IDAH DEPARTMENT OF FISH AND GAME

FISHERY MANAGEMENT REPORT

Steven M. Huffaker, Director

2004 UPPER SNAKE REGION

By

Dan Garren, Regional Fishery Biologist
William C. Schrader, Senior Fishery Research Biologist
Damon Keen, Assistant Fish Hatchery Manager
Jim Fredericks, Regional Fishery Manager

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APPENDIX

MOUNTAIN LAKES INVESTIGATIONS

Dan Garren, Regional Fishery Biologist

ABSTRACT

As part of a three-year comprehensive survey, ten mountain lakes in the Upper Snake Region were sampled during 2004. Surveys consisted of population monitoring using gill nets, angling and visual observations as well as habitat assessment, amphibian presence/absence surveys and evaluations of human use and impacts. Data were used to validate current stocking rates to assure we are providing quality fisheries. Angler catch rates ranged from 0 to 7.8 fish per hour in the ten lakes surveyed. Our catch rate objective of one fish per hour was met in seven of the 10 lakes, two of which are not on our stocking rotation and are sustained with natural reproduction. Three lakes did not meet our catch rate objective, two of which would benefit from increased stocking frequencies. Although the third lake did not meet our catch rate objective during the survey, we believe the current stocking rate is adequate. Natural reproduction was evident in seven lakes, and assumed to be substantial enough to support the fishery in three lakes. Amphibians were found in three of 10 lakes.

Authors:

Dan Garren
Regional Fishery Biologist

Jim Fredericks
Regional Fishery Manager

INTRODUCTION

Fishing is a popular attraction at many of the mountain lakes in the Upper Snake Region of Idaho. However, current data describing these fisheries is limited. Prior to the 2002 sampling season, we met with the United States Forest Service fisheries biologist out of the Salmon/Challis Region to agree on a collaborative sampling methodology for mountain lakes. Guidelines for regional mountain lake management were jointly established, and include the following:

1. Maximize the effective use of hatchery introductions
2. Manage for a diversity of species within given drainages
3. Maintain catch rates of one fish per hour or better
4. Maintain some lakes in each drainage as fishless for native aquatic species

OBJECTIVE

To obtain current information for fishery management decisions on mountain lakes, including angler use and success, fish population characteristics, spawning potential, stocking success, limnology, morphology, and notes on other aquatic life and develop appropriate management recommendations.

METHODS

To gather fish population information, mountain lake sampling consisted of an overnight gill net set with a standard experimental gill net (20 m by 1.5 m, with mesh sizes of 2.5 cm, 5 cm and 7.5 cm bar mesh) set perpendicular to the shore in combination with visual observations of fish presence and a minimum of one hour of angling. All anglers encountered while surveying a lake were interviewed for catch rate information, and combined with results from our own angling efforts. Physical parameters such as lake type, aspect and depth profile were estimated by on-site observations while surface area and shoreline distance were measured using Maptech Terrain Navigator Pro (Maptech 2005) distance measuring tool. Depth profile was classified as shallow (< 1 m), moderate (1-2 m) or deep (> 2 m), and estimated while on-site. Amphibian presence/absence data was collected by walking shoreline areas and recording species encountered. Conductance and temperature were measured with appropriate meters. The potential for natural recruitment was estimated by ranking the quality of habitat present in the inlets and outlets. We defined quality habitat as having clean pebble or cobble substrate with sufficient flows to allow adult fish to spawn, and offspring to migrate into the lake. The length of habitat present in the inlets/outlets was estimated, and ranked according to quality and abundance (Excellent = abundant spawning habitat present; Adequate = enough habitat present to maintain a fishery; Fair = habitat present, but limited in abundance; Poor = no suitable habitat). Additionally, the timing of surveys was scheduled to correspond to the third year following stocking and prior to the current years stocking. This provides the best opportunity to document natural reproduction by analyzing length frequencies and visually observing fish. If recruitment was strictly dependent on stocking, only one or possibly two size classes of fish should be present. Human use and impacts were measured by walking the shoreline and recording information on trail condition, litter amounts and the number of campfire rings. Although subjective, access difficulty was estimated as easy (access less than two km with low to moderate elevation gain), moderate (two to five km access with moderate elevation gain), and difficult (> 5 km approach with substantial elevation gains).

RESULTS

Survey results are summarized in Table 1. Our samples collected rainbow trout *Oncorhynchus mykiss*, brook trout *Salvelinus fontinalis*, Yellowstone cutthroat trout *O. clarki bouvieri*, golden trout *O. aguabonita* and Arctic grayling *Thymallus arcticus*. Survey results indicate the management objective of one fish per hour is being met on Angel Lake, Big Lake, Fall Creek Lakes # 1 and #2, Golden Lake, Green Lake, Round Lake and Starhope Lake. The catch rate objective is not being met on Fishpole Lake or Iron Bog Lake. Natural reproduction was found in Angel Lake, Big Lake, Fall Creek Lakes # 1 and # 2, Iron Bog Lake, Round Lake and Starhope Lake. Amphibian populations (either Columbia spotted frogs or Long-toed salamanders) were found in Fishpole Lake, Iron Bog Lake and Round Lake. Data on individual lakes is presented in Appendix A.

DISCUSSION

Survey results show our catch rate objective is being met on the majority of lakes sampled and actively managed by IDFG. Angler use appears to be heaviest in lakes that require little effort to reach. Although our sample size is low, there is evidence suggesting lakes with difficult access provide higher catch rates, possibly as a result of decreased effort. Future analysis should explore the relationship among access, catch rates and angler use. In addition to catch rate objectives, established guidelines call for some lakes to remain fishless to provide areas of refuge for amphibians. Three of the ten lakes sampled had both fish and amphibians present. The remaining lakes all had a spring or lake in the drainage within two km that was fishless and could provide additional opportunities for amphibians and native species, thereby meeting our objective. We do not currently monitor these fishless water bodies, but may incorporate them in future surveys where information on amphibians would be beneficial. Data from the past three years of mountain lake assessment should be compiled and analyzed over the coming year to evaluate broad-scale changes to our stocking protocol.

RECOMMENDATIONS

1. Maintain current stocking rates in Fall Creek Lake #1 and Green Lake.

2. Continue to manage Fall Creek Lake # 2 and Starhope Lake as wild fisheries (no stocking). Terminate stocking on Angel Lake and manage as a wild fishery.

3. Increase stockings by 1,000 fish each in Fishpole Lake and Iron Bog Lake, and evaluate catch rates in 2007.

4. Increase stocking frequency on Big, Round and Golden Lakes from every third year to every other year.

5. Manage Fall Creek Lake # 1 for golden trout only. If golden trout are not available, do not substitute additional fish species.

6. Compile all mountain lakes data from the past three years to explore relationship between access, angler effort and catch rates and adjust stocking protocol as necessary.

Table 1. Results from lake surveys in the Upper Snake Region, Idaho, 2004.

Lake Name	Surface Area (ha)	Depth[a]	Species Present[b]	Natural Production	Amphibians Present[c]	Angling CPUE	Gill Net CPUE	Campfire Rings (No.)	Access Difficulty	Angler Use
Angel	6.2	Deep	RBT GLD	Common	No	7.0	--	0	Difficult	Rare
Big	6.8	Deep	YCT	Rare	No	1.0	--	10	Easy	High
Fall Creek 1	0.9	Moderate	GLD	Rare	No	0	30	1	Moderate	Moderate
Fall Creek 2	1.5	Deep	RBT	Abundant	No	7.8	8	1	Moderate	Moderate
Fishpole	3.0	Deep	YCT	None	Yes (LTS)	0	1	7	Easy	High
Golden	1.0	Deep	GLD	None	No	1.5	8	2	Easy	High
Green	1.9	Deep	CTT GR	None	No	1.5	7	4	Easy	Moderate
Iron Bog	4.1	Deep	YCT HYB RBT	Rare	Yes (CSF)	0.3	6	10	Easy	High
Round	2.4	Deep	YCT GR	Rare	Yes (LTS CSF)	2.0	14	3	Easy	High
Starhope	0.5	Deep	BKT	Common	No	2.0	3	3	Easy	Moderate

[a] – Depth was estimated as shallow (< 2 m), moderate (= 2 m) or deep (> 2 m)
[b] – Species abbreviations: RBT = rainbow trout; GLD = golden trout; YCT = Yellowstone cutthroat trout; CTT = unspecified cutthroat trout; GR = Arctic grayling; HYB = hybrid trout (RBT x CTT); BKT = brook trout
[c] – Amphibian abbreviations: LTS = long-toed salamander; CSF = Columbia spotted frog

Appendix A. Mountain lake report summaries.

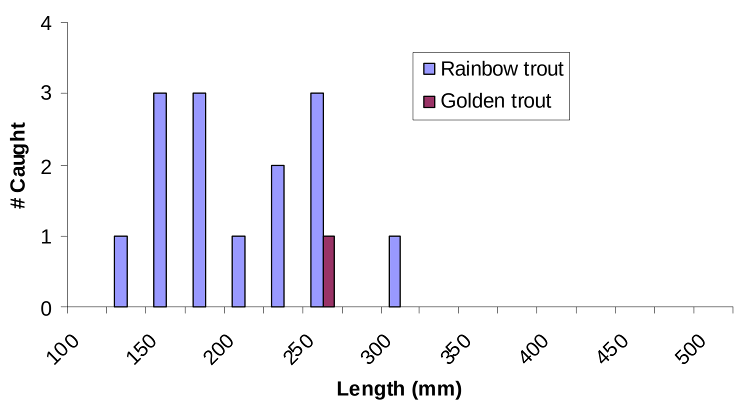
Angel Lake

737,265 E 4,853,837 N Z 11

Angel Lake is located in the headwaters of Fall Creek in the Big Lost River drainage near Mackay Idaho. The lake is deep, measures 930 m in circumference (6.2 ha), and resides at an elevation of 3,133 meters. Conductivity in this cirque lake was 28 umho/cm^3. Surrounding habitat is mainly boulders and rocky scree, with very few nearby trees. There was no trail to or around the shoreline, no litter, no fire rings or any other evidence of human use. As a result, we believe very few anglers visit annually. There were no inlets, no outlets and no visible spawning habitat at the time of sampling. Access is difficult, and consists of a drive up Fall Creek, followed by a four km hike on a maintained trail followed by about four km of difficult cross country travel.

On August 8, 2004, we surveyed the fishery and physical characteristics of Angel Lake. The fishery survey consisted of an overnight gill net set using experimental nets set perpendicular to the shore in combination with angling and visual observations. We were unable to retrieve our gill nets promptly, as they tangled with the bottom. Consequently, we did not include that data in this report. We fished for a total of two hours, and caught rainbow trout (13 fish) and golden trout (one fish). We also observed numerous trout in the 50 - 300 mm range. No amphibians were observed during our shoreline survey.

Our survey indicates Angel Lake is meeting the fishery objective of one fish per hour (actual catch rate 7 f/h). Access is difficult, and there is no evidence of human use of the area. Our length frequency information and fish observations suggest natural reproduction occurs in spite of the lack of spawning habitat. We suspect this reproduction could sustain our catch rate goals. Rainbow trout have not been stocked since 1998, and now dominate the fishery. Angel Lake has been stocked with as many as 1,200 fingerling golden trout, although recent stockings have been 300 golden trout. We only collected one golden trout in the course of our survey, and don't believe stocking Angle Lake is a wise use of this limited resource. Therefore, we recommend removing Angel Lake from the stocking schedule and assessing natural reproduction in the coming years.



Length frequency of fish caught in Angel Lake, 2004 and recent stocking history.

Year	Species	No. Stocked
2001	Golden Tr	300
2000	Golden Tr	1,233
1998	RBT	500
1990	Golden Tr	750
1989	YCT	650

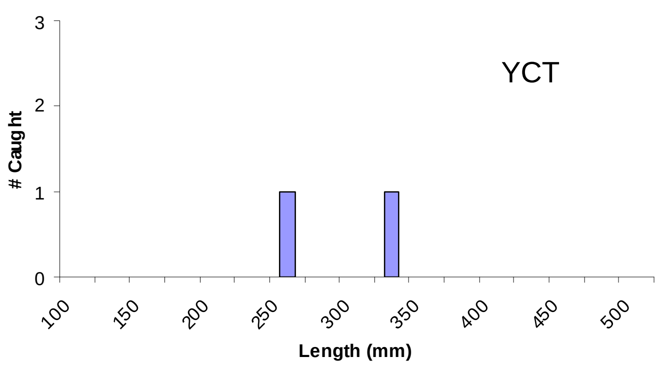
Big Lake

269,902 E; 4,845,516 N Z 12

Big Lake is located in the headwaters of Lake Creek in the Big Lost River drainage near Mackay Idaho. The lake measures 1.1 km in circumference (6.8 ha) and sits at an elevation of 2,956 meters. This deep cirque lake had a conductance of 30 umho/cm^3. Surrounding habitat is a mix of open moraine and coniferous trees, with some rocky scree nearby. There was a well-defined trail to and around the shoreline, significant litter and ten fire rings to suggest significant human use. There were four inlets and one outlet that provided a total of 200 m^2 of suitable spawning habitat at the time of sampling. Access is easy, and consists of a drive up Lake Creek to the trailhead, followed by a nine km hike on a maintained trail that accommodates hiking, horses, motorcycles and four-wheelers.

On July 27, 2004, we surveyed the fishery and physical characteristics of Big Lake. The fishery survey consisted of angling and visual observations of fish. We did not set gill nets due to time constraints. We fished for a total of two hours, and caught two Yellowstone cutthroat trout. We also observed numerous trout in the 100 - 200 mm range. No amphibians were observed during our one-hour shoreline survey.

Our survey indicates Big Lake is meeting the fishery objective of one fish per hour (actual catch rate 1.0 f/h). Access is easy, and there is evidence of significant human use. Our length frequency information combined with fish observations and available habitat suggest some natural reproduction. However, we don't believe this reproduction could sustain our catch rate objective given the high use this lake receives. Rainbow trout were stocked in 2003 as part of a mountain lakes research project. Normal stocking protocol is 3,500 cutthroat trout every three years. Given the ease of motorized access to this drainage, we recommend continuing to stock 3,500 Yellowstone cutthroat trout, but on a two-year rotation and evaluating this change in the coming years.



Length frequency for trout captured in Big Lake, 2004 and recent stocking information.

Year	Species	No. Stocked
2004	HL YCT	3,500
2003	Hayspur RBT	1,000
2003	Triploid Kaml	500
2001	HL YCT	3,500

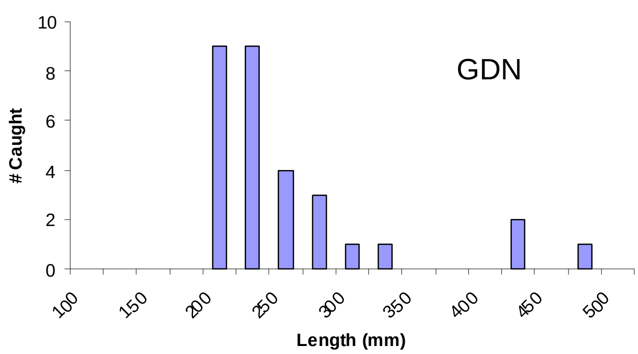
Fall Creek Lake # 1

737,329 E; 4,852,707 N Z 11

Fall Creek Lake # 1 is located in the headwaters of Fall Creek in the Big Lost River drainage near Mackay Idaho. The lake measures 360 m in circumference (0.9 ha), at an elevation of 2,966 m and a moderate depth. This cirque lake had a conductance of 88 umho/cm^3. Surrounding habitat consists of rocky moraine and some coniferous trees nearby. There was no trail around the shoreline, no litter, and only one fire ring suggesting minimal human use. There was one inlet and one outlet that provided approximately 30 m^2 of suitable spawning habitat at the time of sampling. Access is moderate, and consists of a drive up Wildhorse Creek to the trailhead on Fall Creek, followed by a four km hike on a maintained trail followed by three km of cross-country travel.

On August 19, 2004, we surveyed the fishery and physical characteristics of Fall Creek Lake # 1. The fishery survey consisted of an overnight gill net set using experimental nets set perpendicular to the shoreline in combination with angling and visual observations of fish. Gill nets captured 30 golden trout ranging in size from 205-475 mm. We fished for a total of two hours following the gill net survey, but caught no fish. We also observed numerous trout in the 100 - 300 mm range. No amphibians were observed during our 20-minute shoreline survey.

Our data indicate Fall Creek Lake #1 does not meet the fishery objective of one fish per hour (actual catch rate 0.0 f/h). However, our angling survey followed a very successful gill net survey, which we believe affected our catch rates. Based on the high gill net catch rate in and ancillary information from anglers fishing Fall Creek Lake # 1 in 2004, we believe the fishery provides adequate catch rates. Access is moderate, and there is evidence of moderate human use. Our length frequency information combined with fish observations and available habitat suggest limited natural reproduction. However, we don't believe this reproduction could sustain our catch rate goals. Typical stocking is approximately 500 golden trout every three years. We recommend continuing this stocking rate when golden trout are available and managing strictly for golden trout.



Length frequency for trout captured in Fall Creek Lake #1, 2004 and recent stocking information.

Year	Species	No. Stocked
2004	Golden trout	500
2000	Golden trout	462
1996	Golden trout	1,719

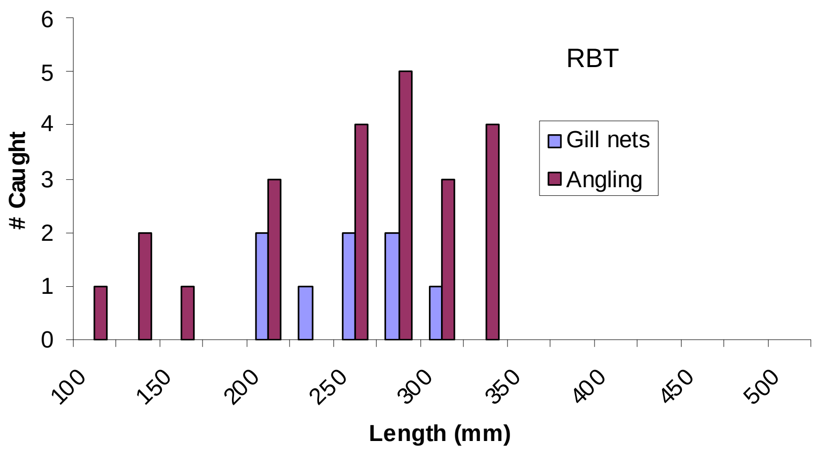
<u>Fall Creek Lake # 2</u>

736,489 E; 4,852,792 N Z 11

Fall Creek Lake # 2 is located in the headwaters of Fall Creek in the Big Lost River drainage near Mackay Idaho. The lake measures 524 m in circumference (1.5 ha), and sits at an elevation of 3,136 m. This deep cirque lake had a conductance of 74 umho/cm^3. Surrounding habitat consists of rocky moraine and rocky scree. There was no shoreline trail, no litter, and only one fire ring suggesting minimal human use. There were two inlets and one outlet that provided approximately 14 m^2 of suitable spawning habitat at the time of sampling. Access is moderate, and consists of a drive up Wildhorse Creek to the trailhead on Fall Creek, followed by a four km hike on a maintained trail followed by four km of cross-country travel.

On August 19, 2004, we surveyed the fishery and physical characteristics of Fall Creek Lake # 2. The fishery survey consisted of an overnight gill net set in combination with angling and visual observations of fish. Gill nets captured eight rainbow trout ranging in size from 200-300 mm. We fished for a total of three hours and caught 23 rainbow trout ranging in size from 100 – 325 mm. We also observed numerous trout in the 100 - 400 mm range. No amphibians were observed during our 20-minute shoreline survey.

Our data indicate Fall Creek Lake #2 exceeds the fishery objective of one fish per hour (actual catch rate 7.8 f/h). Access is moderate, and there is evidence of moderate human use. We have no records of this lake being stocked, in spite of the presence of rainbow trout. Our length frequency information, fish observations, habitat surveys and lack of stocking records show the lake is supported by natural reproduction. No additional stockings are warranted.



Length frequency distribution of fish collected in Fall Creek Lake #2, 2004. No stocking records exist for this lake.

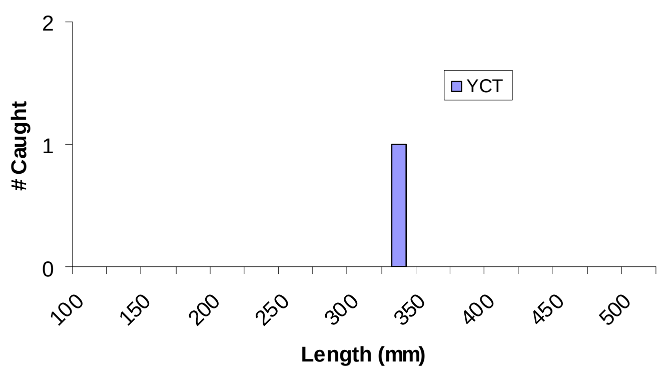
Fishpole Lake

270,155 E; 4,835,876 N Z 12

Fishpole Lake is located in the headwaters of Iron Bog Creek in the Big Lost River drainage southeast of Mackay Idaho. The lake has 710 m of shoreline (3.0 ha), and resides at an elevation of 2,835 m. This deep cirque lake has a conductance of 30 umho/cm^3. Surrounding habitat consists of grassy moraine with patches of coniferous trees. There was a partial trail around the shoreline, substantial litter, and seven fire rings suggesting a high degree of human use. There were no inlets or outlets that provided any suitable spawning habitat at the time of sampling. Access is easy, and consists of a drive up the left fork of Iron Bog Creek to the trailhead, followed by a two km hike on a maintained trail followed by 1.5 km of easy cross-country travel.

On August 2, 2004, we surveyed the fishery and physical characteristics of Fishpole Lake. The fishery survey consisted of an overnight gill net set in combination with angling and visual observations of fish. Gill nets captured one 330 mm cutthroat trout. IDFG personnel and volunteer Boy Scout troops fished for a total of 13 hours without catching a fish. We did observe three fish of unknown size while surveying. We also found Long-toed salamanders during our two-hour shoreline survey.

Our data indicate Fishpole Lake does not meet the fishery objective of one fish per hour (actual catch rate 0.0 f/h). Access is easy, and there is evidence of significant human use. There is no evidence of natural reproduction, and the population is likely supported solely by our stockings. Given the easy access and popularity of this area, we recommend increasing the stocking rate by 1,000 fish to improve catch rates. The fishery should be monitored three years following this increase to see if catch rates improve.



Length frequency distribution of fish caught in Fishpole Lake, 2004 and recent stocking information.

Year	Species	No. Stocked
2004	HL YCT	2,502
2001	HL YCT	2,500
1998	HL YCT	2,500
1995	HL YCT	3,500
1993	HL YCT	1,500

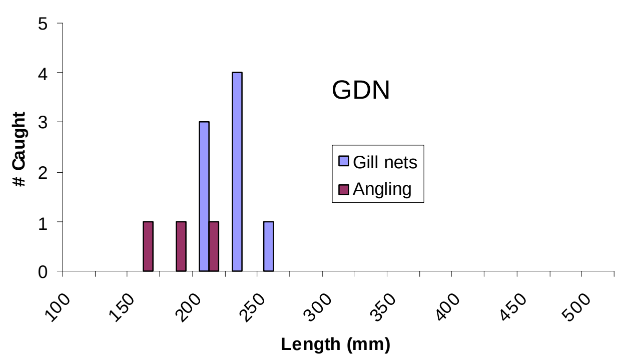
Golden Lake

269,587 E; 4,845,768 N   Z 12

Golden Lake is located in the headwaters of Lake Creek in the Big Lost River drainage near Mackay Idaho. The lake measures 423 m in circumference (1.0 ha), at an elevation of 2,962 m. This deep cirque lake has a conductance of 10 umho/cm^3. Surrounding habitat is a mix of rocky scree, boulders and sub-alpine firs. There was a partial trail around the shoreline, moderate litter and two fire rings to indicate human use. Given this, we believe numerous anglers visit annually. There were no inlets, no outlets and no visible spawning habitat at the time of sampling. Access is easy, and consists of a drive up Lake Creek, followed by a nine km hike on a maintained trail that can accommodate hiking, horseback riding, motorcycles and ATV's

On August 8, 2004, we surveyed the fishery and physical characteristics of Golden Lake. The fishery survey consisted of an overnight gill net set in combination with angling and visual observations of fish. Our gill nets captured eight golden trout ranging in size from 210 – 265 mm. We fished for two hours and caught three golden trout ranging in size from 150 – 200 mm. We also observed several trout in the 200 mm range. No amphibians were observed during our shoreline survey.

Our survey indicates Golden Lake is meeting the fishery objective of one fish per hour (actual catch rate 1.5 f/h). Access is easy via motorized vehicle, and there appears to be a high degree of human use. Our length frequency information and fish observations suggest no natural reproduction. Golden Lake has been stocked with as few as 300 fingerlings, although recent stockings have been 1,000 fish. Since the lake is located in the easily accessed and highly used Lake Creek drainage, we recommend keeping the current stocking rate of 1,000 fish, but increasing the stocking frequency to every other year. We also recommend managing Golden Lake as a single-species lake featuring Golden trout. If these fish are not available, additional species should not be stocked.



Length frequency for fish caught in Golden Lake, 2004 and recent stocking information.

Year	Species	No. Stocked
2004	Golden Trout	1,000
2001	Golden Trout	600
2001	Kamloop RBT	400
1996	Golden Trout	1,146
1990	Golden Trout	750

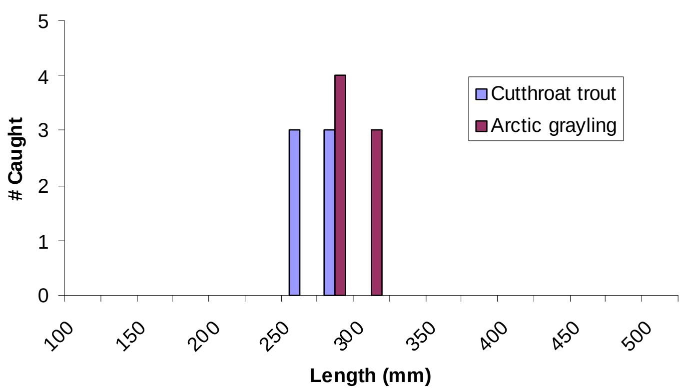
Green Lake

269,586 E; 4,842,985 N Z 12

Green Lake is located off of Muldoon Creek in the West Fork Big Lost River drainage near Mackay Idaho. The lake has 570 m of shoreline (1.9 ha), and resides at an elevation of 2,928 m. This deep cirque lake has a conductance of 50 umho/cm^3. Surrounding habitat is a mix of rocky scree, boulders and coniferous trees. There was a partial trail around the shoreline, moderate litter and four fire rings to suggest moderate human use. There were no inlets and one outlet that provided 2 m^2 of spawning habitat at the time of sampling. Access is easy, and consists of a five km drive up Muldoon Creek, followed by a three km drive up a rough four-wheel drive trail to an old mine. A short hike of 1 km gives access to Green Lake.

On July 29, 2004, we surveyed the fishery and physical characteristics of Green Lake. The fishery survey consisted of an overnight gill net set in combination with angling and visual observations. Our gill nets captured six Arctic grayling ranging in size from 273 – 311 mm and one cutthroat trout (270 mm). We fished for a total of four hours and caught five cutthroat trout ranging in size from 265 – 295 mm and one Arctic grayling (310 mm). We also observed several trout in the 200-350 mm range. No amphibians were observed during our 40-minute shoreline survey.

Our survey indicates Green Lake is meeting the fishery objective of one fish per hour (actual catch rate 1.5 f/h). Access is easy via a short hike, and there is evidence of significant human use. Our length frequency information and fish observations suggest no natural reproduction. Green Lake has been stocked with a mix of 1,000 cutthroat trout and 1,000 Arctic grayling fingerlings, although recent stockings have been 1,000 cutthroat trout. Given the easy access and high degree of use, we recommend keeping the current stocking rate of 1,000 cutthroat trout, and 1,000 Arctic grayling when available.



Length frequency for fish captured in Green Lake, 2004 and recent stocking information.

Year	Species	No. Stocked
2004	HL YCT	1,020
2001	Grayling	1,000
2001	HL YCT	1,000
1998	Grayling	1,000
1998	HL YCT	1,000

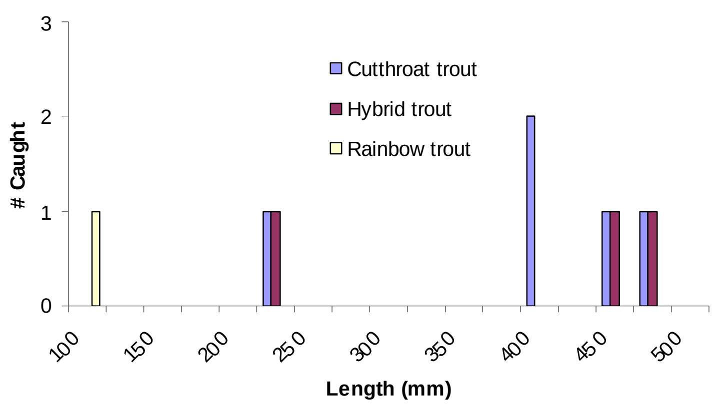
Iron Bog Lake

270,642 E; 4,837,026 N Z 12

Iron Bog Lake is located in the headwaters of Iron Bog Creek in the Big Lost River drainage south of Mackay Idaho. The lake measures 1.1 km in circumference (4.1 ha), and sits at an elevation of 2,761 m. This deep cirque lake has a conductance of 60 umho/cm^3. Surrounding habitat is grassy moraine with patches of coniferous trees. There was a complete trail around the shoreline, substantial litter, and ten fire rings suggesting a high degree of human use. There was one inlet and one outlet that provided 125 m^2 of suitable spawning habitat at the time of sampling. Access is easy, and consists of a drive up the left fork of Iron Bog Creek to the trailhead, followed by a two km hike on a maintained trail.

On August 2, 2004, we surveyed the fishery and physical characteristics of Iron Bog Lake. The fishery survey consisted of an overnight gill net set in combination with angling and visual observations of fish. Gill nets captured six fish (two hybrid trout and four cutthroat trout) ranging in size from 225 – 480 mm. IDFG personnel and volunteer Boy Scout troops fished for a total of 12 hours and caught three fish (one each of rainbow trout, hybrid trout and cutthroat trout). We also observed trout ranging in size from < 100 mm – 450 mm. We also found Columbia spotted frogs during our 40-minute shoreline survey.

Our data indicates Iron Bog Lake does not meet the fishery objective of one fish per hour (actual catch rate 0.3 f/h). Access is easy, and there is evidence of significant human use. The presence of young fish suggests the fishery is supported in part by natural reproduction as well as our stockings. Cutthroat trout have not been stocked since 1998, and are still present, as are juvenile rainbow trout. Given the easy access and popularity of this area, we recommend increasing the stocking rate by 1,000 fish, and suggest monitoring the fishery periodically.



Length frequency for fish caught in Iron Bog Lake, 2004 and recent stocking information.

Year	Species	No. Stocked
2004	Triploid Kamloop	3,500
2001	Domestic Kamloop	3,500
1998	Triploid Kamloop	3,500
1995	HL YCT	3,500
1993	HL YCT	1,500

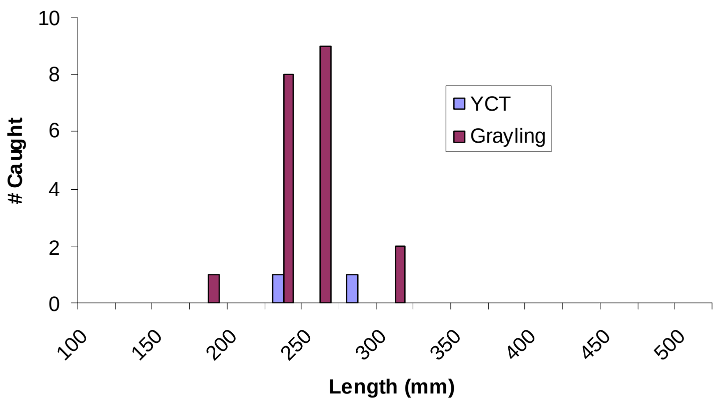
Round Lake

272,282 E; 4,845,121 N Z 12

Round Lake is located in the headwaters of Lake Creek in the Big Lost River drainage near Mackay Idaho. The lake has 600 m of shoreline (2.4 ha), and sits at an elevation of 2,875 m. This deep cirque lake has a conductance of 50 umho/cm^3. Surrounding habitat is grassy moraine and patches of coniferous trees. There was a partial trail around the shoreline, moderate litter, and three fire rings suggesting significant human use. There was one inlet and one outlet that provided less than 10 m^2 of suitable spawning habitat at the time of sampling. Access is easy, and consists of a drive up the Lake Creek road to the trailhead, followed by a nine km hike on a maintained trail that can accommodate hiking, horseback riding, motorcycle and ATV traffic.

On July 28, 2004, we surveyed the fishery and physical characteristics of Round Lake. The fishery survey consisted of an overnight gill net set in combination with angling and visual observations of fish. Gill nets captured 13 Arctic grayling that ranged in size from 230 – 270 mm, and one cutthroat trout (230 mm). We fished for a total of four hours and caught four Arctic grayling (180 - 300 mm) and one cutthroat trout (295 mm). We also observed about 25 rising fish, but were unable to estimate size. We found approximately 25 unidentified frogs and one adult salamander during our 40-minute shoreline survey.

Our data indicates Round Lake meets the fishery objective of one fish per hour (actual catch rate 2.0 f/h). Access is easy via motorized vehicle, and there is evidence of human use. The size range of fish encountered suggests natural reproduction occurs, but is not likely extensive enough to support the fishery. Given the easy access and popularity of this area, we recommend continuing the current stocking rate, but increasing the frequency to every other year as opposed to every third year.



Length frequency for fish caught in Round Lake, 2004 and recent stocking information

Year	Species	No. Stocked
2001	Grayling	1,500
1998	Grayling	1,500
1995	Grayling	1,513
1992	HL YCT	1,000
1988	HL YCT	2,000

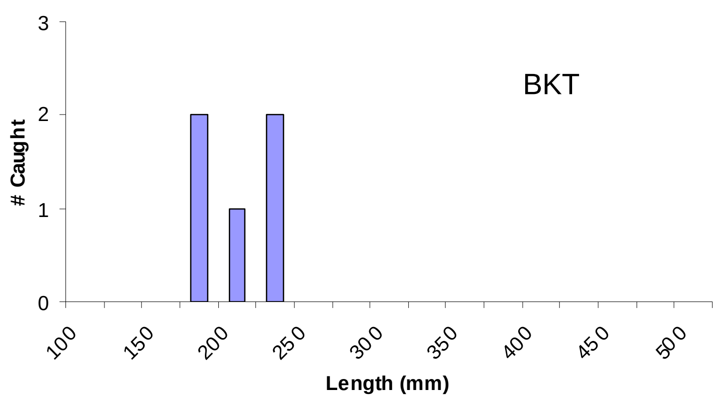
Starhope Lake

264,799 E; 4,842,045 N   Z 12

Starhope Lake is located in the headwaters of Starhope Creek in the Big Lost River drainage near Mackay Idaho. The lake measures 267 m in circumference (0.5 ha), and resides at an elevation of 2,861 m. This deep cirque lake had a conductance of 20 umho/cm^3. Surrounding habitat consists of a mix of rocky moraine and some nearby sub-alpine fir trees. There was a trail around the shoreline, no litter, and three fire rings suggesting moderate human use. There was no inlet and one outlet that provided approximately 30 m^2 of suitable spawning habitat at the time of sampling. Access is easy, and consists of a drive up Starhope Creek to the trailhead 3.5 km from the Copper Basin Loop Road, followed by a two km hike on a maintained trail.

On August 3, 2004, we surveyed the fishery and physical characteristics of Starhope Creek. The fishery survey consisted of an overnight gill net set in combination with angling and visual observations of fish. Gill nets captured three brook trout ranging in size from 220 - 245 mm. We fished for one hour and caught two more brook trout (185 and 195 mm). We also observed numerous trout in the 100 - 150 mm range. No amphibians were observed during our 20-minute shoreline survey.

Our data indicates Starhope Lake meets the fishery objective of one fish per hour (actual catch rate 2.0 f/h). Access is easy, and anglers are using the area. Our length frequency information, fish and observations and stocking records all suggest natural reproduction is responsible for supporting this fishery. We stocked brook trout here in the late 1970's, followed by a decade of rainbow trout stocking. We have not stocked since 1988, and only encountered brook trout in the current survey. Since we are meeting our catch rate objective, no additional stockings are warranted.



Length frequency of fish caught in Starhope Lake, 2004 and the most recent stocking information.

Year	Species	No. Stocked
1988	RBT	3,000
1984	RBT	3,000
1982	RBT	3,000
1978	BKT	990
1971	Grayling	7,000

RIVERS AND STREAMS INVESTIGATONS

Dan Garren, Regional Fishery Biologist
William C. Schrader, Senior Regional Fishery Biologist
Damon Keen, Assistant Fish Hatchery Manager
Jim Fredericks, Regional Fishery Manager

ABSTRACT

We estimated trout densities and population parameters on the Mack's Inn, Ora and St. Anthony sections of the Henrys Fork Snake River in May, 2004. Estimated trout densities (fish per km) were 119, 1,191 and 301 in the Mack's Inn, Ora and St. Anthony sections, respectively. Species composition was 66% Yellowstone cutthroat trout, 31% rainbow trout and 3% brook trout in the Mack's Inn section, 94% rainbow trout and 6% brown trout in the Ora section and 1% Yellowstone cutthroat trout, 27% rainbow trout and 72% brown trout in the St. Anthony section. Overall trout densities have declined 68% since 2002 in the Mack's Inn section, and increased by 4% in the Ora section since 1991. Rainbow trout relative stock density (RSD-400) was high for the Mack's Inn (81) and Ora (83) sections, suggesting limited recruitment over the past two years. We also collected otoliths from the Stone Bridge section to gather information on age and growth of mountain whitefish, and found mean length at age three was 271 mm. We estimated annual mortality for mountain whitefish at 23% from age three to ten.

Authors:

Dan Garren
Regional Fishery Biologist

Jim Fredericks
Regional Fishery Manager

METHODS

We used two drift boat mounted electrofishers to assess fish populations in four sections of the Henrys Fork Snake River (Mack's Inn, Ora, Stone Bridge and St Anthony). All samples except the Stone Bridge sample employed one marking run, followed by a seven-day rest, and a single-pass recapture event. The Stone Bridge sample was strictly to collect mountain whitefish *Prosopium williamsoni* for age and growth analysis and consisted of a single-pass electrofishing run. Rainbow trout *Oncorhynchus mykiss*, brown trout *Salmo trutta*, Yellowstone cutthroat trout *O. clarki bouvieri* and brook trout *Salvelinus fontinalis* collected during initial runs were marked with a caudal fin hole punch, measured for total length (TL) and released to the area of capture. We made population estimates for all trout > 150 mm using the Partial Log-Likelihood method and Montana's MR5 data analysis program (MR5; Montana Department of Fish, Wildlife, and Parks 1994). Recaptures in the Mack's Inn section were low; therefore we used Petersen's mark-recapture with Chapman's modification and the MR5 data analysis program. Relative stock densities (RSD-400) were calculated as the number of each species ≥ 400 mm / by the number of each species ≥ 200 mm. Likewise, RSD-500 used the same formula, and the number of each species ≥ 500 mm as the numerator. We collected otoliths from a random sample of mountain whitefish in the Stone Bridge reach for age and growth analysis. Length at age, mortality and survival were all calculated based on otoliths and catch-curve analysis.

RESULTS

Mack's Inn

We collected 140 fish over two days of electrofishing in Mack's Inn. Species composition of trout handled was dominated by Yellowstone cutthroat trout (66%) followed by rainbow trout (31%), and brook trout (3%). We only targeted trout, and did not collect whitefish. Size distribution of cutthroat trout was skewed towards larger fish (RSD-400 = 44, Figure 1), with mean size of 321 mm and median size of 370 mm. We captured no fish greater than 500 mm (Table 1). Size distribution of rainbow trout showed a bimodal distribution, with mean size of 280 mm, median size of 148 mm, 18% of the captured fish greater than 500 mm (Figure 1) and an RSD-400 of 81 (Table 1). We estimated 575 trout > 150 mm (95% CI = 112 – 1,037, cv = 0.41, Figure 2) in the section, which equates to 120 fish per km (Table 2).

Ora to Vernon

We collected 556 fish in the Ora section of the Henrys Fork Snake River during the two-day population estimate. Species composition of the trout catch was 94% rainbow trout, 6% brown trout and <1% brook trout. We only targeted trout, and did not collect whitefish. Rainbow trout and brown trout stock density indices were high, with RSD-400 of 83 for rainbow trout and 77 for brown trout (Table 1). Mean and median size of rainbow trout was 384 mm and 436 mm respectively, with an RSD-500 of 5 (Figure 3). Mean and median size of brown trout was 415 mm and 468 mm respectively, with an RSD-500 of 39. We estimated 3,572 trout > 150 mm for the section (95% CI = 2,473 – 4,671; cv = 0.20), which equates to 1,190 fish per km (Table 2). We only recaptured two brown trout in our survey, making individual species estimates inaccurate. Therefore, we estimated abundances with all trout combined, and proportioned individual species abundances out based on ratios found with electrofishing. Rainbow trout density estimates were 3,358 for the three km section (1,119 fish per km), while brown trout were estimated at 214 fish (71 fish per km).

Stone Bridge

We collected 296 mountain whitefish during our one-day electrofishing survey in the Stone Bridge section of the Henrys Fork Snake River. Mountain whitefish had a mean and median size of 287 mm, with no fish greater than 500 mm (Figure 4). We collected otoliths from all captured fish, and calculated mean length at age and annual mortality. Mean length at age three was 271 mm, and maximum age was 17 (Table 3). Mortality estimates were calculated from catch curve analysis over a range of ages, with the most plausible estimate of 23% annually from ages three to ten (Table 4). One assumption associated with catch curve use is the requirement of constant recruitment, which is rarely met. Catch at age values departing from a catch curve regression can represent variable recruitment (Maceina 1997). Recruitment in mountain whitefish appeared to be variable as demonstrated by the residuals associated with the catch curve in Figure 5.

St. Anthony

We collected 256 fish in the St. Anthony to Parker section of the Henrys Fork Snake River during the two-day population estimate. Species composition of the trout catch was 72% brown trout, 27% rainbow trout and 1% Yellowstone cutthroat trout (Table 1). We only targeted trout, and did not collect whitefish. Brown trout and rainbow trout stock densities (RSD-400) were 50 for brown trout and 23 for rainbow trout. Mean and median size of brown trout was 264 mm and 199 mm respectively, with an RSD-500 of 5 (Figure 6). Mean and median size of rainbow trout was 227 mm and 180 mm respectively, with no fish captured greater than 500 mm. We estimated 2,104 trout > 150 mm in this reach (95% CI = 920 – 3,288; cv = 0.29), which equates to 301 trout per km (Table 2). No rainbow trout were recaptured which made individual species estimates impossible. Therefore, we estimated abundances for all trout combined, and proportioned individual species abundances out based on ratios found with electrofishing. Estimates of abundance for the seven km reach were 1,515, 568 and 21 for brown trout, rainbow trout and Yellowstone cutthroat trout respectively.

DISCUSSION

Our Mack's Inn population estimate shows a decline in trout densities compared to past surveys. We suspect our surveys may be influenced by spawning migrations of trout residing in Island Park Reservoir. The decline shown in our most recent estimate may be impacted by replacing stockings of fertile rainbow trout in Island Park Reservoir with sterile triploid rainbow trout which began in 2000. It is unlikely that sterile trout would show spawning-related migrations, thereby reducing the migratory component of the Mack's Inn rainbow trout population and reducing our density estimates. Yellowstone cutthroat trout show a marked increase following our stocking program which began in 2002. Our goal was to establish a late-running migratory fish that would be vulnerable to anglers during the general season. Cutthroat trout will spawn in May and June, and may exhibit a similar migratory behavior as rainbow trout which would make them vulnerable to anglers during the fishing season. We also hope that some cutthroat will remain in the river and provide a resident fishery.

Population estimates in the Ora section show a high-density rainbow trout population dominated by larger fish. Density estimates from this reach are similar to those from the Box Canyon upstream, and are among the highest for the entire river. Few juvenile trout were caught, which suggests poor recruitment from the 2001 and 2002 year-classes. The RSD-400 of 83 in the Ora reach corroborates this and is indicative of a population dominated by large fish, but lacking juveniles. The result may be lower adult densities in upcoming years.

Mountain whitefish from the Stone Bridge section were long-lived and exhibited variable recruitment as evident by variation in catch at age. We hypothesize that this variable recruitment is offset by low annual mortality and a long lifespan (up to 17 years old). This life strategy may allow the species to flourish with less than optimal environmental conditions. Several weak or missing year-classes can easily be compensated for as environmental conditions improve, and the older, long-lived fish successfully reproduce.

Trout densities in the St. Anthony reach show an interesting reversal from the high densities found in upstream reaches. Previous reports have suggested the Henrys Fork Snake River below St Anthony may be limited by irrigation withdrawals and low flows, thereby reducing trout abundance (IDFG Fisheries Management Plan 2001). Existing habitat is capable of supporting trout as shown by the presence of both adult and juvenile rainbow and brown trout. However, mortality may be higher in this section as a result of the above-mentioned impacts or other factors. Habitat quality tends to decrease downstream of St Anthony as a result of increased sedimentation and flow alterations from irrigation withdraws. This may limit primary production and contribute to the lower densities estimated in the current study. Additional study is warranted to determine factors limiting trout abundance below St Anthony.

RECOMMENDATIONS

1. Continue to monitor trout population trends in representative reaches of the Henrys Fork Snake River.

2. Continue collecting otoliths from trout and whitefish for use in age, growth and cohort analysis from multiple reaches of the Henrys Fork Snake River.

3. Continue to sample downstream of St Anthony to assess potential limiting factors on trout abundance.

4. Set temperature-sensing thermographs throughout the river to monitor summer temperatures.

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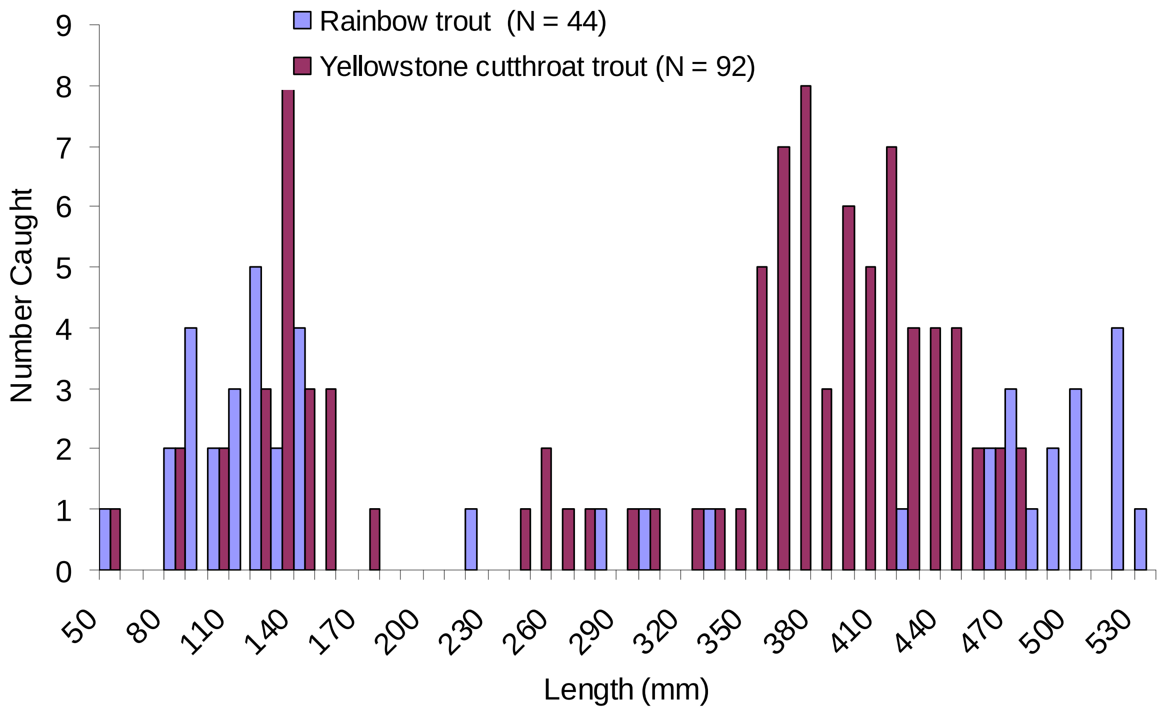

Figure 1. Length frequency distribution for Yellowstone cutthroat trout and rainbow trout collected electrofishing in the Mack's Inn section of the Henrys Fork Snake River, Idaho, 2004.

Table 1. Trout population index summaries for the Henrys Fork Snake River, Idaho 2004.

Reach	Species	Mean length at capture (mm)	Median length at capture (mm)	RSD-400	RSD-500	Fish per km	Percent Contribution to catch
Mack's Inn	Yellowstone cutthroat trout	321	370	44	0	89	66
	Rainbow trout	280	148	81	18	25	31
	Brook trout	282	246	--	0	5	3
Ora	Rainbow trout	384	436	83	5	1,119	94
	Brown trout	415	468	77	39	71	6
St Anthony	Yellowstone cutthroat trout	345	--	50	0	1	1
	Rainbow trout	227	180	23	0	80	72
	Brown trout	264	199	50	5	221	27

Table 2. Data used in population estimates from the Henrys Fork Snake River, Idaho during 2004 and flow levels during sampling.

River reach	Number Marked	Number Captured	Number Recaptured	Population Estimate	Confidence Interval	Density (No./ km)	Discharge (Q)
							-- [a]
Mack's Inn							
Yellowstone cutthroat trout	32	41	2	468[d]	--	79[d]	
Rainbow trout	16	5	1	158[d]	--	37[d]	
All trout[d]	49	49	3	575	112 - 1,037	120	
							40.5m^3/s [b]
Ora							
Rainbow trout	246	218	17	2,908[d]	--	1,119[d]	
Brown trout	15	16	2	186[d]	--	71[d]	
All Trout	261	235	19	3,572	2,473 – 4,671	1,190	
							58.6m^3/s [c]
St Anthony							
Rainbow trout	17	29	0	224[d]	--	80[d]	
Brown trout	55	81	9	596[d]	--	221[d]	
Yellowstone cutthroat trout	1	1	0	8[d]	--	1[d]	
All trout	73	111	9	2,104	920 – 3,288	301	

[a]No data available
[b]Data obtained from USGS gauge near Ashton Reservoir (13046000)
[c]Data obtained from USGS gauge near St Anthony (13050500)
[d]Individual species densities estimated from all fish combined, and partitioned out based on relative abundance as determined from electrofishing.

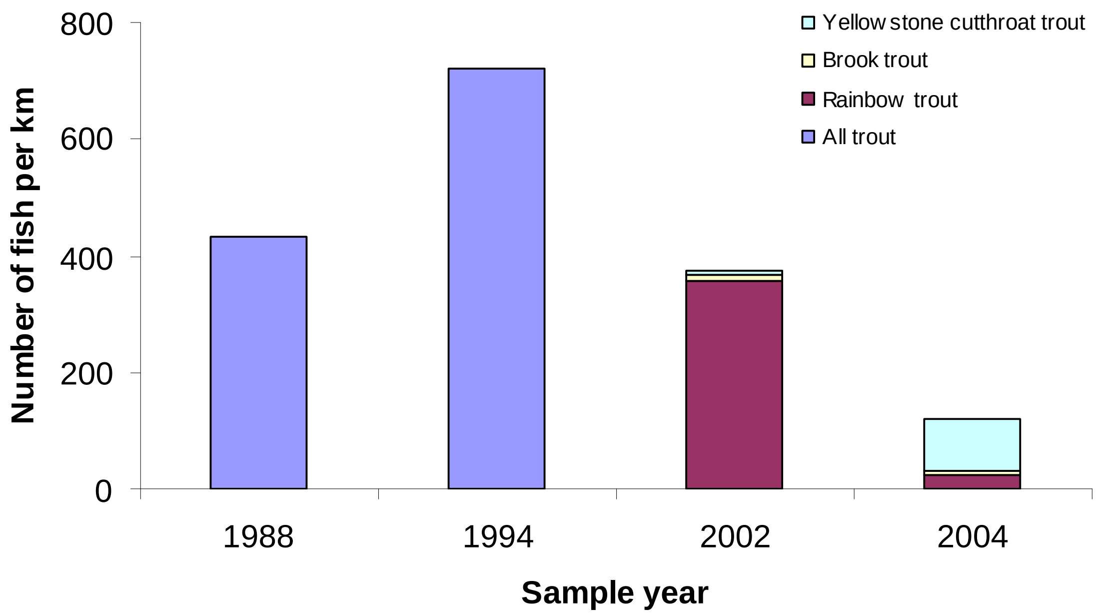

Figure 2. Population estimates for the Mack's Inn section of the Henrys Fork Snake River, Idaho. 2004 estimates include Yellowstone cutthroat trout as well as rainbow trout.

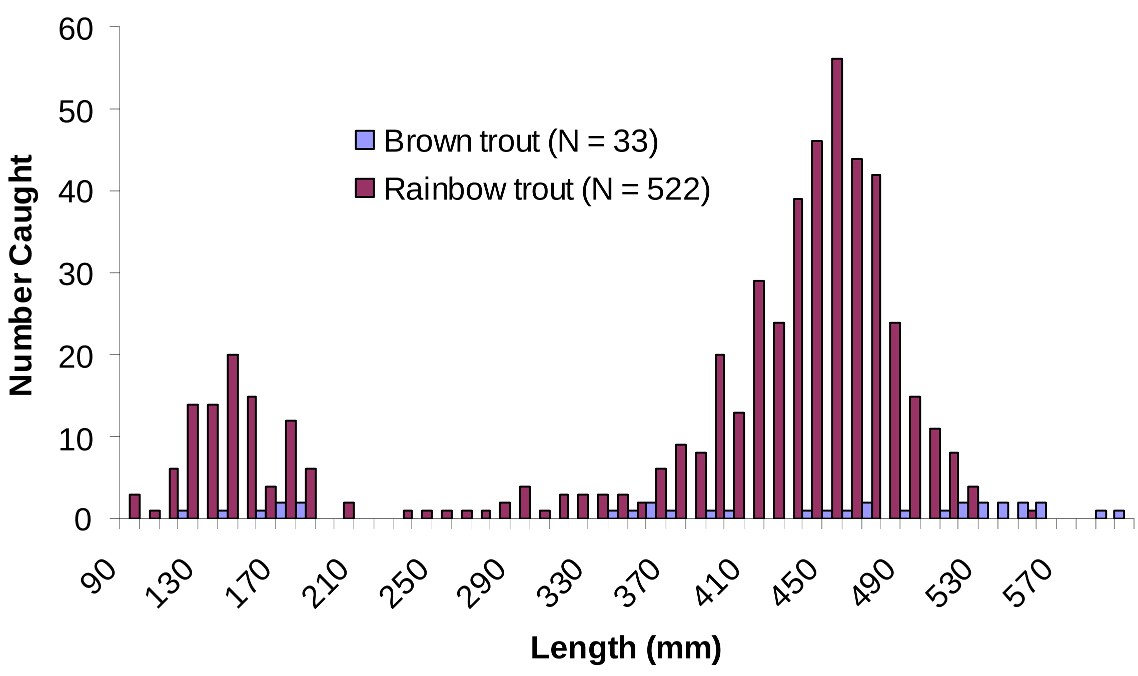

Figure 3. Length frequency distribution for brown trout and rainbow trout collected electrofishing in the Ora section of the Henrys Fork Snake River, Idaho, 2004.

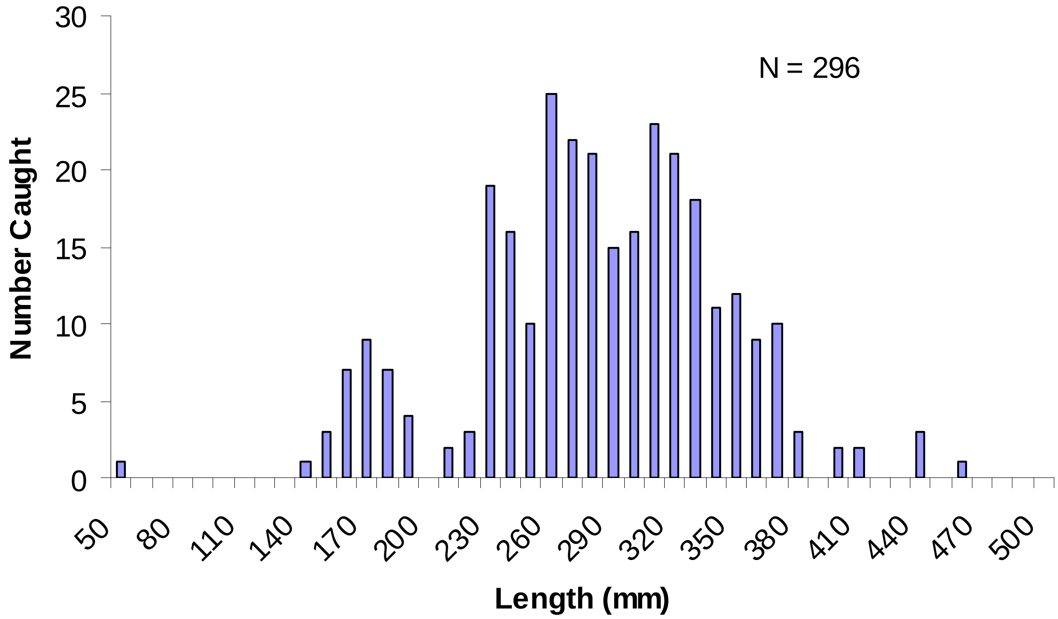

Figure 4. Length frequency distribution for mountain whitefish collected in the Stone Bridge section of the Henrys Fork Snake River, Idaho 2004.

Table 3. Mean length at age of mountain whitefish collected electrofishing in the Stone Bridge section of the Henrys Fork Snake River, Idaho 2004 based on otoliths.

Species	Mean Length at Age											
	1	2	3	4	5	6	7	8	9	10	11	12
Mountain whitefish	173	239	271	299	312	324	343	340	373	364	393	382
(No. Collected)	(30)	(44)	(60)	(44)	(19)	(40)	(10)	(14)	(10)	(10)	(4)	(7)

Table 4. Mortality and survival estimates for mountain whitefish captured electrofishing in the Stone Bridge section of the Henrys Fork Snake River, Idaho 2004. Estimates are based on catch-curve analysis.

Location	Age Class	Estimate		
		Z	Survival	Mortality
Stone Bridge	1 to 12	-0.209	81	19
	2 to 12	-0.244	78	22
	3 to 12	-0.262	77	23
	1 to 10	-0.189	83	17
	2 to 10	-0.237	79	21
	3 to 10	-0.265	77	23

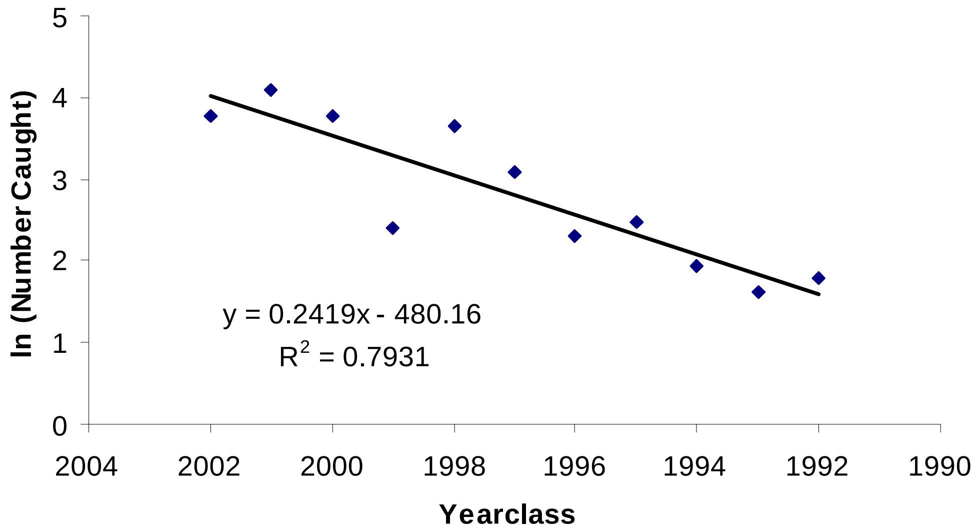

Figure 5. Catch curve for mountain whitefish collected in the Stone Bridge section of the Henrys Fork Snake River, Idaho 2004.

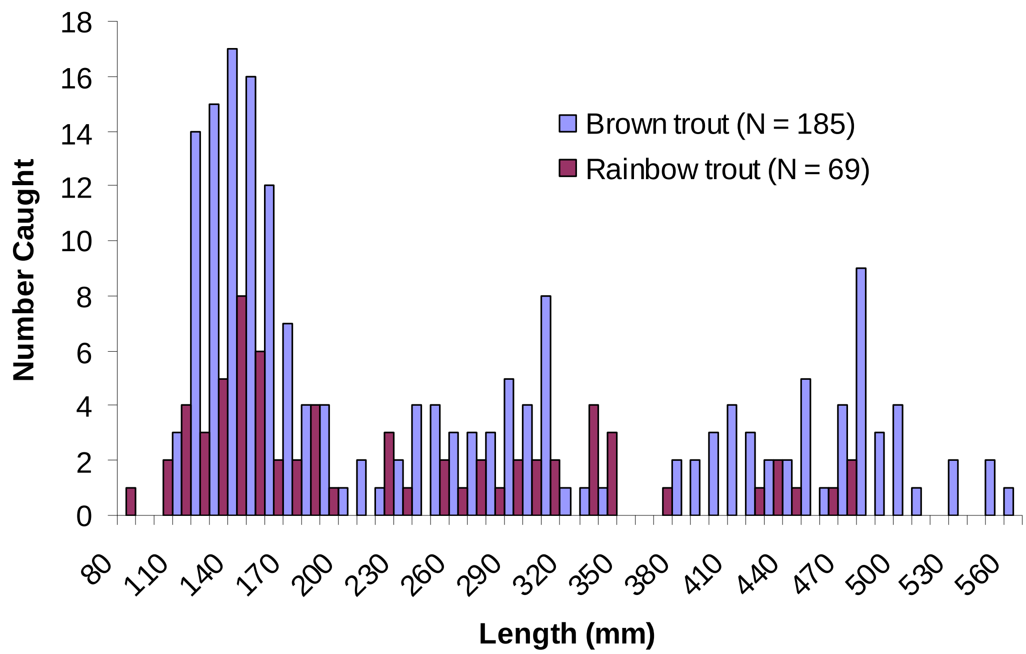

Figure 6. Length Frequency distribution for rainbow trout and brown trout collected electrofishing in the St Anthony section of the Henrys Fork Snake River, Idaho 2004.

FALL RIVER

ABSTRACT

We conducted a mark-recapture population estimate during June 2004 on one section of the Fall River to obtain fish population parameters and density estimates. Mountain whitefish *Prosopium williamsoni*, rainbow trout *Oncorhynchus mykiss* and brook trout *Salvelinus fontinalis* represented 58, 42 and <1% of the catch, respectively. Rainbow trout and mountain whitefish densities were 474 and 1,305 fish per km, respectively. Mean length of rainbow trout collected was 189 mm. Only 13 of 622 rainbow trout collected were greater than 400 mm. Rainbow trout PSD was 31. Mean length of mountain whitefish was 305 mm.

Authors:

Dan Garren
Regional Fishery Biologist

Jim Fredericks
Regional Fishery Manager

METHODS

A 10.3 km reach of the Fall River (UTM start 468,152 E, 4,877,091 N Z 12; UTM stop 460,294 E, 4,872,348 N Z 12) was electrofished with two drift boat electrofishers to determine species composition and to estimate densities. We attempted to collect all salmonids encountered. After collecting, fish were identified, measured for length (TL – mm), marked with a hole punch in the caudal fin, and released. The recapture run occurred after a two day rest. We did not wait the standard seven-day rest because we were concerned about the possibility of a decrease in flows, which would make sampling difficult. We estimated densities using a Modified Petersen estimator and Montana's MR-5 data analysis program (MR-5, MDFWP 1994).

RESULTS

We collected 1,489 fish over the course of our two-day survey. Species composition was dominated by mountain whitefish *Prosopium williamsoni* (58%), followed by rainbow trout *Oncorhynchus mykiss* (42%) and brook trout *Salvelinus fontinalis* (< 1 %). We only collected salmonids, and did not attempt to collect other species. Rainbow trout and mountain whitefish density (fish per km) was estimated to be 474 and 1114, respectively (Table 1). Mean length of rainbow trout was 189 mm and was skewed towards smaller fish (Figure 1), with a Proportional Stock Densities (PSD) of 31 and an RSD-400 of five. Mean length of mountain whitefish was 305 mm and was skewed towards larger fish (Figure 2).

DISCUSSION

Rainbow trout density (fish per km) in the Fall River is similar to rainbow trout density in the Chester Reach of the Henrys Fork Snake River (Garren et al 2004a). However, size distributions between these water bodies differ markedly. Length frequency of rainbow trout in the Chester Reach is dominated by fish larger than 350 mm while the Fall River sample is dominated by fish less than 300 mm. Growth to age-1 appears similar between the Chester reach and the Fall River as evidenced by a similar mode of fish between 100 and 180 mm in both rivers. Reasons for the paucity of larger rainbow trout in the Fall River are not clear. Future work should focus on determining the reasons for this disparity and include age and growth analysis and mortality estimates for the Fall River.

Mountain whitefish length frequency from the Fall River was similar to those collected from downstream in the Henrys Fork Snake River. Recruitment of small mountain whitefish to the population appears limited due to the lack of smaller (< 250 mm) fish in the length frequency. Limited recruitment in mountain whitefish populations was reported earlier in the Stone Bridge reach of the Henrys Fork Snake River from 2002, 2003 and 2004, the Chester reach of the Henrys Fork Snake River in 2003 and the Box Canyon reach of the Henrys Fork Snake River in 2003 (Garren et al. 2004a, 2004b and current report). Age and growth analysis from these studies suggests mountain whitefish are long lived, and have variable recruitment based on catch curve residual analysis. The population from the Fall River appears to demonstrate a similar life history strategy.

RECOMMENDATIONS

1. Repeat population survey in the Fall River and collect otoliths from trout and whitefish for age and growth analysis.

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Table 1. Total catch and population estimates for fish collected electrofishing in Fall River, Idaho 2004. Population estimates and resulting densities were derived with a Modified Petersen Estimator (MR-5, MDFWP 1994).

Species	Mark	Capture	Recapture	Pop. Estimate (# in reach)	95% CI	Fish per km
Rainbow trout	188	154	5	4,882	1,392-8,371	474
Brook trout	1	1	0	--	--	--
Mountain whitefish	477	383	15	11,471	6,225-16,717	1,114

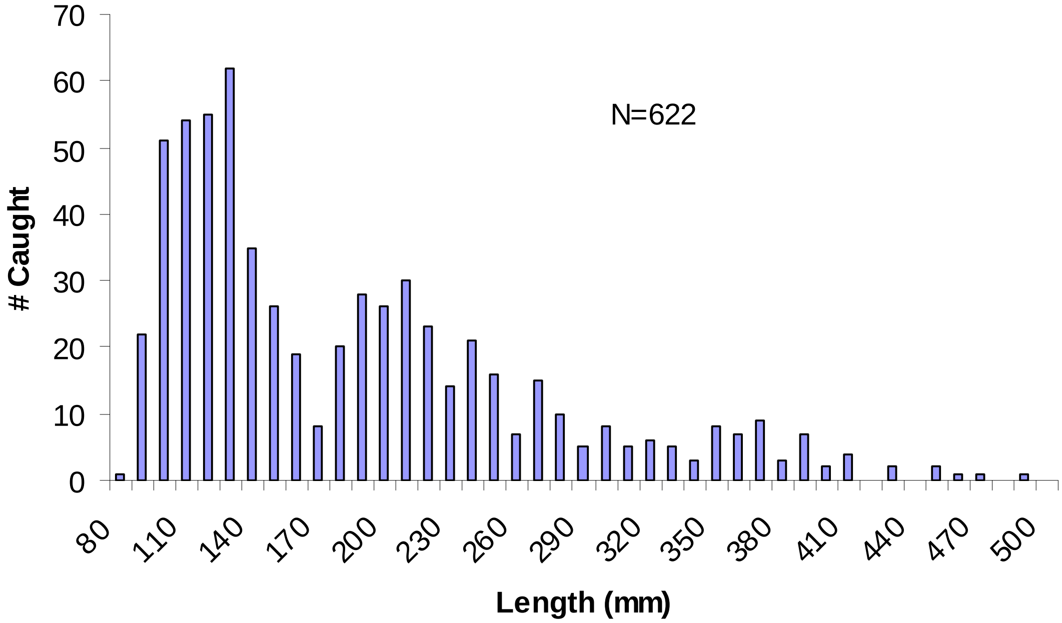

Figure 1. Length frequency distribution for rainbow trout collected electrofishing in the Fall River, Idaho 2004.

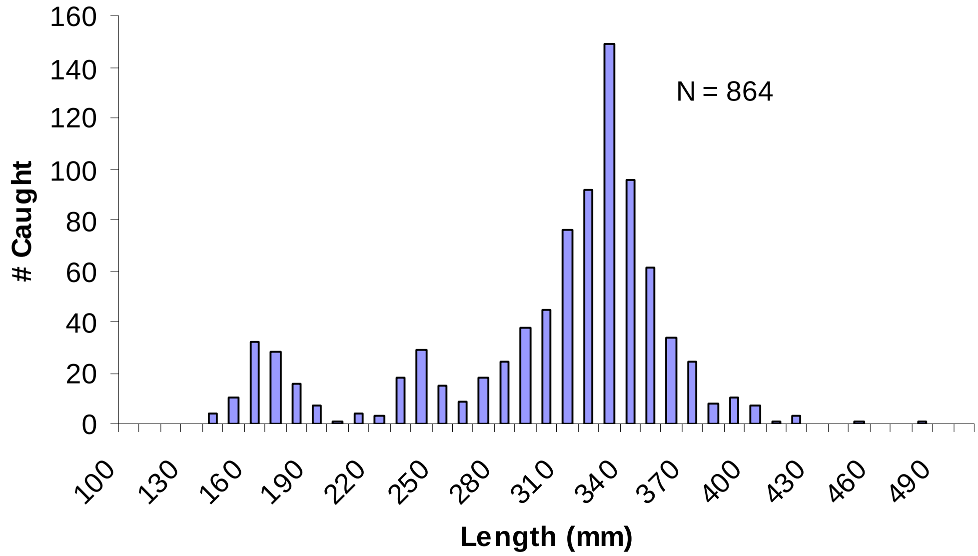

Figure 2. Length frequency distribution for mountain whitefish collected electrofishing in the Fall River, Idaho 2004.

CONANT CREEK

ABSTRACT

We estimated trout density in one section of Conant Creek at 4.3 trout per 100 m using a three-pass depletion during July 2004. Yellowstone cutthroat trout *Oncorhynchus clarki bouvieri*, rainbow and hybrid trout (rainbow trout *O. mykiss* x cutthroat trout), brook trout *Salvelinus fontinalis* and mountain whitefish *Prosopium williamsoni* comprised 39, 46, 10 and 7% of the catch, respectively.

Authors:

Dan Garren
Regional Fishery Biologist

Jim Fredericks
Regional Fishery Manager

METHODS

We used two backpack electrofishers and a three-pass depletion in one section of Conant Creek, a tributary to the Fall River to describe species composition and to estimate density. Backpacks were operated in tandem, each covering half of the stream channel while moving upstream. We sampled a 720-m reach of the creek (UTM start 472,172 E, 4,872,481 N Z 12; UTM stop 472,763 E, 4,872,581 N Z 12). We held all salmonids encountered in buckets until the sample was complete before identifying and measuring for length (TL – mm) and releasing. Nongame species were not collected. We estimated densities based on the resulting depletions over our three passes (Zippin 1956).

RESULTS

We collected a total of 29 trout over our three passes. Species composition was dominated by Yellowstone cutthroat trout *Oncorhynchus clarki bouvieri* (39%), rainbow trout O. mykiss (39%), hybrid trout (rainbow trout x cutthroat trout, 7%); brook trout *Salvelinus fontinalis* (10%) and mountain whitefish *Prosopium williamsoni* (7%). Mean length of fish collected was 277, 240, 259 and 145 for brook trout, Yellowstone cutthroat trout, rainbow and hybrid trout and mountain whitefish, respectively. Density estimates (fish per 100 m) are presented in Table 1.

LITERATURE CITED

Zippin, C. 1956. An evaluation of the removal method of estimating animal populations. Biometrics 12: 163-169.

Table 1. Total catch and population estimates for fish collected electrofishing in Conant Creek, Idaho 2004.

Species	1st Pass	2nd Pass	3rd Pass	Pop. Estimate (# in reach)	95% CI	Fish per 100 m [a]
Yellowstone cutthroat trout	7	4	1	12	12 - 14	1.67
Rainbow trout	5	2	3	12	10 – 21	1.67
Hybrid trout	1	1	0	2	2 - 7	0.30
Brook trout	3	0	0	3	--	0.42
Mountain whitefish	1	1	0	2	2 - 7	0.30
All fish	17	8	4	31	29 - 37	4.30

[a]Based on total fish depletion, and partitioned out via relative abundances.

SOUTH FORK SNAKE RIVER

ABSTRACT

A total of 1,591 trout were captured during four days of electrofishing at the Conant section in October 2004. Trout species composition and relative abundance were cutthroat trout *Oncorhynchus clarki bouvieri* (41%), rainbow trout *O. mykiss* and hybrid rainbow x cutthroat trout *O. clarki x mykiss* (35%), and brown trout *Salmo trutta* (23%). No lake trout *Salvelinus namaycush* or kokanee salmon *O. nerka kennerlyi* were caught. Estimated densities were 478 fish/km for cutthroat trout, 530 fish/km for rainbow and hybrid trout, 383 fish/km for brown trout, and 1,443 fish/km for all species combined. Mean total length was 324 mm for cutthroat trout, 294 mm for rainbow and hybrid trout, 314 mm for brown trout, and 311 mm for all species combined. Quality stock density (QSD) was 13.3% for cutthroat trout, 23.7% for rainbow and hybrid trout, 23.9% for brown trout, and 19.4% for all species combined.

At the Pine Creek weir, a total of 2,170 trout were trapped from March 25 to June 28, 2004. Most were cutthroat trout – 2,143 fish or 99% of the total. Another 27 rainbow and hybrid trout (1% of the total) were trapped and relocated to kid's fishing ponds. Rainbow trout were caught between April 22 and June 22. Cutthroat trout were caught between April 14 and June 25, but most (98.4%) were caught after May 13. Rainbow trout total length ranged from 255 to 520 mm and averaged 395 mm (n=27). Cutthroat trout ranged from 140 to 550 mm and averaged 367 mm (n=2,143), but most (95.4%) were greater than 300 mm. Weir or trap efficiency as measured by mark-recapture was estimated to be 98.1%. The high efficiency was due to re-designing the weir panels and using removable metal pickets. The Burns Creek, Rainey Creek, and Palisades Creek weirs were not operated due to their low efficiencies and structural deficiencies.

Of twenty rainbow trout redds radio-tagged in the upper South Fork Snake River before the May 23, 2004, freshet (19,000 ft^3/s), four redds may have been disrupted based on tag displacement. But only one of these tags actually moved downstream as determined by GPS. Because significant gravel movement was not observed - either during the freshet or as evidenced by the absence of new gravel bars later in the year - it is questionable whether the freshet caused any redd disruption. It is more likely that displaced tags were the result of rainbow or cutthroat trout redd super-imposition.

Rotary drum fish screens were operated on irrigation diversions in Palisades and Burns creeks during 2004. We did not salvage fish in the Palisades Dam stilling basin because it was not dewatered.

Authors:

William C. Schrader
Senior Fishery Research Biologist

Jim Fredericks
Regional Fishery Manager

INTRODUCTION

Fish trapping and collection facilities (weirs) in four major South Fork Snake River spawning tributaries are used to limit hybridization and insure the genetic integrity of a large component of the cutthroat trout spawning population. The weirs are essentially checkpoints that allow sorting and removal of rainbow trout. The first structure was constructed at Rainey Creek in 1996-1997, with weir panels installed in 2000. The next weir was constructed at Palisades Creek in 1998-1999, followed by Burns Creek in 2000 and Pine Creek in 2001. Host (2003) began trapping at all the weirs except Pine Creek in 2001. Trapping began at the Pine Creek weir in 2002. Besides trapping adult spawners moving upstream, each weir except Pine Creek also serves as an irrigation diversion dam with screening to pass juvenile fish and post-spawners moving downstream. The structures have also allowed accurate measurement of decreed water and have prevented streambed alterations to obtain that water. The Pine Creek weir was constructed and is operated solely for capturing upstream migrating fish. After low trap efficiencies and high cutthroat trout mortality were observed in 2003 (Schrader and Fredericks, in press), Idaho Department of Fish and Game (IDFG) and its cooperators determined to modify all the weirs beginning in 2004.

Recent South Fork Snake River research has found that native cutthroat trout have higher reproduction and juvenile survival than rainbow trout when the magnitude of the runoff peak flow is high relative to the base winter flow (Moller and Van Kirk 2003). The mechanisms for this are unknown, but rainbow trout spawn during April and May and it is possible that high flows after spawning scour redds – thereby reducing egg-to-fry survival. It is also possible that higher maximum to minimum flow ratios cause increased physiological stress on rainbow trout prior to spawning, reduce the spawning habitat available to rainbow trout in the main river, decrease rainbow trout fry survival, or induce more cutthroat trout to migrate into tributaries to spawn – all of which would contribute to higher cutthroat trout and lower rainbow trout numbers.

OBJECTIVES

1. Monitor South Fork Snake River trout populations by electrofishing.
2. Re-design and operate the fish weir on Pine Creek to maintain a genetically pure spawning population of cutthroat trout.
3. Assess rainbow trout redd disruption and gravel movement caused by the May 23 freshet (19,000 ft^3/s).
4. Operate rotary drum fish screens on irrigation diversions in Palisades and Burns creeks.

METHODS AND STUDY AREA

Electrofishing

Trout populations in the South Fork Snake River have been monitored annually using electrofishing since 1986. Four river sections have been sampled (Figure 1): Palisades (5.0 km, 39.50 ha), Conant (4.9 km, 34.79 ha), Twin Bridges (2.9 km, 19.14 ha), and Lorenzo (4.8 km, 22.08 ha). However, only the Conant section has been sampled every year, a portion of which was sampled in 1982 as well (Moore and Schill 1984). During 2004, the Conant section was electrofished on October 4, 6, 12, and 14. The upper or lower half of the section was sampled each day. Flows varied from 112.8 to 114.7 m^3/s (3,983 to 4,049 ft^3/s) at the Irwin gage (USGS, provisional data; Appendix A). Roughly 70.8 m^3/s (2,500 ft^3/s) is needed for safe boat operation and efficient sampling.

Fish were captured using direct-current (DC) electrofishing gear (Coffelt VVP-15 powered by a Honda 5000 W generator) mounted in an Alumaweld jet boat. We used pulsed DC current through two boom-and-dangler anodes fixed to the bow while driving downstream. The boat hull was the cathode. The VVP settings and water conductivity were similar to previous years (Schrader and Fredericks, in press).

We attempted to capture all species and sizes of trout. Fish were anesthetized and identified, and total length (TL) was measured to the nearest millimeter. Fish less than 100 mm (approximately age-0) were not marked as they are not efficiently recruited to the gear. Larger and older fish were marked with a caudal fin punch and released.

We assumed capture probabilities did not vary with species, and relative abundance was estimated using proportions of all individual trout captured (excluding recaptures). Although capture probabilities vary with fish length (Schill 1992), population size structures (length frequency distributions) and average fish lengths were estimated using all sizes of individual fish captured. Quality stock density was estimated using the number of individual fish captured ≥406 mm divided by the number ≥203 mm, multiplied by 100. Density was estimated using two methods in the MR5 computer program (MDFWP 1997). The log-likelihood method was preferred over the modified Petersen method if modeled efficiency curves were acceptable (termcode=1 and at least one of two chi-square p-values>0.05).

Pine Creek Weir

During 2004, we operated a fish weir at Pine Creek but not at Burns, Rainey, or Palisades creeks. Host (2003) provides a complete description of each weir and trap facility. However, at Pine Creek, we replaced the resistance board, floating weir panels (Ironwood Specialties, http://www.fishtraps.com/) with "hard" panels constructed with aluminum frames and 1.27 cm diameter electrical conduit pickets (Figure 2). We also installed a temporary picket weir in a small side channel that carries water around the main weir during high runoff.

The main Pine Creek weir was installed on March 25, generally checked daily, and removed on June 28. The side channel weir was installed on May 4. Pickets were pulled and both weirs were off-line during extreme high water on April 9-10 and May 28-June 1. All fish trapped at the weir were anesthetized, identified (species and gender), and measured (TL). Cutthroat trout were marked with a temporary caudal fin punch so they would not be counted twice and were released above the weir to spawn. Rainbow trout were loaded into an aerated fish tank and hauled to kids fishing ponds.

We estimated weir efficiency by trapping a sample of post-spawners returning downstream. Post-spawner trapping began June 17, although fish were observed moving downstream earlier, and ended June 28 when the weir was removed. The proportion of marked to total cutthroat trout (both marked and unmarked) caught was the weir efficiency. We assumed the larger (approximately greater than 300 mm) post-spawn fish were fluvial, had migrated upstream, spawned, and were returning downstream when they were caught. We further assumed that marked and unmarked fish were a random sample of all returning cutthroat trout. Statistically, this implies that the proportion of marked to total fish in our sample was an unbiased estimate of the proportion of marked fish in the total population. Unlike Host (2003) who evaluated the genetics of outmigrating fry, our goal in using this method was to evaluate the physical effectiveness of the picket weir to block and trap upstream migrating fish.

Streamflows are not currently measured at any South Fork Snake River tributary. However, we used the difference between main river flows measured at the USGS Heise and Irwin gages as a surrogate for flows in the tributaries (Moller and Van Kirk 2003). This provided a single hydrograph to compare with our fish trapping results to help evaluate the weir. In addition, water stage was recorded when we checked weir from a staff gage located just upstream. A water temperature logger that recorded data every 30 minutes was operated above the weir by Idaho State University (Ernest Keeley, personal communication). In addition, water temperature was measured with a hand-held thermometer when we checked the weir.

Rainbow Trout Redd Radio Telemetry

We tested two different methods to assess rainbow trout redd disruption and gravel movement caused by the spring freshet. One used a radio transmitter or tag planted within the redd. Another used colored markers placed around the redd. Visual assessment was not possible because of turbidity and water depth during high flows. Radio transmitters (ATS model F1835) were roughly the size of spawning gravel, weighed 15 g, and had external whip antennas. Their frequencies ranged from 151.803 to 151.994 MHz. Each had a mortality switch that operated in reverse – the pulse rate would double (from 30 to 60 ppm) if the tag moved. After 3 days of non-movement, the pulse rate would revert back to 30 ppm. We developed a special pipe tool to plant each tag approximately 10 cm into the redd pillow. The whip antenna extruded from the surface of the redd. Finally, three yellow-painted rocks, roughly the size of baseballs, were placed on top of and around the redd in a triangle.

Twenty rainbow trout redds were radio-tagged and marked between Palisades Dam and the Swan Valley highway bridge (Figure 3). Each redd was geo-referenced using a hand-held GPS receiver (Garmin Model 12) with estimated positional error of 10 m. Ten redds were just below the spillway (all in the main river), four were at Indian Creek (two in the main river and two in a side channel), three were at Squaw Creek (one in the main river and two in a side channel), and three were at Fall Creek (one in the main river and two in two different side channels). Redds were tagged at various flows throughout the spawning season – from 2,280 cfs on April 20 to 11,200 cfs on May 10. Pairs of spawning rainbow trout were observed on most redds. Radio tags were monitored as flow levels changed and included the day before and after the freshet (May 23). Tags were recovered and markers were inspected on June 14 (6 tags) and November 17-18 (14 tags). Not all tags could be recovered in June due to high flows (8,300 cfs).

Fish Screens

We operated and maintained rotary drum fish screens on two irrigation diversions in Palisades and Burns creeks during 2004. An unknown number of outmigrating cutthroat trout fry and post-spawners were prevented from being entrained in the irrigation ditches.

RESULTS

Electrofishing

A total of 1,591 trout were captured during four days of electrofishing at the Conant section in October 2004. Trout species composition and relative abundance were cutthroat trout (41.4%), rainbow trout (35.4%), and brown trout (23.2%; Figure 4, Appendix B). No lake trout or kokanee salmon were captured. Less than 1% of the cutthroat trout was of hatchery origin.

The 2004 cutthroat trout length frequency distribution shows a relatively weak group of age-1 fish (about 100 to 250 mm) relative to age-2 and older fish (>250 mm; Figure 5). Stronger groups of age-1 rainbow trout (about 150 to 280 mm) and brown trout (about 180 to 280 mm) were observed. Ages were approximated from these length frequency distributions and need to be validated with otoliths or dorsal fin rays in the future.

Mean total length was 324 mm for cutthroat trout, 294 mm for rainbow trout, 314 mm for brown trout, and 311 mm for all species combined (Appendix B). Quality stock density was 13.3% for cutthroat trout, 23.7% for rainbow trout, 23.9% for brown trout, and 19.4% for all species combined. Sample sizes were similar to previous years.

Electrofishing sampling efficiencies (R/C) were similar to previous years and ranged from 9% for rainbow trout to 13% for cutthroat trout (Appendix B). Estimated age 1 and older fish densities were 478 fish/km for cutthroat trout, 530 fish/km for rainbow trout, 383 fish/km for brown trout, and 1,443 fish/km for all species combined.

Pine Creek Weir

From March 25 to June 28, 2004, we trapped a total of 2,170 fish at the Pine Creek weir, of which 1.2% were rainbow trout (11 females and 16 males) and 98.8% were cutthroat trout (1,652 females and 491 males; Figure 6). Rainbow trout were caught between April 22 and June 22. Cutthroat trout were caught between April 14 and June 25, but most (98.4%) were caught after May 13.

The estimated weir or trap efficiency of the new picket weir was 98.1% using our mark-recapture technique. Of 464 total fish trapped moving downstream from June 17 to 28, 454 were marked and 9 were unmarked cutthroat trout. One unmarked post-spawn rainbow trout was also trapped. It is likely the unmarked fish swam by the weir when it was off-line April 9-10 and May 28-June 1 during high water, or when we pulled pickets to clean the weir.

Trapped rainbow trout ranged in size from 255 to 520 mm (TL, Figure 7). Cutthroat trout ranged from 140 to 550 mm, but most (95.4%) were greater than 300 mm. Mean total length was 395 mm (n=27) for rainbow trout and 367 mm (n=2,143) for cutthroat trout.

Rainbow Trout Redd Radio Telemetry

Four redds may have been disrupted based on radio tag displacement, i.e. the tag was recovered outside of or on top of the gravel (Appendix C). But only one of these tags (in redd number 16 at Indian Creek in the main river) actually moved downstream approximately 20 m as determined by GPS. The movement was observed the day after the May 23 freshet (19,000 ft^3/s). Displaced tags in redd number 15 (Indian Creek side channel), 17 (Indian Creek main channel), and 7 (below the dam) were at or near their original location when recovered.

DISCUSSION

The 2004 cutthroat trout density estimate (478 fish/km) at Conant is 43% less than 2003 and is the lowest recorded since 1986 when electrofishing began (Figure 8). Cutthroat trout are now about a fourth as abundant as they were in the early 1990s (1,400 to 2,300 fish/km) – at least in the upper river for which Conant is the standard monitoring reach. Similarly, cutthroat trout abundance in the electrofishing catch relative to other taxa has declined from near 90% in the 1980s to near 40% in 2004 (Figure 9). Since cutthroat trout were once the predominant taxa in the fishery, it is not surprising that total trout density has declined by half as well – from about 2,800 trout/km in 1999 to a record low 1,400 trout/km in 2004.

The decline of cutthroat trout in the South Fork Snake River cannot be attributed to over-harvest. Cutthroat trout have likely been under-exploited for some time – only 286 cutthroat trout were harvested in 2003, an insignificant portion (3%) of the total harvest (Schrader and Fredericks, in press). Exploitation in 2003 was estimated to be 2.6% for cutthroat trout $\geq$406 mm and 0.3% for cutthroat trout $\geq$203 mm. In addition, legal harvest of cutthroat trout was eliminated in 2004 and illegal harvest is probably low.

It is more likely that declining cutthroat trout abundance has been caused by increasing rainbow trout combined with adverse flow conditions during the current drought. Poor cutthroat trout recruitment and year class failures are suggested by rising QSDs (Figure 10). However, rising QSDs could also be caused by increasing numbers of large relative to small cutthroat trout. Moller and Van Kirk (2003) have shown that cutthroat trout recruitment is positively correlated to spawning tributary flows as well as maximum to minimum flow ratios in the main river. In addition, rainbow trout recruitment is negatively correlated to maximum to minimum flow ratios.

The rainbow trout density estimate at Conant is 43% less than 2003 (Figure 8). The increasing trend observed over the past may now be reversing itself – probably due to increased harvest. For the first time, there were no harvest limits on rainbow trout during 2004, and anglers had the opportunity to fish on rainbow trout spawning beds in the spring. However, for the second year in a row, we estimated more rainbow than cutthroat trout at Conant (although 95% confidence intervals overlap).

The effects of the 2004 freshet (19,000 ft^3/s on May 23) on rainbow and cutthroat trout recruitment (i.e. age 1 or yearling abundance) can not be measured until 2005. The rainbow trout redd radio telemetry was a pilot study designed to explore the flow-related mechanisms that affect recruitment – or at least are correlated to recruitment. We hoped to evaluate redd disruption and gravel movement by using three criteria: 1) radio tag displacement, 2) radio tag mortality signal activation, and 3) marker movement. Unfortunately, the latter two methods proved unreliable. Several mortality signals were verified as "false" by actual inspection of the redd. "False" signals were due to water velocity effects on the protruding antenna. Yellow markers on redds could only be identified in shallow water in June and, by November, most of the markers became covered with algae and were difficult to identify. Also, some markers on shallow water redds observed in June had been buried by spawning cutthroat trout.

Although one to four radio-tagged rainbow trout redds (five to twenty percent) may have been disrupted during the 2004 freshet, it is questionable whether the freshet actually caused the disruption. Significant gravel movement was not observed, either during the freshet or later in the season as evidenced by the formation of new gravel bars. It is more likely that displaced radio tags were the result of subsequent spawning rainbow or cutthroat trout. Redd super-imposition is common with salmonids. This confounding factor needs to be accounted for in future redd disturbance research.

We believe the Pine Creek weir operation in 2004 was, for the first time, clearly a success. Despite the 43% decline in cutthroat and rainbow trout densities in the main river, almost ten times more fish were trapped using the "hard" picket weir in 2004 compared to using the floating weir in 2003 (Figure 6). Further, estimated weir or trap efficiency increased from 40% in 2003 to 98% in 2004. More fish were trapped at Pine Creek in 2004 (over 2,100 fish) than in any other year of weir operation except Burns Creek in 2001 (over 3,100 fish). However, the operational and maintenance requirements for a picket weir are considerably higher than for a floating weir. It should be noted that a capable, motivated, and full-time resident of Swan Valley (Lucian Albano) – who checked the picket weir twice daily – was instrumental in making 2004 a success in Pine Creek.

The overall goal of the weirs is to restrict rainbow and hybrid trout movement into key cutthroat trout spawning tributaries – thereby limiting hybridization and providing genetic refuge for and core populations of cutthroat trout. Efficiencies for each of the floating weirs have been estimated to be less than 50% in the past (Schrader and Fredericks, in press). By allowing more than 50% of the rainbow and hybrid trout to pass and presumably spawn and hybridize with cutthroat trout, it is clear that the floating weirs have not been successful in achieving our overall goal. This is in contrast to Host's (2003) conclusion that the floating weirs were effective in limiting hybridization based on genetic analyses of outmigrating fry. We recommend that picket weirs be considered in all the tributaries in the future after weighing their costs and benefits.

The fish weirs provide a valuable opportunity to highlight the importance of native trout conservation. Not surprisingly, the structures have generated significant interest from both the angling and non-angling public alike. With our cooperators, we've constructed and placed educational signs at the most highly visible weir sites. These signs are designed to explain the purpose and importance of using the weir facilities to maintain healthy populations of cutthroat trout. Our success at Pine Creek has shown that the weirs – if designed properly and operated with diligence – can conserve cutthroat trout while educating anglers about the value of native trout.

RECOMMENDATIONS

1. Continue to implement flow management objectives recommended by EBSM (Hauer et al. 2004) and Moller and Van Kirk (2003). Encourage BOR to provide spring flushing flows in 2005, even if the tradeoff is slightly lower winter flows. Monitor the effects on rainbow trout redds using radiotelemetry.
2. Continue to monitor South Fork Snake River trout populations by electrofishing. Sample the Conant and Lorenzo sections in 2005.
3. Repeat the fully randomized creel survey in 2005 to evaluate our angler outreach campaign as well as the new fishing regulations. Continue to inform and educate anglers regarding benefits to cutthroat trout by harvesting rainbow trout.
4. Repeat rainbow trout exploitation estimates in 2005 using pre-season stock abundance and harvest.
5. Continue to operate the Pine Creek picket weir. Modify the Rainey Creek weir to a similar design with removable pickets and operate in 2005. Do not operate the Burns Creek weir in 2005.
6. Modify the Palisades Creek weir with pickets or Mitsubishi floating panels and operate on an experimental basis in 2005. Evaluate weir efficiency.
7. Operate and maintain rotary drum fish screens on irrigation diversions in Palisades and Burns creeks.

ACKNOWLEDGEMENTS

IDFG employees Trapper Bradshaw, Eric Crawford, Dan Duggan, Heather Halbritter, and Cameron Wheeler helped with electrofishing. Lucian Albano tended the weir. Trapper Bradshaw, Aaron Weber, and Lucian Albano helped with the radio telemetry. Funding was provided by U.S. Department of Interior, Bureau of Reclamation, under grant agreement #1425-03-FC-10-9910 (Ecologically Based System Management).

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FIGURES

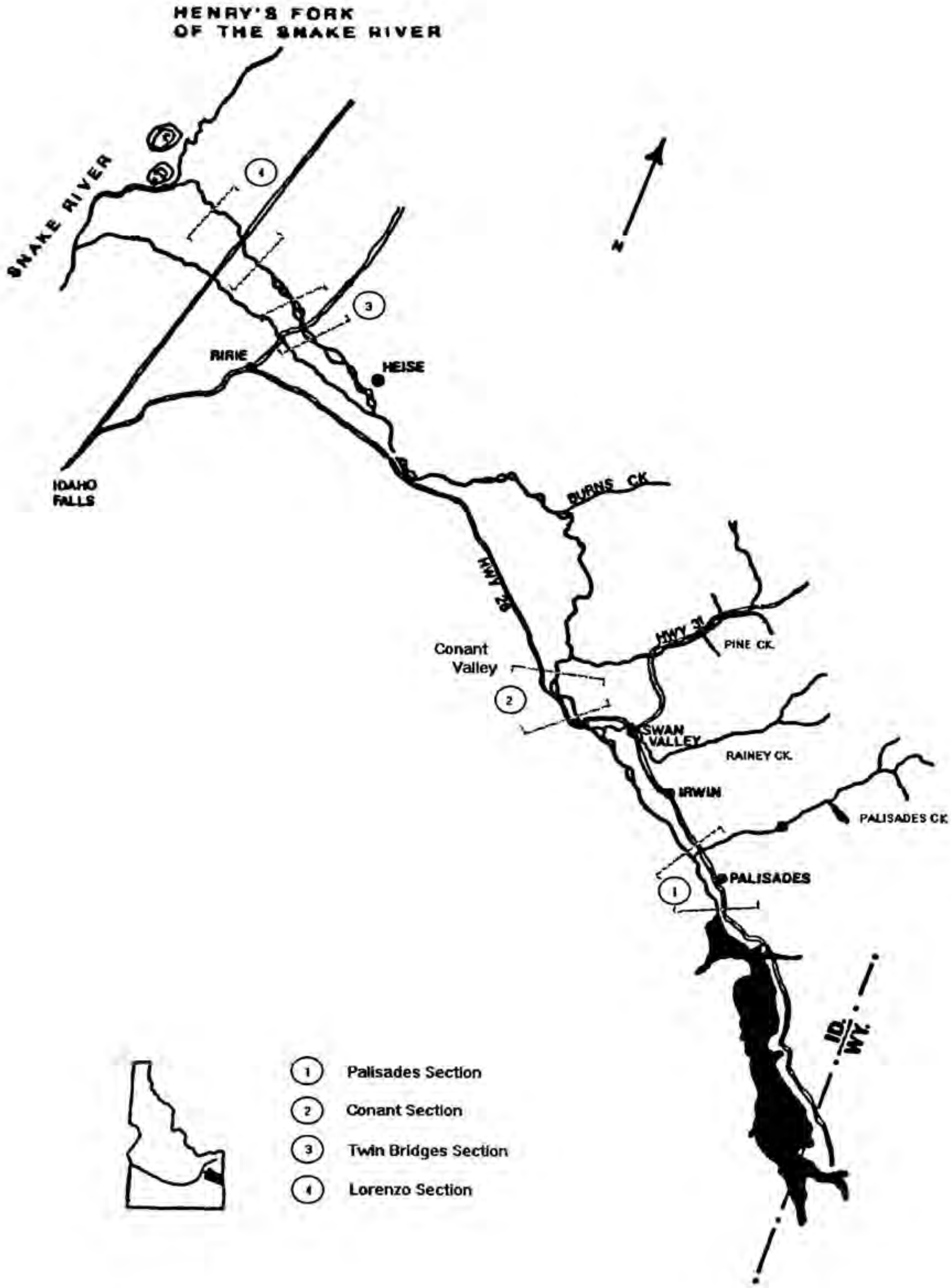


Figure 1. Map of South Fork Snake River, Idaho, showing standard electrofishing sections and the four major spawning tributaries.

Figure 2. Photos of the Pine Creek fish weir with old floating panels (top photo, June 15, 2002) and new “hard” picket panels (bottom photo, April 2, 2004), South Fork Snake River, Idaho.

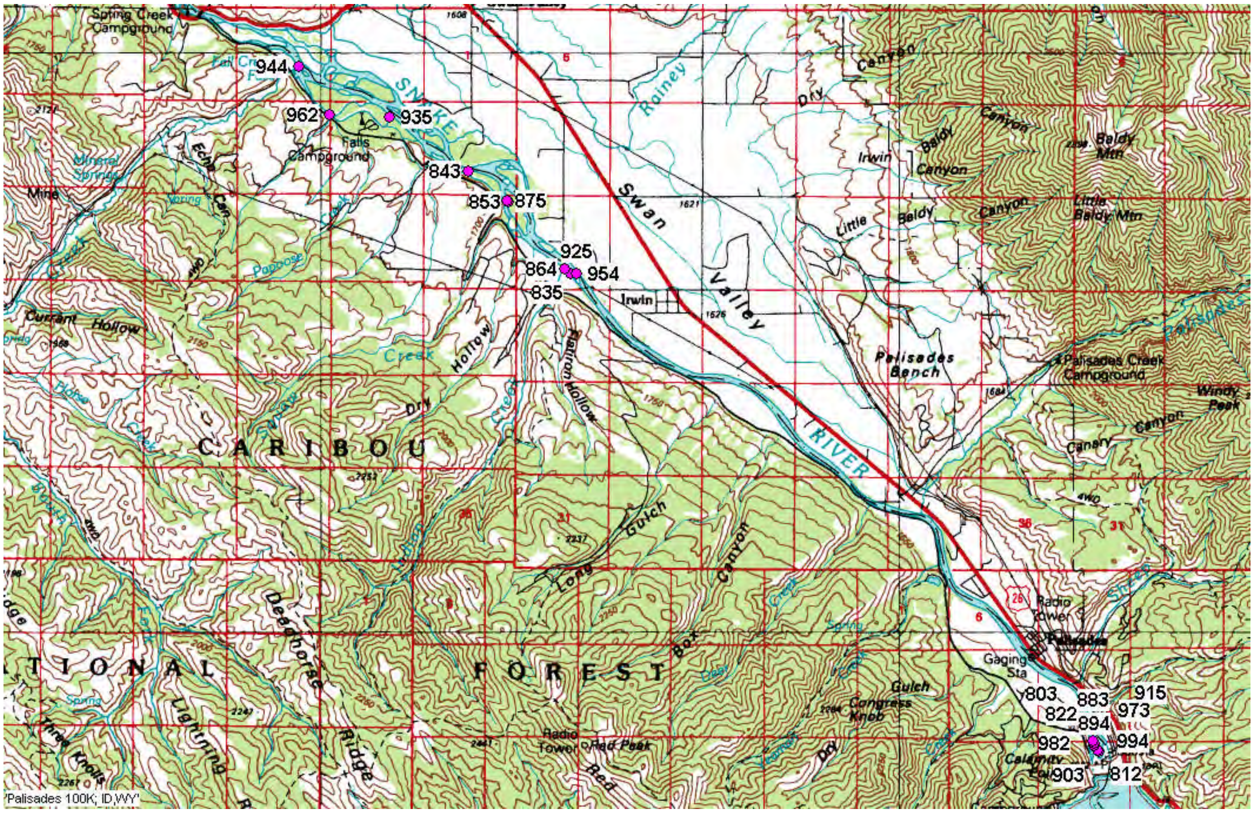


Figure 3. Location of 20 rainbow trout redds that were radio-tagged in the upper South Fork Snake River, Idaho, 2004. Numbers are frequencies (KHz) on the 151 MHz band.

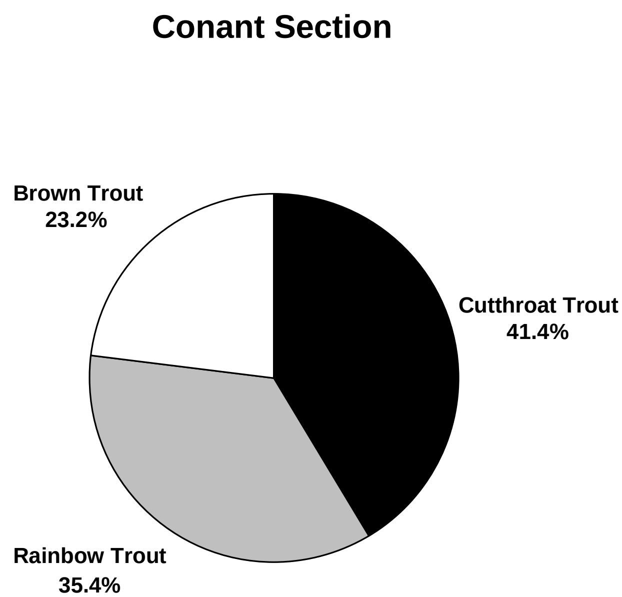


Figure 4. Trout species composition and relative abundance at the Conant electrofishing section (*n* = 1,591), South Fork Snake River, Idaho, 2004.

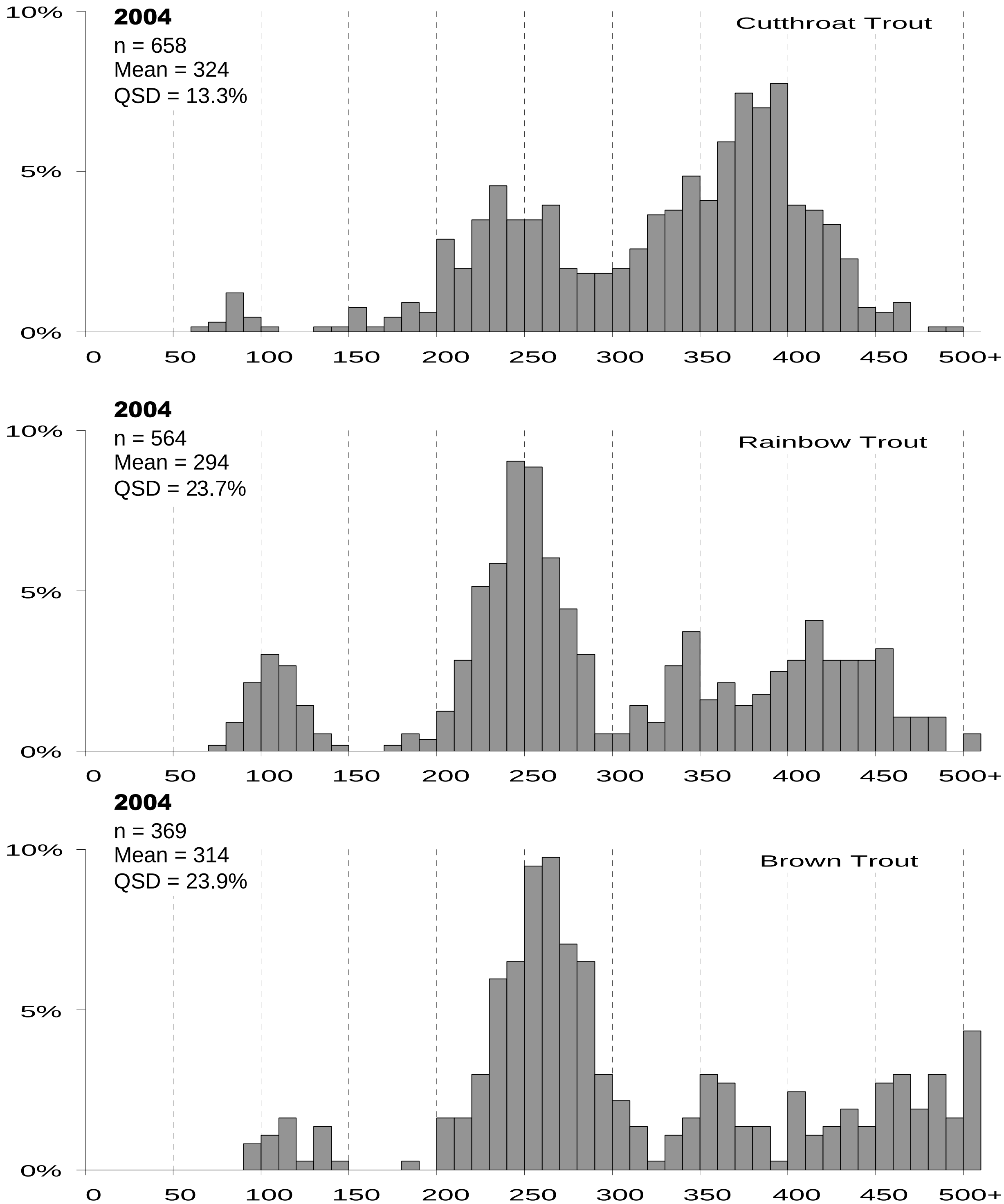
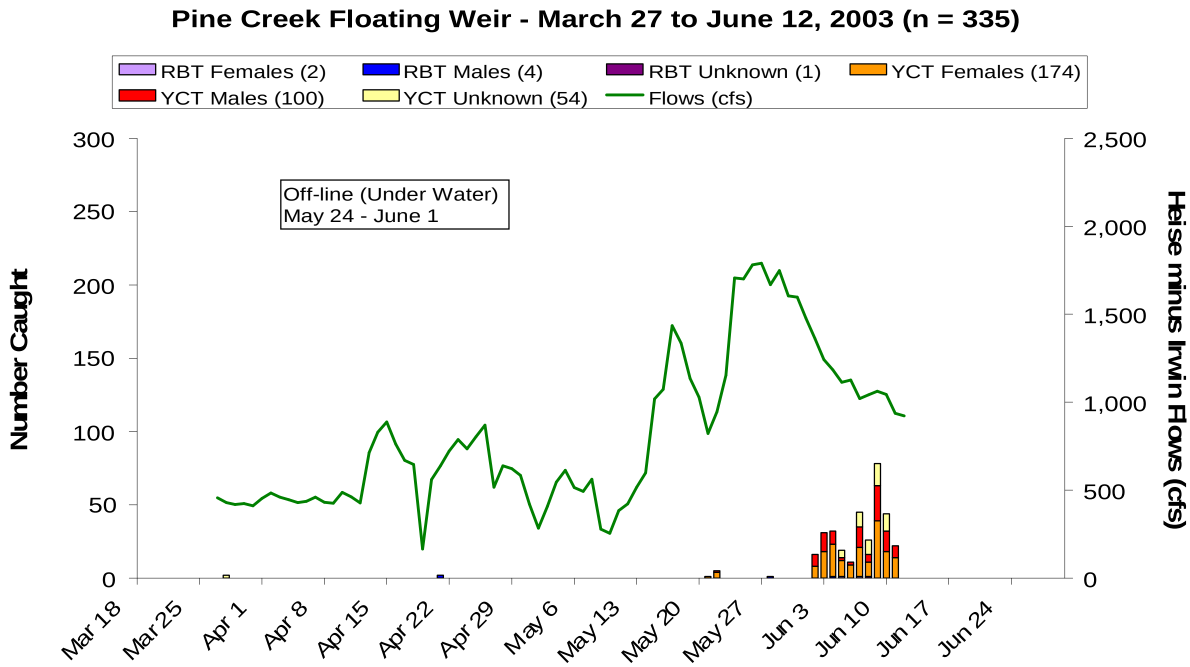


Figure 5. Length frequency distributions (total length, mm) of cutthroat trout (top), rainbow trout (middle), and brown trout (bottom) captured in the fall at the Conant electrofishing section, South Fork Snake River, Idaho, 2004. Total individual fish captured during mark (*M*) and recapture (*C* - *R*) runs = *n*.



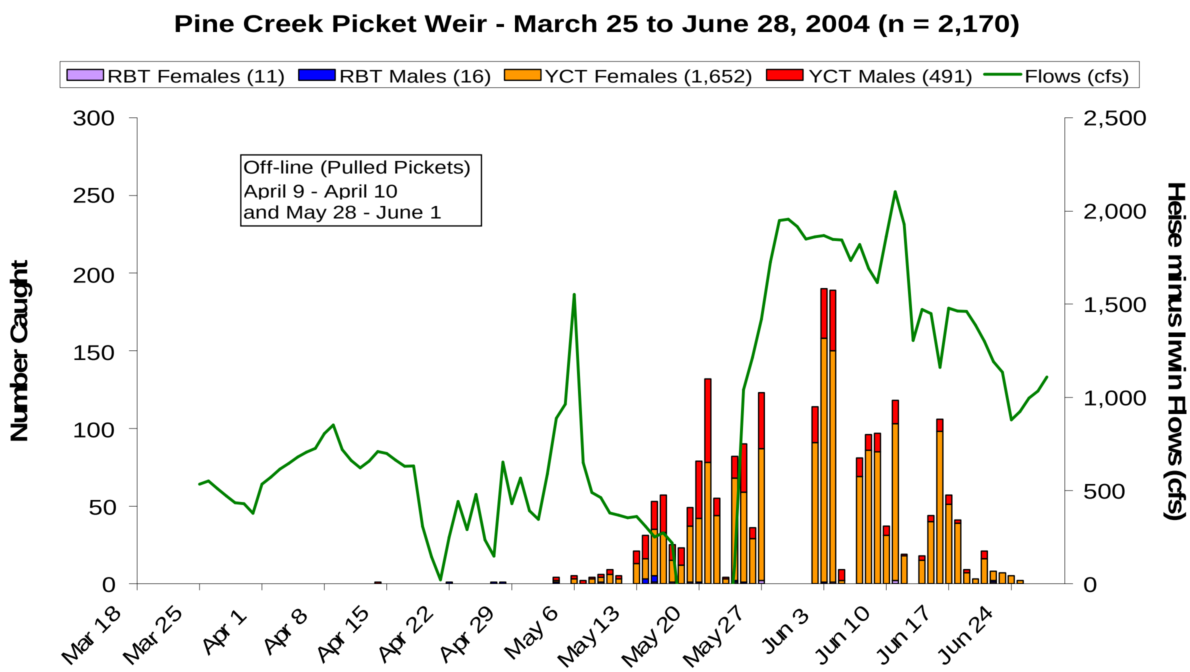
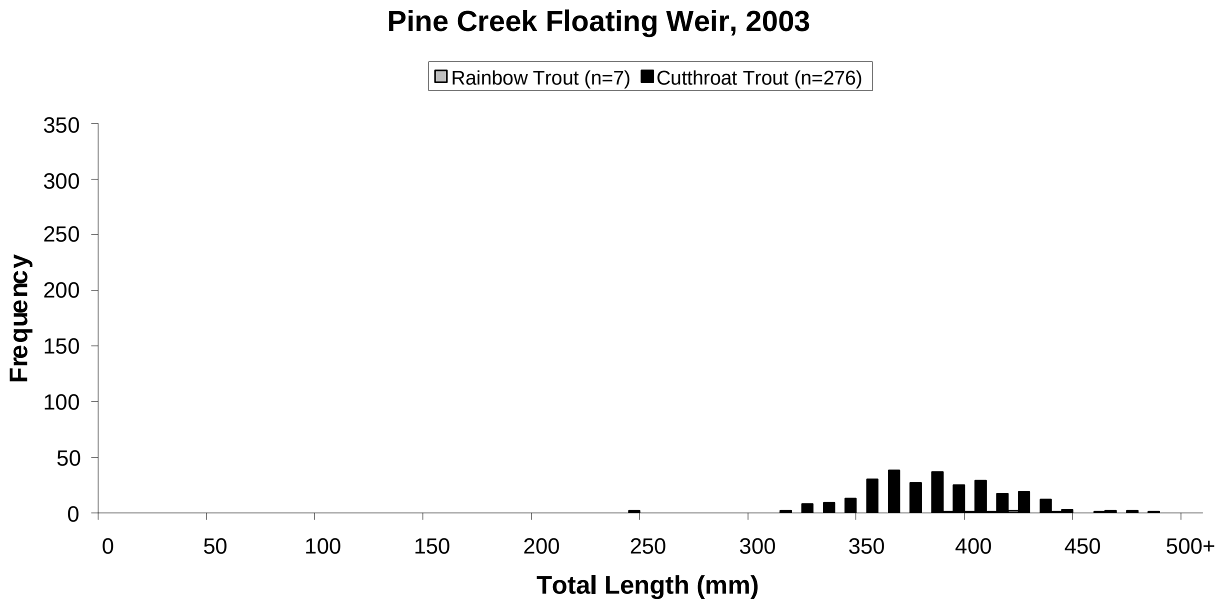


Figure 6. Number of fish captured, run timing, and hydrograph at the Pine Creek weir, South Fork Snake River, Idaho, 2003 (top) and 2004 (bottom). RBT = rainbow trout; YCT = cutthroat trout.



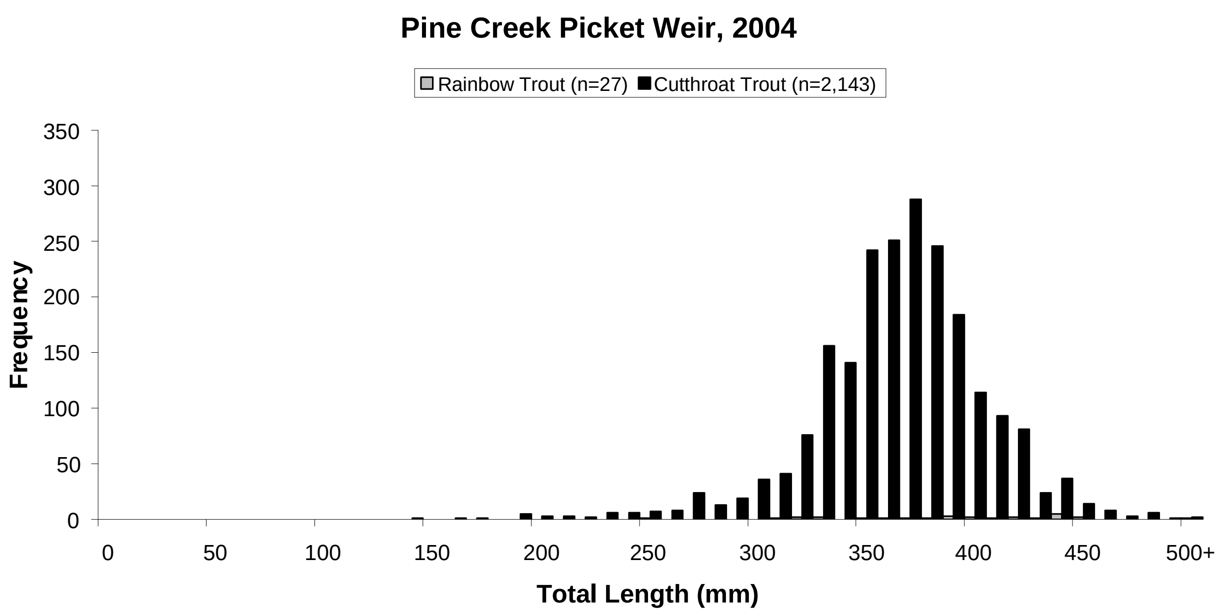


Figure 7. Length frequency distributions of rainbow and cutthroat trout measured at the Pine Creek weir, South Fork Snake River, Idaho, 2003 (top) and 2004 (bottom).

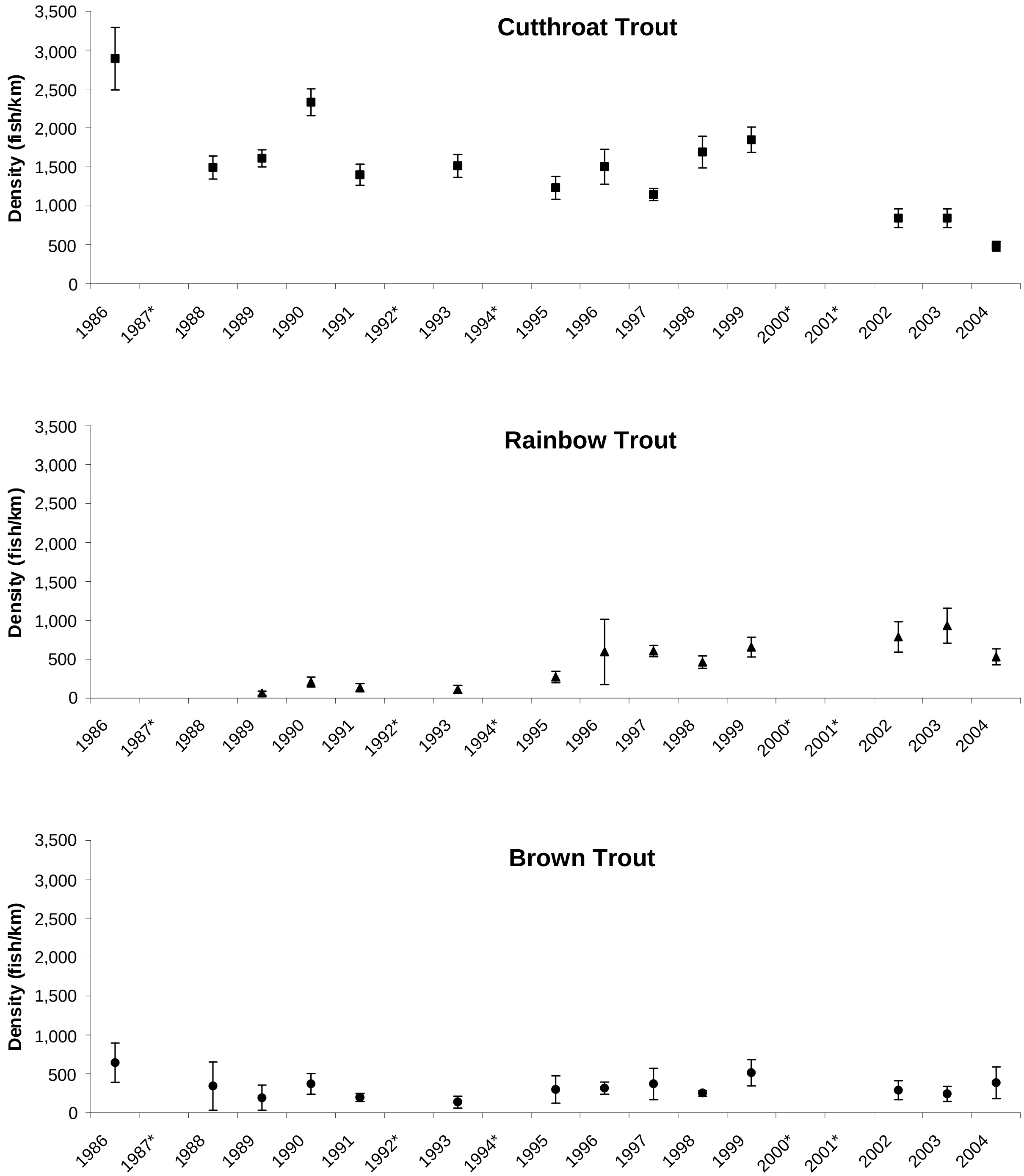


Figure 8. Density trends for age-1 and older cutthroat (top, ≥102 mm), rainbow (middle, ≥152 mm), and brown trout (bottom, ≥178 mm) at the Conant electrofishing section, South Fork Snake River, Idaho, October and November 1986-2004. Confidence intervals are at 95%. Asterisks indicate years when no estimate was possible.

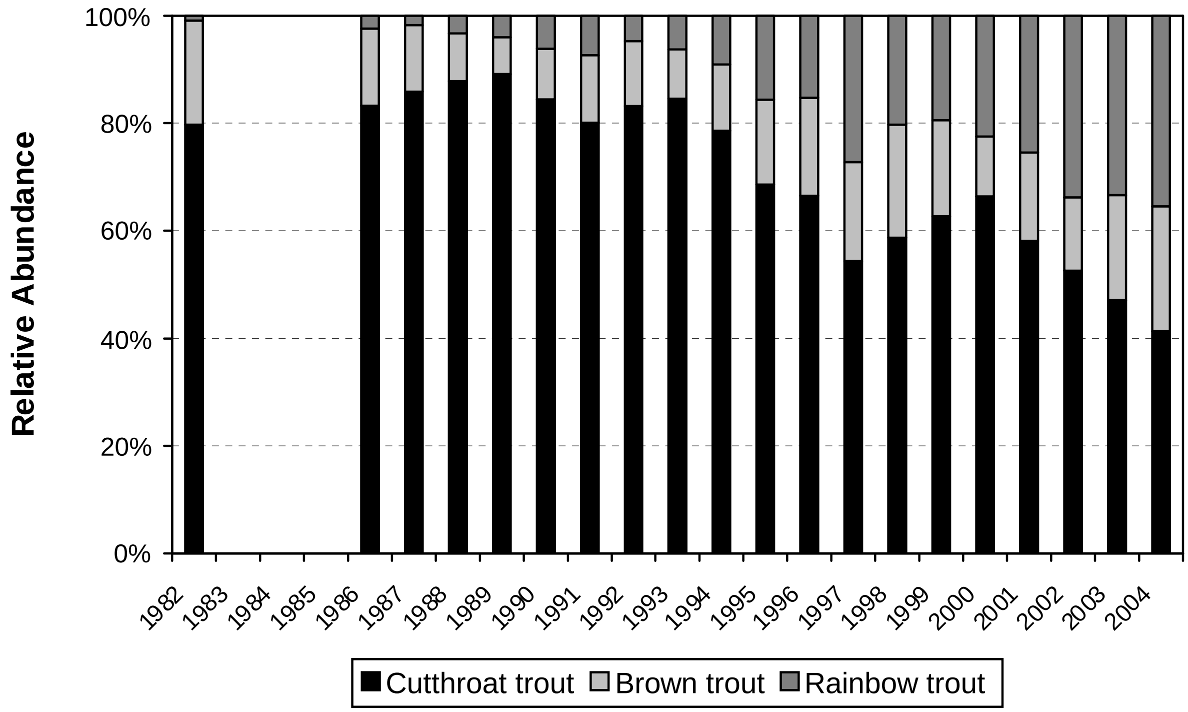


Figure 9. Trout relative abundance trends at the Conant electrofishing section, South Fork Snake River, Idaho, 1982-2004. The 1982 data is from Moore and Schill (1984).

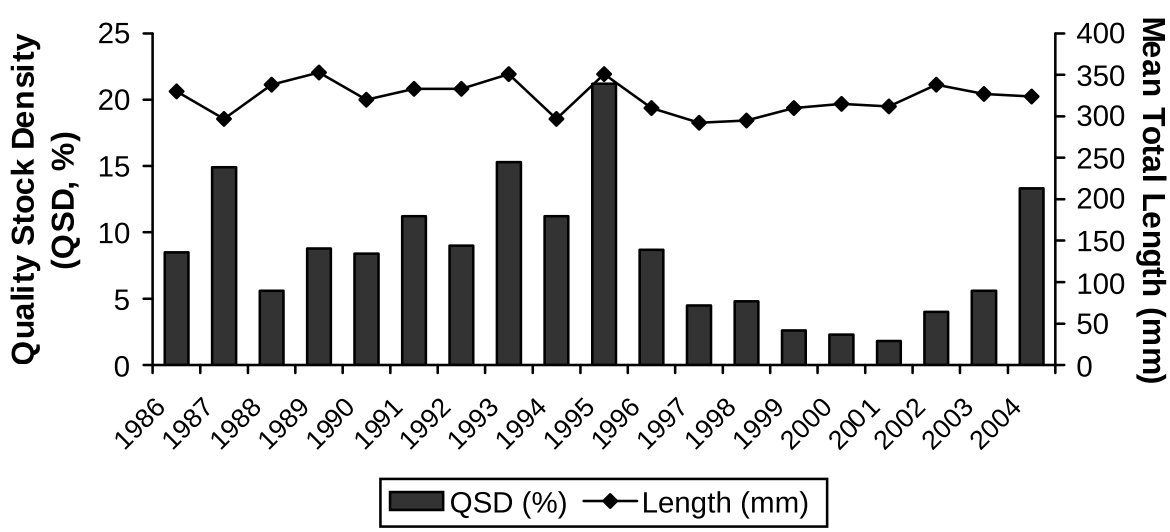


Figure 10. Cutthroat trout quality stock density (QSD) and mean total length trends at the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2004.

APPENDICES

Appendix A. Sampling dates, flows, and catch rates at the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2004. Flows were recorded at the USGS Irwin gage.

Sampling dates	Range of flows (m^3/s)	Range of flows (ft^3/s)	Mean flow (m^3/s)	Catch rate (trout/day)[a]
11/4,5, 6, 7,20 1986	100.3-107.0	3,540-3,780	101.7	413
11/5,6 1987[b,c]	24.6-26.6	869-941	25.6	174
10/3,4,11 1988	102.0-105.1	3,600-3,710	103.5	630
10/18,19,27 1989	84.7-86.7	2,990-3,060	86.0	930
10/11,12,18 1990	98.8-104.5	3,490-3,690	100.8	1,292
10/7,8,15 1991	127.2-135.7	4,490-4,790	131.7	741
10/14 1992[b]	60.3	2,130	60.3	719
10/13,14,21,22 1993	74.2-108.2	2,620-3,820	90.9	481
10/7,11,14 1994[b]	34.6-69.1	1,220-2,440	52.4	368
10/5,6,12,13 1995	72.8-115.8	2,570-4,090	93.2	436
10/3,4,10,11 1996	106.5-107.3	3,760-3,790	106.9	472
10/16,17,23,27 1997[d]	70.0-99.1	2,470-3,500	84.5	851
10/7,8,14,15 1998	91.5-126.6	3,230-4,470	109.6	593
10/13,14,20,21 1999	101.1-118.1	3,570-4,170	109.6	763
10/19,26 2000[b]	87.8-95.2	3,100-3,360	91.5	603
10/4,5 2001[b]	117.2-117.5	4,140-4,150	117.4	669
10/3,4,10,11 2002	68.0-72.8	2,400-2,570	71.6	423
10/8,9,15,16 2003	87.2-141.6	3,080-5,000	107.9	523
10/4,6,12,14 2004	112.8-114.7[e]	3,983-4,049[e]	113.5[e]	423

[a] Includes recaptured fish; catch rate = (*M* + *C*) / number days sampled.
[b] No recapture runs due to low flows.
[c] Only 3.2 km of larger 4.9 km section was electrofished with drift boat.
[d] Major habitat changes with spring, 1997, runoff.
[e] Provisional data.

Appendix B. Electrofishing mark-recapture statistics for the Conant electrofishing section, South Fork Snake River, Idaho, 1982-2004.

Appendix B-1. Trout species composition and relative abundance (percent of catch) at the Conant electrofishing section, South Fork Snake River, Idaho, 1982 and 1986-2004. Age 1 cutthroat trout are 102-254 mm, age 1 rainbow trout are 152-279 mm, and age 1 brown trout are 178-279 mm. Total individual fish captured during mark (*M*) and recapture (*C* - *R*) runs are in parentheses.

Year	Cutthroat trout[a]		Rainbow trout		Brown trout		Lake trout	Kokanee	Total	
	All	Age 1	All	Age 1	All	Age 1	All	All	All	Age 1
1982[b,c]	79.0 (181)	ND[d]	0.9 (2)	ND	19.2 (44)	ND	0.9 (2)	0.0 (0)	100.0 (229)	ND
1986[c]	83.1 (1,647)	59.7 (191)	2.4 (47)	4.7 (15)	14.4 (285)	35.6 (114)	0.2 (4)	0.0 (0)	100.0 (1,983)	100.0 (320)
1987[c,e,f]	85.9 (299)	87.6 (85)	1.7 (6)	2.1 (2)	12.4 (43)	10.3 (10)	0.0 (0)	0.0 (0)	100.0 (348)	100.0 (97)
1988	87.8 (1,570)	54.2 (115)	3.2 (58)	9.0 (19)	8.9 (159)	36.8 (78)	0.1 (1)	0.0 (0)	100.0 (1,788)	100.0 (212)
1989	89.2 (2,291)	66.5 (165)	4.0 (103)	14.9 (37)	6.8 (175)	18.5 (46)	0.0 (0)	0.0 (0)	100.0 (2,569)	100.0 (248)
1990	84.3 (2,978)	71.7 (849)	6.1 (216)	12.2 (145)	9.5 (335)	16.0 (190)	0.1 (4)	0.0 (0)	100.0 (3,533)	100.0 (1,184)
1991	80.1 (1,646)	51.2 (290)	7.3 (150)	18.4 (104)	12.6 (259)	30.4 (172)	0.0 (0)	0.0 (0)	100.0 (2,055)	100.0 (566)
1992[e]	83.2 (598)	62.2 (115)	4.7 (34)	11.4 (21)	12.1 (87)	26.5 (49)	0.0 (0)	0.0 (0)	100.0 (719)	100.0 (185)
1993	84.6 (1,528)	54.5 (109)	6.3 (113)	13.5 (27)	9.2 (166)	32.0 (64)	0.0 (0)	0.0 (0)	100.0 (1,807)	100.0 (200)
1994[e]	78.5 (867)	70.4 (357)	9.1 (100)	12.4 (63)	12.3 (136)	17.2 (87)	0.0 (0)	0.1 (1)	100.0 (1,104)	100.0 (507)
1995	68.6 (1,121)	31.4 (150)	15.7 (256)	36.5 (174)	15.8 (258)	32.1 (153)	0.0 (0)	0.0 (0)	100.0 (1,635)	100.0 (477)
1996	66.4 (1,190)	49.9 (371)	15.3 (274)	23.5 (175)	18.1 (325)	26.6 (198)	0.1 (1)	0.1 (1)	100.0 (1,791)	100.0 (744)
1997[g]	54.3 (1,676)	34.6 (489)	27.2 (840)	40.7 (575)	18.4 (567)	24.6 (348)	0.0 (1)	0.1 (2)	100.0 (3,086)	100.0 (1,412)
1998	58.7 (1,312)	56.0 (424)	20.3 (454)	15.2 (115)	21.0 (469)	28.8 (218)	0.0 (1)	0.0 (0)	100.0 (2,236)	100.0 (757)
1999	62.7 (1,803)	36.6 (269)	19.5 (560)	28.3 (208)	17.8 (513)	35.0 (257)	0.0 (0)	0.0 (0)	100.0 (2,876)	100.0 (734)
2000[e]	66.4 (800)	42.8 (110)	22.5 (271)	38.1 (98)	11.1 (134)	19.1 (49)	0.0 (0)	0.0 (0)	100.0 (1,205)	100.0 (257)
2001[e]	58.1 (778)	36.4 (122)	25.5 (341)	37.3 (125)	16.4 (219)	26.3 (88)	0.0 (0)	0.0 (0)	100.0 (1,338)	100.0 (335)
2002	52.5 (845)	14.4 (44)	33.8 (543)	65.6 (200)	13.6 (219)	20.0 (61)	0.1 (1)	0.0 (0)	100.0 (1,608)	100.0 (305)
2003	47.1 (924)	31.1 (183)	33.4 (655)	45.2 (266)	19.5 (383)	23.6 (139)	0.0 (0)	0.0 (0)	100.0 (1,962)	100.0 (588)
2004	41.4 (658)	25.2 (141)	35.4 (564)	44.9 (251)	23.2 (369)	29.9 (167)	0.0 (0)	0.0 (0)	100.0 (1,591)	100.0 (559)

[a] Includes hatchery cutthroat trout.
[b] Only 1.9 km of larger 4.9 km section was electrofished; data from Moore and Schill (1984).
[c] Electrofishing conducted in early November rather than October.
[d] ND = no data.
[e] No recapture runs due to low flows.
[f] Only 3.2 km of larger 4.9 km section was electrofished with drift boat.
[g] Major habitat changes with spring, 1997, runoff.

Appendix B-2. Mean total length and quality stock density (QSD) of trout captured in the fall at the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2004. Total individual fish captured during mark (*M*) and recapture (*C* - *R*) runs equals *n*. QSD = (number ≥406 mm / number ≥203 mm) x 100.

Year	Cutthroat trout[a]			Rainbow trout			Brown trout			All trout[b]		
	n	Mean (mm)	QSD (%)	*n*	Mean (mm)	QSD (%)	*n*	Mean (mm)	QSD (%)	*n*	Mean (mm)	QSD (%)
1986[c]	1,647	330	8.5	47	308	11.4	285	337	29.0	1,983	330	11.5
1987[c,d,e]	299	298	14.9	6	262	0.0	43	249	11.5	348	292	14.3
1988	1,570	338	5.6	58	327	12.3	159	309	22.8	1,788	335	7.3
1989	2,291	354	8.8	103	323	20.6	175	343	38.5	2,569	351	11.2
1990	2,978	319	8.4	216	269	13.3	335	266	20.4	3,533	310	9.7
1991	1,646	332	11.2	150	252	6.6	259	275	14.1	2,055	320	11.3
1992[d]	598	333	9.0	34	283	2.9	87	264	6.6	719	323	8.4
1993	1,528	351	15.3	113	341	18.2	166	329	34.2	1,807	348	17.2
1994[d]	867	298	11.2	100	251	13.4	136	237	7.4	1,104	287	10.9
1995	1,121	350	21.2	256	278	10.5	258	287	15.8	1,635	328	18.7
1996	1,190	311	8.7	274	262	6.6	325	284	12.7	1,791	297	9.2
1997[f]	1,676	291	4.5	840	263	4.3	567	275	12.5	3,086	279	6.0
1998	1,312	296	4.8	454	318	13.3	469	279	8.4	2,236	297	7.4
1999	1,803	309	2.6	560	313	11.6	513	293	9.1	2,876	307	5.5
2000[d]	800	315	2.3	271	307	13.8	134	312	12.8	1,205	312	6.0
2001[d]	778	312	1.8	341	304	16.9	219	311	17.6	1,338	310	8.2
2002	845	338	4.0	543	326	23.6	219	339	34.0	1,608	334	14.4
2003	924	327	5.6	655	298	19.1	383	270	29.2	1,962	306	14.0
2004	658	324	13.3	564	294	23.7	369	314	23.9	1,591	311	19.4

[a] Includes hatchery cutthroat trout.
[b] Includes other trout, i.e. lake trout and kokanee.
[c] Electrofishing conducted in early November rather than October.
[d] No recapture runs due to low flows.
[e] Only 3.2 km of larger 4.9 km section was electrofished with drift boat.
[f] Major habitat changes with spring, 1997, runoff.

Appendix B-3. Mark-recapture statistics for age 1 and older cutthroat trout (≥102 mm), rainbow trout (≥152 mm), brown trout (≥178 mm), and all trout (≥102 mm) at the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2004. Cases where $R \leq 3$ and unbiased density estimates are not possible (Ricker 1975) are highlighted.

Year	Cutthroat trout[a]				Rainbow trout				Brown trout				All trout[b]			
	M[c]	*C*[c]	*R*[c]	*R/C* (%)	*M*	*C*	*R*	*R/C* (%)	*M*	*C*	*R*	*R/C* (%)	*M*	*C*	*R*	*R/C* (%)
1986[d]	1,170	546	70	12.8	32	16	2	12.5	183	105	8	7.6	1,392	669	80	12.0
1987[d,e,f]	281	ND[e]	ND	ND	5	ND	ND	ND	26	ND	ND	ND	329	ND	ND	ND
1988	1,100	561	98	17.5	41	18	1	5.6	113	46	4	8.7	1,256	628	103	16.4
1989	1,416	1,050	200	19.0	57	55	10	18.2	92	76	11	14.5	1,578	1,184	221	18.7
1990	1,733	1,522	317	20.8	113	109	14	12.8	173	117	12	10.3	2,062	1,766	343	19.4
1991	1,145	625	140	22.4	98	54	9	16.7	150	119	19	16.0	1,402	799	168	21.0
1992[e]	595	ND	ND	ND	34	ND	ND	ND	76	ND	ND	ND	716	ND	ND	ND
1993	972	623	100	16.1	74	41	6	14.6	101	64	10	15.6	1,154	730	116	15.9
1994[e]	853	ND	ND	ND	87	ND	ND	ND	110	ND	ND	ND	1,077	ND	ND	ND
1995	631	542	77	14.2	130	140	17	12.1	150	108	13	12.0	914	800	107	13.4
1996	707	548	72	13.1	155	111	5	4.5	212	124	18	14.5	1,082	788	95	12.1
1997[g]	910	895	164	18.3	429	467	72	15.4	344	281	82	29.2	1,695	1,668	319	19.1
1998	674	682	61	8.9	216	247	26	10.5	257	216	49	22.7	1,164	1,175	136	11.6
1999	1,019	883	117	13.3	345	241	29	12.0	293	241	31	12.9	1,661	1,370	177	12.9
2000[e]	797	ND	ND	ND	260	ND	ND	ND	133	ND	ND	ND	1,195	ND	ND	ND
2001[e]	776	ND	ND	ND	321	ND	ND	ND	208	ND	ND	ND	1,322	ND	ND	ND
2002	495	394	50	12.7	295	257	24	9.3	111	104	9	8.7	908	764	83	10.9
2003	422	571	72	12.6	272	360	29	8.1	143	165	27	16.4	861	1,195	128	10.7
2004	315	379	51	13.5	227	304	29	9.5	169	202	22	10.9	737	914	102	11.2

[a] Includes hatchery cutthroat trout.
[b] Includes other trout, i.e. lake trout and kokanee.
[c] *M*=number of fish marked on marking run; *C*=total number of fish captured on recapture run; *R*=number of recaptured fish on recapture run.
[d] Electrofishing conducted in early November rather than October.
[e] No recapture runs due to low flows; ND = no data.
[f] Only 3.2 km of larger 4.9 km section was electrofished with drift boat.
[g] Major habitat changes with spring, 1997, runoff.

Appendix B-4. Estimated abundance (*N*) of age 1 and older cutthroat trout (≥102 mm), rainbow trout (≥152 mm), brown trout (≥178 mm), and all trout (≥102 mm) at the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2004. Confidence intervals (±95%) are in parentheses. Cases where *R*≤3 and unbiased estimates are not possible (Ricker 1975) are highlighted.

Year	Cutthroat trout[a]		Rainbow trout		Brown trout		All trout[b]	
	N/section	*N*/km	*N*/section	*N*/km	*N*/section	*N*/km	*N*/section	*N*/km
1986[c]	14,162 (1,970)	2,890 (402)	NUE[d]	NUE	3,142 (1,239)	641 (253)	13,935 (1,192)	2,844 (243)
1987[c,e,f]	NE[e]	NE	NE	NE	NE	NE	NE	NE
1988	7,307 (726)	1,491 (148)	NUE	NUE	1,667 (1,521)	340 (310)	9,005 (851)	1,838 (174)
1989	7,890 (528)	1,610 (108)	310 (128)	63 (26)	937 (794)	191 (162)	8,788 (514)	1,793 (105)
1990	11,418 (846)	2,330 (173)	1,002 (316)	204 (64)	1,806 (650)	369 (133)	14,633 (853)	2,986 (174)
1991	6,854 (665)	1,399 (136)	658 (264)	134 (54)	954 (252)	195 (52)	7,920 (562)	1,616 (115)
1992[e]	NE	NE	NE	NE	NE	NE	NE	NE
1993	7,409 (734)	1,512 (150)	538 (250)	110 (51)	662 (380)	135 (78)	8,058 (635)	1,644 (130)
1994[e]	NE	NE	NE	NE	NE	NE	NE	NE
1995	6,028 (719)	1,230 (147)	1,325 (354)	270 (72)	1,442 (863)	294 (176)	8,349 (767)	1,704 (156)
1996	7,360 (1,101)	1,502 (225)	2,911[g] (2,058)	594[g] (420)	1,537 (383)	314 (78)	11,233 (1,254)	2,292 (256)
1997[h]	5,609 (373)	1,145 (76)	2,962 (358)	604 (73)	1,808 (995)	369 (203)	9,659 (458)	1,971 (93)
1998	8,286 (999)	1,691 (204)	2,258 (385)	461 (79)	1,219 (176)	249 (36)	10,770 (763)	2,198 (156)
1999	9,051 (798)	1,847 (163)	3,207 (621)	654 (127)	2,507 (829)	512 (169)	13,873 (868)	2,831 (177)
2000[e]	NE	NE	NE	NE	NE	NE	NE	NE
2001[e]	NE	NE	NE	NE	NE	NE	NE	NE
2002	4,119 (582)	841 (119)	3,845 (956)	785 (195)	1,409 (600)	288 (122)	8,845 (783)	1,805 (160)
2003	4,114 (583)	840 (119)	4,563 (1,106)	931 (226)	1,174 (487)	240 (99)	8,745 (642)	1,785 (131)
2004	2,344 (301)	478 (61)	2,595 (511)	530 (104)	1,879 (998)	383 (204)	7,071 (595)	1,443 (122)

[a] Includes hatchery cutthroat trout.
[b] Includes other trout, i.e. lake trout and kokanee.
[c] Electrofishing conducted in early November rather than October.
[d] NUE = unbiased estimate not possible as *R* ≤ 3.
[e] No recapture runs due to low flows; NE = no estimate.
[f] Only 3.2 km of larger 4.9 km section was electrofished with drift boat.
[g] Modified Peterson rather than log-likelihood estimate.
[h] Major habitat changes with spring, 1997, runoff.

Appendix C. Radio telemetry data for the 2004 freshet, South Fork Snake River, Idaho.

Redd #	Location	Date & Time	Freq (MHz)	Activity	Flow (cfs)	Notes
1	Dam Power House	4/21/2004 14:45	151.812	Installed	3,530	
1	Dam Power House	5/4/2004 16:30	151.812	Slow	11,200	No see rocks
1	Dam Power House	5/10/2004 15:30	151.812	Slow	11,200	
1	Dam Power House	5/17/2004 20:30	151.812	Slow	10,700	
1	Dam Power House	5/20/2004 15:00	151.812	Slow	15,600	
1	Dam Power House	5/22/2004 14:40	151.812	Slow	18,400	
1	Dam Power House	5/24/2004 11:55	151.812	Slow	18,600	
1	Dam Power House	11/18/2004 13:40	151.812	Slow	900	Removed tag, no move; 2 rocks OK, 1 no find; 18" flowing water; buried under 1-2" gravel - hard to find antenna
2	Dam Power House	4/21/2004 15:15	151.903	Installed	3,530	
2	Dam Power House	5/4/2004 16:30	151.903	Slow	11,200	No see rocks, deep
2	Dam Power House	5/10/2004 15:30	151.903	Slow	11,200	
2	Dam Power House	5/17/2004 20:30	151.903	Slow	10,700	
2	Dam Power House	5/20/2004 15:00	151.903	Slow	15,600	
2	Dam Power House	5/22/2004 14:40	151.903	Slow	18,400	
2	Dam Power House	5/24/2004 12:00	151.903	Slow	18,600	
2	Dam Power House	11/18/2004 13:50	151.903	Slow	900	Removed tag, no move; 1 rock OK, 2 no find; 1" standing water; somewhat buried
3	Dam Willow Hole	4/20/2004 15:00	151.803	Installed	2,280	
3	Dam Willow Hole	5/4/2004 17:00	151.803	Slow	11,200	No see rocks, deep
3	Dam Willow Hole	5/10/2004 15:30	151.803	Slow	11,200	
3	Dam Willow Hole	5/17/2004 20:40	151.803	Slow	10,700	
3	Dam Willow Hole	5/20/2004 15:10	151.803		15,600	
3	Dam Willow Hole	5/22/2004 14:50	151.803		18,400	
3	Dam Willow Hole	5/24/2004 12:00	151.803	Slow	18,600	
3	Dam Willow Hole	11/18/2004 15:20	151.803	Slow	900	Removed tag, no move; rocks OK; 6-8" flowing water

Appendix C. Continued.

Redd #	Location	Date & Time	Freq (MHz)	Activity	Flow (cfs)	Notes
4	Dam Willow Hole	4/21/2004 16:15	151.822	Installed	3,530	
4	Dam Willow Hole	5/4/2004 17:00	151.822	Slow	11,200	No see rocks, deep
4	Dam Willow Hole	5/10/2004 15:30	151.822	Slow	11,200	
4	Dam Willow Hole	5/17/2004 20:40	151.822	Slow	10,700	
4	Dam Willow Hole	5/20/2004 15:10	151.822	Slow	15,600	
4	Dam Willow Hole	5/22/2004 14:50	151.822	Slow	18,400	
4	Dam Willow Hole	5/24/2004 12:00	151.822	Slow	18,600	
4	Dam Willow Hole	11/17/2004 12:55	151.822	Slow	900	Removed tag, no move; rocks OK; dry and buried under 1" gravel
5	Dam Willow Hole	4/21/2004 17:30	151.883	Installed	3,530	
5	Dam Willow Hole	5/4/2004 17:00	151.883	Slow	11,200	No see rocks, deep
5	Dam Willow Hole	5/10/2004 15:30	151.883	Slow	11,200	
5	Dam Willow Hole	5/17/2004 20:40	151.883	Slow	10,700	
5	Dam Willow Hole	5/20/2004 15:05	151.883	Slow	15,600	
5	Dam Willow Hole	5/22/2004 14:50	151.883	Slow	18,400	
5	Dam Willow Hole	5/24/2004 12:00	151.883	Slow	18,600	
5	Dam Willow Hole	11/17/2004 13:20	151.883	Slow	900	Removed tag, no move; 1 rock OK, 1 buried, 1 no find; dry and buried under 6" gravel
6	Dam Willow Hole	4/21/2004 17:15	151.894	Installed	3,530	Fish on redd
6	Dam Willow Hole	5/4/2004 17:00	151.894	Slow	11,200	No see rocks, deep
6	Dam Willow Hole	5/10/2004 15:30	151.894	Slow	11,200	
6	Dam Willow Hole	5/17/2004 20:35	151.894	Slow	10,700	
6	Dam Willow Hole	5/20/2004 15:05	151.894	Slow	15,600	
6	Dam Willow Hole	5/22/2004 14:45	151.894	Slow	18,400	
6	Dam Willow Hole	5/24/2004 12:00	151.894	Slow	18,600	
6	Dam Willow Hole	11/18/2004 14:35	151.894	Slow	900	Removed tag, no move; rocks no find; 1-2" flowing water

Appendix C. Continued.

Redd #	Location	Date & Time	Freq (MHz)	Activity	Flow (cfs)	Notes
7	Dam Willow Hole	4/21/2004 17:00	151.915	Installed	3,530	
7	Dam Willow Hole	5/4/2004 17:00	151.915	Slow	11,200	No see rocks, deep
7	Dam Willow Hole	5/10/2004 15:30	151.915		11,200	
7	Dam Willow Hole	5/17/2004 20:35	151.915		10,700	
7	Dam Willow Hole	5/20/2004 15:05	151.915		15,600	
7	Dam Willow Hole	5/22/2004 14:50	151.915		18,400	
7	Dam Willow Hole	5/24/2004 12:05	151.915		18,600	
7	Dam Willow Hole	11/18/2004 14:50	151.915	Slow	900	
8	Dam Willow Hole	4/21/2004 17:15	151.973	Installed	3,530	
8	Dam Willow Hole	5/4/2004 17:00	151.973	Slow	11,200	No see rocks, deep
8	Dam Willow Hole	5/10/2004 15:30	151.973		11,200	
8	Dam Willow Hole	5/17/2004 20:45	151.973	Slow	10,700	
8	Dam Willow Hole	5/20/2004 15:15	151.973	Slow	15,600	
8	Dam Willow Hole	5/22/2004 15:00	151.973		18,400	
8	Dam Willow Hole	5/24/2004 12:15	151.973		18,600	
8	Dam Willow Hole	11/18/2004 14:30	151.973	Slow	900	Removed tag, no move; rocks OK; 3-4” flowing water
9	Dam Willow Hole	4/20/2004 15:30	151.982	Installed	2,280	Fish on redd
9	Dam Willow Hole	5/4/2004 17:00	151.982	Slow	11,200	No see rocks, deep
9	Dam Willow Hole	5/10/2004 15:30	151.982	Slow	11,200	
9	Dam Willow Hole	5/17/2004 20:40	151.982	Slow	10,700	
9	Dam Willow Hole	5/20/2004 15:15	151.982	Slow	15,600	
9	Dam Willow Hole	5/22/2004 14:55	151.982	Slow	18,400	
9	Dam Willow Hole	5/24/2004 12:10	151.982	Slow	18,600	
9	Dam Willow Hole	11/18/2004 14:45	151.982	Slow	900	Removed tag, no move; rocks no find; 4-6” flowing water

Appendix C. Continued.

Redd #	Location	Date & Time	Freq (MHz)	Activity	Flow (cfs)	Notes
10	Dam Willow Hole	4/20/2004 15:15	151.994	Installed	2,280	Fish on redd
10	Dam Willow Hole	5/4/2004 17:00	151.994	Slow	11,200	No see rocks, deep
10	Dam Willow Hole	5/10/2004 15:30	151.994		11,200	
10	Dam Willow Hole	5/17/2004 20:40	151.994	Slow	10,700	
10	Dam Willow Hole	5/20/2004 15:10	151.994	Slow	15,600	
10	Dam Willow Hole	5/22/2004 14:50	151.994	Slow	18,400	
10	Dam Willow Hole	5/24/2004 12:00	151.994	Slow	18,600	
10	Dam Willow Hole	11/18/2004 15:45	151.994	Slow	900	Removed tag, no move; 2 rocks OK, 1 no find; 12" flowing water; hard to find antenna
11	Fall Cr Channels	5/10/2004 11:30	151.935	Installed	11,200	Channel mouth, fish on redd
11	Fall Cr Channels	5/17/2004 19:15	151.935	Slow	10,700	
11	Fall Cr Channels	5/20/2004 13:35	151.935		15,600	Redd OK, tag no move
11	Fall Cr Channels	5/22/2004 13:40	151.935	Slow	18,400	
11	Fall Cr Channels	5/24/2004 14:20	151.935	Slow	18,600	
11	Fall Cr Channels	6/14/2004 13:00	151.935	Slow	8,310	Removed tag, no move; rocks OK
12	Fall Cr Channels	4/22/2004 13:30	151.962	Installed	4,320	Questionable redd at beaver dam
12	Fall Cr Channels	5/4/2004 14:15	151.962	Slow	11,200	Rocks OK
12	Fall Cr Channels	5/10/2004 13:00	151.962	Slow	11,200	
12	Fall Cr Channels	5/17/2004 19:10	151.962	Slow	10,700	
12	Fall Cr Channels	5/20/2004 13:25	151.962	Slow	15,600	
12	Fall Cr Channels	5/22/2004 13:30	151.962	Slow	18,400	
12	Fall Cr Channels	5/24/2004 14:15	151.962	Slow	18,600	
12	Fall Cr Channels	6/14/2004 12:50	151.962	Slow	8,310	Deep, no see tag; rocks OK
12	Fall Cr Channels	11/17/2004 14:15	151.962	Slow	900	Removed tag, no move; rocks OK; 1" flowing water; just below new beaver dam

Appendix C. Continued.

Redd #	Location	Date & Time	Freq (MHz)	Activity	Flow (cfs)	Notes
13	Fall Cr Main	4/22/2004 14:00	151.944	Installed	4,320	Near Falls
13	Fall Cr Main	5/4/2004 13:45	151.944	Slow	11,200	No see rocks
13	Fall Cr Main	5/10/2004 13:15	151.944	Slow	11,200	
13	Fall Cr Main	5/17/2004 19:05	151.944	Slow	10,700	
13	Fall Cr Main	5/20/2004 13:20	151.944		15,600	
13	Fall Cr Main	5/22/2004 13:25	151.944		18,400	
13	Fall Cr Main	5/24/2004 14:10	151.944	Slow	18,600	
13	Fall Cr Main	6/14/2004 12:45	151.944		8,310	Deep, no see tag
13	Fall Cr Main	11/18/2004 17:00	151.944		900	Removed tag, no move; 1 rock OK, 2 no find; 16-18" swift water and clean gravel; stepped on yesterday?
14	Indian Cr Channels	5/10/2004 14:00	151.835	Installed	11,200	Fish on redd; channel upper end
14	Indian Cr Channels	5/17/2004 19:50	151.835	Slow	10,700	
14	Indian Cr Channels	5/20/2004 14:00	151.835	Slow	15,600	
14	Indian Cr Channels	5/22/2004 15:25	151.835	Slow	18,400	
14	Indian Cr Channels	5/24/2004 14:40	151.835	Slow	18,600	
14	Indian Cr Channels	6/14/2004 14:25	151.835	Slow	8,310	Removed tag, no move; rocks OK
15	Indian Cr Channels	5/10/2004 14:15	151.864	Installed	11,200	Test dig? No fish on redd; channel lower end
15	Indian Cr Channels	5/17/2004 19:50	151.864	Slow	10,700	
15	Indian Cr Channels	5/20/2004 14:05	151.864		15,600	Redd OK, tag no move
15	Indian Cr Channels	5/22/2004 15:25	151.864		18,400	
15	Indian Cr Channels	5/24/2004 14:45	151.864	Slow	18,600	
15	Indian Cr Channels	6/14/2004 14:15	151.864		8,310	

Appendix C. Continued.

Redd #	Location	Date & Time	Freq (MHz)	Activity	Flow (cfs)	Notes
16	Indian Cr Main	4/22/2004 15:00	151.925	Installed	4,320	Fish on redd
16	Indian Cr Main	5/4/2004 14:50	151.925	Slow	11,200	One rock moved
16	Indian Cr Main	5/10/2004 12:30	151.925	Slow	11,200	Rocks OK
16	Indian Cr Main	5/17/2004 20:00	151.925	Slow	10,700	Deep
16	Indian Cr Main	5/20/2004 13:55	151.925	Slow	15,600	
16	Indian Cr Main	5/22/2004 13:50	151.925		18,400	
16	Indian Cr Main	5/24/2004 14:40	151.925		18,600	MOVED ABOUT 25 M DOWNSTREAM
16	Indian Cr Main	6/14/2004 14:40	151.925		8,310	Deep, no see tag; MOVED ABOUT 25 M DOWNSTREAM
16	Indian Cr Main	11/17/2004 16:00	151.925	Slow	900	
17	Indian Cr Main	4/22/2004 15:00	151.954	Installed	4,320	Fish on redd; next to 151.925
17	Indian Cr Main	5/4/2004 15:40	151.954	Slow	11,200	Two rocks moved – fish dug?
17	Indian Cr Main	5/10/2004 12:30	151.954		11,200	Added another rock
17	Indian Cr Main	5/17/2004 20:00	151.954		10,700	Deep
17	Indian Cr Main	5/20/2004 13:55	151.954		15,600	
17	Indian Cr Main	5/22/2004 13:50	151.954		18,400	
17	Indian Cr Main	5/24/2004 14:35	151.954		18,600	
17	Indian Cr Main	6/14/2004 14:40	151.954		8,310	Deep, no see tag
17	Indian Cr Main	11/17/2004 15:55	151.954		900	

Appendix C. Continued.

Redd #	Location	Date & Time	Freq (MHz)	Activity	Flow (cfs)	Notes
18	Squaw Cr Main	5/10/2004 13:30	151.843	Installed	11,200	Fish on redd
18	Squaw Cr Main	5/17/2004 19:25	151.843	Slow	10,700	
18	Squaw Cr Main	5/20/2004 13:40	151.843	Slow	15,600	
18	Squaw Cr Main	5/22/2004 13:40	151.843	Slow	18,400	
18	Squaw Cr Main	5/24/2004 14:25	151.843	Slow	18,600	
18	Squaw Cr Main	6/14/2004 13:20	151.843	Slow	8,310	Removed tag, no move; 2 rocks OK, 1 no find
19	Squaw Cr Channels	5/10/2004 12:00	151.853	Installed	11,200	Channel mouth, fish on redd
19	Squaw Cr Channels	5/17/2004 19:30	151.853	Slow	10,700	
19	Squaw Cr Channels	5/20/2004 13:45	151.853	Slow	15,600	
19	Squaw Cr Channels	5/22/2004 13:45	151.853	Slow	18,400	
19	Squaw Cr Channels	5/24/2004 14:30	151.853	Slow	18,600	
19	Squaw Cr Channels	6/14/2004 13:40	151.853	Slow	8,310	Removed tag, no move; 1 rock OK, 2 no find - everything buried; YCT spawning
20	Squaw Cr Channels	5/10/2004 12:00	151.875	Installed	11,200	Channel mouth, fish on redd
20	Squaw Cr Channels	5/17/2004 19:30	151.875	Slow	10,700	
20	Squaw Cr Channels	5/20/2004 13:45	151.875	Slow	15,600	
20	Squaw Cr Channels	5/22/2004 13:45	151.875	Slow	18,400	
20	Squaw Cr Channels	5/24/2004 14:30	151.875	Slow	18,600	
20	Squaw Cr Channels	6/14/2004 13:40	151.875		8,310	Removed tag, no move; rocks OK; 1" flowing water

HENRYS LAKE

ABSTRACT

We used 50 standard experimental gill nets (25 sinking, 25 floating) to assess fish populations and relative abundance in Henrys Lake during May 2004. We captured brook trout *Salvelinus fontinalis*, Yellowstone cutthroat trout *Oncorhynchus clarki bouvieri*, hybrid trout (rainbow trout *O. mykiss* x Yellowstone cutthroat trout) and Utah chub *Gila atraria*. Catch rates for all trout combined were statistically different from levels recorded in 2003. We then separated catch rates by species and found statistical differences in catch rates for cutthroat trout and hybrid trout compared to 2003 catch rates. Yellowstone cutthroat trout catch rate differences were only significant at the alpha = 0.2 level. Brook trout catch rates were not statistically different from the past several years. Brook trout have not been stocked since 1998 and showed a significant decline from a peak in abundance found in 2000. Although median catch rates of Utah chub are close to the peaks in abundance found in 1993 and 2000, the difference among these catch rates was not statistically significant. We had 150 otoliths aged, and found Utah chubs to be long-lived and have a low mortality rate.

We used the coefficient of variation obtained from 2004 netting efforts to estimate the level of precision obtained with an increased number of sampling units, and found using 50 net nights of effort gives the ability to detect changes in catch rates of 22% for brook trout, 16% for hybrid trout, 44% for Utah chub, 14% for Yellowstone cutthroat trout and 13% for all trout combined.

We monitored dissolved oxygen levels to assess the possibility of a winterkill event from Dec 30 through February 20. Depletion estimates predicted dissolved oxygen would reach critical levels (10 g/m^3) by the end of January. Therefore, we implemented the helixor aeration system on January 8 and portable aerators on January 15. We did observe a limited amount of mortality around the mouth of Hatchery Creek and Pittsburg Creek from February 18 to April 1.

We conducted a diet analysis of trout to assess predation rates on Utah chub. We analyzed 416 trout and 216 Utah chub stomachs collected in May gill net surveys, and found fish to be an insignificant portion of trout diets. Further analysis showed overlap between trout and Utah chub diet, but we believe this does not limit trout abundance due to the large quantities of available forage.

The 2004 spawning operations at Henrys Lake produced 1,123,790 - eyed Yellowstone cutthroat trout eggs and 76,210 eyed hybrid trout eggs. Cutthroat trout in the Hatchery Creek run averaged 490 mm total length (TL), while hybrid trout averaged 588 mm TL. Pathology reports for viral and bacterial presence detected one positive result from one family of cutthroat trout eggs (bacterial presence), which was subsequently destroyed.

Riparian tributary fencing was maintained at ten locations around the lake. Fencing was removed from two sites where new conservation agreements made the fences obsolete, and new fencing was installed on one new site. Nine fish diversion screens were maintained and run over the course of the year.

Fry trapping and adult spawning fish surveys were implemented on Howard, Duck and Targhee creeks, which have been identified as the most important spawning tributaries on Henrys Lake. Traps caught low numbers of trout fry (59 - 423 fry total). Spawning surveys documented adult Yellowstone cutthroat trout using tributaries. An additional 84 adult spawning cutthroat trout were moved upstream of a culvert blockage on Targhee Creek.

Authors

Dan Garren
Regional Fishery Biologist

Damon Keen
Assistant Hatchery Manager

Jim Fredericks
Regional Fishery Manager

METHODS

Population Monitoring

As part of routine population monitoring, we collected gill net samples from six standardized locations (Appendix A) for a total of 50 net nights in Henrys Lake on May 3, 4, 8, 14, 17, 19, 20, 24 and 25, 2004. Gill nets consisted of either floating or sinking models measuring 46 m by 2 m, with mesh sizes of 2 cm, 2.5 cm, 3 cm, 4 cm, 5 cm and 6 cm bar mesh. Nets were set at dusk and retrieved the following morning. We identified captured fish to species and recorded total lengths (TL). We calculated catch rates as fish per net night and also calculated 95% confidence intervals. We assumed a non-normal distribution to our data and used a Kruskal-Wallis one-way analysis of variance to detect differences in population trends among data collected from 1993 to present.

We assessed age and growth by analyzing otoliths removed from all captured trout. Otoliths were stored in envelopes and aged using a dissecting scope. Otoliths were read in whole view if distinct growth rings were present. All otoliths that gave conflicting results when aged twice were sectioned, polished and read in cross section. We also contracted ageing of 150 Utah chub *Gila atraria* otoliths to Auburn University's Fisheries Department. Otoliths were mounted in epoxy, sectioned and read using two readers and a pattern recognition computer program.

We attempted to validate methods for defining year-class strength by analyzing catch rate data of an age class from the current year and comparing it to catch rate data from the previous year. We considered a relationship good if the strength of the year-class carried forward to the following year (i.e. strong age-1 year-class predicted strong age-2 year-class).

Gill Net Precision

We evaluated the level of precision of our standard gill net surveys using the equation of Cyr et al. (1992):

$$N = (CV_s / CV_x)^2$$

Where CV_s is the coefficient of variance of the sample, CV_x is the desired level of precision, and N is the number of gill net nights. We defined two levels of precision – one level for preliminary studies (ability to detect a 50% change in the catch rate), and one level suitable for management studies (ability to detect a 25% change in the catch rate).

Water Quality

We measured winter dissolved oxygen concentrations, snow depth, ice thickness and water temperatures at established sampling sites on Henrys Lake (Appendix A). Holes were drilled in the ice with a gas-powered ice auger prior to sampling. We used a YSI model 550-A oxygen probe to collect dissolved oxygen samples and estimated total g/m^3 of oxygen by averaging dissolved oxygen readings at ice bottom and one meter below ice bottom, and summing readings at subsequent one-meter intervals to the bottom. Similar methods were used for summer oxygen monitoring from mid-June through the end of October.

Diet Analysis

We repeated a diet study initiated in 2003 (Garren et al. 2004), and analyzed the stomach contents of fish collected during gill net samples in May to assess predation on Utah chub by trout, and to assess possible interactions between trout and Utah chub. Stomachs were removed from fish collected in routine gill net samples, stored in individually labeled plastic bags, and immediately frozen. For each stomach, we identified individual food items, separated items by genera and then counted and weighted each genera to the nearest gram. In instances where extremely high densities were encountered (i.e. Daphnia and occasionally scuds), we randomly analyzed a sub-sample of contents and expanded the results to represent total content.

Spawning Operation

We operated the Hatchery Creek fish ladder for the spring spawning run from January 10, through January 14. The ladder was opened again on March 2nd and remained open until April 30th. Fish ascending the ladder were identified as Yellowstone cutthroat trout or hybrid trout (rainbow trout *x* Yellowstone cutthroat trout) and counted. We measured total length for a sub-sample (10%) of each group. Yellowstone cutthroat trout were produced using ripe females spawned into seven-fish pools and fertilized with pooled milt from four to seven males. Hybrid trout were produced with Yellowstone cutthroat trout eggs and Kamloops rainbow trout milt obtained from Hayspur Hatchery. Hybrid trout were sterilized by inducing a triploid condition using pressure to shock the eggs post-fertilization. Once hybrid trout eggs reached 47 minutes and 45 seconds post-fertilization, the eggs were placed in the pressure treatment machine at 10,000 psi and held at this pressure for 5 minutes. Random samples of eggs were sent to the Eagle Fish Health Lab to test induction rates of sterilization. The remaining Hybrid trout eggs were shipped to Ashton and Mackay Hatcheries for hatching, rearing and subsequent release back into Henrys Lake and other local waters. Yellowstone cutthroat trout eggs were shipped to Mackay and American Falls Hatcheries for hatching, rearing and release back into Henrys Lake.

We took disease samples from the spring spawning run. Ovarian fluids were collected from seven female egg pools of Yellowstone cutthroat trout during spawning. All combined batches were tested. Random viral samples were taken from 25 seven-female egg pools in the spring run. We sacrificed a mixed-sex group of 60 adult Yellowstone cutthroat trout during the spring run for disease testing. All samples were sent to the Eagle Fish Health Laboratory.

Riparian Fencing and Fish Screening

Electric fencing has been in place at Henrys Lake since the early 1990's to protect riparian areas from grazing livestock. We stretched fencing and installed solar panels, batteries, and connections during May 2004 at ten sites on the tributaries of Henrys Lake as established in routine maintenance guidelines. We routinely checked fencing during the summer and fall for proper voltage and function.

Fish diversion screens are located at nine sites on the tributaries of Henrys Lake. Screens were maintained, cleaned and checked for proper operation on a daily basis during the summer and fall months of 2004.

Fry Trapping and Adult Spawner Evaluation

We trapped fry at three tributaries of Henrys Lake; Targhee, Howard, and Duck creeks. We installed Krey-Meekin fry traps at historical locations in close proximity to the mouths of the tributaries, except in the case of the Howard Creek trap, which was moved downstream from its historical location to the tributary mouth to enhance fry capture.

Traps were installed during early summer to coincide with the approximate time of swim up and subsequent migration from the tributaries. We installed the traps in the main flow of the channels to capture the bulk of the fry. Additionally, we blocked channel flow bypassing the traps and diverted it into the traps. Water depths of 1-4 cm were maintained over the trap to entrain fry and to minimize mortality and escapement. Fry traps were checked, cleaned, and maintained daily during the duration of trapping. Yellowstone cutthroat trout, brook trout, hybrid trout, and nongame species were measured (total length – mm) and recorded. We also recorded additional information regarding trap function and efficiency.

Adult spawner counts were conducted on the three tributaries where we trapped fry. We walked the reaches known to support spawning habitat and observed spawning activity. We recorded numbers and species of trout observed. We also captured adult spawners below a culvert road crossing on Targhee Creek and moved them above this obstruction during May and June using a backpack electrofisher and volunteer netters. The captured spawners were counted, loaded into an oxygenated fish tank and moved above the culvert approximately 2 km before being released to complete the spawning process.

RESULTS

Population Monitoring

We collected 1,314 fish in 50 net nights (Figure 1). Catch composition was 25% cutthroat trout, 17% hybrid trout, 3% brook trout, and 55% Utah chub. Cutthroat trout ranged from 100 to 644 mm TL (Figure 2), hybrid trout 107 to 650 mm (Figure 3), and brook trout 150 to 535 mm (Figure 4). Brook trout catch rates in gill nets have declined significantly from 2000 levels ($p < 0.002$, Kruskal-Wallis one-way AOV; Figure 5). Catch rates for both hybrid trout and cutthroat trout were greater than in 2003 (Figures 6 and 7), with hybrid trout showing a statistical increase compared to catch rates from 2003. Hybrid trout catch rates remained at the 13-year average, but were lower than the peak of abundance documented in the early 2000's. Cutthroat trout were well above the 13-year average, and captured at their highest rate since 1998. However, this increase was only significant at the alpha = 0.20 level. Further analysis showed that catch of age one and two cutthroat trout were well above the five-year mean for these age classes (Figures 8 and 9). However, catch rates for three-year old and older fish (> 400 mm) continue to be below long-term means. We attempted to identify the first fully recruited age class to our gill nets by plotting catch of a given age against previous years catch rates for the same year-class and found a weak relationship for age one vs. age two fish, suggesting catch of age one fish are unreliable as a predictor of age two catch (Figure 10). However, a strong relationship exists for age two fish compared to age three (Figure 11), which suggests this may be an accurate gauge of year-class fluctuations. Utah chub mean catch rate was higher than previous years samples (Figure 12). However, the difference in mean catch rates is not significant ($p = 0.77$, AOV). Due to the high variability of gill net catch rates on Utah chub, it is more appropriate to look at median catch. Our median catch rate in 2004 was 2.5 fish per net night, slightly above the 1.4 average from 1991-2004 (Figure 13), but still below the peak of abundance found in 2000.

Additional information obtained from population sampling included the ratio of fin clips from fish marked prior to stocking (Table 1). Since 1994, 10% of all Yellowstone cutthroat trout stocked receive an adipose-fin clip prior to stocking. We ascertain the level of natural reproduction by observing fin clips in recaptured fish throughout the year. When adipose-clipped fish constitute 10% or more of all fish encountered, natural reproduction is assumed to be minimal. This year we found 28 of 323 Yellowstone cutthroat trout were adipose-clipped fish, suggesting limited natural reproduction.

Gill Net Precision

We calculated the number of gill net nights needed to obtain a precision necessary for preliminary studies (50% change in catch rates) in Henrys Lake was 3, 4, 5 and 10 nets for all trout combined, Yellowstone cutthroat trout, hybrid trout and brook trout, respectively. To obtain precision necessary to detect a 25% change in catch rates would require 13, 16, 20 and 40 nets for all trout combined, Yellowstone cutthroat trout, hybrid trout and brook trout, respectively (Table 2). Using the same calculations for Utah chub, 38 nets would be required to detect a 50% change in catch rates, while 153 nets would be required to detect a 25% change in catch rates. We decided to use 50 net nights of effort in our standard spring samples, which will result in being able to detect a change of 13 to 22% in catch rates for trout and a 44% change in catch rates for Utah chub.

Water Quality

We recorded oxygen profiles during December 2003 through February 2004 at three standard sites (Pittsburgh Creek, County Boat Dock and Wild Rose), as well as occasional readings at the Hatchery and Outlet. Total oxygen diminished from 21.2 g/m^3 to 4.8 g/m^3 at the Pittsburgh Creek site, 19.2 g/m^3 to 3.2 g/m^3 at the County dock, and 24.4 g/m^3 to 3.4 g/m^3 at the Wild Rose site (Table 3). This data was used to estimate the approximate date dissolved oxygen would fall below 10.0 g/m^3 (our level of concern), and showed oxygen levels would reach this level by the end of January (Figure 14). As a preventative measure, we implemented our Helixor aeration system on January 8 and portable aerators in various locations on January 15. We noted higher than average mortality at the hatchery ladder in March, including juvenile trout and sculpin. We also observed fish crowding the creek mouths in an effort to reach areas of higher oxygen concentrations. We observed 1,219 trout mortalities between Hatchery Creek and Pittsburg Creek between February 18 and April 1, and estimated an additional 800 mortalities. However, we have no way of estimating lakewide mortality.

Diet Analysis

We collected and analyzed 416 trout stomachs and 216 Utah chub stomachs collected in May, and found that during the period of study, trout rarely consumed fish. Only two fish were found in 632 stomachs. We also looked for possible competitive interactions by comparing stomach contents from Utah chub to those from trout and found partial dietary overlap. However, the overlap comes from consumption of daphnia and scuds, both of which we believe are highly abundant. By number, daphnia (70%), chironomids (24%) and scuds (7%) made up the bulk of all fish diets, with leeches, caddis, snails, clams and various other items contributing a minor portion to the overall diet (< 1% each). By weight, the most important food items were chironomids (55%), scuds (31%), daphnia (8%) and caddis larvae (5%) with leeches, snails and other organisms contributing a minor portion to the overall diet (<1% each). (Tables 4 and 5).

Spawning Operation

Between January 12 and April 30, 4,403 Yellowstone cutthroat trout ascended the hatchery spawning ladder. Of these, 48% were males and 52% were females. Mean lengths were 498 and 482 mm; respectively with a combined mean length of 490 mm. Hybrid trout totaled 791 fish and consisted of 54% males and 46% females with mean lengths of 571 mm and 605 mm, respectively.

We collected 3,386,400 green eggs from 1,196 Yellowstone cutthroat trout females for a mean fecundity of 2,748 eggs per female (Table 4). Eyed Yellowstone cutthroat trout eggs totaled 1,123,790 for an overall eye-up rate of 34%. We shipped all eyed Yellowstone cutthroat trout eggs to Mackay Hatchery where they were hatched, reared, and subsequently released back into Henrys Lake in the fall of 2004 as fingerlings (921,000 fingerlings). Green egg to fingerling survival was approximately 27.2%. We committed ten days to Yellowstone cutthroat trout spawning.

We collected 1,436,650 green eggs from 517 female Yellowstone cutthroat trout for hybrid trout production (Table 5). Hatchery personnel raised 5% of these eggs to the eye-up stage. All eyed hybrid trout eggs were shipped to the Mackay Hatchery for hatching, rearing, and subsequent release into Henrys Lake in the fall of 2004. Mean sterilization rates for hybrid trout were 99% during 2004. Green egg to fingerling survival was approximately 2.7%. We stocked 38,250 sterile hybrids and devoted four days to production of hybrid eggs during 2004.

Disease sampling was completed on adult spawning fish during the spring and fall runs. Results and discussion will be included in the resident fisheries pathologist report (Idaho Department of Fish and Game, unpublished data). One bacterial disease sample taken during spawning was positive in the spring run.

Riparian Fencing and Fish Screening

Electric fencing functioned well during the year. Voltages remained high throughout the season and riparian infringements by cattle were rare. Fish screens functioned well on Targhee and Howard creeks but did not work on Duck Creek due to low water conditions.

A new conservation agreement that excludes grazing was adopted between landowners along Duck and Kelly creeks and the Nature Conservancy and the Bureau of Land Management. This allowed us to remove three fences that we have maintained for several years. The new agreements provide for wetland enhancements, development restrictions, and voluntary grazing restrictions. As a result, fences on the west shoreline of Henrys Lake, Kelly Springs, and Lower Duck Creek were removed. Additionally, we initiated a new fence agreement with Fremont County along a section of the lake shoreline that had been previously unprotected and subject to grazing degradation. This new county boat dock fence was constructed entirely with the salvaged Kelly Springs fence for a significant cost savings. This new fence should protect vegetation on approximately 1/3 km of the west shoreline of Henrys Lake.

Fry Trapping and Adult Spawner Counts

We started fry trapping on Duck Creek on June 14, Howard Creek on June 21, and Targhee Creek on July 1. We counted fry at these sites until out-migration stopped. We captured 423, 59 and 69 Yellowstone cutthroat trout fry in Targhee, Duck and Howard Creeks, respectively. Due to low numbers of migrating fry, we were unable to estimate efficiency for our traps. Our traps functioned relatively well with the exception of the Howard Creek trap, which plugged with debris regularly.

We conducted our adult spawner counts, and found 134 adults in Duck Creek, 109 adults in Targhee Creek, and no adults in Howard Creek. We moved 84 adults from the vicinity of the highway 87 culvert to the Dry Fork Targhee Creek trailhead.

DISCUSSION

Overall, there was an increase in our gill net catch rates (fish/net night) during 2004 sampling compared to previous years. This increase was not statistically different from our 10-year average, but was significant compared to last year's catch (p=0.02, Kruskal-Wallis one-way AOV). This increase is primarily attributed to high gill net catch rates of age one and two cutthroat trout, which were caught at rates above the long-term mean. Although these fish will likely contribute little to the catch this season, they will be influential on catch rates in the 2005 fishing season when these fish enter the fishery as age two and three fish. The low gill net catch of older year-classes indicate they are not as prevalent as in past years, and are likely contributing to the decline in catch reported by anglers.

We monitor the contributions of natural reproduction from Yellowstone cutthroat trout with our adipose-fin clipping program. Ten percent of our Yellowstone cutthroat trout receive an adipose fin clip prior to stocking, which allows us to estimate natural reproduction. When the ratio of adipose clips observed in the fishery approaches 10%, we assume natural reproduction is limited. A ratio less than 10% suggests natural reproduction is adding to the population. Over the past six years, the ratio of fin clipped cutthroat trout has exceeded 10% on four occasions, indicating that during drought years, natural reproduction does not contribute significantly to the fishery. This year we found 28 of 323 Yellowstone cutthroat trout were adipose-clipped fish. This 9% clipped fish may suggest some limited amount of natural reproduction, but it is more likely an artifact of sampling variation.

Utah chub catch rates in our gill nets increased for the second year in a row, but show no statistical increase due to high variation among nets. Gill net catch rates are at their highest level with the current year's sample (> 14 fish per net night). Compared to other local water bodies with high Utah chub abundance (Mud Lake, 47 fish / net night; Island Park Reservoir, 48 fish / net night), catch rates in Henrys Lake remain low. Our 2004 mean gill net catch of nearly 15 Utah chub per net night would suggest a large increase over past years samples (previous high of 8.6 fish per net in 2000). However, almost half of the 728 Utah chub were captured in one gill net (314 total). This suggests a non-random distribution, which requires non-parametric means of analysis that focus on a metric other than the mean. When median catch rates are analyzed, our 2004 catch rates were within the range of previous samples. Although meaningful inferences on Utah chub densities are hampered by low gill net sample numbers in past years and high variability among nets, we are concerned that the population of Utah chub may be increasing and warrants close monitoring.

Age and growth information of Utah chub suggest a long-lived population with low annual mortality. The oldest Utah chub we encountered was from the 1991 year-class, which is two years older than the first year we detected their presence. However, prior to 1991, Henrys Lake was sampled with trap nets, which may have been less successful at catching Utah chub. In 1991, only six gill nets were set. Given the non-uniform distribution of Utah chub, it is possible our 1991 sample did not detect them even though they were present. Combined with the age information from the current year, it is likely that Utah chub have been present in Henrys Lake longer than we realized.

Prior to 1991, the fishery in Henrys Lake was monitored with trap nets, with gill nets becoming the standard technique from 1991 on. Up until 2001, six nets constituted a standard sample for obtaining population information. Starting in 2001, we increased sample size to the current 50 net nights of effort. Based on our analysis, using six net nights effort provided low precision for trout species, and was of limited use for tracking changes in Utah chub abundances (greater than an order of magnitude difference change in abundance needed to detect a change). We believe that the current level of 50 net nights is adequate for monitoring trout, and will prove more useful in monitoring Utah chub. Additional netting effort is not warranted for trout management, but may benefit Utah chub monitoring efforts. However, based on available manpower and time constraints, we believe our current level of effort is adequate for monitoring Henrys Lake.

Dissolved oxygen data collected during the winter of 2003-2004 showed stressful levels of oxygen (< 10 g/m^3) during February and March. As a result, we used our aeration system to create an area of refuge around Hatchery Creek, as well as smaller areas of refuge at other tributaries where trout were congregating. During the winterkill event of 1992, numerous trout were observed crowding lake tributaries as oxygen diminished. These areas provide refuge against anoxic conditions which trout were able to take advantage of. During the 2003-2004 winter we observed similar behavior, with fish crowding tributaries as a result of the diminished dissolved oxygen. We also observed dead and dying fish during March, including adult trout, sub adult trout and sculpin. Although it is not uncommon to see limited mortality around Hatchery Creek during the spawn, the presence of smaller trout and sculpin indicates additional mortality other than that associated with spawning. Even though we saw limited mortality around the tributaries, we estimated less than 2,000 dead trout. However, we have no way of knowing the number of trout that died lakewide. Our population sampling with gill nets in May following this stressful period was encouraging, and suggests limited impact from this winterkill based on catch rates. Therefore, we concluded that the poor oxygen conditions did not cause a large-scale die-off. However, egg survival from 2004 hatchery operations were much lower than expected, and may be a direct result of poor oxygen conditions during the spawn.

Based on diet analysis conducted over the past two years, we don't believe predation is a controlling factor on adult Utah chub abundance. No Utah chub were recovered from stomachs, suggesting trout rarely feed on adult fish in Henrys Lake. Utah chub age and growth information also supports this. Mortality rates on age one and older Utah chub are low, despite slow growth rates that keep some adults at a vulnerable size for many years. Heavy predation should alter the size structure, making older fish less common. We aged one Utah chub to 14 years (1991 year-class), and found nearly 20% of all aged fish were 8 years old or older. In direct conflict with our findings, past diet studies on Henrys Lake have identified fish as a major portion of brook trout diets (Spateholts 1984, Irving 1952). We did not sample enough brook trout to make conclusions on their impact on Utah chub. We hypothesize that the reinstatement of the brook trout stocking may increase predation on Utah chub as they have historically consumed fish. Another impact associated with an increase in chub abundance is competition with trout for forage. There is a partial dietary overlap between these species, with chironomids, scuds and daphnia making up a significant amount of the overall diet of all fish analyzed. We believe this overlap is inconsequential at present, as chironomids and scuds are found in extreme abundance, and daphnia are assumed to be in high densities as well. Further, relative weights for trout of all size classes exceed expected averages, suggesting forage is extremely abundant.

RECOMMENDATIONS

1. Continue annual gill net samples at 50 net nights of effort.
2. Collect otolith samples from all trout species; use for cohort analysis and estimates of mortality/year-class strength.
3. Continue winter dissolved oxygen monitoring, and implement aeration when necessary.
4. Monitor Utah chub densities, and continue work on determining population dynamics within the lake.

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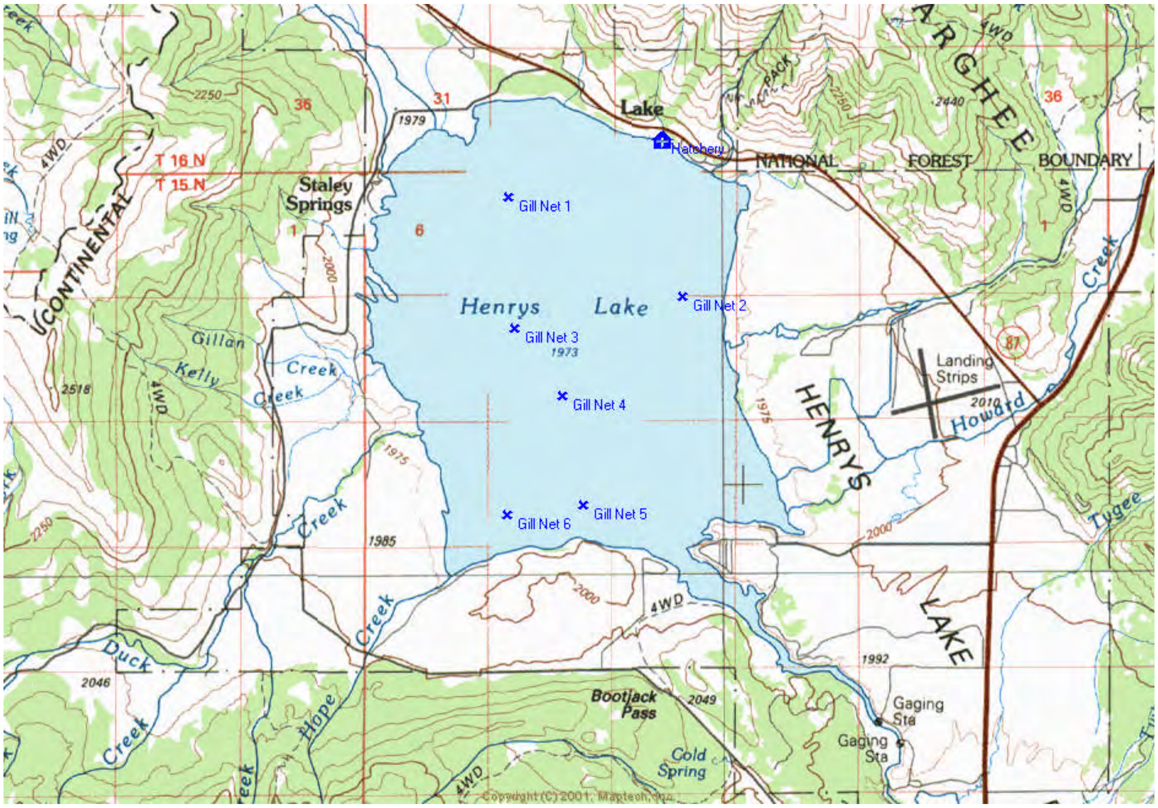

Figure 1. Spatial distribution of gill net locations used in population monitoring in Henrys Lake, Idaho.

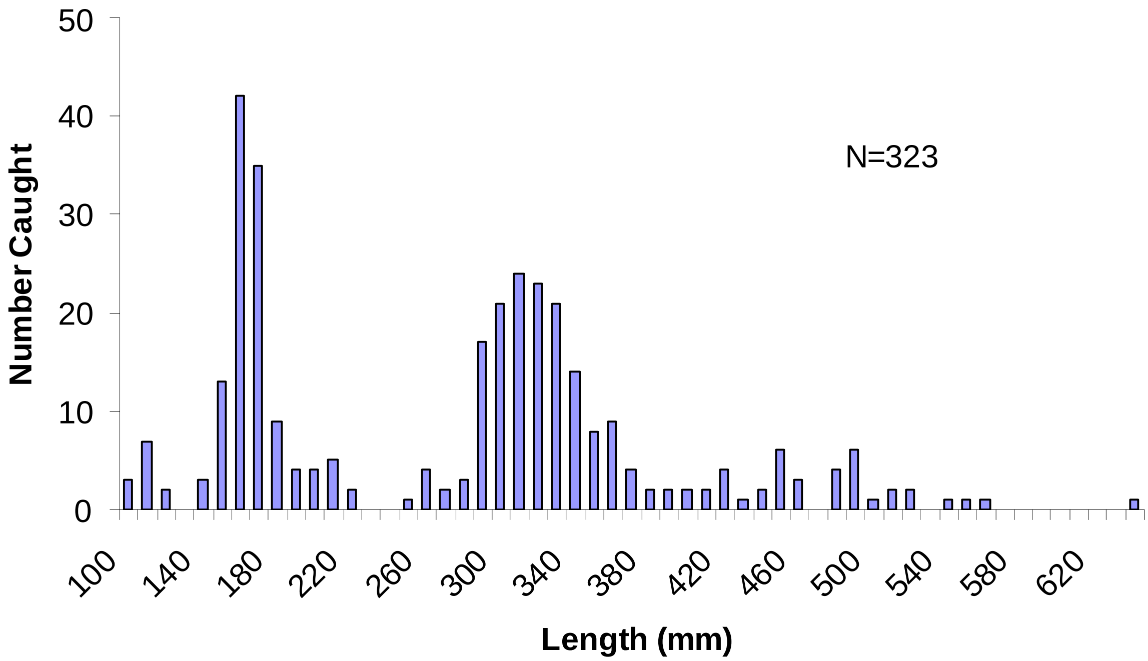

Figure 2. Yellowstone cutthroat trout length frequencies from gill nets set in Henrys Lake, Idaho, 2004.

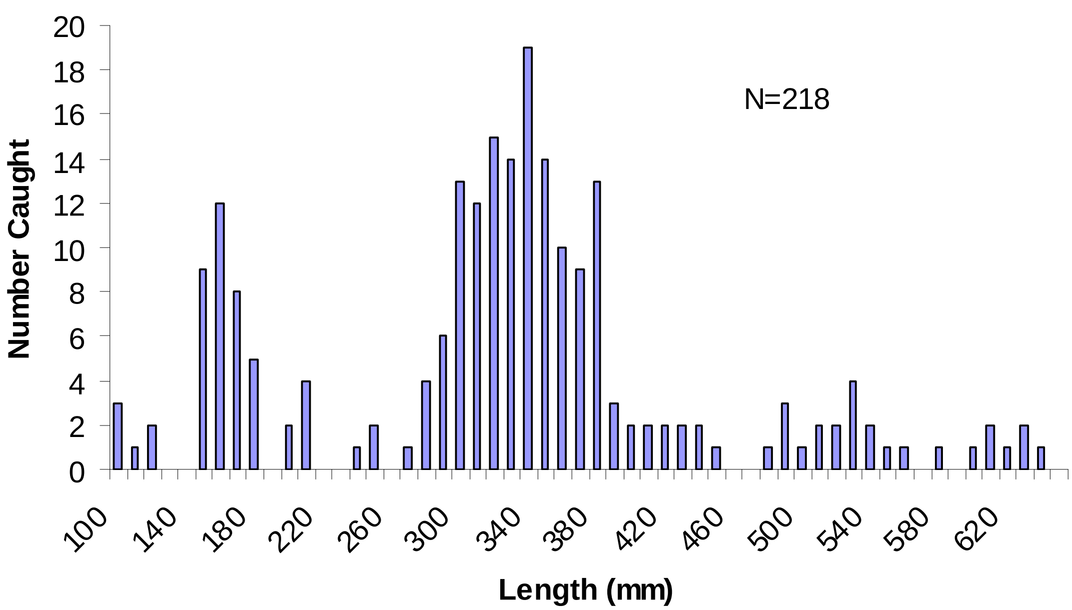

Figure 3. Hybrid trout length frequencies from gill nets set in Henrys Lake, Idaho, 2004.

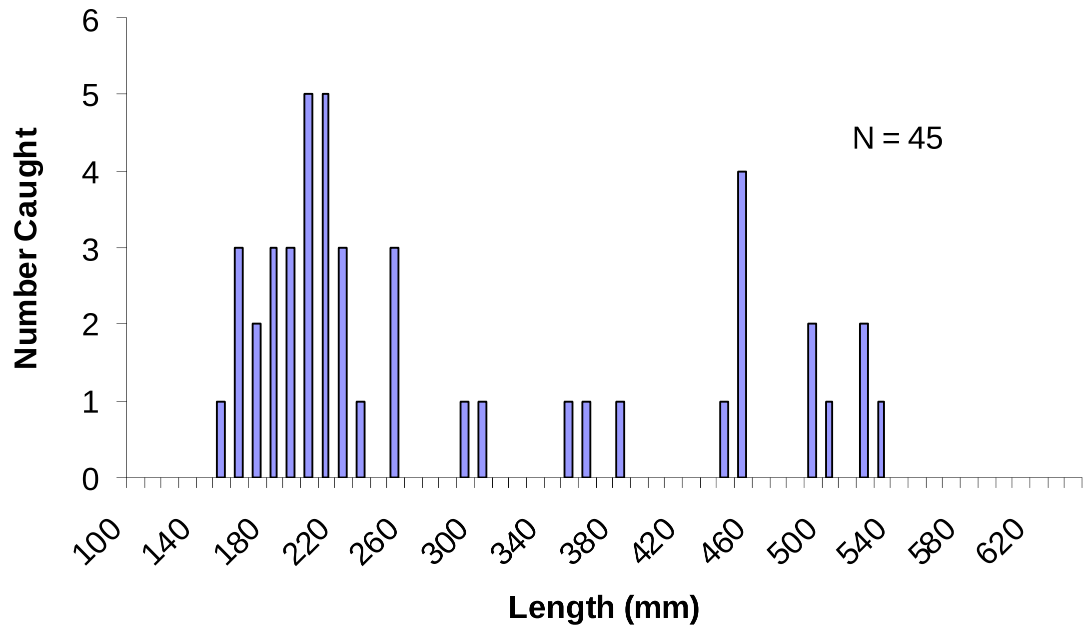

Figure 4. Brook trout length frequencies from gill nets set in Henrys Lake, Idaho, 2004.

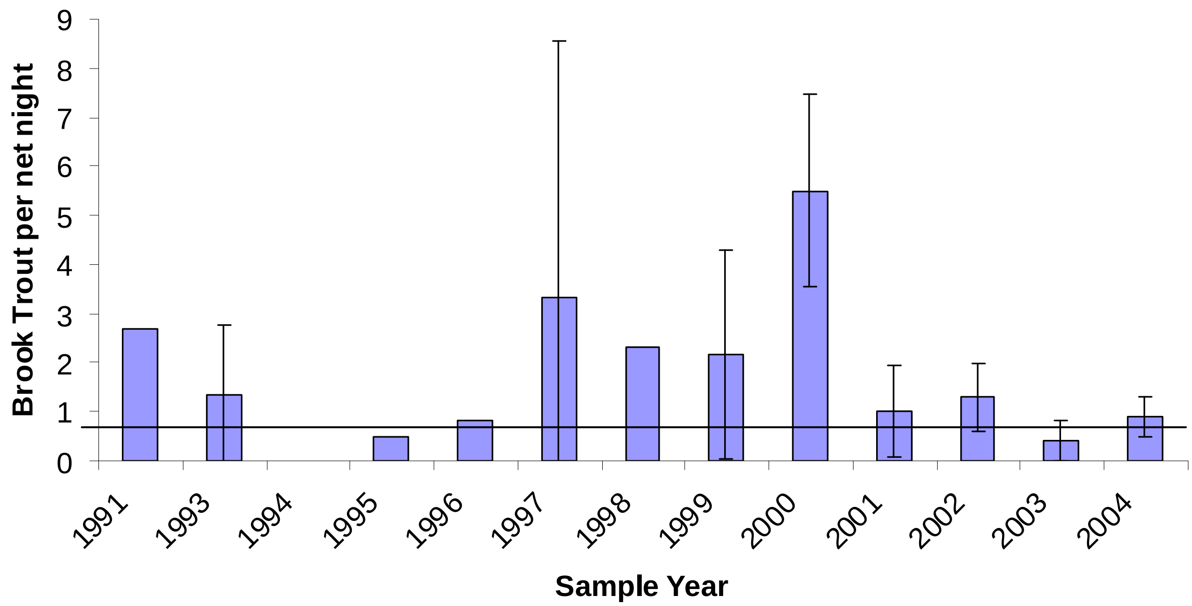

Figure 5. Brook trout catch rates in gill nets set in Henrys Lake, Idaho, 1991 to present. Mean catch rate for brook trout was 1.7 fish per net over the 13-year period. Error bars represent 95% confidence intervals.

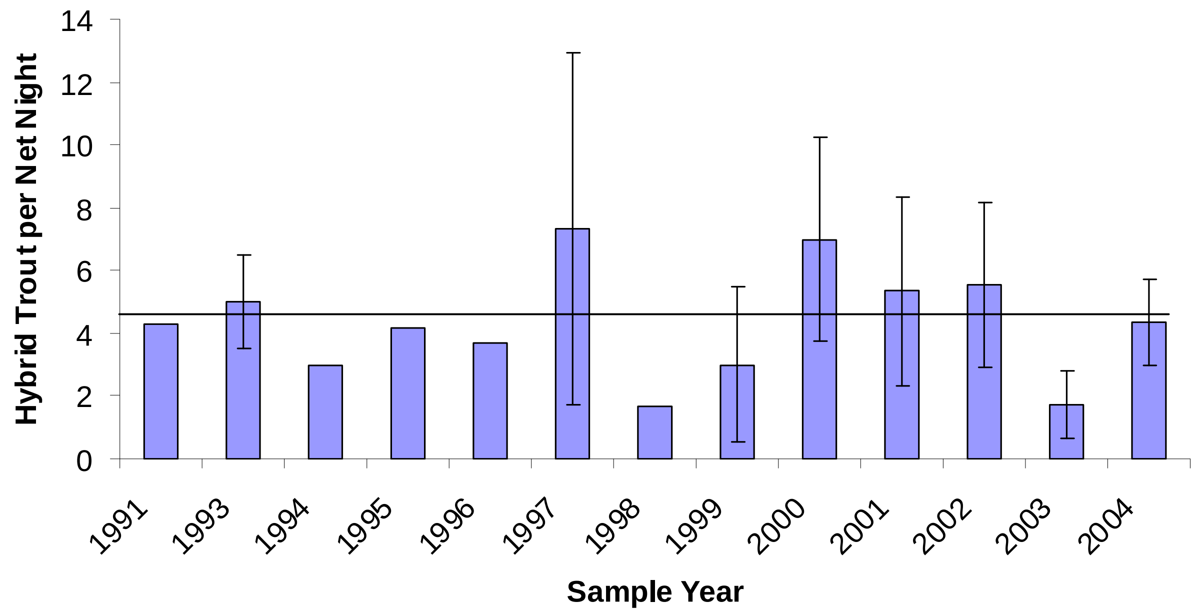

Figure 6. Hybrid trout catch rates in gill nets set in Henrys Lake, Idaho, 1991 to present. Mean catch rate for hybrid trout was 4.3 fish per net over the 13-year period. Error bars represent 95% confidence intervals.

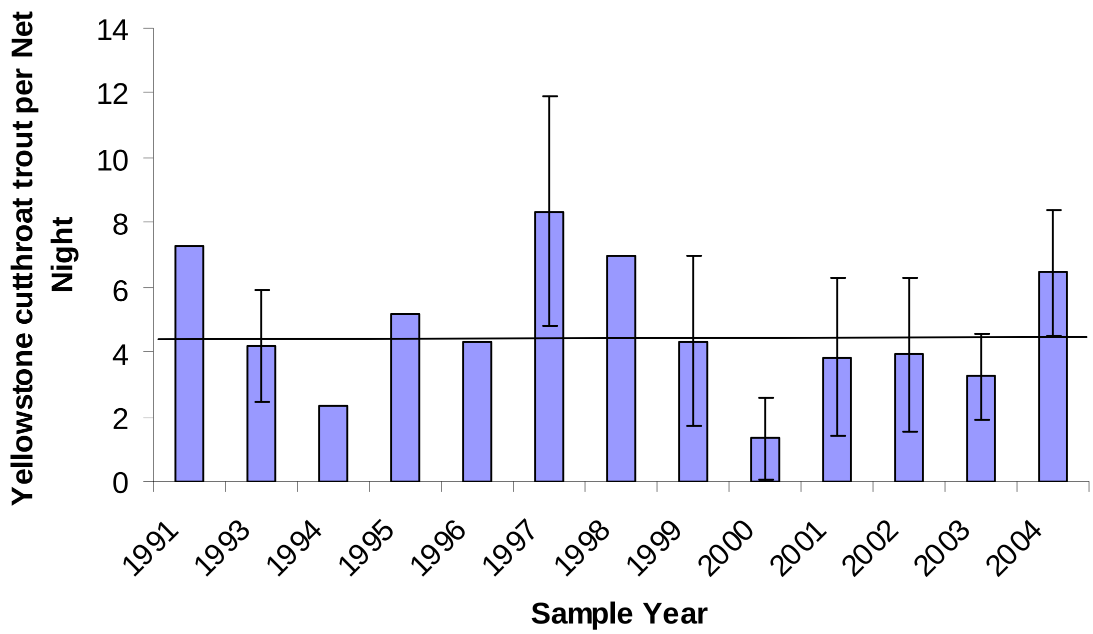

Figure 7. Yellowstone cutthroat trout catch rates in gill nets set in Henrys Lake, Idaho, 1991 to present. Mean catch rate for cutthroat trout was 4.8 fish per net over the 13-year period. Error bars represent 95% confidence intervals.

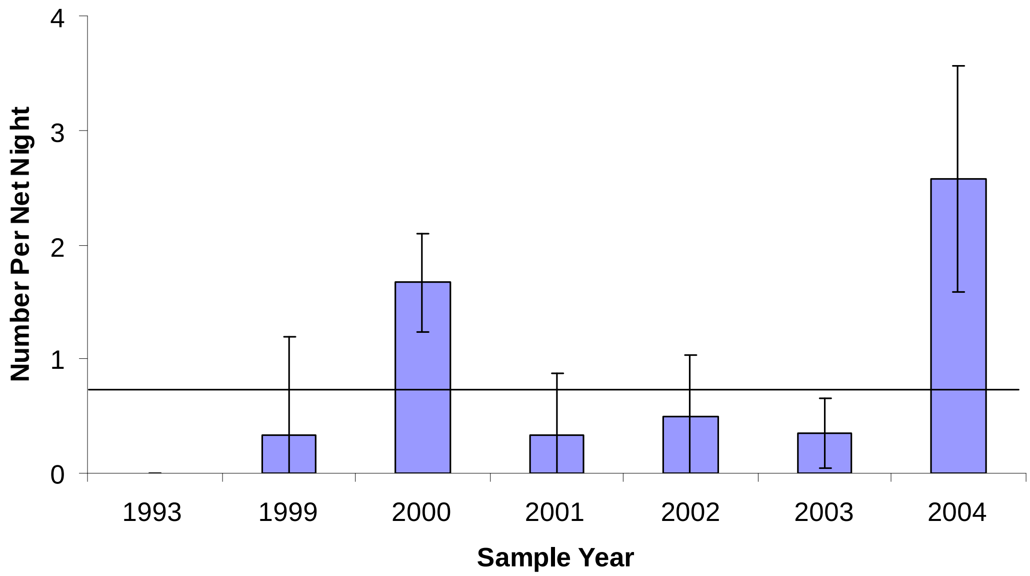

Figure 8. Catch per unit effort (number per net night) of age-1 Yellowstone cutthroat trout in Henrys Lake, Idaho. Horizontal bar represents a mean catch of 0.8 fish per net night. Error bars indicate 95% confidence intervals.

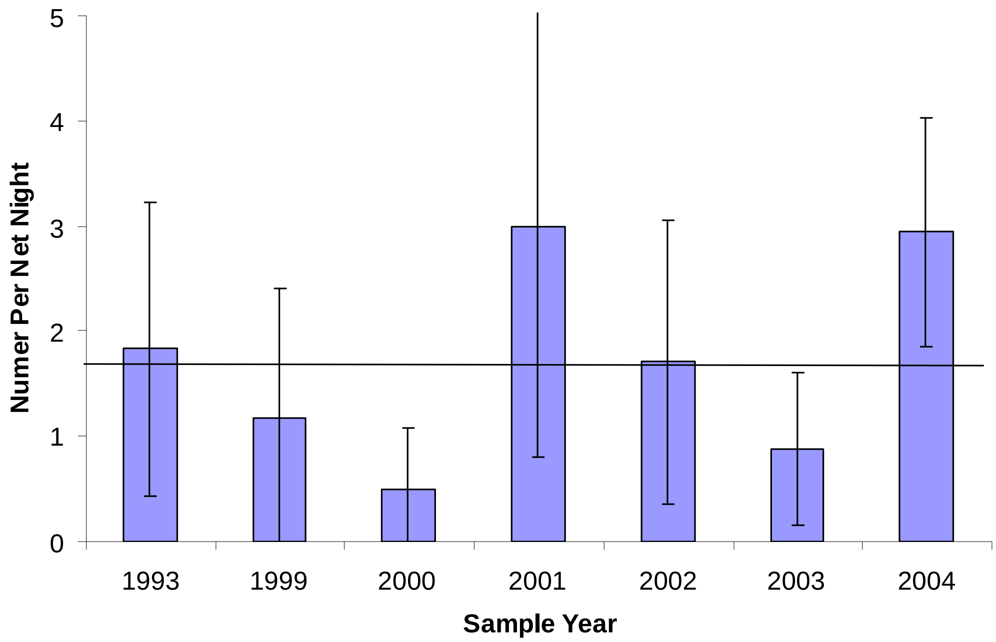

Figure 9. Catch per unit effort (number per net night) of age-2 Yellowstone cutthroat trout in Henrys Lake, Idaho. Horizontal bar represents a mean catch of 1.7 fish per net night. Error bars indicate 95% confidence intervals.

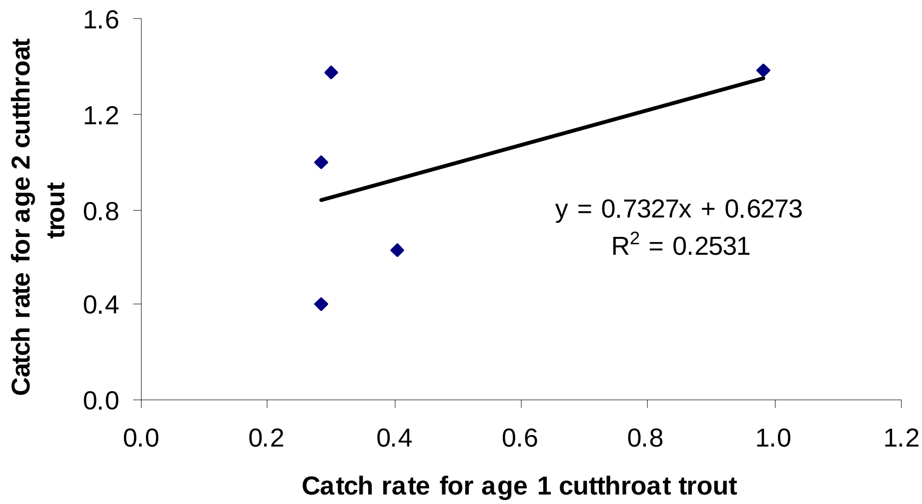

Figure 10. Regression depicting catch rates for age-1 vs. age-2 Yellowstone cutthroat trout in Henrys Lake, Idaho.

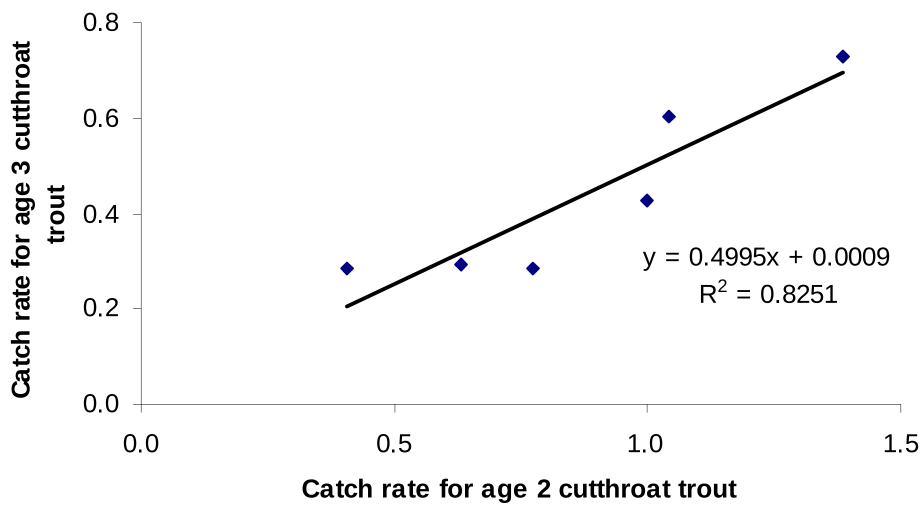

Figure 11. Regression depicting catch rates for age 2 vs. age 3 Yellowstone cutthroat trout in Henrys Lake, Idaho.

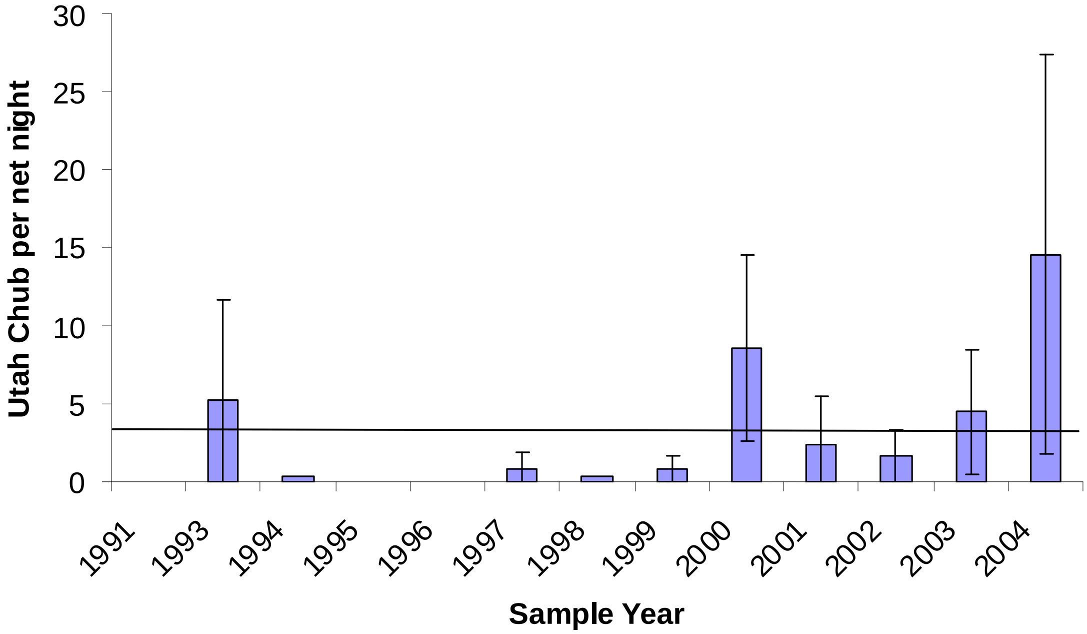

Figure 12. Utah chub catch rates in gill nets set in Henrys Lake, Idaho, 1991 to present. Mean catch rate was 3.0 chub per net over the 13-year period. Error bars represent 95% confidence intervals.

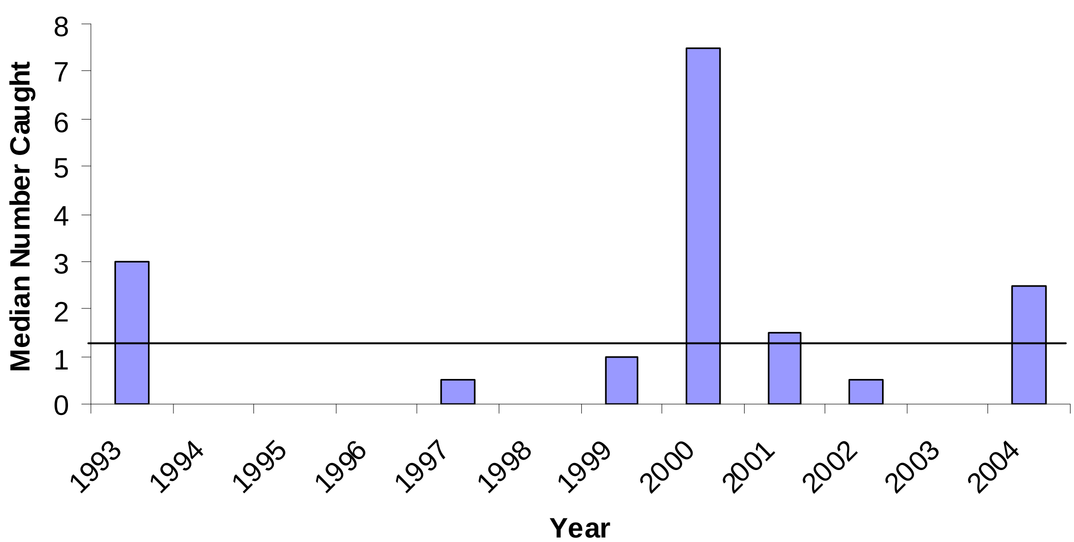

Figure 13. Median Utah chub catch rates in gill nets set in Henrys Lake, Idaho, 1991 to present. Median catch rate was 1.4 chub per net over the 13-year period.

Table 1. Fin clipping data from trout stocked in Henrys Lake, Idaho observed in annual creel surveys. Ten percent of all stocked Yellowstone cutthroat trout and brook trout receive an adipose fin clip annually.

	Yellowstone cutthroat trout				Brook trout			
Year	No. Clipped	No. of fish observed	No. of clipped fish observed	Percent clipped	No. Clipped	No. of fish observed	No. clipped fish observed	Percent clipped
2004*	92,100	323	28	8%	98,711	45	11	24%
2003*	163,389	324	50	15%	--	--	--	--
2003	163,389	106	37	35%	--	--	--	--
2002	110,740	38	7	18%	--	6	2	33%
2001	99,110	116	22	19%	--	30	6	20%
2000	100,000	14	1	7%	--	3	0	0%
1999	124,920	160	20	13%	--	48	5	10%
1998	104,740	--	--	--	2,067	--	--	--
1997	123,690	178	5	3%	2,044	11	1	9%
1996	100,290	--	--	--	1,961	1	0	0%

*Obtained from gill net samples.

Table 2. Number of nets required by species to obtain the desired level of precision for Henrys Lake gill net effort.

Species	Desired Level of Precision		
	50 (Preliminary)	25 (Management)	10 (Research)
Brook trout	10	40	248
Hybrid trout	5	20	124
Yellowstone cutthroat trout	4	16	98
Utah chub	38	153	959
All Trout	3	13	84

Table 3. Dissolved oxygen (DO) readings (mg/l) recorded in Henrys Lake, Idaho wintertime monitoring 2003-2004.

Location	Date	Snow depth (mm)	Ice depth (mm)	DO Ice bottom	DO 1 meter	DO 2 meters	DO 3 meters	Total g/m^3
Pittsburg Creek	Dec 30	300	400	8.9	8.7	6.7	5.7	21.2
	Jan 7	125	425	13.0	7.9	4.0	1.3	15.7
	Jan 16	200	425	11.6	6.9	2.8	1.1	13.2
	Feb 2	300	450	7.7	4.4	1.4	0.3	7.8
	Feb 20	100	700	4.9	2.9	0.7	0.2	4.8
County Boat Dock	Dec 30	250	325	11.3	9.7	6.2	2.5	19.2
	Jan 7	300	400	9.1	6.9	0.9	0.2	9.1
	Jan 16	100	450	7.7	5.1	0.9	0.1	7.4
	Feb 2	250	450	3.2	3.1	0.5	0.2	3.9
	Feb 20	275	575	2.5	2.9	0.3	0.2	3.2
Wild Rose	Dec 30	250	325	12.4	11.1	9	3.6	24.4
	Jan 7	200	400	11.7	8.1	2	0.5	12.4
	Jan 16	25	500	9.2	1	0.7	0.2	6.0
	Feb 2	150	450	2.8	3.4	2.4	0.5	6.0
	Feb 20	250	625	2.6	2.4	0.8	0.1	3.4

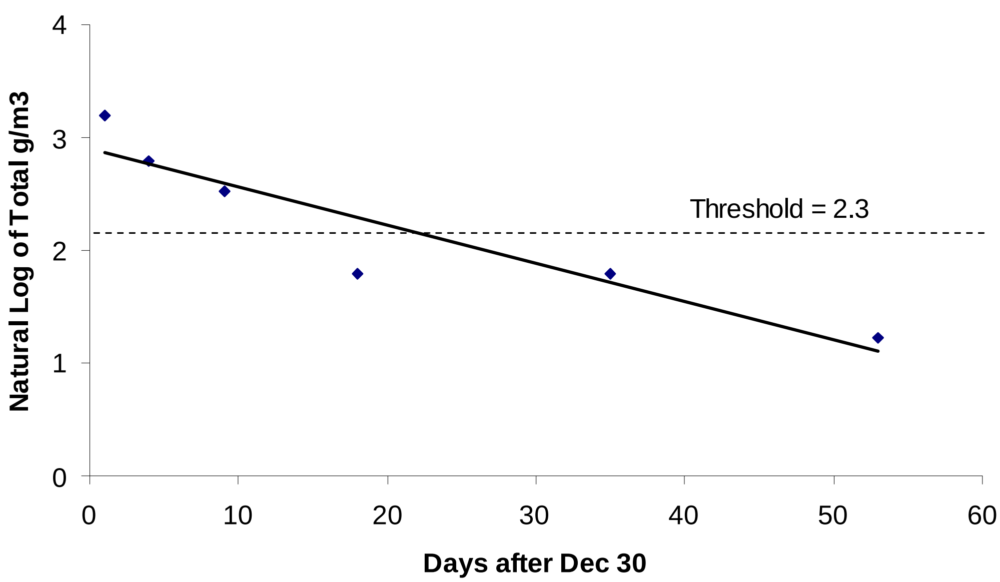

Figure 14. Oxygen depletion rate for the Wild Rose collection station, Henrys Lake, Idaho. Threshold level of 2.3 was reached on January 22 according to the predicted rate of decline.

Table 4. Diet composition for trout collected in Henrys Lake, Idaho, 2004. Figures presented are percent of contents by weight.

Food Type	Brook trout (n = 29)	Hybrid trout (n = 154)	Yellowstone cutthroat trout (n = 233)	Utah chub (n = 216)	Total (n = 632)
	Species				
Scuds	41	41	22	4	31
Vegetation	0	0	0	0	0
Leech	1	0	0	0	0
Chironomid	56	47	71	44	55
Mayfly	0	0	0	0	0
Daphnia	2	12	6	2	8
Damsel	0	0	0	0	0
Fish	0	0	0	0	0
Fish egg	0	0	0	0	0
Bivalve	0	0	0	0	0
Snail	0	0	0	2	0
Caddis	0	0	1	43	5
Other	0	0	0	5	1

Table 5. Diet composition for trout collected in Henrys Lake, Idaho, 2004. Figures presented are percent of contents by number.

Food Type	Brook trout (n = 29)	Hybrid trout (n = 154)	Yellowstone cutthroat trout (n = 233)	Utah chub (n = 216)	Total (n = 632)
	Species				
Scuds	17	7	6	2	7
Vegetation	0	0	0	0	0
Leech	0	0	0	0	0
Chironomid	41	14	35	60	24
Mayfly	0	0	0	0	0
Daphnia	41	79	60	33	70
Damsel	0	0	0	0	0
Fish	0	0	0	0	0
Fish egg	0	0	0	0	0
Bivalve	0	0	0	0	0
Snail	0	0	0	0	0
Caddis	0	0	0	0	0
Other	0	0	0	5	0

Table 6. 2004 Henrys Lake Yellowstone cutthroat trout spawning summary.

Spawn Date	Lot Number	Females Spawned	No. of Green Eggs	Mean Fecundity	No. of Eyed Eggs	Disease Status	Percent Eye-up
Jan 21	1	211	569,700	2,700	352,419	Neg.	62
Jan 26	2	105	283,500	2,700	162,097	Neg.	57
Jan 28	3	174	469,800	2,700	253,226	Neg.	54
Mar 10	6	210	588,000	2,800	108,870	Neg.	19
Mar 15	7	140	392,000	2,800	58,871	Neg.	15
Mar 18	8	98	264,600	2,700	53,226	Neg.	20
Mar 22	9	68	190,400	2,800	15,625	Neg.	8
Mar 25	10	70	196,000	2,800	35,484	Neg.	18
Mar 29	11	48	134,400	2,800	21,875	Neg.	16
Apr 27	14	72	198,000	2,750	62,097	Neg.	31
Total		1,196	3,286,400	2,748	1,123,790		34

Table 7. 2004 Henrys Lake hybrid trout spawning summary.

Spawn Date	Lot Number	No. of Females Spawned	No. of Green Eggs	Mean Fecundity	No. of Eyed Eggs	Disease Status	Percent Eye-up
Mar 1	4	151	422,800	2,800	0	Neg.	0
Mar 4	5	147	411,600	2,800	0	Neg.	0
Apr 8	12	135	371,250	2,750	62,500	Neg.	17
Apr 15	13	84	231,000	2,750	13,710	Pos (7)	6
Total		517	1,436,650	2,800	76,210		6

APPENDIX

Appendix A. Locations used in standard Henrys Lake gill net sets and standard dissolved oxygen monitoring stations. Coordinates are given as UTMs.

Gill Net Sites

Gill Net 1.	467,252 E	4,944,882 N	Z 12
Gill Net 2.	469,510 E	4,943,608 N	Z 12
Gill Net 3.	467,217 E	4,940,776 N	Z 12
Gill Net 4.	467,320 E	4,943,171 N	Z 12
Gill Net 5.	467,962 E	4,942,292 N	Z 12
Gill Net 6.	468,203 E	4,940,874 N	Z 12

Dissolved Oxygen Sites

County boat dock:	465,725 E	4,944,234 N	Z 12
Wild Rose:	467,751 E	4,945,816 N	Z 12
Outlet:	471,374 E	4,938,741 N	Z 12
Pittsburg Creek:	469,446 E	4,943,838 N	Z 12
Hatchery Ladder:	469,290 E	4,945,489 N	Z 12
Cliffs:	467,072 E	4,940,951 N	Z 12

Submitted by:

Dan Garren
Regional Fishery Biologist

William C. Schrader
Senior Fishery Research Biologist

Damon Keen
Assistant Fish Hatchery Manager

Jim Fredericks
Regional Fishery Manager

Approved by:

Virgil K. Moore, Chief
Fisheries Bureau

Steven P. Yundt
State Fish Manager