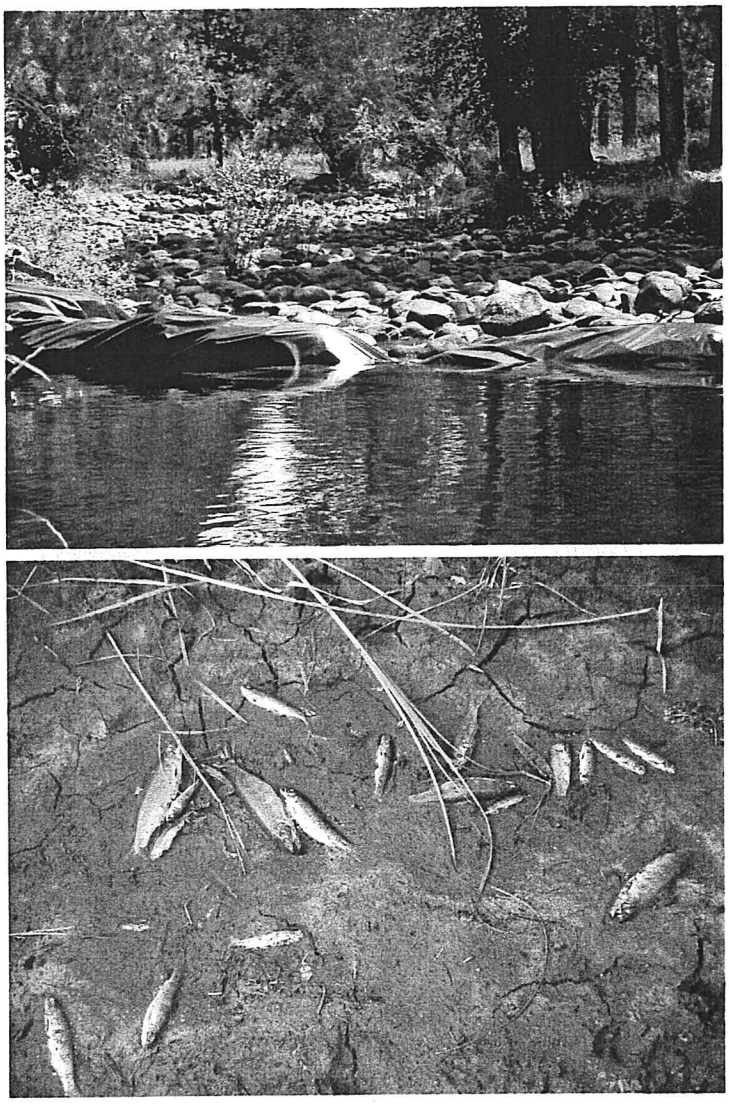
ANNUAL REPORT 2005

AN ASSESSMENT OF LOSSES OF NATIVE FISH TO IRRIGATION DIVERSIONS ON SELECTED TRIBUTARIES OF THE BITTERROOT RIVER, MONTANA



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JANUARY 2006

Abstract—Information about entrainment rates of fish into irrigation diversion canals in riverine systems and the factors that influence these rates is limited. This information is important for resource managers who are interested in better understanding how water withdrawals into irrigation diversions affect the fishery resources they manage. During the 2005 field season, we sampled fish species by snorkeling and electrofishing at 60 sites located in 7 canals on Lost Horse Creek and 5 diversions on Tin Cup Creek. Sites were sampled multiple times throughout the season to assess the temporal variability of entrainment rates. Nine stream sites and 13 canal sites were also sampled for trout fry with stationary trap nets. Discharge, temperature, and preliminary habitat measurements were obtained in stream and diversion locations throughout the field season.

Introduction

Withdrawals of surface water for irrigation and stock water leave the mainstem of the Bitterroot River and its tributaries chronically dewatered during the irrigation season (Spoon 1987). These water withdrawals affect native fish populations by entraining migratory life forms of native trout in irrigation diversion canals at multiple life stages (Clothier 1953; Hallock and Van Woert 1959) and through the loss and degradation of available habitat for aquatic species.

Diversion canal fish screening projects provide an exceptional opportunity to increase survival of native fish species. Evaluations of screens on diversions on Skalkaho Creek, a major tributary of the Bitterroot River, clearly demonstrate their utility in returning entrained fish to the stream (Gale 2005). The Montana Department of Fish, Wildlife and Parks anticipates screening additional diversion canals on tributaries to the Bitterroot River. Development of a sound passage and screening plan for these tributaries will require accurate information about the magnitude of entrainment on ditches.

Our goal is to aid this process through an assessment of losses of native fish in irrigation diversions on selected tributaries to the Bitterroot River. Entrainment in irrigation diversions is being quantified through snorkeling abundance estimates, electrofishing estimates, and fry trapping. Sampling occurs throughout the irrigation season to capture temporal variability of entrainment. Physical and spatial characteristics of irrigation diversions are being quantified and incorporated into a model relating such characteristics to rates of entrainment of migratory fish to gain an understanding of the characteristics of diversions that influence entrainment of migratory salmonids. A predictive model to identify the physical and spatial characteristics of diversions that correlate with rates of entrainment would facilitate development of future screening plans by eliminating or reducing the need for fish sampling.

Study area and methods

Our assessments were conducted on diversions on a subset of Bitterroot River tributaries (Tin Cup, Lost Horse, Blodgett, and Big creeks; Figure 1) originating from the west known to support spawning by fluvial fish as previously determined by Montana Fish, Wildlife, and Parks personnel using telemetry (Javorsky 2000, 2002; Clancy 2003). For the 2005 field season, Lost Horse and Tin Cup creeks were selected for sampling because of access granted by landowners, number of irrigation canals, and overall size of the tributaries and the irrigation systems they support.

Lost Horse is a fourth-order stream that is primarily on Forest Service land until about 9 km above the mouth, where it enters private land and is dewatered by 7 diversions. These are, in descending order from the uppermost diversion: Bitterroot Irrigation Ditch or BRID Ditch, Highline or Clausin-Kramis Ditch, Clubhouse Ditch, Low Ditch, Point of Diversion 1 or POD 1 Ditch, Point of Diversion 5 or POD 5 Ditch, and the Ward Ditch (Figure 2). Tin Cup is a third-order stream that enters private land at about 7 kilometers above its confluence with the mainstem

of the Bitterroot River and is dewatered by 5 diversions. These are, in descending order from the uppermost diversion: Tin Cup County Water and Sewer District (TCCWSD) or McIntosh-Morello Ditch, Ford-Hollister Supplemental Ditch, Chaffin-Whinnery Ditch, Click-Matteson Ditch, and Mill Ditch (Figure 3). The main Ford-Hollister Ditch and Frazier-Spoon Ditch take surface water out of Little Tin Cup Creek, above its confluence with Tin Cup Creek. The Lost Horse and Tin Cup Creek fisheries include westslope cutthroat, bull trout, brook trout, rainbow trout, brown trout, sculpins, and longnose dace (Clancy 2005).

Age-0 Fish.—Stationary trap nets were used to quantify entrainment of small juvenile salmonids (less than 40 mm total length) during the primary emigration period in June, July, August, and September. All fish captured were identified to species, counted, and measured (mm). Trap nets were staked in irrigation canals 50 meters downstream from headgates, and 50 meters downstream from intake channels and irrigation canals in Lost Horse and Tin Cup Creeks. A total of 13 sites were trap-netted on Lost Horse Creek, 7 in irrigation canals and 6 in creek locations downstream of canals. A total of 11 sites were trap-netted on Tin Cup Creek, 6 in irrigation canals and 4 in creek locations. Stationary trap net sites were sampled twice a month for 48 hours, from June through the end of September in canals, and July through the end of September in creek locations (Figure 4).

Adult and Juvenile Fish.—Juvenile and adult fish abundances were determined by snorkeling periodically throughout the duration of the irrigation season. Irrigation canal reaches to be sampled by snorkeling were selected through a stratified-random sampling design stratified by distance from headgate and habitat and landcover type. Each canal had one stratum sampled directly behind the headgate whose length was proportional to channel width, and was about 100 times the channel width. Two 150-meter experimental reaches were sampled within each subsequent stratum, with the number of subsequent strata determined by the length of the canal. Irrigation canal reaches were sampled once a month throughout the irrigation season, roughly May through October (Figure 4).

If the opportunity existed, canals were reconnoitered after they had been shut down for the season by a combination of visual estimates and electrofishing of shallow pools of water remaining after canal shut-down.

Physical Characteristics.—Discharge readings from fixed measuring devices already installed in canals were taken once a week in each canal. Two gauge types were used for discharge measurements in Lost Horse and Tin Cup Creeks. Two Aquarods, continuous-logging staff gauges, were deployed on each creek from June through October, and set to log at 30-minute intervals. In addition, staff gauges were installed in creeks below diversion dams at sites that were not directly adjacent to Aquarod sites, and stage level was recorded once a week.

Temperature loggers were placed in 9 locations on Lost Horse Creek and 6 locations on Tin Cup Creek, about 50 m below diversion dams of each ditch and at each Aquarod site (Figures 2 and 3). Loggers were deployed from May through October. Temperatures were recorded once an hour for this period.

Several other characteristics of diversions were measured, including intake channel length, diversion dam dimensions, dimensions of headgates, habitat type at headgate, angle of diversion to thalweg, and dominant substrate at headgate.

Results

Age-0 Fish.—A total of 514 trout fry in Lost Horse Creek and 305 trout fry in Tin Cup Creek were captured. In Lost Horse Creek, the largest numbers of entrained trout fry (<50 mm TL) were captured in the Ward and Clubhouse Ditches. The peak of trout fry emigration in Lost Horse Creek occurred during the July "new moon" trapping session, from July 5 to July 7 (Table 2, Figure 5). Numbers of trout fry captured in stream sites were low. In Tin Cup Creek, the largest numbers of entrained trout fry were captured in the TCCWSD and Click-Matteson Ditches. The peak of trout fry emigration in Tin Cup Creek occurred during the July "full moon" trapping session, from July 18 to July 20 (Table 2, Figure 6). For the 2005 field season, trout fry were not identified to species due to the difficulty in accurately identifying newly emerged trout fry. These data are currently unadjusted for capture efficiencies.

Adult and Juvenile Fish.—A total of 9,256 adult and juvenile fish in Lost Horse Creek (Table 3) and 2,819 adult and juvenile fish in Tin Cup Creek (Table 4) were observed or captured. In Lost Horse Creek, the greatest number of entrained fish were observed or captured in the Ward Ditch (3,966); however, from mid-July through September, this ditch diverts supplementary water (and inputs of fish) from the mainstem of the Bitterroot River. The second greatest number of entrained fish were observed or captured in the BRID Ditch (2,859). Identification to taxon of *Oncorhynchus* spp. fish (<100 mm TL) was especially difficult in to determine by snorkeling in diversions close to the confluence with the Bitterroot River (i.e., Ward, POD 1, POD 5, Low, Clubhouse) due to the extensive hybridization of westslope cutthroat and rainbow trout that we observed on Lost Horse.

In Tin Cup Creek, the greatest number of entrained fish were observed or captured in the TCCWSD Ditch (1,867), and Mill Ditch (435). In comparison to Lost Horse Creek, where brook trout were highly abundant, the species composition of fishes observed or captured in Tin Cup Creek was made up of a higher proportion of native westslope cutthroat trout.

Physical characteristics.—A preliminary survey of discharge data shows that the BRID Ditch diverted the greatest amount of water from Lost Horse Creek. During the height of the irrigation season in July and August, many reaches of Lost Horse Creek were either dry or at very low flows, with the majority of stream flow being diverted for irrigation. The Mill and TCCWSD Ditches diverted the greatest amount of water from Tin Cup Creek. The irrigators diverted water for a longer period of time on Lost Horse Creek than on Tin Cup Creek, with the irrigation season for most canals ending in late October and November (although at reduced flows), versus ending in August or September on Tin Cup Creek.

Plans for 2006

We will continue to follow the sampling design established in 2005 on Lost Horse and Tin Cup Creeks, with several potential modifications. We may sample sites close to the headgates of the diversions more frequently, as our results from 2005 indicate that the greatest concentration of fish in these diversions occurs near the headgates. In addition, physical characteristic measurements of canals will be replicated and made more precise.

Data collected in 2005 will be analyzed, and entrainment abundance estimates and site-specific characteristics will be used to develop a predictive model as described above. If the opportunity exists, we will then test the predictive power of the model by sampling diversions on Big Creek and Blodgett Creek.

References

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Figure 1. The Bitterroot River drainage, including the location of Big, Blodgett, Lost Horse, and Tin Cup Creeks, and the location of Hamilton and Darby, Montana.

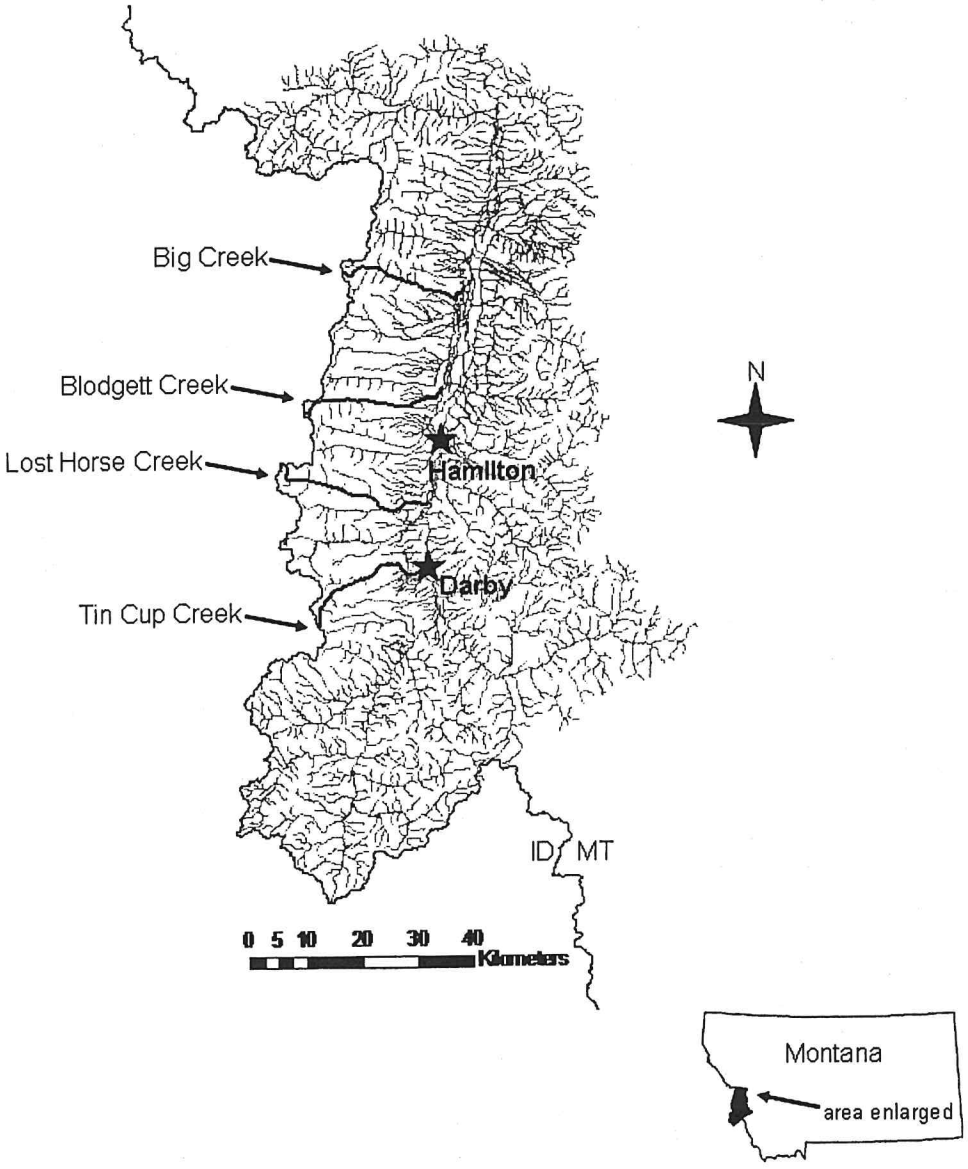

Figure 2. Schematic map of Lost Horse Creek, Montana, showing locations of diversions, Aquarods, staff gauges, and temperature loggers.

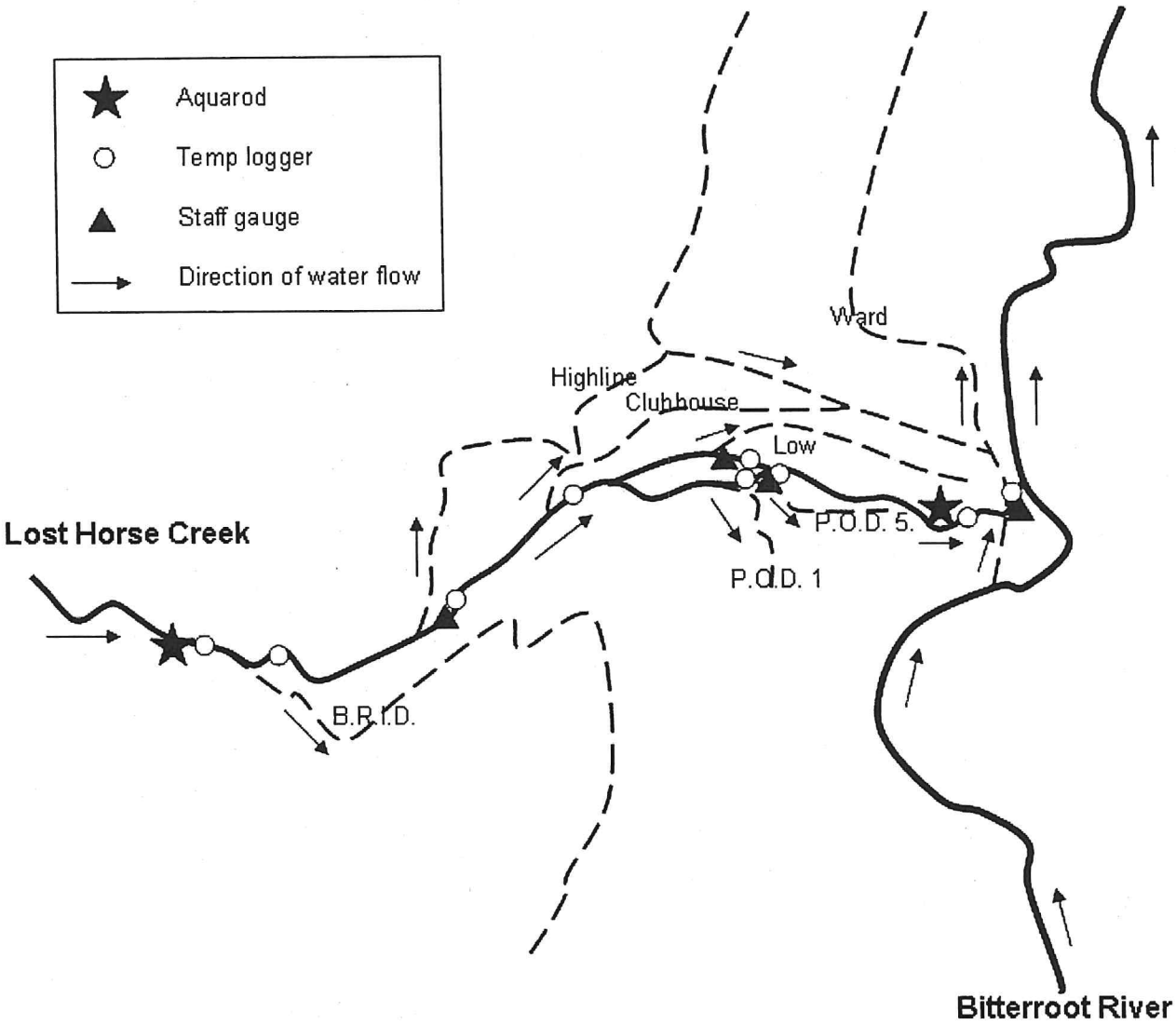

Figure 3. Schematic map of Tin Cup Creek, Montana, showing locations of diversions, Aquarods, staff gauges, and temperature loggers.

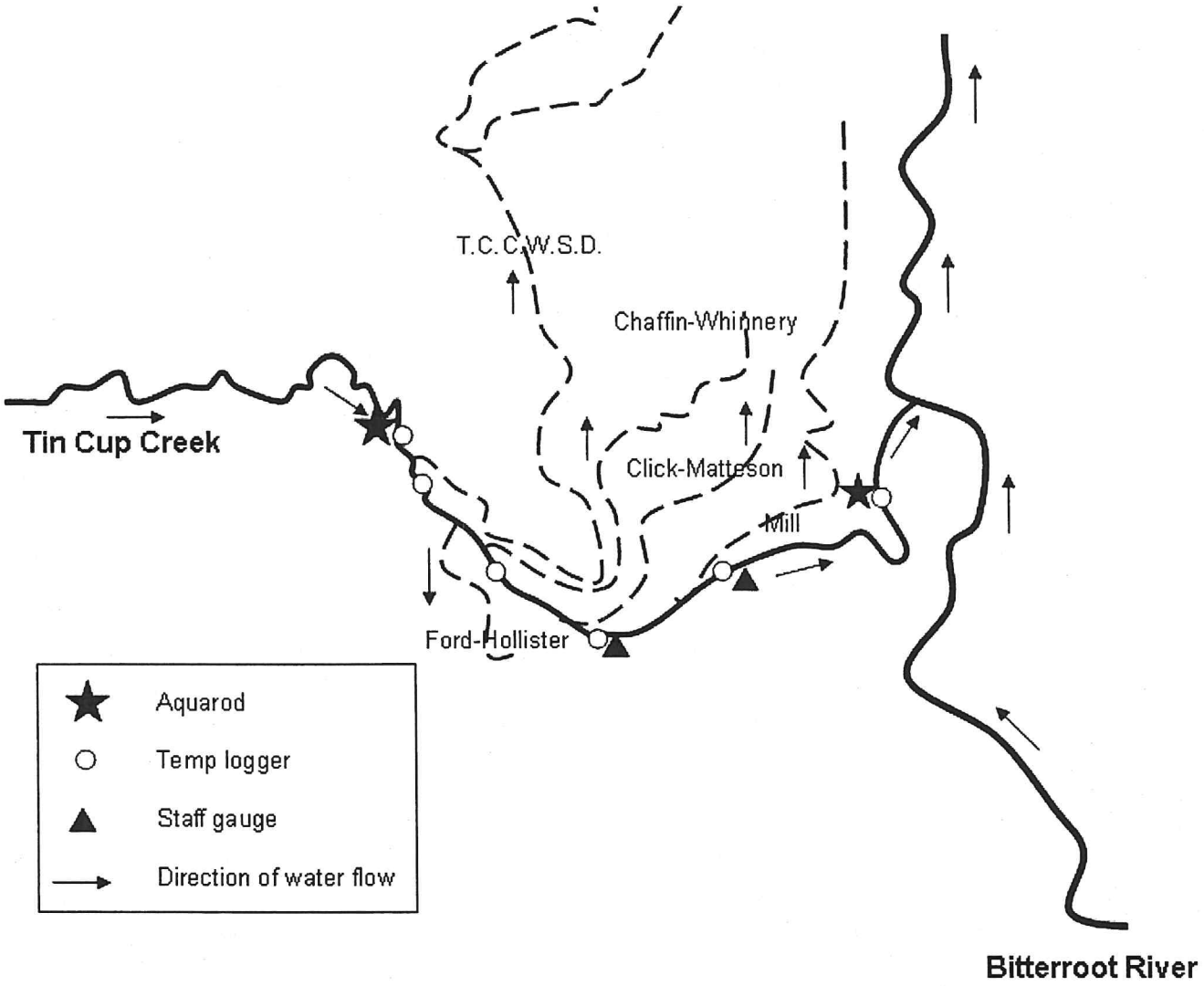

Figure 4. Sampling schedule and frequency.

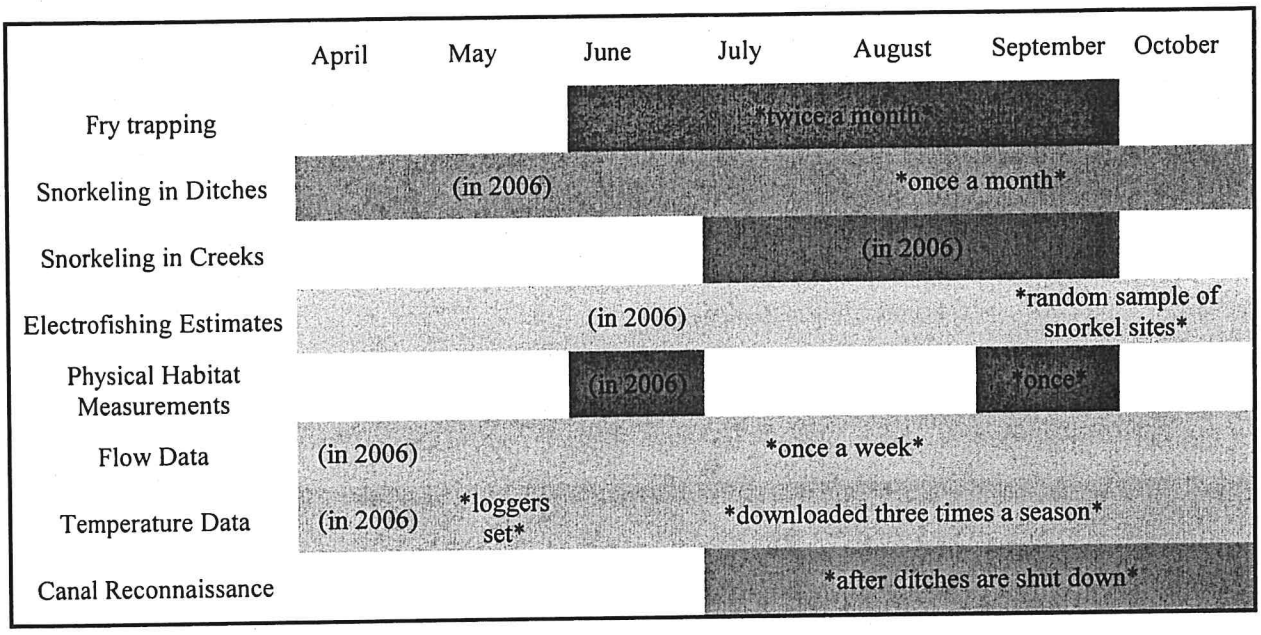

Figure 5. Fry trapping results for Lost Horse Creek.

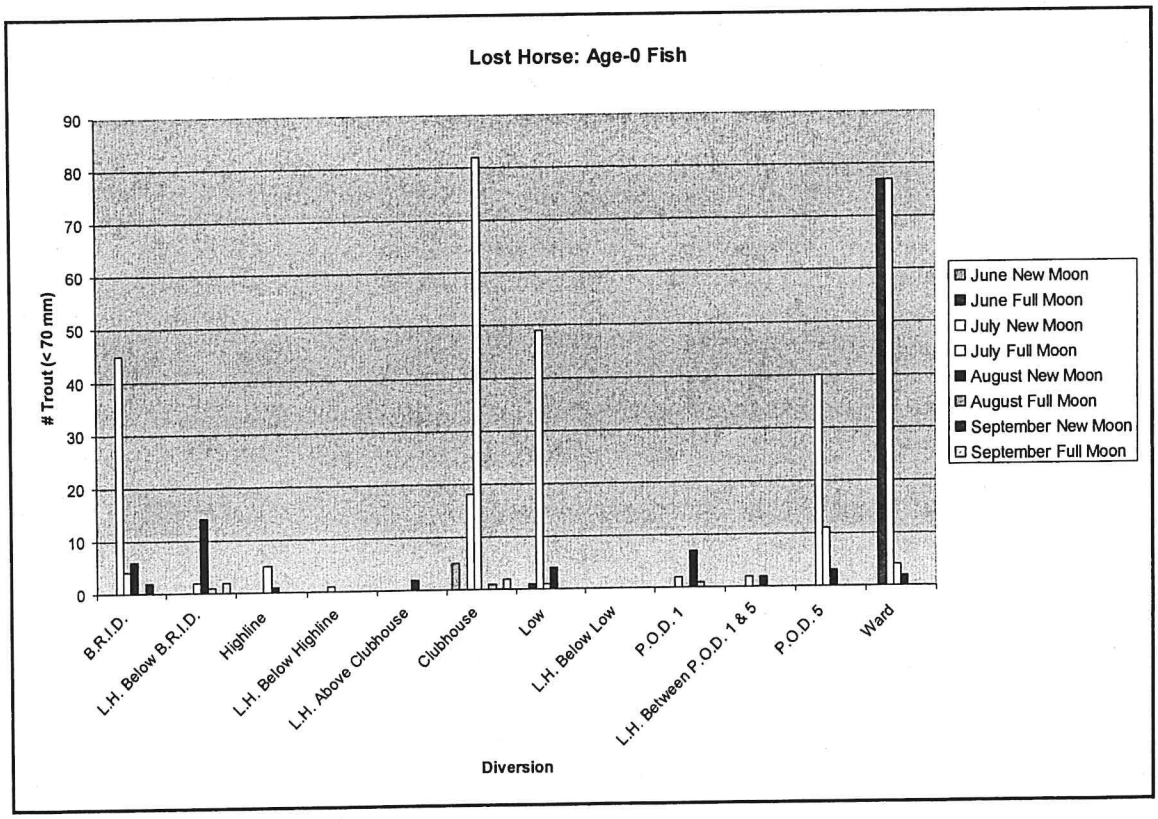

Figure 6. Fry trapping results for Tin Cup Creek.

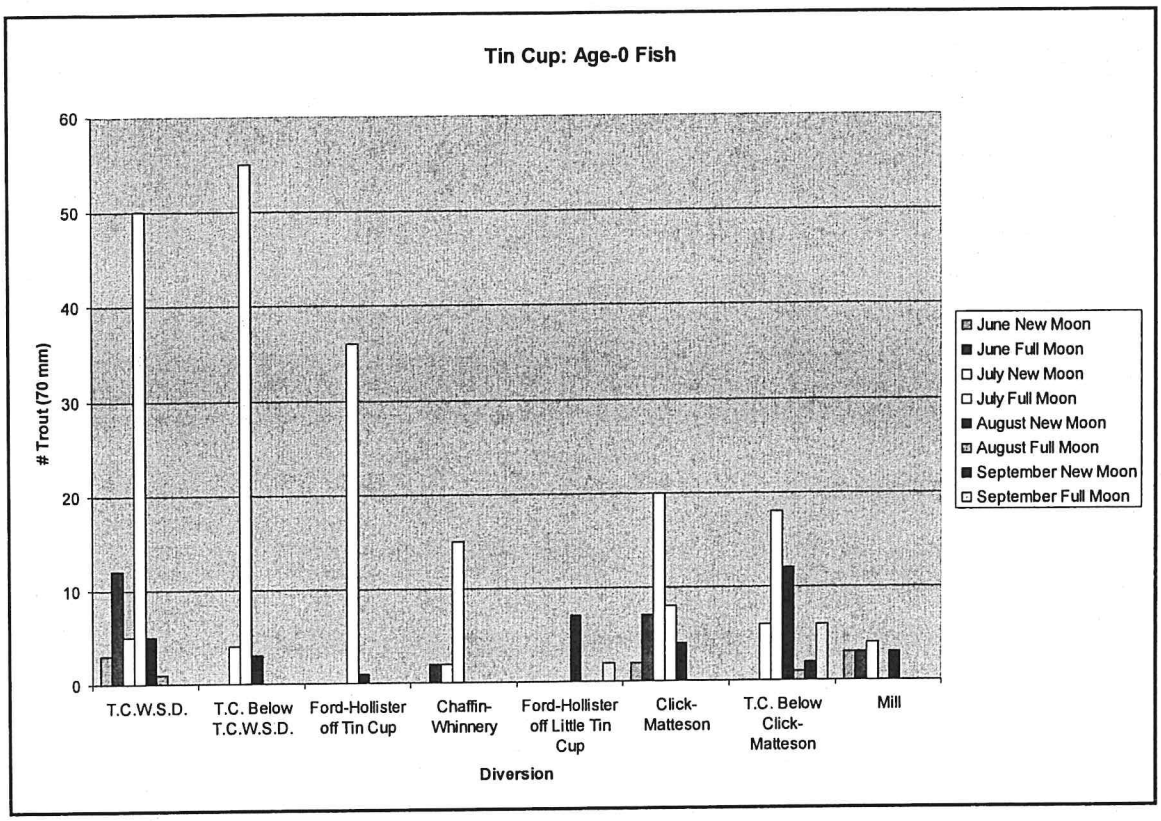

Table 1. Sites sampled by snorkeling, electrofishing, and reconnaissance in 2005 on Lost Horse and Tin Cup Creeks. HUC 17010205, Bitterroot, Montana. Stationary trap net sites were located 50 m downstream in Stratum 1 Reach 1 of all diversions.

Stream	Diversion	Site	Latitude[1]	Longitude[1]
Lost Horse	BRID	Stratum 1 Reach 1	46.100511	114.259406
		Stratum 2 Reach 15	46.100625	114.233361
		Stratum 2 Reach 25	46.103500	114.217000
		Stratum 2 Reach 35	46.091894	114.215994
	Highline	Stratum 1 Reach 1	46.103578	114.236283
		Stratum 2 Reach 8	46.114939	114.235219
		Stratum 2 Reach 12	46.117864	114.228981
		Stratum 3 Reach 1	46.120425	114.221203
		Stratum 3 Reach 2	46.121186	114.219969
		Stratum 4 Reach 6	46.133242	114.209642
		Stratum 4 Reach 8	46.134956	114.208719
		Stratum 5 Reach 1	46.124758	114.212689
		Stratum 5 Reach 4	46.123589	114.205408
	Clubhouse	Stratum 0 Reach 2	46.117042	114.218789
		Stratum 1 Reach 1	46.118286	114.217461
		Stratum 2 Reach 1	46.118075	114.215667
		Stratum 2 Reach 7	46.119719	114.208219
		Stratum 3 Reach 1	46.122989	114.203922
		Stratum 3 Reach 10	46.122508	114.185828
	Low	Stratum 1 Reach 1	46.117356	114.206853
		Stratum 2 Reach 1	46.118056	114.204931
		Stratum 2 Reach 7	46.121389	114.194553
	POD 1	Stratum 1 Reach 1	46.115083	114.205697
		Stratum 2 Reach 6	46.110786	114.199311
		Stratum 2 Reach 9	46.108094	114.201197
	POD 5	Stratum 1 Reach 1	46.115578	114.203006
		Stratum 2 Reach 2	46.114944	114.199944
	Ward	Stratum 1 Reach 1	46.114603	114.173933
		Stratum 2 Reach 2	46.118822	114.175322
		Stratum 2 Reach 9	46.124381	114.178672
Tin Cup	TCCWSD	Stratum 1 Reach 1	46.009097	114.221228
		Stratum 2 Reach 7	46.001681	114.208783
		Stratum 2 Reach 9	46.000872	114.205369
		Stratum 3 Reach 5	46.006578	114.205386
		Stratum 3 Reach 14	46.014492	114.207092
		Stratum 4 Reach 2	46.024083	114.210447
		Stratum 4 Reach 8	46.031600	114.217169

[1] Approximate coordinates from ArcMap.

	Stratum 5 Reach 9	46.041778	114.208697
	Stratum 5 Reach 13	46.042922	114.205247
	Stratum 6 Reach 10	46.038611	114.201461
	Stratum 6 Reach 12	46.040083	114.199200
Ford-Hollister	Stratum 1 Reach 1	46.005325	114.216944
	Stratum 2 Reach 2	46.002133	114.217144
	Stratum 2 Reach 3	46.001286	114.215775
	Stratum 3 Reach 1	45.997575	114.213614
Chaffin-Whinnery	Stratum 1 Reach 1	46.002578	114.213364
	Stratum 2 Reach 1	46.000028	114.202706
	Stratum 2 Reach 2	46.000164	114.200603
	Stratum 3 Reach 7	46.011206	114.199167
	Stratum 3 Reach 11	46.017611	114.185864
Click-Matteson	Stratum 1 Reach 1	45.998553	114.203875
	Stratum 2 Reach 3	46.000197	114.198694
	Stratum 2 Reach 4	46.001183	114.197825
Mill	Stratum 1 Reach 1	45.998689	114.196108
	Stratum 2 Reach 5	46.004153	114.189347
	Stratum 2 Reach 9	46.006011	114.183572
	Stratum 3 Reach 6	46.012014	114.183133
	Stratum 3 Reach 7	46.012364	114.181592
	Stratum 4 Reach 3	46.019106	114.181694
	Stratum 4 Reach 9	46.025686	114.186969

Table 2. Number of trout fry captured in 2005 using stationary trap nets in stream and diversion locations in Lost Horse and Tin Cup Creeks.

Stream	Site	Dates set	Number of trout fry
Lost Horse	BRID	6/6-6/7/2005	0
		6/21-6/22/2005	0
		7/7-7/9/2005	45
		7/18-7/20/2005	4
		8/8-8/10/2005	6
		8/17-8/19/2005	0
		9/2-9/3/2005	2
		9/16-9/17/2005	0
	Lost Horse below BRID	7/7-7/9/2005	0
		7/18-7/20/2005	2
		8/8-8/10/2005	14
		8/17-8/19/2005	1
		9/2-9/3/2005	0
		9/16-9/17/2005	2
	Highline	6/6-6/8/2005	0
		6/21-6/23/2005	0
		7/7-7/9/2005	0
		7/18-7/20/2005	5
		8/8-8/10/2005	1
		8/17-8/19/2005	0
		9/2-9/3/2005	0
		9/16-9/17/2005	0
	Lost Horse below Highline	7/7-7/9/2005	1
		7/18-7/20/2005	0
		8/17-8/19/2005	0
		9/2-9/3/2005	0
		9/16-9/17/2005	0
	Clubhouse intake channel	8/9-8/10/2005	2
		8/17-8/19/2005	0
		9/2-9/3/2005	0
		9/16-9/17/2005	0
	Clubhouse	6/6-6/8/2005	5
		6/21-6/23/2005	0
		7/7-7/9/2005	18
		7/18-7/20/2005	82
		8/8-8/10/2005	0
		8/17-8/19/2005	1
		9/2-9/3/2005	0
		9/16-9/17/2005	2
	Low	6/6-6/8/2005	0

	6/21-6/23/2005	1
	7/7-7/9/2005	49
	7/18-7/20/2005	1
	8/8-8/10/2005	4
	8/17-8/19/2005	0
	9/2-9/3/2005	0
	9/16-9/17/2005	0
Lost Horse above & below Low	7/18-7/20/2005	0
	8/8-8/10/2005	0
	8/17-8/19/2005	0
	9/2-9/3/2005	0
	9/16-9/17/2005	0
POD 1	6/7-6/8/2005	0
	6/21-6/23/2005	0
	7/7-7/9/2005	2
	7/18-7/20/2005	0
	8/8-8/10/2005	7
	8/17-8/19/2005	1
	9/2-9/3/2005	0
	9/16-9/17/2005	0
Lost Horse between POD 1 &5	7/7-7/9/2005	2
	7/18-7/20/2005	0
	8/8-8/10/2005	2
	8/17-8/19/2005	0
	9/2-9/3/2005	0
	9/16-9/17/2005	0
POD 5	6/7-6/8/2005	0
	6/21-6/23/2005	0
	7/7-7/9/2005	40
	7/18-7/20/2005	11
	8/8-8/10/2005	3
	8/17-8/19/2005	0
Ward	6/6-6/8/2005	0
	6/21-6/23/2005	77
	7/7-7/9/2005	77
	7/18-7/20/2005	4
	8/8-8/10/2005	2
	8/17-8/19/2005	0
	9/2-9/3/2005	0
	9/16-9/17/2005	0
Lost Horse above & below Ward	7/7-7/9/2005	38
	7/18-7/20/2005	0
	8/8-8/10/2005	0
	8/17-8/19/2005	0
	9/2-9/3/2005	0

		9/16-9/17/2005	0
Tin Cup	TCCWSD	6/2-6/4/2005	3
		6/23-6/25/2005	12
		7/5-7/7/2005	5
		7/20-7/22/2005	50
		8/3-8/5/2005	5
		8/22-8/24/2005	1
	Tin Cup below TCCWSD	7/6-7/7/2005	4
		7/20-7/22/2005	55
		8/3-8/5/2005	3
		8/22-8/24/2005	0
		9/2-9/3/2005	0
		9/17-9/18/2005	0
	Ford-Hollister off Tin Cup	7/20-7/21/2005	36
		8/3-8/5/2005	1
		8/22-8/24/2005	0
	Chaffin-Whinnery	6/2-6/4/2005	0
		6/23-6/25/2005	2
		7/5-7/7/2005	2
		7/20-7/22/2005	15
	Ford-Hollister off Little Tin Cup	6/2-6/4/2005	0
		6/23-6/25/2005	0
		7/5-7/7/2005	0
		7/20-7/22/2005	0
		8/3-8/5/2005	7
		8/22-8/24/2005	0
		9/2-9/3/2005	0
		9/17-9/18/2005	2
	Click-Matteson	6/2-6/4/2005	2
		6/23-6/25/2005	7
		7/5-7/7/2005	20
		7/20-7/22/2005	8
		8/3-8/5/2005	4
	Tin Cup below Click-Matteson	7/6-7/7/2005	6
		7/20-7/22/2005	18
		8/3-8/5/2005	12
		8/22-8/24/2005	1
		9/2-9/3/2005	2
		9/17-9/18/2005	6
	Mill	6/2-6/4/2005	3
		6/23-6/25/2005	3
		7/5-7/7/2005	4
		7/20-7/22/2005	0

	8/3-8/5/2005	3
	8/22-8/24/2005	0
	9/2-9/3/2005	0
	9/17-9/18/2005	0
Tin Cup below Mill	7/6-7/7/2005	2
	7/20-7/22/2005	0
	8/3-8/5/2005	0
	8/22-8/24/2005	0
	9/2-9/3/2005	4
	9/17-9/18/2005	0

Table 3. Fishes captured by electrofishing and observed by snorkeling or reconnaissance in diversions on Lost Horse Creek.

Diversion	Site	Date	Method	Species	Number captured or observed
BRID	Stratum 1 Reach 1	7/27/2005	Snorkel	westslope cutthroat	235
				brook trout	696
				rainbow trout	1
				brown trout	12
				longnose dace	6
				sculpin	6
				Total	956
		8/17/2005	Snorkel	westslope cutthroat	220
				brook trout	702
				brown trout	53
				longnose dace	2
				sculpin	4
				Total	971
		9/17/2005	Snorkel	westslope cutthroat	96
				brook trout	252
				brown trout	31
				unidentified trout	4
				longnose dace	1
				sculpin	7
				Total	391
		10/16/2005	Snorkel	westslope cutthroat	30
				brook trout	78
				brown trout	6
				unidentified trout	3
				longnose dace	1
				sculpin	3
				Total	104
		10/16/2005	Electrofish[2]	westslope cutthroat	50
				brook trout	186
				brown trout	11
				longnose dace	11
				sculpin	18
				Total	276
	Stratum 2 Reach 15	8/18/2005	Snorkel	westslope cutthroat	26
				brook trout	36
				brown trout	2
				Total	64
		9/18/2005	Snorkel	westslope cutthroat	11
				brook trout	17
				brown trout	2
				unidentified trout	1

[2] Only half of reach (200 m out of 400 m) electrofished

				longnose dace	1
				Total	32
		9/18/2005	Electrofish	westslope cutthroat	16
				brook trout	34
				brown trout	5
				Total	55
	Stratum 2 Reach 25	7/27/2005	Snorkel	Total	0
		8/18/2005	Snorkel	westslope cutthroat	1
				brook trout	1
				brown trout	1
				unidentified trout	1
				Total	4
		9/18/2005	Snorkel	westslope cutthroat	1
				brook trout	5
				Total	6
	Stratum 2 Reach 35	7/27/2005	Snorkel	Total	0
		8/18/2005	Snorkel	Total	0
Highline	Stratum 1 Reach 1	8/1/2005	Snorkel	bull trout	1
				westslope cutthroat	22
				brook trout	25
				brown trout	9
				longnose dace	1
				Total	58
		8/23/2005	Snorkel	westslope cutthroat	20
				brook trout	37
				brown trout	15
				Total	71
		9/25/2005	Snorkel	westslope cutthroat	9
				brook trout	11
				brown trout	3
				unidentified trout	1
				Total	24
		10/15/2005	Snorkel	westslope cutthroat	3
				brook trout	11
				brown trout	2
				sculpin	2
				Total	19
		10/15/2005	Electrofish	westslope cutthroat	14
				brook trout	28
				brown trout	3
				longnose dace	1
				sculpin	14
				Total	60
		11/10/2005	Electrofish Recon[3]	westslope cutthroat	19
				brook trout	11

[3] Reconnaissance by electrofishing after canal was shut down for the season, or at extremely low flows prior to canal shut-down.

				brown trout	5
				sculpin	3
				Total	38
	Stratum 2 Reach 8	8/1/2005	Snorkel	westslope cutthroat	5
				brook trout	1
				Total	6
		8/23/2005	Snorkel	westslope cutthroat	4
				brook trout	2
				Total	6
		9/25/2005	Snorkel	westslope cutthroat	6
				brook trout	1
				Total	7
	Stratum 2 Reach 12	8/1/2005	Snorkel	westslope cutthroat	1
				brook trout	2
				unidentified trout	1
				Total	4
		8/23/2005	Snorkel	brook trout	4
				Total	4
		9/25/2005	Snorkel	westslope cutthroat	2
				Total	2
	Stratum 3 Reach 1	8/1/2005	Snorkel	Total	0
		8/23/2005	Snorkel	brook trout	3
				Total	3
	Stratum 3 Reach 2	8/1/2005	Snorkel	brook trout	3
				Total	3
		8/23/2005	Snorkel	westslope cutthroat	4
				brook trout	1
				brown trout	1
				Total	6
	Stratum 4 Reach 6	8/2/2005	Snorkel	Total	0
		8/22/2005	Snorkel	Total	0
	Stratum 4 Reach 8	8/2/2005	Snorkel	Total	0
		8/22/2005	Snorkel	Total	0
	Stratum 5 Reach 1	8/2/2005	Snorkel	brook trout	9
				Total	9
		8/23/2005	Snorkel	westslope cutthroat	1
				brook trout	14
				Total	15
	Stratum 5 Reach 4	8/2/2005	Snorkel	Total	0
		8/25/2005	Snorkel	Total	0
Clubhouse	Stratum 0 Reach 2	7/13/2005	Snorkel	brook trout	54
				unidentified trout	1

			Total	55
	8/12/2005	Snorkel	westslope cutthroat	4
			brook trout	94
			brown trout	1
			Total	99
	9/10/2005	Snorkel	westslope cutthroat	1
			brook trout	59
			rainbow trout	4
			unidentified trout	1
			Total	65
	10/8/2005	Snorkel	westslope cutthroat	2
			brook trout	112
			brown trout	3
			Total	117
	11/11/2005	Electrofish Recon	westslope cutthroat	17
			brook trout	257
			rainbow trout	6
			brown trout	14
			Total	294
Stratum 1 Reach 1	7/13/2005	Snorkel	bull trout	1
			westslope cutthroat	4
			brook trout	35
			rainbow trout	1
			Total	41
	8/12/2005	Snorkel	westslope cutthroat	5
			brook trout	96
			brown trout	1
			Total	102
	9/11/2005	Snorkel	westslope cutthroat	7
			brook trout	123
			brown trout	5
			unidentified trout	6
			Total	141
	9/11/2005	Electrofish	westslope cutthroat	6
			brook trout	122
			brown trout	2
			Total	130
	10/8/2005	Snorkel	westslope cutthroat	15
			brook trout	102
			brown trout	4
			mountain whitefish	1
			Total	122
Stratum 2 Reach 1	7/13/2005	Snorkel	brook trout	11
			unidentified trout	2
			Total	13
	8/12/2005	Snorkel	westslope cutthroat	7
			brook trout	40
			brown trout	3
			Total	50

		9/10/05	Snorkel	westslope cutthroat	2
				brook trout	13
				brown trout	2
				unidentified trout	2
				Total	19
		9/10/2005	Electrofish	westslope cutthroat	5
				brook trout	28
				brown trout	4
				Total	37
		10/8/2005	Snorkel	westslope cutthroat	5
				brook trout	6
				unidentified trout	5
				Total	16
	Stratum 2 Reach 7	7/13/2005	Snorkel	Total	0
		8/12/2005	Snorkel	Total	0
		9/10/2005	Snorkel	westslope cutthroat	2
				brook trout	2
				unidentified trout	1
				longnose sucker	10
				longnose dace	7
				Total	22
		10/8/2005	Snorkel	westslope cutthroat	4
				brook trout	3
				unidentified trout	2
				Total	9
	Stratum 3 Reach 1	8/15/2005	Snorkel	westlope cutthroat	2
				longnose sucker	100
				Total	102
	Stratum 3 Reach 10	7/13/2005	Snorkel	Total	0
		8/15/2005	Snorkel	Total	0
Low	Stratum 1 Reach 1	7/14/2005	Snorkel	westslope cutthroat[4]	3
				brook trout	15
				unidentified trout	1
				longnose sucker	1
				longnose dace	1
				Total	21
		8/15/05	Snorkel	bull trout	1
				westslope cutthroat[4]	35
				brook trout	32
				brown trout	25
				unidentified trout	3
				mountain whitefish	2
				Total	98

[4] Westslope cutthroat (<100 mm TL) trout were difficult to distinguish from cutthroat x rainbow hybrids and juvenile rainbow trout in this and other ditches on Lost Horse Creek. The number shown includes westslope cutthroat and hybrids grouped together.

	9/17/2005	Snorkel	westslope cutthroat[4]	41
			brook trout	17
			brown trout	9
			unidentified trout	3
			longnose dace	1
			Total	71
	10/9/2005	Snorkel	westslope cutthroat[4]	7
			brook trout	5
			brown trout	1
			unidentified trout	2
			longnose dace	1
			Total	16
	10/9/2005	Electrofish	westslope cutthroat[4]	62
			brook trout	55
			rainbow trout	3
			brown trout	17
			longnose dace	1
			sculpin	6
			Total	144
	11/11/2005	Electrofish Recon	westslope cutthroat[4]	59
			brook trout	31
			rainbow trout	3
			brown trout	13
			longnose dace	5
			sculpin	2
			Total	113
Stratum 2 Reach 1	7/14/2005	Snorkel	westslope cutthroat[4]	1
			brook trout	4
			longnose sucker	2
			Total	7
	8/15/2005	Snorkel	bull trout	2
			westslope cutthroat[4]	45
			brook trout	15
			brown trout	7
			mountain whitefish	2
			longnose sucker	40
			longnose dace	10
			Total	121
	10/9/2005	Snorkel	westslope cutthroat[4]	4
			unidentified trout	1
			longnose sucker	3
			longnose dace	1
			Total	9
Stratum 2 Reach 7	7/14/2005	Snorkel	brook trout	1
			Total	1
	8/15/2005	Snorkel	westslope cutthroat[4]	2
			longnose sucker	2
			Total	4
	10/9/2005	Snorkel	unidentified trout	1

				Total	1
POD 1	Stratum 1 Reach 1	7/12/2005	Snorkel	westslope cutthroat[4]	1
				brook trout	2
				mountain whitefish	1
				longnose sucker	1
				longnose dace	2
				Total	7
		8/12/2005	Snorkel	westslope cutthroat[4]	8
				brook trout	15
				brown trout	5
				longnose dace	1
				Total	29
	Stratum 2 Reach 6	7/12/2005	Snorkel	Total	0
		8/12/2005	Recon	Total	0
	Stratum 2 Reach 9	7/12/2005	Snorkel	brook trout	1
				Total	1
		8/12/2005	Recon	Total	0
POD 5	Stratum 1 Reach 1	8/11/2005	Electrofish	westslope cutthroat[4]	11
				brook trout	4
				brown trout	3
				unidentified trout	2
				longnose dace	1
				Total	21
	Stratum 2 Reach 2	8/11/2005	Electrofish	Total	0
Ward	Stratum 1 Reach 1	7/29/2005	Snorkel	westslope cutthroat[4]	55
				brook trout	444
				rainbow trout	1
				brown trout	17
				unidentified trout	4
				mountain whitefish	109
				longnose sucker	3
				Total	632
		8/22/2005	Snorkel	westslope cutthroat[4]	154
				brook trout	567
				rainbow trout	5
				brown trout	2
				unidentified trout	3
				mountain whitefish	175
				longnose sucker	10
				longnose dace	1
				Total	917
		9/24/2005	Snorkel	westslope cutthroat[4]	248
				brook trout	767
				rainbow trout	1
				brown trout	16

			mountain whitefish	204
			longnose sucker	2
			Total	1248
	10/23/2005	Snorkel	westslope cutthroat[4]	50
			brook trout	215
			rainbow trout	1
			brown trout	15
			unidentified trout	18
			mountain whitefish	56
			Total	355
	11/15/2005	Electrofish Recon	westslope cutthroat[4]	38
			brook trout	285
			rainbow trout	13
			brown trout	7
			unidentified trout	27
			mountain whitefish	4
			longnose sucker	12
			sculpin	1
			Total	387
Stratum 2 Reach 2	7/29/2005	Snorkel	westslope cutthroat[4]	2
			brook trout	161
			brown trout	2
			unidentified trout	1
			mountain whitefish	12
			longnose sucker	1
			Total	179
	8/22/2005	Snorkel	westslope cutthroat[4]	5
			brook trout	80
			brown trout	1
			unidentified trout	3
			mountain whitefish	7
			longnose sucker	2
			Total	108
Stratum 2 Reach 9	7/29/2005	Snorkel	brook trout	32
			rainbow trout	1
			brown trout	12
			longnose sucker	1
			longnose dace	1
			Total	47
	8/22/2005	Snorkel	westslope cutthroat[4]	3
			brook trout	70
			brown trout	17
			mountain whitefish	3
			Total	93

Table 4. Fishes captured by electrofishing and observed by snorkeling or reconnaissance in diversions on Tin Cup Creek.

Diversion	Site	Date	Method	Species	Number captured
TCCWSD	Stratum 1 Reach 1	7/25/2005	Snorkel	westslope cutthroat	146
				brook trout	26
				rainbow trout	2
				brown trout	2
				unidentified trout	2
				Total	178
		8/16/2005	Snorkel	westslope cutthroat	104
				brook trout	34
				brown trout	20
				unidentified trout	4
				sculpin	1
				Total	163
		10/22/2005	Electrofish Recon	westslope cutthroat	938
				brook trout	61
				brown trout	164
				sculpin	8
				Total	1271
	Stratum 2 Reach 7	7/26/2005	Snorkel	westslope cutthroat	43
				brook trout	6
				brown trout	5
				Total	54
		8/17/2005	Snorkel	westslope cutthroat	55
				brook trout	1
				brown trout	22
				Total	78
	Stratum 2 Reach 9	7/29/2005	Snorkel	westslope cutthroat	29
				brook trout	3
				Total	32
		8/17/2005	Snorkel	westslope cutthroat	69
				brook trout	1
				brown trout	4
				Total	47
	Stratum 3 Reach 5	7/25/2005	Snorkel	westslope cutthroat	2
				brook trout	1
				Total	3
		8/16/2005	Snorkel	westslope cutthroat	29
				Total	29
	Stratum 3 Reach 14	7/25/2005	Snorkel	unidentified trout	1
				Total	1
		8/16/2005	Snorkel	westslope cutthroat	3
				Total	3
	Stratum 4 Reach 2	7/26/2005	Snorkel	Total	0

		8/16/2005	Snorkel	westslope cutthroat	3
				brook trout	4
				unidentified trout	1
				Total	8
	Stratum 4 Reach 8	7/26/2005	Snorkel	Total	0
		8/16/2005	Snorkel	Total	0
	Stratum 5 Reach 9	8/16/2005	Snorkel	Total	0
	Stratum 5 Reach 13	8/15/2005	Electrofish	Total	0
	Stratum 6 Reach 10	7/26/2005	Snorkel	Total	0
	Stratum 6 Reach 12	7/26/2005	Electrofish	Total	0
Ford-Hollister	Stratum 1 Reach 1	7/28/2005	Snorkel	westslope cutthroat	8
				brook trout	1
				brown trout	1
				Total	10
		8/19/2005	Snorkel	westslope cutthroat	11
				brook trout	6
				brown trout	3
				Total	20
	Stratum 2 Reach 2	7/28/2005	Snorkel	westslope cutthroat	3
				Total	3
		8/19/2005	Snorkel	westslope cutthroat	3
				Total	3
	Stratum 2 Reach 3	7/28/2005	Snorkel	Total	0
		8/19/2005	Snorkel	westslope cutthroat	1
				Total	1
	Stratum 3 Reach 1	7/28/2005	Snorkel	westslope cutthroat	12
				brook trout	1
				Total	13
		8/19/2005	Snorkel	westslope cutthroat	11
				brook trout	2
				Total	13
Chaffin-Whinnery	Stratum 1 Reach 1	7/15/2005	Snorkel	westslope cutthroat	56
				brook trout	5
				Total	61
		8/1/2005	Recon	westslope cutthroat	2
				brook trout	3
				brown trout	2
				Total	7
	Stratum 2 Reach 1	7/15/2005	Snorkel	unidentified trout	1
				Total	1

	Stratum 2 Reach 2	7/15/2005	Snorkel	Total	0
	Stratum 3 Reach 7	7/15/2005	Electrofish	Total	0
	Stratum 3 Reach 11	7/18/2005	Electrofish	Total	0
Click-Matteson	Stratum 1 Reach 1	7/22/2005	Snorkel	westslope cutthroat	102
				brook trout	43
				brown trout	2
				Total	147
	Stratum 2 Reach 2	7/22/2005	Snorkel	Total	0
	Stratum 2 Reach 4	7/22/2005	Snorkel	longnose dace	1
				Total	1
	All strata	8/10/2005	Recon	westslope cutthroat	17
				brook trout	16
				brown trout	2
				unidentified trout	210
				longnose dace	2
				Total	257
Mill	Stratum 1 Reach 1	8/2/2005	Snorkel	westslope cutthroat	77
				brook trout	37
				brown trout	67
				Total	181
		8/24/2005	Snorkel	westslope cutthroat	116
				brook trout	27
				brown trout	40
				unidentified trout	1
				sculpin	1
				Total	185
		10/30/2005	Electrofish Recon	westslope cutthroat	10
				brook trout	2
				brown trout	4
				unidentified trout	1
				Total	17
	Stratum 2 Reach 5	8/4/2005	Snorkel	brook trout	2
				Total	2
		8/24/2005	Snorkel	westslope cutthroat	7
				brook trout	1
				brown trout	1
				Total	9
	Stratum 2 Reach 9	8/3/2005	Snorkel	westslope cutthroat	1
				brook trout	1
				Total	2
		8/24/2005	Snorkel	westslope cutthroat	2

			brook trout	1
			Total	3
Stratum 3 Reach 6	8/3/2005	Snorkel	Total	0
	8/26/2005	Electrofish	westslope cutthroat	1
			Total	1
Stratum 3 Reach 7	8/3/2005	Snorkel	Total	0
	8/26/2005	Electrofish	Total	0
Stratum 4 Reach 3	8/3/2005	Snorkel	brook trout	9
			brown trout	2
			unidentified trout	1
			Total	12
	8/24/2005	Electrofish	brook trout	6
			Total	6
Stratum 4 Reach 9	8/4/2005	Electrofish	brook trout	12
			longnose dace	4
			Total	16
	8/24/2005	Electrofish	brook trout	1
			Total	1