POST-SPAWN MOVEMENTS AND JUVENILE OUTMIGRATION OF FLUVIAL BEAR RIVER BONNEVILLE CUTTHROAT TROUT IN HOBBLE CREEK, WY

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EXECUTIVE SUMMARY

Bonneville cutthroat trout (BCT) currently occupy <5% of their historic range and the subspecies is considered 'Sensitive' by the USDA Forest Service and has special designation in the states of Utah, Idaho, and Wyoming. Research has shown that BCT in the Bear River system exhibit a unique fluvial life history strategy, using habitats in lower elevation, mainstem rivers for growth and maintenance and migrating large distances (up to 90 km) to headwater habitats to spawn. Unfortunately, three full-spanning diversion structures on the Thomas Fork River currently prevent fluvial fish from accessing critical upstream spawning habitats and entrain downstream migrants in irrigation canals.

In 2002 Trout Unlimited entered into a partnership with several federal and state agencies and land owners and water users in the Thomas Fork Valley in southeastern Idaho to begin retrofitting these Thomas Fork diversion structures with fish screens and fish bypass channels to allow fluvial BCT to migrate around the structures. As part of a BACI (before-after-control-impact) study design to evaluate population recovery in the Thomas Fork following restoration activities, Trout Unlimited began in June 2003 to monitor fluvial BCT movements in Hobble Creek in western Wyoming, a tributary that is known to provide spawning habitat for fluvial migrants in the Bear River system. We used picket weirs to capture all fish greater than 100 mm moving upstream and downstream in Hobble Creek, and conducted three pass depletion electrofishing surveys in 100 m reaches throughout the drainage.

Our primary observations from 3 months of fish sampling were: (i) large numbers of juvenile BCT between 90-120 mm TL migrated out of Hobble Creek during spring

run-off, (ii) few large adults moved downstream during the summer, and (iii) BCT that moved downstream through our weir did not represent a cross-section of resident populations upstream. We speculate that the majority of the juvenile BCT outmigrants are fluvial offspring, that adult spawners move out of spawning tributaries immediately after spawning (prior to July 1) or remain in spawning tributaries through September, and that fluvial spawning occurs in the same sections of stream each year. We plan to continue trapping in the Smith's Fork drainage and expand our fish monitoring efforts to the Thomas Fork drainage to explore the knowledge gaps associated with alternative life history strategies, movement timing, and fluvial population numbers. Additionally, outmigration numbers in the Smith's Fork will act as a control to quantify the restoration treatment effect (barrier removal) in the Thomas Fork, and promote a better understanding of the relative contributions of the Smith's and Thomas Forks to the Bear River East BCT metapopulation. The open migration corridor between the Bear River and the upper Smith's Fork is critical to the persistence of fluvial Bear River BCT, and providing upstream fish passage in the Thomas Fork will further ensure the long-term persistence of BCT populations in the Bear River system.

ACKNOWLEDGEMENTS

Most of the funding for this project was provided by the Bureau of Land Management and USDA Forest Service through a grant from the National Fish and Wildlife Foundation (Project No. 2001-0203-000). In addition, the Wyoming and Idaho State Councils of Trout Unlimited and the Southeast Idaho Chapter of Trout Unlimited contributed funding through the Trout Unlimited Embrace-a-Stream Program. Thomas

Fork diversion bypass and fish screen construction is being conducted through a partnership between Trout Unlimited, the USDA Forest Service, the US Fish and Wildlife Service, Thomas Fork landowners, the Faucet Irrigation Company, the Bear Lake Regional Commission, and Idaho Fish and Game. A collecting permit for tributary survey work in the upper Smith's Fork River was issued by the Wyoming Game and Fish Department. We thank James Capurso (USDA Forest Service, Fisheries Biologist, Caribou-Targhee National Forest) and Deb Mignogno (USFWS, Eastern Idaho Field Office Supervisor) for securing funding for the three Thomas Fork diversion fixes. Valuable field assistance was provided by Justin Bezold, Erica Engle, Christopher Forristal, and Matt Fox, Trout Unlimited, with additional field assistance from numerous volunteers.

PROGRAM INTRODUCTION

The Strategies for Restoring Native Trout Program

Native trout species have experienced drastic declines in their distributions over the past century due to habitat degradation, over harvest, and the introduction of nonnative salmonids. Historically, restoration efforts for many species of native trout have focused on headwater streams and high-elevation lakes above barriers because isolated populations can be protected from invading nonnative salmonids. However, success rates for native fish introductions into such habitats are generally less than 50%, and habitat quality or quantity are frequently cited as the cause of failure (Williams et al. 1988, Hendrickson and Brooks 1991, Harig et al. 2000, Hilderbrand and Kershner 2000, Harig and Fausch 2002). Trout require different temperatures, flow, substrate, and physical structure at each life history stage, so they often must move between distant habitat patches to meet their habitat requirements, especially in disturbed watersheds (Fausch et al. 1995, Schlosser 1995). It is likely that headwater sites lack the spatial heterogeneity and connectivity of habitat patches needed to maintain persistent trout populations, and conservation will require restoration of larger-scale watersheds to meet their diverse life history needs.

Recognizing the importance of scale in the conservation of native trout, biologists recently have proposed metapopulation concepts to guide management (i.e., that regional populations of a species may persist in variable environments as collections of local populations interacting through dispersal; Rieman and Dunham 2000). Unfortunately, few remaining native trout habitats are large enough to support a metapopulation, so restoration efforts are necessary to establish multiple, interconnected populations within a healthy watershed. Such large-scale restoration efforts require a considerable expenditure of resources, and little funding is usually available for long-term monitoring and evaluation. Therefore, Trout Unlimited introduced the "Strategies for Restoring Native Trout" program in 2001 to scientifically monitor cooperative, large-scale restoration efforts that improve or expand existing aquatic habitat for native trout (i.e., incorporate control systems, randomly apply treatments, and replicate treatments where feasible). Our program supports restoration efforts in multiple watersheds, including the upper Bear River basin in southeastern Idaho, western Wyoming, and eastern Utah, with the goal of identifying effective large-scale restoration tools that improve our ability to design future watershed restoration efforts.

INTRODUCTION

Bonneville cutthroat trout (BCT) currently occupy <5% of their historic range and the subspecies is designated as ‘Sensitive’ by the USDA Forest Service and the state of Wyoming, and ‘a Species of Concern’ by the states of Utah and Idaho. The Thomas Fork, the neighboring Smith’s Fork, and sections of the Bear River between these two tributaries support one of the most genetically pure populations of BCT throughout its native range and comprise what is likely the last connected large river habitat available to the subspecies. Independent research projects were initiated in 1998 and 1999 by the University of Wyoming and Utah State University, respectively, with the goal of gaining a better understanding of the life history characteristics, habitat requirements, and movement patterns of BCT within the Thomas Fork and Bear River. These studies showed that BCT in this system exhibited a fluvial life history strategy, using habitats in lower elevation, mainstem rivers for growth and maintenance and migrating large distances (up to 90 km) to headwater habitats to spawn. This research also indicated that three full-spanning diversion structures on the Thomas Fork block access to upstream spawning habitats and entrain downstream migrants in irrigation canals (Colyer 2002, Schrank 2002).

These studies and others like them suggest that past efforts to protect native cutthroat trout subspecies through isolation (Stuber et al. 1988, Moyle and Sato 1991, Young 1995) may have come at the expense of localized life history adaptations and genetic diversity. In addition to habitat and space limitations that might render isolated tributary populations especially vulnerable to extinction (Dunning et al. 1992, Hilderbrand and Kershner 2000, Harig and Fausch 2002, Novinger and Rahel 2003), these ‘conservation by isolation’ techniques also select against migratory life histories and can lead to genetic and behavioral changes within the isolated population (Northcote et al. 1970, Northcote 1992, Young 1996). As a result, reestablishing watershed connectivity is now the preferred conservation tool in many systems.

The Thomas Fork—Smith’s Fork—Bear River network constitutes what is likely the last mainstem river habitat available to fluvial BCT and provides a unique opportunity for this type of large-scale watershed reconnection project. In 2002 Trout Unlimited partnered with the US Forest Service, the US Fish and Wildlife Service, Idaho Department of Fish and Game, Faucet Irrigation Co., and several private landowners in the Thomas Fork Valley in southeastern Idaho to begin retrofitting the three full-spanning irrigation diversion structures in the Thomas Fork with fish screens and fish bypass channels. Fluvial BCT in this system face a two-fold challenge during their migrations between mainstem and spawning habitats. During dry years adults in the mainstems of the Thomas Fork and Bear River are prevented from accessing spawning habitats in the upper Thomas Fork and its tributaries by full spanning irrigation diversions along the lower Thomas Fork (Colyer 2002). During wetter years irrigation activities begin late enough to allow upstream migration of fish past irrigation diversions, but nearly 50% of those fish subsequently die in unscreened irrigation ditches during their post-spawn return to mainstem habitats (Schrank 2002, Thomas Fork landowners, pers. comm.). Current research suggests that adult BCT moving downstream in the Smith’s Fork suffer a similar fate in irrigation canals (J. Roberts, University of Wyoming, pers. comm.). To date, research has focused on adult BCT in the system, and we now have a better understanding of adult fluvial BCT movement patterns and life history requirements. However, we still know very little about the effective size of this population component or about juvenile migration patterns and distributions throughout the system. To that end, Trout Unlimited initiated research in 2003 in the Smith's Fork of the Bear River to gain a better understanding of (i) fluvial BCT population numbers, and (ii) juvenile distributions and outmigration timing in the Bear River and its tributaries. We plan to use this information to evaluate population recovery in the Thomas Fork following our restoration activities.

METHODS

Trout Unlimited is conducting all monitoring and evaluation activates associated with the Thomas Fork fish passage project. As part of a BACI (before-after-control-impact) study design, we began in June 2003 to monitor downstream BCT movements in Hobble Creek in western Wyoming, a tributary that is known to provide spawning habitat for fluvial migrants from the lower Smith's Fork and the Bear River (**Figure 1**). We used picket weirs and two way trap boxes to capture all fish greater than 100 mm moving upstream and downstream in Hobble Creek. We also conducted three pass depletion electrofishing surveys in 100 m reaches throughout the upper drainage.

Trapping.—We monitored upstream and downstream movements in Hobble Creek from June 30, 2003 through September 22, 2003 using a picket weir with upstream and downstream trap boxes. The weir was located approximately 400 m downstream from the confluence of Hobble and Coantag Creeks (4690144 N 517065 E, UTM NAD27, zone 12). All BCT were weighed and measured and those >130 mm total length were anesthetized with clove oil (30 mg/L; Prince and Powell 2000) and implanted with Passive Integrated Transponder (P.I.T.) tags. We implanted all BCT >200 mm with Visible Implant (V.I.) tags in addition to the P.I.T. tags. All captured brown trout (BNT) were measured, and BCT and BNT captured prior to August 1 were given adipose clips. On August 1 we began to clip the right maxillary of all captured BCT in order to differentiate between fish that we had clipped and the adipose clipped fish that were released into the Smith's Fork in July by WYG&F. We counted and recorded the direction of movement for all other fish species that we captured. Following handling, all fish were released either upstream or downstream of the trap depending on their direction of travel.

Population Surveys.— We conducted electrofishing surveys upstream from the weir location site in both Hobble and Coantag Creeks (**Figure 1**). We established 100 m survey sites at 1 km intervals moving upstream from the trap, and used block nets with a standard three-pass depletion methodology. We conducted a third pass only if the second pass yielded >20% of the total number of trout captured in the first two passes. We calculated maximum likelihood abundance estimates for BCT captured during surveys using the Zippin estimator within the program CAPTURE (White et al. 1982). All BCT were weighed and measured and tagged according to the same size criteria used for weir captures. All BNT were measured and numbers of mountain whitefish (MWF) and mottled sculpin (MS) were recorded.

Angling.—We periodically angled for BCT and tagged captured fish with P.I.T. and V.I. tags to document trends in fluvial BCT densities in habitats upstream of our traps and to see whether these fish later moved through our traps. All angled fish were captured with artificial flies tied on single barbless hooks and kept in in-stream live wells for no longer than 15 minutes before processing. All angled BCT were anesthetized, weighed, measured, and tagged according to the protocol previously outlined. All angled BNT were measured and recorded.

RESULTS

Trapping.—Between June 30 and September 22 we captured a total of 623 BCT, 133 BNT, 166 mottled sculpins (MS), 231 mountain whitefish (MWF), and 3 suckers (not identified to species; **Table 1**). Ninety-six percent of captured BCT were moving downstream (595 of 623). Mean total length for captured BCT was 130 mm and ranged from 89 to 480 mm. Length frequency comparisons between BCT captured in weir traps and those captured during electrofishing surveys in Hobble and Coantag Creeks indicated that BCT moving through the weir were not representative of the size classes present in upstream populations. BCT between 90 and 120 mm TL accounted for roughly 67% of all of the BCT captured in our traps, while that size class made up only 18% and 35% of BCT surveyed in Hobble and Coantag Creeks, respectively (**Figure 2**). BCT capture rates were high at the outset of trapping and declined throughout July and August, suggesting that we installed our weir at or just after the peak of outmigration. (**Figure 3**).

Population surveys.—We surveyed 13 sites in Hobble Creek between July 23 - 27 and captured a total of 96 BCT, 38 BNT, and 681 MS. We tagged 47 BCT with P.I.T. tags and 25 with V.I. tags. We had 6 mortalities, all of which appeared to be due to electrofishing injuries. Abundance estimates ranged from 4 to 19 BCT per 100 m reach and mean total length ranged from 105 to 308 mm across sample sites, indicating a non-uniform distribution of size classes among sites. We surveyed 8 sites in Coantag Creek between August 18 - 21 and captured 97 BCT, 5 BNT, 1 MWF, and 613 MS. We tagged 33 BCT with P.I.T. tags and 16 with V.I. tags. We had 5 mortalities that were probably due to injuries incurred during electrofishing. Abundance estimates in Coantag Creek ranged from 5 to 26 BCT per 100 m reach. Mean total length ranged from 91 to 204 mm, again indicating a non-uniform distribution of age classes among our sample sites (**Table 2**).

Angling.—We captured a total of 15 BCT by angling on four different occasions. All angled fish were tagged with P.I.T tags and 11 of the 15 also received V.I. tags. Total lengths ranged from 168 to 470 mm. Two of these fish were subsequently recaptured by angling several weeks after they were tagged at or near their initial locations. However, none of the BCT tagged during angling had moved downstream through our weir by the time that it was removed at the end of September.

DISCUSSION

This three month observational study of fluvial BCT movements in Hobble Creek provided some unexpected initial insights into movement patterns of juvenile and adult BCT, several of which suggest potential avenues for future research. Our trapping and electrofishing results indicate that: (i) large numbers of juvenile BCT between 90-120 mm TL migrated out of Hobble Creek during spring run-off, (ii) few large adults moved downstream during the summer, and (iii) BCT that moved downstream through our weir did not represent a cross-section of resident populations upstream.

Observation I - Large numbers of juvenile BCT between 90-120 mm TL migrated out of Hobble Creek during spring run-off.

Hobble Creek is thought to provide spawning habitat for fluvial Bear River BCT (Colyer 2002) and we suspect that these outmigrants are fluvial offspring. Juveniles were captured in surprisingly high numbers (i.e. 25-30 individuals per day) at the outset of trapping, but those numbers declined throughout July and August, suggesting that we installed our weir sometime at or just after the peak of juvenile outmigration. If we assume that outmigration numbers follow a somewhat normal distribution, then we can conclude that many of these fish were probably outmigrating during June, as well. Our trap boxes were able to reliably retain only BCT that were greater than 100 mm in length, so we cannot say whether YOY were outmigrating during this time. To our knowledge no one has ever documented this kind of large-scale juvenile outmigration in an interior cutthroat trout population. At the outset of this study we expected that fluvial BCT offspring probably remained in tributaries for 2-3 years until they attained greater sizes, at which point they would start to gradually move downstream. Our preliminary findings show that may not be the case. Sixty-seven percent of BCT that we captured were probably age 1 fish (90-120 mm TL), suggesting that many juvenile BCT appear to remain in spawning tributaries for only 1 year after they emerge before moving downstream.

Observation ii - Few large fish were captured in our traps, so we assume that fluvial adults are either moving out of spawning tributaries immediately after spawning (prior to July 1) or are remaining in spawning tributaries through September.

Recent studies have significantly improved our understanding of the life history requirements, seasonal distributions, habitat preferences, and migration patterns of fluvial BCT in the Bear River (Schrank 2002, Schrank et al. 2002, Colyer 2002, Burnett 2003), but we still know very little about the effective size of this population component. Initially we had hoped to use weirs to estimate the numbers of fluvial adults that were spawning in Hobble Creek without disturbing spawning fish by electrofishing or snorkeling. Based on studies conducted in the neighboring Thomas Fork drainage, we assumed that BCT would be actively spawning between May 15 and June 15 (Colyer 2002, Schrank 2002). However, high streamflows prevented us from installing our weirs prior to June 30, and we caught surprisingly few adult outmigrants after that date.

One possible explanation is that fluvial adults remained in Hobble Creek after they spawned and did not make it downstream to our weir by the time it was removed at the end of September. We captured several large (>400 mm) fish upstream from our weir in Hobble creek during angling and electrofishing surveys in July and August, but none of these tagged fish moved downstream through the weir. We did capture a few untagged adults moving downstream during the last few days of trapping in late September, which suggests the possibility that adults were just beginning to move when we removed our weirs. However, a more likely explanation is that many of the fluvial spawners had already left Hobble Creek by the time we installed our weir. Schrank

(2002) found that only 20% of tagged post-spawn adult BCT in the Thomas Fork remained in the tributaries in which they had spawned. Similarly, anecdotal evidence suggests that large numbers of adult spawners use a fairly discrete section of Hobble Creek for spawning, but then begin to move downstream soon afterwards (H. Berge, USDA Forest Service volunteer, pers. comm.). Researchers in the lower Thomas Fork and the Bear River found that radio tagged BCT that overwintered in these mainstem reaches disappeared in the spring and then reappeared at the beginning of the fall. A few of these fish were successfully tracked to upstream locations in Hobble Creek during May and June prior to transmitter failure (Colyer et al. in prep).

Observation iii - Comparisons between BCT length-frequency histograms for electrofishing survey reaches and for weir captures show that BCT moving downstream through our weir did not represent a cross-section of upstream populations.

Juvenile BCT ranging in size from 90 to 120 mm accounted for 67% of all weir captures, but that size class made up only 35% and 18% of our survey populations in Coantag and Hobble Creeks, respectively. Electrofishing surveys further indicated that juvenile fish were not evenly distributed throughout the two streams but were concentrated at specific sites. In Coantag and Hobble Creeks we found that juveniles dominated our samples at only one site in each stream. Survey reach 16 in Coantag Creek had a population estimate of 26 fish, with all but one of them ranging in size between 77 and 132 mm TL. Similarly, reach 4 in Hobble Creek had a population estimate of 19, with 14 of those ranging in size between 72 and 131 mm TL. This concentration of age 1 BCT these sites may suggest that fluvial spawning activity occurs nearby. This hypothesis is corroborated by anecdotal evidence that spawning BCT return each year to spawn in the same sections of Coantag and Hobble Creeks (H. Berge, USDA Forest Service volunteer, pers. comm.), so we intend to test this hypothesis in the future.

CONSERVATION IMPLICATIONS AND FUTURE PLANS

Telemetry studies in 1998-1999 showed that fluvial Bear River Bonneville cutthroat trout used spawning habitats in both the Thomas Fork and the Smith's Fork. Currently, however, drought conditions combined with diversion barriers are preventing BCT from accessing Thomas Fork tributaries, and some of the only spawning habitat now available to BCT is found in the Smith's Fork drainage. Fish have been documented moving out of the Thomas Fork and upstream into the Smith's Fork when the Thomas Fork is not passable (Colyer 2002). As such, we believe that the open migration corridor between the Bear River and the upper Smith's Fork is critical to the persistence of fluvial Bear River BCT. Providing fish passage around diversion barriers in the Thomas Fork and screening irrigation canals in both the Thomas and Smith's Forks will further ensure the long-term persistence of BCT populations in the Bear River system.

This year we plan to continue trapping in the Smith's Fork drainage (Hobble Creek) and expand our trapping efforts to the Thomas Fork drainage (Salt Creek). Two of the diversion barriers on the Thomas Fork are slated for removal in 2004 and the third in 2005. We will continue to fill in the knowledge gaps associated with alternative life history strategies, movement timing, and fluvial population numbers, as well as documenting the movement of BCT between upstream spawning habitats and mainstem overwintering habitats. Following our restoration efforts we expect to see increased numbers of BCT outmigrants in the Thomas Fork as migration barriers are removed and fluvial adults are afforded access to tributary spawning habitats. By using outmigrant numbers in the Smith's Fork as a control we will be able to isolate and quantify the treatment effect (barrier removal) in the Thomas Fork, as well as gain a better understanding of the relative contributions of the Smith's and Thomas Forks to the Bear River East BCT metapopulation.

Table 1. GPS locations for Bonneville cutthroat trout (BCT), brown trout (BNT), mottled sculpin (MS), mountain whitefish (MWF), and suckers (S; not identified beyond family) captured by trapping, angling, and electrofishing in Hobble and Coantag Creeks between 6/25/03 and 9/22/03.

Species	# captured (# tagged)	Date	Method	Location (UTM, NAD 27, zone 11)
BCT	3(3)	6/26/03	Angling	4713748 N 1011844 E
BCT	4(4)	6/27/03	Angling	4710461 N 1011792 E
BCT	4(4)	6/27/03	Angling	4710573 N 1011838 E
BCT	3(3)	7/04/03	Angling	4710081 N 1011737 E
BCT	1(1)	7/05/03	Angling	4713726 N 1011837 E
BCT	5(4)	7/23/03	Electrofishing	4710407 N 1011801 E
BNT	13(0)	7/23/03	Electrofishing	4710407 N 1011801 E
BCT	4(3)	7/23/03	Electrofishing	4711387 N 1011989 E
BNT	11(0)	7/23/03	Electrofishing	4711387 N 1011989 E
BCT	6(5)	7/23/03	Electrofishing	4712357 N 1011763 E
BNT	10(0)	7/23/03	Electrofishing	4712357 N 1011763 E
BCT	19(4)	7/24/03	Electrofishing	4713276 N 1011867 E
BNT	3(0)	7/24/03	Electrofishing	4713276 N 1011867 E
BCT	7(5)	7/24/03	Electrofishing	4714310 N 1011857 E
BCT	3(1)	7/24/03	Electrofishing	4715246 N 1011888 E
BNT	1(0)	7/24/03	Electrofishing	4715246 N 1011888 E
BCT	5(2)	7/25/03	Electrofishing	4716252 N 1011702 E
BCT	8(3)	7/25/03	Electrofishing	4717300 N 1011714 E
BCT	4(1)	7/26/03	Electrofishing	4718222 N 1011631 E
BCT	14(5)	7/26/03	Electrofishing	4719263 N 1011867 E
BCT	8(6)	7/27/03	Electrofishing	4719987 N 1012584 E
BCT	4(3)	7/27/03	Electrofishing	4720861 N 1012974 E
BCT	9(6)	7/27/03	Electrofishing	4721762 N 1013268 E
MWF	1(0)	8/18/03	Electrofishing	4709898 N 1012118 E
BNT	2(0)	8/18/03	Electrofishing	4709898 N 1012118 E
BCT	13(6)	8/18/03	Electrofishing	4709898 N 1012118 E
BCT	7(0)	8/18/03	Electrofishing	n/a
BNT	2(0)	8/19/03	Electrofishing	4709125 N 1013520 E
BCT	25(1)	8/19/03	Electrofishing	4709125 N 1013520 E
BCT	5(0)	8/19/03	Electrofishing	4708715 N 1014337 E
BCT	10(6)	8/20/03	Electrofishing	4709908 N 1017606 E
BCT	13(9)	8/20/03	Electrofishing	4709036 N 1017197 E
BCT	14(4)	8/21/03	Electrofishing	4708474 N 1016334 E
BNT	1(0)	8/21/03	Electrofishing	4708584 N 1015363 E
BCT	9(7)	8/21/03	Electrofishing	4708584 N 1015363 E
BCT	623(124)	6/30/03—9/22/03	Weir Trapping	4690144 N 517065 E **(Zone 12)**
BNT	133(0)	6/30/03—9/22/03	Weir Trapping	4690144 N 517065 E **(Zone 12)**
MS	166(0)	6/30/03—9/22/03	Weir Trapping	4690144 N 517065 E **(Zone 12)**
MWF	231(0)	6/30/03—9/22/03	Weir Trapping	4690144 N 517065 E **(Zone 12)**
S	3(0)	6/30/03—9/22/03	Weir Trapping	4690144 N 517065 E **(Zone 12)**

Table 2: Bonneville cutthroat trout (BCT) abundance and size data from three-pass depletion electrofishing on 100 m reaches in Hobble and Coantag Creeks in July and August 2003 (see Figure 1 for reach locations). *N* = population estimate, *p* = capture probability, SE = standard error, and CI = confidence interval.

	No. of BCT Pass			BCT Abundance				Total Length (mm)		Weight (g)	
Reach	1	2	3	*p*	*N*	SE	95% CI	Mean	SE	Mean	SE
Hobble Creek--July 23-27, 2003											
1[a]	5							307.6	54.0		
2[a]	4							215.0	53.8	170.7	88.6
3[a]	6							286.2	42.7	439.1[c]	159.5
4	16	3		0.86	19	0.8	19-19	125.6	13.6	38.3[d]	14.5
5	6	1		0.87	7	0.4	7-7	145.7	17.9	42.5	13.1
6	3	0			3[b]			104.7	12.8	11.9	4.4
7	2	2	1	0.56	5	1.2	5-5	124.2	22.9	33.6	19.4
8	7	1		0.89	8	0.4	8-8	126.6	27.5	47.5	34.4
9	3	1	0	0.80	4	0.2	4-4	106.5	17.7	16.8	9.0
10	8	4	2	0.61	14	1.5	14-24	116.9	15.7	35.0[e]	13.2
11	4	2	2	0.52	9	1.9	9-20	166.3	27.2	75.1	29.1
12	3	1	0	0.80	4	0.2	4-4	152.8	15.5	45.0	12.6
13	6	2	1	0.70	9	0.7	9-9	193.8	24.8	105.4	31.8
Coantag Creek--August 18-21, 2003											
14	6	5	2	0.50	14	2.8	14-29	146.5	16.0	52.0	17.7
15	6	1		0.87	7	0.4	7-7	133.7	27.8	52.4	31.9
16	14	9	2	0.60	26	2	26-36	108.2	7.7	21.6	10.1
17	4	1		0.83	5	0.5	5-5	90.6	6.2	7.6	2.0
18	8	1		0.90	9	0.4	9-9	203.2	24.9	131.6	38.3
19[f]	8	4	3	0.51	17	2.8	16-31	146.5	28.5	122.2	73.7
20	8	4	1	0.68	13	0.9	13-13	204.4	31.7	215.2	101.8
21	7	2	1	0.71	10	0.6	10-10	138.5	15.6	40.8	13.0

[a] Stream width and flow prevented the use of block nets so we did not attempt depletion sampling but instead made only one pass.

[b] Capture probability and a reliable population estimate could not be calculated when BCT were not captured on the second pass so the number of captures was reported without confidence intervals for this reach.

[c] Mean weight was calculated from only 5 BCT because one BCT was not weighed accurately (TL = 126).

[d] Mean weight was calculated from only 18 BCT because one BCT was not weighed accurately (TL = 76).

[e] Mean weight was calculated from only 13 BCT because one BCT was not weighed accurately (TL = 67)

[f] One BCT escapee (TL ~ 110) was included in pass totals but not measured or weighed.

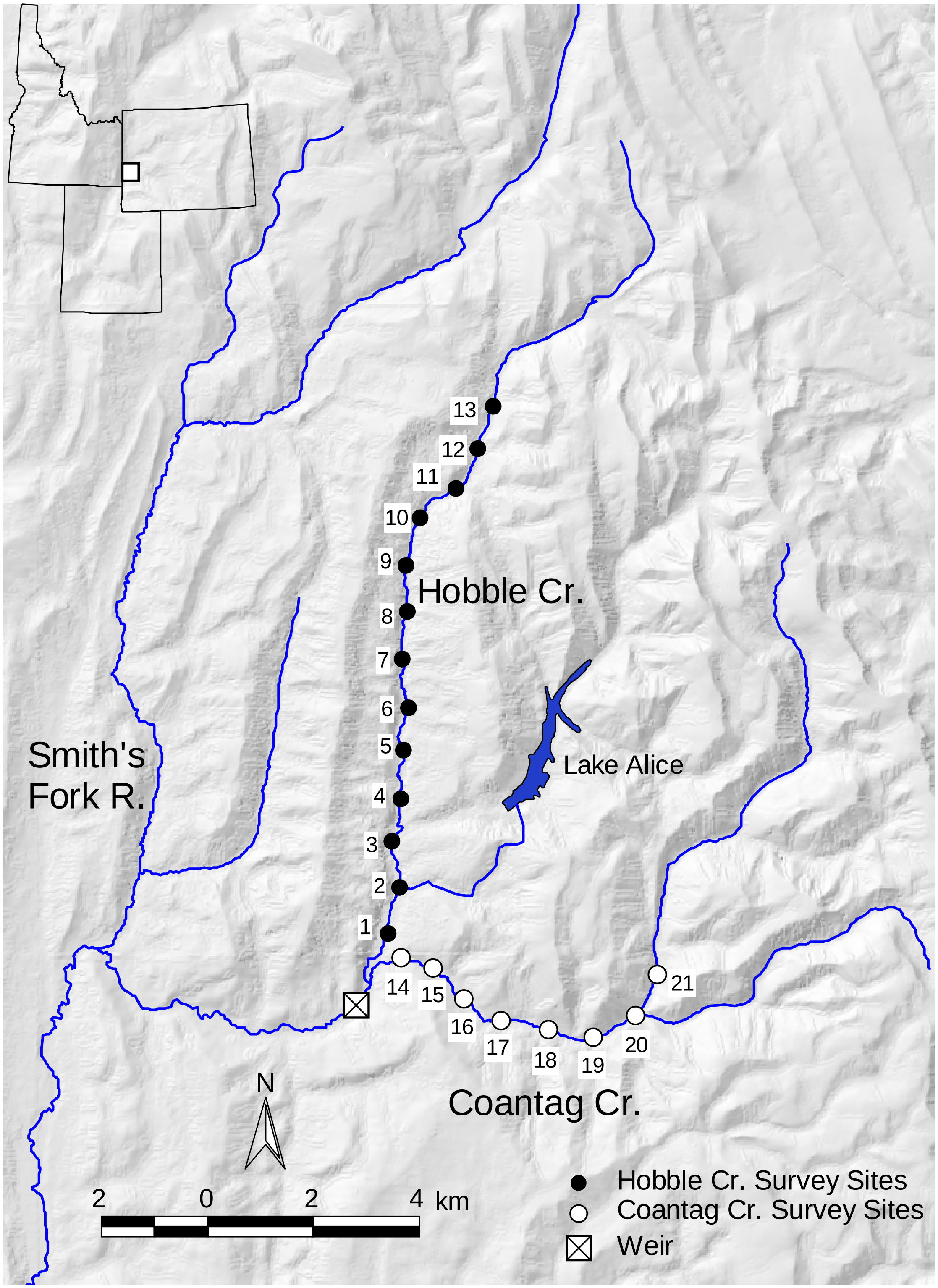

Figure 1. Map of Hobble Creek study area. Numbers correspond to reaches listed in Table 2.

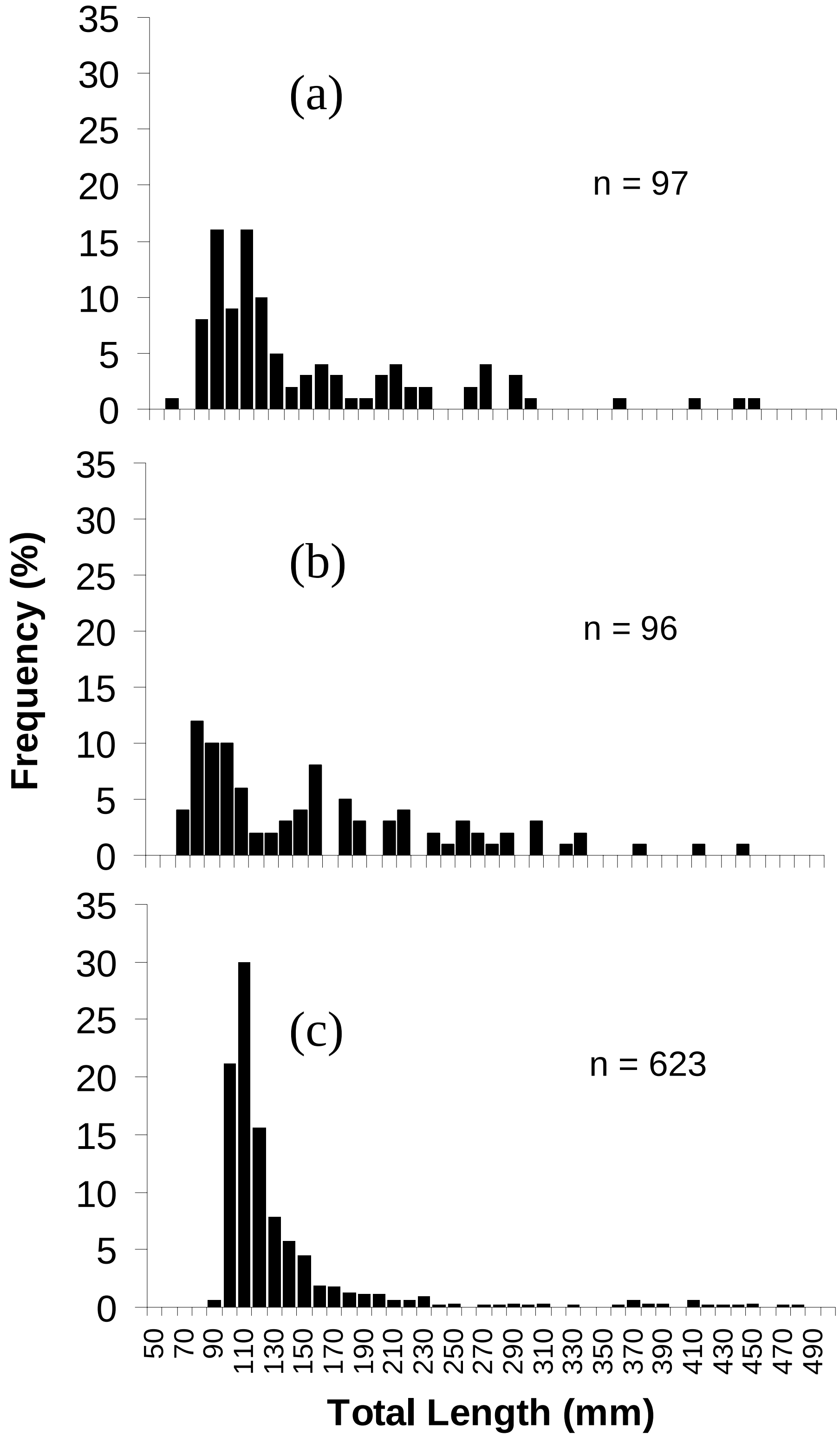

Figure 2. Length-frequency histograms for BCT captured by electrofishing in (a) Coantag Creek and (b) Hobble Creek in July and August 2003, and by weir trapping below the confluence of the two from July through September 2003 (c).

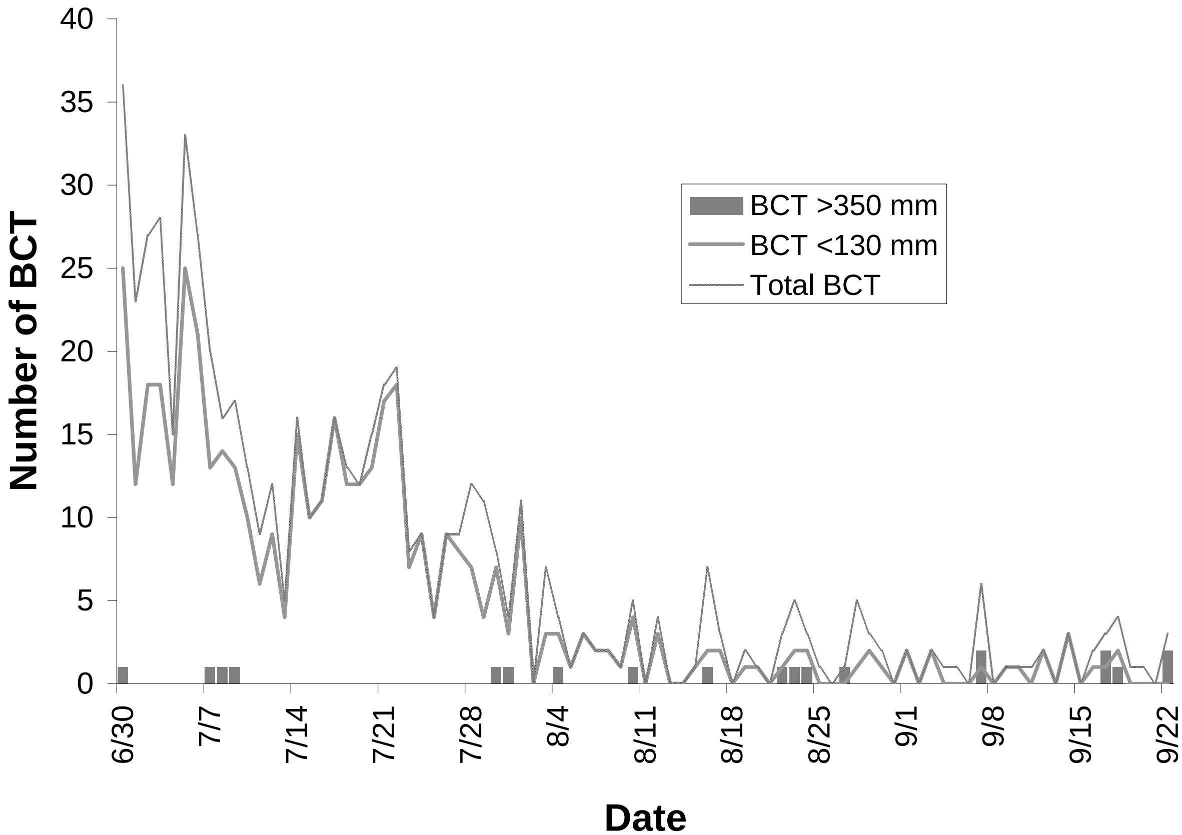

Figure 3. Chart of outmigration numbers and timing for two size classes of BCT. Numbers of juvenile BCT moving downstream through the weir traps were greatest during July and decreased throughout the summer. In contrast, the few large adult BCT that were captured in our traps moved throughout the study period in no obvious pattern.

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