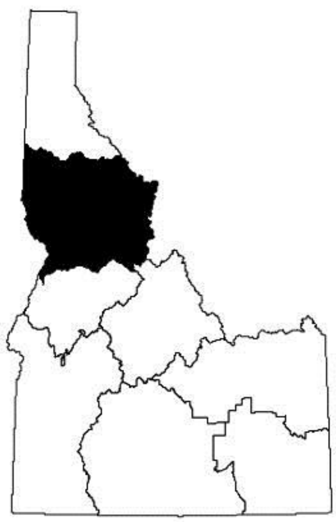
FISHERY MANAGEMENT INVESTIGATIONS

IDAHO DEPARTMENT OF FISH AND GAME
FISHERY MANAGEMENT ANNUAL REPORT

Virgil Moore, Director



CLEARWATER REGION

2013

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ABSTRACT

Angler exploitation rates of hatchery catchable Rainbow Trout *Oncorhynchus mykiss* were evaluated in the Hordemann Pond, Snake River Levee Pond, and Deyo Reservoir during 2013. Previous evaluations of Hordemann Pond indicated that it gets too hot during the summer months to support a Rainbow Trout fishery. The late May stocking resulted in a total use (fish harvested plus fish released) of 0%, confirming that Rainbow Trout are not surviving in the pond after mid-May. This supports data previously collected indicating that dredging the pond is warranted. Additional angler exploitation evaluations of Hordemann Pond should be conducted post-dredging.

The Snake River Levee Pond was evaluated to determine the success of a new fall Rainbow Trout stocking. Total use was estimated to be 25.0%.

Deyo Reservoir angler exploitation was evaluated for the first time in 2013. Total use through July 1, 2014 was estimated to be 27.3% for the June stocking and 30.3% for the October stocking. Both estimates were above the statewide average of 15.7% return for reservoirs from 2006 - 2009. However, they were below the management goal of a 40.0% return to creel. Most of the tag returns from the June stocking occurred by the end of July, while most of the tag returns for the October stocking occurred during the following spring fishery.

Exploitation rates were evaluated for Smallmouth Bass *Micropterus dolomieu* in the Hells Canyon reach of the Snake River in 2012 and 2013. Angler exploitation was estimated at 6.5% in 2012 and 7.7% in 2013. These estimates are below the estimate of 23.6% for Idaho reservoirs. Total use was estimated to be 12.9% in 2012 and 15.9% in 2013. With low exploitation rates and substantial catch and release occurring, efforts to manipulate the population of SMB in the Snake River through angling would likely meet with limited success. However, removing the bag limit on SMB could encourage some additional harvest.

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INTRODUCTION

An important component of our lowland lake fisheries are the catchable size (203 mm - 254 mm) Rainbow Trout *Oncorhynchus mykiss* stocked by our hatcheries. As part of the lowland lake program, hatchery trout provide an easily accessible harvest opportunity, they create an “instant” fishery stocked, and they meet very high angler demand in areas where natural reproduction is unable to meet harvest pressure. They are managed with a goal of maintaining a minimum catch rate of 0.5 fish/hour in each lake, and return to creel rates >40% (IDFG 2013). Evaluating the return to creel rates, especially in new fishing waters, provides information to manage angling and harvest opportunities.

The Snake River below Hells Canyon Dam in Idaho is known for its anadromous fisheries. Every spring, millions of smolts are carried down this river to the ocean. The returning adults create important fisheries in the Snake River and Salmon River that contributed substantially to the estimated 241,111 fishing trips and $66,686,000 spent on fishing in the anadromous sections of those rivers (IDFG, *unpublished data*). The migrating smolts face numerous obstacles in their journey to ocean, including predators such as Smallmouth Bass (SMB) *Micropterus dolomieu*. Smallmouth Bass are a popular non-native sportfish throughout this river system. As such, they present competing challenges for state and federal agencies charged with both the conservation of native, sensitive, or ESA-listed species and the management of freshwater angling opportunities (Carey et al. 2011). Due to the importance of these fisheries, a better understanding of the SMB population is necessary to manage this species, its fishery, and its impact on anadromous fish. Thus, we initiated a tagging program in collaboration with the U.S. Geological Survey (USGS) to determine angler exploitation of SMB in the Snake River.

OBJECTIVE

1. Evaluate angler exploitation rates of hatchery catchable-sized Rainbow Trout in select regional ponds.

2. Evaluate angler exploitation rates of Smallmouth Bass in the Hells Canyon reach of the Snake River.

STUDY AREA

Angler exploitation studies of catchable Rainbow Trout were conducted on two regional ponds and the newly constructed Deyo Reservoir (Figure 1). The Snake River Levee Pond (SRLP) (aka Kiwanis Park Pond) is located next to the Kiwanis Park along the Snake River in Lewiston, Idaho, and Hordemann Pond is located in Moscow, Idaho. These are both small ponds <2 ha in surface area.

Deyo Reservoir is located approximately 5 km west of Weippe, Idaho, at an elevation of 920 m (Figure 1). It is a 22.3 ha reservoir created by the damming of Schmidt Creek, a tributary to Lolo Creek, Idaho. Deyo Reservoir has a maximum depth of approximately 10 m, a mean depth of approximately 5 m, and a volume of approximately 550 acre/ft. The upper end of the reservoir has been developed into a wetland area to provide habitat for waterfowl and other wildlife. The drainage basin is composed of a mix of forest and cropland. Facilities at the reservoir include a campground with both full hookups and primitive sites, numerous fishing docks (including ADA accessible), boat ramp, picnic pavilion, and toilets.

The Snake River, at 1,735 km in length, is the largest tributary of the Columbia River. Its watershed is the tenth largest among North American rivers, and covers almost 280,000 km^2 in six states. It has an average discharge of >1,500 m^3/s. Its headwaters are in western Wyoming. From there the river flows west through the Snake River Plain in Idaho, into Hells Canyon, and through the Palouse Hills before joining the Columbia River at Washington's Tri-Cities. Angler exploitation was evaluated in five reaches of the Snake River, stretching from the Port of Wilma in Washington upstream to Sheep Creek in Hells Canyon (Figure 2). Fish were also tagged in the lower Clearwater River near the confluence with the Snake River. Primary access points to this part of the Snake River are boat ramps in Lewiston, Couse Creek, Heller Bar, Pittsburg Landing, and Hells Canyon Dam. Within this section of the Snake River is the Hells Canyon National Recreation Area (HCNRA), which encompasses the river from the Cache Creek Administrative Site at RK 283, upstream to Hells Canyon Dam at RK 398.

METHODS

Angler exploitation surveys were conducted for hatchery catchable sized Rainbow Trout stocked. In 2013, fish were tagged in Hordemann Pond in April (N = 25) and May (N = 25), the SRLP in October (N = 50) and in Deyo Reservoir in June (N = 300) and October (N = 299). Exploitation (harvest) and total use (fish harvested plus fish released) were estimated using angler-returned t-bar anchor tags. Tag returns were collected using the IDFG "Tag You're It" program and analyzed according to the methods described in e (Meyer et al. 2010).

Angler exploitation of SMB was evaluated in five reaches of the Snake River, stretching from the Port of Wilma in Washington upstream to Sheep Creek in Hells Canyon (Figure 2). Fish were also tagged in the lower Clearwater River near the confluence with the Snake River. The five Snake River reaches were: Port of Wilma to Blue Bridge, Blue Bridge to Asotin, Asotin to the Grand Ronde River, Grand Ronde River to the confluence with the Salmon River, and Vanpool to Sheep Creek (Figure 2). These fish were collected and tagged by USGS staff using boat mounted electrofishing and FLOY t-bar anchor tags. Exploitation (harvest) and total use (fish harvested plus fish released) were estimated using angler-returned tags. Tag returns were collected using the IDFG "Tag You're It" program and analyzed according to the methods described in Meyer et al. 2010.

RESULTS

Hatchery Rainbow Trout

Exploitation of hatchery Rainbow Trout at Hordemann Pond in 2013 (through 365 days at large) were 12.5% for the April tagging event (Table 1) and 0.0% for the May tagging event. Total use through 365 days at large (Table 1) was also 12.5% for the April tagging event and 0.0% for the May tagging event. There was no use beyond 365 days at large. In the SRLP, exploitation (through 365 days at large) of hatchery Rainbow Trout stocked in October was 25.0% (Table 1). Total use through 365 days at large (Table 1) was also 25.0%.

In Deyo Reservoir, Rainbow Trout were tagged on June 6, 2013 (n = 299) and October 23, 2013 (n = 299). Exploitation rates through 365 days at large were 17.8% for the June tagging event (Table 1) and 18.8% for the October tagging event. Exploitation rates for 366 -

730 days at large were 4.3% for the June tagging event and 0.0% for the October tagging event. Total use through 365 days at large (Table 1) was 23.0% for the June tagging event and 30.3% for the October tagging event. Total use beyond 365 days (through July 1, 2014) was 4.3% for the June tagging event.

Snake River Smallmouth Bass

A total of 2,429 SMB were tagged in 2012, including 2,355 non-reward tags and 74 $50 reward tags. In 2013, a total of 4,107 SMB were tagged, with 4,083 non-reward tags and 24 $50 reward tags. Tagged SMB ranged in length from 145 - 538 mm (Figure 3). A total of 94 tags were returned in 2012, and 162 in 2013. The 2013 returns include fish tagged in both 2012 and 2013. Fish with tags returned ranged in length from 152 - 450 mm (Figure 3). Exploitation rates are through January 14, 2014. For the 2012 tagging, angler exploitation was 6.5% (Table 2). For the 2013 tagging, angler exploitation was 7.7% (Table 3). The exploitation rates in the Port of Wilma to Blue Bridge section were 4.4% in 2012 and 4.6% in 2013. The exploitation rates in the Blue Bridge to Asotin section were 22.1% in 2012 and 12.5% in 2013. The exploitation rates in the Asotin to Heller Bar section were 7.8% in 2012 and 13.7% in 2013. The exploitation rates in the Heller Bar to the Salmon River section were 13.1% in 2012 and 9.3% in 2013. The exploitation rates in the Vanpool to Sheep Creek section were 3.6% in 2012 and 4.6% in 2013. The exploitation rate in the Lower Clearwater River was 51% in 2012.

Total use of SMB was 12.9% in 2012 (Table 2), and 15.9% in 2013 (Table 3). Total use in the Port of Wilma to Blue Bridge section was 10.3% in 2012 and 9.9% in 2013. Total use in the Blue Bridge to Asotin section was 26.5% in 2012 and 25.0% in 2013. Total use in the Asotin to Heller Bar section was 17.6% in 2012 and 22.3% in 2013. Total use in the Heller Bar to the Salmon River section was 21.8% in 2012 and 18.6% in 2013. Total use in the Vanpool to Sheep Creek section was 9.5% in 2012 and 13.25 in 2013.

DISCUSSION

Hatchery Rainbow Trout

Angler exploitation of hatchery Rainbow Trout was evaluated in two regional ponds to monitor changes to the regional stocking plan. Hordemann Pond was evaluated to determine if there were differences in exploitation rates based on stocking at different times in the spring. The SRLP was evaluated to determine the effectiveness of a fall stocking.

Previously, Hordemann Pond was suspected to get too hot during the summer. An angler exploitation evaluation in 2012 indicated that very few tag returns occurred after May. In fact, only one tag return was reported in Hordemann Pond longer than five days after the May 17th, 2011 stocking. This indicates that these fish did not survive long, either from water conditions, angler harvest, or predation. Given that total use for the May 17th stocking was only 9.2% (compared to 77.8% for the April 26th stocking) higher water temperatures were most likely the primary issue. Subsequently, IDFG partnered with the City of Moscow to deepen Hordemann Pond by dredging. This should help improve water temperatures and result in a longer fishing season, and higher harvest and total use rates. However, dredging was not completed until August 2013, after the spring fishery. As such, the 2013 evaluations were conducted prior to this project. Once again, results showed that the April stocking was successful (12.5% total use) while the late May stocking was unsuccessful (0.0% total use). However, exploitation was much lower in the April 2013 stocking than the April 2011 stocking. This was likely due to poor water conditions occurring much earlier in 2013. As such, we should evaluate both April and May stockings after dredging to determine if any improvements are made to the fishery. Additionally, dissolved oxygen and water temperature profiles should be monitored at least bi-weekly for a full season to determine when the pond is suitable for hatchery Rainbow Trout survival. We should also investigate the potential benefits of a small aeration unit during the time period during which Hordemann Pond supports a viable fishery.

In 2011, the SRLP was the region's most successful stocking location, with the March and April stockings resulting in total use of 66.8% and 72.1%, respectively. These high exploitation rates were likely due to its urban location and easy access. However, due to high summer water temperatures, no tags were returned beyond June 13th, 2011. In order to improve return rates and extend the length of the spring fishing season, water releases from the Snake River into the SRLP were to be conducted in May/June each year. With such high return rates at this location, we decided to implement a fall stocking to provide additional fishing opportunity. The stocking conducted in October 2013 resulted in a total use of 25.0%. This was lower than the spring return rates in the SRLP, and was lower than most of the other fall stocking return rates (0.0 - 68.5%) seen in regional reservoirs during 2011 - 2013 (Hand et al. In Review). Even though this return rate was below the IDFG management goal of a 40% angler catch rate for hatchery catchable Rainbow Trout, the SRLP provides a beneficial fall fishery with easy access for anglers. Thus, we recommend continuing fall stockings in the SRLP.

As this was the first time Rainbow Trout were stocked into Deyo Reservoir, this was the initial evaluation of the stocking program. Through 365 days at large, total use (fish harvested plus fish released) was estimated to be 23.0% for the June 2013 tagging event (Table 1) and 30.3% for the October 2013 tagging event. There was exploitation from the June stocking past the one year mark, indicating that there is some carryover from these stockings. Total use past 365 days at large (through July 1, 2014) was 4.3%. This is a good sign, as carryover increases the opportunity for angler to catch these fish.

Total use through July 1, 2014 was therefore estimated to be 27.3% for the June tagging event. This was higher than rates of 9.4 - 13.9% calculated for four other June stockings in regional reservoirs in 2013. Total use through July 1, 2014 was 30.3% for the October tagging event (Table 1). This was within the range of 0.0 - 53.1% calculated for four other October stockings in regional reservoirs in 2012 (there were no other fall stockings in 2013 where exploitation rates were evaluated). Both angler exploitation estimates for 2013 were above the mean of 15.7% exploitation calculated for hatchery Rainbow Trout in Idaho reservoirs and ponds from 2006 - 2009 (Meyer et al. 2009), and the statewide average of 18.0% for reservoirs in 2011 (IDFG unpublished data). However, these estimates were below the IDFG management goal of a 40% angler catch rate for hatchery catchable Rainbow Trout.

Tag returns from the June tagging event (Figure 4) show that most returns occurred by the end of July. This is to be expected since most of the effort in our regional reservoirs occurs from May - August each year (Hand et al. In Review). Based on this information, no changes are suggested at this time for future spring stockings. Tagged fish from the October stocking were caught all the way through August 8th, 2014 (Figure 5), with most of the fish caught during the spring 2014 fishery. This indicates that many of these fish were able to overwinter. Due to the successful overwintering, fall stockings should be continued in Deyo Reservoir.

Snake River Smallmouth Bass

Angler exploitation of SMB was evaluated in the Hells Canyon Reach of the Snake River in a collaboration with the United States Geological Service (USGS). Due to the importance of the anadromous fisheries in the Snake River, a better understanding of the SMB population is necessary to manage this species, its fishery, and its impact on anadromous fish.

The estimated harvest rates of 6.5% in 2012 and 7.7% in 2013 were substantially below the average exploitation rate of 23.6% for SMB estimated for Idaho reservoirs by Meyer et al. (2009). This is expected due to the limited access to this portion of the Snake River compared to reservoirs. Not surprisingly, exploitation was much higher in the river sections near Lewiston, ID and Clarkston, WA with easier access compared to the upper sections which are mostly accessible by boat only (Tables 2 and 3). Total use (fish harvested plus fish released) was estimated to be 12.9% in 2012 and 15.9% in 2013. These rates were approximately double the estimated harvest rates, indicating that as many fish are caught and released as are harvested.

Anglers generally prefer to keep the larger fish they catch (Aday and Graeb 2012). The length distribution of tagged SMB harvested in the Snake River during 2012 and 2013 was similar to the length distribution of SMB tagged (Figure 3), with only slightly higher harvest percentages for fish above 260 mm. This suggests that SMB anglers were generally not selectively harvesting larger fish due to size preferences.

Smallmouth Bass generally consume vertebrates (primarily fish) and invertebrates (such as crayfish) in their native range. However, they are non-selective, opportunistic feeders (Pflug and Pauley, 1984; Weidel et al., 2000; Warren, 2009), which means they may consume juvenile salmonids when the species overlap in time and space. Studies have determined that in the Columbia and Snake river basins, the percent of SMB diets containing salmonids ranged from 0 - 65% (Zimmerman 1999; Carey et al. 2011). Predation was much higher in the lower Snake River (25.8% salmon) than in the Columbia River (12.4 - 14.2% salmon; Zimmerman 1999). However, Naughton and Bennett (2004) determined that juvenile salmonids accounted for only 5% of SMB diets in the Snake and Clearwater rivers above Lower Granite Reservoir. While SMB are impacting juvenile samonids, it appears that this impact is lower in upstream reaches. This may be partially due to faster water velocities in the free flowing river sections reducing predation opportunities (Naughton et al 2004).

With low exploitation rates and substantial catch and release occurring, efforts to manipulate the population of SMB in the Snake River through angling would likely meet with limited success. However, removing the bag limit on SMB could encourage some additional harvest. If reducing the SMB population is deemed necessary for reducing predation on juvenile salmonids, other means of control will have to be considered. Based on the studies mentioned previously, it appears that predation is more of an issue in the slower moving river reaches below the confluence of the Snake and Clearwater rivers. Therefore, potential control would likely be implemented downstream of this study area.

MANAGEMENT RECOMMENDATIONS

1. Continue to improve public awareness of regional small pond stockings, specifically the new locations in the Snake River Levee Pond and Hordemann Pond, through the use of regional fishing trailer, media releases, and postings at local businesses.

2. Re-evaluate angler exploitation rate of spring stocking of hatchery catchable trout in Hordemann Pond after dredging to determine if improvements are made in return rates.

3. Monitor water quality in Hordemann Pond to determine if an aeration unit could improve fish survival and the quality of the fishery.

4. Continue fall stocking in Snake River Levee Pond to provide fall fishing opportunity for the community.

5. Continue spring and fall stockings of hatchery catchable Rainbow Trout in Deyo Reservoir.

Table 1. Angler exploitation rates (estimated harvest), and total use (fish harvested and fish released) for small ponds in the Clearwater Region, Idaho, 2013, through July 1, 2014.

Water body	Tagging date	Tags released	Disposition			Adjusted exploitation		Adjusted total use	
			Harvested	Harvested b/c tagged	Released	Estimate	90% C.I.	Estimate	90% C.I.
Hordemann Pond	4/22/2013	25	1	0	0	12.5%	14.5%	12.5%	14.5%
Hordemann Pond	5/20/2013	25	0	0	0	0.0%	0.0%	0.0%	0.0%
Deyo Reservoir	6/6/2013	299	17	3	2	22.1%	5.4%	27.3%	6.2%
Deyo Reservoir	10/23/2013	299	19	5	8	18.8%	5.5%	30.3%	7.3%
Snake River Levee Pond	10/23/2013	50	4	0	0	25.0%	14.4%	25.0%	14.4%
Average						15.7%	8.0%	19.0%	8.5%

Table 2. Angler exploitation rates (harvest), and total use (fish harvested plus fish released) of Smallmouth Bass tagged in the Snake River, Idaho, in 2012.

		Tags Released		Disposition		Adjusted exploitation		Adjusted total use	
Location	Tagging Date	Non Reward	$50 Reward	Harvested	Released	Estimate	90% C.I.	Estimate	90% C.I.
Lower Clearwater River	6/6/2012	2	0	1	0	178.6%	131.2%	178.6%	131.2%
	7/16/2012	3	0	0	0	0.0%	----	0.0%	----
	8/9/2012	2	0	0	0	0.0%	----	0.0%	----
	Section Totals	7	0	1	0	51.0%	48.9%	51.0%	48.9%
Port of Wilma to Blue Bridge	4/24/2012	1	0	0	0	0.0%	----	0.0%	----
	5/15/2012	7	0	0	0	0.0%	----	0.0%	----
	5/31/2012	19	0	0	0	0.0%	----	0.0%	----
	5/31/2012	34	0	1	0	10.5%	10.7%	10.5%	10.7%
	6/5/2012	16	0	2	0	44.7%	30.7%	44.7%	30.7%
	6/27/2012	80	0	1	1	0.0%	----	8.9%	6.5%
	6/28/2012	67	0	2	1	5.3%	5.5%	16.0%	9.4%
	7/19/2012	27	0	2	0	5.3%	5.5%	5.3%	5.5%
	8/7/2012	21	0	0	0	0.0%	----	0.0%	----
	8/8/2012	15	0	0	0	0.0%	----	0.0%	----
	8/27/2012	33	0	1	0	5.1%	5.2%	5.1%	5.2%
	8/28/2012	70	0	0	1	0.0%	----	23.8%	23.8%
	9/17/2012	28	0	0	0	0.0%	----	357.3%	37.9%
	9/18/2012	12	0	0	1	0.0%	----	13.2%	13.4%
	10/15/2012	54	0	0	0	0.0%	----	0.0%	----
		484	0	9	4	4.4%	1.9%	10.3%	3.0%
Blue Bridge to Asotin	4/23/2012	2	0	0	0	0.0%	----	0.0%	----
	5/16/2012	12	0	2	0	59.5%	40.0%	59.5%	40.0%
	6/4/2012	4	0	0	0	0.0%	----	0.0%	----
	6/5/2012	13	0	1	0	27.5%	27.3%	27.5%	27.3%
	6/6/2012	46	2	4	1	23.3%	13.6%	23.3%	13.6%
	6/25/2012	61	2	4	3	17.6%	10.3%	29.3%	13.3%
	7/18/2012	24	1	1	0	14.9%	15.1%	14.9%	15.1%
	Section Totals	162	5	12	4	22.1%	7.3%	26.5%	8.1%
Asotin to Heller Bar	5/7/2012	9	0	1	1	39.7%	38.7%	79.4%	51.6%
	5/21/2012	2	0	0	0	0.0%	----	0.0%	----
	6/6/2012	11	1	1	0	32.5%	32.0%	32.5%	32.0%
	6/20/2012	32	1	2	2	11.2%	11.4%	33.5%	19.2%
	7/2/2012	14	0	0	0	0.0%	----	0.0%	----
	7/5/2012	29	1	0	0	0.0%	----	0.0%	----
	10/9/2012	22	0	0	0	0.0%	----	0.0%	----
	10/10/2012	14	1	0	1	0.0%	----	16.2%	16.4%
	10/25/2012	50	2	1	1	25.5%	25.4%	51.0%	34.8%
	Section Totals	183	6	5	5	7.8%	4.1%	17.6%	6.2%
Heller Bar to Salmon River	4/23/2012	13	0	0	0	0.0%	----	0.0%	----
	4/25/2012	2	0	0	0	0.0%	----	0.0%	----
	5/8/2012	8	1	0	0	0.0%	----	0.0%	----
	5/22/2012	5	0	0	0	0.0%	----	0.0%	----
	6/5/2012	13	0	1	0	27.5%	27.3%	27.5%	27.3%
	6/18/2012	20	1	1	0	17.9%	18.0%	17.9%	18.0%
	7/3/2012	14	1	1	0	25.5%	25.4%	25.5%	25.4%
	10/9/2012	22	1	0	1	0.0%	----	27.5%	27.3%
	10/11/2012	28	1	0	0	0.0%	----	0.0%	----
	10/12/2012	34	2	1	3	12.8%	12.9%	51.0%	24.9%
	10/22/2012	40	1	2	0	21.0%	15.0%	21.0%	15.0%
	10/24/2012	47	2	3	2	26.8%	15.6%	44.7%	19.8%
	Section Totals	246	10	9	6	13.1%	4.6%	21.8%	6.1%
Vanpool to Sheep Creek	4/26/2012	22	1	1	2	16.2%	16.4%	48.7%	27.4%
	5/9/2012	48	2	1	0	7.4%	7.6%	7.4%	7.6%
	5/10/2012	31	1	0	1	0.0%	----	0.0%	----
	5/24/2012	15	1	0	0	0.0%	----	0.0%	----
	6/7/2012	69	2	1	1	5.2%	5.3%	5.2%	5.3%
	6/8/2012	72	3	1	0	5.0%	5.1%	5.0%	5.1%
	6/21/2012	77	4	1	0	4.6%	4.8%	4.6%	4.8%
	7/6/2012	65	3	0	0	0.0%	----	0.0%	----
	10/9/2012	203	8	3	5	16.5%	9.7%	44.0%	15.7%
	10/10/2012	125	5	1	5	0.0%	----	8.8%	4.1%
	10/11/2012	105	4	0	0	0.0%	----	2.9%	2.9%
	10/22/2012	207	9	2	3	3.4%	3.5%	20.4%	8.6%
	10/23/2012	160	6	4	4	1.7%	1.8%	6.9%	3.6%
	10/24/2012	74	4	3	0	14.5%	8.6%	14.5%	8.6%
	Section Totals	1,273	53	18	21	3.6%	1.1%	9.5%	1.9%
GRAND TOTALS		2,355	74	54	40	6.5%	1.2%	12.9%	2.0%

Table 3. Angler exploitation rates (harvest), and total use (fish harvested plus fish released) of Smallmouth Bass tagged in the Snake River, Idaho, in 2013.

Location	Tagging Date	Tags Released: Non Reward	Tags Released: $50 Reward	Disposition: Harvested	Disposition: Released	Adjusted exploitation: Estimate	Adjusted exploitation: 90% C.I.	Adjusted total use: Estimate	Adjusted total use: 90% C.I.
Port of Wilma to Blue Bridge	5/1/2013	34		1	1	13.1%	10.7%	26.1%	15.0%
	5/2/2013	108		2	1	8.2%	4.8%	12.3%	5.9%
	5/15/2013	131		2	2	6.8%	4.0%	13.6%	5.6%
	5/16/2013	18		1		24.7%	19.9%	24.7%	19.9%
	5/28/2013	1				0.0%	----	0.0%	----
	5/29/2013	59			1	0.0%	----	7.5%	6.2%
	5/30/2013	143		2	1	3.1%	2.6%	9.3%	4.5%
	6/10/2013	83			1	0.0%	----	5.3%	4.4%
	6/12/2013	72		1	1	6.2%	5.1%	12.3%	7.2%
	6/13/2013	97		1	3	0.0%	----	18.3%	7.5%
	6/24/2013	112		3	1	11.9%	5.7%	15.9%	6.6%
	6/25/2013	15				0.0%	----	0.0%	----
	6/26/2013	10				0.0%	----	0.0%	----
	7/8/2013	12				0.0%	----	0.0%	----
	7/9/2013	108		2	1	8.2%	4.8%	12.3%	5.9%
	7/10/2013	31			1	0.0%	----	14.3%	11.7%
	7/29/2013	62		2		14.3%	8.3%	14.3%	8.3%
	7/30/2013	54			1	0.0%	----	8.2%	6.8%
	7/31/2013	88				0.0%	----	0.0%	----
	8/19/2013	59				0.0%	----	0.0%	----
	8/20/2013	43				0.0%	----	0.0%	----
	9/9/2013	59				0.0%	----	0.0%	----
	9/10/2013	36				0.0%	----	0.0%	----
	Section Totals	1,435	0	17	15	4.6%	1.1%	9.9%	1.7%
Blue Bridge to Asotin	4/30/2013	25	1	3	1	0.0%	----	53.3%	24.3%
	5/2/2013	7				0.0%	----	0.0%	----
	5/13/2013	71		4		25.0%	10.3%	25.0%	10.3%
	5/14/2013	112		2	2	4.0%	3.3%	15.9%	6.6%
	5/16/2013	31			1	0.0%	----	14.3%	11.7%
	5/28/2013	129		5	4	10.3%	5.0%	31.0%	8.6%
	5/29/2013	17			1	0.0%	----	26.1%	21.1%
	5/30/2013	50		1	2	8.9%	7.3%	26.6%	12.5%
	6/10/2013	57		1	1	7.8%	6.4%	15.6%	9.0%
	6/11/2013	110		7	1	27.3%	8.5%	31.2%	9.2%
	6/12/2013	17		1		26.1%	21.1%	26.1%	21.1%
	6/24/2013	35		1	1	12.7%	10.4%	25.4%	14.6%
	6/26/2013	11				0.0%	----	0.0%	----
	7/8/2013	2				0.0%	----	0.0%	----
	Section Totals	674	1	25	14	12.5%	2.6%	25.0%	3.9%
Asotin to Heller Bar	4/23/2013	8	1	1		0.0%	----	0.0%	----
	4/26/2013	29	1	2	1	30.6%	17.5%	45.9%	21.1%
	5/7/2013	18		1	1	26.1%	21.1%	52.2%	29.0%
	5/10/2013	67		3	1	13.3%	7.7%	26.5%	10.9%
	5/20/2013	114		2	3	7.8%	4.6%	19.5%	7.2%
	5/24/2013	53		1	1	8.4%	6.9%	16.8%	9.7%
	6/4/2013	154		8	1	20.2%	6.4%	25.9%	7.3%
	6/19/2013	68		2		13.3%	7.7%	13.3%	7.7%
	6/21/2013	42		2	1	11.4%	9.3%	34.1%	15.9%
	7/1/2013	64		1		6.9%	5.7%	6.9%	5.7%
	Section Totals	617	2	23	9	13.7%	2.8%	22.3%	3.7%
Heller Bar to Salmon River	4/22/2013	58	2	2	3	15.3%	8.9%	38.3%	13.9%
	5/6/2013	71	3	2		12.5%	7.3%	12.5%	7.3%
	5/7/2013		1	1		----	----	----	----
	5/21/2013	23			1	0.0%	----	19.3%	15.7%
	5/22/2013	28				0.0%	----	0.0%	----
	6/3/2013	47				0.0%	----	0.0%	----
	6/5/2013	86		2	2	10.3%	6.0%	20.6%	8.5%
	6/18/2013	44		2	1	20.2%	11.7%	30.3%	14.2%
	7/2/2013	25		1		0.0%	----	17.8%	14.5%
	Section Totals	382	6	10	7	9.3%	2.8%	18.6%	4.1%
Vanpool to Sheep Creek	4/8/2013	73	2	1	1	6.1%	5.0%	12.2%	7.1%
	4/9/2013	26	1		1	0.0%	----	17.1%	13.9%
	4/24/2013	155	6	3	4	8.6%	4.1%	20.0%	6.4%
	4/25/2013	80	3	4	1	16.6%	7.9%	22.2%	9.1%
	5/8/2013	186	3		3	0.0%	----	7.2%	3.4%
	5/9/2013	102		2	2	4.4%	3.6%	17.4%	7.2%
	5/23/2013	63			1	0.0%	----	7.0%	5.8%
	6/5/2013	54		1		8.2%	6.8%	8.2%	6.8%
	6/6/2013	106			2	0.0%	----	8.4%	4.9%
	6/20/2013	130		1	3	3.4%	2.8%	13.7%	5.7%
	Section Totals	975	15	12	18	4.6%	1.2%	13.2%	2.3%
GRAND TOTALS		4,083	24	87	63	7.7%	1.0%	15.9%	1.7%

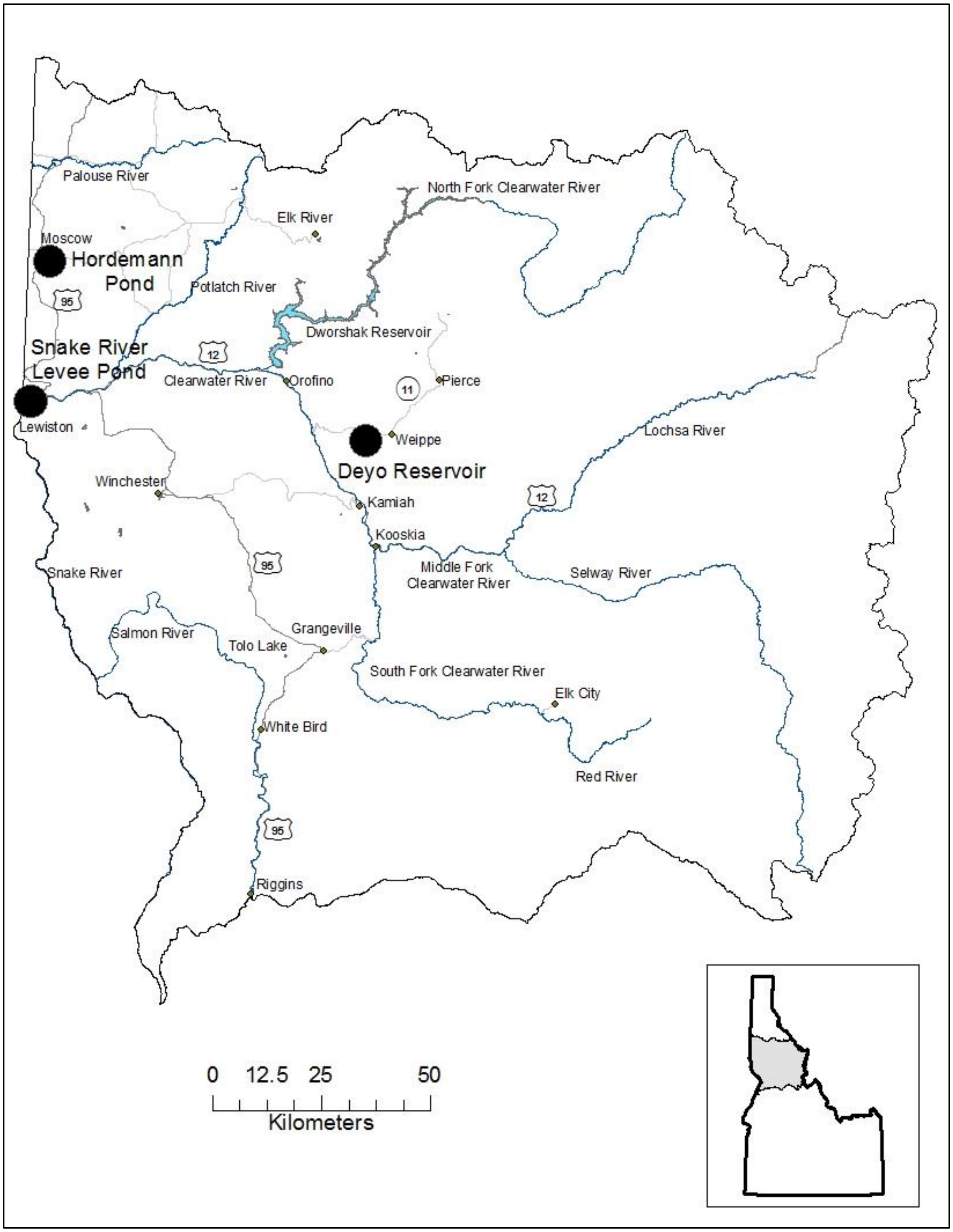

Figure 1. Map showing fish stocking locations at the Snake River Levee Pond, Hordemann Pond, and Deyo Reservoir in Idaho, where angler exploitation studies were conducted in 2013.

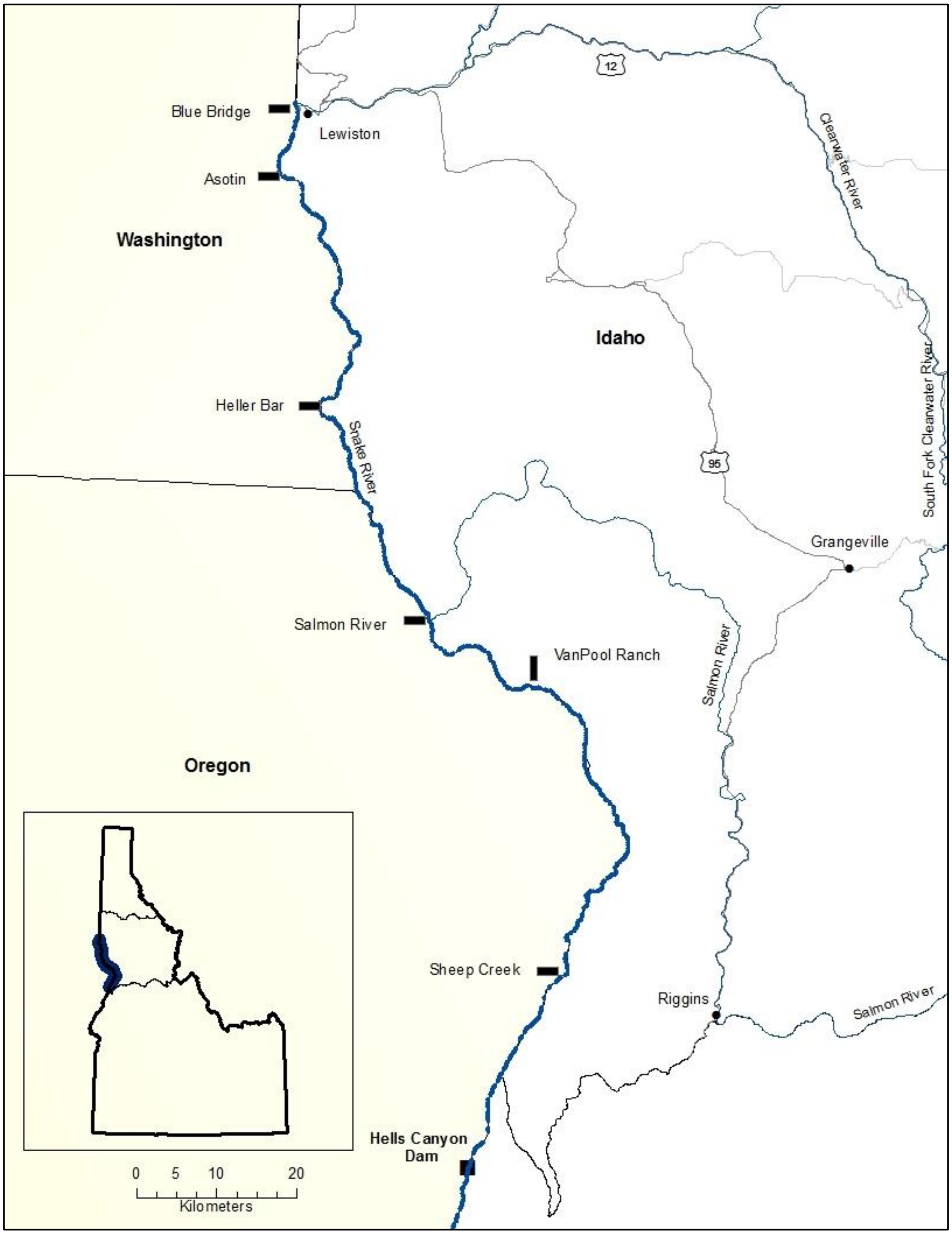

Figure 2. Snake River reach locations where harvest and total use (harvest plus fish released) were estimated for Smallmouth Bass tagged in 2012 and 2013.

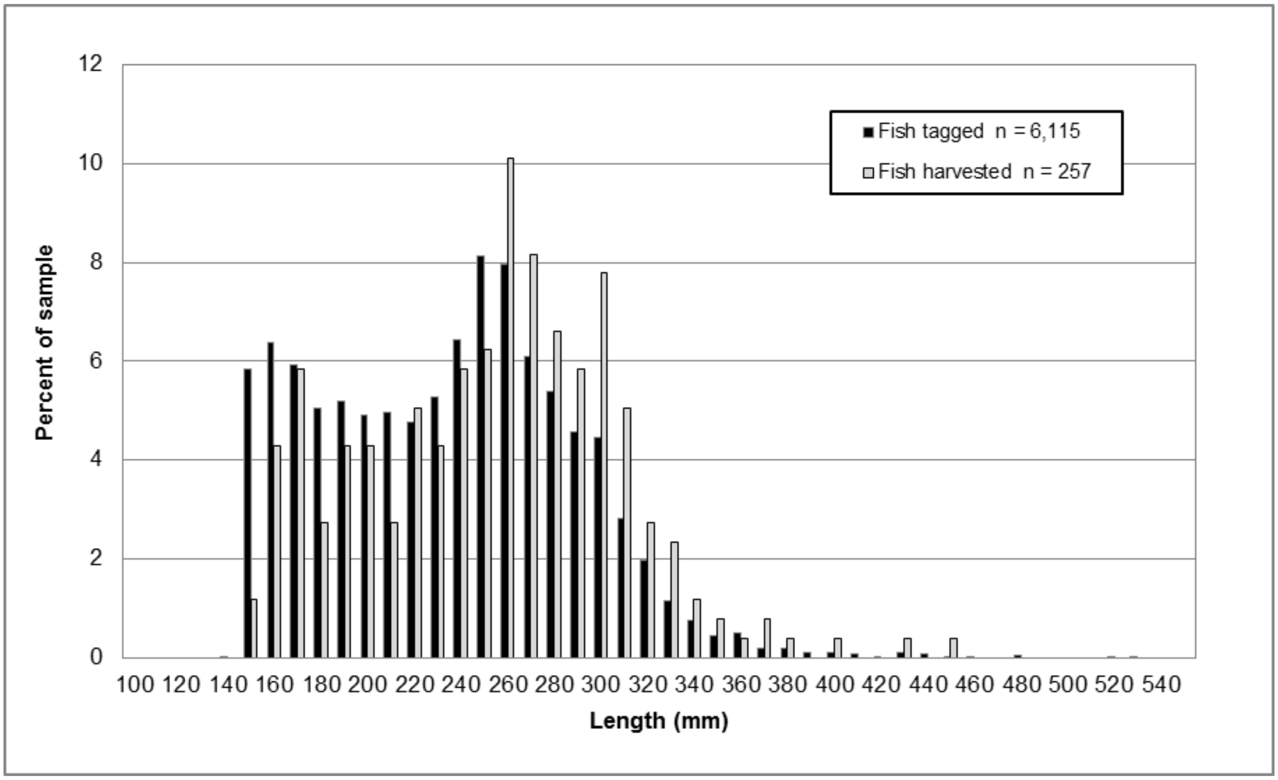

Figure 3. Length frequency distributions of Smallmouth Bass tagged to estimate angler exploitation in the Snake River (2012-2013) and tagged Smallmouth Bass that were caught (and tags returned) by anglers.

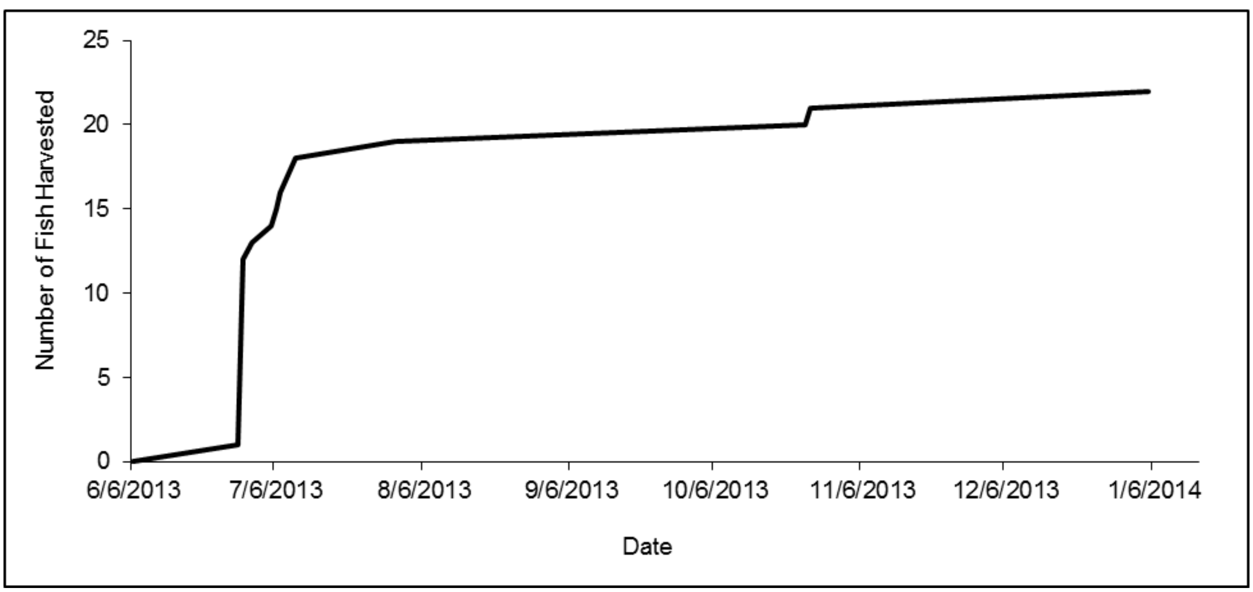

Figure 4. Cumulative number of tagged hatchery catchable Rainbow Trout caught from Deyo Reservoir, Idaho, from June 6, 2013 stocking, based on angler exploitation surveys (299 fish tagged).

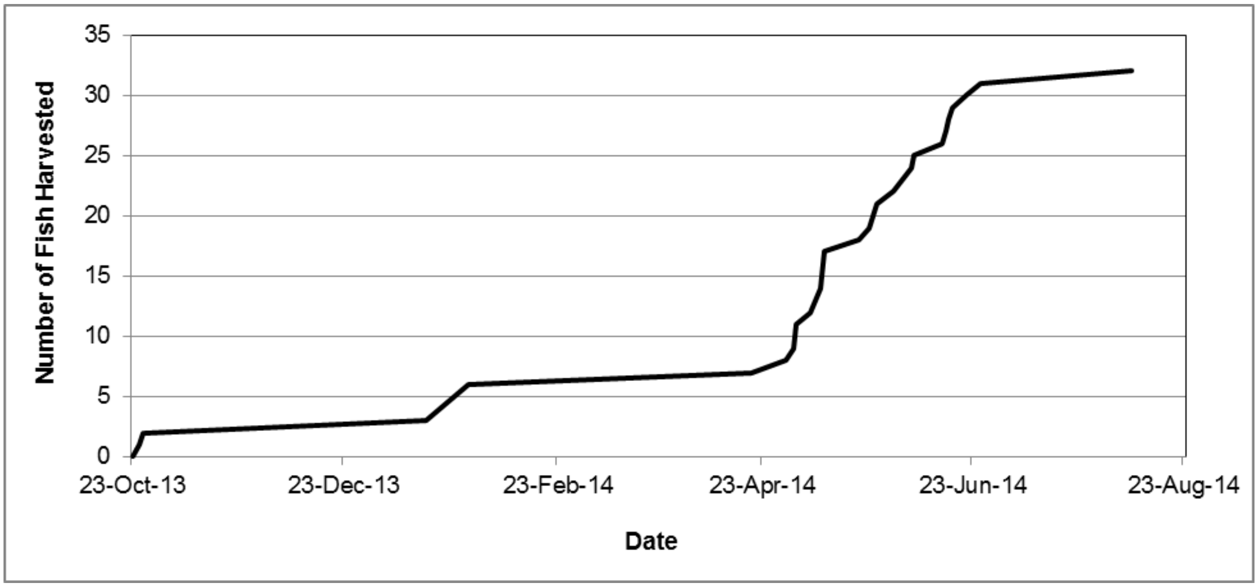

Figure 5. Cumulative number of tagged hatchery catchable Rainbow Trout caught from Deyo Reservoir, Idaho, from October 23, 2013 stocking, based on angler exploitation surveys (299 fish tagged).

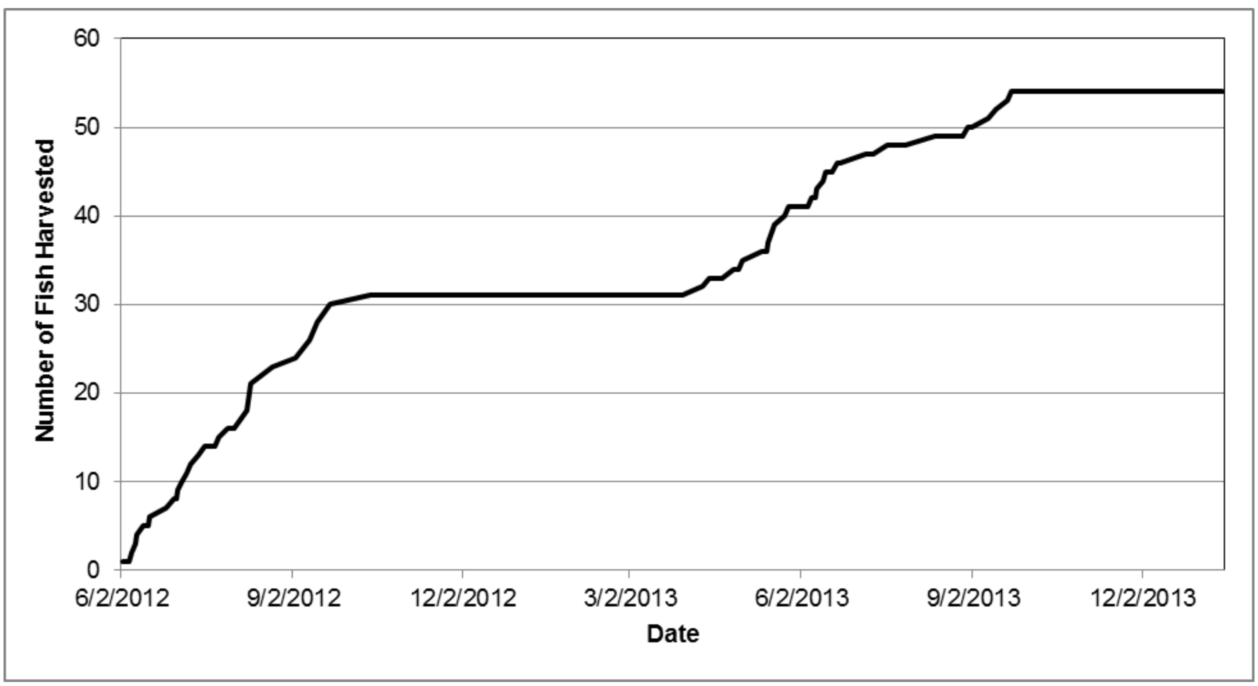

Figure 6. Cumulative number of tagged Smallmouth Bass harvested from the Snake River, Idaho, from 2012 angler exploitation surveys based on tag returns reported through January 30, 2014 (2,429 fish tagged).

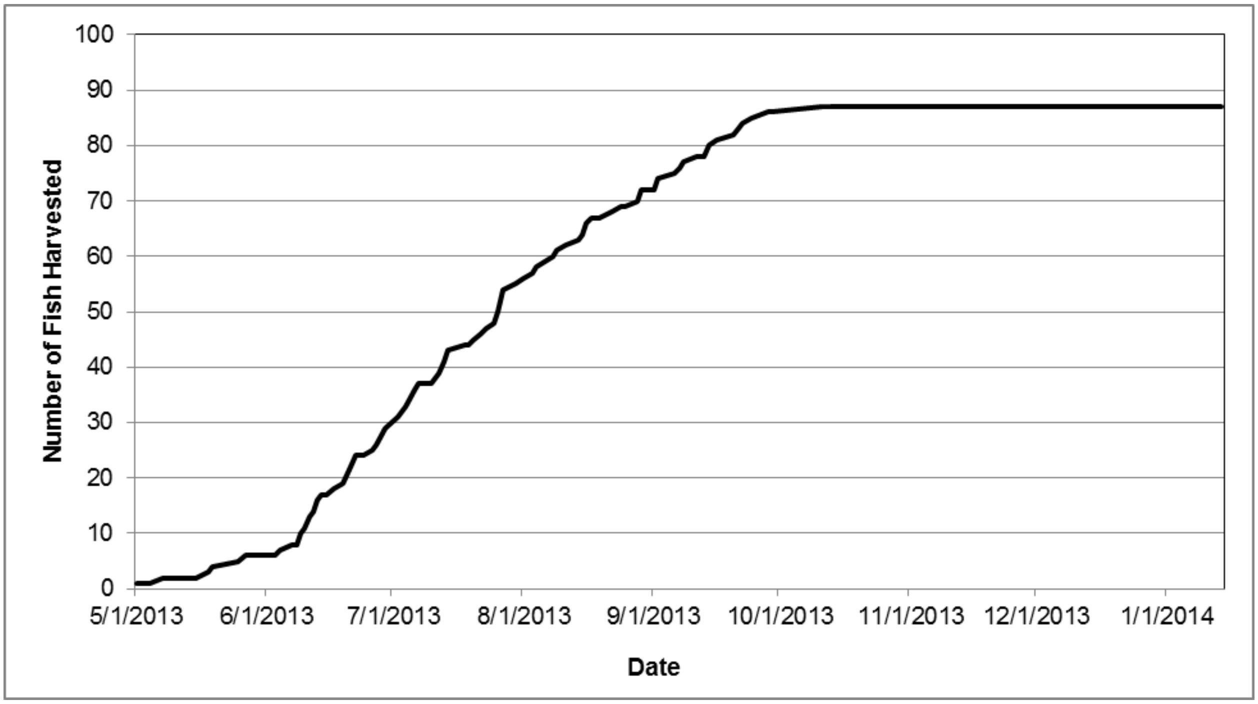

Figure 7. Cumulative number of tagged Smallmouth Bass harvested from the Snake River, Idaho, from 2013 angler exploitation surveys. Based on tag returns reported through January 30, 2014 (4,107 fish tagged).

LOWLAND RESERVOIR AND POND INVESTIGATIONS

ABSTRACT

During 2013, the zooplankton community in Deyo Reservoir was generally dominated by Cyclopoida and Bosmina. Larger taxa (Daphnia and Cyclopoida) averaged <1.3 mm through the sampling period, the minimum length indicated as preferred size for *Oncorhynchus* species. A notable drop in abundance and size of Daphnia occurred after stocking over 19,000 Rainbow Trout in June for the grand opening of this fishery. Future stockings of Rainbow Trout should not occur at such high densities to avoid depleting this important food source.

Idaho Fish and Game renovated Soldier's Meadow Reservoir on November 7th, 2013 using the piscicide rotenone. The purpose of this renovation was to remove stunted populations of Black Bullhead, Yellow Perch, and Black Crappie which were illegally introduced over the last decade. These fish had overpopulated the reservoir, resulting in many small fish. A total of 1,464.8 L of rotenone was applied to the reservoir and its tributary streams. Rotenone concentrations remained above lethal level (above 2.0 ppm) for a period of 43 days. Due to the extended period of lethal rotenone levels, 100% mortality of all fish was expected.

We conducted a creel survey in 2013 on Campbell's Pond, to collect information on angler effort, catch, and harvest. Angler surveys were conducted from May 23rd to November 27th, 2013. A total of 2,258 instantaneous angler counts were conducted by remote camera during the creel survey, resulting in an estimated total angler effort of 2,759 hours. Anglers caught an estimated 7,661 fish, including 7,120 hatchery Rainbow Trout, 301 Bluegill, and 240 Largemouth Bass. The catch rate for all fish combined was 3.7 fish/hour. Assuming bias rates of self-report cards are similar at Campbell's Pond, the corrected estimate is 5,624 Rainbow Trout caught during the creel survey. This results in a corrected exploitation rate of 86.5% for the creel survey.

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INTRODUCTION

Idaho's Clearwater Region has a substantial diversity of fishing opportunities. However, many of these fisheries are restrictive in nature: large rivers with anadromous fisheries, high elevation rivers and streams managed with restrictive regulations to manage wild cutthroat trout populations, and mountain lakes with difficult access. Because of these restrictive regulations and access, the region's lowland lake program has been designed and managed to provide additional fishing and harvest opportunities with easy access. Managing these reservoirs and ponds is a priority for the Clearwater Region fisheries staff.

With this in mind, the Idaho Department of Fish and Game (IDFG), in conjunction with support from local communities, constructed a 22.3 ha reservoir on Schmidt Creek near Weippe, Idaho in 2012. Named Deyo Reservoir, its purpose was to provide a new recreational fishery and aboost to the local economy with minimal negative biological impacts (DuPont 2011). The proposed fishery management strategy for this reservoir was to provide a "two-story" fishery, with both cold and warm-water species. In 2012, largemouth bass *Micropterus salmoides* and Bluegill *Lepomis macrochirus* were stocked into Deyo Reservoir to provide a self-sustaining warm water fishery. In 2013, the year this reservoir was first opened to public use, sterile catchable Rainbow Trout were stocked to provide a "put-and-take" fishery. In order to properly manage this new fishery, limnology, zooplankton, and fish populations need to be monitored.

Creel surveys conducted by IDFG personnel from 1993 to 2012 indicated that angler effort and the fishery in Soldier's Meadow Reservoir (SMR) have been in a state of decline. The results of an angler opinion survey in 2012 (Hand et al. In Review) showed that the majority of anglers supported IDFG taking action to renovate the reservoir. As such, SMR was renovated with Rotenone on November 7th, 2013. A total of 1,590 L of rotenone was applied at a rate of 2.0 ppm to remove stunted populations of Black Crappie, Black Bullhead, and Yellow Perch. The project was conducted in November when the reservoir was at its lowest level. This allowed us to reduce the quantity of rotenone needed for the treatment by 1,940 gallons (82.2%). It also provided a safety margin in the event of substantial rainfall, which if the reservoir was full, would cause the treated water to exit the reservoir, potentially killing fish downstream.

This renovation project presented us with the unique opportunity of allowing the public to determine the management direction of SMR, with our guidance. Our ability to allow the public make this decision was based upon SMR's proximity to several other lowland reservoirs that already provide a variety of angling opportunities. Angler input was solicited through a public meeting and several email surveys. The public meeting provided attendees with detailed information about the reservoir, the fish populations that had been there, and realistic expectations for various species and options for the future. A survey was also emailed to a large list of anglers who have signed up to receive periodic communications regarding regional fisheries information. After several rounds of surveys, it became clear that a put-grow-take kokanee fishery was the most preferred option. Fingerling kokanee were stocked in Soldier's Meadow Reservoir in spring 2014. Some catchable size Rainbow Trout have also been stocked to provide an additional fishing opportunity.

Campbell's Pond is an important recreational destination for the numerous small communities located between Orofino and Pierce, Idaho. With a small campground, the facility supports both day and overnight use for anglers, hunters, and other outdoor enthusiasts. We have never conducted any surveys to determine the angler effort, catch, or harvest at this pond. Due to its popularity, this information would be beneficial to future management of the fishery.

OBJECTIVES

1. Survey zooplankton in Deyo Reservoir to track changes in population as the new fishery is developed.

2. Renovate Soldier’s Meadow Reservoir with rotenone to eliminate Black Crappie, Yellow Perch, and Black Bullhead.

3. Survey zooplankton in Soldier’s Meadow Reservoir to track pre- and post-rotenone abundance and species composition.

4. Evaluate angler effort and catch in Campbell’s Pond utilizing trail cameras and angler self-report cards.

STUDY AREA

Deyo Reservoir is located approximately 5 km west of Weippe, Idaho, at an elevation of 920 m (Figure 1). It is a 22.3 ha reservoir created by the damming of Schmidt Creek, a tributary to Lolo Creek, Idaho. Deyo Reservoir has a maximum depth of approximately 10 m, a mean depth of approximately 5 m, and a volume of approximately 550 acre/ft. The upper end of the reservoir was developed into a wetland area to provide habitat for waterfowl and other wildlife. The drainage basin is composed of a mix of forest and cropland. Facilities at the reservoir include a campground with both full hookups and primitive sites, numerous fishing docks (including ADA accessible), a boat ramp, a picnic pavilion, and three CXT outhouses.

Soldier’s Meadow Reservoir is located approximately 45 km southeast of Lewiston Idaho, and 10 km west of Winchester, Idaho (Figure 8). It is a 47.8 hectare reservoir with a mean depth of 5.6 meters and a maximum depth of 14.0 meters, and lies at an elevation of 1,378 meters. Facilities at this reservoir include primitive camping, a boat ramp, and a CXT outhouse.Soldier’s Meadow Reservoir was constructed for the Lewiston Orchards Irrigation District (LOID) to retain water for irrigation purposes. Its primary water supply is from Webb and Captain John creeks. Water level fluctuations on an annual basis are commonplace. Severe water reductions usually begin by late June or early July as water is discharged for storage in Mann Lake. Low pool generally occurs during late fall towards the end of the irrigation season. Severity and timing of water level fluctuations is dependent on water yield in the LOID-managed watershed and irrigation demand. The timing of annual variations in water level can have major effects on the spawning success of warm-water species. Also, low pool levels through the winter have a negative effect on carrying capacity.

Campbell’s Pond is located approximately 10 km northwest of Pierce, Idaho (Figure 8). It is an approximately 4.1 ha pond. Facilities at the pond include camping, a boat ramp, picnic tables, an ADA accessible fishing dock, and three outhouses.

METHODS

Limnology Sampling

Limnology sampling was conducted in Deyo Reservoir and Soldiers Meadow Reservoir and consisted of collecting monthly dissolved oxygen (DO) and temperature profiles. This occurred from April through December on Deyo Reservoir and August through December on Soldiers Meadow Reservoir. Dissolved oxygen and temperature profiles were taken from a boat with a YSI model 550A meter at the surface and 1 m increments down to the bottom of the lake. The boat was kept stationary in the deepest part of the lake while measurements were taken. Temperature was recorded in ˚C, and dissolved oxygen in mg/L.

Zooplankton Sampling

Monthly zooplankton sampling was conducted on Deyo Reservoir from May - December, and Soldier's Meadow Reservoir from August - December during the 2013 field season. Samples were collected with a Wisconsin style plankton net (80 micron mesh, 30 cm diameter mouth). The boat was anchored at the deepest location on each lake based upon bathymetric maps and depth finder readings. When anchoring the boat, the anchor was slowly dropped and slack in the anchor line was let out to let the boat drift away from the anchor location. Three vertical tows were taken from that location. Tows were started 1m above the bottom of the lake to avoid disturbing sediment. Depth of tow was recorded on each sample jar. Samples were rinsed into sample jars and stored in 70% ethyl alcohol. A Rite-in-the-Rain label was placed inside the sample jar. Samples were labeled with date, reservoir, number of tows, depth of tow, and personnel present.

In the laboratory, zooplankton samples were diluted into a known volume container (typically 100 ml) and 5 ml aliquots were then subsampled. Subsamples were counted until 200 of the most dominate family were observed. The density of zooplankton in each individual tow was then estimated expanding the subsample estimate by total volume to the tow. Tow volume (π) was calculated by:

$$\pi \cdot r^2 \ x \ h$$

where r = radius of the net and h = depth of tow.

Zooplankton were counted based on two categories, cladoceran (Ceriodaphnia, Diaphanasoma, and Daphnia) and copepods (Cyclopoids and Calanoids). All zooplankton within these groups were enumerated within the sample. In addition, the first 30/sample cladocerans and/or most abundant zooplanktor in the sample were measured under the dissecting microscope to establish a length distribution for the sample.

Soldier's Meadow Reservoir Rotenone Application

A chemical treatment was conducted on Soldier's Meadow Reservoir using the piscicide rotenone. Standard rotenone project procedures were followed for planning, safety, and application (Horton 1997; Finlayson et al. 2000; Finlayson et al. 2010).

Treatment of Soldiers Reservoir occurred on November 7, 2013 after it was drawn down to meet downstream irrigation and minimum stream flow needs. This draw down reduced the full pool volume of Soldiers Meadow Reservoir from 2,360 acre/ft to 420 acre/ft (82% reduction). With the reservoir drawn down, no surface water flow occurred out of the reservoir, allowing us to let the rotenone neutralize naturally which typically takes 4 to 6 weeks. The lake was determined to be naturally detoxified when caged hatchery Rainbow Trout had 100% survival for 24 hours. Fish were tested on December 20, 2103.

A treatment dose of 2.0 ppm rotenone was applied to the lake. The reservoir was treated using several methods: drip stations applied rotenone to the reservoir's tributaries; Venturi pump outfitted boats applied rotenone to all surface area accessible; a deep application boat applied rotenone to the deepest regions of the lake. Dead fish were not removed from the reservoir.

Some water seepage occurred through the dam and drain pipe of Soldier's Meadow Reservoir. As such, a detoxification station was set up immediately downstream of the dam to treat this water and to prevent downstream fish kills. Potassium permanganate was mixed in a 1,135 L tank at a 2.5% solution for detoxification. This solution was released to achieve a 5 ppm potassium permanganate level in the seepage occurring from the reservoir. This continued until it was determined that rotenone in the lake had naturally detoxified.

Angler Survey

Angler effort, catch and harvest were evaluated at Campbell's Pond from May 23 - November 29, 2013. Due to its remoteness, Campbell's Pond was surveyed with digital trail cameras and angler report cards instead of traditional in-person interviews and angler counts. Sampling intervals were a calendar month (November and December were combined).

Two Moultrie® GameSpyi60 digital game cameras were utilized to conduct angler counts. One was placed across the pond from the main access point and positioned to cover the boat ramp and the two docks, and the lower half of the pond. The second camera was placed at the boat ramp pointing towards the upper end of the pond to cover several popular shore fishing locations and the upper half of the pond. The cameras were programmed to take a picture every hour to estimate use at that time. An estimated angler count was produced by counting the number of anglers in each photo. Angler survey cards and on-site return boxes were used to collect completed trip interviews (Hand et al. In review).

Angler effort (e_i), for a fishing period (i) was estimated as:

$$e_i = I_i * T$$

where I_i is the instantaneous count of anglers multiplied by the length of the fishing period (T). Total effort (E) for a survey period is calculated by expansion:

$$E = \sum_{i=1}^{n} (\frac{e_i}{\pi_i})$$

where π_i is the total probability that fishing period (i) is included in the sample. Standard errors (SE) for effort estimates were calculated as:

$$SE(E) = \sqrt{(Var(E_1) + (Var(E_2)}$$

E_1 and E_2 represent effort from weekdays and weekends respectively. Full equations for calculating variance of angler effort are listed in Pollack et al. (1994).

Angler catch was estimated as:

$$C = E * R_1$$

The catch rate calculated from complete trips (R_1), is calculated as:

$$R_1 = \frac{\sum_{i=1}^{n} c_i}{\sum_{i=1}^{n} L_i}$$

This is the sum of the catches (c_i) divided by the sum of the trip lengths (L_i). Standard errors for effort estimates were calculated as:

$$SE(E) = \sqrt{(Var(C_1) + (Var(C_2)}$$

C_1 and C_2 represent catch from weekdays and weekends respectively. Full equations for calculating variance of angler catch are listed in Pollack et al. (1994).

RESULTS

Deyo Reservoir

Limnology

Limnology samples were collected from April - December, 2013. Dissolved oxygen and temperature levels changed throughout the year. However, dissolved oxygen profiles from April - October were very homogenous, with typical anoxic conditions present in the hypolimnion (Figure 9). Monthly temperature measurements showed very similar patterns to the DO measurements (Figure 9). Temperatures >21°C and DO levels <5.0 mg/L are considered stressful to fish and can result in reduced survival. During July and August, water temperatures were >21°C down to a depth of 3 m, and DO at this time was <5.0 mg/L below 1 m in depth. Using these metrics, no water in Deyo Reservoir was conducive for Rainbow Trout survival (Figure 9). However, utilizing an upper thermal limit of 25°C would result in some of the water column being conducive for Rainbow Trout survival (Figure 9). In November and December, most of the water column had a DO concentration >5.0 mg/L.

Zooplankton

Zooplankton samples were collected in Deyo Reservoir monthly from May - December, 2013. The zooplankton population was composed of five taxa: Chydoridae, Daphnia, Cyclopoida, Bosmina, and Calanoida. Zooplankton composition and density changed substantially throughout the sampling period, with Daphnia the most abundant taxa in May and late September, Cyclopoida the most abundant in June, early September, and December, and Bosmina the most abundant in July, August, and November (Figure 10,
Figure 11). Peak zooplankton densities occurred in late July due to the proliferation of Bosmina (
Figure 11). A noticeable decline in Daphnia density occurred during the month of June (
Figure 11). This correlated with the stocking of over 19,000 catchable Rainbow Trout on June 6 for the grand opening of Deyo Reservoir.

Average lengths of Daphnia ranged from 0.5 - 1.0 mm, and Cyclopoida from 0.4 - 0.6 mm (Figure 12). Length frequency distributions from each sample found that Daphnia >1.3 mm in length ranged from 0.0 to 7.8% of the individuals collected (Figure 13). Length frequency distributions from each sample show that no Cyclopoids >1.3 mm in length were found in any samples collected in 2013 (Figure 14). Average lengths of Daphina dropped from about 1 mm to 0.5 mm in length from June 15 to June 25 and then remain at this smaller size through the rest of the year (Figure 12). This initial drop in zooplankton size correlated with when over 19,000 catchable Rainbow Trout were stocked on June 6 for the grand opening of Deyo Reservoir.

Soldier's Meadow Reservoir

Limnology

Limnology samples were collected from August - December, 2013. Temperatures >21°C and DO levels <5.0 mg/L are considered stressful to fish and can result in reduced survival. During August, very little of the reservoir was conducive for kokanee or Rainbow Trout survival with water temperatures >21°C down to a depth of 3 m, and DO at this time was <5.0 mg/L below 4 m in depth (Figure 15). Fall turnover in mid-September resulted in a condition in which the entire water column had a DO concentration <5.0 mg/L. Thus, no water in SMR was conducive for kokanee or Rainbow Trout survival from mid-September through at least the early October sample (Figure 15). Oxygen levels returned to >5.0mg/L by the November sample.

Zooplankton

Zooplankton samples were collected in SMR monthly from August to December, 2013. The zooplankton population was composed of six taxa: Chydoridae, Daphnia, Cyclopoida, Ceriodaphnia, Bosmina, and Calanoida. The composition was primarily Ceriodaphnia (46%) in August, Bosmina (60 - 72%) in September and October, Calanoida (46%) in November, and only Cyclopoida in December (Figure 16). Densities (# of individuals/m^3) were also highly variable ranging from 8 - 58,636/m^3 (Figure 17). The highest zooplankton densities were observed in August and declined steadily through December. Daphnia densities peaked in December, after Soldiers Meadow Reservoir was rotenoned on November 7.

Average lengths of Cyclopoida ranged from 0.56 - 0.73 mm (Figure 18). Length frequency distributions from each sample show that no Cyclopoids (Figure 19) or Daphnia (Figure 20) >1.3 mm in length were found in any samples collected in 2013. Since Daphnia were only collected during one sample (November 6th), an average length over time graph was not developed.

Rotenone Application

Soldier's Meadow Reservoir and its tributaries were treated on November 7th, 2013 with a total of 1,590 L of rotenone at a rate of 2.0 ppm to remove stunted populations of Black Crappie, Black Bullhead, and Yellow Perch. Shortly after treatment, numerous dead Black Crappie, Black Bullhead, and Yellow Perch were observed in the water. Most fish observed were less than 175 mm with exception of a few catchable Rainbow Trout and one Largemouth Bass. Dead fish were not removed to keep nutrients in the reservoir. A total of 1,200 L of a 5 ppm potassium permanganate solution was used to detoxify the water seeping out below the reservoir.

Caged hatchery Rainbow Trout were placed in Soldiers Meadow Reservoir on December 20, 2013. They showed a 100% survival after 24 hours. Based on these finding, it was determined that the reservoir had naturally detoxified and the drip station used to detoxify the seepage through the dam was discontinued 43 days after the rotenone treatment.

Campbell's Pond

Angler surveys were conducted on Campbell's Pond from May 23rd through November 27th, 2013. A total of 2,258 instantaneous angler counts were conducted by remote camera during the creel survey, resulting in an estimated total angler effort of 2,759 hours (SE ± 141; Table 3). Slightly more effort occurred on weekdays (50.5%) than weekends (49.5%). The highest angler effort occurred in June and July (Table 3).

Catch rate and harvest data for the 2012 creel survey on Campbell's Pond was based on 62 voluntary angler report cards. Anglers caught an estimated 7,661 fish, of which 7,120 (92.9%) were hatchery Rainbow Trout, 301 were Bluegill (3.9%), and 240 (3.1%) were Largemouth Bass. The catch rate for all fish combined was 3.7 fish/hour. The catch rates for individual species were 3.6 fish/hour for Rainbow Trout, <0.1 fish/hour for Bluegill, and <0.1 fish/hour for Largemouth Bass. Anglers harvested an estimated 4,068 fish, 53.1% of the fish caught. The overall harvest rate was 2.4 fish/hour. Harvest consisted of 3,987 (98.0%) hatchery Rainbow Trout and 81 (2.0%) Largemouth Bass. Ninety-three percent of the fishery at Campbell's Pond is supported by hatchery catchable size Rainbow Trout. With 6,500 hatchery catchable Rainbow Trout stocked into Campbell's Pond in 2013, the estimated return to creel was 110.0%.

DISCUSSION

Deyo Reservoir

During 2013, the zooplankton community in Deyo Reservoir was generally dominated by Cyclopoida and Bosmina. Daphnia were the predominant species in only the May and mid-September samples. A noticeable decline in Daphnia density and size occurred during the month of June. Densities dropped to near zero and average sized dropped from about 1.0 mm to 0.5 mm. These changes correlated with the stocking of over 19,000 catchable Rainbow Trout on June 6 for the grand opening of the reservoir.

Large sized zooplankton species, especially *Daphnia* sp., often compose a substantial portion of the diet of lake dwelling trout species (Galbraith 1967; Hyatt 1980; Eggers 1982; Schneidervin and Hubert 1987) and juvenile warm-water species (Chipps and Graeb 2010). This change in abundance and size of Daphnia we observed is concerning as it greatly limits food for not only the stocked Rainbow Trout but also the smaller Bluegill that occur in the reservoir. Although many things can influence Daphnia densities such as predators, water temperatures, and edible phytoplankton abundance, we believe this decline in density and size was due to this stocking event for several reasons. First, Deyo Reservoir is a new highly productive reservoir, which should promote the growth of edible phytoplankton for Daphnia to feed on. In fact, throughout the summer, when Daphnia size was suppressed, the reservoir had a green coloration to it indicating a high abundance of phytoplankton. Second, when the decline occurred, water temperatures were relatively stable. Third, the only other real predator in the lake were Bluegill. We first stocked about 300 - 400 Bluegill 75 - 175 mm in size in 2012.

Although the Bluegill reproduced successfully, we don't think that after one year that there were enough Bluegill to have this type of impact on Daphnia density and size. Finally, the decline in density and size occurred immediately after stocking the Rainbow Trout and the size of the Daphnia remained suppressed throughout the summer and fall.

Literature suggests that the size of Daphnia that trout prefer is > 1.3 mm (Galbraith 1975; Tabor et al. 1996; Wang 1996). What is interesting is we believe these trout drove the average size of Daphnia down to around 0.5 mm. In fact, from July through December, we measured very few Daphnia > 0.6 mm, well below the size of zooplankton preferred by trout. This indicates we stocked considerably more trout into this reservoir than it could support. The number of trout we stocked was unusually high for a reservoir of this size. This was a one-time occurrence to stimulate excitement for the grand opening of Deyo Reservoir. This is a good reminder that when stocking trout into lakes, one should consider how many fish the lake can support and how much harvest occurs. Multiple stocking events of fewer fish will likely have less of an effect on Daphnia density and abundance than one large stocking event.

High temperatures and low DO levels are often a concern for our lowland reservoir trout fisheries. Based on the IDFG standards for temperature and DO thresholds, the volume of water available for Rainbow Trout to survive was substantially reduced in July and August, 2013 (Figure 9). However, we believe there was still a suitable amount of habitat for trout to survive in this reservoir. Trout have been found to congregate in small areas during times when habitat is limited without having population level effects (Stevens and DuPont 2011).

An additional issue is the potential effects of fall turnover in reservoirs with a large anoxic hypolimnion. This is a concern for potential fall stockings of catchable trout in Deyo Reservoir, as fall turnover can reduce the dissolved oxygen levels of the reservoir to below the 5.0 mg/L needed for Rainbow Trout. While fall turnover did not completely eliminate usable habitat, DO levels did drop to levels very close to the 5.0 mg/L threshold (Figure 9). If fall stockings are considered in the future, they should be conducted after fall turnover to avoid potential fish kills.

Soldier's Meadow Reservoir

The results of creel surveys conducted since 1993 showed that angler effort and the quality of the fishery at Soldier's Meadow had steadily declined over the last 15 years (Hand et al. In Review). When asked about improvements to the reservoir, the majority of anglers (61.1%) surveyed during 2012 supported IDFG taking action to renovate the reservoir (Hand et al. In Review).

Rotenone is typically used to eliminate invasive or nuisance fish species. Black Bullhead have a rotenone tolerance level of approximately 0.25 - 1 ppm for 48 hours at 15°C (Orciari 1979). The level used to treat Soldier's Meadow Reservoir (2 ppm) was well above this tolerance level, which increased the likelihood of 100% mortality (Orciari 1979). Because we were able to allow the rotenone to detoxify naturally, we were able to maximize the amount of time the reservoir remained at lethal levels. When tested with caged trout 43 days after treatment, we found the reservoir had completely detoxified. Although dead fish were observed throughout the reservoir after treatment, the level of success will not be understood until future fish surveys occur.

Soldier's Meadow Reservoir has been managed as a two-story fishery, with both warm-water fish and hatchery Rainbow Trout. However, this renovation project presented us with the unique opportunity of allowing the public to determine the management direction with our guidance. Our ability to allow the public to make this decision was based upon SMR's proximity to several other lowland reservoirs that already provide a variety of angling opportunities. Angler input was solicited through a public meeting and several email surveys. The public meeting provided attendees with detailed information about the reservoir, the fish populations that had been there, and realistic expectations for various fish species. Many options were considered, including trout only, warm-water fish only, a combination of both, and kokanee. The public was then asked to select their preferred option. A survey was also emailed to a large list of anglers who have signed up to receive periodic communications regarding regional fisheries information. After several rounds of surveys, a put-grow-take Kokanee fishery was selected by the public as the preferred option. Fingerling kokanee will be stocked in the spring of 2014. Some catchable size Rainbow Trout will also be stocked to provide an additional fishing opportunity. An added benefit of this fishery is that due to the relatively short life cycle of kokanee (2-3 years), we will be able to quickly determine if it is successful. Additionally, if it is deemed unsuccessful, the short life cycle of these fish will allow us to implement a different fishery in a short time frame with minimal effort.

High temperatures and low DO levels are a concern for our lowland reservoir fisheries. Based on the IDFG standards for temperature and DO thresholds (Horton 1992), the volume of water available for kokanee and Rainbow Trout to survive in Soldier Meadow Reservoir was substantially reduced in August, 2013 (Figure 15). Even with this reduction, there was suitable habitat available for trout to survive through the summer. An additional issue is the potential effects of fall turnover in reservoirs with a large anoxic hypolimnion. This would be a concern for potential fall stocking of catchable trout in SMR, as fall turnover can reduce the dissolved oxygen levels of the reservoir to <5.0 mg/L needed for Rainbow Trout. This situation occurred during September and October of 2013, resulting in no water in SMR being conducive for kokanee or Rainbow Trout survival (Figure 15). This has now happened several times in recent years in SMR. To avoid potential fish kills, any fall stockings should be conducted once DO levels rise above 5.0mg/L after fall turnover.

Large sized zooplankton species, especially *Daphnia* sp., often compose a substantial portion of the diet of lake dwelling trout species (Galbraith 1967; Hyatt 1980; Eggers 1982; Schneidervin and Hubert 1987). The zooplankton community in SRM was dominated by smaller taxa such as Ceriodaphnia and Bosmina. Larger taxa (Daphnia and Cyclopoida) were not abundant and were considerably smaller than the >1.3 mm minimum length that literature indicates is the preferred size for *Oncorhynchus* species (Galbraith 1975; Tabor et al. 1996; Wang 1996). This was likely due to the high abundance of small Yellow Perch, Black Bullhead, and Black Crappie that occurred in this reservoir prior to the renovation.

Additional zooplankton surveys should be conducted post-renovation to compare community size/composition to pre-renovation metrics. This will provide some insight into the potential for successful fingerling stockings, and the effects of stunted fish populations on a zooplankton community. Without an improvement in the quantity of large zooplankton, it will be difficult to implement a successful fingerling Rainbow Trout or kokanee fishery. These fish need an adequate food source to survive and growth in the reservoir long enough (at least 1 - 2 years) to reach sizes desirable to anglers.

Campbell's Pond Creel Survey

The creel survey conducted in 2013 was the first ever for Campbell's Pond, and was intended to provide information on angler effort, catch, and harvest. From late November through mid-May the pond is generally not accessible due to snow blocking the access road. The 2,759 hours of effort was at the lower end of the range of 803 - 36,331 hours of effort estimated for regional lowland lakes in 2012 (Hand et al. In Review). However, on a per hectare basis, Campbell's Pond (673 hours/ha) had the fourth highest effort of the ten regional reservoirs/ponds surveyed (99 - 1,370 hours/ha) in 2012 - 2013.

Angler catch and harvest rates tend to be biased high because unsuccessful anglers are less likely to return a card (Carline 1972, Fraidenburg and Bargmann 1982, Pollack et al. 1994). In 2012, at seven regional reservoirs where both methods were utilized, catch rates and harvest rates for hatchery Rainbow Trout averaged 79% and 70% higher for self-report cards than what was estimated from creel surveys (Hand et al. In Review). We must be aware of this bias when using self-report cards to estimate catch and harvest at Campbell's Pond. Assuming the bias rates are similar at Campbell's Pond, we can correct the catch and harvest rates to provide more accurate estimates. Thus, the corrected estimates are 5,624 Rainbow Trout caught, and 2,790 harvested during the creel survey. This results in a corrected exploitation rate of 86.5% for the creel survey. This rate is well above the mean of 15.7% exploitation calculated for hatchery Rainbow Trout in Idaho reservoirs and ponds from 2006 - 2009 (Meyer et al. 2009), and the statewide average of 18.0% for reservoirs in 2011 (IDFG unpublished data). Additionally, it is above the IDFG management goal of a 40% angler catch rate for hatchery catchable Rainbow Trout. Thus, we recommend continuing the current stocking regime in Campbell's Pond. Additionally, we recommend utilizing the "Tag You're It" angler exploitation program to compare return rates between these two techniques.

MANAGEMENT RECOMMENDATIONS

1. Continue to monitor zooplankton in Deyo Reservoir as the warm-water fishery develops and Rainbow Trout stocking levels are adjusted.

2. Assess zooplankton and water quality in Soldier's Meadow Reservoir in 2014 for pre- and post-renovation comparisons.

3. Restock Soldier's Meadow Reservoir with kokanee and low numbers of catchable Rainbow Trout; utilize magnum size catchables if available.

4. Conduct kokanee evaluation of Soldier's Meadow Reservoir in fall 2014 to assess survival and growth.

5. Continue current stocking regime for hatchery catchable Rainbow Trout in Campbell's Pond.

6. Conduct evaluation of angler exploitation of hatchery catchable Rainbow Trout in Campbell's Pond utilizing "Tag You're It" program.

Table 3. Summary of angler effort (hours) as determined through a creel survey conducted on Campbell's Pond, Idaho, from May 23rd - November 27th, 2013.

Month	Total Weekday	Total Weekend	Total Effort	Standard Error	Percent Error
May	60	181	241	37	15.5
June	617	549	1,167	107	9.1
July	376	290	667	55	8.2
August	196	103	299	36	11.9
September	59	161	220	45	20.4
October	83	74	157	29	18.7
November	0	9	9	6	59.5
Totals	1,392	1,367	2,759	141	5.1

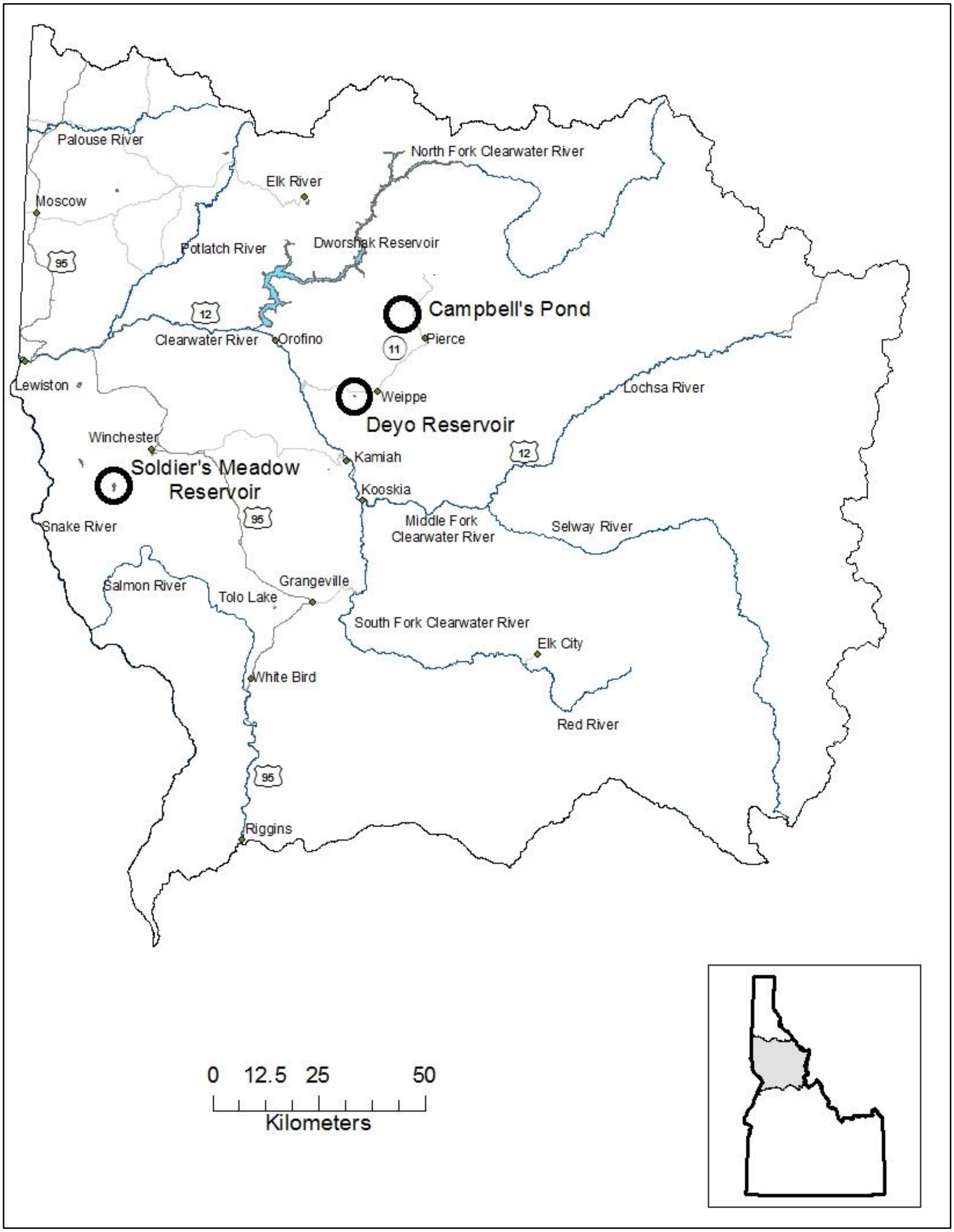

Figure 8. Map showing locations of Deyo Reservoir, Soldier's Meadow Reservoir, and Campbell's Pond, Idaho.

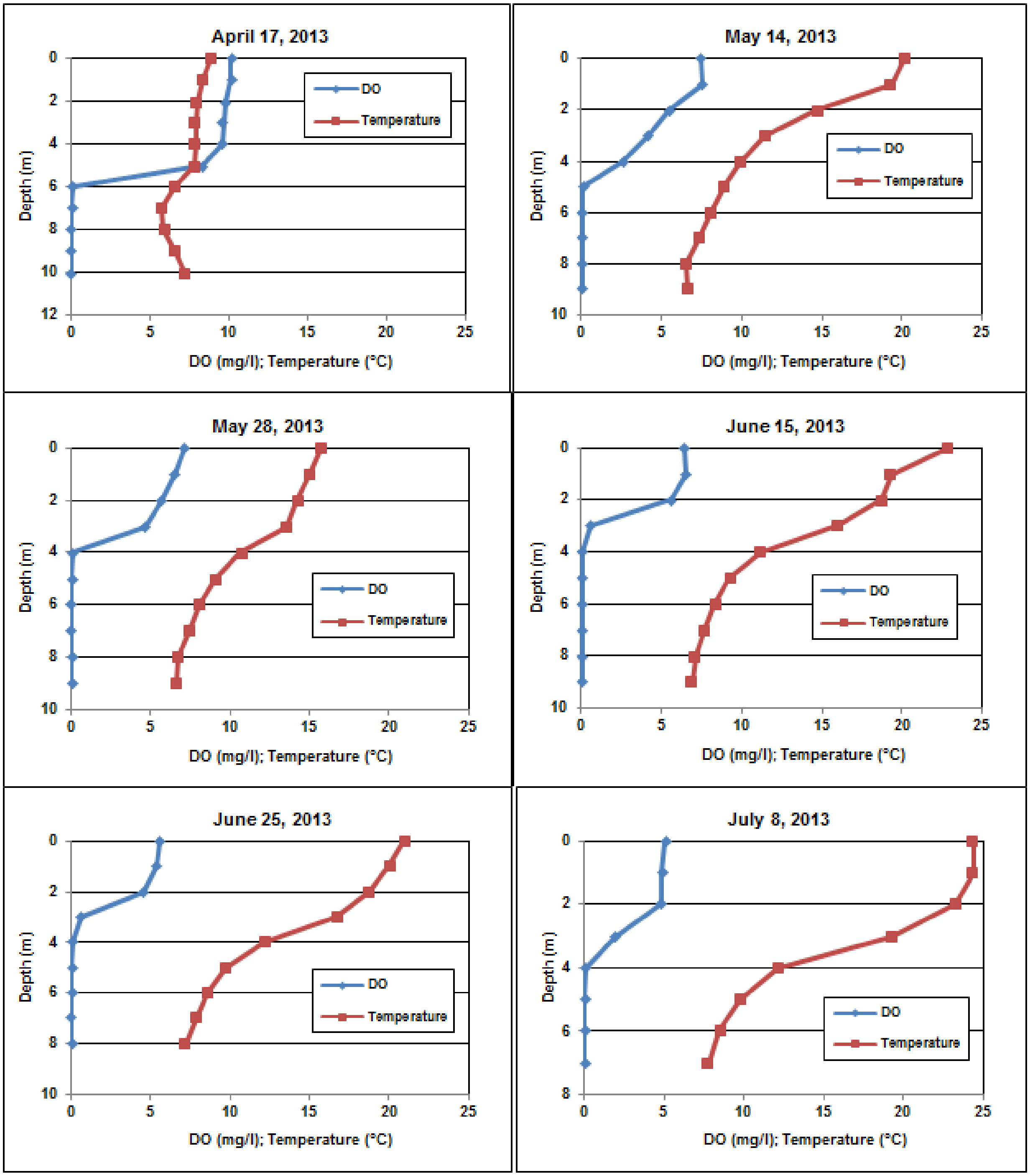

Figure 9. Dissolved oxygen (DO, mg/L) and temperature (ºC) profiles collected in Deyo Reservoir, Idaho,

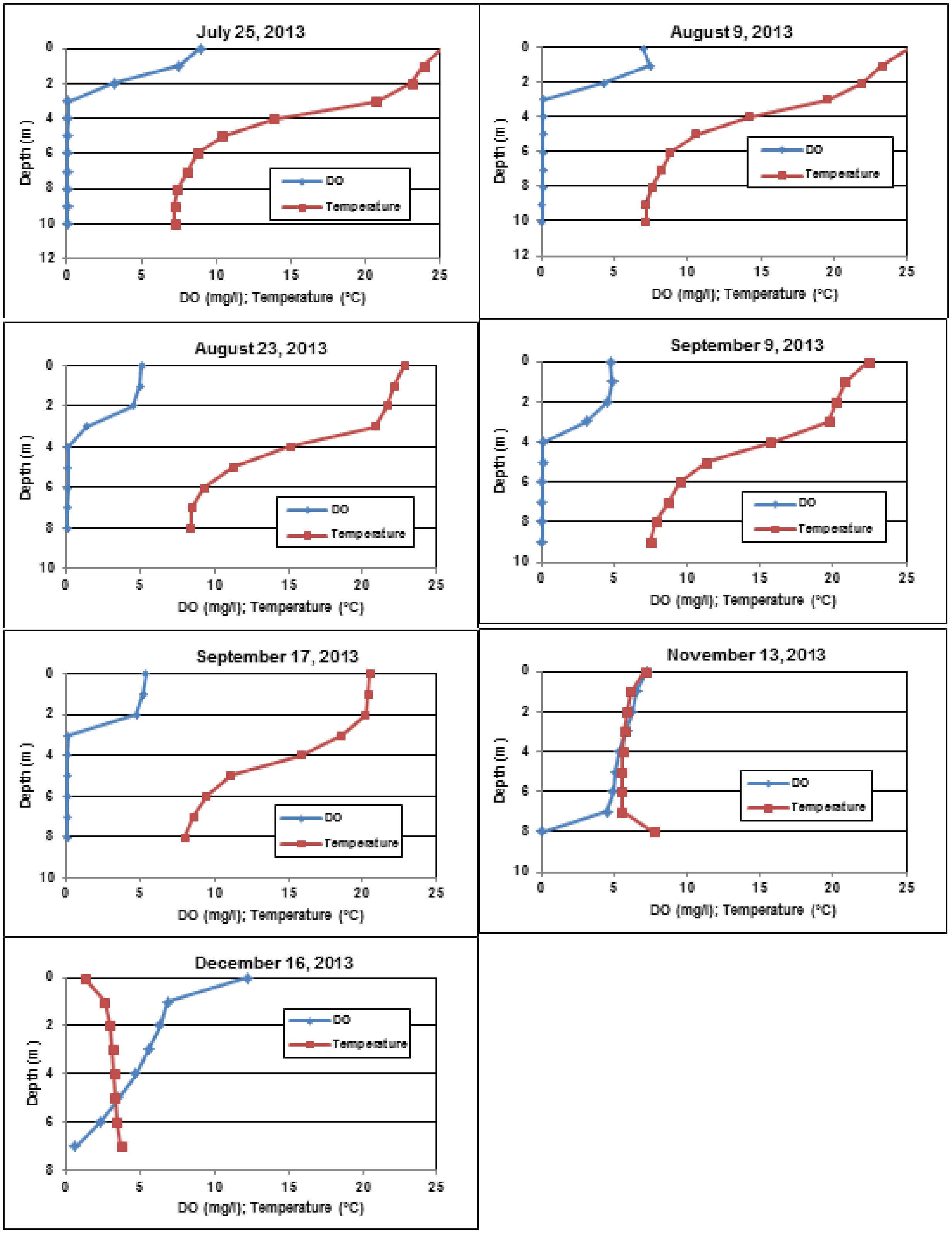

Figure 9. Continued.

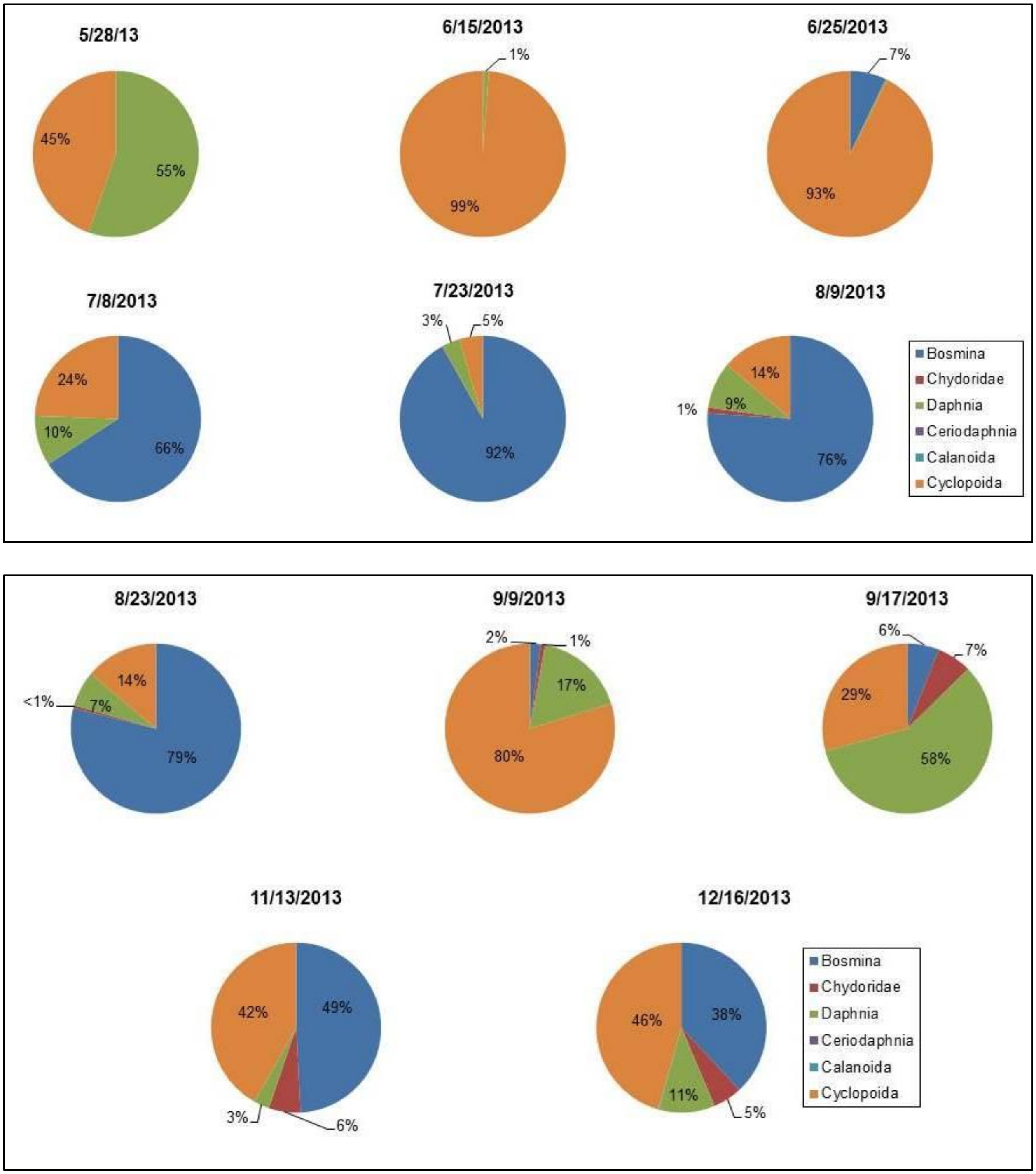

Figure 10. Zooplankton community composition based on monthly samples collected in Deyo Reservoir, Idaho, during 2013.

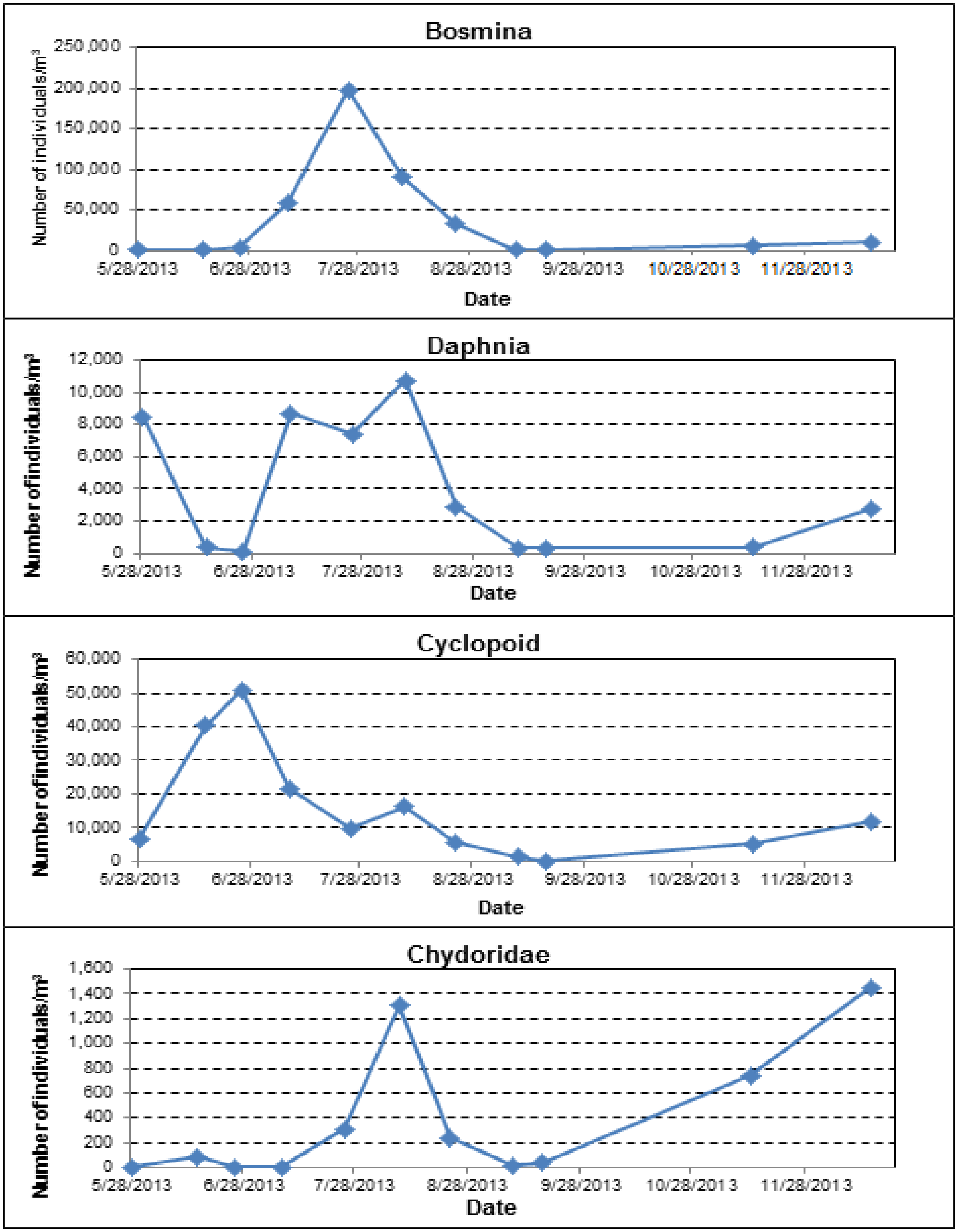

Figure 11. Densities of zooplankton taxa collected from monthly sampling in Deyo Reservoir, Idaho, during 2013.

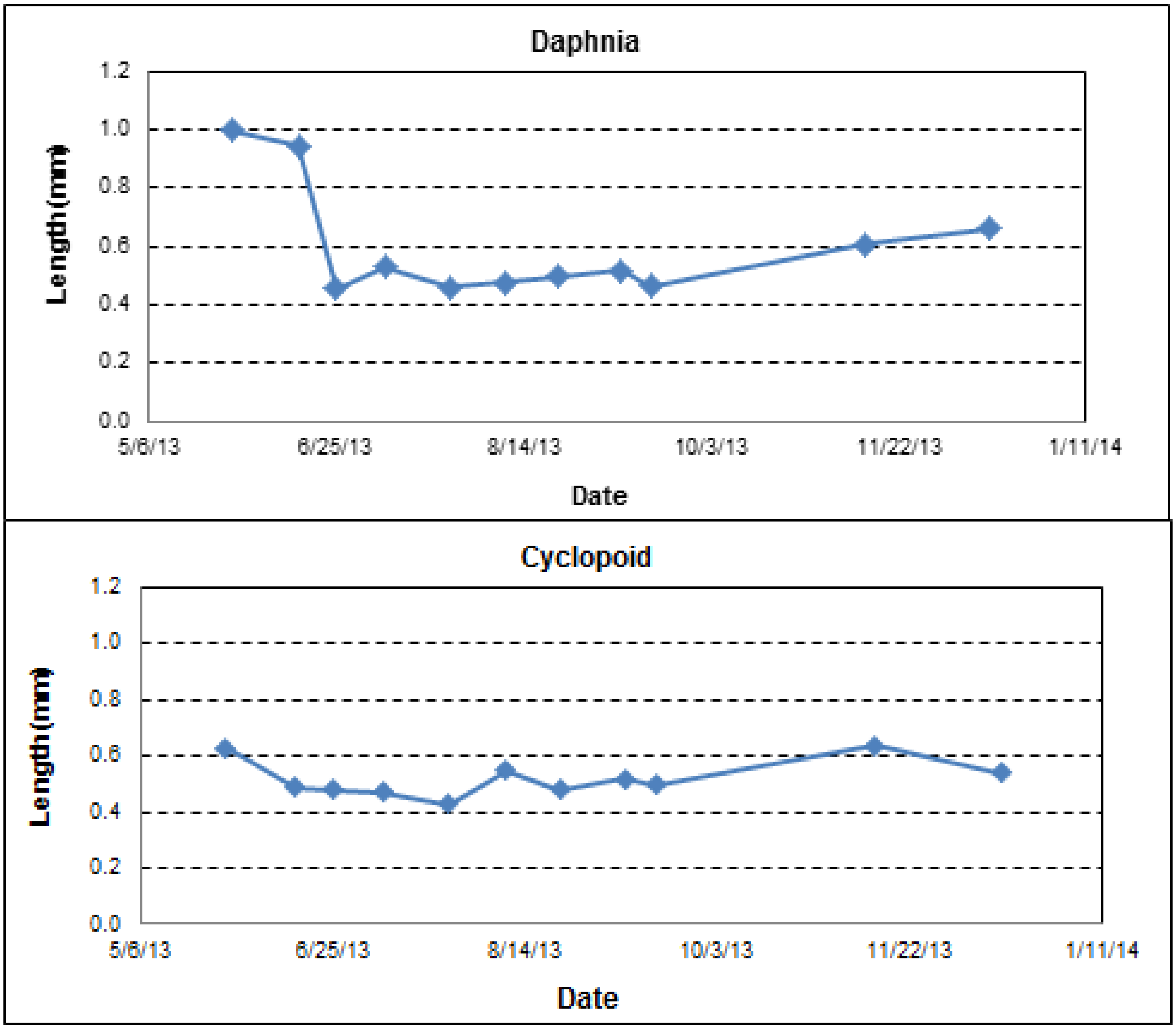

Figure 12. Average length (mm) of Cyclopoida and Daphnia collected from monthly sampling in Deyo Reservoir, Idaho, in 2013.

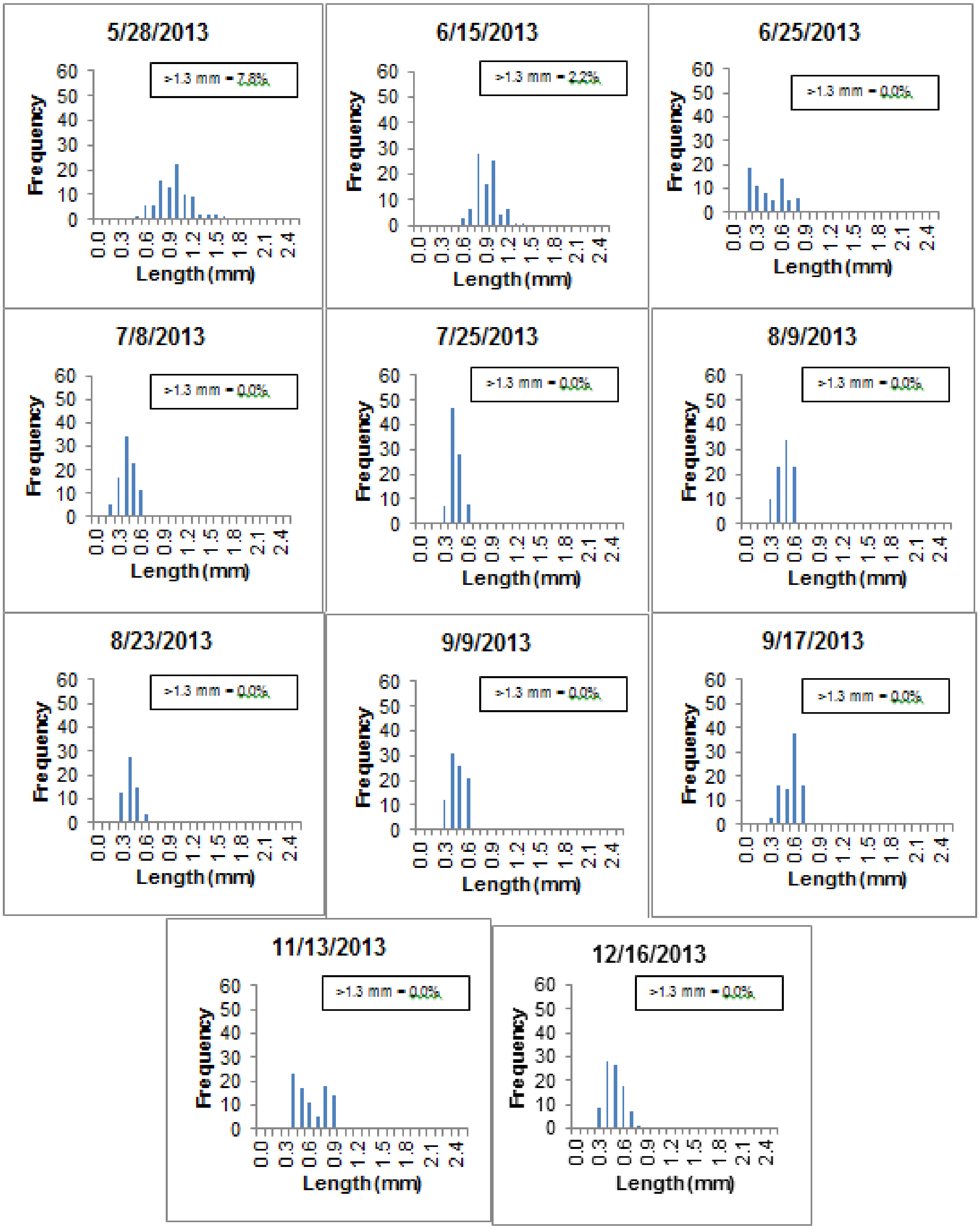

Figure 13. Length frequency distribution of Daphnia collected from zooplankton samples in Deyo Reservoir, Idaho, in 2013.

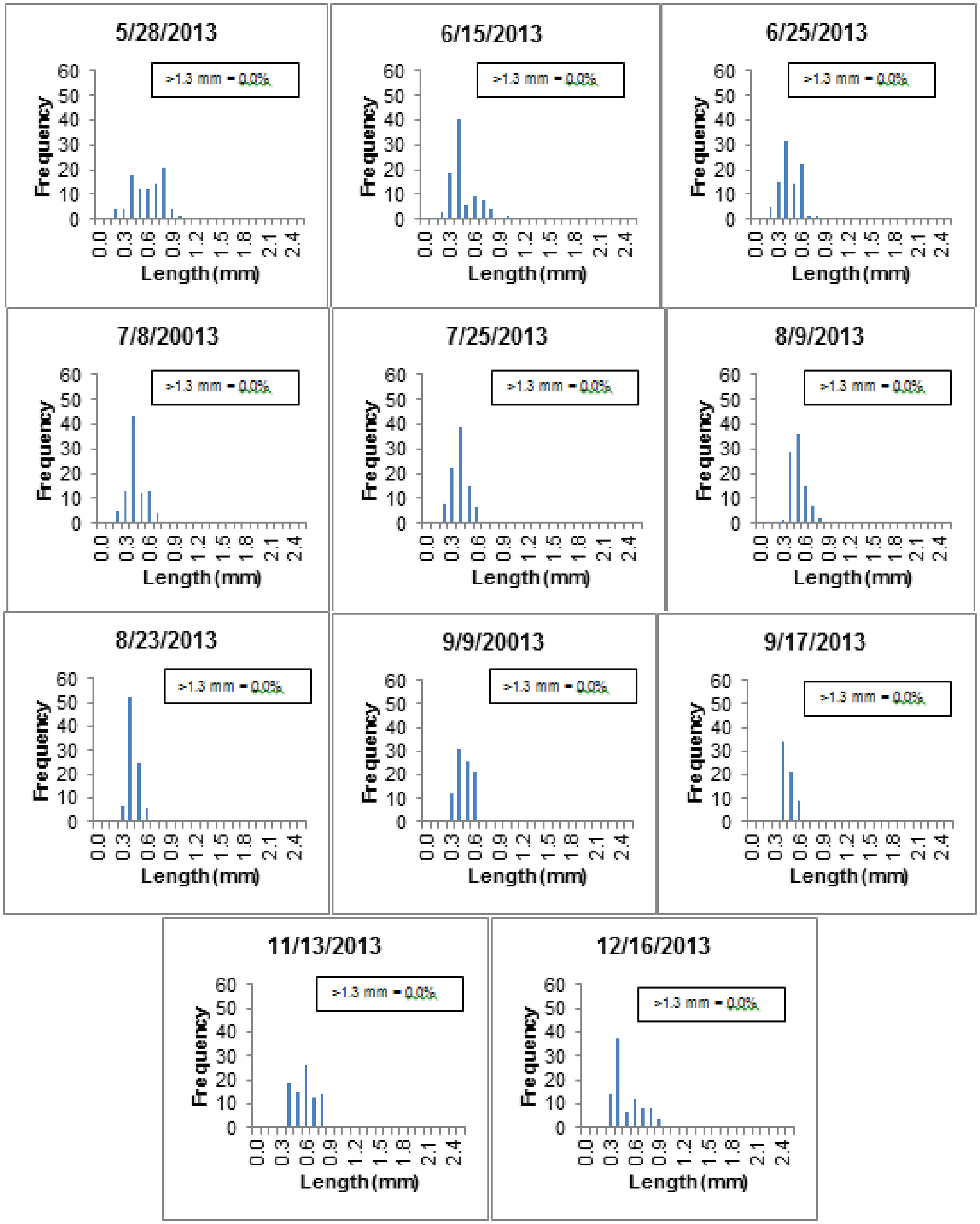

Figure 14. Length frequency distribution of Cyclopoida collected from zooplankton samples in Deyo Reservoir, Idaho, in 2013.

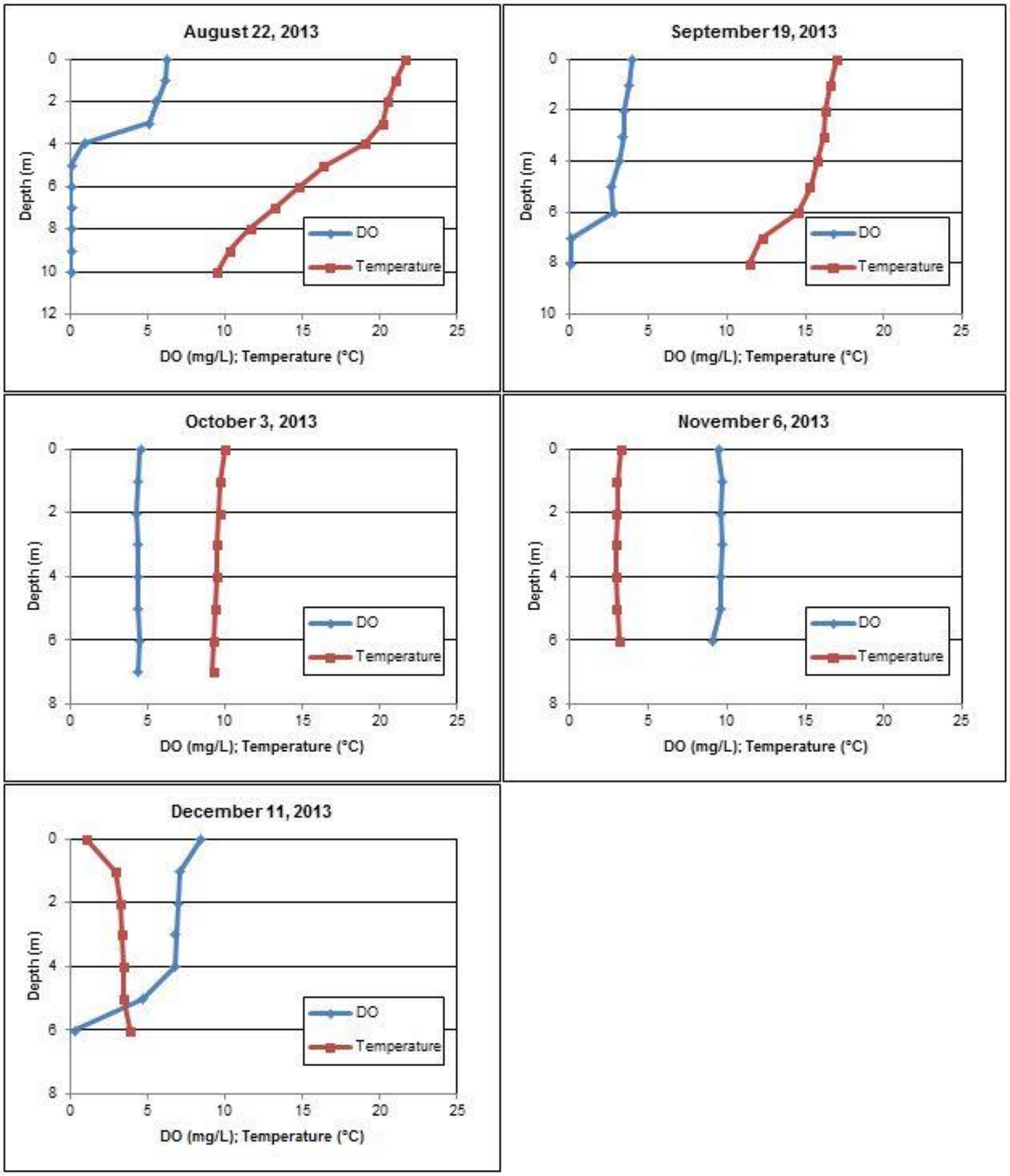

Figure 15. Dissolved oxygen (DO, mg/L) and temperature profiles (ºC) collected in Soldier's Meadow Reservoir, Idaho, during 2013.

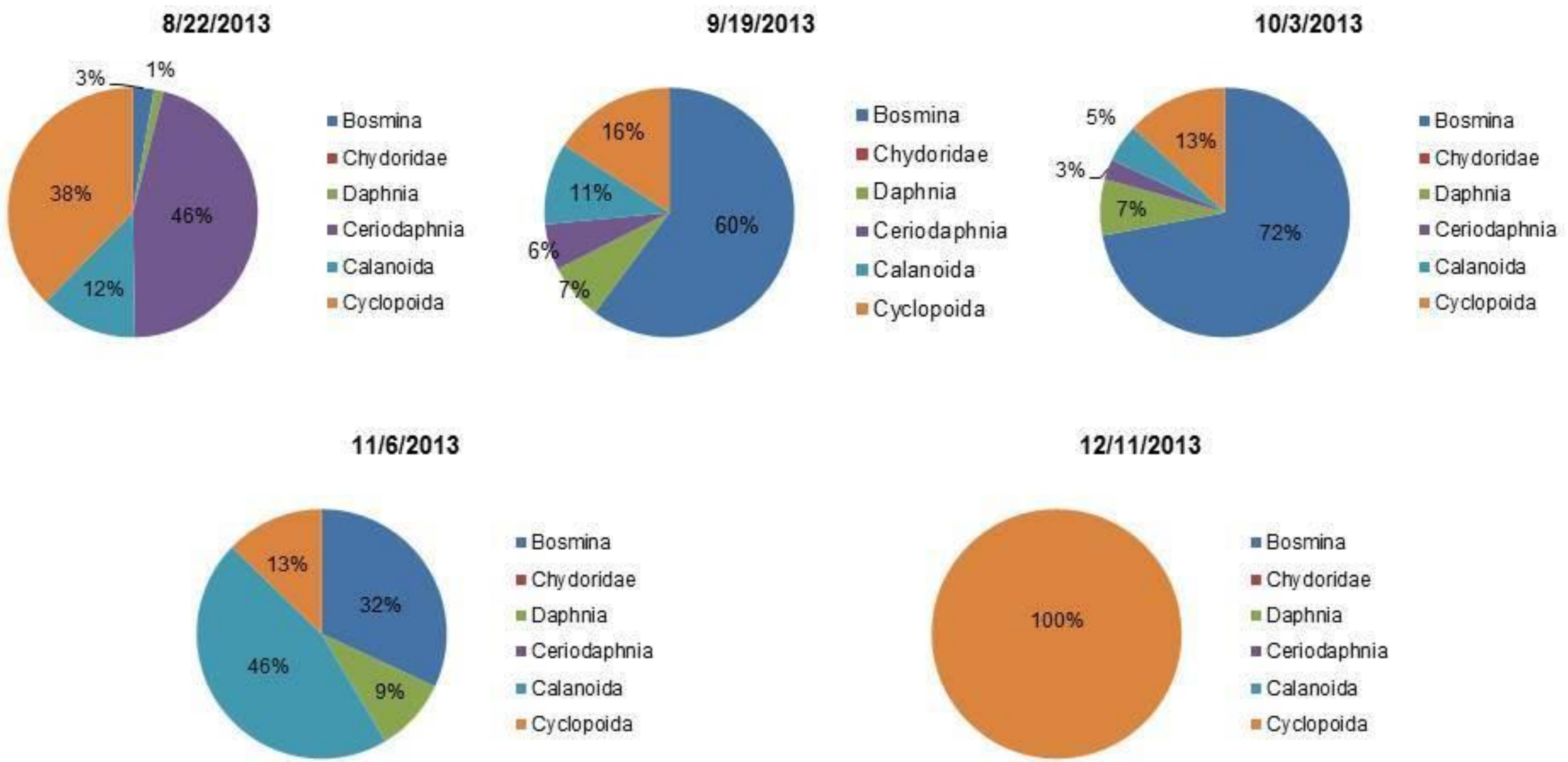

Figure 16. Zooplankton community composition based on monthly samples collected in Soldier’s Meadow Reservoir, Idaho, during 2013.

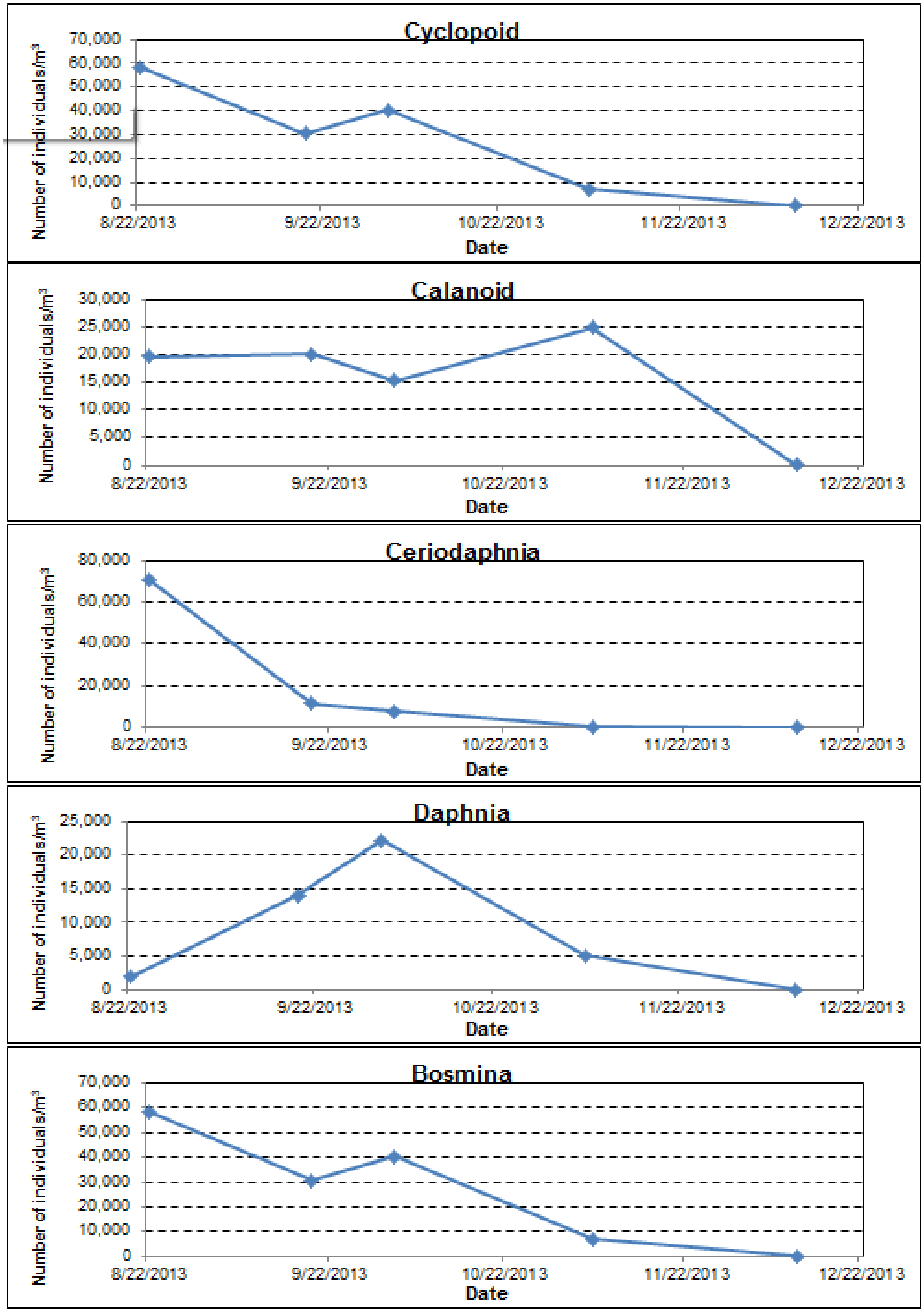

Figure 17. Densities of zooplankton taxa collected from monthly sampling in Soldiers Meadow Reservoir, Idaho, during 2013.

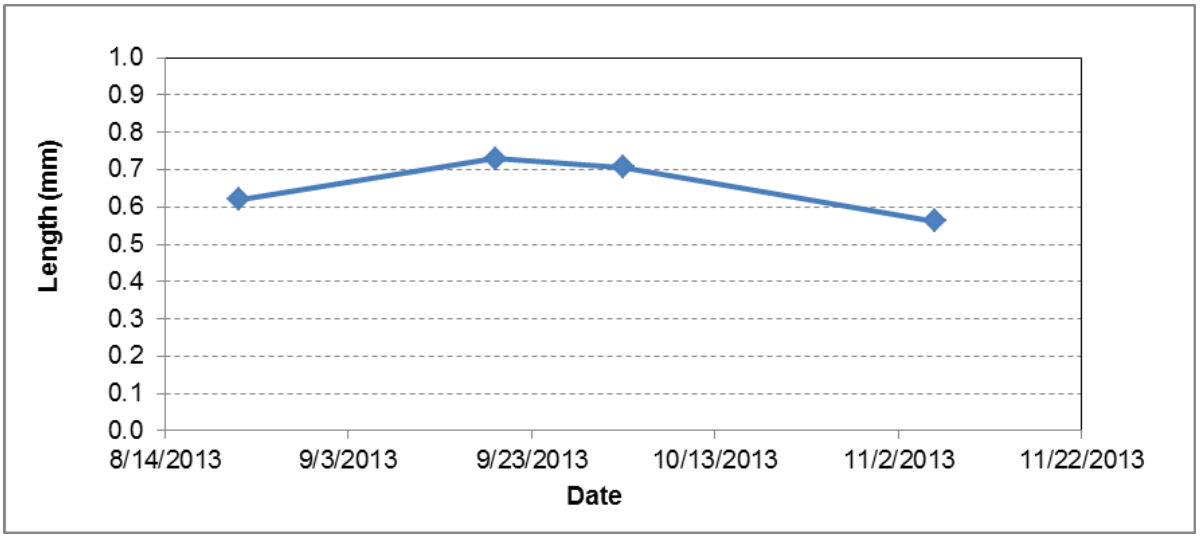

Figure 18. Average length (mm) of Cyclopoida collected from monthly sampling in Soldier's Meadow Reservoir, Idaho, in 2013.

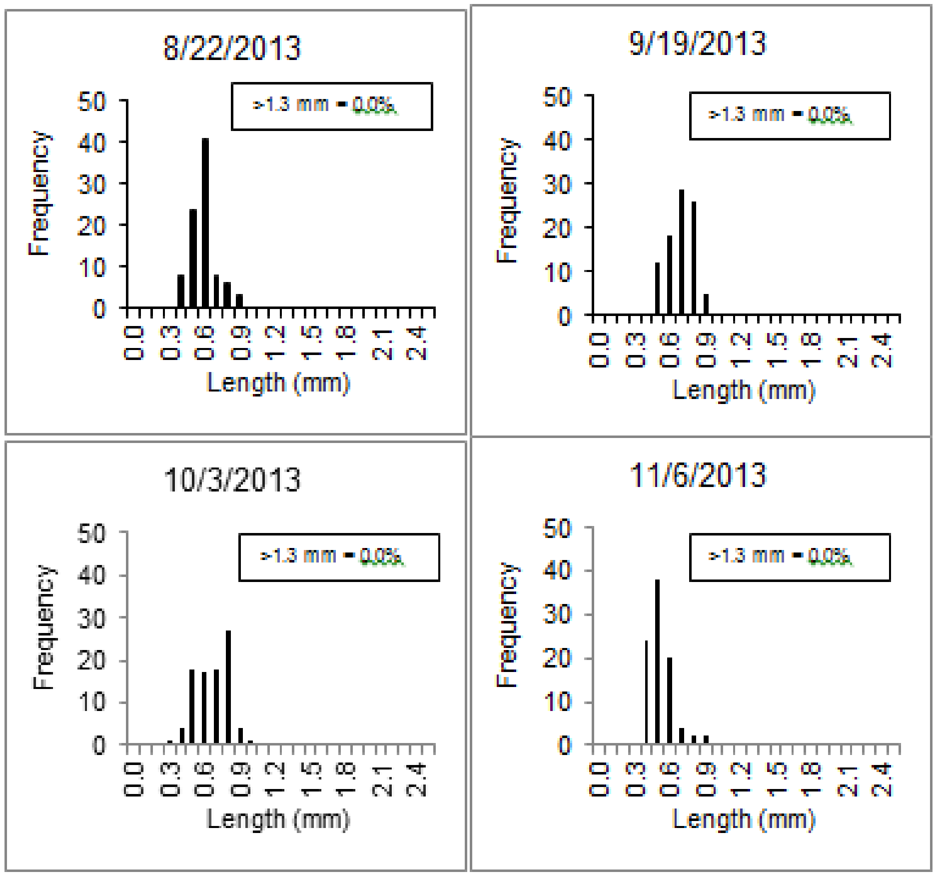

Figure 19. Length frequency distribution of Cyclopoida collected from zooplankton samples in Soldier's Meadow Reservoir, Idaho, in 2013.

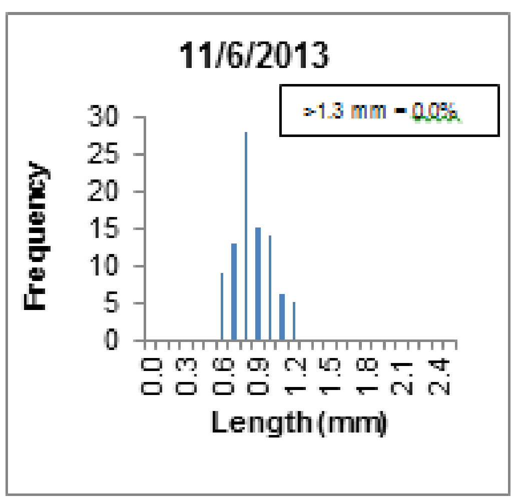

Figure 20. Length frequency distribution of Daphnia collected from zooplankton samples in Soldier's Meadow Reservoir, Idaho, in November, 2013.

SCHMIDT CREEK MONITORING

ABSTRACT

Deyo Reservoir was built under an agreement that included monitoring its outflow to assess whether the operation of this dam influenced steelhead occuring downstream in Schmidt Creek. Deyo Reservoir was completed in 2012, and monitoring began that year near the mouth of Schmidt Creek where steelhead had been found in the past. This agreement required Schmidt Creek to be monitored for a period of five years post construction of Deyo Reservoir. This report summarized the first two years of this assessment (2012-2013). A fixed station monitored stream dissolved oxygen (DO), water temperature, and conductivity, while stream flow was measured bi-weekly. During 2012, temperatures peaked at 20.9˚C and exceed 20˚C for seven days. During 2013, temperatures peaked at 21.2˚C and exceed 20˚C for four days. Additionally, DO concentrations in Schmidt Creek remained above 6 mg/L throughout both monitoring seasons. Thus, water temperature and DO continue to show no negative response to the construction of Deyo Reservoir. We will continue to monitor the site through 2016 with monthly field visits that will include DO and stream flow measurements, and utilize a HOBO™ temperature logger to provide continuous temperature monitoring data.

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INTRODUCTION

The Idaho Department of Fish and Game (IDFG), in conjunction with support from local communities, finished construction of a 22.3 ha reservoir on Schmidt Creek near Weippe, Idaho, in 2012. Named Deyo Reservoir, its purpose was to provide a new recreational fishery and an economic boost to the local economy with minimal negative biological impacts (DuPont 2011). To determine if construction of this reservoir had any potential impacts to steelhead in Schmidt Creek, water quality was monitored below the reservoir.

Fish surveys of Schmidt Creek in reaches within close proximity to the reservoir observed Long-nose Dace, *Rhinichthys cataractae,* as the only native species in that area. Fish species distributed in lower Schmidt Creek include Rainbow Trout/steelhead trout *Oncorhynchus mykiss*, sculpin sp., and dace (DuPont 2011). Surveys conducted on Schmidt Creek by IDEQ in 2002, within 60 m of the mouth of the creek, also collected Rainbow Trout/steelhead. Given the presence of Rainbow Trout/steelhead in lower Schmidt Creek, an agreement was made with the U.S. Fish and Wildlife Service to monitor outflow of the Deyo Reservoir project area pre- and post-construction to ensure no deleterious effects were observed in downstream habitats below the reservoir (DuPont 2011). If deleterious effects were observed, IDFG would modify water release strategies as needed.

OBJECTIVES

1. Monitor temperature, DO, and conductivity in Schmidt Creek pre- and post-reservoir construction to ensure no deleterious effects to fishes are observed downstream.

STUDY AREA

Deyo Reservoir is located on Schmidt Creek, a tributary to Lolo Creek, Idaho (

Figure 21). Schmidt Creek contains designated critical habitat for steelhead from its mouth to 1.1 km upstream. The end of steelhead critical habitat is 2.7 km below the Deyo Reservoir Dam site. Prior to construction of Deyo Reservoir, stream flow within Schmidt Creek was considered intermittent within the reservoir project area and potentially perennial in lower reaches depending on annual precipitation within the drainage area.

METHODS

Schmidt Creek was monitored in 2012 and 2013 for stream temperature, dissolved oxygen, conductivity, and flow at a monitoring location approximately 50 m upstream from its confluence with Lolo Creek. Temperature was recorded hourly in °C using a HOBO temperature logger. Dissolved oxygen and conductivity were recorded bi-weekly using a YSI Model 85 meter. Stream flow was recorded bi-weekly using an OTT MF Pro flow meter. Data was collected from May 8th - November 16th, 2012, and May 15th - December 12th, 2013.

RESULTS

Average daily water temperature at the Schmidt Creek monitoring station was 12.9°C in 2012 and 11.3°C in 2013. Maximum daily water temperatures exceeded 15˚C for 72 days in

2012 and 94 days in 2013 (Figure 22). Minimum daily water temperatures exceeded 15˚C for 26 days in 2012 and 34 days in 2013.

Average DO measured on Schmidt Creek was 10.4 mg/L in 2012 and 8.5 mg/L during the 2013 sampling season. Dissolved oxygen levels in 2012 ranged from 8.3 - 13.1 mg/L and in 2013 from 6.3 - 11.6 mg/L (
Figure 23). Dissolved oxygen levels were above 6.0 mg/l for the entirety of both sample seasons.

Conductivity in Schmidt Creek ranged from 48 - 119 µS/m in 2012 and from 40 - 146 µS/m in 2013 (
Figure 24). Conductivity readings were similar in both 2012 and 2013 with conductivity increasing during the summer and then declining through the fall.

Stream flow at the Schmidt Creek monitoring station did remain visible throughout the 2012 and 2013 sampling seasons. In 2012, flows ranged from a high of 11 cfs in May to a low of <0.1 cfs through most of the summer (
Figure 25). In 2013, flows ranged from a high of 0.8 cfs in May to a low of <0.1 cfs in August - September (
Figure 25). No de-watering of the stream channel was observed during either 2012 or 2013.

DISCUSSION

The construction of Deyo Reservoir during the summer of 2011 appears to have little effect on environmental parameters measured downstream in Schmidt Creek. Overall, water temperatures within Schmidt Creek remained below lethal limits for Steelhead during both the 2012 and 2013 monitoring season. During 2012, temperatures peaked at 20.9˚C and exceeded 20˚C for seven days. During 2013, temperatures peaked at 21.2˚C and exceed 20˚C for four days. Previous studies have shown Rainbow Trout/steelhead avoid temperatures in the mid 20ºC (Neilsen et al. 1994 and Matthews and Berg 1997) but temperatures at or near 20ºC are not detrimental, especially for short periods of time. Average water temperatures in Schmidt Creek were actually higher prior to construction of Deyo Reservoir than they have been post-construction. Additionally, DO concentrations in Schmidt Creek remained above 6 mg/L throughout both monitoring seasons. Thus, water temperature and DO continue to show no negative response to the construction of Deyo Reservoir.

Summer low flows have been found to be a limiting factor for steelhead populations in many streams in the lower Clearwater River drainage (Banks and Bowersox 2015). Summer low flows also likely play a large role in the abundance of juvenile steelhead that can rear in Schmidt Creek based on the flows we documented. Stream flow at the Schmidt Creek monitoring station did remain visible throughout the 2012 and 2013 sample seasons even though in August, 2012 we couldn't document it due to most flow occurring through interstitial spaces. It should be noted that almost all earthen dams allow some water to seep through them. The dam for Deyo Reservoir is not an exception. We monitored the amount of water seeping through the dam in 2013 and found that during the low flow period (June through September) seepage through the dam ranged from 28 gallons/min (0.06 ft^3/sec) to 35 gallons/min (0.08 ft^3/sec). Based on flows measured near the mouth of Schmidt Creek where steelhead have been documented, this seepage likely contributed significantly to summer low flows and potentially increases carrying capacity for steelhead during the summer. The substantial differences observed in spring flows between 2012 and 2013 is attributable to a much larger snowpack in 2012 that melted in a short period of time.

We will continue to monitor the site during the 2014 - 2016 field seasons with monthly field visits that will include DO and stream flow measurements, and utilize a HOBO™ temperature logger to provide continuous temperature monitoring data.

MANAGEMENT RECOMMENDATIONS

1. Continue to monitor Schmidt Creek limnology as required through 2016.

Figure 21. Map showing location of Deyo Reservoir, Idaho, and the Schmidt Creek monitoring station.

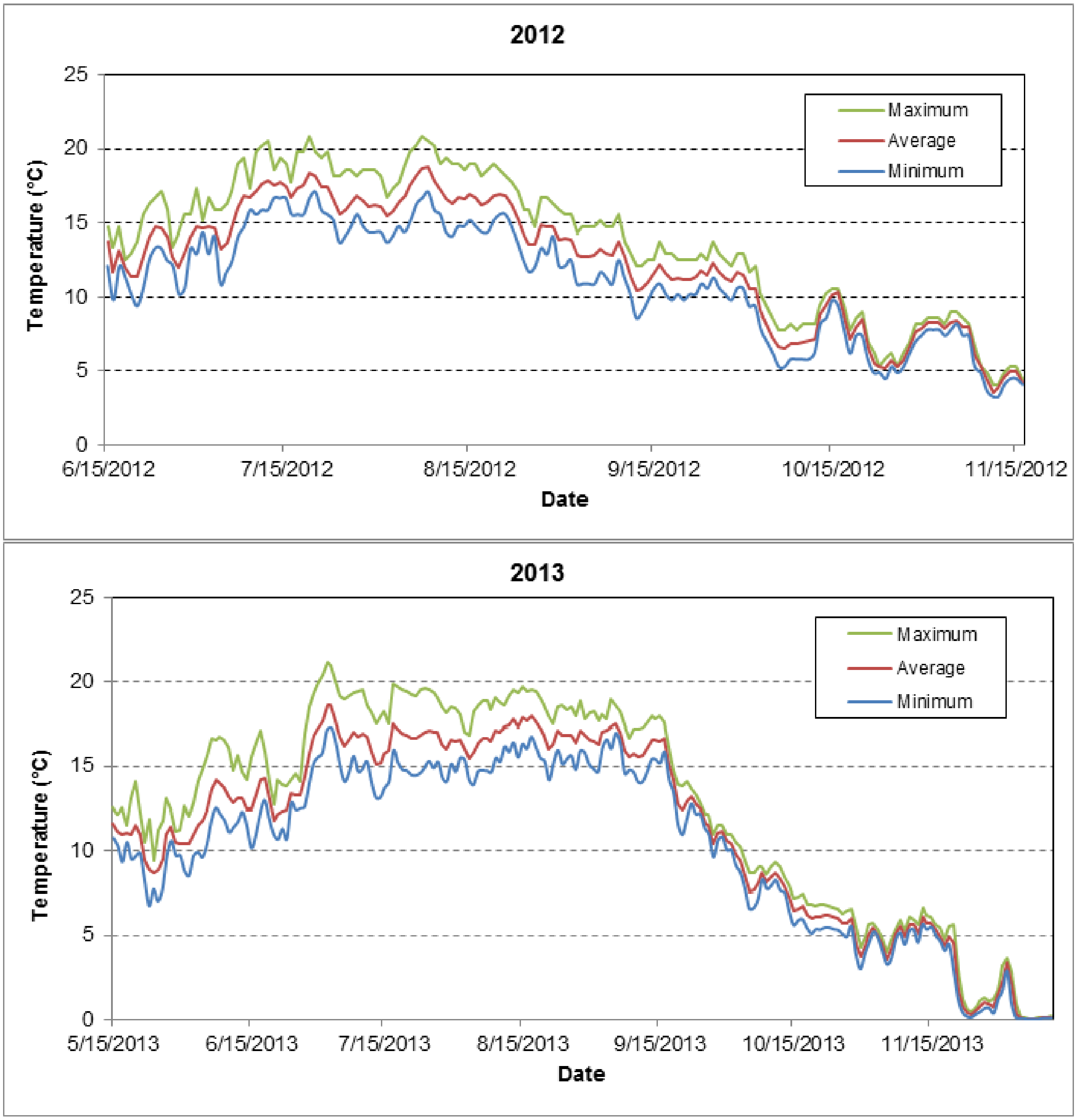

Figure 22. Mean, maximum, and minimum daily water temperatures measured at the Schmidt Creek, Idaho, monitoring station (N 46.355800°, W -116.052637°) during 2012 and 2013.

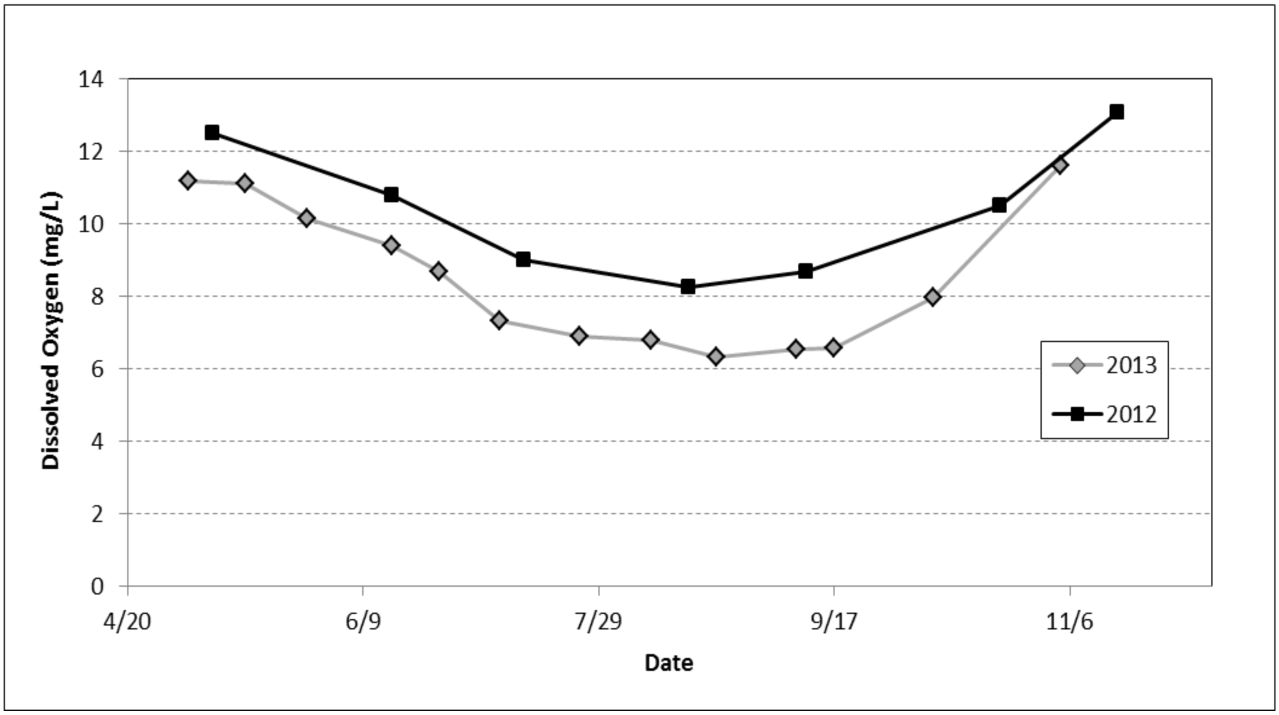

Figure 23. Dissolved oxygen levels (mg/L) at the Schmidt Creek, Idaho, monitoring station (N 46.355800°, W -116.052637°) during 2012 and 2013.

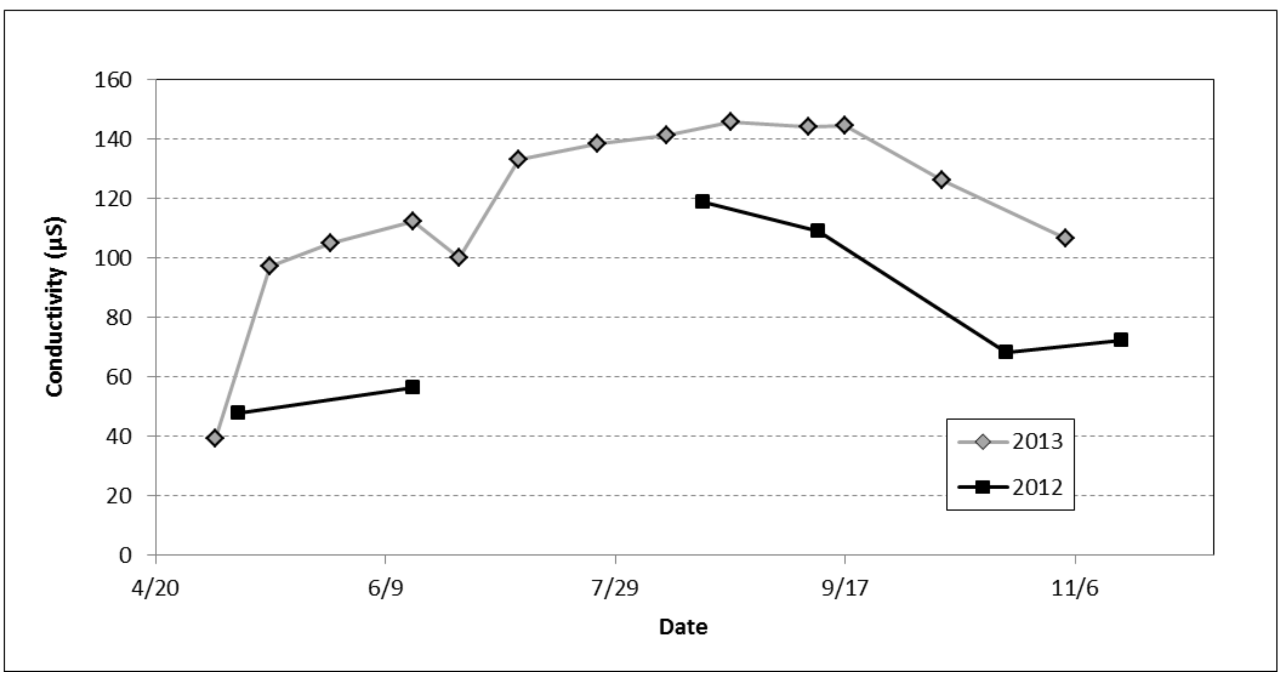

Figure 24. Conductivity (µS) readings at the Schmidt Creek, Idaho, monitoring station (N 46.355800°, W -116.052637°) during 2012 and 2013.

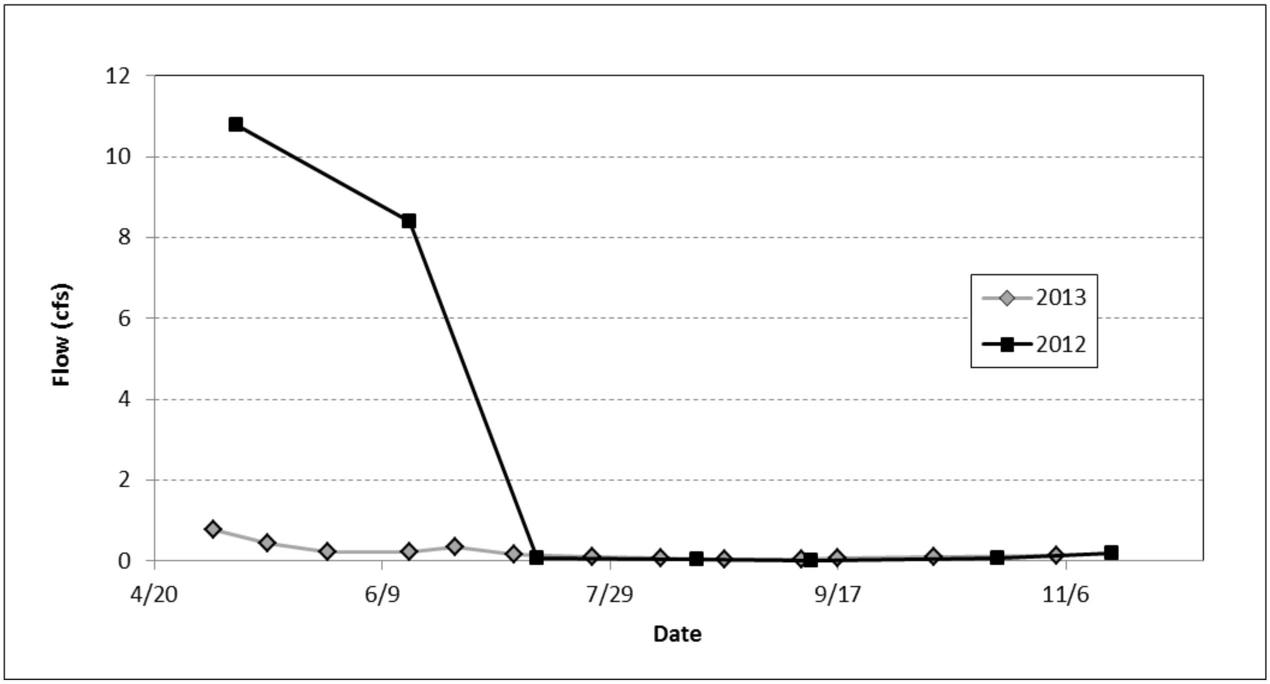

Figure 25. Measured flow readings (CFS; cubic feet per second) at the Schmidt Creek, Idaho, monitoring station (N 46.355800°, W -116.052637°) during 2012 and 2013.

SELWAY RIVER POPULATIONS TREND SURVEYS

ABSTRACT

Snorkel surveys were conducted on the Selway River in 2012 and 2013 to assess trends in the Westslope Cutthroat Trout (WCT) population. In 2012, we surveyed 33 sites on the Selway River. Of these, nine were historic general parr monitoring sites with an average density of 0.54 fish/100 m^2 for WCT. Twenty-four sites were 1-person trend sites, with an average of 7.8 WCT observed per site. An average of 1.2 fish/transect for fish >305 mm was the lowest since 2004. In 2013, we surveyed 29 sites on the Selway River. Of these, five were historic general parr monitoring sites with an average density of 0.63 fish/100 m^2 for WCT. Twenty-four sites were 1-person trend sites, with an average of 15.0 WCT observed per site. An average of 3.5 fish/transect for fish >305 mm was the second highest since 1990. Hook-and-line sampling was conducted to provide information on the sport fishery and monitor potential hooking mortality. A total of 388 and 206 WCT were collected in 2012, and 2013, respectively. The 25-year average is 360 fish caught by angling. Fly-fishing and lures (spoons and spinners) were used as angling techniques. Both methods captured a wide length frequency distribution; however, lures accounted for higher percentages of fish caught >305 mm (55.5% in 2012; 87.0% in 2013), and >356 mm (75.8% in 2012; 87.0% in 2013). The minimum mortality rate from hook and line sampling for WCT was 2.3% in 2012 and 3.6% in 2013, within the range of 0.3 - 5.5% mortality seen in studies involving cutthroat trout. Assuming hooking mortality for the angling public is similar to IDFG surveys, annual catch and release mortality for float trip anglers was estimated at 7 - 57 Westslope Cutthroat Trout/year using U.S. Forest Service permit data. However, this survey did not include anglers who hike, ride horses, or fly into the roadless section of the Selway River.

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Regional Fisheries Manager

INTRODUCTION

An angler use and economic survey in 2011 (IDFG, unpublished data) estimated 40,584 angler trips occurred on the major Westslope Cutthroat Trout *Oncorhynchus clarkii lewisii* (WCT) fisheries of the North Fork Clearwater, Lochsa, and Selway Rivers. These trips generated an estimated $13,311,606 in expenditures including groceries, lodging, and fishing gear. As demand on these fisheries continues, it is important to track the status of these fish populations to ensure continued quality fishing and to conserve wild native trout populations.

Westslope Cutthroat Trout are distributed throughout the Selway River drainage, occupying both the main river and tributaries. Both resident and fluvial life history forms are present. Snorkel surveys have been conducted to monitor WCT population. The fishery in the Selway River has been regularly evaluated through snorkel surveys from White Cap Creek downstream to Selway Falls since 1973. These surveys show that after catch-and-release regulations were implemented (1976) in this reach, WCT abundance more than tripled and peaked out in 1986. After 1986, WCT counts have fluctuated, likely in response to drought, temperature extremes, flooding, and observer variability (

Figure 26). Similar long-term fluctuations in WCT abundance have also been observed in other Idaho rivers (Flinders et al. 2013; Ryan et al. 2014). As the majority of this watershed is afforded protected status through wilderness or roadless designations, land management and human development have little influence on WCT abundance. Limiting factors for WCT are closely tied to natural regimes. The one exception may be where Brook Trout *Salvelinus fontinalis* occur as they have been found to influence WCT abundance. However, Brook Trout have been found at higher densities in only a few tributaries and rarely in the main Selway River. As such, Brook Trout are not believed to have a population level effect in the Selway River. The WCT population in the Selway River is considered to be strong and stable.

Due to limited vehicle access to this watershed, fishing pressure on the Selway River and its tributaries is relatively light. Currently, the fishery in the Selway watershed is managed under three different fishing rules. In all tributaries, a daily limit of two WCT is allowed. The rules on the Selway River for WCT are catch-and-release except for downstream of Selway Falls where a daily limit of two WCT >356 mm is allowed from Memorial Weekend to November 30. This area also receives the most recreation as a road parallels it. However, WCT use is limited in this reach of the Selway River during much of the summer due to unsuitable water temperatures. For these reasons, impacts from fishing are believed to have minimal influence on this WCT population. Monitoring this WCT population is important as it provides insight to trends in abundance in a watershed with light fishing pressure and limited harvest..

OBJECTIVES

1. Assess trends in Westslope Cutthroat Trout abundance and size in the Selway River through angling surveys and snorkel surveys of historic sites.

STUDY AREA

The Selway River begins in the headwaters of the Bitterroot Mountain Range and flows about 163 km to its confluence with the Lochsa River to form the Middle Fork Clearwater River. The Selway River watershed has an area of over 5,200 km^2. The majority of the watershed occurs at elevations over 1,200 m. Land ownership in the Selway River watershed is almost

100% Federal and is managed by the U.S. Forest Service. About 95% of the watershed is afforded some level of protected status, primarily as wilderness (Selway Bitterroot and Frank Church River of No Return Wildernesses) or roadless areas. The Selway River has a road that parallels its path for the lower 30 km and about 15 km in the upper reaches. Due to the protected status of this watershed, natural disturbance, such as fire, flooding, and drought are factors most likely to influence changes in the landscape over time.

The Selway River supports wild runs of spring and fall Chinook Salmon *Oncorhynchus tshawytscha*, summer steelhead and Pacific Lamprey *Entosphenus tridentatus*, although hatchery supplementation for both spring and fall Chinook Salmon occurs in this watershed. Native WCT, resident Rainbow Trout, Bull Trout *Salvelinus confluentus*, and Mountain Whitefish *Prosopium williamsoni* also occur in the watershed. Bull Trout are located mainly in the Selway River and the higher elevations streams whereas Mountain Whitefish occur mainly in the mainstem Selway River and the largest tributaries. Rainbow Trout were stocked in the lower Selway River (along the roaded reach) for decades, ending in 1990. Brook Trout were introduced in the early 1900's, mostly into high mountain lakes. Brook Trout are now located in some of the lower gradient streams and high mountain lakes mostly in the western half of this watershed. Brook Trout are rarely observed in the Selway River. Smallmouth Bass occur in the Selway River downstream of Selway Falls. Westslope Cutthroat Trout are believed to occur in all the tributaries in the Selway River watershed where sufficient flow and gradient occurs. Both resident and fluvial WCT occur in the tributaries. Selway Falls, which is a series of drops, is located about 30 km upstream from the mouth of Selway River. It is unclear what percent of fluvial fish navigate Selway Falls during their annual migrations. These falls are not complete barriers to fish, as steelhead and Chinook Salmon navigate them every year. A fish ladder was built through a tunnel at Selway Falls in 1964 to improve passage of these fish. It is unclear how these falls and tunnel have influenced the passage of WCT.

To help monitor the WCT population in the Selway River, snorkel surveys were conducted on historic trend sites (Figure 27). Two types of sites are snorkeled in the Selway River. The first group of sites were originally part of the General Parr Monitoring (GPM) program, which was developed to estimate anadromous fish response to Bonneville Power Association habitat improvement projects (Scully et al. 1990). These sites are now surveyed utilizing the IDFG standard snorkel survey techniques developed by Thurow (1994). This technique entails using an appropriate number of snorkelers to cover the entire width of the river to allow for the calculation of fish densities. The second group of sites surveyed were 1-person trend monitoring sites. These sites were developed for monitoring changes in abundance of resident fish such as WCT and Mountain Whitefish *Prosopium williamsoni.* These sites utilize one person to conduct the survey. While these surveys allow for monitoring trends in abundance and size distribution, densities cannot be calculated due to the lack of complete coverage of the entire river width. In addition, angling surveys were conducted when floating the river from White Cap Creek to the take out just upstream of Meadow Creek (Figure 27).

METHODS

Refer to Rivers and Streams Investigations in DuPont et al. (2011) for descriptions of methodologies used for Selway River snorkel and angling surveys. GPS coordinates and photographs of each 1-person snorkel site are provided in Appendices "L" and "M" of DuPont et al. (2011).

RESULTS

From July 21 - 27, 2012, a total of 33 sites were surveyed on the main stem Selway River. Of these, nine sites were historic general parr monitoring sites where standard snorkel techniques were used. At these sites, an average density of 0.54 fish/100 m^2 WCT and 1.01 fish/100 m^2 Mountain Whitefish were observed (Table 4). Results and analysis of data collected on other species can be found in Kennedy et al. (2013). The other 24 sites were 1-person snorkels sites. In 2012, an average of 7.78 WCT were observed per site (Table 5). The average number of WCT per transect declined in every section of the Selway river, and was the lowest since 2007. In 2012, the average number of WCT >305 mm was 1.2 fish/transect, and was the lowest since 2004. There was a decline in numbers of WCT >305 mm observed per transect in all river sections except the Three-Links Creek to Race Creek section. This section had the highest number of WCT >305 mm (2.2 fish/transect), which was a 69.2% increase over 2011. These sites continue to show substantial fluctuation in the number of WCT observed from year to year (Table 5 and

Figure 28). At the 1-person snorkel sites, a total of 351 WCT were observed. Of these, 62 (17.7%) were >305 mm, 17 (4.8%) were >356 mm, and 3 (0.9%) were >406 mm.

A hook-and-line survey of WCT was conducted on the Selway River from July 21 - 27, 2012 in conjunction with the annual snorkel survey. A total of 554 fish were collected over six days of sampling, including WCT (n = 388), Rainbow Trout (n = 142), WCT x Rainbow Trout hybrids (n = 16), Mountain Whitefish (n = 4), Bull Trout (n = 3), and Redside Shiner (n = 1). The 388 WCT caught was 3.2% above the 25-year average of 376 fish (Figure 29). Angling effort (both number of anglers and time spent angling) and ability were similar to previous years. These fish ranged in total length from 132 - 417 mm (
Figure 30), with 110 (32.5%) >305 mm, 31 (9.2%) >356 mm, and 2 (0.6%) >406 mm (
Figure 31). The percent of fish collected >305 mm and >356 mm increased slightly from 2011, and we have seen overall increasing trends since 1975 (
Figure 31). The average length of WCT caught in 2012 was 259 mm (
Figure 32). This is just below the 25-year average length of 260 mm. Of the 388 WCT caught, 205 (52.8%) were caught on flies and 183 (47.2%) on lures (spoons and spinners). Both methods captured a wide length frequency distribution (
Figure 33); however, lures accounted for 55.5% of the fish caught >305 mm, and 75.8% > 356 mm. The Rainbow Trout collected ranged in length from 95 - 375 mm (

Figure 30). A total of 11 direct angling mortalities (2.0%) were recorded through angling effort, including nine WCT (2.3%) and two Rainbow Trout (1.4%) (Table 6). Previous hook scars were not documented on any fish caught.

From July 12 - 19, 2013, a total of 29 sites were surveyed on the main stem Selway River. Of these, five sites were historic general parr monitoring sites where standard snorkel techniques were used. At these sites, an average density of 0.63 fish/100 m^2 WCT and 0.44 fish/100 m^2 Mountain Whitefish were observed (Table 7). Results and analysis of data collected on other species can be found in Kennedy et al. (2013). The other 24 sites were 1-person snorkels sites. For 2011, an average of 15.0 WCT were observed per site (Table 7). The average number of fish per transect increased in every section of the Selway river from 2012. In 2013, the average number of fish >305 mm was 3.5 fish/transect, the second highest average since 1990. The Running Creek to Bear Creek section had the highest average number of fish >305 mm (7.8 fish/transect) recorded since sampling began in 1973. These sites continue to show substantial fluctuation in the number of WCT observed from year to year (Table 5 and Figure 26). At these sites 1-person snorkel sites, a total of 499 WCT were observed. Of these, 127 (25.5%) were >305 mm, 42 (8.4%) were >356 mm, and 14 (2.8%) were >406 mm.

A hook-and-line survey of WCT was conducted on the Selway River from July 12 - 19, 2013 in conjunction with the annual snorkel survey. A total of 384 fish were collected over six days of sampling, including WCT (n = 306), Rainbow Trout (n = 73), WCT x Rainbow Trout hybrids (n = 4), and Bull Trout (n = 1). The 306 WCT collected was 17.6% below the 25-year average of 370 fish caught (Figure 29). Angling effort (both number of anglers and time spent angling) and ability were similar to previous years. These fish ranged in total length from 130 - 402 mm (Figure 30), with 101 (33.0%) >305 mm, 23 (7.5%) >356 mm, and 2 (0.7%) >406 mm (Figure 31). The percent of fish collected >305 mm and >356 mm increased slightly from 2012, and we have seen overall increasing trends since 1975 (Figure 31). The average length of WCT caught in 2013 was 263 mm (Figure 32). This was just over the 25-year average length of 260 mm. Of the 306 WCT caught, 59 (19.3%) were caught on flies and 247 (80.7%) on lures (spoons and spinners). Both methods captured a wide length frequency distribution (Figure 33); however, lures accounted for 87.0% of the fish caught >305 mm, and 87.0% > 356 mm. The Rainbow Trout collected ranged in length from 130 - 355 mm, with an average length of 182 mm (Figure 30). A total of 11 direct angling mortalities (2.9%) were recorded through angling effort. This is a minimum estimate, as delayed mortality could not be quantified. Westslope Cutthroat Trout accounted for all 11 mortalities (3.6% of WCT caught). Previous hook scars were not documented on any fish caught.

DISCUSSION

Annual snorkel surveys have occurred in the Selway River since 1973 and counts have fluctuated considerably from year-to-year. In fact, annual fluctuations in excess of 100% have occurred the last three year. We don't believe the actual WCT population is fluctuating this much on an annual basis and question whether this is even possible. We suspect that much of the year-to-year variation in counts is likely attributable to differences in flow, water temperature, and observer variability. When compared to snorkel counts in other Idaho rivers with WCT, such as the St. Joe River, Coeur d'Alene River and Middle Fork Salmon River, fluctuations in counts were much greater in the Selway River surveys (Flinders et al. 2013; Ryan et al. 2014). This suggests that more care needs to occur to insure counts occur in a similar manner, with trained personnel, and at more similar flows and water temperatures from year to year to help reduce variability. It may also be beneficial to evaluate whether increasing the number of snorkelers from one to two could also reduce the annual variability. Snorkel surveys that occur in the St. Joe River, Coeur d'Alene River and Middle Fork Salmon River, all utilize two snorkelers at most of their sites.

The 1-person snorkel counts that have occurred since 1973 in the Selway River indicate that the long-term WCT trend in abundance is relatively flat. Although the annual snorkel counts may not be precise, this information does give us confidence that this WCT population is stable given the length of time (40 years) that this survey has been occurring. Additionally, we have seen steady increases in the percent of fish >305 mm observed by snorkeling since 1973, and in fish collected >305 mm and >356 mm by angling since 1975 (Figure 28). These trends are similar to those seen for WCT by Ryan et al. (2014) in the St. Joe and Coeur d'Alene river systems in northern Idaho.

Early studies of WCT in the St. Joe River, Kelly Creek, and the Lochsa River, Idaho, concluded that the low WCT densities were a result of overfishing (Mallet 1967; Dunn 1968; Rankel 1971; Lindland 1977). Rules on the Selway River allowed a daily bag limit of 15 trout up through 1973 and a daily bag limit of 10 trout from 1973-1975 with no more than three being

WCT in 1974 and 1975. Concerns over declining WCT populations prompted IDFG to implement catch-and-release rules in the Selway River in 1976. Our surveys showed that after catch-and-release regulations were implemented in the Selway River, WCT abundance tripled after a four year period. Similar trends in WCT abundance have also been observed after catch and release rules were implemented in the St. Joe River, Kelly Creek, and Lochsa River (Lindland 1977). For these streams, Westslope Cutthroat Trout counts increased 7-12 fold over a 4-5 year period. Although the response was not as great in the Selway River, it does show that implementing catch-and-release rules can have a noticeable effect on WCT abundance even in remote difficult to access rivers such as the Selway River.

The Selway River system provides a popular WCT fishery that is often compared by anglers to other northern Idaho Cutthroat Trout fisheries. Average densities for WCT of all sizes in the Selway River (0.54 fish/100 m^2), are similar to, albeit somewhat lower than densities observed in 2013 for the North Fork Coeur d' Alene River (0.75 fish/100 m^2, Ryan et al. 2014) and higher than the Lochsa River (0.40 fish/100 m^2; see Lochsa River Fish Trend Surveys below). The St. Joe River had a substantially higher WCT density across all size classes in 2013 (1.42 fish/100 m^2, Ryan et al. 2014).

Westslope Cutthroat Trout are relatively easy fish to catch, and angling mortality is of interest in order to maintain a healthy population and fishery. Direct hooking mortality estimates from angler caught fish in 2013 (3.6%) was similar to what has been observed during the previous six years this was assessed (ranged from 0.6 - 4.9%). These mortality rates for WCT were within the range of 0.3 - 5.5% mortality seen in most studies involving cutthroat trout (Marnell and Hunsacker 1970; Dotson 1982; Schill et al. 1986).

A study conducted by the USFS from 2006 - 2010 (Jakobar 2011) indicated that anglers on float trips annually spent an average of 406 hours fishing the Selway River and caught an average of 1,112 trout (all species combined). No fish were reported harvested. Assuming hooking mortality for the angling public is similar to IDFG surveys, annual catch-and-release mortality for float trip anglers is estimated at 7 - 37 fish/year. It must be noted that this survey does not include anglers who hike, ride horses, or fly into the roadless section of the Selway River. These observations suggest that total angling effort and fishing mortality are low on the Selway River.

It is likely that differences in water conditions during sampling has led to some of the fluctuations seen annually in both snorkel densities and in hook-and-line catch rates of WCT. From 2002 - 2007, sampling was started when river flows were between 865 - 1,280 cfs. Since 2008, however, annual sampling trips were started with river flows of 1,460 - 1,640 cfs, a substantial difference in water levels. Water temperatures tend to increase as the river level drops during the summer months and fish in the main stem river may seek areas with cooler water temperatures or higher DO concentrations such as in the tributaries or riffle areas. This could suggest that more fish are utilizing the main river when flows are higher and water temperatures are generally lower. However, comparing the number of fish collected by angling to river flows at time of sampling from 1975 - 2011 shows no relationship between these two parameters (Figure 34; $r^2 = 0.003$). We also compared the number of WCT observed in the 1-person snorkel transects to river flows at the time of sampling for the same time period to determine if difference in water level might affect snorkel counts. A weak negative relationship was detected (Figure 35; $r^2 = 0.06$). The combination of these two analyses suggests that in higher flows snorkelers are less likely to see fish for reasons such as less clarity, the snorkeler is traveling faster, and/or the fish are using habitat that makes them more difficult to see. As such, continuing to sample within the recommended flow range of 1200 - 1500 cfs will help maintain consistency in our sampling and the ability to compare data between years.

MANAGEMENT RECOMMENDATIONS

1. Continue to conduct annual Selway River snorkel surveys to monitor trends in resident fish populations.

2. Investigate strategies to reduce observer variability in snorkel counts

3. Continue to target survey timing when river flows are between 1,200 - 1,500 cfs to reduce potential environmental bias in survey results.

Table 4. Westslope Cutthroat Trout densities (GPM sites; fish/100 m2) and number of fish per transect (1-person sites) determined by snorkel surveys of the main stem Selway River, Idaho, in 2012.

Mainstem GPM sites

Site	Transect length (m)	Transect width (m)	Temp °C	Cutthroat Trout	Steelhead (Snake River basin)	Mountain Whitefish	Chinook Salmon (spring run)	Bull Trout
Bad Luck Creek	88	45	15.0	0.57	0.18	0.64	0.00	0.00
BeaverPt	135	20	18.0	0.04	0.08	0.56	5.31	0.12
Below Tango	100	52	16.0	0.54	0.10	0.48	0.08	0.00
Big Bend	94	30	16.0	0.50	0.11	1.32	0.00	0.00
Hells Half Acrre	90	15	16.0	0.89	1.61	0.64	7.81	0.24
Little-CW	85	19	12.0	0.56	0.74	2.29	8.30	0.12
Mag-Xing	180	35	16.0	0.11	0.18	0.27	1.55	0.07
North Star	93	39	none	1.13	0.11	1.90	0.03	0.00
Osprey Island	119	44	16.0	0.50	0.40	1.02	0.00	0.02
Average Density				0.54	0.39	1.01	2.56	0.06
St. Dev.				0.34	0.50	0.69	3.56	0.08

Mainstem 1-Person Sites

Site	Transect length (m)	Transect width (m)	Temp °C	Cutthroat Trout	Steelhead (Snake River basin)	Mountain Whitefish	Chinook Salmon (spring run)	Bull Trout
1/2 Mile Below White Cap	-	-	-	5	4	6	-	-
1 Mile Below White Cap	-	-	-	6	2	11	23	-
Cougar Bluff	-	-	-	5	-	5	-	-
1/2 Mile Below Running	-	-	-	14	6	40	-	1
Archer	-	-	-	6	9	8	-	-
Selway Lodge	-	-	-	6	6	-	-	-
Above Goat Creek Rapid	-	-	-	9	7	47	21	-
Above Rodeo	-	-	-	-	-	-	-	-
Below Rodeo	-	-	-	3	14	1	-	-
Below Pettibone	-	-	-	14	6	3	-	-
Rattlesnake Bar	-	-	-	2	-	1	-	-
Below Ham	-	-	-	1	7	8	-	-
Below Hell Creek	-	-	-	9	8	14	-	-
Moose Creek Confluence	-	-	-	25	21	21	16	-
Divide Creek	-	-	-	3	13	39	-	-
Above Ladle	-	-	-	9	30	13	-	-
Below Ladle	-	-	-	4	16	6	-	-
Below Osprey Rapid	-	-	-	5	6	3	-	-
Below 3-Links	-	-	-	7	32	21	8	-
Dry Bar	-	-	-	12	50	29	25	-
Above Wolf Creek	-	-	-	3	2	-	-	-
Above Renshaw	-	-	-	18	11	22	-	-
Otter	-	-	-	10	5	14	-	-
Packer	-	-	-	3	9	-	-	-
Average # of Fish				7.78	12.57	15.60	18.60	1.00
St. Dev.				5.74	11.84	13.76	6.80	---

Table 5. Average number of fish/transect of Westslope Cutthroat Trout as determined by 1-person snorkel surveys in the main stem Selway River, Idaho, 1973 - 2013.

Fish > 305mm

River Section	1973	1974	1975	1976	1977	1978	1980	1982	1984	1986	1988	1990	1992	1994	1995	1996	1997	1998	1999	2001	2002	2003	2004	2005	2007	2008	2009	2010	2011	2012	2013
White Cap Creek to Running Creek	0.4	0.6	0.8	1.6	2.4	1.2	1.7	1.0	1.7	3.2	3.3	2.0	0.3	0.5	0.0	0.0	0.5		1.0	3.7	5.7	0.7	1.0	4.0	0.3	2.7	0.0	1.7	3.8	0.3	3.0
Running Creek to Bear Creek	0.8	0.4	1.2	1.0	4.0	2.2	2.2	1.2	3.6	2.8	2.6	2.6	2.4	1.0	0.0	0.0	3.0		0.3	5.0	4.3	1.7	1.0	1.0	2.0	1.8	0.3	2.8	4.7	0.3	7.8
Bear Creek to Moose Creek	1.8	1.2	0.4	1.5	4.4	4.2	1.6	2.4	4.4	4.0	5.0	1.2	3.0	1.0	1.2	0.0	1.5	0.0	2.8	4.2	2.3	3.3	1.4	0.9	0.7	2.0	0.8	2.0	3.8	0.2	2.0
Moose Creek to Three-Links Creek	0.6	1.3	0.7	1.9	3.3	3.1	3.9	4.2	6.2	5.9	5.8	1.4	0.3	0.0	0.3	0.9	1.6	0.3	3.4	2.3	2.2		1.7	3.4	0.0	0.8	2.8	2.3	7.0	3.0	2.8
Three Links Creek to Race Creek	1.2	0.3	1.4	1.2	2.5	3.0	1.8	3.5	4.8	3.6	3.2	3.7	0.9	0.0	0.0	3.0	2.3	3.0	1.0	0.7	0.8		0.5	1.8	5.0	0.8	4.3	4.0	1.3	2.2	1.8
Average	1.0	0.7	0.9	1.4	3.3	2.7	2.2	2.5	4.1	3.9	4.0	2.2	1.4	0.5	0.3	0.8	1.8	1.1	1.7	3.2	3.1	1.9	1.1	2.2	1.6	1.6	1.6	2.5	4.1	1.2	3.5

All Fish

River Section	1973	1974	1975	1976	1977	1978	1980	1982	1984	1986	1988	1990	1992	1994	1995	1996	1997	1998	1999	2001	2002	2003	2004	2005	2007	2008	2009	2010	2011	2012	2013
White Cap Creek to Running Creek	4.2	3.4	6.8	7.2	10.8	7.4	13.2	11.2	11.0	15.2	13.3	6.8	4.8	7.5	13.0	10.7	6.0		17.0	13.3	12.7	10.3	8.0	13.5	2.3	15.3	6.7	7.0	11.5	5.3	4.7
Running Creek to Bear Creek	7.2	4.8	6.6	6.2	18.6	10.6	18.6	11.2	17.4	19.2	11.6	16.4	9.4	9.0	13.3	15.5	26.5		12.6	12.7	21.0	8.3	5.0	6.0	4.5	8.5	4.0	9.0	10.2	8.8	16.2
Bear Creek to Moose Creek	5.3	7.5	5.0	6.0	17.4	19.6	16.0	16.2	19.4	21.4	21.8	7.4	6.2	8.3	13.3	15.0	7.8	1.0	16.6	7.5	8.6	10.6	7.0	8.4	3.6	15.0	10.2	13.8	12.5	5.8	8.5
Moose Creek to Three-Links Creek	4.5	8.2	6.3	8.8	22.0	20.9	21.7	20.3	25.7	26.1	24.3	6.8	4.4	3.0	6.0	8.5	10.5	2.0	10.6	5.3	12.6		12.0	19.8	1.8	14.8	21.4	31.3	22.8	9.2	52.8
Three Links Creek to Race Creek	5.0	3.4	4.6	6.1	9.3	9.8	17.2	20.8	16.3	24.6	17.4	11.7	3.0	6.0	6.4	30.0	15.0	7.6	4.2	1.3	2.2		5.5	6.7	15.3	10.3	12.5	16.0	11.0	8.8	11.2
Average	5.2	5.5	5.9	6.9	15.6	13.6	17.3	15.9	17.9	21.3	17.7	9.8	5.6	6.8	10.4	15.9	13.2	3.5	12.2	8.0	11.4	9.7	7.5	10.9	5.5	12.8	11.0	15.4	13.6	7.6	18.7

Table 6. Minimum estimated angling mortality rates of Westslope Cutthroat and Rainbow Trout from hook-and-line surveys on the Selway River, Idaho, from 2008 - 2013.

Year	Westslope Cutthroat Trout	Rainbow Trout
2008	2.9	2.8
2009	3.3	11.5
2010	0.6	2.6
2011	4.9	5.3
2012	2.3	1.4
2013	3.6	0.0
Overall	2.9	3.4

Table 7. Westslope Cutthroat Trout densities (GPM sites; fish/100 m2) and number of fish per transect (1-person sites) determined by snorkel surveys of the main stem Selway River, Idaho, in 2013.

Mainstem GPM Sites

Site	Transect length (m)	Transect width (m)	Temp °C	Cutthroat Trout	Steelhead (Snake River basin)	Mountain Whitefish	Chinook Salmon (spring run)	Bull Trout
Bad Luck Creek	90	42	-	0.58	0.00	0.48	0.00	0.05
Below Tango	100	51	-	0.35	0.26	0.26	0.08	0.00
Big Bend	100	41	15.0	0.30	0.00	0.23	0.00	0.00
North Star	97	40	16.5	1.07	0.00	0.65	0.31	0.00
Osprey Island	118	45	16.0	0.84	0.17	0.58	0.02	0.00
Average Density				0.63	0.09	0.44	0.08	0.01
St. Dev.				0.33	0.12	0.19	0.13	0.02

Mainstem 1-Person Sites

Site	Transect length (m)	Transect width (m)	Temp °C	Cutthroat Trout	Steelhead (Snake River basin)	Mountain Whitefish	Chinook Salmon (spring run)	Bull Trout
1/2 Mile Below White Cap	61	26	13.0	0	2	5	-	-
1 Mile Below White Cap	-	-	-	4	-	11	-	-
Cougar Bluff	66	22	-	10	7	11	-	-
1/2 Mile Below Running	54	32	-	29	4	12	-	-
Archer	52	22	-	10	-	-	-	-
Selway Lodge	49	27	-	12	-	-	-	-
Above Goat Creek Rapid	94	35	-	14	-	-	-	-
Above Rodeo	54	30	14.0	9	4	12	-	-
Below Rodeo	-	-	-	7	2	7	-	-
Below Pettibone	-	-	-	16	9	16	-	-
Rattlesnake Bar	-	-	-	6	1	2	-	-
Below Ham	-	-	-	6	5	1	-	-
Below Hell Creek	-	-	-	7	-	-	-	-
Moose Creek C\onfluence	18	55	-	46	23	15	-	-
Divide Creek	100	38	-	31	13	50	-	-
Above Ladle	-	-	-	47	48	4	-	-
Below Ladle	47	14	-	35	12	12	-	-
Below Osprey Rapid	-	-	-	5	6	5	-	-
Below 3-Links	-	-	-	4	-	-	-	-
Dry Bar	40	18	-	22	23	28	-	-
Above Wolf Creek	-	-	-	10	10	7	-	-
Above Renshaw	-	-	-	1	-	2	-	-
Otter	-	-	-	25	17	3	-	-
Packer	-	-	-	5	1	2	-	-
Average # of Fish				15.04	11.00	10.79	-	-
St. Dev.				13.61	11.83	11.58	-	-

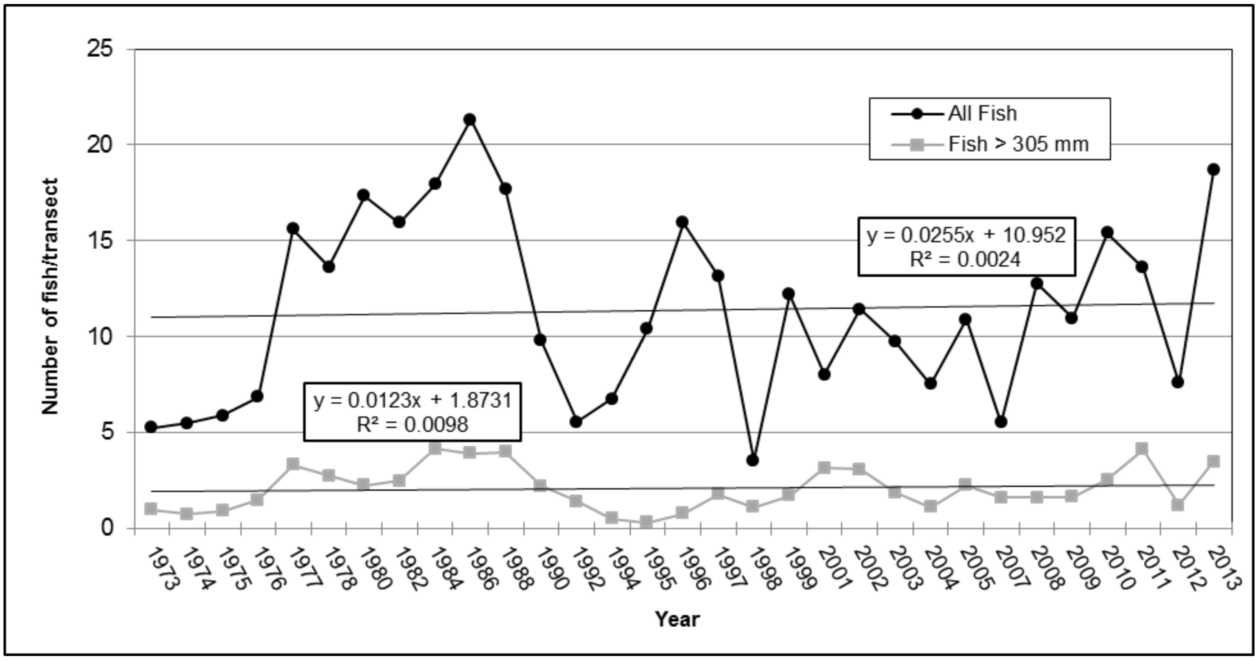

Figure 26. Average number of Westslope Cutthroat Trout counted per transect as determined by 1-person snorkel surveys in the main-stem Selway River, Idaho, 1973 - 2013.

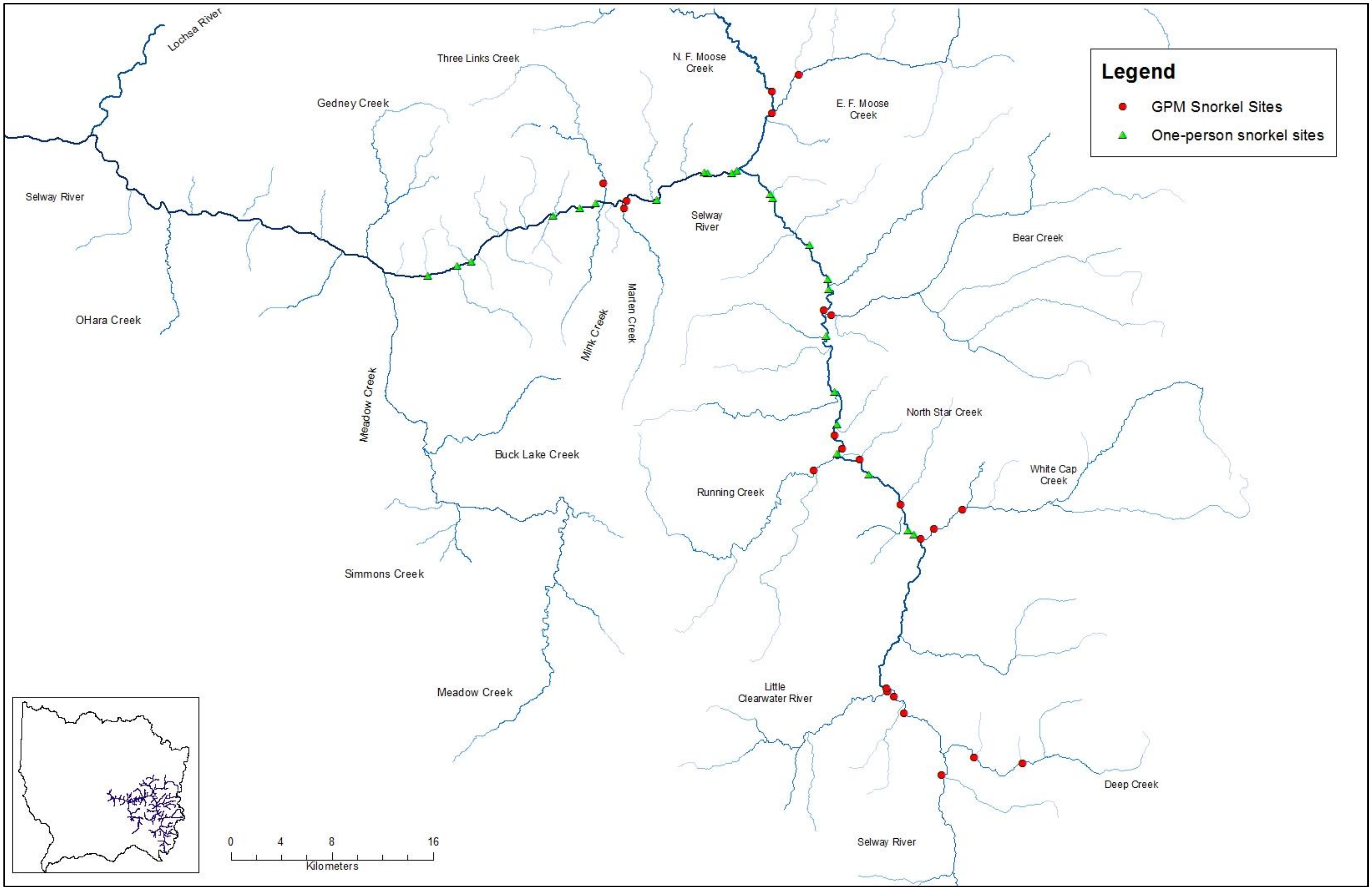

Figure 27. Map of snorkel sites surveyed in the Selway River basin, Idaho, in 2012 and/or 2013. General Parr Monitoring (GPM) and 1-person trend sites are shown separately.

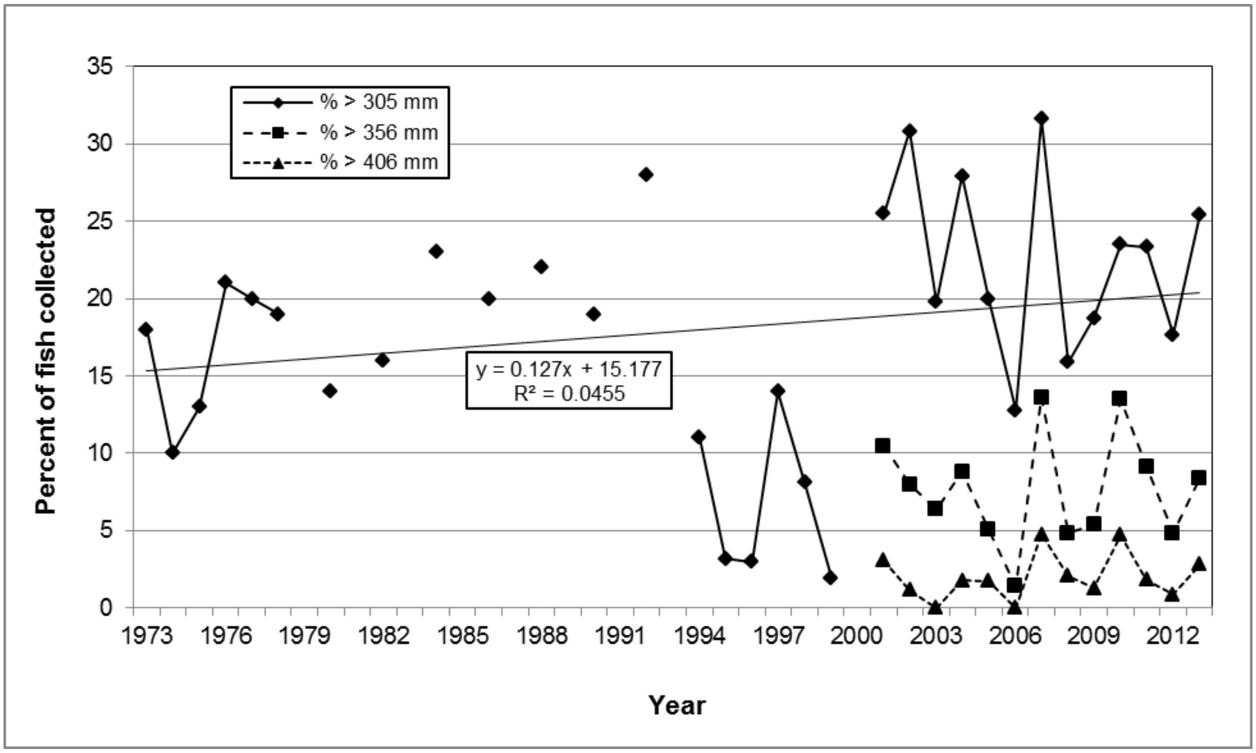

Figure 28. Percent of Westslope Cutthroat Trout observed by snorkeling the main stem Selway River, Idaho, above lengths of 305 mm, 356 mm, and 406 mm, from 1973 - 2013.

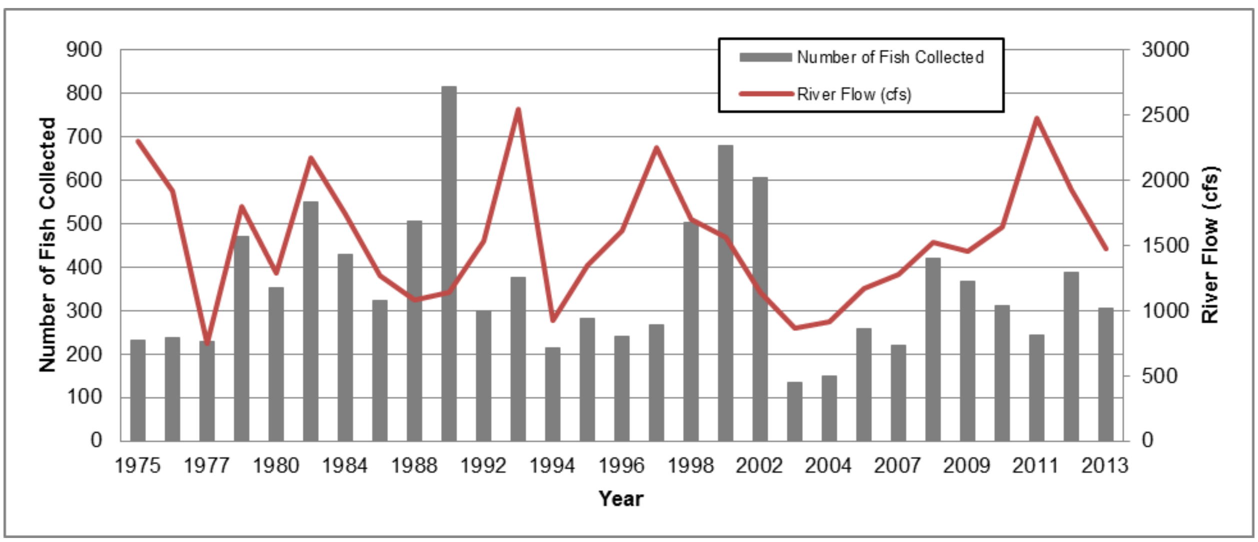

Figure 29. Number of Westslope Cutthroat Trout caught by angling in the Selway River, Idaho, compared to river volume at time of launch, 1975 - 2013.

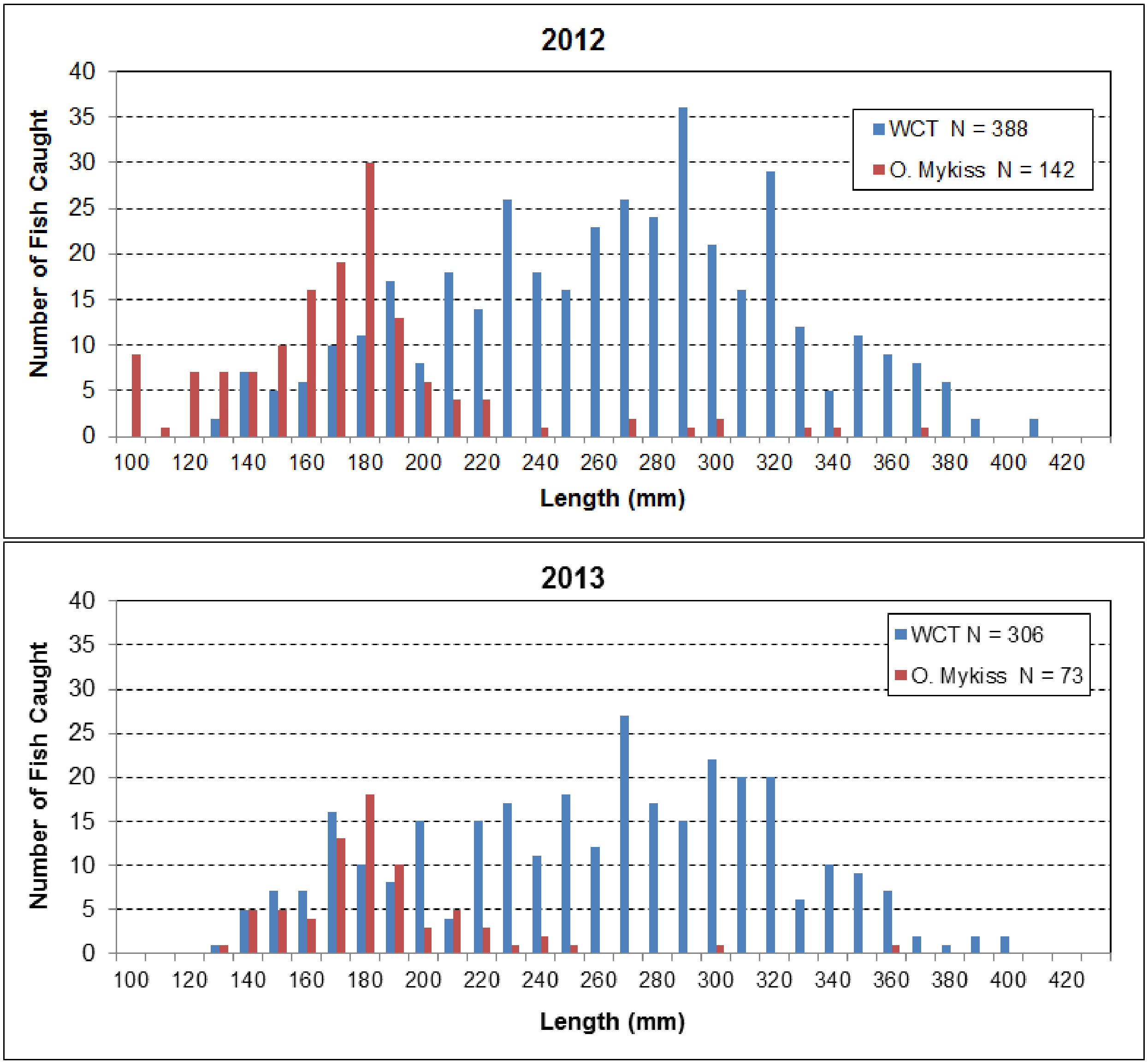

Figure 30. Length frequency distribution of Westslope Cutthroat Trout and Rainbow Trout caught by angling in the Selway River, Idaho, in 2012 and 2013.

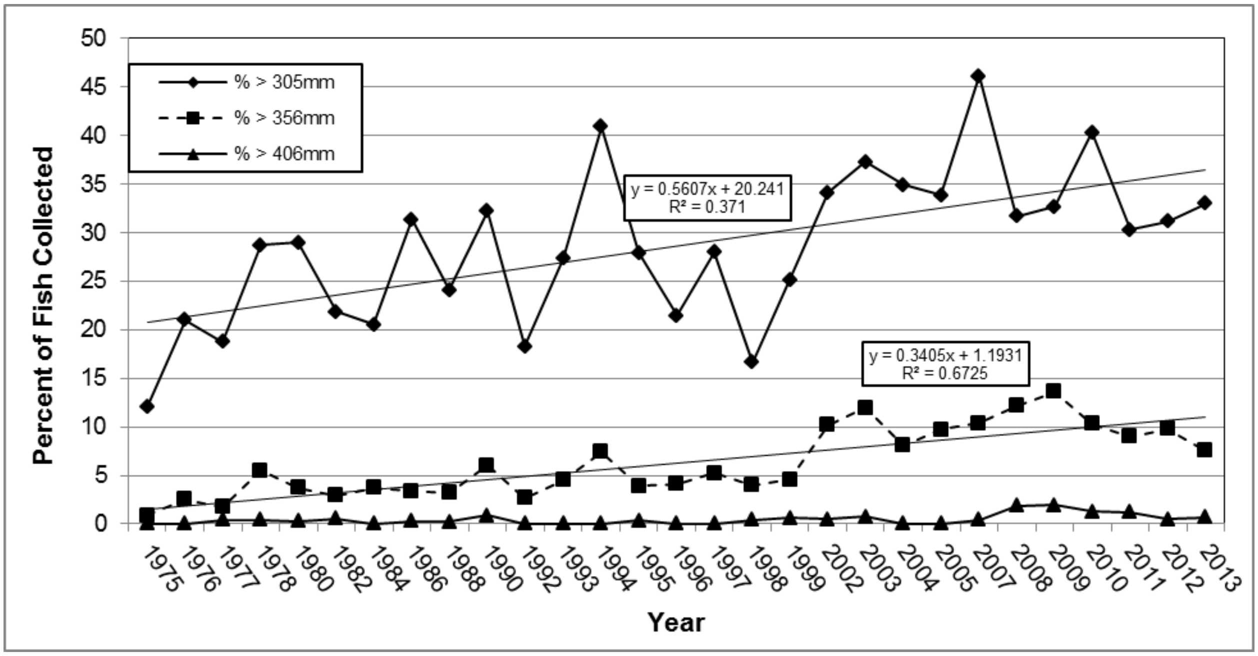

Figure 31. Percent of Westslope Cutthroat Trout collected by angling in the Selway River, Idaho, above lengths of 305 mm, 356 mm, and 406 mm, from 1975 - 2013.

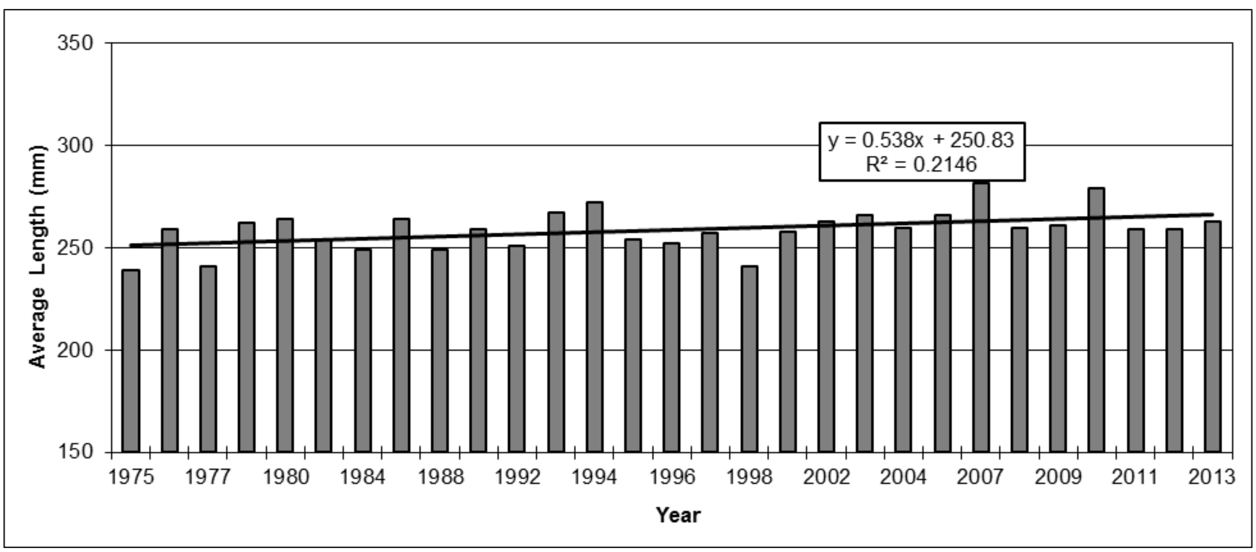

Figure 32. The average total length (mm) of Westslope Cutthroat Trout captured through hook and line surveys on the Selway River, Idaho, 1975 - 2013.

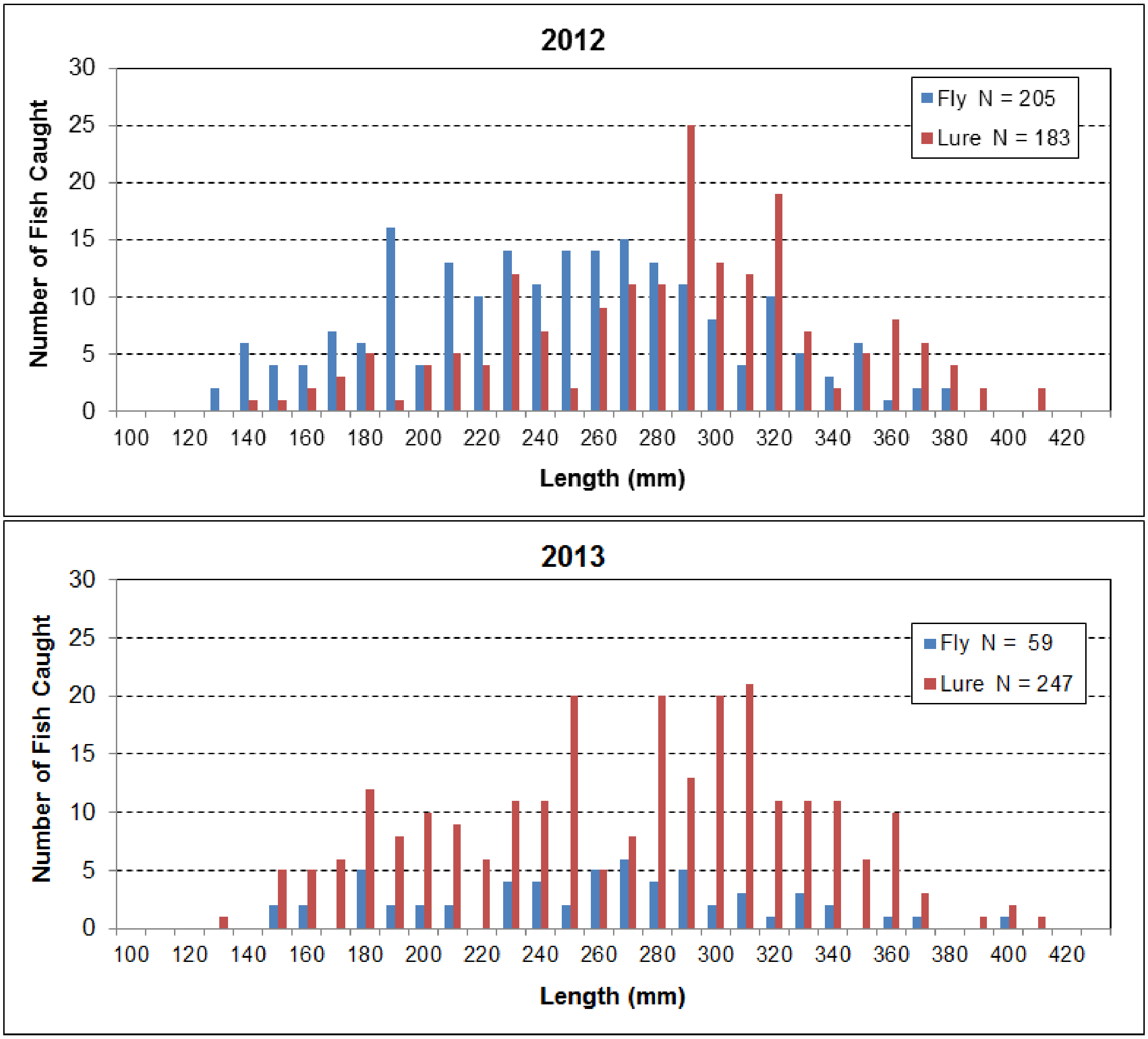

Figure 33. Comparison of length frequency distributions of Westslope Cutthroat Trout caught by anglers using lures and flies in the Selway River, Idaho, in 2012 and 2013.

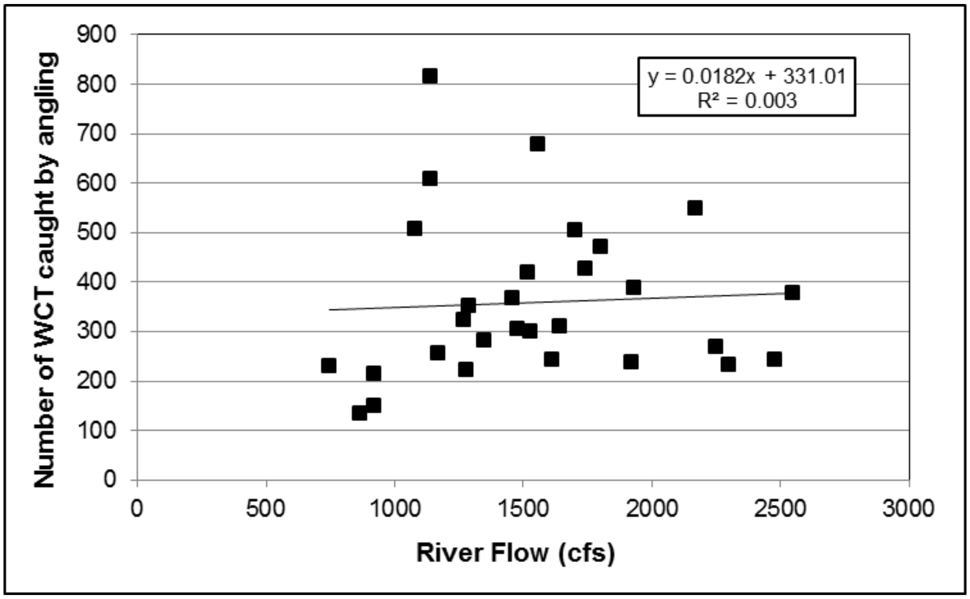

Figure 34. Regression plot of river flow versus number of Westslope Cutthroat Trout (WCT) caught by angling in the Selway River, Idaho, from 1975 - 2013.

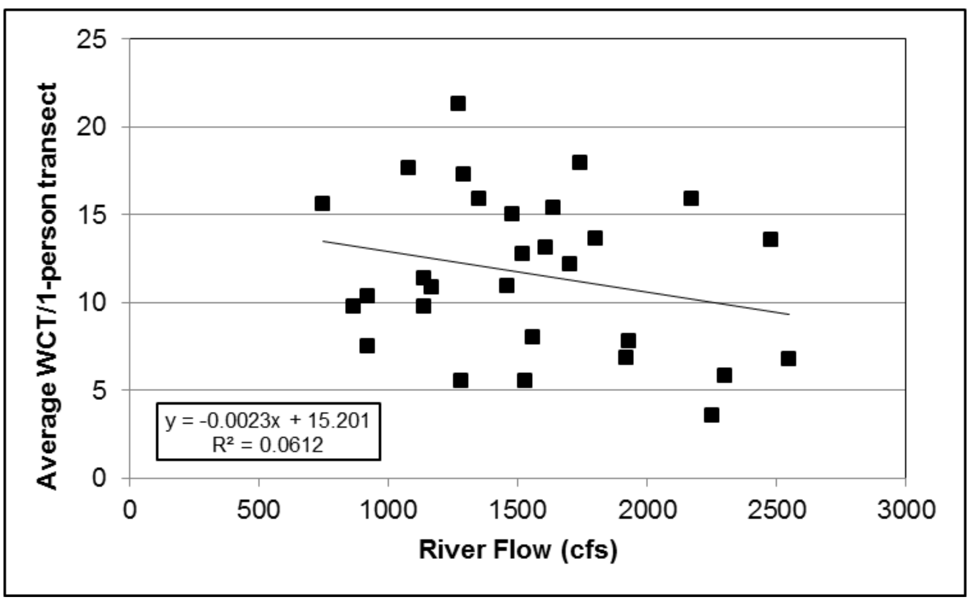

Figure 35. Regression plot of river flow versus average number of Westslope Cutthroat Trout (WCT) observed in 1-person snorkel transects in the Selway River, Idaho, from 1975 - 2013.

LOCHSA RIVER RESIDENT FISH TREND SURVEYS

ABSTRACT

Snorkel surveys were conducted on the main stem Lochsa River in 2013 to assess trends in the Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi* (WCT) population and to establish trends for other resident fishes. We snorkeled a total of 38 transects in the main-stem Lochsa River, Crooked Fork Creek and Colt Killed Creek during August 8-11, 2013. Twenty-two of those sites were established in the late 1970s and revisiting those sites allowed for direct comparisons of contemporary and historic densities in the Lochsa River drainage. Westslope Cutthroat Trout densities ranged from 0 to 2.11 fish/100 m^2 with an average density across all transects snorkeled of 0.40 fish/100 m^2. Observed densities across all Lochsa River mainstem sites were similar to densities observed in 1980 and 1981 surveys. Cutthroat Trout larger than 300 mm represented 50.0% of all WCT observed. The lowest WCT densities were observed below Wilderness Gateway Bridge, where harvest of two fish over 14 inches is allowed. We observed the highest densities of WCT in Colt Killed Creek, where harvest of two fish any size is allowed. We observed a positive correlation between WCT densities and elevation, which is likely a behavioral response of fish seeking thermal refuge during the hot summer months. We conclude the low densities of WCT below Wilderness Gateway Bridge is related primarily to this behavioral response to water temperatures, rather than a result of angler harvest.

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INTRODUCTION

An angler use and economic survey in 2011 (IDFG unpublished data) estimated 40,584 angler trips occurred on the major Westslope Cutthroat Trout *Oncorhynchus clarkii lewisii* (WCT) fisheries of the North Fork Clearwater, Lochsa, and Selway Rivers. These trips generated an estimated $13,311,606 in expenditures including groceries, lodging, and fishing gear. As demand on these fisheries continues, it is important to track the status of these fish populations to ensure continued quality fishing and to conserve wild native trout populations.

Westslope cutthroat trout are distributed throughout the Lochsa River drainage, occupying both the main-stem river and tributaries. Both resident and fluvial life history forms are present. The abundance of WCT in the Lochsa is likely different than it was historically. Early studies of WCT concluded that the low densities that were observed were a result of overfishing (Mallet 1967; Dunn 1968; Rankel 1971). US Highway 12, which runs along the entire length of the Lochsa River, was completed in 1962. Its completion opened up the entire length of the Lochsa River to easy access for anglers. By 1966, the WCT population was considered to have been drastically reduced (Lindland 1977), likely due to high levels of harvest. A 1956 creel survey (Corning 1956) estimated WCT catch at 5,948 fish. By 1976, creel surveys (Lindland 1977) showed catch had dwindled to 654 WCT. The low WCT population prompted the implementation of catch-and-release regulations in 1977 upstream of the Wilderness Gateway Campground bridge.

Over the years, snorkel surveys have been conducted to monitor the WCT population, among other objectives. Densities improved seven-fold in the catch-and-release section, and four-fold in the harvest section from 1977 - 1981 after the catch-and-release regulations were implemented (Lindland 1982).

Although occasional snorkeling efforts have been conducted in the Lochsa River since 1981 (see Hand 2008), the efforts in 2013 marked the first occasion since 1981 where the trend surveys established by Graham (1977) were revisited, thus allowing for a direct comparison of observed densities across time. The primary objective of this survey was to re-establish trend monitoring to evaluate current WCT densities, while simultaneously establishing trend and presence/absence surveys for other resident fishes, especially Smallmouth Bass *Micropterus dolomieu*, which are believed to have invaded the lower Locsha and Selway rivers.

OBJECTIVES

1. Assess WCT abundance and size distribution in the Lochsa River through snorkel surveys of historic sites. Compare WCT abundance to historic evaluations conducted 1975-1981.

2. Establish baseline information describing presence/absence, upstream distribution, and (if possible) abundance of Smallmouth Bass.

3. Document the distribution and relative abundances of other resident fishes.

4. Develop site descriptions for all reaches surveyed to facilitate repeatability of surveys and establish modern abundance trends.

STUDY AREA

The Lochsa River begins in the headwaters of the Bitterroot Mountains on the Idaho-Montana border. It is formed by the confluence of Crooked Fork Creek and Colt Killed Creek (formerly White Sands Creek). It flows 113 km southwest, joining the Selway River at the town of Lowell, ID, to form the Middle Fork Clearwater River. The Lochsa River drainage covers 3,056 km^2, all in Idaho County. The majority of the watershed occurs at elevations over 1,200 m. Most of the sub-basin is granitic rock that is part of the Idaho batholith. Land ownership in the Lochsa River drainage is mixed, with the majority of the land under public ownership managed by the U.S. Forest Service. Nearly 80% of the drainage is designated as wilderness (Selway Bitteroot Wilderness Area) or roadless. The Lochsa River itself is designated a Wild and Scenic River. The primary private landowner in the drainage is Western Pacific Timber Company. They, and previous owners, have intensively managed this area for timber production. These actions are believed to limit fish populations in some areas through sedimentation, poor in-stream cover, and impacts from upland disturbances.

Currently, the Lochsa River drainage is divided into three distinct trout harvest management areas. On the mainstem Locsha River from the mouth to the Wilderness Gateway Motor Bridge, there is an allowed harvest of two cutthroat exceeding 14 inches from Memorial Day weekend through November 30. From the Wilderness Gateway Motor Bridge to the confluence of Colt Killed and Crooked Fork Creeks, the mainstem Lochsa River is catch and release for all trout. Crooked Fork Creek, from its confluence with Colt Killed Creek to Brushy Fork Creek is also under catch and release regulations for trout. Colt Killed Creek and Crooked Fork Creek above Brushy Fork Creek are managed under Clearwater Region general rules (harvest of two fish, any size is allowed). Clearwater Region general fishing rules apply to all other species with the exception of salmon and steelhead.

The Lochsa River watershed supports wild runs of spring Chinook Salmon, summer steelhead, and Pacific Lamprey. Additionally, hatchery releases of spring and summer Chinook Salmon occur in this watershed. Native WCT, resident Rainbow Trout, Bull Trout, and Mountain Whitefish also occur in the watershed. Bull Trout are located mainly in the main-stem Lochsa River and the higher elevation streams, whereas Mountain Whitefish occur primarily in the main-stem Lochsa River and the largest tributaries. Rainbow Trout were stocked in the Lochsa River for decades, ending in 1990. Brook Trout were introduced in the early 1900's, mostly into high mountain lakes. They are now located in high mountain lakes and just a few of the lower gradient streams and are rarely observed in the Lochsa River. Smallmouth Bass are purported to occur in the Lower Lochsa River.

METHODS

Snorkel surveys were conducted on the main-stem Lochsa River at locations shown on Figure 36. We snorkeled a total of 38 transects in the main-stem Lochsa River, Crooked Fork Creek and Colt Killed Creek during August 8-11, 2013 (Table 8). In order to maintain consistency with surveys conducted on the Lochsa River from 1975-1980 by Graham (1977), Mabbott (1982), and Lindland and Pettit (1981), we snorkeled 22 transects in the main-stem Lochsa established by those researchers to evaluate population trends for WCT and steelhead. We snorkeled six additional transects in the main-stem Lochsa, five transects in Crooked Fork Creek, and five transects in Colt Killed Creek in order to more comprehensively evaluate resident fish population trends in the Lochsa drainage in the future. Two of the five sites on Crooked Fork creek were historical sites established by the General Parr Monitoring (GPM)

Program while the remaining three were not previously surveyed and were selected by scouting for high quaility habitat. All five sites on Colt Killed Creek were not previously surveyed and were selected due to presence of high quality pool and run cutthroat habitat.

All sample transects were snorkeled by one or two divers. A single diver was used only when the entire wetted width of the stream could be effectively observed by one diver. This occurred only in Colt Killed and Crooked Fork Creek transects. Snorkelers floated downstream within 10-20 m of the shoreline and observed towards the thalweg and towards their respective shorelines. Snorkelers remained as motionless as possible and tried to stay within 10 m of the shoreline to slow their downstream speed and increase the time they were able to observe fish in the transect. Previous studies reported the larger of two replicate counts at each transect, but due to time limitations, we chose to snorkel each transect only once. Divers made counts of all game fishes (Westslope Cutthroat Trout, Rainbow Trout (or juvenile steelhead), Mountain Whitefish, Bull Trout, and Smallmouth Bass) in one-inch length categories.

Unlike the historical surveys, we did not differentiate stream resident Rainbow Trout and putatively anadromous steelhead parr in our counts. Northern Pikeminnow, suckers *Catostomus spp.*, Redside Shiner *Richardsonius balteatus*, and Longnosed Dace *Rhinichthys cataractae* were counted in length categories of less than or greater than 12 inches (305 mm) within each transect. Transect length and average width (based on five measurements) was measured using a rangefinder. Visibility was estimated at each site by having a snorkeler back away from a model fish until markings on the fish were indistinguishable, the snorkeler then moved back towards the fish until the markings were discernable again. This distance was recorded to estimate visibility. Date, time of day, water temperature, and weather conditions were also recorded for each site. We visually estimated the percentages of pool, run, riffle, and pocket habitats in each transect. Transect descriptions for the Lochsa River drainage snorkel survey are located in Appendix A.

Densities of WCT were estimated per 100 m of transect length in order to be consistent and comparable with studies conducted in 1975-1981. Those studies summarized densities across three strata in the mainstem Lochsa river: Mouth of Lochsa River to Fish Creek, Fish Creek to Lake Creek, and Lake Creek to Crooked Fork Creek. We replicated those summaries for comparative purposes. It should be noted that previous studies doubled transect length to account for two divers. Our 2013 trend estimates also used this approach, but only for historical comparisons. We included both historical survey sites and new added sites in our estimation of the 2013 trend data point as there was no statistical or biological difference in the means and distributions of densities in new versus historic sites. We also estimated densities per 100 m^2 to be consistent with modern estimates in other river systems in northern Idaho. We evaluated densities of WCT across elevational gradients, as well as by harvest management section.

RESULTS

A total of 38 snorkel sites were surveyed from July 30 - August 14, 2013 on the main-stem Lochsa River, Crooked Fork Creek, and Colt Killed Creek. Twenty-eight sites were surveyed on the main-stem Lochsa River, five on Colt Killed Creek, and five on Crooked Fork Creek. Densities of WCT ranged from 0 to 2.1 fish/100 m^2 with an average density across all transects snorkeled of 0.4 fish/100 m^2. Across WCT harvest management sections, Colt Killed Creek (2 trout, any size) had the highest WCT densities (mean = 0.8 fish/100 m^2, SE = 0.01), followed by the catch and release section of the Lochsa (mean = 0.5 fish/100 m^2, SE = 0.13), Crooked Fork Creek (Catch and Release, mean = 0.5 fish/100 m^2, SE = 0.22). The lowest WCT densities were observed in the two fish over 14 inches harvest section of the Lochsa below Wilderness Gateway Bridge (mean = 0.04 Fish/100 m^2, SE = 0.01) (Figure 37). Densities of WCT were positively correlated with elevation (Figure 38). This correlation was even stronger when using density of WCT > 300 mm. Cutthroat trout larger than 300 mm represented 50.0% of all WCT observed. Rainbow Trout densities ranged from 0.00 to 1.37 fish/100 m^2 with an average density of 0.1 fish/100 m^2 across all transects. Mountain Whitefish densities ranged from 0.0 to 7.7 fish/100 m^2 with an average density of 1.0 fish/100 m^2. We observed six Bull Trout during our surveys, with two at a single transect in the upper main-stem Lochsa (LR25), and two each in Colt Killed and Crooked Fork Creeks. No Smallmouth Bass were observed during this survey. Observations of all fishes, including nongame species can be found in Table 2.

Densities of WCT were stable relative to the historic surveys completed in the early 1980s across all three main-stem Lochsa River strata (Table 10). From the mouth of the Lochsa River to Fish Creek, observed densities increased from 0.50 fish/100 m in 1980 to 0.84 fish/100m in 2013. Similarly, observed densities in the strata beginning at Fish Creek and ending at Lake Creek increased from 5.0 fish/100 m to 6.1 fish/100 m. The largest increase in observed densities occurred in the strata beginning at Lake Creek and ending at Crooked Fork Creek, with 8.0 fish/100 m in 1980 and 10.1 fish/100 m in 2013. We observed fewer RBT (of all life history forms combined) in 2013 (0.6 fish/100 m) than were observed in the 1975-1981 (mean = 3.3 fish/100 m) surveys (Table 10). The historical studies reported observed densities of RBT and steelhead parr separately, breaking juvenile steelhead into age-1 fish and fish age-2 or greater. We did not differentiate between resident RBT and steelhead, instead we made counts of all *O. mykiss* combined.

DISCUSSION

The observed WCT abundance in all three Lochsa River sections snorkeled in 2013 were higher than what was observed in 1980 and 1981 (Table 10). This gives us confidence the observed densities from the 2013 effort are reflective of continued relatively high population densities as a result of restrictive harvest regulations. However, because inter-annual fluctuations in snorkel counts are common due to actual changes in fish abundance and observer error/biases, more regular surveys will better elucidate modern population trends and inter-annual fluctuations. Because size structure was not summarized in Lindland (1982), we can’t examine changes in the density of large (>300 mm) cutthroat observed in the study area as a result of catch and release or restrictive harvest regulations. Counts of WCT > 300 mm comprised 50.0% of the fish observed in 2013.

One potential area of confusion that is important to clarify is with the overall (all river sections combined) abundance count (fish/100 m) of WCT in 2013 displayed in Table 10. Overall estimates in 2013 (3.88 fish/100 m) were slightly lower than those reported for 1981 (4.00 fish/100 m), even though higher densities were reported for each river section in 2013 versus 1981. The reasons for this discrepancy is additional sites were added to the most downstream river section (Mouth to Fish Creek) in 2013 to better assess use of fishes in this reach and potential expansion of Smallmouth Bass into the Lochsa River. Because these added sites were longer sites (when compared to upstream sites) with relatively low WCT counts, they drove down the overall estimate when compared to 1981. This illustrates the importance of evaluation of overall trends within the context of trends over time within individual strata (river sections). As such, future trend evaluations should occur at the scale of the current management zones in the Lochsa, as well as across all sections.

In the main-stem Lochsa River, we observed WCT densities nearly 13 times higher in the catch are release section (mean density = 0.50 fish/100 m^2, SE = 0.13) than in the harvest reach below the Wilderness Gateway Motor Bridge (mean density = 0.04 fish/100 m^2, SE = 0.01). However, angler harvest alone does not explain these differences in density, as Colt Killed Creek (where 2 trout of any size can be harvested) had the highest observed WCT densities of any management reach (mean density = 0.79 fish/100 m^2, SE = 0.33). We observed a strong correlation between WCT densities measured at each site and elevation (Figure 38). The highest transect densities observed in this study occurred at elevations over 670 m, which we speculate is largely a function of cooler water temperatures at higher elevations

Water temperatures are likely an important driver of both the distributions and densities of fishes observed in the Lochsa River. As water temperatures rise throughout the summer, fish, especially WCT, tend to move to achieve more optimal temperatures (Hunt 1992). In the Lochsa River, this likely means upstream summer movements. The Lochsa River is a high gradient system, gaining 5.4 m per km from the Selway River confluence to the Colt Killed Creek - Crooked Fork Creek confluence. Generally, summertime stream temperatures decrease with increasing elevation. According to the NorWeST stream temperature model (http://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html), modeled 19-year average August stream temperatures are 18 - 20 C in most river reaches below Boulder Creek (which joins the Lochsa River approximately 800 meters below Wilderness Gateway Motor Bridge). Between Boulder Creek and Warm Springs Creek, average August temperatures have historically been in the 16-18 C range. In the study area above Warm Springs Creek, average August temperatures drop to the 14 - 16 C or the 12 - 14 C range. Optimal temperatures for WCT are 13 - 15 C (Bear et al. 2007). Because temperature is a primary variable driving fish metabolism, behavior, and subsequently distribution, we conclude WCT densities in the Lochsa River drainage are not likely a result of allowed harvest in both lower elevation main-stem reaches and in Colt Killed Creek.

While there is some opportunity for WCT harvest in the Lochsa River system, the system is managed with restrictive or catch and release regulations. Early studies of WCT in the St. Joe River, Kelly Creek, and the Lochsa River, Idaho, concluded that the low WCT densities were a result of overfishing (Mallet 1967; Dunn 1968; Rankel 1971; Lindland 1977). Concern over declining populations prompted IDFG to implement catch-and-release rules in the Lochsa River in 1977. The initial and sustained increasing trend seen in the WCT fishery in the Lochsa River indicates that the catch-and-release rule has been successful in improving the density of WCT in the river. The data in Table 3 shows a substantial increase in the average number of WCT observed per transect after the rule change. This suggests that the rule change had an early and lasting effect on the WCT populations in the Lochsa. A similar trend was observed in the St. Joe River and Kelly Creek after catch-and-release rules were implemented (Johnson 1977). It should be noted that even with some harvest opportunity, the Lochsa River and Colt Killed Creek maintain a stable and productive WCT fishery.

The Lochsa River system provides a popular WCT fishery that is often compared by anglers to other northern Idaho Cutthroat Trout fisheries. Average densities for WCT of all sizes in the Lochsa River (0.40 fish/100 m^2) are similar to, albeit somewhat lower than densities observed in 2013 for the North Fork Coeur d' Alene River (0.75 fish/100 m^2, Ryan et al. 2014) and the Selway River (0.54 fish/100 m^2, see Selway River Fish Trend Surveys above). The St. Joe River had a substantially higher WCT density across all size classes in 2013 (1.42 fish/100 m^2, Ryan et al. 2014).

Observational studies, such as snorkeling are based on detectability, which, in this case, is a function of underwater visibility and distribution of individual fish within the river corridor. For this reason, we recommend striving to repeat these surveys in future years at similar flows. River flows during our surveys, as measured at the United States Geological Survey station at Lowell were within 200 - 350 cubic feet per second (cfs) of summer base flows (which occurred in mid-September). Flows at the Lowell stream gauge were approximately 600 cfs during the week in which the main-stem Lochsa River snorkel reaches were surveyed.

While no Smallmouth Bass were observed in this study, they have been observed by anglers in the Middle Fork Clearwater River, where they are targeted as a gamefish. Anecdotal reports suggest they are also present in the lower Selway River. Future surveys in the Lochsa River should continue to record presence or absence of these non-native sportfish, as they may experience a climate-mediated spread (see Rahel and Olden 2008) throughout the upper Clearwater River system.

MANAGEMENT RECOMMENDATIONS

1. Continue to monitor Smallmouth Bass distribution and abundance in the Lochsa River drainage to assess whether upstream colonization is occurring.

2. Snorkel the complete set of sites (historic and new) described in this report in at least two consecutive years and with greater frequency in coming years to better describe population trends and inter-annual variation in fish densities.

Table 8. Snorkel transect locations and characteristics for sites surveyed in the Lochsa River, during 2013. The new site name list is intended to be a standardized list used for future surveys. See appendix A for complete site descriptions.

Stream	New site name	Data sheet name	Latitude	Longitude	Elevation (m)	Total length (m)	Ave. width (m)	Site area (m^2)	Pool (%)	Riffle (%)	Run (%)	Pocket (%)
Lochsa River	LR01	LOC1	46.1478	-115.59184	445	215	74.0	15,910	0	10	90	0
	LR02	HL01	46.15893	-115.59	450	348	55.8	19,401	0	0	100	0
	LR03	HL02	46.16798	-115.58292	454	686	61.0	41,846	95	0	5	0
	LR04	HL03	46.20862	-115.54226	477	355	47.4	16,827	100	0	0	0
	LR05	HL04	46.21971	-115.52935	482	350	51.6	18,060	60	0	40	0
	LR06	LOC3	46.22899	-115.51059	494	415	51.0	21,165	0	15	85	0
	LR07	HL06	46.2257	-115.49619	494	210	57.8	12,138	30	0	70	0
	LR08	HL07	46.25156	-115.40046	541	360	34.8	12,540	40	0	60	0
	LR09	HL08	46.25329	-115.40022	543	100	31.6	3,160	0	0	90	10
	LR10	HL09	46.25561	-115.39953	545	310	30.4	9,424	100	0	0	0
	LR11	LOC6	46.29295	-115.37714	573	230	33.8	7,774	60	0	40	0
	LR12	HL10	46.33232	-115.34618	607	135	43.0	5,805	0	15	70	15
	LR13	HL11	46.33481	-115.34382	610	230	42.6	9,798	0	10	90	0
	LR14	HL12	46.33938	-115.31657	624	130	33.2	4,316	70	0	30	0
	LR15	HL13	46.33947	-115.31275	628	226	41.7	9,417	0	15	80	5
	LR16	LOC10	46.34486	-115.30704	633	130	36.6	4,758	50	0	50	0
	LR17	HL14	46.38297	-115.23227	706	125	28.0	3,500	10	5	75	10
	LR18	HL15	46.42353	-115.14409	792	156	31.4	4,898	80	0	20	0
	LR19	HL16	46.44567	-115.09087	828	316	38.2	12,071	80	0	20	0
	LR20	HL17	46.45316	-115.06233	845	295	34.0	10,030	75	0	25	0
	LR21	HL18	46.45842	-115.03786	856	360	28.2	10,152	80	0	20	0
	LR22	HL19	46.46582	-114.98612	878	120	62.0	7,440	0	15	85	0
	LR23	LOC20	46.47312	-114.95871	891	220	39.0	8,580	90	0	10	0
	LR24	LOC22	46.46448	-114.92977	907	192	40.8	7,834	0	10	85	5
	LR25	HL20	46.47337	-114.88909	936	168	28.8	4,838	0	0	95	5
	LR26	HL21	46.494	-114.85339	948	103	35.5	3,657	0	0	90	10
	LR27	HL22	46.49952	-114.83298	973	140	31.0	4,340	85	0	15	0
	LR28	HL23	46.51224	-114.76119	1,008	209	52.4	10,952	0	0	90	10

Table 8. Continued.

Stream	New site name	Data sheet name	Latitude	Longitude	Elevation (m)	Total length (m)	Ave. width (m)	Site area (m^2)	Pool (%)	Riffle (%)	Run (%)	Pocket (%)
Crooked Fork	CFC01	CF01	46.52901	-114.67628	1,074	91	22.4	2,038	5	20	70	5
	CFC02	CF02	46.55032	-114.67323	1,101	102	17.8	1,816	20	5	70	5
	CFC03	Strata 4.1B	46.56405	-114.64634	1,146	108	18.8	2,030	0	10	65	25
	CFC04	CF03	46.57039	-114.62919	1,159	110	20.4	2,244	0	10	80	10
	CFC05	Strata 3.2B	46.58146	-114.61118	1,199	99	11.8	1,165	5	5	70	20
Colt Killed	CKC01	CK01	46.51173	-114.66801	1,058	239	30.0	7,170	0	10	70	20
	CKC02	CK02	46.51072	-114.66254	1,062	120	27.4	3,288	20	0	80	0
	CKC03	CK03	46.51491	-114.65285	1,074	114	29.0	3,306	5	5	80	10
	CKC04	CK04	46.5142	-114.65033	1,075	132	29.2	3,854	5	0	80	15
	CKC05	CK05	46.51454	-114.64423	1,080	190	19.8	3,762	35	15	40	10

Table 9. Numbers of fishes observed in snorkel surveys in the Lochsa River in 2013. Column headers are abbreviated for Westlsope Cutthroat Trout (WCT), Rainbow Trout (RBT), Bull Trout (BT), Mountain Whitefish (MWF), age zero Chinook Salmon (CNK0), adult Chinook Salmon (CNK Ad), Smallmouth Bass (SMB), Dace sp. (Dace), Large Scale Suckers (LSS), Norther Pikeminnow (NPM), Redside Shiner (RSS), and Sculpin sp (Sculpin). The new site name list is intended to be a standardized list used for future surveys.

Stream	New site name	Data sheet name	WCT	RBT	BT	MWF	CNK0	CNK Ad	SMB	Dace	LSS	NPM	RSS	Sculpin
Lochsa River	LR01	LOC1	0	0	0	0	0	0	0	0	29	1	0	0
	LR02	HL01	7	1	0	34	0	0	0	0	70	25	0	0
	LR03	HL02	6	2	0	61	0	0	0	0	9	7	1	1
	LR04	HL03	1	0	0	126	0	0	0	0	27	17	4	0
	LR05	HL04	3	0	0	169	0	0	0	6	14	11	50	0
	LR06	LOC3	13	2	0	46	0	0	0	0	13	22	0	0
	LR07	HL06	9	1	0	21	0	0	0	0	32	23	50	0
	LR08	HL07	6	1	0	168	0	0	0	0	7	8	0	0
	LR09	HL08	4	1	0	14	1	0	0	0	4	0	0	0
	LR10	HL09	0	0	0	16	28	0	0	1	0	4	1	0
	LR11	LOC6	4	9	0	35	0	0	0	0	10	9	0	0
	LR12	HL10	12	3	0	33	0	0	0	7	13	17	0	0
	LR13	HL11	20	2	0	19	0	0	0	0	23	42	0	0
	LR14	HL12	6	2	0	28	0	0	0	0	22	85	0	0
	LR15	HL13	3	0	0	49	0	0	0	0	100	68	0	0
	LR16	LOC10	7	1	0	24	6	0	0	10	23	5	0	0
	LR17	HL14	74	29	0	74	2	0	0	1	0	1	0	0
	LR18	HL15	26	3	0	46	12	0	0	0	0	0	0	1
	LR19	HL16	25	6	0	92	0	0	0	0	26	21	0	0
	LR20	HL17	31	12	0	143	0	0	0	0	11	8	0	0
	LR21	HL18	39	0	0	364	0	0	0	0	30	8	0	0
	LR22	HL19	15	3	0	2	0	0	0	0	0	0	0	0
	LR23	LOC20	2	0	0	0	0	1	0	0	40	8	0	0
	LR24	LOC22	56	0	0	105	0	0	0	0	0	0	0	0
	LR25	HL20	45	0	2	76	0	0	0	0	14	9	0	0
	LR26	HL21	32	0	0	34	0	0	0	0	1	0	0	0
	LR27	HL22	39	0	0	334	0	5	0	0	23	30	0	0
	LR28	HL23	19	0	0	1	1	0	0	0	0	0	0	0

Table 9. Continued

Stream	New site name	Data sheet name	WCT	RBT	BT	MWF	CNK0	CNK Ad	SMB	Dace	LSS	NPM	RSS	Sculpin
Crooked Fork	CFC01	CF01	6	2	0	0	29	0	0	0	0	0	0	0
	CFC02	CF02	24	18	1	60	21	0	0	0	0	0	0	0
	CFC03	Strata 4.1B	5	2	0	0	45	0	0	0	0	0	0	0
	CFC04	CF03	2	0	1	0	13	0	0	0	0	0	0	0
	CFC05	Strata 3.2B	4	16	0	16	41	0	0	0	0	0	1	0
Colt Killed	CKC01	CK01	13	0	0	0	0	0	0	0	0	0	0	0
	CKC02	CK02	44	0	0	33	0	6	0	0	0	0	0	0
	CKC03	CK03	18	0	0	0	1	0	0	0	0	0	0	0
	CKC04	CK04	5	0	0	0	0	0	0	0	0	0	0	0
	CKC05	CK05	67	0	2	82	1	14	0	0	0	0	0	0

Table 10. Comparison of Westslope Cutthroat Trout (WCT) and various forms of O. mykiss snorkel counts in 2013 in the Lochsa River watershed, Idaho, relative to estimates from 1975-1981. Note that historic densities were measured in units of Fish per 100 m (linear measurement, not area). The values below for 2013 have been adjusted to these units.

				Steelhead	
Stream Section	Year	WCT	RBT	≥ Age 2	Age 1
Mouth of Lochsa to Fish Creek	1975	0	0.37	0.96	0
	1976	0.16	0.04	0.29	0
	1977	0.08	4.23	0.38	0.15
	1978	0.11	2.56	0.51	0.11
	1979	0.13	4.38	0.38	0.38
	1980	0.33	0.66	1	0.66
	1981	0.5	11	4.5	1
	2013	0.84	0.16	----	----
Fish Creek to Lake Creek	1975	0	2.5	9.73	2.92
	1976	0.07	2.7	5.45	0.11
	1977	0.08	7.6	2.9	0.7
	1978	1.17	4.46	5.12	2.12
	1979	0.41	1.18	2.27	1.86
	1980	5	11	2	0.33
	1981	3.75	10.3	3.5	1.5
	2013	6.09	1.47	----	----
Lake Creek to Crooked Fork Creek	1975	0	1.14	2.54	2.22
	1976	0	3.72	3.92	0.23
	1977	1.15	0	4.28	2.14
	1978	2.2	0	5.84	2.37
	1979	3.04	0.68	4.05	2.7
	1980	8	0	5.33	2.66
	1981	6.67	0	6.67	4.33
	2013	10.1	0.2	----	----
Overall	1975	0	1.34	4.41	1.71
	1976	0.08	2.15	3.21	0.11
	1977	0.19	2.6	2	0.6
	1978	0.82	2.89	3.02	1.2
	1979	0.68	2.61	1.8	1.4
	1980	3.73	4.67	2.27	0.93
	1981	4	7	2.33	1.33
	2013	3.88	0.61	----	----

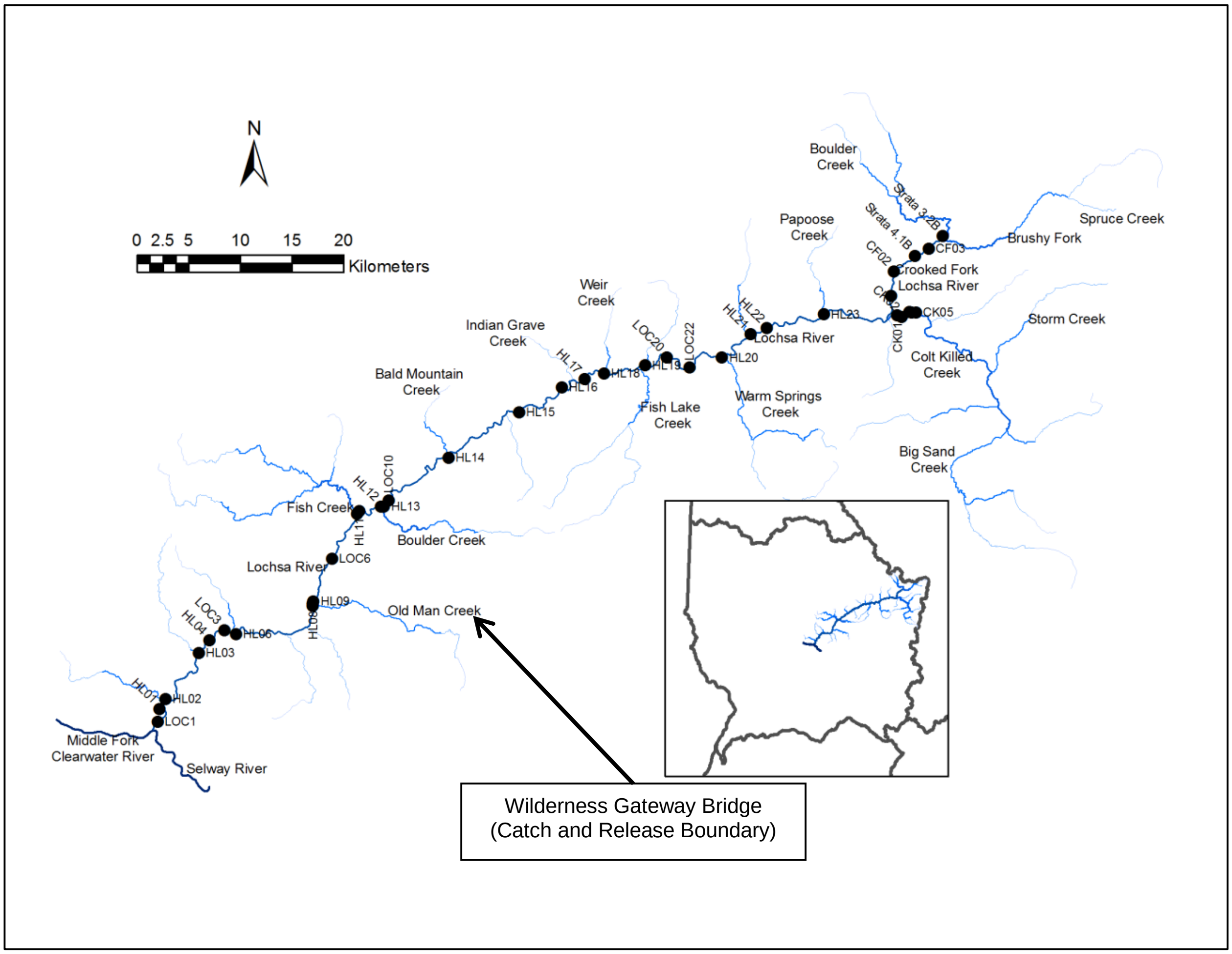

Figure 36. Map of snorkel sites surveyed in the Lochsa River, Idaho, in 2013. Site names shown here correspond to those used on field data sheets. Refer to Table 1 for a list of these site names and their corresponding standardized new name.

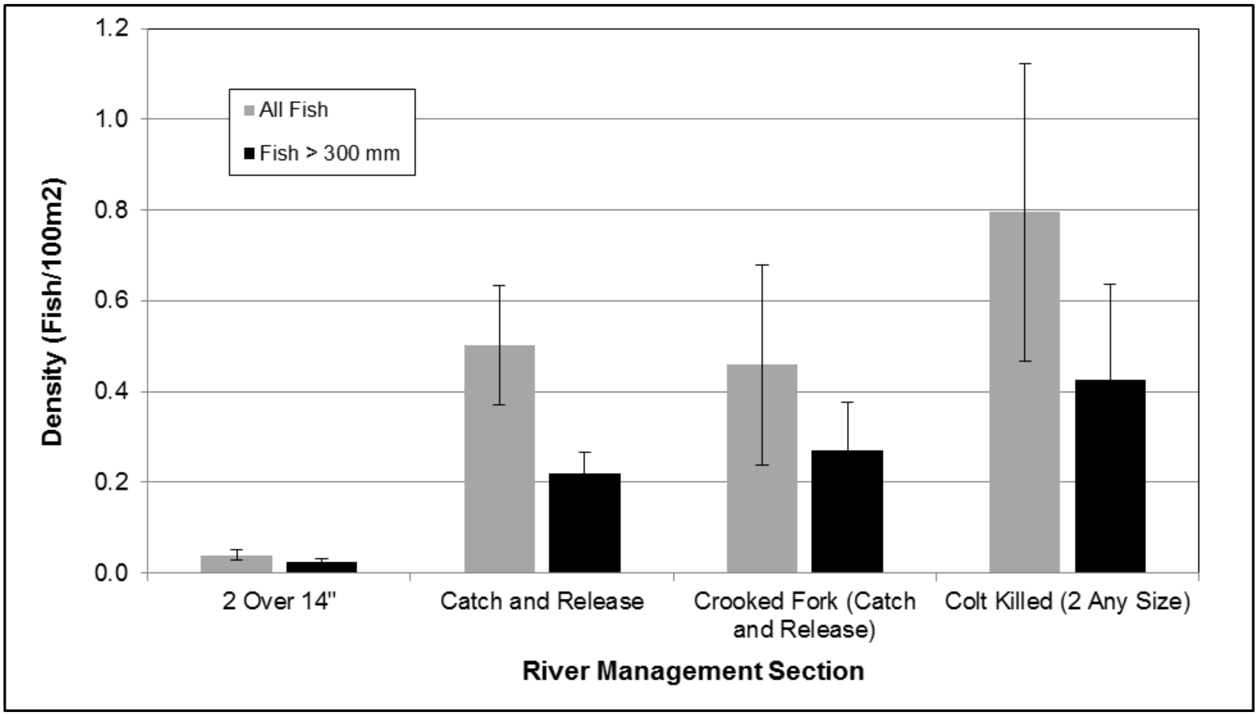

Figure 37. Average densities of Westslope Cutthroat Trout in four harvest management sections in the Lochsa River drainage, Idaho, observed during snorkel surveys in 2013.

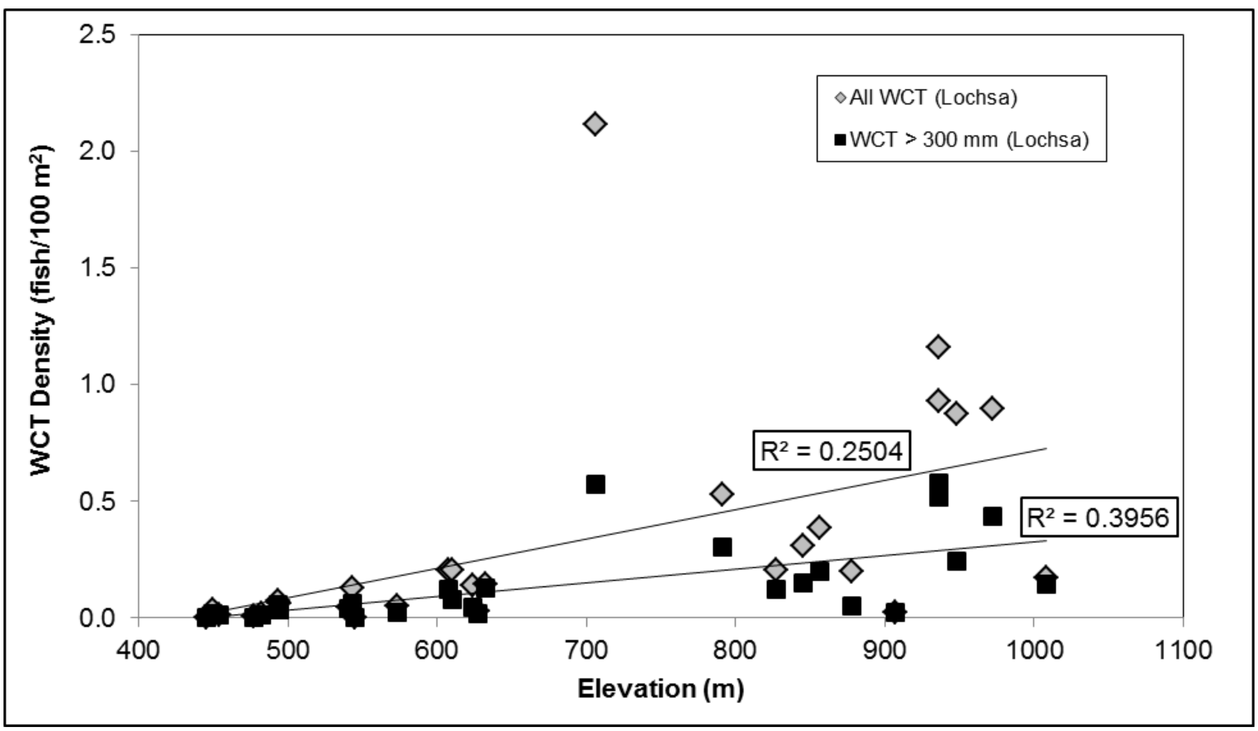

Figure 38. Westslope Cutthroat Trout (WCT) densities at trend snorkel sites as a function of elevation in the Lochsa River, Idaho, in 2013.

BULL TROUT REDD SURVEYS

ABSTRACT

Bull Trout *Salvelinus confuentus* redd count surveys were conducted on nine stream reaches within the North Fork Clearwater River sub-basin in order to assess long-term population trends for mature Bull Trout. A total of 61 redds were observed, all within seven index reaches used for long-term trend monitoring. The number of redds observed in these reaches ranged from 40 in 2001 to 87 in 2005, with a mean of 64.4. The Kendall's τ ($\tau = 0.31$) was not significant ($p = 0.19$). While trends in redd count data are consistent with a stable, but fluctuating population, continued decline below counts observed in recent years could indicate the beginning of a decline.

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INTRODUCTION

In 1998, Bull Trout *Salvelinus confluentus* were listed as threatened under the Endangered Species Act. Bull Trout in the North Fork Clearwater River sub-basin are part of the Clearwater River Recovery Unit. However, the construction of Dworshak Dam, approximately two km from its confluence with the main-stem Clearwater River, has genetically isolated the North Fork Clearwater River population from the rest of the recovery unit. The criterion for Bull Trout recovery specified by the U.S. Fish and Wildlife Service (USFWS) includes achieving an adult abundance of 5,000 individuals in the North Fork Clearwater River Core Area and maintaining local populations that are stable or increasing for at least 15 years (USFWS 2002).

Redd count surveys are commonly used to monitor trends in spawning populations of Bull Trout. Since Bull Trout are fall spawners, they construct redds at an ideal time for observation, when stream flows are low and stable. Redd count surveys were continued in the North Fork Clearwater River sub-basin to maintain a long-term data set in an effort to monitor trends in the spawning population of Bull Trout.

OBJECTIVES

1. Assess trends in the spawning population of Bull Trout in the North Fork Clearwater Core Area.

STUDY AREA

Bull Trout redd surveys were conducted within the North Fork Clearwater River subbasin above Dworshak Reservoir (Figure 39). The sub-basin is located primarily within the Clearwater National Forest and all survey reaches are located within the forest boundaries. While forest lands are managed by the U.S. Forest Service (USFS), fish populations are managed by the Idaho Department of Fish and Game (IDFG).

As in previous years, USFS personnel surveyed reaches of Bostonian Creek, Niagara Gulch, Placer Creek, and Vanderbilt Gulch, all of which are index reaches. Index reaches of Long Creek, Lake Creek and Goose Creek were surveyed by IDFG personnel. In addition, IDFG personnel surveyed historical reaches of Isabella Creek and Quartz Creek (Figure 39). No surveys were conducted in tributaries to the Little North Fork Clearwater River in 2013.

METHODS

Each stream was surveyed twice by USFS personnel, with the first round of surveys completed on August 29 and 30, when fish were beginning to construct redds. Redd locations were marked with a GPS and detailed descriptions were recorded to prevent double counting. The final round of surveys was completed on September 12 and 13, after spawning was complete. Personnel from IDFG conducted a single round of surveys during the week of September 23 through 27, which was a week later than previous years.

Redds were identified based on the size and depth of the disturbance, size and sorting of the substrate, color of the substrate in relation to the surrounding streambed, and stream morphology. The length and width of redds were measured to the nearest 10 cm and the location was determined using a GPS. We did not try to determine whether redds were constructed by adfluvial, fluvial, or resident fish based on redd size because there is likely some overlap in the size of redds constructed by each life history variant (Dan Kenney, USFS personal communication).

To evaluate trends in the spawning population, we analyzed the number of redds counted in seven index reaches that have been surveyed fairly consistently since 2001. Since trends in red count data are not likely to be linear, and the underlying model may be difficult to determine. JMP 9.0 was used to calculate Kendall's tau, a nonparametric rank correlation technique, to determine the direction and significance of the trend (Reiman and Meyers 1997). For ease of visual interpretation, a trend line was fit to the count data using a simple linear regression. Since data from the same seven reaches was consistently used, we used total counts rather than redds/reach for simplicity. Data from 2012 was not included in the analysis because IDFG did not survey three of the index reaches that year. All statistics used a significance level of $\alpha = 0.05$.

RESULTS

Nine transects were surveyed in 2013, in which 61 redds were observed (Table 11). All 61 redds occurred in the seven index reaches. The total number of redds occurring in the index reaches has ranged from a low of 40 in 2001, to a high 87 in 2005, with a mean of 64.4 for the 12-year period. The Kendall's tau ($\tau = 0.31$) indicated a positive slope, but was not significant ($p = 0.19$; $\alpha = 0.05$). Likewise, the regression line fit to the data yielded a positive slope (Figure 40), but was not significant ($p = 0.28$). Redds ranged from 0.4 to 1.3 m^2 in size, with a mean of 1.0 m^2 (Table 12).

DISCUSSION

While redd counts are commonly used to monitor trends in Bull Trout populations, there are several weaknesses in this methodology that should be considered. Al-Chokhachy et al. (2005) found that redd counts were generally comparable within, but not between basins. They further cautioned that redd counts may not be as accurate for the resident component in systems like the North Fork Clearwater River that have both a large migratory component and a small resident component. Therefore, these surveys may only be effective at monitoring the large migratory component of this population.

Dunham et al. (2001) found that changes in the spatial distribution of spawning activity could potentially affect the accuracy of redd counts performed on limited segments of index streams. If spawning use was to shift to a section of stream outside of the survey reach in a given year, it would give an erroneous appearance that the number of spawners had decreased. This may be the case with the historical survey reach on Isabella Creek. The upper boundary of this reach was a logjam that was believed to be a barrier to fish passage. When surveyed this year, the barrier was no longer present, possibly due to high spring flows in 2011. Since there is no longer a barrier to fish passage at this location, it is possible that spawners are using habitat that was recently opened up above it and that counts on this reach are no longer indicative of the spawning population in this stream.

Dunham et al. (2001) further found a considerable amount of variability between observers. Likewise, Muhlfeld et al. (2006) found inaccuracies amongst observers, but found that observer error was less with experienced surveyors. This could be problematic for maintaining a high level of accuracy in surveys conducted by IDFG due to the reliance on a temporary workforce. Increasing the level of training for all surveyors, in particular novice surveyors, is critical to ensuring the usefulness of the data collected.

Bull Trout redd count data for the North Fork Clearwater River subbasin suggests that the population has been stable since 2001. While both simple linear regression and Kendall's tau indicate an increasing trend, neither of these were significant. Therefore, while we cannot be certain that the population has increased since 2001, there is also no evidence that it has decreased.

Although redd numbers had generally increased between 2001 and 2010, the last two counts were down. This downturn may be the result of natural fluctuations in an otherwise stable spawning population. Redd count data from other Bull Trout populations in Northern Idaho and Montana have historically exhibited a considerable degree of interannual variation (Reiman and McIntyre 1996, Reiman and Meyers 1997), which suggests that fluctuations in spawning populations may be common. Counts for 2013 did increase slightly from those for 2011, the year for which the decrease was first observed. Counts for core areas in Northern Idaho exhibited a mixture of trends. The Lake Pend Oreille and St. Joe River core areas were both down from the previous two years, whereas the Priest Lake and Kootenai River core areas were about the same or up slightly (Ryan et al 2014). Future monitoring should reveal if it is a low in the natural cycle or the beginning of a downturn in the population.

RECOMMENDATIONS

1. Continue to assist the USFS with Bull Trout redd surveys in order to maintain the long-term dataset for the purpose of monitoring trends in spawner abundance.

2. Consider lengthening the reach were redds are counted in Isabella Creek.

3. IDFG survey crews should participate in redd count training with Region 1 or coordinate with the USFS to provide standardized training for survey crews.

Table 11. Historical Bull Trout redd counts, including the number of redds counted for each stream reach, the number of surveys performed each year, and the number of redds counted in all seven index reaches for years that all seven reaches were surveyed. Index reaches are indicated by grey shading.

Stream Surveyed	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
North Fork Clearwater River	--	--	--	--	--	--	--	--	0	--	--	--	--	--	--	--	--	--	--	--
Black Canyon	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--
Bostonian Creek	0	0	0	0	0	4	1	1	1	18	12	15	14	26	13	15	15	11	4	9
Boundary Creek	--	--	--	--	--	--	--	--	--	2	3	10	--	--	--	0	--	12	--	--
Collins Creek	--	--	--	--	--	--	--	0	--	--	--	--	--	--	--	--	--	--	--	--
Goose Creek	--	--	--	--	--	--		1	0	2	1	12	8	1	0	2	0	3	--	4
Hidden Creek	--	--	--	--	--	--	--	--	1	0	--	--	--	--	--	--	--	--	--	--
Isabella Creek	--	--	--	--	--	--	--	--	1	1	0	0	--	1	1	--	--	--	--	0
Kelley Creek - NFK	--	--	--	--	--	--	--	14	--	--	--	--	--	--	--	6	--	--	--	--
Lake Creek	--	--	--	--	--	--	19	7	20	14	5	2	5	3	0	2	0	4	--	1
Little Moose Creek	--	--	--	--	--	--	--	0	--	--	--	--	--	--	--	--	--	--	--	--
Long Creek	--	--	--	--	--	--	0	0	5	0	8	10	1	6	10	11	--	4	--	3
Moose Creek	--	--	--	--	--	--	0	0	0	0	0	0	0	0	0	--	0	--	--	--
Niagra Gulch	--	--	--	--	--	--	2	5	6	10	3	4	2	2	2	4	6	2	1	5
Orogrande Creek	--	--	--	--	--	--	--	--	--	--	--	0	--	--	--	--	--	--	--	--
Osier Creek	--	--	--	--	--	--	3	0	2	0	--	--	--	--	--	--	--	--	--	--
Placer Creek	3	1	2	2	2	7	4	2	4	6	2	3	5	2	3	1	3	1	3	7
Pollock Creek	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--
Quartz Creek	--	--	--	--	--	--	--	4	0	0	0	0	--	--	8	--	--	--	--	0
Ruby Creek	--	--	--	--	--	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--
Skull Creek	--	--	--	--	--	--	--	--	0	6	5	3	--	4	9	--	--	--	--	--
Slate Creek	--	--	--	--	--	--	--	--	--	--	--	3	--	--	--	0	--	0	--	--
Swamp Creek	--	--	--	--	--	--	2	0	1	0	0	2	--	1	--	--	--	--	--	--
Upper NF	--	--	--	--	--	--	--	--	--	7	3	6	--	--	--	0	--	14	--	--
Vanderbilt Gulch	--	--	--	--	--	--		24	18	13	12	41	35	39	43	49	57	31	33	32
Weitas Creek	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Windy Creek	--	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Breakfast Creek																				
Floodwood Creek	--	--	--	--	--	--	--	--	4	0	0	--	--	--	--	--	--	--	--	--
Gover Creek	--	--	--	--	--	--	--	--	--	1	0	--	--	--	--	--	--	--	--	--
Stony Creek	--	--	--	--	--	--	--	--	4	0	0	--	--	--	--	--	--	--	--	--
Little North Fork Clearwater																				
Buck Creek	--	--	--	--	--	--	--	--	--	5	--	--	--	--	--	--	--	--	--	--
Canyon Creek	--	--	--	--	--	--	--	--	--	0	--	--	--	--	--	--	--	--	--	--
Butte Creek	--	--	--	--	--	--	--	5	0	--	--	--	--	--	--	--	--	--	--	--
Rutledge Creek	--	--	--	--	--	--	--	--	--	1	1	6	0	--	--	--	--	--	--	--
Rocky Run Creek	--	--	--	--	--	--	--	--	5	1	3	21	13	8	--	8	10	1	14	--
Lund Creek	0	7	2	2	1	1	13	5	7	8	5	19	7	30	22	11	6	1	8	--
Little Lost Lake Creek	0	1	1	1	7	3	1	--	6	7	16	1	38	36	14	5	19	1	2	--
Lost Lake Creek	0	0	0	0	--	1	--	--	0	--	1	--	10	13	8	9	7	6	5	--
1268 Bridge to Lund Cr.	--	--	--	--	--	--	--	17	6	13	8	16	18	20	13	3	6	19	14	--
Lund Cr. to Lost Lake Cr.	--	--	3	1	9	8	3	12	7	7	5	8	16	21	9	11	9	11	16	--
Lost Lake Cr. to headwaters	0	2	0	0	--	5	1	--	5	6	5	11	13	8	20	14	7	6	31	--
Number of Surveys	6	6	7	7	5	9	14	18	26	29	25	23	16	18	17	18	14	17	11	9
Total Redds for all streams	3	11	8	6	19	31	50	97	104	129	98	193	185	221	175	151	145	127	131	61
Total Redds for 7 index tribs								40	54	63	43	87	70	79	71	84		56		61

Table 12. Size of redds encountered by IDFG personnel during Bull Trout redd surveys in the North Fork Clearwater River sub-basin on September 26, 2013.

Stream	Redd	Length (cm)	Width (cm)	Area (m^2)
Lake Creek	1	180	70	1.3
Goose Creek	1	160	100	1.6
Goose Creek	2	80	50	0.4
Goose Creek	3	160	80	1.3
Goose Creek	4	100	50	0.5
Long Creek	1	150	80	1.2
Long Creek	2	150	75	1.1
Long Creek	3	90	75	0.7

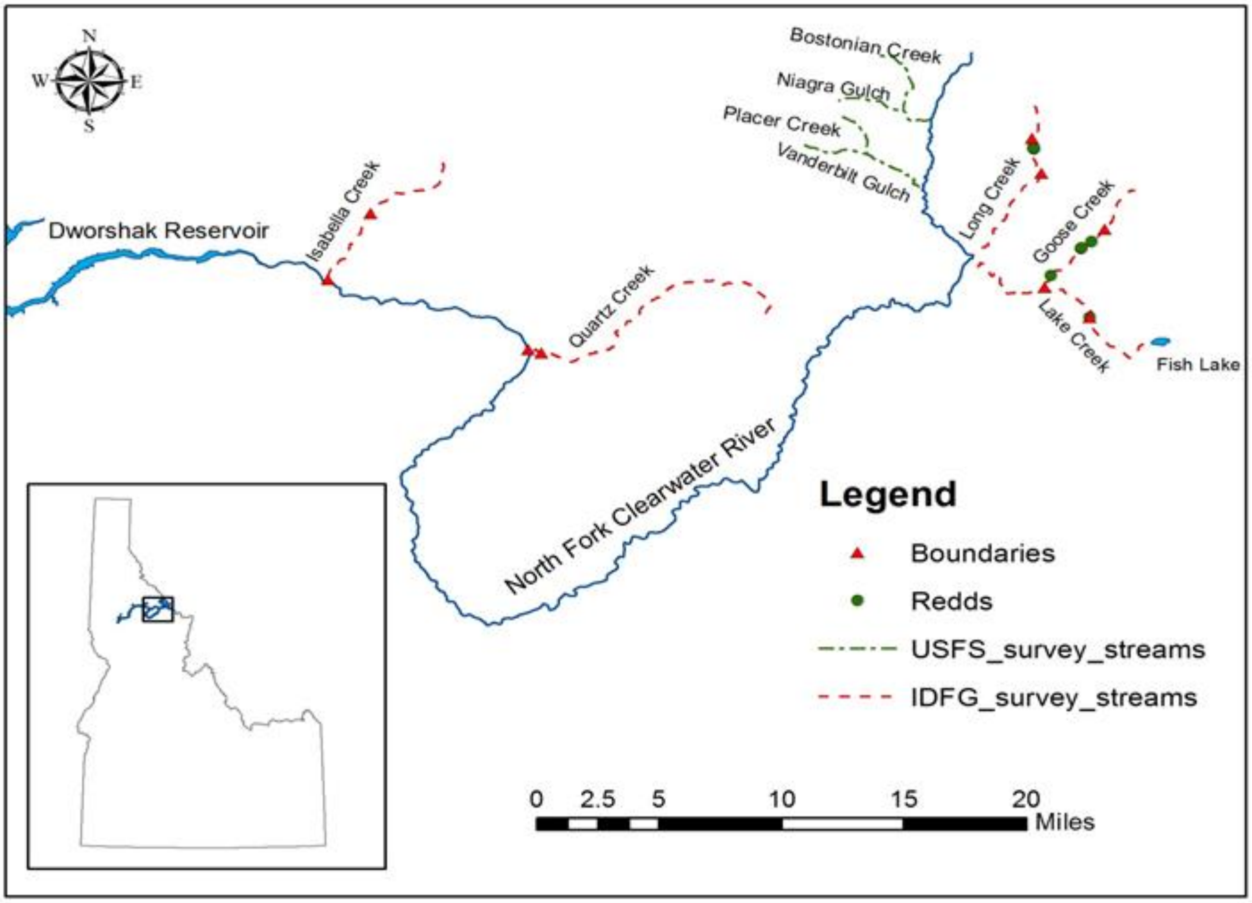

Figure 39. Reach locations for Bull Trout redd counts in 2013. Streams surveyed by IDFG personnel are indicated in red. Boundaries of the survey reaches are indicated by red diamonds and redds identified during the surveys are indicated by green diamonds. Streams surveyed by USFS personnel are indicated in green, but locations of reach boundaries and redds are not shown.

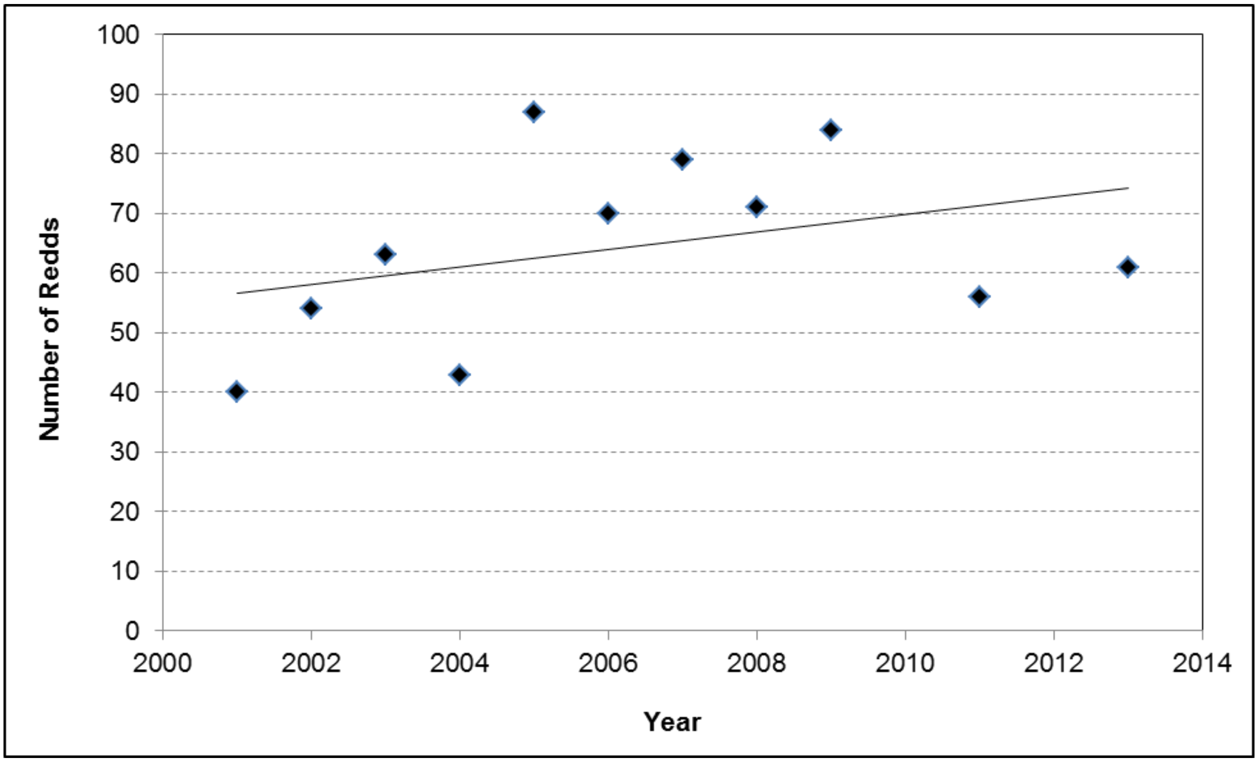

Figure 40. Total number of Bull Trout redds counted annually in seven index reaches in the North Fork Clearwater River subbasin. The trend line was fitted using simple linear regression to assist with visualizing the long term trend but was not significant ($p = 0.28$).

MOUNTAIN LAKES MONITORING IN CONSIDERATION OF AMPHIBIAN RISK ASSESSEMNT IN NORTH CENTRAL IDAHO

ABSTRACT

A 20-year study was designed in 2006 to evaluate long-term trends in amphibian populations within high mountain lakes and to determine the extent trout stocking was a threat to their persistence. Mountain lake surveys prior to 2006 provide baseline information on amphibian and fish abundance and distribution, and were utilized to develop an amphibian risk assessment based on the amount of fishless lakes and ponds within fifth field hydrologic unit code (HUC 5) watersheds throughout the Clearwater Region.

In 2013, surveys were completed on 16 lakes, including the five lakes that had yet to be surveyed. In the first round of completed sampling, 63 of 74 lakes (85.1%) had Columbia Spotted Frogs (CSF) present. Of these, 23 lakes had fish present and 40 did not have fish present. Additionally, 26 of 74 lakes (35.1%) had Long-toed Salamanders (LTS) present. Of these, 3 lakes had fish present and 23 did not have fish present.

Data analysis in 2013 primarily focused on modeling trends in amphibian population abundance as opposed to presence/absence. We explored two methods of estimating detection rates: (1) by using zero-inflated models specific to that life stage, and (2) by assuming presence of all life stages at any lake for which salamanders had ever been detected. Our best estimates of detection rates for both CSF (97%) and LTS (75%) are comparable to published values of 91% and 74% (Pilliod et al. 2010). We also conducted a power analysis to estimate the level of population change we will be able to detect over the course of this study. After 20 years, and assuming six surveys on each of the 74 lakes, changes in the adult CSF population of >1.5% per year (>26% over 20 years) should be reliably detected (Power >80%). For LTS, a composite score of all life stages outperformed any individual life stage, with the projected ability to reliably detect trends of >1.7% per year (>29.0% over 20 years).

Habitat relationships for both LTS and CSF were generally consistent with previous studies (Pilliod et al. 1996; Murphy 2002). For CSF, the proportion of fine substrates in a lake was positively correlated with a lake having at least three adult frogs. Depth also had a significant positive relationship with this binary response variable. Long-toed Salamanders were highly affected by fish presence. This is likely attributable to the longer larval stage of LTS (relative to CSF) which increases the susceptibility to predation during this aquatic life stage. Snowpack was never a significant predictor of amphibian abundance.

Preliminary results show no significant trends or changes in amphibian distribution or abundance since sampling began. Once additional rounds of surveys are completed, we will have a better idea if they are truly stable as suggested by power analyses.

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INTRODUCTION

Amphibian population reduction and species extinction has given urgency to amphibian conservation, inventory efforts to determine baseline data, and monitoring to determine trends in amphibian populations (Houlahan et al. 2000; Stuart et al. 2004; Beebee and Griffiths 2005; Orizaola and Brana 2006). Potential factors in amphibian population decline are numerous and include: habitat modification/fragmentation, introduction of predators/competitors, increased UV-B radiation, changes in precipitation/snowpack, and pathogen infection (Alford and Richards 1999; Corn 2000; Pilliod and Peterson 2000; Marsh and Trenham 2001). Throughout the North Central Mountains of Idaho, direct (predation) and indirect (resource competition, habitat exclusion, and population fragmentation) impacts on amphibian populations from introductions of trout into historically fishless lakes are a cause for concern (Petranka 1983; Semlitsch 1988; Bradford 1989; Figiel and Semlitsch 1990; Bradford et al. 1993; Brönmark and Edenhamn 1994; Gulve 1994; Brãna et al. 1996; Tyler et al 1998). Trout have been stocked into high mountain lakes to provide recreational opportunities to backcountry visitors. As much as 95% of previously and/or currently stocked high mountain lakes throughout the western United States that were once fishless, now contain fish through regular stocking efforts or self-sustaining populations from legacy stocking efforts (Bahls 1992). Murphy (2002) estimated that 96% of lakes within the Clearwater National Forest were historically fishless as the headwater area topography where lakes are located is relatively steep. According to historical stocking records, some lakes in North Central Idaho were stocked as early as the 1930s (Murphy 2002). Out of the estimated 3,000 mountain lakes in Idaho, approximately 1,355 lakes (45%) are stocked or have natural fish populations (IDFG 2012)

Mountain lake ecosystems in North Central Idaho contain amphibians such as Long-Toed Salamanders (LTS) *Ambystoma macrodactylum* and Columbia Spotted Frogs (CSF) *Rana luteiventris*, although Idaho Giant Salamanders *Dicamptodon aterrimus*, Western Toads *Bufo boreas*, and Rocky Mountain Tailed Frogs *Ascaphus montanus* may also be present. Common reptiles found at these mountain lakes may also include Common Garter Snakes *Thamnophis sirtalis* and Western Terrestrial Garter Snakes *T. elegans*, both of which were historically (before fish introductions) the main amphibian predators (Murphy 2002). The Idaho Department of Fish and Game (IDFG) Clearwater Region contains 711 mountain lakes. Approximately 400 mountain lakes were previously inventoried in the Clearwater Region through cooperation between the IDFG and United States Forest Service (USFS).

Murphy (2002) found that CSF occurrence (and breeding occurrence) in this area was not significantly different in lakes with or without fish after accounting for habitat effects (CSF were positively associated with increasing amounts of sedge meadow perimeter and silt/organic substrate). However, CSF abundance at all life stages was significantly lower in lakes with fish than without fish (Murphy 2002). Long-Toed Salamander larvae and/or breeding adult occurrence and abundance (adults are typically terrestrial except to breed) was significantly less common in lakes with fish then lakes without fish (Murphy 2002). However, where native (not stocked) Westslope Cutthroat Trout (WCT) *Oncorhynchus clarkii lewisi* existed in lakes, the impact on LTS was not as severe as compared to lakes that were historically fishless and later stocked with introduced western trout (Murphy 2002). Other studies have examined relationships between introduced trout and salamanders. Direct negative impacts by fish on amphibian populations have been mostly attributed to trout preying upon amphibians when they are at a larval stage, although trout may also cause salamanders to avoid lakes previously used as breeding sites (indirect impact) (Kats et al. 1993; Figiel and Semlitsch 1990; Bradford et al. 1993; Knapp 1996; Pilliod 1996; Graham and Powell 1999; Murphy 2002).

Introduced fish populations may also indirectly impact amphibian gene flow, recolonization, and subsequent persistence. The degree of gene flow in mountain lake amphibians likely relies on connectivity between higher and lower elevations subpopulations (with low gene flow). Gene flow may also occur between neighboring lakes that are not necessarily within the same wet stream migration corridor when overland dispersal is not drastically limited by headwater topography, precipitation, and or canopy cover (Murphy 2002). Tallmon et al. (2000) suggests that LTS within north-central Idaho are panmictic (randomly interbreeding populations) with high levels of within population variation providing evidence that populations are not evolving in complete isolation. Amphibian populations or demes in these headwater areas likely never evolved with native fish and may lack the appropriate defensive, behavioral, or chemical responses to coexist with introduced fish populations (Kats et al. 1988).

Westslope Cutthroat Trout, Rainbow Trout (RBT) *O. mykiss*, RBT x WCT hybrids, and Brook Trout (BKT) *Salvelinus fontinalis* are the most common introduced fish species in high mountain lakes in the Clearwater Region. Although, many lakes within the study area have a stocking history that may include Yellowstone Cutthroat Trout *O. bouvieri*, California Golden Trout *O. mykiss aguabonita* (last stocked in 1990 in the Clearwater Region - Steep Lakes), Arctic Grayling *Thymallus arcticus* (last stocked in 1982 in the Clearwater Region - Bald Mountain Lake), and various forms of trout hybrids. The term "introduced western trout" may be more appropriate for *Oncorhynchus* species in these lakes where natural reproduction is occurring, as the degree of hybridization is unknown in lakes where multiple species have been stocked (Behnke 1992). The Clearwater Region currently stocks 87 of its 711 high mountain lakes. Most lakes are stocked with fry-sized WCT on a three year rotation by fixed wing aircraft.

Murphy (2002) found that certain species of introduced trout tend to have a greater impact on amphibian occupancy than others. Brook Trout tend to impact CSF and especially LTS occurrence and breeding to a greater extent than the presence of either *Oncorhynchus* species. This impact is derived from differences in fish spawning times/behavior and variations in amphibian habitat usage just after ice off conditions in mountain lakes (Murphy 2002). Westslope Cutthroat Trout and RBT in these lakes spawn in spring/summer, which often coincides with times that amphibian breeding occurs. As a result, both fish species are typically preoccupied with spawning in inlets or outlets while amphibians are typically breeding within the lake itself. This difference in spawning habitat use may allow amphibians to breed with fewer disturbances by WCT and RBT (Murphy 2002). In contrast, BKT are fall spawners and are actively moving and foraging throughout the lake in spring and therefore more likely to prey upon any amphibian life stage and/or harass breeding adults (Murphy 2002). Furthermore, BKT tend to be more benthic oriented (where salamanders usually occur), utilize larger prey items, and attain higher densities within mountain lakes than *Oncorhynchus* species (Griffith 1974). Columbia Spotted Frogs are less affected by BKT presence than LTS because of their different habitat associations and shorter length of larval stages.

Long-Toed Salamanders occupy a wide range over the western United States and Canada. The majority of LTS in Idaho sub-alpine lakes have a two year larval stage, making them susceptible to predation by fish for a longer period of time. Studies suggest that they are more susceptible to impacts by introduced fish than the CSF (Murphy 2002). However, conclusive evidence of LTS decline is insufficient (Graham and Powell 1999). For this reason, a long-term monitoring project (20 years) was initiated in the Clearwater Region to provide knowledge of the amphibian population dynamics within alpine lakes of north-central Idaho. Long-term monitoring of mountain lakes will allow for amphibian population trends to be identified and will give managers the ability to determine whether sufficient fishless habitat exists to support amphibian populations into the future.

Prior to the 2006 mountain lakes field season, a long-term monitoring study design and protocol was developed for mountain lakes. The study design and protocol addressed the amphibian risk assessment that has been developed through previous studies and inventories of mountain lakes conducted within north-central Idaho (Schriever 2006).

The amphibian risk assessment is based on the amount of fishless habitat that exists within a watershed at the HUC5 level. At the individual HUC5 watershed level, it is assumed that monitoring will be able to examine conditions that may dictate local response in the interactions of stocked fish and native amphibian populations to provide a more defined opportunity for prioritized management action (Murphy 2002). While there are many risk factors associated with amphibian declines, our assessment focused on considering impacts that may be associated with native and stocked fish in lakes on a HUC5 watershed basis. The amphibian risk assessment for these high mountain lake ecosystems has four categories: control or no risk, low, moderate, and elevated (Figure 41).

- *Control or no risk* – watershed has never experienced fish introductions through stocking activities.
- *Low* – At least 50% of the lakes within a watershed are fishless <u>AND</u> a minimum 20% of the lake surface area within the watershed is fishless.
- *Moderate* – 50% of lakes within a watershed are fishless <u>OR</u> 20% of surface area is fishless.
- *Elevated* – Meets neither requirement, less than 50% of the lakes within a watershed are fishless <u>AND</u> less than 20% of the surface area within the watershed is fishless.

Two watersheds (HUC5) were selected randomly from each of the amphibian risk categories (region-wide from all HUC5 watersheds that contained lakes) for sampling (Appendix B). This resulted in five HUC5 watersheds containing 33 lakes within the Nez Perce National Forest and three HUC5 watersheds containing 39 lakes within the Clearwater National Forest, for a total of 72 lakes (Appendix B). In 2013, a third randomly selected control watershed was added (In Nez Perce Forest) to increase the sample size of fishless control lakes, bringing the study's total to nine watersheds that contain 74 lakes (Figure 42; Appendix B). Attempts will be made to sample all lakes within a selected HUC5 watershed within the same field season. The 20-year period for the high mountain lakes long-term monitoring project will allow for each of these lakes be sampled six different times. The repetition of sampling events will allow for comparisons comparing trends within and between watersheds (for comparisons among amphibian risk classes). In addition, repetition of sampling events will address the normal patterns of recruitment fluctuations often common among amphibian populations. Sampling frequency and rotation order are adjusted to accommodate weather and fire conditions.

OBJECTIVES

1. Evaluate the long-term impacts of fish on amphibian populations within the high mountain lake ecosystems in the IDFG Clearwater Region.

2. Assess whether current fish management in high mountain lakes of North Central Idaho is sufficient to provide long-term persistence of amphibian populations.

STUDY AREA

The 74 lakes selected for this study are located in the Bitterroot National Forest, Clearwater National Forest, and Nez Perce National Forest, located in north-central Idaho (Figure 42). These three national forests encompass the entirety or portions of four wilderness areas (Frank Church, Gospel Hump, Hells Canyon, and Selway Bitterroot) and one Pioneer Area (Mallard Larkins). Within the Bitterroot, Clearwater, and Nez Perce National Forests are eight, fourth field hydrologic unit code (HUC4) sub-basin drainages containing 105 mountain lake management areas at the fifth field hydrologic unit code (HUC5) level. The HUC4 sub-basin drainages include: the North Fork of the Clearwater River, the South Fork of the Clearwater River, the Lochsa River, the Upper and Lower Selway River, the Middle Fork and Lower Salmon rivers, and the Hells Canyon reach of the Snake River.

In 2013, IDFG personnel surveyed 24 water bodies within five HUC5 watersheds: Warm Springs Creek, Storm Creek, and Old Man Creek within the Clearwater National Forest, and Bargamin Creek and Big Harrington Creek within the Nez Perce National Forest.

Photographs, routes and bathymetric/surrounding area maps of lakes within the HUC5 watersheds are maintained in the Clearwater Region office within the mountain lakes database. As of 2013, not all of these files are complete, and will require completion in following years of the study. Available files are located in the IDFG Clearwater Region shared drive at the address: S:\Fishery\MTN Lakes\Long Term Monitoring\Photos, Lake Maps, Routes.

METHODS

Field Sampling

Field sampling was conducted following the same protocol used throughout the duration of this project. This protocol was updated and revised after the 2013 field season to improve the accuracy and comparability of results from year to year. A complete description of the sampling protocol can be found in Appendix D.

Laboratory Analysis

Fish scales were photographed under magnification (20-60x) and catalogued. In the future, they may be analyzed to determine age and growth rates, and compared to stocking records to determine if natural recruitment is occurring.

Zooplankton were subsampled (n >200 for each unique combination of site, survey date, and depth) and identified under magnification to the taxon levels listed in the protocol (Appendix E).

Statistical Analysis

Fish

Catch per unit effort (CPUE) was calculated for each gill net set. In order to make comparisons of fish condition among lakes and across time within our study, regional length-weight relationships were established for each fish species, according to the equation:

$$W = a * L^b$$

where W is weight in grams, L is total length in mm, and a and b are parameters obtained by non-linear least-squares estimation. These relationships were derived by averaging all study data for the appropriate species on a fish-by-fish basis, thereby providing a convenient benchmark against which individual survey data could be compared. For each lake, an average relative weight ($W_r = W/W_s$) was calculated, where W_r is the relative weight, W is the actual weight (g), and W_s is the average species- and length-specific weight (modified from Wege and Anderson 1978).

Explanatory and response variables

We evaluated a set of explanatory variables that were selected for their potential to structure amphibian distributions, based on a review of amphibian research in high mountain lakes (e.g., Knapp and Matthews 2000, Murphy 2002, Pilliod et al. 2010). Most of these variables characterize a site's habitat, climate, and ecological community:

Depth: maximum lake depth in meters (square root transformed).
Elevation: elevation in meters.
Fines: proportion of fine sediments in the lake (organic substrate + silt).
Fish: Presence or absence of fish (categorical).

The distribution of maximum lake depths was highly skewed, with a long right tail. In order to avoid excessive influence of a few deep lakes on regression parameter estimates, and to linearize the relationship between depth and the response variables, a square root transformation was applied. Lake surface area and littoral zone were not included because they were highly correlated to maximum depth (Pearson's correlation > 0.7; Figure 43).

In addition to site-specific variables, two time-specific elements of climate and season were included:

Julian day: day of the year on which sampling occurred.
Snowpack: average April snowpack for the Clearwater Region in the calendar year during which sampling took place (obtained from NRCS SNOTEL Data).

Response variables of interest were the presence and abundance of amphibians:

Presence: whether or not a species occupies a site (also referred to as occupancy).
Abundance: the number of individuals occupying a site.

Presence, occurrence, and occupancy are often defined inconsistently in the literature. Definitions presented herein attempt to follow general rules but should be considered specific to this report. Presence can be estimated using amphibian detections and non-detections (i.e., occurrence), while abundance can be estimated using amphibian counts.

Occurrence: whether or not a species is detected at a site during a visual encounter survey (i.e., **Count** > 0). (Used to estimate Presence.)

Count: the number of individuals found during a visual encounter survey. (Used to estimate Abundance.)

Proper estimation of presence and abundance must account for imperfect detection, i.e. the failure to detect a species when it is present. We present a zero-inflated model for doing this later. However, zero-inflated models are parameter-rich, and would benefit from at least a third round of surveys. Therefore, for this interim report, we directly model amphibian occurrence and counts rather than estimates of true presence and abundance.

Generalized linear models for presence and abundance data

Ordinary linear regression methods assume that error in the response variable is normally distributed. However, this assumption is usually not met with presence and abundance data. Generalized linear modeling extends ordinary linear regression by allowing for non-normal error distributions. For a binary response, such as presence/absence (detection/non-detection), the appropriate distribution is the Bernoulli trial (i.e., a binomial distribution with $n = 1$); the corresponding class of generalized linear models is logistic regression. A Poisson distribution is often appropriate for count data: it represents the number of detections for a fixed sampling effort, given that detections occur randomly within the sample at a constant average probability. However, counts of animals are frequently more variable than expected by a Poisson distribution. This over-dispersion is often attributable to demographic stochasticity, clustering behavior, or other covariates that are not accounted for by the model (Zuur et al. 2009). In these situations, a negative binomial distribution, which contains an extra dispersion parameter, may more accurately represent error.

A common alternative to generalized linear modeling is to transform the count data (e.g., with a log transformation) to better meet the classical assumptions of normality and homogeneity of variances. These transformations allow researchers to tap into the powerful, well-developed toolkits of classical statistics (e.g., ordinary linear regression). Some classical tests are moderately robust to violations of assumptions, but forcing data into a classical framework can fail to accurately represent error structures. This may result in loss of information, misguided conclusions on the significance of relationships, and inaccurate parameter estimates (Bolker 2008). As generalized linear modeling techniques become more advanced and more flexible, they present opportunities for researchers to use statistical methods that are better customized to their specific dataset and research questions (Bolker et al. 2009).

Additive models were used to test for non-linear relationships between explanatory and response variables. For our dataset, non-linearity did not significantly improve models, with the exception of seasonal changes in counts. We chose to model this seasonality by including polynomial terms of Julian day within a linear framework rather than through additive modeling. Henceforth, we present only the results of linear modeling.

To avoid pseudo-replication within a repeated measures study design, we used generalized linear mixed models (GLMMs) that included "Site" as a random effect. Generalized linear mixed model parameters were estimated using Gauss-Hermite quadrature (glmer and glmmML packages in R), which is preferred over simpler and more common penalized quasi-likelihood methods, especially for small sample sizes and non-normal error distributions (Bolker et al. 2009).

Spatial patterns

For CSF and LTS, we used GLMMs to describe spatial patterns of amphibian presence and abundance (i.e., lake-by-lake variation, assuming no long-term temporal trend). The full logistic model for occurrence was:

$$\text{Occurrence} \sim \text{Depth} + \text{Elevation} + \text{Fines} + \text{Fish} + \text{Julian day} + (\text{Julian day})^2 + \text{Snowpack} + (1 \mid \text{Site})$$

where (1 | Site) denotes that Site is included as a random effect. A final model was obtained via backwards selection of the explanatory variables. From each successive model, the least significant term was dropped until all remaining terms were significant ($p < 0.05$). For marginally significant terms ($0.05 < p < 0.1$), competing models were also compared using Akaike and Bayesian information criteria (AIC and BIC).

Because presence of stray adult migrant CSF may mask the absence of breeding populations, we also tested a model with the binary response variable (Count > 2). In addition, we modeled the occurrence of garter snakes, including both Common Garter Snakes and Western Terrestrial Garter Snakes. Two additional biological explanatory variables - the presence of CSF and the presence of LTS – were included in the garter snake occurrence model to investigate possible species associations that may arise either from interspecific interactions or from a common response to external factors.

The full generalized linear model for abundance of CSF and LTS was analogous to the logistic model for occurrence, with the exception of an offset term:

$$\text{Count} \sim \text{Depth} + \text{Elevation} + \text{Fines} + \text{Fish} + \text{Julian day} + (\text{Julian day})^2 + \text{Snowpack} + \text{offset}(\log(\text{Perimeter})) + (1 \mid \text{Site})$$

The new offset term, offset(log(Perimeter)), adjusts the model such that we are dealing with amphibian densities (counts per meter of shoreline) rather than counts per lake, thus facilitating comparison across lakes of different sizes. Final models were again obtained via backwards selection.

Long-term trends

When looking for long-term temporal trends, the main variable of interest was:

Year: the calendar year during which sampling occurred

For a first estimate of change, we focused on a subset of 45 lakes for which both historic surveys (from the 1980s and 1990s) and two rounds of study surveys (2006-2014) exist - three time points total across ~25 years for each lake. Then, for all study lakes, we developed a formal GLMM. Only the time-varying factors - Julian Day and Snowpack - were tested as potential covariates. All site-to-site variation was contained within a single random effect, **Site**.

The full occurrence model for each amphibian species was:

$$\text{Occurrence} \sim \text{Year} + \text{Julian day} + (\text{Julian day})^2 + \text{Snowpack} + (1 \mid \text{Site})$$

where Julian Day and (Julian Day)^2 were included to allow for changes in occurrence across the sampling season.

For abundance models, each species' best life stage (or composite score of multiple life stages) was selected for the response variable, Count (see Power Analysis, below, for selection criteria). The full abundance model to look at long-term trends for each amphibian species' selected life stage was:

$$\text{Count} \sim \text{Year} + \text{Julian day} + (\text{Julian day})^2 + \text{Snowpack} + (1 \mid \text{Site}).$$

Using zero-inflated models to estimate detection rates

Proper estimation of presence and abundance must account for imperfect detection. One way to accomplish this is to use zero-inflated error distributions in generalized linear models. Zero-inflated distributions represent the combination of two separate processes: (1) whether or not the species is detected (the zero-inflation part), and (2) the count of animals, given that the species is detected (the count part). Thus, a zero-inflated model provides estimates of both detection rate (from the zero-inflation parameter) and true occupancy or abundance (from the mean of the presence or count process).

In order to accurately estimate these extra parameters, zero-inflated models require sufficient replication of observations over a period during which the population is closed. This assumption is easier to meet for presence models (no colonization or extinction) than for abundance models (no migration or intrinsic population growth). Many studies survey sites multiple times within a season, but for remote mountain lakes this is difficult. With just two rounds of surveys complete, we were unable to simultaneously estimate zero-inflated distribution parameters and the effects of multiple explanatory variables. When additional survey rotations are completed, zero-inflated models should be able to provide unbiased estimates of habitat effects and temporal trends; until then, we use non-zero-inflated models and acknowledge their limitations.

However, we were able to obtain preliminary estimates for zero-inflated distribution parameters by using a simple model that only accounts for site-to-site variability in presence and abundance. This produces conservative estimates of detection rates by assuming that populations are closed across the eight-year study period. Zero-inflated occupancy models were carried out using Presence software (formerly PRESENCE); zero-inflated abundance models were carried out using the "pscl" package in R. The best error distribution for abundance (Poisson or negative binomial, zero-inflated or not) was identified for each life stage of each species by comparing candidate distributions with Vuong's non-nested hypothesis test.

Power analysis

Based on the appropriate error distributions for each species and life stage, power analyses were used to predict the ability to detect population trends after the full study duration (20 years). Power analysis can be described according to the following steps:

1. Identify a study scenario, both in terms of sampling (e.g., the current plan of sampling 74 lakes six times each over a 20-year period) and true biological effects (e.g., an average of 2% decline per year across 20-year study).
2. Generate realistic count data based on the sampling scenario and on the error distribution that was selected to best describes the species and life stage of interest.
3. Analyze the data. Can we detect the trend imparted to the counts?
4. Repeat Steps 1-3 many times. (We performed 250 replicates per scenario.) The probability of correctly identifying the biological effects (e.g., the population change) is defined as the power.
5. Repeat Steps 1-4 for each scenario of interest.

For both CSF and LTS, power analysis was used to select the life stage best able to detect population trends. We also tested a composite score for long-toed salamanders:

$$\text{Composite} = \text{Adults} + 2^{nd}\text{ year larvae} + \text{ceiling}(\ln(1^{st}\text{ year larvae} + 1))$$

where ceiling(x) indicates the smallest integer ≥x, and ln(x) represents the natural log of x. (First year larvae were log transformed to reduce high variability in counts and bring them to a scale comparable with adults and 2^{nd} year larvae.) For each life stage, power analysis was used to quantify the study's ability to detect population trends after 10, 20, and 30 years.

RESULTS

Among Clearwater Region lakes >1,500 m in elevation (n = 703), fish-containing lakes are on average larger and deeper than fishless lakes (Figure 44). Most lakes that have not been sampled are small and at high elevation (Figure 44). The lakes selected for this monitoring study (n = 74) closely mimic regional patterns.

In 2013, mountain lakes field personnel surveyed 24 water bodies from five HUC5 watersheds. Seven mapped lakes and marshes in the Big Harrington watershed were visited for the first time: two were small lakes (Big Harrington Lakes #1 and #6); one contained only small ephemeral pools (<20 m^2) in a meadow (Big Harrington Marshes #1-2); and four had become completely vegetated, containing only wet meadow and small streams. As such, only Big Harrington Lakes #1 and #6 were added to the project. Another lake, Eagle Creek Lake in the Running Creek watershed, was determined to be dry by visual inspection from the adjacent ridge, and no survey was performed. In total, 16 study lakes were surveyed in full during the 2013 field season. The sampling in 2013 completed the first round of surveys for this project.

Fish Surveys

Nine of the 16 surveyed lakes contained fish (Table 13); the other seven lakes were fishless. Four lakes had Westslope Cutthroat Trout, three had Rainbow Trout, three had

WCTxRBT hybrids, and two had Brook Trout present. Gill net CPUE ranged from 0.1 - 3.7 fish/hour, with an average of 1.6 fish/hour (Table 14). Angling CPUE ranged from 5.8 - 12.0 fish/hour, with an average of 7.8 fish/hour (Table 14). Average total length of trout collected from both methods were 187 mm for Brook Trout, 222 mm for Rainbow Trout, 260 mm for Westslope Cutthroat Trout, and 217 mm for WCTxRBT hybrids. Average weight of trout collected from both methods were 86 g for Brook Trout, 141 g for Rainbow Trout, 240 g for Westslope Cutthroat Trout, and 139 g for WCTxRBT hybrids.

Brook Trout were more likely to occupy lower elevation lakes and to occur at high densities when compared with *Oncorhynchus* sp. based on surveys conducted from 2006 - 2013 (Figure 45). Among study lakes, there was a negative correlation between fish density (as estimated by CPUE) and maximum fish length. On average, maximum fish length decreased by 31 mm for every two-fold increase in CPUE (P = 0.045; Figure 45). There was no significant correlation of elevation (P = 0.62) or fish species (P = 0.44) on density-specific maximum total length.

There was considerable variation in length-weight relationships among fish species in the study lakes for data collected from 2006 - 2013 (Figure 46). Non-linear least squares estimates for equations of the form $W = a * L^b$, where W is weight in grams and L is total length in mm, are:

BKT:	$W = (4.5 \times 10^{-6})\ L^{3.14}$
RBT:	$W = (2.5 \times 10^{-4})\ L^{2.41}$
WCT:	$W = (7.1 \times 10^{-6})\ L^{3.05}$
WCT x RBT hybrids	$W = (8.7 \times 10^{-6})\ L^{3.01}$

Columbia Spotted Frog abundance and distribution

Columbia Spotted Frogs were detected in 14 of 16 survey lakes (87.5%) sampled in 2013 (Table 3). In the first complete round of sampling, 63 of 74 lakes (85.1%) had CSF present (Table 4). Of these, 23 lakes had fish present and 40 did not have fish present. Thus far, 58 lakes have been surveyed twice. Of these, 52 (89.7%) had CSF present. Twenty lakes (38.5%) with CSF had fish present and 38 lakes (61.5%) had no fish.

No explanatory variables were significant in the CSF occurrence model, likely due in part because there was little variation in presence/absence data. When the binary response variable was altered to indicate counts of at least three adults (which occurred in 56% of study surveys), three explanatory variables became significant: Fines (positive relationship; P <0.001; Figure 47), Depth (positive relationship; P = 0.01), and Julian Day (negative relationship; P = 0.02). Fish presence did not affect CSF occurrence (P = 0.73; Figure 48).

Counts of all three life stages of CSF showed clear seasonal trends: adult counts remained fairly constant until mid-August when they began to decline; tadpole counts were highest early in the season; and sub-adult counts increased as tadpoles metamorphosed mid-season (Figure 49). After controlling for habitat effects and seasonality, adult frog abundance was ~40% lower in fish-containing lakes relative to fishless lakes; however, this effect was not significant (P = 0.13).

Long-toed Salamander abundance and distribution

Long-toed Salamanders were detected in 7 of 16 surveys lakes (43.8%) sampled in 2013 (Table 3). In the first round of sampling, 26 of 74 lakes (35.1%) had LTS present (Table 4). Of these, 3 lakes had fish present and 23 did not have fish present. Thus far, 58 lakes have been surveyed twice. Of these, 29 (50.0%) had LTS present. Seven lakes (24.1%) with LTS had fish present and 16 lakes (75.9%) had no fish.

The best occurrence model included a single, highly significant explanatory variable: Fish (negative relationship; P <0.001). Long-toed Salamanders were 3.7 times more likely to occupy fishless lakes than fish-containing lakes (Figure 48). Although salamanders occur more frequently in shallower lakes, after controlling for the effects of fish presence, depth had no significant relationship with salamander occurrence (P = 0.85) (Figure 50). Long-toed Salamanders also showed strong seasonal variation (P <0.001).

Garter Snake abundance and distribution

Garter snakes were detected in 28% of study surveys (38 of 136). Elevation was the only non-biological variable with unambiguous significance (P = 0.02). Three biological explanatory variables - the presence of fish, frogs, and salamanders - were also explored as explanatory variables for garter snake occurrence. Fish presence exhibited no significant relationship with garter snakes (P = 0.63); frog presence a marginally significant positive relationship (P = 0.07); and salamander presence a significant positive relationship (p = 0.01). Estimated garter snake occurrence (measured as the proportion of surveys in which snakes were detected) declined from ~50% at 1900 m to <20% at 2200 m, and snakes were encountered nearly twice as frequently at lakes with salamanders (38% of study surveys) when compared to lakes without salamanders (21% of study surveys; Figure 50).

While the Elevation-only model had the best BIC score among the models lacking amphibian predictors, a model that also included two marginally significant variables, Fines (P = 0.11) and Julian Day (P = 0.10), had the best AIC score. Bayesian information criteria has a higher penalty on model complexity than AIC, so it is generally preferred when a false negative (omitting a significant variable) is less of a problem than a false positive (including a non-significant variable).

Comparing life stages: error distributions, detection rates, and power to detect trends

After accounting for site-to-site variation (but not other covariates), count error for CSF adults was best modeled using a negative binomial distribution. The estimated detection rate for adults was 97% (Table 5). For sub-adults and larvae, estimated detection rates were lower, at 91% and 84% respectively. Correspondingly, zero-inflation significantly improved count models for these two life stages.

For LTS, error distributions for all three life stages required zero inflation. Correspondingly, estimated detection rates were: 68% for adults, 64% for 2nd year larvae, and 75% for 1st year larvae (Table 5). These estimates are likely overly optimistic because they consider each life stage independently: adults were detected in just 17% of surveys at lakes for which any life stage was detected at least once; 2nd year larvae in 11%; 1st year larvae in 60%; and any life stage (i.e., composite score >0) in 64%.

The ability of each life stage to detect long-term population trends, as measured by power analyses, correlated to detection rate. For CSF, adults had the highest detection rate and the highest power (Figure 12). After 20 years and 6 surveys of 74 lakes, adult frog population trends of >1.5% per year (>26% over 20 years) should be reliably detected (Power >80%). Power for detecting trends in sub-adults and tadpoles were lower, corresponding to lower detection rates. For LTS, 1st year larvae had the highest power among the three life stages (Figure 52). Using 1st year larvae, population trends of >2.0% per year (>33.0% over 20 years) are projected to be reliably detected after the full study duration. However, the composite score outperformed any individual life stage, with the projected ability to reliably detect trends of >1.7% per year (>29.0% over 20 years).

Long-term trends in presence and abundance

The occurrence of CSF remained fairly constant across time in 45 lakes for which both historic data and two rounds of study data exist (Figure 53). A logistic regression for all lakes and surveys confirmed that there was no significant long-term trend in frog presence (P = 0.36; Figure 54). Long-toed salamander occurrence was more variable: they were detected in 22 lakes during historic surveys, 12 lakes in Round 1, and 18 lakes in Round 2 (Figure 53). However, there was no significant long-trend in occurrence (P = 0.43; Figure 54), possibly due to a larger noise-to-signal ratio from low detection rates.

Abundance models found no significant long-term trends in amphibian population size, both for CSF (P = 0.55) and for long-toed salamanders (P = 0.23) (Figure 54 and Figure 55). However, only eight years into the 20-year study, the ability to detect population trends is somewhat limited. Indeed, analyses suggest that only large trends of >4% per year (>34.0% after 10 years) are detectable after 10 years. After 20 years, power will increase substantially, and if the study is extended to 30 years or more, power will continue to modestly improve (Figure 56).

DISCUSSION

Fish Distribution and Abundance

On average, fish-containing lakes in the Clearwater Region were larger, deeper, and at lower elevations than fishless lakes. This pattern probably reflects the influence of multiple processes, including stocking, dispersal, spawning, and winterkill. Managers may choose to stock waters that receive the heaviest recreational use, and these lakes are frequently larger (more appealing destination) and at lower elevations (easier access). Ease of access also reduces the time and effort required to stock a lake, especially in the early to mid-1900s when jugs of fingerlings were packed into mountain lakes on the backs of horses and mules. Fish are more likely to disperse across low gradients, in a downstream direction, and in systems where streams are larger, all of which are more common at lower elevations. Once present in a lake, spawning success can be limited by stream flow and substrate type, and these factors also correlate to lake size, depth, and elevation. Furthermore, trout can be extirpated by winterkill if all available habitat is shallow and exposed to severe cold; hence they may be more likely to persist in deeper lakes and at lower elevations.

Fish Data Analysis

For standardized comparison of fish condition across regions, a common approach is to use relative weights (Wege and Anderson 1978). Because we were only interested in comparisons among lakes and across time within our study, we instead compared individual surveys to the appropriate species' regional length-weight relationship, which was obtained by averaging all study data for that species on a fish-by-fish basis. In the equation $W = a * L^b$, where W is weight and L is length, b was estimated to be about three for cutthroat trout and hybrids, indicating approximately isometric growth. A higher estimate for brook trout (b = 3.14) may indicate that these fish become stockier at larger sizes.

Larger Rainbow Trout at Dan and Dodge lakes frequently displayed a very lean build. Since Dan and Dodge were the only lakes in our study with Rainbow Trout, the "regional" length-weight relationship obtained from study data strongly reflected this (b = 2.41). However, because this estimate came from relatively few fish our Rainbow Trout equation should be considered only a preliminary estimate.

Amphibian Distributions and Trends

Habitat relationships for both LTS and CSF were generally consistent with previous studies (Pilliod et al. 1996; Murphy 2002). For CSF, the proportion of fine substrates in a lake was positively correlated with a lake having at least three adult frogs. Depth also had a significant positive relationship with this binary response variable. However, this should be interpreted with caution as lake depth is positively correlated with lake perimeter. Since surveys covered all shoreline areas exactly once, this corresponds to a greater search effort at larger lakes. Our numeric abundance responses do not exhibit this bias because they were modeled with an offset to correct for differences in perimeter (i.e., sampling effort) among lakes.

Long-toed Salamanders were highly affected by fish presence. This is likely attributable to the longer larval stage of LTS (relative to CSF) which increases the susceptibility to predation during this life stage. Yellow-legged Frogs in the Sierra Nevada range have a longer larval life stage and are similarly highly affected by fish (Knapp et al. 2001). Other wildlife also prey upon amphibians in high mountain areas. For example, Murray et al. (2005) observed Gray Jays feeding on LTS larvae that were concentrated in drying ponds. In the Trinity Alps, California, American Dippers, American Robins, and Clark's Nutcrackers - all of which also occur in the Clearwater Region's mountains - have been observed feeding on small amphibians in lentic habitats (Garwood 2006, Garwood et al. 2009). Through effects of competition and predation that cascade up and down the food chain, fish may affect everything from nutrient status (Schindler et al. 2001) to predators.

Snowpack was never a significant variable in modeling effects on amphibian abundance. The exception was larvae counts (of both LTS and CSF), but this was only due to the problematic TMTC (too many to count) values for large larval congregations prior to 2012. With only two years of specific counts (2012 - 2013), both of which were during high snowpack years, substituting specific numbers for the TMTC values (or omitting them entirely) biased the results. Since larvae are probably the life stage most likely to be affected by that year's snowpack, follow-up analyses after additional surveys will help elucidate the relationship between climate and amphibian abundance. It may also be worthwhile to investigate a time-lagged effect of snowpack on adults, although a preliminary look that included the previous year's snowpack in GLMMs did not indicate a significant relationship for either amphibian species.

Preliminary results show no significant trends in amphibian distribution or abundance. Once additional rounds of surveys are completed, we will have a better idea if they are truly stable (as suggested by power analyses).

Detection Rates

We explored two methods of estimating detection rates for CSF and LTS: (1) using zero-inflated models for each life stage independently, and (2) assuming that all life stages of a species were present if any life stage had ever been observed at the lake. For LTS, estimates obtained using the second method were significantly lower than for the first method. This is probably because the second method produces an overly conservative detection estimate when the abundance and detectability of different life stages relative to one another vary from lake to lake. For example, in shallow ponds and deeper fish-containing lakes where LTS adults were observed, a failure to find 2nd year LTS larvae would represent a false negative detection even though that life stage may actually be absent from the lake.

Our best estimates of detection rates for both CSF (97%) and LTS (75%) are comparable to published values of 91% and 74% (Pilliod et al. 2010). The lower detection rate for LTS is not unexpected: adults are cryptic and difficult to detect during visual encounter surveys, and 2nd year larvae often occur in deeper water not easily surveyed from shore. First year larvae are more easily detected, but they do have a limited range in space and time relative to mobile, long-lived adults. Using 1st year larvae, or a composite score of all three life stages appears to be the best option when analyzing salamander visual encounter survey data.

For fish, detection rates of gillnetting are very high. Pilliod et al. (2010) estimated gillnet detection rates to be 1.0, and even visual surveys for fish in shallow mountain lakes resulted in very good detection rates (P = 0.89). Furthermore, although trout in mountain lakes often trended towards becoming more abundant and smaller in size in the decades since their introduction, most established mountain lake trout populations are now relatively stable in abundance and size structure. Thus, for the purposes of evaluating fish impacts on amphibians, gillnet sampling frequency might be reduced in lakes where past surveys have demonstrated the presence of stable, self-sustaining trout populations. This sampling effort might be redirected to better sample amphibians or other native organisms of interest. However, continued fish sampling could be warranted if the research is also aimed to detect and evaluate inter-annual changes in fisheries productivity.

Use of Zero-inflation

When a species is not perfectly detected, zero-inflated models improve occupancy estimates. Naïve occupancy estimates (i.e., those obtained by assuming that error distributions are not zero-inflated) are too low because they do not account for sites at which the species was present but undetected. If detection rates are constant across sites, failing to account for zero-inflation will merely reduce the magnitude of estimates of habitat effects or temporal trends; however, if detection rates vary according to site or survey covariates (e.g., habitat or weather), estimates are far less reliable and can even get the direction of the relationship incorrect (Tyre et al. 2003, Martin et al. 2005). True occupancy or abundance can sometimes be more accurately estimated by modeling variable detection rates on their own separate set of covariates (Martin et al. 2005).

Although adding detail to a model relaxes its underlying assumptions, each additional layer of complexity - e.g., zero-inflation or inclusion of additional covariates - increases the demands on the quantity and quality of the data. For this study, with just two or three rounds of surveys complete, the dangers of over-fitting were real. Hence, we limited model complexity by: estimating habitat effects and temporal trends using un-inflated generalized linear mixed models; proposing only approximations of zero-inflated error distributions for each species and life stage; and refraining from modeling covariates on detection rates until further surveys are performed. In the future, analyses may consider using methods such as cross-validation to avoid model over-fitting.

Garter Snakes

Garter snakes were more likely to occur at lower elevations, suggested a possible thermal limit to their range. We found a significant positive relationship between garter snakes and amphibians. This result is consistent with the finding of Matthews et al. (2002) for the relationship between Mountain Garter Snakes (*T. elegans elegans*) and Yellow-Legged Frogs in the Sierra Nevada Mountains. Amphibians may be a key prey source for garter snakes. However, whereas Matthews et al. (2002) found a strong negative relationship between garter snake presence and fish occupancy, we found no such relationship in the Clearwater Region's mountain lakes. A probable explanation for this is that the primary amphibian species in the Sierra Nevada study region, the Yellow-Legged Frog, is usually eliminated by fish. In contrast, CSF in the Clearwater Region are less affected by fish, thus providing suitable forage for snakes regardless of the lake's fish status. It is also possible that the subspecies of garter snake found in the Clearwater Region (the Wandering Garter Snake *T. elegans vagrans*, and the Valley Garter Snake *T. sirtalis fitchi*) may be better able to subsist on non-amphibian prey, possibly including fish.

Other Study Considerations

At the conclusion of this study, it may be possible to scale up the results to a larger landscape level using GIS. The use of geo-referenced regional datasets of climate, temperature, and habitat variables could allow for broader application of results. However, a few issues must first be taken into consideration. The proportion of fishless lakes is greater in the study sample than in the region because (1) HUC5s were stratified by fish occupancy prior to random sampling, thereby increasing the relative frequency of relatively rare HUC5s with few fish, and (2) previously un-surveyed lakes (which are more likely to be smaller, higher, and fishless) were all sampled for the monitoring project. Sampling bias is another issue to consider. Fish are not random in their occupancy of habitat at a landscape scale. We would need to ensure that we have enough range in habitat covariates (elevation, depth, area, etc.) for both fishless and fish-containing lakes to allow for controlling covariates in a model.

Another issue to consider is how to treat the small ponds/puddles discovered in 2013 that contain amphibians. Although not included in the original study design, they represent important amphibian habitat. If we attempt to scale up our results, we must consider that (1) most maps will not accurately represent such habitats, (2) most fish-based surveys will not make note of them, either, and (3) even in our study we encountered them incidentally and incompletely. Additionally, these ponds/puddles potentially serve as source populations for nearby mountain lakes. Thus, the "loss" of an amphibian species based on observations from one survey to the next at a given lake may not be accurate. Nearby source populations could regularly reseed a lake's population as a natural course of events.

RECOMMENDATIONS

1. Continue monitoring high mountain lakes within HUC5 watersheds in the Clearwater Region as part of the long-term amphibian risk assessment.

2. As smaller lentic areas dry or infill, lake number and surface area reduction should be updated to determine if HUC5 watersheds change in amphibian risk classification.

3. Analyze amphibians on a population based scale rather than in terms of presence/absence to provide a more precise measure of population trends.

4. Utilize population models that incorporate probability of detection, growth rates, carrying capacities, and process noise to provide more accurate estimates of trends in mountain lake amphibian populations.

5. Determine how to address the small ponds/puddles encountered near study lakes.

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Table 13. Fish species presence in high mountain lakes in the Clearwater Region, Idaho, used to evaluate the long term impacts of fish stocking on amphibian populations.

Lake name	Watershed/ risk level	Historical survey date	First round survey date	Second round survey date	Historical fish	First round fish	Second round fish
Bilk Mountain	Goat/Control	8/10/2003	8/18/2006	7/21/2012	NONE	NONE	NONE
Goat	Goat/Control	7/9/1986	7/21/2012	NA	NONE	NONE	NA
Mud	Goat/Control	8/11/2003	8/17/2006	7/19/2012	NONE	NONE	NONE
Bilk	Up.Meadow/Control	7/11/1986	7/22/2012	NA	NONE	NONE	NA
Elk	Up.Meadow/Control	NA	7/25/2012	NA	NA	NONE	NA
Section 27	Up.Meadow/Control	NA	7/23/2012	NA	NA	NONE	NA
Big Harrington #1	Big Harr/Control	NA	7/5/2013	NA	NA	NONE	NA
Big Harrington #6	Big Harr/Control	NA	7/5/2013	NA	NA	NONE	NA
Fox Peak Lower	N.F. Moose/Low	8/28/2001	7/10/2006	8/19/2011	NONE	NONE	NONE
Fox Peak Upper	N.F. Moose/Low	8/28/2001	7/10/2006	8/19/2011	NONE	NONE	NONE
Isaac Creek	N.F. Moose/Low	NA	7/9/2006	8/20/2011	NA	NONE	NONE
Isaac	N.F. Moose/Low	8/17/1988	7/7/2006	8/20/2011	WCT/RBT	WCT/RBT	WCT
Section 28	N.F. Moose/Low	8/30/2001	7/20/2009	NA	NONE	NONE	NONE
West Moose #1	N.F. Moose/Low	NA	8/7/2006	9/25/2011	NA	NONE	NONE
West Moose #2	N.F. Moose/Low	NA	8/5/2006	NA	NA	NONE	NONE
West Moose #3	N.F. Moose/Low	NA	8/3/2006	9/23/2011	NA	NONE	NONE
West Moose #4	N.F. Moose/Low	NA	8/4/2006	9/23/2011	NA	NONE	NONE
West Moose #5	N.F. Moose/Low	NA	8/4/2006	9/24/2011	NA	NONE	NONE
West Moose #6	N.F. Moose/Low	NA	8/5/2006	9/24/2011	NA	NONE	NONE
West Moose #7	N.F. Moose/Low	NA	8/6/2006	9/24/2011	NA	NONE	NONE
West Moose #8	N.F. Moose/Low	NA	8/5/2006	9/24/2011	NA	NONE	NONE
West Moose #9	N.F. Moose/Low	NA	8/5/2006	9/24/2011	NA	NONE	NONE
Dan	Storm/Low	8/21/1991	8/21/2009	8/28/2013	RBT	RBT	RBT
Dodge	Storm/Low	8/20/1991	9/12/2010	8/28/2013	RBT	RBT	RBT
Lookout	Storm/Low	7/30/1996	9/13/2010	8/28/2013	RBT	RBT	RBT
Maud	Storm/Low	8/22/1991	9/14/2010	NA	NONE	NONE	NA
Middle Storm	Storm/Low	8/22/1997	8/9/2009	8/5/2012	NONE	NONE	NA
North Sec. 25	Storm/Low	9/10/1996	8/10/2009	8/4/2012	NONE	NONE	NONE
North Storm	Storm/Low	8/22/1997	8/9/2009	8/5/2012	NONE	NONE	NONE
N.E. Ranger	Storm/Low	9/10/1996	7/11/2007	7/10/2012	NONE	NONE	NONE
Old Stormy	Storm/Low	9/10/1996	8/4/2012	NA	NONE	NONE	NA
Ranger	Storm/Low	9/9/1996	7/10/2007	7/9/2012	RBT	RBT	RBT
Section 27	Storm/Low	9/8/1996	7/9/2007	7/9/2012	NONE	NONE	NONE
Siah	Storm/Low	9/9/1996	7/8/2007	7/7/2012	WCT/RBT	WCT/RBT	WCT/RBT
South Sec. 25	Storm/Low	9/10/1996	8/10/2009	8/4/2012	NONE	NONE	NONE
Storm	Storm/Low	8/21/1997	2/21/2007	8/6/2012	NONE	NONE	NONE

WCT=Westslope Cutthroat Trout, RBT=Rainbow Trout, BKT=Brook trout, HY=RBT/WCT Hybrid

Table 13 Continued.

Lake name	Watershed/ risk level	Historical survey date	First round survey date	Second round survey date	Historical fish	First round fish	Second round fish
Eagle Creek	Running/Moderate	NA	9/7/2009	NA	NA	NONE	NA
Running	Running/Moderate	8/15/2001	7/25/2008	7/23/2012	BKT	BKT	BKT
Section 26	Running/Moderate	NA	7/24/2008	7/24/2012	NA	NONE	NONE
Section 26 #2	Running/Moderate	NA	7/24/2008	7/24/2012	NA	NONE	NONE
Dodge	Warm Springs/Moder	7/27/1996	7/20/2009	NA	NONE	NONE	NA
East Wind	Warm Springs/Moder	8/11/1995	8/23/2008	8/18/2012	WCT	WCT	NONE
Hungry	Warm Springs/Moder	7/8/1991	8/22/2011	8/16/2013	WCT/RBT	WCT	WCT
Low. N. Wind	Warm Springs/Moder	7/16/1996	8/25/2008	8/17/2012	NONE	NONE	NONE
Middle Wind	Warm Springs/Moder	8/12/1995	8/24/2008	8/16/2012	WCT	WCT	WCT
N.W. Wind	Warm Springs/Moder	8/12/1995	7/17/2009	8/19/2012	NONE	NONE	NONE
South Wind	Warm Springs/Moder	8/11/1995	8/23/2008	8/18/2012	NONE	NONE	NONE
Up. N. Wind	Warm Springs/Moder	7/16/1996	8/25/2008	8/17/2012	NONE	NONE	NONE
West Wind	Warm Springs/Moder	8/12/1995	8/25/2008	8/17/2012	WCT	WCT	WCT
Wind Pond	Warm Springs/Moder	8/12/1995	8/23/2008	8/19/2012	NONE	NONE	NONE
Bleak Creek	Bargamin/Elevated	7/7/1989	8/13/2010	9/12/2013	NONE	NONE	NONE
Boston Mtn.	Bargamin/Elevated	9/7/1989	8/12/2010	9/13/2013	WCT	WCT	WCT
Goat Lake	Bargamin/Elevated	6/20/1989	7/19/2010	NA	WCT	NONE	NA
Lake Creek E.	Bargamin/Elevated	7/6/1989	7/17/2010	NA	WCT/RBT/HY	WCT/RBT/HY	NA
Lake Creek. S.	Bargamin/Elevated	7/12/1989	7/16/2010	NA	WCT/RBT	RBT	NA
Lake Creek W.	Bargamin/Elevated	6/11/1989	7/17/2010	NA	RBT	RBT	NA
MacArther	Bargamin/Elevated	8/5/1995	7/27/2008	7/18/2013	WCT/RBT	WCT/RBT	WCT/RBT
Stillman	Bargamin/Elevated	8/4/1995	7/28/2008	7/17/2013	WCT	WCT	WCT
Three Prong	Bargamin/Elevated	NA	9/6/2009	7/21/2013	NA	NONE	NONE
Chimney	Old Man/Elevated	7/7/1995	7/3/2010	8/3/2013	BKT	BKT	BKT
Dishpan	Old Man/Elevated	7/15/1995	9/28/2010	10/1/2012	BKT	BKT	BKT
Elizabeth	Old Man/Elevated	7/16/1995	9/26/2010	9/30/2012	BKT/WCT	BKT/WCT	BKT/WCT
Flea	Old Man/Elevated	7/13/1995	7/3/2010	8/3/2013	NONE	NONE	NONE
Florence	Old Man/Elevated	7/23/1991	7/22/2006	9/28/2012	WCT	WCT	WCT
Hjort	Old Man/Elevated	7/15/1995	9/29/2010	9/29/2012	BKT	BKT	BKT/WCT
Kettle	Old Man/Elevated	7/21/1991	8/1/2010	7/31/2013	RBT	NONE	NONE
Lloyd	Old Man/Elevated	7/15/1995	8/3/2010	9/30/2012	BKT	BKT	BKT
Lottie	Old Man/Elevated	NA	7/29/2010	9/1/2012	NA	BKT	BKT
Lottie Upper	Old Man/Elevated	7/14/1991	7/29/2010	8/31/2012	BKT	BKT	BKT
Maude East	Old Man/Elevated	7/16/1991	8/1/2010	9/1/2012	RBT	RBT	WCT/HY
Maude North	Old Man/Elevated	7/17/1991	7/31/2010	9/2/2012	NONE	NONE	NONE
Maude West	Old Man/Elevated	7/25/1991	8/1/2010	9/1/2012	RBT	RBT	WCT/HY
Old Man	Old Man/Elevated	7/14/1995	7/28/2010	7/31/2013	BKT	BKT	BKT
Wood	Old Man/Elevated	7/20/1991	7/31/2010	8/1/2013	NONE	NONE	NONE

WCT=Westslope Cutthroat Trout, RBT=Rainbow Trout, BKT=Brook trout, HY=RBT/WCT Hybrid

Table 14. Summary of catch per unit effort (CPUE), average total length, and average weight of fish captured during high mountain lake surveys in the Clearwater Region, Idaho, in 2013.

		CPUE (fish/hr)		Average	Average
Lake	Species	Gill net	Angling	length (mm)	weight (g)
Boston Mountain Lake					
	WCT	0.1		270	175
	WCTxRBT	0.8	12.0	230	107
Chimney Lake					
	BKT	3.7		178	63
Dan Lake					
	RBT	1.5		190	91
	WCTxRBT	0.1		226	120
Dodge Lake					
	RBT	1.0		277	225
Hungry Lake					
	WCT	0.7		279	262
Lookout Lake					
	RBT		5.8	153	43
MacArthur Lake					
	WCT	0.1		383	560
	WCTxRBT	1.6		205	158
Old Man Lake					
	BKT	2.2		203	129
Stillman Lake					
	WCT	1.2	7.1	241	173
Average		1.6	7.8	214	130

WCT = Westslope Cutthroat Trout, RBT = Rainbow Trout, BKT = Brook trout

Table 15. Amphibian presence in high mountain lakes in the Clearwater Region, Idaho, used in the evaluation of long term impacts of fish stocking on amphibian populations.

Lake Name	Watershed/risk level	Historical Survey Date	First Round Survey Date	Second Round Survey Date	Historical Amphibians	First Round Amphibians	Second Round Amphibians
Bilk Mountain	Goat/Control	8/10/2003	8/18/2006	7/21/2012	CSF	CSF/LTS	CSF
Goat	Goat/Control	7/9/1986	7/21/2012	NA	CSF	CSF/LTS	NA
Mud	Goat/Control	8/11/2003	8/17/2006	7/19/2012	CSF/LTS	CSF/LTS	CSF
Bilk	Up.Meadow/Control	7/11/1986	7/22/2012	NA	CSF	CSF/LTS	NA
Elk	Up.Meadow/Control	NA	7/25/2012	NA	NA	CSF/LTS	NA
Section 27	Up.Meadow/Control	NA	7/23/2012	NA	NA	CSF/LTS	NA
Big Harrington #1	Big Harr/Control	NA	7/5/2013	NA	NA	NONE	NA
Big Harrington #6	Big Harr/Control	NA	7/5/2013	NA	NA	CSF	NA
Fox Peak Lower	N.F. Moose/Low	8/28/2001	7/10/2006	8/19/2011	CSF/LTS	CSF	CSF/LTS
Fox Peak Upper	N.F. Moose/Low	8/28/2001	7/10/2006	8/19/2011	CSF/LTS	CSF	CSF/LTS
Isaac Creek	N.F. Moose/Low	NA	7/9/2006	8/20/2011	NA	CSF	CSF/LTS
Isaac	N.F. Moose/Low	8/17/1988	7/7/2006	8/20/2011	CSF	CSF	CSF
Section 28	N.F. Moose/Low	8/30/2001	7/20/2009	NA	CSF/LTS	CSF/LTS	NA
West Moose #1	N.F. Moose/Low	NA	8/7/2006	9/25/2011	NA	CSF/LTS	CSF/LTS
West Moose #2	N.F. Moose/Low	NA	8/5/2006	NA	NA	CSF	NA
West Moose #3	N.F. Moose/Low	NA	8/3/2006	9/23/2011	NA	CSF/LTS	CSF/LTS
West Moose #4	N.F. Moose/Low	NA	8/4/2006	9/23/2011	NA	CSF/LTS	CSF/LTS
West Moose #5	N.F. Moose/Low	NA	8/4/2006	9/24/2011	NA	CSF/LTS	CSF
West Moose #6	N.F. Moose/Low	NA	8/5/2006	9/24/2011	NA	CSF/LTS	CSF/LTS
West Moose #7	N.F. Moose/Low	NA	8/6/2006	9/24/2011	NA	CSF/LTS	CSF
West Moose #8	N.F. Moose/Low	NA	8/5/2006	9/24/2011	NA	CSF	LTS
West Moose #9	N.F. Moose/Low	NA	8/5/2006	9/24/2011	NA	CSF	CSF
Dan	Storm/Low	8/21/1991	8/21/2009	8/28/2013	CSF	CSF	CSF
Dodge	Storm/Low	8/20/1991	9/12/2010	8/28/2013	CSF	CSF	CSF
Lookout	Storm/Low	7/30/1996	9/13/2010	8/28/2013	CSF	CSF	CSF
Maud	Storm/Low	8/22/1991	9/14/2010	NA	CSF/LTS	CSF	NA
Middle Storm	Storm/Low	8/22/1997	8/9/2009	8/5/2012	CSF/LTS	CSF	CSF/LTS
North Sec. 25	Storm/Low	9/10/1996	8/10/2009	8/4/2012	CSF/LTS	CSF	CSF/LTS
North Storm	Storm/Low	8/22/1997	8/9/2009	8/5/2012	CSF	CSF	CSF/LTS
N.E. Ranger	Storm/Low	9/10/1996	7/11/2007	7/10/2012	CSF/LTS	CSF	CSF/LTS
Old Stormy	Storm/Low	9/10/1996	8/4/2012	NA	CSF/LTS	CSF/LTS	NA
Ranger	Storm/Low	9/9/1996	7/10/2007	7/9/2012	CSF	NONE	CSF/LTS
Section 27	Storm/Low	9/8/1996	7/9/2007	7/9/2012	CSF/LTS	CSF	CSF/LTS
Siah	Storm/Low	9/9/1996	7/8/2007	7/7/2012	CSF	CSF	CSF/LTS
South Sec. 25	Storm/Low	9/10/1996	8/10/2009	8/4/2012	CSF/LTS	CSF	CSF
Storm	Storm/Low	8/21/1997	2/21/2007	8/6/2012	CSF/LTS	NONE	LTS

CSF=Columbia spotted frog, LTS=Long-toed salamander, IGS=Idaho Giant Salamander

Table 15. Continued.

Lake Name	Watershed	Historical Survey Date	First Round Survey Date	Second Round Survey Date	Historical Amphibians	First Round Amphibians	Second Round Amphibians
Eagle Creek	Running/Moderate	NA	9/7/2009	NA	NA	NONE	NA
Running	Running/Moderate	8/15/2001	7/25/2008	7/23/2012	CSF	NONE	CSF
Section 26	Running/Moderate	NA	7/24/2008	7/24/2012	NA	NONE	CSF
Section 26 #2	Running/Moderate	NA	7/24/2008	7/24/2012	NA	LTS	NONE
Dodge	Warm Springs/Moderate	7/27/1996	7/20/2009	NA	CSF/LTS	CSF	NA
East Wind	Warm Springs/Moderate	8/11/1995	8/23/2008	8/18/2012	CSF/LTS	CSF	CSF
Hungry	Warm Springs/Moderate	7/8/1991	8/22/2011	8/16/2013	CSF	CSF	CSF
Low. N. Wind	Warm Springs/Moderate	7/16/1996	8/25/2008	8/17/2012	CSF/LTS	NONE	NA
Middle Wind	Warm Springs/Moderate	8/12/1995	8/24/2008	8/16/2012	CSF	CSF	CSF
N.W. Wind	Warm Springs/Moderate	8/12/1995	7/17/2009	8/19/2012	CSF/LTS	CSF/LTS	CSF
South Wind	Warm Springs/Moderate	8/11/1995	8/23/2008	8/18/2012	CSF/LTS	CSF/LTS	CSF
Up. N. Wind	Warm Springs/Moderate	7/16/1996	8/25/2008	8/17/2012	LTS	CSF/LTS	CSF/LTS
West Wind	Warm Springs/Moderate	8/12/1995	8/25/2008	8/17/2012	CSF	CSF	CSF/LTS
Wind Pond	Warm Springs/Moderate	8/12/1995	8/23/2008	8/19/2012	CSF/LTS	CSF/LTS	CSF/LTS
Bleak Creek	Bargamin/Elevated	7/7/1989	8/13/2010	9/12/2013	CSF/LTS	CSF	CSF/LTS
Boston Mtn.	Bargamin/Elevated	9/7/1989	8/12/2010	9/13/2013	CSF/LTS	CSF	CSF
Goat Lake	Bargamin/Elevated	6/20/1989	7/19/2010	NA	LTS	CSF/LTS	NA
Lake Creek E.	Bargamin/Elevated	7/6/1989	7/17/2010	NA	CSF	CSF/LTS	NA
Lake Creek. S.	Bargamin/Elevated	7/12/1989	7/16/2010	NA	CSF	CSF/TF	NA
Lake Creek W.	Bargamin/Elevated	6/11/1989	7/17/2010	NA	CSF	CSF	NA
MacArther	Bargamin/Elevated	8/5/1995	7/27/2008	7/18/2013	CSF/LTS	CSF	CSF/LTS
Stillman	Bargamin/Elevated	8/4/1995	7/28/2008	7/17/2013	CSF	CSF/LTS	CSF/LTS
Three Prong	Bargamin/Elevated	NA	9/6/2009	7/21/2013	NA	CSF/IGS	CSF/IGS
Chimney	Old Man/Elevated	7/7/1995	7/3/2010	8/3/2013	NONE	CSF	CSF
Dishpan	Old Man/Elevated	7/15/1995	9/28/2010	10/1/2012	CSF	CSF	CSF
Elizabeth	Old Man/Elevated	7/16/1995	9/26/2010	9/30/2012	CSF	NONE	NONE
Flea	Old Man/Elevated	7/13/1995	7/3/2010	8/3/2013	CSF	CSF/LTS	CSF/LTS
Florence	Old Man/Elevated	7/23/1991	7/22/2006	9/28/2012	CSF/LTS	CSF/LTS	CSF
Hjort	Old Man/Elevated	7/15/1995	9/29/2010	9/29/2012	CSF	CSF	CSF
Kettle	Old Man/Elevated	7/21/1991	8/1/2010	7/31/2013	CSF/LTS	CSF/LTS	CSF/LTS
Lloyd	Old Man/Elevated	7/15/1995	8/3/2010	9/30/2012	NONE	NONE	NONE
Lottie	Old Man/Elevated	NA	7/29/2010	9/1/2012	NA	CSF	CSF
Lottie Upper	Old Man/Elevated	7/14/1991	7/29/2010	8/31/2012	CSF	CSF	CSF
Maude East	Old Man/Elevated	7/16/1991	8/1/2010	9/1/2012	CSF	CSF	CSF/LTS
Maude North	Old Man/Elevated	7/17/1991	7/31/2010	9/2/2012	CSF/LTS	CSF/LTS	CSF
Maude West	Old Man/Elevated	7/25/1991	8/1/2010	9/1/2012	CSF	CSF	CSF/LTS
Old Man	Old Man/Elevated	7/14/1995	7/28/2010	7/31/2013	CSF	CSF	CSF
Wood	Old Man/Elevated	7/20/1991	7/31/2010	8/1/2013	CSF/LTS	CSF/LTS	CSF/LTS

CSF=Columbia spotted frog, LTS=Long-toed salamander, IGS=Idaho Giant Salamander

Table 16. Summary of the number of mountain lakes surveyed in the Clearwater Region, Idaho, containing Columbia Spotted Frogs (CSF) and Long-toed Salamanders (LTS), based on fish presence. Historic surveys were conducted from the 1980's to early 2000's. Round 1 and Round 2 surveys were conducted between 2006 and 2013.

Historic Surveys (55 Lakes)

	Amphibian Presence		
Fish Presence	CSF	LTS	None
Fish	24	5	2
No Fish	27	23	0

1st Round Surveys (74 Lakes)

	Amphibian Presence		
Fish Presence	CSF	LTS	None
Fish	23	3	4
No Fish	40	23	4

2nd Round Surveys (44 Lakes)

	Amphibian Presence		
Fish Presence	CSF	LTS	None
Fish	14	5	2
No Fish	22	16	2

Table 17. Best error distributions for counts of Columbia Spotted Frog and Long-toed Salamander (by species and life stage), as determined by generalized linear mixed models.

Species	Life stage	Distribution	Detection rate
Columbia spotted frog	Adult	NB	0.97
	Subadult	ZINB	0.91
	Larvae	ZINB	0.84
Long-toed salamander	Adult	ZIP	0.68
	2+ year larvae	ZIP	0.64
	1st year larvae	ZINB	0.75

<u>KEY</u>
ZI = zero-inflated
P = Poisson
NB = negative binomial

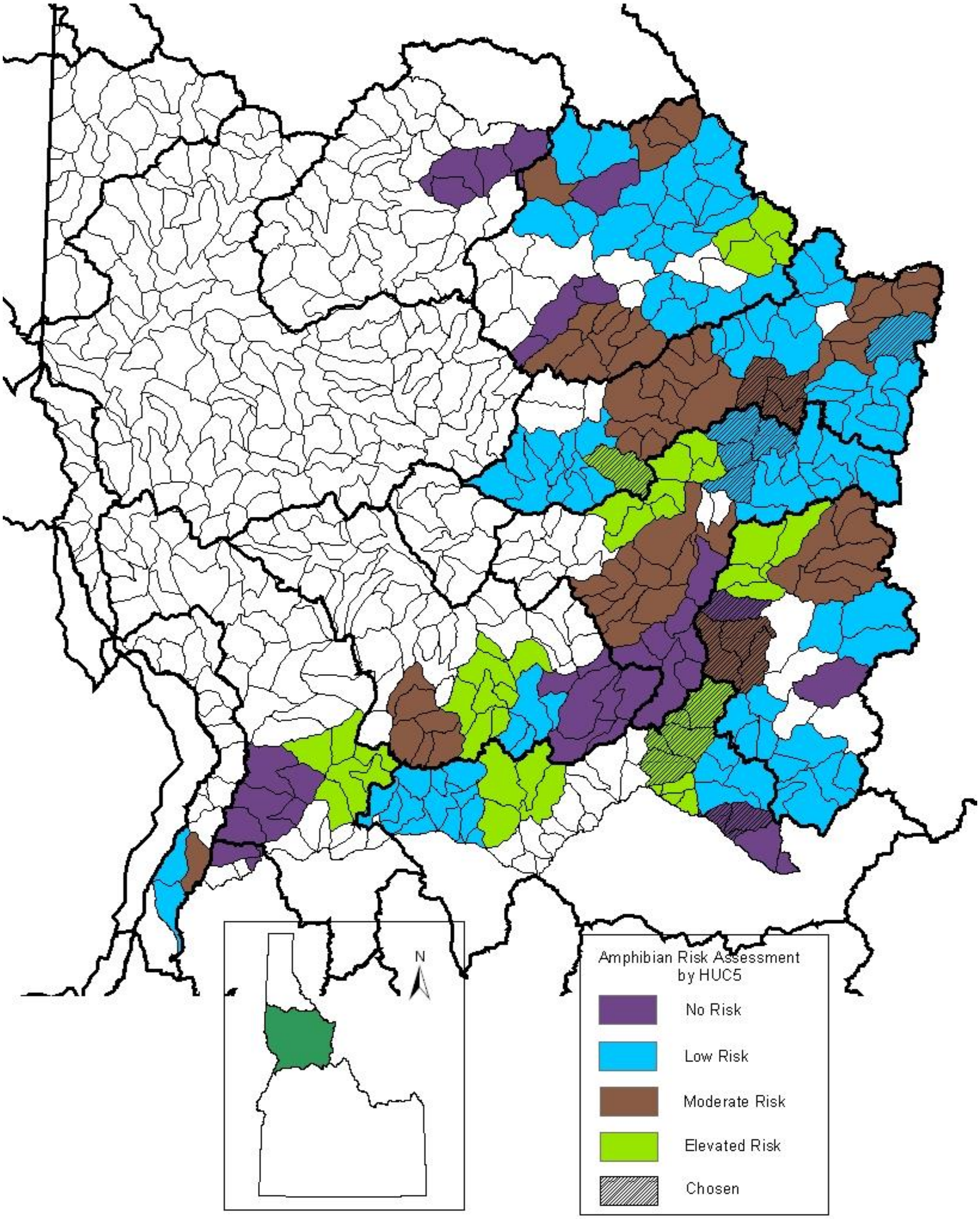


Figure 41. Hydrologic Unit Code 5 (HUC5) watersheds in the Clearwater Region, Idaho, that contain mountain lakes, classified by amphibian risk assessment.

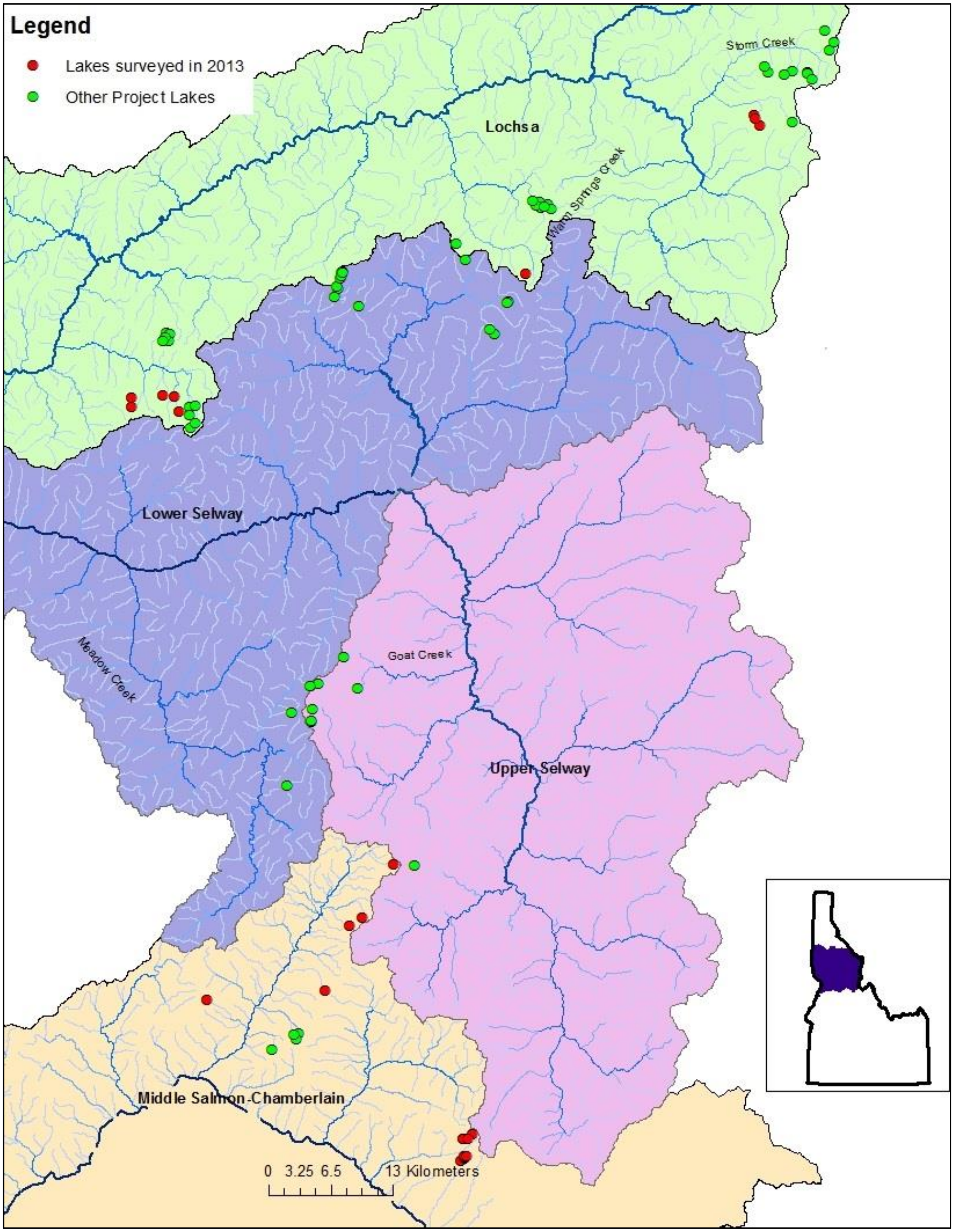


Figure 42. Map of the study area, which is contained by the Clearwater Region, Idaho.

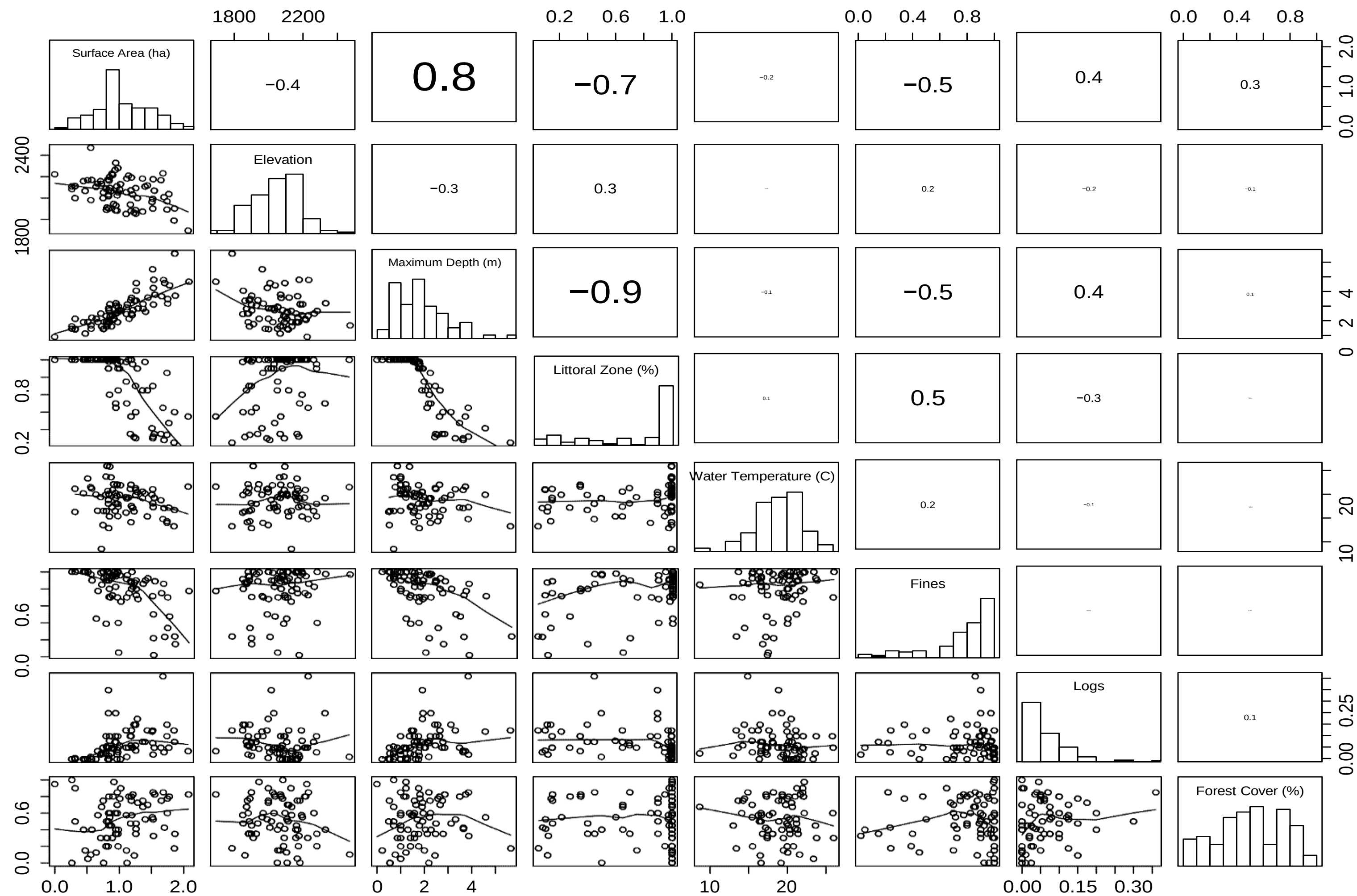


Figure 43. Scatterplot matrix of habitat variables evaluated for their potential to impact amphibian distributions in mountain lakes of the Clearwater Region, Idaho.

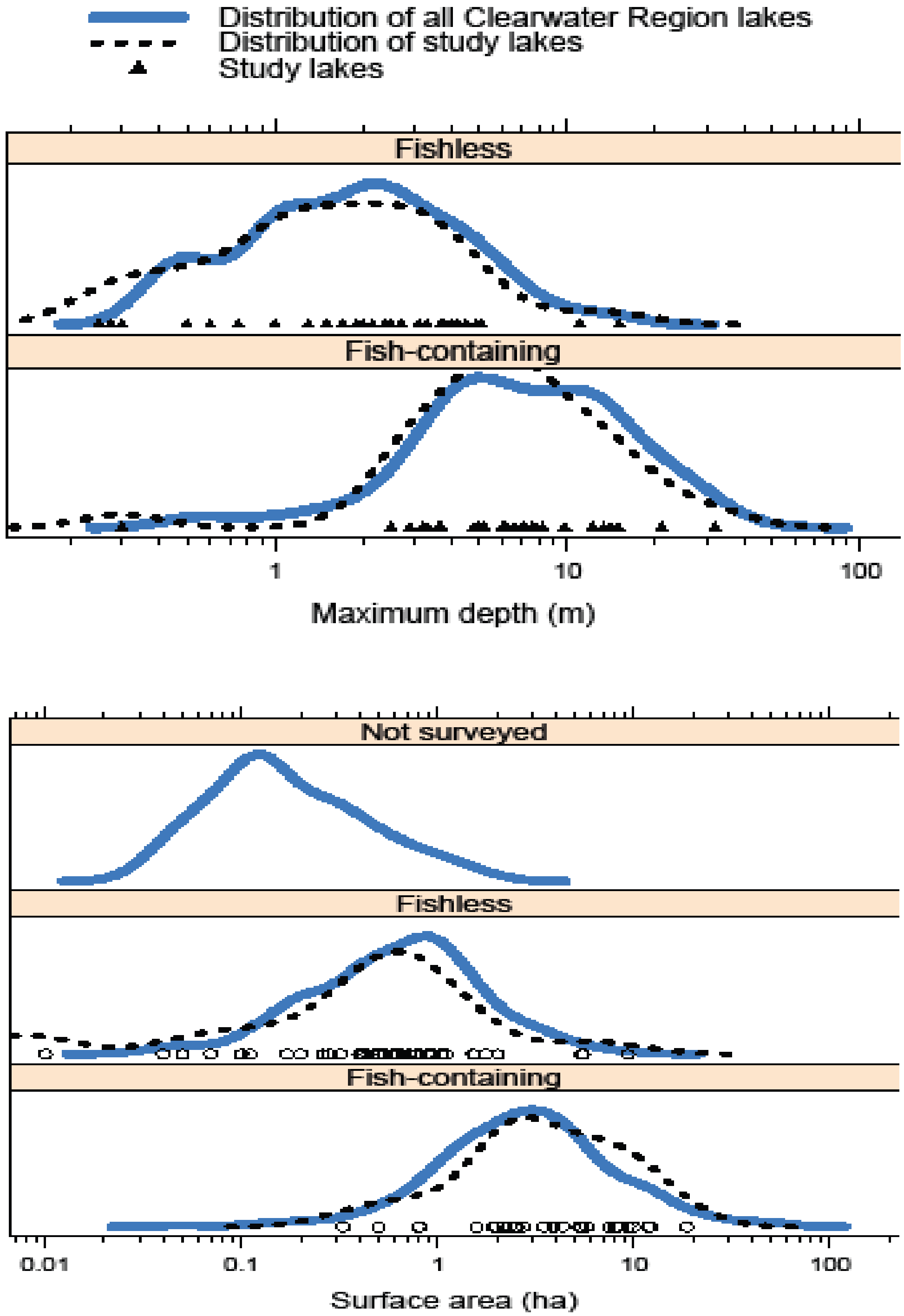


Figure 44. The distribution of mountain lakes in the Clearwater Region, Idaho, comparing fish status (fish-containing or fishless) by maximum depth, surface area, and elevation.

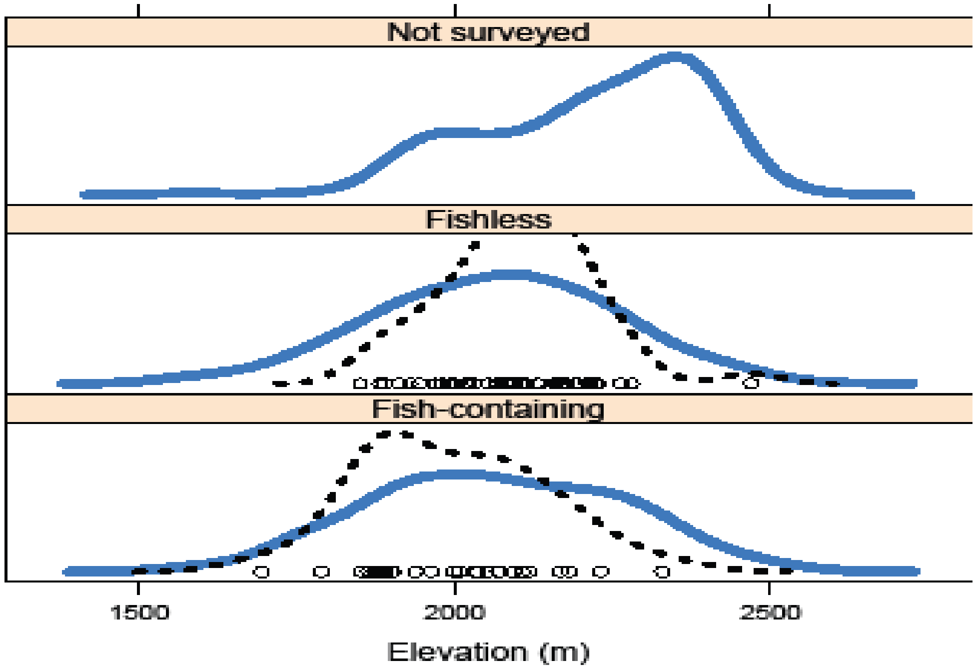
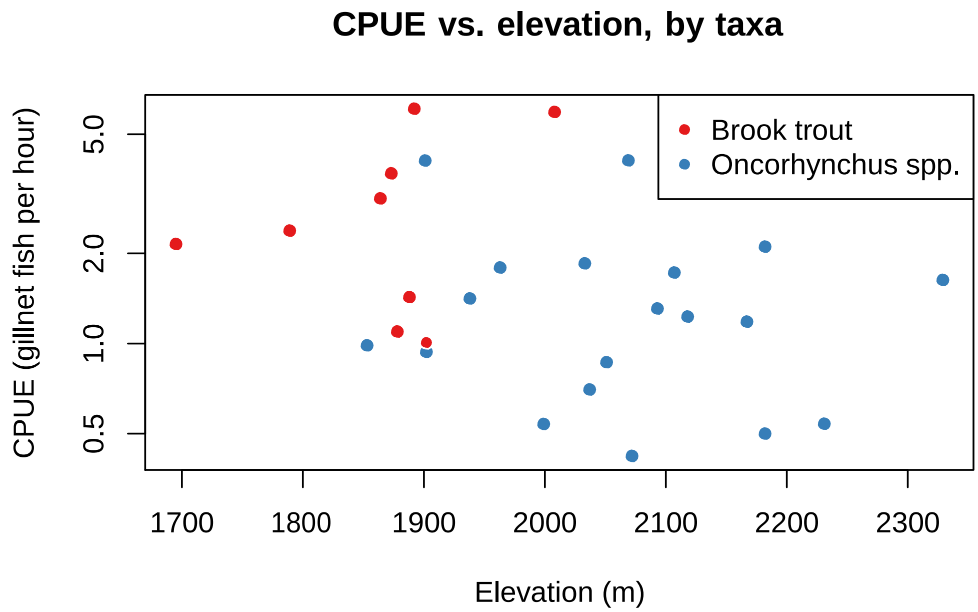


Figure 44. Continued.



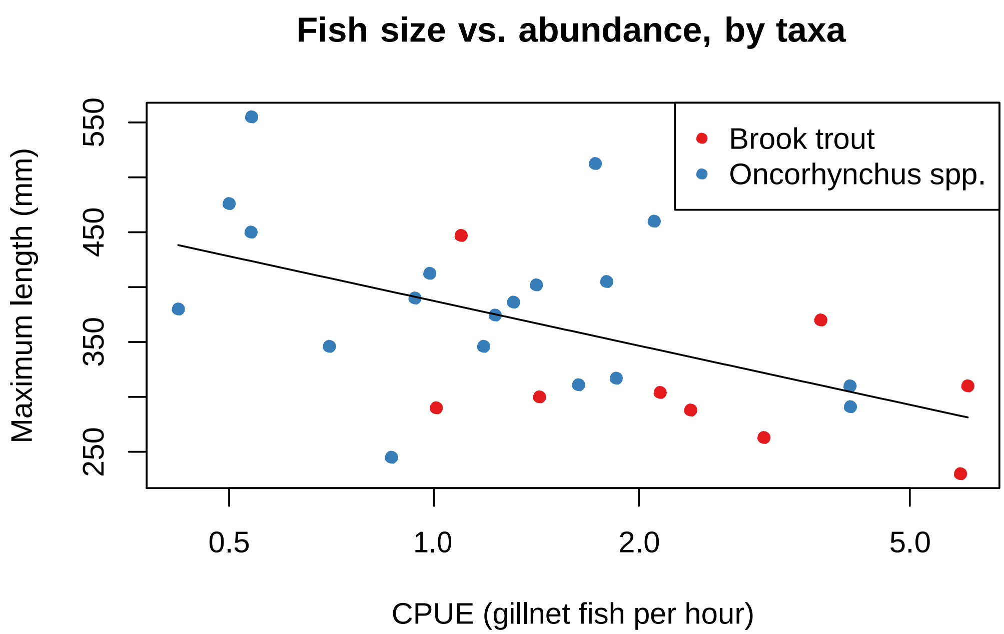


Figure 45. Comparisons of catch per unit effort (CPUE) of Westslope Cutthroat Trout and Brook Trout versus elevation (m) and maximum length (mm) for fish collected in mountain lake surveys in the Clearwater Region, Idaho, during 2006 - 2013.

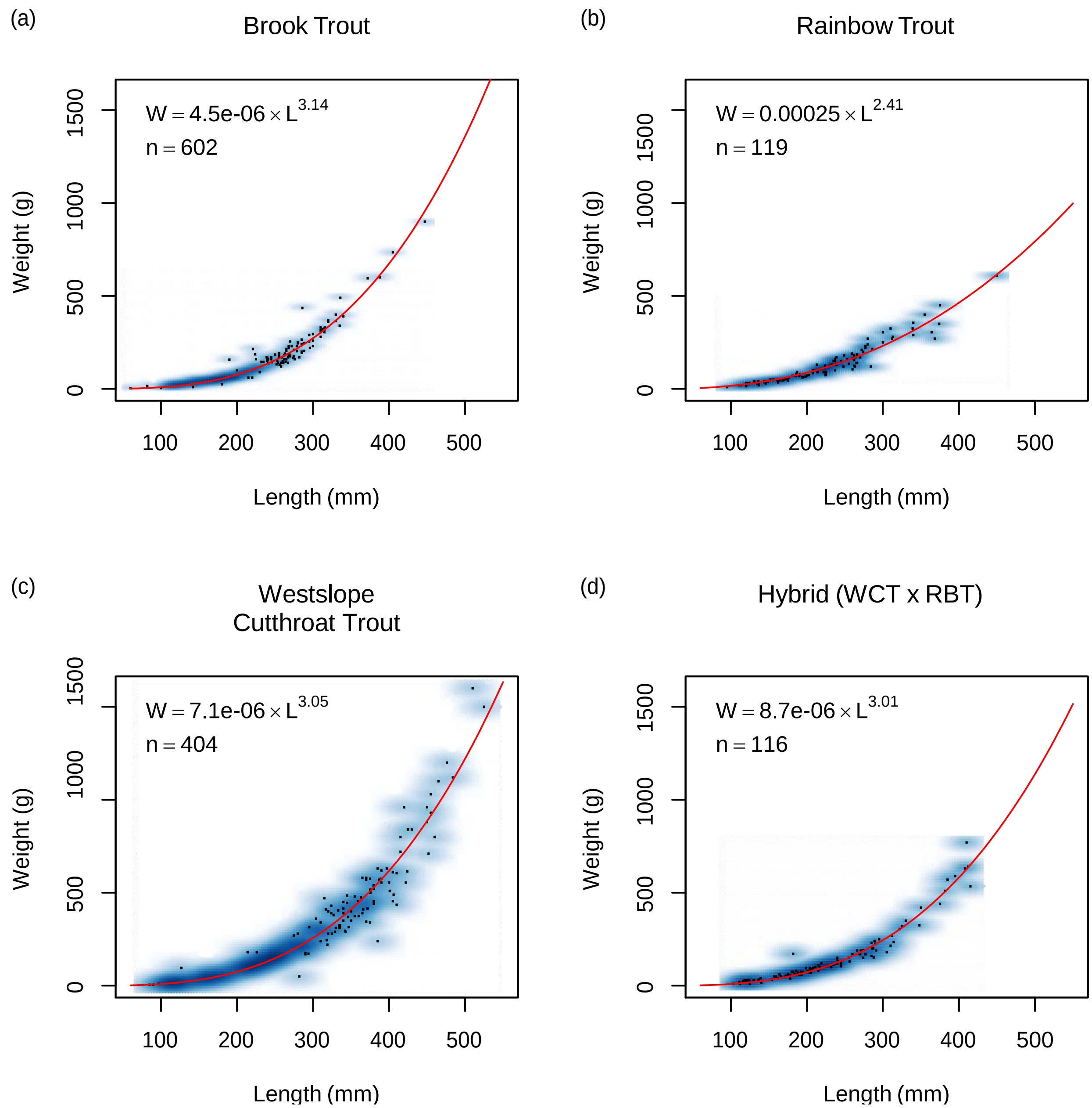


Figure 46. Length-weight relationships, by species, of fish collected in high mountain lake surveys in the Clearwater Region, Idaho, during 2006 - 2013.

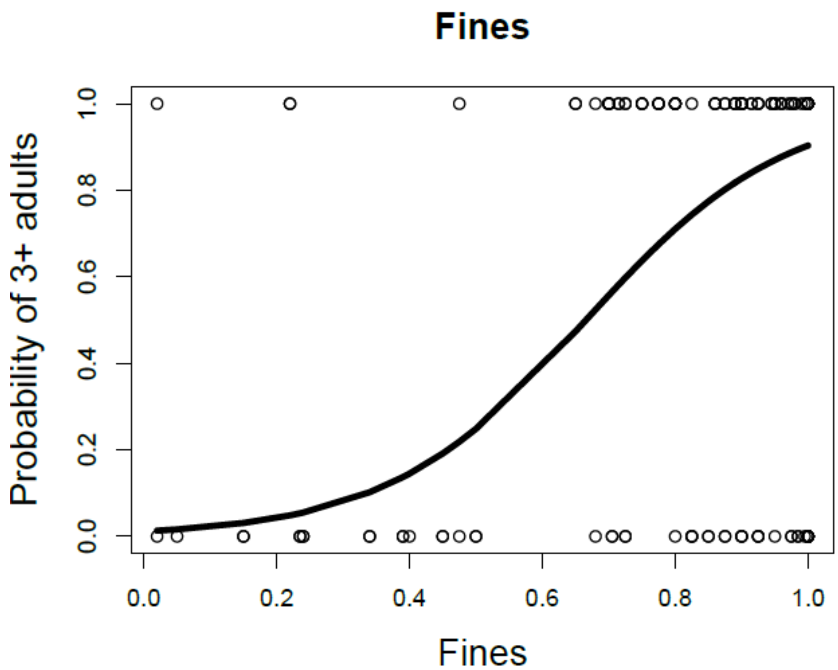


Figure 47. The probability of detecting at least three adult Columbia spotted frogs in a mountain lake, plotted as a logistic function of the proportion of fine substrate in a lake. Black circles indicate study data; each circle represents one survey.

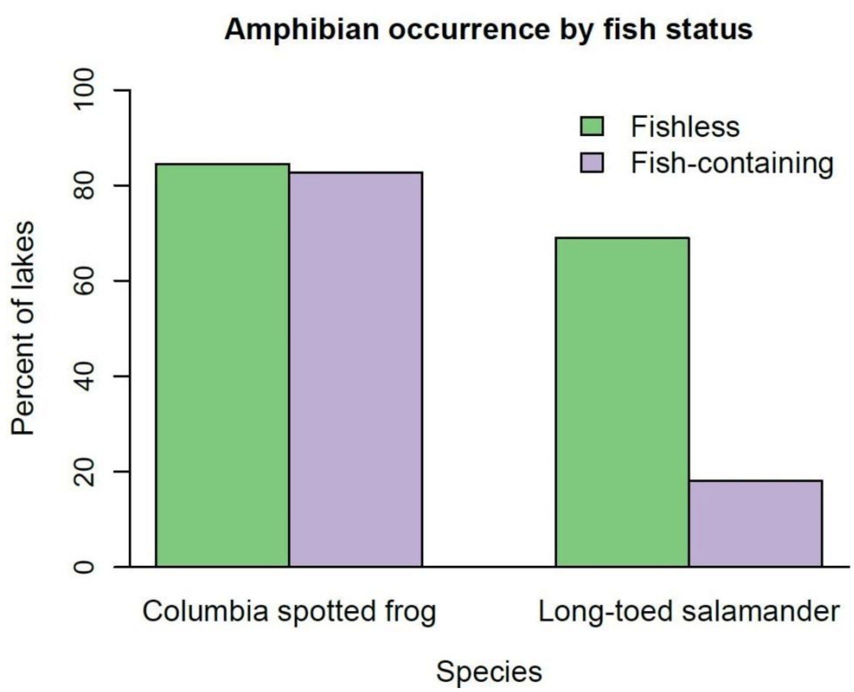


Figure 48. The proportion of study lakes in the Clearwater Region, Idaho, containing Columbia Spotted Frogs or Long-toed Salamanders, according to fish presence or absence.

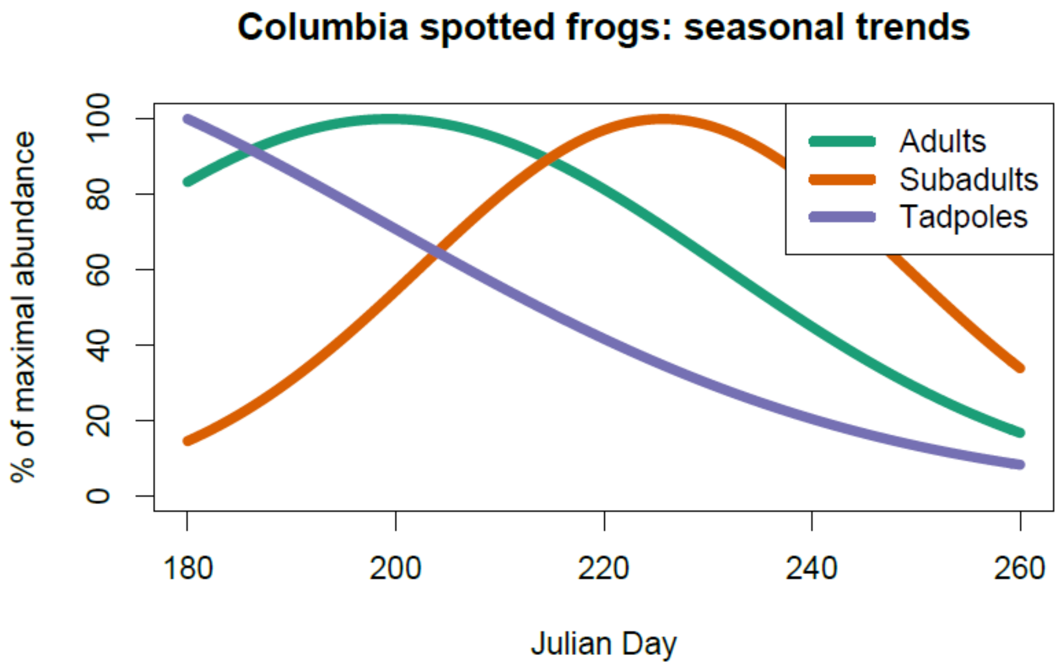


Figure 49. Seasonal trends in counts of Columbia Spotted Frogs found in mountain lakes in the Clearwater Region, Idaho.

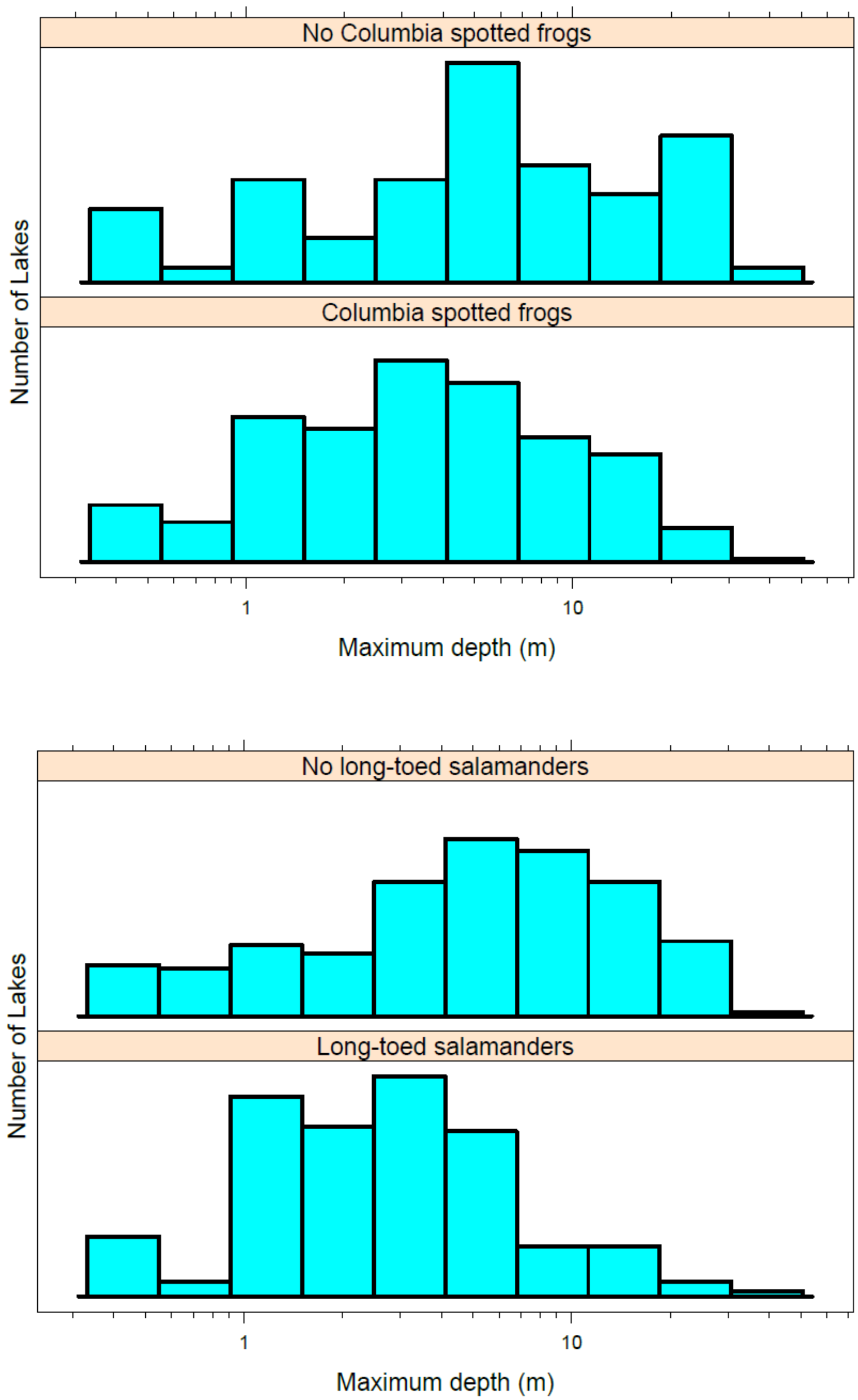


Figure 50. The distribution of Columbia Spotted Frogs and Long-toed Salamanders in mountain lakes in the Clearwater Region, Idaho, according to maximum lake depth.

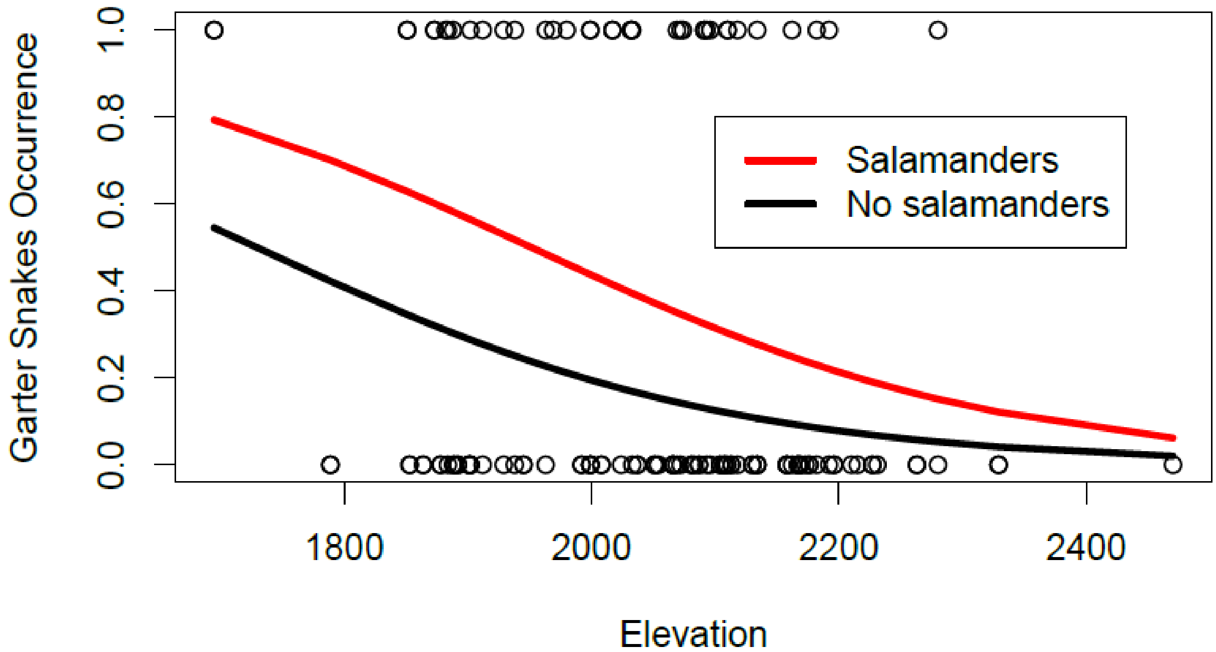
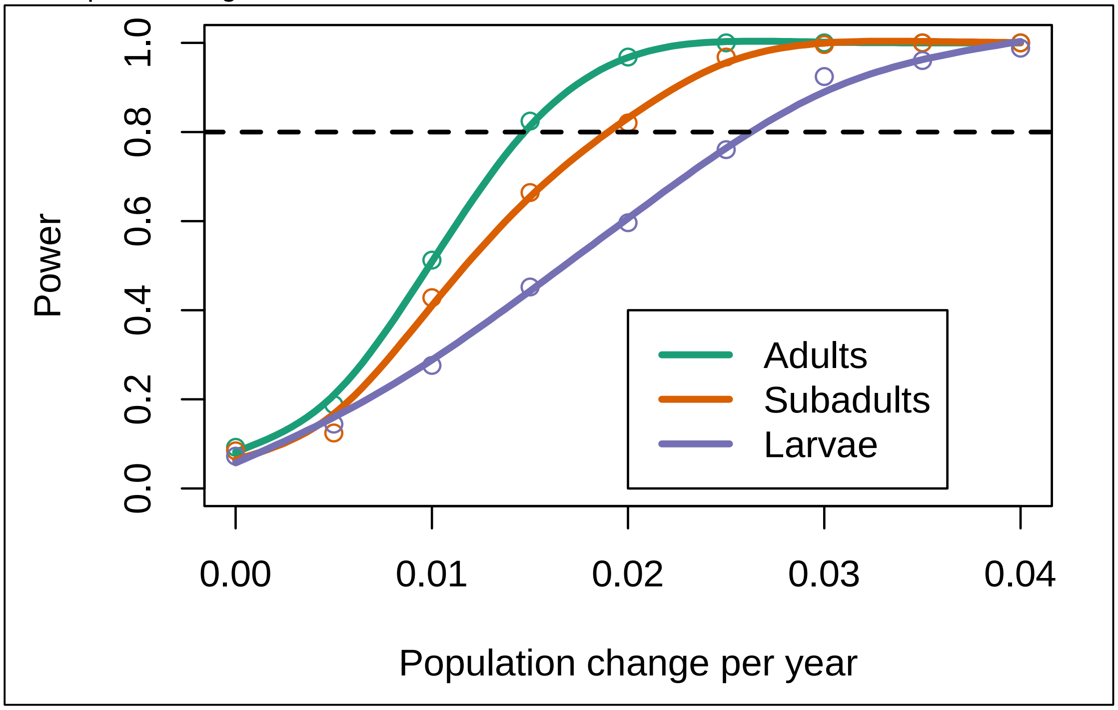


Figure 51. The probability of garter snake occurrence at mountain lakes in the Clearwater Region, Idaho, by lake elevation (m).

Columbia Spotted Frogs



Long-toed Salamanders

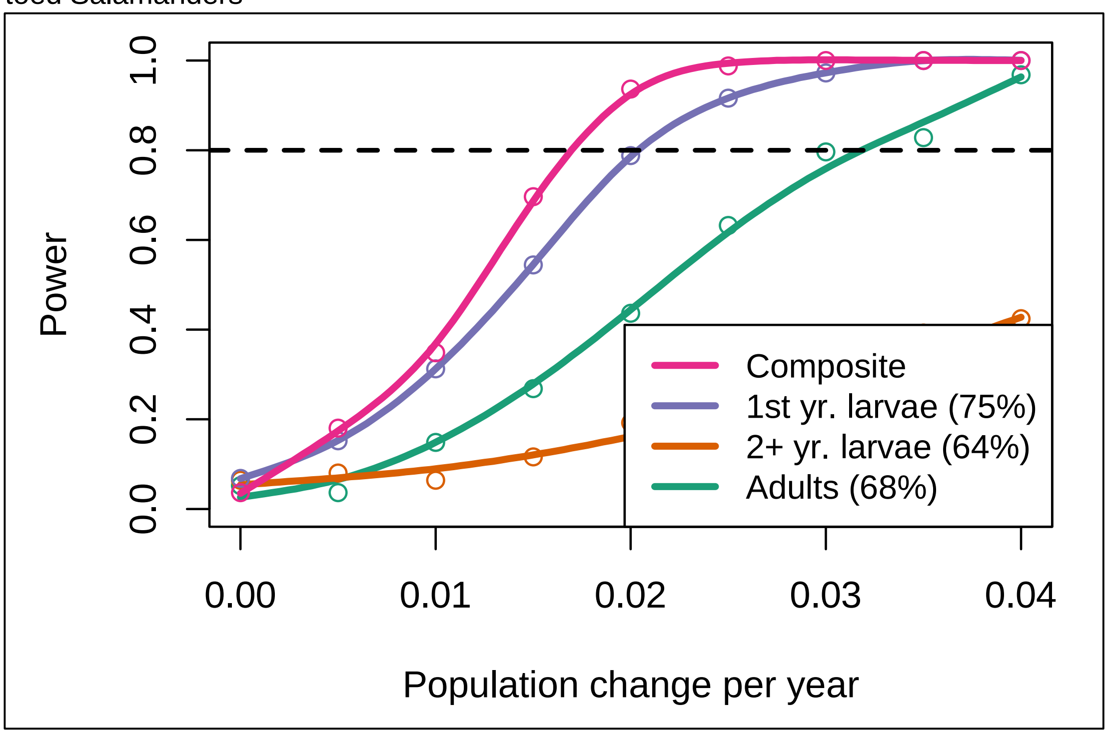


Figure 52. Power by life stage to detect changes in population abundance of Columbia Spotted Frogs and Long-toed Salamanders in mountain lakes of the Clearwater Region, Idaho, over the course of the 20-year study.

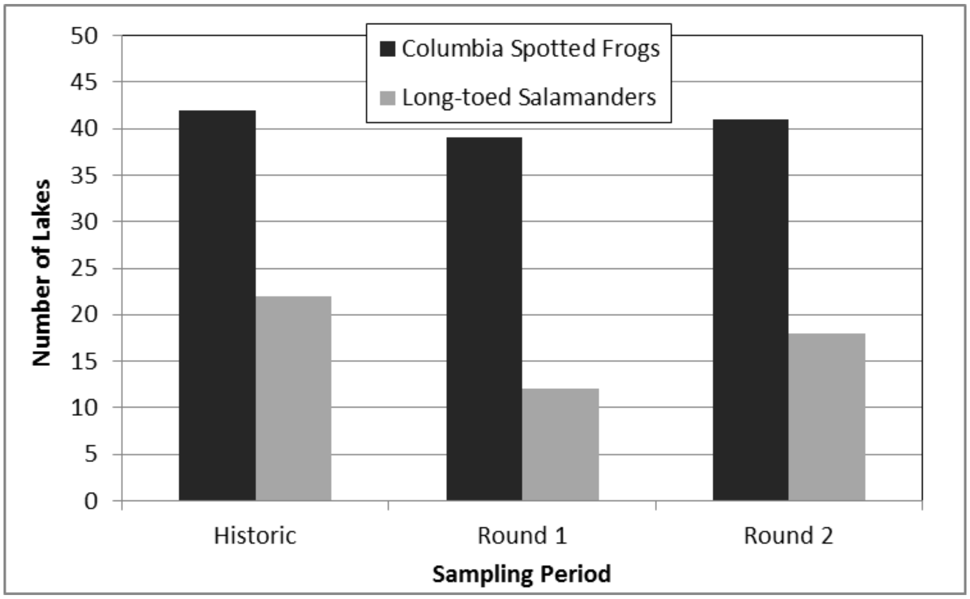


Figure 53. Long-term trends in occupancy of Columbia Spotted Frogs and Long-toed Salamanders in 45 mountain lakes in the Clearwater Region, Idaho. Historic surveys were conducted from the 1980's to early 2000's. Round 1 and Round 2 surveys were conducted between 2006 and 2013.

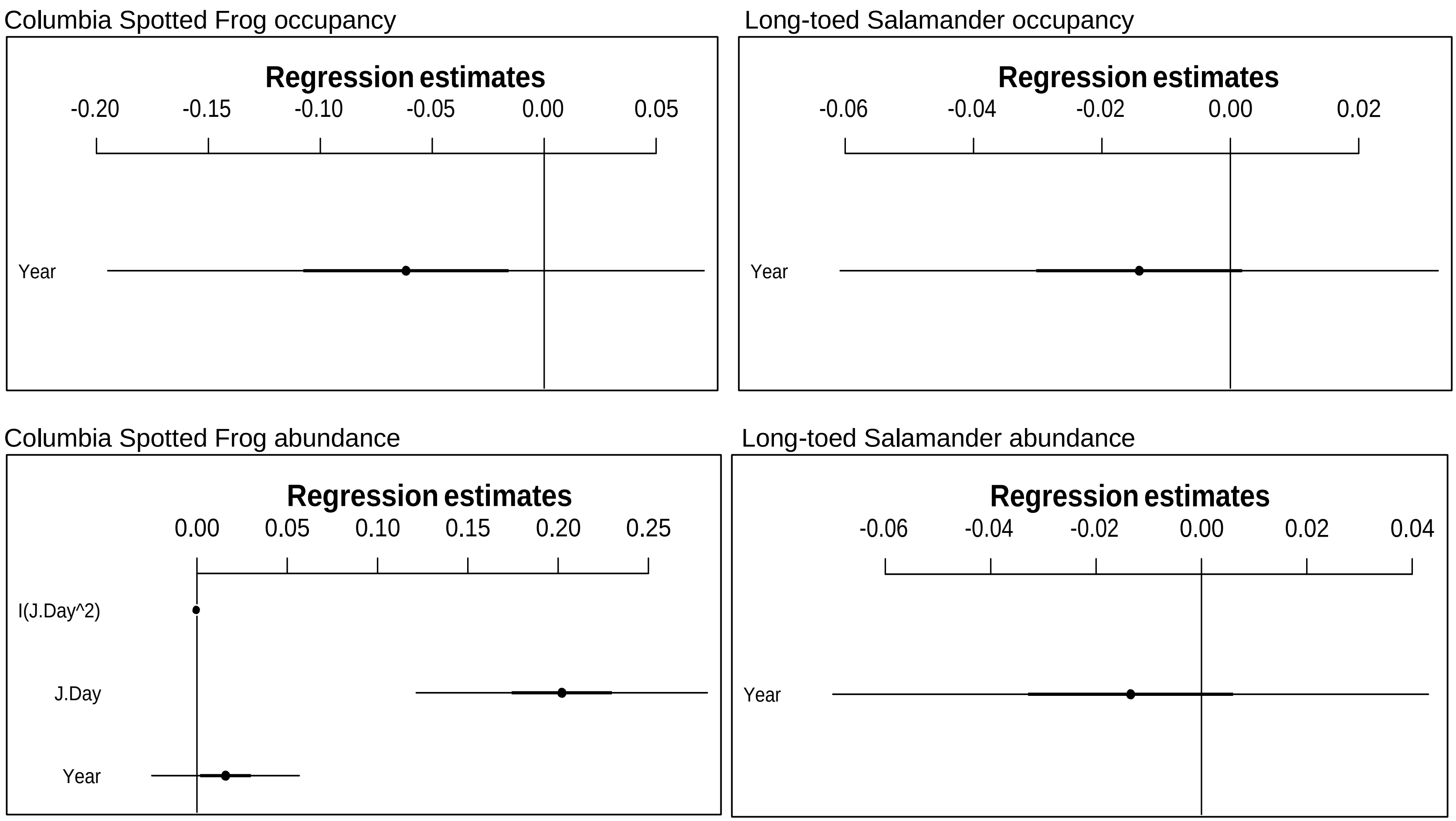


Figure 54. Estimates for the regression year parameter in generalized linear models of population trends, for Columbia Spotted Frog occupancy and abundance, and Long-toed Salamander occupancy and abundance.

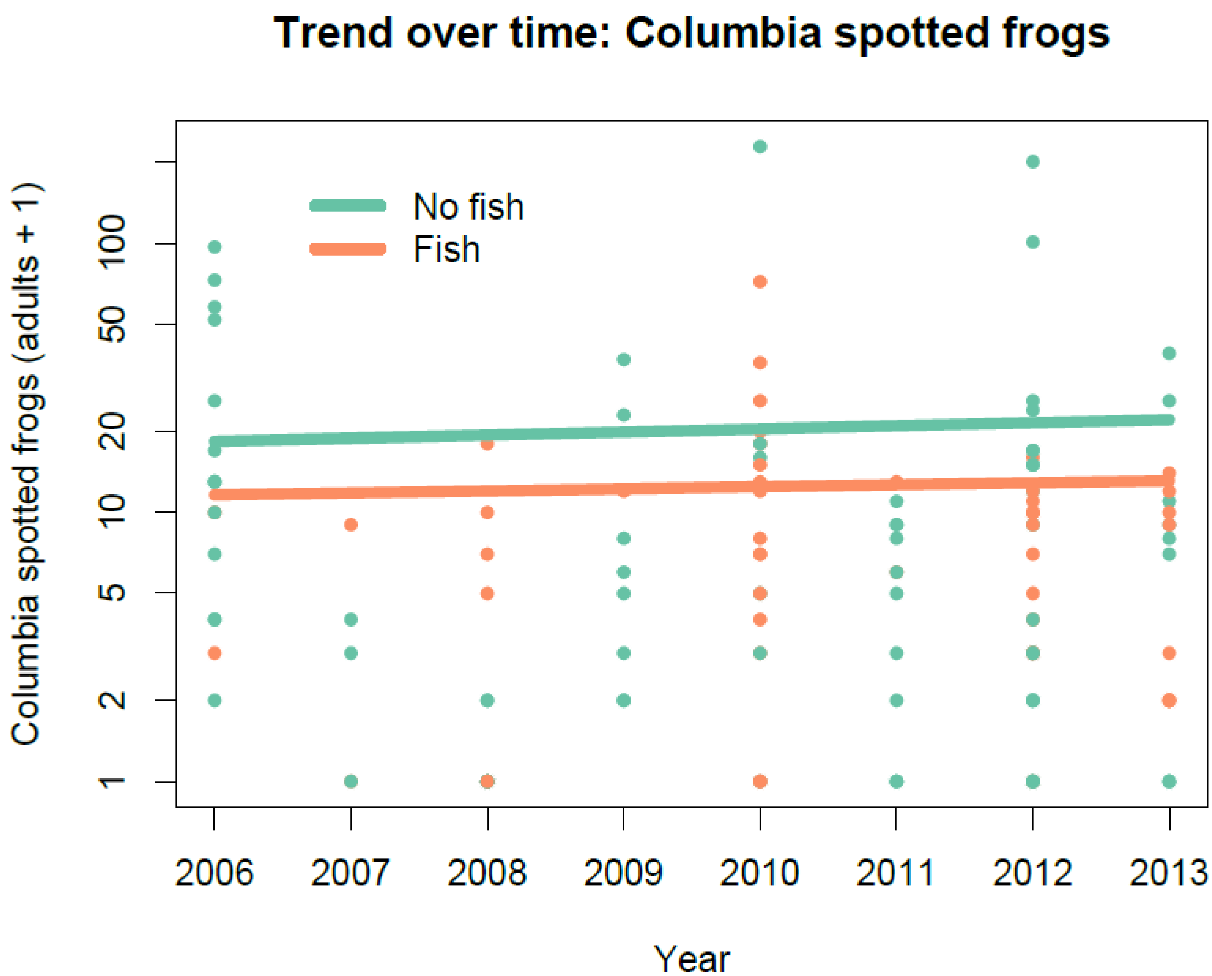
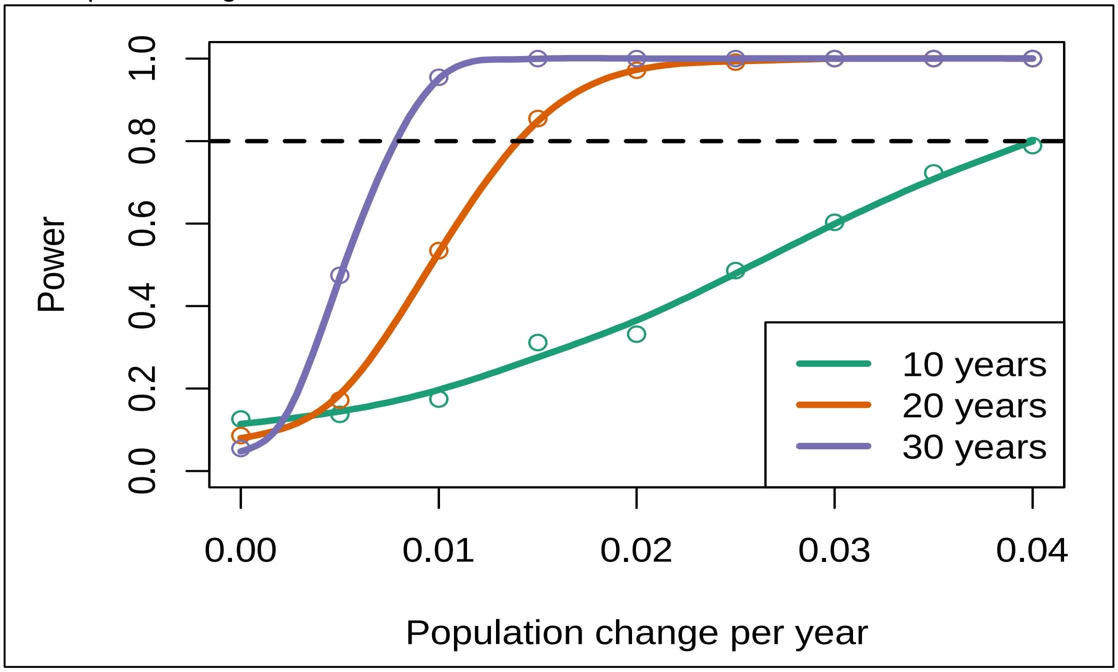


Figure 55. Generalized linear model of trends in Columbia spotted frogs abundance for fishless and fish-containing lakes based on a negative binomial distribution for fish collected in mountain lakes in the Clearwater Region, Idaho, from 2006 - 2013.

Columbia Spotted Frogs



Long-toed Salamanders

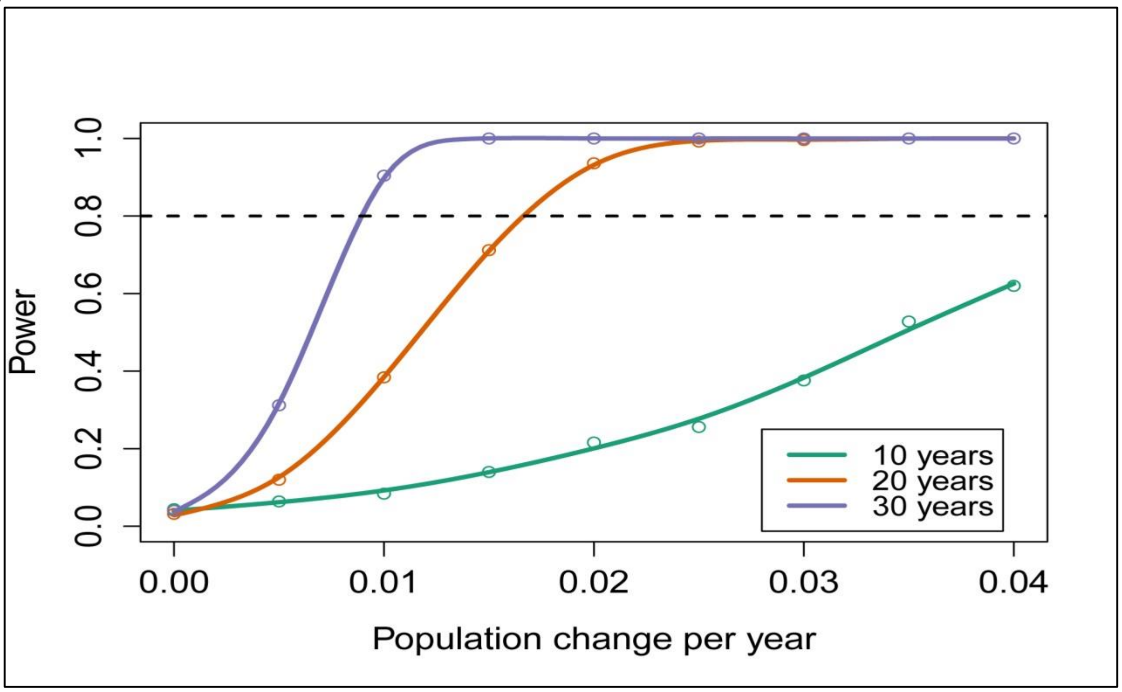


Figure 56. Figure 44Figure 44Projected power to detect changes in population of Columbia Spotted Frogs and Long-toed Salamanders in high mountain lakes of the Clearwater Region, Idaho, after 10, 20, and 30 years of sampling.

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APPENDICES

Appendix A. Lochsa River resident fish snorkel survey site descriptions.
LR01

Description:

Site is in Lowell Just above upper Wilderness Inn driveway. There is a large pullout that can be used for parking on the river side of the highway directly across from the small convenience store near the Wilderness Inn. Transect starts at GPS point and ends at riffle near large pullout for parking.

GPS (WGS84): Latitude: 46.14780 Longitude: 115.59184

Length: 215 m

TLD

BLU

LR02

Description:

Site is located just below the mouth of Lowell Creek. There is a pullout on the river side of the highway for parking. The transect is a run with riffles as upper and lower habitat breaks. Transect start is near GPS point and end is below parking area.

GPS (WGS84): Latitude: 46.15893 Longitude: 115.59000

Length: 348m

TLD

BLU

LR03

Description:

Site is located just above the mouth of Pete King Creek. There are two pullouts for parking, one near the start, opposite side of the river; and one near the end, on the river side of highway. The majority of the transect is a pool; the upper habitat break is a riffle located at the GPS point, while the lower break is at the mouth of Pete King Creek where the pool shallows.

GPS (WGS84): Latitude: 46.16798 Longitude: 115.58292

Length: 686m

TLD

BLU

LR04

Description:

Site is located near gravel bar downstream of canyon creek. There is a large pullout for parking right next to the start of the transect. The entire transect is a pool; the upper break is a riffle running into the pool and the lower break is the end of the pool.

GPS (WGS84): Latitude: 46.20862 Longitude: 115.54226

Length: 355m

TLD

BLU

LR05

Description:

Site is located downstream of Glade Creek. There is a small pullout for parking halfway through the transect. The transect consists of run into pool; the upper break is a riffle into the run and the lower break is the end of the pool.

GPS (WGS84):	Latitude:	46.21971	Longitude:	115.52935

Length: 350m

TLD

BLU

LR06

Description:

Site is located a half mile below the mouth of Deadman Creek. There are two pullouts for parking, one located right next to the start and one right next to the end. The majority of the transect is a run; the upper and lower breaks are riffles.

GPS (WGS84): Latitude: 46.22899 Longitude: 115.51059

Length: 415m

TLD

BLU

LR07

Description:

Site is located in the river bend above the mouth of Deadman Creek. There is a large pullout next to the site for parking. The transect consists of run into pool. The upper break is a riffle and the lower break is the end of the pool.

GPS (WGS84): Latitude: 46.22570 Longitude: 115.49619

Length: 210m

TLD

BLU

LR08, LR09, LR10

Description:

These three sites are located very close to each other, almost consecutive. They are located right next to the mouth of Oldman Creek. There are two pullouts for parking, one below the creek and one above. LR10 Starts above Oldman Creek where a small rapid pours into a pool to create the upper break. The lower break is the end of the pool. LR09 starts where the riffle/pocket water adjacent to the lower break of LR10 turns to a run and the lower break is the mouth of Oldman Creek. The Start of LR08 is just below the mouth of Oldman Creek where the riffle and pocket water turn to a run. LR08 consists of a run into pool and the lower break is where the pool ends.

GPS (WGS84):	**LR08**	Latitude:	46.25156	Longitude:	115.40046
	LR09	Latitude:	46.25329	Longitude:	115.40022
	LR10	Latitude:	46.25561	Longitude:	115.39953

Length: **LR08**: 360m **LR09**: 100m **LR10**: 310m

LR08 TLD BLU

LR09 TLD BLU

LR10 TLD BLU

LR11

Description:

Site is located halfway between Macaroni Creek and Snowshoe Creek. There is a pullout just above the site for parking. The transect is a run into pool; the upper break is a riffle and the lower break is the end of the pool.

GPS (WGS84): Latitude: 46.29295 Longitude: 115.37714

Length: 130m

TLD

BLU

LR12, LR13

Description:

LR13 is located just above the mouth of Fish Creek and LR12 is located just below the mouth of Fish Creek. There is parking at the fish creek river access site and there is a pullout just below the end of LR12. LR13 is a run which starts at a riffle and ends at the mouth of Fish Creek. LR12 starts where the riffle and pocket water below the mouth of Fish Creek turns to a run and ends at a riffle where the river splits around a small island.

GPS (WGS84):	**LR12**	Latitude:	46.33232	Longitude:	115.34618
	LR13	Latitude:	46.33481	Longitude:	115.34382
Length:	**LR12:** 135m		**LR13:** 230m		

LR12

TLD

BLU

LR13

TLD

BLU

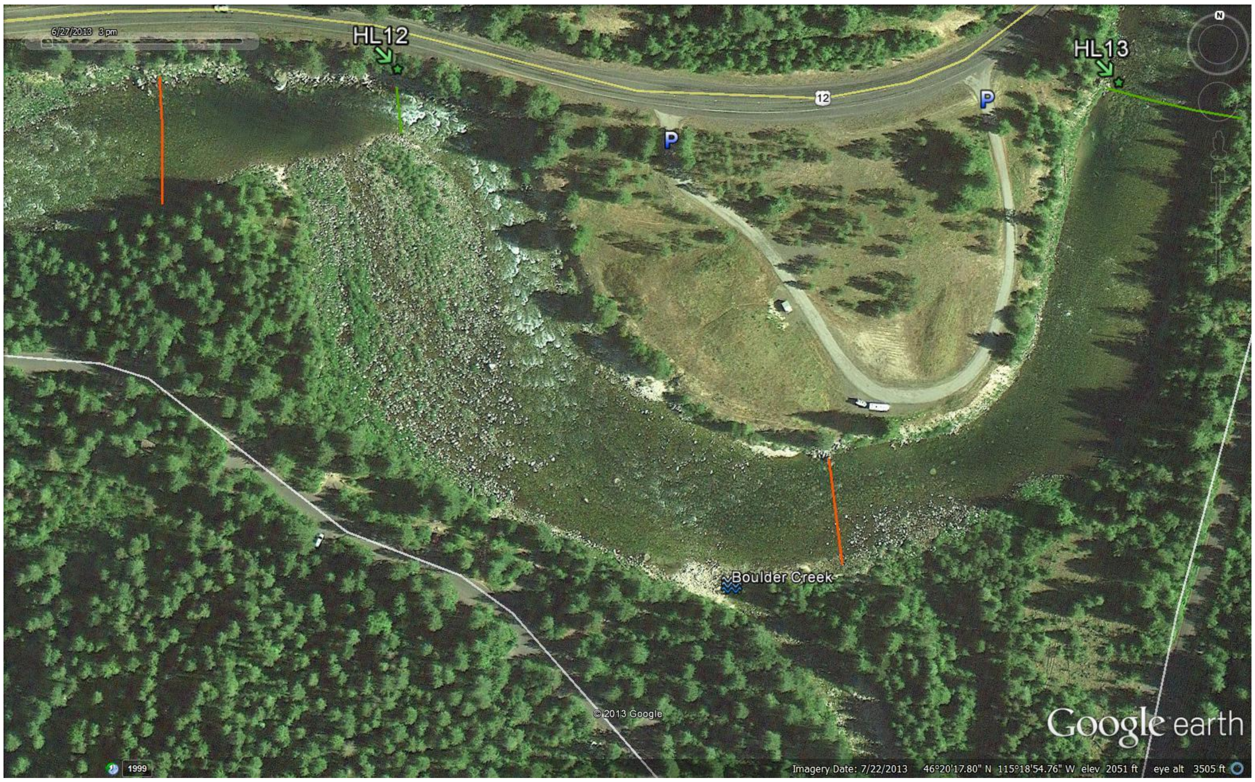
LR14, LR15

Description:

Sites are located near the mouth of Boulder Creek where there is an S curve in the river. There is a large horseshoe pullout with primitive campsites along it which can be used for parking. LR15 is located near the upper entrance of the horseshoe. The transect is a run which starts and ends with a riffle. LR14 is located below the lower entrance of the horseshoe. The transect is a run into pool and starts where the river takes a sharp bend and a riffle turns into a run. The lower break is the end of the pool.

GPS (WGS84):	**LR14**	Latitude:	46.33938	Longitude:	115.31657
	LR15	Latitude:	46.33947	Longitude:	115.31275

Length: **LR14**: 130m **LR15**: 226m



LR14

TLD

BLU

LR15

TLD

BLU

LR16

Description:

Located just above Wilderness Gateway bridge. There is a pullout next to the bridge for parking. The transect is a run into pool. The upper break is a riffle and the lower break is the end of the pool.

GPS (WGS84): Latitude: 46.34486 Longitude: 115.30704

Length: 130m

TLD

BLU

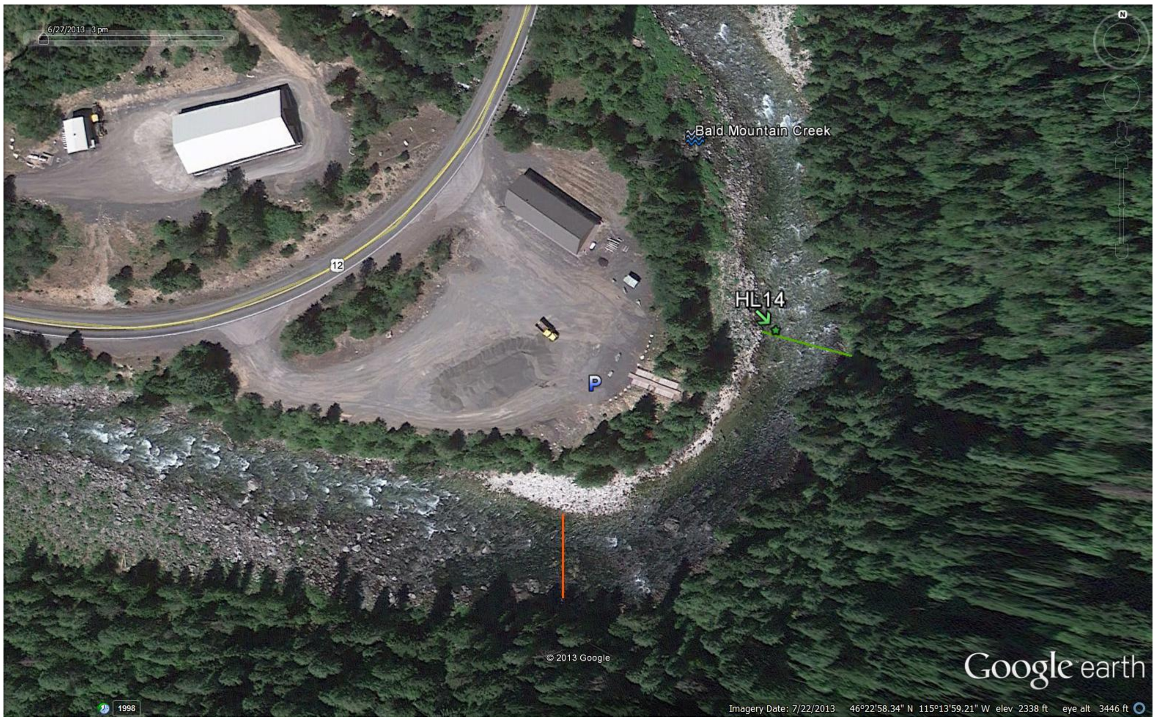
LR17

Description:

Site is located just below the mouth of Bald Mountain Creek. There is a pullout and parking for the Bald Mountain river access ramp right next to the site. The transect is a run with riffles as the upper and lower breaks.

GPS (WGS84):	Latitude:	46.38297	Longitude:	115.23227

Length: 125m



TLD

BLU

LR18

Description:

Site is located above the mouth of Skookum Creek. There is a pullout for parking near the end of the transect. The transect is a run into pool where the upper break is a riffle and the lower break is the end of the pool.

GPS (WGS84): Latitude: 46.42353 Longitude: 115.14409

Length: 156m

TLD BLU

LR19

Description:

Site is located approximately 1.2 road miles downstream of Indian Graves Creek. There is a large pullout on the side of the road which has a short road attached that leads to the river near the start of the transect. The transect is a run into pool that has a riffle at the start and ends at the end of the pool.

GPS (WGS84): Latitude: 46.44567 Longitude: 115.09087

Length: 316m

TLD

BLU

LR20

Description:

Site is located just above the mouth of Indian Meadow Creek. There is a small pullout for parking near the end of the transect. The transect is a run into pool where the upper break is a riffle and the lower break is the end of the pool.

GPS (WGS84): Latitude: 46.45316 Longitude: 115.06233

Length: 295m

TLD

BLU

LR21

Description:

Site located just below the mouth of Weir Creek. There is a small pullout for parking right next to the transect. The transect consists of a run into a long pool. The upper break is a riffle and the transect ends at an old culvert pipe on highway side of river.

GPS (WGS84): Latitude: 46.45842 Longitude: 115.03786

Length: 360m

TLD

BLU

LR22

Description:

Site is located just below the mouth of Postoffice Creek. There is a pullout for parking just below the transect. The transect is a run which starts where the river converges after splitting around an island and ends at a riffle.

GPS (WGS84): Latitude: 46.46582 Longitude: 114.98612

Length: 120m

TLD

LR23

Description:

Site is located near Bear Mountain Creek. There is a large pullout for parking right next to the site. The transect is a run into pool where the start is at a riffle and the end is where the pool ends.

GPS (WGS84): Latitude: 46.47312 Longitude: 114.95871

Length: 180m

TLD

BLU

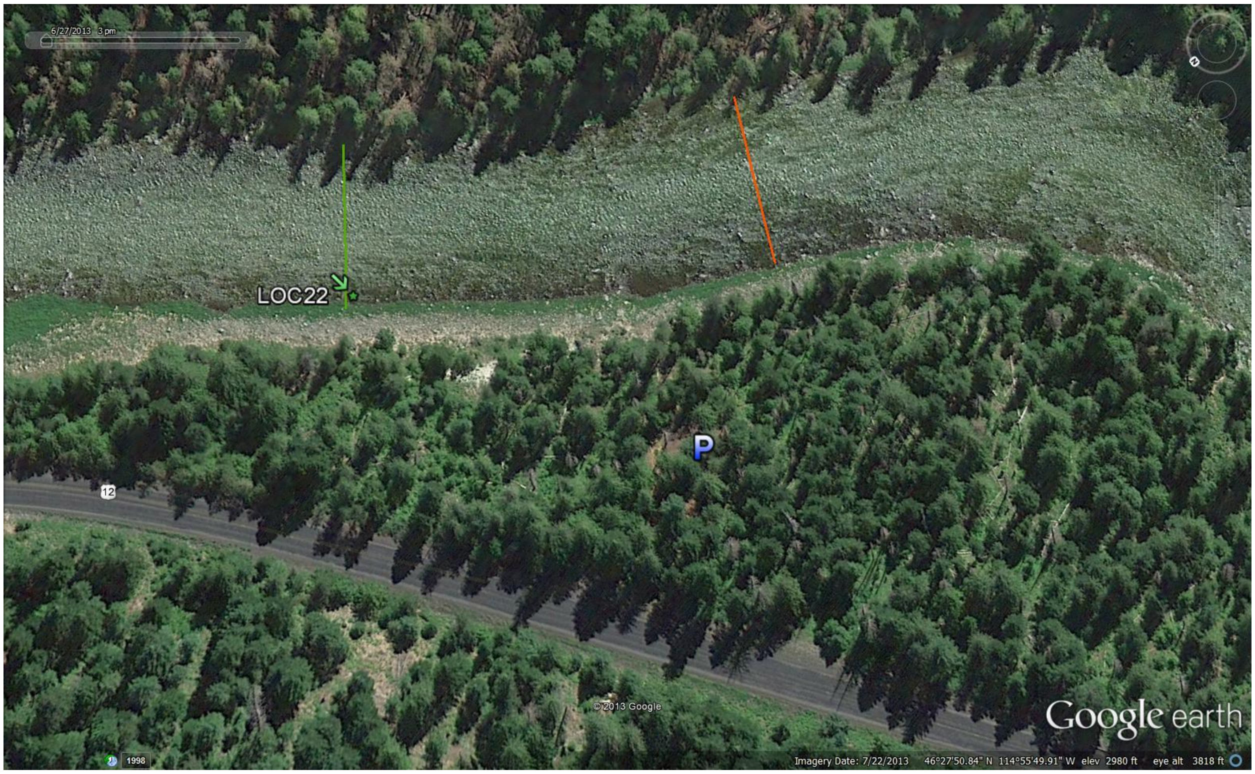
LR24

Description:

Site is located approximately 1.8 road miles below the Jerry Johnson campground. There is a small road which pulls off the road into a wooded section on the river side of the highway which has an area to park right next to the transect.

GPS (WGS84): Latitude: 46.46448 Longitude: 114.92977

Length: 100m



TLD

BLU

LR25

Description:

The site is located just below the mouth of Warm Springs Creek. There is a pullout for parking just below the end of the transect. The transect is a run with riffles for upper and lower breaks.

GPS (WGS84):	Latitude: 46.47337	Longitude:	114.88909

Length: 168m

TLD

BLU

LR26

Description:

Site is located just above the mouth of Wawaalamnime Creek. There is parking at doe creek road below the transect. The transect is a run that starts at a riffle and ends at mile marker 154.

GPS (WGS84):	Latitude:	46.49400	Longitude:	114.85339

Length: 103m

TLD BLU

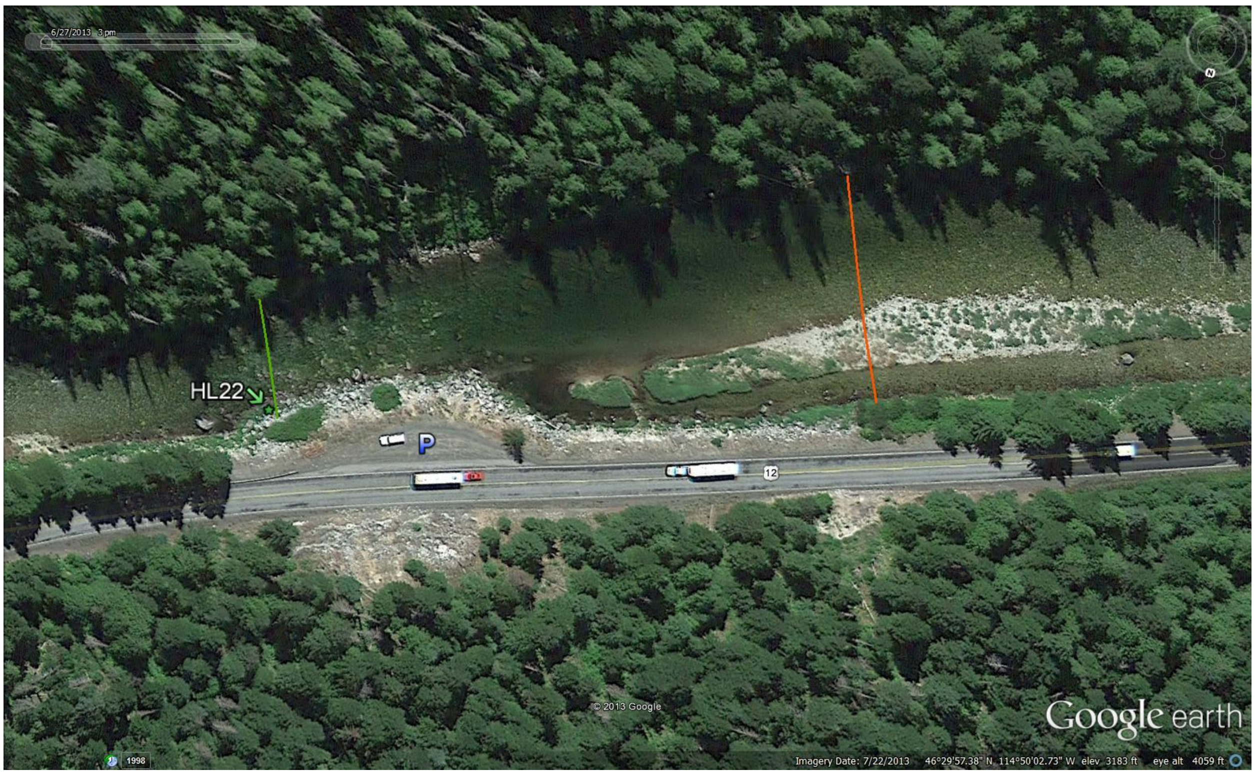

LR27

Description:

Site is located approximately 0.6 miles below the mouth of Badger Creek. There is a large pullout right next to the site for parking. The transect is a run into pool with a riffle for the upper break and the end of the pool as the lower break.

GPS (WGS84): Latitude: 46.49952 Longitude: 114.83298

Length: 140m



TLD

BLU

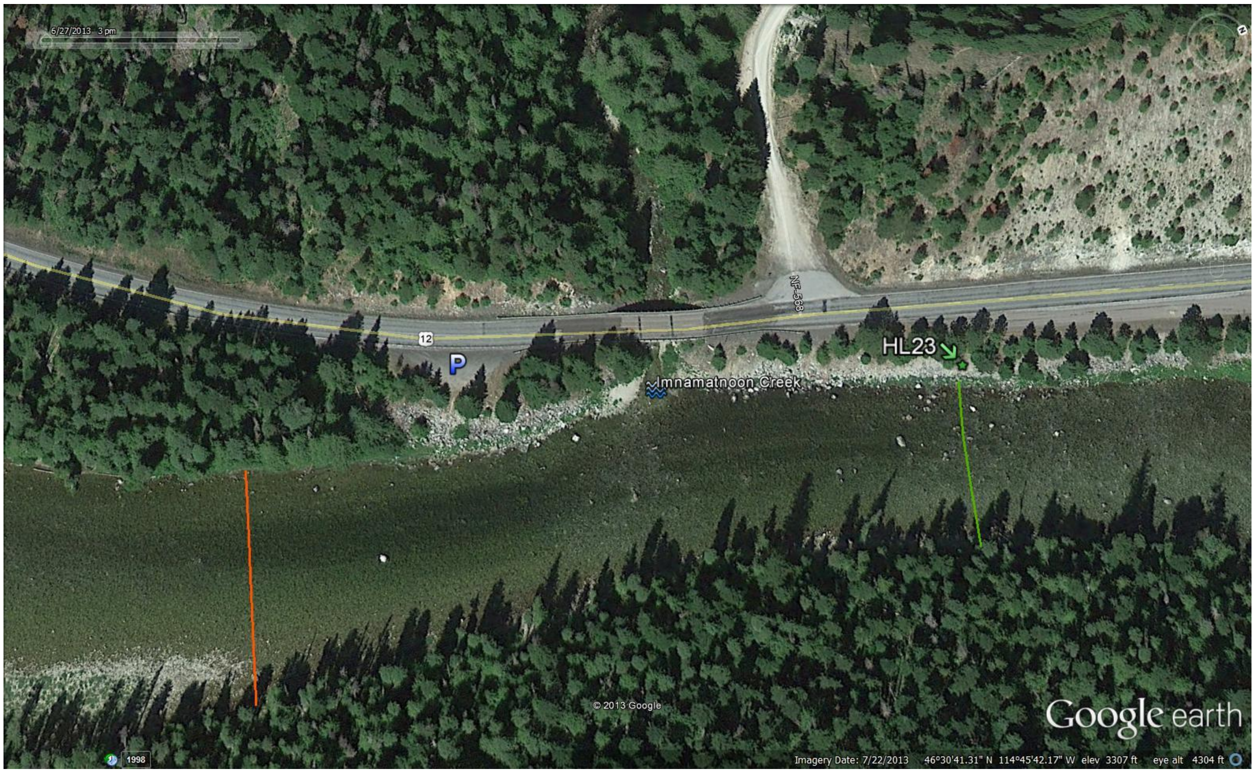
LR28

Description:

The site is located right next to the mouth of Imnamatnoon Creek. There is a pullout just below the mouth of Imnamatnoon Creek for parking. The transect is a run that starts at a riffle, extends past the mouth of Imnamatnoon Creek and ends at a riffle.

GPS (WGS84): Latitude: 46.51224 Longitude: 114.76119

Length: 209m



TLD

BLU

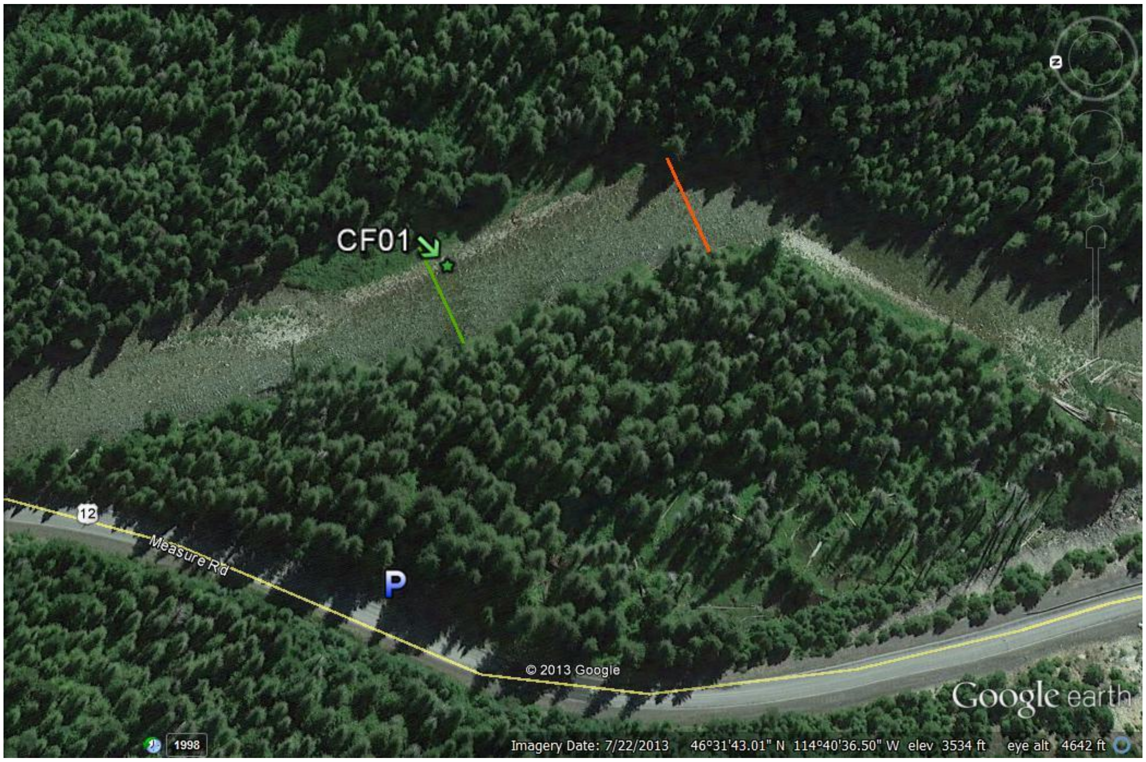
CFC01

Description:

Site is located approximately 0.9 miles above the Forest Road 111 turnoff. There is a small pullout right next to the site right next to a large wooded area for parking. Cut through the wooded area to get to the transect. The transect is mostly a run which starts and ends with a riffle.

GPS (WGS84): Latitude: 46.52901 Longitude: 114.67628

Length: 91m



TLD

BLU

CFC02

Description:

The site is located approximately 0.75 miles above the Cedar Grove Picnic area. There is a large pullout next to the site for parking. The transect is a run into pool that starts at a riffle and ends at the end of the pool.

GPS (WGS84):	Latitude:	46.55032	Longitude:	114.67323

Length: 102m

TLD

BLU

CFC03

Description:

Site is located approximately 1.7 miles above snorkel site CFC02. There is a pullout next to the site for parking. The transect is a run which starts and ends with a riffle.

GPS (WGS84): Latitude: 46.56405 Longitude: 114.64634

Length: 108m

TLD

BLU

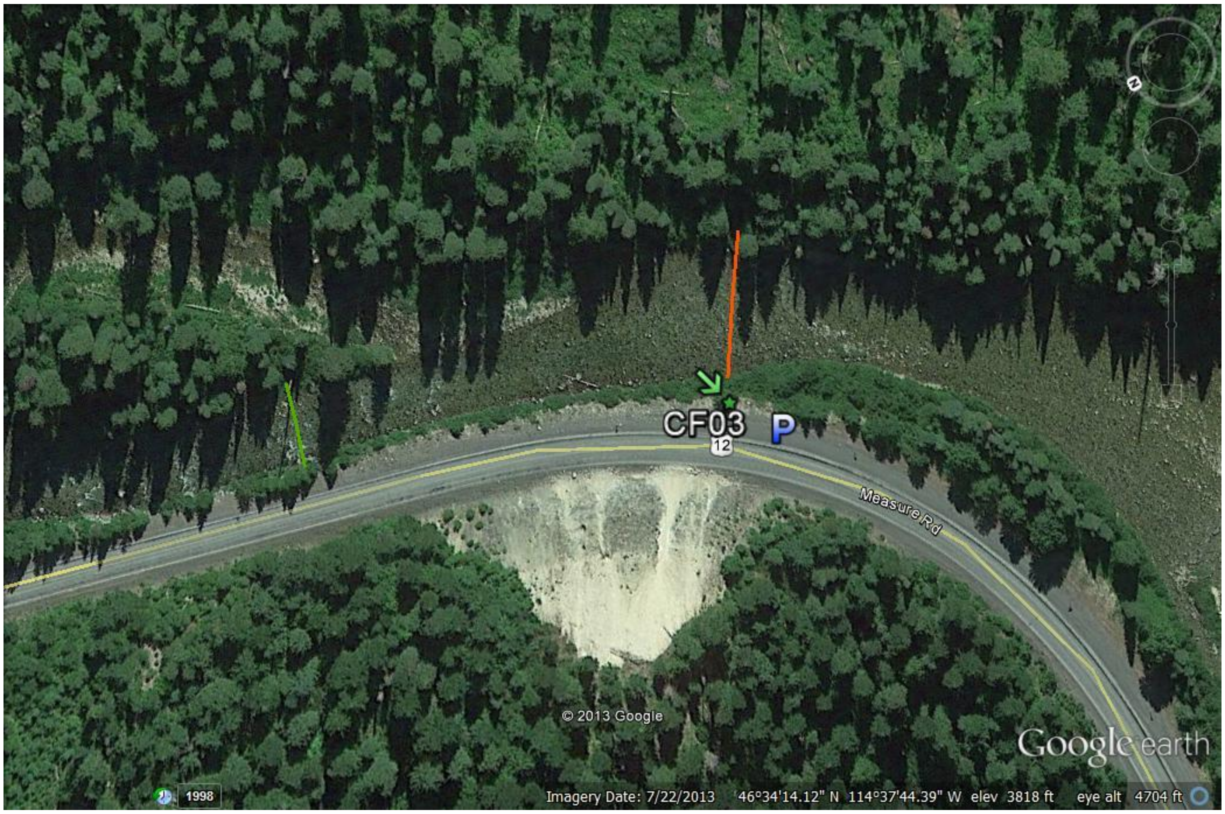
CFC04

Description:

Site is located approximately 1 mile above snorkel site CFC03. There is a wide shoulder toward the end of the transect for parking. The GPS point is located toward the end of the transect. The transect is a run with riffles as upper and lower breaks.

GPS (WGS84): Latitude: 46.57039 Longitude: 114.62919

Length: 110m



TLD

BLU

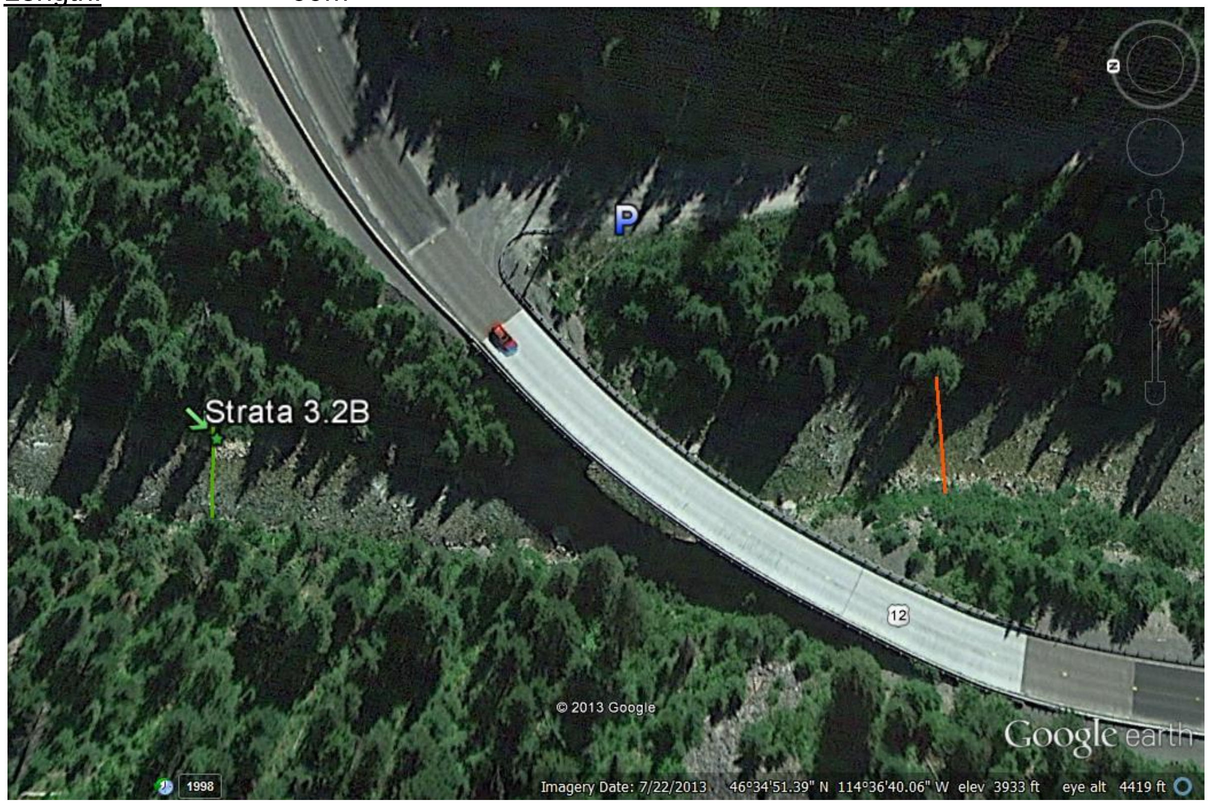
CFC05

Description:

Site is located underneath the highway 12 bridge as it crosses over Crooked Fork Creek and approaches Lolo Pass. There is parking across the bridge on the Forest Road 369 pullout. The transect is a run that starts at a plunge pool and ends at a riffle.

GPS (WGS84): Latitude: 46.58146 Longitude: 114.61118

Length: 99m



TLD

BLU

CKC01

Description:

To get to the sites on Colt Killed Creek take Forest Road 111 to the two bridges that cross Crooked Fork Creek and Colt Killed Creek right before they converge to form the Lochsa River. After crossing the first bridge over Crooked Fork Creek, but before crossing the bridge over Colt Killed Creek, there is a road that follows Colt Killed Creek for approximately half a mile before it turns away from the creek. Where the road turns from the creek there is a trailhead for a trail that follows Colt Killed Creek. CKC01 is located not far from the trailhead. All five sites on Colt Killed Creek will require some bushwhacking to get to. The transect is a shallow run which starts and ends with a riffle.

GPS (WGS84): Latitude: 46.51173 Longitude: 144.66801

Length: 239m

TLD

BLU

CKC02

Description:

Site is located approximately 0.3 river miles above CKC01. Taking the trail or river walking are about the same time to get to this site. The transect is a run into pool. The start is a small rapid and the lower break is the end of the pool.

GPS (WGS84): Latitude: 46.51072 Longitude: 114.66254

Length: 120m

TLD

CKC03
Description:

The site is located approximately 0.7 river miles above CKC02. It is best to take the trail to a spot near the site and bushwhack to the site. The transect starts at a riffle and small pool and ends at a riffle.

GPS (WGS84): Latitude: 46.51491 Longitude: 114.65285

Length: 114m

TLD

BLU

CKC04

Description:

Site is located approximately 200 meters above CKC03. It is best to river walk from CKC03 to CKC04. The transect is a run that starts and ends with a riffle.

GPS (WGS84): Latitude: 46.51420 Longitude: 114.65033

Length: 132m

TLD

BLU

CKC05
Description:

The site is located approximately 0.3 miles above CKC04. The easiest way to get to the site is to take the trail past the site where the trail lowers towards the stream and cross the stream to the other side to get to the start of the transect. The transect consists of two consecutive pools. The upper pool is a one person snorkel. The second snorkeler can wait at the beginning of the second pool and wait for the first snorkeler to reach them. The lower break is the end of the second pool.

GPS (WGS84): Latitude: 46.51454 Longitude: 114.64423

Length: 190m

TLD

BLU

Appendix B. Watersheds (HUC5) selected for an amphibian risk assessment project on high mountain lakes in the Clearwater Region, Idaho.

HUC5 Watershed	National forest	Amphibian risk classification	% and # of fishless lakes	% and # of fishless surface area
Big Harrington Creek	Nez Perce	Control	100% (2 lakes)	100% (unknown)
Goat Creek	Nez Perce	Control	100% (3 lakes)	100% (0.96 total ha)
Upper Meadow Creek	Nez Perce	Control	100% (3 lakes)	100% (1.64 total ha)
North Fork Moose Creek	Nez Perce	Low	93% (13 of 14 lakes)	53% (6.05 of 11.43 ha)
Storm Creek	Clearwater	Low	64% (9 of 14 lakes)	56% (18.56 of 33.37 ha)
Running Creek	Nez Perce	Moderate	75% (3 of 4 lakes)	9% (0.84 of 9.21 ha)
Warm Springs Creek	Clearwater	Moderate	60% (6 of 10 lakes)	12% (3.45 of 28.63)
Bargamin Creek	Nez Perce	Elevated	22% (2 of 9 lakes)	8% (1.52 of 19.52 ha)
Old Man Creek	Clearwater	Elevated	20% (3 of 15 lakes)	4% (3.14 of 75.76 ha)

Appendix C. General characteristics of lakes selected for a long-term high mountain lake amphibian monitoring project in the Clearwater Region, Idaho.

Lake Name	HUC5 Watershed	Longitude (datum WGS 84, format decimal degrees)	Latitude (datum WGS 84, format decimal degrees)	Size (ha)	Maximum Depth (m)	Elevation (m)
Bilk Mountain	Goat/Control	115.0380	45.9396	0.18	<0.5	2113
Goat	Goat/Control	115.0040	45.9650	0.36	1.9	2182
Mud	Goat/Control	114.9856	45.9354	0.42	0.9	1889
Bilk	Up.Meadow/Control	115.0498	45.9370	0.85	4	2054
Elk	Up.Meadow/Control	115.0783	45.8430	0.67	N/A	2029
Section 27	Up.Meadow/Control	115.0732	45.9117	0.12	N/A	2100
Fox Peak Lower	N.F. Moose/Low	114.7875	46.3000	0.49	3.7	2017
Fox Peak Upper	N.F. Moose/Low	114.7896	46.2991	0.49	3.8	2032
Isaac Creek	N.F. Moose/Low	114.8122	46.2735	0.44	0.8	1912
Isaac	N.F. Moose/Low	114.8058	46.2692	5.43	4.8	1901
Section 28	N.F. Moose/Low	114.8461	46.3386	0.5	1.3	2074
West Moose #1	N.F. Moose/Low	114.9899	46.2940	1.1	3.1	2130
West Moose #2	N.F. Moose/Low	115.0141	46.3260	0.11	<1.0	2169
West Moose #3	N.F. Moose/Low	115.0191	46.3108	0.41	<1.0	2091
West Moose #4	N.F. Moose/Low	115.0210	46.3129	0.51	<1.0	2162
West Moose #5	N.F. Moose/Low	115.0157	46.3199	0.54	1.9	2096
West Moose #6	N.F. Moose/Low	115.0142	46.3223	0.88	2.7	2110
West Moose #7	N.F. Moose/Low	115.0234	46.3029	0.47	1.7	2173
West Moose #8	N.F. Moose/Low	115.0127	46.3271	0.07	<1.0	2167
West Moose #9	N.F. Moose/Low	115.0128	46.3258	0.04	<1.0	2158
Dan	Storm/Low	114.4577	46.4766	2.16	3.3	2019
Dodge	Storm/Low	114.4487	46.4677	4.32	7	2118
Lookout	Storm/Low	114.4559	46.4736	0.33	0.6	2051
Maud	Storm/Low	114.4048	46.4702	9.32	6	1969
Middle Storm	Storm/Low	114.3552	46.5381	1.04	3.3	2081
North Sec. 25	Storm/Low	114.3858	46.5173	0.28	<1.0	2134
North Storm	Storm/Low	114.3496	46.5456	0.63	2	2227
N.E. Ranger	Storm/Low	114.4062	46.5186	0.32	0.3	1999
Old Stormy	Storm/Low	114.3787	46.5109	0.88	1.5	2210
Ranger	Storm/Low	114.4160	46.5149	2.74	3.7	1999
Section 27	Storm/Low	114.4383	46.5168	0.47	1.2	1999
Siah	Storm/Low	114.4437	46.5232	5.26	21	1963
South Sec. 25	Storm/Low	114.3853	46.5165	0.2	<1.0	2134
Storm	Storm/Low	114.3623	46.5562	5.42	11	1992

Appendix C. Continued.

Lake Name	HUC5 Watershed	Longitude (datum WGS 84, format decimal degrees)	Latitude (datum WGS 84, format decimal degrees)	Size (ha)	Max. Depth (m)	Elevation (m)
Eagle Creek	Running/Moderate	114.9068	45.7695	0.0	Dry	2222
Running	Running/Moderate	115.0463	45.9151	8.4	13.3	2008
Section 26	Running/Moderate	115.0476	45.9034	0.4	2.0	2087
Section 26 #2	Running/Moderate	115.0468	45.9049	0.2	1.5	2104
Dodge	Warm Springs/Mod.	114.8593	46.3544	0.9	<1.0	1882
East Wind	Warm Springs/Mod.	114.7365	46.3918	7.5	7.6	2167
Hungry	Warm Springs/Mod.	114.7652	46.3267	10.0	12.2	2037
Low. N. Wind	Warm Springs/Mod.	114.7492	46.3933	0.2	0.1	2066
Middle Wind	Warm Springs/Mod.	114.7455	46.3889	5.8	8.2	2069
N.W. Wind	Warm Springs/Mod.	114.7568	46.3947	0.7	1.5	1945
South Wind	Warm Springs/Mod.	114.7319	46.3871	0.8	2.5	2263
Up. N. Wind	Warm Springs/Mod.	114.7477	46.394	0.6	0.5	2066
West Wind	Warm Springs/Mod.	114.7514	46.3905	2.0	7.0	2072
Wind Pond	Warm Springs/Mod.	114.7407	46.3901	0.3	2.5	2158
Bleak Creek	Bargamin/Elevated	115.0231	45.6513	0.5	4.9	2196
Boston Mtn.	Bargamin/Elevated	115.1813	45.6418	0.8	5.2	2329
Goat Lake	Bargamin/Elevated	115.0931	45.5954	0.9	3.1	2280
Lake Creek E.	Bargamin/Elevated	115.0577	45.6111	1.6	4.8	2182
Lake Creek. S.	Bargamin/Elevated	115.0622	45.6057	8.1	14.8	2231
Lake Creek W.	Bargamin/Elevated	115.0647	45.6094	3.5	5.0	2182
MacArther	Bargamin/Elevated	114.9754	45.7206	2.0	3.2	2107
Stillman	Bargamin/Elevated	114.9923	45.7126	1.2	13.3	2093
Three Prong	Bargamin/Elevated	114.9333	45.7706	1.0	2.7	2192
Chimney	Old Man/Elevated	115.2959	46.1968	2.3	6.0	1864
Dishpan	Old Man/Elevated	115.217	46.1974	2.0	2.5	1878
Elizabeth	Old Man/Elevated	115.2094	46.1989	11.9	31.9	1789
Flea	Old Man/Elevated	115.2955	46.2051	1.5	2.4	1851
Florence	Old Man/Elevated	115.2159	46.1778	12.1	7.8	1917
Hjort	Old Man/Elevated	115.2096	46.1828	0.5	3.2	1902
Kettle	Old Man/Elevated	115.2319	46.1932	5.5	15.0	2176
Lloyd	Old Man/Elevated	115.2175	46.1896	9.3	5.9	1892
Lottie	Old Man/Elevated	115.2506	46.267	3.5	3.6	1873
Lottie Upper	Old Man/Elevated	115.2446	46.2655	2.5	6.1	1888
Maude East	Old Man/Elevated	115.2467	46.2595	1.9	6.2	1938
Maude North	Old Man/Elevated	115.2511	46.2619	0.8	2.5	1884
Maude West	Old Man/Elevated	115.2549	46.2589	2.5	9.8	1853
Old Man	Old Man/Elevated	115.2382	46.2071	18.6	4.0	1695
Wood	Old Man/Elevated	115.2528	46.2076	0.8	4.5	1929

APPENDIX D. High mountain lake sampling protocol, updated and revised after 2013 field season.

Goal

Examine how fisheries management activities relate to persistence of native fauna at the local population and metapopulation scale within the high mountain lake ecosystems of North Central Idaho for the Idaho Fish and Game (IDFG), Clearwater Region (#2) and United States Forest Service cooperators (Nez Perce and Clearwater National Forests).

Objective

- Stratify watersheds by lake according to habitat occupied by fish, i.e. group 5th code HUC watersheds that are low, high, elevated and control into groups.
- Randomly select two to three 5th code HUCs from each amphibian risk category. Survey two watersheds every summer in a long term monitoring program.
- Perform a statistical analysis of amphibian occurrence and relative abundance within four amphibian risk categories.
- Collect genetics samples for information to aid in a population or metapopulation viability analysis (PVA or MPVA).

Statistical Analysis

Mountain lakes that exist in watersheds (HUC5) which make up drainage systems (HUC4) lend themselves to a nested type of analysis. An analysis of variance (ANOVA) or a multiple linear regression (MLR) would work best with relative abundance measures in the nested type of analysis. Analysis of statistics will be more in depth once sessions with University of Idaho statistical counseling center (SCC) have been completed.

Sampling Protocol

1. Approaching the lake

Find a location to take photographs and record appropriate metadata from a position above the lake. Use binoculars to identify if amphibians are visible in obvious locations.

2. Amphibian Survey - Visual Encounter Survey (VES)

Upon arrival to the lake, the amphibian VES should be performed first (before setting gill nets) following previous mountain lake survey methodology (Crump and Scott 1994; Murphy 2002). VES's are timed perimeter searches for amphibians in which each individual amphibian and reptile encountered is recorded by species and life stage to determine presence and relative abundance. All littoral areas of lake will be sampled, as well as inlets outlets and associated wetlands (Murphy, 2002). Whenever possible, each lake will be surveyed twice in a close temporal span, so a detectability estimate for each lake survey can be determined. This usually means surveying the lake twice in two days: one in the afternoon upon arrival at the lake, and once the following morning before retrieving the gill net.

To begin a VES, select a start point along the lake shoreline. Once that point is reached, record the start time and commence a shoreline and littoral zone search for amphibians and reptiles. If multiple observers are present, you may choose to split the survey and converge at the far shore; record each segment separately. At some lakes, steep topography or dense vegetation may limit shoreline access. In such cases, estimate the percentage of shoreline surveyed. You may choose to wade through the littoral zones of lakes to conduct the VES, but this should be done with caution as the substrate in most mountain lakes of the Clearwater Region is dominated by silt, which is very unstable and can immobilize personnel conducting searches. Dip nets will be used to sweep through vegetation in order to observe cryptic individuals or egg-masses.

Each encounter of an amphibian will be stratified by the habitat type in which the individual was encountered. Life stage of the individual will be recorded; egg-masses, larvae, juvenile, sub-adult, and adult. You may encounter areas in lakes where there are hundreds of Columbia spotted frog larvae. If an actual count is not feasible, approximate the number of larvae seen, and continue searching. Once the entire perimeter of the lake is searched (i.e., you have returned to the starting point or converged at the far shore), record an end time and tally each species by life stage.

During the VES, remember to look for an appropriate area to set a gill net - it should have deep water access and be relatively free of submerged woody debris and rocks. VESs are also times when there are opportunities to record (1) the presence and qualitative abundances of aquatic invertebrates, (2) details of inlets and outlets, (3) information that is to be recorded on bathymetry/surrounding area maps, (4) campsite inventories, (5) shoreline forest species composition, and (6) other animal observations (see habitat sampling section). During VES searches, the observer should record information in a small Rite in the Rain notebook. After the VES, data should be transferred to the lake data sheet - this helps to keep data sheets neat and legible.

Minimizing disturbance to amphibians by gill net placement or removal is important. Thus VES sampling for amphibians should be performed after a sufficient amount of time from the disturbance of either gill net setting or removing (separated by 2-3 hours). Temporally separating gill net usage for fish and VES for amphibians is important because amphibian behavior and observabilty often vary with human activities/disturbances. Metadata for each survey is critical, as the behavior of amphibians and our ability to observe them is often highly variable with weather, temperature, time of day, predators, prey, etc.

A 50 to 100 meter perimeter search for terrestrial adults should also be conducted.

3. <u>Gill Netting (if lake contains fish)</u>

This is a timed gill netting effort, thus always record start and end times for calculation of catch per unit effort. The location of the gill net set should be recorded with a description and a sketch. Packable mountain lake gill nets are employed, usually during overnight sets for a duration of 12 hours (or as close to that time as possible). Gill nets are set by one person in a float tube or ultralight raft. Other personnel may assist by holding or tying off the other end and watching to ensure that the net set is perpendicular to the shoreline. The person setting the net will place the pre-stacked net (accordion style or neatly stuffed in its compression sack) on the front of the float tube and kick out toward the center of the lake while simultaneously paying out net. The smaller mesh sizes should face the shore (i.e., arranged on top of the compression sack) and the larger mesh sizes the deep water, with a float tied to the larger mesh end by a length of cord greater than the lake depth to assist retrieval. Once the net is paid out and extended to its full length the end of the gill net can be dropped to the bottom of the lake (mountain lake gill nets are sinking gill nets) and the float attached. Note that this process is somewhat dangerous and attention must be given to ensure that feet do not become entangled while setting the net. To minimize entanglement with the gill net, the person setting the net should not wear wading boots (just neoprene booties covering their feet). If using waders, we suggest that waders be put on at the lake shoreline just before the net is set, so as to minimize chances for puncturing wader booties.

Special attention should be paid to where the gill net is to be set; a good time to scout for a suitable location is during the VES. Areas with submerged woody debris and boulders should be avoided, as the net may become snagged upon retrieval. Preferred areas should also encompass deeper areas of the lake. Gill nets are 50 meters in length and should reach the deeper parts of most mountain lakes.

All trout captured in the net are recorded by species, weighed (g) using a spring scale, and measured (mm) for total length. Collect scale samples from all fish for age and growth analysis. When used in correlation with stocking history, age information can be used to determine if natural recruitment is occurring (Murphy 2002). Fish captured in gill net will also be subject to a stomach sample analysis for evidence of amphibian predation (Murphy, 2002).

After use of gill nets, crews should ensure that nets are free of debris and mud which may contain pathogens that could be transferred to other lakes. Gill nets should be dried before storage for any length of time exceeding a couple days. Gill nets should be repaired between trips into the field unless repair in the field is necessary.

4. <u>Habitat Surveys (from float tube)</u>

If the lake has not been previously sampled, develop a bathymetric map by using the portable depth sounder while in the float tube. Use a traversing pattern (multiple passes over different areas) across the lake and recording the depth at each point on a sketch of the lake area.

Once the deepest area of the lake has been found, take a deep tow (2 vertical tows) with the zooplankton net by lowering the net (with a cord the has depths measured) to ~ 0.5 meters above lake bottom and retrieving net at approximately 0.3 meters per second. Horizontal tows (2 oblique tows) can be performed from shore by throwing net toward lake center and allowing net to sink below the water surface also retrieving the net at ~ 0.3 meters per second (shallow or oblique tows should be ~ five meters in length). After each vertical tow or series of horizontal tows, transfer captured zooplankton from the net into the sieve. The squirt bottle (filled with lake water, squirted through the mesh from the outside to avoid contamination) will help to wash zooplankton off the net. Then attach an ethanol bottle to the squirt top and use it to transfer zooplankton to the sampling container. Note that the final solution should be ~70% ethanol – more concentrated solutions may burst Daphnia and other delicate zooplankton. Label sampling containers in two ways: 1) a paper label with lake name and date written in pencil placed inside of the sample, 2) use sharpie to write lake name and date on outside of sample. Beware that sharpie ink (especially ink directly on the plastic) is easily removed by ethanol, so take appropriate precautions.

In all deeper lakes, determine secchi depth. This measurement indicates lake productivity. The High Mountain Lakes project uses a small (~6 inch diameter) secchi disk. It floats (to keep its packed weight light), so add rocks to a mesh bag beneath the disk to sink it. Record the depth at which it disappears from sight.

5. Habitat Surveys (on shore)

Describe the lake and surrounding area in words (bulleted points) on the data sheet. Also draw a detailed map of the lake and surrounding area in a notebook. You may instead choose to annotate printed lake maps. Record locations of gill net sets and terrestrial amphibian searches; these should replicate previous years' sampling locations if they are known.

During or after the VES, record all campsites on surrounding area maps and record degree of human impact/size affected on the data sheet. Physical and chemical parameters, littoral zone substrate composition, and forest cover sections are fairly straightforward. Note that the handheld pH/conductivity/temp (EC) meter will need occasional calibration (see instructions with the meter) and that when a surface temperature is taken, it should be done so in a shaded area of the lake. Remember that littoral zones within these lake areas are defined by the area three meters deep or less and emergent vegetation is that vegetation growing out of lake bottom and has an above water surface portion. The data for the stream characteristics section should be collected for inlets and outlets for up to 50 meters or when a fish passage barrier has been reached. Typically, inlets in these headwater areas are small, seeps, or come from adjacent scree fields. In this case fill out as much of the stream characteristics section as is possible.

6. Angling Survey

If lake contains fish and if time permits, conduct rod and reel sampling. Record species and total length of each fish caught and fishing method (fly/spinner).

7. Fish Sampling (working up fish from gill net sample)

If any fish are alive remove those fish and attempt to revive, record a total length for these fish and release back into the lake. After removing live fish, work from one end of the net to the other removing dead fish and any small debris that will cause the net to tangle. Place dead fish in the water to prevent desiccation and to reduce the attraction of various insects (flies). Once all fish are removed from the net, record the total length (mm) and weight (g) for all dead fish. Stomach samples from at least ten fish should be analyzed for evidence of amphibian predation. Record any identifiable prey items. Scale samples should be taken from at least 20 fish that represent various size classes from the sample. Place scales in scale envelopes and record date/lake name/species/total length/weight of that fish on the outside of the scale envelope. Snap a photo of all fish captured in the gill net sample.

Dead fish can be disposed of by burying, but in many mountain lake areas the soil profiles are very shallow/rocky and digging a sufficient hole to bury fish maybe difficult. In many areas a scree (rock) field maybe associated with lake areas and fish can be disposed of by placing fish in between rocks, leaving as few fish exposed as possible (dispose of fish as far from any campsites as possible to minimize any future confrontations with possible bears in the area). While working up fish, lay the gill net in an area where it can dry. This will greatly reduce the odor from a gill net that has captured fish. Note that drying gill nets should always be attended as birds can be attracted to the fish odor on the net and birds walking in the net can become entangled. After setting or drying a net, always pre-stack the net for the next use. If the net is not completely dry and must be packed in a day pack or larger backpack, you may want to bring a small garbage bag to confine gill net inside compression sack from other personal gear.

8. Equipment Cleaning

Be sure to rinse/clean all equipment before using in next lake to avoid potential transportation of plants/animals/diseases. Waders, float tube/raft, dip nets and other equipment that comes in contact with lake water, vegetation, or substrate should be cleaned and free of soil and debris (and dried if possible) before surveying other lakes in order keep pathogen transportation and infection to a minimum. If cleaning of equipment involves a bio-degradable soap, make sure to clean equipment approximately 200 feet away from lake system and streams. A collapsible bucket may aid in such cleaning tasks. **Repair of gill nets** should be performed between trips unless repair in the field is necessary.

9. Daily Check-ins

SPOT messages (Check-in/OK) should be sent daily. USFS radio check-ins with the district's ranger station, typically 1-2x daily, should be performed according to a pre-arranged schedule. *Help will be sent in after two missed check-ins*. Note that some ranger stations are closed on weekends. Rangers should also be provided with the contact information of a person with access to SPOT messages so that, should the USFS radio malfunction, they can deduce your safety from SPOT check-ins. In case of emergency, communication via USFS radio is usually preferred to SPOT because you can describe the precise nature of the situation.

10. Upon Return to Office...

Gill nets should be dried before storage for any length of time exceeding a couple days. Repair of gill nets should be performed between trips into the field unless repair in the field is necessary. Data sheets/notebook notes should be photocopied when returning from the field. Be sure to write out any pertinent notes from the trip such as description of route taken, dangers encountered, etc. Maintenance of field and sampling equipment should also be performed promptly when returning from the field.

Appendix E. High mountain lake zooplankton sample analysis protocol.

Magnification to Ocular Unit Conversion:

For the Leica Compound Microscope Model MZ-6

Scope Magnification	1 Ocular Unit= mm
0.63	1.59
0.80	1.25
1.00	1.00
1.25	0.79
1.60	0.63
2.00	0.50
2.50	0.39
3.20	0.31
4.00	0.25

Equipment list
-Leica MZ-6 compound Microscope
-Light source
-Petri dish with grid background and lid cover to prevent desiccation
-150 ml beaker (150-250 mls)
-100 ml graduated cylinder (100-200 ml)
-Sieve with aperture size smaller or same size as net mesh (64-80 µm)
-Ethyl alcohol
-Pipet (variable 1-10 ml volume capacity) with tip aperture 4mm or greater
-Needle tool
-Watch maker forceps with fine point tips
-Samples
-Glass vials, and Para-film (seal around lids) for storage after analysis
-Distilled water
-Squeeze bottle for distilled water
-Liquid dish soap

Parameters from Sampling Data Necessary for Analysis
-Depth of vertical (deep) tows and length of oblique (shallow) tows
-Radius of zooplankton net ring (mouth) used during sampling
-Mesh size of zooplankton net used during sampling
-Mesh size of sieve used during sampling

Step by Step Instructions for Analysis

1. Pour contents of zooplankton sample into sieve and wash thoroughly with distilled water from squeeze bottle
2. Pour contents of sieve into 100 ml graduated cylinder to a known volume, usually 100 ml (record volume of sample after removing entire sample from sieve).
3. Pour contents of graduated cylinder into 150 ml beaker.
4. Using the pipet tip, stir sample in circular and up/down motions to ensure uniformity of sample.
5. Using the pipet to remove one or two 5ml subsamples from the beaker (record how many 5ml subsamples used in analysis).
6. Put subsamples into Petri dish with counting cell grid drawn on bottom.

7. Add one to five drops of soap to Petri dish with subsamples to reduce air bubbles and zooplankton sticking to Petri dish bottom.
8. Enumerate zooplankton to family and measure all adult metasome structures (top of head to base of tail) (when possible), count but do not measure *Chaoborus*, and do not count or measure naupliar stages or rotifers of other families (can record qualitative abundance).
9. Ideally there should be 300-400 individuals in the count of subsamples of the most abundant family(if there is not an additional subsample may be required in the analysis).
10. Remember to record the magnification at which zooplankton in subsamples were measured.
11. Replace subsamples in beaker when finished with enumerations and measuring process.
12. Pour contents of beaker into sieve and wash down with alcohol into new glass storage container (vial) and write a label stating lake name, date, and type of sample (vertical/deep or obliquie/shallow) on a strip of rite-in-the-rain paper and place inside glass sample jar with sample.
13. Use Para-film to seal lid to glass sample vial for storage purposes.
14. Determine volume of tow using volume of cylinder equation πr^2 xh (where r= radius of the net mouth used and h=haul depth) (remember to convert appropriate units, meters in this case).
15. Determine how many individuals of each family were in the known volume of entire sample from the subsamples examined (amount of individuals from entire sample usually 100ml is now the amount of individuals from the entire volume of haul depth and specific zooplankton net).
16. For example, if you found 5 Daphnia in a 2 ml subsample taken from 100 ml of known volume from the original sample, we find that 250 Daphnia were present in 100 ml from the known volume that 100 ml sample which represents the larger volume netted determined from the volume of a cylinder equation $V = \pi r^2 * h$.

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