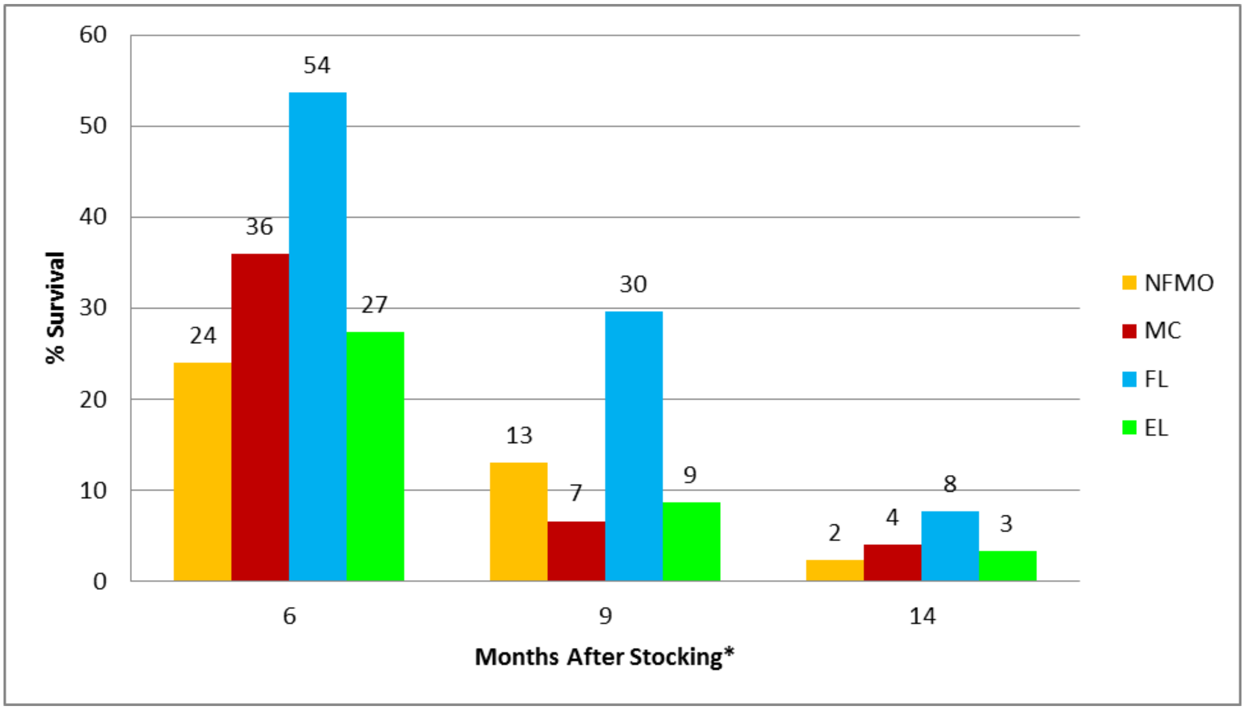


Figure 7: Mean First Year Percent Survival (2012-2014)



* = The first sample for the 2013 cohort was completed at 7 months post-stocking

Mean Percent Survival over the Three Study Years

For all three time intervals the Fish Lake strain exhibited the highest mean survival during the 2012-2014 periods (Figure 7). Fish Lake survival at the 6, 9, and 14 month intervals was 54%, 30%, and 8%, respectively. Mean survival of the other three strains at the 6, 9, and 14 month intervals ranged from 24%-36%, 7%-13%, and 2%-4%, respectively (Figure 7).

The Fish Lake strain statistically outperformed the other three strains during the 6 and 9 month samples based off of a 95% confidence interval. The NFMO survival was significantly less during the 6 month time-frame and the Eagle Lake strain was significantly less during the 9 month time-frame. Survival of the McConaughy strain was significantly less than the Fish Lake strain during both the 6 and 9 month samples (Figures 8-10).

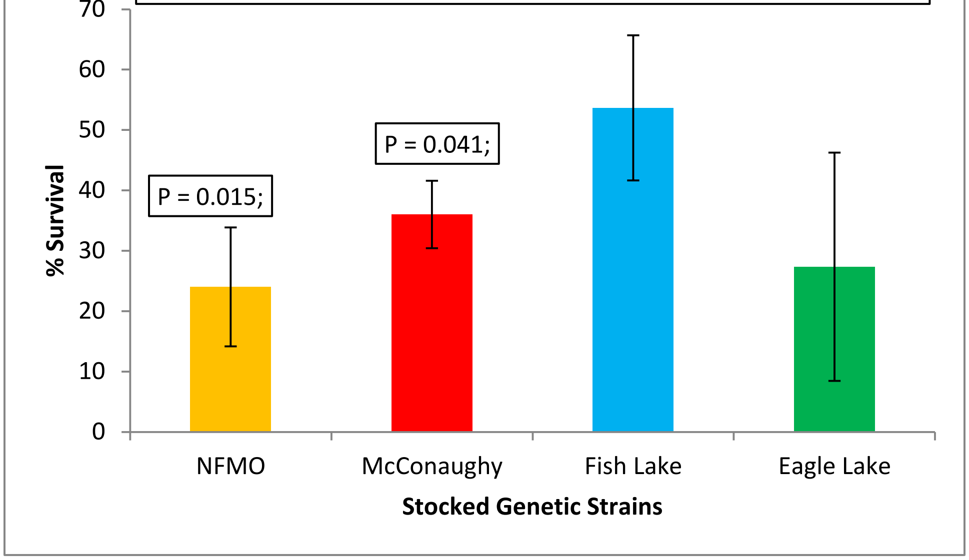


Figure 8: Mean 6-Month Survival Comparing Fish Lake Strain to Other Strains

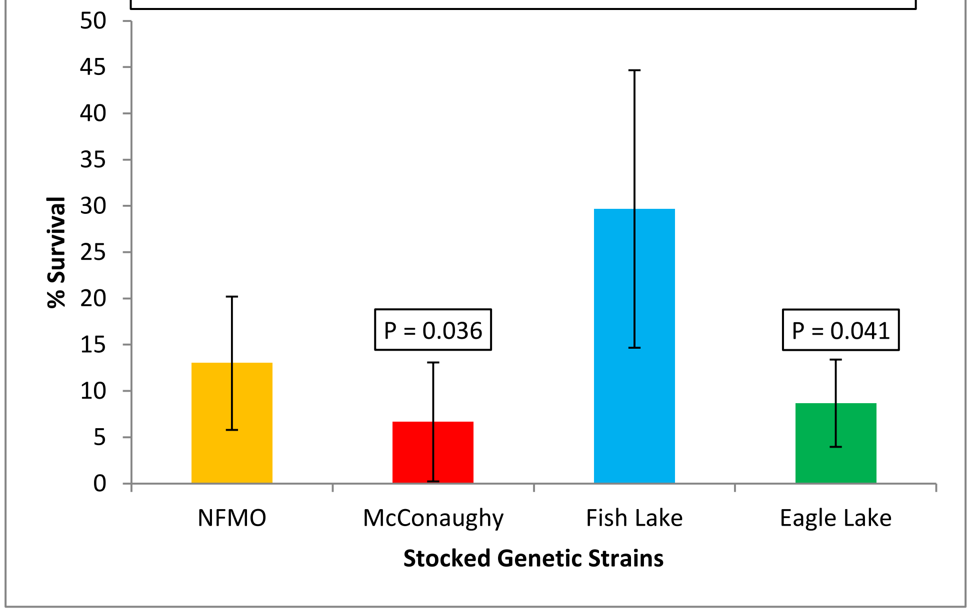


Figure 9: Mean 9-Month Survival Comparing Fish Lake Strain to Other Strains

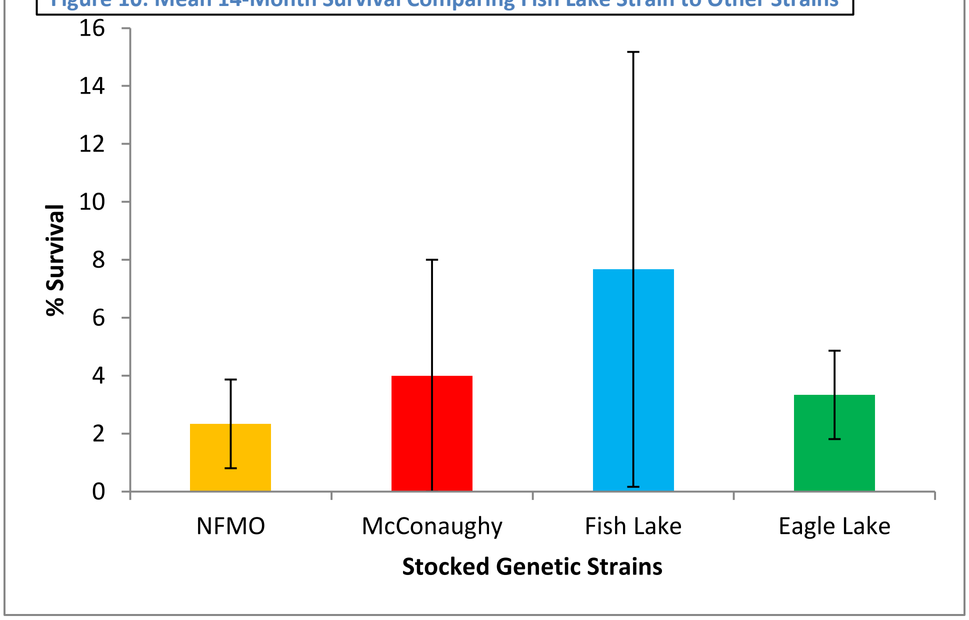


Figure 10: Mean 14-Month Survival Comparing Fish Lake Strain to Other Strains

Survival More than One Year Post-Stocking

Table 6: Number of Individuals after 1 Year in the River

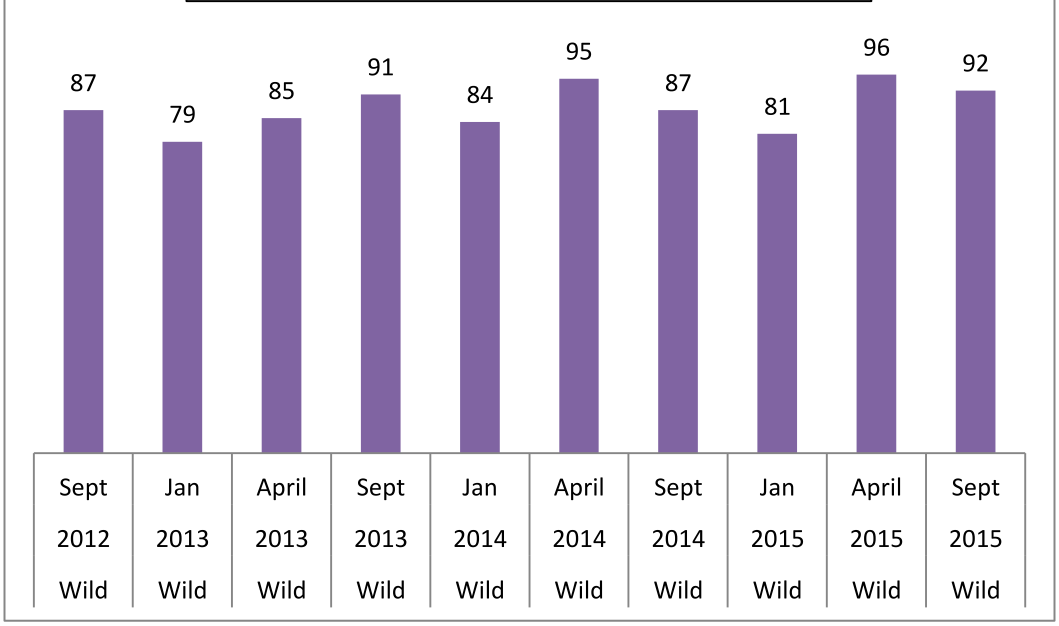
With all strains, the number of individuals collected after 1 year was very low. After 14 months, no more than 4 individuals (Fish Lake in January 2015) of any one strain were collected at any sample (Table 6).

Stocked in 2012				
Strain	14 mo #s	18 mo #s	21 mo #s	26 mo #s
NFMO	4	2	2	0
MC	3	2	1	0
FL	9	1	1	1
EL	3	1	0	0
Stocked in 2013				
NFMO	2	3	2	0
MC	2	0	0	0
FL	9	4	1	2
EL	4	2	2	0

Body Condition

During the study a total of 1,803 trout were weighed to determine body condition. Individual relative weights varied greatly by size, strain, time of year, and whether or not the fish was stocked or a result of natural reproduction (wild). Wild trout mean relative weight was lowest during the three winter (January or February) samples. Mean relative weight values for wild trout ranged from 79-84 in winter, 85-96 in the April samples and 87-92 in the September samples (Figure 11).

Figure 11: Variation in Mean Relative Weight of the Wild Trout



Mean relative weight of all stocked trout ranged from 84-88 at 2 months post-stocking (September), 72-77 at 6 months post-stocking (winter) and 67-79 at 9 months post-stocking (April) (Figure 12). Mean relative weight of stocked trout during the second year of life in the river was similar to wild trout, ranging from 82-89 in September, 75-85 in January, and 82-89 in April.

Figure 12: Comparison of Mean Relative Weights for Stocked Trout during their First 14 Months in the River to Wild Trout at the Same Time

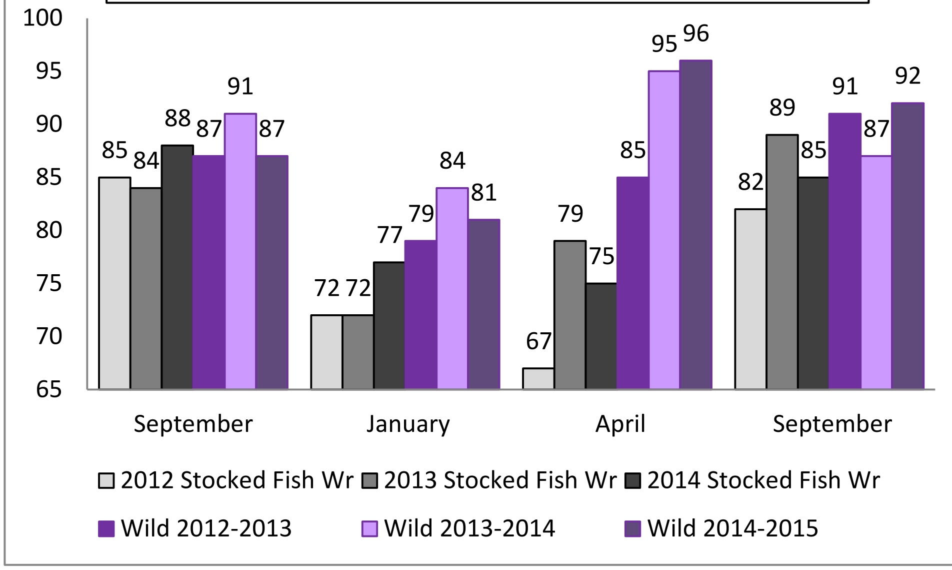


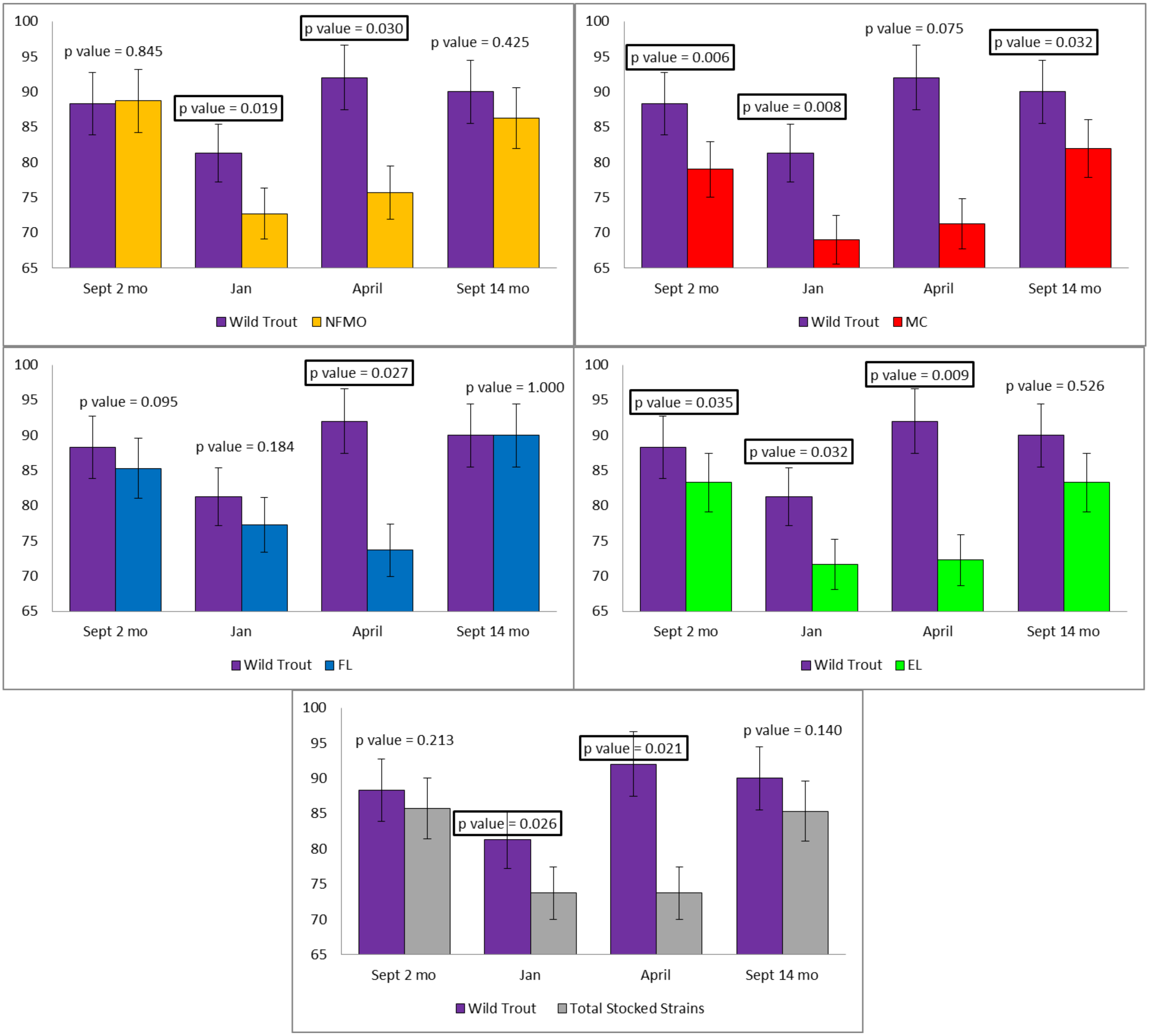
Table 7: Relative Weight Values During the January Samples

		Measured Wr	Mean Wr
January 2013	NFMO	53-91	72
	McConaughy	51-84	65
	Fish Lake	59-99	77
	Eagle Lake	49-81	67
	Wild	52-125	77
		Measured Wr	Mean Wr
January 2014	NFMO	51-103	74
	McConaughy	51-118	84
	Fish Lake	64-115	72
	Eagle Lake	49-87	70
	Wild	49-107	70
		Measured Wr	Mean Wr
January 2015	NFMO	65-102	76
	McConaughy	59-98	72
	Fish Lake	62-109	81
	Eagle Lake	47-96	76
	Wild	39-119	81

Mean wild trout relative weights were significantly higher than stocked trout relative weights at the 6 and 9 month sample periods. When compared to each individually stocked strain, wild trout mean relative weights were significantly higher in eight of the twelve comparisons throughout the first year in the river. No individual strain statistically outperformed the wild strain at any sample point through the first year (Figure 13).

All fish exhibited the greatest variation of individual relative weight at the January samples (Table 7), but only the Fish Lake strain was not significantly different from the wild trout at that sample. Of the four stocked strains, the Fish Lake strain had the highest average relative weight value (77). Other average relative weight values were 74 for McConaughy, 74 for NFMO, 71 for the Eagle Lake strain, and 76 for the wild trout.

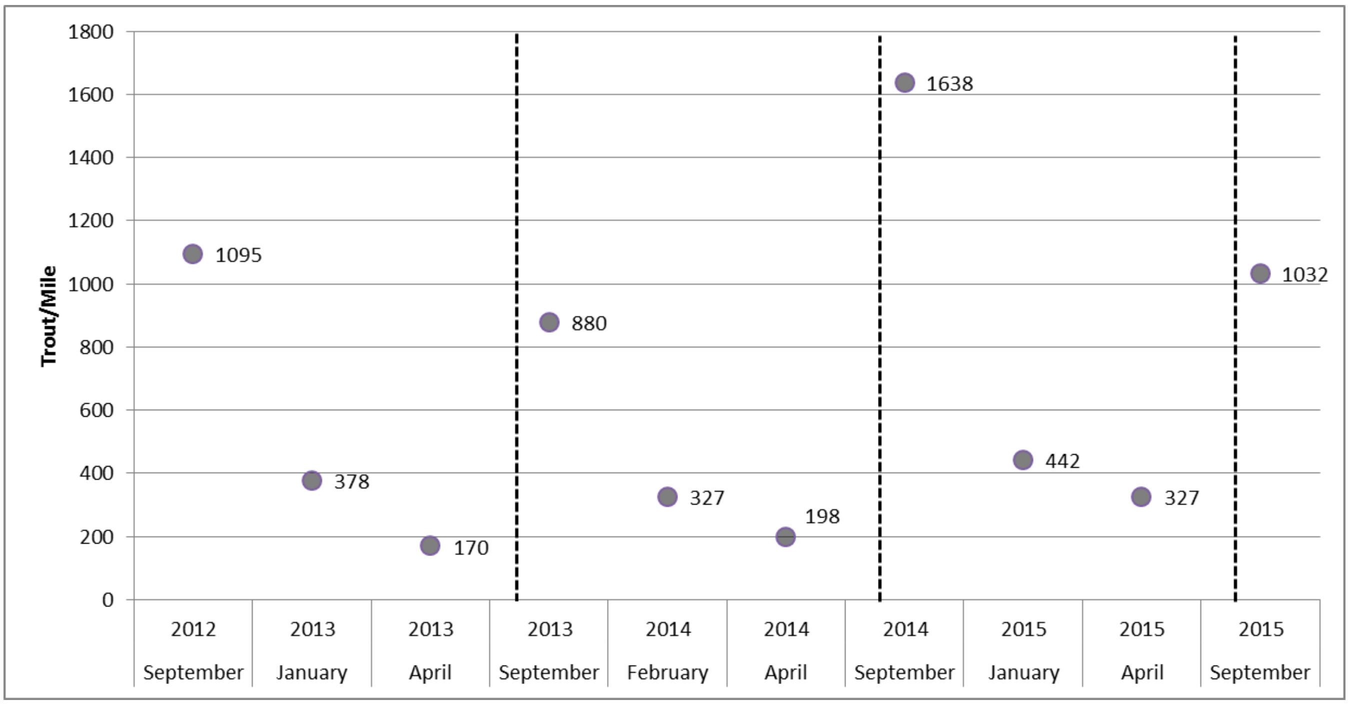
Figure 13: Statistical Comparison of Mean Relative Weights of Wild Fish to Stocked Strains



Population Estimates

Fish/mile population estimates based off of a modified Lincoln-Peterson model ranged between 170 and 1,638 with the lowest estimates coming during the April samples and the highest estimates in September after the July stockings.

Figure 14: Population Estimates (Trout/Mile)



Discussion

The Eleven Point BRTA stands in a unique position within our statewide trout areas. It requires an individualized management approach to provide the best angling experience at an acceptable cost. This project provides an excellent opportunity to improve long-term management through informed decision-making.

Strain Performance in the River – Survival

Over the study period, the Fish Lake strain Rainbow Trout consistently outperformed the other three stocked strains. Even when considering available data from pre-evaluation years discussed in the introduction (2008-2011), no stocked strain approaches the survival level of the Fish Lake strain.

Percent survival at 12 months was not determined, but can be reasonably estimated to be between the values determined at the 9 and 14 month post-stocking sample periods. With this assumption, mean percent survival of the Fish Lake Strain at twelve months is the only strain that approaches the 10% goal suggested in the original proposal (Appendix B).

The 2014 winter sample that was postponed a month because of high, turbid water conditions resulted in the lowest winter catch rates for the Fish Lake, Eagle Lake and North Fork Cross strains. The following 9 month sample saw very limited changes in catch rates with these three strains. Conversely, the McConaughy strain exhibited its highest recorded 6 and 9 month survival values during these samples. It is unclear if high water conditions and subsequent differences in strain behavior could have contributed to these varying catch rates.

Potential Factors Impacting Survival

Within the introduction of this report, many potential factors influencing survival were introduced and discussed. Additional factors are discussed below in light of data collected during the study.

The abundance of potential predators within the BRTA is an interesting topic. In the winter as water temperatures cool, Smallmouth Bass move to warmer, more temperature-regulated waters near springs (Peterson and Rabeni 1996). Numbers and size structure of smallmouth bass are then elevated within the BRTA. Smallmouth bass CPUE rates in the BRTA ranged from a low of 1.5 at the April 2015 sample to a high of 10.6 at the January 2013 sample. (Table 8) The mild January of 2015 resulted in lower catch rates, but similar size structure compared to other years. Large Smallmouth Bass may feed on Rainbow Trout during the winter months, but it is unclear how much of a measurable impact these predators have on the resident or stocked trout, if any. It is likely that other BRTAs would experience the same influx of winter predators, but there is no evidence to suggest trout numbers decline. Regardless of the precise impact, the observed body condition changes during the study validate this is not the primary factor affecting survival.

Table 8: Smallmouth Bass Captured During the Strain Evaluation Project

Month	Year	#	EF hrs	CPUE	PSD(11)	PSD(12)	PSD(14)	PSD(15)	PSD(17)	PSD(18)
Sept	2012	18	4.9	3.7	59	53	24	24	0	0
Jan	2013	43	4.1	10.6	78	66	46	27	2	0
April	2013	32	5	6.3	26	15	4	0	0	0
Sept	2013	37	4.7	7.8	62	56	27	21	6	0
Feb	2014	42	4.2	9.9	88	74	41	24	7	0
April	2014	18	3.9	4.6	27	13	0	0	0	0
Sept	2014	44	5.6	7.9	58	40	16	14	0	0
Jan	2015	22	5	4.4	77	55	32	32	0	0
April	2015	7	4.8	1.5	14	14	14	14	0	0
Sept	2015	48	6.2	7.8	63	46	17	6	0	0

Another factor that must be considered is the possibility of trout emigration out of the management area. Data collected in January of 2009 indicated very low catch rates (1.35 CPUE) of BRTA marked Rainbow Trout downstream in the WRTA. In an April 2014 sample upstream of the BRTA, 10 trout were captured at a rate of 4.6 trout/hour (Table 9). These samples suggest emigration is not significant, nor contributing to the Rainbow Trout density decline in the BRTA.

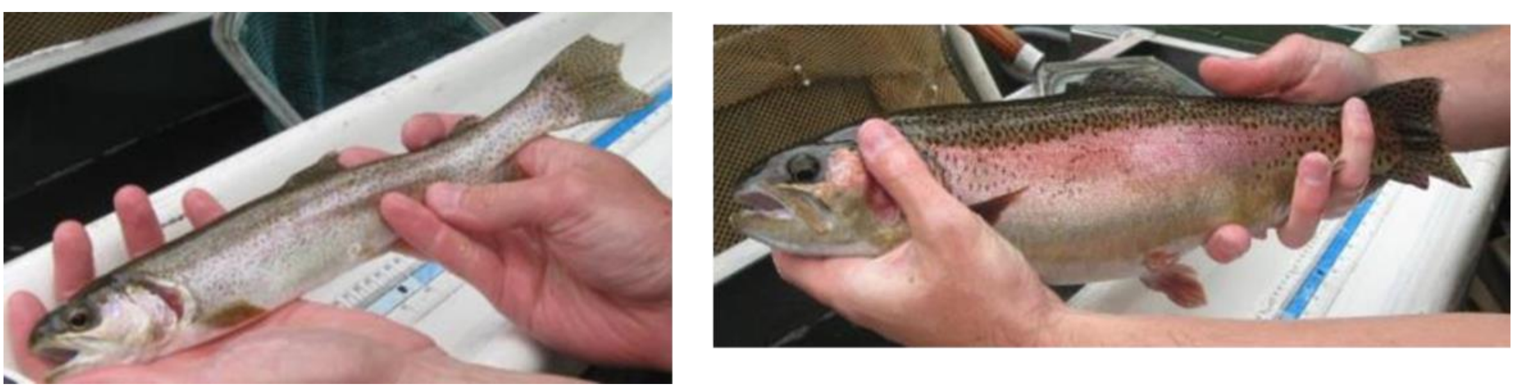
Table 9: Trout Emigration Upstream of the BRTA in April 2014

Strain	#	CPUE
Fish Lake	4	1.8
McConoughy	1	0.5
NFxMO	1	0.5
Eagle Lake	4	1.8
Total	10	4.6

Prey selection and feeding efficiency appear to be the primary factors impacting stocked trout survival, especially within the first year. Overall stocked trout mean body condition decreases after stocking. As fish survival declines throughout the year, two populations emerge from the stocked trout: a population whose body condition declines until they are removed from the population (death) and a population that maintains relative weights at a level to sustain life. These two populations are illustrated by the large amount of variation in individual fish body condition at the January and April samples. This seasonal decline in body condition was also observed in wild trout populations during the winter sample, although not as dramatic as that observed in the stocked trout, but rebounded by the April sampling period. By the 14 month sample, those stocked fish that survive tend to have body conditions similar to the wild trout population. This trend suggests seasonal variation and that fish are not consuming enough higher quality food, expending too much energy capturing and ingesting food to sustain their behavior, or a combination of both. It is apparent from survival rates that these low relative weight fish are not surviving. While some decline in relative weight may be attributable to spawning stress another likely reason for the decline is seasonal fluctuations in invertebrate food sources. Li et. al (2016) found that Oncorhyncus trout in the pacific northwest consumed more prey in the spring, but rates of consumption fell in the fall when "fewer and smaller prey were eaten." Also, multiple studies have shown that terrestrial insects are an abundant potential food source for trout in the warm seasons of the year, but less prevalent in the winter (Hunt 1975, Kawaguchi and Nakano 2001, Sweka and Hartman 2008). While, Kosnicki and Sites (2011) demonstrated that Missouri Ozark streams have high benthic macroinvertebrate variability.

While the majority of trout showed decreased winter relative weights, a small number of fish each year (<15%) sustain relative weight values $\geq$ 90. Sampling observations and angler reports suggest that these fish are transitioning and selecting larger prey items as fish are routinely found in the mouths of these trout. In addition, anglers often target larger trout with minnow-type lures. Fish that are not getting the nutritional needs to survive, likely are not able to transition to feeding on minnows when seasonal conditions limit invertebrate densities. Multiple studies suggest that trout will not grow beyond about 12 inches "or live much past four years of age" unless they can transition to survive on larger prey items (Stolz and Schnell 1991). For Rainbow Trout to survive in the Eleven Point's Blue Ribbon Trout Area, it appears they must not only change learned hatchery feeding behavior, but also transition to larger prey items, like fish or crayfish.

Figure 15: Pictures of Two Stocked Rainbow Trout of Identical Length Taken from the 2014 Winter Sample



Management Decisions to Improve the Fishery

Overall, anglers appear satisfied with the current regulation setup on the river with two separate trout management areas. Anglers in the BRTA experience excellent catch-and-release fishing for a few months after stocking, but fish numbers and expected angler satisfaction declines as the stocked fish die over the course of the year. Management decisions focus on producing a quality year-round fishery within the BRTA. As a result of the study, the following decisions will be implemented to provide an improved angling experience.

1) **Exclusively stock Fish Lake Strain Rainbow Trout within the Blue Ribbon Trout Area.**

The statistically significant success of the Fish Lake strain over the North Fork cross and the McConaughy strains at 6 months in the river, and the McConaughy and Eagle Lake strains at 9 months in the river, makes that strain the best choice for future stocking. Also, the Fish Lake strain had body conditions most similar to wild fish over the course of the study. Stocking only Fish Lake strain will allow the greatest number of fish to be available in the river for an improved catch and release fishing experience (Appendix B) with some fish surviving over a year.

2) **Split the annual stocking into two equal stockings that would include one in the spring and one in the fall.**

Splitting the stocking distributes fish more evenly over the course of a year. The strategy provides more fish in the river during months when trout numbers were previously very low (spring and early summer) and expands catch-and-release fishing opportunities. Since the actual number of stocking days should not change, the hatchery should not experience any additional workload or costs.

3) **Increase the number of fish stocked within the Blue Ribbon Trout Area from 6,000 to 8,000 when fish are available.**

According to the trout stocking allocation, stockings could increase 33% before reaching the river's recommended maximum stocking density (Appendix D).

These management decisions will specifically address goals 1 and 4 of A Plan for Missouri Trout Fishing. They will ensure that quality trout fishing opportunities continue, while enhancing and diversifying those opportunities within the BRTA.

Acknowledgements

Many people in Fisheries and Resource Science Division assisted with this project by contributing to the experimental design, fish production, data collection and analysis, and development of management actions that resulted from this project. The information learned through this project would not have been possible without the teamwork and commitment of all involved. Specifically, I want to say thank you to John Ackerson who worked with Mike Siepker, Jeff Koppelman, and James Civiello to develop this project. John also collected much of the data for the project and helped develop management actions from the results of this project. I would also like to thank Andy Turner for his efforts collecting data, providing initial results (some of which are included in this report), providing many of the photos included in this report, and leading efforts to develop management actions resulting from this project. Thank you to all of Ozark Region Fisheries staff for their help with data collection during nice and not so nice weather conditions. Thank you to James Civiello, Tom Whelan, and the entire Montauk and Shepherd of the Hills hatchery staffs who requested, secured, and raised eggs, fry and fingerling trout. Thank you also to AJ Pratt for your supervision and report review. Lastly, thanks to Fisheries Administration that approved, supported and allowed Ozark Region staff to pursue this project.

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Appendices

Appendix A: Historic Rainbow Trout Stocking Records - Eleven Point

Year	#	Size	Location	Reference
1911 & 1912	N/A	N/A	Alton, MO	SE Turner 1974 Report
1913 & 1914	N/A	N/A	Alton, MO	SE Turner 1974 Report
1915 & 1916	N/A	N/A	Alton, MO	SE Turner 1974 Report
1916	N/A	N/A	Greer Spring, MO	SE Turner 1974 Report
1925	N/A	N/A	Greer Spring	SE Turner 1974 Report
1926	N/A	N/A	Greer Spring	SE Turner 1974 Report
1936 - 1966	N/A	N/A	N/A	SE Turner 1974 Report
1962	5000	N/A	N/A	Miller, Et al 2000 WIA Report
1963	5000	N/A	N/A	Miller, Et al 2000 WIA Report
1964	50500	N/A	N/A	Miller, Et al 2000 WIA Report
1965	6000	N/A	N/A	Miller, Et al 2000 WIA Report
1966	52000	N/A	N/A	Miller, Et al 2000 WIA Report
1967	7000	N/A	N/A	Miller, Et al 2000 WIA Report
1968	8000	N/A	N/A	Miller, Et al 2000 WIA Report
1969	10800	N/A	N/A	Miller, Et al 2000 WIA Report
1971	8000	N/A	N/A	Miller, Et al 2000 WIA Report
1972	8000	N/A	N/A	Miller, Et al 2000 WIA Report
1973	12200	N/A	N/A	Miller, Et al 2000 WIA Report
1974	15200	N/A	N/A	Miller, Et al 2000 WIA Report
1975	9600	N/A	N/A	Miller, Et al 2000 WIA Report
1976	8800	N/A	N/A	Miller, Et al 2000 WIA Report
1977	8800	N/A	N/A	Miller, Et al 2000 WIA Report
1978	8800	N/A	N/A	Miller, Et al 2000 WIA Report
1979	8800	N/A	N/A	Miller, Et al 2000 WIA Report
1980	8800	N/A	N/A	Miller, Et al 2000 WIA Report
1981	8800	N/A	N/A	Miller, Et al 2000 WIA Report
1982	1020	N/A	N/A	Miller, Et al 2000 WIA Report

	0			
1983	8800	N/A	N/A	Miller, Et al 2000 WIA Report
1984	8800	N/A	N/A	Miller, Et al 2000 WIA Report
1985	8800	N/A	N/A	Miller, Et al 2000 WIA Report
1986	8800	N/A	N/A	Miller, Et al 2000 WIA Report
1987	12000	N/A	N/A	Miller, Et al 2000 WIA Report
1988	12000	N/A	N/A	Miller, Et al 2000 WIA Report
1989	16000	N/A	N/A	Miller, Et al 2000 WIA Report
1990	12000	N/A	N/A	Miller, Et al 2000 WIA Report
1991	12000	N/A	N/A	Miller, Et al 2000 WIA Report
1992 - New Statewide Trout Regulations				
1992	12300	N/A	Trout Mgmt Area	Miller, Et al 2000 WIA Report
1992	2000	10-12"	Wild Trout Mgmt Area	Ackerson 2005 Executive Summary Report
1993	13000	N/A	Trout Mgmt Area	Miller, Et al 2000 WIA Report
1993	525	6"	Wild Trout Mgmt Area	Ackerson 2005 Executive Summary Report
1993	1000	10-12"	Wild Trout Mgmt Area	Ackerson 2005 Executive Summary Report
1994	12000	N/A	Trout Mgmt Area	Miller, Et al 2000 WIA Report
1995	12000	N/A	Trout Mgmt Area	Miller, Et al 2000 WIA Report
1996	12000	N/A	Trout Mgmt Area	Miller, Et al 2000 WIA Report
1997	12000	N/A	Trout Mgmt Area	Miller, Et al 2000 WIA Report
1998	16000	N/A	Trout Mgmt Area	Miller, Et al 2000 WIA Report
1998	2000	6"	Wild Trout Mgmt Area	Ackerson 2005 Executive Summary Report
1999	2000	6"	Wild Trout Mgmt Area	Ackerson 2005 Executive Summary Report
2000	2000	6"	Wild Trout Mgmt Area	Ackerson 2005 Executive Summary Report
2003	1,500	10"	Wild Trout Mgmt Area	Ackerson 2005 Executive Summary Report
2004	4380	11.5"	Wild Trout Mgmt Area	Ackerson 2005 Executive Summary Report

2004	1120	13.3"	Wild Trout Mgmt Area	Ackerson 2005 Executive Summary Report
2005 - WTMA nomenclature changed to BRTA				
2005	5500	8"	Blue Ribbon Trout Area	"Blue Ribbon Summ Table" electronic excel file
2005	1375	12.4"	Blue Ribbon Trout Area	"Blue Ribbon Summ Table" electronic excel file
2006	5500	6.8"	Blue Ribbon Trout Area	"Blue Ribbon Summ Table" electronic excel file
2006	1375	12.1"	Blue Ribbon Trout Area	"Blue Ribbon Summ Table" electronic excel file
2007	5500	12.6"	Blue Ribbon Trout Area	"Blue Ribbon Summ Table" electronic excel file
2008	5500	12.6"	Blue Ribbon Trout Area	"Blue Ribbon Summ Table" electronic excel file
2009	5000	12.3"	Blue Ribbon Trout Area	"Blue Ribbon Summ Table" electronic excel file
2010*	5300	12.4"	Blue Ribbon Trout Area	"Blue Ribbon Summ Table" electronic excel file
2011	~3370	~12.8"	Blue Ribbon Trout Area	"Blue Ribbon Summ Table" electronic excel file
2011^	~1630	~12.8"	NF X MO RBT	"Blue Ribbon Summ Table" electronic excel file

* = Eagle Lake strain
^ = NF x MO RBT strain

Appendix B: Multi-divisional Proposal to Evaluate the Trout Stocking Regime in the Eleven Point River

Proposal for evaluating the Eleven Point River trout stocking regime

By: John Ackerson, Mike Siepker, Jeff Koppelman, and James Civiello

Follow-up discussions held since the meeting in West Plains on 5 January 2010 related to rainbow trout (RBT) genetics and the planned evaluation of multiple strains of RBT in the Eleven Point River has contributed to the development of this proposal. It has been decided that discussions and proposed plans for the evaluation should take into consideration the following objectives:

1. *Maintain a fishery of catchable-sized RBT within the Eleven Point River Blue Ribbon Trout Area (BRTA). This will be accomplished by increasing the current estimated first-year survival of 5% to at least 10% first-year survival of stocked fish within the BRTA.*

2. *Provide a "wild-type" fishing experience in the BRTA of the Eleven Point River through catch of fish with a long residence time. By stocking different strains of trout or smaller trout in higher numbers, fish surviving to a catchable size will more closely mimic wild fish in appearance and behavior. This will provide anglers with a better experience while saving MDC rearing costs.*

There is very little published information on rainbow trout strain evaluations that is relevant to the Eleven Point River. Most trout are stocked into put-and-take fisheries where longer term survival is not of concern, similar to many areas in Missouri. Numerous other studies have evaluated strains in lake environments (e.g., Ayles 1975; Klupp et al. 1978). Fay and Pardue (1986) evaluated the performance of five strains (Sand Creek, Standard Winter, Fish Lake, Ennis, and McConaughy) of rainbow trout in fished and unfished streams in Virginia. Although the focus of this study was on the fished streams, it is interesting to note that survival, movement, and mortality rates did not vary among strains in the unfished stream.

Based on these discussion points, we developed the following plan for consideration by Fisheries Division. The following plan was developed based on existing knowledge and the professional opinions of past and current MDC Fisheries Management, Resource Science and Hatchery staff; the following is a timeline for evaluating the Eleven Point River RBT stocking regime. Considering the objectives above and the goal of providing the best possible angling experience at an acceptable cost to MDC, we propose the following two-phased project plan and timeline. We feel that it is a logical approach that maintains the presence of catchable fish while also making progress on recovering or developing the wild trout aspect of the Eleven Point BRTA. At this time we are only asking for approval of Phase 1.

PROJECT PLAN

Phase 1: Experimental strain evaluation using catchable-sized fish.

1. During 2010, 5,300 catchable-size (12-14”) RBT were stocked into the Eleven Point BRTA as in previous years. These fish were the Eagle Lake strain. The Eagle Lake strain originates from a single site, Eagle Lake (CA), and is considered long-lived and tolerant of alkaline conditions.
2. Catchable-sized RBT (5,500 total consisting of 3,500 MO fall RBT and 2,000 NF♂ × MO♀ crosses) will be stocked in 2011.
3. The strain evaluation will begin with initial stocking in 2012 and continue with subsequent stockings in 2013 and 2014. Strains were selected after extensive literature review, both peer-reviewed and gray (incl. state and federal reports), speaking with several trout biologists and hatchery managers around the country. The strains suggested for initial evaluation (2012 – 2014) are:
    a. Fish Lake (Erwin National Fish Hatchery, Erwin, TN)
    b. Eagle Lake (Erwin National Fish Hatchery, Erwin, TN)
    c. McConaughy (Ennis National Fish Hatchery, Ennis, MT)
    d. North Fork (North Fork of the White River males will be used to cross with MO RBT females, dependent on availability). Milt from males will be collected from the field, with no transfer of male broodstock.
        i. During the evaluation, 1,500 of each of the four strains will be stocked, totaling 6,000 catchable-sized RBT per year. Due to variation among strains, stocking sizes may vary, but will be minimized to the fullest extent possible.
        ii. Hatchery performance measures (monthly feed conversion, mortality, weight gain, % gain, food fed, disease tolerance, and reaction to culturist) of each strain will be recorded as is currently done during trout rearing. A pre-stocking fish health assessment will also be conducted at six months and one week prior to stocking. Post-stocking assessments will be considered but monitoring condition by relative weight will be the primary post stocking health assessment tool.
        iii. A combination of fin clips and coded wire tags will be used to differentiate both the strain and year stocked.
        iv. Mortality or excessive emigration resulting in less than 10% first-year survival within the BRTA for two consecutive years would result in the rejection of the strain from further consideration during this evaluation.
4. Survival of the catchable-sized RBT within the BRTA will be assessed with September, January, and April mark-recapture samples following each experimental stocking. To assess upstream migration out of the BRTA, an additional single sample (CPUE) from Cane Bluff to Greer Access will be conducted in April each year. To assess downstream migration of stocked RBT, an additional single sample (CPUE) will be conducted from Turner Mill to Whitten Access in January of each year. It may be possible that a strain has higher than expected emigration rates; however, if first-year survival of that strain is adequate to support emigration while still achieving our first-year survival goals within the BRTA then we would consider that a successful

strain. Evaluating emigration will simply provide additional information on sources of BRTA fish loss.

5. After the 2014 stocking has been evaluated with a final electrofishing survey in April 2015, progress on the strain evaluation component will be assessed, and recommendations will be provided to Fisheries Administration by November 2015 regarding stocking status and future management in the Eleven Point River BRTA. At that time, we could evaluate stocking four alternative strains of catchable-size RBT if the initial four strains do not meet management objectives, or we could implement Phase 2.

Appendix C: Elastomer Tagging Procedure and Tag Retention Evaluation

Elastomer Tagging Procedure and Tag Retention Evaluation

7/22/2013

by

Andy Turner, Sydney Thomas, and Kerry Fishel

INTRODUCTION

Currently Ozark Fisheries is working on the Eleven Point River Trout Strain Evaluation Project to help identify possible options to increase survival and/or growth of stocked rainbow trout in the Eleven Point River Blue Ribbon Trout Area. A requirement of this project is the stocking of four alternative strains of rainbow trout for a period of up to three years. In order to assess survival and growth it is necessary to be able to identify each strain independently and within stock year.

This has presented a problem, as after the second year of tagging there must be eight unique marks that are also not confused with marks used in previous stockings (N = 4). To address this issue elastomer tags were evaluated for retention, tagging efficiency, cost, tag placement, and overall usability. The following report outlines these assessments and provides a description of the process that worked best in our testing. Northwest Marine Technology, Inc. supplied these tags, along with written and video instructions. These instructions were very helpful, and it is recommended that they be reviewed prior to using elastomer tags. However, our procedure varied slightly from their recommendations, which provided some benefits that were helpful in increasing tagging efficiency.

TAGGING PROCEDURE

Supplies

2 Plastic fold-out tables
Chairs
Shade canopy
Cooler filled with ice
4, 3mL Tubes elastomer (1 red, 1 blue, 1 green, 1 orange)
2, 1mL syringes curing agent
8 Mixing syringes (3mL, 12 gauge)
8, 1" Regal clips
80 Injecting syringes (0.3mL, 29 gauge)
3, 20-Gallon plastic containers
Fish anesthetic MS-222 (Tricaine mesylate)
3 Mechanical fish counters
3 Ziplock bags
3-4 Small fish nets
Disposal container for needles

Northwest Marine Technology, Inc. (http://www.nmt.us/) visual implant elastomer (VIE) tagging kits were used for this project. One 3mL tube of elastomer for each of four colors (12mL total) was used to tag a total of 8859 fish. These kits provided the elastomer, curing agent, and injecting syringes.

Mixing Procedure

The tagging kits provided directions for mixing; however, there was a modified procedure developed that was found to have higher efficiency (fish tagged per milliliter).

The following modified steps were developed for preparing the elastomer:

1. Remove compressor from a 3mL syringe. While holding horizontally or slightly tilted, inject the desired amount of elastomer into the 3 mL syringe and then add the curing agent (ratio 10:1, respectively). Try to keep the mixtures from flowing into the needle tip and mix between 0.5-2mL at a time.
2. Mix the color and curing agent with an unfolded regal clip (or regular paper clip) while continuing to hold the syringe horizontally. Mix thoroughly.
3. Place the compressor in the 3 mL syringe and turn syringe vertically where the needle-end is pointed up.
4. Compress the syringe until there is no air remaining.
5. Insert the 3 mL needle into the smaller 0.3 mL tagging syringe and inject until 1/3 full (about 0.1-0.15 mL).
6. Place compressor in small tagging syringe.
7. While holding vertically (needle-side up), compress until no air remains and a small amount of elastomer comes out of the needle.
8. Insert needle in fish. Inject tag. Remove needle. Try to stop dispensing tag before removing needle from tissue. Wipe away excess elastomer with your finger and towards the injection site to prevent wiping action from pulling elastomer out.

It is important to note the holding positions of the syringe in order to minimize elastomer waste and to reduce air bubbles in the syringes. Also, the elastomer mixture can begin to set within an hour of mixing; therefore, mixing should only take place immediately before injecting tags. Setting time may be extended by keeping the mixture cold or expedited in warmer conditions. The injecting syringes were only filled 1/3 full because the compressors tended to break if filled with much more of the dense elastomer mixture.

Tagging Setup

Chairs and tables were placed under a shade canopy. The shade helped keep the trout and elastomer mixtures cooler. Mounted fish counters were placed on the tables and inside Ziploc bags to keep track of the number of fish tagged. A mixture of 2 mL of elastomer and the hardening agent was prepared in a 3mL mixing syringe and transferred into the 0.3mL injecting syringes. This created about 15-20 injection needles ready for use. Injecting syringes that were not being used immediately were stored in a cooler. Adjacent to the tables, each of the 3, 20-gallon, plastic containers were filled with 15 gallons of raceway water and mixed with anesthetic (MS-222) to immobilized the trout to be tagged. Use of MS-222 requires a 21 day holding period before stocking into public waters, so tagged trout were not stocked until this time period was exceeded.

Tagging

There were five people tagging fish, two people running fish from the anesthesia containers to the tagging tables, and one person collecting fish from the raceway. Cycles of 15-20 trout were transferred from the raceway to the anesthesia containers. After the fish became anesthetized, they were brought to the tagging table with nets. It is important to note that tout needed to be completely immobilized by the anesthesia to be tagged. Failure to do so resulted in fish flopping that bent, weakened, and broke tagging needles. Taggers injected a small line (about one centimeter long) of elastomer in the clear adipose eye tissue on the posterior side of the eye. Trout were then returned to the raceway. After emptying an injecting syringe, taggers simply grabbed a new syringe from the cooler. A total of 2.5mL of elastomer had to be mixed for each of the four strains tagged: McConaughy (Red), Fish Lake (Blue), North Fork Cross (Orange), and Eagle Lake (Green).

STRAIN EVALUATION TAGGING

A minimum of 2000 fish from each of the four strains were tagged using four different colors: red, blue, orange, and green (Figure 1). Overall, 8859 trout were tagged at a rate that ranged from 1080 fish per hour to 1497 fish per hour (Figure 2). Total cost for elastomer material to tag 8859 rainbow trout was $220. This works out to approximately 2 ½ ¢ per tagged rainbow trout.

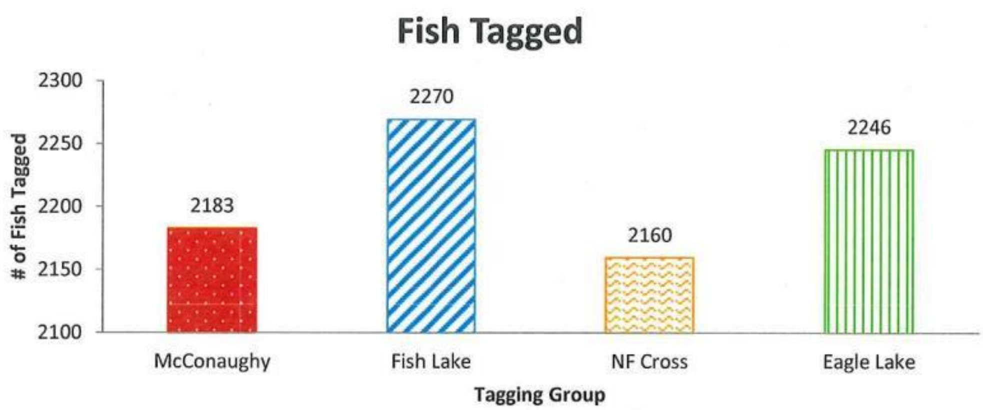

Figure 1. 2183, 2270, 2160, and 2246 were tagged from the McConaughy, Fish Lake, North Fork Cross, and Eagle Lake strains, respectively.

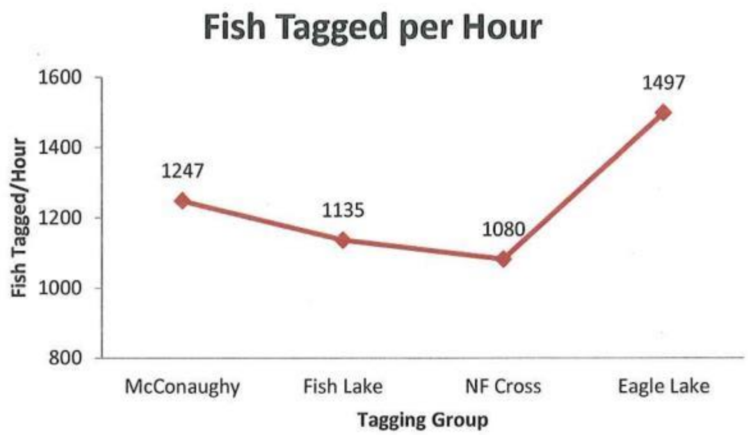

Figure 2. The tagging rate was calculated as fish tagged per hour. The average was 1240 fish per hour.

Elastomer efficiency (the number of fish tagged per mL of elastomer) varied (Figure 3). The McConaughy strain exhibited the highest efficiency at 944 fish per milliliter. There are two factors that resulted in this increase in efficiency: 1) this was the first strain tagged and taggers were a little more conservative with the amount of elastomer injected and 2) individuals of this strain tended to be smaller than other strains and as a result required less elastomer per tag. The subsequent tagging runs' efficiencies leveled out in the mid-800s with the last two runs (NF Cross and Eagle Lake) having the same efficiency of 864 fish per milliliter. The average tagging efficiency was 875 fish per milliliter.

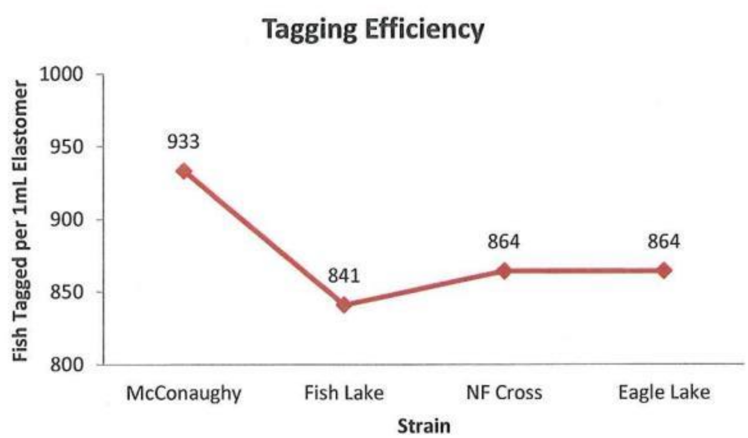

Figure 3. The McConaughy strain had the highest efficiency at 933 fish tagged per 1mL elastomer. The other three strains had very close efficiencies ranging between 841-864 fish tagged per 1mL elastomer.

There was fish mortality during the tagging process (Figure 4). Several factors likely contributed to these mortalities including low oxygen levels in the anesthesia containers, heat, time out of water, and high anesthesia concentrations. The first strain tagged was the McConaughy strain, which also had the highest mortality. With each subsequent group tagged mortality rates were reduced. This reduction was a result of changing the anesthesia water more frequently and reducing tagging time. The first strain tagged (McConaughy) did not receive a water change during the tagging process. While tagging the remaining three strains, anesthesia water was refilled with cold raceway water every 800-1000 fish. There was an initial 75% drop in mortality from the first tag group to the second (Figure 5). This was followed by an additional reduction to only 6 mortalities (0.3% of tagged fish) in the final tag group.

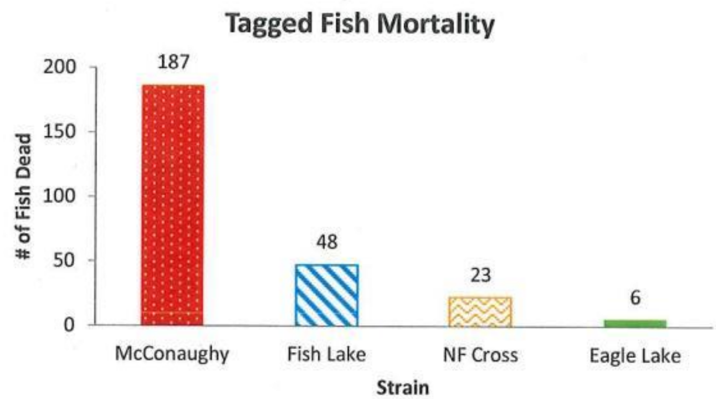

Figure 4. Number of fish mortalities per strain and in order tagged.

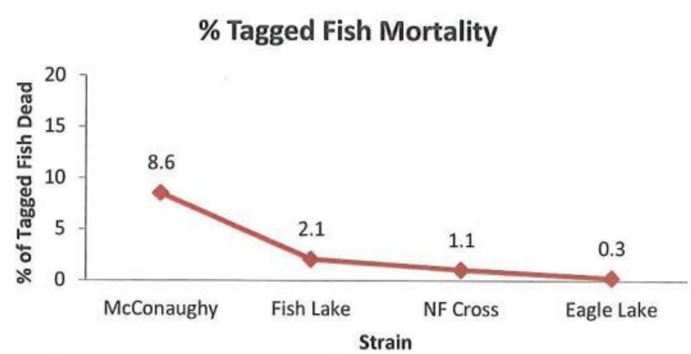

Figure 5. Proportion of the total mortalities for total fish tagged. Reported in order tagged.

TAG RETENTION

Prior to use for the Eleven Point River Trout Strain Evaluation Project, tag retention was evaluated in 509 trout and for a term of 12 months. Tag injection was as described above but the method for mixing was as outlined in the instructions provided from Northwest Marine Technology. We found these mixing methods to be a little cumbersome and wasteful of tagging material. As a result we altered or mixing methods to those described above and saw an increase in tagged fish per mL from ~400 to 864.

Trout were injected with either 1) a red adipose eye tag or 2) a green adipose eye tag and a green chin tag. Initial tagging occurred in May 2012. Tag retention was checked at 14 days, 5 months, 7 months, 10 months, and 12 months. Fish weight was also recorded on the starting date and end date.

Results

After 12 months, 218 out of 248 living fish retained their tags (Figure 6). There was a very small, yet steady loss of total tags throughout the 12 month study (Figure 7). All tag colors and placements continued to have retention above 90% up to the 10 month check. The green chin location lost a high number of tags between the 10 month and 12 month check causing its retention to drop to 67%. Both eye tags remained above 90% retention. Following completion of the retention study, some of the fish with missing tags were sacrificed and the flesh around the tagging site was explored with a scalpel. Eye tags that could not be seen visually were also not located within surrounding tissue. Most of the chin tags (5 of 7) that could not be seen visually were located deeper within the tissue and were still retained by the fish even though they could not be identified visually. This suggested that fish growth had an impact on tag identification with the chin location but not the eye location. Trout growth was attributed to the increase in tag loss from the chin location between the 10 and 12 month tag check.

Figure 6. Percent of all tags retained over time.

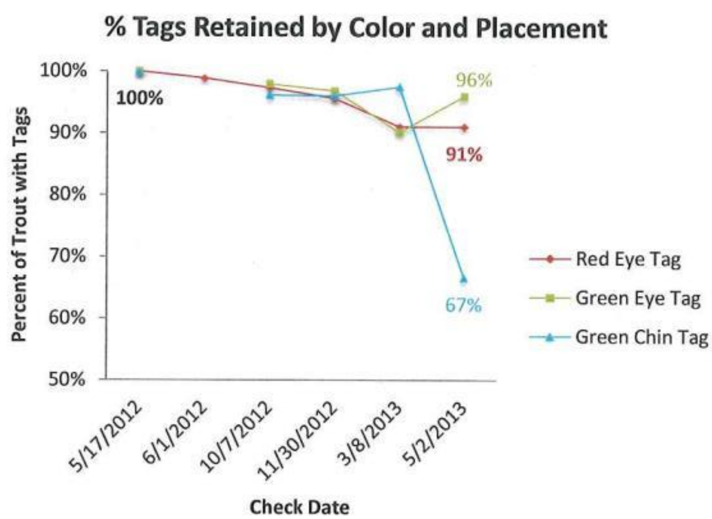

Figure 7. Percent tag retention of living trout since previous check date.

Fifty seven percent of the study fish died during the 12 month study period (Figure 8). Limited space available at the hatchery required that study fish be kept in 3'x3'x8' cages. High mortality was attributed to the confined space, stress, and physical damage to fish by the cage walls. The 10 month check had a 12% higher mortality than any other previous check, and the 12 month check had the highest mortality rate at 32% (Figure 9). An increase in trout mortality rates with time was attributed to the growth of study fish. As these fish increased in size, crowding in the cages also increased and was believed to contribute to higher rates of mortality.

Figure 8. Percent cumulative mortality from the start date to each check date. In the 12 month period, 57% of tagged trout died.

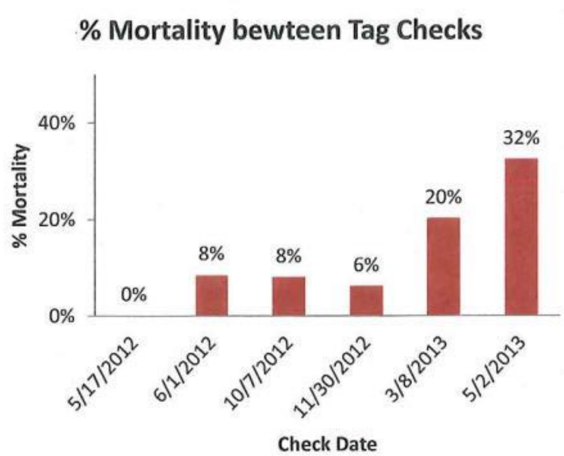

Figure 9. Percent mortality between for each check period. Mortality hovered around 6-8% for the first 7 months. At the 10 month and 12 month checks mortality continually increased to 20% and 32%, respectively.

There was an increase in average weight from 0.7lbs to 1.32lbs. This showed a near doubling of size throughout the study. The eye tags seemed unaffected by this growth and growth did not seem to attribute to any adipose eye tag loss. However, near the end of the study, chin tag loss increased, tag movement from tag location was noticed, and growth was rapid. Tag loss in the chin location was attributed mainly to growth and subsequent movement and covering of tags.

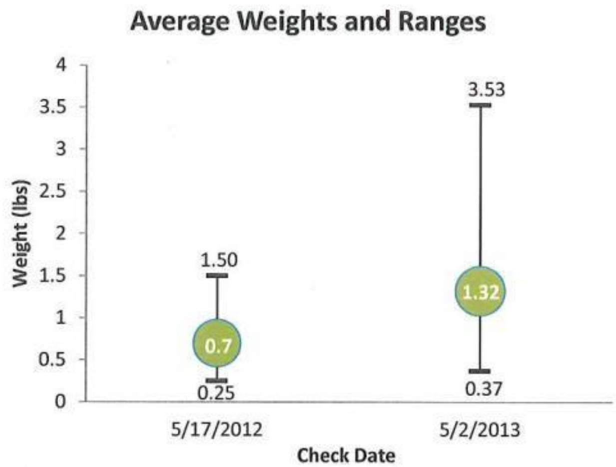

Figure 10. Average weight and range of weights at day one of the retention study and upon completion. Average weight is represented by the number inside the green circles. The range is represented by the bar extending below and above the average weight circles.

SUMMARY

Overall, elastomer tagging proved an effective and easy method for tagging the four rainbow trout strains. Tagging efficiency averaged 875 fish tagged per milliliter of elastomer, with as many as 975 fish per milliliter. For a crew of eight people (5 tagging), the tagging rate averaged 1240 fish per hour. However, tagging rates could be higher as shown by the final tagging group, which tagged 1497 fish per hour. It cost 2½¢ to tag each fish, or about $25 for 1000 fish. Adipose eye tags had the highest retention rate (93%), while chin tags exhibited a drop in retention after 10 months. This indicates chin tags are poor markers in long term studies (> 10 months) with fish expected to have significant growth. Tag retention was independent of tag color (red or green).

Appendix D: Excerpts from A Plan for Allocation and Stocking of Trout in Missouri July 2009

A Plan for
Allocation and Stocking of Trout in Missouri

July 2009

Prepared by

John Ackerson, James Civiello, Craig Fuller (Chair), Todd Gemeinhardt, Jennifer Girondo, Dave Mayers, Kevin Meneau, Phil Pitts, Mike Siepker, and Tom Whelan

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Background and Current Practices

This plan is intended to partially fulfill Goal 1 (Objectives 1, 3 and 4), Goal 4 (Objective 1) and Goal 6 (Objective 2) of *A Plan for Missouri Trout Fishing* (2003).

The following paragraphs are excerpted from *A Plan for Missouri Trout Fishing* and provide a background and basis for this document.

> *Trout fishing is a popular activity in Missouri, accounting for about 14 percent of all angling effort. Trout habitat, however, is limited and only about 145 miles of cold streams and Lake Taneycomo are currently managed as year-round trout fisheries.*
>
> *Most of Missouri's trout fishing is provided by stocking hatchery-reared trout. Approximately 2 million trout are reared in five Department of Conservation hatcheries, Neosho National Fish Hatchery and occasionally at other federal hatcheries.*

This document is intended to provide a consistent framework and overall guidance for trout stocking conducted by the Missouri Department of Conservation (MDC). Managers should utilize, in a consistent, efficient and equitable manner, these stocking rates to distribute the limited number of trout available for stocking in Missouri. The result will be improved trout fishing for Missouri's anglers, furthering our goal of providing ... *the highest quality trout fishing experience that can be offered.*

Clearly, fisheries managers must weigh a variety of factors when developing or refining stocking requests under this plan. In most cases, we will not be stocking at levels as high as the calculated maximum rate. The "more is better" approach should be avoided, and requests should be based on good knowledge of factors such as existing trout populations, habitat quality, carrying capacity, condition of fish within the population and fishing pressure. Managers must be willing to adjust stocking rates as any of these factors change, as the average size of fish stocked increases or as more refined information becomes available. Therefore, this should be considered a dynamic document, subject to further consideration and modification as additional and pertinent information becomes available.

Missouri's current trout program consists of four trout parks, Lake Taneycomo, twenty-nine winter trout fishing areas in urban lakes and ponds, nine blue ribbon trout areas, three red ribbon trout areas and nine white ribbon trout areas. The trout parks are managed with the multiple objectives of providing consistently high success and catch rates in easily-accessible fishing areas in publicly-accessible parks. Catchable-size rainbow trout, typically averaging 12.5 inches, are stocked nightly at each trout park during the March 1 through October 31 fishing season, at a rate of 2.25 trout per anticipated tag sold. Typically, there are nearly one million rainbow trout stocked at the four trout parks annually. **This plan contains no recommendation to change the current stocking formula for the trout parks during the March 1 through October 31 fishing season.** The four trout parks also host a winter catch-and-release season from the second Friday in November through the second Monday in February. Currently, trout are stocked during the winter catch and release season at three of the four trout parks. However, stocking rates are not consistent among the parks or from year to year (Table 1a).

Excluding the four trout parks, more than 800,000 brown and rainbow trout are stocked in Missouri streams and impoundments (including Lake Taneycomo) each year. Stocking rates vary, and there has been no standard formula or framework for determining stocking rates for these waters.

Lake Taneycomo is Missouri's only tailwater trout fishery and is the largest body of coldwater habitat in Missouri (2,080 acres). Lake Taneycomo is currently stocked at a rate of 700,000 rainbow trout and 10,000 brown trout annually, producing acceptable angler catch rates, trout growth rates and trout condition factors. This stocking rate reflects a reduction compared to historic stocking rates of the 1980s which reached a maximum of 1.68 million trout annually. These higher stocking rates during the 1980s were thought to be contributing factors in the decline of the Lake Taneycomo trout fishery during that period. As a result, stocking rates were reduced to the current level and a stocking schedule that matches the annual variation in fishing pressure has been adopted. **This plan contains no recommendation to change the current stocking rate for Lake Taneycomo.**

Twenty-nine urban lakes and ponds are stocked during the cool months to provide trout fishing opportunities, generally in cities and towns where there are no other trout fishing opportunities nearby. Winter trout fishing areas are managed as put-and-take or delayed harvest fisheries. Those areas managed as delayed harvest fisheries implement "catch-and-release" regulations for the first part of the winter season, then, are opened to harvest under statewide regulations. The delayed harvest winter trout fishing areas maintain higher catch rates after stocking, yet still provide harvest opportunities. Generally, put-and-take winter trout fishing areas are stocked at a higher rate than delayed harvest fisheries. Currently, put-and-take winter trout fishing areas are stocked at rates ranging from 182 trout per acre to 1,600 trout per acre, and delayed harvest winter trout fishing areas are stocked at rates ranging from 351 trout per acre to 400 trout per acre (Table 2).

The most diverse trout fishing opportunities in Missouri are provided by the "ribbon" trout areas located on Ozark streams. ***Blue*** ribbon trout areas include parts of large, cold streams with excellent trout habitat and smaller streams that support naturally reproducing rainbow trout populations. Harvest is limited to maintain the maximum density of adult trout, create excellent catch-and-release fishing and provide the occasional chance to harvest a trophy. Blue ribbon trout areas on the Current and North Fork of the White rivers are stocked with brown trout. The blue ribbon area on the Eleven Point River is stocked with rainbow trout only. ***Red*** ribbon trout areas have high-quality trout habitat stocked primarily with brown trout. They provide good catch-and-release fishing and a chance to harvest quality-size trout. ***White*** ribbon trout areas are coldwater streams capable of supporting trout populations year 'round. All receive periodic stockings of rainbow trout, and some also receive brown trout. They provide great opportunities for catching and harvesting trout and the occasional chance to harvest a large trout.

Current stocking rates vary across the ribbon trout areas (Table 3). Most of these rates were originally based on historic practices or local knowledge of individual water bodies. In some cases, stocking rates were further refined using habitat information, information derived from angler surveys or the results of electrofishing surveys and related fish population data.

Recommendations

Trout will be allocated to individual waters based on consideration of pertinent factors including: capability to support trout either year 'round or throughout the winter in small impoundments, stream or impoundment surface area, angling pressure and public access, and in the case of ribbon trout areas, the status of any self-sustaining trout populations and adult trout habitat rating information. The following recommendations should be followed to guide future trout stocking in Missouri:

1. **With the exception of small impoundments stocked for the winter program, trout should not be stocked into any waters where physical habitat (e.g., flow, water temperature, water quality) or public access is considered limiting.**
2. **Small blue ribbon trout areas that support three or more year classes of naturally-reproduced trout and have trout populations large enough to support existing or anticipated fishing pressure should not be stocked.**
3. **The maximum stocking rate will be 300 trout per acre for Bennett Spring, Montauk and Roaring River; and 400 trout per acre for Maramec, during the winter catch and release season at the trout parks. Additionally, 70 percent of the trout stocked during the winter catch and release season will be included as part of the total number of trout stocked for opening day on March 1 (Table 1b).** These recommended maximum stocking rates are consistent with those that are being recommended for impounded, "delayed

harvest" winter trout fishing areas, except that they are slightly reduced due to the standing crop of trout present at Bennett Spring, Montauk and Roaring River trout parks. The recommended maximum stocking rate for Maramec is consistent with impounded, "delayed harvest" winter trout fishing areas due to the fact that Maramec is open to fishing during the winter catch and release season seven days per week compared to the four days per week at the other three trout parks. Additionally, Maramec is also open to bait fishing throughout its entirety during the regular season, which likely results in a lower standing crop of trout due to higher rates of harvest and hooking mortality, compared to the other parks where flies and/or artificial lures only may be used in designated areas. For example, sampling data from Bennett Spring indicate that, on average, zones that allow only flies (zone 1) and flies/artificial lures (zone 2) contain 81 percent more trout than the "bait" fishing zone (zone 3) at the end of the regular season.

4. **The maximum stocking rate will be 700 trout per acre for put-and-take winter trout fishing areas and 400 trout per acre for delayed harvest winter trout fishing areas.** These recommended maximum stocking rates have supported acceptable catch rates and angler satisfaction in the past (*K. Meneau, personal communications*).
5. **Allocate trout stocking in ribbon areas according to a formula that includes habitat suitability and angling pressure.** A better understanding of the physical habitat characteristics of Missouri's trout streams within the ribbon trout areas has recently (2006 – 2007) been achieved by the visual classification and rating of adult trout habitat. The visual classification system used was originally derived from the *Habitat Suitability Index Models and Instream Flow Suitability Curves* for both rainbow and brown trout (Raleigh et al. 1984; 1986). Using information from these publications, a rating system was developed for Missouri pool and riffle-run habitats. This system included a ranking protocol for three important habitat features. In pool habitat, features included low velocity resting areas, bottom obscurence and depth and velocity. Feeding stations, bottom obscurence and variation in depth and velocity were considered for riffle-run habitats. Mike Siepker, MDC Resource Science Division, has completed a related report entitled "A Survey of Missouri's Trout Habitat Quality" summarizing this effort and its results which can be accessed on-line at: http://mdcsharepoint/sites/resourcescience/Documents/Aquatic and Wetland Systems/Rivers and Streams/Trout_Habitat_Survey_FinalReport.pdf.

   Two formulae have been developed to assist managers in determining minimum and maximum stocking rates for ribbon trout areas. Although both formulae are based on the concept of carrying capacity, the resulting minimum and maximum calculated stocking rates are intended to be guidelines on acceptable stocking rates for individual ribbon trout areas, not target rates or recommended objectives. The minimum calculated stocking rate was developed to produce an estimated number of trout to stock annually to bring the total trout population of a given area back to carrying capacity at a single point in time post-stocking, while compensating for total annual mortality resulting from both angling and natural causes. The maximum calculated stocking rate was developed to produce an estimated number of trout to stock annually to compensate for total annual mortality and maintain carrying capacity in a given area throughout the year. Therefore, managers with areas that have high annual mortality due to high angler effort or exploitation rates could use stocking rates that are closer to the maximum. It is also likely that to justify maximum stocking rates, managers will need to know angler effort and exploitation rates or other factors relating to total mortality. It is also likely that more stocking trips will be needed over the course of the year when the maximum rates are used. For each area, stocking trout to reach or maintain carrying capacity may depend on the timing of stocking trips, the number of stocking trips and the duration between stocking trips. Exceeding the calculated maximum stocking rate should be a rare exception and considered on a case-by-case basis in consultation with hatchery staff and Fisheries Division administrators and must be adequately justified. Such justifications should reflect habitat suitability, but should be based primarily on exceptionally high fishing pressure and efforts to maintain acceptable angler catch rates. Similarly, stocking requests below the recommended minimum should be justified and approved on a case-by-case basis.

Both stocking formulae have been developed into a functional Microsoft Excel® spreadsheet file "Trout Stocking Allocation Calculation_CJF.xlsx". One formula is used for blue ribbon and red ribbon trout areas where habitat ranking data is more heavily weighted and lower angler effort relative multipliers are used in calculating stocking rates. This formula is intended to be more applicable in managing "put-grow-and-take" fisheries, such as blue ribbon and red ribbon trout areas. The second formula is used for white ribbon trout areas where habitat ranking data is less heavily weighted and higher angler effort relative multipliers may be selected. The white ribbon trout area formula is intended to be more applicable in managing "put-and-take" fisheries.

A trout manager could derive an annual stocking request for one of Missouri's ribbon trout areas using the concept of carrying capacity (60 pounds per acre) as a starting point, then enter additional information pertaining to species of trout to stock, size of trout to stock, estimated survival rate, habitat quality ranking data, warm water temperature considerations, angler effort and numbers of trout previously stocked. It should also be noted that the estimated carrying capacity of 60 pounds per acre only takes trout (rainbow trout and brown trout) into consideration, not total carrying capacity of the stream which would include the entire fish community. Examples of the "Trout Stocking Allocation Calculation" spreadsheet can be found in Table 4 and directions for making the calculations are included in a following section.

For comparison, Pennsylvania streams are stocked at a maximum rate of 475 trout/acre/year (Pennsylvania Bureau of Fisheries 1997). Yearling rainbow trout were stocked at annual rates up to 150 per acre in large fertile trout streams in Michigan (Michigan Department of Natural Resources 1977), and age 1+ rainbow trout were stocked at maximum annual rates of 120 fish per acre in streams and rivers in Quebec (Qu bec Ministore du Loisir 1988). In Wisconsin, yearling (legal; 7 to 9 inches) trout are stocked at rates between 25 and 300 per acre, varying as a function of both habitat quality and angling pressure (A. Kaas, Wisconsin Department of Natural Resources, personal communication). In Wyoming, trout streams sustain standing stocks at or near productive capacity; 45% of stream trout stocks exceed 60 pounds per acre, 20% exceed 120 pounds per acre and only 10 % of stream trout populations sustain more than 200 pounds per acre (Wiley 2006). Platts and McHenry (1988), studying streams in seven western ecoregions, found standing stocks ≤ 60 pounds (trout and char) per acre were most common (55 to 96% of observations) for streams across all seven ecoregions, suggesting that streams sustain trout to carrying capacity. Similarly, in Missouri carrying capacity for trout (primarily brown trout) was estimated to be 60 pounds per acre on the Meramec River (A. Austin, personal communication).

6. **Allocate surplus rainbow trout broodstock and other large rainbow trout among the trout parks, Lake Taneycomo, White Ribbon trout areas and winter trout fishing areas.** Presently Bennett Spring, Montauk, Roaring River and Shepherd of the Hills hatcheries maintain rainbow trout broodstock. Each year a portion of the retained broodstock ages out of optimum gamete production and is replaced with younger stock. In addition, some younger, prospective-broodstock candidates that are retained and raised to sexual maturity are present in excess of what is needed for gamete production. The total number of retired and excess broodstock available for reassignment to sportfish use varies from hatchery to hatchery and year to year, yielding a potential annual range of approximately 1,000 to 2,000 surplus rainbow trout broodstock for the coldwater hatchery system as a whole. Sizes of these fish range from 1.5 to 2 pounds for young excess males to 3 to 5+ pounds for older trout retired from service. In the past nearly all surplus broodstock were stocked into Lake Taneycomo and the trout parks. This arrangement has been logical in that it has minimized transportation effort, and the recipient fisheries are intensively managed and fished. More recently, surplus broodstock have been stocked into Lake Taneycomo and the four trout parks in reduced numbers, while adding surplus broodstock to both winter trout fishing areas and white ribbon trout areas. The impetus for the wider distribution of surplus broodstock is Objective 4.4 of *A Plan for Missouri Trout Fishing* (2003)...*Determine the feasibility of diversifying the size distribution of rainbow trout available for put-and-take stocking*. The total number of surplus broodstock is now allocated so that: trout parks receive 55%; Lake Taneycomo receives 20%; white ribbon trout areas receive 12.5%; and winter trout fishing areas (St. Louis and Kansas City) receive 12.5% (Table 5).

   The broodstock sub-committee has developed a functional Microsoft Excel® spreadsheet, file "Trout Broodstock Allocation Calculation 10_08.xls", to assist hatchery managers in allocating surplus broodstock for white ribbon trout areas based on the current year's surplus numbers (Table 6). Entering the number of available broodstock for any given year into the "Total Number Broodstock Available" cell on the spreadsheet will change each stream's allocations based on the formula. This formula works with a minimum of 440 fish, anything less than that and it becomes problematic due to the fact that the white ribbon trout areas receive 12.5% of the total number of surplus broodstock and that 12.5% of 440 is equal to 55; which is only enough trout to fulfill the "Base" number of 6 fish in each area as seen in column "D" of Table 6.

Anticipated Impacts and Implications

Excluding the four trout parks (Bennett Spring, Maramec, Montauk and Roaring River), approximately 854,995 rainbow and brown trout were stocked by MDC in Missouri waters during 2008. If the number of trout stocked in the trout parks in 2008 (937,728) is added to the accumulated maximum stocking rates listed in Table 4 (876,078), the total number of trout stocked would be 1,813,806. While it is unlikely that the maximum stocking rates will be used in all cases, this yields a 21,083 (2.5%) increase over 2008 numbers stocked outside of the trout parks and represents only a 1.2% overall increase in trout stocking. This increase is well below the 10% increase in production capacity described in Goal 2, Objective 2.1 of *A Plan for Missouri Trout Fishing* (2003) that could be used to expand the trout program once the remaining anticipated hatchery renovations are complete and to address the need to establish a 10% emergency buffer. Some coldwater hatchery renovations have already been completed and more are underway; actual increases in production capacity are yet to be determined.

Trout Stocking Allocation Calculation

When using the "Trout Stocking Allocation Calculation" spreadsheet it is important to note that data need only be entered into the cells that are bordered with the red box. The following is a short list of instructions for filling in parameter values for the calculation:

1. Enter the average length (inches) of trout to be stocked. Please note that the condition factor in the formula should be equal to 0.0004055 for rainbow trout (i.e. =1/(0.0004055*(F6)^3) and the condition factor in the formula should be equal to 0.00043 for brown trout (i.e. =1/(0.00043*(F6)^3).
2. Enter the total square meters of the managed area you are stocking. This number can be obtained from the habitat type summary table for individual ribbon areas in the report "A Survey of Missouri's Trout Habitat Quality".
3. Enter an estimate of annual survival. For example: if you have an estimated annual survival rate of 15.8% for rainbow trout within a white ribbon area; then enter "15.8". Keep in mind, annual survival estimates may be obtained from a variety of resources including, but not limited to, long-term CPUE data, catch curves, mark and re-capture population density estimates, tagging studies, etc.
4. Enter square meters of habitat type and rank. These numbers can be obtained from the habitat type summary table for individual ribbon areas in the report "A Survey of Missouri's Trout Habitat Quality". Numbers of trout suggested are proportionate to percentages of physical habitat within each class rank. Blue/red ribbon trout areas are more heavily weighted with regards to physical habitat ranking than white ribbon trout areas.

5. For warm water temperature considerations, enter the average number of days per year the water temperature does not fall below 70 degrees F. Also, enter the percentage of the ribbon area to be stocked where the water temperature does not fall below 70 degrees F. For example, if you have 20 days that the water temperature does not fall below 70 degrees F within the downstream 1/3rd of your ribbon area, enter 20 for the number of days and 33.3 for the area affected. This information should be available from water temperature data collected from all ribbon areas. If you don't have this information, contact Kathy DeiSanti (Resource Science – Columbia).
6. Enter a relative value for angler effort. There are different ranges of angler effort values for the different ribbon areas. For example: blue ribbon area angler effort values range from (0.0, low - 0.1, high); red ribbon area from (0.0, low - 0.2, high); and white ribbon area from (0.0, low - 0.3, high).
7. Enter the number of trout stocked last year. Managers should note that this number is used in combination with the estimated survival rate to calculate an existing trout population in the area which is relevant to the carrying capacity. The formula only takes into consideration trout stocked in the area of interest. Therefore, if a manager is using the formula to calculate a stocking rate for a ribbon area that is adjacent to another ribbon area, trout park or any other source of trout, then, potential trout migrations into the area should be accounted for.
8. After the values in the above seven steps are entered, the formula will calculate a minimum and maximum number of trout to be stocked annually.
9. After reviewing the minimum and maximum stocking rate, determine a number that you will stock. Enter this number and the formula will calculate a minimum number of stocking trips required so that carrying capacity will not be exceeded. Remember to round up on the number of stocking trips.

Table 3. Current (2008) Ribbon Trout Areas Stocking Rates.

BLUE RIBBON AREAS	#Miles	#Acres	#RBT/Yr.	#RBT/Ac.	#BNT/Yr.	#BNT/Ac.
Barren Fork Creek	3.2	13.7	0	N/A	0	N/A
Blue Springs Creek	4.0	13.4	0	N/A	0	N/A
Crane Creek	8.0	26.5	0	N/A	0	N/A
Current River	9.0	63.3	0	N/A	6,000	95
Eleven Point River	5.5	85.1	5,500	65	0	N/A
Little Piney Creek	9.9	58.6	0	N/A	0	N/A
Mill Creek	7.7	25.1	0	N/A	0	N/A
North Fork of the White River	8.6	154.5	0	N/A	600	4
Spring Creek	6.2	33.0	0	N/A	0	N/A
RED RIBBON AREAS	#Miles	#Acres	#RBT/Yr.	#RBT/Ac.	#BNT/Yr.	#BNT/Ac.
Meramec River	8.2	86.4	0	N/A	5,800	67
North Fork of the White River	7.0	121.7	0	N/A	6,000	49
Roubidoux Creek	2.2	16.3	0	N/A	800	49
WHITE RIBBON AREAS	#Miles	#Acres	#RBT/Yr.	#RBT/Ac.	#BNT/Yr.	#BNT/Ac.
Capps Creek	2.0	17.3	4,000	231	1,000	58
Current River	7.7	82.9	8,000	97	0	N/A
Eleven Point River	14.2	211.4	16,000	76	0	N/A
Hickory Creek	2.7	12.6	3,000	238	0	N/A
Little Piney Creek	3.7	25.9	2,100	81	0	N/A
Niangua River	11.5	174.3	7,500	43	5,000	29
Roaring River	4.0	27.9	4,000	143	500	18
Roubidoux Creek	0.9	7.3	6,500	890	0	N/A
Stone Mill Spring	0.3	1.4	3,900	2,786	0	N/A

Table 4. Microsoft Excel Trout Stocking Allocation Calculation for Ribbon Trout Areas.

Trout Stocking Allocation Calculation

Stream: Template

Management Type: Blue_Red Ribbon

Parameters Used For Calculation	Formula	Value	Description Of Parameter Value To Be Entered
Carrying Capacity (lbs/Acre):	60	***	< Assumption: maximum from literature review
Fish number to pounds conversion:	#DIV/0!		< Enter length of fish to be stocked in inches
Area to be stocked (Acres):	0.0		< Enter total square meters from habitat survey
Carry Over (% annual survival):	0		< Enter estimated annual survival
Percent Riffle Rank 1 Habitat:	#DIV/0!		< Enter total of Riffle Rank 1 habitat in square meters from habitat survey
Percent Riffle Rank 1- Habitat:	#DIV/0!		< Enter total of Riffle Rank 1- habitat in square meters from habitat survey
Percent Riffle Rank 2+ Habitat:	#DIV/0!		< Enter total of Riffle Rank 2+ habitat in square meters from habitat survey
Percent Riffle Rank 2 Habitat:	#DIV/0!		< Enter total of Riffle Rank 2 habitat in square meters from habitat survey
Percent Riffle Rank 2- Habitat:	#DIV/0!		< Enter total of Riffle Rank 2- habitat in square meters from habitat survey
Percent Riffle Rank 3+ Habitat:	#DIV/0!		< Enter total of Riffle Rank 3+ habitat in square meters from habitat survey
Percent Riffle Rank 3 Habitat:	#DIV/0!		< Enter total of Riffle Rank 3 habitat in square meters from habitat survey
Percent Pool Rank 1 Habitat:	#DIV/0!		< Enter total of Pool Rank 1 habitat in square meters from habitat survey
Percent Pool Rank 1- Habitat:	#DIV/0!		< Enter total of Pool Rank 1- habitat in square meters from habitat survey
Percent Pool Rank 2+ Habitat:	#DIV/0!		< Enter total of Pool Rank 2+ habitat in square meters from habitat survey
Percent Pool Rank 2 Habitat:	#DIV/0!		< Enter total of Pool Rank 2 habitat in square meters from habitat survey
Percent Pool Rank 2- Habitat:	#DIV/0!		< Enter total of Pool Rank 2- habitat in square meters from habitat survey
Percent Pool Rank 3+ Habitat:	#DIV/0!		< Enter total of Pool Rank 3+ habitat in square meters from habitat survey
Percent Pool Rank 3 Habitat:	#DIV/0!		< Enter total of Pool Rank 3 habitat in square meters from habitat survey
Warm water temperature consideration:	0.000		< Enter average number of days per year water temperatures do not fall below 70°F
Warm water temperature consideration:			< Enter percentage of managed area affected
Angler effort consideration:			< Enter angler effort: Blue Ribbon=(Low-0.0 - 0.1-High);Red Ribbon=(Low-0.0-0.2-High)
Number of trout stocked last year:			< Enter the number of trout stocked last year

MINIMUM NUMBER OF TROUT TO BE STOCKED ANNUALLY:	#DIV/0!	
MAXIMUM NUMBER OF TROUT TO BE STOCKED ANNUALLY:	#DIV/0!	
ENTER HOW MANY TROUT WILL YOU STOCK:		
MINIMUM NUMBER OF STOCKINGS PER YEAR REQUIRED:	#DIV/0!	(Round up)

Table 4 (cont).

Calculation:	Blue_Red Ribbon	
Maximum number per acre (carrying capacity):	#DIV/0!	
Area to be stocked:	0.0	
Carrying Capacity given area only:	#DIV/0!	
Warm water temperature deduction:	#DIV/0!	
Carrying Capacity with temperature consideration:	#DIV/0!	
Proportion of stock for Riffle Rank 1 Habitat:	#DIV/0!	100%
Proportion of stock for Riffle Rank 1- Habitat:	#DIV/0!	90%
Proportion of stock for Riffle Rank 2+ Habitat:	#DIV/0!	80%
Proportion of stock for Riffle Rank 2 Habitat:	#DIV/0!	70%
Proportion of stock for Riffle Rank 2- Habitat:	#DIV/0!	60%
Proportion of stock for Riffle Rank 3+ Habitat:	#DIV/0!	50%
Proportion of stock for Riffle Rank 3 Habitat:	#DIV/0!	40%
Proportion of stock for Pool Rank 1 Habitat:	#DIV/0!	100%
Proportion of stock for Pool Rank 1- Habitat:	#DIV/0!	90%
Proportion of stock for Pool Rank 2+ Habitat:	#DIV/0!	80%
Proportion of stock for Pool Rank 2 Habitat:	#DIV/0!	70%
Proportion of stock for Pool Rank 2- Habitat:	#DIV/0!	60%
Proportion of stock for Pool Rank 3+ Habitat:	#DIV/0!	50%
Proportion of stock for Pool Rank 3 Habitat:	#DIV/0!	40%
Carrying Capacity with Temp. and Habitat considerations:	#DIV/0!	
Adjustment for annual morality:	#DIV/0!	< Minimum number to stock
Carrying Capacity plus replacement fish:	#DIV/0!	
Adjustment for angler effort:	#DIV/0!	
Result of angler effort adjustment:	#DIV/0!	
Adjustment for previous years stocked survival:	0	
MAXIMUM NUMBER OF TROUT TO BE STOCKED ANNUALLY:	#DIV/0!	

Trout Stocking Allocation Calculation

Stream: Eleven Point River

Management Type: Blue Ribbon

Parameters Used For Calculation	Formula	Value	Description Of Parameter Value To Be Entered
Carrying Capacity (lbs/Acre):	60	***	< Assumption: maximum from literature review
Fish number to pounds conversion:	1.3	12.5	< Enter length of fish to be stocked in inches
Area to be stocked (Acres):	85.1	344,866	< Enter total square meters from habitat survey
Carry Over (% annual survival):	0.08	8	< Enter estimated annual survival
Percent Riffle Rank 1 Habitat:	0.020	6,972	< Enter total of Riffle Rank 1 habitat in square meters from habitat survey
Percent Riffle Rank 1- Habitat:	0.182	62,691	< Enter total of Riffle Rank 1- habitat in square meters from habitat survey
Percent Riffle Rank 2+ Habitat:	0.048	16,650	< Enter total of Riffle Rank 2+ habitat in square meters from habitat survey
Percent Riffle Rank 2 Habitat:	0.039	13,505	< Enter total of Riffle Rank 2 habitat in square meters from habitat survey
Percent Riffle Rank 2- Habitat:	0.021	7,244	< Enter total of Riffle Rank 2- habitat in square meters from habitat survey
Percent Riffle Rank 3+ Habitat:	0.051	17,556	< Enter total of Riffle Rank 3+ habitat in square meters from habitat survey
Percent Riffle Rank 3 Habitat:	0.012	4,066	< Enter total of Riffle Rank 3 habitat in square meters from habitat survey
Percent Pool Rank 1 Habitat:	0.085	29,317	< Enter total of Pool Rank 1 habitat in square meters from habitat survey
Percent Pool Rank 1- Habitat:	0.299	103,254	< Enter total of Pool Rank 1- habitat in square meters from habitat survey
Percent Pool Rank 2+ Habitat:	0.134	46,288	< Enter total of Pool Rank 2+ habitat in square meters from habitat survey
Percent Pool Rank 2 Habitat:	0.043	14,836	< Enter total of Pool Rank 2 habitat in square meters from habitat survey
Percent Pool Rank 2- Habitat:	0.016	5,441	< Enter total of Pool Rank 2- habitat in square meters from habitat survey
Percent Pool Rank 3+ Habitat:	0.037	12,744	< Enter total of Pool Rank 3+ habitat in square meters from habitat survey
Percent Pool Rank 3 Habitat:	0.012	4,032	< Enter total of Pool Rank 3 habitat in square meters from habitat survey
Warm water temperature consideration:	0.000		< Enter average number of days per year water temperatures do not fall below 70 °F
Warm water temperature consideration:			< Enter percentage of managed area affected
Angler effort consideration:		0.10	< Enter angler effort: Blue Ribbon=(Low-0.0 - 0.1-High);Red Ribbon=(Low-0.0-0.2-High)
Number of trout stocked last year:		5,500	< Enter the number of trout stocked last year

MINIMUM NUMBER OF TROUT TO BE STOCKED ANNUALLY: 4,849

MAXIMUM NUMBER OF TROUT TO BE STOCKED ANNUALLY: 10,691

ENTER HOW MANY TROUT WILL YOU STOCK:

MINIMUM NUMBER OF STOCKINGS PER YEAR REQUIRED: (Round up)

Table 4 (cont).

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