Fishery Resources Status and Trends, Global Climate Change Component: Mountain Whitefish, *Prosopium williamsoni*, Monitoring Project in the Lochsa River Drainage of Northern Idaho

An Investigation of the Response of Mountain Whitefish Distribution and Spawning Migration Timing to Long Term Changes in Water Temperatures in the Lochsa River, Idaho

Final Report 2012 – 2015

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Introduction

Mountain whitefish, *Prosopium williamsoni* is a broadly distributed salmonid which ranges from the Colorado River basin to the Mackenzie River basin, and as far east as the Yellowstone River (Behnke 1992). They inhabit cold, low gradient steams, and are typically found lower in river systems than most stream dwelling salmonids (Maret et al. 1997). In Idaho, mountain whitefish are most often found in 5th to 7th order streams 15 meters in width or greater (Meyer, et al., 2009). Unlike most other North American native salmonids, the life history, status, and habitat requirements of mountain whitefish are not extensively researched, possibly because they are less appealing to anglers (Northcote and Ennis, 1994).

A study of mountain whitefish in the Lochsa River drainage was conducted by the Idaho Fishery Resource Office (FRO) from 1992-1994 as part of the Fishery Resource Status and Trends program developed by the U.S. Fish and Wildlife Service (Rockhold and Berg 1995). The study was conducted under the Global Climate Change component designed to collect long-term population and environmental data for specific fish species. The study was conducted in Colt Killed Creek (formerly White Sands Creek) and Crooked Fork creeks, located in the headwaters of the Lochsa River drainage.

Mountain whitefish were selected as the target species for the following reasons: (1) rigid temperature requirements for whitefish egg development, (2) wide distribution of whitefish throughout the western United States, (3) the abundance of whitefish in the Lochsa River drainage and (4) water temperatures recorded in the Lochsa that approach the upper limits of mountain whitefish (Brown 1952). The objectives of the study were: 1) to document baseline data on mountain whitefish distribution and spawning migration patterns, 2) monitor water temperatures within the Lochsa River drainage, and 3) to model future water temperatures due to climate change and predict the response of mountain whitefish to those temperatures (Rockhold and Berg 1995).

An annual downstream migration was observed for mountain whitefish in Colt Killed Creek. The migration began with a late summer pre-spawning migration out of the upper stream reaches to lower elevation pools as stream temperatures decreased from 8°C to 4°C from mid-August to mid-September. Spawning condition was observed when fish were tagged and ripeness was noted. The sampling indicated that spawning occurred during October and usually coincided with water temperatures of 3°C, with most fish being spent by late October. A post-spawning migration was observed where the fish continued downstream for presumed overwintering.

This study was initiated in 2012 as a continuation of the work conducted from 1992-1994, implementing the recommendations of the Idaho Fisheries Resource Office made at that time. The study had two objectives: 1) documentation of mountain whitefish distribution, densities and spawning migration timing; and, 2) monitoring water temperatures within the study area and

describing the relationship between mountain whitefish distribution and their spawning migration timing with water temperature.

Methods

Study Site

Colt Killed Creek, previously known as White Sands Creek until 1986, is 37.8 kilometers long from its source at White Sands Lake near the Idaho-Montana border in the Bitterroot Mountains to Powell Junction, Idaho. Powell Junction is where Colt Killed Creek joins Crooked Fork Creek to form the Lochsa River. Over this distance, the creek drops 1,061 m from 2,139 m above sea level at White Sands Lake to 1,070 m at the confluence with Crooked Fork Creek. Colt Killed Creek drains approximately 860 km^2 of coniferous forest, with a limited mixture of deciduous forest, alpine vegetation, and rocky outcrops at higher elevations.

To maintain consistency for comparative purposes, we initially intended to use the previous study sites and methods used in the 1992-1994 study (Rockhold and Berg 1995). Sites were initially chosen based stream width, depth, water velocity, and presence of mountain whitefish (Berg and Garcia 1992). All 20 sites were identified and GPS tagged in July, 2013 (Figure 1). Due to the difficulty and gradient of the terrain, many of these sites were deemed inaccessible in 2013, and in 2013 - 2015 surveys were conducted only at sites 1, 2, 4, 7, 11, and 12. A full description of all study sites can be found in Appendix I.

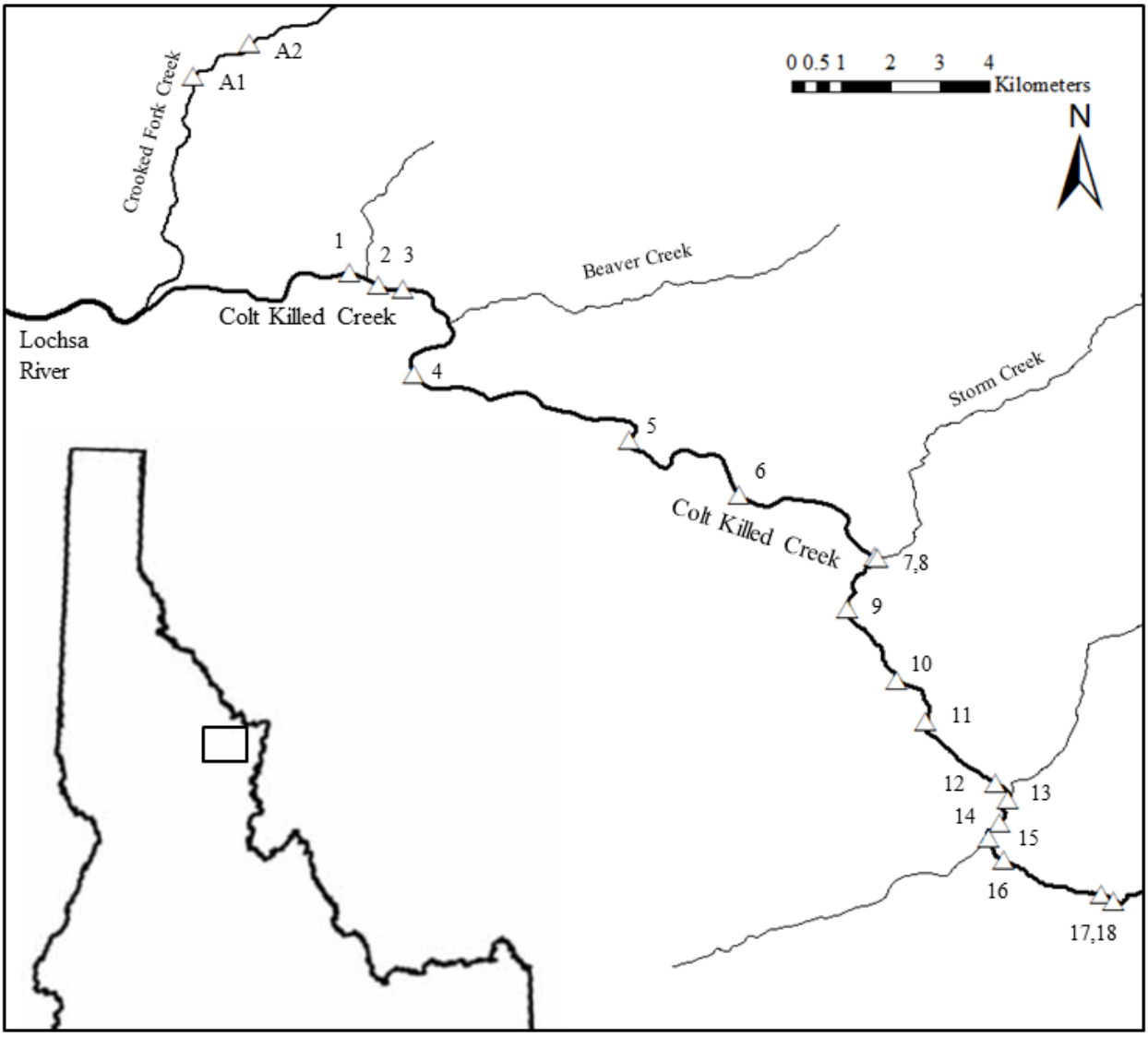

Figure 1. Location of snorkel survey sites on Colt Killed Creek Idaho, 1992 - 1994. In 2013, snorkel counts were conducted at sites 1, 4, 7, 11, and 12. In 2014 and 2015 snorkel counts were conducted at sites 1, 2, 4, 7, 11, and 12.

Mountain whitefish density

Snorkel counts (Thurow 1994) were conducted at each site in the beginning of each field season to determine baseline mountain whitefish distributions and densities on Colt Killed Creek, and throughout the late summer and fall to determine relative abundance across the survey sites. Baseline counts were performed immediately after peak summer flows had abated. Initial surveys were conducted on July 24-26 in 2013. Surveys were conducted in a downstream direction with two snorkelers at each survey site. During each count the snorkelers recorded the number of mountain whitefish observed and the water temperature at the survey site. In the

event that large numbers of mountain whitefish were observed at a site, multiple passes (maximum of 3) were conducted to verify the count. Densities were calculated using the number of mountain whitefish per 100 meters for each site. Additional surveys were intended to be conducted at three week intervals during 2013. The 2013 Federal Government shutdown precluded surveying from late September to mid-October.

In 2014, initial surveys were conducted on July 26-27. All sites were surveyed every third week, until September, when they were snorkeled weekly in an effort to more fully capture spawning migrations. The study plan was to snorkel all sites until no whitefish remained, however road closures and difficult winter conditions forced the premature cessation of surveys at many sites. The three upper sites (7, 11, and 12) were no longer accessible after October 19. All sites were deemed inaccessible after November 4, 2014.

In 2015, initial surveys were conducted on July 9 and 10. All sites were snorkeled approximately every two weeks until September 14, after which they were snorkeled weekly. No surveys were conducted between August 21 and September 14, 2015, as the survey sites were closed to access due to the Jay Point Complex fires. No mountain whitefish were seen at the three upper sites after resumption of snorkel surveys on September 14.

Movement

Mountain whitefish migrations were timed using relative densities at monitoring sites. The onset of the pre-spawn migration was considered to be the first date by which mountain whitefish were absent from site 7 as determined by snorkel survey. Site 7 was chosen as it is the most downstream of the upper sites.

The onset of the post-spawn migration was considered to be the first date by which mountain whitefish density was lower than 10 fish per 100 meters as site 2. Site 2 was chosen as it was the site of the largest pre-spawning congregations from 1992-1994.

In order to more finely time the migrations of mountain whitefish, radio telemetry monitoring was initiated in the 2013 season. 2013 was considered a pilot season, and 13 fish were radio-tagged. Mountain whitefish were sampled with hook and line at sites 11 and 12. In 2014, we intended to tag 35 mountain whitefish. However, due to hook and line sampling difficulties, only 2 fish were radio-tagged.

Only mountain whitefish above 200 grams were radio-tagged in order to keep tag loads below 2% and ensure that only reproductively mature fish were tagged. Fish selected for tracking were anaesthetized streamside and intracoelomically implanted with a Lotek MST-930 transmitter.

Using guidelines from Taylor et al. (2011) mountain whitefish were anaesthetized in a 60 ppm AQUI-S 20E bath until reflexes were absent and opercular movements were slow and irregular (i.e., stage 5; Summerfelt and Smith 1990). Fish were then placed in a v-shaped aluminum

surgery trough. A maintenance bath of the same AQUI-S 20E solution was continuously pumped over the gills of the anaesthetized fish during surgery. A small incision was made in the ventral body surface, posterior to the pelvic girdle, along the midline. An 18 gauge needle was then inserted externally in an anterior direction exiting through the incision. A small spoon, ground down to suitable dimensions was used to shield the viscera. The transmitter antenna was passed through the needle, and the needle was then removed. The transmitter was then gently placed into the body cavity and positioned slightly anterior to the incision. Three simple interrupted sutures (Ethicon 4-0) were used to close the incision, with an additional suture placed over the antenna at the point which it exited the body of the fish. The fish were then placed in 20 cm diameter live tubes and returned to the river until they were sufficiently recovered and exhibited normal swimming behavior.

Two temporary fixed radio telemetry receiving stations were installed in 2013. The first was located at the waste water treatment pump house at the USFS facility at Powell Junction, Idaho. The second was located approximately 200 meters downstream of site 11, below the Colt Killed Creek pack bridge. Temporary fixed stations consisted of a Lotek 400A radio telemetry receiver, 12 volt battery, and two antennas. The receivers and battery were installed in a secure lock box and chained to a sturdy tree near the creek. Antennas were installed 40 meters up and downstream of the receiver to detect the direction of movement of tagged fish. Care was taken to hide all elements of the fixed station to reduce risk of tampering with the equipment. No evidence of tampering was noted in 2013.

Monitoring was expanded in 2014 to include 2 additional fixed temporary monitoring locations. One site was located approximately 500 meters upstream of site 4; the second was installed approximately 1000 meters upstream of site 2.

Radio telemetry efforts in 2013 and 2014 were plagued by an inability to capture and radio-tag mountain whitefish, as well as frequent equipment failure. As a result, radio telemetry was discontinued for the 2015 season.

Temperature tracking

To relate mountain whitefish distribution and migration timing to their environment, stream temperatures were recorded at one hour intervals at four sites throughout the study area. Onset HOBO TidbiT v2 temperature data logger (model# UTBI-001) were housed in a perforated pvc tube and adhered to large boulders below the low water line using an underwater epoxy (Fox FX-764) (Isaak et al. 2012). The data loggers were placed at sites 11, 4, and 1, and also in the Lochsa River near Wilderness Gateway. Temperature data was recovered in the field using the HOBO waterproof shuttle (model# U-DTW-1) and required HOBO software (serial# BHW-PRO-CD).

Results

Mountain Whitefish Densities and Distribution

2012

The 2012 field season was complicated by the Powell SBW Complex fires. Started by numerous lightning strikes, the fires ultimately burned 67,000 acres in and around the study area. Access to study sites was restricted in early August and continued through the field season. By September, all survey sites on Colt Killed Creek were within the area closed to access.

Due to these restrictions, field activities in 2012 were primarily performed in the narrow time window between the early summer thaw and the fire closures. The main accomplishments of the 2012 field season were locating sites A1 and A2 on Crooked Fork Creek and sites 1 -4 and 7-10 on Colt Killed Creek. No snorkel counts were performed in 2012. A total of 7 mountain whitefish were sampled and Floy-tagged at sites 2 and 3 in August, prior to area closure.

2013

Four snorkel counts were conducted in 2013. Mountain whitefish were observed at all sites during initial surveys and peaked at 1,595 mountain whitefish per 100 meters at site 4 on September 11, 2013. Counts are summarized in Table 1.

Table 1. Mountain whitefish observed in Colt Killed Creek, July - October 2013. Counts are standardized to fish per 100 meters.

Site	Length (m)	24-Jul	14-Aug	11-Sep	30-Oct
1	113	12	35	123	0
4	22	18	464	1595	0
7	16	88	206	0	
11	48	25	0	0	
12	37	19	49	30	

2014

10 snorkel counts were conducted in 2014. Mountain whitefish were observed at all sites until September 13, 2014 and peaked at 671 mountain whitefish per 100 meters at site 4 on October 2, 2014. Counts are summarized in Table 2.

Table 2. Mountain whitefish observed in Colt Killed Creek, July - November, 2014. Counts are standardized to fish per 100 meters.

Site	Length (m)	26-Jul	16-Aug	5-Sep	13-Sep	20-Sep	27-Sep	2-Oct	18-Oct	28-Oct	3-Nov
1	81.9	61	125	34	133	56	43	115	187	20	20
2	50.3	24	93	215	254	332	437	447	286	42	0
4	82	35	161	344	488	634	582	671	354	10	0
7	28.4	11	49	113	0	0	0	0	0		
11	35.8	53	64	3	8	11	6	14	50		
12	33.7	18	39	39	59	15	45	33	0		

2015

12 snorkel counts were conducted in 2015. Mountain whitefish were observed at all sites until September 14, 2015 and peaked at 649 mountain whitefish per 100 meters at site 4 on October 15, 2015. Counts are summarized in Table 3.

Table 3. Mountain whitefish observed in Colt Killed Creek, July - November, 2015. Counts are standardized to fish per 100 meters.

Site	Length (m)	9-Jul	20-Jul	5-Aug	20-Aug	14-Sep	19-Sep	30-Sep	7-Oct	15-Oct	21-Oct	29-Oct	5-Nov
1	81.9	99	100	105	125	134	151	126	134	220	219	90	1
2	50.3	101	83	93	195	256	167	360	306	410	183	125	2
4	82	185	238	346	328	513	579	618	541	649	399	0	0
7	28.4	74	141	232	56	0							
11	35.8	25	59	34	50	0							
12	33.7	59	30	30	36	0							

Movement

Site 7 is the lowermost of the upper monitoring sites, and the first date when no mountain whitefish were observed at site 7 was considered the beginning of the pre-spawn downstream migration. From 2013 – 2015 and 1992 – 1994 the mean date by which mountain whitefish were absent from monitoring site 7 was September 12, the 255th day of the year. Mountain whitefish densities at site 7 are summarized in Figure 2.

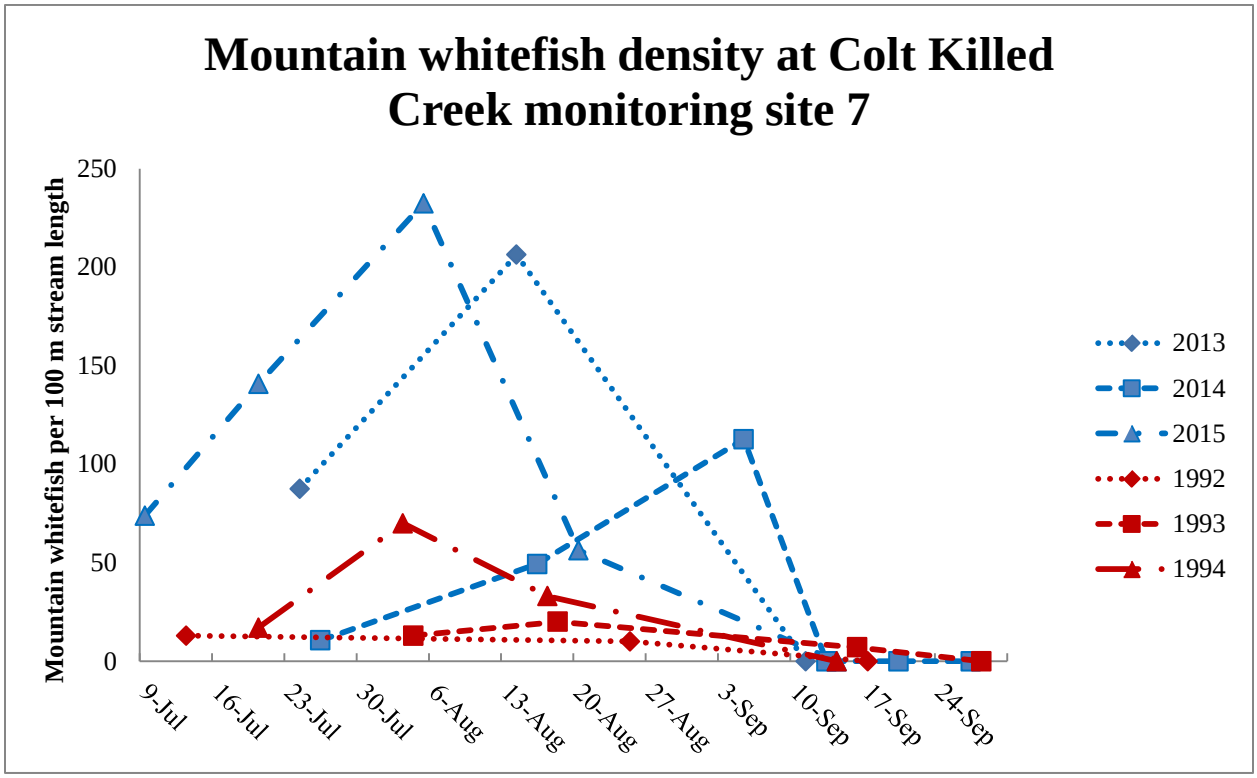

Figure 2. Mountain whitefish observed per 100 meters of stream length at site 7 on Colt Killed Creek, 1992 - 1994 and 2013 - 2015.

From 2013 – 2015 the mean date by which mountain whitefish density was lower than 10 fish per 100 meters at site 2 was November 4, the 308th day of the year. From 1992 – 1994 the mean date by which mountain whitefish density was lower than 10 fish per 100 meters at monitoring site 2 was October 31, the 304th day of the year. There was no significant difference between these dates (Welch's $t(3) = 1.477$, $p=0.236$). Mountain whitefish densities at site 7 are summarized in Figure 3.

Radio Telemetry

2013

Radio telemetry was intended as a pilot study for the 2013 season, utilizing remnant tags from a 2006 project. Two fixed temporary monitoring station were installed and 13 whitefish were tagged in 2013. The feasibility of using radio telemetry to monitor the movements of mountain

whitefish was demonstrated; however no meaningful movement data was collected regarding the spawning migrations.

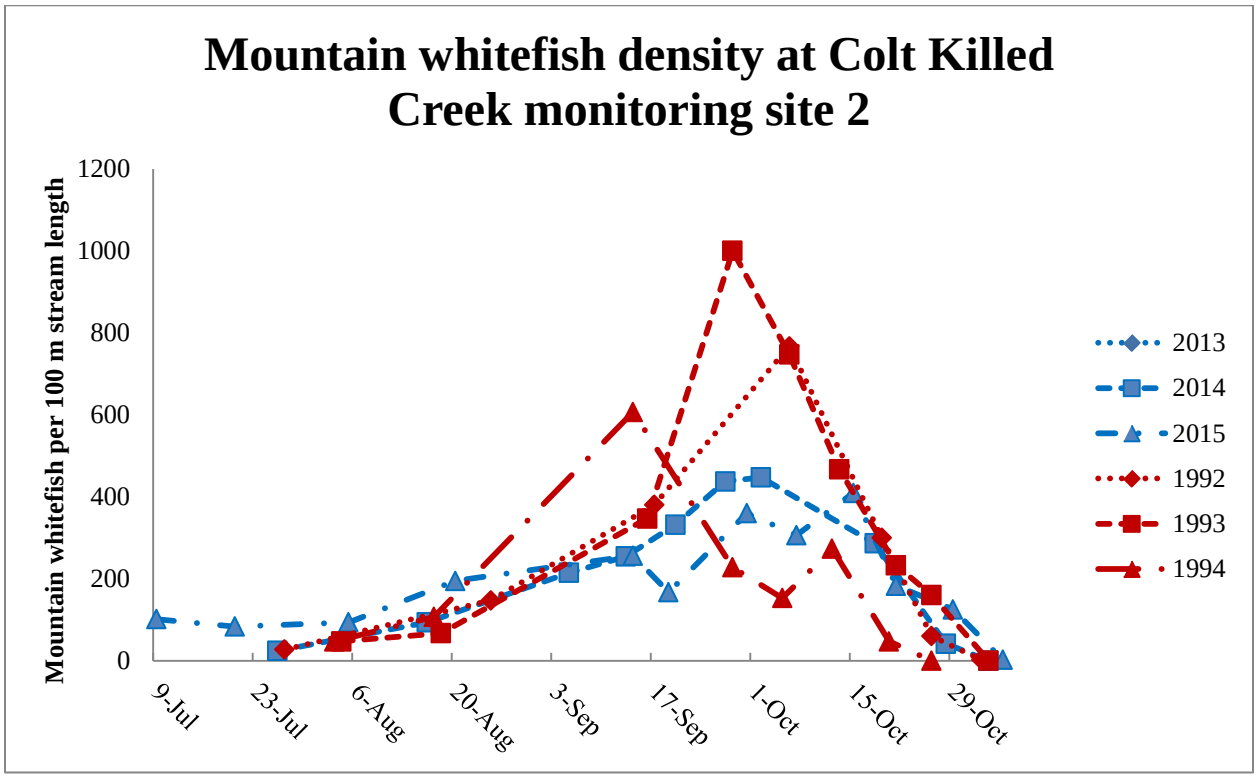

Figure 3. Mountain whitefish observed per 100 meters of stream length at site 2 on Colt Killed Creek, 1992 - 1994 and 2013 - 2015.

2014

Radio telemetry was expanded in 2014 to include two additional temporary fixed monitoring stations and up to 35 tags. After an extensive hook and line sampling period, two mountain whitefish were tagged in 2014. The 2014 field season was marked by numerous technical difficulties and no detections, or meaningful data of any kind, were obtained in 2014. Radio telemetry in Colt Killed Creek was discontinued in 2015.

Temperature monitoring

The Hobo Tidbits were downloaded twice annually, at the commencement and end of the monitoring season. Temperatures showed little variation between years. The mean stream temperature at monitoring site 1 during the mountain whitefish migration period (September 12 to November 4) in 2013 – 2015 was 7.45°C. In 1992 – 1994, the mean stream temperature during that timeframe was 6.06° C. Although these differences were not significant ($t(4) = 2.179$, $p = 0.095$), the general trend is slightly warmer temperatures observed in 2013-2015 than

were observed in 1992-1994. Stream temperatures at Colt Killed Creek monitoring site 1 are summarized in Figures 4 – 6.

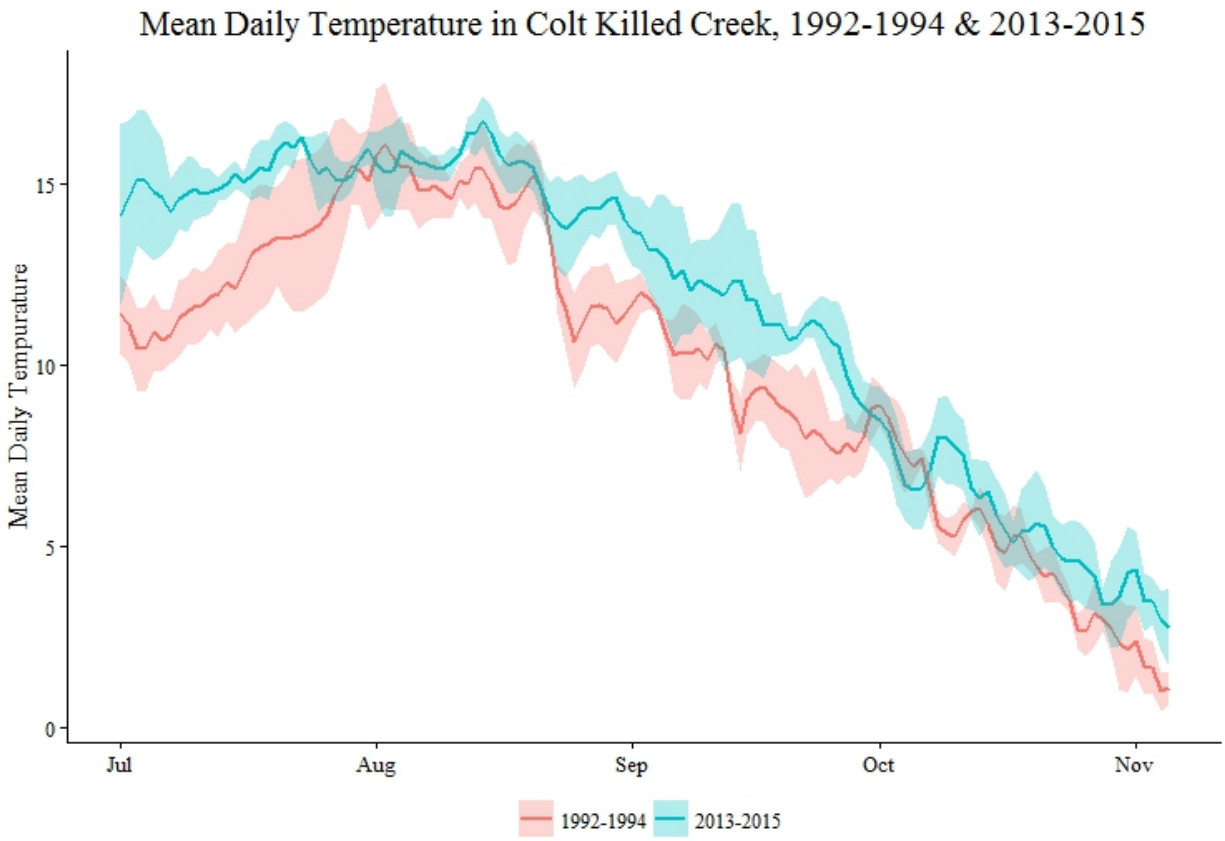

Figure 4. Mean daily stream temperature at site 1 in Colt Killed Creek, 1992 - 1994 and 2013 - 2015.

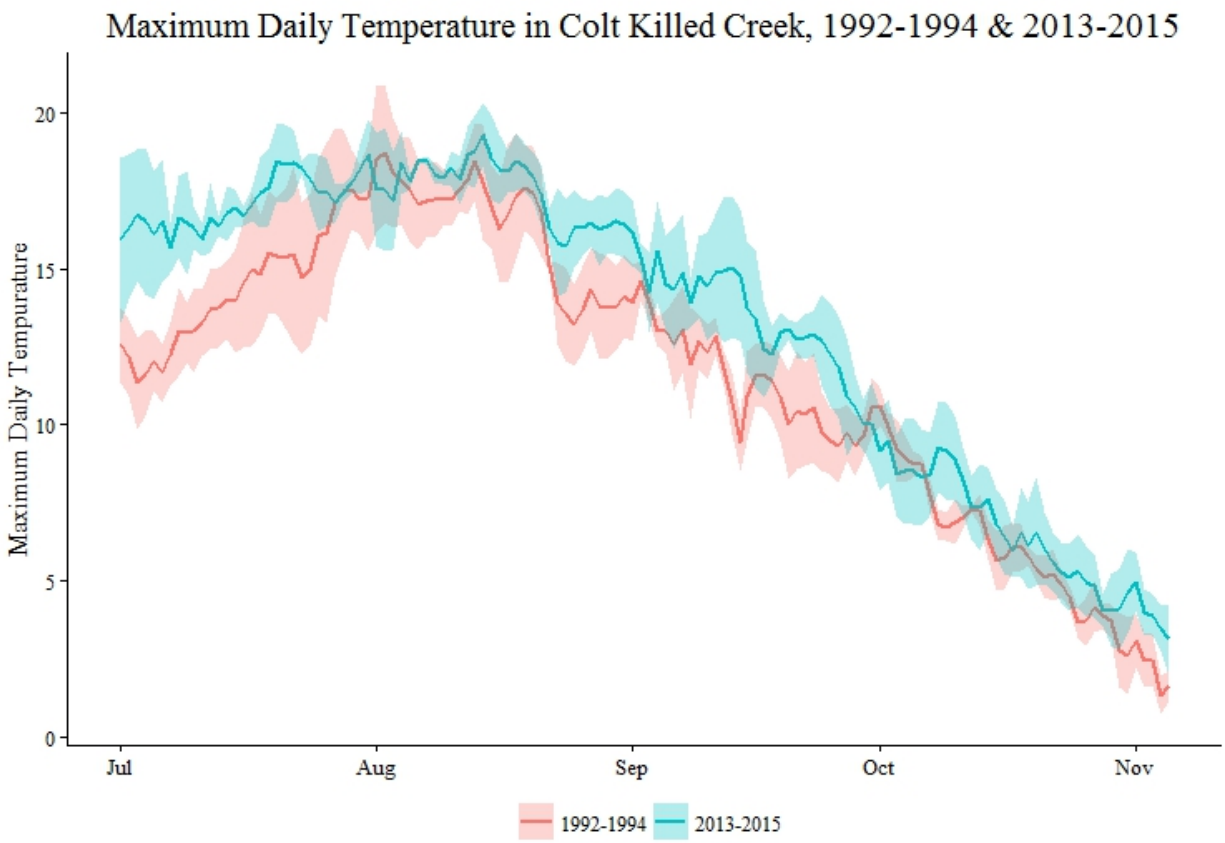

Figure 5. Maximum daily stream temperature at site 1 in Colt Killed Creek, 1992 - 1994 and 2013 – 2015.

Discussion

Density

Overall density patterns reflected the natural history of mountain whitefish and the change of the season. In summer, fish were present in low number throughout surveyed sites in Colt Killed Creek. As fall approached, mountain whitefish congregated in large numbers at relatively fewer sites downstream. This is consistent with patterns noted in 1992 – 1994.

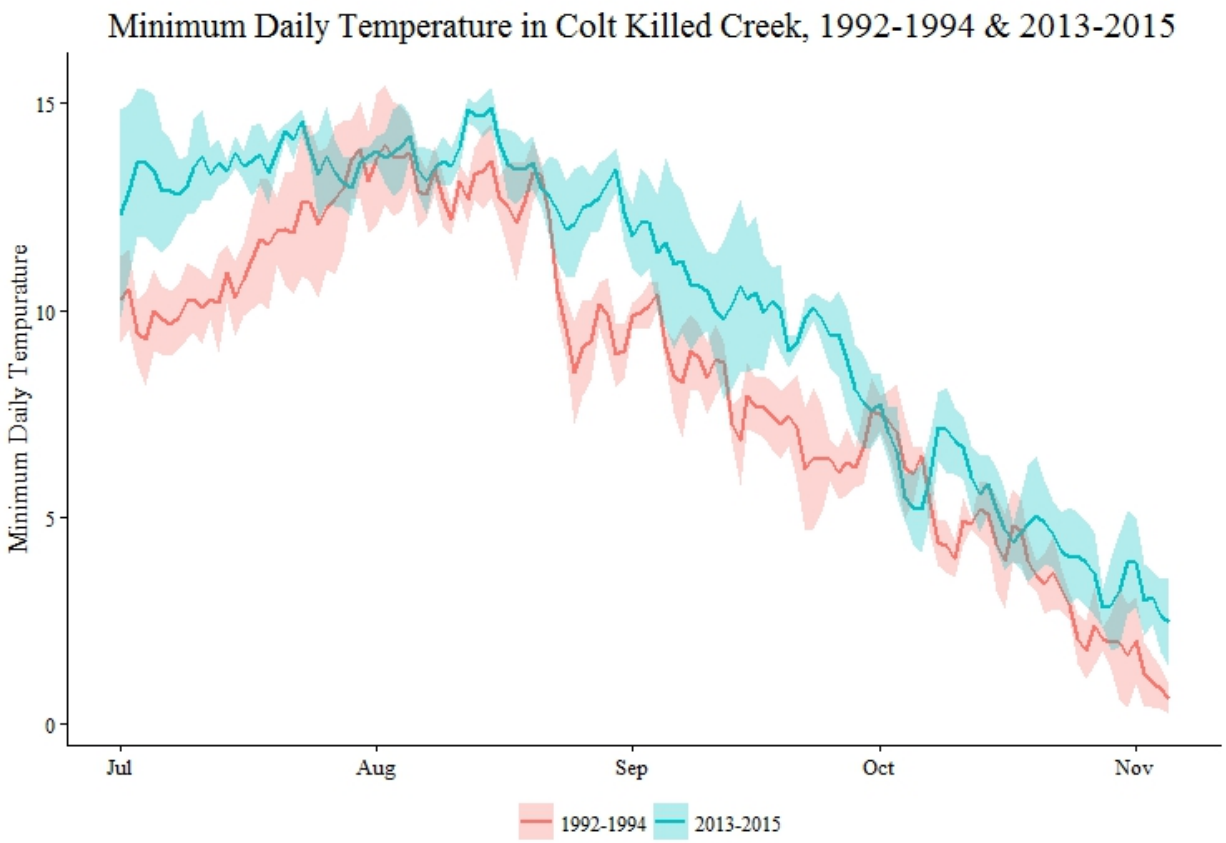

Figure 6. Minimum daily stream temperature at site 1 in Colt Killed Creek, 1992 - 1994 and 2013 – 2015.

There were shifts in relative density among the survey sites between the two iterations of this study. In 1992-1994, during mid-summer snorkel counts, mountain whitefish were broadly scattered throughout the upstream locations, with no site having consistently greater densities. In 2013-2015, although mountain whitefish were noted at all sampling locations during baseline surveys, the highest densities were typically seen at site 7. Site 7 is immediately downstream of the confluence of Colt Killed Creek and Storm Creek. While we conducted no temperature monitoring at site 7, preliminary observations suggest that Storm Creek may be a source of colder water into main stem Colt Killed Creek. Site 7 may be functioning as thermal refugia during the elevated mean stream temperatures observed during July in 2013-2015. Future versions of this project should monitor temperatures at site 7.

Movement, distribution, and spawn timing

Seasonal mountain whitefish migrations have been documented in the Sheep River (Thompson and Davies 1976), the North Fork Clearwater River (Petit and Wallace 1975), the Methow River (Benjamin et al. 2013), and Colt Killed and Crooked Fork Creeks from 1992-1994 (Rockhold

and Berg 1995). We observed a similar pattern here. Shifts in relative abundance indicated a pre-spawn migration to large holes in lower Colt Killed Creek. Mountain whitefish remained in large spawning aggregations at site 2 and 4 until evacuating Colt Killed Creek entirely by very early November each year. While no attempt was made to observe spawning, these aggregations coincide with mean daily stream temperatures of 4° to 8° C, at which mountain whitefish have been known to spawn (Thompson and Davies 1976, Brown 1952, Carlander 1969).

Temperature monitoring

Mean daily stream temperatures in Colt Killed Creek during the migration period were not significantly different between study periods, but a general trend towards slightly warmer temperatures was observed. This warming was primarily seen before and after the month of August. Peak August stream temperatures were extremely similar across all study years; variability between study periods was mostly seen in the months of July and again in September. The result was a thermal regime typical of August in 1992-1994 observed from early July to mid-September in 2013-2015.

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Appendix I. Colt Killed and Crooked Fork Creek site descriptions. Only sites 1, 2, 4, 7, 11, and 12 were sample in 2013 – 2015.

Site	Site Name	Length (m)	Latitude	Longitude
1	Below Cabin	113	46.514816	-114.644799
2	Above Cabin	75	46.512558	-114.63958
3	Rock Ledge	25	46.511929	-114.635126
4	Tallus	22	46.496535	-114.632989
5	Big Cutt	19	46.484407	-114.594039
6	Big Flat	23	46.474586	-114.574261
7	Below Storm	16	46.463433	-114.549549
8	Above Storm	16	46.463072	-114.549072
9	Pika	29	46.453922	-114.554745
10	Pillar	41	46.441084	-114.545689
11	Bridge	48	46.433672	-114.540368
12	Tamarack	37	46.422526	-114.527836
13	Fern	47	46.419391	-114.525591
14	Rock Ledge	9	46.415168	-114.527099
15	Big Sand	17	46.412619	-114.529099
16	Plunge	12	46.408545	-114.526207
17	Hidden	16	46.402356	-114.508647
18	Log jam	16	46.401057	-114.506428
101	Moe	39	46.550273	-114.672984
102	Russian	33	46.556242	-114.662882