Upper Truckee River Lahontan Cutthroat Trout Restoration Project

2012 Annual Report

USDA Forest Service, Lake Tahoe Basin Management Unit

Written by

Christopher Lemmers (Biological Science Technician) and Maura Santora (Aquatic Biologist)

Reviewed by

Sarah Muskopf (Acting Forest Aquatic Biologist)

Approved by

Holly Eddinger (Biological Program Leader)

Table of Contents

Executive Summary 2
Introduction 2
Methods 6
Results 7
2012 Field Work 7
Genetic Results 11
2008-2012 Progress 11
Discussion 15
Works Cited ..... **Error! Bookmark not defined.**
Appendix A 19
Appendix B. 20
Appendix C. ..... **Error! Bookmark not defined.**

Executive Summary

In 2012, the Lake Tahoe Basin Management Unit (LTBMU) Aquatics Department continued implementation of the Upper Truckee River Lahontan Cutthroat Trout Restoration Project which began in 2009. Non-native trout were removed from approximately 7.4 km of the main stem of the Upper Truckee River below Meiss Meadows, the outlet tributary of Round Lake, and the inlet and outlet of Dardanelles Lake. A total of 5,505 fish were sampled. All non-native species were removed, which included 3,359 brook trout (*Salvelinus fontinalis*). A total of 231 native speckled dace (*Rhinichthys osculus*) were returned to the river. Lahontan cutthroat trout (LCT = *Oncorhynchus clarki henshawi*) captured in the project area totaled 1,904. Of these, 1,136 LCT were returned to the upper portion of the river, while 768 were removed from the lower portion of the project area due to potential hybridization with rainbow trout (*Oncorhynchus mykiss*).

Introduction

Historically, Lake Tahoe's fishery was dominated by a single predator, the Lahontan cutthroat trout (LCT). LCT were extirpated from Lake Tahoe by 1939 (Cordone and Frantz 1968, Moyle 2002). Several factors contributed to the extinction of LCT including over-fishing, logging, mining, dams, water diversions, intense grazing, road building, urban development, and the introduction of non-native fish and other aquatic organisms. These activities are believed to have cumulatively contributed to the change in Lake Tahoe's fish composition and degradation of fish habitat (SNEP 1996, Murphy and Knopp 2000). LCT were listed as an endangered species in 1970 (Federal Register Vol. 35, p.13520). In 1975, under the Endangered Species Act of 1973 as amended, LCT was reclassified as threatened

to facilitate management and to allow for regulated angling (Federal Register Vol. 40, p.29864).

Since the end of the 19th century, numerous non-native species have been introduced to water bodies in the Lake Tahoe basin, altering its biological assemblage. The non-native salmonid species found in Lake Tahoe and/or inlet streams include: rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), brook trout (*Salvelinus fontinalis*), kokanee salmon (*Oncorhynchus nerka*), and lake trout (*Salvelinus namaycush*). Lake trout are currently found in Lake Tahoe, Fallen Leaf Lake, Stony Ridge Lake, and Gilmore Lake. The non-native warm water fish that have been documented to occur in the Lake Tahoe inlet streams and near shore environment are: brown bullhead (*Ameiurus nebulosus*), bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), black crappie (*Pomoxis nigromaculatus*), and goldfish (*Carassius auratus*) (Kamerath et al. 2008). The presence of non-native fish has been found to disrupt the natural food webs, and to be negatively correlated with the distribution and abundance of native fish (Moyle and Nickols 1973, Betolli et al. 1992, Findlay et al. 2000, MacRae and Jackson 2001, Vander Zanden et al. 2003, Carey et al. 2011). Brook trout and brown trout compete with cutthroat trout for space and resources (Gerstung 1988b, Gresswell 1988, Griffith 1988, Fausch 1989, Hilderbrand 1998, Schroeter 1998, Dunham et al. 1999). Rainbow trout, a closely related species, spawn at the same time and use the same spawning habitat as LCT with which it can interbreed creating hybrid individuals (Vander Zanden et al. 2003).

California Department of Fish and Game (CDFG), in collaboration with USFS, reintroduced LCT from Macklin Creek into the headwaters of the Upper Truckee River (UTR) in Meiss Meadows in 1989 and 1990 initiating the reclamation of a total of 8 km of stream and 15 lake acres. Reclamation activities involved rotenone application, electro-fishing, and gill-netting to remove non-native brook trout from the UTR prior to LCT re-introduction. Since the initial reclamation activities, annual maintenance removal efforts occurred in Meiss Meadows until 2009, after three consecutive years of zero non-natives was achieved. Since 2009, the Meiss Meadow population has been allowed to recover from sampling and electro-shocking effects. CDFG currently monitors the success of brook trout removal efforts through voluntary angler reporting. The LCT population in Meiss Meadows is currently one of the only high-elevation self-sustaining populations found in meadow habitat in the Sierra Nevada Mountain Range.

In 2009, the Lake Tahoe Basin Management Unit (LTBMU) began implementation of the Upper Truckee River Lahontan Cutthroat Trout Restoration Project. The project area encompasses 16 km of perennial stream and 85 acres of lake habitat within the UTR watershed (Figure 1), and is referred to as the expansion area. The objective of the effort was to facilitate natural range expansion of the Meiss Meadows LCT population downstream by removing non-native trout. The project will reclaim 16 km of stream habitat for federally threatened LCT in the UTR. The project is in California (El Dorado County) on National Forest System land within the LTBMU and is entirely in the Meiss Management Area (USDA 1988).

Reclaiming aquatic habitats in the UTR watershed is consistent with CDFG goals and objectives for recovering and developing waters for native salmonid fisheries. The CDFG currently works

under the interagency Fishery Management Plan for Lahontan Cutthroat Trout in California and Western Nevada Waters (Gerstung 1988a), which identifies the UTR as a priority area in Lake Tahoe to reclaim aquatic habitats for LCT. Additionally, the UTR and tributaries upstream of the confluence with Showers Creek are designated by the California Fish and Game Commission as a Heritage and Wild Trout Water for a self-sustaining population of LCT within their historic (native) distribution.

Restoration efforts in the expansion area were approved by the U.S. Fish and Wildlife Service (USFWS) in the 2008 Biological Opinion (BO; File #: 2008-F-0434-BO). During the 2010 field season, re-initiation of consultation was conducted and an amended BO (file #: 2008-F-0434-R001) was received in October 2010. The amended BO allowed for the removal of LCT where potential hybridization with rainbow trout was anticipated. The LTBMU and USFWS agreed that in the interest of LCT recovery in the Lake Tahoe basin, genetically pure populations of LCT within the expansion area is the desired goal.

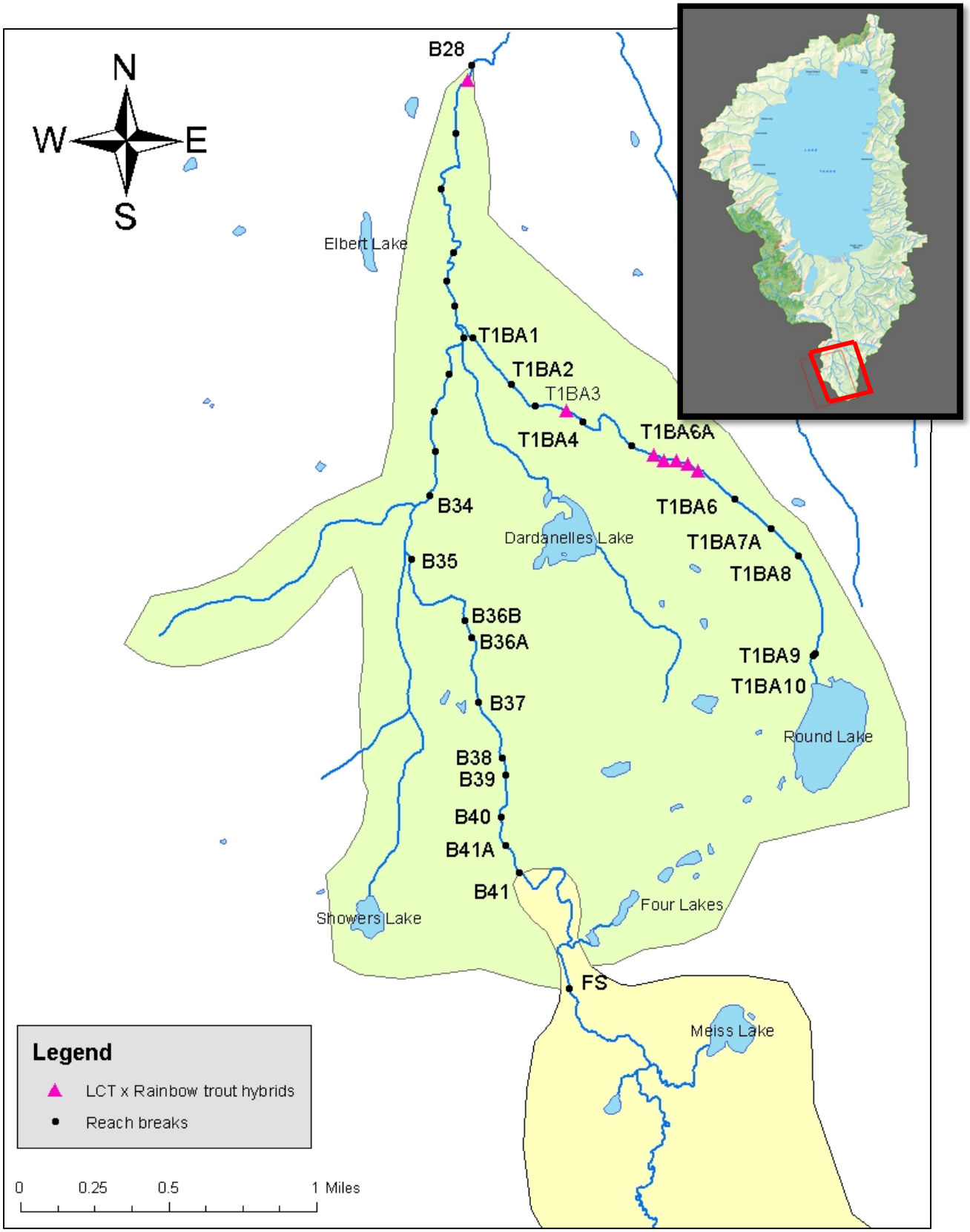


Figure 1. The Lake Tahoe Basin Management Unit (LTBMU) Upper Truckee River Lahontan Cutthroat Trout Restoration Project Area and Accomplishments.

Methods

The LTBMU Aquatics Crew manually removed brook trout and selected LCT by electro-fishing methodology. "Guidelines for Electro-fishing Waters Containing Salmonids Listed under the Endangered Species Act" (Service) 2000) was used to develop the protocol. A three-pass depletion method was used on the UTR main stem to enable tracking of brook trout removal progress on a site-specific basis. Three-pass depletion relies on barriers to prevent the recapture of the same fish during multiple passes. Natural low water fish barriers (i.e. waterfalls, chutes, cascades) were identified in 2008 before implementation of the project, and were used to break the river up into treatment reaches. If a reach on the UTR contained no brook trout on the first pass, only one pass was conducted. If brook trout were detected, 3-pass depletion was initiated. The barriers used in 2012 were the same as those used in 2011 and 2010 (Figure 1), so that progress could be compared annually. Throughout implementation, fish sampled were identified and measured into size classes. Non-native trout and sacrificed LCT were also sexed. Above barrier 36B (Figure 1) on the main stem of the UTR, all LCT and speckled dace (*Rhinichthys osculus*) were relocated upstream to previously treated reaches and brook trout were removed from the river. Below barrier B36, speckled dace were relocated upstream to previously treated reaches, and brook trout, rainbow trout, and LCT were removed as defined in the amended BO (file #: 2008-F-0434-R001).

Three pass depletion was implemented on the entire Round Lake tributary (RLT) for the first time in 2012. For the most part, single pass depletion was completed in past years due to time constraints, except in 2010 from T1BA4 downstream to the confluence of the UTR. In the RLT, all salmonids were removed below barrier T1BA6A due to hybridization risk. Throughout the project area, genetic samples were taken from LCT to determine where introgression had already taken place. After every sample, the tweezers and scissors were decontaminated with 95% isopropyl alcohol and that alcohol was burned off. Samples were sent the University of Nevada at Reno for genetic analysis.

Two backpack Smithroot LR-12 electro-fishers were used for survey efforts. The electro-fisher was set between 300-500 Volts and 30-60 Hertz for all reaches. These settings are not standard but worked well with the observed electric conductivity and turbidity. Fish recovered quickly in most instances. Electro-fisher settings were adjusted as needed and recorded when changed. Two electro-fishing crews (3 person crews) implemented removal treatments from the end of August through the third week in October. To increase efficiency and productivity, both crews conducted passes on a single reach with one crew beginning approximately 20 to 30 minute prior to the second crew. Upon completion, one crew would initiate survey efforts on the next reach while the other crew completed the third pass.

On the UTR, reaches B41 through B39 (0.6 km) were treated with single pass methods because no non-native salmonids were detected on the first pass. The remaining 5 reaches (1.5 km) from barrier B38 through B35 were treated with the 3-pass depletion method. Single pass on RLT only occurred on T1BA8 (0.6 km) because of absence of non-native salmonids. The reach above T1BA9 was dry this year. The remaining reaches (T1BA7A-T1BA1, 2.4 km) were treated with 3-pass depletion.

In 2012, the LTBMU crew initiated removal of non-native salmonids in Dardanelles Lake using gill nets. Lightweight, monofilament gill nets made with six different size meshes (10, 12.5, 18.5, 25, 33, 38 mm) were used. Each panel is 6 m long and 1.8 m deep, making the nets a total of 64 square meters. These are sinking nets designed to maximize the capture of small fish, but will effectively capture fish of all sizes. Nets were deployed, using float tubes, around the perimeter of the lake and pulled out towards the deepest areas. A minimum of two crew members were needed for each net set. One crew member would be on shore tying the top of the net to a land anchor, while carefully watching the person in the float tube and recording the data. The float tuber would pull the net away from shore, allowing it to flake out into a straight line. Once the net was fully stretched, the person on the float tube would tie off the bottom of the net to a rock to anchor it on the bottom. Parachute cord was tied to the float line and a foam float was attached as a buoy. The net's smallest mesh size was anchored to shore, while the largest mesh size was anchored in deep water, targeting the size class that tends to inhabit each area of a lake. Nets were cleaned by starting at the shore end of the net. Nets were pulled up to the float tube for fish and debris to be removed as well as algae to be scrubbed off (cleaner nets are less visible to the fish). The net was then stretched tight and redeployed at a different angle to increase efficiency. Time and date were recorded after each cleaning. Additionally, as nets were cleaned, trout were measured into size classes and species identified (if possible), and sunk in the deepest part of the lake. All field data was recorded in a Rite in the Rain® spiral notebook and then input into an Excel database and the USFS corporate Natural Resource Information System (NRIS) geodatabase in the Aquatic Surveys (AqS).

Results

2012 Field Work

In 2012, non-native trout removal occurred on approximately 7.4 km of stream and 18 acres of lake habitat in the project area including: 2.1 km on the mainstem UTR, 3.1 km on the RLT, 2.1 km on the Dardanelles inlet/outlet streams, and 18 acres of Dardanelles Lake. Electro-fishing efforts captured a total of 5,055 fish: 1,904 LCT, 2,909 brook trout, and 242 speckled dace (Figure 2). Of this, all brook trout and 768 LCT were manually removed. Accidental mortalities included one LCT in the 0-5 cm size class, 10 LCT in the 5-10 cm size class, and 11 speckled dace. Genetic samples were collected from 109 individuals and locations documented (Appendix A). Gillnetting activities in Dardanelles Lake captured 450 brook trout (Figure 3).

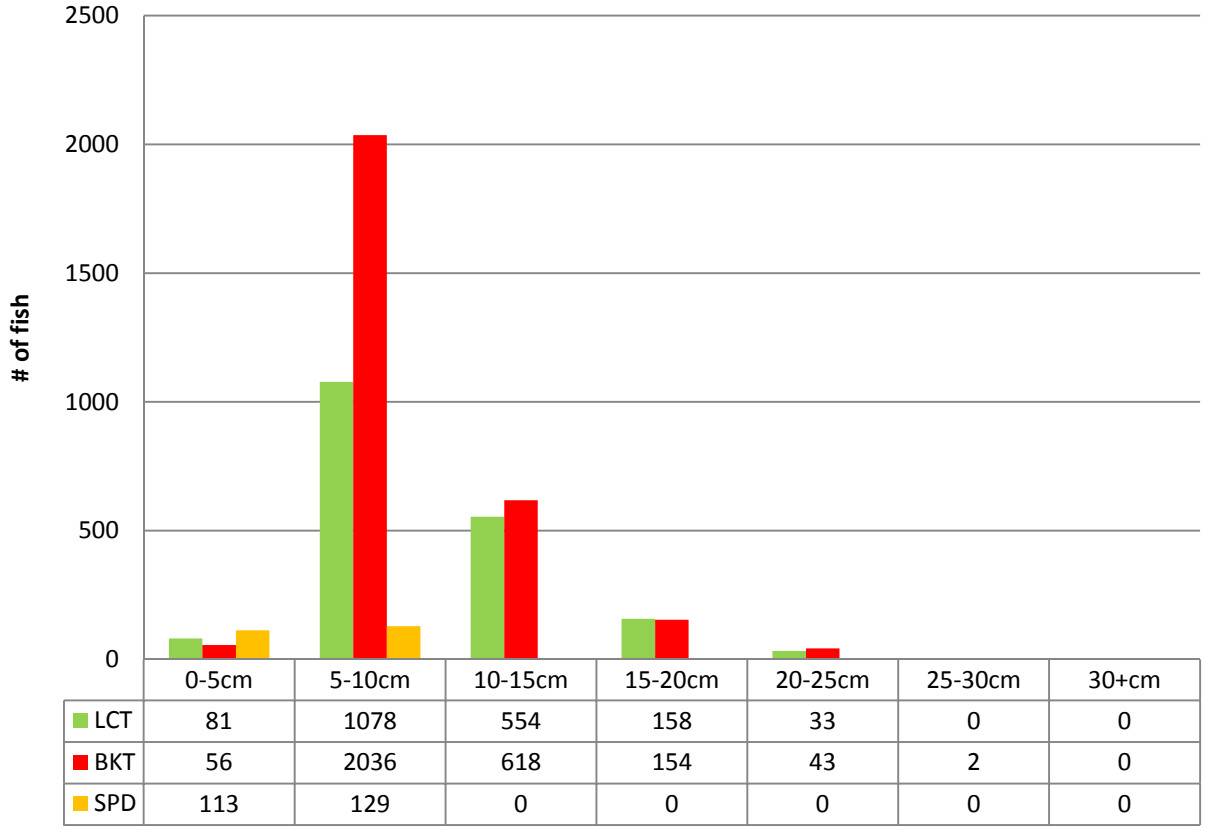


Figure 2. Total number of fish captured through electrofishing efforts in the expansion area in 2012.

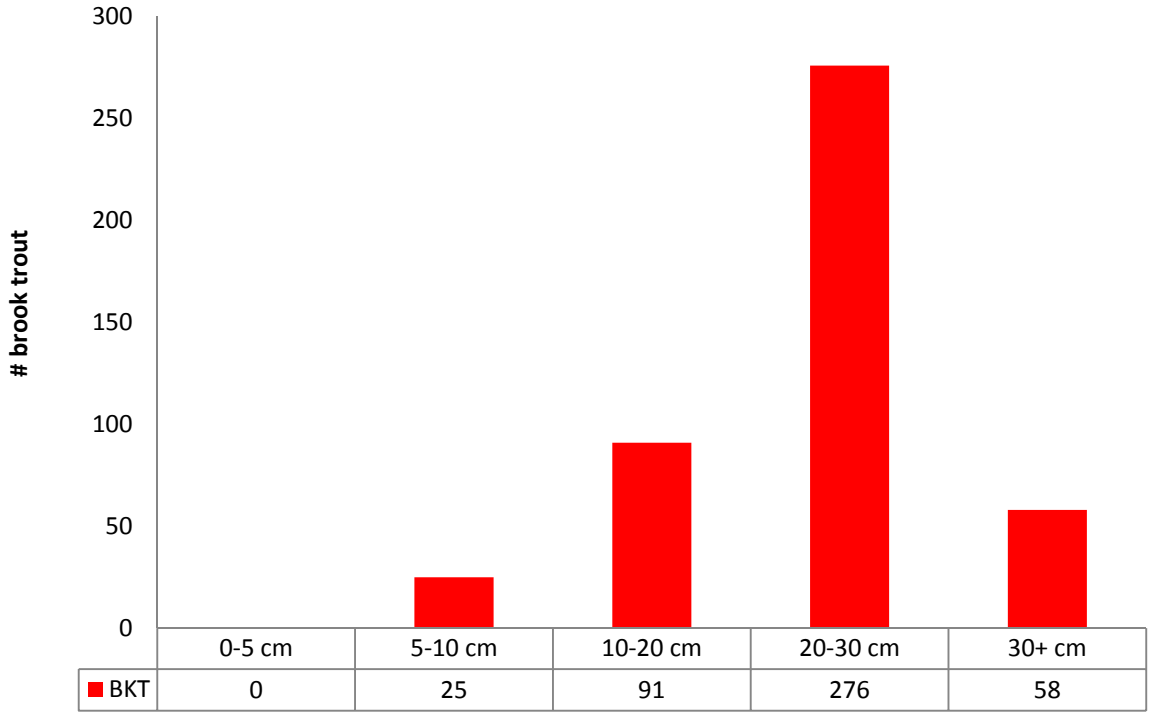


Figure 3. Size class distribution of brook trout caught in gillnetting at Dardanelles Lake, 2012.

On the mainstem of the UTR, 933 fish were captured (Figure 4). Non-native trout removals on the UTR included 187 brook trout. Of the total 594 LCT caught, 35 below barrier B36B were removed and the remaining 559 were returned to the river upstream of previously treated reaches. Only one deformed (perch-form) LCT was caught in 2012. All 152 speckled dace were released back into the river. Below barrier B36B, only 6 genetic samples were collected from LCT.

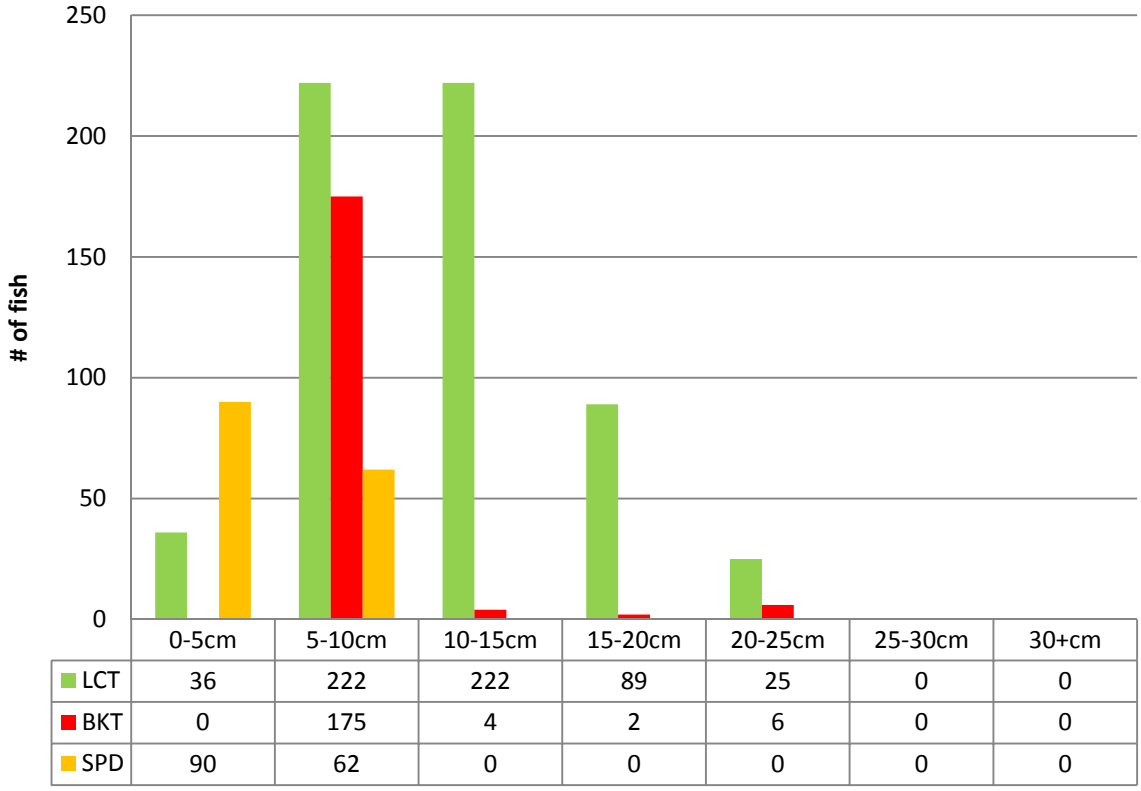
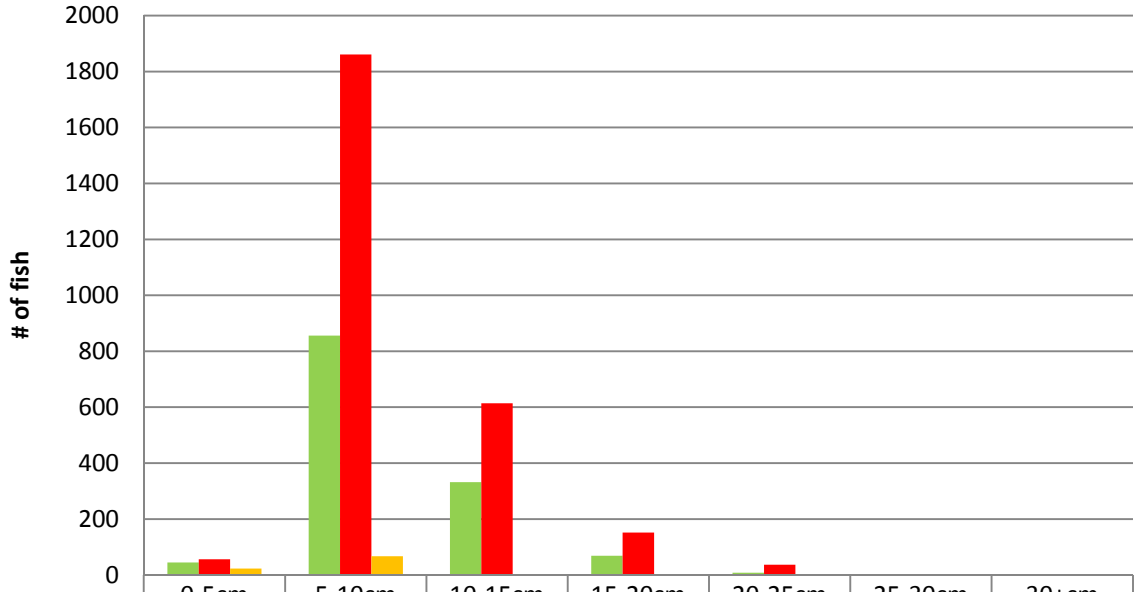


Figure 4. Size class distribution of fish sampled in the UTR in 2012.

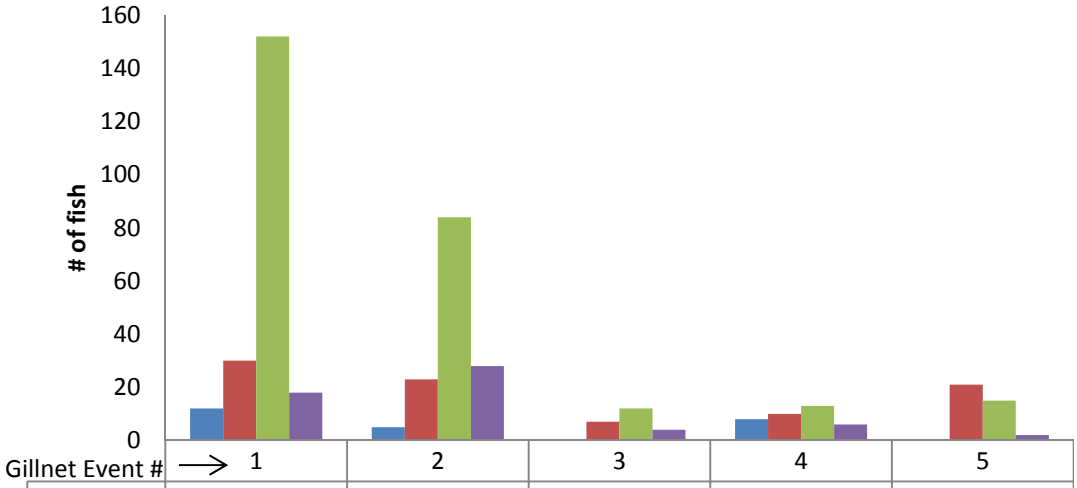
On the RLT, a total of 4,122 fish were sampled (Figure 5). Non-native trout removal on the RLT included 2,722 brook trout. Of the 90 speckled dace caught, 79 were released back into the creek (11 accidental mortalities). Of the total 1,310 LCT caught, 733 below barrier T1BA6 were removed and the 577 LCT caught above the barrier were released back into RLT. Between barriers T1BA10 to T1BA9 no fish were sampled because the stream was subsurface. Below T1BA8 to the confluence of the RLT and UTR, brook trout were detected in every reach in addition to LCT and speckled dace. Genetic samples were taken from 61 LCT collected between barrier T1BA6A and T1BA1 (Appendix A).



	0-5cm	5-10cm	10-15cm	15-20cm	20-25cm	25-30cm	30+cm
LCT	45	856	332	69	8	0	0
BKT	56	1861	614	152	37	2	0
SPD	23	67	0	0	0	0	0

Figure 5. Size class distribution of fish sampled in the RLT in 2012.

A total of 18 gillnets were set in Dardanelles Lake for approximately 30 days, and each net was cleaned 5 times in this period. All fish sampled were identified as brook trout. Figure 6 displays the number of fish caught during each cleaning. Nearly 95% of the 450 fish caught were 10cm or larger (Figure 3). Eleven nets were set in mid-October to be over-wintered.



Gillnet Event # →	1	2	3	4	5
5-10 cm	12	5	0	8	0
10-20 cm	30	23	7	10	21
20-30 cm	152	84	12	13	15
30+ cm	18	28	4	6	2

Figure 6. Depletion of brook trout caught per gillnetting cleaning event on Dardanelles Lake, 2012.

Genetic Results

Genetic results from the 2010 field season were received in August of 2011. Results indicated hybridization between LCT and rainbow trout has occurred in the expansion area. A hybrid individual was found in a lower reach on the UTR (between B28-B31, Figure). On RLT, there were numerous individuals that displayed low level introgression (1 rainbow trout allele) between T1BA6 and T1BA6A (Figure 1). Exact location data for each sample and total number of samples collected in 2010 was not taken.

Genetic results from the 2011 field season were received in August of 2012. Again, results indicate hybridization has occurred in the expansion area. All 77 samples taken from the UTR in 2011, between barriers B38 and B33, resulted in either pure LCT or rainbow trout. Out of 45 samples taken from the RLT, between barriers T1BA6 and T1BA1, five individuals (11%) displayed low level introgression (1 rainbow trout allele), while the rest resulted in either pure LCT or rainbow trout. These hybrids were found below barrier T1BA6 on the RLT (Figure 1).

2008-2012 Progress

A total of 21.6 km of river have been treated since 2008 (Table 1).

Table 1. Kilometers treated per year for each river segment.

Year	UTR (13 km total)		RLT (8.6 km total)	
	Kilometers Treated	Reaches Treated	Kilometers Treated	Reaches Treated
2008	1.3	B41-B37	0.00	--
2009	1.8	B41-B36B	0.00	--
2010	5.3	B41-B28	2.3	T1BA9-T1BA6, T1BA4-T1BA1
2011	2.6	B41-B33	3.1	T1BA10-T1BA1
2012	2.1	B41-B35	3.1	TIBA10-T1BA1

Numbers of brook trout and LCT caught between barriers B41 to B37 (the most upstream reaches in expansion area) from 2008 to 2012 on the mainstem of the UTR are displayed in Table 2. Overall, brook trout numbers have decreased while LCT numbers have increased in these upstream reaches (Figures 7-9). In addition, smaller size classes (0-5cm and 5-10cm) of brook trout have decreased, or in some reaches have been eradicated (Figure 8). Smaller size class LCT numbers are more variable by year, but have generally increased (Figure 9). Since 2011, zero brook trout been documented between B41 and B41A (Table 2). Treatment will continue in these upstream reaches until three years of zero catch is obtained.

Table 2. Fish caught on same upper reaches (totaling 1300m) of the UTR over 5 years.

Year	Brook Trout			LCT		
	B41-B41A	B41A-B38	B38-B37	B41-B41A	B41A-B38	B38-B37
2008	23	207	--	28	51	--
2009	6	19	68	25	34	12
2010	3	3	3	68	69	26
2011	0	0	6	39	121	93
2012	0	2	2	41	185	181

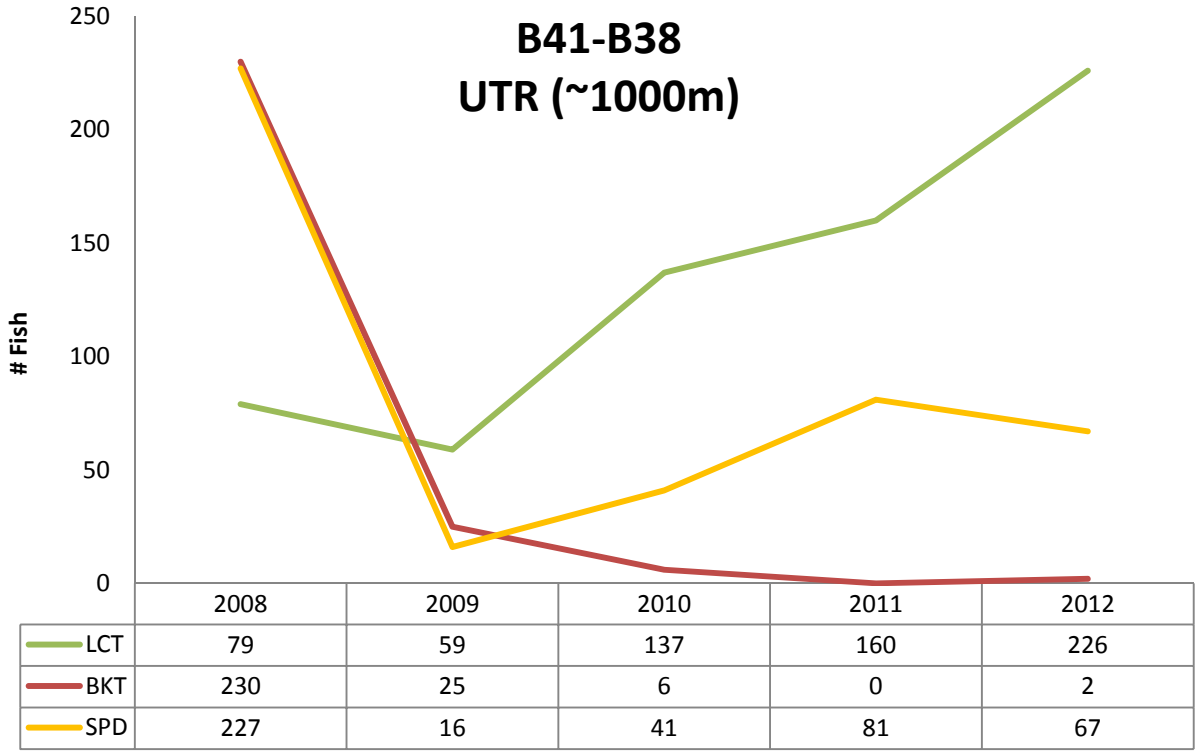
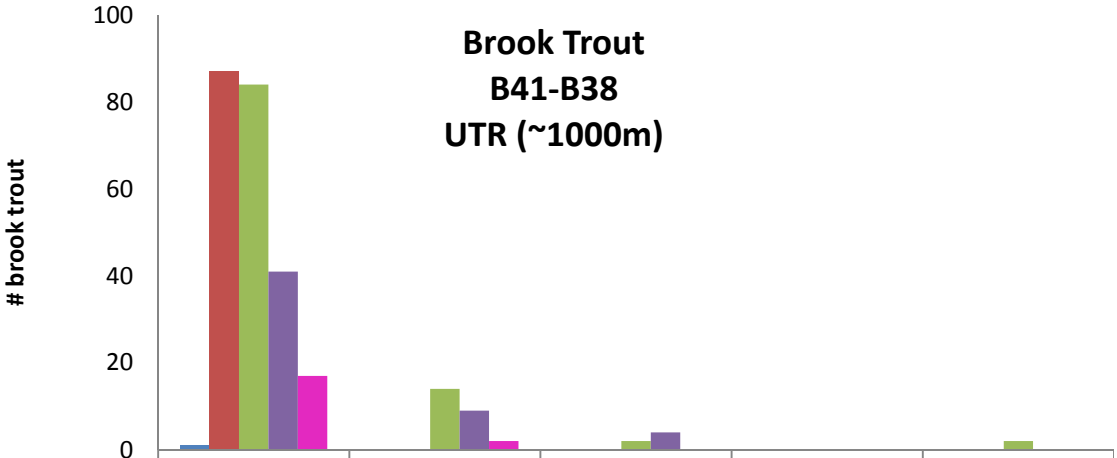
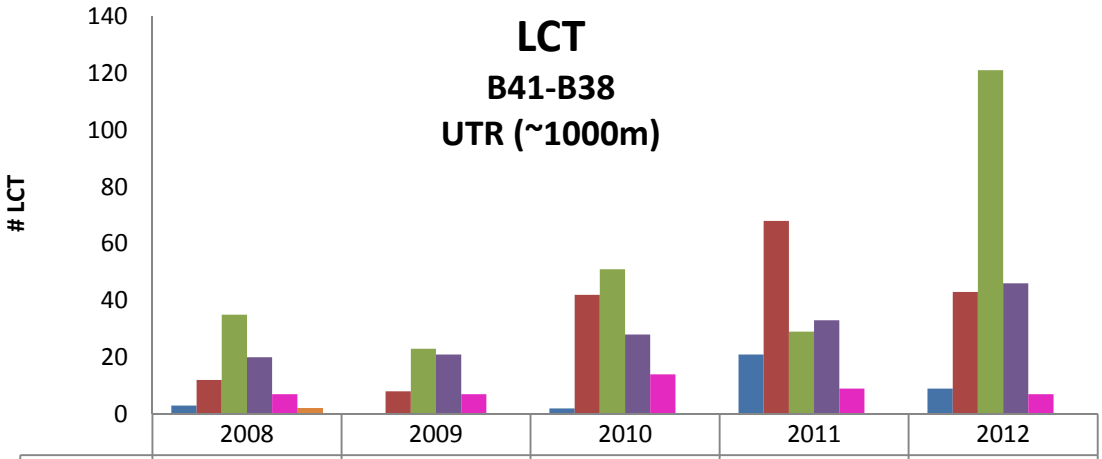


Figure 7. Total number of individuals caught by species on the same upper reaches of the UTR.



	2008	2009	2010	2011	2012
0-5cm	1	0	0	0	0
5-10cm	87	0	0	0	0
10-15cm	84	14	2	0	2
15-20cm	41	9	4	0	0
20-25cm	17	2	0	0	0

Figure 8. Distribution of brook trout size class on the same upper reaches of the UTR.



	2008	2009	2010	2011	2012
0-5cm	3	0	2	21	9
5-10cm	12	8	42	68	43
10-15cm	35	23	51	29	121
15-20cm	20	21	28	33	46
20-25cm	7	7	14	9	7
25-30cm	2	0	0	0	0

Figure 9. Distribution of LCT size class on the same upper reaches of the UTR.

Numbers of brook trout and LCT caught between barriers T1BA10 – T1BA6A (the most upstream reaches) from 2010 to 2012 on RLT are displayed in Figure 10. Both brook trout and LCT numbers have increased each year from 2010 to 2012 (Figure 10). The size class distributions for both species are displayed in Figures 11 & 12.

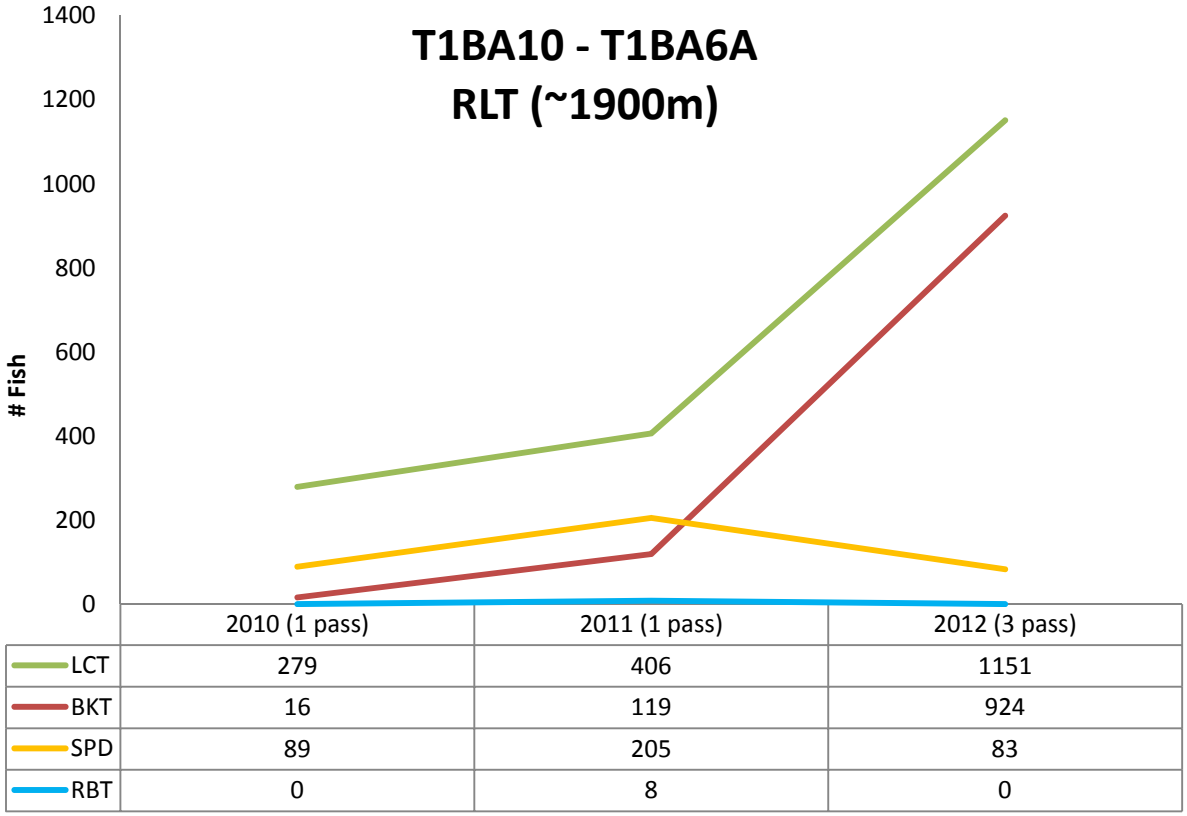
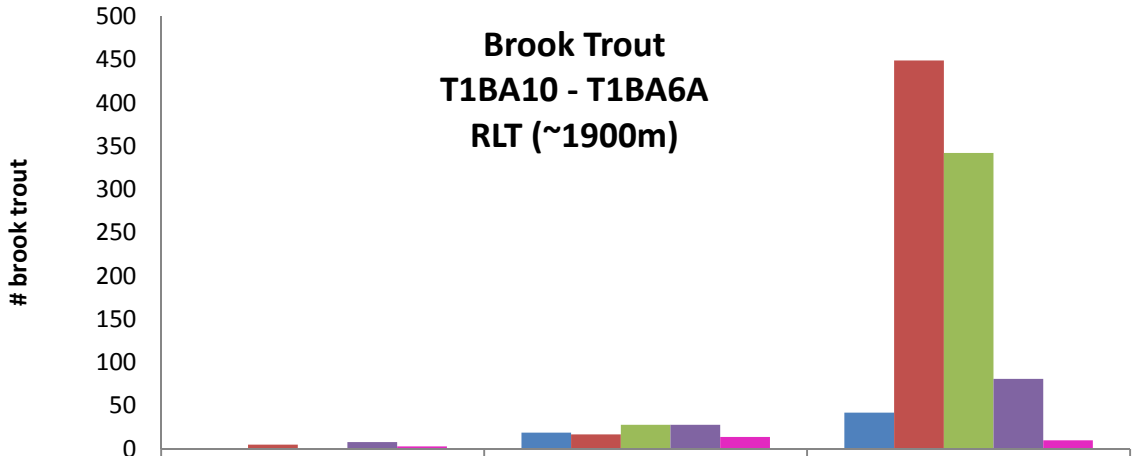
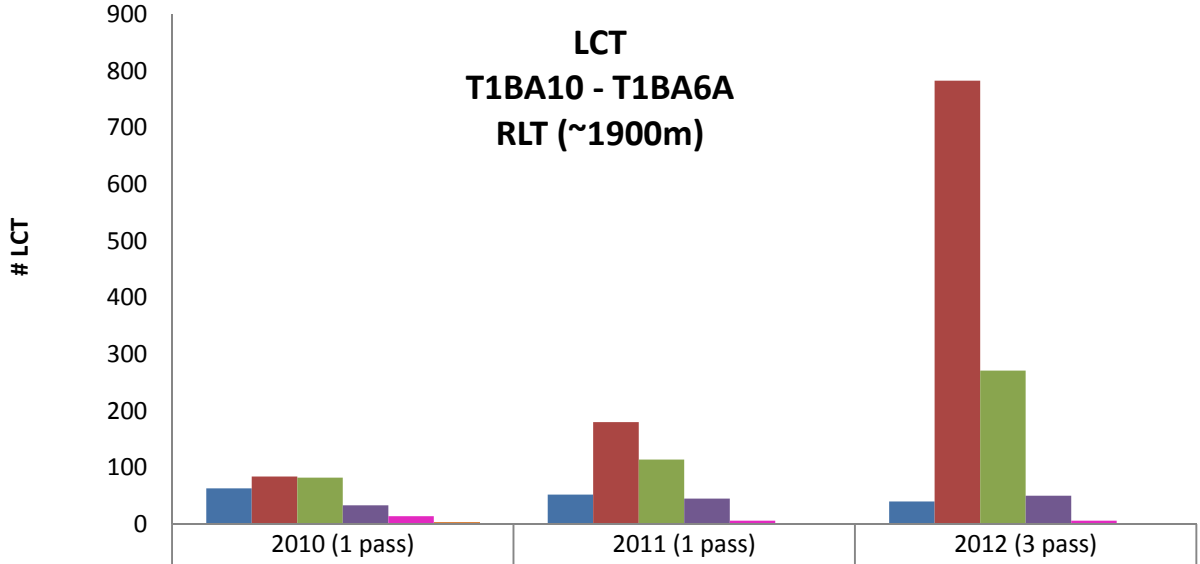


Figure 10. Total number of individuals caught by species on the same upper reaches of the RLT over 3 years.



	2010 (1 pass)	2011 (1 pass)	2012 (3 pass)
0-5cm	0	19	42
5-10cm	5	17	449
10-15cm	0	28	342
15-20cm	8	28	81
20-25cm	3	14	10

Figure 11. Distribution of brook trout size class on the same upper reaches of the RLT.



	2010 (1 pass)	2011 (1 pass)	2012 (3 pass)
0-5cm	63	52	40
5-10cm	84	180	783
10-15cm	82	114	271
15-20cm	33	45	50
20-25cm	14	6	6
25-30cm	3	0	0

Figure 12. Distribution of LCT size class on the same upper reaches of the RLT.

Discussion

During the 2012 field season, LCT were detected consistently in all treatment reaches of the UTR and RLT. More LCT were present in the upper reaches than in the lower reaches, most likely attributed to being downstream of the Meiss Meadow reclamation area where a self-sustaining population of LCT exists or downstream of Round Lake where LCT has been stocked intermittently between 1955 and 2008 by CDFG, and because of the reduction in brook trout numbers. Throughout the expansion area, LCT were found in all size classes. This suggests suitable spawning habitat is available in the system, reproduction is occurring, and LCT may thrive in the expansion area when competition with and predation from brook trout is diminished. This theory is supported by the increase in LCT in the upper reaches of the UTR in the expansion area from 2008 through 2012 (Figure 7 & 9).

Greater numbers of fish were sampled as compared to 2010 and 2011. Water levels in the UTR mainstem were high in 2011 and extremely low in 2012. In low water years, fish may move downstream or find refuges where more water is present; whereas in high water years, it is more difficult to catch fish through electro-fishing. Additionally, it was the first year RLT was completely surveyed with 3-pass depletion methodology. RLT hasn't had full 3 pass depletion methodology in the past due to time constraints and lack of manpower.

It is difficult to compare RLT data throughout the years because only 1 pass was completed in 2010 and 2011, while 3 passes were completed in 2012. Additionally, in some years the upper reach (T1BA9 upstream to Round Lake) of the stream was dry, as in 2012. However, it does seem that brook trout numbers increased in 2012, along with LCT numbers (Figures 10 & 11). It is unclear why this has occurred, but may be related to the absence of high water barriers in a large portion of this creek, or may be related to the removal of larger LCT in the stream due to hybridization risk.

Dardanelles Lake has been stocked with brook trout intermittently between 1950 and 2000. In 2012, Dardanelles Lake was gillnetted for the first time in an effort to remove the brook trout. Nearly 95 percent of the 450 fish caught were 10 cm or larger (Figure 3), though there were 25 brook trout under 10 cm. It seems that natural reproduction in Dardanelles Lake may have occurred, but was not very successful. The inlet and outlet to this lake were inadvertently treated when the lake was gillnetted because they were completely dry. This 2.1 km section of stream looks like it only runs in the early spring when snowmelt occurs. It is doubtful that brook trout can utilize this stream habitat for spawning.

Only one deformed (perch-form) LCT was found in RLT 2012 compared with three found in 2011. Although electrofishing is intended as a sampling method, some settings on the electro-fisher or repeated sampling can impact non-target native species. Because of this unintended consequence, streams reaches with three consecutive years of zero non-natives detected will be rested until project effectiveness monitoring is initiated.

In 2011, 122 genetic samples were collected and locations documented. Only 5 of these samples resulted in hybridization, all in RLT. In these rainbow trout x LCT hybrids, only one rainbow trout allele was found indicating a very low level of introgression has occurred. Furthermore,

this single allele was the same one detected in all the hybrids. These results indicate hybridization occurred in the past, and this single allele has persisted in the lineage. No first generation hybrids have been detected, so it is unclear why hybridization has not occurred more often. However, genetic results affirm where the distribution of rainbow trout is, and therefore, the barriers below which LCT will continue to be sacrificed to prevent any possible hybrids from persisting.

Literature Cited

Betolli, P. W., M. J. Maceina, R. L. Noble, and R. K. Betsill. 1992. Piscivory in largemouth bass as a function of aquatic vegetation abundance. North American Journal of Fisheries Management **12**:509-516.

Carey, M. P., B. L. Sanderson, T. A. Friesen, K. A. Barns, and J. D. Olden. 2011. Smallmouth Bass in the Pacific Northwest: A Threat to Native Species; a Benefit for Anglers. Pages 305-315 Reviews in Fisheries Science.

Cordone, A. J. and T. C. Frantz. 1968. An Evaluation of Trout Planting in Lake Tahoe. Pages 68-69.

Dunham, J., M. Peacock, B. Rieman, R. Schroeter, and G. Vinyard. 1999. Local and geographic variability in the distribution of stream-living Lahontan cutthroat trout. Transactions of the American Fisheries Society:875-889.

Fausch, K. D. 1989. Do gradient and temperature affect distribution of, and interactions between, brook char (*Salvelinus fontinalis*) and other resident salmonids in streams? Physiol. Ecol. **1**:303-322.

Findlay, C., D. Bert, and L. Zheng. 2000. Effect of introduced piscivores on native minnow communities in Adirondack lakes. Canadian Journal of Fisheries and Aquatic Sciences:570-580.

Gerstung, E. R. 1988a. Fishery Management Plan for Lahontan cutthroat trout (*Salmo clarki henshawi*) in California and Western Nevada waters. Inland Fisheries, California Dept. of Fish and Game, Sacramento, California.

Gerstung, E. R. 1988b. Status, life history, and management of Lahontan cutthroat trout. Pages 93-106 *in* American Fisheries Society Symposium.

Gresswell, R. E. 1988. Status and management of interior stocks of cutthroat trout. American Fisheries Society Symposium, Bethesda, Maryland.

Griffith, J. S. 1988. A review of competition between cutthroat trout and other salmonids. Pages 134-140 *in* R. E. Gresswell, editor. American Fisheries Society Symposium, Bethesda, Maryland.

Hilderbrand, R. H. 1998. Movements and conservation of cutthroat trout. Utah State University, Logan, Utah.

Kamerath, M., S. Chandra, and B. C. Allen. 2008. Distribution and impacts of warm water invasive fish in Lake Tahoe, CA-NV, USA. Pages 35-41 Aquatic Invasions.

MacRae, P. S. D. and D. A. Jackson. 2001. The influence of smallmouth bass (*Micropterus dolomieu)* predation and habitat complexity on the structure of littoral zone fish assemblages. Canadian Journal of Fisheries and Aquatic Sciences **58**:342-351.

Moyle, P. B. 2002. Inland Fishes of California. University of California Press, Berkeley, California.

Moyle, P. B. and R. D. Nickols. 1973. Ecology of some native and introduced fishes of the Sierra Nevada foothills in central California. Copeia **3**:478-490.

Murphy, D. D. and C. M. Knopp. 2000. Lake Tahoe Watershed assessment. Page 2 v. General technical report PSW GTR-175-176. Pacific Southwest Research Station, USDA Forest Service,, Berkeley, CA.

Schroeter, R. E. 1998. Segregation of stream dwelling Lahontan cutthroat trout and brook trout patterns of occurance and mechanisms for displacement. University of Nevada, Reno, Nevada.

NMFS (National Marine Fisheries Service). 2000. Guidelines for electro-fishing waters containing salmonids listed under the Endangered Species Act.*in* N. O. a. A. Administration, editor.

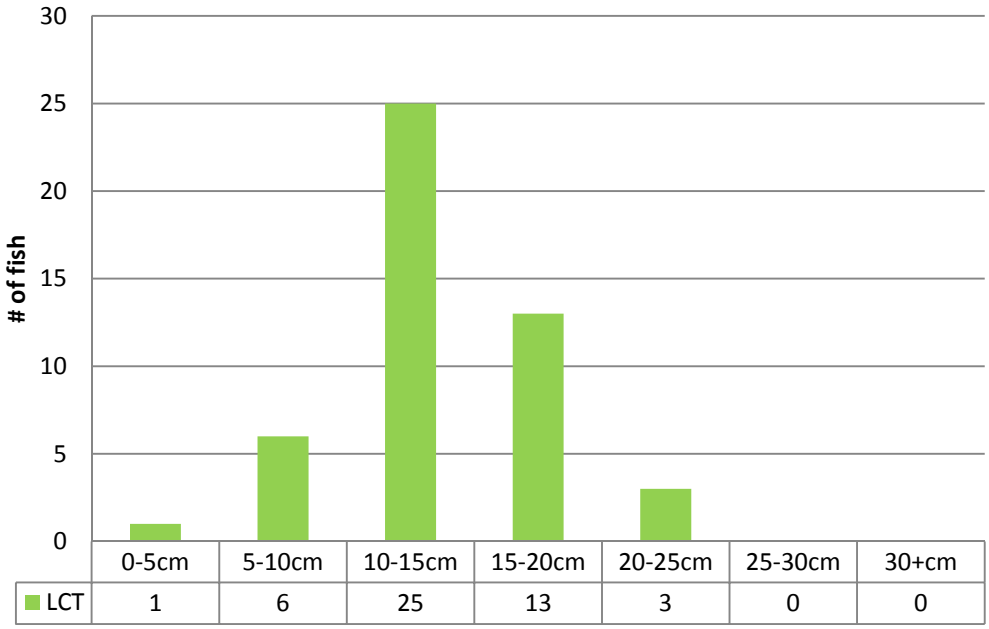
SNEP. 1996. Sierra Nevada Ecosystem Project Report.*in* Centers for Water and Wildland Resources, editor., University of California, Davis.

USDA (U.S. Department of Agriculture). 1988. Land and Resource Management Plan for the Lake Tahoe Basin Management Unit.Forest Service.

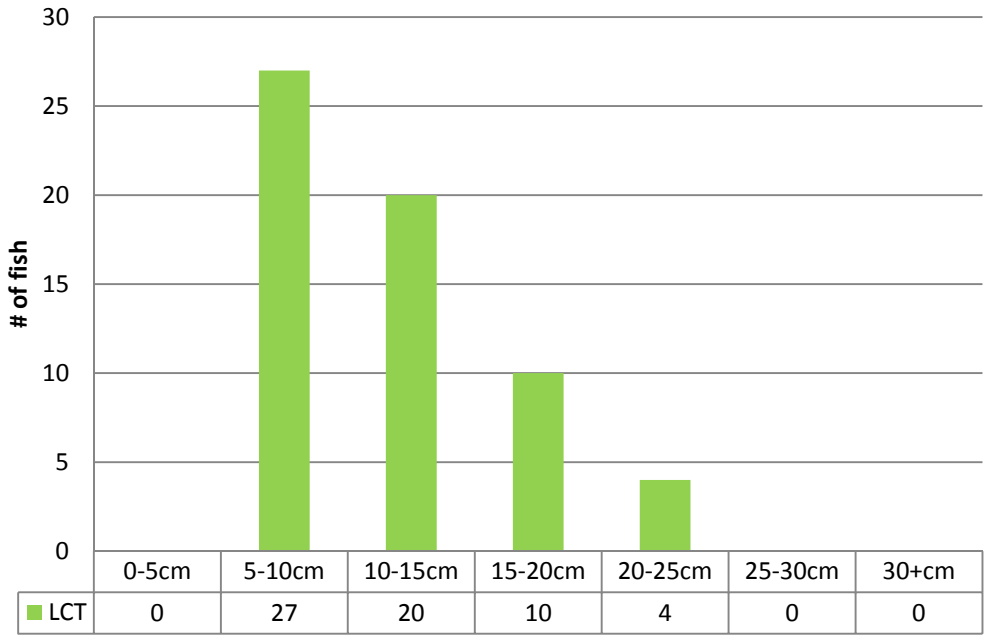
Vander Zanden, J., S. Chandra, B. C. Allen, J. E. Reuter, and C. R. Goldman. 2003. Historical Food Web Structure and Restoration of Native Aquatic Communities in the Lake Tahoe (California-Nevada) Basin. Ecosystems **6**:274-288.

Appendix A

Distribution of genetic samples taken by size class on the main stem of the UTR in 2012.

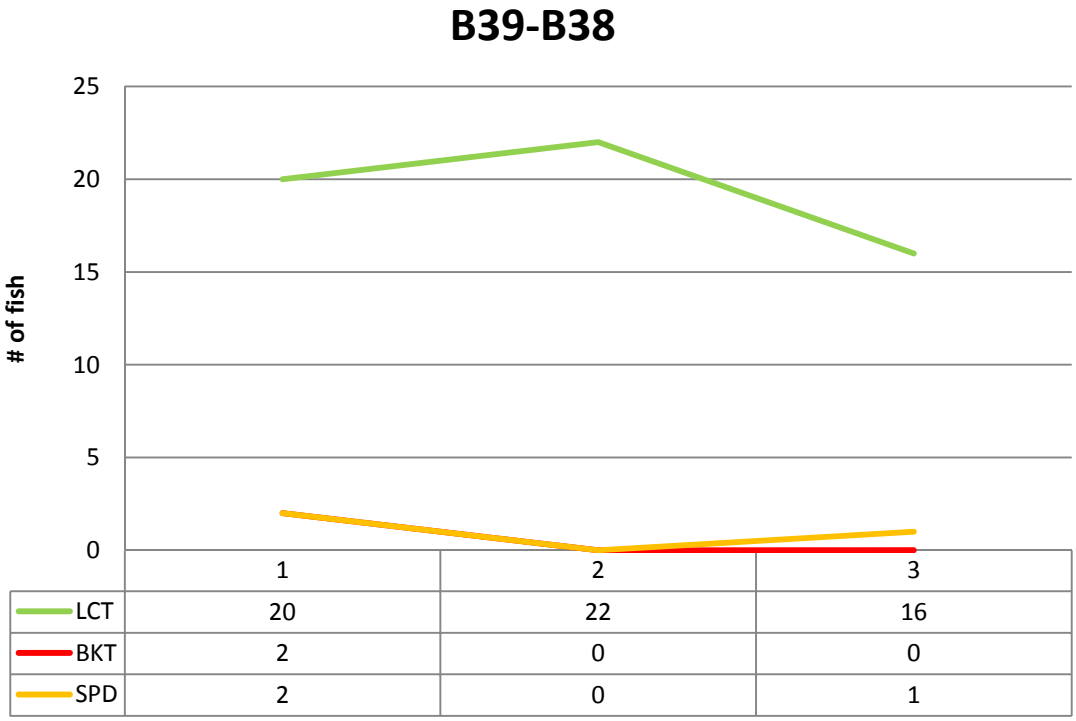


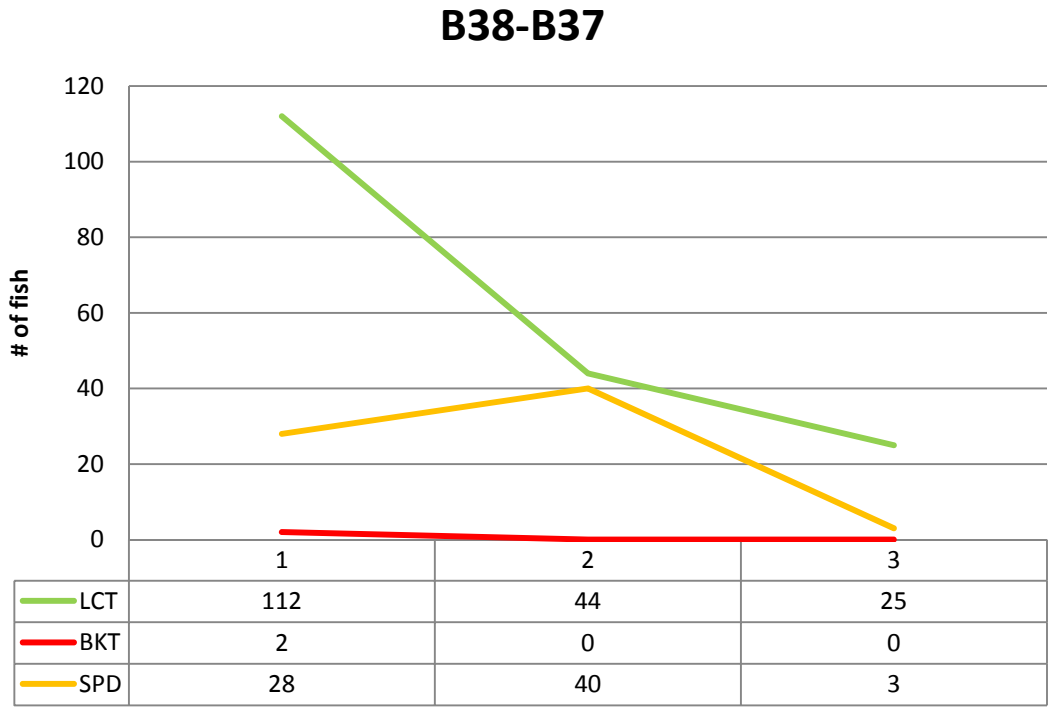
Distribution of genetic samples taken by size class on Round Lake Tributary in 2012.



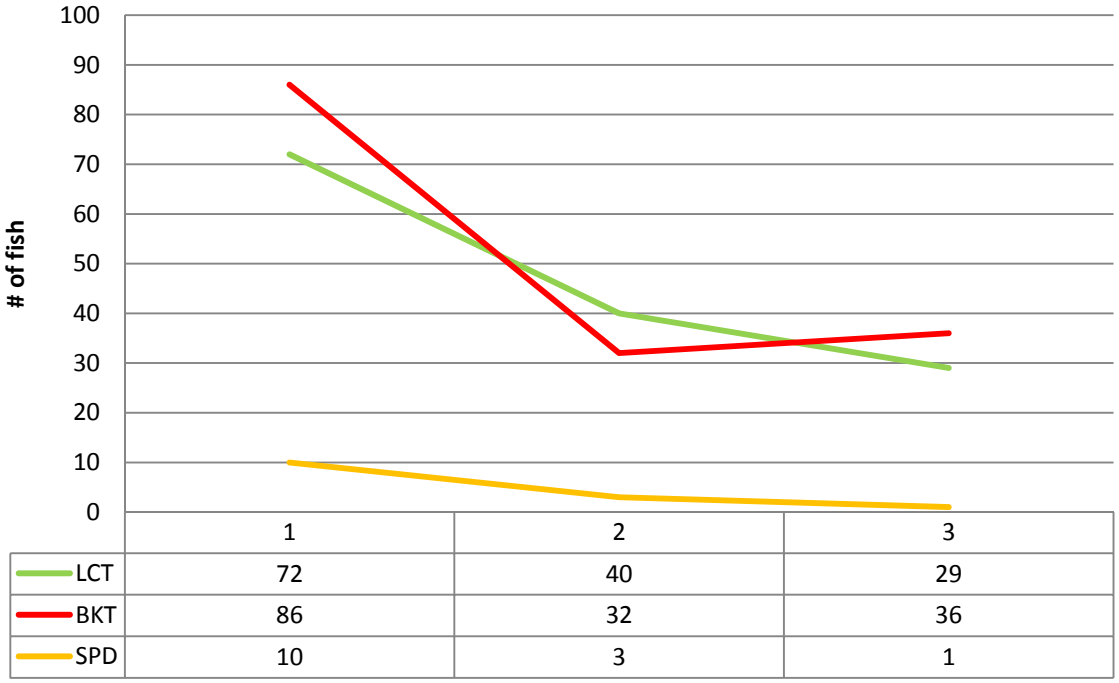
Appendix B.

Depletion for reaches per pass on the UTR & RLT, 2012.

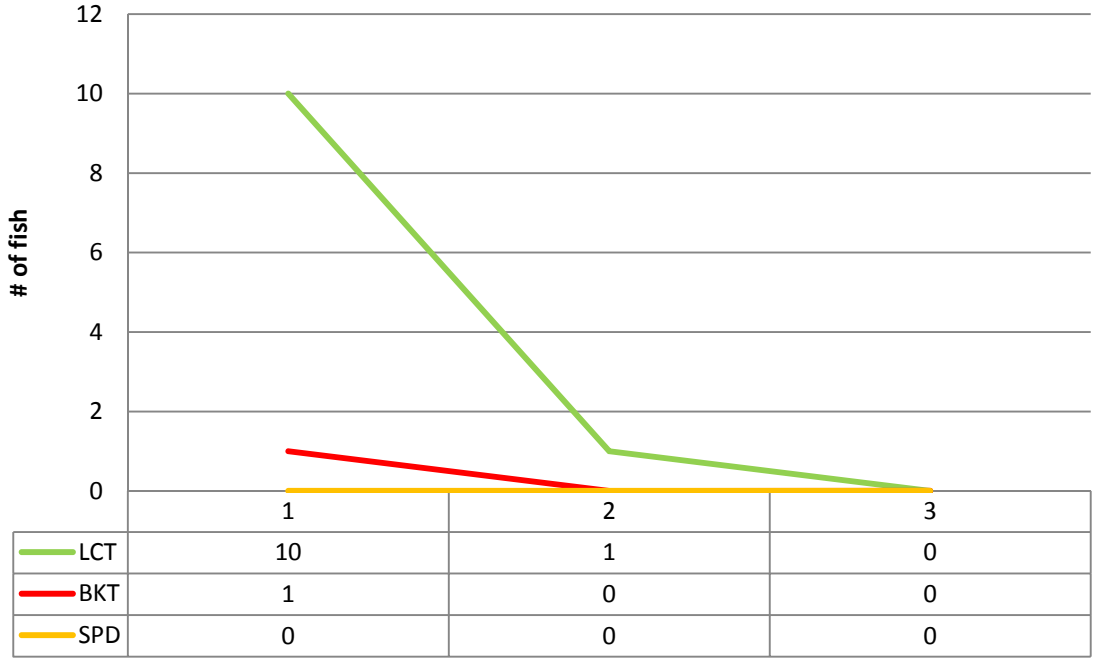


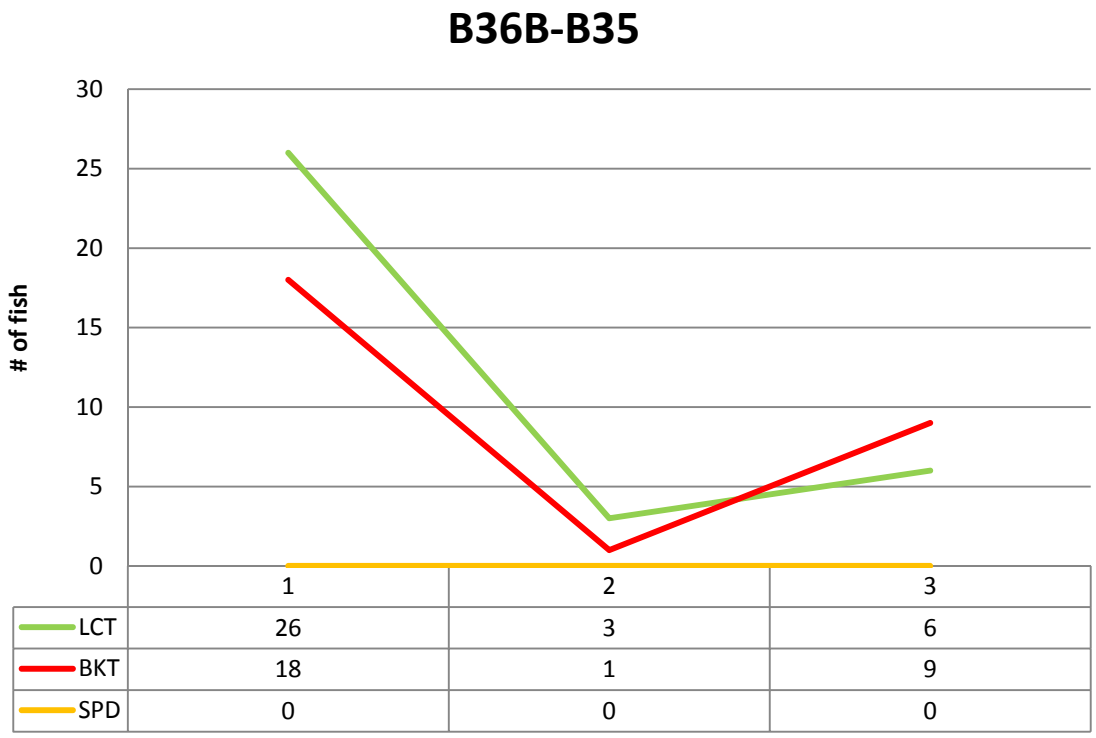


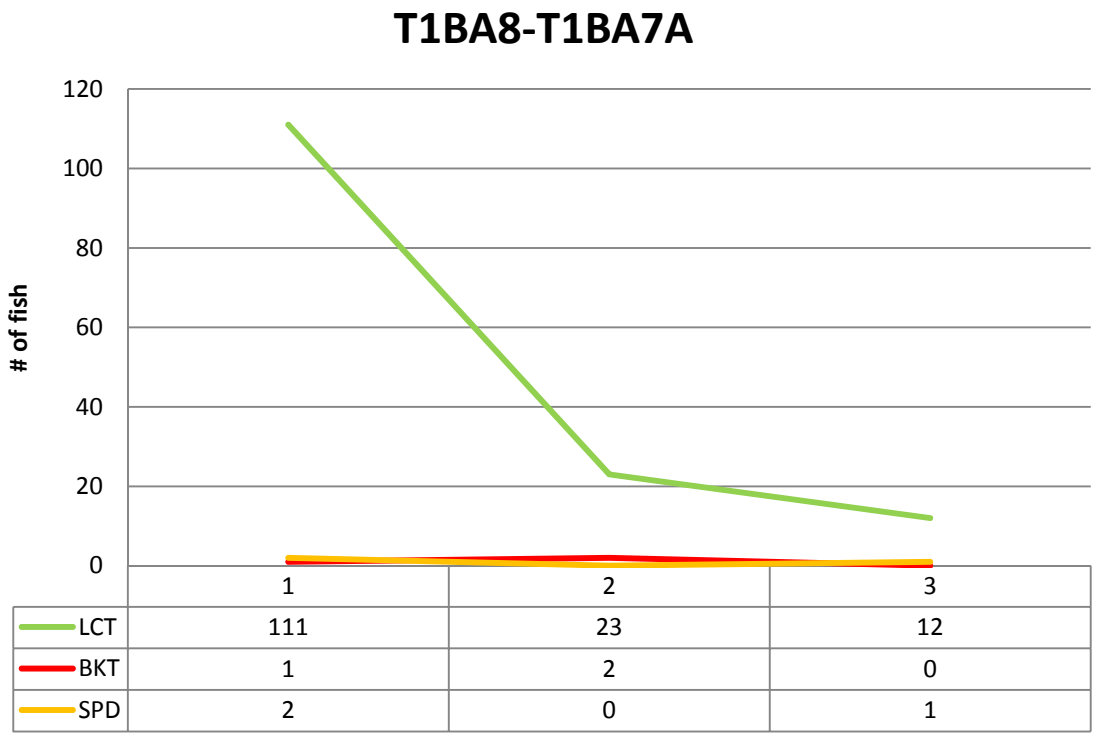
B37-B36A

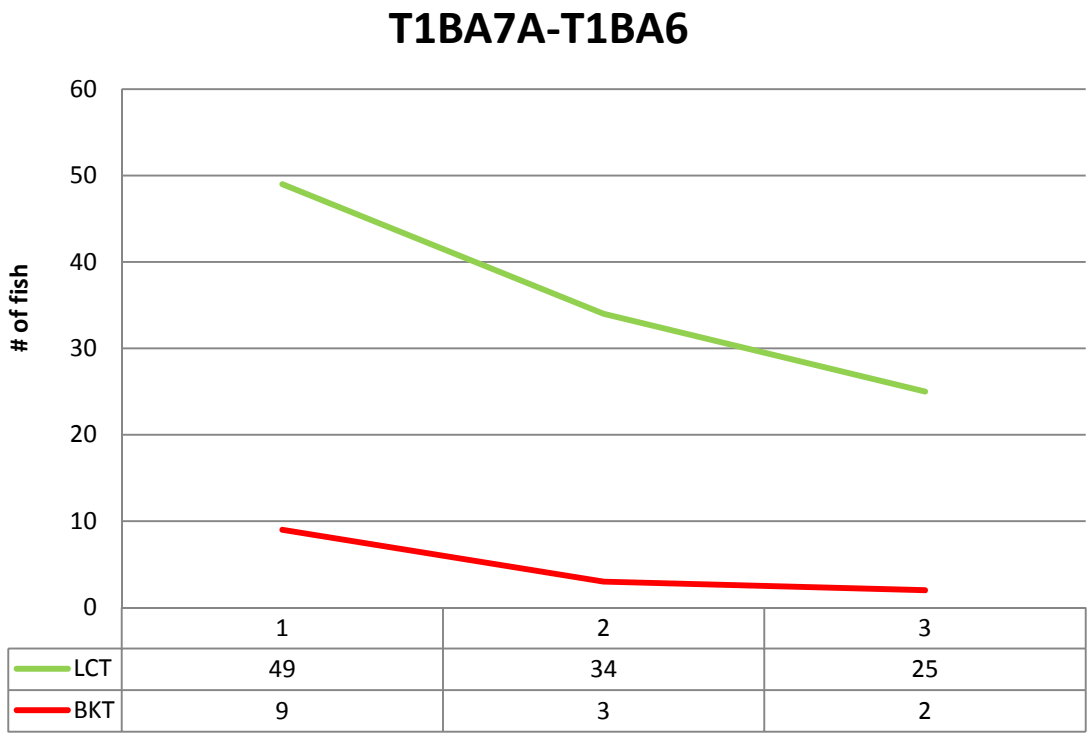


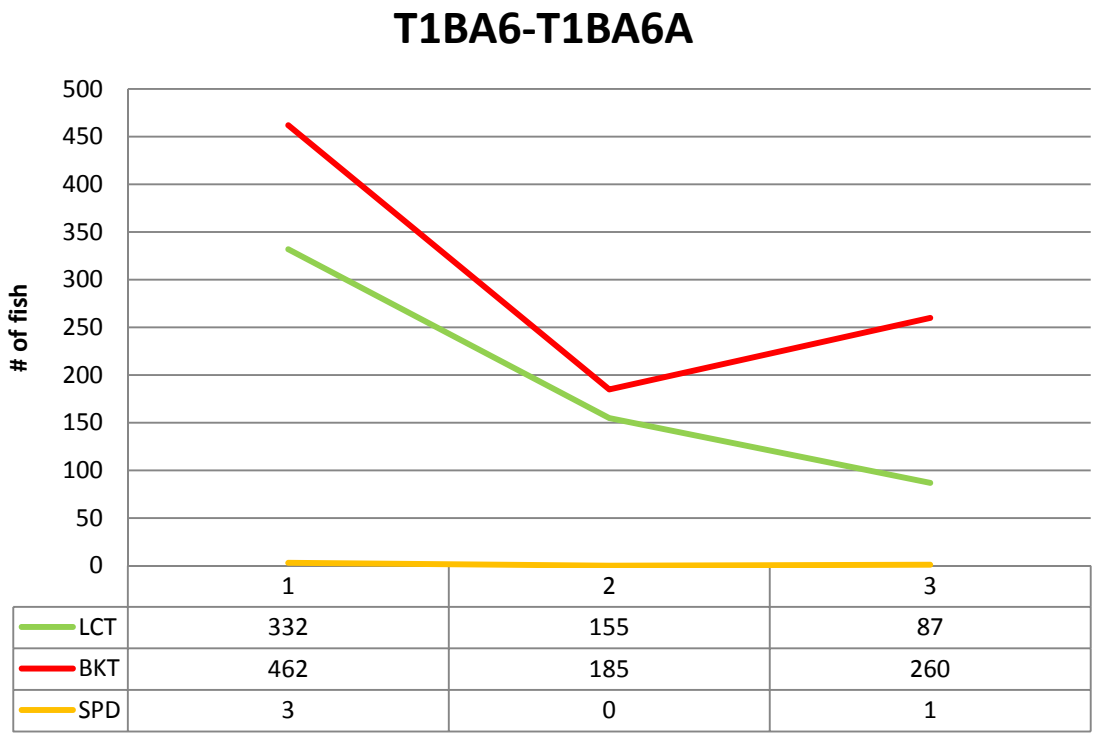
B36A-B36B

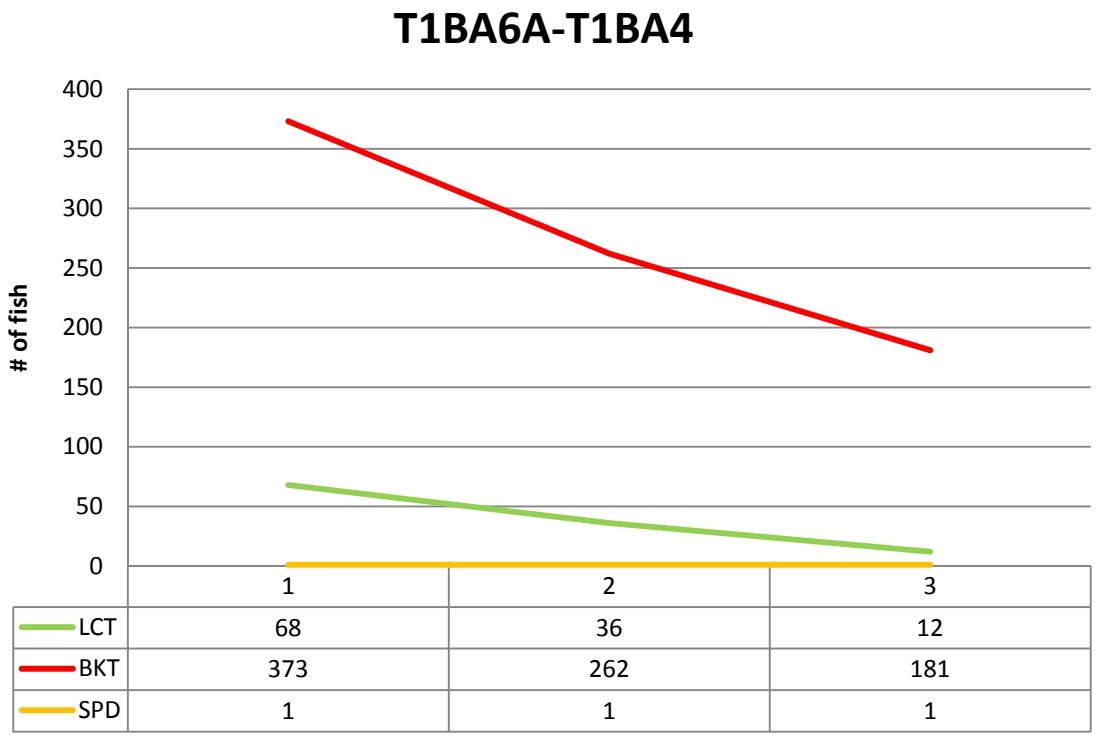


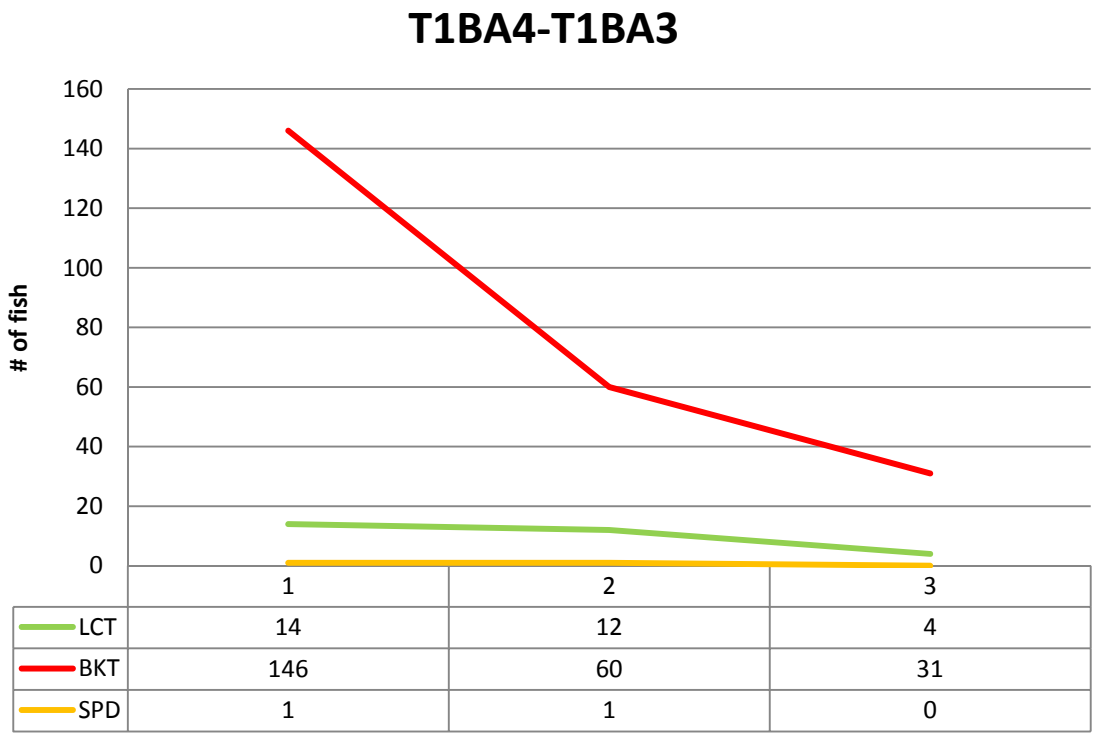

B36B-B35
# of fish
30
25
20
15
10
5
0
1
2
3
LCT 26 3 6
BKT 18 1 9
SPD 0 0 0

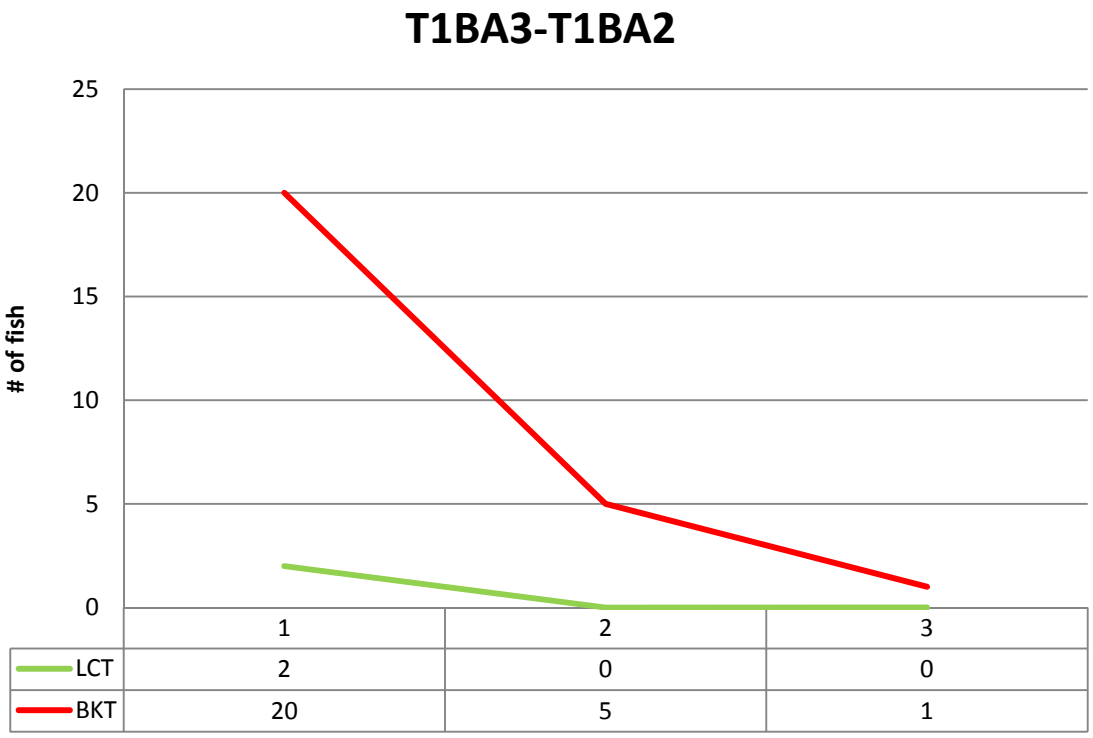

T1BA8-T1BA7A
# of fish
120
100
80
60
40
20
0
1
2
3
LCT 111 23 12
BKT 1 2 0
SPD 2 0 1

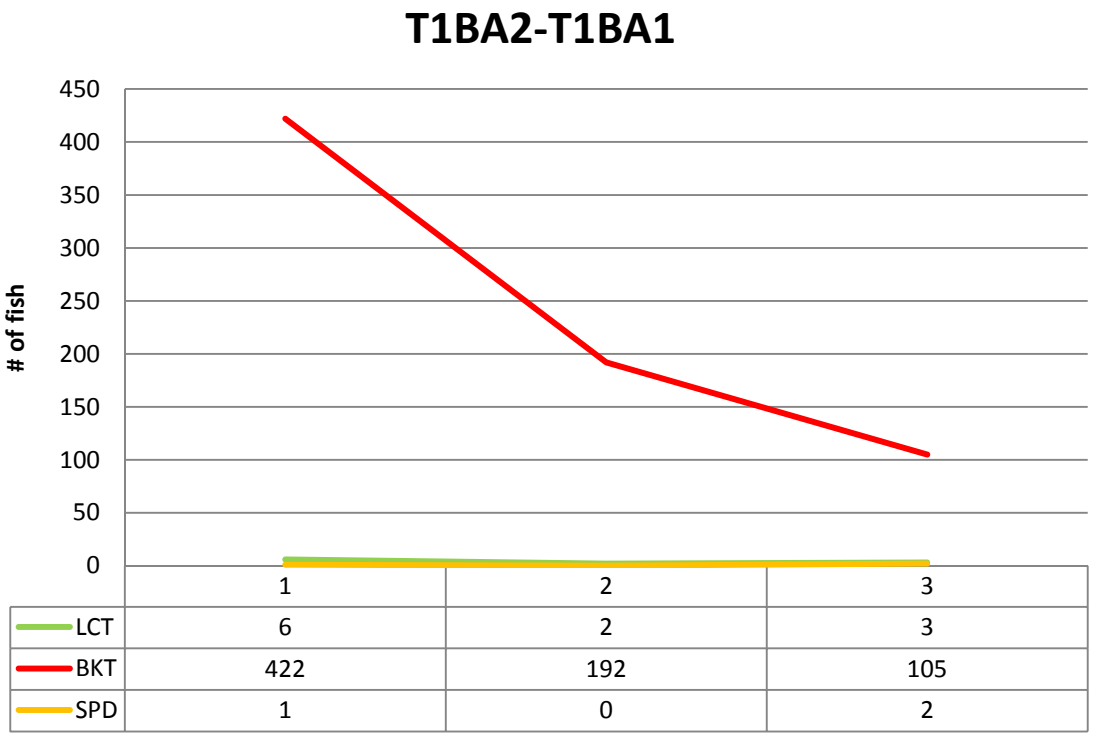

T1BA7A-T1BA6
# of fish
60
50
40
30
20
10
0
1
2
3
LCT 49 34 25
BKT 9 3 2


T1BA6-T1BA6A
# of fish
500
450
400
350
300
250
200
150
100
50
0
1
2
3
LCT 332 155 87
BKT 462 185 260
SPD 3 0 1


T1BA6A-T1BA4
# of fish
400
350
300
250
200
150
100
50
0
1
2
3
LCT 68 36 12
BKT 373 262 181
SPD 1 1 1


T1BA4-T1BA3
# of fish
160
140
120
100
80
60
40
20
0
1
2
3
LCT 14 12 4
BKT 146 60 31
SPD 1 1 0


T1BA3-T1BA2
# of fish
25
20
15
10
5
0
1
2
3
LCT 2 0 0
BKT 20 5 1


T1BA2-T1BA1
# of fish
450
400
350
300
250
200
150
100
50
0
1
2
3
LCT 6 2 3
BKT 422 192 105
SPD 1 0 2