Matthew E. Jaeger
Robert W. Van Kirk
Ted Kellogg

Distribution and Status of Yellowstone Cutthroat Trout in the Henry's Fork Watershed

Abstract

*We electrofished and snorkeled streams in the Henry's Fork watershed upstream of and including Fall River, the Teton River watershed, and the Snake River Plain Sinks drainages adjacent to the western edge of the Henry's Fork watershed to assess the distribution of Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*). Yellowstone cutthroat trout were present in 20 of 138 reaches of stream sampled in the Henry's Fork watershed. They were isolated from nonnative salmonids in all or part of eight of the 20 reaches. This represents occupancy in about 17 percent of the historic range of the subspecies and exclusive occupancy in about 3 percent thereof. Yellowstone cutthroat trout were observed in 35 of 48 streams sampled in the Teton watershed and were the only trout species observed in five of these 35 streams, representing occupancy in about 89 percent of fish-bearing habitat and exclusive occupancy in about 19 percent of fish-bearing habitat, all of which lies within the historic range of the subspecies. In the Sinks drainages, Yellowstone cutthroat trout were observed in 19 of the 38 streams surveyed and were the only trout species observed in seven. They occupied about 52 percent of fish-bearing habitat and exclusively occupied about 19 percent of it. We do not know with certainty whether the Sinks drainage streams lie within the historic range of Yellowstone cutthroat trout. Distribution of Yellowstone cutthroat trout within their historic range has drastically declined throughout the Henry's Fork watershed; however, additional populations have been established outside of the subspecies' historic range. The status of Yellowstone cutthroat trout within its current range is uncertain because of the lack of genetic information and the presence of nonnative salmonids.*

Key words: Yellowstone cutthroat trout, *Oncorhynchus clarki bouvieri*, nonnative species, population status.

Introduction

The Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*) is the most widely distributed and abundant inland cutthroat trout subspecies in North America (Varley and Gresswell 1988). Following deglaciation (6,000-8,000 years ago) and subsequent invasion of redband rainbow trout (*Oncorhynchus mykiss*) into the lower Snake River system, the historic range of the subspecies included the Snake River above Shoshone Falls, the Yellowstone River drainage downstream to the Tongue River, and two now extinct populations in Waha Lake, Idaho, and Crab Creek, Washington (Behnke 1992). Although once widespread, the distribution of Yellowstone cutthroat trout has declined to the point where the subspecies has been petitioned for listing under the Endangered Species Act. Varley and Gresswell (1988) estimated that in the late 1980s, genetically pure Yellowstone cutthroat

Matthew E. Jaeger, Henry's Fork Foundation, Ashton, ID, 83420
Robert W. Van Kirk, Dept. of Mathematics, Idaho State University, Pocatello, ID, 83209
Ted Kellogg, USDA Forest Service, St. Anthony, ID, 83445

trout still occupied 85 percent of historically occupied lake habitats but only 10 percent of historically occupied stream habitats. Yellowstone cutthroat trout currently occupy 63 percent of the historically occupied habitats occurring on lands administered by the USDA Forest Service (May 1996).

The Yellowstone cutthroat trout is the only trout native to the Henry's Fork watershed (Behnke 1992). Although commercial harvest and federal egg-taking programs at Henry's Lake may have reduced Yellowstone cutthroat trout numbers prior to 1900, decline of Yellowstone cutthroat trout in the watershed was caused primarily by hybridization with rainbow trout and competition with brook trout *(Salvelinus fontinalis)* (Griffith 1988, Thurow *et al*. 1988, Gresswell 1995, Gregory and Griffith this issue). Recreational harvest of Yellowstone cutthroat trout early in the 20th century also may have played a role in the decline of the subspecies in the watershed, particularly when combined with aggressive stocking programs that used primarily brook and rainbow trout (Van Kirk and Gamblin this issue). Habitat degradation and fragmentation also may have contributed to declines in Yellowstone cutthroat trout (Thurow *et al*. 1988, May 1996).

Following deglaciation, three different life history forms of Yellowstone cutthroat trout evolved (Varley and Gresswell 1988). *Resident* populations hatch, rear, and spawn within relatively short sections of their natal streams. *Fluvial* populations reside in large streams and rivers but ascend smaller tributaries to spawn. Juveniles spend from 1 to 3 years rearing in the tributaries before descending to the main river. *Adfluvial* populations reside in lakes, and spawners migrate into tributaries or outlets to spawn. Juveniles may remain in the stream for 1 or more years before migrating to the lake, or they may migrate shortly after hatching, especially in tributaries that dry up late in the summer.

All three of these life history forms have been observed recently in the Henry's Fork watershed. A well-documented and intensively managed adfluvial Yellowstone cutthroat trout and rainbow x cutthroat hybrid *(O. mykiss* x *O. clarki)* fishery exists in Henry's Lake (Brostrom and Watson 1988). This adfluvial population is supported by wild reproduction of Yellowstone cutthroat trout in Henry's Lake tributaries and hatchery production of Yellowstone cutthroat trout and rainbow x cutthroat hybrid trout. Wild and hatchery brook trout also are present in the Henry's Lake system. Yellowstone cutthroat trout and rainbow x cutthroat hybrids are present in Henry's Lake Outlet and the upper Henry's Fork downstream of Henry's Lake. Their presence is generally attributed to downstream migration from Henry's Lake (Elle and Corsi 1994). The Henry's Lake dam is a barrier to upstream migration back into the lake.

A viable fluvial population of Yellowstone cutthroat trout exists in the lower Henry's Fork and lower Teton River drainages (Conley 1993, Idaho Department of Fish and Game 1996). This population exists in sympatry with rainbow, rainbow x cutthroat hybrid, brook, and brown trout *(Salmo trutta)* (T. Maret, U.S. Geological Survey, personal communication). Irrigation diversions have disrupted connectivity in this portion of the watershed, thereby inhibiting trout from accessing spawning and rearing habitat in certain reaches (Gregory 2000). Numerous stream resident populations were observed during data collection for this study. Based on these recent observations of adfluvial, fluvial and resident populations of Yellowstone cutthroat trout in the watershed and on the historical presence of all habitat types required for the three life history forms, we assume that all three life history forms were historically present in the watershed.

The objective of our study was to assess the present distribution of stream-resident Yellowstone cutthroat trout in the Henry's Fork watershed upstream of and including the Fall River drainage, the Teton watershed, and selected streams in the Snake River Plain Sinks area immediately west of the Henry's Fork watershed. We initiated the study because of uncertainty about the current distribution of the subspecies within the watershed. This information may be valuable to federal and state management and regulatory agencies, especially in light of the current petition to list Yellowstone cutthroat trout as a threatened species under the Endangered Species Act. Our study can serve as a starting point to determine and prioritize those populations that need protection or restoration, as well as an indication of the current distribution and status of the subspecies in the watershed relative to historic occupancy. Our study also builds upon and updates previous distribution and status summaries for Yellowstone cutthroat trout.

The data presented in this paper were collected as part of two different survey efforts, one carried out by the Henry's Fork Foundation of Ashton, Idaho, and the other by the USDA Forest Service, Targhee (now Targhee-Caribou) National Forest, headquartered in St. Anthony, Idaho. Although the two projects were designed and implemented in coordination with each other, they were each funded at different levels and had different objectives. Therefore, the methods used and the types of data collected varied between the projects. Data for the Henry's Fork and Fall River watersheds came primarily from the Henry's Fork Foundation project, and those for the Teton and Sinks watersheds came primarily from the Forest Service. Rather than take a least-common-denominator approach to presentation of the results of these studies, we have chosen to include the maximum amount of relevant data collected by these two survey efforts, even though data are not consistent across all watersheds surveyed. One exception is that we did not illustrate the Sinks drainage data on a map because the primary emphasis of this journal issue, and therefore this paper, is on the Henry's Fork watershed.

Study Area

The study area consisted of the Henry's Fork watershed above and including the Fall River drainage, which we will refer to as the Henry's Fork watershed, and portions of the Teton River and Snake River Plain Sinks drainages. Immediately below the Fall River confluence, an irrigation diversion on the Henry's Fork acts as a barrier to upstream migration. We surveyed all streams in the Henry's Fork watershed upstream of this barrier believed to be capable of supporting trout. A small number of streams in the watershed that offered marginal trout habitat were omitted. Excepting Targhee Creek, Henry's Lake tributaries were surveyed on a limited basis because of the extensive research and management attention they receive from Idaho Department of Fish and Game (IDFG). The majority of streams in the Teton watershed, which occur on the Targhee-Caribou National Forest, were surveyed. The mainstem Teton River was not surveyed; IDFG maintains a consistent research, monitoring, and management program for Yellowstone cutthroat trout in the Teton River. We also surveyed streams in the portions of the Beaver-Camas, Medicine Lodge, and Birch Creek subwatersheds that occur on the Targhee-Caribou National Forest (see Fig. 2 in Van Kirk and Benjamin this issue for a location map of these watersheds). All of these streams sink into lava flows on the Snake River Plain west of the Henry's Fork watershed; we refer to the collective drainage area of these streams as the Sinks drainage.

We expect that Yellowstone cutthroat trout were historically present in all stream and lake habitats capable of supporting trout that have been connected to the mainstem Snake River since the most recent local geologic events. This includes all of the Teton and Henry's Fork watersheds that occurred within our study area with the possible exceptions of Split Creek (an Island Park Caldera stream that sinks without joining another stream) and the Fall River watershed upstream of Cave Falls. We also expect that Yellowstone cutthroat trout were likely excluded from some high-gradient alpine streams in all portions of the study area because of the marginal habitat they offer.

Although Yellowstone Park personnel believe that there were historically no fish above Cave Falls in the Fall River watershed, the southwest corner of Yellowstone Park was reported to have "very abundant" stocks of trout in 1889 (Jordan 1889, Yellowstone National Park 1989, J. Varley, Yellowstone Center of Resources, personal communication). Jordan (1889) depicted the upstream range of trout in this portion of the park as the Fall River up to Terraced Falls, Mountain Ash Creek up to Union Falls, and the Bechler River up to Colonnade Falls. Varley and Schullery (1998) however, reported that Yellowstone cutthroat trout, and all other salmonids, were introduced to the Fall and Bechler rivers. Because Jordan (1889) did not investigate the Fall River watershed within Yellowstone National Park and therefore did not have first-hand knowledge of it, we assume the historic range of Yellowstone cutthroat trout extended up to Cave Falls of the Fall River as described by Yellowstone National Park (1989) and Varley and Schullery (1998). We acknowledge that historical occupancy in this portion of the watershed is not known with certainty.

Likewise, it is not known whether Yellowstone cutthroat trout are native to the Sinks drainage. With the exception of a single sculpin (*Cottus* sp.), we know that all species observed in the Sinks drainages during our study were stocked in the area at various times during the past century (e.g., Costley 1941). Additionally, in a survey of the Medicine Lodge subwatershed, Maret *et al*. (1997) found only rainbow trout, an introduced species, and shorthead sculpin (*C. confusus*). The absence of nongame fish, i.e., fish that unlikely have been introduced, in the Beaver-Camas, Medicine Lodge, and Birch subwatersheds suggests that these drainages were historically fishless. Macroinvertebrate assemblages found in these streams are similar to those commonly found in the Salmon River watershed to the immediate north and west of the Sinks drainages (D. Gustafson, Montana State University, personal communication). Furthermore, the shorthead sculpin observed by Maret *et al*. (1997) is not native to the Henry's Fork and other Upper Snake watersheds but is native to most of the tributaries to the Snake River below Shoshone Falls, which includes the Salmon River (Simpson and Wallace 1982). The cutthroat subspecies native to these lower Snake River tributaries is the westslope cutthroat trout (*Oncorhynchus clarki lewisi*) (Behnke 1992). Based on this information, if cutthroat trout occupied the Sinks drainage streams in the past, they likely were westslope cutthroat trout rather than Yellowstone cutthroat trout.

However, a trans-divide link between the Henry's Fork and Camas Creek watershed appears to exist in the Dry Creek area at the base of the Centennial Mountains (B. Gamett, USDA Forest Service, Salmon-Challis National Forest, personal communication). East and West Dry creeks join briefly before an intermittent branch, labeled East Dry Creek on some maps, leaves the main creek to flow eastward into Sheridan Reservoir, the outlet of which feeds Sheridan Creek in the Henry's Fork watershed. Historically, this intermittent stream would have flowed directly into Sheridan Creek. West Dry Creek continues westward to eventually join Camas Creek. During periods of high water, fish possibly could migrate between the Henry's Fork and Camas watersheds, which provided a mechanism by which Yellowstone cutthroat trout could invade Camas Creek, and therefore its tributary, Beaver Creek, since the last episode of glaciation. Similar intermittent channels could have allowed migration from the Beaver-Camas drainage into the Medicine Lodge and possibly even Birch Creek watersheds. In any case, we do not know whether Yellowstone cutthroat trout historically occupied the Sinks drainage streams that we surveyed.

Methods

Fieldwork was conducted during the summers of 1996-1999. Surveyed streams in the upper Henry's Fork watershed were delineated according to Rosgen stream-classification type (Rosgen 1996) and gradient. Exact locations of stream reaches and detailed descriptions of their habitat characteristics are given in Gregory (1997, 1998, 1999, 2000) and Gregory and Van Kirk (1998). Field crews walked the entire length of each reach, with the exception of some reaches of mainstem Henry's Fork and lower Fall River, which were floated in a drift boat. In all cases, the crew selected a 200-m sample section representative of the entire reach. A sample section was determined to be representative if it had similar trout habitat, gradient, and geomorphologic characteristics to those encountered throughout the reach. A snorkeler traversed the sample section in an upstream direction starting at the bottom of the section and recorded species and lengths or age classes of all trout observed. Where we had anecdotal evidence that Yellowstone cutthroat trout had recently been present in a given stream or where we observed Yellowstone cutthroat trout by snorkeling, we used electrofishing or snorkeling to sample additional sections within the reach. Additional snorkel and electrofishing surveys were conducted using the Forest Service methodology described below. The following streams received additional surveying: Robinson Creek, Little Robinson Creek, Wyoming Creek, Targhee Creek, Tygee Creek, and Yale Creek. Hook-and-line sampling was used to gather supplemental information in several cases.

Reaches of each stream surveyed in the Sinks and Teton drainages were delineated according to Rosgen stream-classification type. Fish surveys were conducted in about 10 percent of each reach in a series of evenly spaced 25-m subsections starting at the National Forest boundary and moving upstream. A single electrofishing pass was made through each subsection with a gasoline-powered backpack electrofishing unit and dip nets. Species and numbers of all trout captured were recorded. Reaches or units of stream within which electrofishing was judged to be ineffective were snorkeled using a protocol similar to that used in the upper Henry's Fork survey. All sample sections within designated wilderness areas were snorkeled because of restrictions on use of motorized equipment. In each subsection, observations ended when at least 10 Yellowstone cutthroat trout longer than 100 mm were captured. In many cases, small, unnamed tributary streams were surveyed a short distance upstream of their confluence with a named stream. In these cases, we considered the tributary a part of the named stream for purposes of reporting data. Jaeger (1998) provides detailed descriptions of the

National Forest stream reach surveys in the Teton and Sinks drainages.

We used information gathered from other recent studies to augment field data collected in this study. A supplementary snorkel survey on the upper reach of Robinson Creek above a waterfall barrier was performed during the summer of 1999. Three 200-m sections were sampled using the aforementioned snorkeling protocol. Electrofishing and snorkeling were performed on Henry's Lake Outlet in 1999 (J. Gregory, Gregory Aquatics, personal communication). The protocol used for the snorkel surveys was as described above. The electrofishing surveys sampled primarily littoral habitat by moving upstream with a backpack electrofishing unit. No blocknets were used. Information from creel surveys of Henry's Lake Outlet and the mainstem Henry's Fork above Island Park Reservoir were used to augment snorkeling and electrofishing data (Van Kirk 1999, R. Dillinger, Shapiro & Associates, personal communication). In the case of the upper Fall River, Yellowstone cutthroat trout presence was inferred from Varley and Schullery (1998). Beula Lake, whose lone outlet is the Fall River, is known to contain Yellowstone cutthroat trout (Varley and Schullery 1998). Because of this source of Yellowstone cutthroat trout, we assumed that the reach of Fall River immediately downstream of the lake also supported Yellowstone cutthroat trout.

We report as "Yellowstone cutthroat trout" all fish observed that appeared upon visual inspection to be Yellowstone cutthroat trout with no signs of hybridization. As recommended by Thurow (1994), snorkelers were trained in identification of Yellowstone cutthroat trout and used coloration, spotting pattern and habitat use to make identifications. However, morphological characteristics are not sufficient to differentiate among cutthroat x rainbow hybrids and pure cutthroat trout (Leary *et al.* 1987). Therefore, we acknowledge that regardless of observation or collection method, some individuals identified as Yellowstone cutthroat trout in this study could have been hybrid trout.

We calculated the percentage of habitat occupied by Yellowstone cutthroat trout by dividing total length of stream reaches containing Yellowstone cutthroat trout by total length of reaches surveyed. Historic habitat within the study area was estimated by measuring the length of all appropriate streams that were surveyed. Stream-reach lengths were measured for the Henry's Fork and Teton watersheds using GPS locations and GIS software. For the Sinks drainages, stream-reach lengths were measured from National Forest 1:126,720 scale maps.

Results

Yellowstone cutthroat trout were observed in 20 of the 138 reaches of stream sampled in the Henry's Fork watershed (Table 1). Because some streams included more than one reach, these 20 reaches represent occurrence in 16 different streams. Of the 20 reaches, Yellowstone cutthroat trout were physically isolated from nonnative salmonids in all or part of eight. These reaches were upper Tygee Creek, Robinson Creek, Wyoming Creek, upper Bechler River, Gregg's Fork, Phillip's Fork, upper Calf Creek, and part of the upper Fall River. Trout were found in 116 of the 138 reaches.

In the Teton watershed, Yellowstone cutthroat trout were observed in 35 of 48 streams surveyed (Table 2). Yellowstone cutthroat trout were the only trout species in five of these 35 streams. These were South Badger Creek, Darby Creek, Deadwood Creek, South Fork Darby Creek, and South Leigh Creek. Deadwood Creek and South Fork Darby are tributaries to Darby Creek. No trout were found in eight of the streams

Table 1. *Trout species presence and morphological characteristics of stream reaches sampled in the Henry's Fork watershed upstream of and including the Fall River drainage. Abbreviations: SN = snorkel, EF = electrofishing, CS = creel survey, HL = hook and line, YCT = Yellowstone cutthroat trout, RBW = rainbow trout, BRK = brook trout, BRN = brown trout. Asterisks indicate that Yellowstone cutthroat trout were historically present in only part of the reach.*

Subwatershed Stream	Reach	Rosgen type	Gradient (%); mean or range	Length (km)	Method(s)	YCT historically present	YCT	YCT x RBW	RBW	BRK	BRN	Unidentified trout
Henry's Lake												
Targhee Cr.	lower	B1-1	4	1.6	SN	X	X			X		
Henry's Lake Outlet												
H.L. Outlet	upper	C4	0.25	9.7	SN, EF, CS	X	X	X	X	X		
H.L. Outlet	lower	B4	1	11.2	SN, CS	X	X	X	X	X		
Jesse Cr.	upper	A3	4	3.1	SN	X			X	X		
Jesse Cr.	lower	C4	0.5	5.7	SN	X			X			
Jones Cr.	complete	C4	0.5	2.0	SN	X			X	X		
Meadow Cr.	upper		0.5	1.9	SN	X			X	X		
Reas Pass Cr.	complete				EF	X		X		X		
Stephens Cr.	complete	C4	1	2.9	SN	X			X	X		
Twin Cr.	upper	A2	6.8	3.3	SN, EF	X	X	X	X	X		
Tygee Cr.	upper	A2		7.5	SN, EF	X	X					
Henry's Fork: Big Springs to Island Park Reservoir												
Elk Springs	complete	B4	2	1.3	SN, EF	X			X	X		
Henry's Fork	upper	C3	0.2	8.4	SN, CS	X	X	X	X	X		
Henry's Fork	lower	B2	0.5	3.5	SN, CS	X	X	X	X	X		
Lucky Dog Cr.	complete	C4	0.5	3.5	SN	X			X	X		
Moose Cr.	upper	C4	0.75	10.8	SN	X			X	X		
Moose Cr.	lower	C4	1.25	1.0	SN	X			X	X		
Sawtell Cr.	upper	A2	9	2.0	SN	X				X		
Sawtell Cr.	middle	B4	2.75	2.3	SN, EF	X				X		
Sawtell Cr.	lower	C4	0.75	0.4	SN, EF	X				X		
Thirsty Cr.	complete				EF	X				X		
Tyler Cr.	upper	A2	6	1.5	SN	X				X		
Tyler Cr.	lower	B2	2	1.7	SN	X				X		

Table 1. *(cont.)*

Subwatershed Stream	Reach	Rosgen type	Gradient (%); mean or range	Length (km)	Method(s)	YCT historically present	YCT	YCT x RBW	RBW	BRK	BRN	Unidentified trout
Island Park Reservoir												
Arange Cr.	complete	A4	8	4.9	SN, EF	X				X		
E. Fk. Hotel Cr.	complete	A2	4	6.0	SN, EF	X				X		
Hotel Cr.	lower	C3	1	1.7	SN	X			X	X		
Howard Cr.	complete	B2	2.5	3.2	SN	X				X		
Meyers Cr.	upper	B3	1.75	6.1	SN	X				X		
Meyers Cr.	lower	B4	1.5	3.9	SN	X				X		
Schneider Cr.	upper	B3	3	4.3	SN	X				X		
Schneider Cr.	lower	B4	2.5	3.3	SN	X				X		
Sheridan Cr.	upper	B1	3	3.2	SN	X			X	X		
Sheridan Cr.	middle	C1	1.5	3.0	SN	X		X	X	X		
Willow Cr.	upper	B3	2.5	4.6	SN	X				X		
Willow Cr.	middle	C3	2	4.6	SN	X				X		
Yale Cr.	middle 2	B3	3.8		SN, EF	X				X		
Yale Cr.	middle 1	B3	6	0.9	SN, EF	X				X		
Yale Cr.	lower	C3	0.75	2.7	SN	X			X	X		
Buffalo River												
Buffalo R.	upper	C4	0.1	1.4	SN	X				X		
Buffalo R.	middle 3	C3	0.1	1.7	SN	X			X	X		
Buffalo R.	middle 2	D2	0.1	3.4	SN	X				X		
Buffalo R.	middle 1	C4	0.1	2.0	SN	X			X	X		
Buffalo R.	lower	C2	0.2	2.0	SN	X			X	X		
Chick Cr.	complete	C4	0.1	3.3	SN	X			X	X		
Elk Cr.	lower	C4	0.1	3.0	SN	X			X	X		
Elk Cr.	upper	C5	0.2	2.0	SN	X						
Toms Cr.	upper	C4	0.1	4.6	SN	X			X	X		
Toms Cr.	lower	C5	0.1	2.7	SN	X						
Henry's Fork: Island Park Dam to Warm River												
Antelope Cr.	upper	C4	0.1	5.4	SN	X						
Antelope Cr.	lower	C5	0.1	0.8	SN	X			X	X		
Blue Springs Cr.	complete	C5	0.1	1.7	SN	X						

Table 1. *(cont.)*

Subwatershed Stream	Reach	Rosgen type	Gradient (%); mean or range	Length (km)	Method(s)	YCT historically present	YCT	YCT x RBW	RBW	BRK	BRN	Unidentified trout
E. Thurmon Cr.	complete	C5	0.1	5.1	SN	X						
Fish Pond Outlet	complete	C6	0.1		SN	X			X			
H.F. Island Park to Last Chance	complete	B3	0.5-1.5	4.5	SN, HL	X			X			
H.F. Last Chance to Harriman	complete	F4	0.14-0.33	3.3	SN, HL	X			X			
H.F. Harriman to Pinehaven	complete	F4	0.06-0.5	12.5	SN, HL	X			X			
H.F. Pinehaven to Riverside	complete	F3	0.13-0.5	6.1	SN, HL	X			X			
H.F. Riverside to Lower Mesa Falls	complete	B2	0.4-2	20.0	SN, HL	X			X			
H.F. Lower Mesa Falls to Warm R.	complete	B2	0.28-3.33	10.6	SN, HL	X	X		X			
Middle Thurmon Cr.	complete	C4	0.1	1.6	SN	X						
Thurmon Cr.	complete	C5	0.1	2.3	SN	X			X	X		
Waterfall Cr.	complete	C4	0.1	2.0	SN							
W. Thurmon Cr.	complete	C6	0.1	1.5	SN	X				X		
Warm River												
Fish Cr.	upper	C5	0.1	5.2	SN	X				X		
Little Robinson Cr.	complete	C3	0.1	9.1	SN	X				X		
N. Fk. Fish Cr.	complete	C4	0.1	4.0	SN	X				X		
Partridge Cr.	middle	C1	0.1	6.4	SN	X						
Partridge Cr.	lower	C5	0.1	3.6	SN	X				X		
Porcupine Cr.	complete	C3	0.1	4.9	SN	X				X		
Robinson Cr.	upper	C3	1	7.7	SN, HL	X*	X			X	X	
Robinson Cr.	middle	C2	0.2	19.6	SN, EF	X	X	X	X	X	X	
Robinson Cr.	lower	C2	0.2	0.9	SN	X	X		X	X	X	
Rock Cr.	lower	C3	0.1	9.0	SN	X				X		
Snow Cr.	upper	C4	0.2	10.0	SN	X				X		
Snow Cr.	lower	C2	0.3	8.5	SN	X				X		
Split Cr.	complete	D2	0.2	5.2	SN					X		
Warm R.	upper	C5	0.1	27.4	SN	X			X	X		
Warm R.	middle 2	C3	3	4.7	SN	X	X		X	X	X	
Warm R.	middle 1	C5	0.1	4.7	SN	X			X		X	
Warm R.	lower	C2	0.1	4.6	SN	X			X		X	
Wyoming Cr.	complete		0.1	12.6	SN	X	X					

Table 1. *(cont.)*

Subwatershed Stream	Reach	Rosgen type	Gradient (%); mean or range	Length (km)	Method(s)	YCT historically present	YCT	YCT x RBW	RBW	BRK	BRN	Unidentified trout
Fall River												
Calf Cr.	upper	G4c	0.5-1	3.2	SN		X					
Calf Cr.	lower	C4	1-30	3.5	SN					X		
Cascade Cr.	upper	B3	2-30	3.4	SN				X			
Cascade Cr.	lower	B3	1-30	3.5	SN		X		X			
Fall R.	upper	E4	1-3	5.3	SN		X					X
Fall R.	middle 3	B3c	1-2	15.1	SN	X			X			
Fall R.	middle 2			37.3	SN	X*			X			
Fall R.	middle 1	B1	1-2	22.9	SN				X			
Fall R.	lower			8.5	SN	X			X			
Mountain Ash Cr.	upper	B3	2-30	5.4	SN							
Mountain Ash Cr.	lower	C3	0.5-1.5	10.4	SN				X	X		
Proposition Cr.	upper	B3	1-30	6.1	SN							
Proposition Cr.	lower	G3	1-3	4.5	SN					X		
Bechler River												
Bechler R.	upper	B3c	1.5-30	10.6	SN		X					
Bechler R.	middle	E4	0.5-1.5	10.7	SN		X		X			
Bechler R.	lower	F4	1-2	5.7	SN				X			
Boundary Cr.	upper	B1	1-30	12.6	SN							
Boundary Cr.	lower	E5	0.25-0.75	11.9	SN				X			
Ferris Fork	complete	B3a	1.5-30	4.0	SN							
Gregg's Fork	complete	F4	1-12	4.9	SN		X					
Little's Fork	complete	A1	1-30	2.8	SN							
Ouzel Cr.	complete	B4	1-30	4.3	SN							
Phillip's Fork	complete	B1c	1.5-30	1.9	SN		X					
Boone Creek												
Boone Cr.	upper	C3	1-3	7.9	SN	X			X	X		
Boone Cr.	lower	B1a	3-6	6.0	SN	X			X			
Middle Boone Cr.	complete	E5	0.25-1.5	3.1	SN	X						
N. Boone Cr.	upper	B4	1.5-6	2.6	SN	X				X		
N. Boone Cr.	lower	E4	0.5-1.5	8.1	SN	X				X		

Table 1. *(cont.)*

Subwatershed Stream	Reach	Rosgen type	Gradient (%); mean or range	Length (km)	Method(s)	YCT historically present	YCT	YCT x RBW	RBW	BRK	BRN	Unidentified trout
N. Fk. M. Boone Cr.	complete	F4	2-4	3.4	SN	X				X		
N. Fk. N. Boone Cr.	complete	A1	1-6	4.0	SN	X*						X
N. Fk. S. Boone Cr.	complete	A3a+	4-20	2.5	SN	X						X
S. Fk. Boone Cr.	upper	B3	1-15	7.8	SN	X						X
S. Fk. M. Boone Cr.	complete	B4	2-4	3.8	SN	X				X		
S. Fk. N. Boone Cr.	complete	A1	4-8	1.5	SN	X						
S. Fk. Boone Cr.	lower	E4	0.5-1	5.1	SN	X				X		
Conant Creek												
Conant Cr.	upper	E4	0.5-10	0.6	SN	X						
Conant Cr.	middle 3	C4	1.5-2	17.8	SN	X						X
Conant Cr.	middle 2	B3	1-3	13.3	SN	X				X		
Conant Cr.	middle 1	A2	3-20	10.8	SN	X				X		
Conant Cr.	lower	B3	1-2	9.9	SN	X						X
Coyote Cr.	upper	A3	0.5-20	0.7	SN	X						
Coyote Cr.	lower	C4	1-7	3.3	SN	X				X		
Granite Cr.	upper	B4	0.5-3	6.3	SN	X						
Granite Cr.	lower	B4	1-7	4.4	SN	X				X		
Hominy Cr.	complete	A3	2-20	3.5	SN	X						
Squirrel Cr.	upper	A4	2-10	2.8	SN	X						
Squirrel Cr.	middle 3	E6	0.5-1	4.0	SN	X				X		
Squirrel Cr.	middle 2	B3	1-3	10.5	SN	X				X		
Squirrel Cr.	middle 1	E4	0.5-1.5	6.9	SN	X						
Squirrel Cr.	lower	B3	1-2	15.0	SN	X						X
Henry's Fork: Warm River to Fall River Confluence												
H.F. Warm R. to Ashton Dam	complete	B3	0.25-0.48	17.7	SN, HL	X			X	X	X	
H.F. Ashton Dam to Fall R.	complete	F3	0.1-0.33	10.4	SN, HL, EL	X		X	X		X	
Rattlesnake Cr.	complete	C5	0-0.5	0.7	SN							
Sand Cr.	upper	E5	0-2.5	9.4	SN							
Sand Cr.	lower	C5	0-0.5	16.2	SN							
Snow Cr.	complete	E6	1-0	17.6	SN					X		
Spring Cr.	complete	E4	0.5-1	8.5	SN							

Table 2. *Trout species presence in streams sampled in the Teton River watershed. Abbreviations: SN = snorkel, EF = electrofishing, YCT = Yellowstone cutthroat trout, RBW = rainbow trout, BRK = brook trout.*

Stream	Length (km)	Method(s)	YCT historically present	YCT	YCT x RBW	RBW	BRK
Bitch Cr. and tributaries	16.7	EF, SN	X	X	X	X	X
Burbank Cr.	1.3	EF	X				X
Calamity Cr.	7.8	EF	X	X			X
Canyon Cr.	9.4	EF	X	X			X
Crater Cr.	0.7	SN	X	X	X	X	
Darby Cr. and tributaries	13.5	EF, SN	X	X			
Deadwood Cr.	1.3	EF	X	X			
Drake Cr.	0.4	EF	X				X
Fox Cr.	12.6	EF, SN	X				X
Game Cr. and tributaries	11.9	EF, SN	X				X
Grizzly Cr.	0.4	SN	X	X	X	X	
Grove Cr.	4.2	EF	X				
Henderson Cr.	2.2	EF	X				
Hinckley Cr.	0.7	EF	X	X			X
Horseshoe Cr.	4.1	EF	X	X			X
Jackpine Cr.	8.3	EF, SN	X	X			X
Little Pine Cr.	4.0	EF	X	X			X
Mahogany Cr.	5.7	EF	X	X			X
Mail Cabin Cr.	3.9	EF	X				
Middle Twin Cr.	0.5	EF	X				
Mike Harris Cr.	5.1	EF	X				X
Moose Cr. and tributaries	17.5	EF	X	X			X
Murphy Cr.	2.0	EF	X	X			X
N. Bitch Cr.	9.6	EF, SN	X	X	X	X	
N. Fork Game Cr.	0.6	EF, SN	X				
N. Fork Horseshoe Cr.	2.1	EF	X	X			X
N. Fork Mahogany Cr.	5.5	EF	X	X			X
N. Fork Teton Cr.	0.5	SN	X	X			X
N. Leigh Cr.	14.8	EF, SN	X	X			X
N. Moody Cr.	13.4	EF	X	X			X
N. Fork Packsaddle Cr.	1.7	EF	X	X			X
N. Twin Cr.	3.0	EF	X	X			X
Packsaddle Cr.	7.4	EF	X	X			X
Pole Canyon	6.8	EF	X				
Ruby Cr.	0.9	EF	X	X			X
S. Badger Cr. and tributaries	12.9	EF, SN	X	X			
S. Bitch Cr.	7.6	SN	X	X	X	X	
S. Fork Darby Cr.	0.9	SN	X	X			
S. Fork Teton Cr.	2.3	SN	X	X			X
S. Leigh Cr.	22.8	EF, SN	X	X			
S. Moody Cr.	11.0	EF	X	X			X
S. Fork Packsaddle Cr.	1.9	EF	X	X			X
S. Twin Cr.	0.4	EF	X				
Slocum Cr.	1.0	EF	X				
Stateline Canyon	1.7	EF	X	X			X
Teton Cr. and tributaries	12.5	EF	X	X			X
Trail Cr.	13.3	EF	X	X			X
Wood Canyon	2.6	EF	X	X	X	X	

surveyed. Yellowstone cutthroat trout were observed in 19 of the 38 streams surveyed in the Sinks drainage and were the only trout species observed in seven (Table 3). These were Crooked Creek, West Indian Creek, West Rattlesnake Creek, East Rattlesnake Creek, Moose Creek, East Dry, and West Dry Creek. No trout were found in one of the streams surveyed in the Sinks drainage.

Discussion

A drastic decline in distribution of small-stream resident Yellowstone cutthroat trout has occurred within the

Table 3. *Trout species presence in streams sampled in the Snake River Plain Sinks drainages. Abbreviations: SN = snorkel, EF = electrofishing, YCT = Yellowstone cutthroat trout, RBW = rainbow trout, BRK = brook trout, BRN = brown trout.*

Stream	Length (km)	Method(s)	YCT historically present	YCT	YCT x RBW	RBW	BRK	BRN
Beaver Cr.	6.5	SN	?			X	X	
Ching Cr.	4.9	EF	?	X			X	
Corral Cr.	5.0	EF	?	X		X		
Cottonwood Cr.	6.6	EF	?				X	
Crooked Cr.	7.8	EF	?	X				
Dairy Cr.	3.6	EF	?			X	X	
Divide Cr.	2.1	SN	?	X		X	X	
E. Camas Cr.	7.8	EF	?					
E. Cottonwood Cr.	1.3	EF	?				X	
E. Dry Cr.	2.8	EF	?	X			X	
E. Dry Cr.	4.0	EF	?	X				
E. Indian Cr.	3.6	SN	?	X		X		
E. Modoc Cr.	5.0	EF	?			X	X	
E. Rattlesnake Cr.	3.4	EF	?	X				
E. Steel Cr.	2.3	EF	?				X	
Horse Cr.	5.2	EF	?	X			X	
Idaho Cr.	3.7	EF	?			X	X	
Irving Cr.	1.3	EF	?	X		X	X	
McNeary Cr.	3.2	EF	?			X	X	
Middle Cr.	4.1	SN	?	X		X		
Miners Cr.	5.0	EF	?				X	
Moose Cr.	2.3	EF	?	X				
N. Fritz Cr.	4.4	EF	?	X		X	X	
Pete Cr.	5.2	EF	?				X	
Pleasant Valley Cr.	3.9	EF	?			X	X	
Ramshorn Cr.	1.9	EF	?				X	
S. Pass Creek	5.5	EF	?	X		X	X	
Saw Cr.	1.5	EF	?				X	
Stoddard Cr.	2.1	EF	?				X	
Threemile Cr.	4.4	EF	?	X			X	
W. Camas Cr.	13.3	EF	?			X	X	X
W. Cottonwood Cr.	2.4	EF	?				X	
W. Dry Cr.	2.3	EF	?				X	
W. Dry Cr.	5.2	EF	?	X				
W. Indian Cr.	2.9	SN	?	X				
W. Rattlesnake Cr.	5.2	SN	?	X				
Webber Cr.	8.6	EF	?	X		X	X	
Willow Cr.	6.8	EF, SN	?			X	X	

Henry's Fork watershed. About 17 percent of the total fish-bearing habitat surveyed still contains Yellowstone cutthroat trout, and about 3 percent supports Yellowstone cutthroat trout populations that are isolated from nonnative salmonids (Table 4, Fig. 1). When only those stream reaches that historically supported trout are included, about 13 percent of fish-bearing habitat currently supports Yellowstone cutthroat trout, and about 3 percent supports Yellowstone cutthroat trout isolated from nonnative species.

Table 4. *Presence of Yellowstone cutthroat trout (YCT) in the Henry's Fork watershed upstream of and including the Fall River drainage.*

	Total	Within YCT historic range
Stream length surveyed	833 km	793 km
YCT present	141 km (17%)	101 km (13%)
YCT present in allopatry	28 km (3%)	20 km (3%)

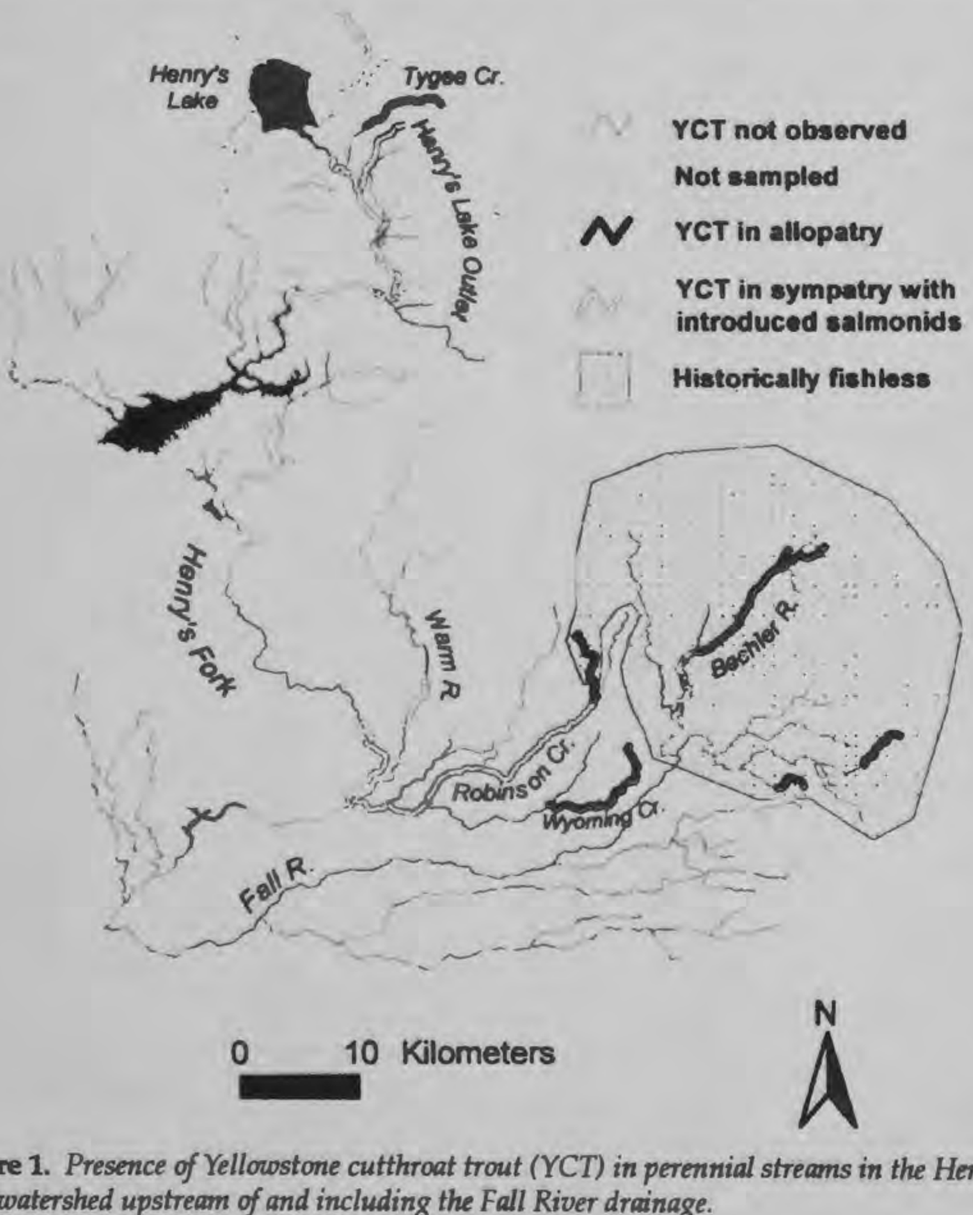

Figure 1. *Presence of Yellowstone cutthroat trout (YCT) in perennial streams in the Henry's Fork watershed upstream of and including the Fall River drainage.*

Although the range of Yellowstone cutthroat trout in the Henry's Fork watershed has greatly declined over the past 150 years, more recent declines also are evident. Our surveys failed to detect Yellowstone cutthroat trout in seven streams where they were observed in the early 1980s (Spateholts and Moore 1985). Nonnative salmonids were observed in these streams in both the early 1980s and during our surveys. We assume that these populations of Yellowstone cutthroat trout became extinct during the past 15 years.

The status of Yellowstone cutthroat trout is more encouraging in the Teton and Sinks drainages than in the Henry's Fork drainage. In the Teton drainage, Yellowstone cutthroat trout were observed in 89 percent of the fish-bearing habitat surveyed and were the only trout species observed in 19 percent of the fish-bearing habitat surveyed (Table 5, Fig. 2). In the Sinks

Table 5. *Presence of Yellowstone cutthroat trout (YCT) in the Teton River watershed and the Snake River Plain Sinks drainages. Percentages represent the proportion of fish-bearing streams containing Yellowstone cutthroat trout.*

	Teton	Sinks
Total stream length surveyed	291 km	167 km
Total fish-bearing stream length surveyed	272 km	159 km
YCT present	241 km (89%)	83 km (52%)
YCT present in allopatry	51 km (19%)	31 km (19%)

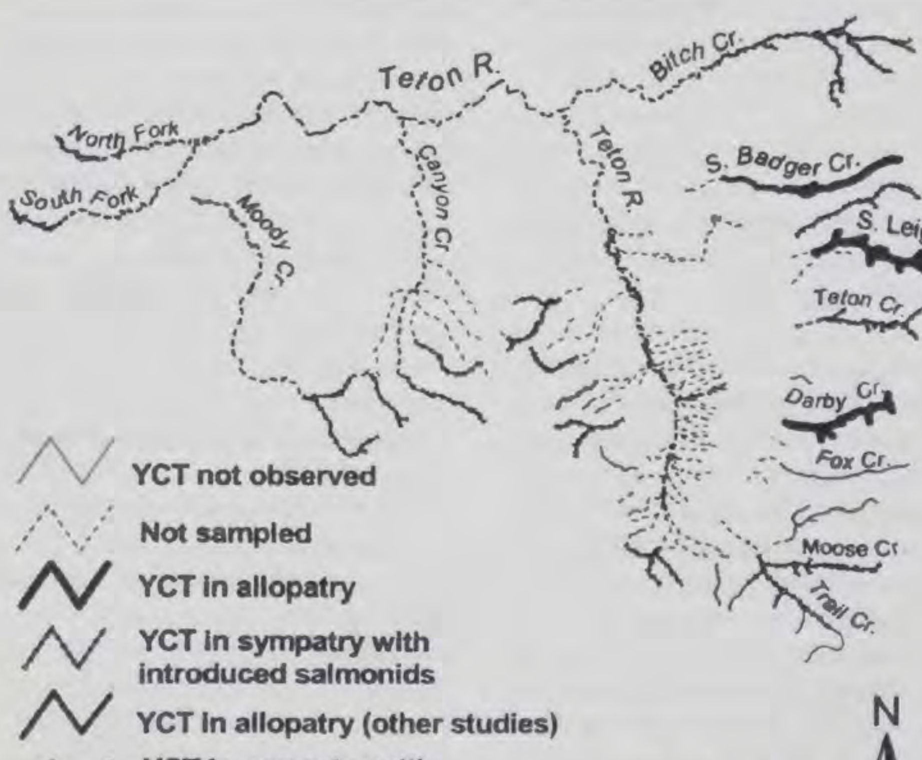

Figure 2. *Presence of Yellowstone cutthroat trout (YCT) in perennial streams in the Teton River watershed. Data from other studies were obtained from Idaho Department of Fish and Game (B. Schrader, IDFG, Idaho Falls, ID, personal communication, and K. Meyer, IDFG, Nampa, ID, personal communication).*

drainage, Yellowstone cutthroat trout were observed in 43 percent of fish-bearing habitat and were the only trout species present in 19 percent of fish-bearing habitat (Table 5). Although Yellowstone cutthroat trout were observed in a higher percentage of the Sinks and Teton drainages than in the Henry's Fork watershed, the Sinks and Teton surveys covered a combined 458 km of stream whereas the upper Henry's Fork study covered 833 stream km (Tables 4 and 5). Additionally, the degree of isolation from nonnative salmonids is currently unknown for the Sinks and Teton populations. All cutthroat trout populations currently existing in the absence of other salmonids in streams where no barrier to upstream migration exists should be considered at high risk. In these streams construction of barriers to prevent invasion of nonnative salmonids should be a high priority. Although barrier construction could further fragment extant populations and contribute to decreased long-term population viability, preservation of pure Yellowstone cutthroat trout populations might be more critical in the short-term and should be assessed on a case-specific basis.

Somewhat ironically, many locations where Yellowstone cutthroat trout currently exist within the study area were not within the historic range of the subspecies. Seven of the 16 Yellowstone cutthroat trout populations detected in the Henry's Fork watershed occurred in streams that were historically barren of salmonids and are probably the result of early introductions (Jordan 1889, Varley and Schullery 1998, W. Jenkins, former USFS Wilderness Technician, personal communication). These seven populations inhabit upper Robinson Creek, Fall River above Terraced Falls, Calf Creek, and the Bechler River drainage above and below Colonnade Falls including Gregg's and Phillip's Forks. Excepting the Bechler River population below Colonnade Falls, these populations exist in allopatry and are isolated by downstream barriers. Therefore, six of the eight stream reaches in the Henry's Fork watershed where Yellowstone cutthroat trout were observed in isolation from nonnative salmonids likely originated from introductions. The remaining two isolated populations (Tygee and Wyoming creeks) also possibly resulted from early introductions in which case no Yellowstone cutthroat trout exist in isolation from nonnative salmonids within their historic range in the Henry's Fork watershed.

If all Teton watershed streams we surveyed lie in the historic range of Yellowstone cutthroat trout, and none of the surveyed Sinks drainage streams lie therein, then 27-29 (36-39%) of the 74 reaches containing Yellowstone cutthroat trout in all surveyed subwatersheds probably occurred outside the subspecies' historical range. Apparently, many of these historically fishless waters were stocked exclusively with Yellowstone cutthroat trout. The same geologic features that prevented Yellowstone cutthroat trout from colonizing these areas prehistorically also have prevented nonnative species from colonizing recently, thus allowing the Yellowstone cutthroat trout populations to persist in isolation and unhybridized.

These surveys have provided us with some idea of the current distribution of resident Yellowstone cutthroat trout within the three watersheds, but they likely represent a "best case" scenario. Detailed work on the genetics of these small-stream populations has yet to be performed. To our knowledge, only the Tygee Creek Yellowstone cutthroat trout population has been subjected to a genetic assessment that is significant at the population level. Encouragingly, evidence of rainbow trout introgression was absent in this isolated population

(M. E. Powell, Hagerman Fish Culture Experiment Station, personal communication). Preliminary genetic assessments of populations of Yellowstone cutthroat trout from West Fork Indian, Wyoming, Crooked, West Fork Rattlesnake, and Moose creeks suggest genetic purity therein; however, genetic integrity at the population level in these streams could not be determined because of small sample sizes (Williams *et al*. 1998). Because most of the non-isolated Yellowstone cutthroat trout populations that we observed exist in sympatry with rainbow trout, genetically pure fish likely will occur only where populations exist in isolation (May 1996). If this proves to be true, Varley and Gresswell's (1988) estimate of 10 percent historical range occupancy by genetically pure stream-dwelling forms of the subspecies might prove to be generous in the areas we surveyed.

We based present distribution on the assumption that Yellowstone cutthroat trout occur only where observed by our and other recent surveys, thereby minimizing estimates of current occupancy. Some of our assumptions concerning historic occupancy in portions of the study area, specifically the upstream extent of occupancy in small, barrier-free streams, tend to maximize historic Yellowstone cutthroat trout distribution. We acknowledge that comparison of historic and current distributions assumed in this paper may exaggerate the extent of decline that has occurred in the study area. However, absence of Yellowstone cutthroat trout throughout much of the study area known to lie within the historic range of the subspecies indicates a drastic decline has occurred.

This study focused primarily on small-stream populations of Yellowstone cutthroat trout exhibiting a resident life-history strategy. Fish exhibiting fluvial and adfluvial life histories likely established these resident populations. Gene flow and dispersal probably occurred among populations, helping to ensure long-term viability in resident populations (May 1996). Although all three life history forms still exist in the watershed, widespread replacement of native trout with nonnative species and the establishment of man-made barriers have fragmented former metapopulations into small, isolated subpopulations, greatly reducing persistence probability. Ironically, in many cases the same barriers that have fragmented populations and compromised long-term viability have isolated Yellowstone cutthroat trout from nonnative salmonids thereby preserving short-term viability and genetic integrity. However, we question whether the remaining isolated resident populations can avoid extinction in the long term now that population connectivity no longer exists (Thurow *et al*. 1988).

We recommend that the genetic status of all remaining isolated cutthroat trout populations in the watershed be determined and adequate conservation measures be implemented to protect all genetically pure populations. These conservation measures might include, but would not be limited to, providing barriers or weirs to isolate remnant Yellowstone cutthroat trout populations from nonnative salmonids, applying and enforcing special angling restrictions, and managing for minimum habitat disturbance. Furthermore, we recommend that restorative measures be initiated to protect and expand Yellowstone cutthroat trout distribution within their historic range. Toward these ends, IDFG is currently undertaking a systematic statewide inventory of cutthroat trout distribution and population status (K. Meyer, IDFG, personal communication). Field work conducted during 1999 included the Teton watershed.

At least one such restorative measure has been implemented in the

Henry's Fork drainage. In the autumn of 1999, Golden Lake and its tributaries, East, Middle, and West Thurmon creeks, were chemically treated to remove nonnative salmonids, and barriers to upstream migration from the mainstem Henry's Fork were constructed. Genetically pure Yellowstone cutthroat trout will be reintroduced into this small watershed in the near future. Additional restoration efforts, in combination with conservation of existing populations, are essential if genetically pure small-stream resident Yellowstone cutthroat trout are to be preserved in the watershed.

ACKNOWLEDGEMENTS

This study was the result of interagency collaboration between the USDA Forest Service and the Henry's Fork Foundation. This research was funded by the National Forest Foundation, the National Fish and Wildlife Foundation, and individual donors to the Henry's Fork Foundation. Kris Drewes of the USDA Forest Service and Mike Kreuzer of the Idaho State University Geographic Information Systems Laboratory provided technical assistance with mapping and database manipulation. Special recognition goes to former Targhee National Forest Fish Biologist Dan Delany and to Jim Gregory of Gregory Aquatics, who designed the surveys and supervised the field crews. Recognition and continued appreciation is also given to the hardworking interns and seasonal technicians who collected the data and surveyed over 800 miles of stream by foot: Brian Krestian, Douglas Hayes, Alicia Austin, Mark Engle, Wade Thorson, Katrina Lund, Sarah Beesley, Ken Theus, David Bressler, Drake Burford, Jim Wilkinson, Clint Jones, Christine Wong, Doug Morical, Eric Bergman, Jeb Wofford, Ryan McShane, Chris Looney, and Trey Overdike.

LITERATURE CITED

Behnke, R. J. 1992. Native trout of western North America. American Fisheries Society Monograph 6. American Fisheries Society, Betheseda, MD.

Brostrom J., and L. Watson. 1988. Evaluation of Henrys Lake trout stocking program. Project F-71-R-11, Subproject IV, Study iii, Job 1. Idaho Department of Fish and Game, Idaho Falls.

Conley, J. M. 1993. Federal aid in fish restoration job performance report. Project F-71-R-15. Idaho Department of Fish and Game, Idaho Falls.

Costlet, R. J. 1941. A stream and lake stocking plan for the Targhee National Forest. USDA Forest Service, Intermountain Region, Ogden, UT.

Elle, S., and C. Corsi. 1994. Regional fisheries management investigations. Project F-71-R-13, Job 6-c. Idaho Department of Fish and Game, Idaho Falls.

Gregory, J. S. 1997. Upper Henry's Fork habitat assessment headwaters to Island Park Dam summer 1996. Report to Henry's Fork Foundation, Ashton, ID. Gregory Aquatics, Mackay, ID.

Gregory, J. S. 1998. Upper Henry's Fork habitat assessment Fall River drainage summer 1998. Report to Henry's Fork Foundation, Ashton, ID. Gregory Aquatics, Mackay, ID.

Gregory, J. S. 1999. Henry's Fork habitat assessment Henrys Fork (Island Park to mouth) and Big Bend Ridge summer 1999. Report to Henry's Fork Foundation, Ashton, ID. Gregory Aquatics, Mackay, ID.

Gregory, J. S. 2000. Henry's Fork habitat assessment mainstem Henry's Fork summer 1999. Report to Henry's Fork Foundation, Ashton, ID. Gregory Aquatics, Mackay, ID.

Gregory, J. S., and J. S. Griffith. This Issue. First-winter survival of caged wild and hatchery cutthroat trout in allopatry and in sympatry with brook trout. Int. J. Sci. 6:217-222.

Gregory, J. S., and R. Van Kirk. 1998. Henry's Fork habitat assessment Island Park Dam to Warm River summer 1997. Report to Henry's Fork Foundation, Ashton, ID. Gregory Aquatics, Mackay, ID.

Gresswell, R. E. 1995. Yellowstone cutthroat trout. Pp. 36-54 *in* M. K. Young, ed., Conservation assessment for inland cutthroat trout. General Technical Report RM-GTR-256, USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Griffith, J. S. 1988. Review of competition between cutthroat trout and other salmonids. American Fisheries Society Symposium 4:134-140.

Idaho Department of Fish and Game. 1996. Statewide fisheries management plan 1996-2000. Idaho Department of Fish and Game, Boise.

Jaeger, M. E. 1998. Final report, Targhee trout restoration project #97-CCS-0401. Henry's Fork Foundation, Ashton, ID.

Jordan, D. S. 1889. A reconnaissance of the streams and lakes in Yellowstone National Park, Wyoming, in the interest of the United States Fish Commission. Bull. U.S. Fish Comm. 9:41-63.

Leary, R. F., F. W. Allendorf, and S. R. Phelps. 1987. Genetic divergence and identification of seven cutthroat trout subspecies and rainbow trout. Trans. Am. Fish. Soc. 116:580-587.

Maret, T. R., C. T. Robinson, and G. W. Minshall. 1997. Fish assemblages and environmental correlates in least-disturbed streams of the upper Snake River Basin. Trans. Am. Fish. Soc. 126:200-216.

May, B. E. 1996. Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*). Pp. 11-34 *in* D. Duff, tech. ed., Conservation assessment for inland cutthroat trout status and distribution. U.S. Department of Agriculture, Forest Service, Intermountain Region, Ogden, UT.

Rosgen, D. 1996. Applied river morphology. Wildland Hydrology, Pagosa Springs, CO.

Simpson, J. C., and R. L. Wallace. 1982. Fishes of Idaho. University Press of Idaho, Moscow.

Spateholts, R., and V. K. Moore. 1985. Henrys Fork fisheries investigations. Project F-73-R-6, Subproject IV, Study III. Idaho Department of Fish and Game, Idaho Falls.

Thurow, R. F. 1994. Underwater methods for the study of salmonids in the intermountain west. General Technical Report INT-GTR-307, USDA Forest Service, Intermountain Research Station, Ogden, UT.

Thurow, R. F., C. E. Corsi, and V. K. Moore. 1988. Status, ecology, and management of Yellowstone cutthroat trout in the upper Snake River drainage, Idaho. American Fisheries Society Symposium 4:25-36.

Van Kirk, R. W. 1999. Angler effort, catch, and attitudes on the Henry's Lake Outlet. Report to The Nature Conservancy of Idaho, Idaho Falls. Department of Mathematics, Idaho State University, Pocatello.

Van Kirk, R. W., and L. Benjamin. This Issue. Physical and human geography of the Henry's Fork Watershed. Int. J. Sci. 6:106-118.

Van Kirk, R. W., and M. Gamblin. This Issue. History of fisheries management in the upper Henry's Fork watershed. Int. J. Sci. 6:263-284.

Varley, J. D., and R. E. Gresswell. 1988. Ecology, status, and management of the Yellowstone cutthroat trout.

American Fisheries Society Symposium 4:13-24.

Varley, J. D., and P. Schullery. 1998. Yellowstone fishes. Stackpole Books, Mechanicsburg, PA.

Williams, R. N., M. S. Powell, R. P. Evans, and D. K. Shiozawa. 1998. Genetic analysis of putative Yellowstone cutthroat trout samples from the Henry's Fork Subbasin. Report to Henry's Fork Foundation, Ashton, ID. Hagerman Fish Culture Experiment Station, Hagerman, ID.

Yellowstone National Park. 1989. Fishery and aquatic management program in Yellowstone National Park. Technical report for calendar year 1988. United States Department of the Interior, National Park Service, Yellowstone National Park, Mammoth, WY.