Yellowstone Cutthroat Trout Survey and Population Assessment - 2005

Final report

by

Jim De Rito and Anne Marie Emery-Miller

Henry's Fork Foundation
P.O. Box 550
Ashton, ID 83420

December 2006

ACKNOWLEDGEMENTS

Numerous individuals and organizations made this project possible. The Henry's Fork Foundation (HFF) fisheries crew was composed of Bryce Cheney, Sara Shiley, Michael Wilson, and Joseph “Haynes” King, who hiked, camped, and collected most of the field data. Bryce was supported by the R. A. James Greene Scholarship, Sara by the Don C. Byers Memorial Scholarship, and Haynes and Michael by the A. Paul Knight Memorial Scholarship. Jim Gregory (Gregory Aquatics) supplied electrofishing equipment, horse packing services, and crew leadership for the Bechler River surveys, as well as data compilation and GIS mapping of all past and present survey data. Surveys in Yellowstone National Park were assisted by Jonas Landes, Kate Fuller, Carrie Wyler, and Tonilyn Bringhurst of the Utah State University Utah Conservation Corps (USUUCC). Corey Lyman (Caribou-Targhee National Forest; CTNF) assisted with the Fall River surveys.

Lee Mabey (CTNF) was instrumental in making this project possible, including survey design, equipment procurement, logistical support, and field assistance. Rob Van Kirk (Idaho State University) and Mike Lein (Friends of the Teton River; FTR) assisted with the development of stream sampling methods for the Henrys Fork Drainage. Rob Gipson and Darren Rhea of the Wyoming Department of Game and Fish and the FTR fisheries crew assisted with HFF crew training and standardization of Henrys Fork Drainage methods. Jim Fredericks (Idaho Department of Fish and Game; IDFG) assisted with the development of sampling methods for the Henrys Fork Drainage and provided electrofishing equipment. Kevin Meyer (IDFG) assisted with the development of sampling methods for the Henrys Fork Drainage and selected IDFG electrofishing sampling sites in the Sinks Drainage. Tony Lamansky (IDFG) selected sites, led crews, and entered data for the IDFG electrofishing in the Sinks Drainage. Dan Garren (IDFG) coordinated field crews for the electrofishing extravaganza in the Sinks Drainage. Sean Damitz (USUUCC) provided logistical support for the USUUCC members. Matt Campbell and Christine Cegelski of the IDFG Eagle Fish Genetics Lab completed the genetic analysis and assessment of all fish samples. Steve Trafton and Joan Rice of HFF provided project support.

The Jackson Hole One Fly Foundation and National Fish and Wildlife Foundation Conservation Partnership provided the funding for this project.

Cover photo: Yellowstone cutthroat trout in Phillips Creek, Yellowstone National Park, September, 2005.

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EXECUTIVE SUMMARY

Stream surveys took place throughout the Henrys Fork and Sinks drainages in 2005. The objectives of these electrofishing surveys was to further assess Yellowstone cutthroat trout *Oncorhynchus clarki bouvieri* distribution, abundance, and genetic status, especially in relation to rainbow trout *O. mykiss* and brook trout *Salvelinus fontinalis*. Sixty-six sites were surveyed on 38 streams in the Henrys Fork watershed between July 11, 2005 and October 6, 2005. Thirty-two sites (48%) were dry when surveyed, whereas thirty-four (52%) of the sites had water. Of the sites with water, trout were found in 22 (65 %). Of the sites with trout; 11 (50%) had brook trout only, 10 (45.5%) had cutthroat trout only, and one site (4.5%) had both cutthroat trout and brook trout. Multiple-pass electrofishing densities in the brook trout only sites (n = 6) averaged 21 fish/100 m^2 (range 2 – 49 fish/100 m^2) and in the cutthroat trout only sites (n =5) averaged 14 fish/100 m^2 (range 3 – 40 fish/100 m^2. Genetic samples were collected from 256 fish from seven different sites on five different streams. All fish were phenotypically identified as Yellowstone cutthroat trout, except for five putative Yellowstone cutthroat trout x rainbow trout hybrids at three sites. All samples were genetically identified as Yellowstone cutthroat trout; no evidence was found of rainbow trout or westslope cutthroat trout introgression at any of the samples sites. Genetic screening of a 65 fish subsample from the Fall and Bechler rivers suggests that these pure Yellowstone cutthroat trout are products of past introductions from Yellowstone Lake. There were 84 sites surveyed on 61 streams in the Sinks Drainages from June 27 to June 29, 2005. No water was found at 24 sites. Of the sites with water, 23 (38 %) had no trout. Of the sites with trout, 22 (59 %) had brook trout only, 9 (24 %) had cutthroat trout only, and 2 sites each had cutthroat trout with brook trout, cutthroat trout with rainbow trout (including hybrids), and rainbow trout only. Multiple-pass electrofishing densities in the brook trout only sites (n =22) averaged 11.5 fish/100 m^2 (range 0.3 - 29 fish/100 m^2) and in the cutthroat trout only sites (n = 8) averaged 9.6 fish/100 m^2 (range 0.3 - 27 fish/100 m^2). Stream surveys conducted in 2005 have further refined the known Yellowstone cutthroat trout distribution in the Henrys Fork and Sinks drainages, including four previously undocumented populations. This information is crucial to the continued management of this cutthroat trout subspecies. However, further survey, assessment, and monitoring are required in both drainages to provide a better understanding of Yellowstone cutthroat trout distribution, abundance, and genetic status in these drainages.

INTRODUCTION

Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*, YCT) evolved as the only trout in the Snake River above Shoshone Falls and in the Yellowstone River upstream of the Tongue River (Behnke 1992). The distribution and abundance of this cutthroat trout subspecies has declined; extirpation or introgressive hybridization of YCT has occurred in over 75% of their historical stream habitat (May et al. 2003). In 1998, YCT were petitioned for listing as "threatened" under the Endangered Species Act. The U.S. Fish and Wildlife Service (USFWS) determined that subspecies listing was "not warranted" in a 90-day finding (USFWS 2001) and a full status review finding (USFWS 2006). YCT are considered a "Sensitive Species" or "Species of Special Concern" by the U.S. Forest Service, the American Fisheries Society, and in all states (Idaho, Wyoming, Montana, Utah, and Nevada) that they inhabit.

The distribution of YCT in the Henrys Fork and the Sinks drainages has declined to a greater extent than that seen throughout most other drainages of the subspecies' range. Through 1999, YCT were found in about 17% of total fish-bearing habitat surveyed in the Henrys Fork (excluding the Teton River drainage) and only 3% contained YCT isolated from other nonnative salmonids (Jaeger et al. 2000). Meyer and Lamansky (2003) stated that only 12 streams in the Henrys Fork Snake River drainage are currently known to contain YCT. In the Sinks drainages, YCT inhabited 43% of fish bearing habitat surveyed and were the only trout present in 19% of fish-bearing habitat (Jaeger et al. 2000). Furthermore, the degree of isolation of YCT from other salmonids in the Sinks drainage is unknown; therefore these populations may be at high risk of invasion (Jaeger et al. 2000).

The Henry's Fork Foundation (HFF) has recently compiled all fisheries survey data collected by the Caribou-Targhee National Forest (CTNF), the Idaho Department of Fish and Game (IDFG), the Bureau of Land Management (BLM), the Wyoming Game and Fish Department (WGFD), and HFF, in the Henrys Fork and Sinks drainages from 1996 to 2004 into a YCT Status Summary. Preliminary results of the draft YCT Status Summary indicate that the distribution of the cutthroat trout in Henrys Fork and Sinks drainages has continued to decline in recent years. Rainbow trout *O. mykiss* or hybrids *O. clarki bouvieri x O. mykiss* have been found during the past five years in what were assumed to be YCT-only populations. These recent findings highlight the need to complete surveys on the streams in which YCT may remain and to strengthen our knowledge of the existing YCT populations. Similarly, the need for more rigorous study and definitive descriptions of YCT in the Henrys Fork and Sinks drainages was noted following the most recently completed fisheries surveys throughout the upper Snake River Basin in Idaho (Meyer and Lamansky 2003).

Genetic data for YCT populations are needed to evaluate wheter rainbow trout hybridization or introgression is present. Limited genetic information has been collected for YCT populations in the Henry's Fork and Sinks drainages and it was recommended that all remaining isolated cutthroat trout populations be evaluated (Jaeger et al. 2000). The need for testing of populations is evident by the increasing invasion of rainbow trout, which has potentially increased the rate of hybridization and introgression of YCT populations.

Genetic testing may also provide a means to evaluate the stocking origin of isolated Yellowstone cutthroat trout populations within a historically fishless part of the Bechler and Fall rivers in Yellowstone National Park. More than 6.6 million and 1.9 million cutthroat trout were stocked in the Bechler and Fall rivers, respectively, from 1920 to 1961 (Varley 1981). However, specific stocking locations aren't matched with hatchery sources that originated from either the Yellowstone River drainage or Idaho (likely Henrys Lake egg source). In addition, cutthroat trout stocked from Idaho sources may have also included westslope cutthroat trout (D. Mahoney, Yellowstone National Park, personal communication).

The purpose of the YCT Survey and Population Assessment is to complete fisheries surveys on the remaining unsurveyed streams that may support YCT in the Henrys Fork and Sinks drainages and to further evaluate known YCT populations. Detailed fisheries and genetic data for the remaining YCT populations are needed to provide a comprehensive assessment for fisheries management needs. The objectives of the YCT Survey and Population Assessment are to collect the requisite fisheries data in the Henrys Fork and Sinks drainages to determine: 1) the distribution and species composition of resident YCT populations, 2) estimates of YCT population sizes, 3) the genetic purity and stocking origins of YCT populations, and 4) characteristics of the stream habitat occupied by YCT populations.

METHODS

Henrys Fork Drainage

Stream lengths selected for sampling were identified in the YCT Status Summary. All past survey sites were plotted on a 1:100,000 Geographic Information Systems (GIS) streams layer. These data were used to classify stream lengths as unsurveyed or surveyed. Surveyed stream lengths were categorized based on YCT absence or presence. Cutthroat trout presence by stream length was categorized relative to other introduced trout species (Figure 1). Unsurveyed stream lengths or those that had limited snorkeling data were selected for survey in 2005.

Sampling sites were selected within the identified stream lengths using a random-systematic method and GIS measurement tools. The initial downstream sampling site was randomly selected within the first two kilometers and then successive upstream sites were located every two kilometers systematically for the extent of the stream length. If the stream was less than four kilometers in length then the midpoint was selected as the sampling site. For every three sampling sites, one site was selected randomly for three-pass electrofishing and the remaining two sites were selected as one-pass electrofishing sites. If only a single site was located on a stream, then it was typically a three-pass electrofishing site. All sampling sites were assigned Global Positioning System (GPS) coordinates (Universal Transverse Mercator (UTM), North American Datum 1927) using www.topozone.com.

The UTM coordinates and a handheld GPS unit were used in the field to locate the stream sampling sites. If no water was found at a site then no additional data, besides pictures, were collected. If a site had water, then a 100-m length of stream was measured with a meter tape. Block nets were set up across the stream at the beginning and end of the site. One or two backpack electrofishing units (Smith-Root Model 15-D) were used to sample fish within a site. At multiple-pass sites, electrofishing passes were conducted until fewer than 40 % of trout from the previous pass were captured. No additional passes were made if no fish were collected. Population estimates and 95% confidence intervals were calculated with MicroFish 3.0 (2005). The fork length of captured fish was measured to the nearest millimeter. Only the first six non-game fish per species per site were measured. These same non-game fish species were selected as voucher specimens per site or stream length. Vouchered specimens were sent to the IDFG Bureau of Fisheries in Boise for cataloging.

Genetic samples were collected from all fish of the genus *Oncorhynchus* encountered at a site. If few *Oncorhynchus* were captured within a 100-m site then spot electrofishing above and below the site was used to capture additional fish. Larger fish were preferred for genetic sampling because they were less likely to be siblings. The adipose fin was clipped on fish > 150 mm, whereas a pelvic fin was clipped on fish < 150 mm. Fin clips were stored in individual vials of ethanol alcohol and the putative species labeled.

Genetic samples were analyzed at the IDFG Eagle Fish Genetics Lab. Individual samples were genetically identified by screening with one mitochondrial DNA (mtDNA) marker (diagnostic among Yellowstone cutthroat trout, westslope cutthroat trout, and rainbow trout) and seven nuclear DNA markers (diagnostic between Yellowstone cutthroat trout and rainbow trout). The stocking origin of Yellowstone cutthroat trout samples collected in historically fishless areas was assessed by screening a subset of samples with a mtDNA Restriction Fragment Length Polymorphism marker that has yielded differences between Henrys Lake and Yellowstone Lake cutthroat trout (see Appendix A; Campbell and Cegelski 2006, for detailed genetic methods).

Habitat measurements were made within the sampling site upon completion of electrofishing. The wetted width was measured to the decimeter and depth to the centimeter at four transects at 0, 33, 66, and 100 m within the site and averaged. The number of pools and large woody debris pieces (singles and aggregates) were counted within the site. The percentage of stable banks was estimated along with substrate composition within riffles and pool tailouts. Comments regarding habitat quality, morphological characteristics, restoration opportunities, etc. were recorded. Photographs were taken at the beginning and end of a site (looking upstream and downstream) and of any other interesting or representative features.

Sinks Drainage

The HFF had initially proposed to survey Sinks Drainage streams with a similar methodology as the Henrys Fork Drainage. However, IDFG proposed and coordinated a cooperative effort of organizations to complete surveys in this drainage during June 27 to 29, 2005. This effort provided an effective and efficient use of personnel, equipment, and sampling effort among all organizations.

Stream sites for the surveys in the Sinks Drainage were selected by IDFG Nampa Fisheries Research personnel from a 1:100,000 land status map (Garren et al. 2006). Sample sites were randomly located on the streams across public and private property. Fish sampling and analysis were similar to that described in the Henrys Fork drainage, except that multiple-pass depletion methods were used at all sites with trout. Habitat measurements were made with a different methodology than that used in the Henrys Fork Drainage and are not summarized herein. Seven survey crews composed of personnel from IDFG, CTNF, and HFF completed all surveys in three days.

RESULTS

Henrys Fork Drainage

Sixty-six sites were surveyed on 38 streams in the Henrys Fork watershed within the Caribou-Targhee National Forest (N = 51 sites on 30 streams), Yellowstone National Park (N = 13 sites on 7 streams), or private land (N = 2 sites on 1 stream) between July 11, 2005 and October 6, 2005 (Figure 1). Thirty-two sites (48%) were dry when surveyed, whereas thirty-four (52%) of the sites had water. Of the sites with water, fish were found in 24 (71%); 22 with trout and 2 with only cyprinids (minnows) or cottids (sculpins). Of the sites with trout; 11 (50%) had brook trout *Salvelinus fontinalis* only, 10 (45.5%) had cutthroat trout only, and one site (4.5%) had both cutthroat trout and brook trout. Cutthroat trout only were found at nine sites in Yellowstone National Park within the upper Bechler River and Fall River subwatersheds. The other two sites that contained cutthroat trout; one with and one without brook trout, were on Dry Creek on the Caribou-Targhee National Forest.

The stream sites surveyed were used to classify the water flow and trout composition of over 185 km of stream length (Table 1). Intermittent stream accounted for 96.7 km (52 %) of the total stream length, most of this within the Warm River subwatershed. Of the perennial stream length, 33.0 km (37 %) had no trout, 31.4 km (36 %) had cutthroat trout only, 22.2 km (25 %) had brook trout only, and 2.0 km (2 %) had both cutthroat trout and brook trout. Cutthroat trout were found in three subwatersheds: Island Park Reservoir, Fall River, and the Bechler River. Over 29 km of stream length contained only cutthroat trout in the Bechler and Fall River subwatershed streams in Yellowstone National Park. Only 4.2 km of stream length, in Dry Creek within the Island Park Reservoir subwatershed, was classified as having cutthroat trout outside of Yellowstone National Park. No cutthroat trout were found in any of the subwatersheds from Island Park Dam downstream to the Fall River confluence, but over 13 km of surveyed stream length had brook trout in this area.

About 41% of the previously unsurveyed stream length in the Henrys Fork drainage was classified in 2005. These classified stream lengths (Table 1) were added to the YCT Status Summary to update the known trout distribution in the Henrys Fork drainage (Table 2). YCT are now known to inhabit about 290 km (25 %) of the surveyed stream length with trout. YCT only are found in about 50 km (5 %) of surveyed length with trout; a 12.4 km (2 %) increase since 2004 (Table 2).

Densities in the brook trout only sites (n = 6) averaged 21 fish/100 m² (range 2 – 49 fish/100 m²) and in the cutthroat trout only sites (n =5) averaged 14 fish/100 m² (range 3 – 40 fish/100 m² (Table 3). Capture probabilities at eight of eleven sites were greater than 0.40. Capture probabilities of less than 0.40 at two (Greggs Fork and Fall River) of three sites occurred where two electrofishing units were required.

Voucher samples of five non-game species (mottled sculpin, paiute sculpin, speckled dace, longnose dace, and redsided shiner) were collected from six sites on three streams (Sheep, Split, and Dry creeks) and sent to IDFG.

Genetic samples were collected from 256 fish from seven different sites on five different streams (Table 4). All fish were phenotypically identified as Yellowstone cutthroat trout, except for five putative Yellowstone cutthroat trout x rainbow trout hybrids at three sites. Of the 256 genetic samples collected, 250 were able to be genetically identified (the other six were not able to be fully processed). All samples were genetically identified as YCT; there was no evidence found of rainbow trout or westslope cutthroat trout introgression at any of the samples sites (Campbell and Cegelski 2006). There was > 95 % probability of detecting as little as 1 % rainbow trout introgression at all sample sites, except West Dry Creek tributary (n = 13). Given the sample size at West Dry Creek there was about a 95 % probability of detecting as little as 1.5 % rainbow trout introgression (Matt Campbell, Idaho Department of Fish and Game, personal communication).

Haplotype 1 and Haplotype 4 were the only haplotypes observed among a subset of 65 samples that were screened within either the Fall River or Bechler River subwatersheds (Table 4, Campbell and Cegelski 2006). The presence of these haplotypes, and the absence of haplotype 6 which is the most frequent in Henrys Lake (a potential stocking source), suggests that these pure Yellowstone cutthroat trout are products of past introductions from Yellowstone Lake (Campbell and Cegelski 2006).

Stream habitat was measured at twenty-nine sites on 17 streams. The average wetted width of sites surveyed was 4.3 m (range 1.3 m to 15.9 m). Dominant substrate for stream sites was gravel (n= 10), cobble (n = 8), fines (n = 6), boulder (n = 2), and bedrock (n = 3). Only two sites were noted that had less than 90 % stable banks, both on Sheep Creek; one with 65 % and the other 85 % bank stability ratings. Habitat condition summaries for all sites are contained in individual stream survey reports (Appendix B).

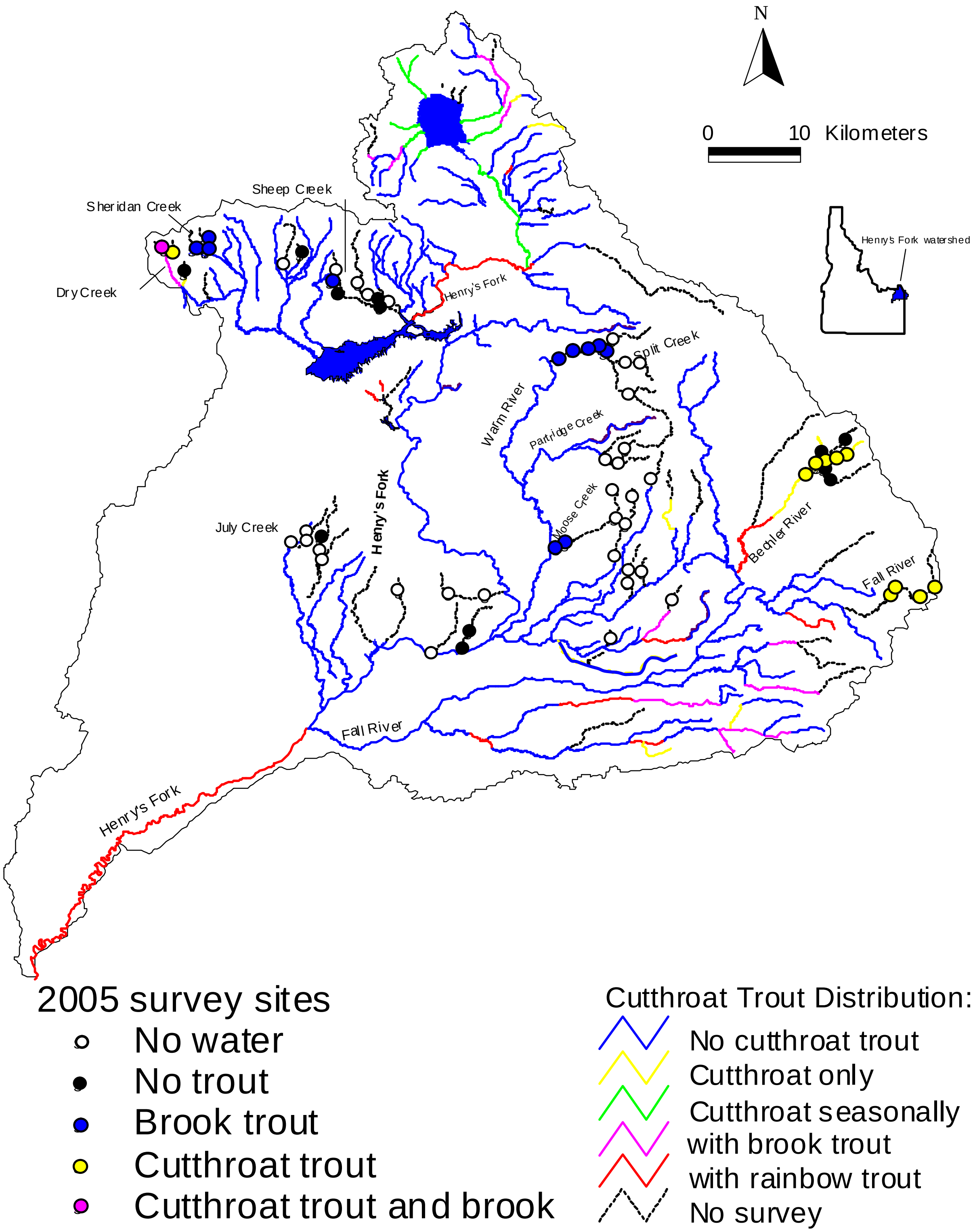

Figure 1. Stream sites surveyed (N = 66) in 2005 in relation to known cutthroat trout distribution by stream length from data compiled through 2004 in the Henrys Fork drainage.

Table 1. Stream sites and stream length classified in the Henrys Fork drainage in 2005.

Subwatershed	Stream name	# of survey sites	Intermittent stream length (km)	Perennial stream length (km) No trout	Cutthroat trout only	Cutthroat trout with brook trout	Brook trout only	Total length (km) classified
Island Park Reservoir								
	Blind Cr.	1		2.4				2.4
	Blue Cr.	1	3.8					3.8
	Dry Cr.	3	4.0	1.7				5.7
	Keg Springs Cr.	1	1.1					1.1
	Sheep Cr.	3		4.6			2.3	6.9
	Tom Cr.	1	3.8					3.8
	Twin Cr.	1					3.2	3.2
	W. Dry Cr.	1				2.0		4.2
	W. Dry Cr., E. trib.	1			2.2			
	E. Dry Cr.	1		2.0				2.0
	W. Fk. Sheridan Cr.	2					3.1	3.1
Totals		16	12.7	10.7	2.2	2.0	8.6	36.2
Henrys Fork: Island Park Dam to Warm River								
	Anderson Mill Canyon	2	9.4					9.4

Table 1 continued. Stream sites and stream length classified in the Henrys Fork drainage in 2005.

Subwatershed	Stream name	# of survey sites	Intermittent stream length (km)	Perennial stream length (km) No trout	Cutthroat trout only	Cutthroat trout with brook trout	Brook trout only	Total length (km) classified
Warm River								
	Dry Robinson Cr.	2	7.6					7.6
	"Little Dry Robinson Cr."	1	3.7					3.7
	M. Fk. Split Cr.	2	8.4					8.4
	Moose Cr.	4	5.0				3.7	8.7
	N. Fk. Fish Cr.	3	9.9					9.9
	N. Fk. Split Cr.	2	6.1				1.4	7.5
	Rock Cr.	1	3.5					3.5
	Sawmill Cr.	1	1.8					1.8
	Snow Cr.	1	3.8					3.8
	S. Fk. Partridge Cr.	3	6.0					6.0
	S. Fk. Split Cr.	1	2.0					2.0
	Split Cr.	4					8.5	8.5
Totals		25	57.8				13.6	71.4
Henrys Fork: Warm River to Fall River confluence								
	Blue Cr.	2		3.7				3.7
	Cold Spring Cr.	1	2.0					2.0
	July Cr.	3	6.9					6.9
	Pine Cr.	2	2.0	2.0				4.0
	Strong Cr.	1	1.4					1.4
	Willow Cr.	1	2.3					2.3
Totals		10	14.6	5.7				20.3

Table 1 continued. Stream sites and stream length classified in the Henrys Fork drainage in 2005.

				Perennial stream length (km)				
Subwatershed	Stream name	# of survey sites	Intermittent stream length (km)	No trout	Cutthroat trout only	Cutthroat trout with brook trout	Brook trout only	Total length (km) classified
Fall River								
	Fall R. (above Beula L.)	2	2.2		6.0			8.2
	Fall R. (below Beula L.)	1			5.8			5.8
	"E. Fk .Savage Cr."	1			1.1			1.1
Totals		4	2.2		12.9			15.1
Bechler River								
	Bechler R.	1			8.1			8.1
	Ferris Fk.	2		8.9				8.9
	Gregg Fk.	3			7.1			7.1
	Littles Fk.	1		5.0				5.0
	Phillips Fk.	2		2.7	1.1			3.8
Totals		9		16.6	16.3			32.9
Grand Totals		66	96.7	33.0	31.4	2.0	22.2	185.3

Table 2. Yellowstone cutthroat trout distribution by stream length in the Henrys Fork drainage: through 2004 (from draft YCT Status Summary), surveyed in 2005, and through 2005 (column 3 plus column 4). Numbers in parentheses are percentages of the stream length in the first column. EBT = Eastern brook trout, RBT = rainbow trout.

		Stream length - km (%)		
Stream length	Stream Classification	through 2004	2005 survey only	through 2005
Total Henrys Fork stream length: 1743 km	Unsurveyed	408 (23)	-	242 (14)
	Surveyed	1335 (77)	166 (9)	1501 (86)
surveyed length	No Trout	200 (15)	129.7 (78)	329.7 (22)
	Trout	1135 (85)	36.6 (22)	1171.6 (78)
surveyed length with trout	No YCT	859 (76)	22.2 (61)	881.2 (75)
	YCT only	38 (3)	*12.4 (34)	50.4 (5)
	YCT with EBT	61 (5)	2.0 (5)	63.0 (5)
	YCT with RBT	85 (7)	0	85.0 (7)
	YCT with EBT & RBT	46 (4)	0	46.0 (4)
	YCT seasonally	46 (4)	0	46.0 (4)

* There were 31.4 km of YCT only classified stream length in 2005, but 19.0 km had been previously surveyed and is accounted for in the 38 km through 2004.

Table 3. Population estimates with upper and lower 95 % confidence intervals, capture probabilities, and trout densities for multiple-pass electrofishing sites within the Henrys Fork drainage. The lower 95 % confidence interval was the total number of trout captured for a site. Three electrofishing passes were made at all sites, except Split Creek (3.5 km) had only two electrofishing passes. All sites were 100 m in length, except West Fork Sheridan Creek was 75 m in length and Split Creek (7.5 km) was 50 m in length.

Stream name	Species	Population estimate	Upper 95 % CI	Lower 95 % CI	Capture probability	Fish/100 m²
Greggs Fk.	YCT	31	51	23	0.345	8
Phillips Fk.	YCT	14	15	13	0.824	3
Fall R. (above Beula L.)	YCT	411	557	238	0.252	40
W. Dry Cr. (tributary)	YCT	13	13	13	1.000	5
W. Dry Cr.	YCT	3	4	3	0.750	1
	EBT	20	24	20	0.576	5
Twin Cr.	EBT	6	6	6	0.857	2
W. Fk. Sheridan Cr.	EBT	46	49	45	0.703	21
Moose Cr.	EBT	110	140	85	0.390	49
North Fork Split Cr.	EBT	11	13	11	0.647	6
Split Cr. (3.5 km)	EBT	154	175	134	0.635	45
Split Cr. (7.5 km)	EBT	9	11	9	0.692	4

Table 4. Genetic samples and results of putative Yellowstone cutthroat trout and Yellowstone cutthroat trout x rainbow trout hybrids collected in the Henry's Fork drainage in 2005. Sampled lengths greater than 100 meters were estimated. All samples were genetically identified as Yellowstone cutthroat trout (Campbell and Cegelski 2006).

Stream	Location Description	Length of sampling (m)	No. samples identified / no. samples collected	Putative species	No. of samples screened for haplotypes	Haplotype(s) observed
Fall River	1.7 km above Beula Lake	100	50 / 50	all YCT, except fish #11 may be hybrid	5	Haplotype 4
Fall River	1.2 km below Beula Lake (and below Bradley Falls)	200	56 / 56	all YCT	18	Haplotype 4
Bechler River	1.5 km downstream from Three Rivers Junction	400	48 / 52	all YCT	20	Haplotype 1 (N = 8) Haplotype 4 (N =12)
Greggs Fork	0.45 km upstream from confluence with Bechler River, above Forlorn Falls and below Twister Falls	425	24 / 25	all YCT, except fish #'s 1,2, and 11 may be hybrids	16	Haplotype 4
Greggs Fork	3.2 km upstream from Bechler River confluence, above Twister Falls	100	22 / 23	all YCT	4	Haplotype 4
Phillips Fork	0.6 km upstream from Bechler River confluence, above Phillips Fork Falls	450	37 / 37	all YCT	2	Haplotype 1
West Dry Creek tributary	1.1 km upstream from West Dry Creek	100	13 / 13	all YCT, except fish #5 may be hybrid	Not applicable	Not applicable

Sinks Drainage

There were 84 sites surveyed on 61 streams in the Sinks Drainages across public and private lands from June 27 to June 29, 2005 (Figure 2). No water was found at 24 sites; half of these sites were in the canyon area southwest of Medicine Lodge Creek. Of the sites with water, 23 (38 %) had no trout. Of the sites with trout, 22 (59 %) had brook trout only, 9 (24 %) had cutthroat trout only, and 2 sites each had cutthroat trout with brook trout, cutthroat trout with rainbow trout (including hybrids), and rainbow trout only. Cutthroat trout only sites were found in Fritz, Webber, and Indian creeks in the Medicine Lodge Creek watershed, Dry and Corral creeks in the Beaver Creek watershed, and no streams in the Camas Creek watershed. Rainbow trout had been previously identified in four of the five streams with cutthroat trout only sites (Figure 2). Corral Creek had not been previously surveyed and no nonnative fishes were found in 2005.

Stream lengths classified are not presented herein from the June 27 to 29, 2005 surveys, because additional stream sites were surveyed by IDFG in the Sinks Drainage during the summer of 2005. Therefore, all surveyed sites will be used to extrapolate to classified stream lengths for the YCT Status Summary, rather than just the 84 sites with which HFF assisted in 2005.

Trout densities in 2005 in the brook trout only sites (n =22) averaged 11.5 fish/100 m² (range 0.3 - 29 fish/100 m²) and in the cutthroat trout only sites (n = 8, no estimate for one of the Dry Creek sites) averaged 9.6 fish/100 m² (range 0.3 - 27 fish/100 m²; Garren et al. 2006). Genetic samples were taken at all sites with *Oncorhynchus*, but none of these samples have been processed (Garren et al. 2006).

DISCUSSION

Four previously undocumented populations of YCT only were surveyed in 2005: two populations in the Fall River (above and below Beula Lake), one in a tributary to West Dry Creek, and one in Corral Creek. The West Dry Creek tributary population may be a suitable source population for YCT reintroductions into other streams, because it is genetically pure. However, the stream length with YCT is only about 2 km long and likely does not support many fish. The Corral Creek population is one of only two in the Sinks Drainage without rainbow trout or hybrids (Figure 2). Therefore, the Corral Creek population is a likely stocking source for cutthroat trout reintroductions into other streams. Indeed, this population, along with fish from Tygee Creek (Henrys Fork Drainage), were used to reintroduce YCT into the Sawtell Creeks (Henrys Fork Drainage) in 2006 (IDFG unpublished data). Although YCT translocations among drainages in the Upper Snake River Basin are not recommended (Cegelski et al. 2006), the limited YCT sources in the Henrys Fork Drainage (Figure 1) and low genetic diversity of the Tygee Creek source population (Cegelski et al. 2006), may necessitate these types of inter-drainage translocations.

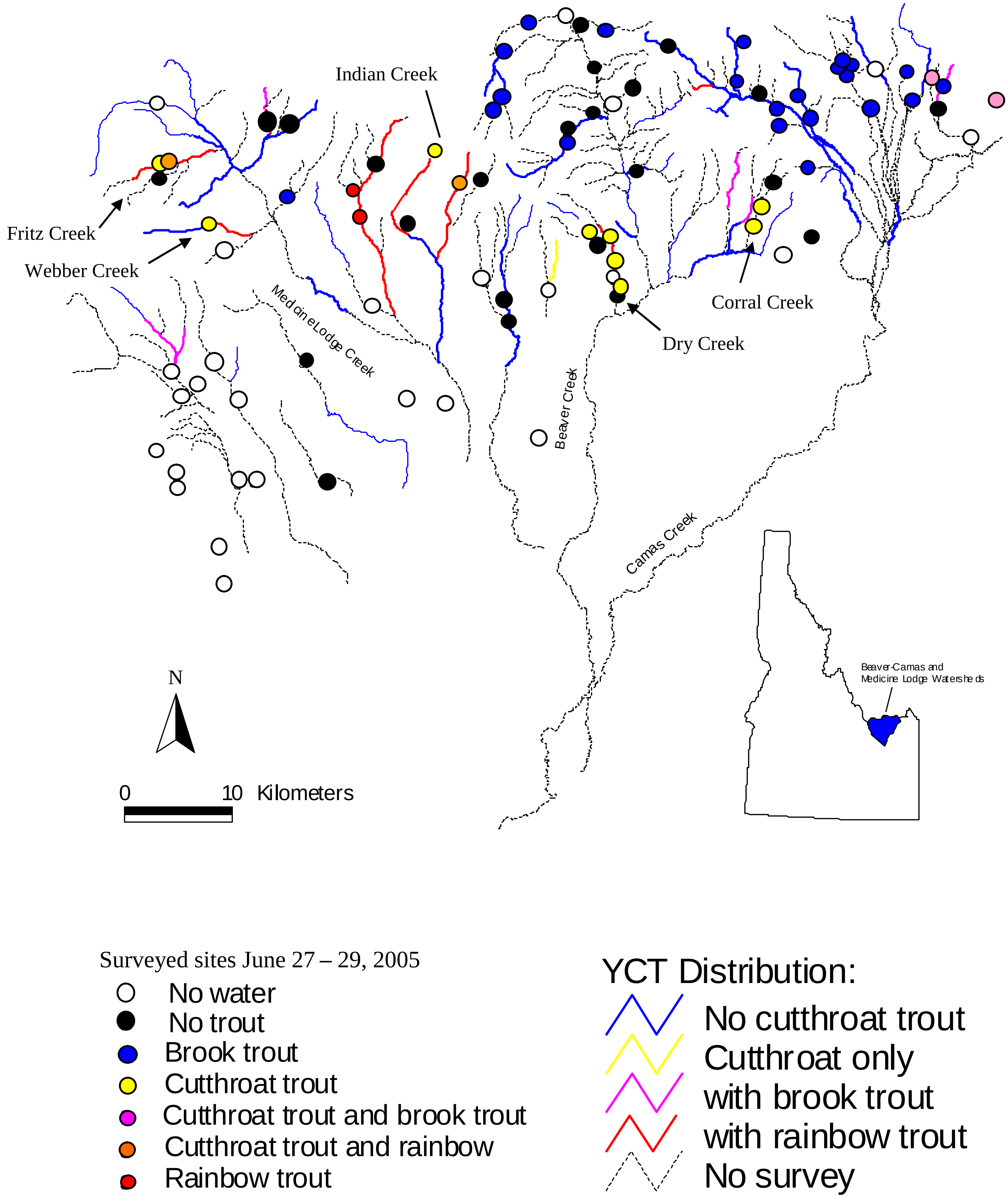

Figure 2. Stream sites (N = 84) surveyed from June 27 to 29, 2005 in relation to cutthroat trout distribution by stream length from data compiled through 2004 in the Sinks Drainage. Survey sites not on a stream course are likely on intermittent streams that are not shown at the 1:100,000 stream layer.

YCT only populations in the upper Bechler River, including the Phillips and Gregg forks, were confirmed by both electrofishing survey and genetic testing in 2005. Genetic testing also suggests that these populations, along with those in the Fall River above and below Beula Lake, had their stocking origins from the Yellowstone River Drainage, rather than the Henrys Fork drainage (Campbell and Cegelski 2006). Because these fish likely originated from outside of the Upper Snake River Basin, then YCT in the upper Bechler and Fall rivers are not likely sources of fish for translocations in the Henrys Fork. However, these are very important YCT populations. There are relatively few isolated populations of YCT throughout the range-wide distribution of the species (May et al. 2003), especially in stream systems as large as the upper Bechler and Fall rivers.

Stream surveys conducted in 2005 have further refined the known YCT distribution in the Henrys Fork and Sinks drainages. In the Henrys Fork drainage through 2005, YCT distribution estimates of 290 km (25 %) of surveyed stream length with trout and YCT only in about 50 km (5 %) of surveyed length with trout are increases over the 141 km (17 %) and 28 km (3%), respectively, estimated by Jaeger et al. (2000). In the Sinks Drainage, surveys conducted in 2005 have discovered another YCT only population in about 5 km of stream length. This will more than double the previous YCT only estimate of 4 km (1 %) of surveyed length with trout from the YCT Status Summary. However, Jaeger et al. (2000) estimated that there were 31 km (19%) inhabited by YCT only in the Sinks Drainages, suggesting that YCT have declined or recent surveys have further refined YCT distribution relative to other nonnative trout, or both.

Brook trout only were found in at least half the sites with trout in both the Henrys Fork and Sinks drainages in 2005. This pattern is similar to most headwater streams in the Henrys Fork, Sinks, and Teton River drainages (YCT Status Summary; Jaeger et al. 2000). Furthermore, brook trout may have an enhanced competitive advantage over YCT in streams that are spring influenced (Gregory 2000). In the Warm River subwatershed, most of the perennial stream length is found below spring sources. These same stream lengths were found to contain only brook trout in 2005, similar to previous surveys throughout the Warm River subwatershed (Figure 1).

The majority of the stream length classified in the Warm River subwatershed in 2005 was intermittent. The streams in this subwatershed originate from the Madison Plateau. This area is of volcanic origin, with low drainage network density and a substantial degree of ground water influence (Van Kirk and Benjamin 2000). Stream lengths above spring sources that exit the plateau were intermittent in most cases. In addition, many other intermittent stream sites (no water) were surveyed in Henrys Fork and Sinks drainages in 2005 (Figures 1 and 2). Such findings are important for further refining our understanding of hydrology and subsequent fish distribution in these drainages.

The distribution of YCT in these Henrys Fork and Sinks drainages is still incomplete, despite the significant survey efforts in 2005. There are 242 km of unsurveyed stream length left in the Henrys Fork drainage (Figure 1 and Table 2) and several times more than that in the Sinks drainage (Figure 2).

Rainbow trout or hybrids have been previously identified in four of five streams where cutthroat trout only were found in the Sinks Drainage in 2005. It is likely that some level of introgressive hybridization is present within these streams. For example, two hybrids were identified in Fritz Creek at a site surveyed in 2005 that was near the cutthroat trout only site. These findings underscore the importance of genetically testing populations, especially if they are going to be used as source populations for other streams.

There were five putative YCT x rainbow trout hybrids identified in the field on three streams in 2005. However, rainbow trout introgression was not detected in either these fish or their populations; all fish were genetically identified as YCT. It is unlikely that genetic tests did not detect hybridization or introgression, because there was a $\geq$ 95 % probability of detecting as little as 1 – 1.5 % rainbow trout introgression in these populations. Therefore, these putative hybrids were all likely pure YCT, but had phenotypic characteristics, e.g., spotting pattern, that gave them a hybridized appearance.

Population estimates of YCT by stream length were unable to be calculated in the Henrys Fork Drainage, because there were only four stream sites with YCT population estimates. Two of these sites were the sole sites on a stream length and the other two had very low capture probabilities. Streams that had long lengths with YCT only, i.e., the Bechler and Fall rivers, were too large to effectively sample with two electrofishing backpack units.

Habitat conditions were good at all sites on public lands of the Caribou-Targhee National Forest and Yellowstone National Park. The two Sheep Creek sites on private land that had low bank stability scores had extensive stream channel alteration from cattle grazing and ditching. The stream channel was nearly undefined in several places above and below these sites, because of these effects.

RECOMMENDATIONS

- The remaining unsurveyed stream length in the Henrys Fork drainage should be surveyed, which would effectively complete a 10-year process to assess YCT distribution and abundance.
- Stream surveys should continue in the Sinks Drainage, focusing on the unsurveyed stream length. If possible, surveys should evaluate the lower mainstems of Camas and Beaver creeks on private land.
- The remaining isolated YCT populations in the Henrys Fork and Sinks drainages should be genetically evaluated to determine purity and genetic structure.
- YCT only stream sites surveyed in the Sinks Drainage in 2005 should be revisited to determine the extent of nonnative presence, because rainbow trout or hybrids had been previously identified in these streams
- West Dry Creek should be evaluated for brook trout removal and restoration of YCT only.
- Sinks Drainage streams should be evaluated for brook trout removal and YCT restoration (Garren et al. 2006).

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APPENDIX A.

Genetic results, Henrys Fork Yellowstone cutthroat samples
Idaho Department of Fish and Game Eagle Fish Genetics Lab

IDAHO DEPARTMENT OF FISH AND GAME
EAGLE FISH GENETICS LAB
1800 Trout Road
Eagle, Idaho 83616

Dirk Kempthorne / Governor
Steven M. Huffaker / Director

January 18, 2007

M E M O R A N D U M

To: Jim Derito, Conservation Director, Henrys Fork Foundation
From: Matthew Campbell, Christine Cegelski, Eagle Fish Genetics Lab
Subject: Genetic results, Henrys Fork Yellowstone cutthroat samples

Jim,

We have completed the genetic analyses on 256 Yellowstone cutthroat trout samples collected from seven sample locations in the Henrys Fork drainage (Figure 1 and Table 1). The primary objective of this study was to assess the purity of Yellowstone cutthroat trout from these areas. A secondary objective, if possible, was to determine the origin of Yellowstone cutthroat trout in the Fall and Bechler Rivers. You mentioned previously that both of these rivers were historically fishless, isolated above natural waterfalls, and that the existing populations may be of Yellowstone Lake origin (Yellowstone Lake Hatchery, WY) or Henrys Lake origin (Ashton and Warm River Hatcheries, ID). You also mentioned that Yellowstone National Park personnel believe that westslope cutthroat trout may have been stocked in these areas in addition to rainbow trout.
In order to address the first objective (purity) we screened samples with a mitochondrial DNA (mtDNA) marker diagnostic between Yellowstone cutthroat trout, westslope cutthroat trout and rainbow trout, and seven diagnostic nuclear DNA (nDNA) markers (Occ16, Occ34, Occ35, Occ36, Occ37, Occ38 and OM55). The nDNA markers are co-dominant Simple Sequence Repeat (SSR) markers which are diagnostic based on size differences in the Polymerase Chain Reaction (PCR) products between rainbow trout and cutthroat trout (Ostberg and Rodriquez 2002). One locus (OMM55) is also diagnostic between all three taxa (Yellowstone cutthroat trout, westslope cutthroat trout and rainbow trout).

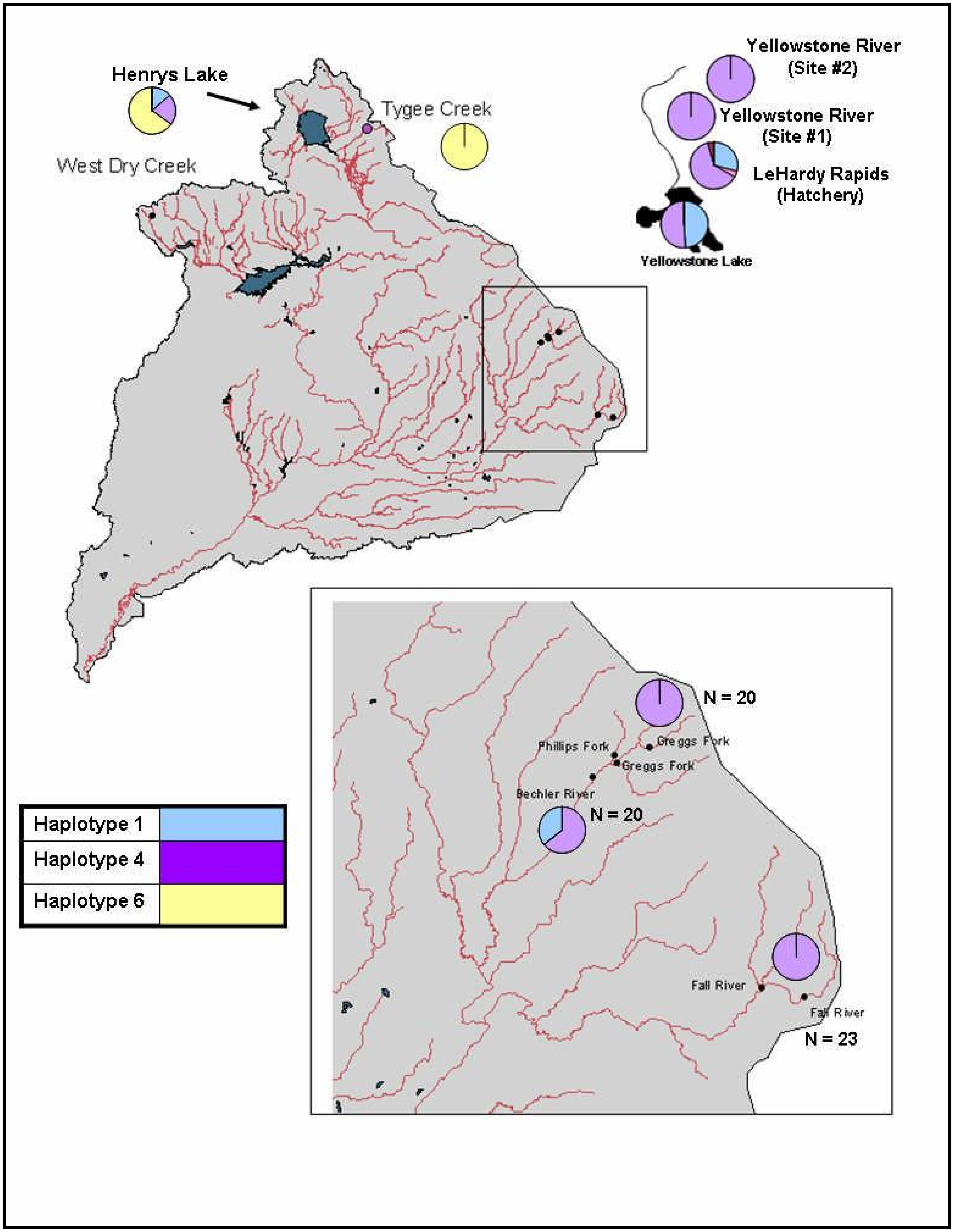

Figure 1. Sampling locations in Henrys Fork drainage and haplotype frequencies (represented by pies). Phillips Fork samples (N = 2; Haplotype 1) not shown.

To address the second objective, concerning the origin of Yellowstone cutthroat trout in the Fall and Bechler Rivers (Henrys Lake strain or Yellowstone Lake strain), we screened a subset of samples from these areas with a mtDNA Restriction Fragment Length Polymorphism (RFLP) marker that has previously yielded haplotype differences between Henrys Lake and Yellowstone Lake cutthroat trout (Campbell 2002).

Table 1. Genetic samples collected in the Henrys fork drainage in 2005.

Stream	**Location Description**	**UTM Zone (NAD27)**	**Easting**	**Northing**	**Length of sampling (m)**	**Date of sampling**	**# of samples**	**Putative species**
Fall River	1.7 km above Beula Lake	12	520065	4889121	100	9-21-05	50	All YCT, except fish #11 may be hybrid
Fall River	1.2 km below Beula Lake (and below Bradley Falls)	12	517432	4889733	200	9-22-05	56	All YCT
Bechler River	1.5 downstream from Three Rivers Junction	12	507526	4903036	400	9-16-05	52	All YCT
Greggs Fork	0.45 km upstream from confluence with Bechler River, above Forlorn Falls and below Twister Falls	12	508999	4903849	425	9-13-05 and 9-14-05	25	All YCT, except fish #'s 1,2, and 11 may be hybrids
Greggs Fork	3.2 km upstream from Bechler River confluence, above Twister Falls	12	511030	4904679	100	9-14-05	23	All YCT, note #19 and #32 are whole fry
Phillips Fork	0.6 km upstream from Bechler River confluence, above Phillips Fork Falls	12	508879	4904328	450	9-15-05	37	All YCT
West Dry tributary	1.1 km upstream from West Dry Creek	12	438681	4928406	100	8-8-05	13	All YCT, except #5

Results (purity)-

We did not find any evidence of rainbow trout or westslope cutthroat trout hybridization/ introgression in any of the sample locations examined. All samples exhibited genotypes/haplotypes indicative of pure Yellowstone cutthroat trout (Appendix A). The probability of detecting introgression within a population is dependent on the number of samples examined and the number of diagnostic loci/alleles examined. Sample sizes for all of the sample locations in this study (except for West Dry tributary, N = 13) were sufficient to have >95% probability of detecting as little as 1% rainbow trout introgression.

Results (origin)-

Two haplotypes (Haplotype 1 and Haplotype 4) were observed among a subset of 65 samples screened (Figure 1). Haplotype 4 was the only haplotype observed among 23 samples from the Fall River and 20 samples from the Greggs Fork. Both haplotypes were observed in 20 samples from the Bechler River (Haplotype 1, N = 8; Haplotype 4, N = 12). Only 2 samples were screened from the Phillips Fork and both samples exhibited Haplotype 1. Haplotypes 1 and 4 are the most common haplotypes observed in Yellowstone Lake and in samples from the LeHardy Rapids Fish Hatchery. Haplotype 4 is fixed in two other populations we have examined from the Yellowstone River. Haplotype 1 and Haplotype 4 are also found in Henrys Lake (~10% and ~23% respectively). However, based on historical stocking records, and the frequency pattern of these two haplotypes in Henrys Lake tributaries, we have previously proposed that their presence in the lake may be the result of introductions of cutthroat trout from Yellowstone Lake (Campbell 2002).

The most common haplotype observed in Henrys Lake (~67%) and fixed in samples from Tyghee Creek (a tributary just below the lake) is Haplotype 6. This haplotype is not present in samples from Yellowstone Lake or the Yellowstone River and has not been observed in any drainages outside of Idaho. The fact that Haplotype 6 is not observed among the 65 samples examined in this study suggests that these pure Yellowstone cutthroat trout populations are most likely not of Henrys Lake strain/origin, and are more likely the product of past introductions from Yellowstone Lake strain/origin Yellowstone cutthroat trout.

Please call me if you have any questions or comments.

Sincerely,

Matthew Campbell

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Appendix A. Raw scores

Henrys Fork-Fall River (below Beula Lake)	Dloop (Rsa-I)	Occ16	Occ16	Occ34	Occ34	Occ35	Occ35	Occ36	Occ36	Occ37	Occ37	Occ38	Occ38	OM55	OM55	GENETIC ID
HFFR-01	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-02	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-03	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-04	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-05	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-06	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-07	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-08	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-09	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-10	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-11	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-12	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-13	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-14	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-15	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-16	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-17	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-18	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-19	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-20	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-21	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-22	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-23	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-24	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-25	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-26	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-27	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-28	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT

HFFR-29	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-30	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-31	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT

Appendix A. Raw scores (Continued)

Henrys Fork-Fall River (below Beula Lake)	Dloop (Rsa-I)	Occ16	Occ16	Occ34	Occ34	Occ35	Occ35	Occ36	Occ36	Occ37	Occ37	Occ38	Occ38	OM55	OM55	GENETIC ID
HFFR-32	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-33	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-34	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-35	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-36	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-37	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-38	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-39	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-40	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-41	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-42	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-43	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-44	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-45	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-46	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-47	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-48	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-49	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
HFFR-50	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT

Henrys Fork-Fall River (Below Beula Lake)	Dloop (Rsa-I)	Occ16	Occ16	Occ34	Occ34	Occ35	Occ35	Occ36	Occ36	Occ37	Occ37	Occ38	Occ38	OM55	OM55	GENETIC ID
FR-01	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-02	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT

FR-03	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-04	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-05	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-06	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-07	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-08	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT

Appendix A. Raw scores (Continued)

Henrys Fork-Fall River (Below Beula Lake)	Dloop (Rsa-I)	Occ16	Occ16	Occ34	Occ34	Occ35	Occ35	Occ36	Occ36	Occ37	Occ37	Occ38	Occ38	OM55	OM55	GENETIC ID
FR-09	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-10	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-11	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-12	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-13	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-14	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-15	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-16	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-17	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-18	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-19	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-20	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-21	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-22	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-23	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-24	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-25	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-26	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-27	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-28	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-29	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT

FR-30	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-31	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-32	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-33	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-34	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-35	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-36	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-37	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-38	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT

Appendix A. Raw scores (Continued)

Henrys Fork-Fall River (Below Beula Lake)	Dloop (Rsa-I)	Occ16	Occ16	Occ34	Occ34	Occ35	Occ35	Occ36	Occ36	Occ37	Occ37	Occ38	Occ38	OM55	OM55	GENETIC ID
FR-39	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-40	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-41	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-42	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-43	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-44	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-45	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-46	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-47	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-48	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-49	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-50	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-51	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-52	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-53	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-54	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
FR-55	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT

FR-56	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT

Henrys Fork-Bechler River	Dloop (Rsa-I)	Occ16	Occ16	Occ34	Occ34	Occ35	Occ35	Occ36	Occ36	Occ37	Occ37	Occ38	Occ38	OM55	OM55	GENETIC ID
BR-01	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-02	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-03	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-04	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-05	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-06	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-07	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-08	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-09	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS
BR-10	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-11	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT

Appendix A. Raw scores (Continued)

Henrys Fork-Bechler River	Dloop (Rsa-I)	Occ16	Occ16	Occ34	Occ34	Occ35	Occ35	Occ36	Occ36	Occ37	Occ37	Occ38	Occ38	OM55	OM55	GENETIC ID
BR-12	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-13	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS
BR-14	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-15	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-16	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-17	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-18	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-19	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-20	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-21	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS
BR-22	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-23	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-24	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-25	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-26	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT

BR-27	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-28	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-29	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-30	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-31	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-32	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-33	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-34	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-35	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-36	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-37	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-38	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-39	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-40	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-41	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-42	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS
BR-43	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT

Appendix A. Raw scores (Continued)

Henrys Fork-Bechler River	Dloop (Rsa-I)	Occ16	Occ16	Occ34	Occ34	Occ35	Occ35	Occ36	Occ36	Occ37	Occ37	Occ38	Occ38	OM55	OM55	GENETIC ID
BR-44	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-45	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-46	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-47	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-48	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-49	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-50	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-51	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
BR-52	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT

Henrys Fork-Greggs Fork (Below Twister Falls)	Dloop (Rsa-I)	Occ16	Occ16	Occ34	Occ34	Occ35	Occ35	Occ36	Occ36	Occ37	Occ37	Occ38	Occ38	OM55	OM55	GENETIC ID

GR-01	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-02	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-03	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-04	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-05	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-06	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-07	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-08	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-09	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-10	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-11	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-12	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-13	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-14	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-15	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-16	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-17	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS
GR-18	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-19	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-20	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT

Appendix A. Raw scores (Continued)

Henrys Fork-Greggs Fork (Below Twister Falls)	Dloop (Rsa-I)	Occ16	Occ16	Occ34	Occ34	Occ35	Occ35	Occ36	Occ36	Occ37	Occ37	Occ38	Occ38	OM55	OM55	GENETIC ID
GR-21	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-22	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-23	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-24	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-25	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT

Henrys Fork-Greggs Fork (Above	Dloop (Rsa-I)	Occ16	Occ16	Occ34	Occ34	Occ35	Occ35	Occ36	Occ36	Occ37	Occ37	Occ38	Occ38	OM55	OM55	GENETIC ID

Twister Falls)

GR-01	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-02	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
GR-03	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS
GR-04	YCT	MISS	MISS	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
GR-05	YCT	MISS	MISS	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
GR-06	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
GR-07	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
GR-08	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
GR-09	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
GR-10	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-11	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
GR-12	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
GR-13	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
GR-14	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
GR-15	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
GR-16	YCT	MISS	MISS	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
GR-17	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
GR-18	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
GR-19	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-20	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-21	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
GR-22	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT

Appendix A. Raw scores (Continued)

Henrys Fork-Greggs Fork (Above Twister Falls)	Dloop (Rsa-I)	Occ16	Occ16	Occ34	Occ34	Occ35	Occ35	Occ36	Occ36	Occ37	Occ37	Occ38	Occ38	OM55	OM55	GENETIC ID
GR-23	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT

Henrys Fork-Phillips Fork	Dloop (Rsa-I)	Occ16	Occ16	Occ34	Occ34	Occ35	Occ35	Occ36	Occ36	Occ37	Occ37	Occ38	Occ38	OM55	OM55	GENETIC ID
PF-01	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
PF-02	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT

PF-03	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
PF-04	YCT	MISS	MISS	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
PF-05	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
PF-06	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
PF-07	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
PF-08	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
PF-09	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
PF-10	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
PF-11	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
PF-12	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
PF-13	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
PF-14	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
PF-15	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
PF-16	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
PF-17	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
PF-18	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
PF-19	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
PF-20	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
PF-21	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
PF-22	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
PF-23	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
PF-24	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
PF-25	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
PF-26	YCT	MISS	MISS	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
PF-27	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
PF-28	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT

Appendix A. Raw scores (Continued)

Henrys Fork-Phillips Fork	Dloop (Rsa-I)	Occ16	Occ16	Occ34	Occ34	Occ35	Occ35	Occ36	Occ36	Occ37	Occ37	Occ38	Occ38	OM55	OM55	
PF-29	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
PF-30	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
PF-31	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT

PF-32	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
PF-33	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
PF-34	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
PF-35	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
PF-36	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
PF-37	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
Henrys Fork-West Dry Creek Tributary	Dloop (Rsa-I)	Occ16	Occ16	Occ34	Occ34	Occ35	Occ35	Occ36	Occ36	Occ37	Occ37	Occ38	Occ38	OM55	OM55	GENETIC ID
WD-01	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
WD-02	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
WD-03	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
WD-04	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
WD-05	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
WD-06	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
WD-07	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
WD-08	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
WD-09	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
WD-10	YCT	B	B	B	B	B	B	B	B	B-1	B-1	B	B	YCT	YCT	YCT
WD-11	YCT	B	B	B	B	B	B	B	B	B	B	B	B	YCT	YCT	YCT
WD-12	YCT	B	B	B	B	B	B	B	B	MISS	MISS	B	B	YCT	YCT	YCT
WD-13	YCT	B	B	B	B	B	B	B	B	MISS	MISS	B	B	YCT	YCT	YCT