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Inventory of Fish Species in the Snake River Watershed Within Yellowstone National Park

Natural Resource Technical Report NPS/GRYN/NRTR–2008/119

ON THE COVER

Upper main stem of the Snake River, Yellowstone National Park. NPS photo.

Inventory of Fish Species in the Snake River Watershed Within Yellowstone National Park

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Acronyms

mm	millimeters
CUT	indeterminate cutthroat trout
SRC	Snake River fine-spotted cutthroat trout
TL	total length
YCT	Yellowstone cutthroat trout
YNP	Yellowstone National Park

Executive Summary

Under the direction of the inventory and monitoring component of the Natural Resource Challenge, National Park Service biologists in Yellowstone National Park (YNP) began a three-year inventory of the Snake River watershed in 2004. Although the Snake River drainage is the third-largest in the park, less than half of the main stem and few of the tributaries had ever been sampled in a systematic manner. Not only does the Snake River contain the most diverse assemblage of native fish species in the park, but two of YNP's three types of cutthroat trout (*Oncorhynchus clarki*) also reside there. Although Yellowstone cutthroat trout (*O. c. bouvieri*) and Snake River fine-spotted cutthroat trout (*O. c. subsp.*) exhibit observable phenotypic differences in terms of their spotting patterns, considerable debate about their true historic distribution and taxonomic status has occurred because the two subspecies have been nearly indistinguishable when examined meristically or genetically.

As a cooperative effort with U.S. Forest Service biologists of the Bridger-Teton National Forest, we sampled the watershed with the following objectives: (1) to conduct a systematic survey of the Snake River tributaries and determine the distribution of the two types of cutthroat trout there; (2) to describe population characteristics of native and non-native fish species; and (3) to obtain samples for genetic analyses in order to compare field identification with laboratory results of individual genetic identity. To accomplish these objectives, we subdivided the main stem into more than 30 sections of 2 km each. Tributary sample sections were much shorter; each section was one-tenth of that stream's total perennial length. In each survey section, the survey crew electrofished 50–100 m of the stream or until a representative sample was obtained. We attempted to catch at least three cutthroat trout longer than 150 mm from each sample reach, as individuals shorter than this length often display indistinct spotting patterns.

Mountain whitefish (*Prosopium williamsoni*) were the most abundant species captured in the main stem, but their distribution was restricted to areas downstream from the confluence with the Heart River. Cutthroat trout and mottled sculpin (*Cottus bairdi*) were captured throughout the watershed. However, the seven fish identified in the field as fine-spotted cutthroat trout were restricted to the lower sections of the main stem. Most of the other native species, and the few brown trout (*Salmo trutta*) and brook trout (*Salvelinus fontinalis*) found in this survey, were collected in the same sections as the mountain whitefish.

The Snake River fine-spotted cutthroat trout were the largest individuals captured during the survey; several were longer than 400 mm. Many of the other cutthroat trout were younger fish between 100 and 125 mm long. Consequently, most of the cutthroat trout caught in the main stem could not be definitively identified in the field as either the fine-spotted form or the large-spotted Yellowstone cutthroat trout.

In most of the tributaries, only Yellowstone cutthroat trout and mottled sculpin were caught. Cutthroat trout, mountain whitefish, and five non-game species were captured from the Heart River. Typically, the cutthroat trout that could be identified in the tributaries were smaller and exhibited different coloration than the adult fish from the main stem.

Forty fin-clip samples from the Snake River and four different tributaries were submitted for genetic analyses. The field classification of individual fish (Yellowstone cutthroat trout, fine-spotted cutthroat trout, or undetermined cutthroat type) was then compared to their respective haplotypes (variations of a gene identified from mitochondrial DNA). More than a dozen haplotypes were detected in the watershed; however, the S1 haplotype was the most common form observed in the main stem and the two uppermost tributaries. Almost all of the Yellowstone cutthroat trout and half of the fine-spotted form were of this type. The dominant haplotype in the Heart River cutthroat trout was different than in most of the other portions of the Snake River watershed, but

it is common in Heart Lake and Yellowstone Lake. The Yellowstone cutthroat trout examined above a waterfall in Forest Creek have developed their own unique haplotype in the 70 years since they were stocked there, indicating that this population likely experienced a genetic bottleneck at some point.

Our comparisons between individual field identification and genetic analyses did not yield a definitive method of reliably separating the Yellowstone cutthroat form from the fine-spotted form. However, the overall distribution of haplotypes in the watershed suggests that there may be several distinct populations in the Snake River headwaters within Yellowstone National Park. For example, despite the lack of obvious physical barriers that would limit upstream fish passage, the Heart River confluence area and adjoining reach appears to be a transition zone separating the current fish assemblages in the Snake River. No Snake River fine-spotted cutthroat, mountain whitefish, or non-native salmonids were caught upstream from there, even though smaller native species, such as mottled sculpin and longnose dace, were captured for several more kilometers upstream. The cutthroat trout residing downstream from Heart River may have a larger migratory component in their life history than do the cutthroat trout in the upper reaches of the river.

Our current survey results about the distribution of native cutthroat trout in the Snake River are equivocal, because the actual historical distribution of the two forms is unknown, and historic stocking of Yellowstone cutthroat trout from Yellowstone Lake has complicated the genetic analyses. However, the basin-wide survey has yielded information on the sympatric distribution of other historic native species in the watershed. It appears that these fish have been able to persist in reasonable numbers despite the presence of non-native fish species in the drainage for more than 100 years. Examination of the current native fishes distribution, combined with additional field classification of cutthroat trout and more detailed genetic markers (e.g., microsatellite analyses), may help to further define specific groups of populations at a small, sub-basin scale.

Acknowledgements

This three-year study was partially funded by the Greater Yellowstone Inventory and Monitoring Network. Project design and methodology were developed by Mark Novak, Bridger-Teton National Forest. Fieldwork and data collection were accomplished by Shane Keep, Mike Jones, Chris Dixon, Maureen Kavanagh, Chris Romankiewicz, Nicole Legere, Joe Naughton, Jeremy Erickson, Jordan Allison, and Hayley Allen. Planning and logistical support were provided by Dave Phillips and the Snake River District rangers, particularly Justin Ivary, Michael Curtis, and Richard Jones. Stock support was provided by Wally Wines and Dave Elwood. Wendy Hafer, of the Yellowstone National Park Fire Cache, was helpful in ensuring that helicopter transport of equipment went smoothly. Carrie Guiles, of the Yellowstone Center for Resources Spatial Analysis Group, produced the maps. Carl Glasow, of Bridger-Teton National Forest, was a valuable assistant in producing timely data summaries.

Chapter 1
Introduction

1.1 Background and objectives

The Snake River drainage is the third-largest watershed in Yellowstone National Park (YNP). Unlike many of the other major rivers in the park, only about one kilometer of the Snake River is paralleled by a road. The watershed historically attracted noted explorers such as Osbourne Russell (Haines 1955), but a lack of easy access to the upper reaches of the river has likely limited visitation to most of the drainage. Surveys by park biologists have also been few, due to the logistical constraints associated with transporting sampling equipment to remote headwaters areas. Throughout the 1970s, for instance, assessments of Snake River fish populations were restricted to angler surveys.

Although more than half of the park's native fish species were historically present in the Snake River drainage, no formal, quantitative examination of the watershed was undertaken until 1983. In that year, park fishery biologists measured physical and chemical characteristics of the Snake River downstream from and including its largest tributary, the Heart River. A variety of electrofishing techniques were used to determine fish species composition and estimate relative abundance of native and non-native species alike (Jones et al. 1984). However, no surveys of the main stem or tributaries were conducted upstream from the Snake River–Heart River confluence. In 1984, mark-and-recapture population estimates were conducted between the Lewis River–Snake River confluence and the park boundary. Mountain whitefish (*Prosopium williamsoni*) was the most commonly collected fish during these surveys.

Since 1984, fisheries monitoring of the Snake River has been restricted to examination of information on angler catch and effort. However, with the advent of the servicewide Inventory and Monitoring Program in 1999 (NPS 1999), biologists in YNP took a renewed interest in investigating the distribution of fishes in the Snake River headwaters. Of particular interest was the distribution of two forms of cutthroat trout within the stream, Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*) and Snake River fine-spotted cutthroat trout (*Oncorhynchus clarki* subsp.) (GRYN 2000). The historical distribution of Snake River fine-spotted cutthroat trout (SRC) is unknown, but this form was thought to be sympatric with the closely-related Yellowstone cutthroat trout (YCT) downstream from Jackson Lake. An ongoing debate has attempted to clarify whether these two types of cutthroat trout are actually separate subspecies. Genetic analyses have suggested that the two forms are nearly identical (Loudenslager and Kitchin 1979; Allendorf and Leary 1988); however, Behnke (1988) proposed that some behavioral and morphological adaptations may have occurred much faster than could be detected via DNA fragments that would unequivocally separate the two cutthroat-trout types. Additionally, he indicated that although a small amount of hybridization occurs between the two forms in the Snake River, behavioral and ecological traits, such as disease resistance, suggest that the fine-spotted form merits recognition as a subspecies distinct from the Yellowstone cutthroat trout (Behnke 1992; 2002).

In 2004, YNP fishery biologists and U.S. Forest Service personnel from the Bridger-Teton National Forest began a three-year survey, funded by the Greater Yellowstone Inventory and Monitoring Network, to determine the distribution of fish species in the Snake River headwaters. Specific objectives included:

1. Conducting a systematic survey of the Snake River main stem and primary tributaries from the park boundary upstream to the river's source in order to determine the distribution of SRC and YCT there;
2. Describing population characteristics of all collected fish, including non-native species, in the watershed; and
3. Collecting fin-tissue samples for genetic analyses in order to examine relationships between observed spotting patterns of cutthroat trout and individual genetic identity.

1.2 Study Area

The Snake River originates at an elevation of approximately 3,000 m in the southern portion of Two Ocean Plateau, on the Continental Divide near the park's boundary with the Bridger-Teton National Forest. From its source, the river flows westerly for about 75 km before leaving YNP near the South Entrance. Numerous named and unnamed tributaries flow into the Snake River within this headwaters area (Figure 1.2). The Lewis River is the largest of these, encompassing one-third of the 117,500-hectare Snake River basin (Jones et al. 1984), but none of the Lewis River watershed was sampled as part of this survey. Polecat Creek, which originates in YNP and flows into the Snake River downstream from the park boundary, was sampled in 2004. Results from that survey will be detailed in a separate report.

Most of the watershed surface is glacial till derived from Pinedale glaciation (Richmond 1973; Richmond and Pierce 1971). Stream gravels and other alluvial materials now cover the low-gradient meadows, such as Fox Park and the Heart River–Snake River confluence area. These surficial deposits overlie an area of complex geologic processes, ranging from Tertiary andesitic volcanic flows in the headwaters to more recent episodes of rhyolite deposition at Lewis Canyon (USGS 1972). Cretaceous sedimentary sandstones and shales have resulted in steep canyons located upstream and downstream from the Heart River.

Historically, much of the watershed's upland areas supported lodgepole pine (*Pinus contorta*) forests, and large, grassy meadows occurred with regular frequency adjacent to the main stem of the Snake River. However, most of the drainage was burned by the Snake River Complex and Huck-Mink wildfires in 1988 (McCartney 1997; Franke 2000). Some of the tributary watersheds, such as Forest Creek, were burned almost entirely; yet, these areas currently exhibit substantial amounts of lodgepole pine re-growth only two decades after the wildfires.

The Snake River is of particular interest in regard to native-fish diversity. It historically contained the highest number of fish species in the park. In addition to the aforementioned cutthroat trout and whitefish, the Snake River watershed is home to numerous non-game native species, including two types of suckers, four minnow species, and the mottled sculpin (*Cottus bairdi*) (Varley and Schullery 1998). This assemblage represents about 70% of all native fish species in the park. Official stocking records indicate that only Yellowstone cutthroat trout from the Yellowstone Lake hatchery were stocked in the Snake River main stem, but several introduced salmonids now inhabit the stream (Varley 1981). Thousands of lake trout (*Salvelinus namaycush*) and brown trout (*Salmo trutta*) were stocked into Lewis and Shoshone lakes in 1890. Brook trout (*Salvelinus fontinalis*) are present primarily in the Lewis River drainage, presumably as a result of a single introduction of approximately 4,500 individuals into Shoshone Creek in 1893. The current presence of these three non-native trout in the Snake River proper is probably due to downstream dispersal from these headwater source populations in the Lewis River.

Most of the Forest Creek basin may have been historically fishless due to a large waterfall located about 1 km upstream from the confluence with the Snake River main stem. This waterfall is estimated to be more than 20 feet tall, and undoubtedly acts as a permanent barrier to upstream fish passage. However, between 1939 and 1943, about 100,000 eyed eggs from the Yellowstone Lake hatchery were annually transplanted into Forest Creek. According to official YNP hatchery records, this represents one of the few fish stockings of a Snake River tributary upstream from the Lewis River.

Figure 1.2. Snake River basin with main stem river and primary tributaries.

Chapter 2
Methods

2.1 Fish distribution

Typically, each wadeable stream was subdivided into 10 sections of equal length for systematic sampling. Because of varying stream lengths, study sections ranged from 800 m in the Heart River to 1,600 m at Forest Creek. All sections in the main stem were 2 km long. On those occasions when probable barriers to upstream fish migration occurred, the downstream terminus of the barrier represented the end of that sample section. The next survey section began immediately upstream from the barrier. Surveys continued upstream until either no fish were captured in three consecutive reaches, stream size was too small to effectively sample, or the headwater source was encountered.

The survey crew proceeded in an upstream direction and used a backpack electrofisher to collect fish from the lowest 50–100 m of each section. This method was also used in the Snake River main stem upstream from the Heart River confluence. Because the large size of the river in the lower reaches (0–15) made backpack electrofishing ineffective, alternative sampling was used there. In these lower reaches, a raft with boom-mounted electrodes and a 3.5-kw generator was floated in a downstream direction until the required number of fish was collected. Length of the sections surveyed in the lower main stem reaches varied considerably, depending on factors such as capture efficiency and current speed. Typically, between 300 and 500 m of each section were sampled there. At all sites, the beginning of each sample section was recorded with a handheld GPS unit to provide capture-location coordinates.

2.2 Population characteristics

All captured fish were identified to species, examined for general condition, measured to the nearest millimeter, and weighed in grams. For age and growth analyses, scales were collected from all trout and from a subsample of whitefish longer than 100 mm total length (TL). Differences in sample-section length and electrofishing effort precluded standardization of capture effort, so population abundances cannot be compared in this study. Rather, comparisons are restricted to species composition and distribution.

2.3 Classification by spotting pattern

Field observation of spotting patterns may be a reliable method for distinguishing Yellowstone cutthroat trout from Snake River fine-spotted cutthroat trout (Kruse 1998; Behnke 2002).

Differences in spot size and distribution are the only recognized means for distinguishing between YCT and SRC. Yellowstone cutthroat trout have larger-sized spots (2–4 mm) that are conspicuous and rounded, and concentrated toward the caudal peduncle (Figure 2.3, top) (Behnke 1992; Baxter and Stone 1995). Snake River fine-spotted cutthroat trout have a profusion of small (1–2-mm), rounded-to-irregular spots that are well distributed across the side of the fish and somewhat concentrated in the caudal peduncle (Figure 2.3, middle) (Behnke 1992; Baxter and Stone 1995).

However, spotting patterns in cutthroat trout smaller than 150 mm TL are often highly variable as a result of faint spots, or parr marks, that mask the spotting pattern (Novak et al. 2005). Thus, to address objectives of this survey, our study design specified that we obtain at least three cutthroat trout longer than this size from each sample reach in order to more reliably describe individual spotting patterns. Captured cutthroat trout were classified as either Yellowstone cutthroat trout or Snake River fine-spotted cutthroat trout. Fish that displayed a spotting pattern that was intermediate to the two classic forms or exhibited an unusual, non-characteristic pattern were categorized as the indeterminate form (Figure 2.3, bottom) This latter situation was common in trout between 125 and 150 mm TL.

2.4 Genetic analyses

Individual samples of ventral-fin tissue were collected from cutthroat trout longer than 125 mm TL for genetic analyses. Samples were submitted to graduate research laboratories for detailed analyses. Specific laboratory procedures are detailed in Janetski (2006) and Novak et al. (2005). The genetic identity of individual fish was then compared to results of spotting pattern classification as identified in the field.

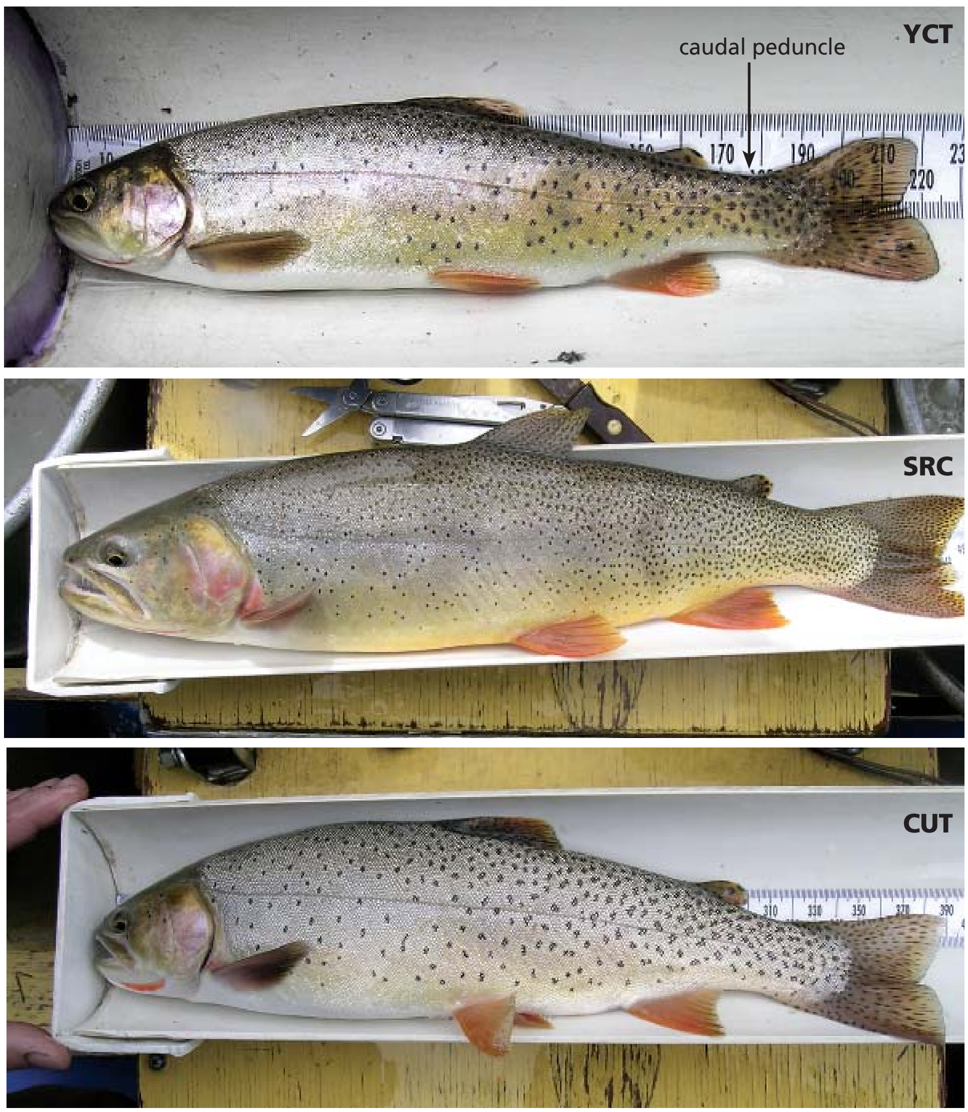

Figure 2.3. Spotting patterns typical of Yellowstone cutthroat trout (*top*), Snake River fine-spotted cutthroat trout (*middle*), and indeterminate cutthroat trout (*bottom; note medium-sized spots of roughly equal distribution*). Photos not to scale.

Chapter 3
Results

3.1 Snake River main stem

In 2004, more than 700 fish of 12 different species were captured from the Snake River main stem. Some form of cutthroat trout was found in 26 of the 33 sample sections (Figure 3.1-1). Mountain whitefish were the most abundant species captured, representing more than half of all fish collected (Table 3.1). About 100 cutthroat trout and mottled sculpin each were caught during the main stem survey, but only a single brook trout, redside shiner (*Richardsonius balteatus*), and Utah sucker (*Catostomus ardens*) was captured.

Cutthroat trout and mottled sculpin were the most widely distributed species, and the only fish collected in the uppermost 10 sample reaches. Although nearly as abundant as mottled sculpin, longnose dace (*Rhinichthys cataractae*) had a more restricted distribution and were not captured upstream from Reach 18 (Table 3.1). All of the mountain whitefish, most of the dace and suckers, and all non-native trout were captured at or downstream from the Snake River–Heart River confluence (Reach 14B).

Cutthroat trout size ranged from several young-of-the year that were less than 50 mm TL to large individuals longer than 400 mm, but most of the

Figure 3.1-1. Locations where all cutthroat trout were found, and where those classified as the fine-spotted form based on spotting patterns were identified in the field.

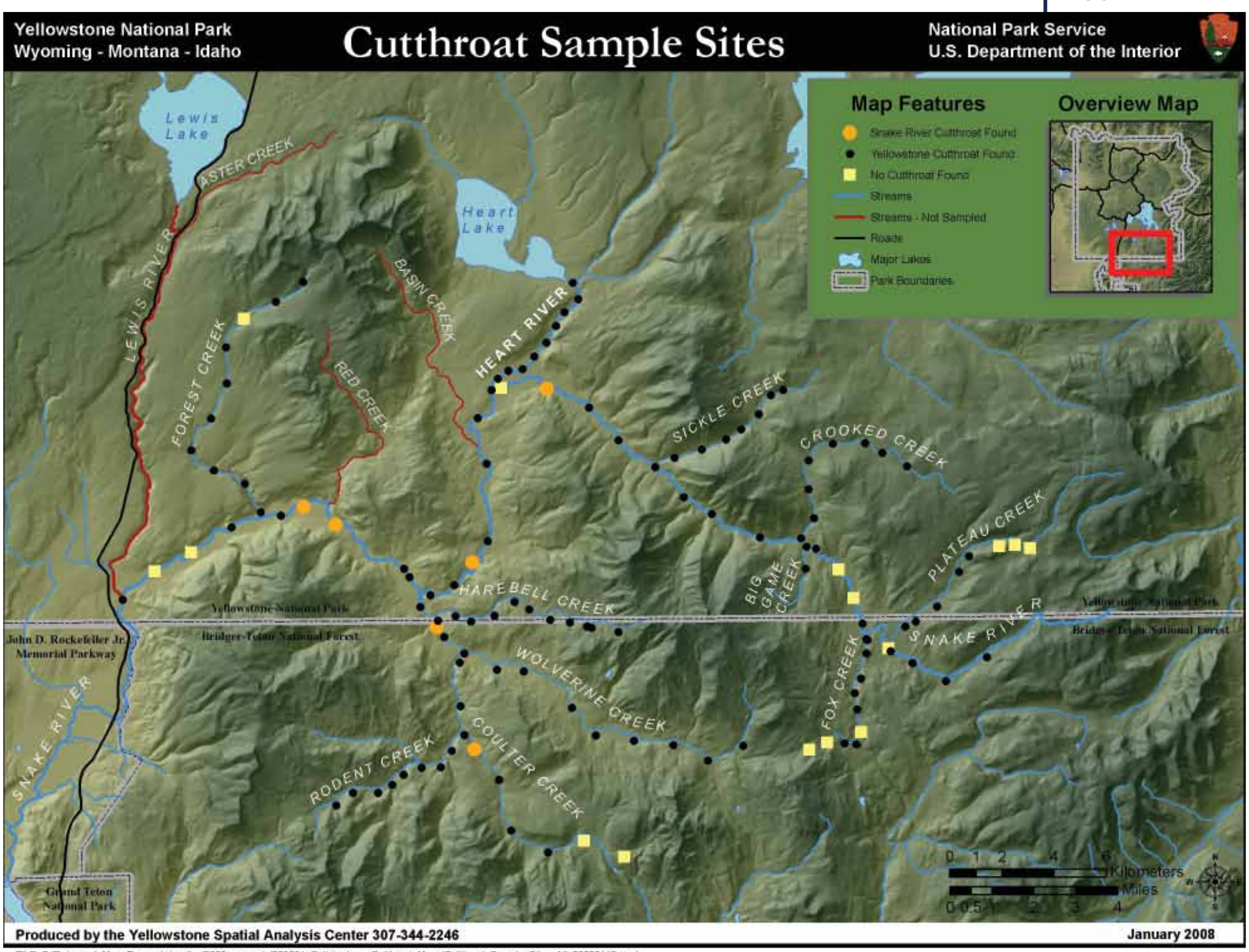

Table 3.1. Total number of fish captured by sample reach in the main stem of the Snake River.

	YCT	SRC	CUT	MWF	BRN	BRK	SCU	LND	SPD	RSS	MTS	UTS	TOTAL
Reach 0			1	8									9
Reach 1				21					2				23
Reach 2				22		1							23
Reach 3			2	62									64
Reach 4		3	1	22	3		1	2					32
Reach 5		1		29	3		3	22	5		1		64
Reach 6	1	1		37	1		3	7					50
Reach 7	1			17			4	21					43
Reach 8			1	13	1		1	13	2				31
Reach 9				5	1			1					7
Reach 10	1		2	40	1			2	1		1		48
Reach 11		1		45				1					47
Reach 12			3	39	2			4		1			49
Reach 13			1	5				6					12
Reach 14				1			15	1					17
Reach 14B			1	33	1		3	2	1			1	42
Reach 15		1	3				5						9
Reach 16	1		4				9	3			1		18
Reach 17			12				4	6					22
Reach 18	1		13				5	3			3		25
Reach 19			8				5	1					14
Reach 20	2		1				3						6
Reach 21	2		2				1						5
Reach 22			1				5						6
Reach 23	1		3				1						5
Reach 24							6						6
Reach 25							6						6
Reach 26	1		3				7						11
Reach 27	1						7						8
Reach 28	1						7						8
Reach 29	1		1										2
Reach 30	2		4				7						13
Reach 31	3		7										10
Total	**19**	**7**	**74**	**399**	**13**	**1**	**108**	**95**	**11**	**1**	**6**	**1**	**735**

Note: Reaches 0–15 represent the lower portion of the river, sampled by raft. Reaches 16–31 were sampled with backpacking electrofishing equipment. Reaches 14B and 15 represent the Snake River–Heart River confluence area discussed in the text.

Species codes

YCT: Yellowstone cutthroat trout
SRC: Snake River fine-spotted cutthroat trout
CUT: indeterminate cutthroat trout
MWF: Mountain whitefish
BRN: Brown trout
BRK: Brook trout
SCU: Mottled sculpin
LND: Longnose dace
SPD: Speckled dace
RSS: Redside shiner
MTS: Mountain sucker
UTS: Utah sucker

captured fish were between 100 and 300 mm TL (Figure 3.1-2). The largest fish were caught in the lower sections of the river (see Appendix A), and there was a general tendency for average trout size to decrease as we surveyed further upstream (Figure 3.1-3). Age determination by scale analyses have not yet been undertaken; however, visual inspection of the combined length structure of the 2004 sample suggests that at least three, and possibly four, age classes of cutthroat trout were present in the river.

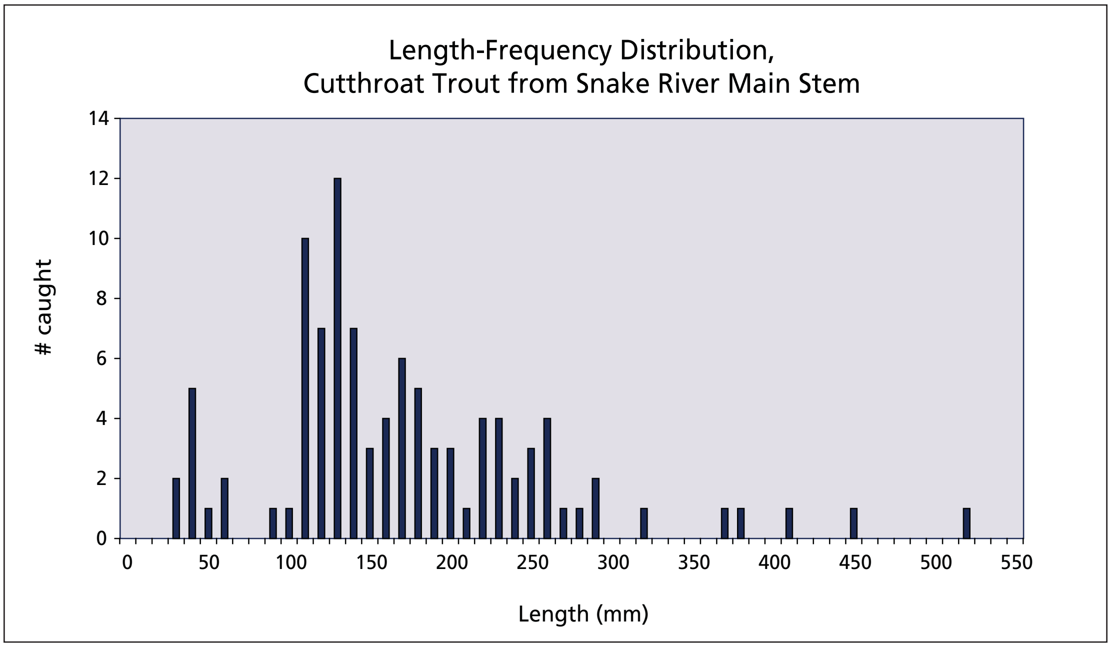

Figure 3.1-2. Length-frequency distribution of cutthroat trout captured from the main stem of the Snake River in 2004.

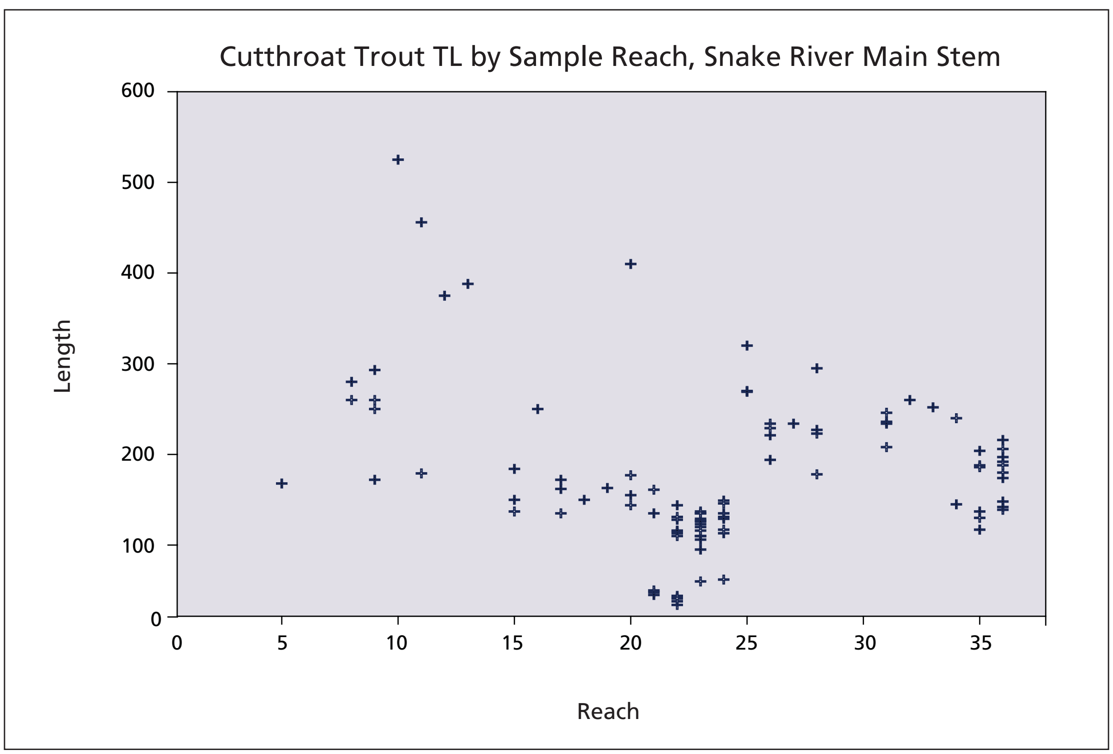

Figure 3.1-3. Individual total lengths (mm) of cutthroat trout caught in the Snake River main stem in 2004, grouped by sample reach.

Only about one-quarter of the cutthroat trout captured in the main stem could be definitively classified as either Yellowstone cutthroat trout or fine-spotted cutthroat trout. Fish exhibiting the typical, large-spotted pattern were represented at most sites upstream from the Snake River–Red Creek confluence. The seven individuals identified as SRC were captured between the Forest Creek–Heart River confluence area (see Figure 3.1-1). More than half of the remaining cutthroat trout were too small (many between 125 and 150 mm TL) to have fully developed spotting patterns characteristic of either subspecies. These were assigned to the general "cutthroat trout" category. An additional 26 fish, ranging from 155 to 388 mm TL, were also assigned to this category because their spotting pattern typically consisted of medium-sized spots well-distributed throughout the fish.

3.2 Forest Creek

The entire Forest Creek drainage was surveyed in 2005. Although the area between the barrier waterfall and the confluence with the Snake River (Reach 1) was about 0.5 km shorter than upstream reaches, it was considered one sample section. The additional upstream sample sections of Forest Creek were approximately 1.6 km apart. Four native fish species were collected from Reach 1, but only cutthroat trout were captured upstream from the waterfall. Substantially larger cutthroat trout were collected from the isolated upstream population than from the lower section with a direct connection to the Snake River (Figure 3.2). Cutthroat trout lengths in the main stem of Forest Creek were similar to those observed in Coulter Creek, but averaged about 25 mm longer than those in the tributaries of that stream (Table 3.2).

Although there are several potential barriers to upstream migration in Forest Creek, cutthroat trout were captured up to the headwaters. The small average length (between 125 and 150 mm TL) of captured trout resulted in the assignment of half of these fish into the cutthroat trout category. Five additional fish (ranging from 160 to 190 mm TL) contained numerous, widely distributed, medium-sized spots, and were also classified as cutthroat trout. About one-third of the trout captured in Forest Creek displayed classic YCT spotting patterns. The lower 100–200 m of several tributary streams upstream from the falls were also sampled, but only one of the fish captured there could be classified as a YCT. None of the fish in the basin exhibited a spotting pattern that could confidently be classified as SRC.

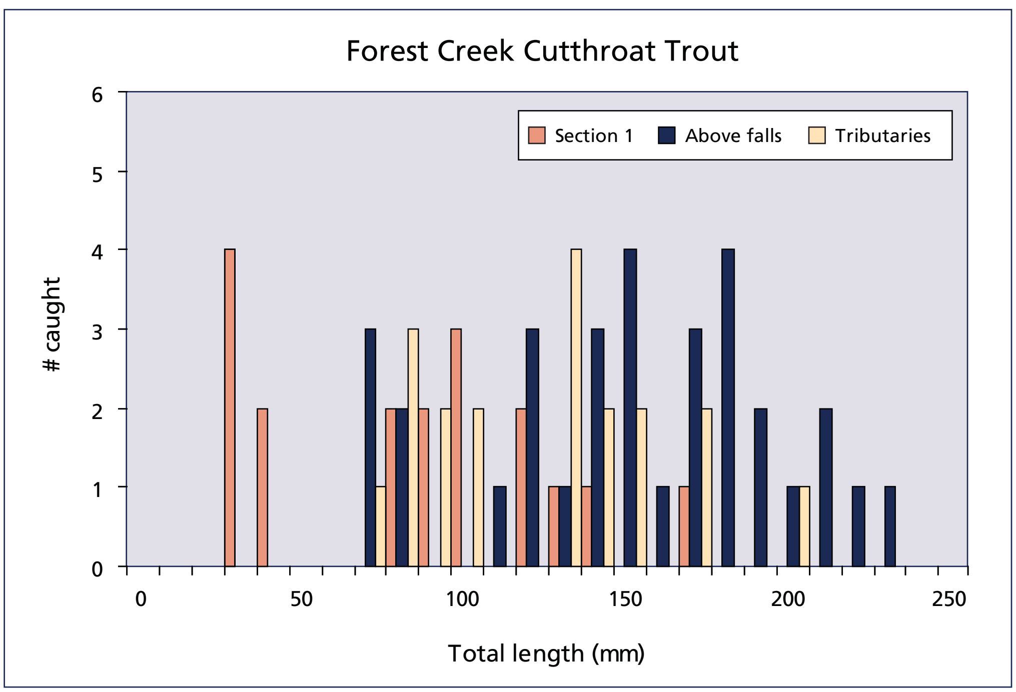

Figure 3.2. Length-frequency distribution of cutthroat trout from Forest Creek.

Table 3.2. Catch statistics for fish captured during inventory of Snake River tributaries, 2004 and 2005.

Species	Reach(es)	Year	Number caught	Mean length (mm)	Length range (mm)
Forest Creek					
Cutthroat trout	R1	2005	18	89	33–171
Cutthroat trout	R2–R10 Main stem	2005	32	155	75–233
Cutthroat trout	R2–R10 Tributaries	2005	19	127	71–204
Cutthroat trout	***All combined***	***2005***	***69***	***130***	***33–233***
Longnose dace	R1	2005	17	78	60–97
Speckled dace	R1	2005	3	89	85–93
Mottled sculpin	R1	2005	5	61	48–75
Coulter Creek					
Cutthroat trout	All	2004	63	149	104–299
Harebell Creek					
Cutthroat trout	All	2004	59	124	86–229
Wolverine Creek					
Cutthroat trout	All	2004	55	127	80–234
Rodent Creek					
Cutthroat trout	All	2004	34	122	86–179
Heart River					
Cutthroat trout	Main stem	2004	106	90	42–227
Cutthroat trout	Main stem	2005	36	112	40–159
Cutthroat trout	***Main stem***	***Combined***	***142***	***95***	***40–227***
Mountain whitefish	Main stem	2004	3	90	87–94
Longnose dace	Main stem	2004	57	64	26–112
Speckled dace	Main stem	2004	7	62	55–69
Mottled sculpin	Main stem	2004	53	67	30–100
Mountain sucker	Main stem	2004	5	63	36–126
Redside shiner	Main stem	2004	2	55	50–59
Sickle Creek					
Cutthroat trout	Main stem	2004	20	111	48–213
Cutthroat trout	Main stem	2005	131	115	33–253
Cutthroat trout	***Main stem***	***Combined***	***151***	***115***	***33–253***
Cutthroat trout	West tributary	2005	15	112	82–195
Cutthroat trout	***All combined***	***Combined***	***166***	***115***	***33–253***
Crooked Creek					
Cutthroat trout	All	2004	39	151	49–274
Cutthroat trout	All	2005	21	181	75–268
Cutthroat trout	***All combined***	***Combined***	***60***	***162***	***49–274***
Mottled sculpin		2004	34	86	33–130
Big Game Creek					
Cutthroat trout		2005	19	143	83–240
Mottled sculpin		2005	7	53	47–67

Table 3.2. Catch statistics for fish captured during inventory of Snake River tributaries, 2004 and 2005, cont.

Species	Reach(es)	Year	Number caught	Mean length (mm)	Length range (mm)
Plateau Creek					
Cutthroat trout (YCT)	Below Plateau Falls	2004	3	191	156–257
Cutthroat trout (CUT)	Below Plateau Falls	2004	13	150	85–261
Cutthroat trout (all)	***Below Plateau Falls***	***2004***	***16***	***158***	***85–261***
Cutthroat trout	Above Plateau Falls	2004	0	–	–
Fox Creek					
Cutthroat trout (YCT)	All	2004	8	180	150–243
Cutthroat trout (CUT)	All	2004	16	111	90–143
Cutthroat trout (all)	***All***	***2004***	***24***	***134***	***90–243***
Total all tributaries sampled	**All**	**2004–2005**	**649**	**98**	**26–274**

Red Creek and Basin Creek were not sampled in 2004–2005.

3.3 Coulter Creek

In 2004, the Bridger-Teton National Forest survey crew surveyed the entire Coulter Creek watershed. Although a large portion of this basin lies outside of YNP, the stream flows directly into the Snake River, in the lower portion of the study area. During the survey, no barriers to upstream fish passage were noted, and cutthroat trout were captured at all but the two uppermost sample sites of Coulter Creek (see Figure 3.1-1). Mountain whitefish were restricted to the lowest reach of Coulter Creek, but native sculpins were found throughout the watershed. Mottled sculpin density was estimated as common-to-abundant in the lower four reaches of Coulter Creek, the lower two-thirds of Rodent Creek, and most of Wolverine Creek. No mottled sculpin were captured in Harebell Creek, but Paiute sculpin (*Cottus beldingi*), were abundant in Reach 1 of that stream. Harebell Creek is the only location where this native species was found during this inventory. Longnose dace were abundant where they were found, but they were generally restricted to the lower-gradient reaches of Coulter Creek and Wolverine Creek. No non-native species were captured during the Coulter Creek survey.

At least 50 cutthroat trout were caught in Coulter Creek and its two primary tributaries, Harebell Creek and Wolverine Creek, but only about half as many cutthroat trout were found in Rodent Creek (see Table 3.2). Mean total length of cutthroat trout was similar in the three tributaries, and averaged about 25 mm less than that noted in Coulter Creek; however, fish exceeding 200 mm TL were rare throughout the watershed (Figures 3.3-1 and 3.3-2).

Ten of the 63 trout from Coulter Creek were identified in the field as YCT, and two were classified as SRC. The number of captured trout classified as YCT was also a minority in the tributary streams, where proportions ranged from a high of 19% in Harebell Creek to a low of 11% in Rodent Creek. Genetic analyses of these fish are pending.

3.4 Heart River

In the 2004 sample, only 10 fish were large enough to be submitted for genetic analyses (Figure 3.4). Based on their spotting patterns, all but one fish was classified as the “cutthroat group.” In 2005, an additional 30 fish were collected for genetic analyses from those sections of stream where the largest fish were caught in 2004. Although this latter group of fish was closer to the desired minimum size for classification, none displayed distinct spotting patterns. Based on their indeterminate spotting pattern,

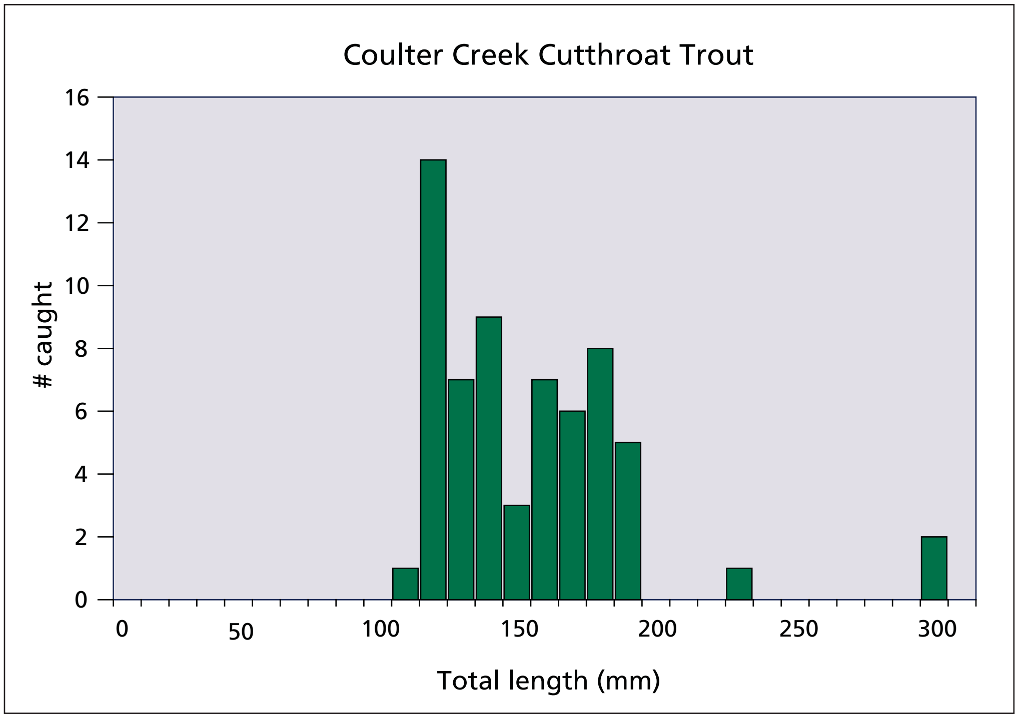

Figure 3.3-1. Length-frequency distribution of cutthroat trout from Coulter Creek.

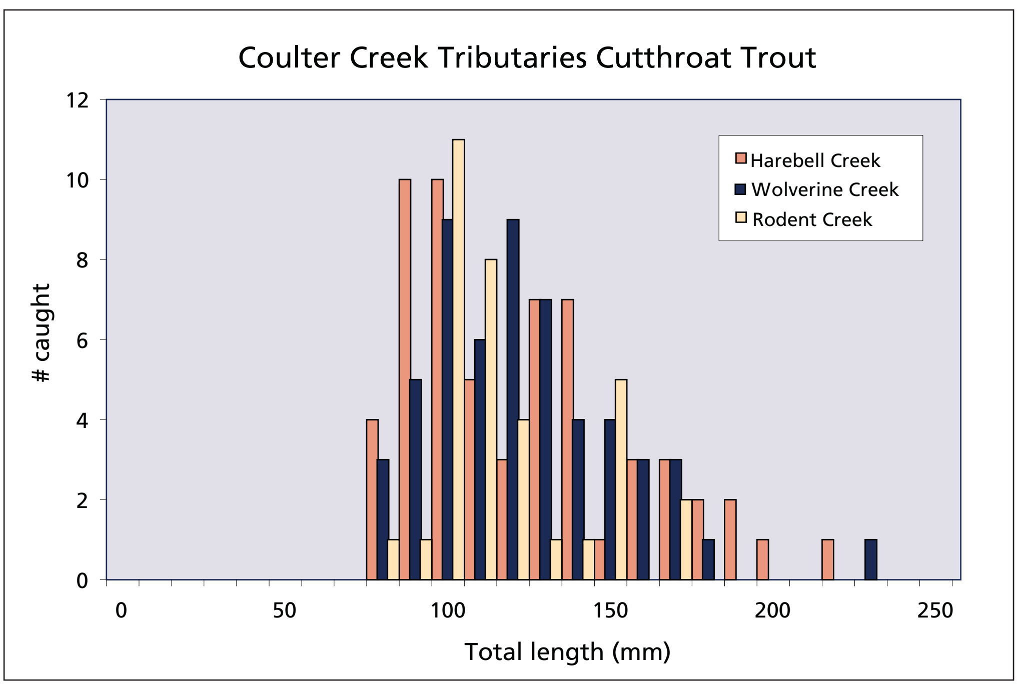

Figure 3.3-2. Length-frequency distribution of cutthroat trout from Coulter Creek tributaries.

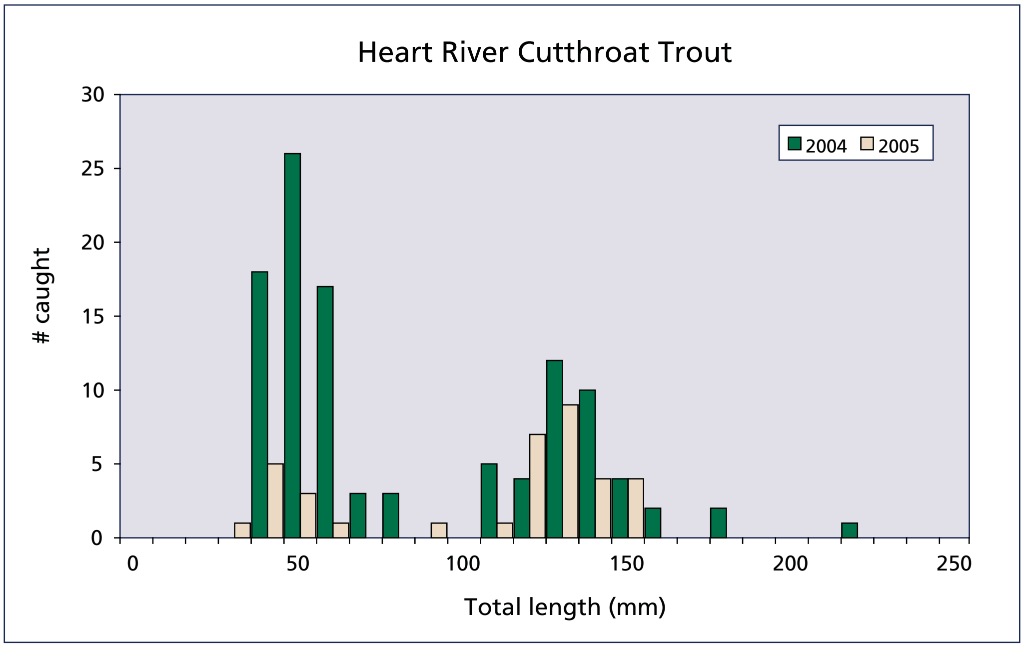

Figure 3.4. Length-frequency distribution of cutthroat trout from the Heart River.

9 of the 10 fish were classified "cutthroat." Most had a uniform silvery color with faint spots that made identification of actual spotting patterns difficult. The only fish that could confidently be assigned to either subspecies was the 220-mm+ YCT caught in 2004.

Only a few juvenile mountain whitefish were captured in the upper reaches of the Heart River, but dace and mottled sculpin were found throughout the stream. In all, seven different native fish species were collected from the Heart River (see Table 3.2).

3.5 Sickle Creek

Sickle Creek flows out of a steep canyon into the Snake River approximately halfway between the headwaters of the river and the South Entrance of the park (see Figure 1.2). In 2004, two sections near the confluence with the Snake River we sampled, and several small (<150-mm-TL) cutthroat trout were caught in the high-gradient areas characterized by bedrock pools and an unstable stream channel. In 2005, the inventory team completed the survey of Sickle Creek, which contains large, low-gradient meadows in its headwaters sections. Cutthroat trout were the only fish species caught in Sickle Creek, and their relative abundance in the upper reaches was the highest of any section yet sampled in the Snake River watershed. Most of the sampled trout had typical YCT spotting patterns; however, several fish had small-to-intermediate-size spots distributed in a pattern typically characteristic of SRC. Several size classes of cutthroat trout were captured throughout the stream, and young of the year were abundant (Figure 3.5).

Several hundred meters of the channel in the headwater areas of the basin were dry during the 2005 survey period. However, the largest cutthroat caught from Sickle Creek was found upstream from the areas of subterranean flow. Similar to other Snake River tributaries, most of the captured trout were shorter than 150 mm TL and could not be confidently assigned to either subspecies. Numerous fish between 150 and 225 mm TL also were assigned to the indeterminate category; seven fish that were classified as YCT were all at least 150 mm TL or longer.

3.6 Crooked Creek

In 2004, seven reaches of Crooked Creek were sampled and numerous groups of cutthroat trout captured. A waterfall estimated at 8–9 m high is located about midway through the seventh reach. No fish were collected upstream from this impassable barrier. Sculpins were also collected throughout the stream. In 2005,

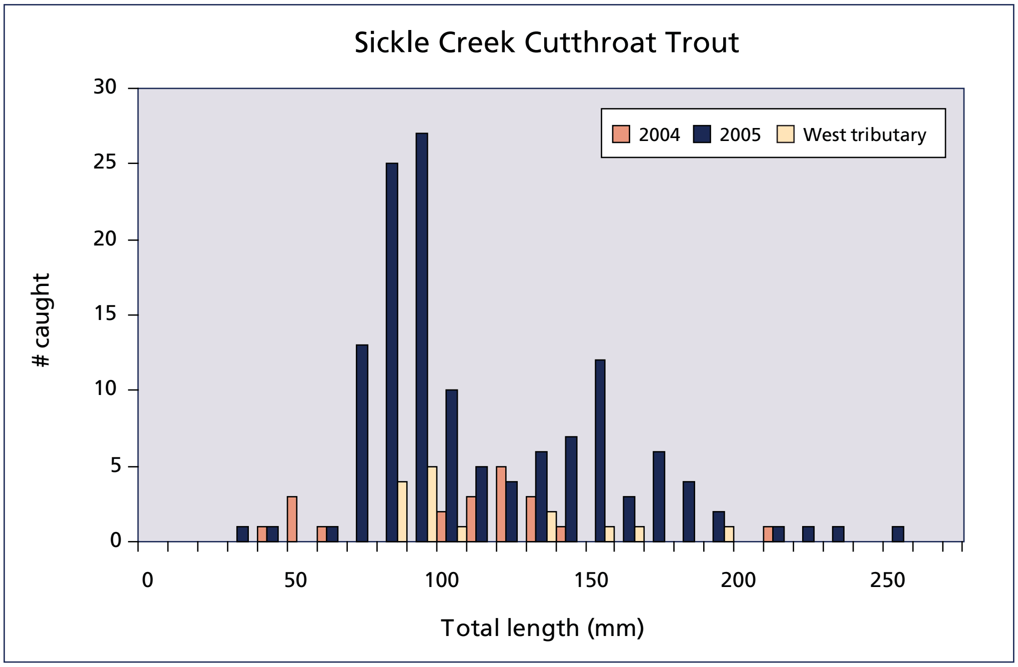

Figure 3.5. Length-frequency distribution of cutthroat trout from Sickle Creek.

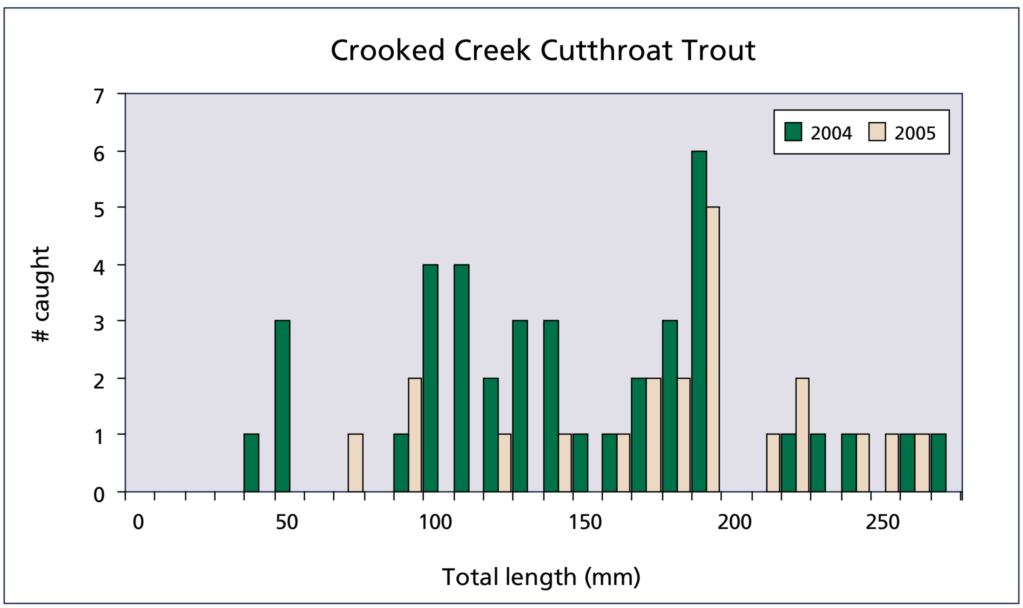

Figure 3.6. Length-frequency distribution of cutthroat trout from Crooked Creek.

an additional 21 cutthroat trout were collected for genetic analyses.

The trout from Crooked Creek were some of the largest collected in any of the tributary streams (Figure 3.6; Table 3.2). Unlike those found in some other sample areas, spotting patterns in many of these fish were well developed. No fish was classified as SRC, but more than half of the fish sampled exhibited typical YCT spotting patterns, with a concentration of large spots in the posterior half of the fish.

3.7 Big Game Creek

In 2005, an inventory was begun on a large, unnamed tributary that flows north from Big Game Ridge into the Snake River just slightly upstream from the Crooked Creek–Snake River confluence. This tributary contributes approximately one-third of the total main stem

flow at that point. For ease of reference, we have termed this stream "Big Game Creek." Due to logistical constraints, we were only able to survey reaches 1 and 2. Cutthroat trout and mottled sculpin were caught in each of the two reaches sampled. Average length of the cutthroat trout in Big Game Creek (90 mm TL) was about 100 mm smaller than of those captured in the two adjacent sample sections of the Snake River main stem.

3.8 Plateau Creek

In 2004, Bridger-Teton National Forest personnel sampled six reaches from the mouth of Plateau Creek upstream to Plateau Falls, which is a high waterfall and permanent barrier to upstream fish passage. Mottled sculpin were common, and cutthroat trout were collected from five of the six sections. Average size of cutthroat trout was similar to that observed in Crooked Creek (see Figures 3.6 and 3.8), but their relative abundance was much less in Plateau Creek. The NPS survey crew also electrofished approximately 200 m of stream above the falls that year, but no fish were seen or captured.

3.9 Fox Creek

In 2004, the Bridger-Teton National Forest crew also completed a survey of the entire Fox Creek drainage. Although this watershed lies outside of YNP, it is one of the uppermost named streams of the Snake River headwaters survey area. Two dozen cutthroat were caught, ranging between 90 and 250 mm TL (see Figure 3.9 and Table 3.2), primarily in low-gradient meadows. As in other Snake River tributaries, many of the sampled cutthroat trout were too small to allow for accurate identification of spotting patterns; genetic analyses are pending.

3.10 Genetic analyses

Samples from almost 200 cutthroat trout in the Snake River watershed were submitted for genetic analyses. These individual fish were classified to their respective haplotypes (variations of a gene identified from mitochondrial DNA). The S1 haplotype was the most common form observed throughout the Snake River main stem (Table 3.10, Figure 3.10). All but two of the trout categorized as YCT and about one-third of those identified in the field as SRC were S1 haplotypes. While more than a half-dozen haplotypes were detected in the main stem, they were restricted primarily to the reaches downstream from the confluence with Sickle Creek. All of the cutthroat trout upstream from that point were the S1 haplotype.

Five haplotypes were found in most of the tributary streams, but Crooked Creek contained

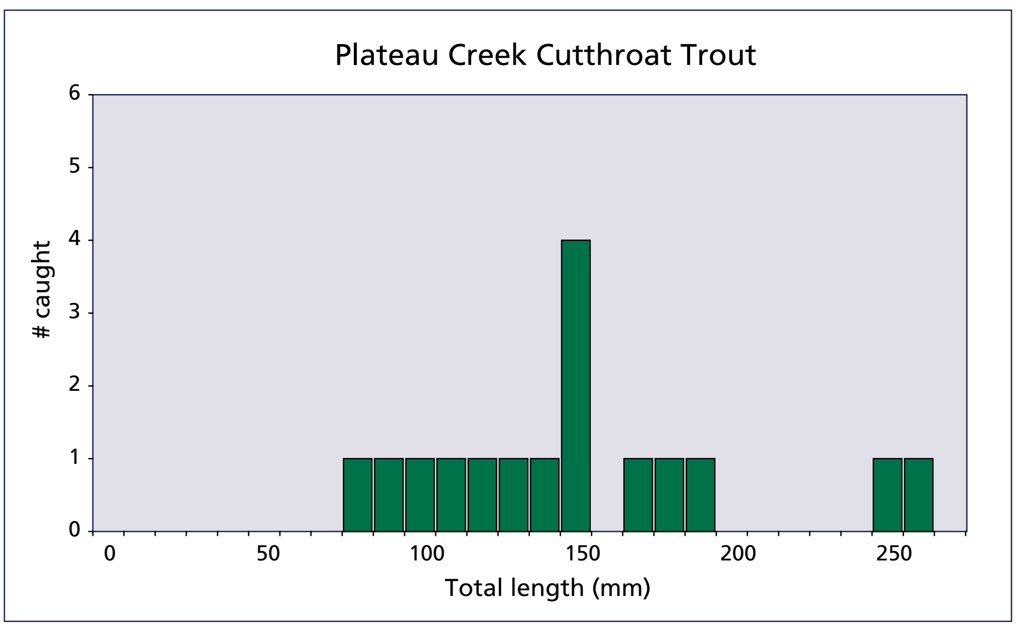

Figure 3.8. Length-frequency distribution of cutthroat trout from Plateau Creek.

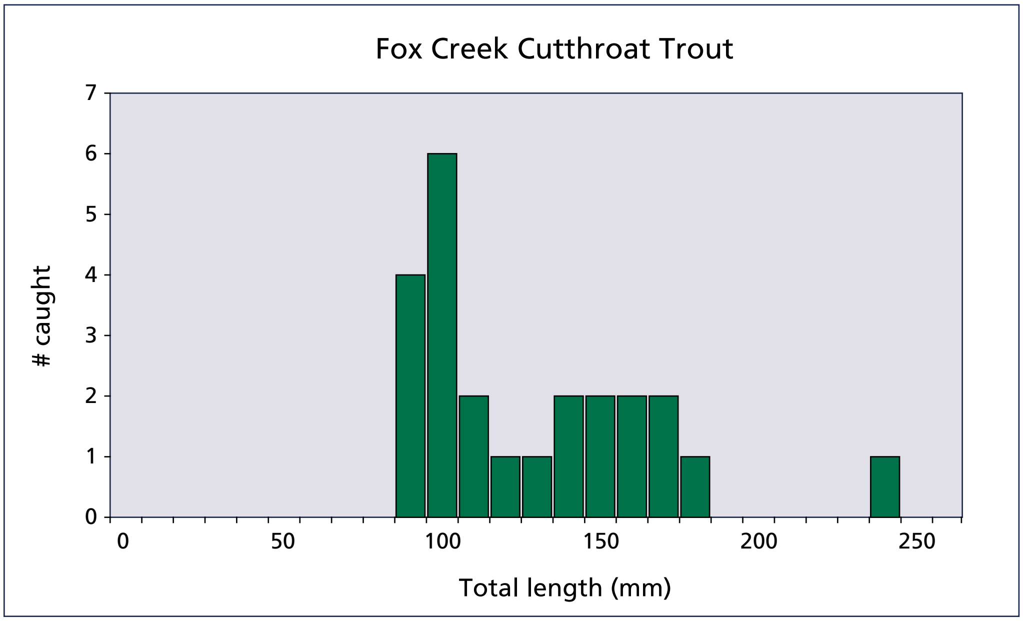

Figure 3.9. Length-frequency distribution of cutthroat trout from Fox Creek.

only the S1 variant and a minor proportion of the B haplotype. In Forest Creek, nearly all of the cutthroat trout upstream from the waterfall were classified as R2, which is a unique haplotype in the Snake River watershed. Sickle Creek trout exhibited a genetic structure similar to those from the main stem, but also contained two minor haplotypes not found elsewhere in the drainage. Although Heart River trout shared haplotypes similar to those observed in the Snake River, the B haplotype was dominant; it is also common in Heart Lake and Yellowstone Lake (Janetski 2006).

Table 3.10. Field identification (Field ID) of typical, large-spotted Yellowstone cutthroat trout (YCT), Snake River fine-spotted cutthroat trout (SRC), and an intermediate form (CUT), compared to results of genetic haplotype categorization.

Water body	Sample date	N	Field ID	Haplotypes (by %)
Snake River (main stem)	2004	25	CUT	**S1**, B, G, N2, –, A, M2, 02
	2004	9	YCT	**S1**, –
	2004	7	SRC	**S1**, B, N2, L2
Crooked Creek	2004/2005	17	CUT	**S1**, B, –
	2004/2005	21	YCT	**S1**, B, –
Forest Creek	2005	34*	CUT + YCT	**R2**, A, N2, S1, –, M2
Heart River	2004/2005	34*	CUT + YCT	**B**, S1, A, L2, –, M2
Sickle Creek	2004/2005	37*	CUT + YCT	**S1**, A, B, –, T2, T1

* Not all samples were able to be analyzed and some individuals could not be assigned to a particular haplotype.

Sample sizes (N) varied among sites and years.

Haplotypes are listed in order of decreasing percentage, with the prevalent haplotype in each sample in bold font. A dash (–) indicates an undescribed haplotype or sample that could not be analyzed.

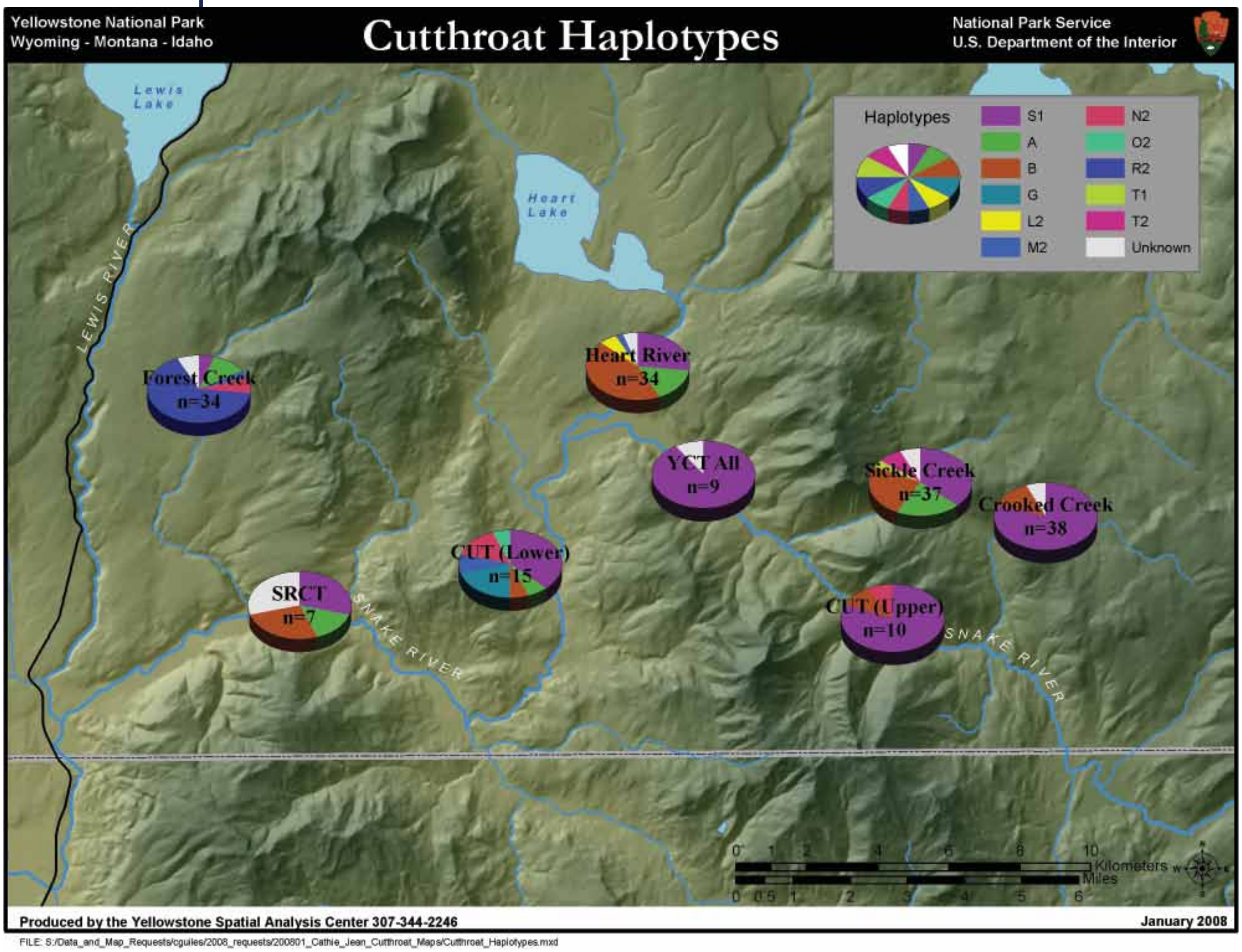

Figure 3.10. Location and proportion of cutthroat haplotypes observed in the Snake River watershed, 2004–2005.

Chapter 4
Discussion

This three-year survey of the Snake River was the first systematic survey of the entire basin within Yellowstone National Park. Nearly two-thirds of the cutthroat trout that we attempted to classify by spotting pattern had indeterminate or intermediate spotting patterns, because a large proportion were juveniles whose small size precluded effective spotting-pattern classification. This was particularly apparent in the Snake River and Heart River. However, some trout as long as 300 mm exhibited medium-size spots, well-distributed over the entire body, and thus were also classified as the indeterminate cutthroat type.

Based on haplotype composition, Janetski (2006) suggested that several cutthroat-trout populations reside within the Snake River study area. However, the historic stocking of cutthroat trout from Yellowstone Lake within the Snake River and many of its tributaries is likely now complicating our ability to distinguish among populations using genetic haplotypes. All three forms of cutthroat trout sampled during our surveys had the same dominant haplotype (S1), which, interestingly, has not previously been detected in cutthroat trout samples obtained from Yellowstone Lake. The A and B haplotypes have proved common in Yellowstone Lake and Heart Lake but, except for those from the Heart River, were only a minor component in the genetics of cutthroat trout we collected.

The historic stocking of Yellowstone Lake cutthroat trout into Heart Lake in the 1930s may be the original source of the current (dominant) B haplotype we found in the Heart River. This haplotype was also found in a genetic survey completed downstream from Jackson Lake by Novak et al. (2005), but was relatively rare in the larger survey area. Also, it is believed that Yellowstone Lake likely flowed south into the present-day Snake River headwaters at the end of the Pinedale glaciation, 15,000–35,000 years ago. Thus, it is not clear whether the occurrence of the B haplotype in the Snake River watershed is a result of historic stocking or a remnant of the paleohydrology of the area.

Our comparisons between individual field identification and genetic analyses did not yield a definitive method of reliably separating the Yellowstone cutthroat form from the Snake River fine-spotted form. However, the overall distribution of haplotypes in the watershed suggests that there may be several distinct populations in the Snake River basin. For example, despite the lack of physical barriers that would limit upstream fish passage, the Heart River confluence area and adjoining reach appears to be a transition zone separating the current fish assemblages in the Snake River. No SRC, mountain whitefish, or non-native salmonids were caught upstream from Reach 15, even though smaller native species, such as mottled sculpin and longnose dace, were captured for several more kilometers upstream. The cutthroat trout in these lower reaches may have a migratory life-history component not found in fish from the river's upper reaches.

Stocking records for Forest Creek do not specify whether the cutthroat trout eggs from Yellowstone Lake were put upstream of the waterfall, but the current, high abundance of cutthroat trout distributed nearly to the headwaters of the watershed suggests that cutthroat eggs were indeed put in the upper reaches of the stream. Genetic analyses of cutthroat trout from Forest Creek indicate that the prevalence of the R2 haplotype in the upstream reaches there confirms that this is an isolated population. Many of the adult cutthroat trout we located in the headwater areas of tributary streams and the upper Snake River proper likely represent non-migratory residents.

Comparison of the current inventory results with the earlier U.S. Fish and Wildlife Service study (Jones et al. 1983) reveals that native species composition, distribution, and abundance has changed little in the lower Snake River during the last 20 years. Juvenile trout were common throughout the basin, but few adults were captured in the lower river. This could indicate that the cutthroat trout within the park are highly migratory and use the lower river primarily for spawning. Mountain whitefish were the most abundant species collected in the lower Snake River during the present and

the 1983 survey. Cutthroat trout and mottled sculpin were also widely distributed. The single SRC caught during the 1983 survey was collected in the same location as multiple captures of that form in 2004. Native cyprinid and catostomid capture locations were similar, and non-native salmonids were a minor component of the total catch in both surveys. Although there continue to be occasional reports of lake trout being caught by anglers in the Snake River (and one was caught during the 1983 electrofishing survey), none was caught during the current inventory.

This inventory enabled the National Park Service to obtain baseline information about the distribution of what may be one of the rarest native fish in the park, the Snake River finespotted cutthroat trout. In addition, the basin-wide survey has yielded information on the sympatric distribution of other native species in the watershed. It appears also that these fish have persisted in reasonable numbers despite the presence of non-native fish species in the drainage for more than 60 years.

Chapter 5
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Appendix A
Photo Sets

Photo set 1. Reaches sampled in 2004 along the lower main stem Snake River.

Photo set 2. Yellowstone cutthroat trout from Reach R3 on the main stem Snake River in 2004.

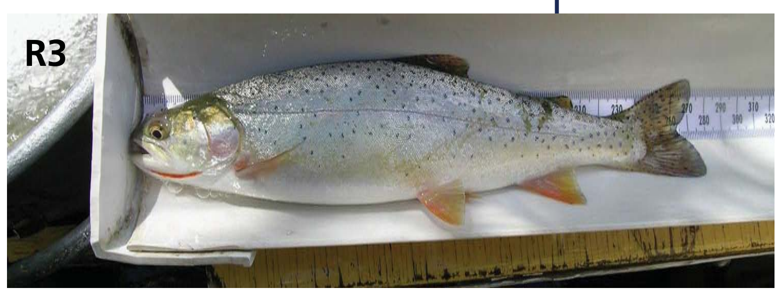

Photo set 3. Reaches sampled in 2004 along the middle main stem Snake River.

Photo set 4. Snake River fine-spotted cutthroat trout from reaches R6 and R7 on the main stem Snake River in 2004.

Photo set 5. Reaches sampled in 2004 along the upper main stem Snake River.

Photo set 6. Snake River fine-spotted cutthroat trout from Reach R11 and brown trout from Reach R12 on the main stem Snake River in 2004.

Photo set 7. Indeterminate cutthroat trout from Reach 15, and Yellowstone cutthroat trout from Reach R18 on the main stem Snake River, 2004.

Photo set 8. Heart River at confluence with Snake River (R0) and other representative reaches sampled by backpack electrofisher in 2004.

Photo set 9. Yellowstone cutthroat trout from Reach 4 on the Heart River in 2004.

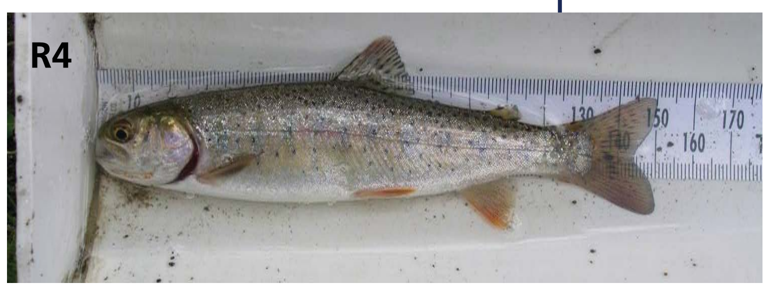

Photo set 10. Upstream views of reaches R1–R8 surveyed on Forest Creek in 2005.

Photo set 11. Yellowstone cutthroat trout from reaches R4 and R6 on Forest Creek in 2005.

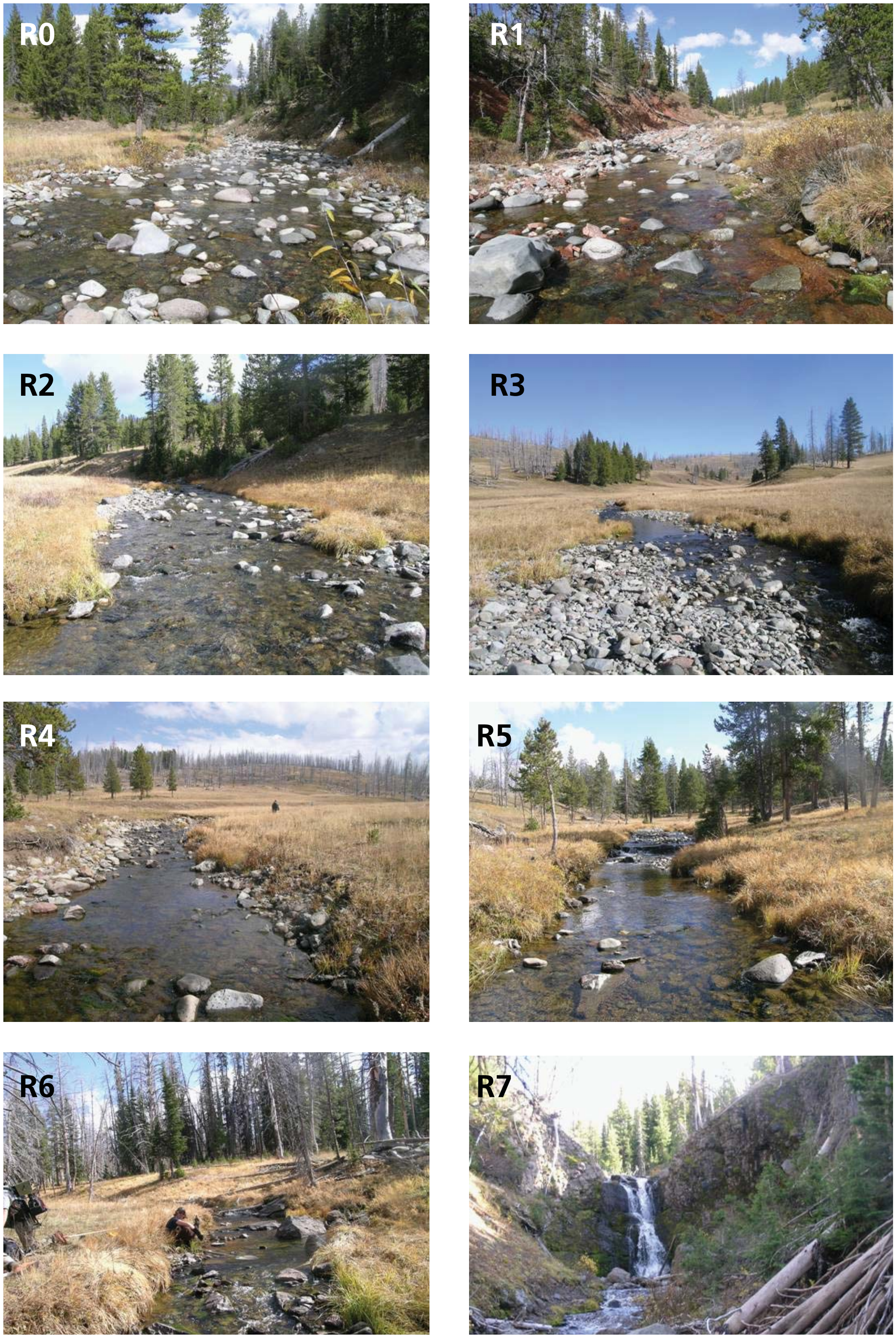

Photo set 12. Upstream views of reaches R0–R7 surveyed on Crooked Creek in 2005.

Photo set 13. Yellowstone cutthroat trout from Reach R1, and indeterminate cutthroat trout from Reach R7 on Crooked Creek, 2005.

Appendix B
Fish Species Named in This Report

Table B. Fish species named in this report.

Common name	Scientific name
brook trout	*Salvelinus fontinalis*
brown trout	*Salmo trutta*
lake trout	*Salvelinus namaycush*
longnose dace	*Rhinichthys cataractae*
mottled sculpin	*Cottus bairdi*
mountain whitefish	*Prosopium williamsoni*
Paiute sculpin	*Cottus beldingi*
redside shiner	*Richardsonius balteatus*
Snake River fine-spotted cutthroat trout	*Oncorhynchus clarki* subsp.
Utah sucker	*Catostomus ardens*
Yellowstone cutthroat trout	*Oncorhynchus clarki bouvieri*

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