Burns Paiute Tribe

Evaluate the Life History of Native Salmonids in the Malheur Subbasin – FY 2003 Annual Report

Prepared for:

Bonneville Power Administration Division of Fish and Wildlife
U.S. Fish and Wildlife Service
U.S. Bureau of Reclamation

Evaluate the Life History of Native Salmonids in the Malheur Subbasin

FY 2003 Annual Report
(BPA Project No. 199701900)

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1.1 Introduction

In 2003, research was conducted on juvenile bull trout (S*alvelinus confluentus*) in the North Fork Malheur River (the North Fork) above Beulah Reservoir (Figure 1-1). Past land management activities, construction of dams, and fish eradication projects (poisoning) in the North Fork have reduced the number of native species in the Malheur River basin (Bowers et al. 1993). Survival of remaining bull trout populations is severely threatened (Buchanan et al. 1997).

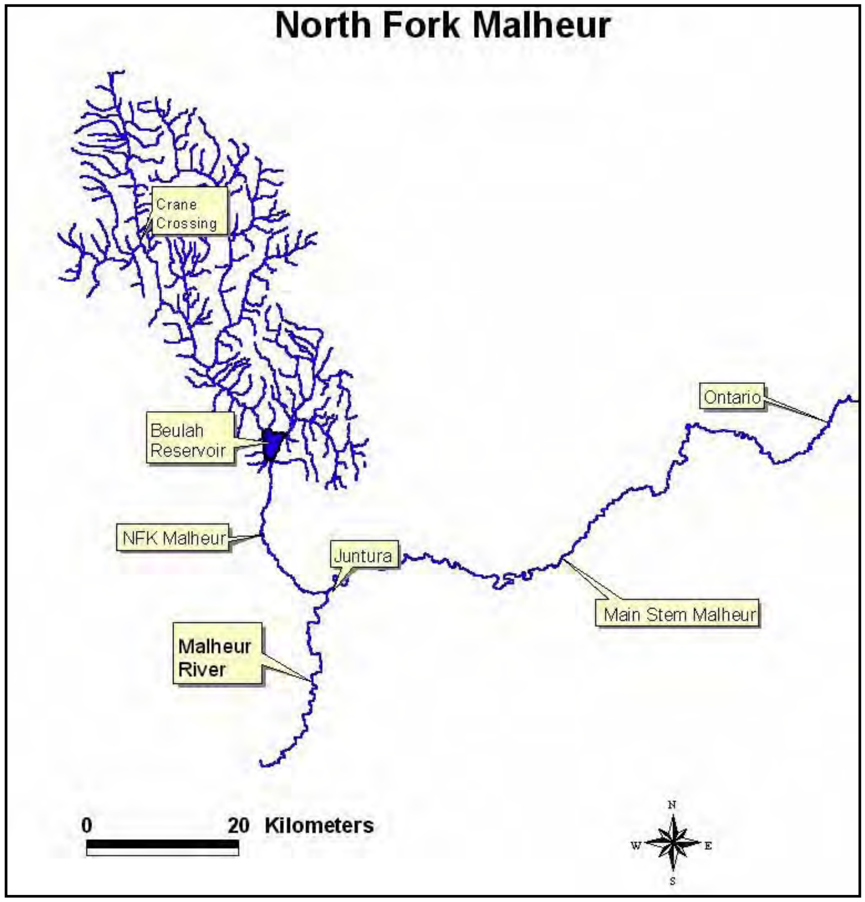


Figure 1–1. Study area for bull trout migration study in 2003.

The North Fork Malheur River bull trout population is currently the largest in the Malheur River drainage (Perkins 2002) and is assumed to be the most secure. Soon after the 1991 ban on bull trout harvest in the Malheur system, research on the life history and distribution of the North Fork bull trout began in 1992 with redd counts (Bowers et al. 1993).

In 1998, the Burns Paiute Tribe (BPT) coordinated with State and Federal agencies to collect data on migratory adult bull trout movement. As previous annual reports have indicated, the study identified new spawning and over-wintering locations throughout the North Fork.

Bull trout have exhibited resident and migratory life history patterns in the Malheur basin.

Currently, there is limited data on juvenile bull trout migratory patterns. This data is necessary to improve the understanding of Malheur River subbasin bull trout life history and effective population management.

1.1.1 Research Objectives

- Document the migratory patterns of juvenile bull trout in the North Fork.
- Determine the seasonal juvenile bull trout use of Beulah Reservoir.

1.1.2 Study Area

The study area includes the Malheur Basin from the Beulah Reservoir to the headwaters of the North Fork (Figure 1-1). Fish collection was conducted in Beulah Reservoir (river kilometer RK 29 to RK 33) and in the North Fork just above Beulah Reservoir (RK 33) and at Crane Crossing (RK 69). Radio telemetry was conducted from Beulah Reservoir to the headwaters of the North Fork. This report reflects all movement data collected from May 22 to October 23, 2003.

1.1.3 Methods

Fish Collection

Bull trout that were 300 mm fork length or smaller were considered candidates for radio implants. Schwabe et al. (2003) determined that at 300 mm, bull trout were about 3 years old. Bull trout tend to mature at three to four years of age. In addition to the length requirements, the weight of the tag could not exceed 5 percent of the body weight of the fish. Therefore, bull trout weighing less than 60 grams were not considered for implantation.

Bull trout were collected using six Fyke nets, two screw traps, and a fish weir with trap boxes. All fish species were counted and all salmonids were weighed and measured. Scale samples were collected from all bull trout captured.

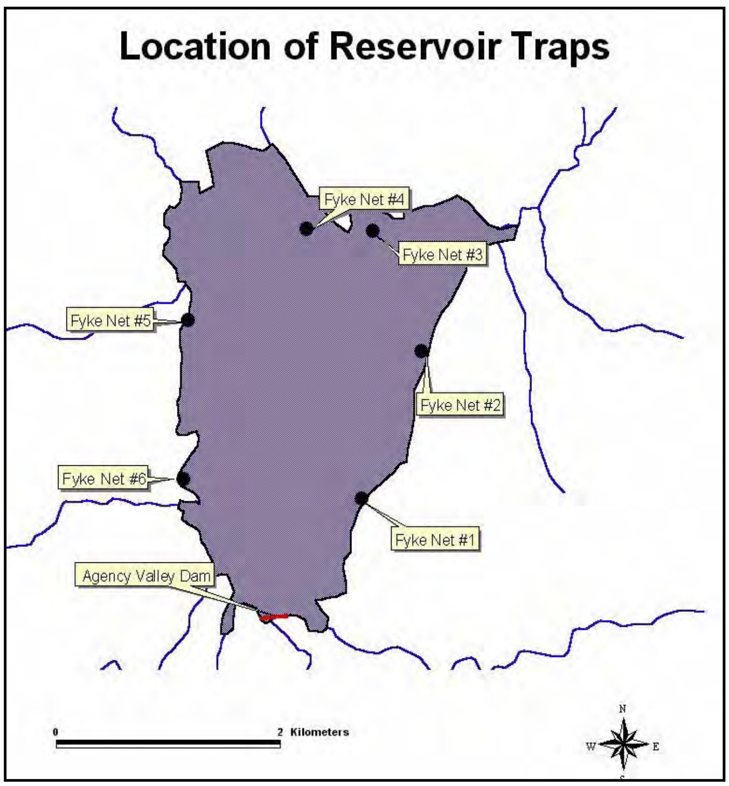


Figure 1–2. Location of nets in Beulah Reservoir, 2003

Reservoir Traps

Fyke nets were placed in Beulah Reservoir to capture juvenile bull trout. On March 23, 2003, six Fyke nets were deployed. Figure 1-2 shows the location of these nets. Personnel typically checked and reset the nets daily; however, weather conditions sometimes made boat travel unsafe; in these cases, the nets were checked every other day. All Fyke nets were removed on May 16, 2003.

Screw Trap

Two five-foot rotary screw traps were set in the North Fork (Figure 1-3). The first rotary screw trap was set up at RK 33 on March 18, 2003, and removed on May 18, 2003. The second screw trap was set up at Crane Crossing (RK 69) on May 20, 2003, and removed on June 29, 2003. The screw traps were checked daily.

Fish Weir

A fish weir was installed above Beulah at RK 33 near screw trap No. 1 (Figure 1-3) on October 7, 2003. The weir trap, designed to span a width slightly larger than the wetted channel, was installed at a slight angle across the North Fork. The structure used ½-inch-diameter conduit with ¼-inch spaces between the rods. Steel rods anchored in to the streambed helped stabilize the weir. Upstream and downstream trap boxes were placed near opposite stream banks and were interlocked into the weir panels. All fish caught in the upstream trap were released upstream; those caught in the downstream trap were released downstream. The weir was removed on November 22, 2003.

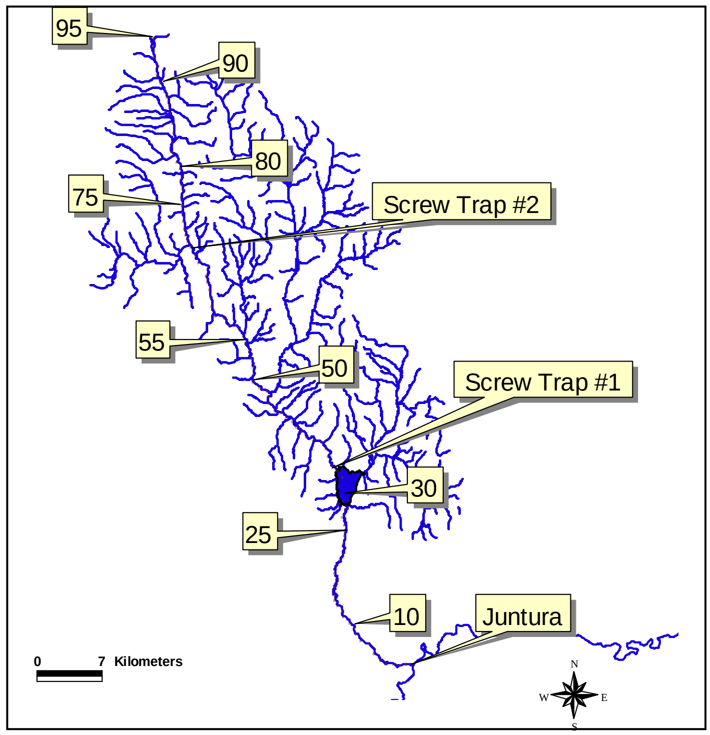


Figure 1–3. Location of screw traps in North Fork Malheur, 2003

1.1.4 Radio and Passive Intergraded Transponder (PIT) Tag Implants

Radio transmitters manufactured by Advanced Telemetry Systems had external whip antennas that emitted a unique frequency in either the 150 or 151 MHz band. Radios came in two sizes: 1.9-gram radios guaranteed for up to 78 days, and 3.6-gram radios guaranteed for up to 195 days. Transmitter weight was not to exceed approximately 5 percent of the bull trout body weight. Bull trout weighing less than 60 grams were not implanted with a radio.

PIT tags were implanted into the muscle adjacent to the dorsal fin on all bull trout over 150 millimeters (mm) using "BioMark" PIT tag injectors and 1¼-inch, 12 gauge injector needles.

The Malheur Bull Trout Working Group set a maximum target of 40 radio-tagged juvenile bull trout to be released into the North Fork. Twenty of the juveniles were to be captured and released just above Beulah Reservoir. The other twenty juvenile bull trout were to be captured and released near Crane Crossing.

Captured bull trout were first anesthetized with "MS 222" (tricaine methanesulfonate); they were then measured (fork length in millimeters) and weighed (grams). Radio transmitters were surgically implanted into the peritoneal cavity of the bull trout using the modified shielded needle technique (Ross and Kleiner 1982). The external whip antennas were threaded through the body cavity and exited behind the pelvic fin. During surgery the gills were bathed with diluted MS 222 (60 mg/liter). Synthetic absorbable surgical sutures and super glue sealed the incision. After surgery, the fish were held in fresh water until equilibrium was achieved; they were then released back into the river. Fish tank aerators were used in all holding buckets to assist with recovery.

Radio Telemetry

Radio telemetry tracking began following the first surgery on May 22, 2003. Weekly tracking for tagged bull trout occurred with an ATS receiver, Yagi antenna, and a 12-channel hand-held GPS unit and was done by foot or truck. Visual identification for the fish was attempted but rarely possible. For all positive identifications, the frequency, time, and UTM location was noted.

1.2 Results

1.2.1 Fish Collection

Fish were collected for tagging from Fyke nets in Beulah Reservoir, and screw traps located just above Beulah Reservoir and at Crane Crossing. In the fall, a weir was placed in the same location as the Beulah Reservoir screw trap to collect juveniles migrating into the reservoir. Fish species collected include bull trout, redband trout (*Orcorhynchus mykiss)*, mountain whitefish (*Prosopium williamsoni*), northern pikeminnow (*Ptychocheilus oregonensis*), redside shiner (*Richardsonius balteatus*), sucker (*Catostomidae spp*.), sculpin (*Cottus spp*.), longnose dace (*Rhinichthys cataractae)*, and speckled dace (*Rhinichthys osculus*) (Table 1-1).

Table 1-1. Number and Species of Fish Collected in the North Fork Malheur River, Oregon. 2003

Species	Fyke nets in Beulah	Screw trap, Beulah	Screw trap, Crane Crossing	Weir,Beulah
Bull Trout	0	1	40	0
Redband/Rainbow Trout	854	862	401	2
Mountain Whitefish	0	0	0	43
Northern Pikeminnow	222	38	1	4
Redside Shiner	509	114	1	8
Sucker	310	603	0	1
Sculpin.	36	12	20	0
Long Nose Dace	15	191	117	0
Speckled Dace	44	555	0	3

Reservoir Traps

The Fyke nets were placed into Beulah Reservoir on March 23, 2003. The nets in the reservoir fished for 53 days. No bull trout were captured in the reservoir in 2003. Fish species captured in the Fyke nets include redband trout, northern pikeminnow, redside shiner, sucker, sculpin, longnose dace, and speckled dace. Redband trout captured in the Fyke nets ranged between 60 mm to 510 mm and up 949 g; average size and weight was 108 mm and 14 g, respectively. Daily and cumulative totals for redband trout captured along with reservoir levels are included in Appendix D. Due to low water and high algae conditions, the nets were removed on May 16, 2003.

Screw Traps

The lower screw trap was installed on March 18, 2003 just above Beulah Reservoir at RK 33. The screw trap fished for 61 days. The lower screw trap caught only one bull trout during this time. The bull trout caught on April 28, 2003 was only 41 grams (158 mm) which was too small for the study. Other fish species collected from the lower screw trap include redband trout, northern pikeminnow, redside shiners, suckers, sculpin, speckled dace, and longnose dace (Table 1-1). The lower screw trap was removed on May 18, 2003 due to low water.

The upper screw trap was installed at Crane Crossing (RK 69) on May 20, 2003, and fished for 40 days. At Crane Crossing, 40 bull trout (Figure 1-4) were captured with only 12 being the appropriate size for the study. The bull trout captured in the screw trap at Crane Crossing ranged from 141 mm to 223 mm (Figure 1-5). Other species captured in the upper screw trap include redband trout, northern pikeminnow, redside shiner, sculpin, and longnose dace (Table 1-1). The upper screw trap was removed on June 29, 2003 because of low water

Figure 1–4. Number of bull trout collected per day from screw trap at Crane Crossing, 2003.

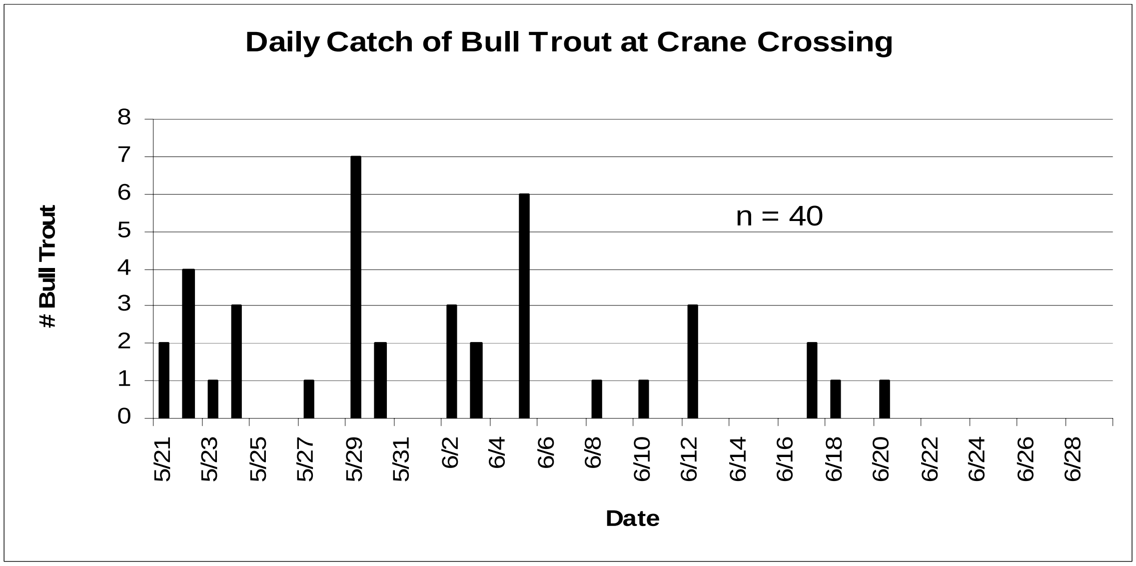
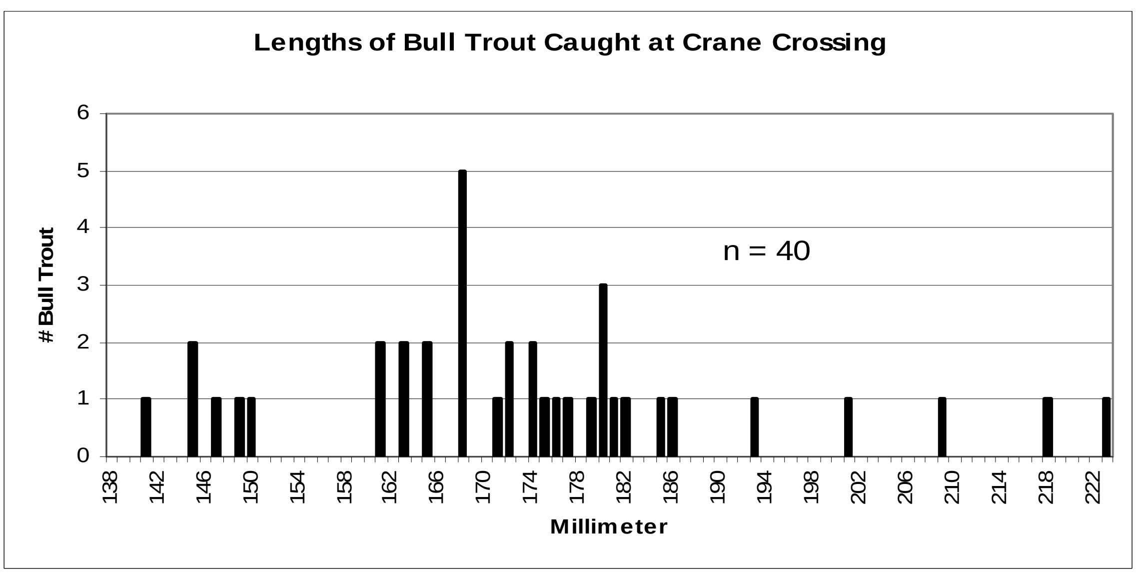


Figure 1–5. Lengths of bull trout caught at Crane Crossing, 2003.



Weir

The weir was installed on October 7, 2003, near the same place the lower screw trap had been, and fished for a total of 43 days capturing no bull trout. Ice build up caused the weir to blow out four times. Other fish species captured in the weir include redband trout, whitefish, northern pikeminnow, redside shiner, sucker, and speckled dace (Table 1-1). On November 22, 2003 the weir was removed due to excessive ice build up.

1.2.2 Juvenile Bull Trout Movement

In 2003, all methods of tracking documented 105 locations. All twelve radio-tagged bull trout were implanted at Crane Crossing. One signal was lost due to unknown reasons. Six fish moved downstream of Crane Crossing with two of those moving back upstream of the implant site. The five remaining fish moved upstream of the implant site to a maximum distance of 16 kilometers.

Of the 12 radios implanted into the fish, two were located in different osprey (*Pandion haliaetus*) nests; one was located in a snake; and five were found in the river with no apparent cause of mortality. One radio signal was lost the day after implantation and may have been a faulty radio. The remaining three fish were tracked until the radio batteries apparently failed.

None of the radio-tagged bull trout were documented in the smaller spawning tributaries of the North Fork. Two radio tags were found in Crane Creek, a tributary 0.5 kilometers above the upper screw trap. The bull trout had either somehow shed the tags or died from unknown reasons.

Table 1-2. Tagged bull trout captured in screw trap at Crane Crossing, North Fork Malheur River, 2003

Date of implant	**Radio frequency** (MHz)	**Weight** (g)	**Fork length** (mm)	**Distance Traveled** (km)		**Status in 2003** (date)
				Downstream	**Upstream**	
May 22	151.793	88	201		12.5	alive (as of 9/30)
May 22	151.602	64	182		12.5	alive (as of 9/30)
May 22	151.961	65	186			missing (5/23)
May 23	150.013	60	175	7.5		tag found (8/6)
May 29	151.782	69	185		1.5	tag found (8/6)
May 29	151.571	61	179	8		bird (6/27)
May 30	151.472	N/A	232	9.5		tag found (7/22)
June 2	151.452	62	180	5.5	1.5	tag found (7/24)
June 3	151.492	69	180	1.5	9.5	alive (as of 8/25)
June 5	151.791	75	193	10.5		snake (8/6)
June 5	151.542	91	209		16	bird (7/15)
June 19	150.153	108	218		8	tag found (8/6)

1.3 Discussion

Migration patterns of radio-tagged bull trout, for the second year of the study, were sporadic after release. Bull trout were documented to move downstream or upstream of the release site in no apparent pattern. The farthest that a bull trout migrated downstream was 10.5 km. The farthest that bull trout migrated upstream was 12.5 km. Although one radio was found in an osprey nest 16 km above the release site, it was suspected that the bird caught the bull trout near the 12.5 km site. There was a highwater event on May 30 that may have pushed some of the newly radio-tagged bull trout downstream. However, some of the other bull trout that were radio tagged after the flood event also moved downstream.

By July, a general upstream migration of subadult bull trout is apparent. Six of the twelve fish that were radio tagged migrated downstream of the implant site. Two of these fish then moved back upstream above their initial release site. The remaining four tags were found downstream of the initial release site.

Five of the twelve radio tagged bull trout never observed below the initial release site migrated upstream to a maximum of 12.5 km. One radio tagged fish was never located after the surgery for unknown reasons.

All but two of the radio tagged bull trout stayed in the mainstem of the North Fork Malheur. Lower Crane Creek was the only tributary to the North Fork Malheur that the subadult bull trout seemed to utilize. Habitat attributes of lower Crane Creek seem to be more similar to the attributes to the mainstem North Fork rather than the habitat of known spawning tributaries.

In general, during April through June, subadult bull trout in the North Fork tend to be widely distributed from Beulah Reservoir to the headwaters. In 1999, subadult bull trout were documented in Beulah Reservoir in April and May (Schwabe et al. 2000) and in the North Fork upstream less than 1 km of the reservoir pool in 2002 (Schwabe et al. 2003). Migratory patterns during this time of year tend to be sporadic. By July, upstream migration of subadult bull trout is evident. The Bureau of Reclamation determined stream water quality conditions in the lower North Fork to be unsuitable for bull trout due to excessively high stream temperatures and low dissolved oxygen levels (USBR 2000). The upstream migration observed may be a direct result of poor water quality in July and August at the lower elevation habitat.

Though upstream migration of subadult bull trout was evident, none were documented in the known spawning tributaries. Electroshocking surveys conducted in known spawning habitat of bull trout in June and July of 1989 found less than 5 percent of the total catch of bull trout were >177 mm in fork length (Bowers et al 1993). Through the data available, it appears subadult bull trout 177 mm to 300 mm fork length prefer to summer rear in larger aquatic habitats compared to known spawning habitat and also prefer habitats that can sustain cool temperatures during the summer months. For the fluvial population of bull trout, the mainstem habitats of Crane Creek and North Fork may prove to be critical summer rearing habitat.

The extent of mainstem habitat utilized by subadult bull trout is not fully understood. Unfortunately, subadult bull trout collected in the lower North Fork and Beulah Reservoir were too small for radio tag implants and the extent of migration could not be determined. Bull trout have been collected from the North Fork at RK 69 in August 1999 using a rotary screw trap (Schwabe et al. 2000) and have been observed during snorkel surveys at RK 52 in August 1997 (USFWS 2002). The relative abundance of bull trout collected at the lower and upper screw trap suggest bull trout density increases with elevation.

Adult bull trout have been found to migrate back into Beulah Reservoir during late October to late November (Schwabe 2000). However, no juvenile fish that were radio tagged in 2003 or 2002 were documented to use the reservoir. The weir was dismantled on November 22, 2003 due to excessive ice build up. There was one juvenile bull trout caught just above Beulah Reservoir on April 28, 2003. This particular fish was too small to implant a radio tag. The previous year, only two juvenile bull trout were captured. This may suggest that bull trout may not use the reservoir at least during drought years. Further research needs to be conducted to determine how juveniles use Beulah Reservoir.

Juvenile bull trout downstream movement from their natal streams most likely occurs during the spring or fall when spring temperatures are cooler. Spring runoff may play a significant role in the movement of juvenile bull trout. As spring flow decreases, the downstream movement of juvenile bull trout may also decrease. This is evident in the high catch rates in May and June at the upper screw trap site in 1998, 1999, 2002, and 2003.

There is a need to continue the research on juvenile bull trout in the North Fork. The unexpected low catch rate of bull trout in Beulah Reservoir may have been influenced by the regional drought conditions in 2001, 2002, and 2003. Radio tagging bull trout during drought years is recommended and will provide local agencies critical information and knowledge in making fish and land management decisions. In addition, little is known on the seasonal distribution of subadult bull trout in the fall months.

Restoration of the North Fork, particularly from the confluence of Bear Creek (RK 52) up to the headwaters, is strongly recommended. Optimal bull trout habitat in Oregon streams occur where water temperature seldom exceeded 15 ^{o}C (Buckman et al. 1992; Ratliff 1992; Ziller 1992). Optimal summer stream temperatures for bull trout are only available in the extreme upper reaches of the North Fork (Perkins 1999). Restoration of riparian and channel condition in the upper North Fork to the extent possible may provide some additional summer rearing habitat for bull trout.

1.4 Acknowledgements

A special thanks to the Bonneville Power Administration and the Bureau of Reclamation who funded this project for the Burns Paiute Tribe Fish and Wildlife Department. We would also like to thank Eric Hawley, Garrett Sam, Todd Richards, Lucas Samor, Jason Isaacson, Tyler Johnson, Kevin Fenn, Jason Fenton, and Lawrence Schwabe for the countless hours that each individual spent in the field checking traps, tracking fish, and all other field work that was contributed to the project.

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Appendix A. Catches of Fish in the North Fork Malheur River, Oregon, 2003.

Figure 1–6. Number and type of fish caught at the North Fork Malheur River weir in 2003.

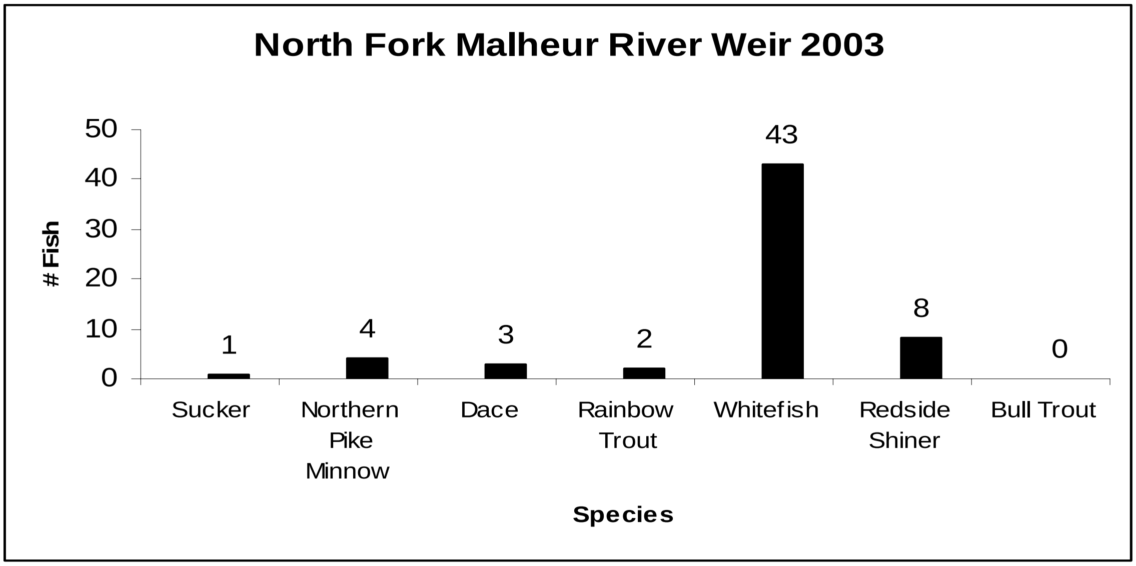


Figure 1–7. Number and type of fish caught in the Beulah Reservoir screw trap in 2003.

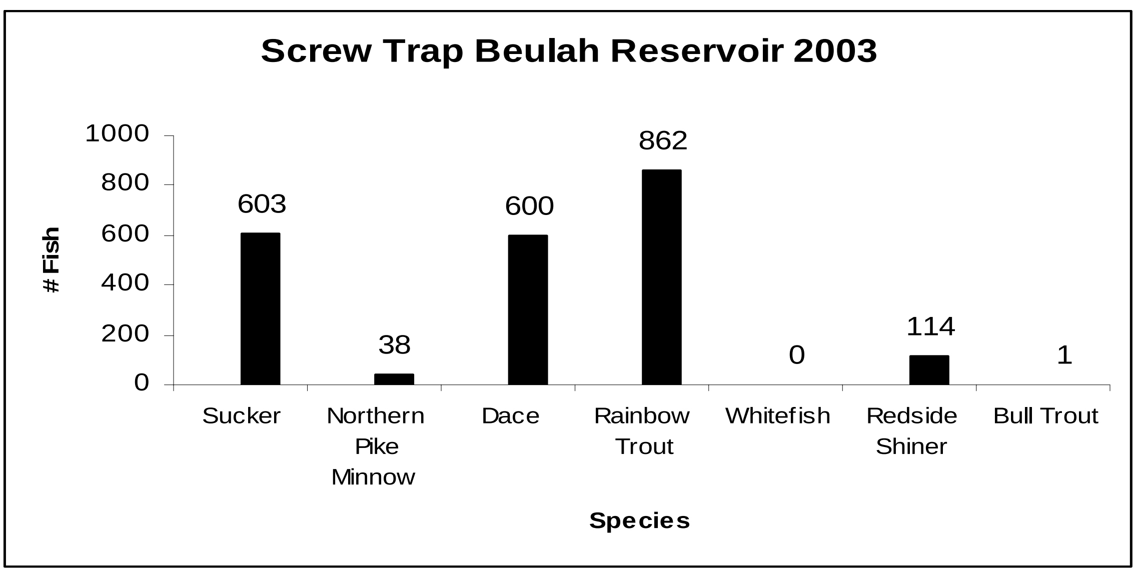


Figure 1–8. Number and type of fish caught in the Crane Crossing screw trap in 2003.

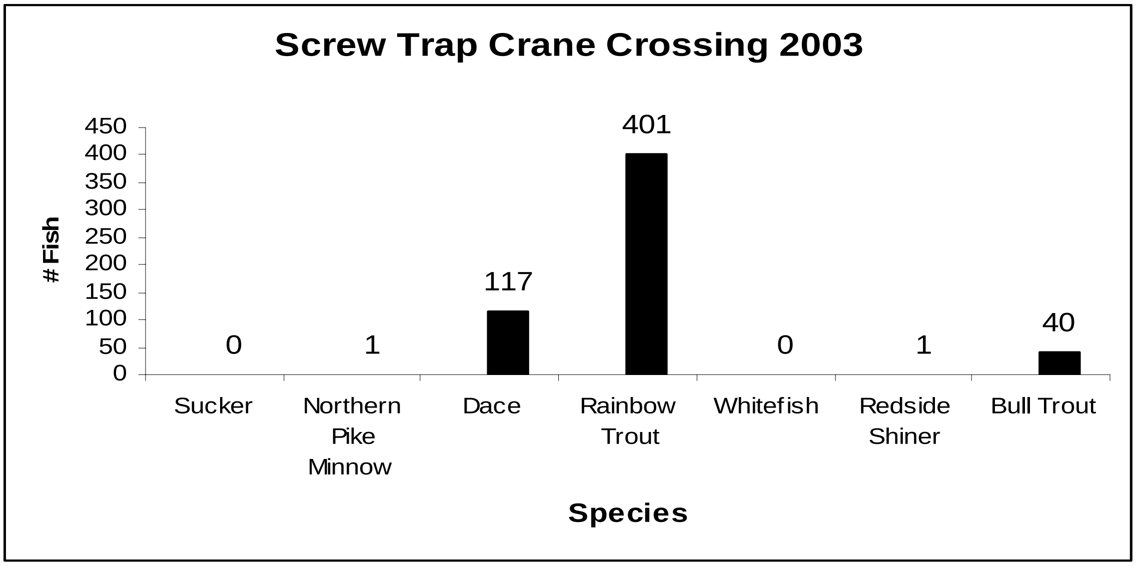
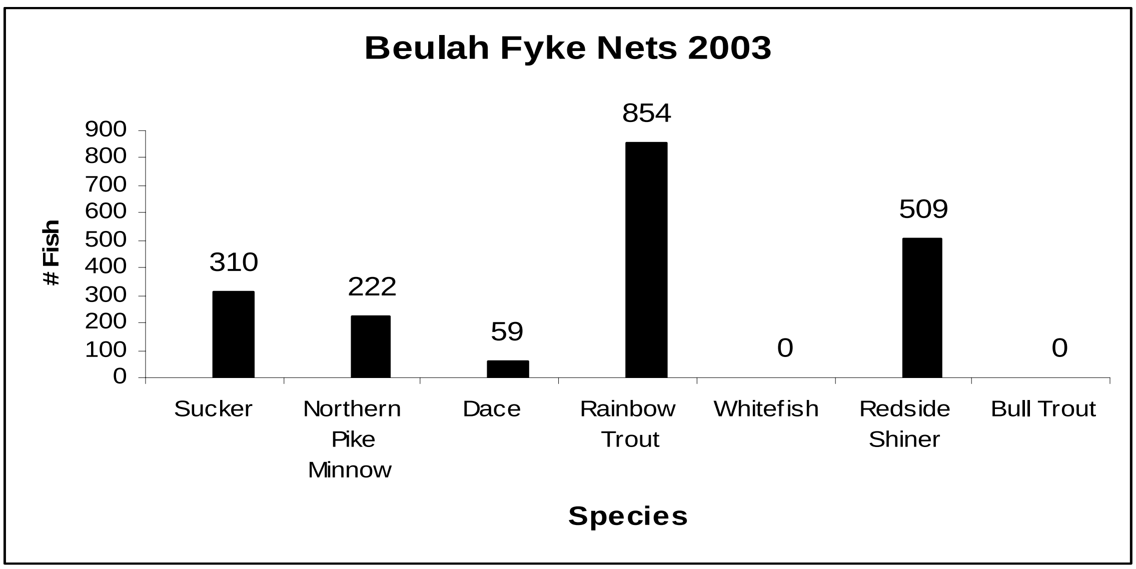


Figure 1–9. Number and type of fish caught in the Beulah Reservoir Fyke nets in 2003.



Appendix B. Length Frequency of Salmonids from the North Fork Malheur 2003.

Figure 1–10. Length frequency of redband trout captured in Beulah Reservoir Fyke nets, 2003.

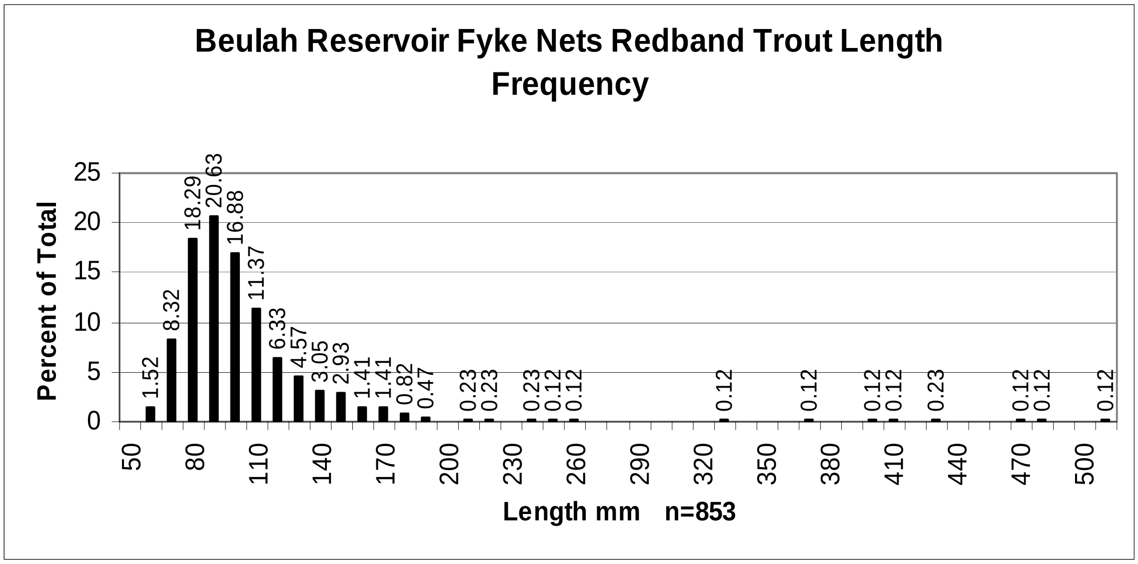


Figure 1–11. Length frequency of redband trout collected from Beulah Reservoir screw trap, 2003.

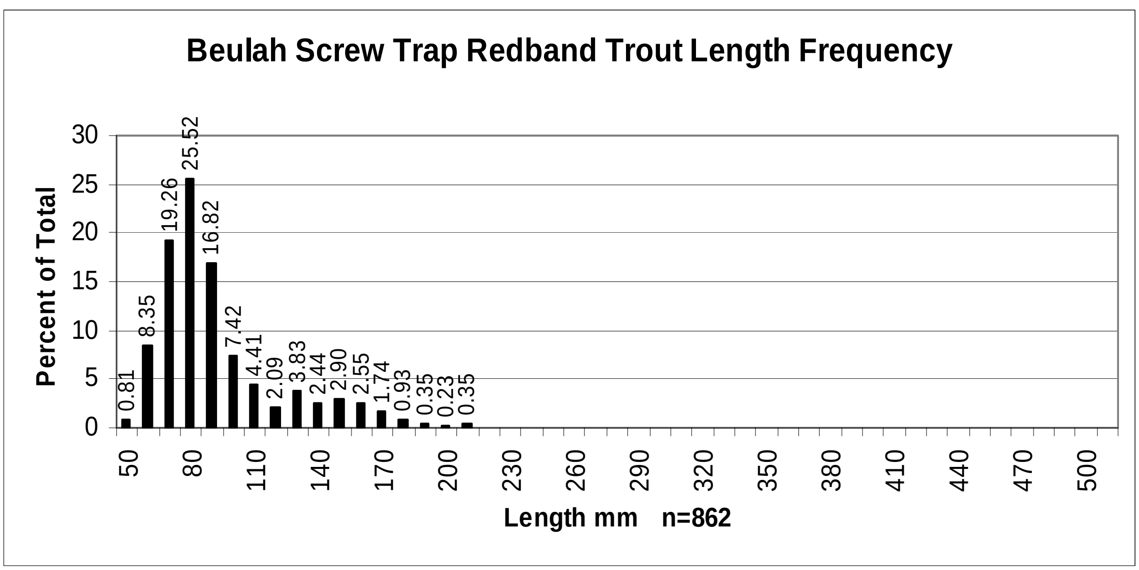


Figure 1–12. Length frequency of bull trout captured from Crane Crossing screw trap, 2003.

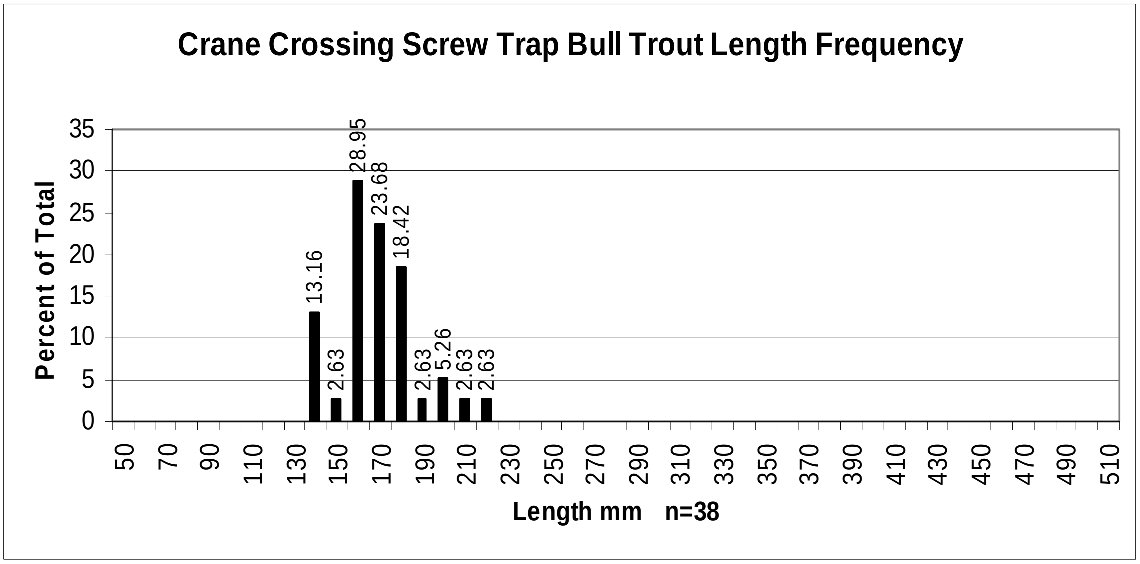


Figure 1–13. Length frequency of redband trout captured from Crane Crossing screw trap, 2003.

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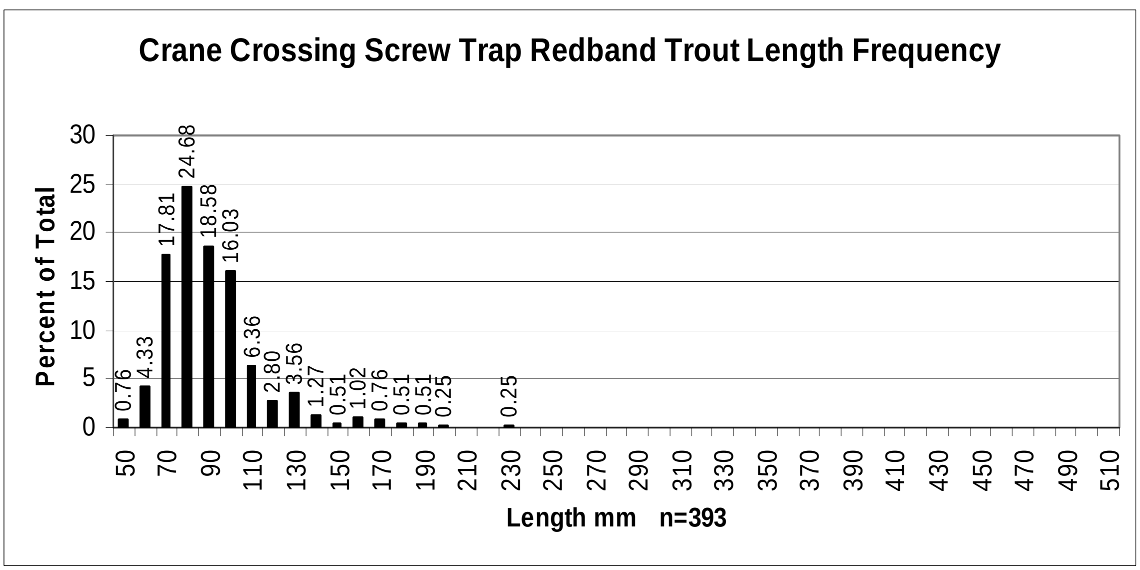


Figure 1–14. Length frequency of mountain whitefish collected from Crane Crossing screw trap, 2003.

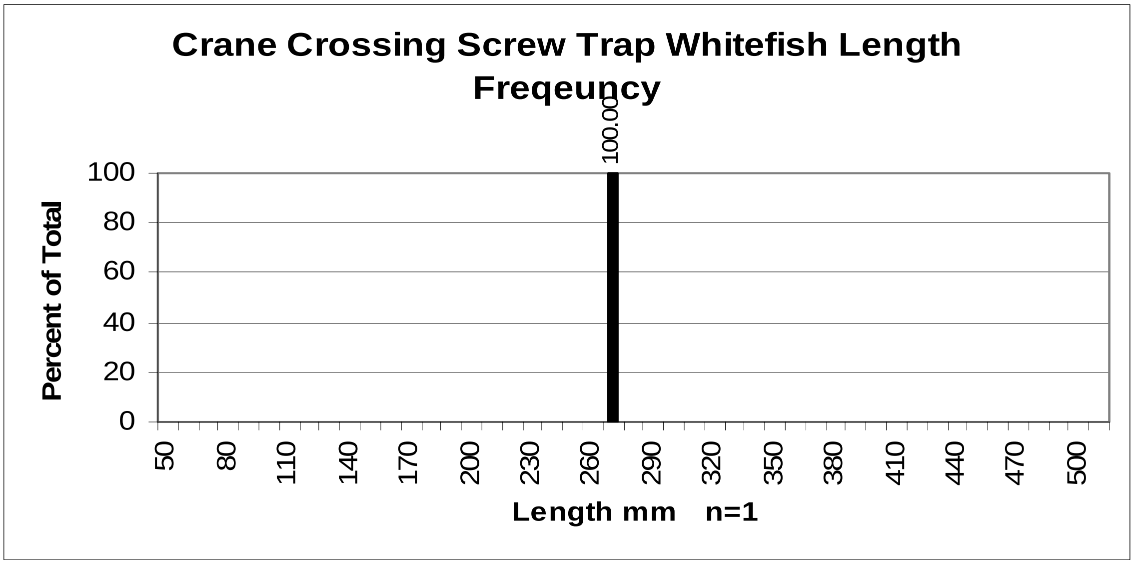


Figure 1–15. Length frequency of mountain whitefish collected from Beulah Reservoir fish weir, 2003.

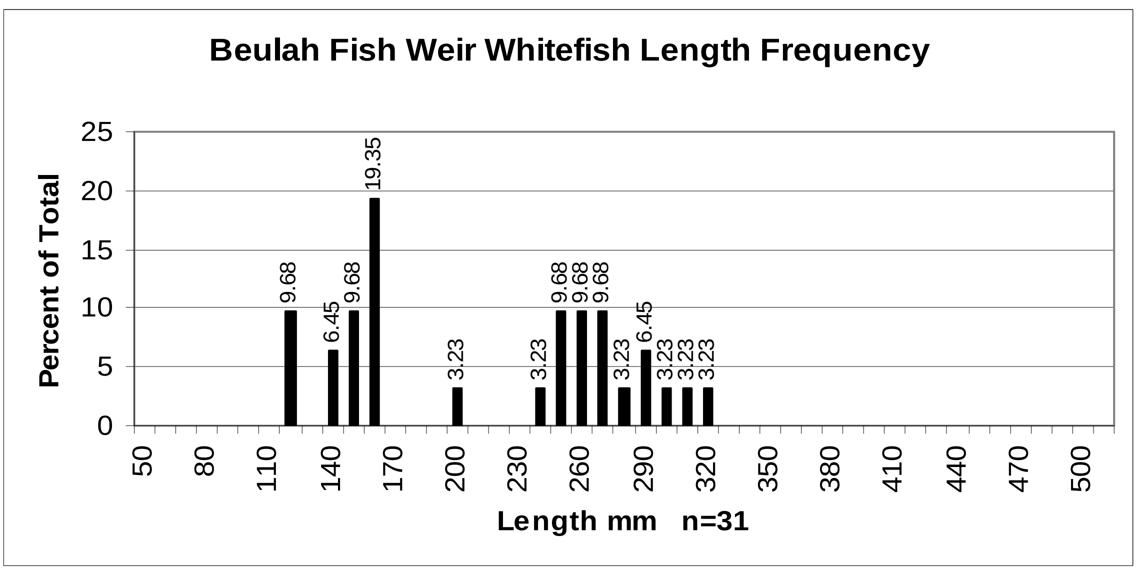
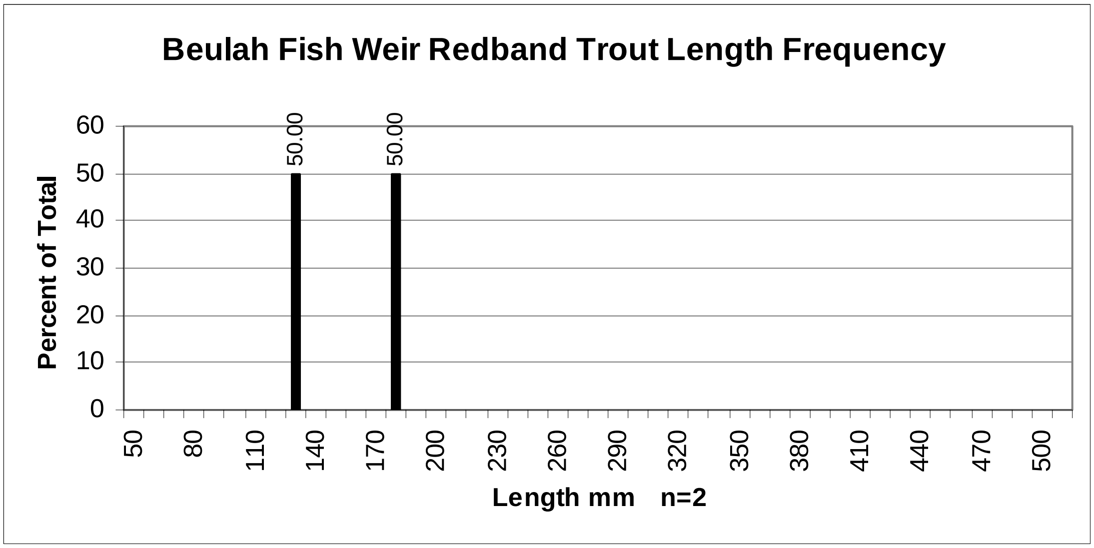


Figure 1–16. Length frequency of redband trout collected from Beulah Reservoir fish weir, 2003.



Appendix C. Weight Frequency of Salmonids from the North Fork Malheur 2003.

Figure 1–17. Weight frequency of redband trout collected from Beulah Reservoir Fyke nets, 2003.

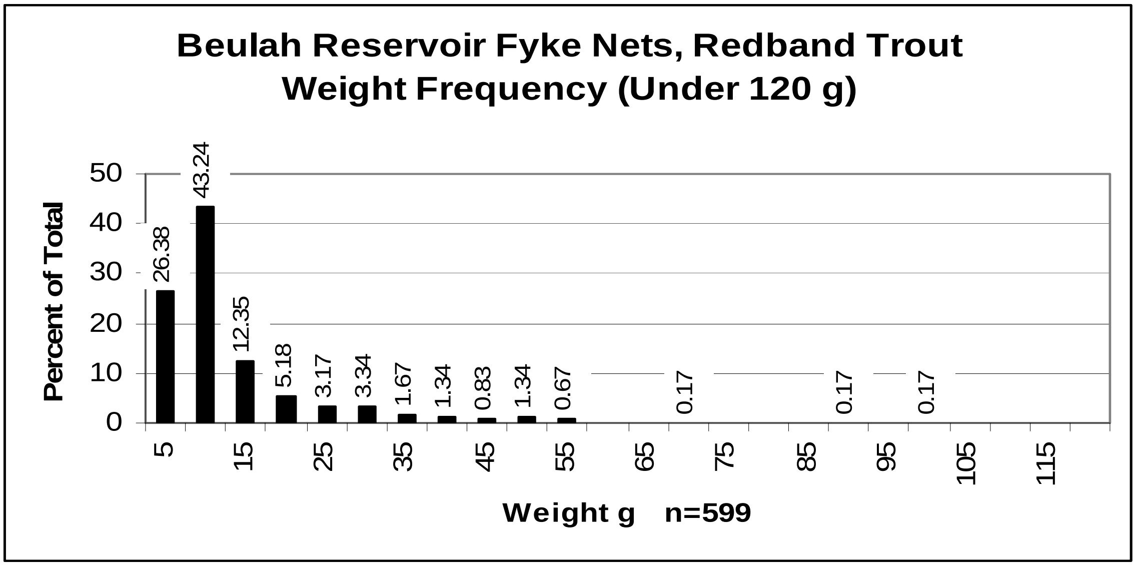


Figure 1–18. Weight Frequency of redband trout collected from Beulah Reservoir screw trap, 2003. .

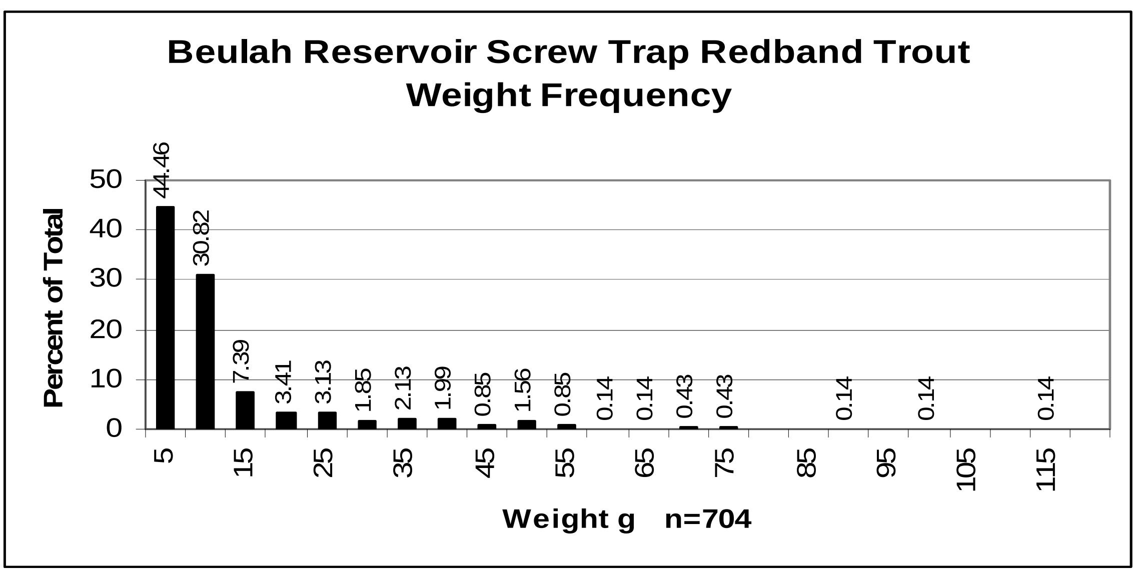
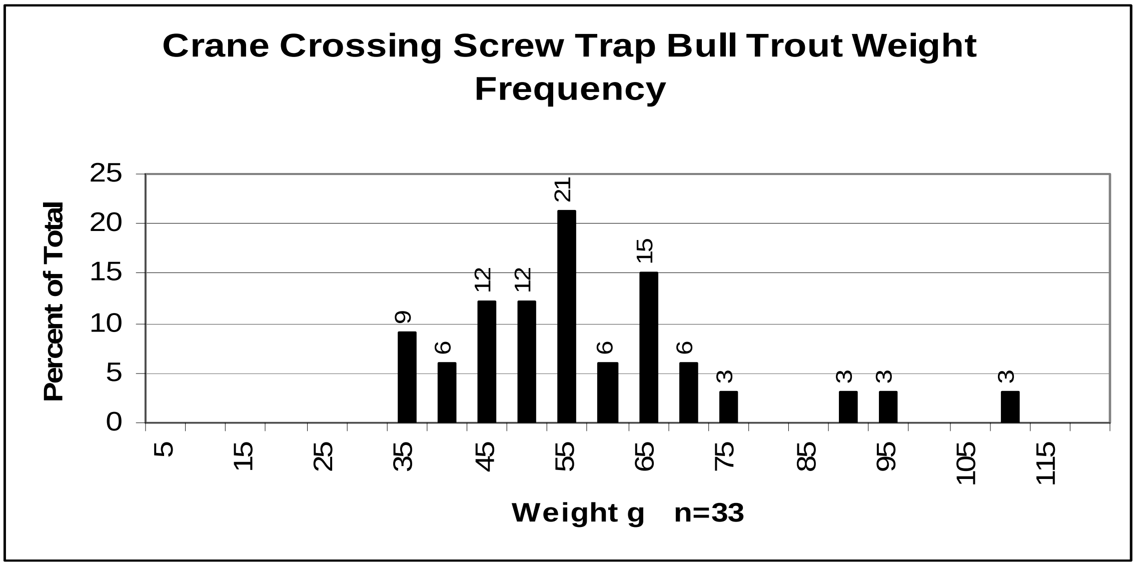


Figure 1–19. Weight frequency of bull trout collected from Crane Crossing screw trap, 2003.



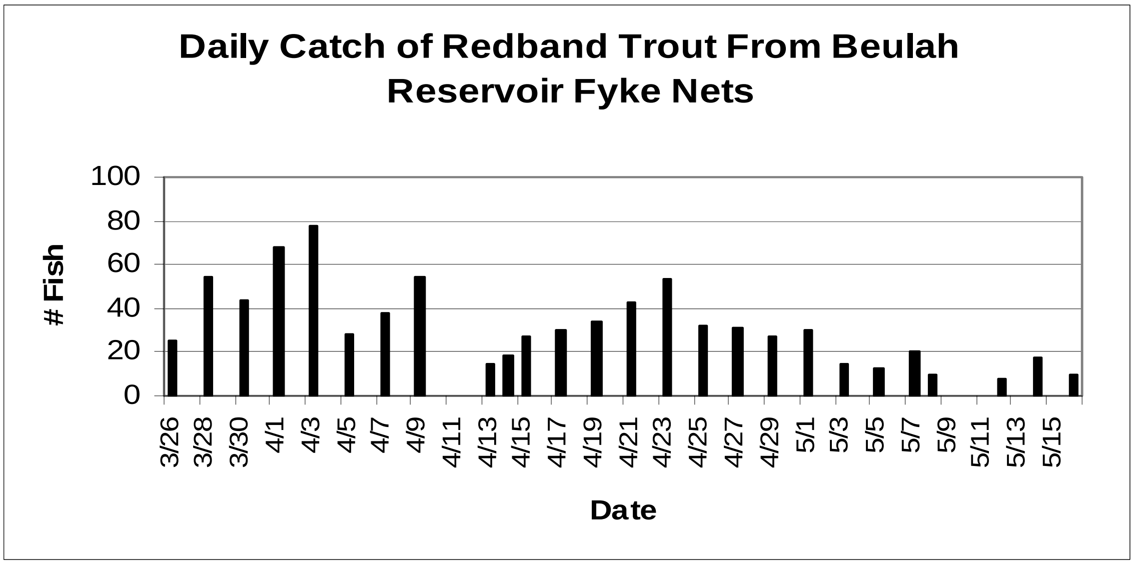
Appendix D: Salmonid Counts and Reservoir Capacity for Fyke Nets at Beulah Reservoir 2003

Table 1-3. Daily and Cumulative Redband counts with Beulah Reservoir capacity, 2003.

Date	**Reservoir level** (acre-feet)	**Redband** Daily	Cum.
3/26/2003	25156.08	25	25
3/27/2003	25543.01	n/a	25
3/28/2003	25895.18	54	79
3/29/2003	26222.99	n/a	79
3/30/2003	26552.23	44	123
3/31/2003	26912.8	n/a	123
4/1/2003	27436.66	68	191
4/2/2003	27861.74	n/a	191
4/3/2003	28271.55	78	269
4/4/2003	28667.39	n/a	269
4/5/2003	29026.27	28	297
4/6/2003	29378.35	n/a	297
4/7/2003	29704.25	38	335
4/8/2003	30003.99	n/a	335
4/9/2003	30303.73	54	389
4/10/2003	30598.57	n/a	389
4/11/2003	30918.19	n/a	389
4/12/2003	31225.6	n/a	389
4/13/2003	31764.84	15	404
4/14/2003	32201.7	18	422
4/15/2003	32571.16	27	449
4/16/2003	32953.1	n/a	449
4/17/2003	33288.31	30	479
4/18/2003	33609.75	n/a	479
4/19/2003	33903.13	34	513
4/20/2003	34183.75	n/a	513
4/21/2003	34507.17	43	556
4/22/2003	34948.48	n/a	556
4/23/2003	35293.18	53	609
4/24/2003	35750.16	n/a	609
4/25/2003	36172.95	32	641
4/26/2003	36130.16	n/a	641
4/27/2003	36114.11	31	672
4/28/2003	36143.53	n/a	672
4/29/2003	36143.53	27	699
4/30/2003	36084.69	n/a	699
5/1/2003	35996.43	30	729
5/2/2003	35836.33	n/a	729
5/3/2003	35663.98	15	744
5/4/2003	35494.25	n/a	744
5/5/2003	35306.23	13	757

5/6/2003	35079.05	n/a	757
5/7/2003	34836.2	20	777
5/8/2003	34590.73	10	787
5/9/2003	34336.81	n/a	787
5/10/2003	34043.44	32	819
5/11/2003	33847	n/a	819
5/12/2003	33650.57	8	827
5/13/2003	33428.63	n/a	827
5/14/2003	33191.37	17	844
5/15/2003	32925.64	n/a	844
5/16/2003	32693.48	10	854

Figure 1–20. Daily catch of redband trout collected from Beulah Reservoir Fyke nets, 2003



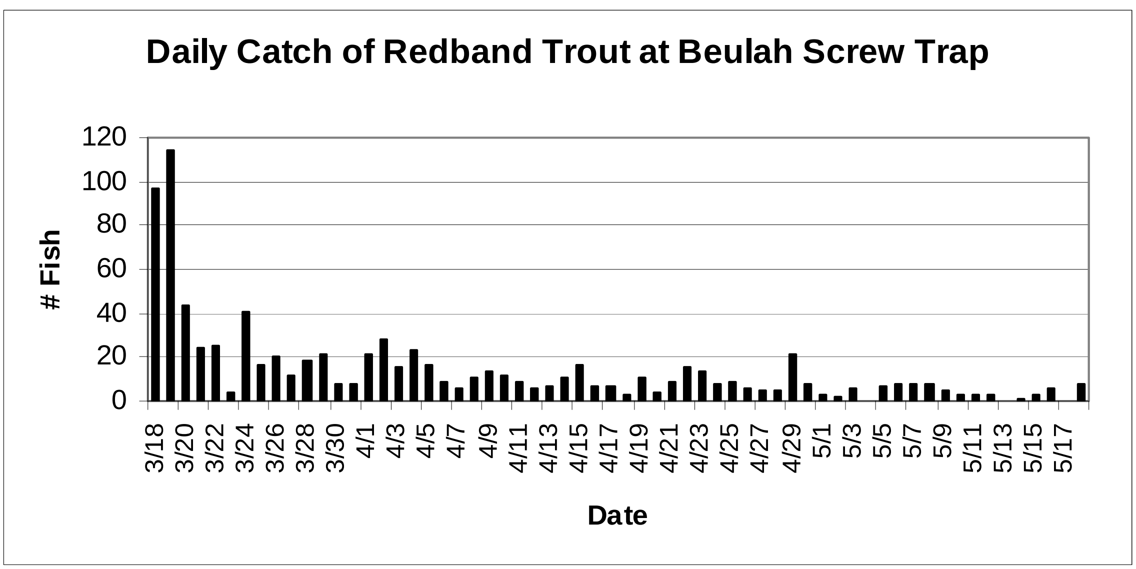
Appendix E: Salmonid Counts and Stream Conditions for Beulah Reservoir Screw Trap 2003

Table 1-4. Redband counts for Beulah Reservoir screw trap and stream conditions, 2003.

	Ave. Daily	Water Temperature		Redband	
Date	**Flow** (cfs)	**Min.** (°F)	**Max**. (°F)	**Daily**	**Cum.**
3/18/2003	184.11	40	47.6	97	97
3/19/2003	166.2	40	48.9	114	211
3/20/2003	169.92	44.3	48.7	44	255
3/21/2003	159.27	43.4	48.3	24	279
3/22/2003	199.34	46.2	47.7	25	304
3/23/2003	303.75	40.7	46.9	4	308
3/24/2003	231.78	38.6	48.2	41	349
3/25/2003	225.84	43.4	45.1	16	365
3/26/2003	279.84	43.1	49.5	20	385
3/27/2003	219.19	39.8	48.5	12	397
3/28/2003	194.39	39.6	49.5	18	415
3/29/2003	183.33	42.2	50.1	21	436
3/30/2003	179.52	44.8	53	8	444
3/31/2003	191.69	48	52.9	8	452
4/1/2003	271.75	47.3	51.5	21	473
4/2/2003	246.05	43.3	49.1	28	501
4/3/2003	218.27	40.1	44.7	15	516
4/4/2003	208.92	39.9	45.1	23	539
4/5/2003	202.13	40	46.3	16	555
4/6/2003	189.15	41	46.5	9	564
4/7/2003	173.76	39.6	50.1	6	570
4/8/2003	167.4	43	52.8	11	581
4/9/2003	159.39	45.7	56.7	14	595
4/10/2003	161.44	47.2	56.7	12	607
4/11/2003	172.22	49.3	57	9	616
4/12/2003	190.63	49.5	54.4	6	622
4/13/2003	244.48	46.3	50.4	7	629
4/14/2003	236.67	44	53.5	11	640
4/15/2003	217.96	41.8	51.7	16	656
4/16/2003	191.56	45.7	52.4	7	663
4/17/2003	179.27	45.1	51.4	7	670
4/18/2003	169.92	45	52.4	3	673
4/19/2003	156.41	43.6	53.3	11	684
4/20/2003	152.26	45.5	56.2	4	688
4/21/2003	162.12	51.5	54.4	9	697
4/22/2003	195.58	50.2	55.2	15	712
4/23/2003	198.89	47.4	58.7	14	726
4/24/2003	223.81	48.1	54.5	8	734
4/25/2003	259.6	43.9	52.1	9	743
4/26/2003	250.8	45.1	51.7	6	749
4/27/2003	234.4	42.5	50.7	5	754

4/28/2003	221.83	43.8	50.2	5	759
4/29/2003	239.95	42.1	54.1	21	780
4/30/2003	208.29	45.5	52.5	8	788
5/1/2003	192.54	45.5	57.2	3	791
5/2/2003	187.69	48	56.2	2	793
5/3/2003	188.99	50.6	58.7	6	799
5/4/2003	210.78	49.4	54.2	n/a	799
5/5/2003	206.21	45.4	53.2	7	806
5/6/2003	189.06	45.6	52.1	8	814
5/7/2003	179.35	45.8	52.1	8	822
5/8/2003	173.15	45.7	51.9	8	830
5/9/2003	164.21	46.3	55.2	5	835
5/10/2003	158.31	48.9	55.4	3	838
5/11/2003	201.84	48.6	56.4	3	841
5/12/2003	206.76	50.4	59.4	3	844
5/13/2003	187.52	48.8	62.2	n/a	844
5/14/2003	184.79	52.7	64	1	845
5/15/2003	196.64	54.4	63	3	848
5/16/2003	201.47	49.2	59.2	6	854
5/17/2003	213.29	46.9	54.6	n/a	854
5/18/2003	200.3	44	56.5	8	862

Figure 1–21. Daily catch of redband trout collected from Beulah Reservoir screw trap, 2003.



Appendix F: Salmonid Counts and Stream Conditions for Beulah Reservoir Fish Weir, 2003

Table 1-5. Redband and Whitefish counts for Beulah Reservoir fish weir and stream conditions, 2003.

	Ave. Daily	Water Temperature		Redband		Whitefish	
Date	**Flow** (cfs)	**Min.** (°F)	**Max.** (°F)	**Daily**	**Cum.**	**Daily**	**Cum.**
10/8/2003	42.76	55.4	61.8	0	0	0	0
10/9/2003	44.2	54.7	59.8	0	0	1	1
10/10/2003	46.52	49.8	55.8	0	0	0	1
10/11/2003	47.01	46.9	51.9	0	0	0	1
10/12/2003	50.93	47.3	52.6	0	0	0	1
10/13/2003	50.04	45.8	51.9	0	0	0	1
10/14/2003	48.77	47.8	52.1	0	0	0	1
10/15/2003	49.07	46.1	50.4	0	0	1	2
10/16/2003	51.29	47	53	0	0	1	3
10/17/2003	49.06	48.7	55.3	0	0	0	3
10/18/2003	47.87	49	54.8	0	0	0	3
10/19/2003	46.94	48.8	55	0	0	0	3
10/20/2003	46.69	50.6	54.9	0	0	0	3
10/21/2003	43.05	51	57.5	0	0	1	4
10/22/2003	41.46	50.4	55.7	0	0	1	5
10/23/2003	41.27	50.6	54.7	1	1	4	9
10/24/2003	41.26	45.9	51.6	0	1	4	13
10/25/2003	41.27	43.5	48.9	0	1	1	14
10/26/2003	41.35	44	50.2	0	1	2	16
10/27/2003	41.61	45.3	51	0	1	1	17
10/28/2003	41.27	48.1	54.5	0	1	2	19
10/29/2003	42.01	47.3	53.6	0	1	2	21
10/30/2003	42.71	42	47.3	0	1	5	26
10/31/2003	41.73	39.2	43	0	1	9	35
11/1/2003	34.92	36.4	40.3	1	2	7	42
11/2/2003	43.64	35.9	39	n/a	2	n/a	42
11/3/2003	46.1	37.1	40.1	0	2	0	42
11/4/2003	40.92	35.5	39.2	n/a	2	n/a	42
11/5/2003	43.68	36.2	40.7	n/a	2	n/a	42
11/6/2003	39.2	35.1	38.8	n/a	2	n/a	42
11/7/2003	41.3	34.8	39.2	n/a	2	n/a	42
11/8/2003	51.56	36.4	41.8	n/a	2	n/a	42
11/9/2003	44.66	37.1	40.8	n/a	2	n/a	42

11/10/2003	44.27	39.5	44.2	n/a	2	n/a	42
11/11/2003	44.19	41.3	46	n/a	2	n/a	42
11/12/2003	44.14	38.7	44	n/a	2	n/a	42
11/13/2003	40.73	35.2	41.3	0	2	0	42
11/14/2003	40.19	34	39.5	n/a	2	n/a	42
11/15/2003	45.99	38.3	42.7	n/a	2	n/a	42
11/16/2003	45.37	40.4	42.5	n/a	2	n/a	42
11/17/2003	46.51	38.2	42.4	n/a	2	n/a	42
11/18/2003	43.96	41.7	46.2	0	2	0	42
11/19/2003	44.11	40.5	45	0	2	1	43
11/20/2003	43.49	37.4	43.1	0	2	0	43
11/21/2003	39.42	34	37.5	0	2	0	43
11/22/2003	64.88	33.7	35	0	2	0	43

Appendix G. Daily Catch of Salmonids Collected at Crane Crossing Screw Trap, 2003.

Figure 1–22. Daily catch of redband trout collected from Crane Crossing screw trap, 2003

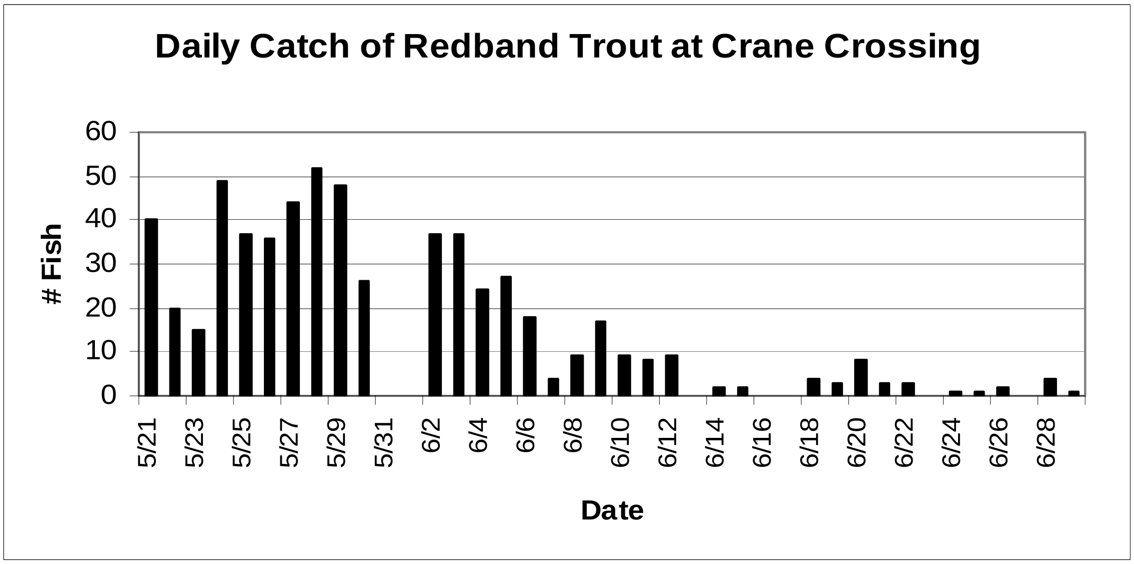
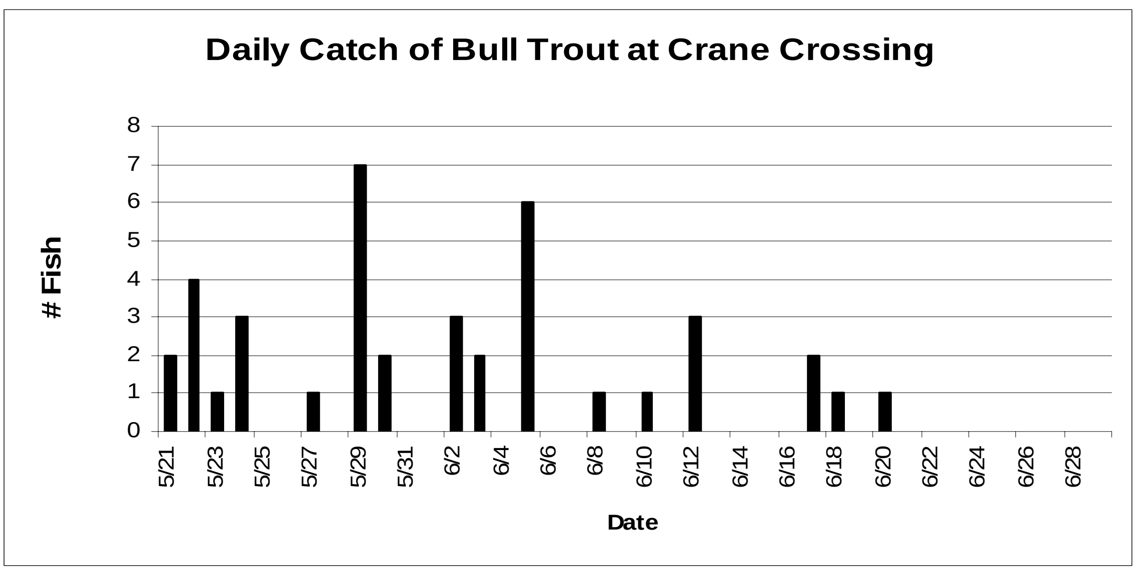


Figure 1–23. Daily catch of bull trout collected from Crane Crossing screw trap, 2003.



Appendix H. Observation of Radio-tagged Bull Trout in the North Fork Malheur River, Oregon. 2003.

Figure 1–24. Movement of Bull Trout released on 05-22-03 in the North Fork Malheur River

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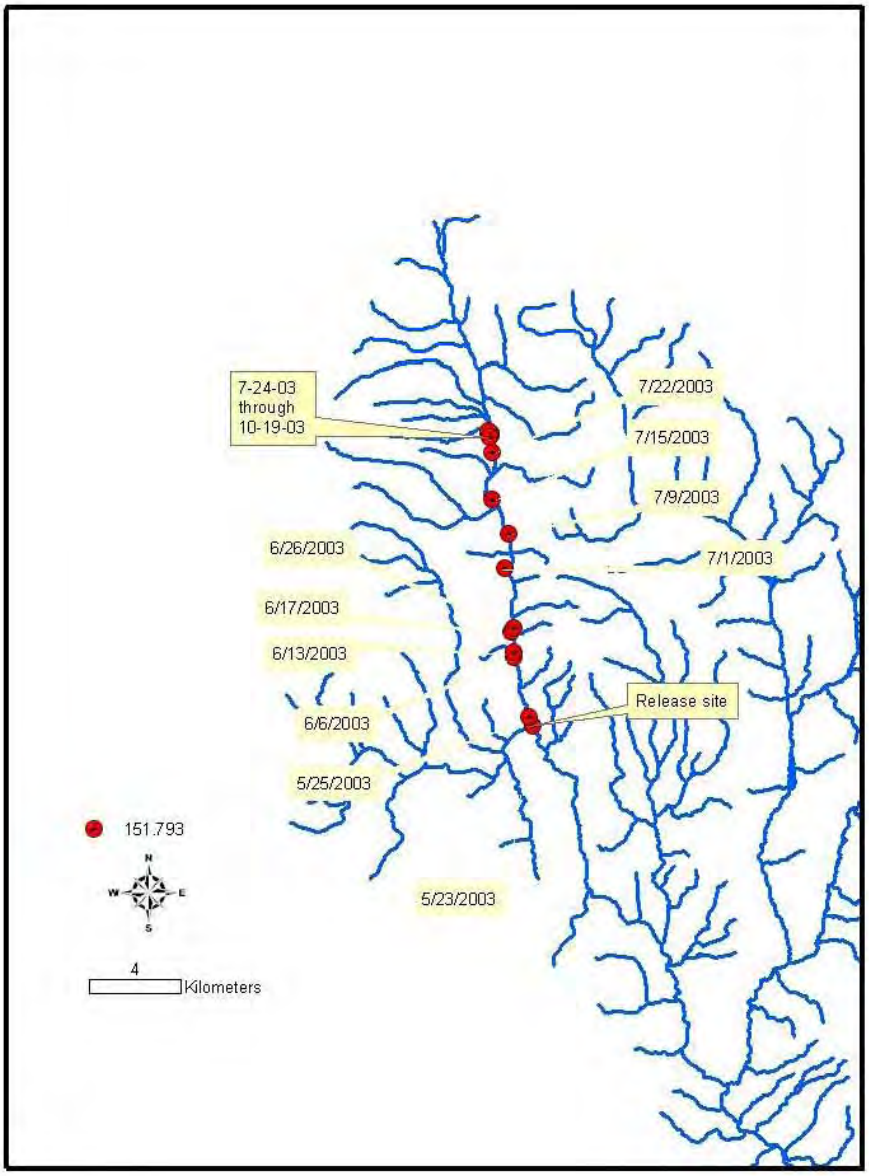


Figure 1–25. Movement of Bull Trout released on 05-22-03 in the North Fork Malheur River.

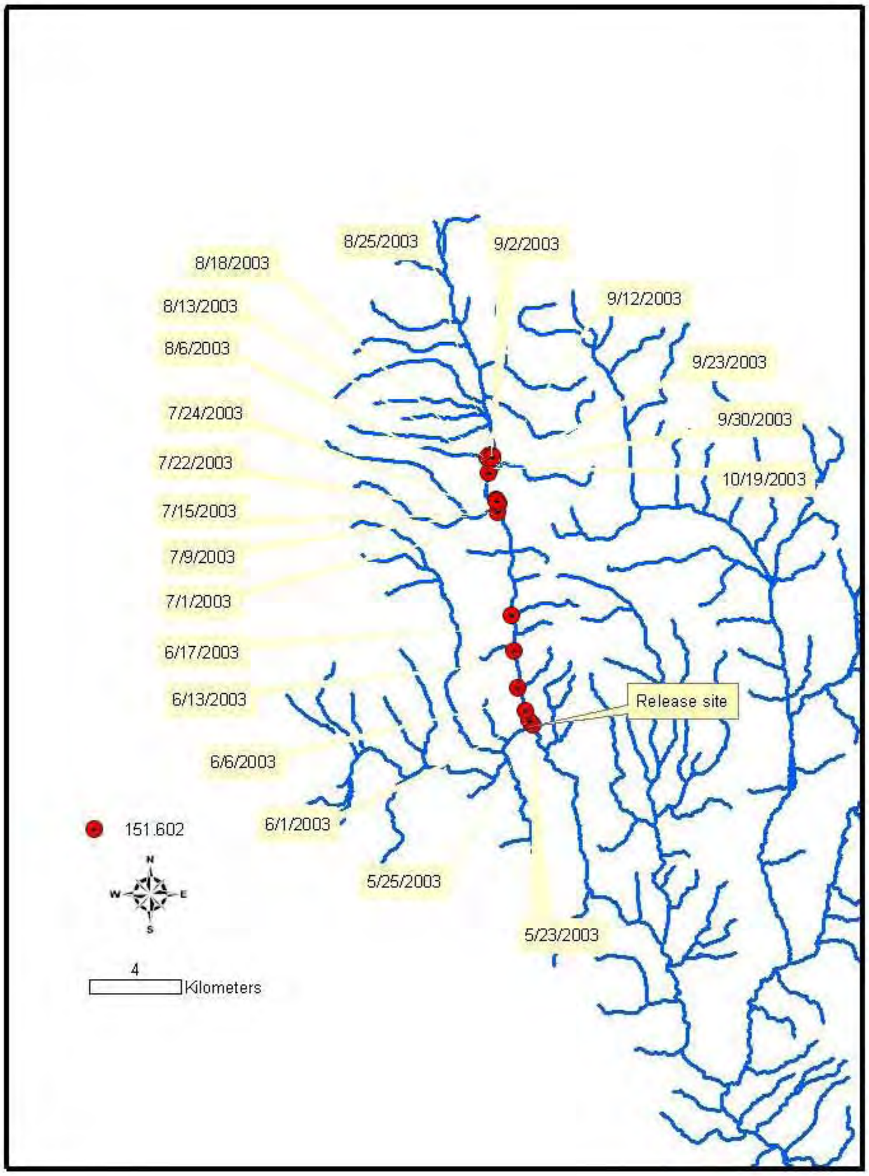


Figure 1–26. Movement of Bull Trout released on 05-23-03 in the North Fork Malheur River.

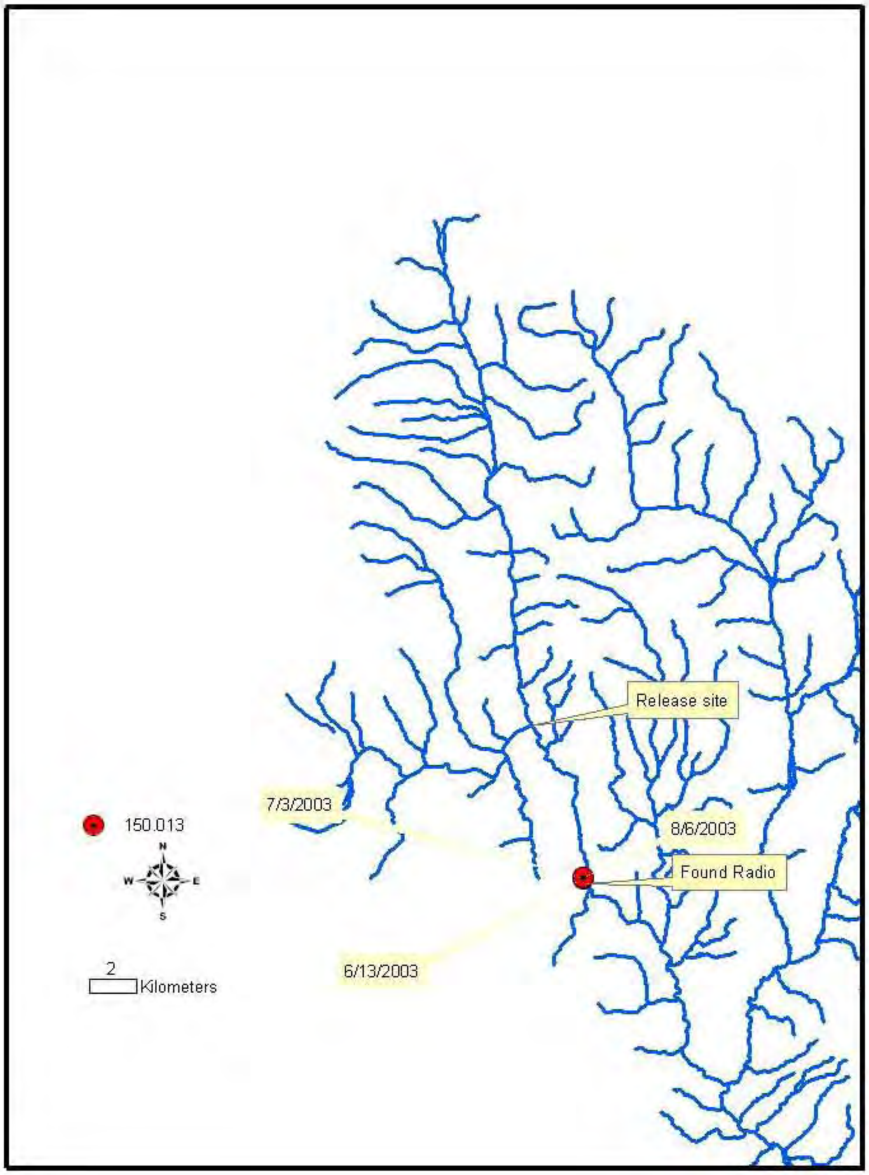


Figure 1–27. Movement of Bull Trout released on 05-29-03 in the North Fork Malheur River.

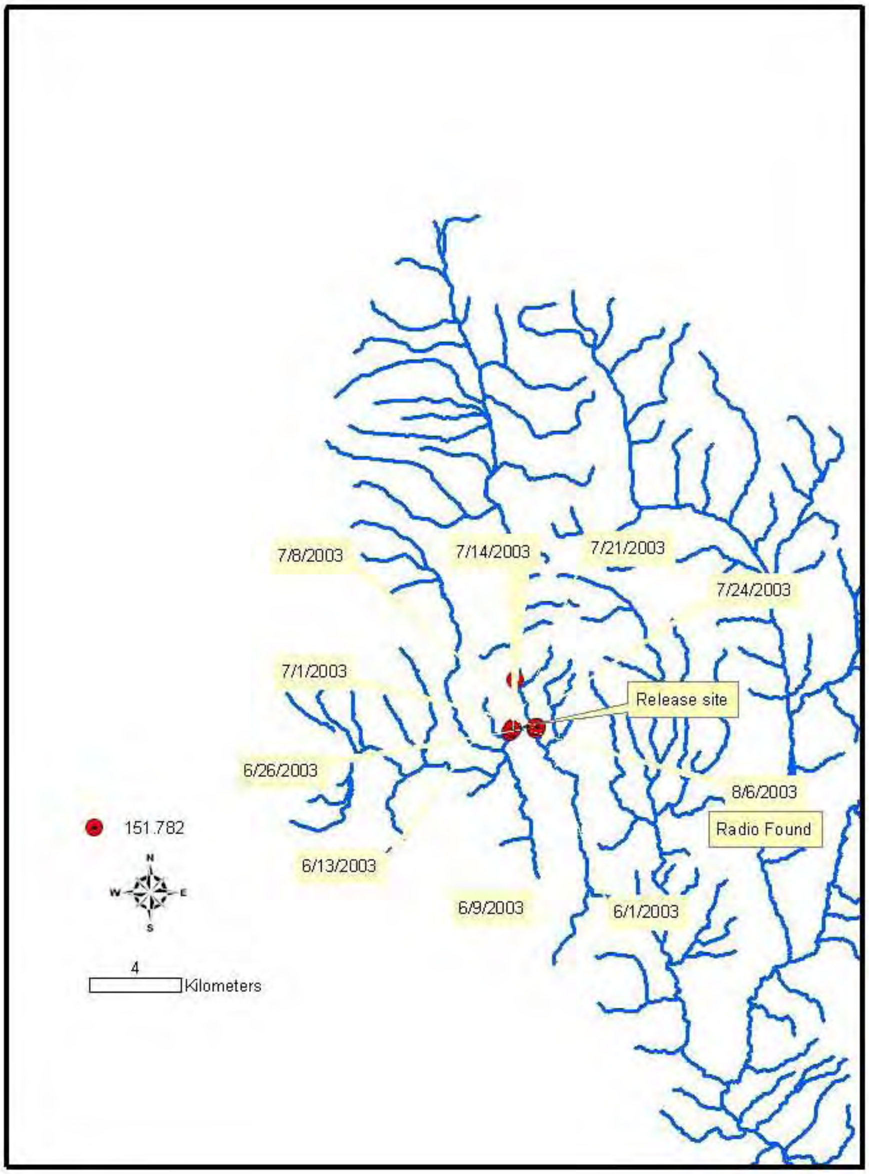


Figure 1–28. Movement of Bull Trout released on 05-29-03 in the North Fork Malheur River.

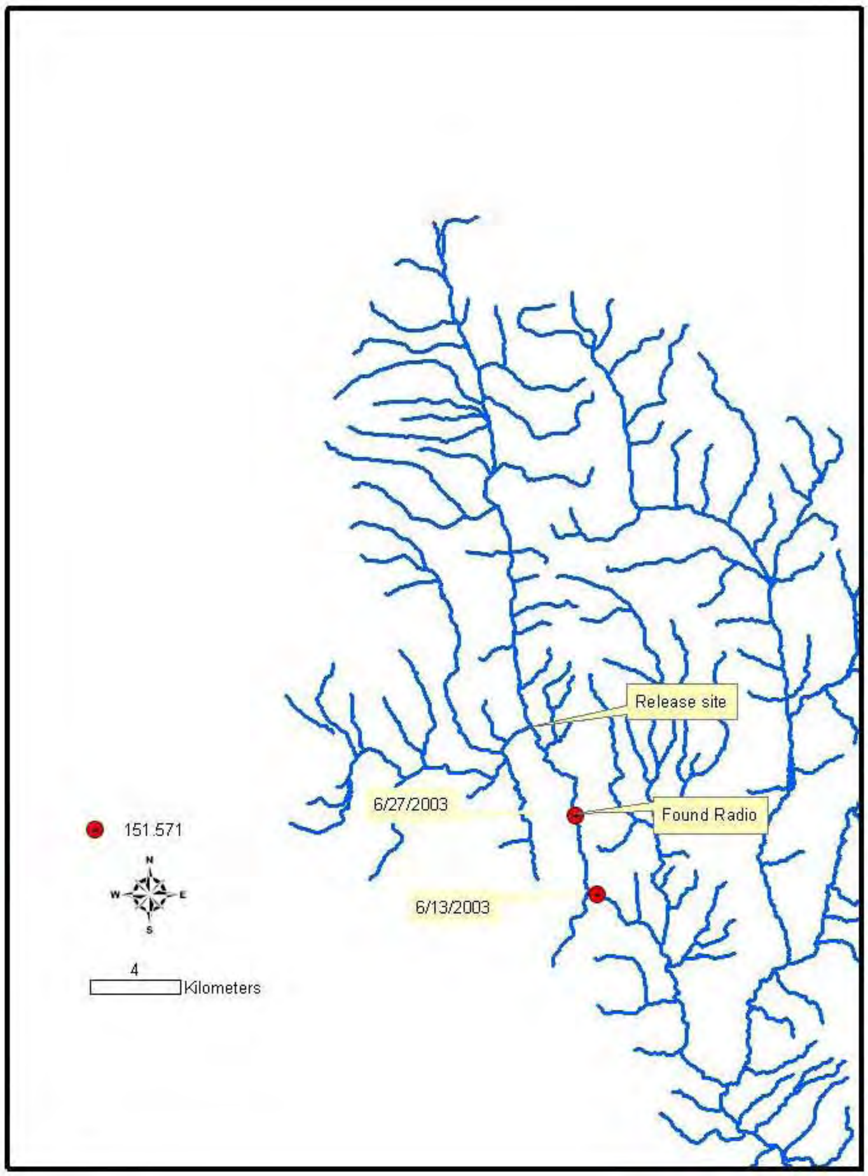


Figure 1–29. Movement of Bull Trout released on 05-30-03 in the North Fork Malheur River.

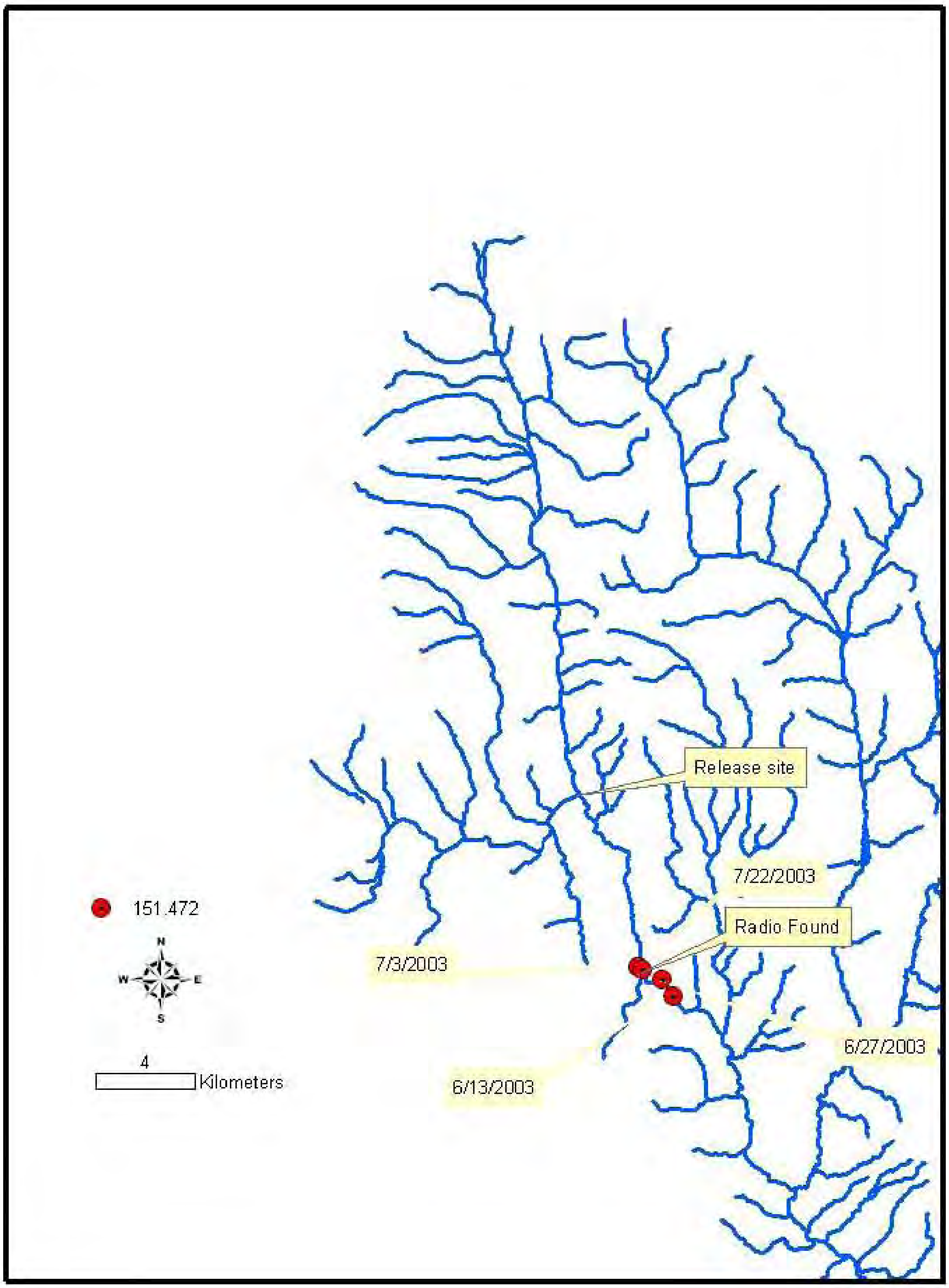


Figure 1–30. Movement of Bull Trout released on 06-02-03 in the North Fork Malheur River.

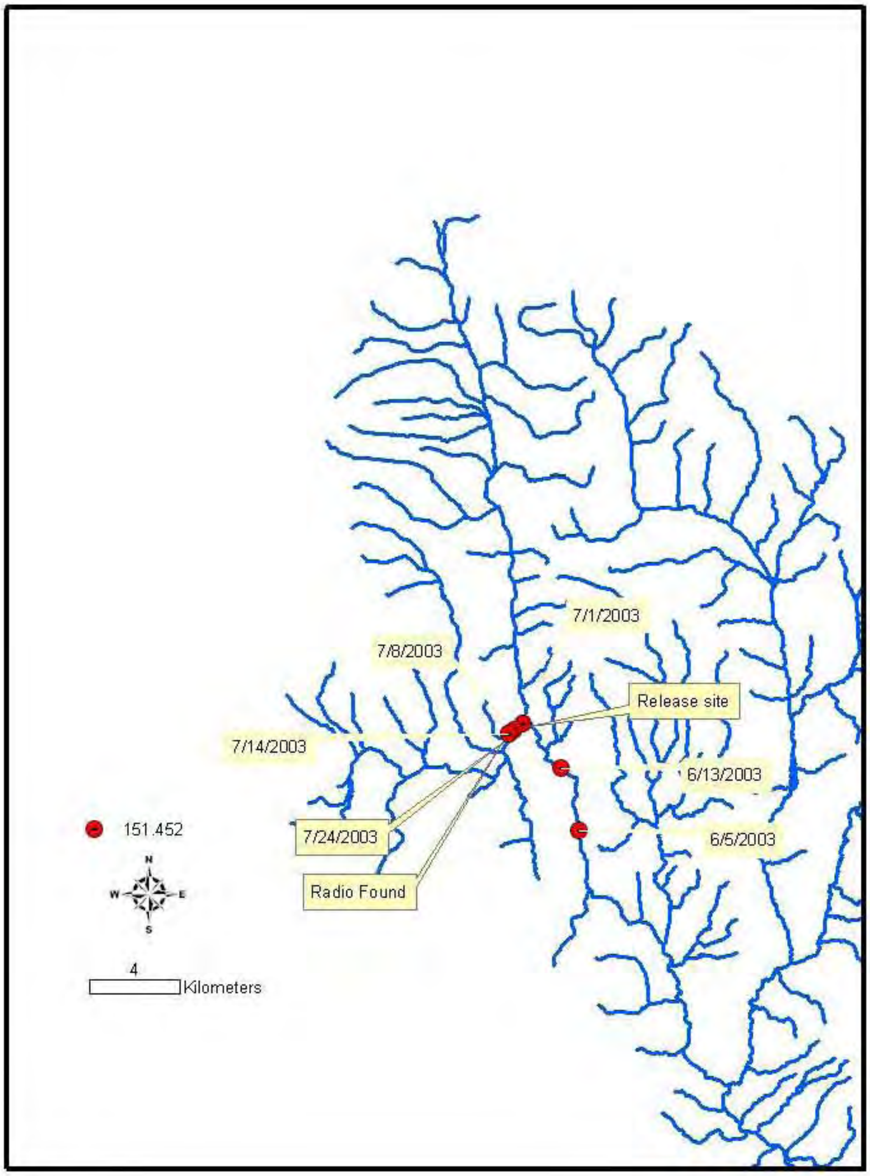


Figure 1–31. Movement of Bull Trout released on 06-03-03 in the North Fork Malheur River.

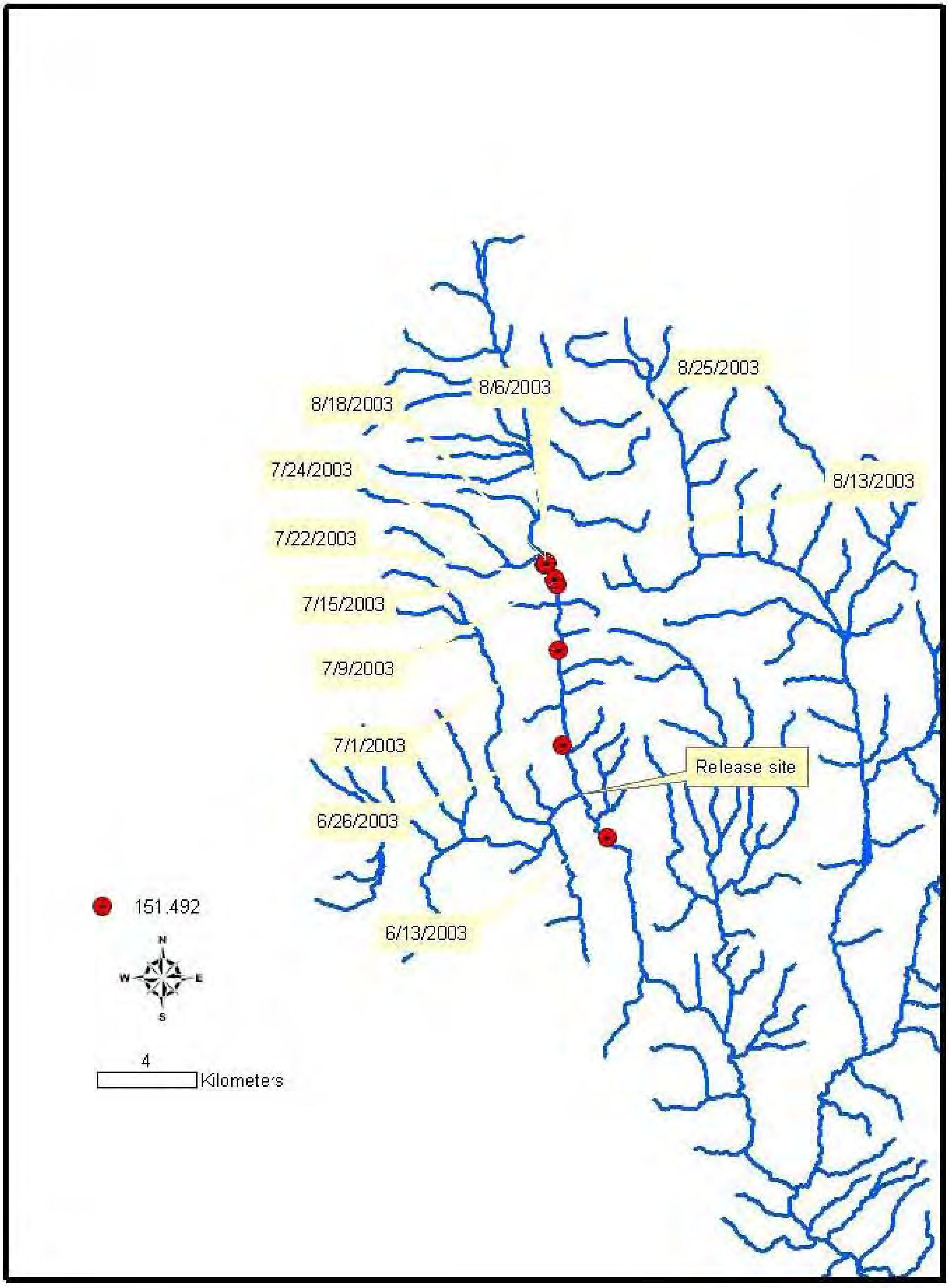


Figure 1–32. Movement of Bull Trout released on 06-05-03 in the North Fork Malheur River.

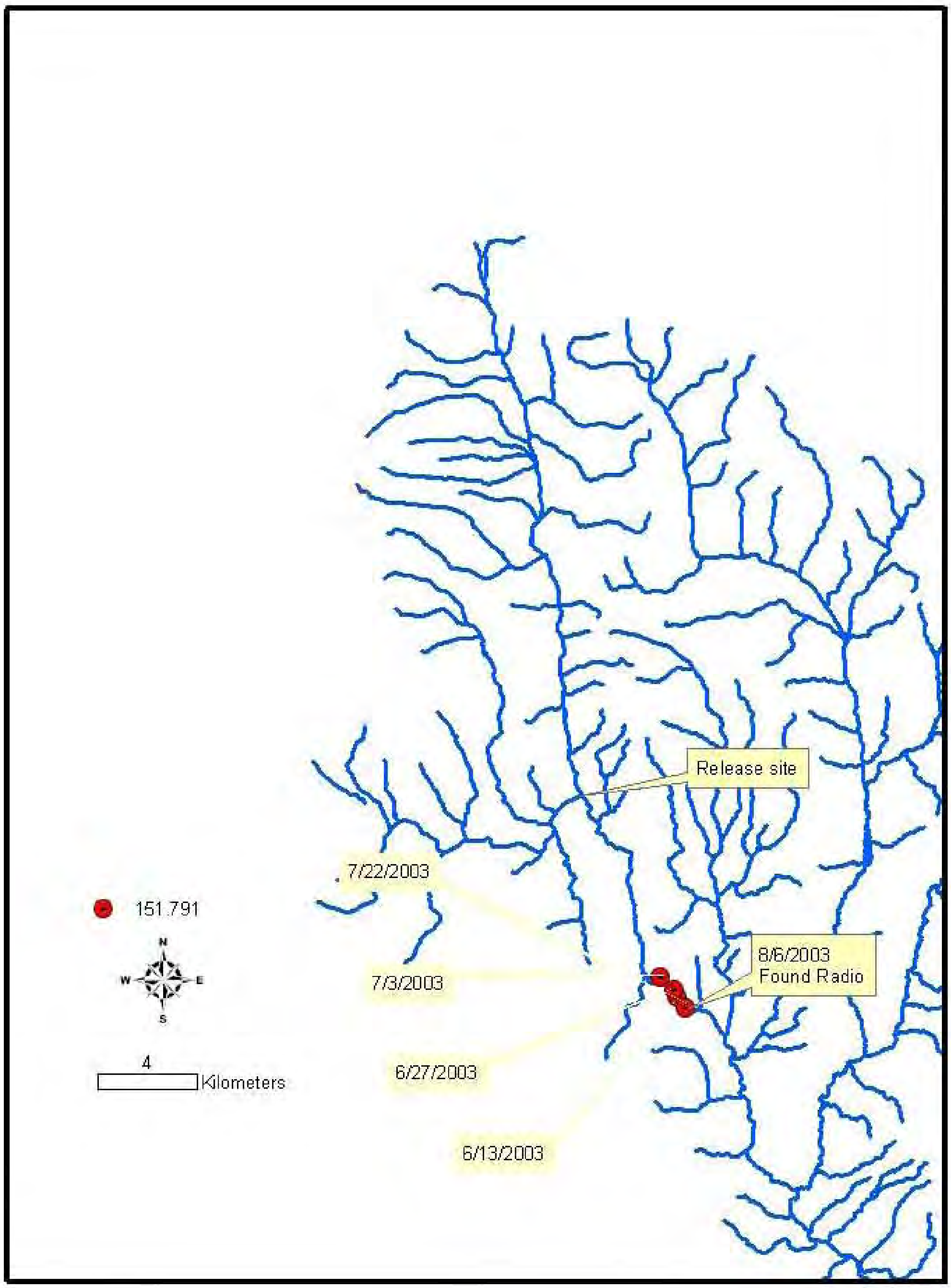


Figure 1–33. Movement of Bull Trout released on 06-05-03 in the North Fork Malheur River.

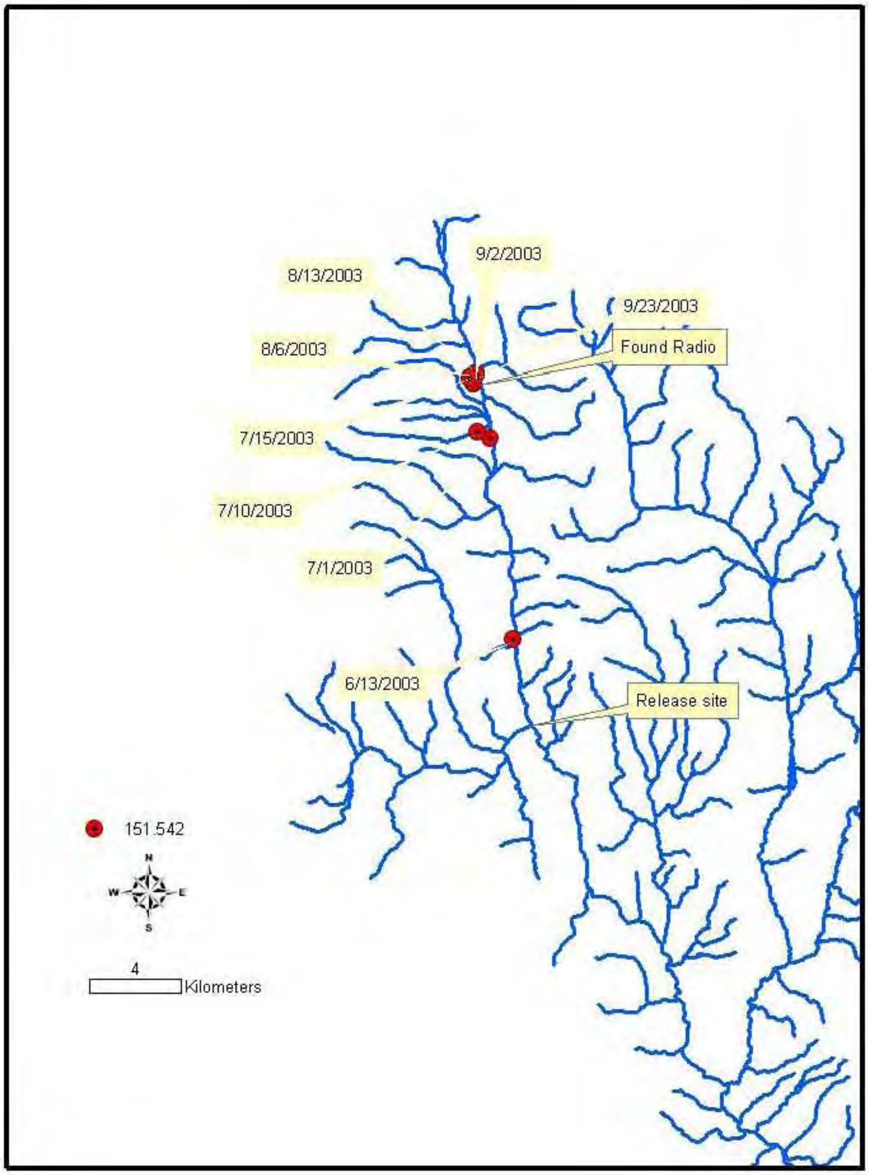
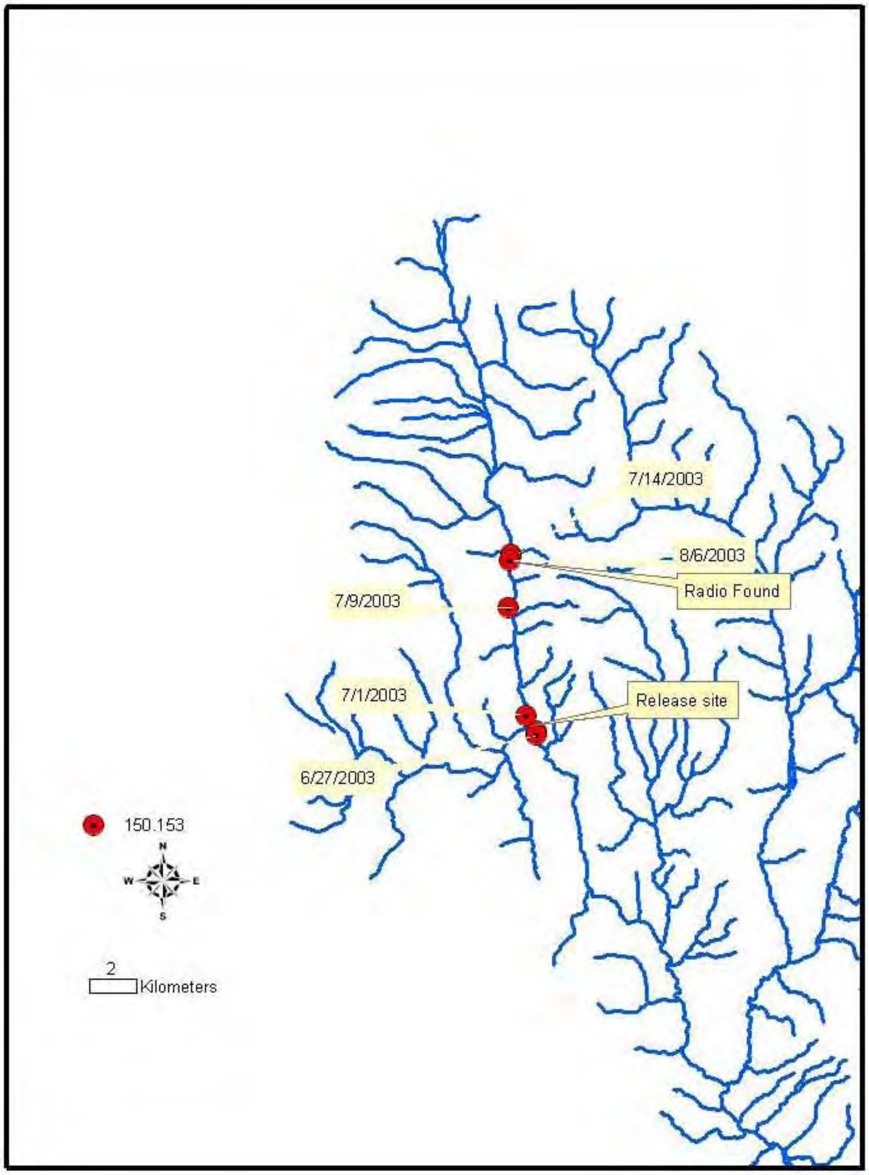


Figure 1–34. Movement of Bull Trout released on 05-23-03 in the North Fork Malheur River.



2.

USE OF A BACKPACK ELECTROFISHER TO DETERMINE THE DISTRIBUTION OF BROOK TROUT (*SALVELINUS FONTINALIS*), BULL TROUT (*SALVELINUS CONFLUENTUS*), AND POTENTIAL HYBRIDS OF BROOK AND BULL TROUT IN LAKE CREEK AND MEADOW FORK BIG CREEK, OREGON.

by Kevin Fenn & Lawrence Schwabe,

Fish and Wildlife Department,

Burns Paiute Tribe, Burns, OR

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Chapter 2 USE OF A BACKPACK ELECTROFISHER TO DETERMINE THE DISTRIBUTION OF BROOK TROUT (*SALVELINUS FONTINALIS*), BULL TROUT (*SALVELINUS CONFLUENTUS*), AND POTENTIAL HYBRIDS OF BROOK AND BULL TROUT IN LAKE CREEK AND MEADOW FORK BIG CREEK, OREGON.

By Kevin Fenn and Lawrence Schwabe
Fish and Wildlife Department
Burns Paiute Tribe
Burns, OR.

2.1 Introduction

The headwaters of the upper Malheur River watershed are located on the south slope of the Strawberry Mountains, approximately 200 river miles (RM) upstream from the Snake River. The source of Lake Creek is High Lake and a variety of springs. Lake Creek merges with Big Creek in Logan Valley at RM 190 to form the upper Malheur River. Big Creek is fed by Snowshoe Creek, Coral Basin Creek, and Meadow Fork Big Creek (Meadow Fork). The source of Meadow Fork is Mud Lake and Little Mud Lake. Meadow Fork's confluence with Big Creek is at RM 8. Big Creek, Snowshoe Creek, and Coral Basin Creek are all spring-fed.

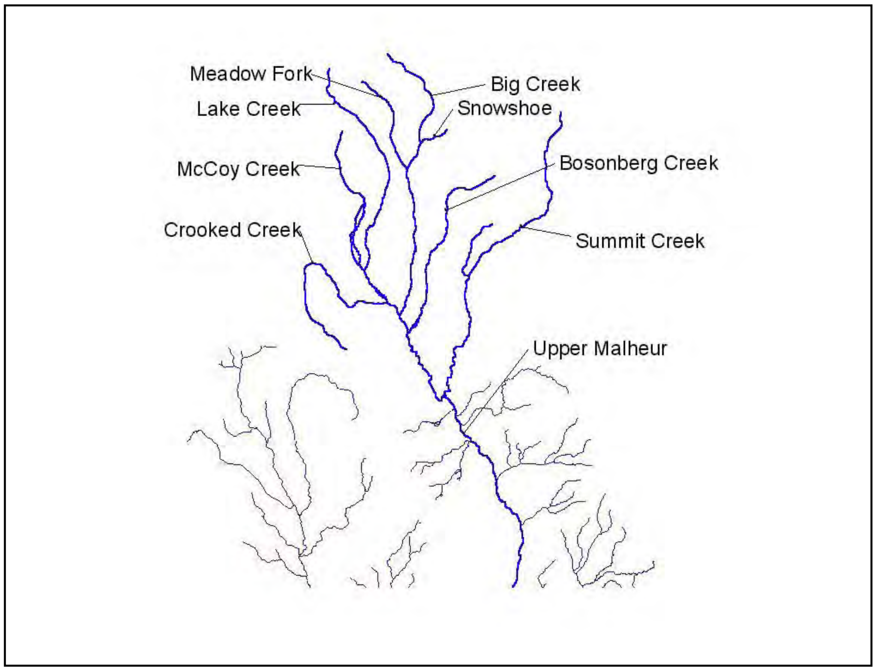


Figure 2–1. Headwater tributaries of the Upper Malheur. Meadow Fork and Lake Creek are shown and are the areas surveyed in 2003.

Bull trout populations have been declining throughout their range (Howell and Buchanan 1992, Kostow 1995) and have been classified at "high risk" of extinction in the Upper Malheur watershed (Buchanan et al. 1997). Bull trout in the Columbia Basin were listed as threatened on June 10, 1998 by the U.S. Fish and Wildlife Service (FR 1998). Current distribution of bull trout in the

Upper Malheur watershed is limited to Lake Creek, Big Creek, the upper Malheur River, and tributaries to Lake and Big Creeks (Bowers et al. 1993; Buckman et al. 1992). Factors leading to the decline of bull trout include land management practices, construction of dams, fish eradication projects, and introduction of non-native species.

The upper Malheur River was surveyed by ODFW in 1982, 1989, and 1993-94. The surveys were limited to a few sample sites but found that distribution of bull trout is limited to Lake Creek, Big Creek, and tributaries of Lake and Big Creeks. Meadow Fork is a historic stronghold for bull trout and is the only stream on the upper Malheur River where bull trout outnumber brook trout (Buckman et al. 1992) and where bull trout observations dominate during spawning surveys (Perkins and Tinniswood 2001). Currently, ODFW has a no size or bag limit for brook trout in the Malheur River subbasin in an effort to help facilitate the recovery of native trout populations.

Both Meadow Fork and Lake Creek have a waterfall barrier which defines the upper limits of bull trout. It is presumed by local fisheries managers that there are no fish species above the waterfall barrier on Meadow Fork. The Burns Paiute Fish and Wildlife Department evaluated fish distribution, for both areas in 2003, below the waterfall barriers.

2.2 Research Objectives

Objectives of research on Lake Creek and Meadow Fork were to:

- Determine distribution of bull trout and brook trout on Lake Creek and Meadow Fork Creek.
- Determine the potential for competition and hybridization between bull trout and brook trout present.

The focus of this study was to determine the distribution of brook trout, bull trout, and potential hybrids on Lake Creek and Meadow Fork of the Upper Malheur watershed. Based on the distribution, the main goal was to determine the potential for competition and hybridization between bull trout and brook trout in the upper Malheur.

Tasks completed in 2003 include:

- Single pass distribution survey on Meadow Fork from its confluence with Big Creek to a major upstream waterfall barrier
- Single pass distribution survey on Lake Creek from Lake Creek Campground to a major upstream waterfall barrier.

2.3 Methods

Sampling on Lake Creek and Meadow Fork followed an identical protocol. Surveyors used a drag tape to measure 50 meters (164 feet) of wetted channel parallel to the bank for each site. Both the upper and lower boundaries of the sites were documented using a GPS (global positioning system) unit. Single passes consisted of electroshocking from the lower site boundary upstream to the upper site boundary. Block nets were not used in these surveys. The entire wetted channel was sampled. Fish were kept in buckets until electroshocking of each site had been completed. All salmonids were measured (fork length in millimeters, mm) and all other species were counted. Brook trout captured were sexually identified if mature.

Fish were collected using a “Smith & Root” electrofisher. Shocking the stream involved three to six individuals. One person operated the shocker, one to two individuals used dip nets to capture fish, and the remaining crew would process the fish when each site was completed. Pelvic fin clips were taken from fish that were identified as bull trout, brook trout, or bull/brook hybrids for genetic sampling. Hybrids were identified by unusual markings that can pertain to both brook trout and bull trout (for example, dorsal spotting, vermiculations on back but a clear dorsal fin, or back spotting with vermiculations on dorsal fin). Photographs of these fish were taken for visual documentation and comparison.

In 2003, Sampling on Meadow Fork started on July 7 and was completed on July 17. The survey started at the Meadow Fork /Big Creek confluence and proceeded upstream ending at the waterfall barrier. Sampling on lower Lake Creek started on July 22 and was completed on August 7. The survey was broken up into three sections: from Lake Creek Trailhead to Lake Creek Waterfall; from Forest Road 1648 to Lake Creek Trailhead; and from Lake Creek Campground to Forest Road 1648. These sections were surveyed in the order listed.

2.4 Results – Meadow Fork Big Creek

On Meadow Fork Big Creek, 5400 meters of linear stream length were surveyed with a total of 108 sample sites. **Brook trout** were collected in 20 of the sites with a total of 29 brook trout captured (Figure 2-2). The last brook trout was collected at site 50 located 2500 m above the confluence with Big Creek, approximately 1 km above the trailhead at an elevation of 5950 feet (Figure 2-36 in Appendix B). Brook trout sampled from Meadow Fork ranged from 71 mm to 209 mm and averaged 141 mm (Figure 2-3). There were 10 females, 7 males, and 12 unidentified brook trout.

Figure 2–2. Distribution of brook trout collected from Meadow Fork electroshocking distribution survey in 2003.

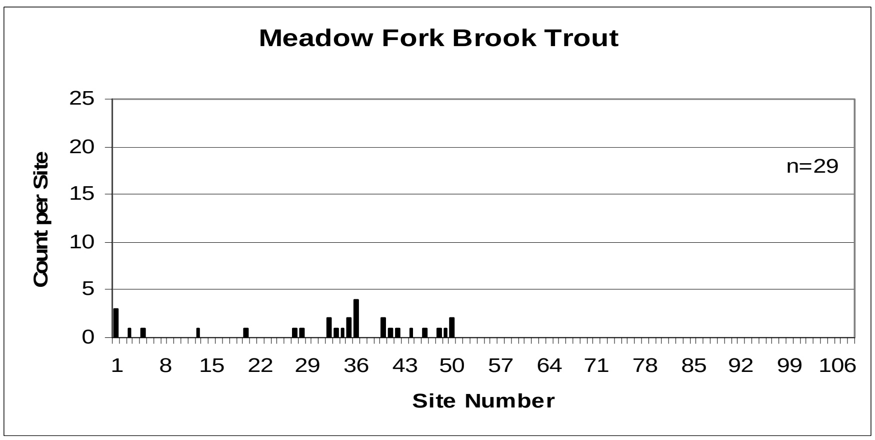
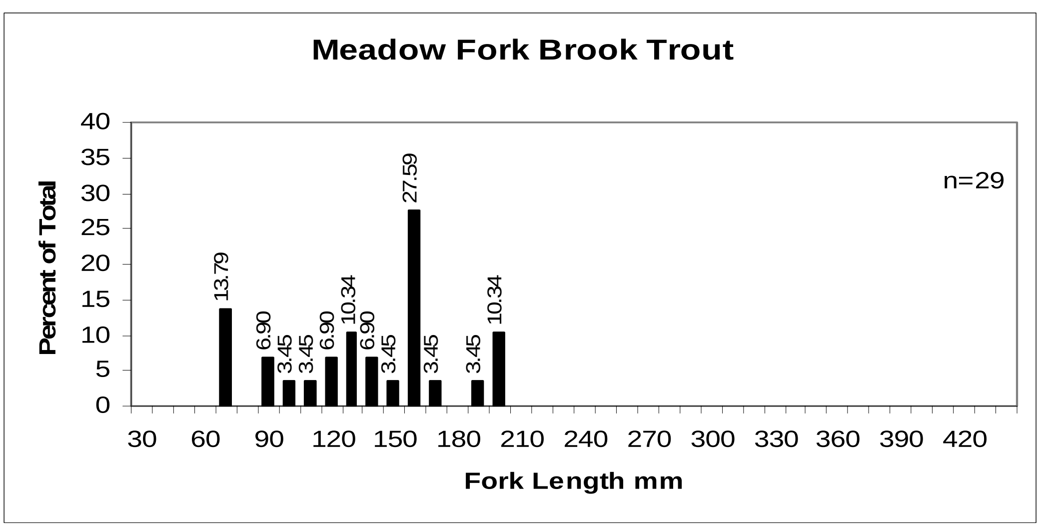


Figure 2–3. Brook trout length frequency from Meadow Fork electroshocking distribution survey in 2003.



Bull trout were found in 91 of the 108 sites surveyed (Figure 2-4). A total of 446 bull trout were captured in Meadow Fork. Bull trout were collected up to site 106, 100 m below the waterfall barrier (Figure 2-37, in Appendix B). Bull trout were not present in the last two sites sampled before the waterfall barrier. Bull trout captured from Meadow Fork ranged from 36 mm to 440 mm and averaged 148 mm (Figure 2-5). Bull trout were the most abundant fish species above site 26 and most relatively abundant salmonid species throughout Meadow Fork (Appendix A).

Figure 2–4. Distribution of bull trout collected from Meadow Fork electroshocking distribution survey in 2003.

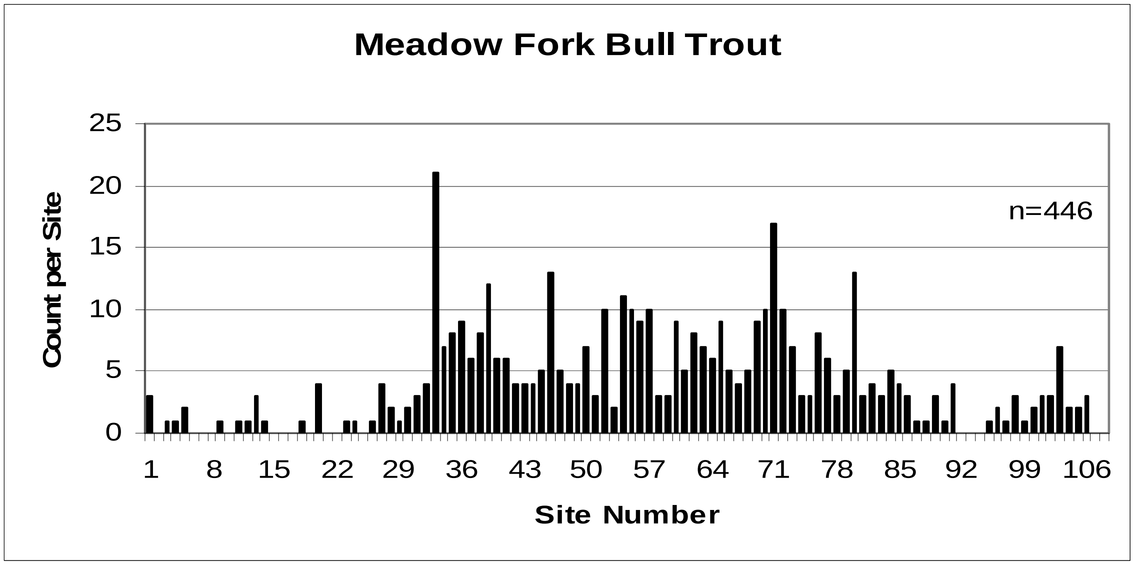
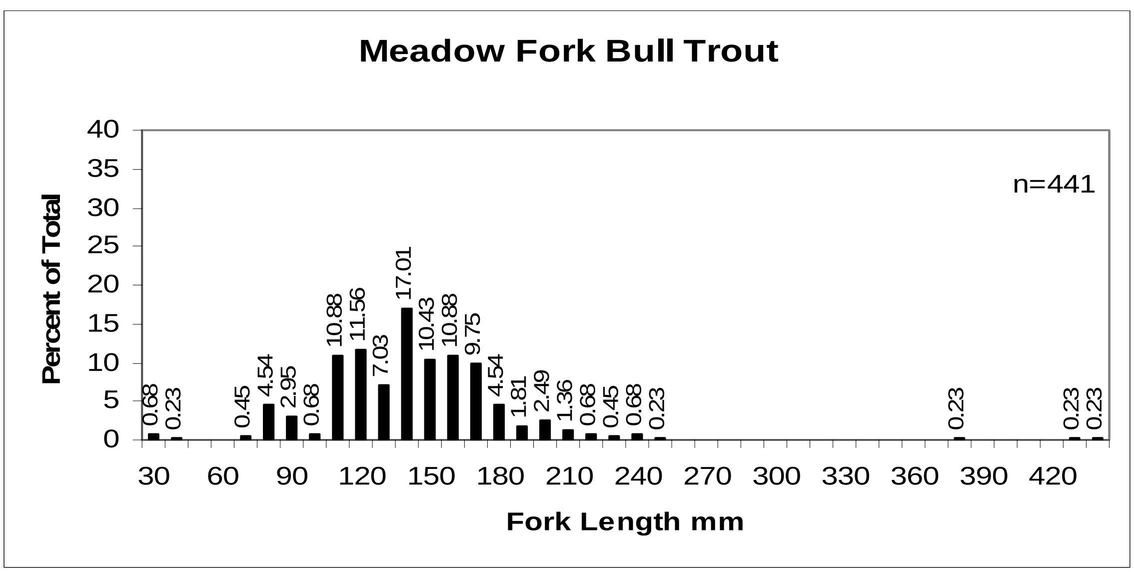


Figure 2–5. Bull trout length frequency from Meadow Fork electroshocking distribution survey in 2003.



Possible bull/brook trout hybrids were captured at seven of the 108 sites surveyed (Figure 2-6). A total of 11 possible hybrids were captured in Meadow Fork. Bull/brook hybrids were not collected above site 75, which is 1650 m below the waterfall barrier (Figure 2-38, in Appendix B). Hybrids from Meadow Fork ranged from 84 mm to 187 mm and averaged 121.6 mm (Figure 2-7).

Figure 2–6. Distribution of bull/brook trout hybrids collected from Meadow Fork electroshocking distribution survey in 2003.

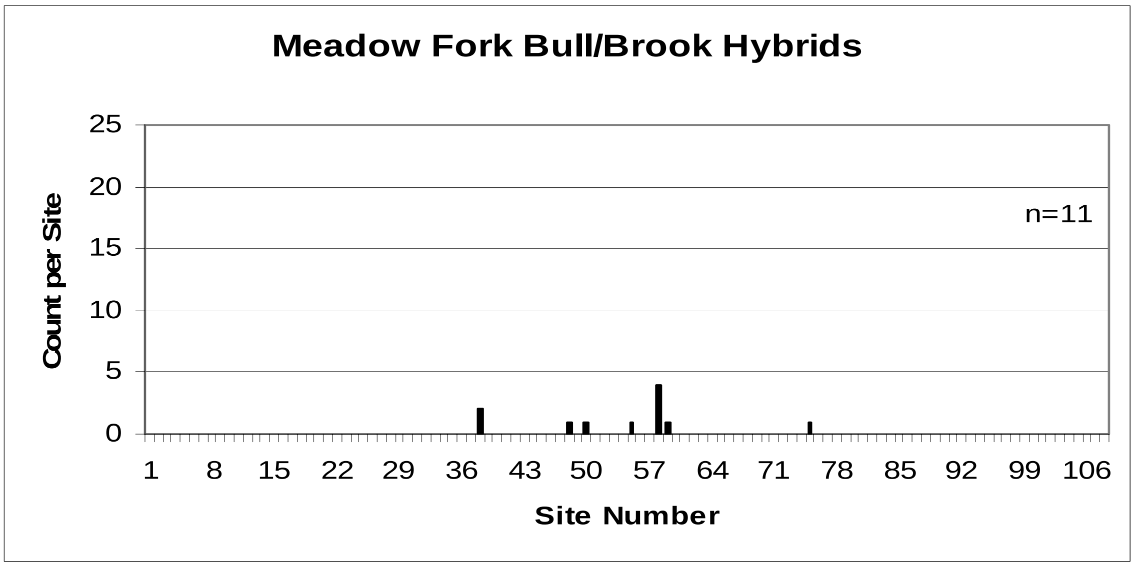
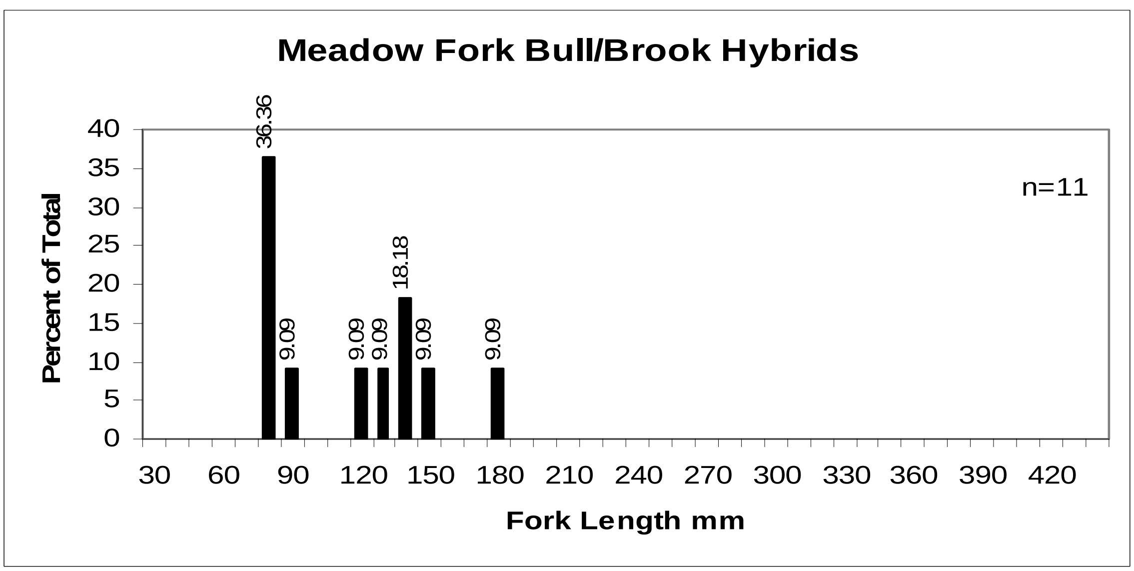


Figure 2–7. Brook/bull trout hybrid length frequency from Meadow Fork electroshocking distribution survey in 2003.



Redband trout (*Oncorhynchus mykiss)* were collected in eight of the 108 sites surveyed (Figure 2-8). A total of 15 redband trout were captured in Meadow Fork. Redband trout were not collected upstream of site 46, which is 3100 meters below the waterfall barrier. Redband trout on Meadow Fork ranged between from 39 mm to 177 mm and averaged 131.4 mm (Figure 2-9). Redband trout were the least relatively abundant salmonid throughout Meadow Fork (Appendix A).

Figure 2–8. Distribution of redband collected from Meadow Fork electroshocking distribution survey in 2003.

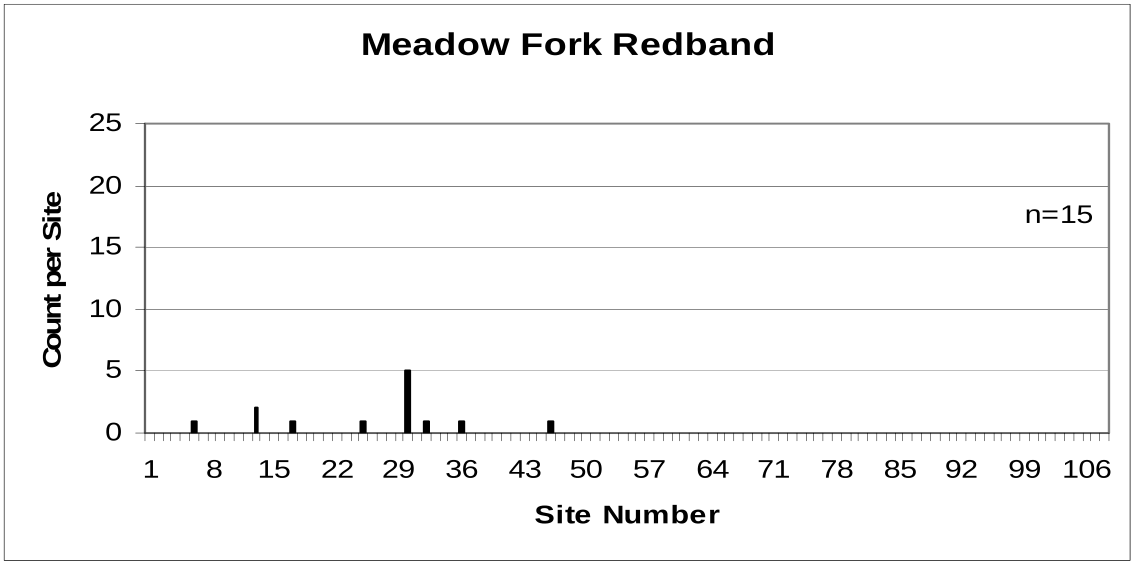
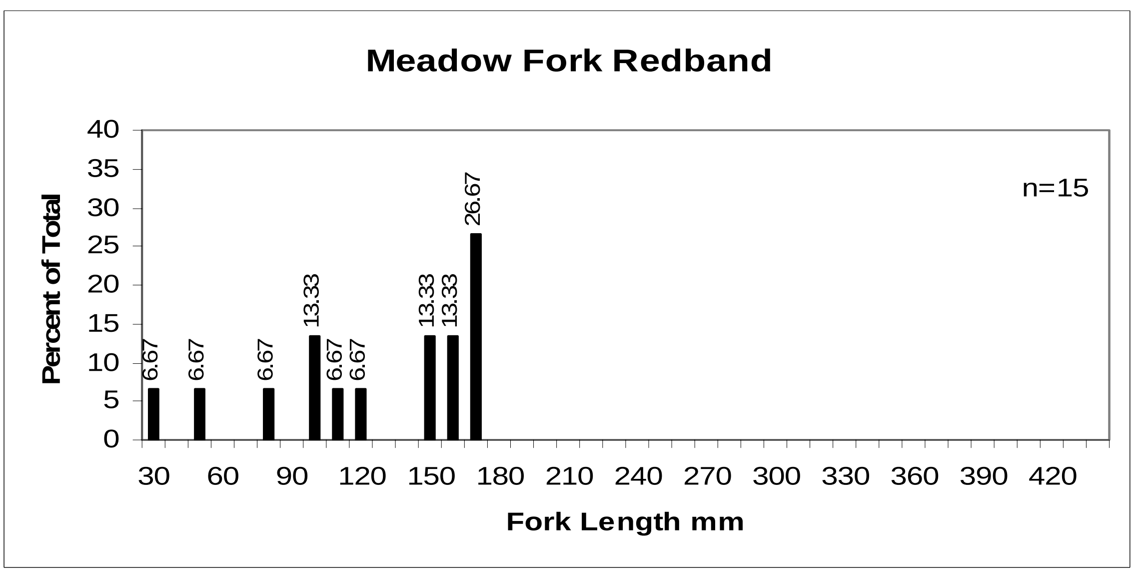
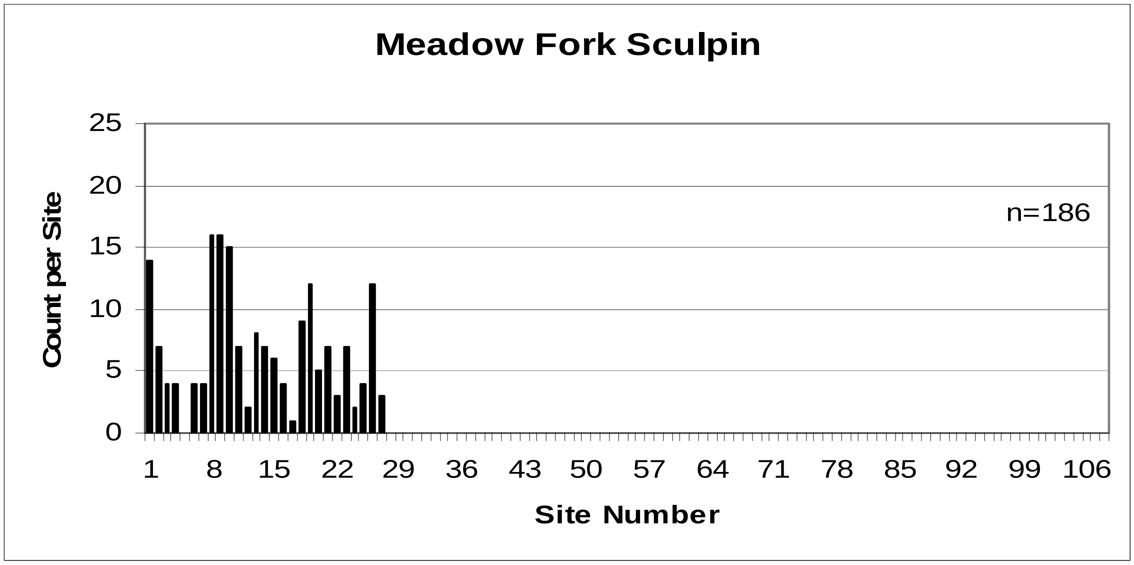


Figure 2–9. Redband trout length frequency from Meadow Fork electroshocking distribution survey in 2003



Sculpin (*Cottus spp*.) were observed in 26 of the 108 sites surveyed, with a total of 186 sculpin collected from these sites. Sculpin were collected from the lower 1320 meters of Meadow Fork Big Creek up to site 27. Sculpin were the most relatively abundant fish species in lower Meadow Fork (site 1 to site 27) (Appendix A).

Figure 2–10. Distribution of sculpin collected from Meadow Fork electroshocking distribution survey in 2003.

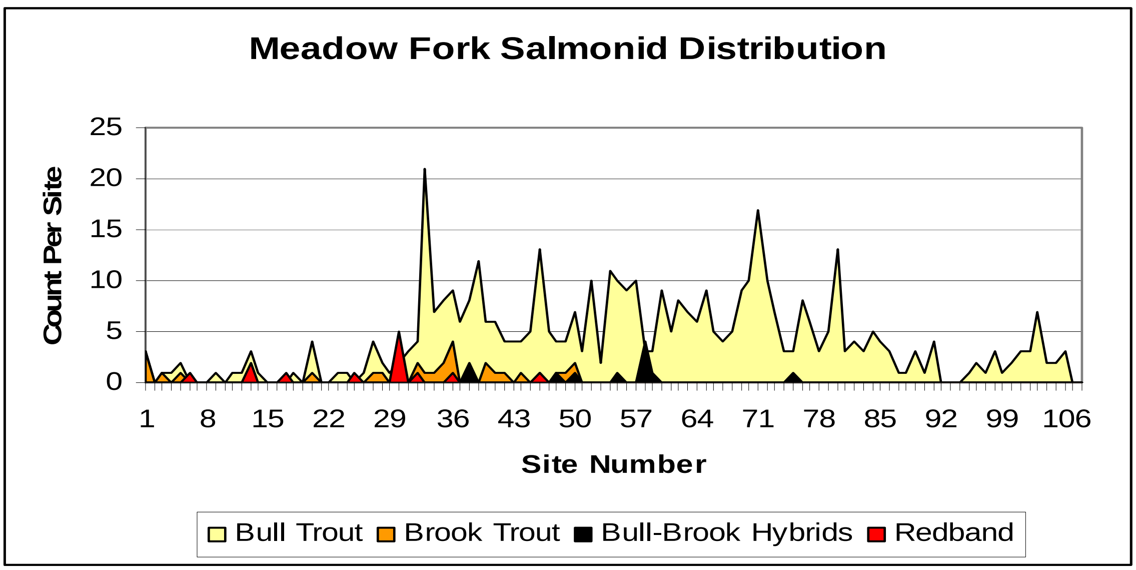


All salmonid species – A total of 108 sites were surveyed on Meadow Fork with fish present in all but five of those sites. A total of three salmonid species were identified and one cottid was identified to genus. Bull/brook hybrids were also identified in Meadow Fork. Bull trout were collected throughout Meadow Fork. Brook trout were only collected from the confluence to site 50. The ratio of bull trout to brook trout in the first 50 sites of Meadow Fork that bull trout and brook trout cohabit is 6:1; the ratio in the entirety of the area sampled in Meadow Fork Creek is 15:1.

Table 2-1. Fish species collected in each section surveyed from Meadow Fork electroshocking distribution survey in 2003

Species	Total	
Bull Trout	446	Ratio 15:1
Brook Trout	29	
Hybrids	11	
Redband	15	
Cottids	186	
Sites with no fish	5	

Figure 2–11. Trout distribution from Meadow Fork electroshocking distribution survey in 2003.



2.5 Results – Lake Creek

On Lake Creek, 8200 meters of lineal stream were surveyed with a total of 164 sample sites. A total of 511 **brook trout** were captured from 119 of the 164 sites (Figure 2-12). Brook trout were captured throughout the stream length of Lake Creek up to the waterfall barrier (Appendix B, Figure 2-37). Brook trout captured ranged from 40 mm to 296 mm fork length, and averaged 144 mm (Figure 2-13). Brook trout are the most relatively abundant fish species throughout the surveyed section of Lake Creek (Figure 2-40). Brook trout and an unidentified species of sculpin are the most relatively abundant fish species from site 1 through site 114 (Figure 2-35 in appendix A). There were 174 females, 226 males, and 111 unidentified brook trout.

Figure 2–12. Distribution of brook trout collected from Lake Creek electroshocking distribution survey in 2003.

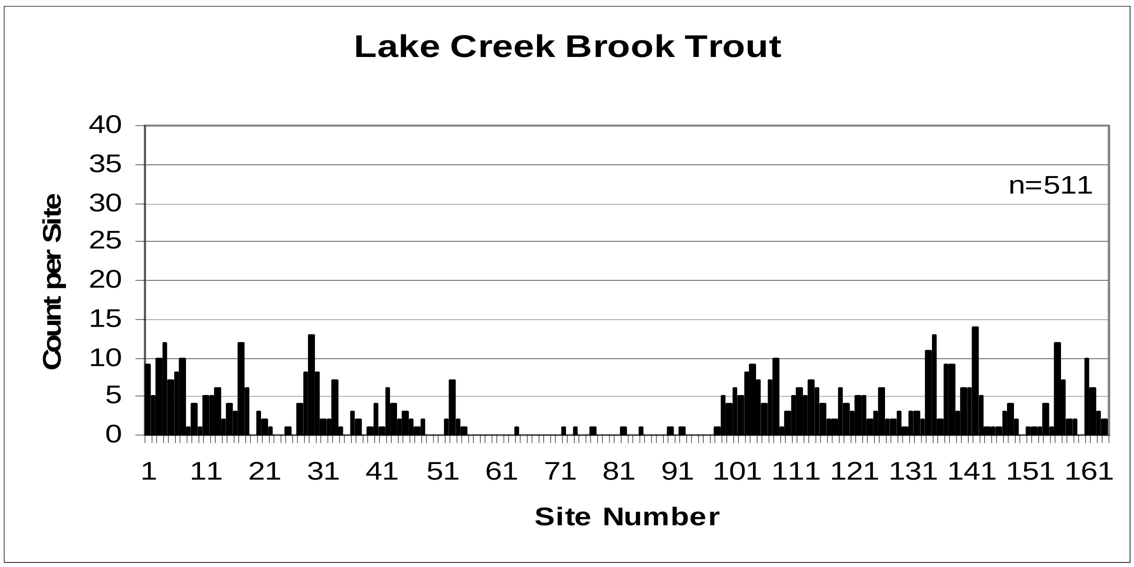


Figure 2–13. Brook trout length frequency from Lake Creek electroshocking distribution survey in 2003

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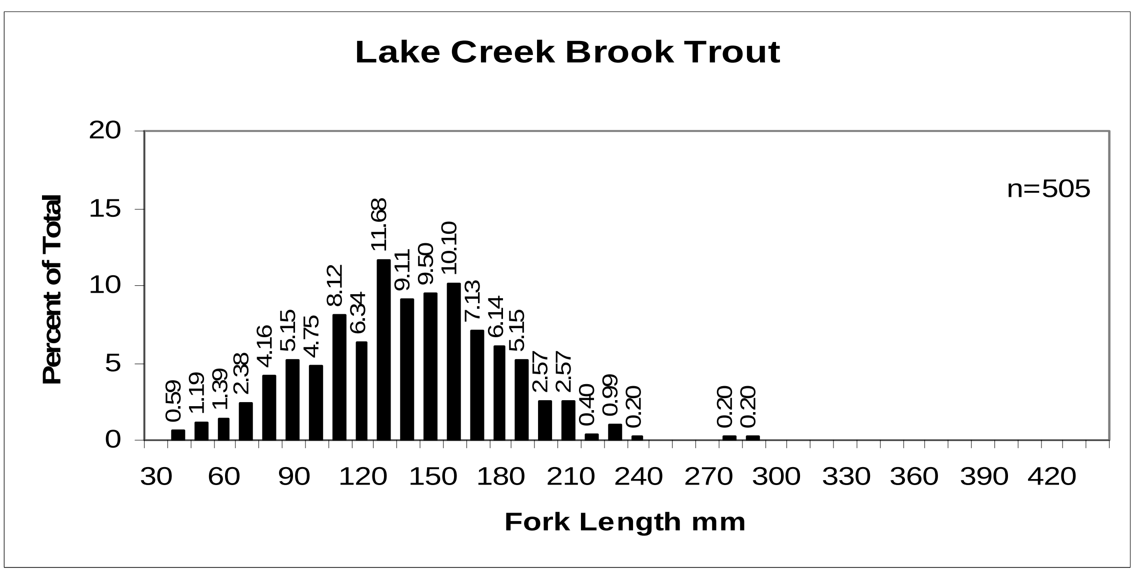


Bull trout were present in 28 of the 164 sites surveyed (Figure 2-14). A total of 67 bull trout were captured, all above the Lake Creek Trailhead. The first bull trout was collected at site 85, which is 4250 meters above Lake Creek Camp; the last bull trout was collected at site 152, which is 600 meters below the waterfall barrier (Figure 2-38 in appendix B). Bull trout captured ranged from 75 mm to 438 mm fork length, and averaged 162 mm (Figure 2-15). Three large bull trout were captured when shocking Lake Creek. All exceeded 400 mm fork length.

Figure 2–14. Distribution of bull trout collected from Lake Creek electroshocking distribution survey in 2003.

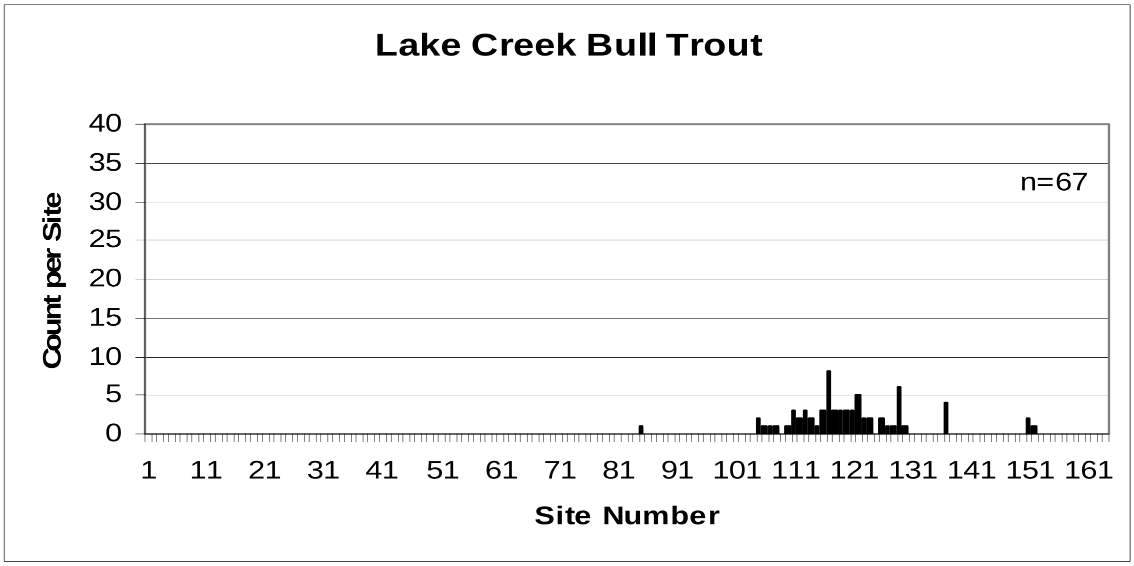
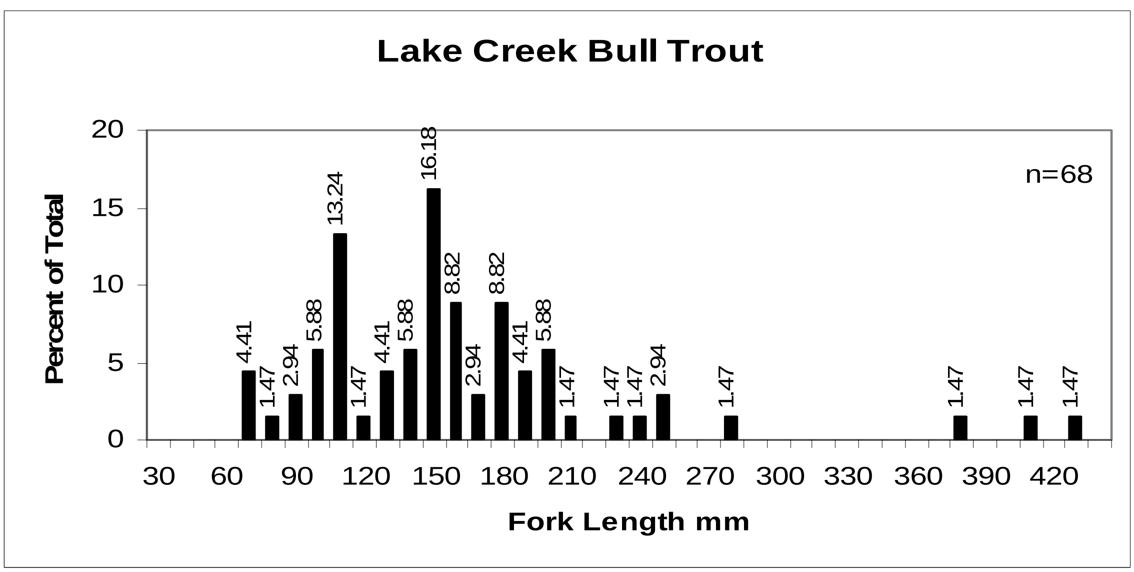


Figure 2–15. Bull trout length frequency from Lake Creek electroshocking distribution survey in 2003



Possible bull/brook trout hybrids were captured at 30 of the 164 sites surveyed (Figure 2-16). A total of 53 hybrids were captured, 50 of which occurred above the Lake Creek Trailhead. The first bull/brook hybrid was collected at site 57, 2850 m above Lake Creek Camp, and the last bull/brook hybrid was collected at site 163, 50 m below the waterfall barrier (Figure 2-39 in appendix B). Hybrids from Lake Creek ranged from 103 mm to 278 mm fork length, and averaged 171 mm (Figure 2-17).

Figure 2–16. Distribution of bull/brook trout hybrids collected from Lake Creek electroshocking distribution survey in 2003.

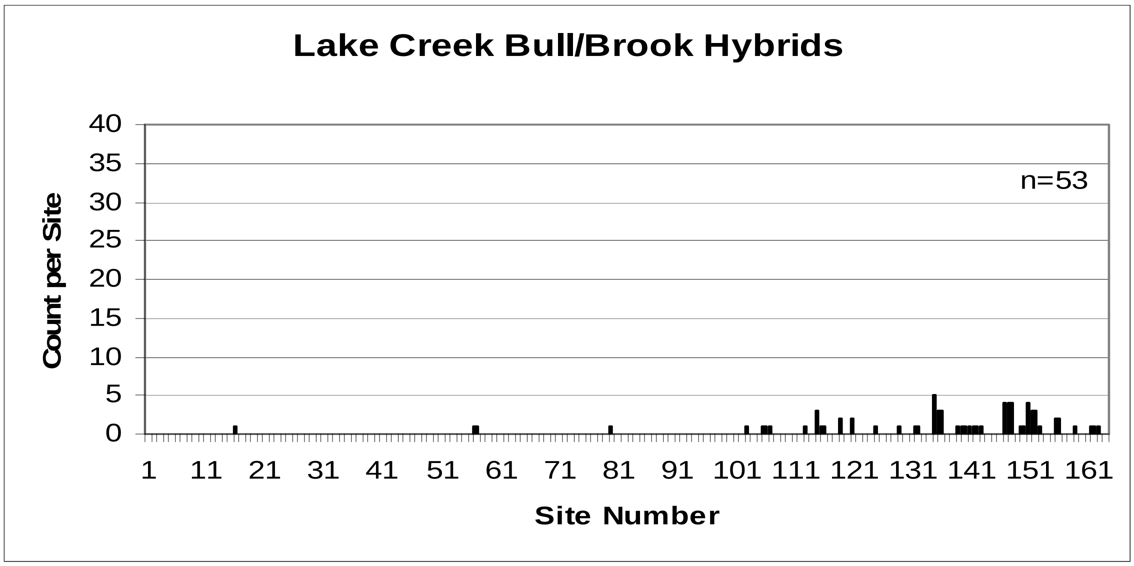
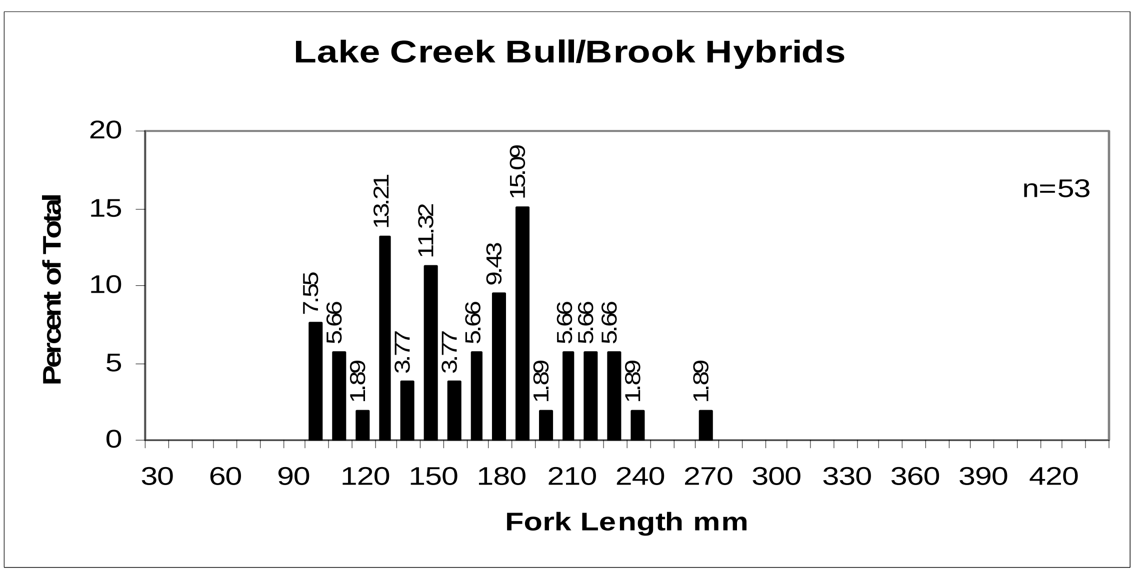


Figure 2–17. Bull/brook trout hybrid length frequency from Lake Creek electroshocking distribution survey in 2003.



A total of 34 **redband trout** were collected in 28 of the 164 sites surveyed (Figure 2-18). Redband trout in Lake Creek are distributed throughout the area sampled up to site 164, at the base of the waterfall barrier. Redband trout from Lake Creek range from 95 mm to 245 mm, and averaged 157 mm (Figure 2-19). Redband trout are the least relatively abundant salmonid throughout the surveyed length of Lake Creek (Figures 2-36 and 2-36).

Figure 2–18. Distribution of redband trout collected from Lake Creek electroshocking distribution survey in 2003.

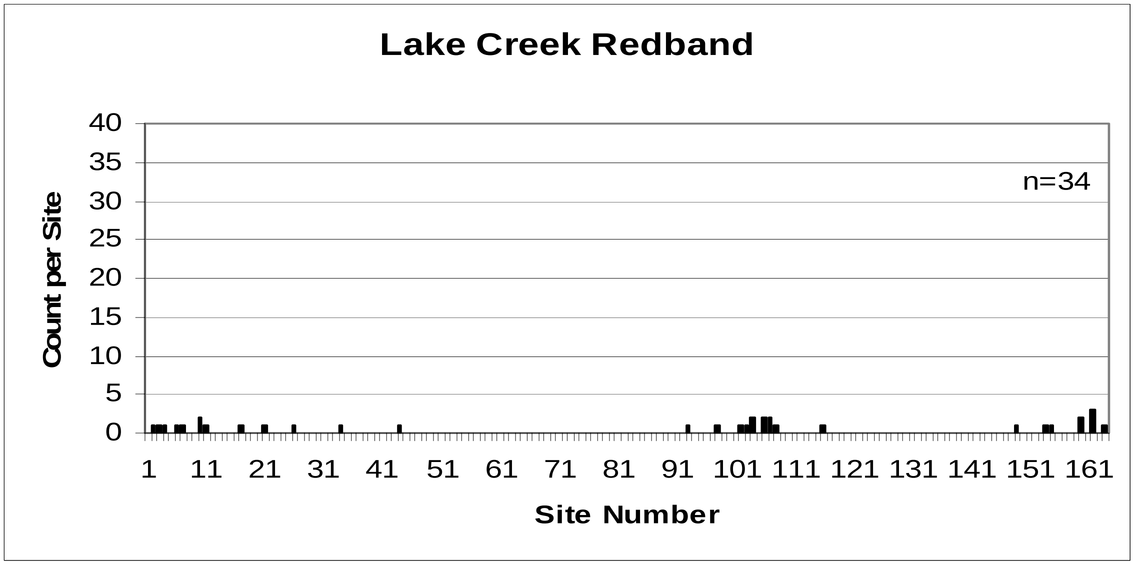
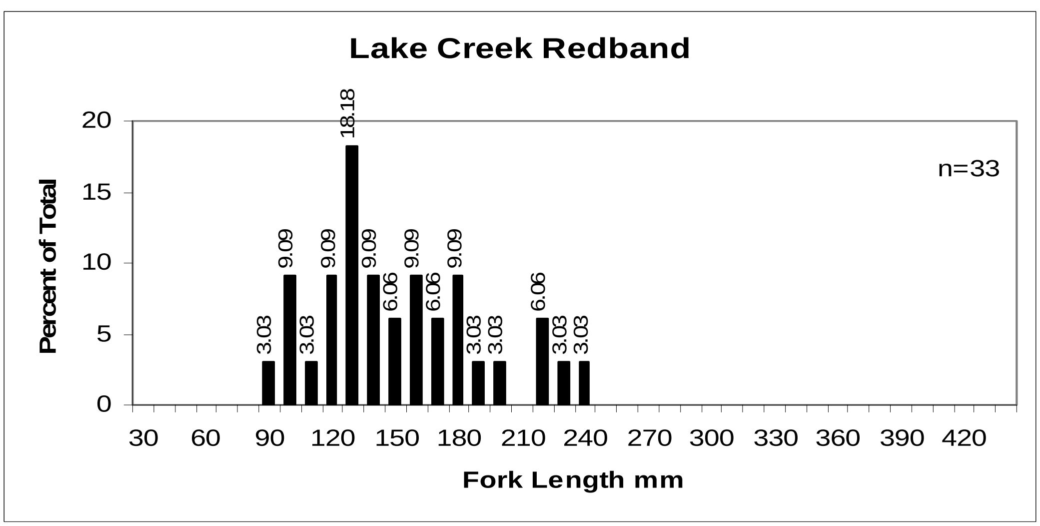
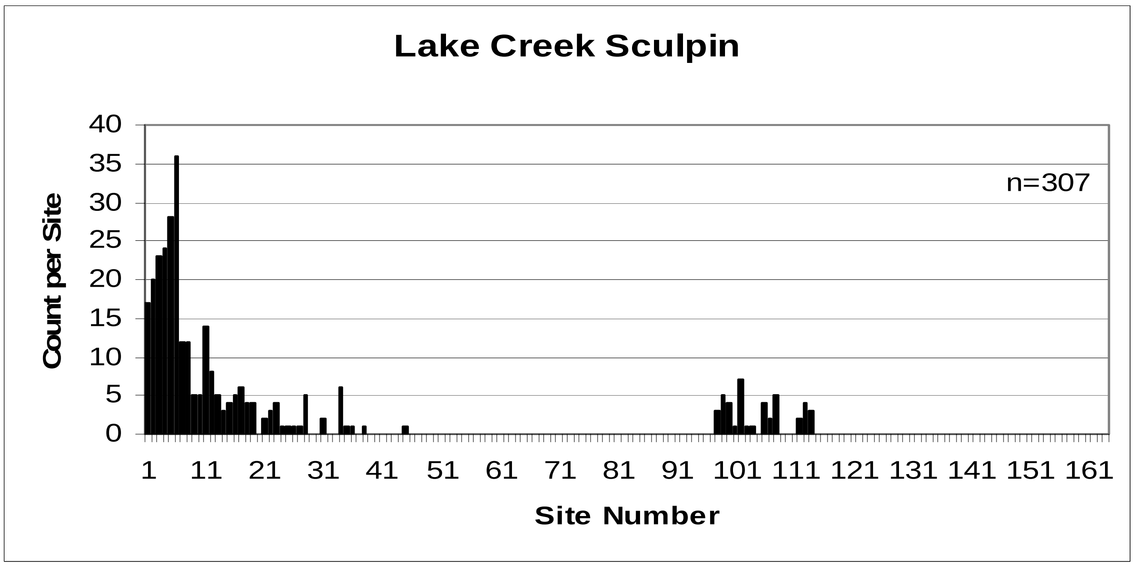


Figure 2–19. Redband trout length frequency from Lake Creek electroshocking distribution survey in 2003.



A total of 307 **unidentified species of sculpin** were collected from 47 of the 164 sites (Figure 2-20). Sculpin were collected from two main areas. Sculpin were collected from Lake Creek Camp to Forest Road 1648, and also a small section of stream above the 1648 and Lake Creek Trailhead. Sculpin were not collected above site 114, which is 2500 m below the waterfall barrier. Brook trout (46 percent) and sculpin (46 percent) are the most dominant fish species from site 1 through site 114 (Figure 2-35).

Figure 2–20. Distribution of sculpin collected from Lake Creek electroshocking distribution survey in 2003.



A total of 164 sites were surveyed on Lake Creek with fish collected in all but 34 of those sites. Sites with no fish were all between sites 49 and 97. A total of three salmonid species were identified and one cottid was identified to the genus taxonomic group. Bull/brook trout hybrids were also identified in Lake Creek. See Table 2-2.

Figure 2–21. Distribution of salmonids collected from Lake Creek electroshocking distribution survey in 2003.

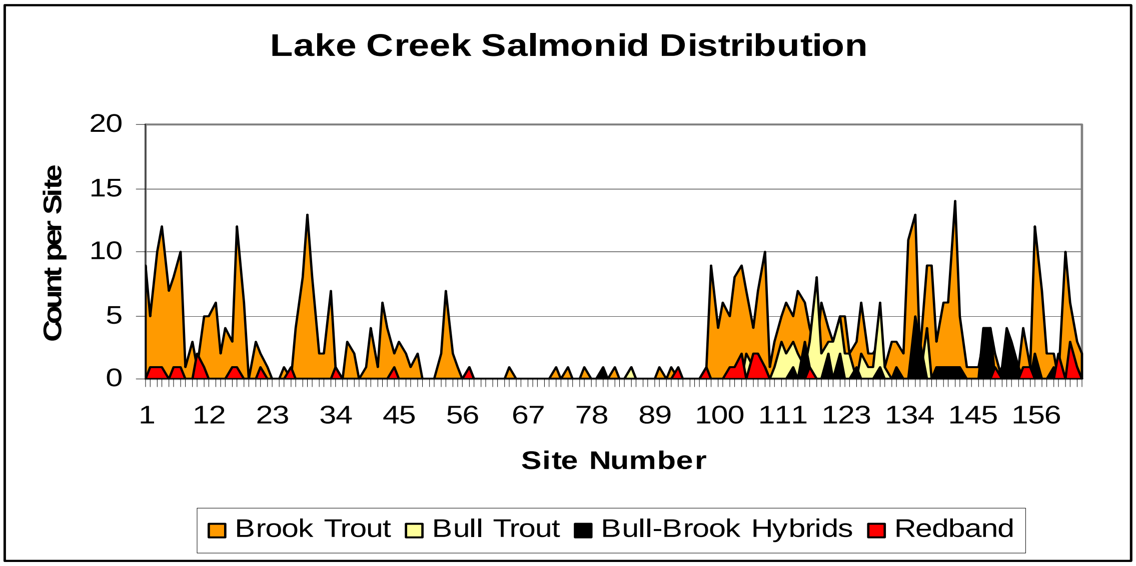


Table 2-2. Fish species collected in each section surveyed from Lake Creek electroshocking distribution survey in 2003

	Lake Creek Camp to Rd. 1648	**Lake Creek Rd. 1648 to trailhead**	**Lake Creek trailhead to falls**	**Totals**	
Dates sampled	Aug. 7	July 30- Aug. 6	July 22-July 29		
Bull Trout	0	0	67	67	Ratio 1:8
Brook Trout	113	97	301	511	
Hybrid	1	2	50	53	
Redband	10	4	20	34	
Cottids	246	25	36	307	
Sites with no fish	0	34	0	34	

2.6 Discussion

Objectives of research on Lake Creek and Meadow Fork were to:

- Determine distribution of bull trout and brook trout on Lake Creek and Meadow Fork Creek.
- Determine the potential for competition and hybridization between bull trout and brook trout present.

The 2003 survey on the Upper Malheur watershed has answered questions of salmonid distribution on Lake Creek and Meadow Fork. The data collected in 2003 suggests that bull trout are the dominant salmonid in Meadow Fork while brook trout are the dominant salmonid in Lake Creek. With bull trout having a stronghold in Meadow Fork but not in Lake Creek, it is important to understand the differences between these tributaries and what influences salmonid distribution. Understanding why bull trout thrive so well in Meadow Fork but not Lake Creek has critical management implications.

As supported by the results of electroshocking, bull trout are the dominant salmonid in Meadow Fork, and could possibly be the key for the recovery and sustainability of the bull trout population in the upper Malheur River drainage. A total of 108 sites were surveyed on Meadow Fork with fish present in all but five of those sites. Bull trout thrive throughout this stream, whereas redband and brook trout are only present in the lower half of Meadow Fork and only in limited numbers. The ratio of bull trout to brook trout throughout the drainage of Meadow Fork is approximately 15:1. Bull trout outnumber brook trout approximately 6:1 in downstream habitats (sites 1 through 50) where sympatric populations of both bull and brook trout were collected. Possible reasons bull trout thrive in Meadow Fork include limited intra-specific competition with non-native species, limited habitat alterations (water diversions), presence of a larger population of fluvial bull trout, and possible differences in water quality (temperature).

The upper reaches of Meadow Fork Creek appear to be exclusively occupied by bull trout. An allopactric bull trout population is/may be present in the upper 2900 meters of Meadow Fork. In other systems where bull and brook trout populations have persisted together, there appears to be a barrier or mechanism separating bull and brook trout spawners. Cold water barriers are suspected to be temperature barriers for brook trout in tributaries to the Metolius River (Ratliff 1992). Gradient does not appear to be a factor. The mechanism of separation of bull and brook trout spawners in Meadow Fork Big Creek has not been determined.

A total of 164 sites were surveyed in Lake Creek below the waterfall with char present in all but 34 of those sites. Sites with no fish were all in an area most affected by a localized thunderstorm and associated flash flood. Brook trout thrive in this stream, whereas bull trout seem to struggle to survive. Distribution of brook trout is constant throughout Lake Creek, whereas bull trout and possible hybrids are mainly present above the Lake Creek Trailhead.

Past telemetry studies on migratory adult bull trout in the Upper Malheur watershed did not find conclusive evidence that migratory bull trout utilized the spawning areas of Lake Creek (Schwabe 2000). In 2003, crews collected three large bull trout that all measured over 400 mm. Fish of this size support the theory that migratory bull trout may utilize Lake Creek, but numbers are relatively low compared to Meadow Fork Creek. Several factors may influence the relative abundance of bull trout in Lake Creek. Limiting factors include: influence of non-native species, potential channel reconfiguration and complex water diversions below Lake Creek Camp resulting in migratory losses, and historical use of Logan Valley affecting Lake Creek (Wenick et al. 2002).

Determining the influence of non-native species on bull trout in Lake Creek is difficult because brook trout have been present in the system for a long time. It is believed that brook trout were stocked in the high lakes of the Strawberry Mountains in the 1930s by sheepherders in exchange for hunting and fishing licenses (Bowers et al. 1993). Based on 2003 field work above the waterfall barrier, there is a self-sustained population of brook trout. This population of brook trout above the waterfall barrier may provide a constant source of recruitment into the lower Lake Creek population. During periods of high flow and runoff, it is possible that brook trout are being pushed over the falls and from High Lake, supplementing Lake Creek's brook trout population.

Below Lake Creek Camp there is private property along Lake Creek for approximately 1 mile until Forest Road 16. Downstream of Forest Road 16, Lake Creek flows into Logan Valley property managed by Burns Paiute Fish and Wildlife. Below Lake Creek Camp, there is potential for channel reconfiguration and complex water diversions. The diversions may alter historic channel conditions, possibly preventing adfluvial bull trout from migrating into Lake Creek. Historically, Logan Valley has been used for grazing and hay crops. In April 2000, Logan Valley property was acquired by Burns Paiute Fish and Wildlife and is now managed to return to pre-use conditions (Wenick et al. 2002).

An isolated thunderstorm occurred in this area on July 26, 2003. This storm, coupled with the 2002 fires in the Upper Malheur watershed, resulted in high water disturbing riparian habitats with extensive erosion of the riparian and channel habitats. At the time of the storm, Burns Paiute Tribe fisheries personnel noted that Big Creek flows had risen enough to breach over Forest Road 1648. In the days following the storm, field personnel noted that flood waters appeared to have doubled bankfull heights and inundated the 30-year floodplain. They also noted that debris flows may have caused headcuts in several areas and that following the storm there were several dead fish on the banks. Also following the storm, there were hail deposits up to 3 feet deep on the banks. Evidence of effects from this storm may be apparent in comparison of catch rates before and after the storm. Catch rates of salmonids in areas sampled before the storm and areas not affected by the storm averaged 6.7 fish/site, but in areas affected by the storm, catch rates averaged 1.4 fish/site (Table 2-2). Impacts of this storm on catch rates can only be speculated because individual sites were not sampled before and after the storm.

Nevertheless, fish collection after the storm decreased. Results of data collected from sites 37 through 97 may have been impacted by the storm. It is suspected that the relative abundance of fish species may not be comparable to those sites sampled prior the storm.

In 2002, the Burns Paiute Tribe initiated the distribution study of Lake Creek. Fire closures terminated the distribution study in 2002. Forty sites were sampled in 2002 beginning at Forest Road 1648. From these 40 sites, bull trout were collected in 2002 and not detected in 2003.

Table 2-3. Average salmonid catch per site by date and separated into sample areas for salmonids collected from Lake Creek electroshocking distribution survey in 2003.

	Lake Creek Trailhead to waterfall (see note)					**Forest Road 1648 to Lake Creek Trailhead** (area most affected by storm)				**Lake Creek Camp to F.R. 1648**
	July 22	July 23	July 24	July 28	July 29	July 30	Aug. 4	Aug. 5	Aug. 6	Aug. 7
No. of Sites	18	18	10	16	4	20	17	28	10	22
No. of Salmonids	142	109	105	67	24	64	27	8	3	115
Salmonids per Site	7.9	6	10.5	4.2	4.8	3.2	1.6	.3	.3	5.2
Note: On July 28 and 29, most of the sites were in an area that was not affected by the storm. This was in the area closest to the waterfall, and there was little evidence of flooding or debris flows.										

After the storm and debris flow, it is important to determine the damage caused to key species. During the 2003 spawning survey completed after this major storm, only seven redds were observed on the Upper Malheur watershed. This count is much lower than in previous years. In the 2002 spawning survey, 48 redds were observed, and in the 2001 spawning survey 270 redds were observed. In 2002, spawning surveys were limited by forest fires, but redds/mile had dropped as well. In 2001, there were 16.6 redds/mile, dropping to 8.1 redds/mile in 2002 (Perkins 2003a). In 2003, there were only 0.8 redds/mile surveyed (Perkins 2003b). Based on redd counts, this storm may have had dramatic affects on bull trout populations of the upper Malheur River.

The USFWS Malheur unit recovery plan addresses metapopulation theory and risk related to stochastic events. There are only two known local populations in the Malheur core area, placing it at the highest level of risk based on classifications of “fewer than five populations” from Reiman and McIntyre (USFWS 2002). With the fire in 2002 and the storm in 2003, it is possible that the Malheur population has experienced great losses. Recolonization of bull trout into these disturbed areas may be slow due to a small remnant population, and the populations are at risk if brook trout prove to be more resilient and displace the native fish species.

Brook trout influence bull trout in the Upper Malheur watershed in several ways. Brook trout compete with bull trout for habitat, resources, and spawning grounds. Past research indicates brook trout are more competitive than bull trout, eventually leading to the possible displacement of the latter (Ratcliffe and Howell, 1992). Brook trout may begin spawning as early as 2 years old, whereas most bull trout do not spawn until 5 years old (Leary et al. 1991). The ability to spawn at a younger age and smaller size leads to better reproductive success, an advantage for brook trout over bull trout. In addition, Gunckel (2000) studied the feeding behavior and diet of allopatric bull trout and brook trout populations, and found that competition was likely due to their similar habitat use and diet. Brook trout are also more aggressive and dominant than bull trout when resources are scarce (Gunckel 2000).

Brook trout can also hybridize with bull trout resulting in a loss of genetic integrity (Ratliff and Howell 1992). Hybridization is suspected to occur in both Meadow Fork and Lake Creek. Morphological characterization research by Markle in 1992 indicated that hybridization may have occurred in Big Creek. Fin clips were taken on all brook trout, bull trout, and potential hybrids collected from Lake Creek and Meadow Fork distribution surveys.

In summary, sympatric populations of bull trout and brook trout were found in both Lake Creek and in Meadow Fork. An allopatric population of bull trout may be present in the upper 2900 meters of Meadow Fork, but a barrier mechanism separating the two populations has not been identified. Brook and bull trout hybrids have been identified in both systems. Results from the genetic analysis will determine the accuracy of the hybrid identification.

2.7 Recommendations

To supplement current distribution information on the Upper Malheur watershed, distribution surveys will be completed on Frazier Creek, Snowshoe Creek, Corral Basin Creek, and Big Creek in 2004. Along with the studies in 2003, this should give an accurate distribution of salmonids in the upper Malheur.

A sub-sample of 20 sites will be completed on Meadow Fork and Lake Creek. Due to the recent disturbance of fires and flash floods, monitoring the re-colonization of fish species back into the habitats of Lake Creek and Meadow Fork is critical in understanding the resilience of the upper Malheur River bull trout population and their interaction with brook trout.

Continue the genetic research on bull trout, brook trout and potential hybrids from the upper Malheur. Knowledge of the rate of hybridization and introgression needs to be understood and results from this study will aid in future land and fish management decisions.

2.8 Acknowledgements

A special thanks to the Bonneville Power Administration and the U.S. Fish and Wildlife Service who funded this project for the Burns Paiute Fish and Wildlife Department. We would also like to thank Eric Hawley, Garrett Sam, Jason Isaacson, Tyler Johnson, Amos First-Raised, Kevin Fenn, Jason Fenton, and Lawrence Schwabe for the time that was put into electroshocking. A special thanks goes to the Burns Paiute Tribe Youth Opportunity Program (YOP) for funding a crew to assist the Fisheries Department. YOP crew members Manuelita Jacobs, Derrek Hawley, and Carla Teeman deserve special thanks for their hard work in completing tasks on Meadow Fork and Lake Creek. They were of a tremendous help to us, contributing to over 8 miles of stream that were shocked.

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Appendix A. Relative Abundance of Species by Site, Meadow Fork Big Creek and Lake Creek, 2003

Figure 2–22. Relative Abundance for Brook Trout per Site on Meadow Fork Big Creek (2003)

The graph below illustrates the relative abundance per site for brook trout collected via electrofishing surveys in 2003. Relative abundance for brook trout is expressed as a percent of the total catch of fish per site. Meadow Fork Big Creek was sampled from its confluence with Big Creek upstream about 5.4 km to the waterfall barrier.

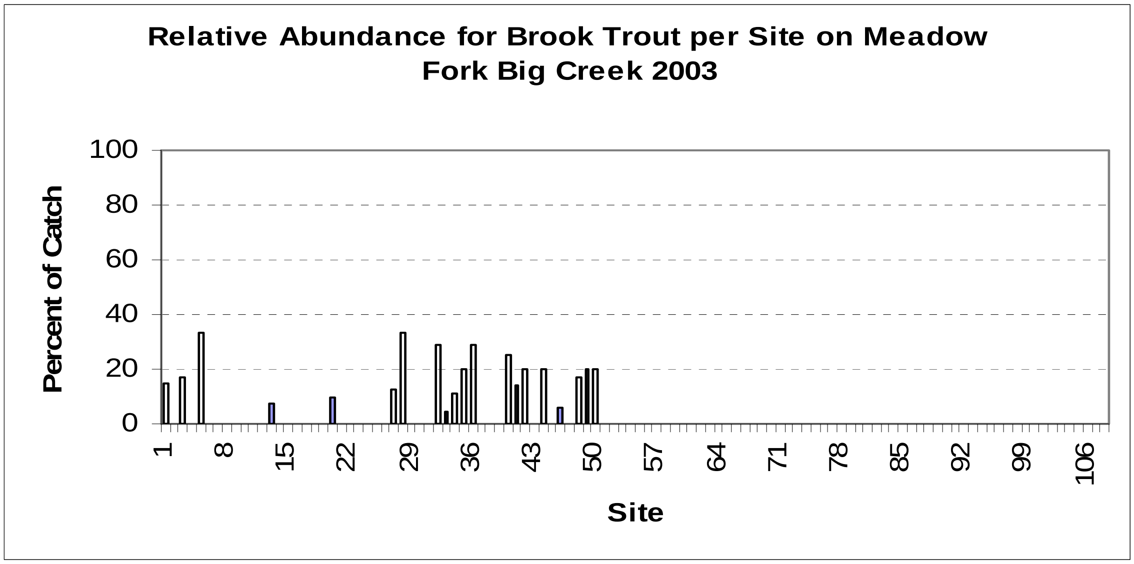


Figure 2–23. Relative Abundance for Bull Trout per Site on Meadow Fork Big Creek (2003)

The graph below illustrates the relative abundance per site for bull trout collected via electrofishing surveys in 2003. Relative abundance for bull trout is expressed as a percent of the total catch of fish per site. Meadow Fork Big Creek was sampled from its confluence with Big Creek upstream about 5.4 km to the waterfall barrier.

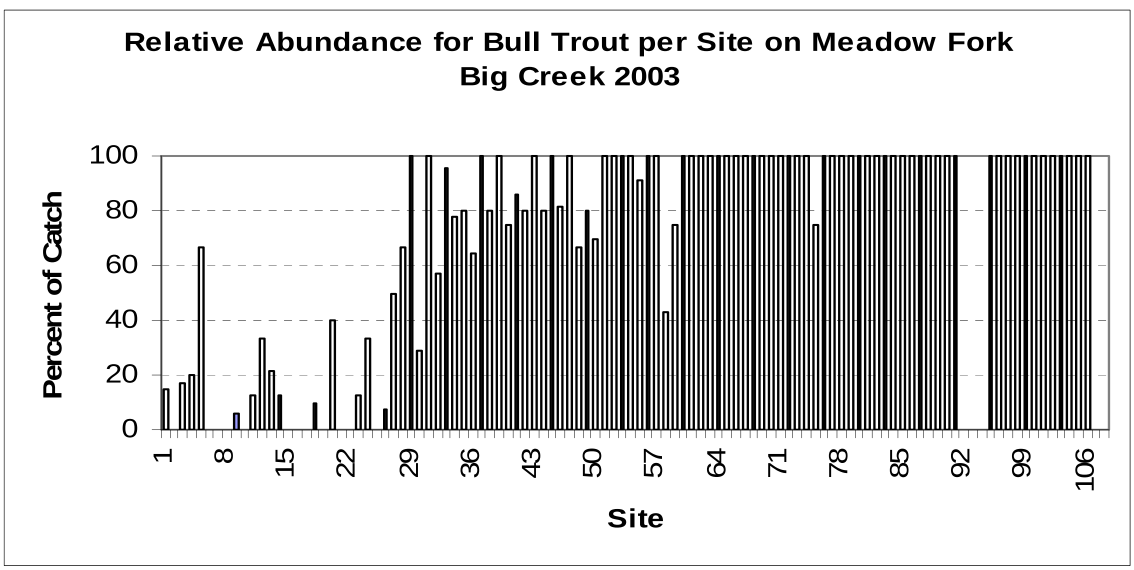


Figure 2–24. Relative Abundance for Potential Hybrid Brook and Bull Trout per Site on Meadow Fork Big Creek (2003).

The graph below illustrates the relative abundance per site for potential bull/brook hybrid trout collected via electrofishing surveys in 2003. Relative abundance for bull/brook hybrid trout is expressed as a percent of the total catch of fish per site. Meadow Fork Big Creek was sampled from its confluence with Big Creek upstream about 5.4 km to the waterfall barrier.

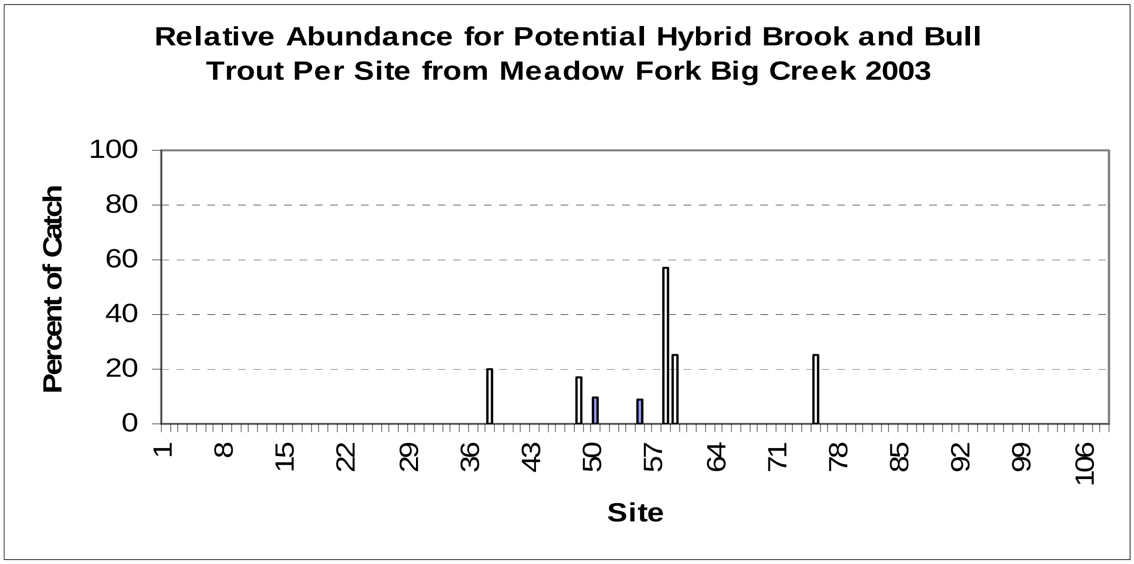


Figure 2–25. Relative Abundance for Redband Trout per Site on Meadow Fork Big Creek 2003

The graph below illustrates the relative abundance per site for redband trout collected via electrofishing surveys in 2003. Relative abundance for redband trout is expressed as a percent of the total catch of fish per site. Meadow Fork Big Creek was sampled from its confluence with Big Creek upstream about 5.4 km to the waterfall barrier .

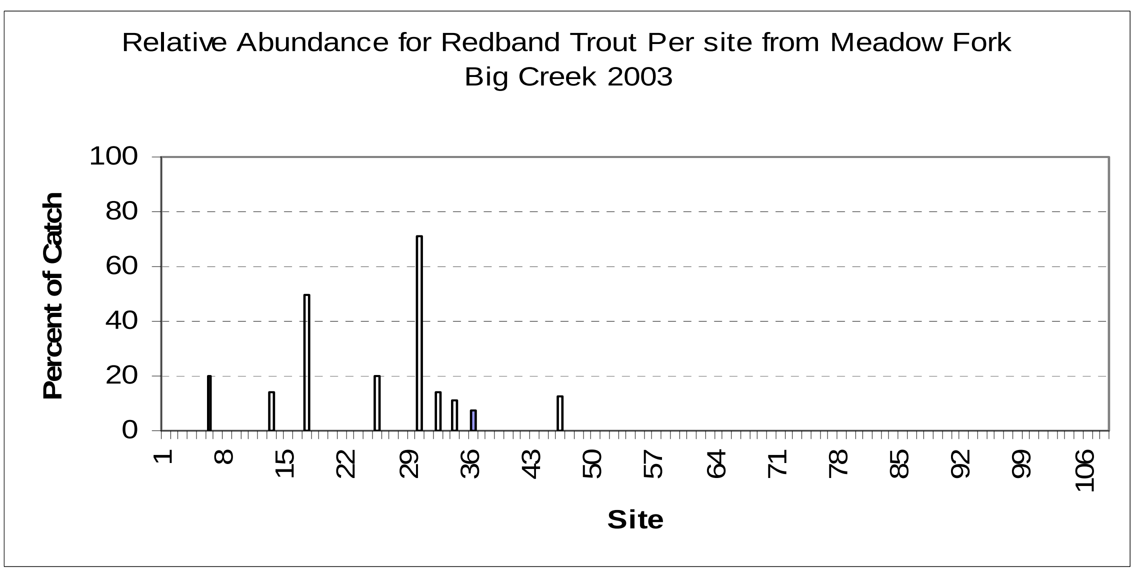


Figure 2–26. Relative Abundance for Cottid spp. per Site on Meadow Fork Big Creek (2003).

The graph below illustrates the relative abundance per site for cottid species collected via electrofishing surveys in 2003. Relative abundance for cottid species is expressed as a percent of the total catch of fish per site. Meadow Fork Big Creek was sampled from its confluence with Big Creek upstream about 5.4 km to the waterfall barrier.

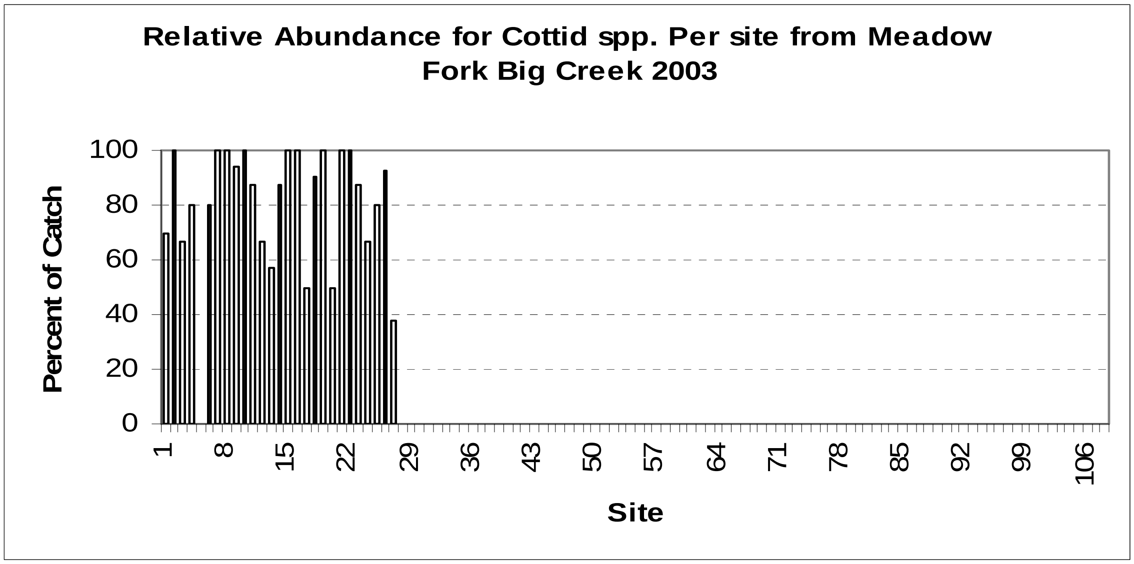


Figure 2–27. Relative Abundance of fish species collected in Meadow Fork Big Creek from sites 1 through 27 (2003).

The graph illustrates relative abundance of fish species collected in 2003 from sites 1 through 27. This section of stream was analyzed separately due to the absence of cottid species upstream of site 27. This may represent the upstream distribution limit for cottid species in Meadow Fork Big Creek. Meadow Fork Big Creek was sampled from its confluence with Big Creek upstream about 5.4 km to the waterfall barrier.

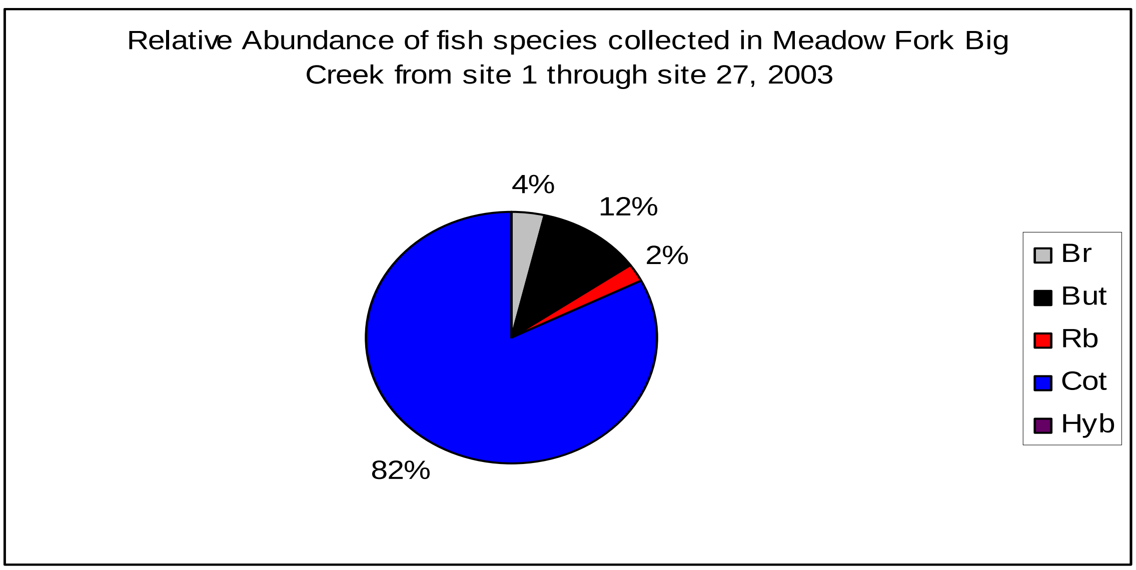


Figure 2–28. Relative Abundance of fish species collected in Meadow Fork Big Creek from sites 28 through 50 (2003).

The graph illustrates relative abundance of fish species collected in 2003 from sites 28 through 50. This section of stream was analyzed separately due to the absence of cottid species downstream of site 27 and absence of redband and brook trout upstream of site 50. Site 50 may represent the upstream distribution limit for redband and brook trout in Meadow Fork Big Creek. Meadow Fork Big Creek was sampled from its confluence with Big Creek upstream to the waterfall barrier located approximately 5.4 km upstream.

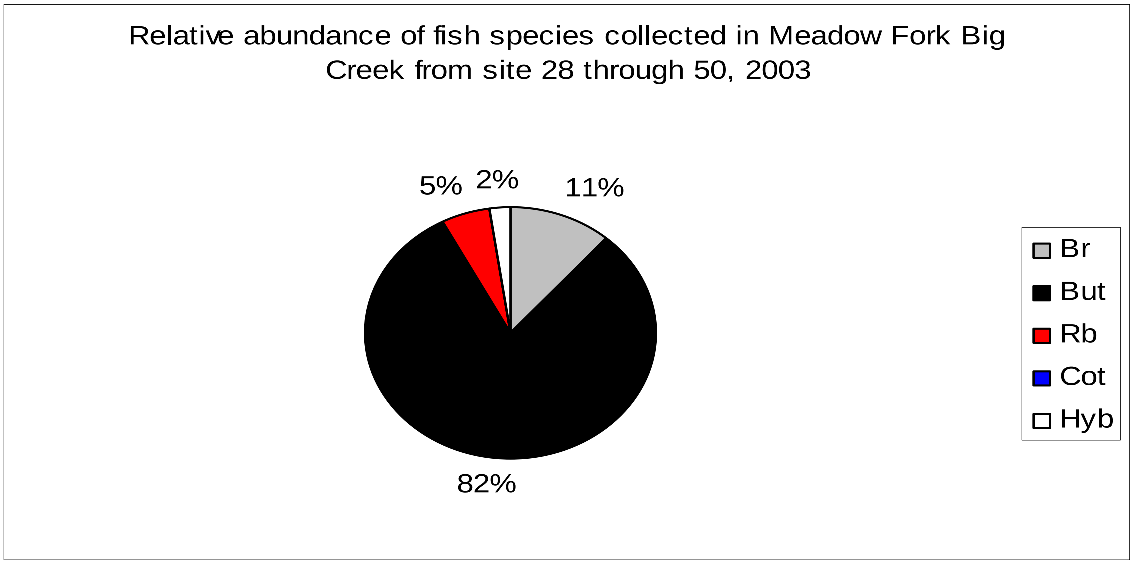


Figure 2–29. Relative Abundance of fish species collected in Meadow Fork Big Creek from site 51 through 108 (2003).

The graph below illustrates relative abundance of fish species collected in from sites 51 through 108. This section of stream was analyzed separately due to the presence of bull trout only. Sites 50 through 108 may represent distribution of the allopatric bull trout population in Meadow Fork Big Creek. Meadow Fork Big Creek was sampled from its confluence with Big Creek upstream about 5.4 km to the waterfall barrier.

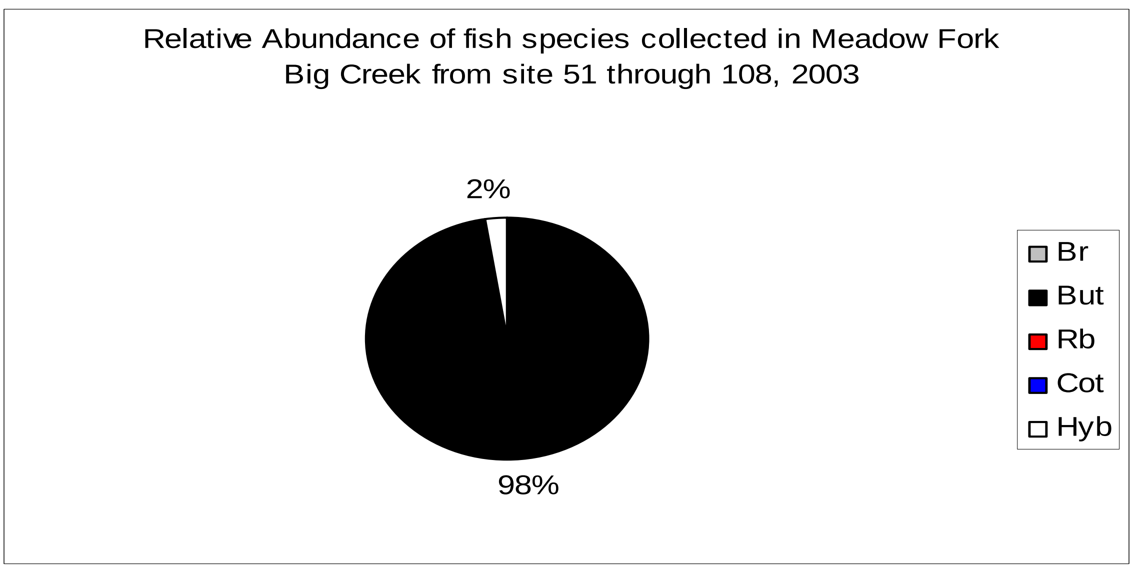


Figure 2–30. Relative Abundance for Brook Trout per Site on Lake Creek (2003).

The graph illustrates the relative abundance per site for brook trout collected via electrofishing surveys in 2003. Relative abundance for brook trout is expressed as a percent of the total catch of fish per site. Lake Creek was sampled from the Forest Service boundary (approximate RK 9) located near Lake Creek Camp upstream about 8.2 km to the waterfall barrier.

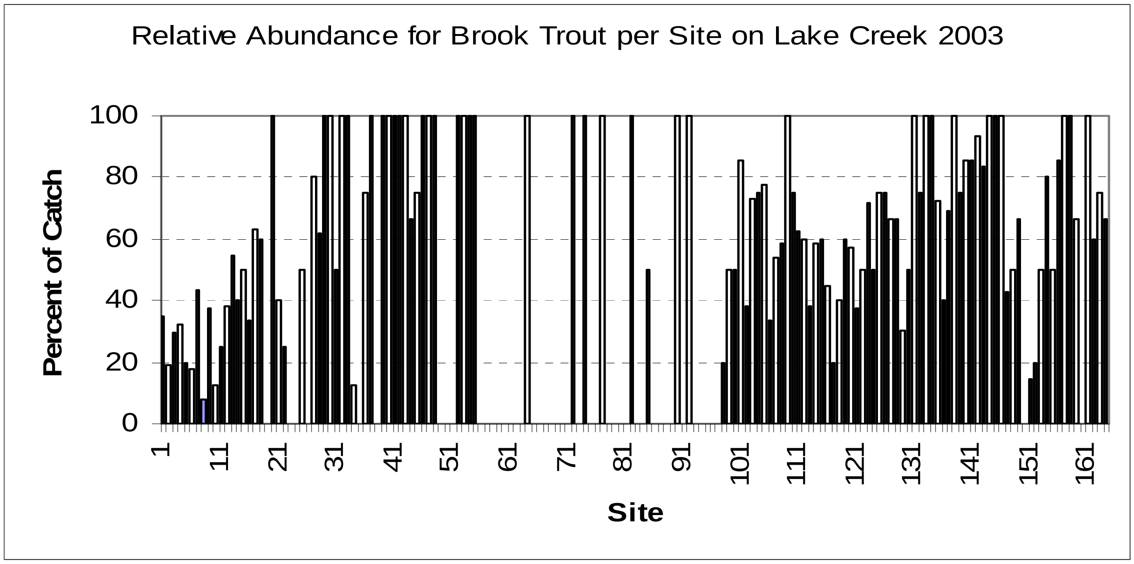


Figure 2–31. Relative Abundance for Bull Trout per Site on Lake Creek (2003).

The graph below illustrates the relative abundance per site for bull trout collected via electrofishing surveys in 2003. Relative abundance for bull trout is expressed as a percent of the total catch of fish per site. Lake Creek was sampled from the Forest Service boundary (approximate river kilometer 9) located near Lake Creek Camp upstream about 8.2 km to the waterfall barrier.

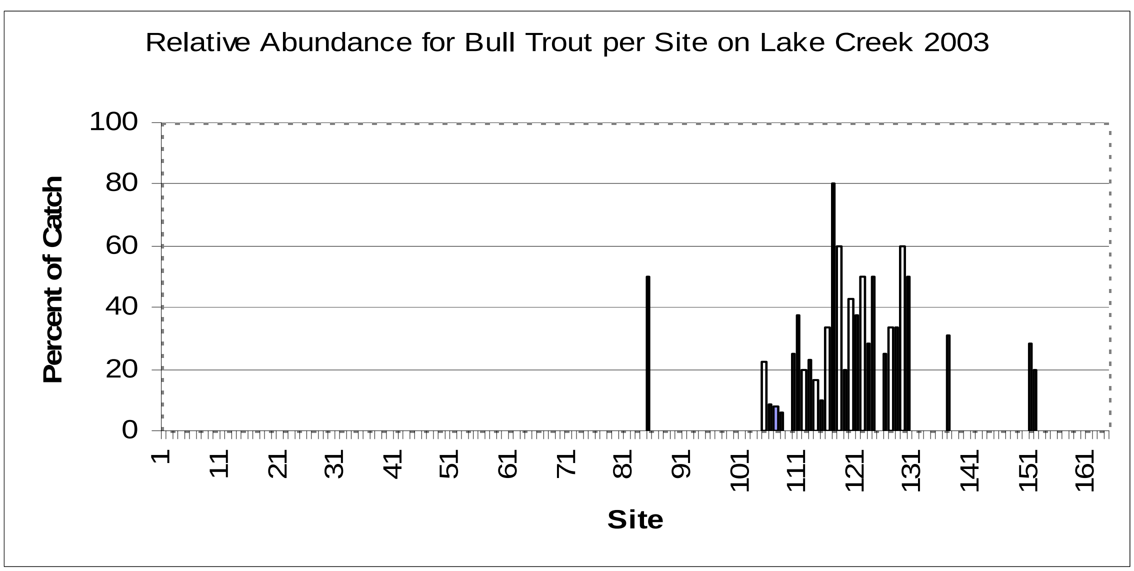


Figure 2–32. Relative Abundance for Redband Trout per Site on Lake Creek (2003).

The graph illustrates the relative abundance per site for redband trout collected via electrofishing surveys in 2003. Relative abundance for redband trout is expressed as a percent of the total catch of fish per site. Lake Creek was sampled from the Forest Service boundary (about RK 9) located near Lake Creek Camp upstream about 8.2 km to the waterfall barrier.

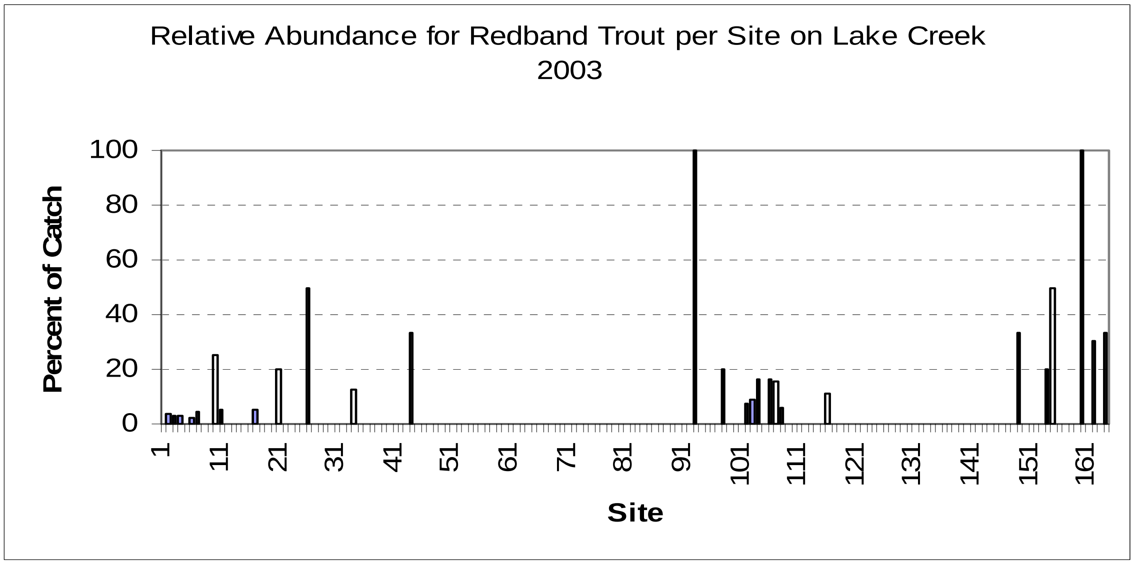


Figure 2–33. Relative Abundance for Brook/Bull Trout Hybrids per Site on Lake Creek (2003).

The graph illustrates the relative abundance per site for brook/bull hybrid trout collected via electrofishing surveys in 2003. Relative abundance for brook/bull hybrid trout is expressed as a percent of the total catch of fish per site. Lake Creek was sampled from the Forest Service boundary (approximate RK 9) located near Lake Creek Camp upstream about 8.2 km to the waterfall barrier located.

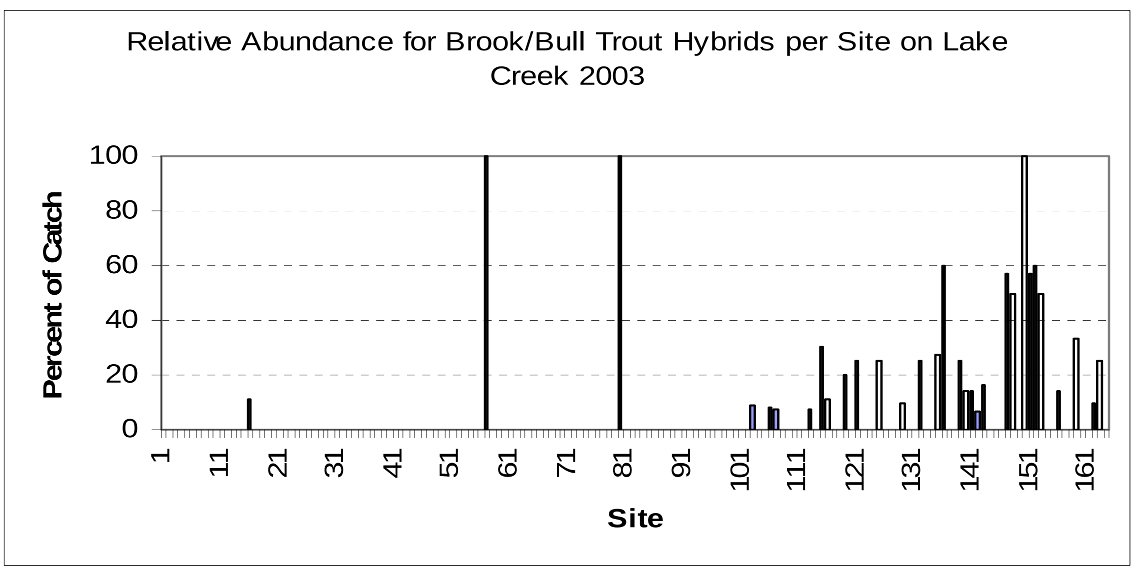


Figure 2–34. Relative Abundance for Sculpin per Site on Lake Creek (2003).

The graph illustrates the relative abundance per site for sculpin collected via electrofishing surveys in 2003. Relative abundance for sculpin is expressed as a percent of the total catch of fish per site. Lake Creek was sampled from the Forest service boundary (approximate RK 9) located near Lake Creek Camp upstream about 8.2 km to the waterfall barrier.

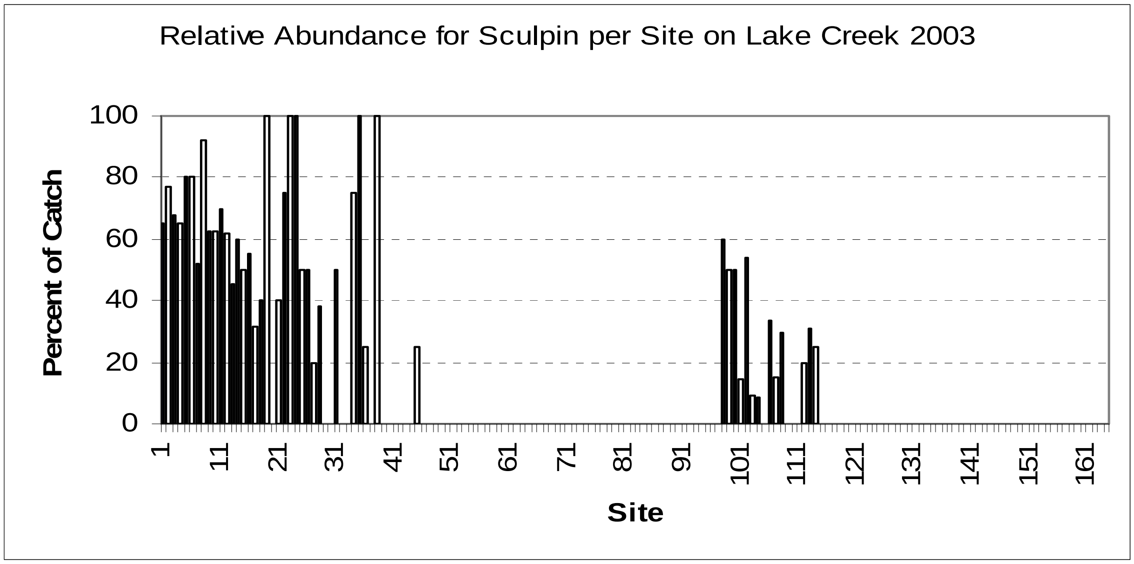


Figure 2–35. Relative Abundance of fish species collected in Lake Creek from sites 1 through 114 (2003).

The graph below illustrates relative abundance of fish species collected in 2003 from sites 1 through 114. This section of stream was analyzed separately due to the absence of cottid species upstream of site 114. Site 114 may represent the upstream distribution limit for sculpin species in Lake Creek. Lake Creek was sampled from the Forest Service boundary (approximate RK 9) located near Lake Creek Camp upstream about 8.2 km to the waterfall barrier.

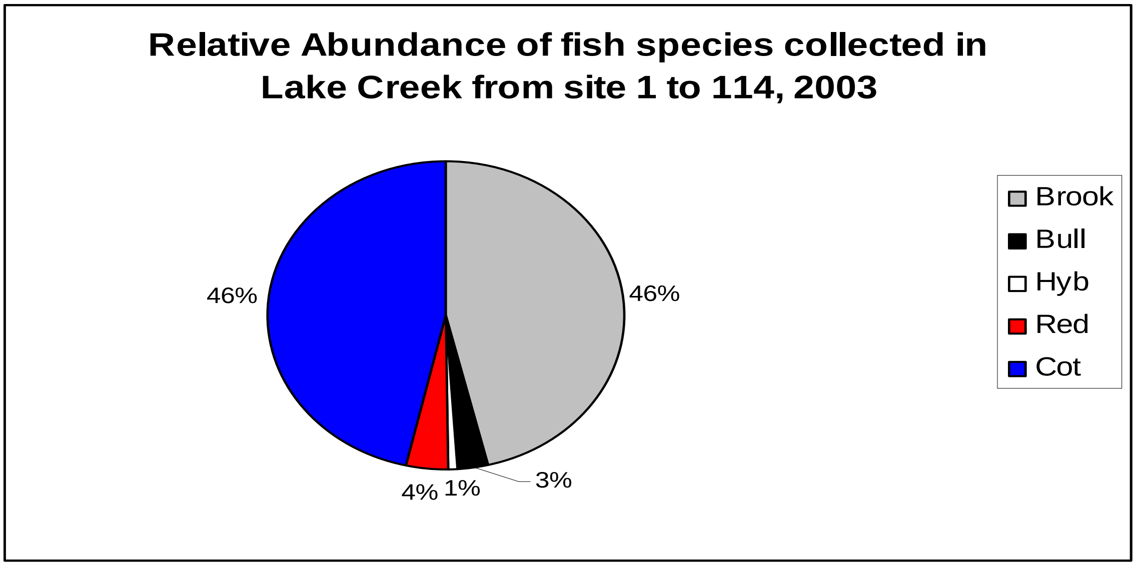
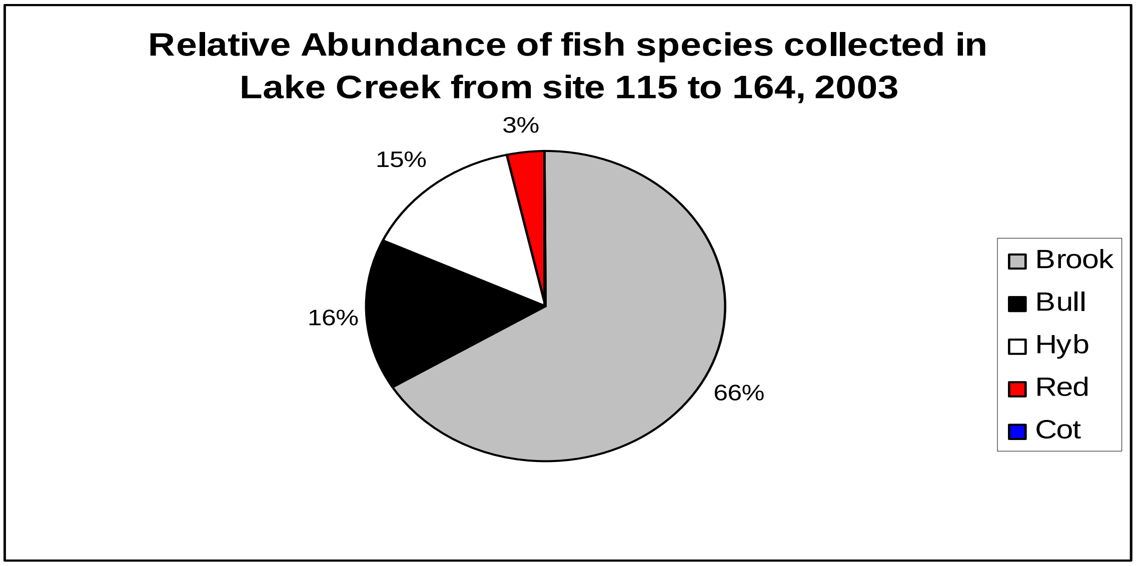


Figure 2–36. Relative Abundance of fish species collected in Lake Creek from sites 115 through 164 (2003).

The graph illustrates relative abundance of fish species collected in 2003 from sites 115 through 164. This section of stream was analyzed separately due to the absence of cottid species. Site 114 may represent the upstream distribution limit for sculpin species in Lake Creek. Lake Creek was sampled from the Forest Service boundary (approximate RK 9) located near Lake Creek Camp upstream about 8.2 km to the waterfall barrier.



Appendix B. Species collected on electroshocking distribution surveys on Meadow Fork Creek and Lake Creek in 2003. *Beginning and end of areas sampled are marked and distribution of fish collected is noted on the maps.*

Figure 2–37. Brook trout collected from Meadow Fork electroshocking distribution survey (2003)

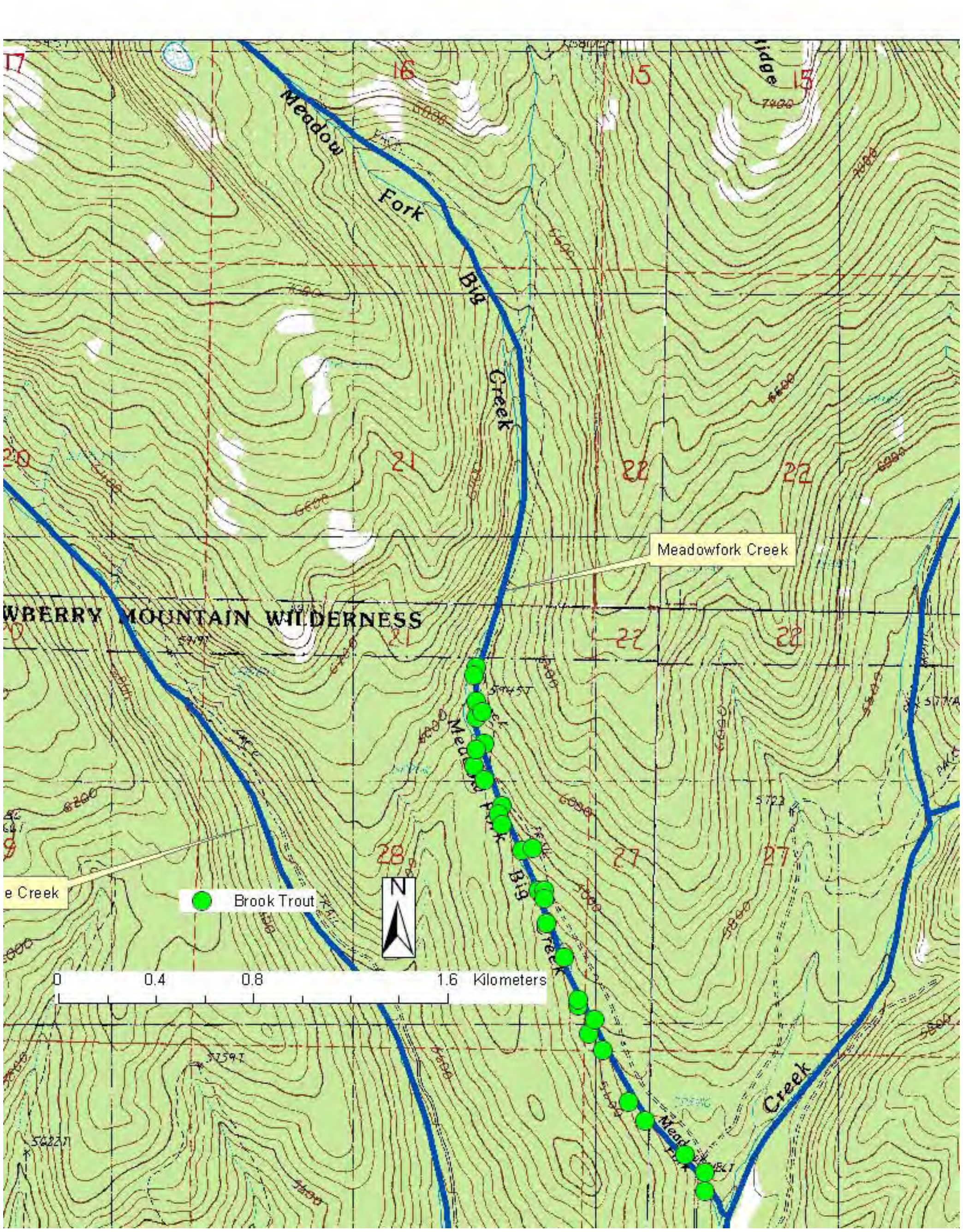


Figure 2–38. Bull trout collected from Meadow Fork electroshocking distribution survey (2003).

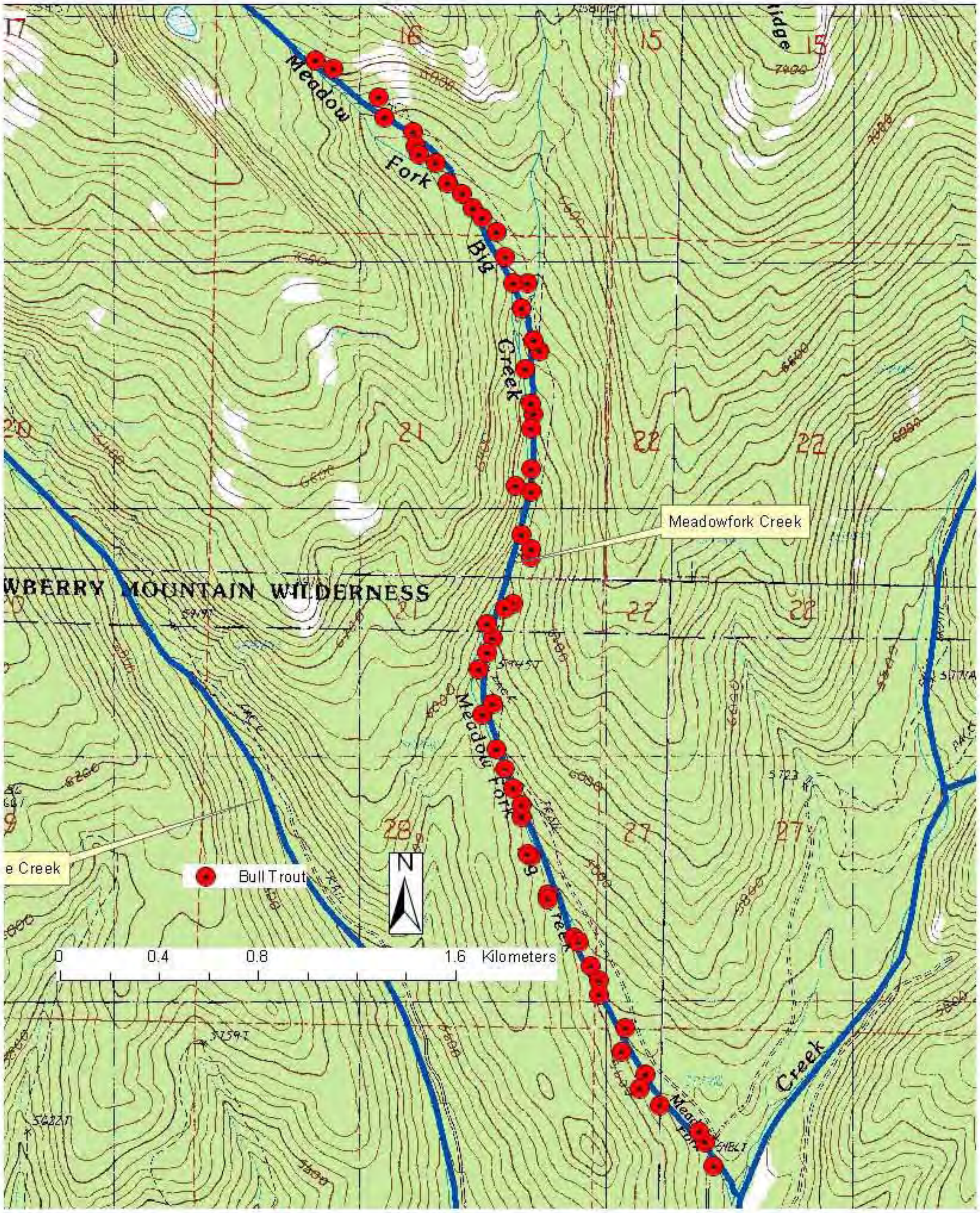


Figure 2–39. Possible bull/brook trout hybrids collected from Meadow Fork electroshocking distribution survey (2003).

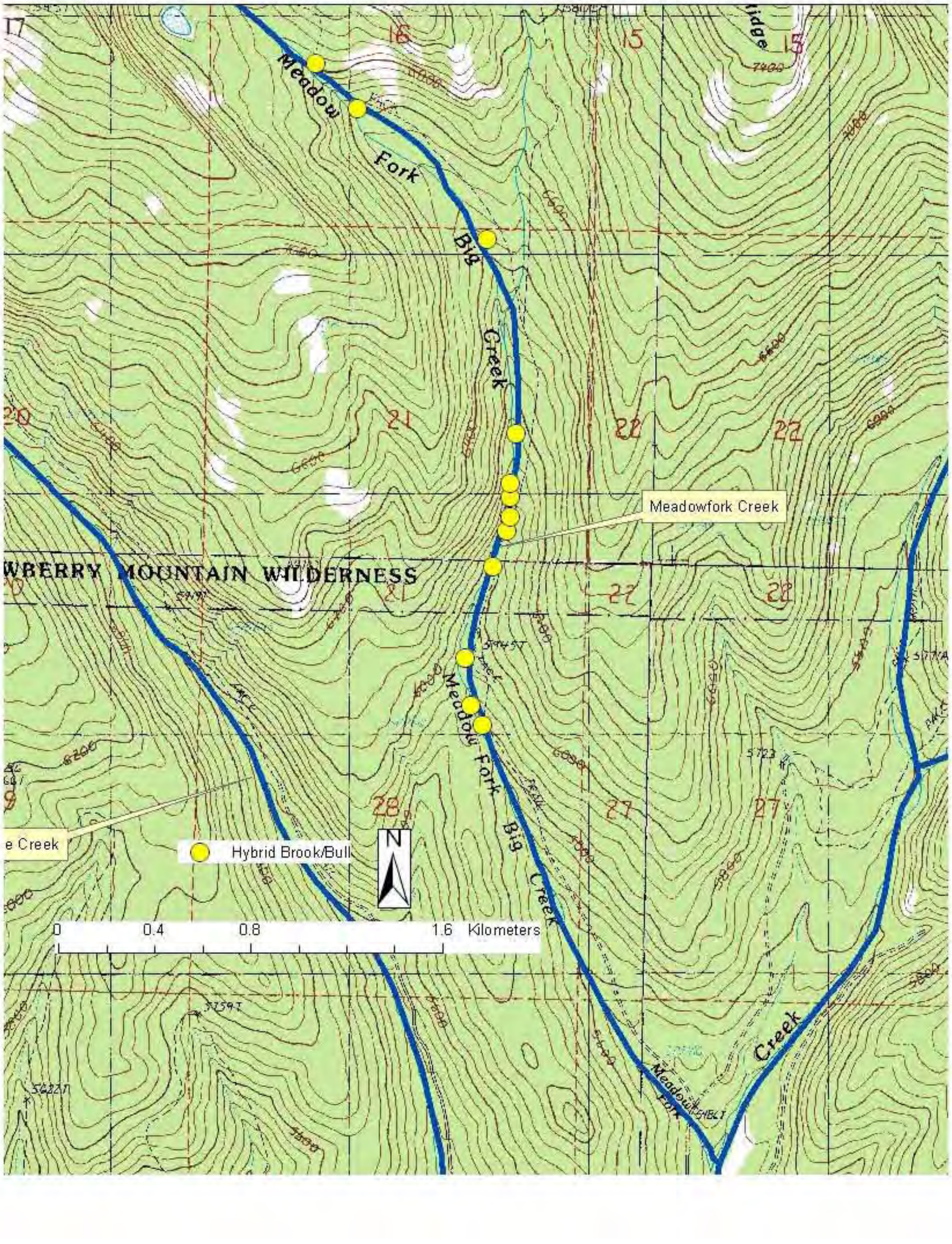


Figure 2–40. Brook trout collected from Lake Creek electroshocking distribution survey (2003).

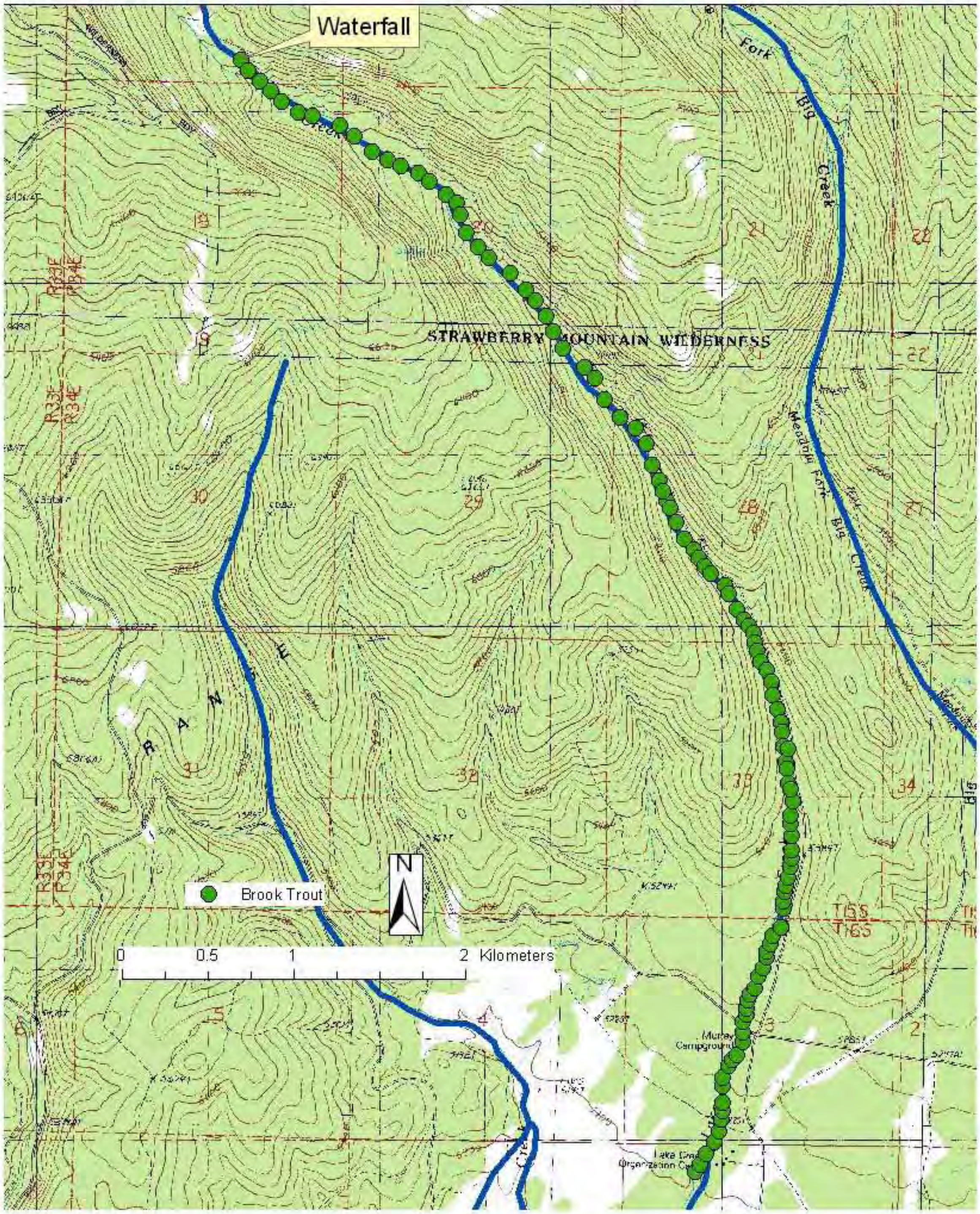


Figure 2–41. Bull trout collected from Lake Creek electroshocking distribution survey (2003).

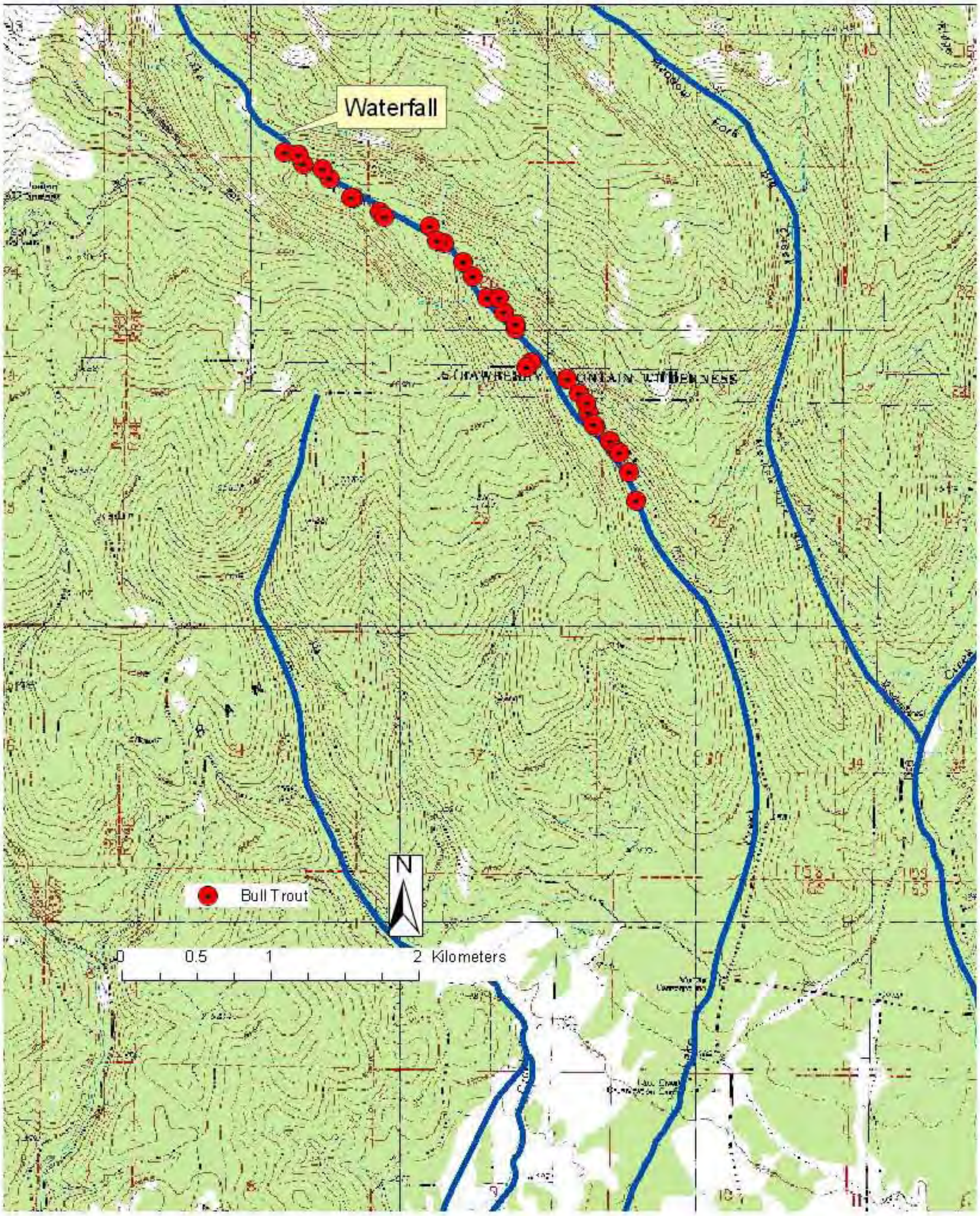
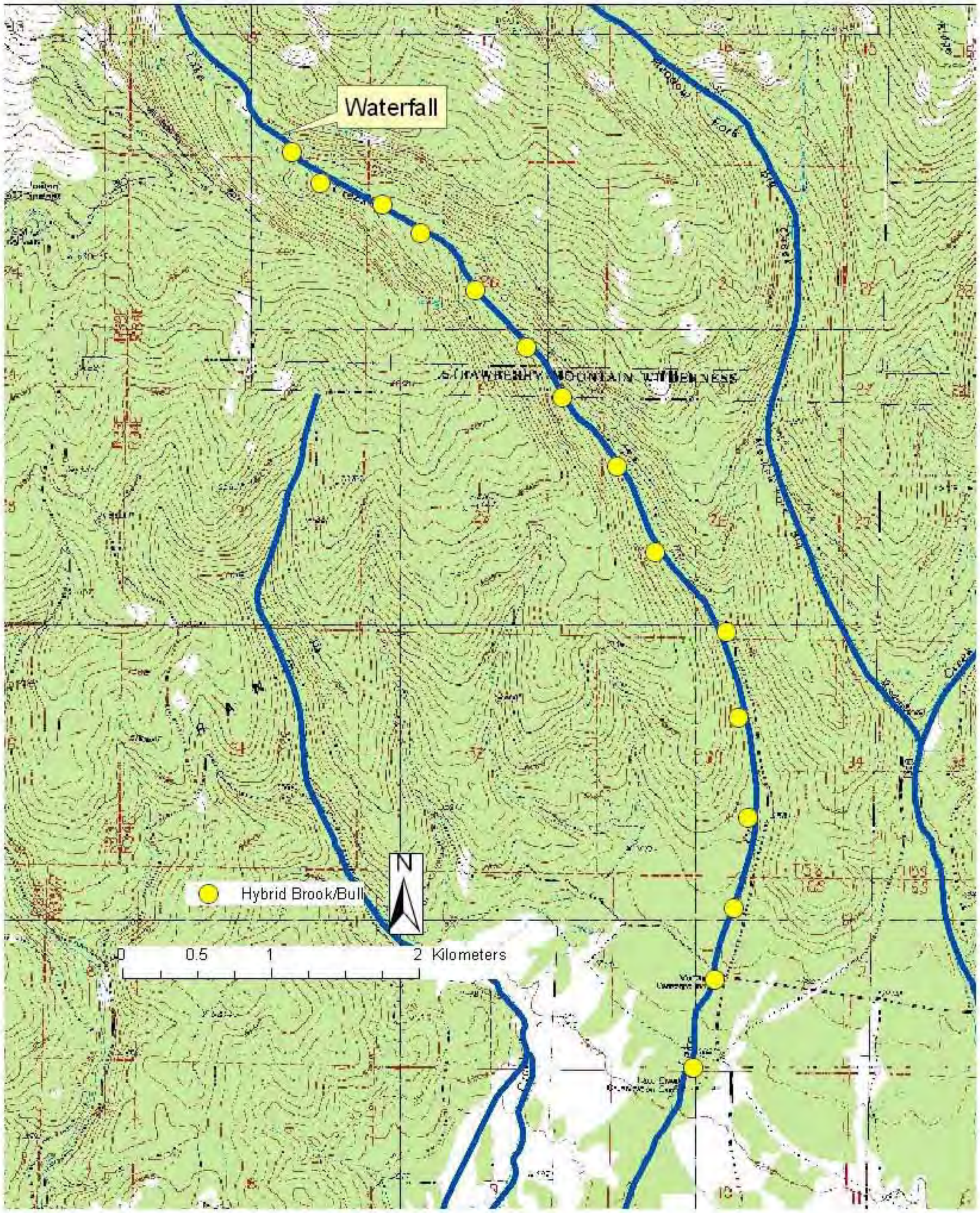


Figure 2–42. Possible bull/brook trout hybrids collected from Lake Creek electroshocking distribution (2003).



3.

USE OF A BACKPACK ELECTROFISHER TO DETERMINE POPULATION SIZE AND DISTRIBUTION OF BROOK TROUT (*SALVELINUS FONTINALIS*) ABOVE THE WATERFALL BARRIER ON LAKE CREEK, OREGON AND USE OF GILL NETS TO DETERMINE SPECIES PRESENCE IN HIGH LAKE, OREGON.

by Kevin Fenn,

Fish and Wildlife Department,

Burns Paiute Tribe, Burns, OR

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Chapter 3 Use of a Backpack Electrofisher to Determine Population Size and Distribution of Brook Trout *(Salvelinus fontinalis)* above the Waterfall Barrier on Lake Creek, Oregon and Use of Gill Nets to Determine Species Presence in High Lake, Oregon.

By Kevin Fenn
Fish and Wildlife Department.
Burns Paiute Tribe, Burns, OR

3.1 Introduction

High Lake and upper Lake Creek are principal components of the headwaters of the upper Malheur River. They are located on the south slope of the Strawberry Mountains approximately 200 river miles (RM) upstream of the Snake River. Upper Lake Creek begins above a major waterfall barrier, located about Lake Creek RM 8. A variety of springs are the source of Lake Creek. Lake Creek merges with Big Creek in Logan Valley (at Malheur RM 190) to form the upper Malheur River.

Brook trout from High Lake and upper Lake Creek may have a direct impact on bull trout that inhabit areas below the waterfall barrier. It is probable that brook trout in Lake Creek are supplemented by brook trout recruitment from above the waterfall.

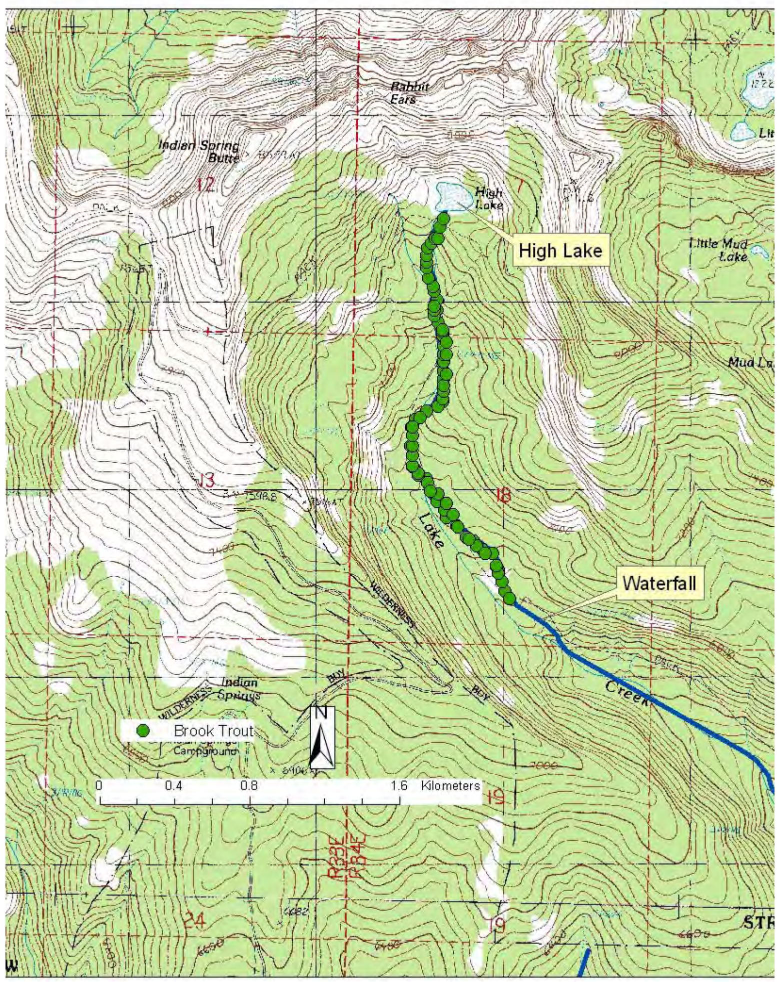


Figure 3–1. Brook trout collected from upper Lake Creek electroshocking distribution survey in 2003.

Brook trout pose a serious threat to bull trout. Research has shown they are able to out-compete bull trout for habitat, including spawning grounds. They hybridize with bull trout, resulting in a loss of genetic integrity. They tend to demonstrate more aggressive behavior in streams with sympatric populations of bull and brook trout (Ratcliff and Howell 1992; Leary et al. 1993; Gunkel 2001). Brook trout may already be partly responsible for low numbers of bull trout in Lake Creek and other headwater tributaries of the Malheur Basin. Hybridization is present in Lake Creek below the waterfall (BPFW 2003).

Oregon Department of Fish and Wildlife (ODFW) has kept detailed stocking records since 1950, and there has been no stocking of brook trout into Lake Creek since this date (Bowers et al. 1993). Prior to 1950, the detail in the stocking records was inadequate; this may explain why there is no documentation of when and where brook trout were introduced into Lake Creek. According to anecdotal information, brook trout fry were stocked by pack train into High Lake in the 1930s by sheepherder volunteers in exchange for free hunting and fishing licenses (Bowers et al. 1993). The brook trout may have come from a hatchery near Canyon Creek, about 6 miles above Canyon City (Ballagh 1926).

Little information is available about the area above the waterfall barrier on Lake Creek. In fact, we have no record of fish sampling in this reach. Brook trout from High Lake have access to Lake Creek through a direct outlet. This outlet flows year-round, but flows are very low in summer months. It is suspected that brook trout move out of High Lake into Lake Creek during periods of high flows and spring run-off.

The goals of the study on upper Lake Creek and High Lake were to determine species presence and abundance from a year-round waterfall barrier to the headwaters of Lake Creek, the population size of salmonids from the waterfall barrier to High Lake, and species presence in High Lake. To accomplish these goals, Lake Creek was electrofished from the waterfall barrier to High Lake to determine species distribution and abundance. We used a two-pass population reduction survey to determine population size of brook trout above the waterfall barrier. Angling and gill nets were used to determine species presence in High Lake. In addition, length and weight data collected from electroshocking in upper Lake Creek and gill-netting in High Lake were analyzed to determine length/weight relationships of brook trout.

3.2 Methods

Sampling of upper Lake Creek began on August 12, 2003 and was completed on September 18, 2003. Sampling began at the first pool above the waterfall and proceeded to High Lake; a total of 2902 meters (m) were sampled. Two studies were completed simultaneously in sampling upper Lake Creek: a distribution survey was completed for all of the wetted channel from the waterfall barrier to High Lake, and a population survey was completed on one-third of the area sampled from the distribution survey. Data from the first pass on population sites was also included in the distribution survey.

Fish were collected using a battery-powered “Smith & Root” electrofisher. Electrofishing the stream involved three to four individuals. One person operated the shocker, one or two individuals used dip nets to capture fish, and the last person measured and weighed the fish when each site was completed. Shocked fish were kept in buckets until processing at the end of each site. Electrofisher settings were set at “J 6 400” to maximize chances of brook trout capture. The electrofisher was kept at this setting unless a native species was collected; in that case, the settings would be decreased; if a bull trout was collected, electroshocking would cease.

3.2.1 Distribution Survey Methods

Distribution survey on upper Lake Creek began at the first pool above the waterfall barrier and proceeded to High Lake, with 100 percent of the wetted channel sampled. Surveyors used a drag tape to measure 50 m of bank parallel to the wetted channel. Upper and lower boundaries of each site were documented using a GPS (global positioning system) unit. Block nets were placed and anchored into the substrate at the upper and lower boundaries of sites. At each site, shocking moved from the lower block net to the upper block net and back down. Fork length was measured on all salmonids collected; all other species were counted.

Habitat data was recorded for all sites. Length, width, and depth of channel were recorded for each habitat type at each site. Length and width were used to determine area of each site. The area of all sites were added together to determine total stream area from the waterfall barrier to High Lake.

3.2.2 Population Survey Methods

A “2/4 pass, 50% population reduction” survey was conducted on upper Lake Creek. Sampling began at the waterfall barrier proceeding upstream for eight sites (total 400 m) and then every 200 m thereafter, distributed to High Lake. Sites were 50 meters in length. Surveyors used a drag tape to measure 50 m parallel to the wetted channel. Block nets were placed at the upper and lower boundaries of sites and anchored into the substrate to prevent fish escapement. One pass consisted of shocking from the lower block net to the upper block net and back down. The second pass required a 50 percent reduction in the collection of age 1+ salmonids (fork length$\geq$ 70 mm) for the site to be complete. If reduction criteria were not met, two more passes were required using the same methodology. GPS units were used to document the upper and lower boundaries of each site. Captured fish were held in buckets, and then measured and weighed after each pass. Captured salmonids were measured; other fish species were only counted.

Population statistical analysis is summarized using population estimation spreadsheets provided by the ODFW Corvallis Research Laboratory (Dambacher, 1997)

3.2.3 High Lake Methods

Sampling at High Lake was conducted on August 26–27, 2003. Gill nets were placed at opposite ends of the lake. The nets were placed at approximately 11 a.m. on Jul6 26 and removed at approximately 10 a.m. on July 27. The gill nets were 125 feet long and 6 feet deep; they consisted of five panels of square mesh. Mesh size of the five panels varied between ¾ inch to 2 inches; the smaller mesh panels were placed closer to the shore. Because of clear water conditions at the lake, it was important to leave the nets set overnight. All fish caught by gill net were measured and weighed. Angling was used to supplement the gill nets to sample and check for species present other than brook trout. Angled fish were only noted for species presence.

3.2.4 Length/Weight Relationship

Brook trout sampled from upper Lake Creek and from High Lake were measured and weighed when sampled. The only brook trout included for data analysis were those measured by fork length (to the nearest millimeter) and weighed to the nearest gram. Condition factor was calculated for all brook trout included in the data analysis using the “Fulton Condition Factor equation” [$(W/L^3)*100,000$] (Williams 2000).

Statistical analysis and calculations of data were computed using “Microsoft Excel” software. An exponential equation and R^2 value was used to calculate the relationship between brook trout length and weight for both upper Lake Creek and High Lake. In addition, regression and R^2 values were used to test the relationship between length and condition factor.

3.3 Results – Upper Lake Creek

3.3.1 Upper Lake Creek Distribution

Fifty-eight sites were surveyed on upper Lake Creek over a period of nine working days. Sites began at the waterfall barrier and concluded at the outlet of High Lake. Brook trout were the only species collected; a total of 855 brook trout were collected on the distribution survey (Figure 3-2). Brook trout ranged from 34 mm to 245 mm fork length (Figure 3-3), weighed 1 g to 189 g (Figure 3-4), and averaged 135 mm and 40.11 g. The majority of the fish came from a meadow just below High Lake with 545 m of channel. Burns Paiute Fisheries personnel captured 480 fish from this reach in the meadow, which was 56 percent of the total catch.

Figure 3–2. Brook trout distribution collected during electroshocking in 2003 from upper Lake Creek, a tributary to the Malheur River, Oregon.

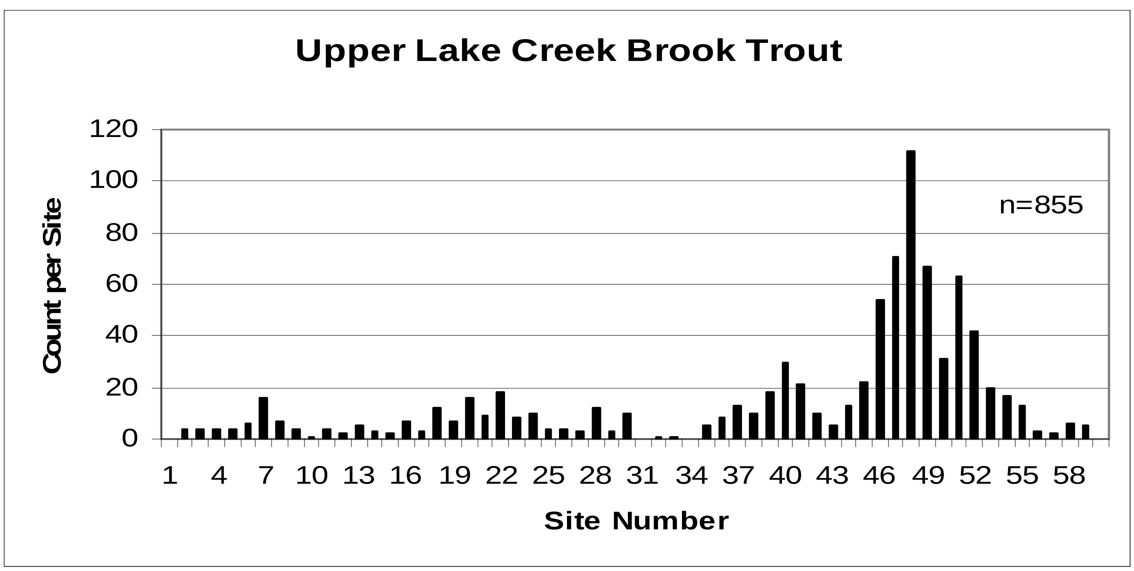


Figure 3–3. Length frequency of brook trout collected during electroshocking in 2003 from upper Lake Creek, a tributary to the Malheur River, Oregon.

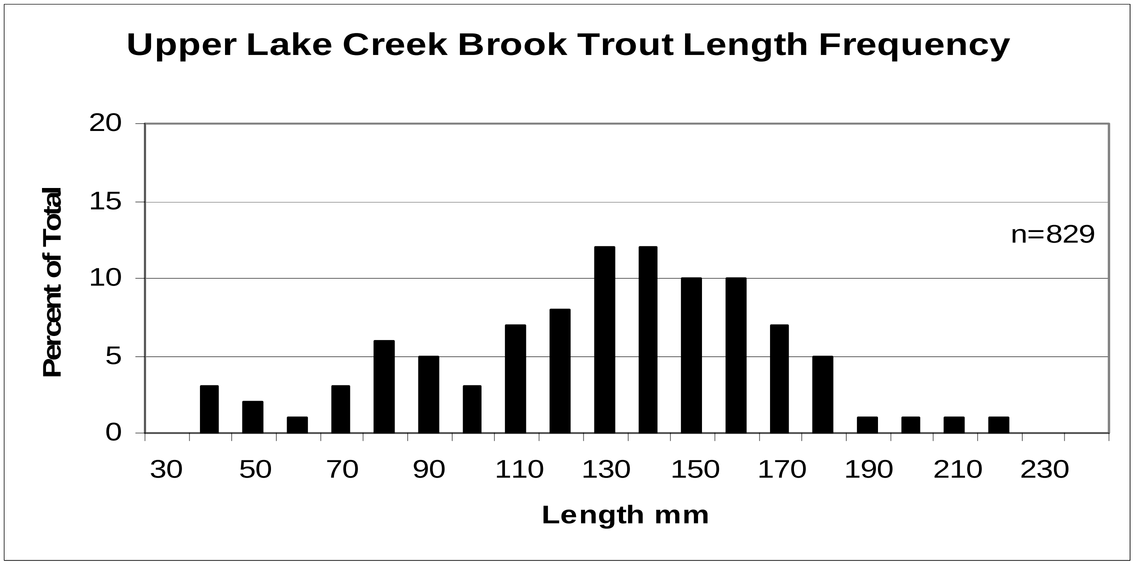
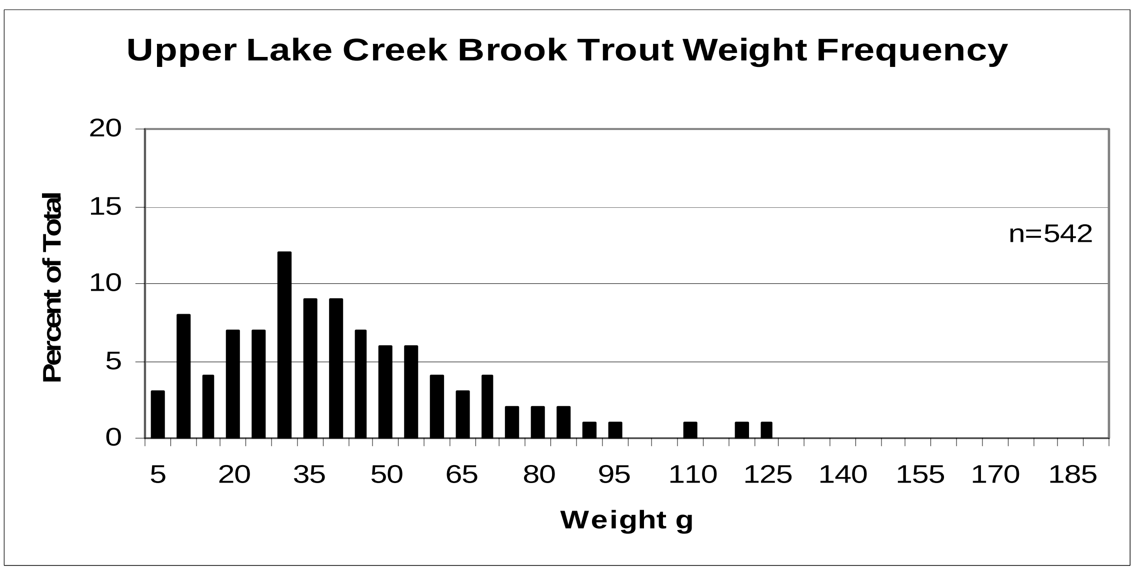


Figure 3–4. Weight frequency of brook trout collected during electroshocking in 2003 from upper Lake Creek, a tributary to the Malheur River, Oregon.



3.3.2 Upper Lake Creek Population Estimate

The 16 population survey sites comprised one-third of the total area from the waterfall barrier to High Lake. Reduction was achieved on all population survey sites. There were 225 1+ and greater brook trout sampled in the 16 sites. Average probability of capture was 89 percent. Using ODFW's electrofishing population estimation spreadsheet, the population estimate for brook trout in upper Lake Creek is 855 fish with a 95% confidence interval of ±417 fish (Dambacher 1997)(Table 3-1).

Table 3-1. Brook trout population estimate results from upper Lake Creek using ODFW population estimation spreadsheet, 2003.

Habitat \type	Population estimate	± 95% CL .	CL % of estimate	Fish per square meter		Fish per lineal meter	
				Habitat type	Reach average	Habitat type	Reach average
Mix	855	417	49%	0.2073		0.295	
Total	855	417	49%	0.2073		0.295	

3.3.3 Upper Lake Creek Densities

The number of brook trout per lineal meter for upper Lake Creek was 0.295 fish/m. The data range for all sites was from 0.02 fish/m to 1.70 fish/m (Figure 3-5). The highest density was in the meadow near High Lake. The number of brook trout per square meter for upper Lake Creek was 0.2073 fish/m^2. Density ranged from 0.02 fish/m^2 to 2.52 fish/m^2 (Figure 3-6). Brook trout per square meter is also highest in the meadow near High Lake.

Figure 3–5. Brook trout per linear meter, by site, collected in 2003 from upper Lake Creek , a tributary to the Malheur River, Oregon.

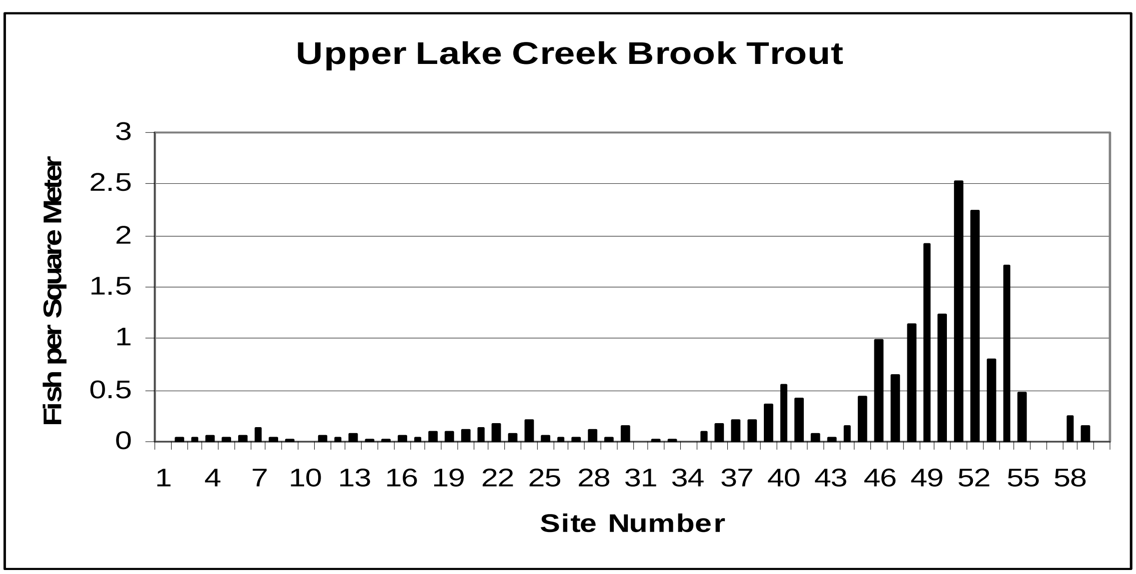
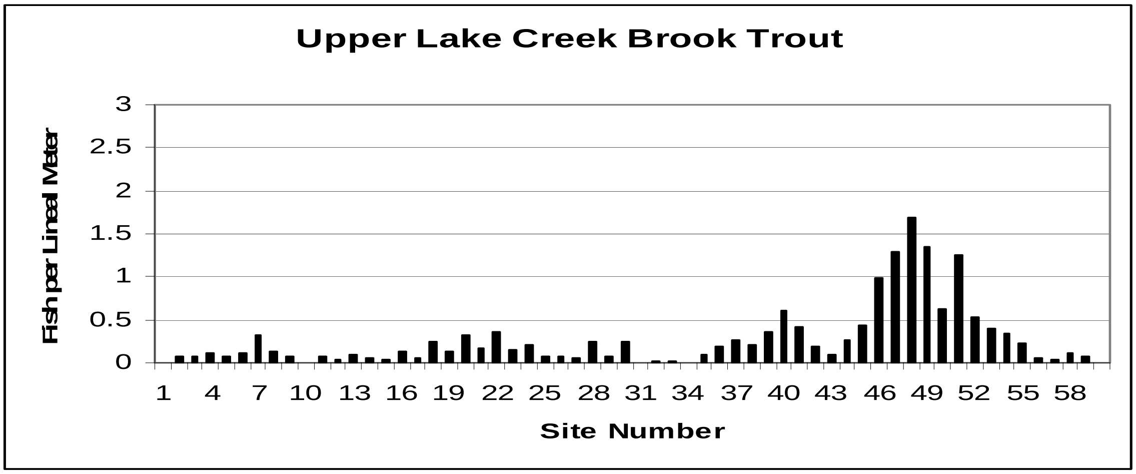


Figure 3–6. Brook trout per square meter, by site, collected in 2003 from upper Lake Creek, a tributary to the Malheur River, Oregon.



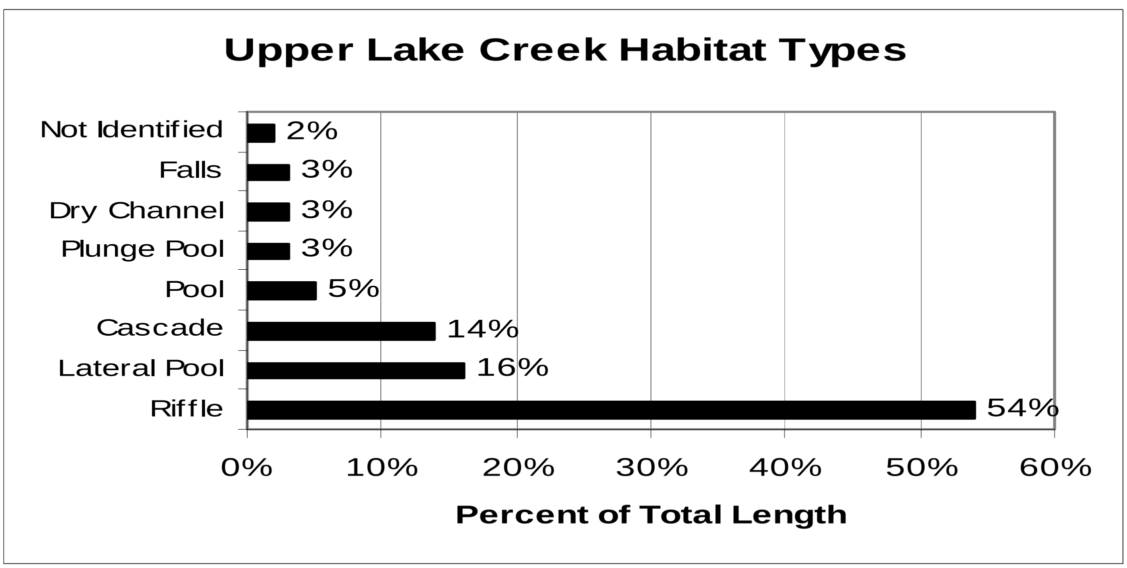
3.3.4 Upper Lake Creek Habitat

Habitat data were collected during the process of conducting distribution surveys on upper Lake Creek. On each site habitat type, length, width, and depth were measured. Total length from the waterfall barrier to High Lake was 2902 m and total area sampled was 4125 m^2. The three main habitat types on upper Lake Creek were riffle, cascade over bedrock, and lateral pool. There were several upstream barriers, located at sites 3, 12, 25, 40, 42, 43, and 54. These barriers are falls that are at least 4 meters in height. Sites 44 to 53 are in a meadow that is just below High Lake. The barrier at site 43 is just below the meadow; the barrier at site 54 is above the meadow and approximately 180 m from High Lake.

Table 3-2. Habitat types, length, area, and volume for habitat date recorded in 2003 during distribution survey from upper Lake Creek, a tributary to the Malheur River, Oregon.

Habitat Type	Habitat Length		Habitat Area		Volume	
	Meters	Percent of total	Area	Percent of total	Volume	Percent of total
Riffle	1542 m	54	2,212.25 m^2	56	390.33 m^3	55
Lateral Pool	471 m	16	517.1 m^2	12	111 m^3	16
Cascade	438 m	14	585 m^2	13	59.35 m^3	8
Pool	128 m	5	175.5 m^2	6	36.6 m^3	5
Plunge Pool	90 m	3	202.1 m^2	5	66.95 m^3	9
Dry Channel	86 m	3	N/A	N/A	N/A	N/A
Falls	81 m	3	172 m^2	4	13.7 m^3	2
Not Identified	50 m	2	150 m^2	4	37.5 m^3	5

Figure 3–7. Habitat types recorded during distribution survey in 2003 from upper Lake Creek, a tributary to the Malheur River, Oregon.



3.4 Results – High Lake

The only species collected in High Lake was brook trout; all 99 brook trout were captured using gill nets. The fish ranged from 107 mm to 210 mm fork length and weighed 16 g to 101 g. Average length and weight was 169 mm and 51.5 g, respectively. At High Lake, approximately 16 angling hours yielded only brook trout; anglers collected 100 brook trout and no other species.

Figure 3–8. Brook trout weight frequency from gillnetting High Lake in 2003.

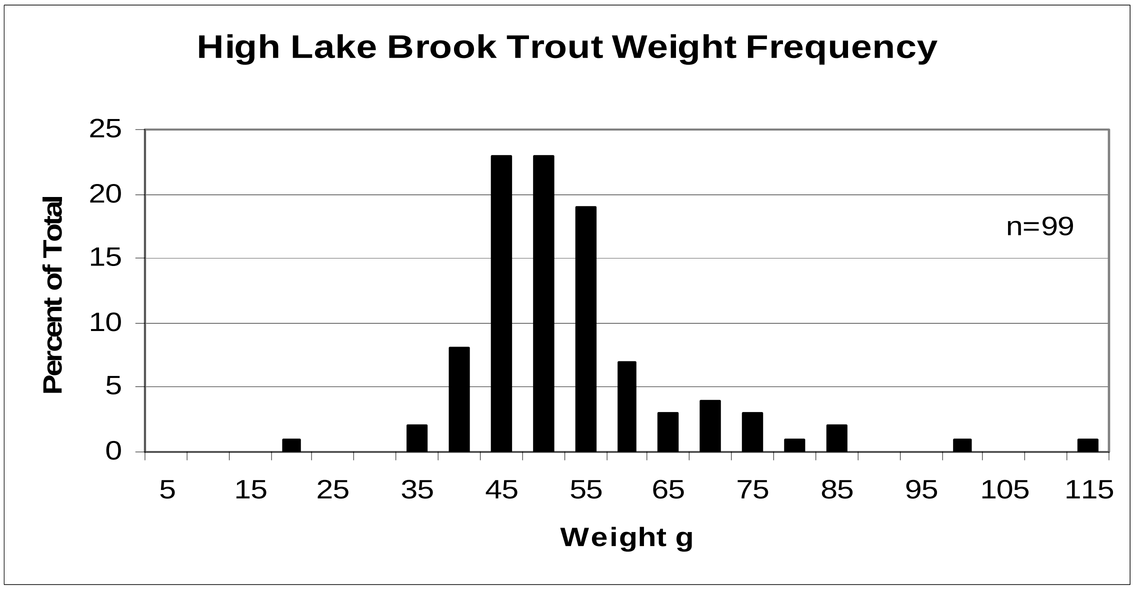
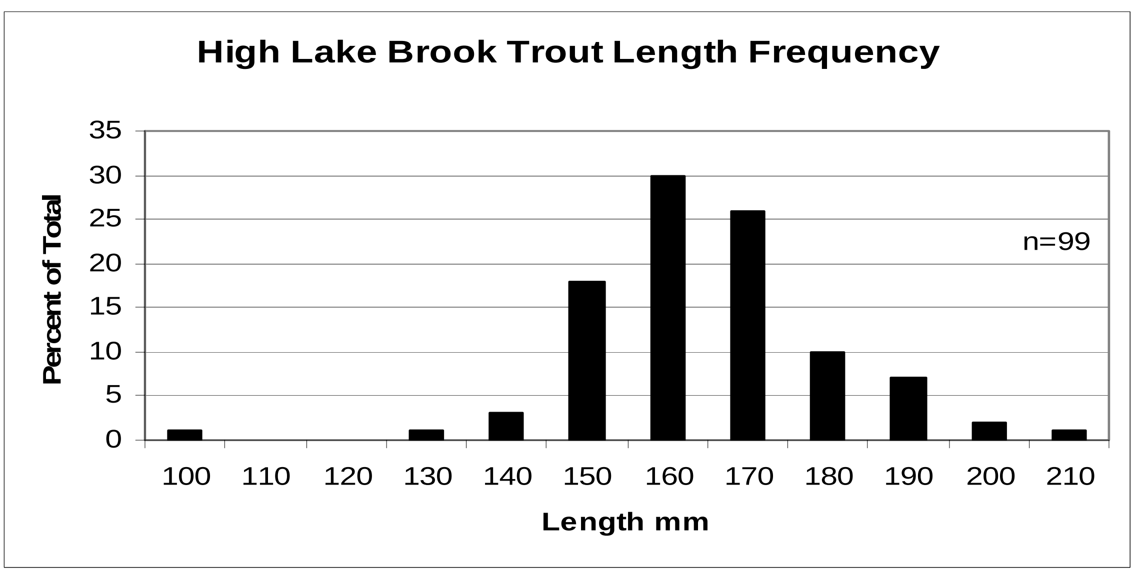


Figure 3–9. Brook trout length frequency from gillnetting High Lake in 2003.



3.4.1 Length/Weight Relationships

The length/weight relationship of brook trout collected from distribution survey on upper Lake Creek is defined by the exponential equation [$y = 1.3118e^{0.022x}$], where x = fork length and y = weight. The R^2 value of this equation is 0.9047, showing over 90 percent of the variation in weight has a direct relationship to fork length. Condition factor for brook trout collected from upper Lake Creek was plotted against fork length. There was a minimal negative relationship present in the comparison between condition factor to fork length ($y = -0.0014x + 1.378$; $R^2 = 0.0361$). Condition factor for brook trout from upper Lake Creek range from 0.57 to 3.89, and averaged 1.17.

Figure 3–10. Length/weight relationship of brook trout collected in 2003 during distribution survey of upper Lake Creek , tributary to the Malheur River, Oregon.

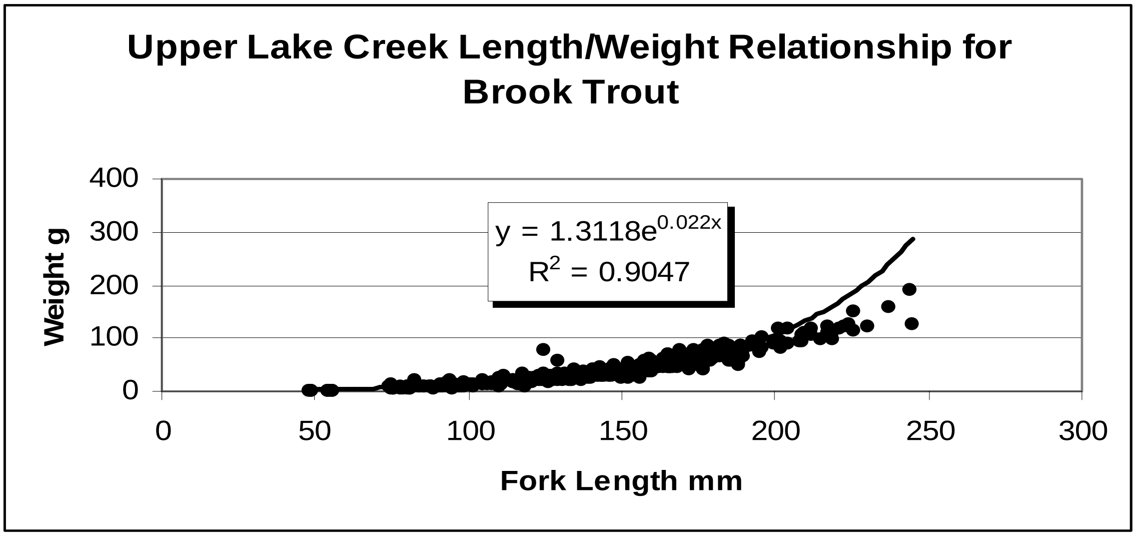
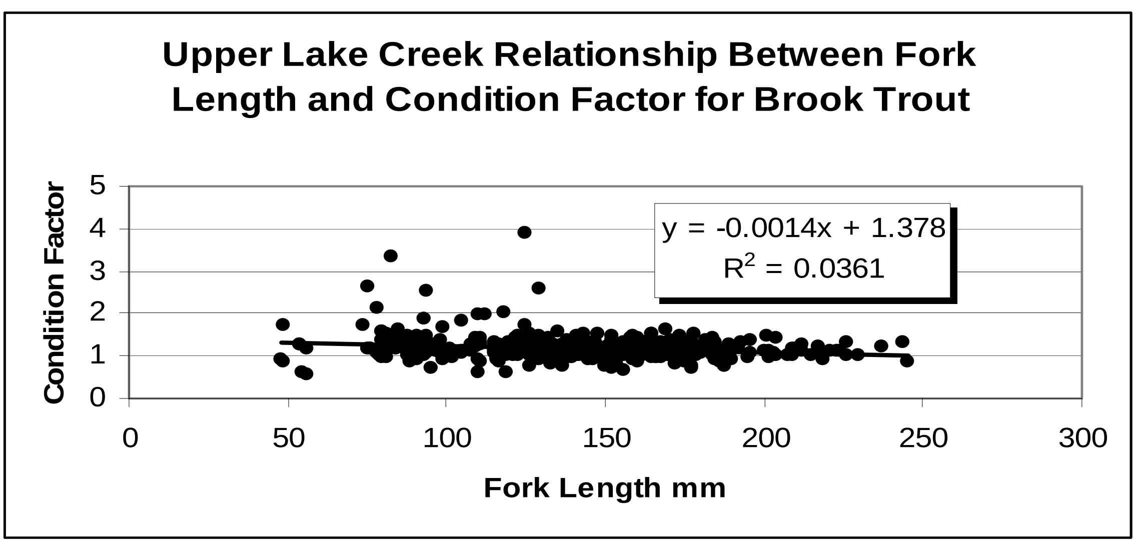


Figure 3–11. Relationship between fork length and condition factor for bull trout collected in 2003 during distribution survey of upper Lake Creek , tributary to the Malheur River, Oregon.



The length/weight relationship of brook trout collected from gillnetting High Lake is defined by the exponential equation [y = 3.7792e 0.0153x], where x = fork length and y = weight. The R2 value of this equation is 0.8597, showing that there is a significant relationship between weight and fork length for brook trout from High Lake.

Condition factor for brook trout collected from High Lake was plotted against fork length. A minimal negative relationship was present in the comparison between condition factor to fork length (y = -0.0031x + 1.5794; R2 = 0.1813). The condition factor for brook trout from High Lake ranged from 0.77 to 1.36, and averaged 1.05.

Figure 3–12. Length/weight relationship of brook trout collected from gillnetting High Lake in 2003.

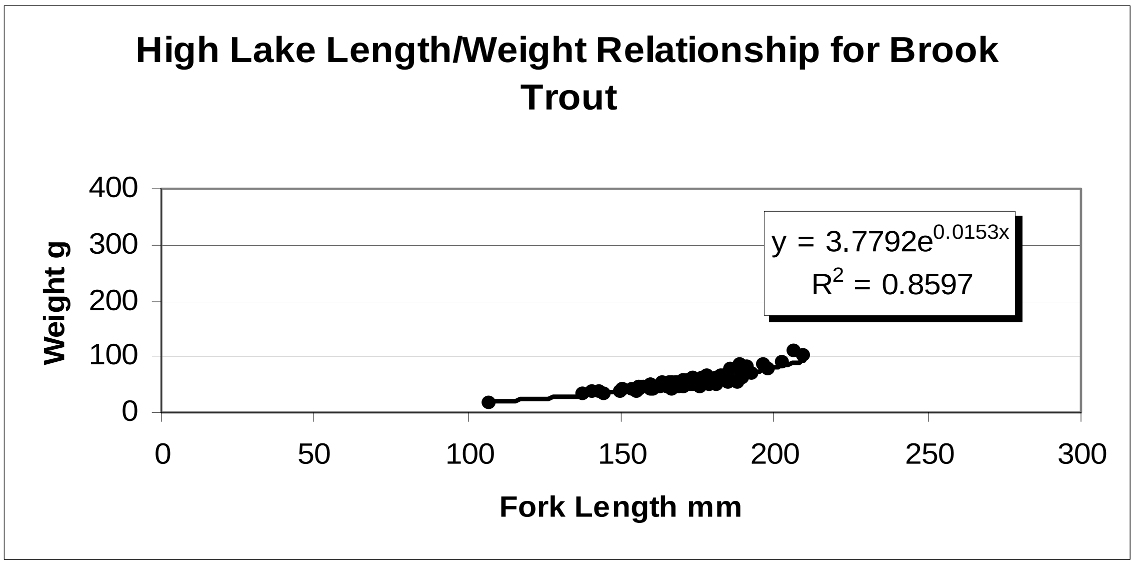


Figure 3–13. Relationship between fork length and condition factor for brook trout collected from gillnetting High Lake in 2003.

3.5 Discussion

The purpose of the study on upper Lake Creek was to:

1. Establish species presence from the waterfall barrier to the headwaters of Lake Creek.
2. Determine the population size of salmonids in Lake Creek above the waterfall barrier.
3. To determine the length/weight relationship of brook trout in upper Lake Creek and High Lake.

To accomplish these goals a distribution survey was completed on upper Lake Creek from the waterfall barrier to its source at High Lake. In addition, a two-pass population reduction survey was completed on a sub-sample of the distribution sites. Finally, a presence/absence survey was completed at High Lake.

This study has helped determine species composition and the potential impacts of eradicating non-native brook trout above the waterfall barrier on Lake Creek. Brook trout were the only species captured when electroshocking upper Lake Creek. Population sampling resulted in an 89 percent probability of capture. If efforts are made to remove brook trout from this system, based on probability of capture electroshocking may be a cost-effective and efficient method of limiting the brook trout population in Lake Creek.

Fifty-eight sites were sampled on upper Lake Creek, brook trout occurred in all except for sites 30 and 33; only 1 fish each was found at sites 31 and 32. At the end of site 33, there is dry channel where the creek goes subterranean for approximately 75 m.

The number of brook trout caught per site was dependent on habitat availability and habitat type. From sites 1 to 30, habitat was good, keeping brook trout numbers in this area fairly consistent. From sites 30 to 33, most of the creek was cascade over bedrock limiting the habitat availability, drastically lowering the number of brook trout. Sites 40 to 43 consist mainly of falls with intermittent pools, with the only habitat in the pockets. Upper Lake Creek runs through a meadow just below High Lake. Sites 44 to 53 are in this meadow (49 to 53 are a spring that feeds into Lake Creek). The meadow contained 545 m of channel with a surface area of 442 m^2, or 11 percent of the total surface area sampled. Fifty-six percent of the fish collected were from the meadow.

High Lake is located approximately 270 m upstream of the meadow. Given the high concentration of brook trout just below High Lake, we suspect that brook trout from the lake and meadow may enter into Lake Creek during periods of high flow and spring run-off.

Evaluation of species presence/absence was the main objective in gill netting and angling at High Lake. Brook trout were the only fish species collected. With brook trout inhabiting High Lake, it is a possible source of recruitment of brook trout for the lower reaches of Lake Creek. Data gathered support the assumption that no other fish species are present in High Lake.

Brook trout were the only salmonid collected, and therefore the only salmonid with a population estimate. There were a total of 16 sites in a 2902 m section of Lake Creek. Approximately 33 percent of the total area from the waterfall barrier to High Lake was sampled, roughly 1375 m^2. This is not a population estimate of brook trout for the entirety of Lake Creek, but rather for only the section above the waterfall barrier.

Analysis of fork length and weight of brook trout shows a significant relationship for both upper Lake Creek and High Lake. In this analysis, condition factor was plotted against fork length, a very slight negative relationship between condition factor and fork length was present for both sample areas as well. The average condition factor of brook trout from High Lake was slightly less than that of brook trout from upper Lake Creek.

From the results of the presence/absence study and population estimate, it was found that brook trout are the only species of fish above the waterfall barrier in Lake Creek and most likely the only fish species in High Lake as well. This shows that there is suitable habitat for other fish species, but access from below is blocked by the waterfall barrier and brook trout have access to Lake Creek from High Lake and above the waterfall barrier.

One goal of sampling High Lake and Lake Creek was to determine the feasibility of eradicating brook trout. Given the numbers of brook trout in High Lake, the best options appear to be: 1) poisoning High Lake, 2) blocking access to Lake Creek from High Lake and shocking the stream below High Lake to remove brook trout.

3.6 Recommendations

- Resample upper Lake Creek population sites to determine the effectiveness of using electrofishing for removal of brook trout.
- Determine possibilities of blocking brook trout access from High Lake entering into Lake Creek.
- Determine effects of using rotenone on High Lake on non-fish species present.

3.7 Acknowledgements

A special thanks to the Bonneville Power Administration and the U.S. Bureau of Reclamation who funded this project for the Burns Paiute Fish and Wildlife Department. We would also like to thank Eric Hawley, Garrett Sam, Jason Isaacson, Tyler Johnson, Bret High, Ray Perkins, Kevin Fenn, Jason Fenton, and Lawrence Schwabe for the hours that were put into electroshocking upper Lake Creek and angling at High Lake.

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4.

SELECTIVE REMOVAL OF BROOK TROUT (*SALVELINUS FONTINALIS*) USING PHEROMONAL BAITING WITH SEXUALLY MATURE MALE BROOK TROUT IN HOOP NETS

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Chapter 4 SELECTIVE REMOVAL OF BROOK TROUT (*SALVELINUS FONTINALIS*) USING PHEROMONAL BAITING WITH SEXUALLY MATURE MALE BROOK TROUT IN HOOP NETS

By Kevin Fenn
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4.1 Introduction

Bull trout (*Salvelinus confluentus)* were listed as threatened by the U.S. Fish and Wildlife Service (FR 1998) on June 10, 1998. Bull trout populations have been declining for many years, with a number of factors contributing to their downfall. These factors include land management practices, construction of dams, chemical treatment projects, and introduction of non-native species (USFWS 2002).

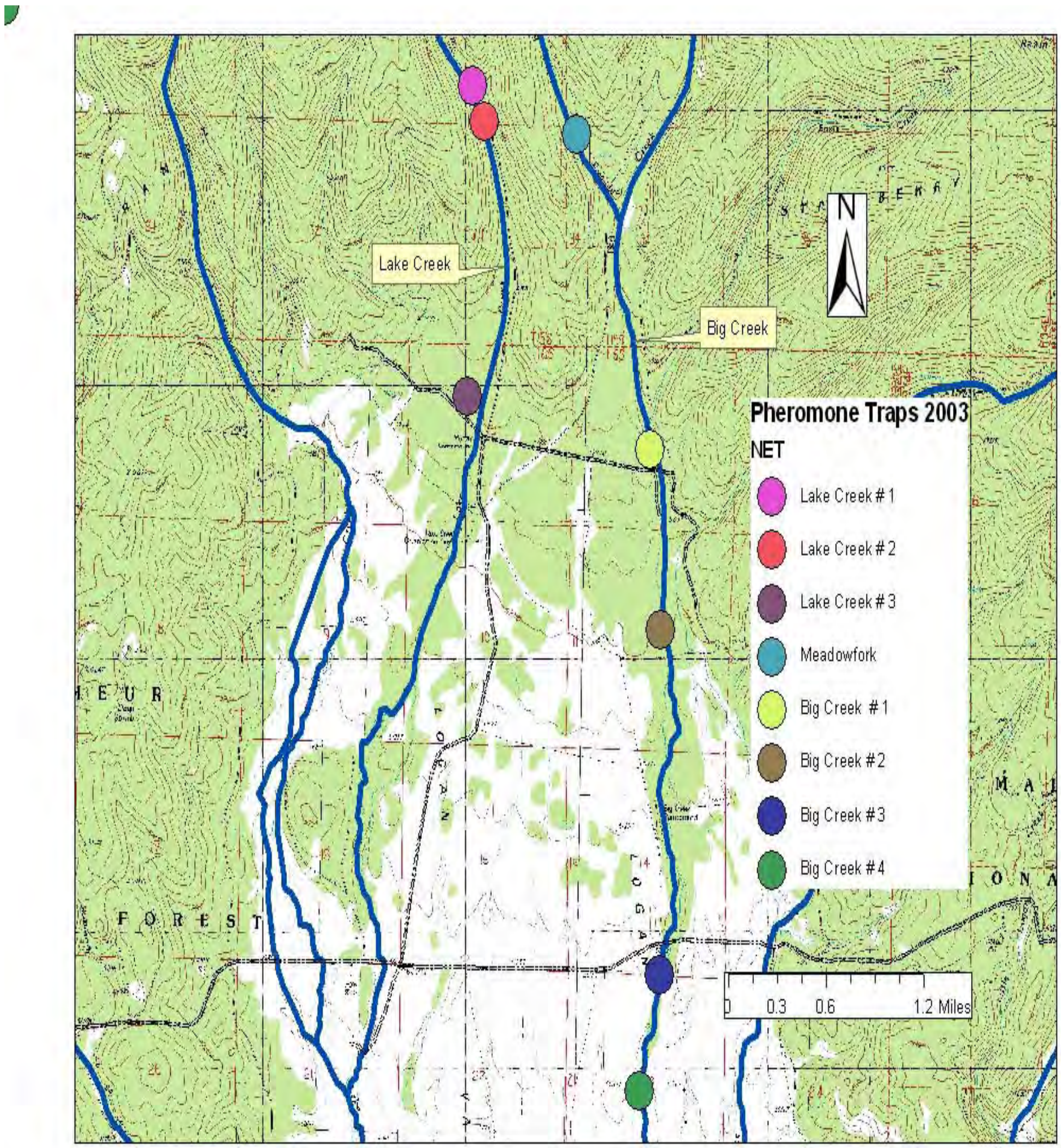
Competition with non-native species is a problem for bull trout throughout their distribution. Brook trout (*Salvelinus fontinalis)* pose a serious threat to bull trout populations due to many reasons including; habitat competition and their ability to hybridize with bull trout resulting in a loss of genetic integrity (Ratliff and Howell 1992; Leary, et al. 1993). Brook trout demonstrate more aggressive and dominant behavior in streams with sympatric populations of bull and brook trout (Gunckel 2001). Brook trout may be partly responsible for the loss of bull trout in some areas, and brook trout represent a threat to bull trout throughout most of the remainder of their range in the upper Malheur River drainage (Upper Malheur watershed). Hybridization is suspected to have occurred in Big Creek, a tributary to the Malheur River (Markle 1992).

Competition of bull trout with brook trout is a problem in the Upper Malheur watershed. Population and presence/absence surveys conducted from 1997 to 2001 found brook trout to be dominant in the upper reaches of all of the streams that were sampled (Bonneville Power Administration Project #199701900). Electrofishing and chemical treatment are methods that are used to remove unwanted fish species. These methods are non-selective and possibly cause hard to non-target species. Because of the negative impacts of these methods on other species present and the possibility of not removing all target species, new methods of removal need to be researched and assessed for viability. One such selective method is using pheromonal baiting (Young et al. 2001).

Pheromones are defined by Dr. Peter Sorensen of the University of Minnesota as “chemical signals that pass between members of the same species that evoke potent, instinctual responses.” He also said “that [pheromonal baiting is] conceivably an inexpensive way to manage populations of nuisance fish” (Moen 2001).

Pheromonal baiting targets a specific population and will not purposefully harm other species. Although it does not directly harm other species, in any type of trap net, there is possible mortality. Pheromonal baiting is an experimental procedure and has had limited use with fisheries. The purpose of this study is to evaluate pheromone baiting as a viable option for selective removal of brook trout in areas of sympatric populations of bull trout in the upper Malheur River.

Figure 4–1. Locations of pheromone traps used in 2003 on Meadow Fork of Big Creek, Big Creek, and upper Lake Creek upper, tributaries to the Malheur River, Oregon



4.2 Methods

The Burns Paiute Tribe Fish and Wildlife Department evaluated pheromonal baiting in the fall of 2003 on the Upper Malheur watershed. Methodology for this research was based on work of

Michael Young in which he researched the use of pheromones as attractants for brook trout (Young et al. 2001). Traps were placed in Meadow Fork Big Creek, Lake Creek, and Big Creek. In the summer of 2003, prior to placing the pheromone traps, distribution surveys were conducted on Lake Creek and Meadow Fork of Big Creek. Species presence based on distribution surveys in these areas include brook trout, bull trout, redband (*Oncorhynchus mykiss),* and sculpin (*Cottus spp*.). Pheromone traps were placed in areas of high concentration of brook trout based on the distribution surveys that were performed and knowledge of species present in Big Creek at Logan Valley.

Four traps were used for this study: one Fyke net and three hoop nets. The hoop nets had a 50 cm diameter hoop with a single throat leading into the cod end of the trap. The Fyke net was 16 feet long with a 3-foot opening and a double throat leading into the cod end. Because the Fyke net was much larger than the hoop nets, it was used in an area of deeper water. The width and depth of the channel only permitted one trap at each location.

Traps were first placed on September 24, 2003 and the last trap was removed on November 1, 2003 because of ice accumulation. When setting the trap, we did not block the entire channel and made sure that the traps were at least two-thirds submerged. Traps were checked daily. All salmonids were measured and other species were counted. Traps were moved when catch rates became low for an extended period of time. Data was analyzed based on catch per effort with a bait fish, and catch per effort without a bait fish. Catch per effort was the average number of brook trout caught in each trap during a 24-hour period. This was only compared for traps that contained a bait fish at some time during the study.

Research suggests that sexually mature brook trout are attracted to traps seeded with mature males better than traps with female attractant fish or with no attractant fish (Young et al. 2001). Based on this work, traps were baited with a sexually mature male brook trout that was placed in the cod end of the hoop net or Fyke net. Originally, bait fish were obtained by angling. After the traps were set, bait fish were caught by the traps. Sexual maturity of brook trout was determined by applying abdominal pressure and checking for presence of eggs or milt. If a mature male fish was captured in the trap, it was left in the trap as an attractant fish for the next day. Bait fish were fin clipped so that they could be recognized each day the trap was checked. Because it was possible for bait fish to escape from traps, bait fish were not present at all times. Baited traps were experimental traps and unbaited traps were control traps.

4.3 Results

Eight pheromone trap locations were used to collect fish in upper Malheur River headwater tributaries. One trap was placed on Meadow Fork, three on Lake Creek, and four on Big Creek. Species caught in the pheromone traps include brook trout, bull trout, redband trout, sculpin, dace (*Rhinichthys spp*.), redside shiner *(Richardsonius balteatus)*, and sucker (*Castostomus spp*.).

Salmonids were caught in all of the traps, and brook trout were the most abundant salmonid. Sculpin, dace, redside shiners, and suckers were only caught from Big Creek trap #4 and are not present in areas where the other traps were located.

4.3.1 Meadow Fork Creek Results

The trap on Meadow Fork was set on September 24, 2003 and fished for 16 days. It was removed on October 9, 2003 because no brook trout were captured. Based on distribution surveys there were very few brook trout in Meadow Fork. The trap collected four bull trout, two redband trout, and one possible hybrid. Bull trout captured ranged from 132 mm to 170 mm and averaged 169 mm. The hybrid measured 147 mm, and the redband trout measured 153 mm and 157 mm.

Figure 4–2. Species collected from pheromone traps placed in Meadow Fork in 2003.

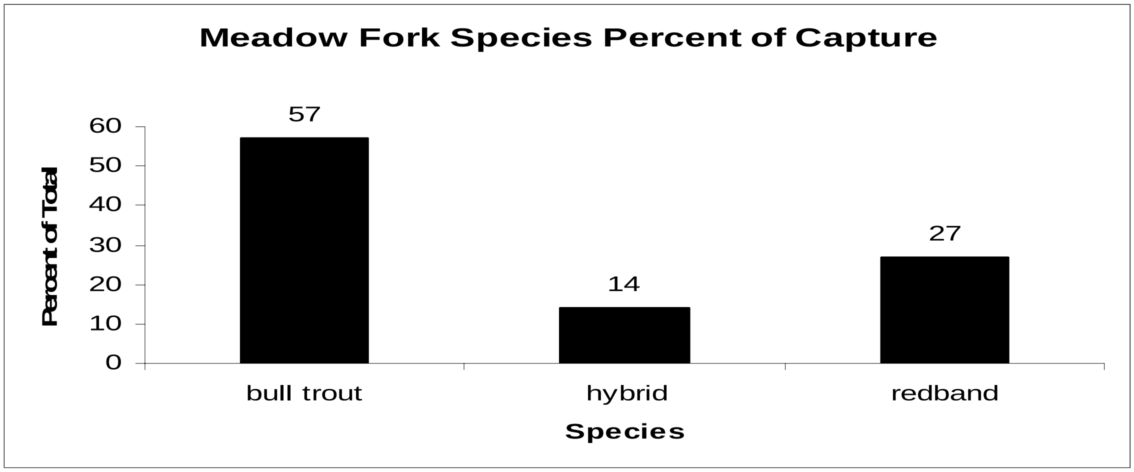


Figure 4–3. Length frequency of bull trout length collected in 2003 from pheromone traps placed in Meadow Fork.

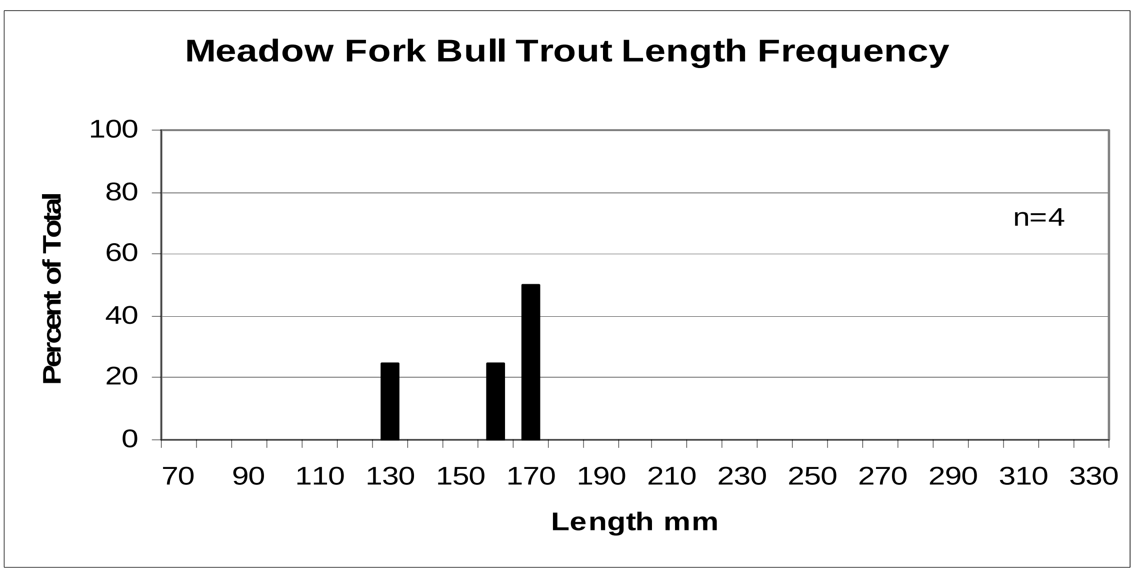


Figure 4–4. Length frequency of bull/brook trout hybrid collected from pheromone traps placed in Meadow Fork in 2003.

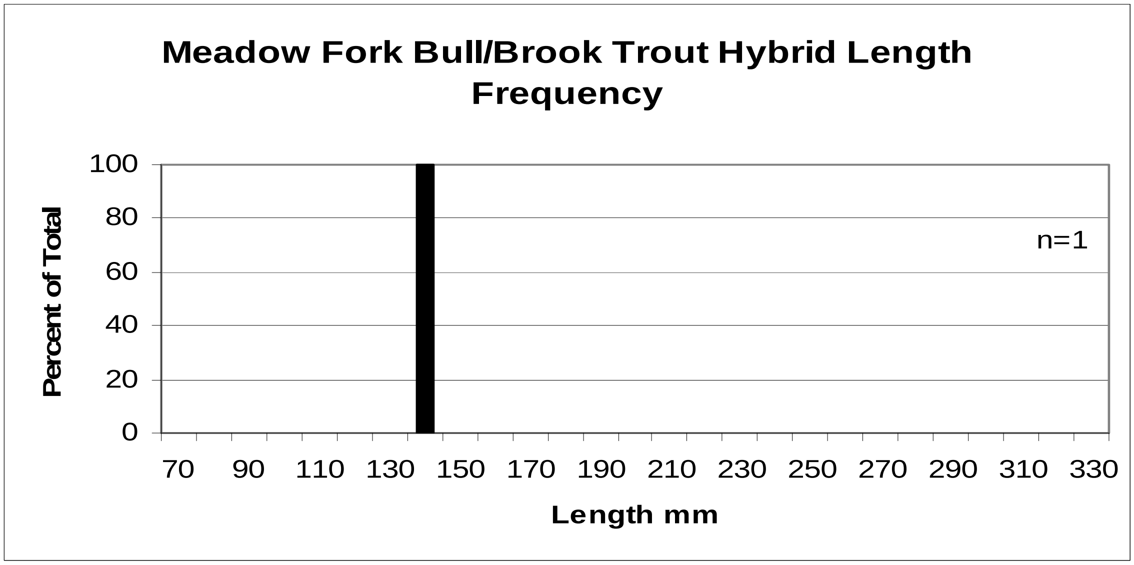
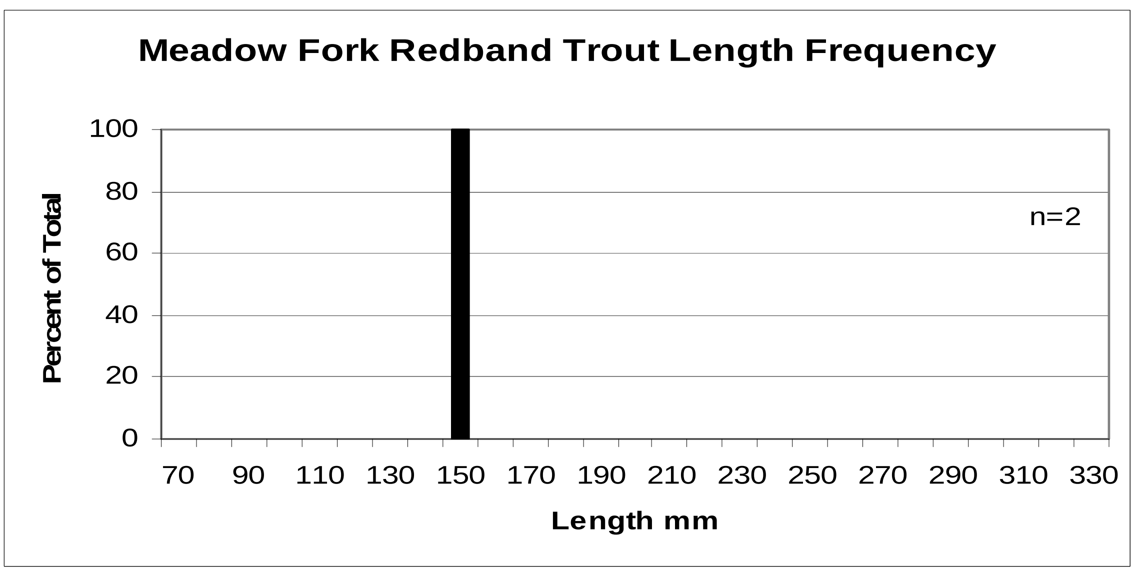


Figure 4–5. Length frequency of redband trout collected from pheromone traps placed in Meadow Fork in 2003.



4.3.2 Lake Creek Results

Lake Creek #1

Lake Creek trap #1 was set on September 24, 2003 and was in use for 16 days. The trap was relocated on October 9 when catch rates dropped below 1 fish/day for over 7 days. The only species collected from Lake Creek trap #1 was brook trout; a total of 22 brook trout were collected. Attractant fish were used in this trap on 4 days. There were 16 males, 2 females, and 3 unidentified brook trout. Brook trout fork length ranged from 143 mm to 237 mm, and averaged 192 mm.

Lake Creek #2

Lake Creek trap #2 was set on October 9, 2003 and was in use for 23 days. This trap was removed on October 31 because of ice accumulation. Only one brook trout was captured from Lake Creek #2. Seed fish were not used in this trap. The brook trout's fork length from Lake Creek trap #2 measured 207 mm.

Lake Creek #3

Lake Creek trap #3 was set on October 9, 2003 and was in place for 23 days. The trap was removed on October 31 due to ice accumulation. Brook trout and redband trout were captured in this trap. A total of 4 brook trout and 1 redband trout were captured with none of the brook trout used as seed fish. Brook trout captured ranged from 109 mm to 161 mm fork length, and averaged 141 mm. The redband trout measured 195 mm fork length.

Figure 4–6. Species collected from pheromone traps placed in Lake Creek in 2003.

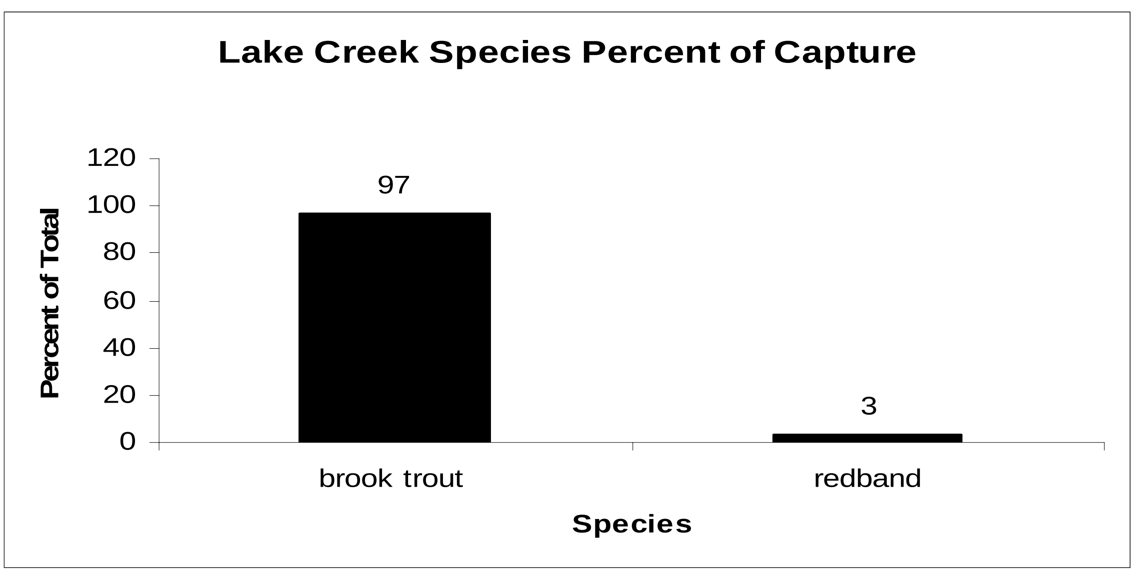


Figure 4–7. Length frequency of brook trout collected from pheromone traps placed in Lake Creek in 2003.

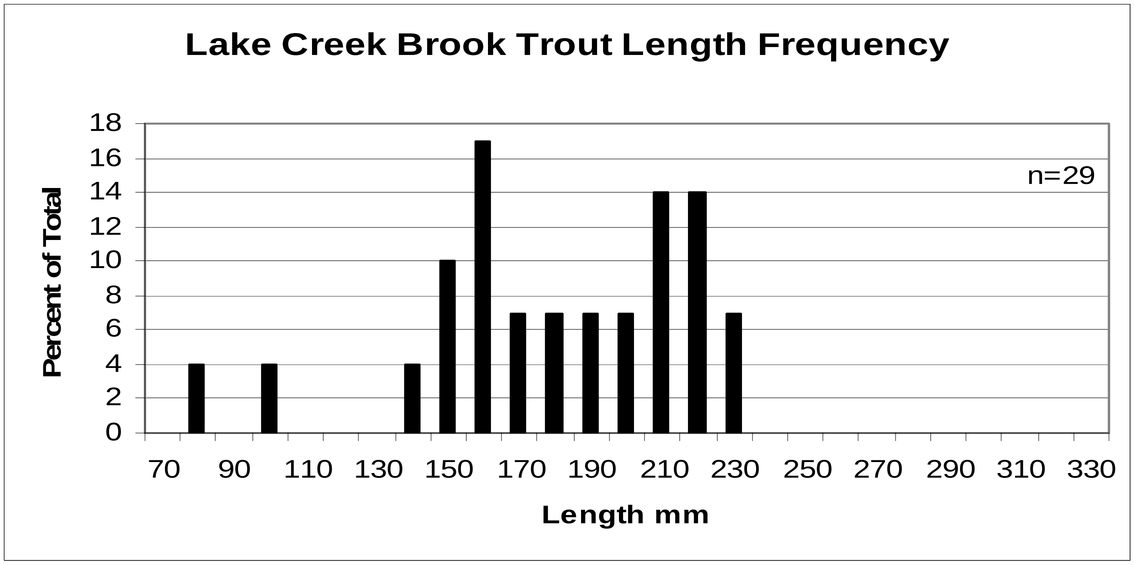
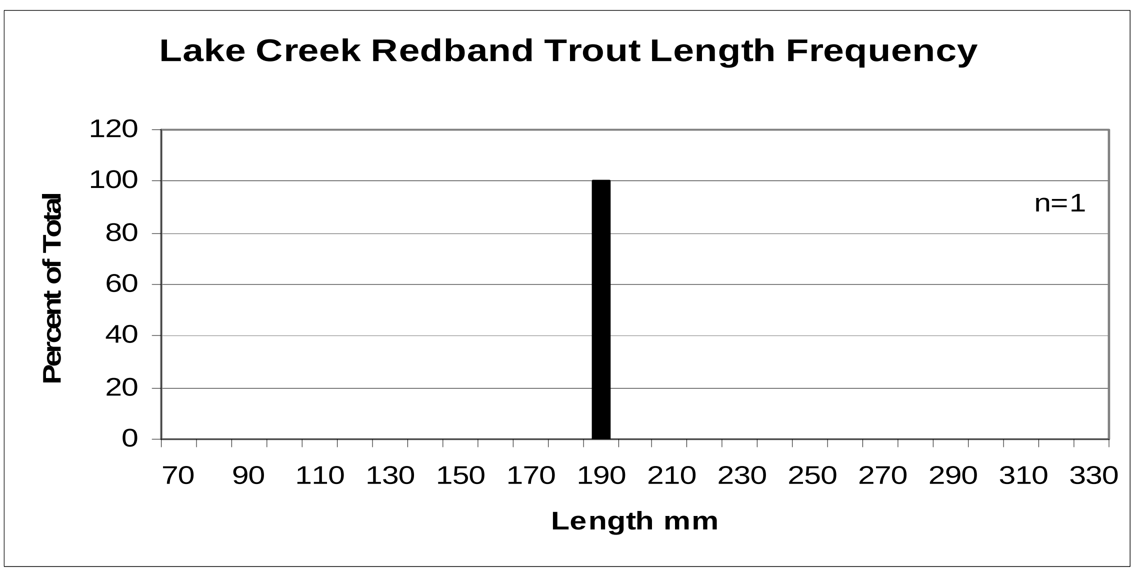


Figure 4–8. Length frequency of redband trout collected from pheromone traps placed in Lake Creek in 2003.



4.3.3 Big Creek Results

Big Creek #1

Big Creek trap #1 was set on September 24, 2003 and was in use for 16 days. This trap was moved on October 9 because of very low numbers of brook trout captured. Two species were captured, including four brook trout and one sculpin. There were 2 males, 1 female, and 1 unidentified brook trout. Seed fish were not used in this trap. Brook trout collected ranged from 117 mm to 190 mm fork length, and averaged 143 mm fork length.

Big Creek #2

Big Creek trap #2 was set on October 9, 2003 and was in use for 22 days. This trap was removed on October 30 because it did not catch any brook trout. Only one redband trout was collected from Big Creek trap #2; it measured 124 mm fork length.

Big Creek #3

Big Creek trap #3 was set on October 30, 2003 and was removed on November 1 because of ice accumulation. There were two brook trout and one redband trout collected from Big Creek trap #3. The brook trout measured 92 mm and 101 mm fork length. The redband trout measured 122 mm fork length.

Big Creek #4

Big Creek trap #4 was set September 24, 2003 and was in place for 39 days. The trap was removed on November 1 because of ice accumulation. Big Creek trap #4 captured fish throughout the study period, so it remained in one location. Fish captured in Big Creek #4 include 49 brook trout, 5 bull trout, 25 redband trout, 6 sculpin, 2 dace, 8 redside shiner, and 3 suckers. Of the brook trout, there were 16 males, 13 females, and 20 unidentified. Seed fish were used in this trap on 9 days. Brook trout collected in Big Creek trap #4 ranged from 73 mm to 335 mm fork length, and averaged 168 mm fork length. Bull trout collected ranged from 180 mm to 279 mm fork length, and averaged 213 mm fork length. Redband trout collected ranged from 77 mm to 275 mm fork length, and averaged 151 mm fork length.

Figure 4–9. Species collected from pheromone traps placed in Big Creek in 2003.

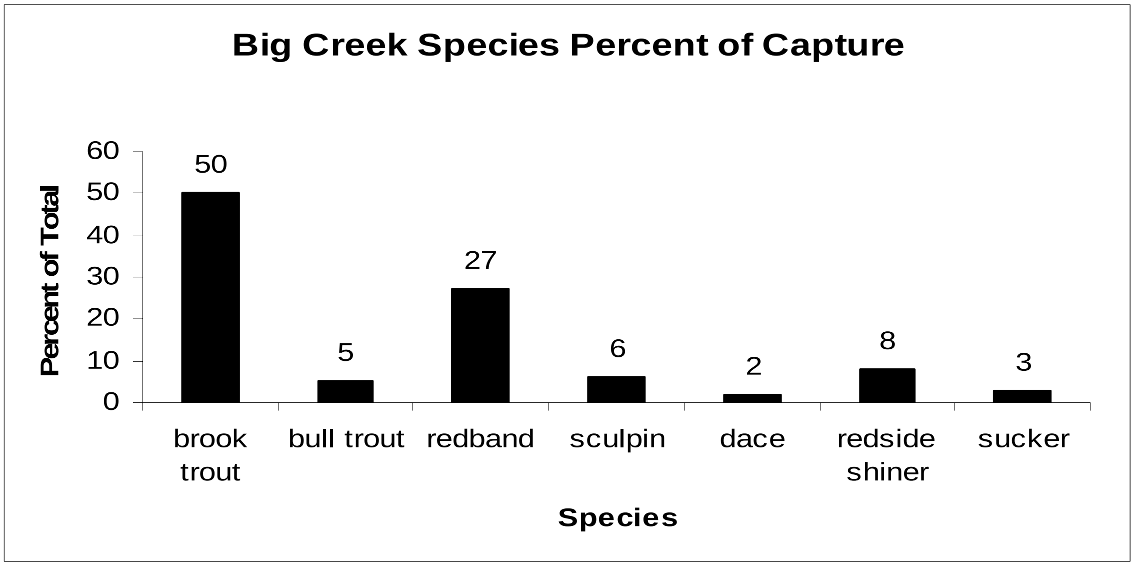


Figure 4–10. Length frequency of brook trout collected from pheromone traps placed in Big Creek in 2003.

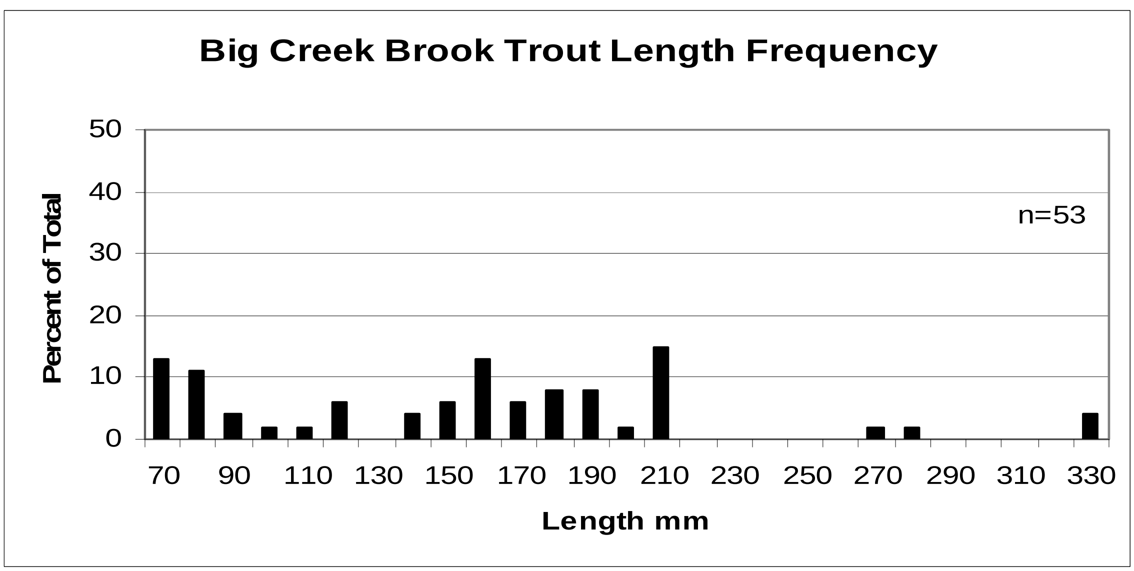


Figure 4–11. Length frequency of bull trout collected from pheromone traps place in Big Creek in 2003.

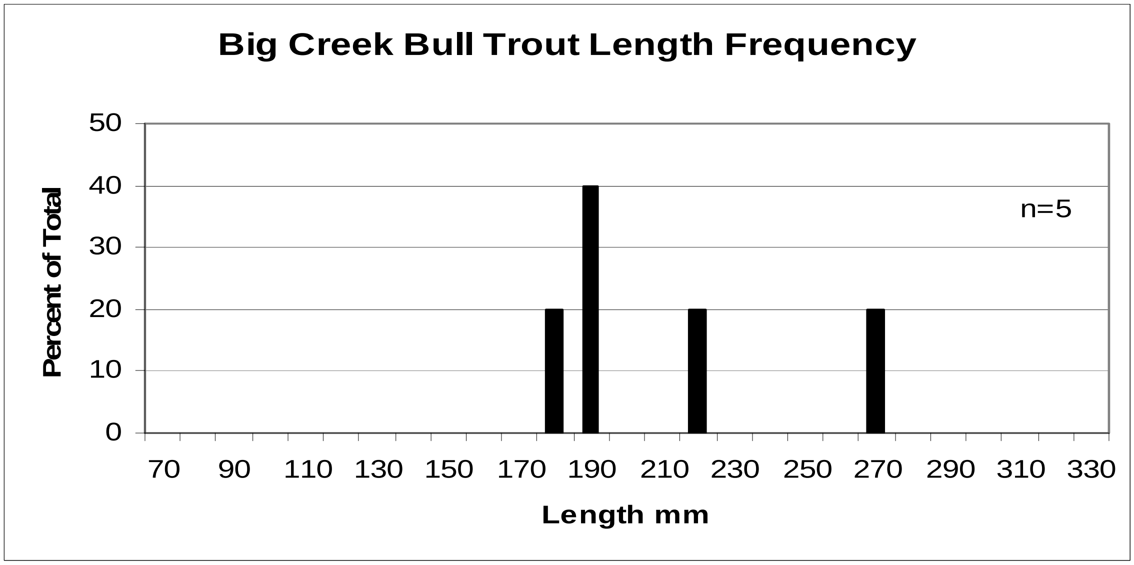
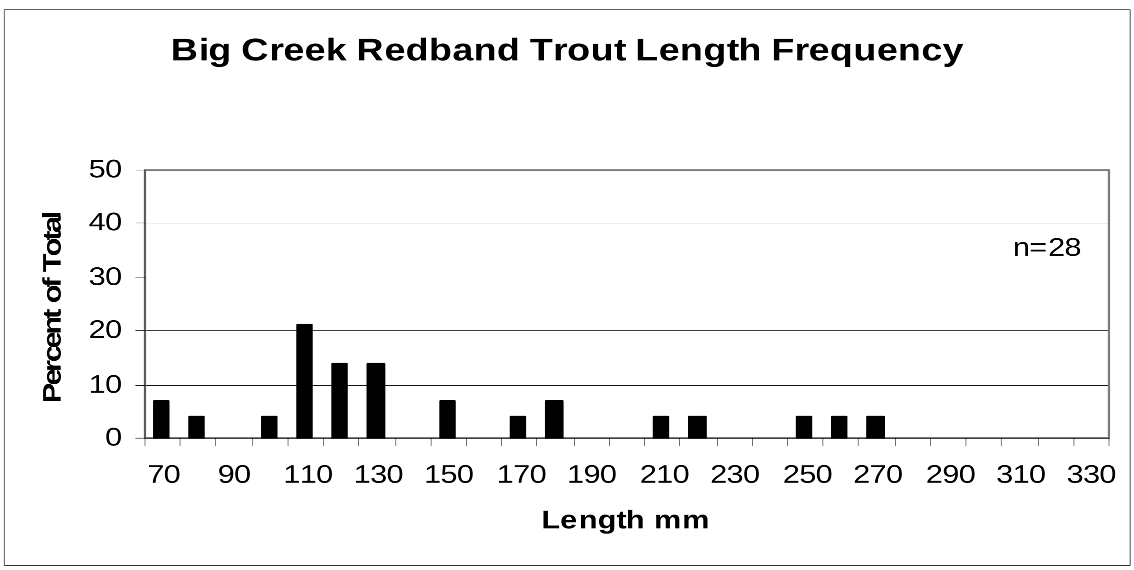


Figure 4–12. Length frequency of redband trout collected from pheromone traps placed in Big Creek in 2003.



4.3.4 Use of Attractant Fish

Lake Creek trap #1 trap and Big Creek trap #4 contained attractant fish. On Lake Creek, the trap was set for 16 days; 12 days without an attractant fish and 4 days with. The catch rate without a bait fish was 1.75 brook trout/day and with a bait fish it was 0.25 brook trout/day. On Big Creek, the trap was set for 36 days, 27 days without an attractant fish and 9 days with. The catch rate without a bait fish was 1.11 brook trout/day, and with a bait fish it was 1.55 brook trout/day. As shown by the catch rates for these two traps, catch rates were inconsistent.

Total effort or trap days for traps containing an attractant fish at some point during the study was 51 days; 39 of the days without an attractant fish, and 12 days with. Catch per effort without a bait fish was an average of 1.31 brook trout per day, and catch per effort with a bait fish averaged of 1.25 brook trout per day. Attractant fish were placed in the cod end of the nets and were able to escape. The longest a bait fish remained in trap was four days and the shortest was less than 1 day.

During the time that Lake Creek trap #1 and Big Creek trap #4 were in place, a total of 71 brook trout were captured: 33 male, 15 female, and 23 not identified. There were also 5 bull trout and 26 redband trout captured.

4.4 Discussion

The purpose of this research was to evaluate the use of pheromonal baiting as a viable option for selective removal of brook trout in areas of sympatry with bull trout in the Upper Malheur watershed. To accomplish this, traps were placed at eight locations for a total of 148 trap days. When possible, traps were baited with sexually mature brook trout. Bait fish were not used enough for accurate conclusions to be made.

The biggest obstacle encountered in this research was keeping attractant fish in the traps. Attractant fish were only contained in the cod end of the trap. Approximately 50 percent of attractant fish escaped in the first 24 hours, and another 40 percent escaped within the next 24 hours. In the future, attractant fish will be placed in minnow traps, which will then be placed in the cod end of the hoop net. Using minnow traps will eliminate the risk of attractant fish escapement.

Much of this study is based on research by Michael K. Young using pheromone baiting in areas where cutthroat trout have been displaced by brook trout. Young's research found that sexually mature males attract other fish best when used as bait fish and that capture of males is 10 times more likely than that of females (Young et al. 2001). Results for Burns Paiute Fish and Wildlife research were limited, and do not allow comparisons to Dr. Young's research.

This was the first year of pheromonal baiting on the upper Malheur River and it helped develop a protocol for future use. During the 2004 field season, more traps will be used to increase overall effort. Increasing the number of traps is feasible because all traps are in close proximity.

4.5 Acknowledgements

A special thanks to the U.S. Fish and Wildlife Service who funded this project for the Burns Paiute Fish and Wildlife Department. We would also like to thank Eric Hawley, Kevin Fenn, Jason Fenton, and Lawrence Schwabe for checking and maintaining the traps.

4.6 References

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5.

STREAM TEMPERATURE MONITORING ON STREAMS FLOWING THROUGH THE LOGAN VALLEY WILDLIFE MITIGATION PROPERTY, 2003.

by Lawrence Schwabe,

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Burns Paiute Tribe, Burns, OR

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5. STREAM TEMPERATURE MONITORING ON STREAMS FLOWING THROUGH THE LOGAN VALLEY WILDLIFE MITIGATION PROPERTY, 2003.

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5.1. Introduction

The Burns Paiute Tribe (the Tribe), U.S. Forest Service (USFS), U.S. Bureau of Land Management (BLM), and Oregon Department of Fish and Wildlife (ODFW) have coordinated efforts and have maintained stream temperature sites in the upper Malheur River drainage (Upper Malheur watershed). The information collected provides land and fish management agencies stream temperature trend data.

The Eastern Oregon Agricultural Research Center in Burns, Oregon (EOARC), a cooperative research effort between Oregon State University and the USDA Agricultural Research Service, has been monitoring stream temperatures on Lake Creek in response to flood irrigation (Boyd and Zamora 2003). EOARC conducted pre-irrigation stream temperature monitoring of Lake Creek in 2002. EOARC and the Tribe irrigated the meadows in 2003 and continued to monitor stream temperatures in Lake Creek. The theory being tested is that flood irrigation of the meadows in Logan Valley will decrease depth to water table in the meadow and should result in increased groundwater inputs into the stream and increase water storage in the soil profile. The increased ground water inputs into the stream are suspected to decrease water temperatures during the summer months.

The Tribe acquired the Logan Valley Oxbow Ranch in April 2000. The land purchase was funded by the Bonneville Power Administration and is intended to benefit fish and wildlife resources. The restoration of stream channel morphology and natural function is a primary goals stated in the Logan Valley Wildlife Mitigation Plan (Wenick 2002).

The lower reaches of Big and Lake Creeks flow through the deeded land of the Logan Valley land acquisition. These drainages support a population of threatened bull trout (*Salvelinus confluentus)*. The current status of this population of bull trout is at a "high risk of extinction" (Buchanan et al., 1997). Thermal barriers on many Logan Valley tributaries may limit bull trout production in the upper Malheur River watershed (Bowers et al. 1993).

Changes in the composition, vigor, and density of riparian vegetation produce corresponding changes in water temperature (Rosgen, 1996). The goals outlined in the Logan Valley Management Plan will encourage the restoration of native riparian vegetation, stream channel morphology, and will be managed for fish and wildlife populations native to the site and surrounding areas. In 2000, stream temperature sites on the property were established. These sites will be used to monitor the trends of stream temperatures that are associated with the management of Logan Valley. Through the current and future management of Logan Valley, the following is anticipated:

- Decrease in seasonal, maximum stream temperatures.
- Decrease in the daily low and high stream temperatures.

5.2. Methods

The Tribe, ODFW, BLM and USFS have coordinated the effort to strategically place thermographs throughout the Upper Malheur watershed. Five temperature sites on the Logan Valley property have been monitored since 2000 (Table 5-1, Figure 5-1)

A commonly used technique for gathering water temperature is the use of continuous data recorders. "StowAway" and "hobo XT" data loggers manufactured by Onset Computer Inc. were used at stream temperature monitoring sites. Loggers were checked for accuracy using methods recommended by Oregon's Water Quality Monitoring Guide Book (*The Oregon Plan for Salmon and Watersheds,* 1999).

Table 5-1. Names of the five stream temperature sites that have been maintained since 2000.

Site Number	Location
1	Lake Creek below McCoy Creek
2	Lake Creek below Crooked Creek
3	Malheur River below Lake and Big Creek
4	Big Creek approximately 1 mile below the 16 road
5	Big Creek below the 16 road

5.3. Data analysis

Data was analyzed for the five temperature sites identified. Raw data on these five sites collected from 2000 through 2002 and new data analysis in this report has been retrieved from the 2002 Annual Report (Schwabe et al. 2003).

Temperature data were analyzed based on rolling daily maximum temperatures averaged over a 7-day period that is referred to as a "maximum weekly average temperature" (MWAT). Maximum, minimum, and average daily temperatures have been identified and are illustrated in Appendix A.

Water temperatures are well suited for native salmonids in the late fall, winter and early spring. Through years of data collection, ODFW has concluded that maximum water temperatures usually occur between mid-July through mid-August, but can also occur as early as June and as late as September. ODFW has identified July 15 through August 15 as a critical period for summer rearing in regards to fish rearing (Perkins 1999). Using the identified 32-day critical period, the data was analyzed for the attributes listed below.

5.3.1. Annual Water Temperature Average

Daily average stream temperature data collected each year at the same site will be averaged for the critical period (July 15 through August 15). Daily average stream temperatures were figured by averaging the daily maximum and minimum stream temperatures. “Annual Water Temperature Average” was figured by taking the average of each daily average for the days identified in the critical period.

5.3.2. Annual Water Temperature Maximum

Daily maximum stream temperature data collected each year at the same site will be averaged for the critical period (July 15 through August 15). This will be the “Annual Water Temperature Maximum.”

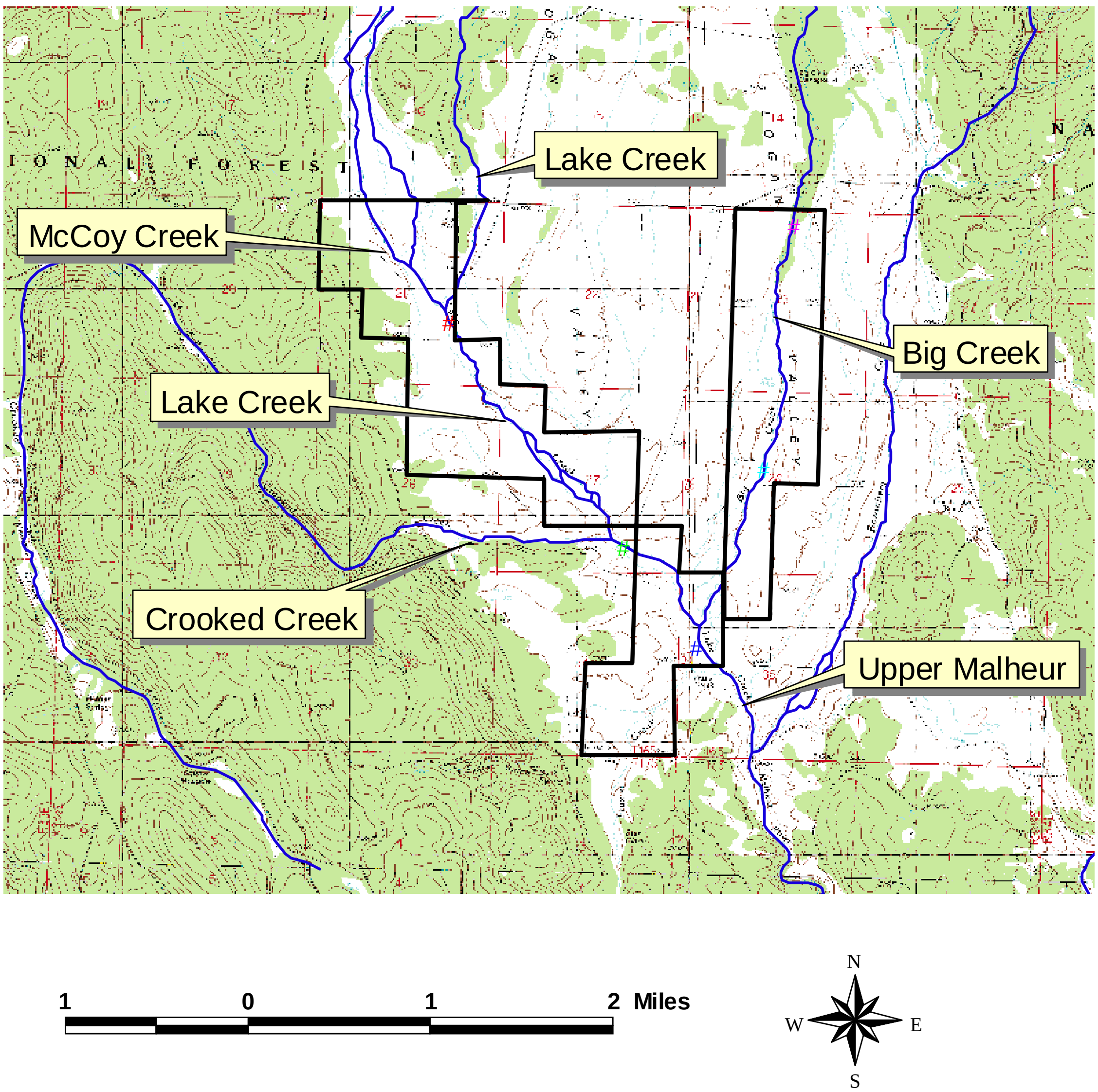
5.3.3. Annual Water Temperature Minimum

Daily minimum stream temperature data collected each year at the same site will be averaged for the critical period (July 15 through August 15). This will be the “Annual Water Temperature Minimum.”

5.3.4. Annual ΔT

Daily temperature ranges, or the differences between daily maximums and daily minimums, were calculated for each day at each site and averaged for the critical period (July 15 through August 15). This is the “Annual ΔT.”

Figure 5–1. Locations of Temperature Probes in Logan Valley.



Temperature Probes

- # **Lake Creek below McCoy Creek**
- # **Lake Creek below Crooked Creek**
- # **Upper Malheur River below Lake and Big Creeks**
- # **Big Creek approx. 1 Mile Below 16rd**
- # **Big Creek at 16 rd**

5.4. Results

In 2003, five stream temperature sites were activated with an 80 percent success rate of retrieving data. See Table 5-2. Data from sites 1 and 2 were collected by EOARC. Data from Site 4 was not included in the analysis because the temperature probe floated to the surface and recorded false stream temperatures. (Other common reasons that stream temperature data are lost are malfunction of stream temperature loggers and loggers lost due to high water.)

All sites exceeded Oregon Department of Environmental Quality (ODEQ) stream temperature standards the stream temperature standard for bull trout the first week of data collection (Table 5-3). The Malheur River site (site 3) was noted to be the only site to exceed the ODEQ general salmonid standard the first week of data collection. The Lake Creek sites (sites 1 and 2) exceeded ODEQ temperature standards more frequently than sites on Big Creek and Malheur River.

Table 5-2. Stream temperature probe sites on the BPT land acquisition property in the Upper Malheur River Subbasin in 2003.

Maximum temperatures are noted both for the year and week and the dates these temperatures occurred.

Site	Max. Temp (°C)	Date of Max. Temp.	MWAT (°C)	Week of MWAT
Site 1 (Upper Lake Cr.)	26.04	7/21/03	25.47	7/15/03 to 7/21/03
Site 2 (Lower Lake Cr.)	23.26	7/20/03	21.87	7/14/03 to 7/20/03
Site 3 (Malheur River Site)	23.81	7/21/03	23.35	7/17/03 to 7/23/03
Site 4 (Lower Big Cr.)	n/a	n/a	n/a	n/a
Site 5 (Upper Big Cr.)	19.87	7/30/03	19.28	7/16/03 to 7/22/03

Table 5-3. Number of days the Maximum Weekly Average Temperature (MWAT) exceeded the DEQ stream temperature standard at five sites on the wildlife mitigation property in Logan Valley, OR.

The temperature criteria for streams with bull trout is 10 °C and for other salmonids the criteria is 17.8 °C.

Site	Number of MWAT days >10 °C	Number of MWAT days >17.8 °C	No. of days site was monitored
Site 1 (Upper Lake Cr.)	134*	88	140
Site 2 (Lower Lake Cr.)	134*	101	140
Site 3 (Malheur River Site)	119*	44*	132
Site 4 (Lower Big Cr.)	n/a	n/a	n/a
Site 5 (Upper Big Cr.)	118*	17	134
* First week of data exceeded the DEQ standard for temperature.			

5.4.1. Annual Water Temperature Average

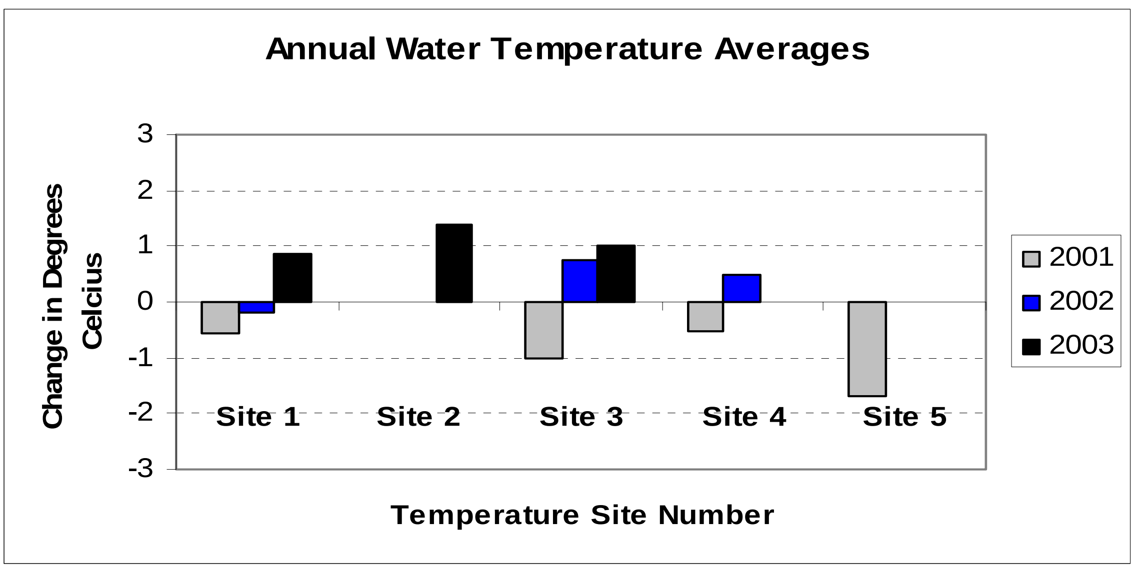
"Annual Water Temperature Average" (AWT Average) was figured for all sites from 2000 through 2003. Figure 5-2 is the annual average water temperature for the mitigation property managed by the Tribe. Of the 4 years of data collected at these sites, all reported record high annual water temperature averages (Table 5-4); AWT Average is the average of the daily averages in the critical period (July 15 to August 15). Unseasonable warm summer temperatures in the region maybe the key influence in these increased temperature values.

Table 5-4. Annual Water Temperature Averages in °C for Logan Valley Streams in Oregon from 2000 through 2003.

Site	2000	2001	2002	2003
Site 1 (Upper Lake Cr.)	17.44	16.88	16.69	17.54
Site 2 (Lower Lake Cr.)	18.80	n/a	17.59	18.99
Site 3 (Malheur River Site)	15.24	14.21	14.96	15.99
Site 4 (Lower Big Cr.)	14.06	13.52	14.01	n/a
Site 5 (Upper Big Cr.)	12.48	10.79	n/a	13.24

Figure 5–2. Comparison between the Annual Water Temperature Averages for each temperature monitoring site in Logan Valley, Oregon.

The year color coded on the graph was compared to the Annual Water Temperature Average figured the preceding year. Change in temperature (°C) is illustrated in the graph.



5.4.2. Annual Water Temperature Maximums

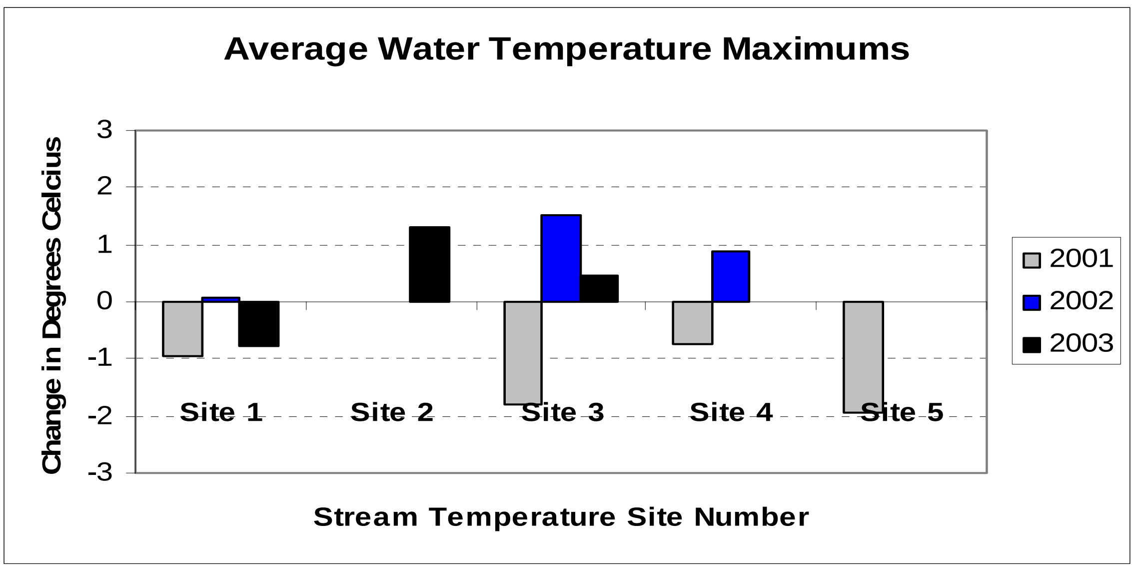
"Annual Water Temperature Maximum" (AWT Maximum) is an average of daily maximum temperatures recorded through the critical period (July 15 to August 15). These generally increased in 2003 compared to 2002. Of the 4 years of data collection at these sites, Upper Big Creek (Site 5) and the Malheur River (Site 3) recorded record annual water temperature maximums (Table 5-5). The two Lake Creek temperature probes did not report record water temperature maximums. Though the AWT Maximum recorded at lower Lake Creek (Site 2) was higher than that of 2002, the upper Lake Creek site (Site 1) recorded a decrease in AWT Maximums (Figure 5-3).

Table 5-5. Annual Water Temperature Maximums in ^{o}C for Logan Valley Streams in Oregon from 2000 through 2003.

Site	2000	2001	2002	2003
Site 1 (Upper Lake Cr.)	23.75	22.79	22.87	22.11
Site 2 (Lower Lake Cr.)	24.27	n/a	22.80	24.11
Site 3 (Malheur River Site)	20.84	19.03	20.54	21.01
Site 4 (Lower Big Cr.)	19.40	18.66	19.53	n/a
Site 5 (Upper Big Cr.)	16.96	15.03	NA	17.49

Figure 5–3. Comparison between the Annual Water Temperature Maximums for each temperature monitoring site in Logan Valley, Oregon

The year color coded on the graph was compared to the Annual Water Temperature Maximum figured the preceding year. Change in temperature (^{o}C) is illustrated in the graph.



5.4.3. Annual Water Temperature Minimums

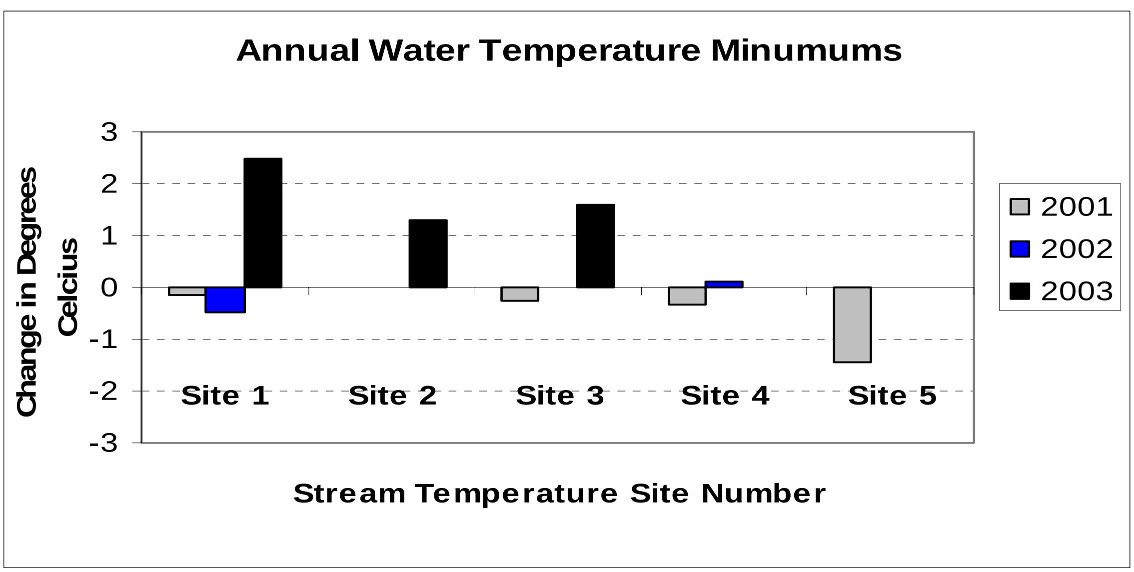
"Annual Water Temperature Minimum" (AWT Minimum) is an average of the daily minimum temperatures recorded through the critical period (July 15 to August 15). They increased in 2003 compared to 2002. Of the 4 years of data collected at these sites, all reported record-high AWT Minimums (Table 5-6). The upper Lake Creek site had the largest increase in AWT Minimum in 2003 compared to 2002 (Figure 5-4).

Table 5-6. Annual Water Temperature Minimums (°C) for streams in Logan Valley, Oregon, 2000- 2003.

Site	2000	2001	2002	2003
Site 1 (Upper Lake Cr.)	11.13	10.97	10.50	12.97
Site 2 (Lower Lake Cr.)	13.32	n/a	12.39	13.68
Site 3 (Malheur River Site)	9.63	9.38	9.38	10.96
Site 4 (Lower Big Cr.)	8.72	8.38	8.50	n/a
Site 5 (Upper Big Cr.)	8.01	6.55	n/a	9

Figure 5–4. Comparison between the Annual Water Temperature Minimums for each temperature monitoring site in Logan Valley, Oregon.

The year color coded on the graph was compared to the Annual Water Temperature Minimum figured the preceding year. Change in temperature (^{o}C) is illustrated in the graph



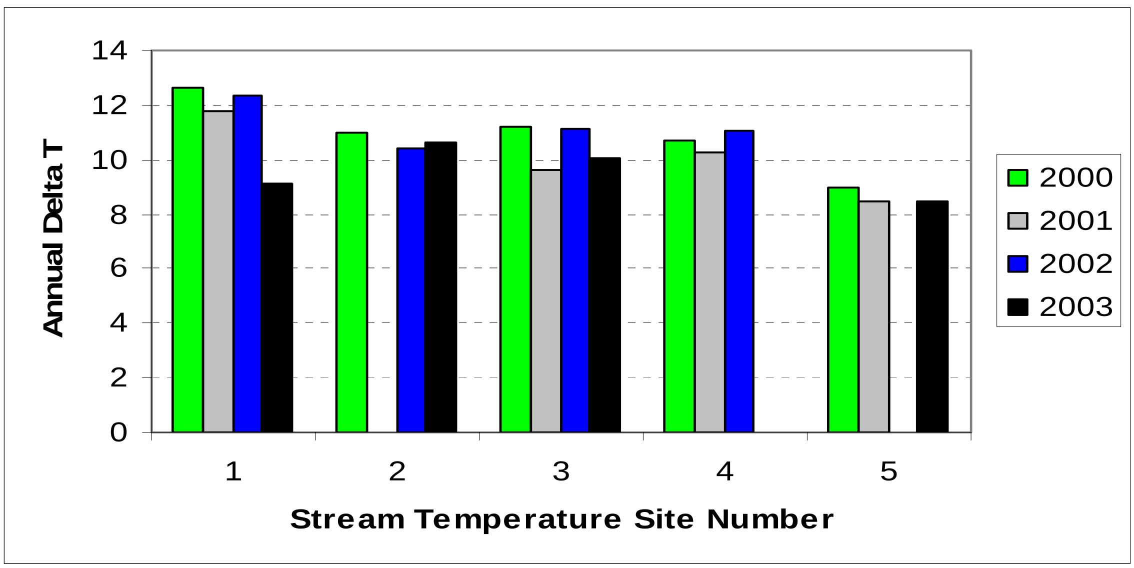
5.4.4. Annual ΔT

The daily average temperature range, or Annual ΔT, for the critical period (July 15 to August 15) remained relatively constant except for the upper Lake Creek site (Site 1) (Figure 5-5). The ΔT at the Upper Lake Creek decreased 3.24 °C resulting in a smaller temperature range in 2003 compared to 2002 (Table 5-7).

Table 5-7. Annual ΔT (daily average temperature range) in °C for critical period (July 15 to August 15).

Site	2000	2001	2002	2003
Site 1 (Upper Lake Cr.)	12.62	11.8	12.38	9.14
Site 2 (Lower Lake Cr.)	10.95	n/a	10.41	10.62
Site 3 (Malheur River Site)	11.2	9.64	11.16	10.05
Site 4 (Lower Big Cr.)	10.68	10.28	11.03	n/a
Site 5 (Upper Big Cr.)	8.95	8.47	n/a	8.49

Figure 5–5. Annual ΔT (daily average temperature range), by site and year. Annual ΔT is the average range of



temperatures recorded for the critical period (July 15 to August 15).

5.5. Discussion

Preliminary results suggest that flood irrigation of the meadows adjacent to Lake Creek do appear to provide a cooling effect to Lake Creek (Boyd and Zamora 2003). In support of the current irrigation study on the Logan Valley Mitigation property, temperature probes on Lake Creek did not report record AWT Maximums compared to the Malheur River site (Site 3) and upper Big Creek Site (Site 5). Furthermore, upper Lake Creek (Site 1) reported a decrease in the AWT Maximum that is located within the irrigation section of Lake Creek. This attribute, nevertheless, was not shared with the lower Lake Creek temperature site (Site 2) which also lies within the irrigated section of stream. Groundwater inputs from the ditch may not be reaching the lower Lake Creek site due to the relatively large distance between the ditch and the channel. This was evident in the data collected by the groundwater monitoring stations as groundwater depth increased at the lower stations of Lake Creek (Boyd and Zamora 2003).

Annual water temperature averages increased at all sites including upper Lake Creek (Site 1). This is largely due to the increase in the AWT Minimums. The upper Lake Creek site (Site 1) had the largest increase in AWT Minimum. With a decrease in AWT Maximum and increase in AWT Minimum, ΔT (daily average temperature range) at the upper Lake Creek site narrowed considerably in 2003.

A relationship between instream summer flow and irrigation was not detected (Boyd and Zamora 2003). Though groundwater levels have increased, at this time it appears that return flow into the stream has minimal effect on instream flows. Return flow or seepage back into the stream is suspected to enhance sedge growth. An increase in sedge communities are suspected to capture additional sediments accelerating the channel aggradation process. The effects of return flows on sedge communities are not being monitored. Baseline Rosgen channel conditions and sites have been identified on Lake Creek in 2003 and are scheduled to be revisited in 2008.

This first year of irrigation and water temperature monitoring occurred in 2003. A minimum of one additional year of research is needed to make sound conclusions on the effect of flood irrigation has on Lake Creek. EOARC will lead this research in 2004.

Currently, three ditches are used to irrigate the meadows of Lake Creek. It is not determined if the cooling effect previously discussed on Lake Creek was a result of one, two, or all three irrigation ditches. In respect to stream temperatures and instream flows, addition research is recommended on the effect each ditch has on groundwater levels and stream temperatures. This information will assist the management in the use and non-use of particular irrigation ditches on the property. Other esthetic resources need to be considered such as the health of wildlife meadow habitat in respect to the irrigation management on the Tribal mitigation property.

The upper Lake Creek site is located within the irrigation portion of stream. This site was selected due to a clearly defined existing channel of Lake Creek but lacks monitoring inflow data that cannot be controlled by the management of the mitigation property. Upstream of this site, Lake Creek flows onto the property in various small channels and annual flow appears to be affected by management upstream of the mitigation property. Three main flows channels have been identified that flow onto the North boundary of the mitigation property. The monitoring of the stream temperature inflow onto the property is highly recommended. EOARC have been conducting stream temperature monitoring on two of these inputs. With recent discussions with the Tribe and EOARC, stream temperature monitoring of the third inflow site will be conducted in 2004. It is highly recommended that these sites be included in the long term monitoring plan of the property.

As riparian and channel conditions improve, it is expected that aquatic habitat, stream temperatures and flows will change. The established monitoring sites and recommended new sites will provide trend data in respect to stream temperatures. The following list is additional recommended monitoring activities that need to be conducted concurrently with the stream temperature monitoring to adequately measure aquatic habitat trends on the Logan Valley mitigation property:

- Establish and maintain stream discharge sites to monitor flow changes over time.
- Continue monitoring stream temperature sites on Logan Valley.
- Collect air temperature and precipitation data from Logan Valley.

5.6. Acknowledgements

A special thanks to the Bonneville Power Administration which funded this project for the Burns Paiute Tribe Fish and Wildlife Department.

5.7. References

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Appendix 5-A. Stream temperature results from five sites in Logan Valley (2003)

Table 5-8. Stream temperature results from 2003 water temperature sites in Logan Valley, Site 1, Upper Lake Creek

Site 1: Upper Lake Creek
Deployed 5/18/2003; Retrieved 10/04/2003
Maximum Temp. 26.04 °C on 7/21/2003
MWAT: 25.47 °C from 7/15/03 to 7/21/03

Date	Max	MWAT	Min	Avg.
5/18/2003	15.64		2.35	8.99
5/19/2003	15.97		5.03	10.50
5/20/2003	16.64		4.76	10.70
5/21/2003	19.15		5.80	12.48
5/22/2003	19.07		6.15	12.61
5/23/2003	12.66		6.57	9.61
5/24/2003	14.15	16.18	6.23	10.19
5/25/2003	19.49	16.73	5.03	12.26
5/26/2003	19.15	17.19	6.23	12.69
5/27/2003	19.40	17.58	6.72	13.06
5/28/2003	14.51	16.92	8.41	11.46
5/29/2003	15.89	16.46	6.30	11.10
5/30/2003	17.64	17.17	5.11	11.37
5/31/2003	18.06	17.73	6.23	12.14
6/1/2003	17.98	17.52	5.03	11.50
6/2/2003	18.06	17.36	5.45	11.75
6/3/2003	18.50	17.23	5.45	11.97
6/4/2003	19.33	17.92	6.85	13.09
6/5/2003	18.65	18.31	6.72	12.69
6/6/2003	19.07	18.52	7.74	13.41
6/7/2003	18.32	18.56	7.06	12.69
6/8/2003	18.06	18.57	6.99	12.52
6/9/2003	17.64	18.51	6.57	12.10
6/10/2003	17.13	18.31	6.72	11.93
6/11/2003	17.00	17.98	8.91	12.95
6/12/2003	18.40	17.94	7.66	13.03
6/13/2003	19.49	18.00	8.68	14.08
6/14/2003	19.49	18.17	7.66	13.58
6/15/2003	20.76	18.56	8.41	14.58
6/16/2003	17.31	18.51	10.33	13.82
6/17/2003	16.38	18.40	9.24	12.81
6/18/2003	13.82	17.95	8.00	10.91
6/19/2003	14.15	17.34	5.88	10.01
6/20/2003	16.38	16.90	5.88	11.13
6/21/2003	12.41	15.88	5.88	9.14
6/22/2003	16.05	15.21	5.80	10.93
6/23/2003	18.48	15.38	6.49	12.48
6/24/2003	20.08	15.91	7.40	13.74
6/25/2003	20.67	16.89	8.91	14.79
6/26/2003	22.54	18.09	9.91	16.22
6/27/2003	19.83	18.58	10.92	15.37
6/28/2003	21.85	19.93	10.59	16.22
6/29/2003	18.40	20.26	10.59	14.49
6/30/2003	19.33	20.38	9.50	14.41
7/1/2003	19.41	20.29	9.58	14.49
7/2/2003	21.17	20.36	9.24	15.21
7/3/2003	21.51	20.21	9.84	15.67
7/4/2003	22.54	20.60	10.59	16.56
7/5/2003	22.20	20.65	10.67	16.43
7/6/2003	22.11	21.18	12.07	17.09
7/7/2003	23.58	21.79	10.59	17.08
7/8/2003	24.19	22.47	11.67	17.93
7/9/2003	24.71	22.97	12.66	18.69
7/10/2003	23.84	23.31	13.41	18.62
7/11/2003	22.89	23.36	13.48	18.18
7/12/2003	23.58	23.55	12.00	17.79
7/13/2003	23.49	23.75	12.33	17.91
7/14/2003	23.93	23.80	13.41	18.67
7/15/2003	25.42	23.98	13.48	19.45
7/16/2003	24.63	23.97	13.89	19.26
7/17/2003	25.34	24.18	14.48	19.91
7/18/2003	25.34	24.53	15.30	20.32
7/19/2003	25.78	24.84	14.07	19.92
7/20/2003	25.78	25.17	15.72	20.75
7/21/2003	26.04	25.47	17.05	21.54
7/22/2003	23.23	25.16	18.06	20.64
7/23/2003	23.23	24.96	15.97	19.60
7/24/2003	21.51	24.41	15.56	18.53
7/25/2003	20.16	23.67	8.83	14.50
7/26/2003	21.77	23.10	12.89	17.33
7/27/2003	23.15	22.73	13.23	18.19
7/28/2003	24.19	22.46	13.82	19.00
7/29/2003	23.49	22.50	13.07	18.28
7/30/2003	21.85	22.30	12.82	17.33
7/31/2003	16.89	21.64	14.89	15.89
8/1/2003	17.72	21.29	14.15	15.93
8/2/2003	20.00	21.04	10.67	15.33
8/3/2003	21.01	20.73	13.74	17.37
8/4/2003	21.43	20.34	12.82	17.12
8/5/2003	21.17	20.01	11.08	16.12
8/6/2003	21.09	19.90	10.67	15.88
8/7/2003	21.01	20.49	10.92	15.96
8/8/2003	21.09	20.97	10.92	16.01
8/9/2003	20.67	21.07	10.59	15.63
8/10/2003	21.09	21.08	11.08	16.08
8/11/2003	21.01	21.02	10.33	15.67

8/12/2003	21.17	21.02	10.17	15.67
8/13/2003	19.67	20.81	12.41	16.04
8/14/2003	20.42	20.73	12.07	16.24
8/15/2003	21.09	20.73	10.33	15.71
8/16/2003	22.20	20.95	11.26	16.73
8/17/2003	18.06	20.51	12.41	15.23
8/18/2003	21.25	20.55	11.00	16.12
8/19/2003	14.97	19.66	10.59	12.78
8/20/2003	17.39	19.34	13.15	15.27
8/21/2003	20.08	19.29	12.41	16.24
8/22/2003	21.09	19.29	10.92	16.01
8/23/2003	21.94	19.25	11.26	16.60
8/24/2003	19.33	19.43	11.41	15.37
8/25/2003	21.17	19.42	12.00	16.58
8/26/2003	20.58	20.22	10.25	15.42
8/27/2003	20.42	20.66	10.59	15.50
8/28/2003	19.75	20.61	8.83	14.29
8/29/2003	19.49	20.38	8.91	14.20
8/30/2003	20.08	20.12	9.91	15.00
8/31/2003	20.50	20.28	10.33	15.41
9/1/2003	20.84	20.23	10.67	15.75
9/2/2003	17.23	19.76	11.75	14.49
9/3/2003	18.99	19.55	11.08	15.03
9/4/2003	20.76	19.70	11.41	16.08
9/5/2003	15.56	19.13	9.84	12.70
9/6/2003	13.48	18.19	9.42	11.45
9/7/2003	9.50	16.62	7.33	8.41
9/8/2003	14.81	15.76	7.74	11.28
9/9/2003	16.97	15.72	8.34	12.65
9/10/2003	16.56	15.38	9.09	12.82
9/11/2003	15.15	14.57	4.76	9.95
9/12/2003	15.30	14.54	4.76	10.03
9/13/2003	15.15	14.78	8.49	11.82
9/14/2003	12.00	15.13	6.64	9.32
9/15/2003	13.07	14.88	5.11	9.09
9/16/2003	13.74	14.42	3.91	8.82
9/17/2003	14.48	14.12	5.19	9.83
9/18/2003	14.55	14.04	5.03	9.79
9/19/2003	14.89	13.98	4.50	9.69
9/20/2003	15.56	14.04	4.76	10.16
9/21/2003	15.30	14.51	5.03	10.17
9/22/2003	15.56	14.87	3.91	9.73
9/23/2003	15.23	15.08	3.64	9.43
9/24/2003	17.72	15.54	6.23	11.97
9/25/2003	17.72	15.99	6.72	12.22
9/26/2003	17.80	16.41	6.99	12.39
9/27/2003	15.56	16.41	7.25	11.40
9/28/2003	16.30	16.55	6.64	11.47
9/29/2003	14.55	16.41	6.15	10.35
9/30/2003	17.05	16.67	9.24	13.15
10/1/2003	15.23	16.31	5.96	10.59
10/2/2003	15.89	16.05	6.23	11.06
10/3/2003	15.30	15.70	8.83	12.07
10/4/2003	16.30	15.80	7.33	11.81

Table 5-9. Stream temperature results from 2003 water temperature sites in Logan Valley, Site 2, Lower Lake Creek.

Site 2. Lower Lake Creek

Date Deployed:

Date Retrieved:

Maximum Temperature: 23.26 °C

Date of Maximum Temperature: 7/20/2003

MWAT: 21.87 ^oC

Date of MWAT: 7/14/03 to 7/20/03

Date	Low	High	Avg.	MWAT
05/18/03	3.11	16.82	9.97	
05/19/03	6.23	17.46	11.85	
05/20/03	6.00	18.34	12.17	
05/21/03	7.17	21.02	14.10	
05/22/03	7.63	20.04	13.84	
05/23/03	8.17	13.82	11.00	
05/24/03	7.63	15.87	11.75	17.62
05/25/03	6.23	21.02	13.63	18.22
05/26/03	7.83	20.69	14.26	18.69
05/27/03	8.71	21.19	14.95	19.09
05/28/03	10.42	17.14	13.78	18.54
05/29/03	8.41	17.62	13.01	18.19
05/30/03	6.39	18.65	12.52	18.88
05/31/03	7.63	19.56	13.60	19.41
06/01/03	6.16	19.23	12.69	19.15
06/02/03	6.54	19.72	13.13	19.01
06/03/03	6.54	20.04	13.29	18.85
06/04/03	8.10	20.69	14.39	19.36
06/05/03	7.94	19.88	13.91	19.68
06/06/03	8.87	20.37	14.62	19.93
06/07/03	8.10	19.39	13.74	19.90
06/08/03	7.94	19.07	13.51	19.88
06/09/03	7.48	19.07	13.28	19.79
06/10/03	7.79	18.10	12.94	19.51
06/11/03	10.11	17.94	14.02	19.12
06/12/03	8.71	19.44	14.07	19.05
06/13/03	9.79	20.78	15.28	19.11
06/14/03	8.71	21.02	14.87	19.34
06/15/03	9.48	22.35	15.92	19.81
06/16/03	11.66	18.42	15.04	19.72
06/17/03	10.11	17.22	13.66	19.59
06/18/03	8.71	15.39	12.05	19.23
06/19/03	6.94	15.39	11.16	18.65
06/20/03	6.78	17.78	12.28	18.22
06/21/03	7.17	13.36	10.27	17.13
06/22/03	6.23	17.22	11.72	16.40
06/23/03	7.63	19.72	13.68	16.58
06/24/03	9.10	21.85	15.47	17.24
06/25/03	10.57	22.69	16.63	18.29
06/26/03	11.50	24.04	17.77	19.52
06/27/03	12.59	20.86	16.72	19.96
06/28/03	11.88	23.02	17.45	21.34
06/29/03	12.28	20.37	16.32	21.79
06/30/03	10.73	21.02	15.88	21.98
07/01/03	11.04	20.69	15.87	21.81
07/02/03	10.73	22.69	16.71	21.81
07/03/03	11.34	23.36	17.35	21.71
07/04/03	11.96	24.50	18.23	22.23
07/05/03	12.28	23.78	18.03	22.34
07/06/03	13.36	23.27	18.32	22.76
07/07/03	12.12	25.00	18.56	23.33
07/08/03	13.21	25.78	19.49	24.05
07/09/03	13.90	26.39	20.15	24.58
07/10/03	14.76	25.52	20.14	24.89
07/11/03	14.60	24.48	19.54	24.89
07/12/03	13.21	25.69	19.45	25.16
07/13/03	13.67	25.43	19.55	25.47
07/14/03	14.44	21.39	17.92	24.95
07/15/03	14.60	27.10	20.85	25.14
07/16/03	15.23	21.66	18.44	24.46
07/17/03	15.71	28.17	21.94	24.84
07/18/03	16.34	27.10	21.72	25.22
07/19/03	14.92	27.63	21.28	25.49
07/20/03	16.82	28.54	22.68	25.94
07/21/03	18.34	28.36	23.35	26.93
07/22/03	19.39	25.95	22.67	26.77
07/23/03	17.22	25.00	21.11	27.25
07/24/03	16.66	23.02	19.84	26.51
07/25/03	9.17	21.52	15.34	25.72
07/26/03	13.75	23.02	18.38	25.06
07/27/03	14.13	24.74	19.43	24.51
07/28/03	14.76	26.57	20.66	24.26
07/29/03	13.67	25.86	19.77	24.24
07/30/03	13.52	23.61	18.56	24.05
07/31/03	N/A	18.02	N/A	23.33
08/01/03	14.76	19.39	17.08	23.03
08/02/03	11.19	23.02	17.10	23.03
08/03/03	14.44	22.69	18.56	22.73
08/04/03	13.75	23.70	18.72	22.32
08/05/03	11.81	23.36	17.58	21.97
08/06/03	11.34	23.69	17.52	21.98
08/07/03	11.34	23.27	17.31	22.73
08/08/03	11.34	23.27	17.31	23.28
08/09/03	10.88	23.27	17.08	23.32
08/10/03	11.66	23.78	17.72	23.48
08/11/03	10.96	23.70	17.33	23.48
08/12/03	10.57	24.22	17.39	23.60
08/13/03	13.06	21.94	17.50	23.35
08/14/03	12.28	22.44	17.36	23.23
08/15/03	10.42	23.87	17.14	23.31
08/16/03	11.81	24.92	18.36	23.55
08/17/03	13.06	20.21	16.63	23.04

08/18/03	11.50	23.36	17.43	22.99
08/19/03	11.19	16.50	13.85	21.89
08/20/03	13.82	18.74	16.28	21.43
08/21/03	13.06	22.44	17.75	21.43
08/22/03	11.50	23.19	17.34	21.33
08/23/03	11.81	23.27	17.54	21.10
08/24/03	11.97	20.53	16.25	21.14
08/25/03	12.43	21.60	17.02	20.89
08/26/03	10.73	21.94	16.33	21.67
08/27/03	11.19	21.94	16.56	22.13
08/28/03	9.33	21.35	15.34	21.97
08/29/03	9.48	21.19	15.33	21.69
08/30/03	10.57	22.19	16.38	21.53
08/31/03	10.88	21.85	16.37	21.72
09/01/03	11.34	22.27	16.80	21.82
09/02/03	12.28	18.58	15.43	21.34
09/03/03	11.50	19.64	15.57	21.01
09/04/03	11.97	22.02	16.99	21.10
09/05/03	10.26	16.34	13.30	20.41
09/06/03	9.64	14.29	11.96	19.28
09/07/03	7.79	10.11	8.95	17.61
09/08/03	8.02	15.23	11.63	16.60
09/09/03	8.79	18.26	13.52	16.56
09/10/03	9.64	17.54	13.59	16.25
09/11/03	5.46	16.58	11.02	15.48
09/12/03	5.46	16.42	10.94	15.49
09/13/03	9.17	16.10	12.64	15.75
09/14/03	7.17	12.35	9.76	16.07
09/15/03	5.14	13.59	9.37	15.83
09/16/03	4.52	14.68	9.60	15.32
09/17/03	5.92	15.47	10.70	15.03
09/18/03	5.30	15.79	10.54	14.91
09/19/03	4.99	15.95	10.47	14.85
09/20/03	5.30	16.58	10.94	14.92
09/21/03	5.61	15.95	10.78	15.43
09/22/03	4.68	15.55	10.11	15.71
09/23/03	4.68	15.15	9.91	15.78
09/24/03	7.09	17.86	12.47	16.12
09/25/03	7.79	18.10	12.94	16.45
09/26/03	8.10	18.10	13.10	16.75
09/27/03	8.25	15.63	11.94	16.62
09/28/03	7.63	16.58	12.11	16.71
09/29/03	7.01	14.60	10.81	16.57
09/30/03	10.11	17.54	13.82	16.91
10/01/03	7.17	16.10	11.64	16.66
10/02/03	7.09	16.18	11.64	16.39
10/03/03	10.26	15.71	12.99	16.05
10/04/03	8.10	16.42	12.26	16.16

Table 5-10. Stream temperature results from 2003 water temperature sites in Logan Valley, Site 3, Malheur River below Lake and Big Creeks.

Site 3. Malheur River below Lake and Big Creeks

Deployed 6/10/03

Retrieved on 10/21/03

Maximum 7-day average temperature of 23.35 °C occurred 7/17/03 to 7/23/03

Max. temperature of 23.81 °C occurred on 7/21/03

Date	Max.	MWAT	Min.	Avg.
6/11/03	17.41		7.00	12.21
6/12/03	15.83		7.31	11.57
6/13/03	16.93		9.31	13.12
6/14/03	18.38		8.07	13.23
6/15/03	19.67		8.99	14.33
6/16/03	19.67		8.23	13.95
6/17/03	20.97	18.41	8.84	14.91
6/18/03	17.09	18.36	10.86	13.98
6/19/03	16.30	18.43	9.31	12.81
6/20/03	14.41	18.07	8.07	11.24
6/21/03	14.25	17.48	6.22	10.24
6/22/03	16.62	17.04	6.07	11.35
6/23/03	12.24	15.98	6.38	9.31
6/24/03	17.09	15.43	5.76	11.43
6/25/03	18.70	15.66	6.69	12.70
6/26/03	20.15	16.21	7.77	13.96
6/27/03	20.80	17.12	8.84	14.82
6/28/03	21.97	18.22	9.61	15.79
6/29/03	19.18	18.59	10.39	14.79
6/30/03	21.13	19.86	9.93	15.53
7/1/03	19.02	20.14	9.93	14.48
7/2/03	18.06	20.04	8.69	13.38
7/3/03	18.22	19.77	8.99	13.61
7/4/03	20.47	19.72	8.69	14.58
7/5/03	20.97	19.58	9.15	15.06
7/6/03	21.63	19.93	9.61	15.62
7/7/03	21.13	19.93	9.77	15.45
7/8/03	20.80	20.18	10.86	15.83
7/9/03	22.30	20.79	9.46	15.88
7/10/03	22.96	21.47	10.24	16.60
7/11/03	23.30	21.87	11.17	17.24
7/12/03	22.30	22.06	11.47	16.89
7/13/03	21.47	22.04	11.63	16.55
7/14/03	22.30	22.20	10.08	16.19
7/15/03	21.97	22.37	10.55	16.26
7/16/03	22.47	22.40	11.32	16.90
7/17/03	22.96	22.40	11.47	17.22
7/18/03	22.79	22.32	11.78	17.29
7/19/03	23.30	22.47	12.24	17.77
7/20/03	23.30	22.73	12.87	18.09
7/21/03	23.81	22.94	11.78	17.80
7/22/03	23.64	23.18	13.17	18.41
7/23/03	23.64	23.35	14.25	18.95
7/24/03	20.31	22.97	15.19	17.75
7/25/03	20.15	22.59	13.33	16.74
7/26/03	19.34	22.03	6.84	13.09
7/27/03	20.31	21.60	7.46	13.89
7/28/03	20.47	21.12	11.63	16.05
7/29/03	22.13	20.91	11.78	16.96
7/30/03	23.47	20.88	12.09	17.78
7/31/03	22.63	21.21	11.32	16.98
8/1/03	20.97	21.33	11.01	15.99
8/2/03	16.30	20.90	13.02	14.66
8/3/03	16.62	20.37	12.24	14.43
8/4/03	19.99	20.30	9.15	14.57
8/5/03	19.99	20.00	12.24	16.12
8/6/03	21.13	19.66	11.17	16.15
8/7/03	20.47	19.35	9.46	14.97
8/8/03	20.64	19.31	9.15	14.90
8/9/03	20.15	19.86	9.31	14.73
8/10/03	19.83	20.31	9.15	14.49
8/11/03	19.83	20.29	8.84	14.34
8/12/03	19.99	20.29	9.15	14.57
8/13/03	20.15	20.15	8.69	14.42
8/14/03	20.80	20.20	8.38	14.59
8/15/03	18.86	19.94	10.71	14.79
8/16/03	19.34	19.83	10.24	14.79
8/17/03	20.64	19.94	8.69	14.67
8/18/03	21.63	20.20	9.46	15.55
8/19/03	16.93	19.76	10.55	13.74
8/20/03	20.15	19.76	9.31	14.73
8/21/03	13.79	18.76	8.84	11.32
8/22/03	15.83	18.33	11.47	13.65
8/23/03	19.51	18.35	10.86	15.19
8/24/03	20.15	18.28	9.31	14.73
8/25/03	20.47	18.12	9.61	15.04
8/26/03	17.57	18.21	9.77	13.67
8/27/03	19.18	18.07	10.24	14.71
8/28/03	19.18	18.84	8.69	13.94
8/29/03	19.02	19.30	8.99	14.01
8/30/03	18.70	19.18	7.46	13.08
8/31/03	18.54	18.95	7.61	13.08
9/1/03	19.02	18.74	8.53	13.78
9/2/03	18.86	18.93	8.99	13.93
9/3/03	19.51	18.98	9.31	14.41
9/4/03	15.98	18.52	9.93	12.96
9/5/03	17.41	18.29	9.77	13.59
9/6/03	19.02	18.33	9.77	14.40
9/7/03	14.09	17.70	8.23	11.16
9/8/03	12.87	16.82	8.38	10.63
9/9/03	8.99	15.41	6.22	7.61
9/10/03	14.56	14.70	7.15	10.86
9/11/03	16.46	14.77	7.31	11.89
9/12/03	15.51	14.50	8.07	11.79

9/13/03	14.56	13.86	4.04	9.30
9/14/03	14.56	13.93	4.20	9.38
9/15/03	14.72	14.19	7.61	11.17
9/16/03	10.86	14.46	6.07	8.47
9/17/03	12.40	14.15	4.67	8.54
9/18/03	13.33	13.71	3.58	8.46
9/19/03	14.09	13.50	4.82	9.46
9/20/03	14.25	13.46	4.51	9.38
9/21/03	14.25	13.41	4.04	9.15
9/22/03	14.72	13.41	4.36	9.54
9/23/03	14.56	13.94	4.67	9.62
9/24/03	14.41	14.23	4.04	9.23
9/25/03	14.09	14.34	4.04	9.07
9/26/03	16.30	14.65	6.07	11.19
9/27/03	16.30	14.95	6.53	11.42
9/28/03	16.30	15.24	6.84	11.57
9/29/03	14.25	15.17	7.00	10.63
9/30/03	15.03	15.24	6.53	10.78
10/1/03	13.33	15.09	5.91	9.62
10/2/03	15.67	15.31	8.69	12.18
10/3/03	14.72	15.09	5.91	10.32
10/4/03	14.88	14.88	6.22	10.55
10/5/03	14.41	14.61	8.69	11.55
10/6/03	14.88	14.70	6.84	10.86
10/7/03	13.17	14.44	7.92	10.55
10/8/03	13.33	14.44	5.60	9.47
10/9/03	11.17	13.79	5.44	8.31
10/10/03	10.55	13.20	3.58	7.07
10/11/03	4.82	11.76	1.84	3.33
10/12/03	8.69	10.94	2.63	5.66
10/13/03	8.99	10.10	1.84	5.42
10/14/03	7.92	9.35	4.20	6.06
10/15/03	4.04	8.03	1.52	2.78
10/16/03	8.53	7.65	3.58	6.06
10/17/03	11.01	7.71	3.58	7.30
10/18/03	9.93	8.44	3.11	6.52
10/19/03	10.08	8.64	4.04	7.06
10/20/03	11.01	8.93	4.82	7.92

Table 5-11. Stream temperature results from 2003 water temperature sites in Logan Valley, Site 5, Big Creek at 16 roads.

Site 5. Big Creek at 16 roads

Deployed 6/8/03

Retrieved on 10/21/03

Maximum 7-day average temperature of 19.28 °C occurred 7/16/03 to 7/22/03

Max. temperature of 19.87 °C occurred on 7/30/03

Date	Max.	MWAT	Min.	Daily Avg.
06/09/03	13.83		2.03	13.005
06/10/03	14.13		3.92	12.545
06/11/03	13.67		3.6	13.31
06/12/03	12.59		3.6	14.825
06/13/03	13.37		4.23	14.995
06/14/03	14.76		4.86	12.155
06/15/03	15.71	14.01	7.03	11.43
06/16/03	15.87	14.30	10.12	11.51
06/17/03	16.98	14.71	10.73	9.575
06/18/03	13.67	14.71	10.27	12.23
06/19/03	13.98	14.91	7.96	12.465
06/20/03	11.04	14.57	9.34	12.22
06/21/03	11.82	14.15	9.81	12.865
06/22/03	13.21	13.80	4.07	13.54
06/23/03	9.34	12.86	9.81	9.19
06/24/03	12.59	12.24	7.64	14.76
06/25/03	15.39	12.48	8.11	12.295
06/26/03	16.5	12.84	10.43	10.98
06/27/03	17.29	13.73	10.58	8.025
06/28/03	18.09	14.63	9.03	8.88
06/29/03	16.02	15.03	10.12	12.71
06/30/03	17.61	16.21	7.18	9.81
07/01/03	14.76	16.52	8.57	12.155
07/02/03	14.6	16.41	7.8	12.465
07/03/03	15.39	16.25	6.25	12.945
07/04/03	16.98	16.21	8.73	9.265
07/05/03	17.29	16.09	7.8	7.945
07/06/03	17.77	16.34	6.41	9.96
07/07/03	17.77	16.37	7.33	9.425
07/08/03	16.66	16.64	7.18	12.3
07/09/03	18.09	17.14	3.29	8.725
07/10/03	18.91	17.64	5.79	8.03
07/11/03	19.23	17.96	6.41	3.365
07/12/03	19.07	18.21	5.79	5.08
07/13/03	17.93	18.24	7.64	10.275
07/14/03	18.09	18.28	5.48	9.73
07/15/03	18.42	18.53	7.33	9.5
07/16/03	18.91	18.65	6.41	5.855
07/17/03	19.23	18.70	5.17	5.78
07/18/03	18.91	18.65	6.87	3.595
07/19/03	19.39	18.70	4.7	6.47
07/20/03	19.71	18.95	2.18	6.24
07/21/03	19.71	19.18	3.13	6.785
07/22/03	19.07	19.28	3.92	4.68
07/23/03	18.42	19.21	2.03	9.035
07/24/03	16.5	18.82	3.6	10.97
07/25/03	16.5	18.47	5.94	12.305
07/26/03	15.87	17.97	6.25	12.39
07/27/03	16.82	17.56	4.07	9.965
07/28/03	16.66	17.12	4.54	9.58
07/29/03	19.23	17.14	3.92	5.32
07/30/03	19.87	17.35	4.38	7.335
07/31/03	18.91	17.69	6.1	6.945
08/01/03	17.46	17.83	6.25	9.655
08/02/03	13.21	17.45	4.07	11.925
08/03/03	13.37	16.96	6.87	14.595
08/04/03	16.5	16.94	6.41	11.91
08/05/03	16.5	16.55	8.42	11.755
08/06/03	16.98	16.13	7.96	8.025
08/07/03	17.13	15.88	8.88	7.165
08/08/03	17.46	15.88	7.8	8.1
08/09/03	17.29	16.46	8.11	8.255
08/10/03	17.29	17.02	3.92	8.33
08/11/03	16.98	17.09	5.32	7.33
08/12/03	16.82	17.14	4.23	8.57
08/13/03	16.98	17.14	4.38	7.33
08/14/03	17.77	17.23	4.07	9.5
08/15/03	15.71	16.98	3.6	9.65
08/16/03	16.82	16.91	6.25	6.795
08/17/03	17.13	16.89	5.48	8.1
08/18/03	17.93	17.02	6.56	8.57
08/19/03	13.98	16.62	7.03	12.55
08/20/03	16.82	16.59	8.42	8.495
08/21/03	11.97	15.77	8.26	12.865
08/22/03	13.21	15.41	7.49	9.97
08/23/03	15.39	15.20	7.8	12.54
08/24/03	16.98	15.18	7.64	7.63
08/25/03	17.46	15.12	7.8	8.175
08/26/03	14.92	15.25	7.33	12.08
08/27/03	16.66	15.23	7.64	11.825
08/28/03	15.87	15.78	7.03	12.21
08/29/03	16.02	16.19	8.11	12.695
08/30/03	15.71	16.23	7.64	12.31
08/31/03	15.39	16.00	9.03	12.08
09/01/03	16.18	15.82	7.96	11.83
09/02/03	16.02	15.98	9.81	11.515
09/03/03	16.5	15.96	7.33	10.9
09/04/03	13.37	15.60	8.88	13.235
09/05/03	15.23	15.49	7.18	12.475
09/06/03	16.18	15.55	7.18	11.525
09/07/03	12.13	15.09	9.03	13.635
09/08/03	9.81	14.18	9.96	8.88
09/09/03	8.11	13.05	11.97	11.37

09/10/03	10.89	12.25	8.42	12.235
09/11/03	13.52	12.27	9.34	14.125
09/12/03	12.28	11.85	7.03	13.42
09/13/03	11.66	11.20	4.86	11.36
09/14/03	12.13	11.20	5.17	13.665
09/15/03	11.97	11.51	7.8	12.77
09/16/03	9.34	11.68	7.96	8.495
09/17/03	10.12	11.57	8.42	10.435
09/18/03	11.04	11.22	5.48	12.945
09/19/03	11.82	11.15	6.72	12.005
09/20/03	11.82	11.18	5.17	12.31
09/21/03	11.97	11.15	5.17	12.865
09/22/03	12.44	11.22	6.25	14.28
09/23/03	12.28	11.64	8.26	13.1
09/24/03	12.28	11.95	7.03	14.05
09/25/03	12.13	12.11	7.96	14.285
09/26/03	13.52	12.35	9.49	13.245
09/27/03	13.52	12.59	8.42	11.97
09/28/03	13.67	12.83	10.12	11.82
09/29/03	12.44	12.83	9.65	14.755
09/30/03	12.75	12.90	11.35	14.885
10/01/03	11.35	12.77	9.34	11.36
10/02/03	12.91	12.88	10.58	14.235
10/03/03	12.28	12.70	9.19	14.285
10/04/03	11.51	12.42	9.34	10.815
10/05/03	12.13	12.20	7.96	14.28
10/06/03	12.59	12.22	8.88	15.07
10/07/03	11.2	12.00	7.33	12.935
10/08/03	10.89	11.93	7.33	11.375
10/09/03	9.19	11.40	7.18	11.35
10/10/03	8.11	10.80	8.11	11.6
10/11/03	5.01	9.87	9.03	10.27
10/12/03	7.03	9.15	7.49	9.42
10/13/03	7.33	8.39	6.87	10.585
10/14/03	6.72	7.75	6.87	9.73
10/15/03	4.7	6.87	5.79	10.12
10/16/03	7.64	6.65	6.41	10.815
10/17/03	9.34	6.82	6.41	11.045
10/18/03	8.88	7.38	6.25	12.235
10/19/03	9.34	7.71	7.8	8.88
10/20/03	9.81	8.06	7.49	7.1

6.

ENTRAINMENT OF BULL TROUT AT AGENCY VALLEY DAM, 2003.

by James Fenton,

Fish and Wildlife Department,

Burns Paiute Tribe, Burns, OR

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TABLES

6. ENTRAINMENT OF BULL TROUT AT AGENCY VALLEY DAM, 2003

By James Fenton
Fish and Wildlife Department
Burns Paiute Tribe, Burns, OR

6.1. Introduction

Bull trout (*Salvelinus confluentus)* in the Malheur River basin are listed as a threatened species as a result of historical and current land use activities, the construction of dams, and fish eradication projects by poisoning (Bowers et al. 1993). One aspect of the negative effects on bull trout is entrainment. The Burns Paiute Tribe (the Tribe), the Oregon Department of Fish and Wildlife (ODFW), and the U.S. Bureau of Reclamation have determined that bull trout entrainment occurs over the spillway of the Agency Valley Dam from its impoundment, Beulah Reservoir (Schwabe et al. 2000).

In 1998 and 1999, a migration study on bull trout was conducted where radio-tagged bull trout were observed in Beulah Reservoir from mid April to late May (Schwabe et al. 2000). For purposes of flood control, the Vale Oregon Irrigation District initiated releases of water from the reservoir in mid-March. During the periods of water release, bull trout were still being observed in the reservoir from mid March through June. As a result of the water release, there was a risk of entrainment through the Agency Valley Dam. In previous research, bull trout have been documented leaving the reservoir during these periods of irrigation withdrawals and returning from post-spawning/migration activities prior to cessation of water releases.

Currently, there are no fish passage facilities at Agency Valley Dam. During 1998 and 1999, water was released over the spillway. This resulted in the entrainment of radio-tagged bull trout from the reservoir. After entrainment, these fish had no way to return upstream of the reservoir and were lost to spawning populations of bull trout. Changes in reservoir operations during the 2000 irrigation season resulted in the release of water through the flow valves rather than over the spillway; this was an effort to reduce the number of entrained bull trout. The Tribe and its partners developed the following objectives to evaluate the impacts of the changed water release strategies:

- Identify bull trout entrainment in response to water management activities.
- Determine if the release of water from the flow valves will reduce the rate of entrainment of radio tagged fish in comparison to traditional water management practices.

This report consists of cumulative data since the water release practices have changed.

6.2. Methods

Creel surveys were conducted once a week in the spring from mid March to mid July. All anglers within ¼-mile below the dam were surveyed. The surveys consisted of recording "catch per effort" (number of fish per hour for the total hours fished per angler). Tribal employees angled while they surveyed other fishermen. Any bull trout that were angled by employees were placed in a bucket with an aerator and transported above the dam to be released in the reservoir.

6.3. Results

In the spring of 2003, no bull trout were observed angled below Beulah Reservoir and seven rainbow trout *Oncorhynchus mykiss* were observed during this same time period (Table 6-1). Other species angled below the reservoir include the northern pike minnow (*Ptychocheilus oregonensis).* There were no creel surveys conducted in the fall of 2003.

Table 6-1. Catch rate (number of fish per hour) for 1999, 2000, 2001, 2002 and 2003.

	No. of Fish Caught in Spring		**No. of Fish Caught in Fall**	
	Bull Trout	Rainbow Trout	Bull Trout	Rainbow Trout
1999	20	150	n/a*	n/a
2000	5	107	0	4
2001	0	13	0	34
2002	0	73	0	36
2003	0	7	n/a	n/a
	Catch Rate (No./hour) for Spring		**Catch Rate (No./hour) for Fall**	
	Bull Trout	Rainbow Trout	Bull Trout	Rainbow Trout
1999	0.05	0.34	n/a	n/a
2000	0.01	0.21	0.00	0.02
2001	0.00	0.08	0.00	0.59
2002	0.00	0.44	0.00	0.43
2003	0.00	0.35	n/a	n/a
* No creel in fall of 1999 or 2003				

6.4. Discussion

From 2000 through 2003, water was released from the reservoir through the flow valves at the bottom of the dam. In the fall of 2001, unknown species of fish were observed coming out of the flow valves (personal observation of Tribal employees). The reservoir was lowered down to around 2,000 acre-feet and it is assumed the fish were concentrated near the upper opening of the tubes and had a greater chance than the year before to become entrained.

As a result of this, the rainbow trout catch rate in the fall of 2001 increased compared to the previous year's study. The spring of 2002 yielded a higher catch rate for rainbow trout than the previous year's study; this indicates that many trout may have been entrained the fall of 2001. In 2002, the reservoir was emptied. The "catch rate" (number of fish per hour) for the fall of 2002 was not as high as the fall of 2001 and could have been due to poor water quality conditions. No bull trout were observed to be angled in the spring or the fall of 2002. Creel surveys were limited in the spring of 2003 because of lack of angler interest at the Beulah Reservoir Tailrace. No anglers other than tribal employees were observed during creel surveys.

Previous studies (Schwabe 2000) indicate that adult bull trout return to Beulah Reservoir in November and December. Since water releases from Agency Valley Dam cease in mid October, returning adult bull trout are less susceptible to fall entrainment. This may help to explain why there were no bull trout observed below the dam. It is unknown if juvenile bull trout reside in the reservoir year-round. Since angling is size-selective, the small bull trout that were entrained most likely would not be caught with hook and line. The Burns Paiute Tribe and its partners are currently conducting a study of juvenile bull trout to help managers determine the best water management practices for the survival of bull trout. Creel surveys will be conducted in the spring of 2004 to continue monitoring salmonid catches below Agency Valley Dam. The Vale Oregon Irrigation District will continue to pass winter and spring inflows, depending on reservoir elevations, thru the flow valves in an effort to minimize bull trout entrainment.

6.5. Acknowledgements

A special thanks to the Bonneville Power Administration and the U.S. Bureau of Reclamation who funded this project for the Burns Paiute Tribe Fish and Wildlife Department. We would also like to thank Eric Hawley, Garrett Sam, Todd Richards, Lucas Samor, and Jason Fenton for completing creel surveys and angling below Beulah Reservoir.

6.6. References

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7.

USE OF A DRIFTBOAT ELECTROFISHER TO DETERMINE PRESENCE/ABSENCE OF BULL TROUT (*SALVELINUS CONFLUENTUS*), AND OTHER SPECIES FROM THE MALHEUR RIVER AT JONESBORO, OREGON, 2003.

by Kevin Fenn & Lawrence Schwabe ,

Fish and Wildlife Department,

Burns Paiute Tribe, Burns, OR

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7. USE OF A DRIFTBOAT ELECTROFISHER TO DETERMINE PRESENCE/ABSENCE OF BULL TROUT (*SALVELINUS CONFLUENTUS*), AND OTHER SPECIES FROM THE MALHEUR RIVER AT JONESBORO, OREGON, 2003.

By Kevin Fenn and Lawrence Schwabe
Fish and Wildlife Department
Burns Paiute Tribe, Burns, OR.

7.1. Introduction

The "Malheur River Mitigation Property" is located on both sides of the Malheur river about 8 miles east of Juntura, Oregon. The property was acquired by the Burns Paiute Tribe (the Tribe) in November 2000 with funding provided by the Bonneville Power Administration. It is referred to locally as the Jones Ranch; the unincorporated community of Jonesboro is toward the western end of the property (Figure 7-1).

The ranch includes 6,700 acres of deeded property and about 25,000 acres leased from the both the U.S. Bureau of Land Management and the State of Oregon. The 6,700 acres adjacent to the river are meadow habitat, and were recently used for growing alfalfa and meadow grass. The leased land is fairly steep and is used for grazing and recreation. Irrigation releases from the reservoirs upstream have significantly altered flow regimes through the property. The Tribe is using passive restoration to negate past activities that caused degradation.

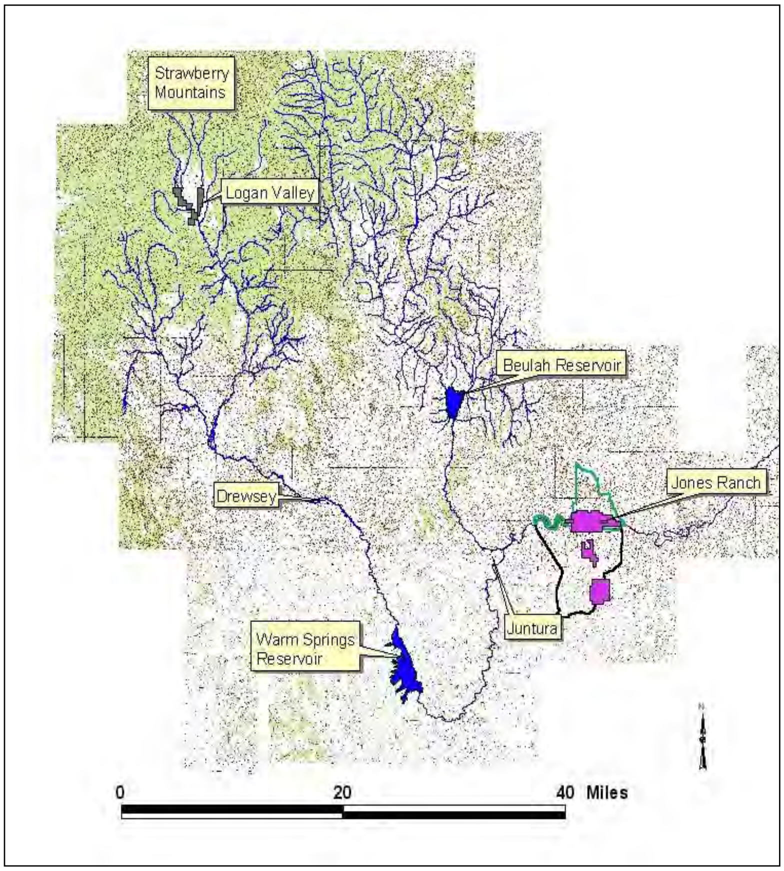

Figure 7–1. Location of Malheur River mitigation sites, including Jones Ranch and Logan Valley properties, managed by the Burns Paiute Fish and Wildlife Department. For this study presence/absence research was conducted at the Jones Ranch using a 16-foot-long driftboat.

Historically, redband trout *(Oncorhynchus mykiss)*, bull trout *(Salvelinus confluentus)*, and anadromous salmonids inhabited the area of the Malheur River at Jonesboro (Hanson et al. 1990; USFWS 2002; Fulton 1970; Haas 1965). With the construction of dams on the Columbia, Snake, and Malheur Rivers, anadromous salmonids no longer have access to the Malheur River. In addition, Agency Valley Dam (Beulah Reservoir) and Warm Springs Dam upstream of the property do not have fish passage facilities, isolating resident fish species above the reservoirs.

In 1999 and 2000, bull trout were entrained over the spillway at Agency Valley Dam (Schwabe et al. 2000), but from 2001 to 2003 no bull trout were observed below the dam. Even in years in which bull trout were observed below the dam, they were not documented downstream of Juntura. Bull trout may have avoided entrainment after 2000 when water release was switched to flow valves rather than over the spillway (Schwabe et al. 2002). Bull trout physiologically require cool water temperatures (Buchanan and Gregory 1997); at Jonesboro, temperatures in August often exceed 23 °C, a limiting factor.

The Malheur River from Namorf Dam (at river kilometer, RK, 111) to Warm Springs Dam (RK 198) contain suitable habitat for trout production. This trout habitat results because cold water is discharged from the base of Warm Springs and Beulah Reservoirs during the irrigation season (Hanson *et al*. 1990).

The purpose of this study is to:

- Determine presence/absence of bull trout in the Malheur River at Jonesboro.
- Determine other fish species present in the Malheur River at Jonesboro.

7.2. Methods

Sampling of the Malheur River through the Jones Ranch was conducted on May 28, 2003 as a cooperative effort between Burns Paiute Fish and Wildlife and Oregon Department of Fish and Wildlife (ODFW). Sampling was conducted using a 16-foot-long driftboat electrofisher supplied by ODFW. The use of a driftboat is a safe and effective approach in the higher-volume river flows typical after the irrigation season has begun. National Marine Fisheries Services (NMFS) electrofishing guidelines were used to minimize the effects electrofishing have on native fish species. All fish collected were identified to species and measured and fork length was recorded.

The drift boat shocker can only effectively fish one side of the river at a time, so alternate banks were sampled at each site. The north bank was sampled at site numbers 1, 3, 5, and 7. The south bank was sampled at sites 2, 4, and 6. Two personnel conducted the sampling; one person operated the boat and one person collected fish with a dip net. The boat drifted downstream, and the operator positioned it close to the bank being sampled. The netter controlled the power switch to the electrofishing equipment. Two 5-gallon buckets were positioned in the boat to hold fish collected during each pass. A minimum of 400 seconds of electrical application was applied at each site. Data on fish were collected onshore once the minimum application was obtained. Fish were not anesthetized for handling.

A total of seven sites were sampled (Figure 7-2; Table 7-1). The beginning and end of each site was documented using a GPS (Global Positioning System) unit. Site length was determined by shocking effort (seconds). A minimum of 400 seconds was applied at each site (Table7-1).

Figure 7–2. Sites sampled within Jones Ranch during driftboat electrofishing in 2003. .

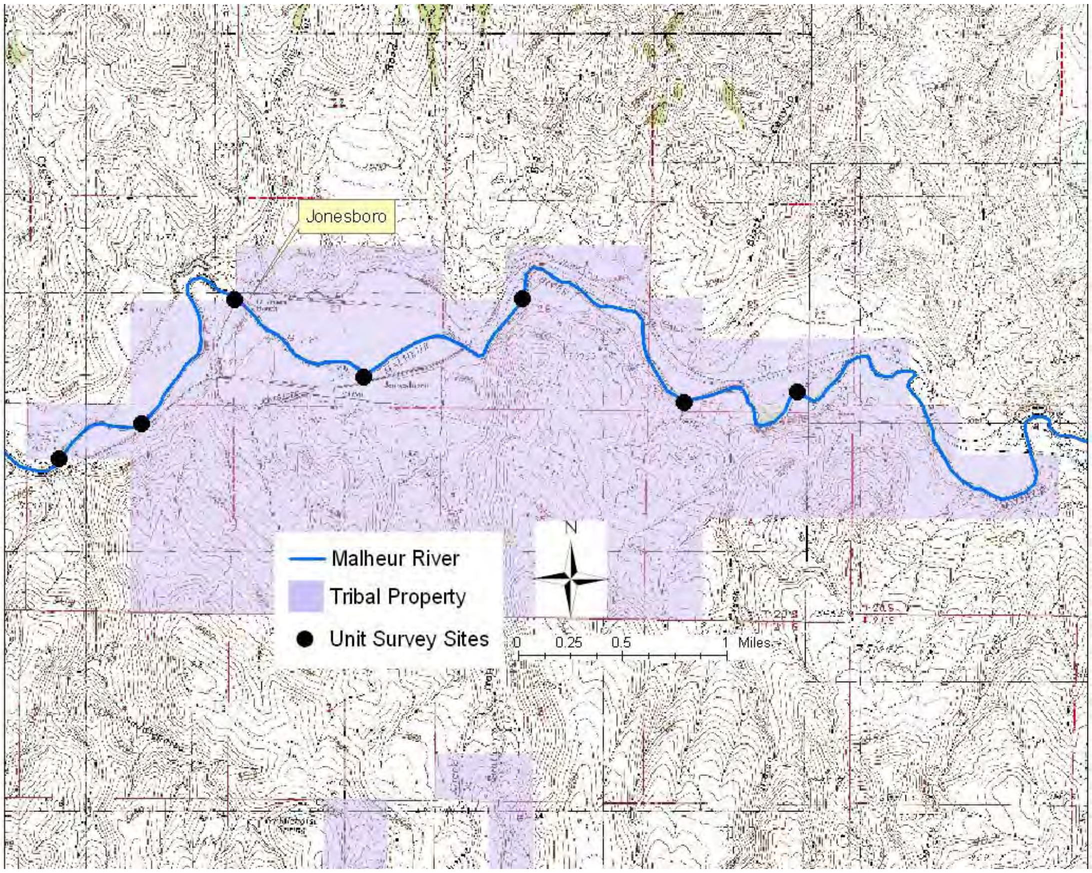

Table 7-1. Driftboat electrofishing site description of the Malheur River on the wildlife mitigation lands (Jones Ranch) of the Burns Paiute Tribe. The river was sampled on May 28, 2003; all sites are within RM 80 to 90.

Site No.	Sample Duration (sec.)	Start Site Coordinates (Decimal Degrees)		Site Description
		Start Site	End Site	
Site 1	435	N 43.78944 W117.94850	N 43.79267 W117.93899	Located 50 meters downstream of diversion dam on west end of property.
Site 2	411	N 43.79332 W 117.93840	N 43.79788 W117.93453	Agriculture field above ranch house.
Site 3	407	N 43.80102 W 117.93201	N 43.79672 W117.92516	Just below bridge at ranch house.
Site 4	445	N 43.79588 W 117.91753	N 43.79688 W117.80807	Large agriculture field below house.
Site 5	423	N 43.80240 W 117.90332	N 43.80013 W117.89570	700 meters downstream of old railroad bridge.
Site 6	453	N 43.79397 W 117.88778	N 43.79195 W117.88073	400 meters below confluence with Black Canyon Creek and Malheur River.
Site 7	506	N 43.79513 W 117.87629	N 43.79573 W117.86969	650 meters downstream of confluence with Indian Creek and Malheur River

7.3. Results

7.3.1. Site 1 (50 m downstream of diversion dam)

A total of 24 fish and 6 species were collected from site 1. The relative abundance of fish at site 1 ranges from a 29.2 percent northern pike minnow to 4.2 percent longnose dace (Figure 7-3, in Appendix 7-A). Fish species collected at site 1 are all endemic to the Malheur River subbasin. The six species identified include:

- Bridgelip Sucker *Catostomus columbianus*
- Chiselmouth Chub *Acrocheilus alutaceus*
- Largescale Sucker *Catostomus macrocheilus*
- Northern Pike Minnow *Ptychocheilus oregonensis*
- Speckled Dace *Rhinichthys osculus*
- Long Nose Dace *Rhinichthys cataractae*

7.3.2. Site 2 (agriculture field above ranch house).

A total of 14 fish and 7 species were collected from site 2. The relative abundance of fish at site 2 ranges from 28.6 percent redside shiner to 7.1 percent speckled dace and chisel mouth chub (Figure 7-4). Fish species collected at site 2 are all endemic to the Malheur River subbasin. The seven species identified include:

- Bridgelip Sucker
- Chiselmouth Chub
- Largescale Sucker
- Northern Pike Minnow
- Redside Shiner *Richardsonius balteatus*
- Speckled Dace
- Long Nose Dace

7.3.3. Site 3 (just below bridge at ranch house)

A total of 43 fish and 6 species were collected from site 3. The relative abundance of fish at site 3 ranges from 25.5 percent northern pike minnow and speckled dace to 6.9 percent largescale sucker (Figure 7-5). Fish species collected at site 3 are all endemic to the Malheur River subbasin. The six species identified include:

- Bridgelip Sucker
- Chiselmouth Chub
- Largeescale Sucker
- Northern Pike Minnow
- Redside Shiner

- Speckled Dace

7.3.4. Site 4. (large agriculture field below house)

A total of 37 fish and six species were collected from site 4. The relative abundance of fish at site 4 ranges from 27 percent northern pike minnow to 2.7 percent redside shiner (Figure 7-6). Fish species collected at site 4 are all endemic to the Malheur River subbasin. The six species identified include:

- Bridgelip Sucker
- Chiselmouth Chub
- Largescale Sucker
- Northern Pike Minnow
- Redside Shiner
- Speckled Dace

7.3.5. Site 5 (700 m downstream of old railroad bridge)

A total of 31 fish and 7 species were collected from site 5. The relative abundance of fish at site 5 ranges from 25.8 percent largescale sucker to a 6.4 percent northern pike minnow (Figure 7-7). Fish species collected at site 5 are all endemic to the Malheur River subbasin. The seven species identified include:

- Bridgelip Sucker
- Chiselmouth Chub
- Largescale Sucker
- Northern Pike Minnow
- Redside Shiner
- Speckled Dace
- Long Nose Dace

7.3.6. Site 6 (400 m below confluence with Black Canyon Creek and Malheur River)

A total of 26 fish and six species were collected from site 6. The relative abundance of fish at site 6 ranges from 23 percent largescale sucker to a 3.8 percent channel catfish (Figure 7-8). Fish species collected at site 6 are all endemic to the Malheur River subbasin except for the collection of one channel catfish. The six species identified include:

- Bridgelip Sucker
- Channel Catfish *Ictaluras punctatus*
- Chiselmouth Chub
- Largescale Sucker
- Northern Pike Minnow
- Speckled Dace

7.3.7. Site 7 (650 m downstream of confluence with Indian Creek and Malheur River)

A total of 57 fish and seven species were collected from site 7. The relative abundance of fish at site 7 ranges from 22.8 percent northern pike minnow to 8.7 percent speckled dace (Figure 7-9). Fish species collected at site 7 are all endemic to the Malheur River subbasin. The seven species identified include:

- Bridgelip Sucker
- Chiselmouth Chub
- Largescale Sucker
- Northern Pike Minnow
- Redside Shiner
- Speckled Dace
- Long Nose Dace

7.3.8. Total of All Sites

A total of seven sites on the Malheur River were sampled with a total of 227 fish collected consisting of eight fish species (Table 7-2). No salmonid species were collected from any of the seven sites. Channel catfish was the only non-native fish species collected in the 2003 survey. Relative abundance was greatest for Northern Pike Minnow and least for channel catfish Figure (7-10). Length frequency of the fish species collected is referred to Appendix 7-B.

Table 7-2. Total count of all fish species collected in the 2003 sample effort on the Malheur River (RM 80 to 90).

Fish were collected using a driftboat electrofishing unit at seven sites. Sampling was conducted on the Malheur River Mitigation Property, which is managed by the Burns Paiute Tribe for fish and wildlife.

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Total
Bridgelip Sucker	5	2	6	3	4	6	9	**35**
Channel Catfish	0	0	0	0	0	1	0	**1**
Chiselmouth Chub	2	1	4	5	5	5	8	**30**
Largescale Sucker	6	2	3	5	8	6	9	**39**
Northern Pike Minnow	7	2	11	10	2	3	13	**48**
Redside Shiner	0	4	8	1	3	0	7	**17**
Speckled Dace	3	1	11	13	6	5	5	**44**
Long Nose Dace	1	2	0	0	3	0	6	**13**
Total	**24**	**14**	**43**	**37**	**31**	**26**	**57**	**227**

7.4. Discussion

Species composition changed from 2002 to 2003, on the Malheur River through the Jones Ranch mitigation property. In 2002, bridgelip and largescale sucker were the dominant fish species, representing approximately 53 percent of total fish collected and the relative abundance of northern pike minnow was less than 5 percent (Schwabe et al. 2003). In 2003, relative abundance of bridgelip and largescale sucker was less than 33 percent and the relative abundance of northern pike minnow was approximately 22 percent. The variation in relative abundance is likely the result of different sampling methods conducted in 2002 and 2003 (Figure 7-11). We used a raft shocker in 2002, and in 2003 we used a driftboat electroshocker. Current management for irrigation has replaced the historical low flows in the summer with sustained high flows (Hanson et al. 1990). Sampling in 2003 was conducted to determine fish presence during the sustained high flows from irrigation releases. In 2002, sampling was done during the low historic summer flows as the irrigation reservoirs went to minimum levels and reservoir outflows equaled inflows.

Detection of fish species varied among the surveys in 2002 and 2003. In 2002, white crappie and rainbow trout were collected from the Malheur River within the Jones Ranch. Neither of these fish were sampled in 2003. Sampling in 2002 occurred after Warm Springs and Beulah Reservoirs were lowered to run-of-river. White crappie were observed in the tailrace of Agency Valley Dam by Tribal staff. White crappie sampled in the Malheur River through Jones Ranch were more likely entrained fish from Warm Springs or Beulah Reservoirs or both.

In 2003, a channel catfish was collected from the Malheur River within the Jones Ranch. Channel catfish were not collected in 2002. Channel catfish are frequently washed downstream into the mainstem Malheur River from Warm Springs Reservoir (Hanson et al. 1990).

Based various information sources, it is likely that bull trout are no longer below the dam. The sources include past and current creel data below Agency Valley Dam, presence/absence surveys at Jonesboro, and existing habitat conditions. The absence of bull trout may be a result of decreased entrainment and seasonally high water temperatures during the summer. Since 2000, there have been no creel observations of bull trout in the tailrace of Agency Valley Dam (Schwabe et al. 2001, 2003a, and 2003b), and bull trout have not been observed in the two years that presence/absence surveys have been conducted at Jonesboro. Entrainment over Agency Valley Dam has been documented in the past (Schwabe et al. 2001) and historically bull trout utilized the entire North Fork Malheur and Malheur Rivers as overwintering habitat (USFWS 2002). It is unlikely that bull trout could sustain a population below the dam due to the lack of spawning habitat and high water temperatures during the summer. They likely overwintered and used these areas as migratory corridors prior to dam construction.

Spatial and temporal distribution of salmonids has been identified in the Malheur River subbasin by past and ongoing telemetry studies (Gonzalez et al. 1998; Schwabe et al. 2000; Schwabe et al. 2003). Sampling of the Malheur River during various seasons and flow regimes may provide some insight into salmonid utilization of the Malheur River through the deeded lands of the Tribe. To date, Burns Paiute Fish and Wildlife Department has conducted a low-flow survey in August and a high-flow survey in May. In 2002, the Tribe initiated a low-flow survey in November, but due to unseasonable cold temperatures and ice formation over the river, the survey was cancelled. Low flow surveys in the spring and fall will be conducted in the future when water temperatures are optimal for salmonids.

7.5. Acknowledgements

A special thanks to the Bonneville Power Administration, which funded this project for the Burns Paiute Fish and Wildlife Department. We would also like to thank Lawrence Schwabe and Ray Perkins for the time they spent in the field completing this project.

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Appendix 7-A. Relative abundance of fish collected during the 2003 presence/absence survey of the Malheur River on the Jones Ranch Malheur River Mitigation property.

Seven sites were sampled between river mile (RM) 80 to 90. Fish species codes: bridgelip sucker (BSU), channel catfish (CC), chiselmouth chub (CHM), largescale sucker (LSS), northern pike minnow (NPM), redside shiner (RSS), speckled dace (SD), longnose dace (LD), white crappie (WC), and redband trout (RB).

Figure 7–3. Relative abundance of fish collected in 2003 at site 1 of presence/ absence survey conducted at Jones Ranch, managed by the Burns Paiute Tribe.

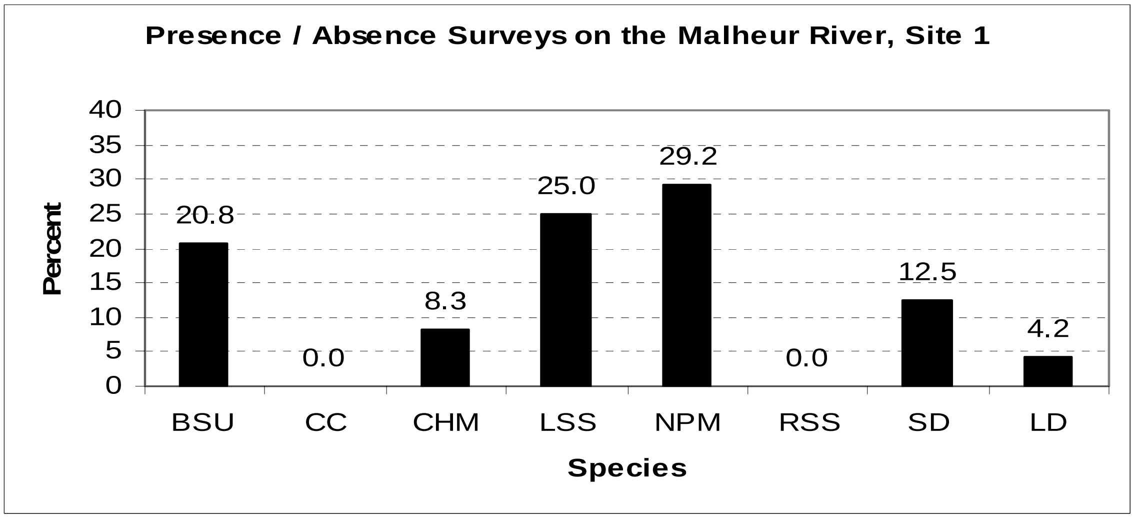


Figure 7–4. Relative abundance of fish collected in 2003 at site 2 of presence/ absence survey conducted at Jones Ranch, managed by the Burns Paiute Tribe.

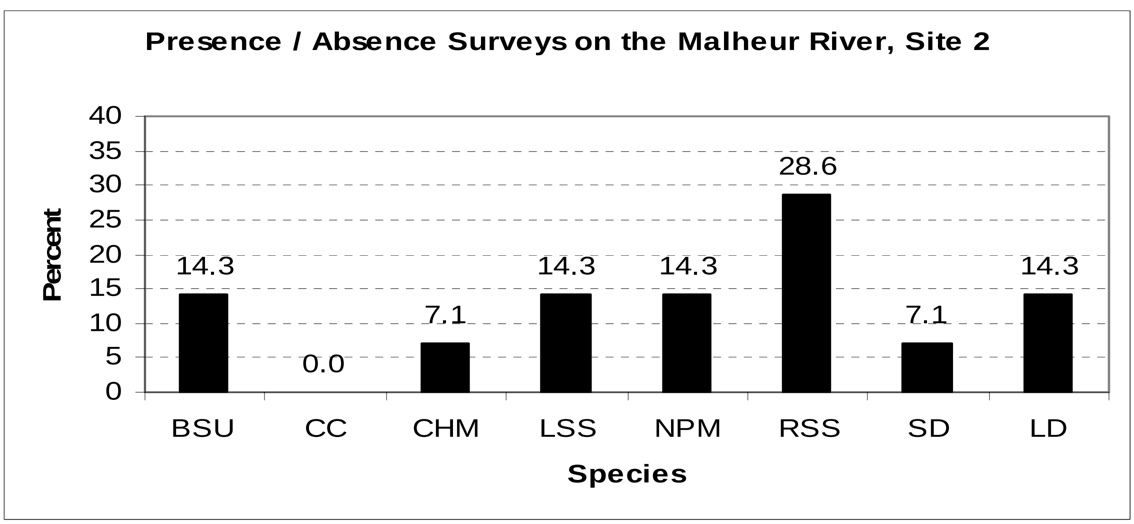


Figure 7–5. Relative abundance of fish collected in 2003 at site 3 of presence/ absence survey conducted at Jones Ranch, managed by the Burns Paiute Tribe. .

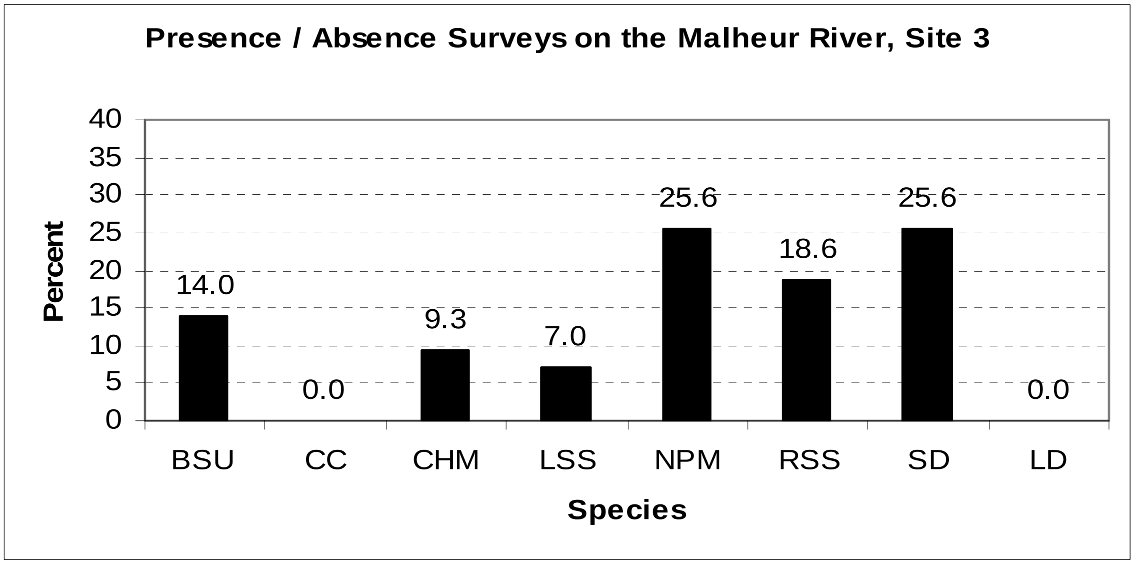


Figure 7–6. Relative abundance of fish collected in 2003 at site 4 of presence/ absence survey conducted at Jones Ranch, managed by the Burns Paiute Tribe.

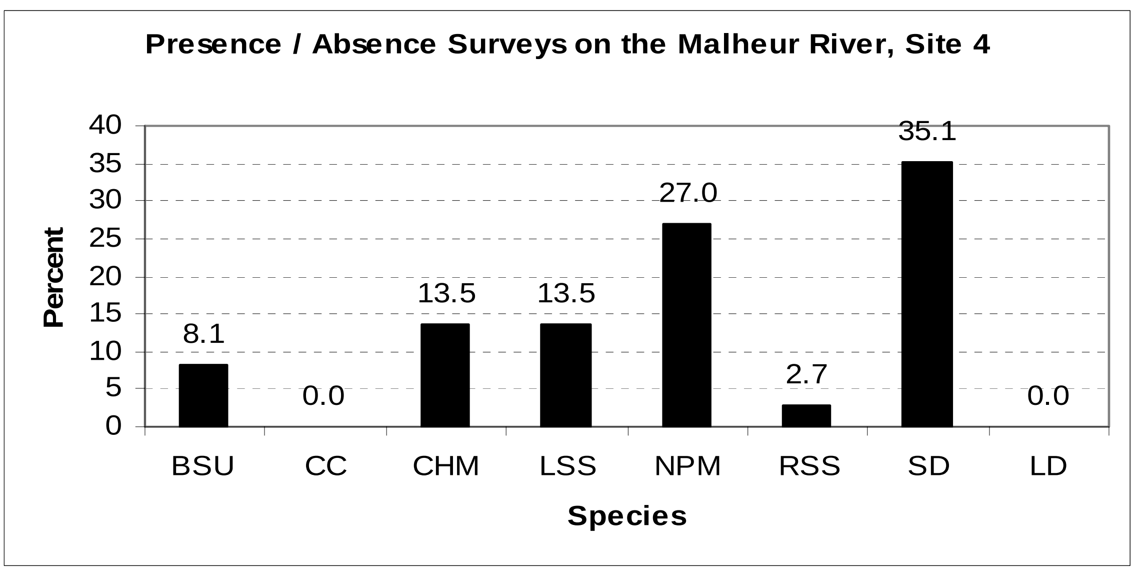


Figure 7–7. Relative abundance of fish collected in 2003 at site 5 of presence/ absence survey conducted at Jones Ranch, managed by the Burns Paiute Tribe.

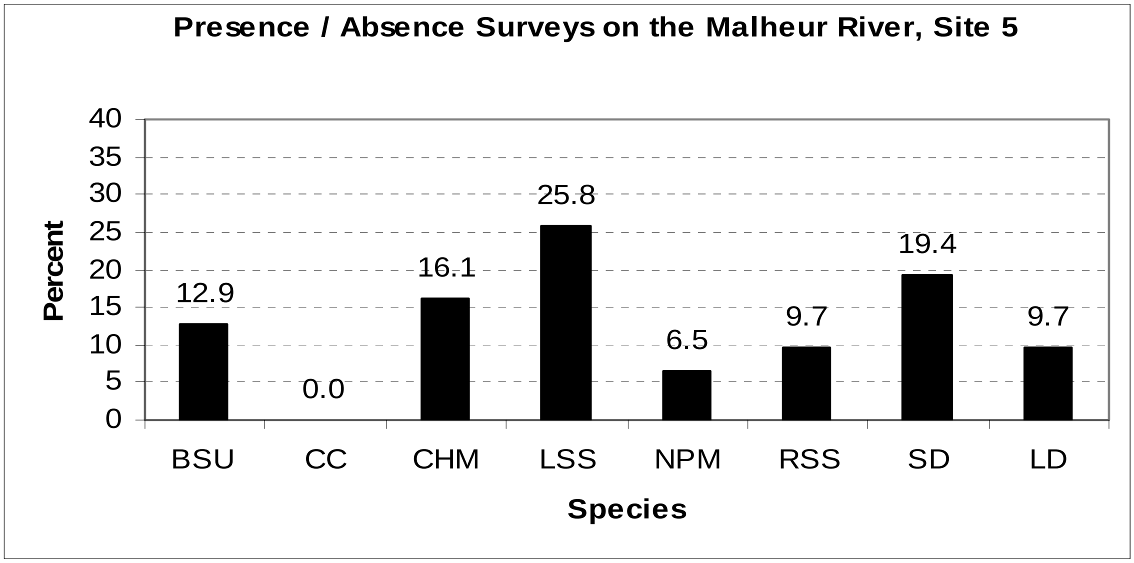


Figure 7–8. Relative abundance of fish collected in 2003 at site 6 of presence/ absence survey conducted at Jones Ranch, managed by the Burns Paiute Tribe.

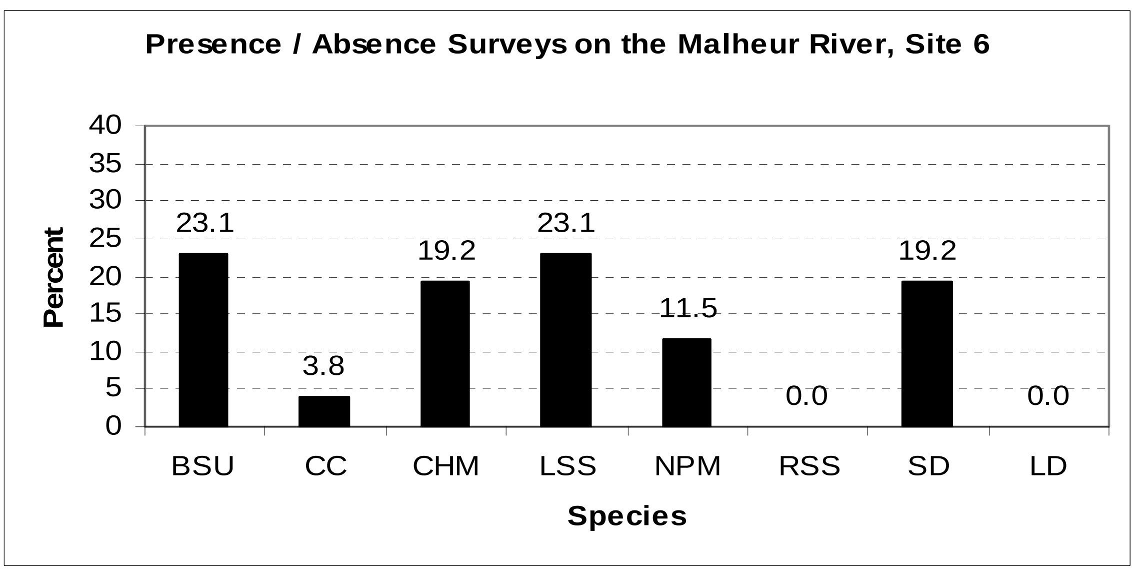


Figure 7–9. Relative abundance of fish collected in 2003 at site 7 of presence/ absence survey conducted at Jones Ranch, managed by the Burns Paiute Tribe.

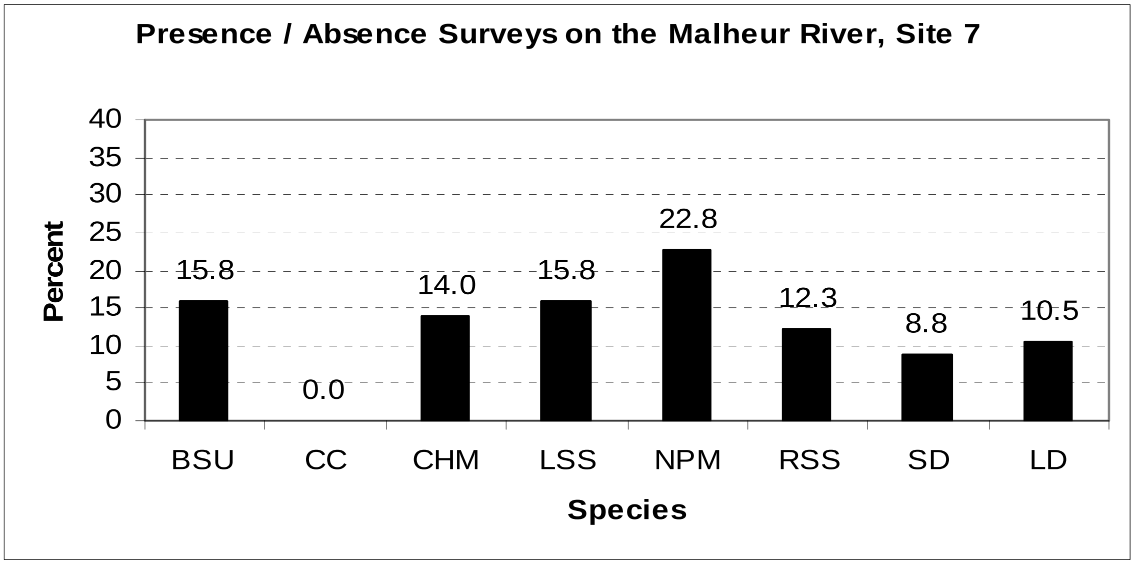


Figure 7–10. Relative abundance of fish collected in 2003 from presence/ absence survey conducted at Jones Ranch, managed by the Burns Paiute Tribe.

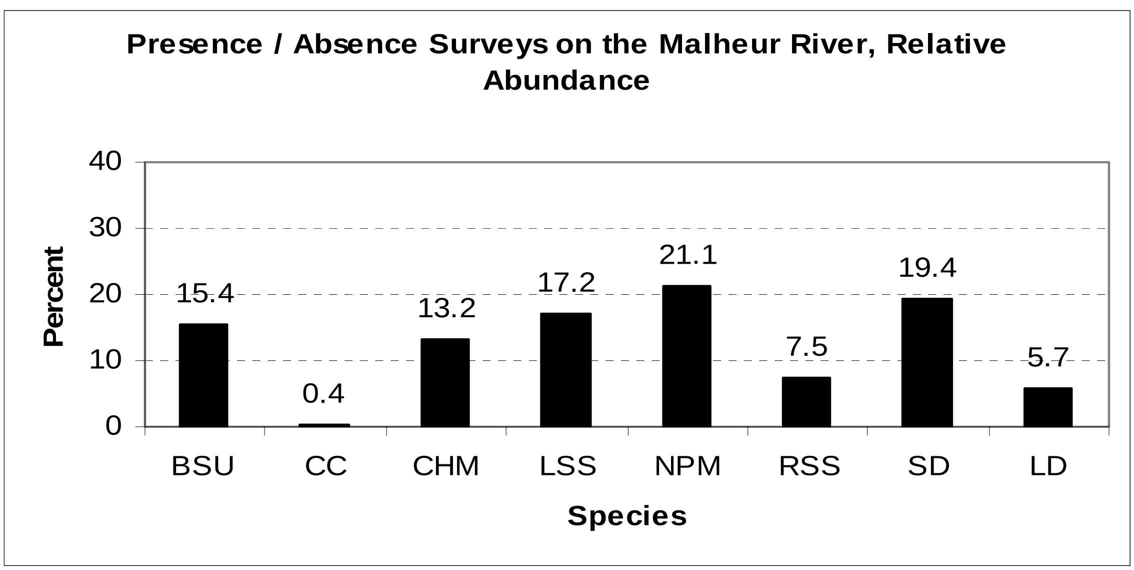
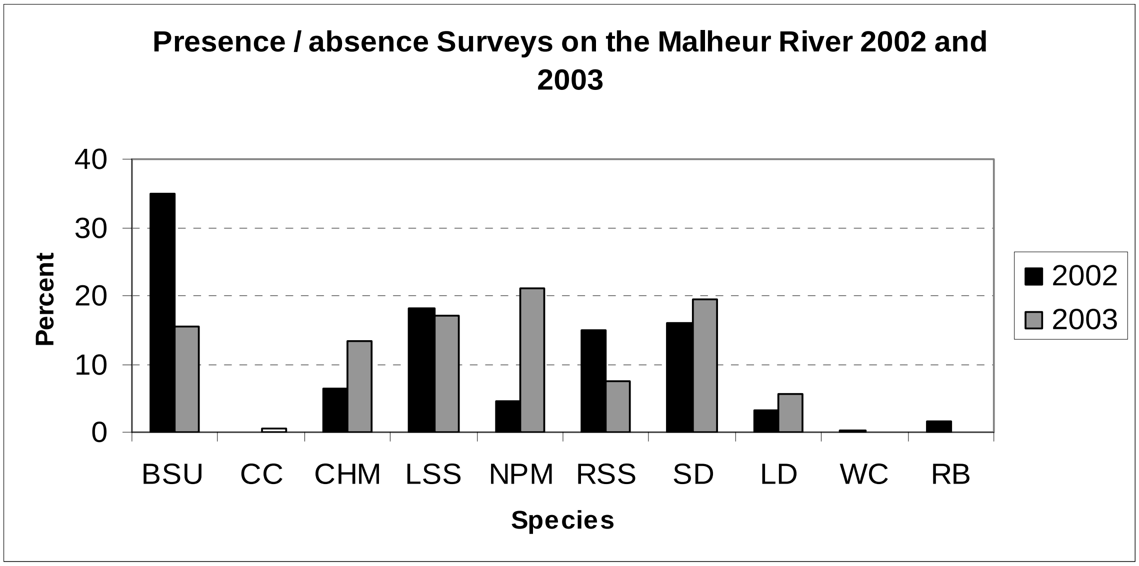


Figure 7–11. Relative abundance of fish species collected during surveys conducted in 2002 and 2003 on the Malheur River at Jones Ranch, managed by the Burns Paiute Tribe. Methodologies vary from each year. Though the survey detected the presence of a few different species, no bull trout were collected in the 2 years of sampling at Jones Ranch



Appendix 2. Length frequency of fish collected during the 2003 presence/absence survey of the Malheur River on the Jones Ranch Malheur River Mitigation property. Seven sites were sampled between RM 80 to 90. A total of eight fish species were present. No graph for channel catfish because only one fish was collected (546 mm).

Figure 7–12. Length frequency of bridgelip sucker collected from sampling at Jones Ranch in 2003.

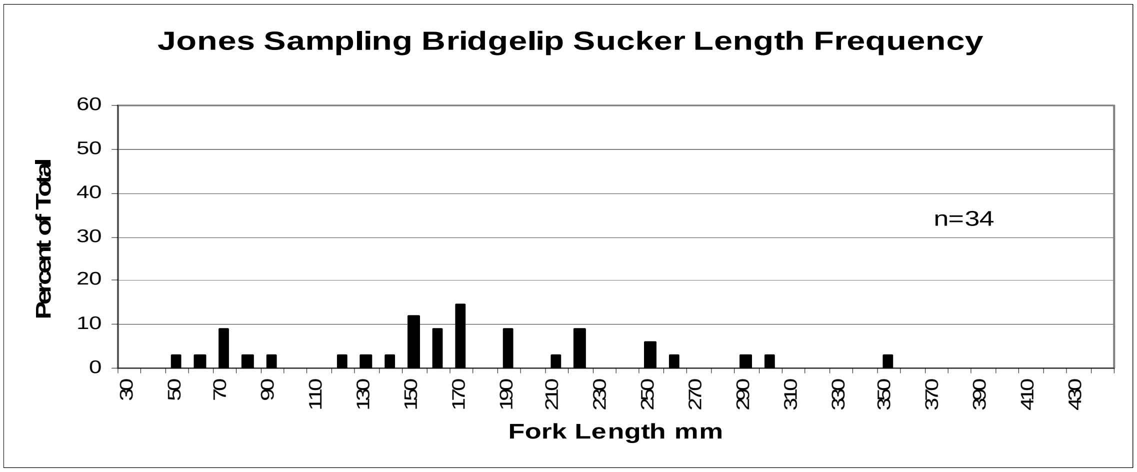


Figure 7–13. Length frequency of largescale sucker collected from sampling at Jones Ranch in 2003.

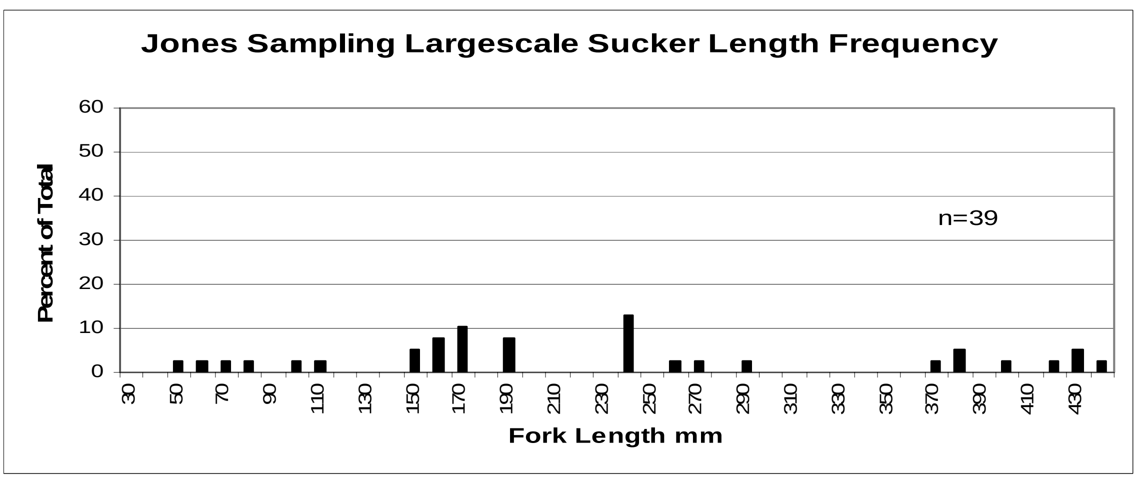


Figure 7–14. Length frequency of Chiselmouth Chub collected from sampling at Jones Ranch in 2003.

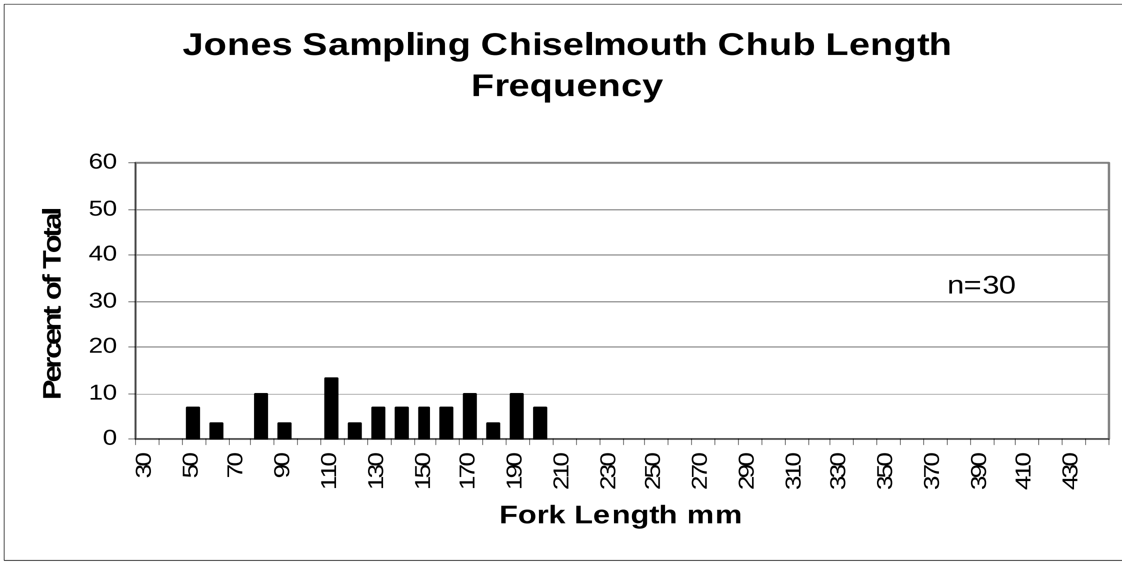


Figure 7–15. Length frequency of Longnose dace collected from sampling at Jones Ranch in 2003.

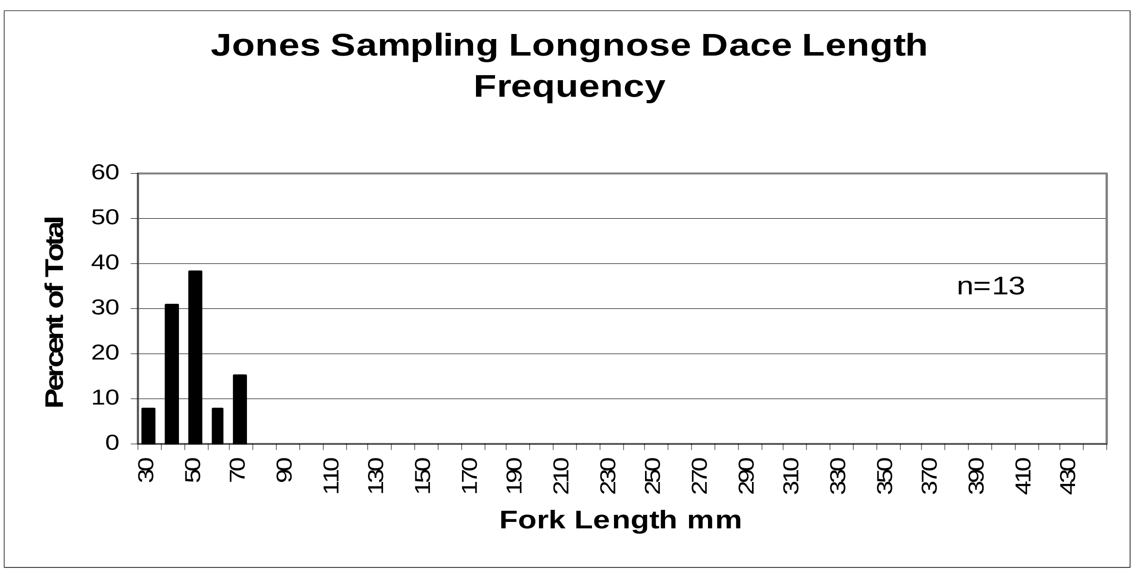


Figure 7–16. Length frequency of speckled dace collected from sampling at Jones Ranch in 2003.

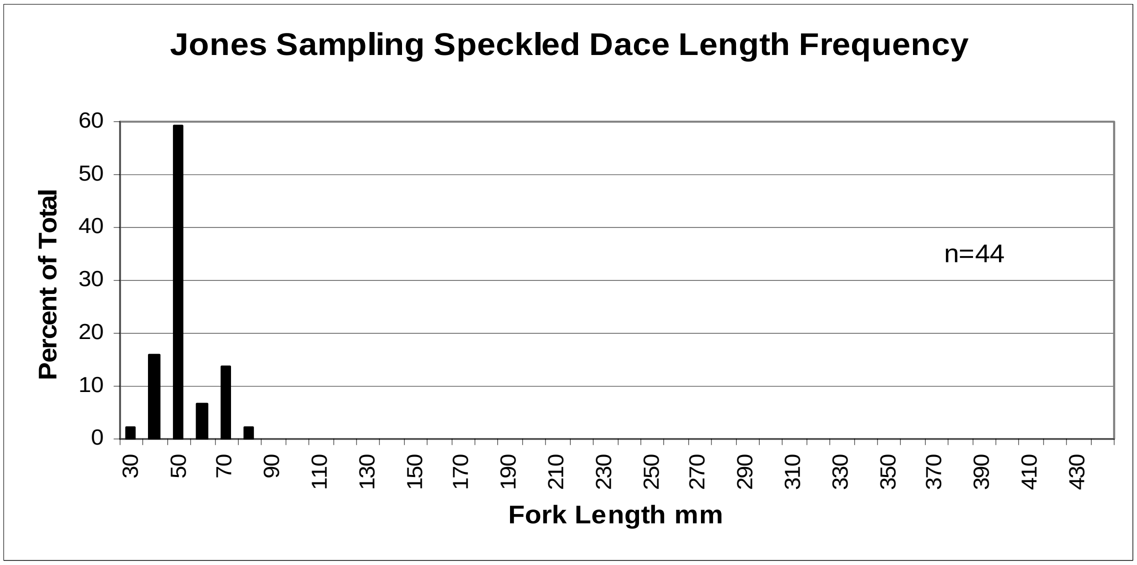


Figure 7–17. Length frequency of northern pikeminnow collected from sampling at Jones Ranch in 2003.

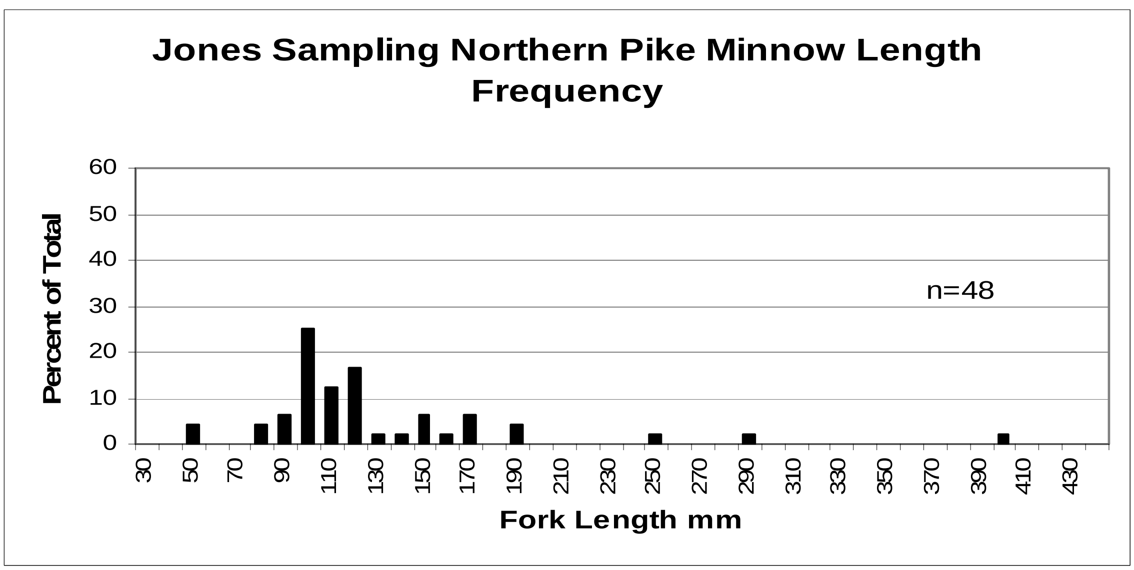
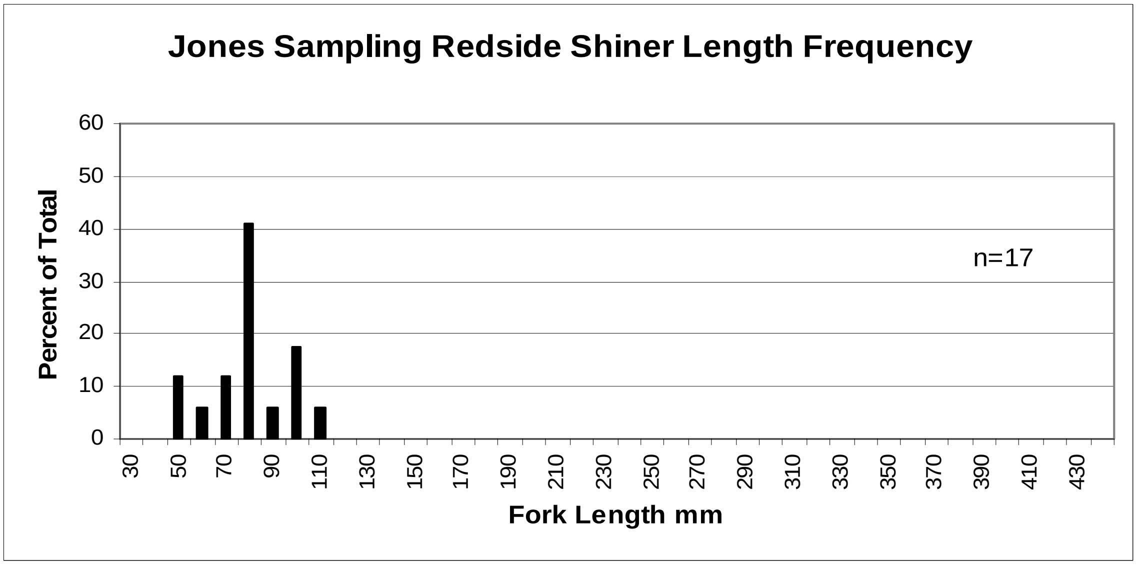


Figure 7–18. Length frequency of redside shiner collected from sampling at Jones Ranch in 2003.



8.

BULL TROUT SPAWNING SURVEY REPORT, 2003.

by Ray Perkins,

Malheur Fish District,

Oregon Department of Fish and Wildlife

Ontario, OR

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8. BULL TROUT SPAWNING SURVEY REPORT, 2003

by Ray Perkins
Malheur Fish District,
Oregon Department of Fish and Wildlife
Ontario, OR

8.1. Introduction

Bull trout *(Salvelinus confluentus*) were known to exist in the North Fork Malheur River watershed (North Fork) and in the Upper Malheur River watershed (Upper Malheur) prior to 1992. As a result of increased interest in the status of bull trout, the Oregon Department of Fish and Wildlife (ODFW) began bull trout spawning surveys in the North Fork watershed in 1992. We hoped to use spawning surveys to track trends in spawning bull trout abundance. The North Fork watershed was selected for initial surveys because it was simpler to understand bull trout spawning without the presence of brook trout (*Salvelinus fontinalis*). Brook trout are present in the upper Malheur River system, and spawn timing overlaps with that of bull trout.

ODFW district staff and volunteers conducted surveys in 1992. Since then, additional cooperators have assisted with the surveys. Present survey participants include ODFW, the Burns Paiute Tribe, Malheur National Forest, U.S. Fish and Wildlife Service, U.S. Bureau of Reclamation, U.S. Bureau of Land Management, and a number of volunteers. This report summarizes data collected through 2003.

From 1992 through 1996, many different stream reaches were surveyed in the hope of finding bull trout redds. Survey reaches were selected using data from stream habitat surveys and population estimates completed in 1991-92 in tributaries of the upper North Fork watershed. Stream reaches were surveyed in mid September and mid October. In 1997, stream reaches were surveyed in late August for the first time. From 1997 to 2002, crews surveyed stream reaches during three time periods — late August, mid September, and late September. Horseshoe Creek is the only new stream reach surveyed since 1997 where redds were observed. In 2003, all sections of streams with known bull trout populations were surveyed in mid September and mid October.

Spawning surveys began in the Upper Malheur watershed in 1998. As with the North Fork watershed, stream habitat surveys population estimates completed in 1994 in Meadow Fork, Snowshoe, Big, and Lake Creeks were used to select the initial stream reaches surveyed. Since then, we have added and dropped stream reaches in lower Summit and Bosonberg Creeks and added stream reaches in Big and Summit Creeks. In 2003, surveys were completed in Lake, Meadow Fork, Snowshoe, and Summit Creeks. No survey was conducted on Big Creek due to lack of personnel.

We believe that the core bull trout spawning areas are being surveyed in the North Fork watershed. Many streams with good habitat have been surveyed in addition to the current stream sections where spawning is observed. In the Upper Malheur watershed, all streams sections with known bull trout populations are currently being surveyed. Several other stream sections that historically contained bull trout have not been surveyed yet. Stream sections may be extended or dropped in the future to incorporate new information.

8.1.1. Study Objectives

There are seven main objectives for this study:

- Determine where bull trout spawn.
- Determine when bull trout spawn.
- Determine the number of spawning bull trout.
- Determine the location and timing of brook trout spawning in relation to bull trout spawning in the Upper Malheur watershed.
- Estimate time spent on redd construction.
- Estimate the number of adults per redd.
- Determine the visibility of redds through the season.

The first three objectives apply to both watersheds. The fourth objective applies to the Upper Malheur watershed and is an effort to separate bull trout spawning from brook trout spawning. The fifth and sixth objectives, which were investigated only in upper Little Crane Creek, were dropped in 2003 due reduced number of personnel. In 2003, we added the seventh, "redd visibility," to help determine the amount of time between surveys necessary to maintain comparability with past surveys.

8.2. Methods

Spawning surveys were completed on streams in the North Fork and Upper Malheur watersheds known or suspected to support bull trout spawning. Stream reaches were surveyed September 16-18 and October 21-22. Volunteers walked upper Little Crane Creek on September 1. To better match the amount of time and personnel available, the number of times each stream reach was surveyed changed this year to two streams in each basins from three on North Fork streams and four on Logan Valley streams. The survey dates were selected to match the dates of surveys between 1992 and 1996. This was done to ensure accurate comparisons with previously collected data.

Teams of one or more persons surveyed each stream reach in an upstream direction; there was at least one experienced surveyor per team. If there were multiple surveyors on a team, they usually walked on opposite sides of the stream. Crews counted redds, recorded numbers of bull trout seen, and estimated total length (inches). Except for the last survey, all redds were flagged to avoid double-counting on subsequent surveys.

Each crew used a GPS (Global Positioning System) unit to record the location of the start and end of stream sections, of redds, and of positively identified bull trout. GPS readings were transferred to data sheets manually during surveys. Each GPS unit was set to record coordinates in decimal degrees or decimal minutes and used NAD 1983. All GPS coordinates were entered into “Arcview 3.1” software and mapped. Attempts were made to correct for GPS unit or recording errors when points were mapped.

In the Upper Malheur watershed, it is impossible to distinguish the difference between bull trout and brook trout redds without identifying the fish creating each redd. Very few fish were identified as to species and associated with redds. Redds enumerated and mapped in the Upper Malheur watershed are an aggregate of both species. The mid-October survey in the Upper Malheur watershed is an attempt to differentiate peak spawning times between bull trout and brook trout.

In 2003, we changed when and how many times stream segments were surveyed. From 1997 to 2002, stream segments were walked during three time periods: the last week of August, mid September, and the last week of September. In 2003, surveys were reduced to two; they were walked mid September and mid October. This change was due to reductions in personnel from all participating agencies. Observations of “redd visibility” was added this year (2003) to allow us to better determine the amount of time between surveys necessary to maintain comparability with past surveys. After each redd was identified, we determined its coordinates, size, visibility, and whether it was occupied. Redd sizes were grouped into three categories: “small” (<0.5m), “medium” (0.5-1.0m), and “large” (>1.5m). Redd visibility was also grouped into three categories: “1” (clearly defined no algae growth), “2” (some erosion and algae growth), and “3” (difficult or impossible to detect).

8.3. Results in North Fork Malheur River watershed

The upper North Fork watershed was surveyed twice. The survey began at the mouth of Deadhorse Creek and ended 2.9 miles upstream (Figure 8-2 in appendix A). No redds or bull trout were observed on either survey (Table 8-1).

Table 8-1. Bull trout redds observed in the mainstem of the North Fork Malheur River.

Year	Redds	Miles	Redds/Mile
1992 [a/]	1	5.9	0.2
1993	1	15.5	0.1
1994	0	7.3	0.0
1995	0	6.0	0.0
1996	6	3.9	1.5
1997	10	2.3	4.4
1998	3	3.8	0.8
1999	9	3.5	2.6
2000	16	3.5	4.3
2001	5	3.0	1.7
2002	8	2.3	3.5
2003	0	3.8	0.0

a/ Does not include 14 questionable redds observed by volunteers included in earlier reports.

8.3.1. Horseshoe Creek

Horseshoe Creek was surveyed twice. The survey began at the confluence with North Fork Malheur River and ended about 1.2 miles upstream (Figure 8-2). One redd and no bull trout were observed on September 16, and no redds or bull trout were observed on October 22 (Table 8-2).

Table 8-2. Bull trout redds observed in Horseshoe Creek, tributary to North Fork Malheur River.

Year	Redds	Miles	Redds/Mile
1998	4	0.4	10.0
1999	4	0.8	5.0
2000	7	0.8	6.3
2001	6	0.6	10.3
2002	3	1.2	2.5
2003	1	0.8	1.3

Deadhorse Creek

Deadhorse Creek was not surveyed this year.

Flat Creek

Flat Creek was not surveyed this year

Spring Creek

Spring Creek was not surveyed this year.

8.3.2. Swamp Creek

Both sections of Swamp Creek were surveyed twice (Figure 8-3 in appendix A). The lower section began at the confluence of the North Fork and continued upstream about 2.0 miles. The upper section began at the end of the lower section and continued upstream about 2.2 miles. No redds and five bull trout were observed on September 16 and 18. Thirteen redds and seven bull trout were observed on October 22 (Table 8-3).

Table 8-3. Bull trout redds observed in Swamp Creek, tributary to North Fork Malheur River.

Year	Redds	Miles	Redds/Mile
1992	0	1.2	0.0
1993	3	2.2	1.4
1994	9	3.9	2.3
1995	0	3.9	0.0
1996	8	3.8	2.1
1997	21	4.1	5.1
1998	24	4.2	5.7
1999	35	4.1	8.5
2000	40	4.1	9.8
2001	22	4.2	5.3
2002	19	2.0	9.5
2003	13	4.2	3.1

8.3.3. Sheep Creek

Sheep Creek was surveyed twice. The survey section begins at the confluence with the North Fork and continues upstream 3.9 miles (Figure 8-3 in Appendix A). Nine redds and no bull trout were observed on September 16. Three redds and no bull trout were observed on October 21 (Table 8-4).

Table 8-4. Bull trout redds observed in Sheep Creek, tributary to North Fork Malheur River.

Year	Redds	Miles	Redds/Mile
1992	0	1.1	0.0
1993	0	2.2	0.0
1994	0	2.2	0.0
1995	2	2.9	0.7
1996	13	3.4	3.8
1997	8	2.9	2.8
1998	17	3.5	4.9
1999	22	3.0	7.3
2000	25	4.0	6.3
2001	15	3.5	4.3
2002	17	3.5	4.9
2003	12	3.9	3.1

Cow Creek

Cow Creek was not surveyed this year.

Little Cow Creek

Little Cow Creek was not surveyed this year.

8.3.4. Elk Creek

Elk Creek was surveyed twice (Figure 8-4 in appendix A). The survey began at the confluence with North Fork Malheur River and ended 1.1 miles upstream at the confluence of the North Fork and South Fork Elk. It continues up the South Fork 0.8 miles and up the North Fork 1.3 miles. Three redds and no bull trout were observed on September 17. Four redds and no bull trout were observed on 22 October (Table 8-5).

Table 8-5. Bull trout redds observed in Elk Creek and its tributaries, the North and South forks.

Year	Redds	Miles	Redds/Mile
1992	1	1.0	1.0
1993	1	2.3	0.4
1994	0	2.0	0.0
1995	1	4.0	0.3
1996	3	4.1	0.7
1997	9	4.1	2.2
1998	6	3.5	1.7
1999	12	3.0	4.0
2000	5	3.0	1.7
2001	3	3.2	0.9
2002	7	2.8	2.5
2003	7	3.2	2.2

Crane Creek

Crane Creek was not surveyed this year.

8.3.5. Little Crane Creek

Little Crane Creek was surveyed three times (Figure 8-5 in appendix A). The survey started at the confluence with Crane Creek and continued upstream 6.1 miles to Forest Road 1665-0498 road. Twenty-seven redds and three bull trout were observed on September 1. Three redds and one bull trout were observed on September 18. No redds and no bull trout were observed on October 22 (Table 8-6).

Table 8-6. Bull trout redds observed in Little Crane Creek, tributary to North Fork Malheur.

Year	Redds	Miles	Redds/Mile
1992			
1993	3	5.6	0.5
1994	4	7.5	0.5
1995	6	6.0	1.0
1996	8	6.0	1.3
1997	16	4.2	3.8
1998	20	6.0	3.3
1999	33	6.1	5.4
2000	60	6.1	9.8
2001	74	6.2	12.0
2002	45	2.8	16.1
2003	30	6.1	4.9

8.3.6. Bull Trout Observations

Beginning in 1999, we recorded the number and location of bull trout observed during spawning ground surveys. The number of bull trout observed during the North Fork surveys continued to decline from a peak of 272 fish in the year 2000 (Table 8-7). In 2003, fish were difficult to see under blue skies and bright sun conditions. The number of larger (>13 inches) bull trout seen was almost even for each of the three survey periods, with two on the first pass, two on the second pass, and three on the third pass.

Table 8-7. Bull trout redds observed in Little Crane Creek, tributary to North Fork Malheur.

Stream	1999	2000	2001	2002	2003	Total
L. Crane Cr.	95	125	65	10	4	**299**
Swamp Cr.	48	66	16	17	12	**159**
Sheep Cr.	43	41	42	18	0	**144**
Horseshoe Cr.	2	0	1	2	0	**5**
Upper N. F.	12	11	0	0	0	**23**
Elk Cr.	18	24	9	15	0	**66**
Deadhorse Cr.	0	0	0	0		**0**
Flat Cr.	0		0			**0**
Spring Cr.			0			**0**
Cow Cr.		5	0			**5**
L. Cow Cr.		0	0			**0**
Total	**218**	**272**	**133**	**62**	**16**	**685**

8.4. Results in Upper Malheur River Watershed

8.4.1. Summit Creek

Upper Summit Creek was surveyed twice (Figure 8-6, appendix B). The survey began at a fence downstream of 1600-0598 road and ended upstream about 1.6 miles. Five redds were observed on September 17 and 19 redds were observed on October 21 (Table 8-8).

Table 8-8. Redds observed in Summit Creek, tributary to Upper Malheur River, from mid September to mid October.

Year	Redds	Miles	Redds/Mile
1999	18	2.3	7.8
2000	43	4.8	9.0
2001	87	1.9	45.8
2002	19	1.4	13.6
2003	24	1.6	15.0

8.4.2. Snowshoe Creek

Snowshoe Creek was surveyed twice (Figure 8-6). The survey began at the confluence with Big Creek and ended about 1.1 miles upstream near the wilderness boundary sign. No redds were observed on September 17, and six redds were observed on October 21 (Table 8-9).

Table 8-9. Redds observed in Snowshoe Creek, tributary to Big Creek, from mid September to mid October.

Year	Redds	Miles	Redds/Mile
1998	10	1.7	5.9
1999	25	1.7	14.7
2000	3	1.7	1.8
2001	16	1.7	9.4
2002	0	1.4	0.0
2003	6	1.1	5.5

Big Creek

Big Creek was not surveyed this year.

8.4.3. Meadow Fork Big Creek

Both sections of Meadow Fork were surveyed twice (Figure 8-7, appendix B). The survey began at the confluence with Big Creek and ended 3.2 miles upstream at a waterfall. No redds or bull trout were observed on either survey (Table 8-10).

Table 8-10. Redds observed in Meadow Fork Big Creek, tributary to Big Creek, from mid September to mid October

Year	Redds	Miles	Redds/Mile
1998	39	3.3	11.8
1999	25	3.3	7.6
2000	51	3.3	14.8
2001	92	3.2	28.9
2002	16	3.2	5.0
2003	0	3.2	0.0

8.4.4. Lake Creek

Both sections of Lake Creek were surveyed twice (Figure 8-7). The survey began at Forest Road 1648 and ended 4.2 miles upstream at a waterfall. Two redds were observed on September 17, and 19 redds were observed on October 21 (Table 8-11).

Table 8-11. Redds observed in Lake Creek, tributary to Upper Malheur River, from mid September to mid October.

Year	Redds	Miles	Redds/Mile
1998	34	2.1	16.2
1999	21	4.3	4.9
2000	22	4.3	5.1
2001	44	4.2	10.5
2002	—	—	—
2003	21	4.2	5.0

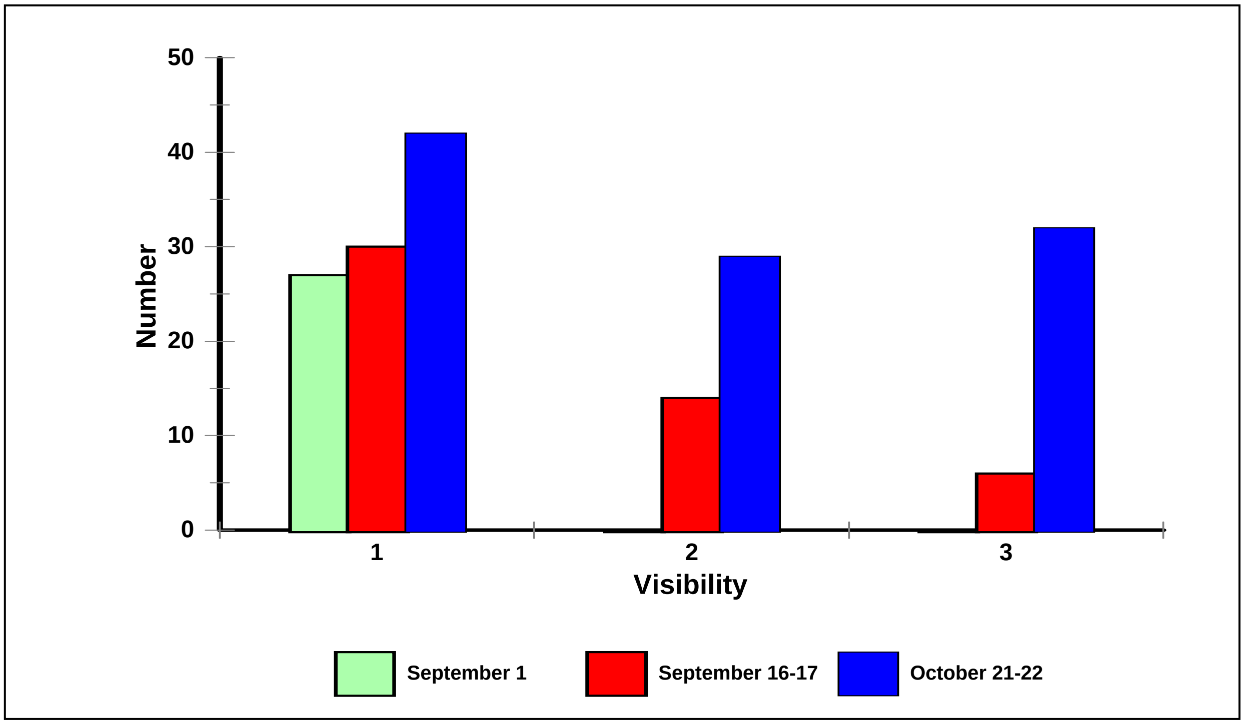
Bosonberg Creek

Bosonberg Creek was not surveyed this year.

8.4.5. Redd Visibility

This was the first year collecting this data. Crews were trained prior to the mid-September survey.. During mid-September surveys, the crews classified 50 redds. Sixty percent were classified as 1's with the rest classified as either 2's or 3's (Figure 8-1.). Twenty-seven of these redds were first identified by two volunteers who walked Little Crane Creek on September 1. They did not collect this data, so I assigned all redds they observed as 1's. During the mid-September survey, there was some disagreement with redd identification, so some hard-to-see redds were classified as 2's or 3's. We will change the protocol next year so that the same person will walk each during all three passes. That should reduce or eliminate any discrepancies in redd identification.

Figure 8–1. The number of redds observed in 2003 for each of the three time periods.



8.5. Discussion

Survey data can be compared effectively from 1996 to the present. Survey techniques and timing varied from 1992 to 1995 on the North Fork Malheur. During those years, project personnel were struggling with uncertainties related to spawning timing and location. Consequently, there was variation in timing of surveys and areas surveyed. In addition, livestock were abundant in some spawning areas during those years making identification of redds difficult. Since 1996, survey areas and timing have been standardized. Expertise of surveyors has also increased and most are familiar with all survey sections. A change in livestock management has reduced stream disturbance and made redds more easily identifiable.

A total of 63 redds were observed in the North Fork watershed in 2003 compared to 99 redds in 2002, a decline of 36 percent (Figures 8-8 and 8-9 in Appendix C). Little Crane, Swamp, and Sheep Creeks continue to be prime spawning areas for bull trout. In 2003, these three streams contained 87 percent of all redds counted. Good spawning habitat seems to be concentrated in small areas of these three streams (Figure 8-3 in appendix A). Spawning activity is known to occur in three other streams, but at comparably low levels.

Elk Creek was the lone bright spot this year. It was the only stream that did not show a decline in redds counted.

Most streams had substantial declines in redds observed since 2002. The headwaters of the North Fork and Horseshoe Creek had the biggest decline in redds counted this year, at 91 percent. Sheep Creek declined by 29 percent, Swamp Creek by 32 percent, and the Little Crane Creek by 50 percent.

Redds were concentrated in areas with the best habitat conditions, particularly those with strong groundwater influence. In Little Crane Creek, few redds were observed downstream of the exclosure fence. In Swamp Creek, most redds were concentrated in the upper mile of the upper stream section surveyed. In Sheep Creek, most redds were concentrated in an area about a mile up from the mouth. All of these areas have strong groundwater influence.

Streams in the Upper Malheur watershed were surveyed again this year. Because of a lack of personnel, Big Creek from Forest Road 16 upstream to Forest Road 1647 and from F.R. 1647 upstream to Snowshoe Creek was not surveyed. Redd counts were the lowest since surveys began in1998. During the mid-September survey, a total of seven redds were observed. No redds were observed in Meadow Fork. Flash flood events during the summer probably played a big part in the lack of redds in this basin this year.

Drought conditions in 2001, 2002, and 2003 are associated with a 58 percent decline from the peak redd count in 2000 in the North Fork watershed. Changes in redd counts varied by stream within the North Fork watershed. In 2001, all streams except Little Crane Creek experienced significant declines. In 2002, Little Crane Creek was the only stream with a large decline. In 2003, all streams except Elk Creek had significant declines in redd counts.

Drought impacts in the Upper Malheur watershed are not as easy to document because of the presents of brook trout. Between 2000 and 2001, the number of redds counted in the North Fork watershed declined, while the count in the Upper Malheur watershed increased. In 2002, the comparison of counts is confounded even more by the limited access caused by forest fires in the watershed. Redd counts in 2002 in Meadow Fork appear to be similar to counts during the same period in 2001, but redd counts in Summit Creek were slightly down from counts during the similar period in 2001.

Appendix 8-A. Locations of Bull Trout Redds Observed during Spawning Surveys in the North Fork Malheur Watershed in 2003.

Figure 8–2. Bull trout redds observed in Horseshoe and upper North Fork Malheur River stream sections in 2003.

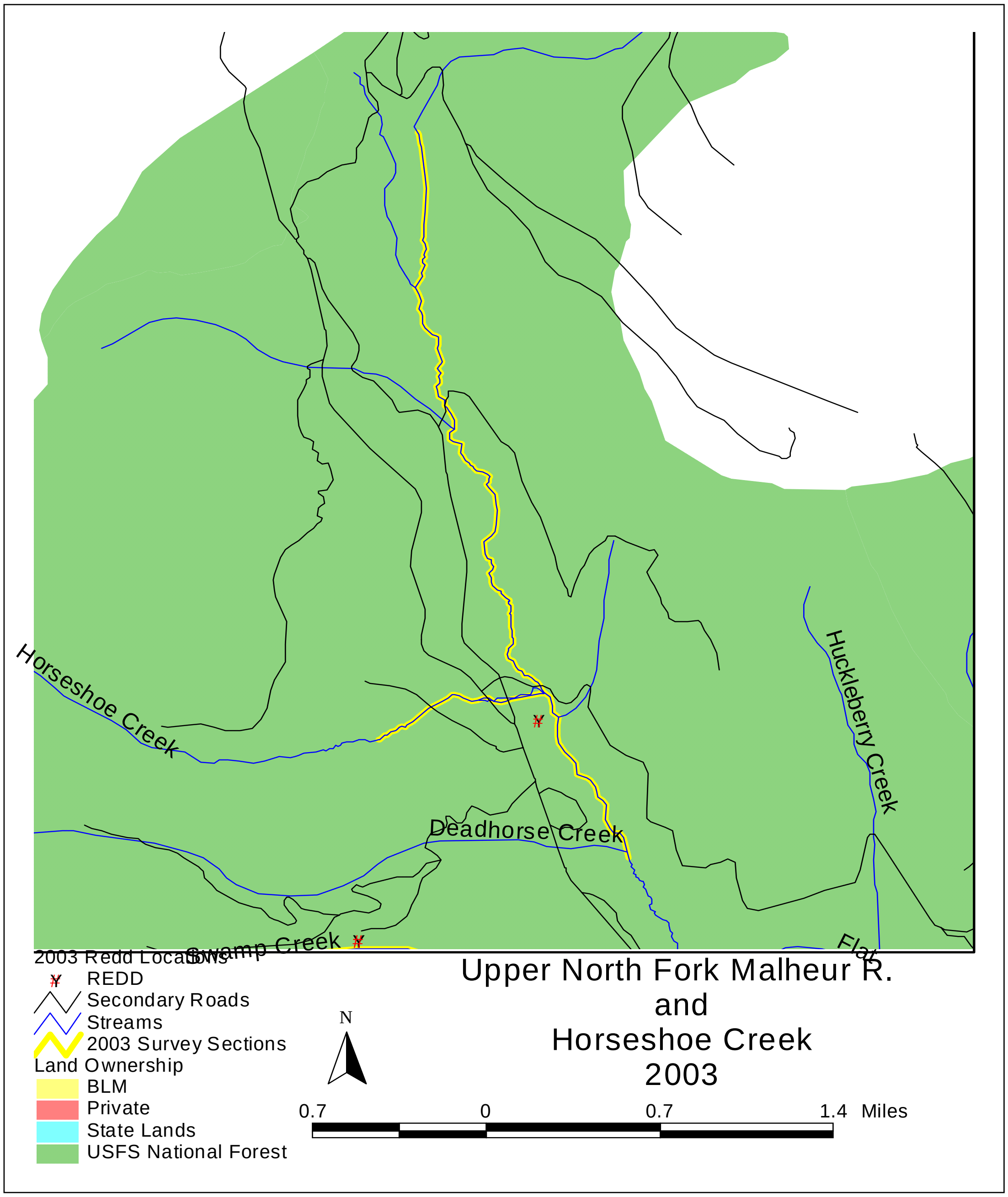


Figure 8–3. Bull trout redds observed in Swamp Creek and Sheep Creek in 2003.

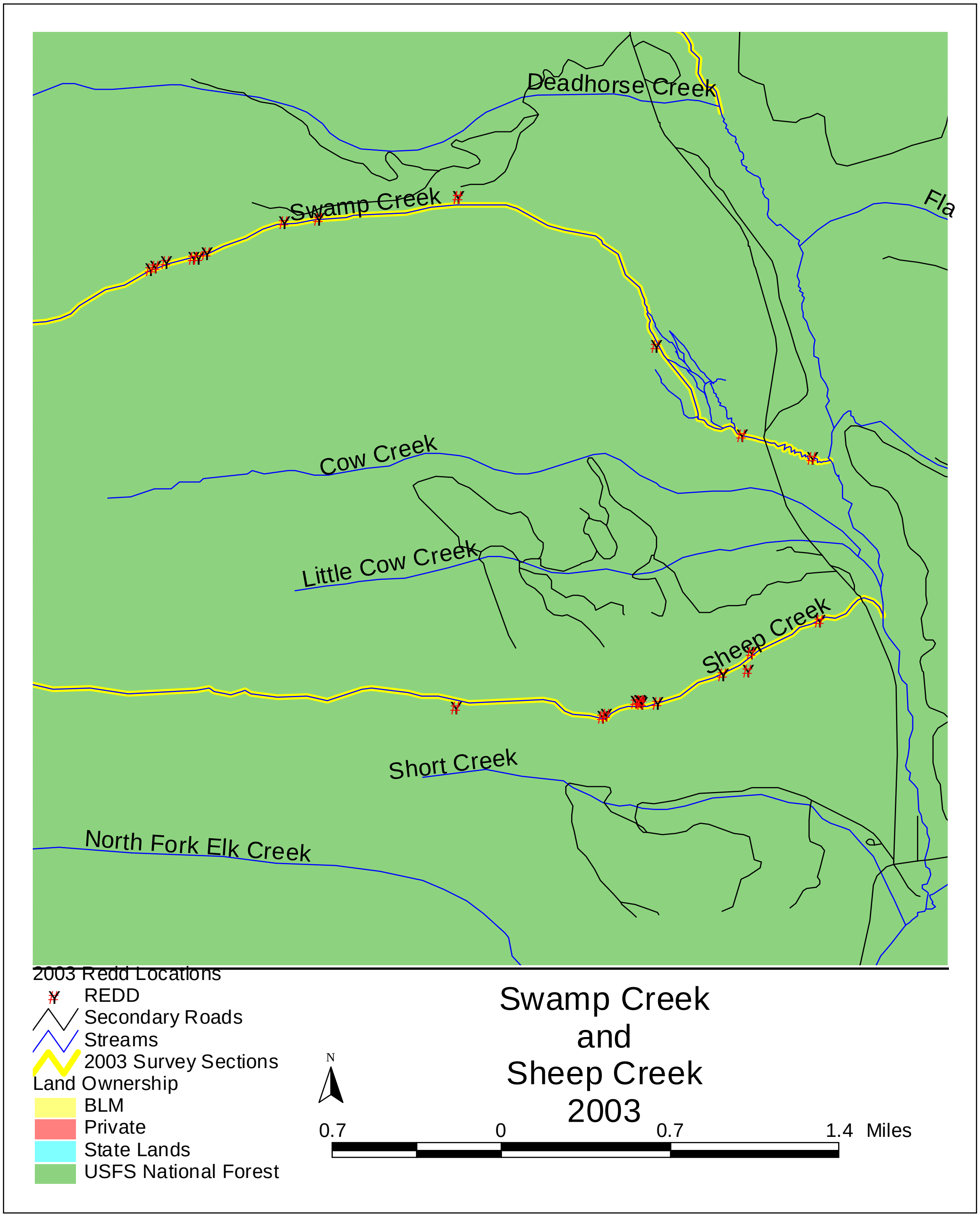


Figure 8–4. Bull trout redds observed in Elk Creek stream sections in 2003.

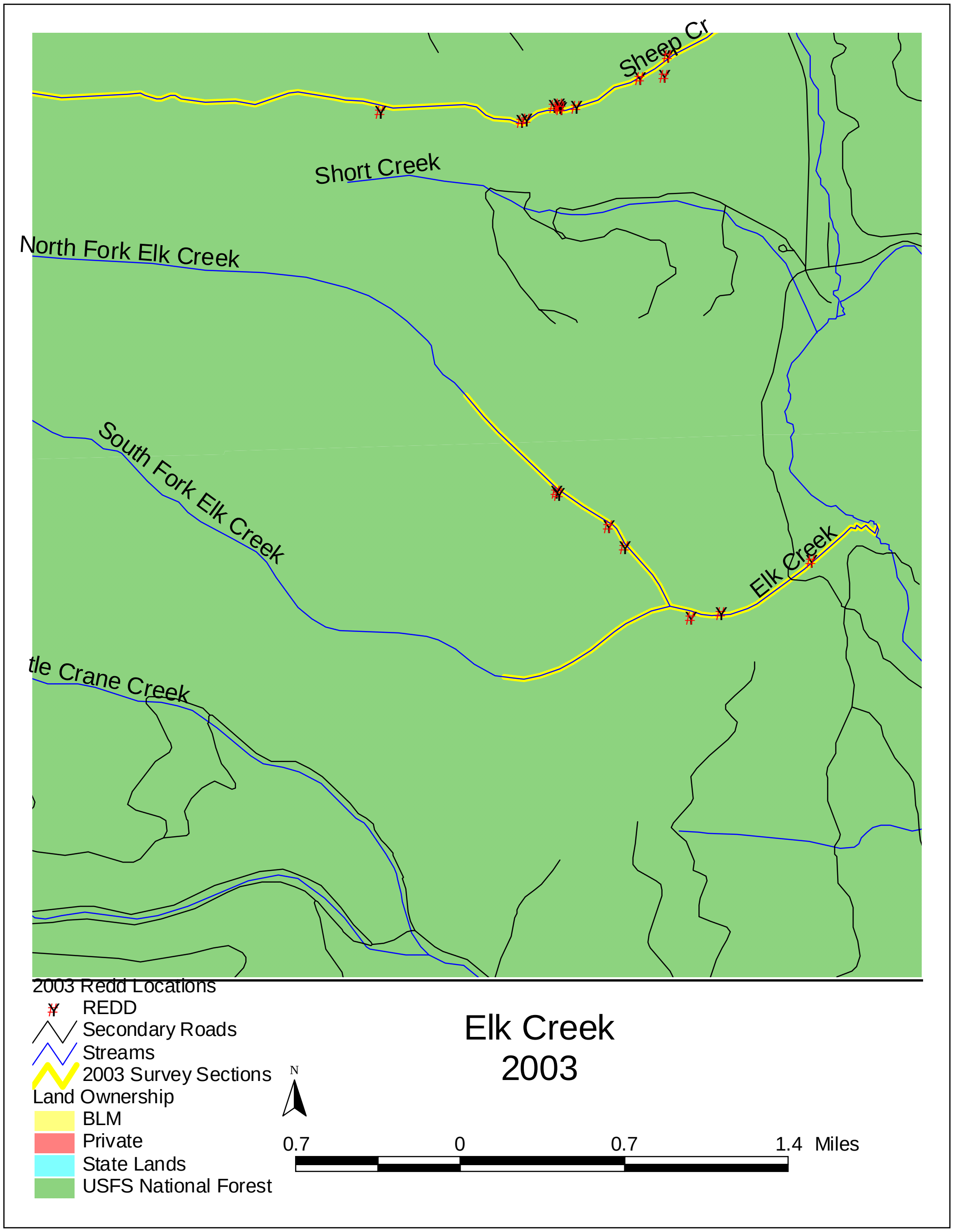
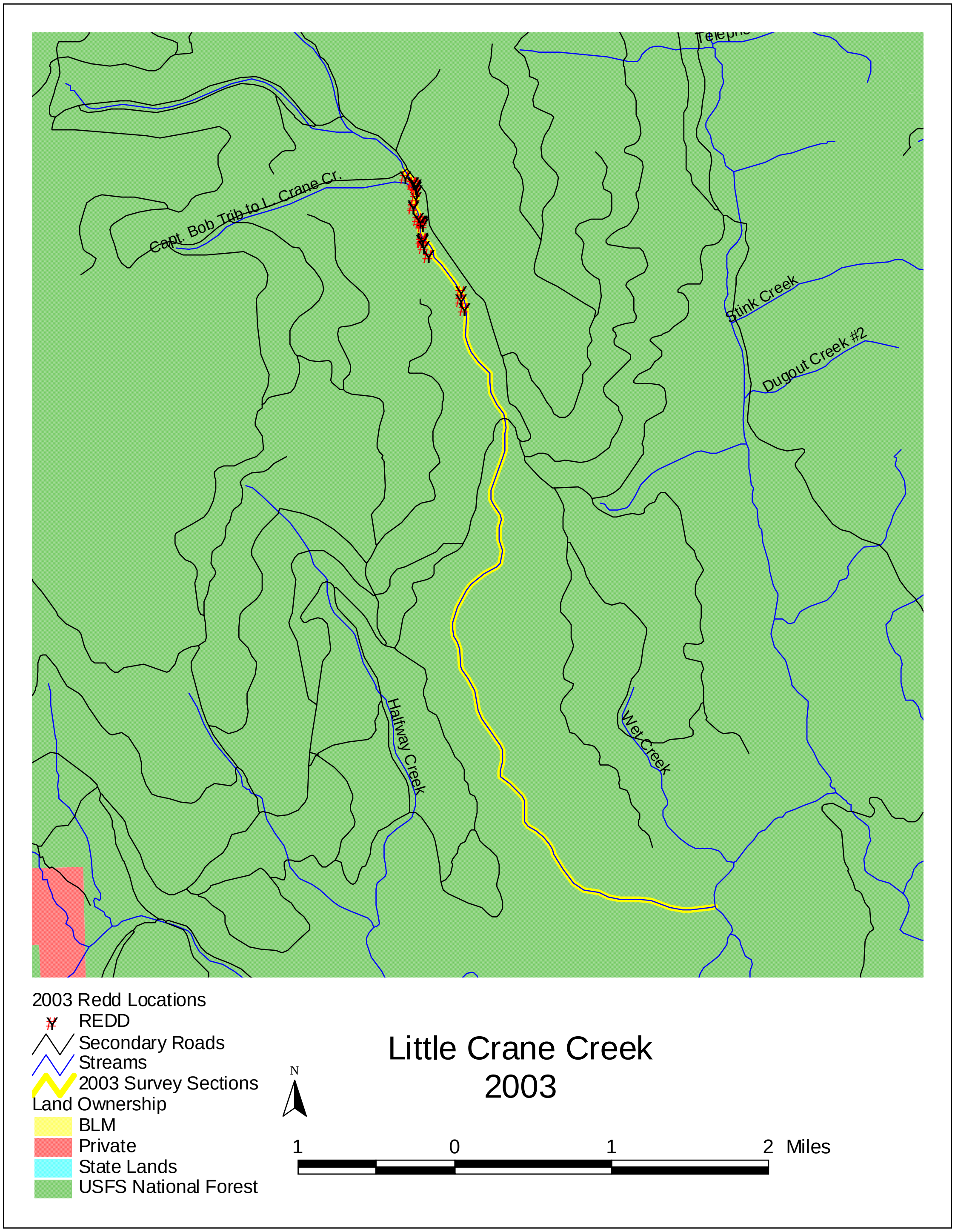


Figure 8–5. Bull trout redds observed in Little Crane Creek stream sections in 2003



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Appendix 8-B. Locations of Redds in the Upper Malheur River Watershed in August-October, 2003.

Figure 8–6. Bull trout redds observed in Summit Creek stream sections in 2003.

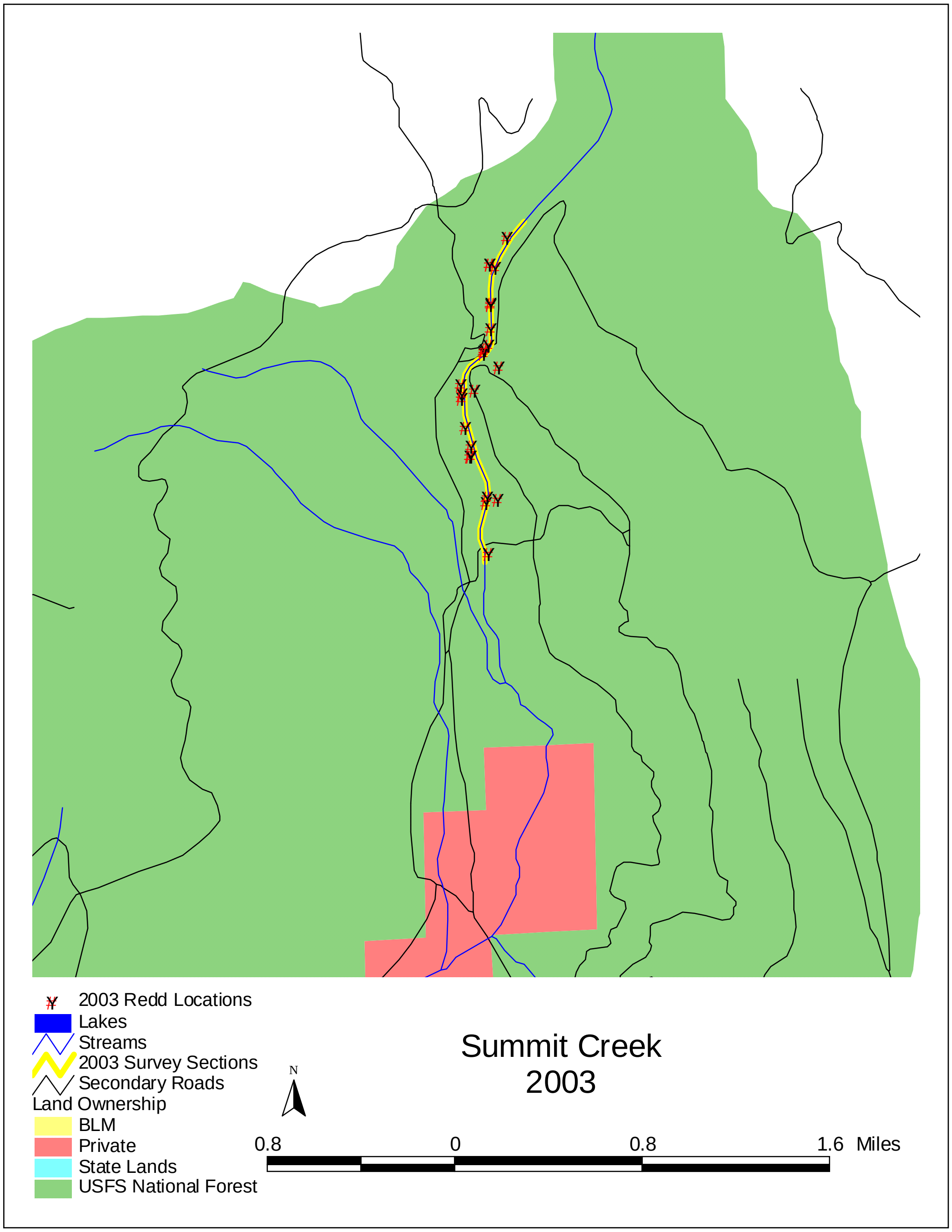
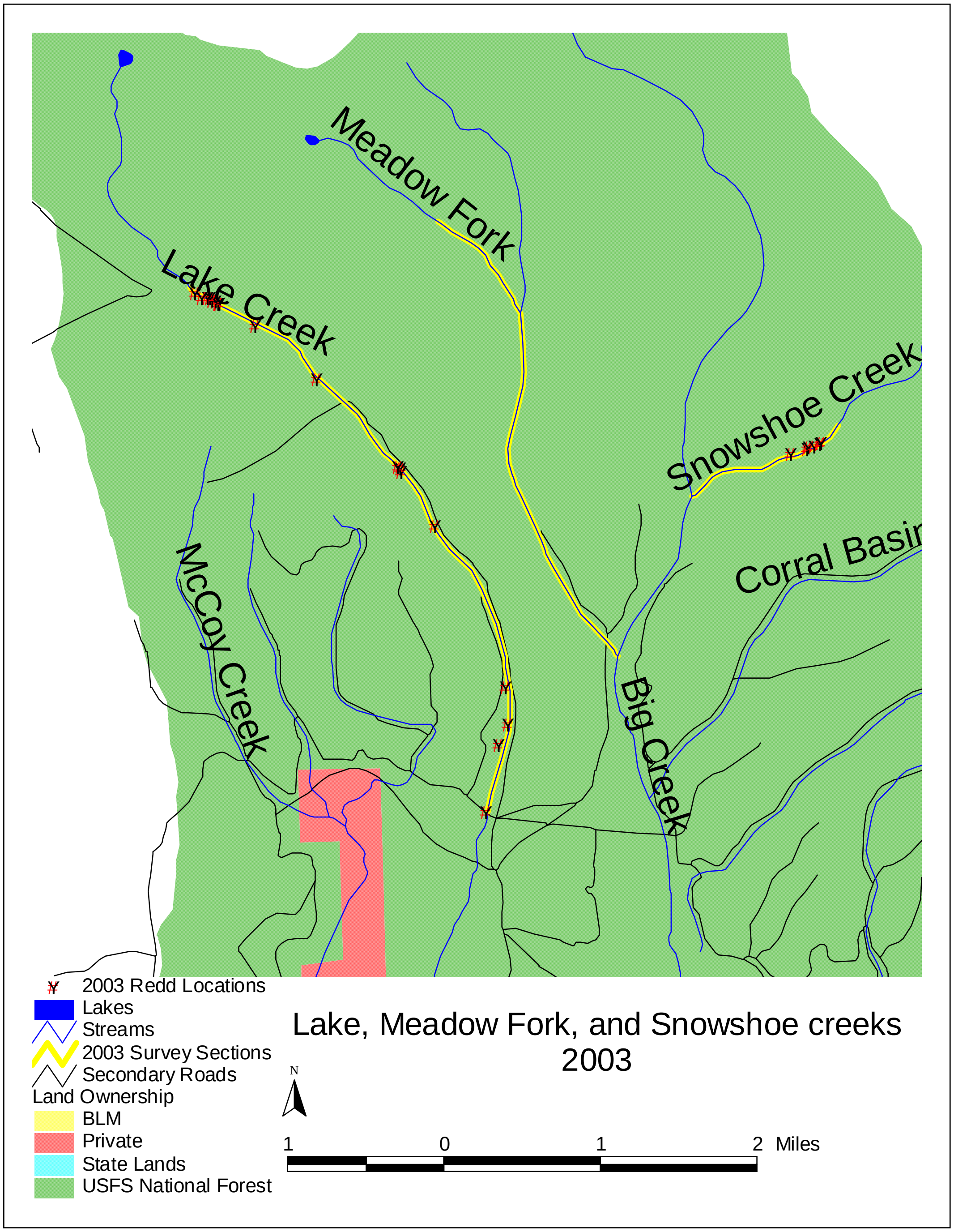


Figure 8–7. Bull trout redds observed in Meadow Fork stream sections in 2003.



Appendix 8-C. Total redd observed in the Upper Malheur River and North Fork Malheur Watersheds from Aug-Oct. 1992-2003, Baker and Grant Counties, Oregon.

Figure 8–8. The number bull trout redds observed in the North Fork Malheur River watershed from 1992-2003.

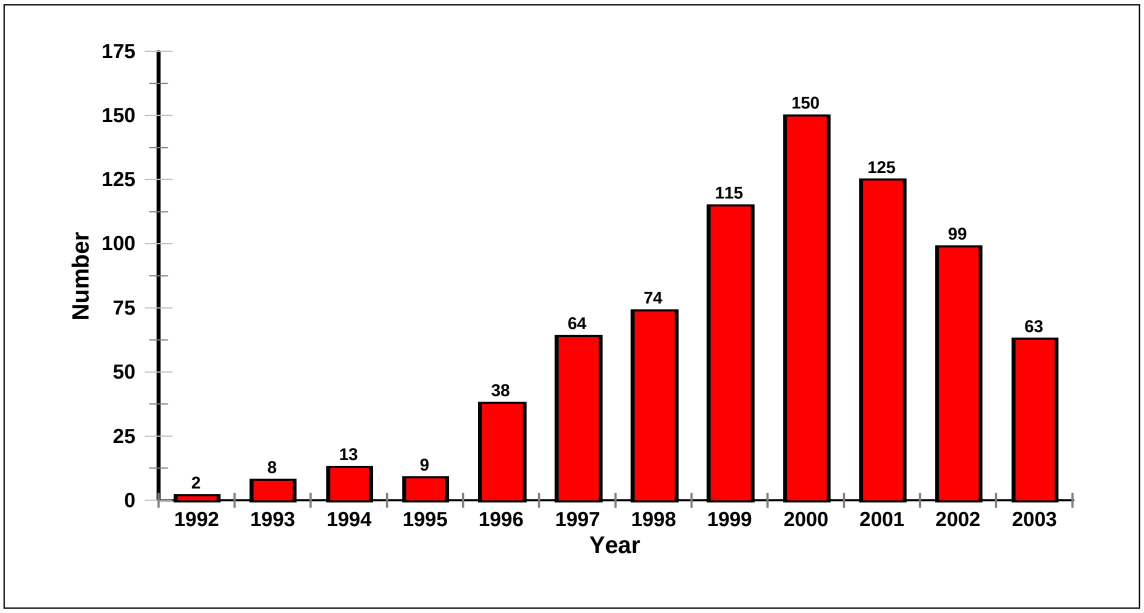


Figure 8–9. The number bull trout redds per mile of stream observed in the North Fork Malheur River watershed from 1992-2003.

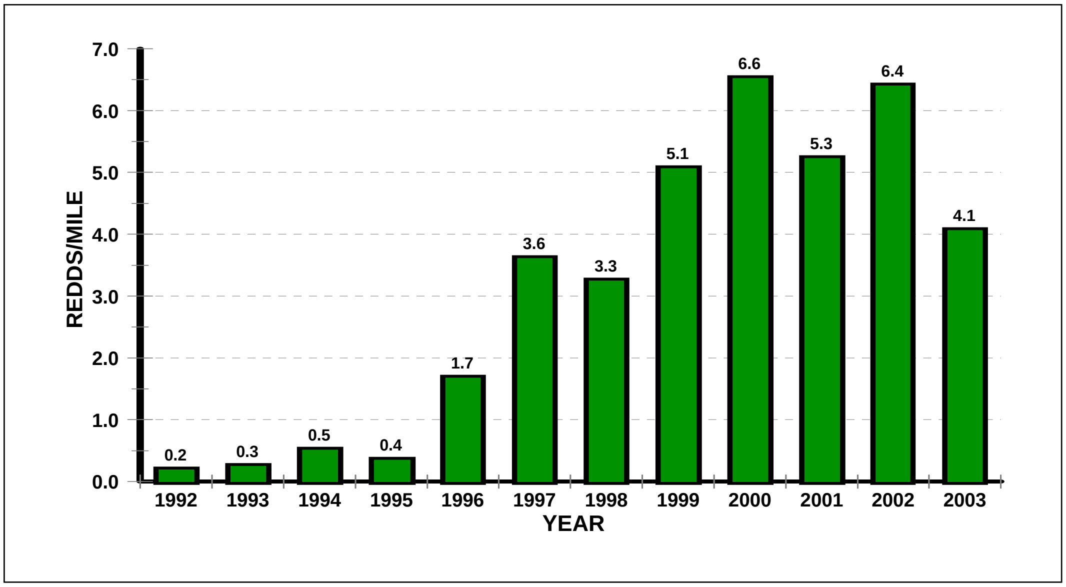


Figure 8–10. The number of redds observed in the upper Malheur River watershed 1998-2003. The counts for 2002 only include counts from Meadow Fork, Snowshoe, and Summit Creeks.

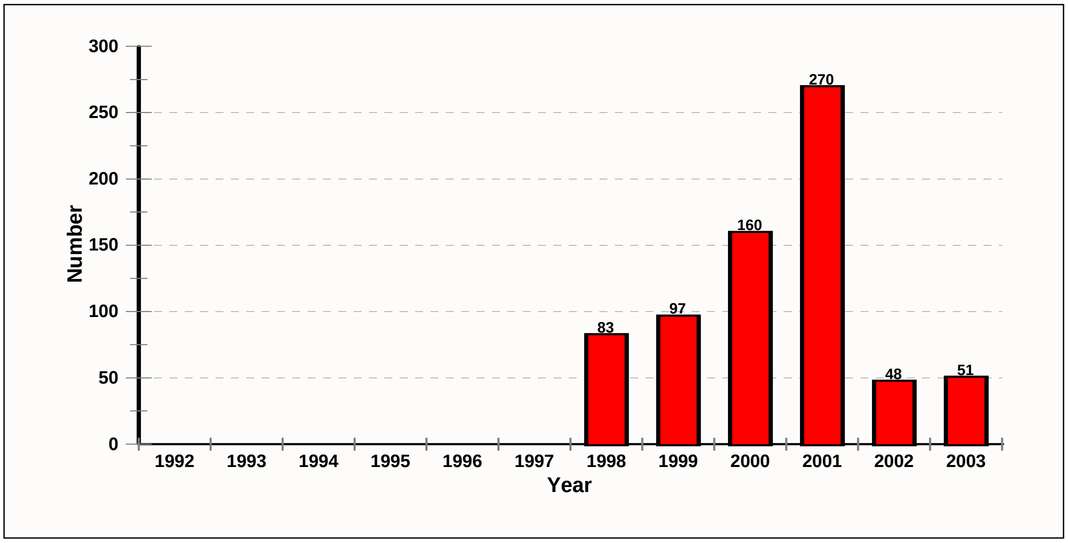


Figure 8–11. The number of redds per mile in the upper Malheur River watershed during August and September from 1998-2003. The counts for 2002 only.

9.

GENETIC ANALYSIS OF PUTATIVE HYBRIDIZATION BETWEEN BULL TROUT AND BROOK TROUT IN THE MALHEUR RIVER BASIN, OREGON, FINAL REPORT (DRAFT)

July 21, 2004

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Purchase Order No. T10017

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Chapter 9 GENETIC ANALYSIS OF HYBRIDIZATION BETWEEN BULL TROUT AND BROOK TROUT IN THE UPPER MALHEUR RIVER, OREGON

9.1 Introduction

Bull trout (*Salvelinus confluentus*) are native to Columbia and Snake River drainages of Oregon, Washington, Idaho, and western Montana. This native range includes the upper Malheur and North Fork Malheur Rivers in eastern Oregon.

Non-native brook trout (*Salvelinus fontinalis*) were historically stocked throughout the western United States and have established naturalized populations where suitable habitat exists. Indeed, brook trout often outcompete and displace native bull trout. For example, non-native brook trout outnumber bull trout 28:1 in Lake Creek, a tributary to the North Fork Malheur River (Lawrence Schwabe, Burns-Paiute Tribe, pers. comm.).

Recently, fish with "intermediate" morphological characteristics suggestive of bull-brook trout hybrids have been observed in the Lake Creek watershed (L. Schwabe, pers. comm.). Two alternative hypotheses can be invoked to explain those morphologically intermediate fish: (1) the fish in question represent the progeny, or genetic descendents, of natural interbreeding between brook and bull trout, or (2) those fish could represent morphological-genetic adaptations of brook trout to a 'bull trout stream." Neither hypothesis can be rejected based on current information.

We describe here the results of a molecular genetic study to ascertain whether non-native brook trout are interbreeding with native bull trout in the upper Malheur River drainage of eastern Oregon. Previous molecular genetic studies of potential interbreeding between bull trout and brook trout have used allozymes, paired interspersed nuclear DNA elements (PINEs), and mitochondrial DNA (mtDNA) to distinguish the two species and fish of hybrid ancestry (Leary et al. 1983, 1993; Spruell et al. 2001; Kanda et al. 2002). None of those previously used approaches represent codominantly expressed, nuclear DNA markers. Allozyme markers are based on enzyme expressions in tissues and generally require sacrifice of the fish. PINEs are dominantly expressed nuclear DNA markers (i.e. heterozygotes and heterozygotes at single loci cannot be distinguished), and mtDNA is only inherited from the maternal parent. In contrast to previous studies, we used codominantly expressed, microsatellite nuclear DNA markers to investigate the potential incidence of natural hybridization in the upper Malheur River. This report represents, to our knowledge, the first use of microsatellite DNA markers for studying natural hybridization between brook and bull trout. One additional benefit of our work has been the identification of a suite of codominantly expressed, nuclear DNA markers for distinguishing brook trout, bull trout, and their hybrid descendants.

9.2 Materials and Methods

9.2.1 Population samples

Biologists for the Burns-Paiute Tribe collected fin tissue (approximately 0.25 cm^2) from each of 100 fish sampled along a 6-mile reach of Lake Creek, a tributary to the North Fork (N.F.) Malheur River . Of those 100 fish, 33, 33, and 34 fish were classified morphologically in the field as "bull trout," "brook trout," and "hybrids," respectively. Those classifications were based on the following criteria (range in standard lengths in parentheses; L. Schwabe, pers. comm.):

- "bull trout": bright spotting on a dark back and clear dorsal fin (SL = 91-438 mm);
- "brook trout": black vermiculations on a dark back and dark and light banding (tiger striping) on the dorsal fin (SL = 63-294 mm);
- "hybrid": any white spotting on the dorsal fin, or bright spotting on a dark back and dark and light banding (tiger striping) on the dorsal fin, or black vermiculations on a dark back and clear dorsal fin (108-278 mm).

Additional fin tissues from 10 bull trout (SL = 161-223 mm) were collected from another region of the North Fork Malheur watershed where brook trout and "hybrids" were not present. Fin tissues from each fish were immediately placed in separate 2.0 mL microcentrifuge tubes containing approximately 1.0 mL of non-denatured 200 proof (100%) ethanol. Tissues from each fish were maintained in ethanol until their DNA was extracted.

We also obtained fin tissues from 15 bull trout from the Clark Fork River, Montana and 16 brook trout from Pine Creek, Iowa as reference specimens to help identify species-specific alleles. For additional cross-species reference, we also obtained tissue samples from two Dolly Varden char (*S. malma*) from Alaska (U.S. Fish and Wildlife Service, Anchorage).

9.2.2 Screening of microsatellite loci

As part of other ongoing work, we have developed a battery of microsatellite DNA loci for bull trout to assist with recovery and genetic monitoring of this ESA-listed species (see Figure 9-1). In collaboration with the Washington Department of Fish and Wildlife (WDFW), we first obtained PCR[1] primer sequences for 30 loci from an enhanced microsatellite library developed specifically for bull trout (Sco102 – Sco220). This library was developed initially by GIS[1], a private biotechnology company in southern California, under contract from WDFW. From WDFW, we also obtained PCR primers for three loci developed for rainbow trout (Omm1128, Omm1070, Omm1130). We also obtained primers for 12 loci developed specifically from brook trout (Sfo1 – SfoD75) and 7 loci from Dolly Varden (Sma3 – Sma24) (Table 9-1 in Appendix). We thus tested a

[1] Polymerase chain reaction.

total of 52 primer pairs for their ability to cross-amplify the respective loci in bull trout, brook trout, and Dolly Varden.

We used three randomly selected bull trout from Montana, two brook trout from Iowa, and two Dolly Varden from Alaska to initially screen and optimize the PCR conditions for 52 microsatellite loci (Table 9-1). DNA for each fish was extracted from fin tissue in a *"Chelex 100"* (Sigma Chemical Co.) resin solution as described by Miller and Kapuscinski (1996). Our Chelex extraction method used approximately 0.1mg of fin tissue in a mixture containing 180 µL of a 5% Chelex solution and 1 µL of Proteinase K, boiled for 8 minutes at 103 ^oC. Extractions were stored at -20 ^oC.

We used a *"MJ Research PTC-200 DNA engine"* thermocycler to amplify, via PCR, DNA at each locus (52 loci total) for each of the seven fish used in our initial screening. PCRs were conducted in 15 µL volumes for each locus. All reactions contained 10X PCR buffer (10 mM Tris-HCL, 50 mM KCL, 1% Triton X-100), 0.2mm dNTPs, 0.5 µM of the forward and reverse primers for that locus, 1.5 or 2 mM $MgCl_2$ (2 test concentrations), and 0.2 units of *Taq* DNA polymerase (obtained from Promega Corporation). Reactions were carried out over a DNA annealing temperature gradient ranging from 50 ^oC to 60 ^oC. PCR conditions were as follows: an initial DNA denaturation at 94 ^oC for 3 minutes, followed by 38 cycles of (a) denaturation at 94 ^oC for 30 seconds, (b) annealing at the gradient temperature for 30 seconds, and (c) primer extension at 72 ^oC for 30 seconds, followed by a final annealing and extension at 72 ^oC for 7 minutes. We included one negative control (Chelex only) with each of the PCR trials to test for the presence of contaminating DNA.

PCR products for each locus for each of the three species were initially visualized on agarose gels stained with ethidium bromide (EtBr). We added 2 µL of 10X loading dye to our PCR products and then loaded 8 µL of the PCR solution onto 2% agarose gels for electrophoresis. Gels stained with EtBr were viewed under UV light and digitally photographed. We identified the optimal annealing temperature and $MgCl_2$ concentration for each locus, as well as the ability of the PCR primers to amplify DNA from all three species (Appendix). Loci providing detectable amplification in brook and bull trout were then used in subsequent genotyping of the individuals representing the sampled populations.

9.2.3 Genotype determinations

We used the Chelex DNA extraction protocol as above to extract total genomic DNA from 100 fish from the Malheur River basin; 33 individuals that had been identified as bull trout, 33 individuals that had been identified as brook trout, and 34 individuals identified as putative hybrids. We also extracted DNA from 10 individuals identified as bull trout from a region of the Malheur River where no hybrids were present, 16 brook trout from Pine Creek in Iowa and 16 bull trout from the lower Clark Fork River in Montana.

We performed PCR reactions for 45 of the 52 optimized loci that amplified in bull and brook trout based on the results of the initial screenings. All forward primers were labeled with one of 4 fluorescent dyes for use on the ABI 3100 genetic analyzer. PCR reaction conditions were as follows; 94 ^oC for 3 minutes followed by 38 cycles of 94 ^oC for 30 seconds, primer specific annealing temperature for 30 seconds and 72 ^oC for 30 seconds with a final extension at 72 ^oC for 7 minutes.

Following thermal cycling, PCR reactions were pooled into groups of four loci (one of each fluorescent dye) and diluted for electrophoresis on the "*ABI 3100*" 16-channel DNA sequencer[2]. Automated electrophoresis was carried out following the manufacturer's protocols with the G5 filter set to produce electropherograms, and electrophoresis data were analyzed using the program "Genescan" (Applied Biosystems Inc.). Genotypes were then determined for each individual at each locus using the "Genotyper Software" package (Applied Biosystems, Inc.).

9.2.4 Data analysis

Genotypic data at each locus were collated among all individuals. Allele frequencies at each locus were then calculated for each of the three population subsamples from Lake Creek, the reference sample from the N.F. Malheur River, and the two out-of-basin reference samples of bull and brook trout from Montana and Iowa, respectively. Based on those allele frequency distributions and the ability of individual loci to produce resolvable genotypes in both brook and bull trout, a subset of loci were selected for performing a "principal components analysis" (PCA) of all genotyped individuals. All genotyped individuals were then plotted onto first two PCA axes (PCI and PCII). This graphical approach provides an unbiased method of distinguishing different genotypic groups without making any assumptions regarding the morphological identity of individuals (Campton 1987).

9.3 Results and Discussion

Based on our initial screenings and other factors, the following loci were excluded from the genotypic analyses of the sampled populations: Sco207, Sco220, Sfo1, Sfo8, Sfo23, Sfo105, Sma21, and Sma24. Genotypic and allele frequency data were thus obtained at 44 loci for at least some individuals representing each of the sampled populations (Appendix 9-B) [not included in this final draft]. Twenty-five of those 44 loci were selected for the principal component analyses (Table 9-1).

Multi-locus genotypes at the 25 selected loci clearly distinguished the three reference populations in a PCA plot: bull trout from the N.F. Malheur River, bull trout from Montana (Clark Fork River), and brook trout from Iowa (Figure 9-1). As noted elsewhere, populations of bull trout from different geographic regions are quite distinct genetically (Spruell et al. 2003**).**

In general, multi-locus genotypes of fish from Lake Creek were highly consistent with their morphological field identifications as "brook trout," "bull trout," and "hybrids" (Figures 9-2 and 9-3). With the exception of six fish identified in the field as "bull trout," fish identified as bull trout and brook trout in Lake Creek formed two highly distinct clusters of individuals when plotted onto the first two principal component axes. Fish identified in the field as "hybrids" formed a broad, genotypically intermediate group between the other two morphotypes. These data and analyses provide irrefutable evidence that introduced brook trout are interbreeding with bull trout in Lake Creek to produce a third, genotypically intermediate group. Moreover, morphological identifications in the field appear to be a fairly accurate method of distinguishing the three groups of fish.

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[2] Applied Biosystems Incorporated (ABI), Foster City, CA

9.4 Future work

This report and associated data files satisfy the cooperative agreement/contract between the Burns Paiute Tribe and the U.S. Fish and Wildlife Service (Conservation Genetics Laboratory, Abernathy Fish Technology Center). However, we are planning to conduct additional analyses as soon as our time permits. Of the 44 loci analyzed, the following loci appeared to be diagnostic or partially diagnostic between brook and bull trout: Omm1128, Sco102, Sco104, Sco110, Sco202, Sco204, Sco206, Sco215, Sco216, Sco217, Sco218, Sfo8, Sfo18, SfoC88, and SfoD75. We plan to select approximately 10 of those loci for additional genotyping and perform "re-run" analyses of all individuals with missing genotypes at those loci. This subset of loci will provide a very powerful analysis that will remove a significant amount of the "genotypic statistical noise" among individuals, particularly those with "intermediate" multi-locus genotypes. Our goal is then to perform more detailed population genetic analyses (e.g. tests for linkage disequilibrium) and assign "hybrid index" scores to each fish analyzed from Lake Creek so that levels of individual introgression can be assessed. These latter analyses will also allow us to determine whether hybridization has proceeded beyond the F1 generation.

9.5 Literature cited

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Table 9-1. Summary of microsatellite loci screened in bull trout, brook trout, and Dolly Varden.

Locus	Printer Sequence (F/R)	Source[1/]	PC Analysis	Comments
Omm1128	F: CCACATCCTAGAACCGTTGA R: CAATACACAGCACCAACAACC	WDFW	Yes	Nearly diagnostic between species.
Omm1070	F: GACAGGTTGTGTCGAATGGA R: GGTGGGATTCAGTGTGTTAAAC	WDFW	Yes	Distinguishes pops. within species, Does not distinguish species.
Omm1130	F: GAGAGATCGAGGAAGAAGATAACA R: GCTGCTTCTCTTTTTAGCCAC	WDFW	Yes	Distinguishes Lake Cr. morphotypes. No data on reference pops.
Sco102	F: CCATCTCTTCTTACCCTCCTC R: CCAAAAAGCAGTTGATAGACC	WDFW	Yes	Nearly diagnostic between species.
Sco103	F: ATCCTCACCCAGAGTTAAAGTG R: GGTTGTGTCGAATGGAGTTC	WDFW	No	Not useful for hybridization studies No data on reference pops.
Sco104	F: GGCCAAATTCATATAATACCC R: AGGCAACATAAAACCTATCAAG	WDFW	Yes	Nearly diagnostic between species.
Sco105	F: GTTTCCCATGCCAATAAAGC R: TCCGGTCTGGTACGTCATAC	WDFW	No	PCR amplifies in bull trout only.
Sco105b[2]	F: GTTTCCCATGCCAATAAAGC R: CCCTCTCTCTCCCTATGAAAG	WDFW	No	PCR amplifies in bull trout only.
Sco106	F: GCCAATAAAGCCCTTAAATTG R: CCCTCTCTCTCCCTATGAAAG	WDFW	No	Does not distinguish Lake Cr. Morphotyoes- No data for reference pops.
Sco107	F: TAGGCTTGTCAGCAGTGAG R: CCGAGTTTCAGAGGATGTC	WDFW	Yes	Bimodal allelic distribution in bull trout. Unimodal allelic distribution in brook tr.
Sco109	F: GCCAGCAAACATTCTTATC R: CCAGGGATGATTTATTGTC	WDFW	No	Incomplete data for Lake Cr. samples Candidate locus for hybrid studies.

Locus	Printer Sequence (F/R)	Source[1/]	PC Analysis	Comments
Sco110	F: CCTTGTGAGAGCTAAGGTAGTG R: GGAGGACATATTCCAACTTTG	WDFW	Yes	Nearly diagnostic between species
Sco200	F: GTGCCTTGGTGGAGATTAC R: CCTTTATGTGTCCCTGTATGA	This report	Yes	Distinguishes pops. within species Does not distinguish species
Sco201	F: AGCCTTTTCCTGTCAGTTTAC R: GGCACAGCATGATCTATCA	This report	No	PCR amplifies in bull trout, inconsistent in brook trout.
Sco202	F: TTGGTTCCTTCCCCTTAGC R: GCTGAAATAGCCGAATCCA	This report	Yes	Diagnostic between species.
Sco203	F: ATCCCCCTCTCTCTCCCTAT R: GCCAATAAAGCCCTTAAATTG	This report	No	Poor PCR amplification in both species.
Sco204	F: GCTAAGGATGGTCACTCAT R: GCAACACAGAAATGTAACTCT	This report	Yes	Nearly diagnostic between species
Sco205	F: GAGAGATGAGTGGATGGATAGA R: GATACCTGAAGGGGAGACAC	This report	No	Poor PCR amplification in both species.
Sco206	F: CACCAGGAAAATAATTGACCT R: TGGTCCAAGACAAGAGTGTT	This report	Yes	Incomplete data for reference and Lake Creek samples. May distinguish species
Sco207	F: GAGGGGGATGAGATTGGT R: TGGATGGGAGGAATGGAT	This report	No	Inconsistent amplification in both species.
Sco208	F: CAGGCTGTCAGTTTATCATTTT R: TGGGAGGTGAGCTTACAAC	This report	No	Inconsistent PCR amplification in both species.
Sco209	F: CCCTGTGTGAAGAAATGTGT R: AGGTTGTGGTATCTGAGTGGT	This report	Yes	Distinguishes pops. within species. Does not distinguish species.
Sco210	F: AGGTGAGTCACTCTTCTAGTCC	This report	No	Incomplete data. May partially distinguish species.

Locus	Printer Sequence (F/R)	Source[1/]	PC Analysis	Comments
	R: CAATCAATCCTCTCTCTCTTC			
Sco211	F: AGCCCAACTGGAGAGAAC R: TGGGAAACACGTTTTAACA	This report	No	Incomplete data. May distinguish pops. within species.
Sco212	F: CACGGGTGGAAATGTTTA R: GGAGACAGGAGTGAGAGAGAC	This report	Yes	Incomplete data. High allelic size overlap between species.
Sco213	F: GCCAGAGATACAAAGATGAGTC R: GCAAACAGAAGACAGTGGTC	This report	No	Poor PCR amplification in both species.
Sco214	F: CCCTTCTCGGTGACGATT R: AACCCCCTCAATGTGGAG	This report	No	Incomplete data. High allelic size overlap between species.
Sco215	F: GAGAGAGAGAGATGGGTGACA R: ATCCACAAAACAAGATTGCTAC	This report	Yes	Incomplete data. May be diagnostic between species.
Sco216	F: CCTTGTGAGAGCTAAGGTAGTG R: GGAGGACATATTCCAACTTTG	This report	No	Incomplete data for Lake Cr. samples. Diagnostic between species.
Sco217	F: TCCTCTGGATGCTGCTAAAG R: CATGCCCACAGTGTGCTA	This report	Yes	Incomplete data. May be diagnostic between species.
Sco218	F: TTCTAACTGTTGGCACTCTG R: GTGTGGTTGGGTGGTAAG	This report	Yes	Incomplete data. Distinguishes species. Some allelic overlap.
Sco219	F: AAAGCCCCTTGAATTTGA R: CGCCATCTTGCTTATTGA	This report	No	PCR amplifies in bull trout only.
Sco220	F: AACGAGTTCTAATGACTCCAAC R: ATCATGCTCATCATCACTCTC	This report	No	Incomplete data. Some allelic overlap
Sfo1	F: ACCATAACCCCCCACCAC R: GTCCCTCCGTGGCAGATT	ABAD	No	Poor PCR amplification in bull trout.

Locus	Printer Sequence (F/R)	Source[1/]	PC Analysis	Comments
Sfo8	F: CAACGAGCACAGAACAGG R: CTTCCCCTGGAGAGGAAA	ABAD	No	Incomplete data. May distinguish bull and brook trout.
Sfo12	F: GGTTTTGAAGAGTGACAG R: CCCGTTTCACAATCAGAG	ABAD	No	Poor PCR amplification in both species.
Sfo18	F: TGGTGTATCCTGCTCCTG R: TGGAATGTGTGTCTGTTTTCT	ABAD	Yes	Appears to be diagnostic between species.
Sfo23	F: GTGTTCTTTTCTCAGCCC R: AATGAGCGTTACGAGAGG	ABAD	No	May be a duplicated locus with more than two genic copies per individual.
SfoC86	F: ACCGATGGCCTTCAACAC R: ATAGGCCCCTACCTCAAACC	USGS	Yes	Bimodal allelic distribution in brook trout, unimodal in bull trout.
SfoC88	F: TAG TCT CTG GTG GGG AAT AAT G R: ATA TCA GCC ATA AGA GCT GGA G	USGS	Yes	Nearly diagnostic between species.
Sfo100	F: ACCTTTGACCTGTACATCGTG R: CAGACCTAGACTAAAGCATCCG	USGS	Yes	Partial data. Not diagnostic, but significant allele frequency differences.
Sfo105	F: CAGGGAAAATGCTAATGTGC R: GGTTGTGTCGAATGGAGTTC	USGS	No	Possibly duplicated locus
SfoC113	F: GGAGCCCAGACTATATTGACG R: CCT TGA AGT CTT GCC AGA TG	USGS	Yes	Considerable allelic overlap between species.
SfoC115	F: CAGTTTCTATCTCCAGGCAATC R: TTCTGAAAGCACTCAACATGG	USGS	Yes	Partially diagnostic, but fixed allelic differences between pops. w/in species.
SfoD75	F: GTAGTGCCAAAACAGGTAGAGC R: CATCCTTATTCCAACCTCAATC	USGS	Yes	Diagnostic between species. Incomplete data.

Locus	Printer Sequence (F/R)	Source[1/]	PC Analysis	Comments
Sma3	F: TGGCTCAAATTAAGATCCTAC R: AGCCATTATGCATTACTTGTTC	USFWS-AK	No	Distinguishes pops. within species; does not distinguish species.
Sma5	F: AGATGTGTGATAAACTCAGCCTC R: AGTTGTTTAAATAGGGCGGATAG	USFWS-AK	No	Similar allele frequencies between species.
Sma10	F: AAAATGTCTCCCCTCCCTCTC R: TCCCTAACATAACAAGTTTTCATCCT	USFWS-AK	Yes	Extensive allelic overlap between species; significant. allele freq. differences.
Sma17	F: AAGGATGGTGAGGACAATACA R: ACCTTGAGAAATCTATATGTGGTCTA	USFWS-AK	No	Incomplete data. Potentially diagnostic? Appears duplicated in bull trout and DV.
Sma 21	F: GGCTGTTCACCACATAGAGTAAT R: TTAAGATGGGATGCATATTCAGT	USFWS-AK	No	PCR amplifies in DV only.
Sma22	F: CCCAATGCAGATAAGACCTT R: TCTATAGGCTTATTTGAATGGAAT	USFWS-AK	Yes	Considerable allelic overlap between species.
Sma 24	F: CATTGATCAAGAAGCCAGTGC R: TGTATTTGGCCAATATAACACAGC	USFWS-AK	No	PCR amplifies in DV only.

[1/] Sources for PCR primer sequences were the following:
WDFW = Jim Shaklee, Washington Department of Fish and Wildlife, Olympia, WA;
ABAD = Angers et al. 1995;
USGS = Tim King, U.S. Geological Survey, Biological Resources Division, Kearneysville, WV;
USFWS-AK = John Wenberg, U.S. Fish and Wildlife Service, Anchorage, AK.

[2/] Primers for Sco105b are the forward primer for Sco105 coupled with the reverse primer for Sco106.

Figure 9–1. Least-squares projections onto the first, two principal component (PC) axes (Axes I and II) of reference bull trout from the North Fork Malheur River, Oregon (white squares, n = 10) and the Clark Fork River, Montana (blue squares, n = 15)), and reference brook trout from Iowa (yellow squares, n = 16) based on their multi-locus genotypes at 25 microsatellite loci (Table 9-1). The first PC axis separated brook and bull trout. The second PC axis separated bull trout from North Fork Malheur and Clark Fork rivers.

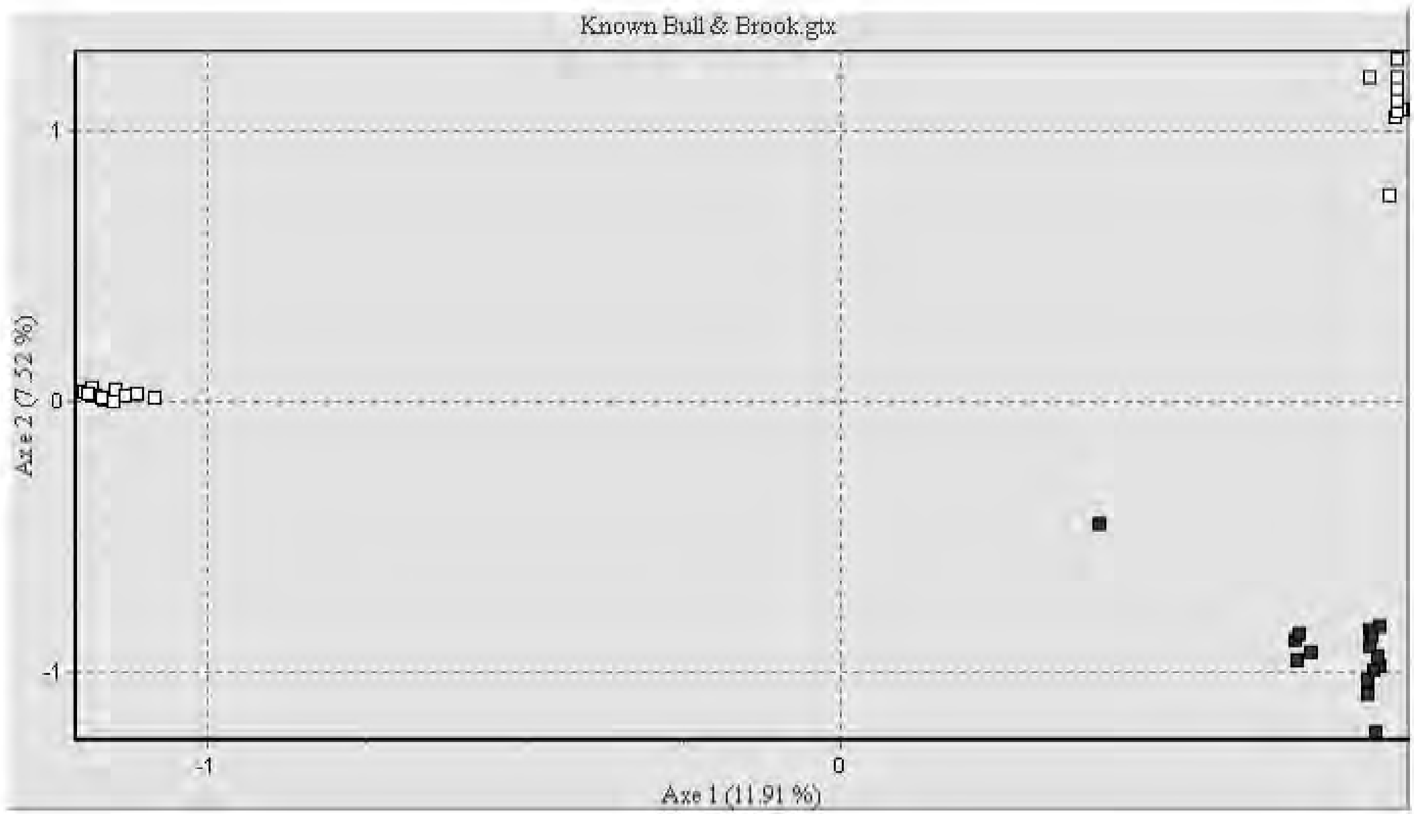

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Figure 9–2. Least-squares projections onto the first, two principal component (PC) axes of fish collected from Lake Creek, a tributary to the N.F. Malheur River in Oregon, based on their multi-locus genotypes at 25 microsatellite loci (Table 9-1).). Fish were identified morphologically in the field as either "bull trout" (blue squares, n = 33), "brook trout" (yellow squares, n = 33), or "hybrids" (white squares, n = 34). See Materials and Methods for details of morphological criteria.

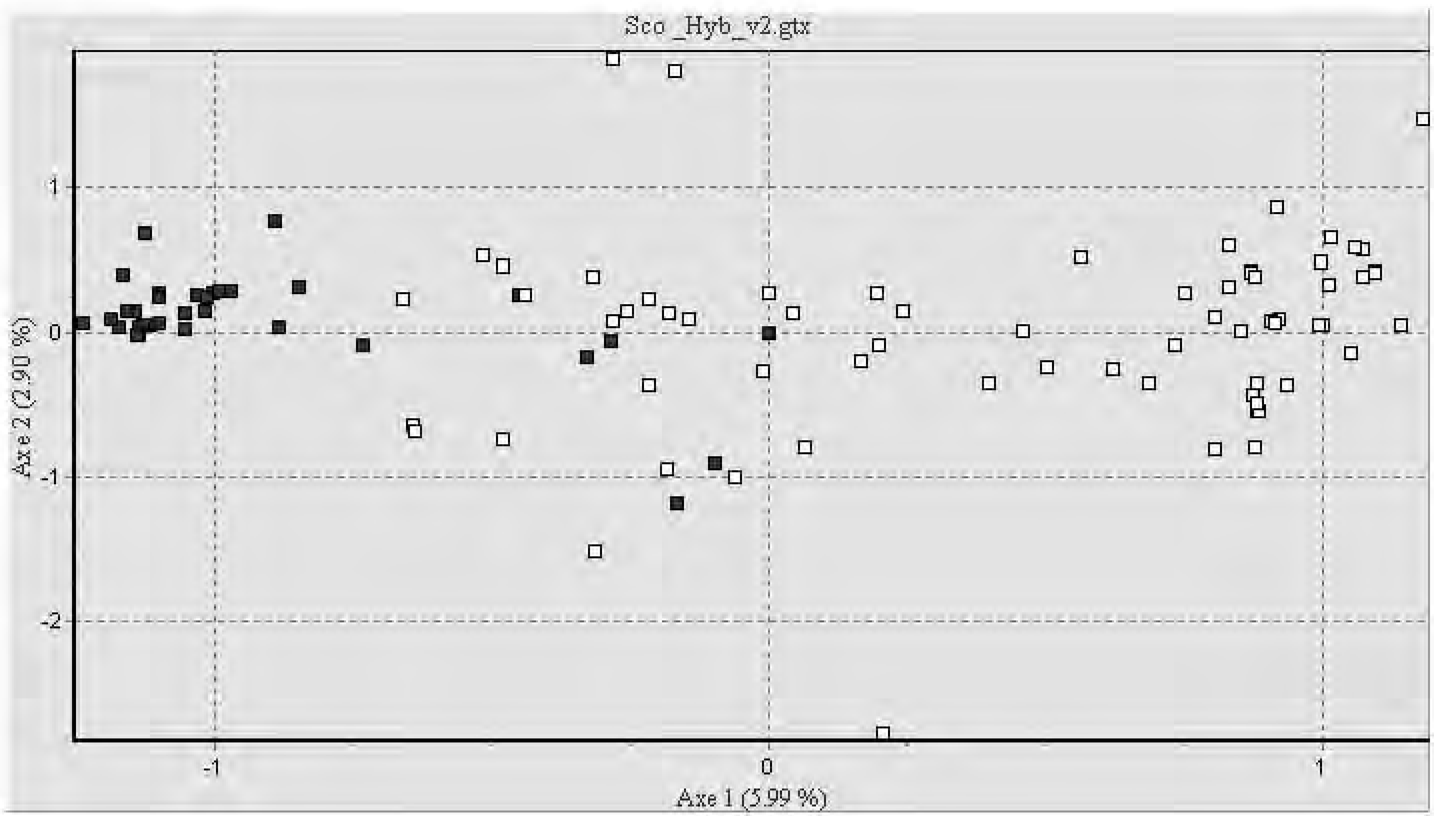
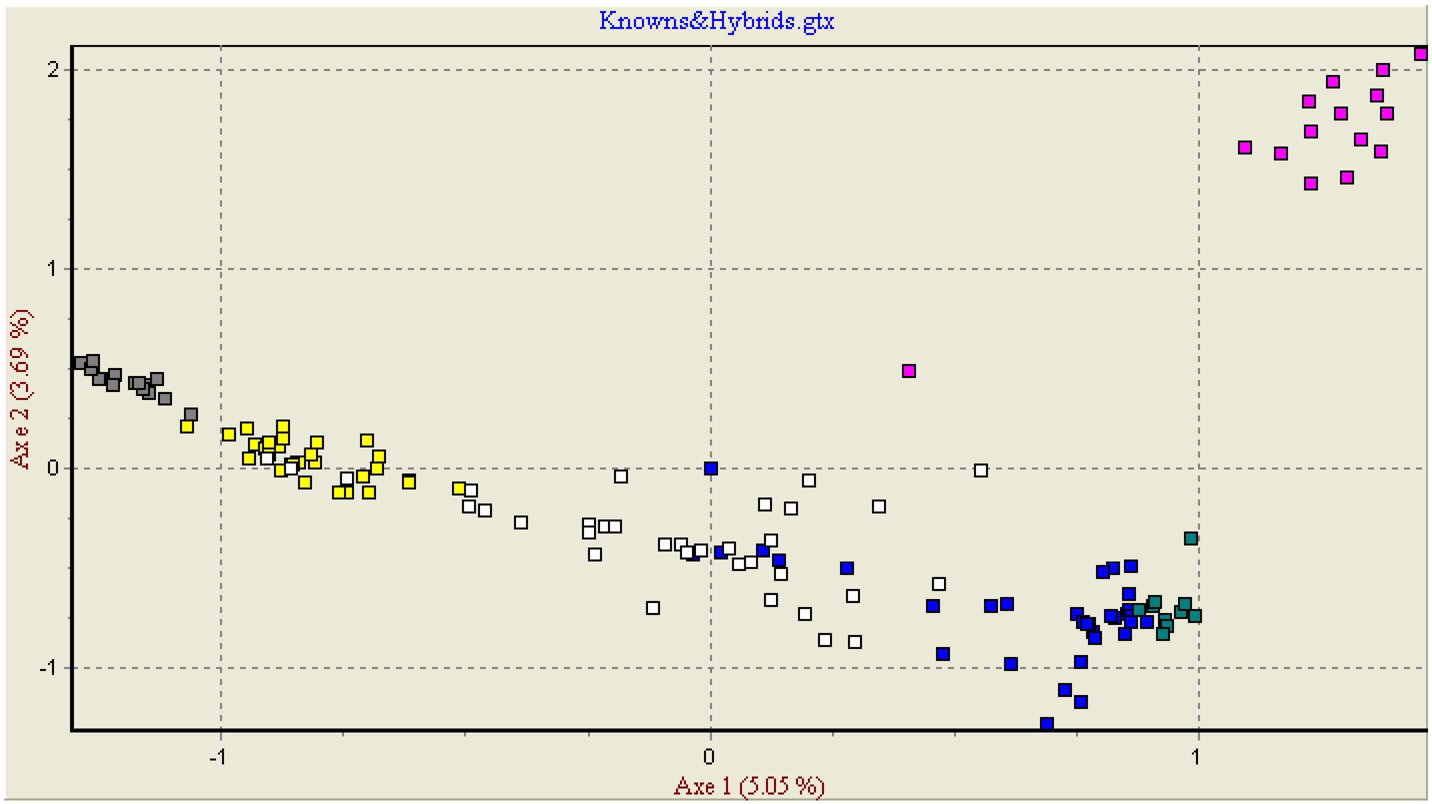


Figure 9–3. Least-squares projections onto the first, two principal component (PC) axes (Axes I and II) of all fish analyzed for this study based on their multi-locus genotypes at 25 microsatellite loci (Table 1). Six groups of fish are shown: bull trout from the Clark Fork River, Montana (violet squares, n=15), bull trout from the N.F. Malheur River (dark green squares, n = 10), fish from Lake Creek identified morphologically in the field as "bull trout" (blue squares, n = 33), "brook trout" (yellow squares, n = 33), or "hybrids" (white squares, n = 34), and brook trout from Pine Creek, Iowa (olive green squares, n = 16).



Appendix 9-A. Summary of PCR conditions and initial screening results for 52 microsatellite loci tested in bull trout, brook trout, and Dolly Varden.

Locus Name	Source Species	Annealing Temperature	MgCl Concentration	Size in Bulls	Brook?	Dolly?	Hybrids?	Notes
Omm1128	Rainbow Trout	55	1.5	220-320	X			Optimized locus from WDFW
Omm1070	Rainbow Trout	55	1.5	170-264	X			Optimized locus from WDFW
Omm1130	Rainbow Trout	55	1.5	270-386	X			Optimized locus from WDFW
Sco102	Bull Trout	55	1.5	130-170	X			Optimized locus from WDFW
Sco103	Bull Trout	55	1.5	185-296	X			Optimized locus from WDFW
Sco104	Bull Trout	55	1.5	330-450	X			Optimized locus from WDFW
Sco105	Bull Trout	55	1.5	166-202				Optimized locus from WDFW
Sco105b	Bull Trout	55	1.5	182-241				Optimized locus from WDFW
Sco106	Bull Trout	55	1.5	172-232	X			Optimized locus from WDFW
Sco107	Bull Trout	55	1.5	190-320	X			Optimized locus from WDFW
Sco109	Bull Trout	60	1.5	250-420	X	X		Optimized locus from WDFW
Sco110	Bull Trout	55	1.5	161-254	X			Optimized locus from WDFW
Sco200	Bull Trout	56	1.5	180	X	X		
Sco201	Bull Trout	58	1.5	150-200				
Sco202	Bull Trout	60	1.5	100	X	X	X	May be duplicated in brook, lower locus try 54, upper locus try higher temps
Sco203	Bull Trout	60	1.5	100-200	X	X		Inconsistent PCR in both brook and bull trout
Sco204	Bull Trout	60	1.5	150-200	X	X	X	
Sco205	Bull Trout	60	1.5	200-300	X	X	X	Inconsistent PCR; monomorphic, could be diagnostic for hybrids
Sco206	Bull Trout	60	1.5	250-300	X	X	X	Could go higher than 60
Sco207	Bull Trout							Inconsistent PCR; looks momomorphic (not optimized for bull trout)
Sco208	Bull Trout	50	1.5	250-300	X	X		Inconsistent PCR in both brook and bull trout
Sco209	Bull Trout	56	1.5	200	X		X	Could work in Dollys with more optimization
Sco210	Bull Trout	60	1.5	200	X	X		
Sco211	Bull Trout	60	1.5	250-300	X	X	X	
Sco212	Bull Trout	60	2.0	300	X	X		Brook and dolly amp at lower temperatures
Sco213	Bull Trout	60	1.5	150-200		X		Poor PCR in both bull and brook trout.
Sco214	Bull Trout	60	1.5	200	X	X		
Sco215	Bull Trout	60	1.5	200	X			
Sco216	Bull Trout	60	1.5	250	X	X	X	Dolly Shows up at lower annealing temps
Sco217	Bull Trout	60	1.5	350	X		X	Looks good for hybridization
Sco218	Bull Trout	60	1.5	250	X	X	X	
Sco219	Bull Trout	53-54	1.5	200				
Sco220	Bull Trout	60	1.5	150	X	X	X	
Sfo1	Brook Trout	52	1.5	100	X	X		Poor PCR in bull trout
Sfo8	Brook Trout	53-54	1.5	200-300	X	X		Could be diagnostic for bulls and dollys
Sfo12	Brook Trout	60	1.5	250-280	X	X	X	Poor PCR in both bull and brook trout.
Sfo18	Brook Trout	54-55	2.0	200	X	X	X	Spruell recommends this for hybrids
Sfo23	Brook Trout	53-54	1.5	100-200	X	X		Hold off on this one for now, looks duplicated
Sfo86	Brook Trout	60	1.5	100	X	X		
Sfo88	Brook Trout	58	1.5	180	X	X	X	
Sfo100	Brook Trout	60	1.5	100	X		X	Looks duplicated at lower temps
Sfo105	Brook Trout	60	1.5	100-200	X	X	X	
Sfo113	Brook Trout	60	1.5	100-200	X	X	X	
SfoC115	Brook Trout	58	1.5	80-100	X	X		
SfoD75	Brook Trout	58	1.5	200-300	X	X	X	good to distinguish all 3
Sma3	Dolly Varden	60	2.0	100	X	X		
Sma 5	Dolly Varden	50	2.0	80-100	X	X	X	Could try at 60 and 1.5 but then brook doesn't show up
Sma10	Dolly Varden	60	2.0	100	X	X		
Sma17	Dolly Varden	60+	1.5	100-150	X	X		Looks duplicated in Bulls and Dollys, needs higher temp
Sma21	Dolly Varden	56	1.5	Doesn't amp		X		PCR amplifies in Dolly Varden only; no PCR in brook or bull trout
Sma22	Dolly Varden	58	1.5	150-200	X	X		
Sma24	Dolly Varden							PCR amplifies in Dolly Varden only; no PCR in brook or bull trout.