Pine Creek and Eagle Lake Rainbow Trout Study – 2007

Spawner Migration,
Upper Watershed Habitat and Rearing Survey,
and
Bogard Spring Creek Brook Trout Removal Experiment

Report to the Pine Creek Coordinated Resource Management Planning Group

30 November 2007

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Lassen County Publication

Summary

This study addresses two main **questions** posed by the Pine Creek Coordinated Resource Management Planning Group:

1. Are ELRT able to migrate to the headwaters of Pine Creek/Bogard Springs Creek?

2. If ELRT are able to migrate to the perennial headwaters and spawn, would there be a successful recruitment of young-of-the-year and juvenile ELRT given the apparent high level of competition from brook trout?

The overall goal of the project is to test whether the numerous watershed restoration activities conducted in the Pine Creek watershed have provided conditions under which a proportion of ELRT can complete their natural life cycle, including migration, spawning, and rearing. This involves two main **objectives**:

1. Track the upstream migration of ELRT spawners from the mouth of Pine Creek, and relate movement to environmental factors such as water temperature and flow.

2. Test the ability of ELRT to spawn and rear in Bogard Springs Creek following the temporary removal of competing non-native brook trout.

In spring 2007 stream flows were low and the migration study was precluded. We transported 16 Eagle Lake Rainbow Trout (ELRT, *Oncorhynchus mykiss aquilarum*).) spawners to the upper watershed to see if they would spawn. Several redds were observed just upstream of Highway 44 and the pond. No young-of-the-year rainbow trout were observed in subsequent surveys, but this may be due to the poor spawning gravel in the locations where the fish were released. From May to September 2007 we conducted monthly habitat and snorkel surveys at 9 sites in upper Pine Creek and Bogard Spring Creek. Brook trout were present at all sites and were the most abundant fish species, with high densities. Other species observed were: Lahontan redside (*Richardsonius egregius*), rainbow trout, speckled dace (*Rhinichthys osculus*), and Tahoe sucker (*Catostomus tahoensis*). In August 2007 we removed brook trout from Bogard Spring Creek with the support of the California Department of Fish and Game, US Forest Service, Susanville Indian Rancheria, and numerous volunteers. We conducted triple pass electrofishing along all of Bogard Spring Creek (3 km; 1.86 miles). Brook trout were removed from the creek, measured for length and weight, and had scales removed for aging. All other species were measured for length and weight and returned to the stream. A total of approximately 4,887 brook trout were removed, with an approximate biomass of 110 kg (242 pounds). A total of 170 rainbow trout were observed, with lengths from 75 to 171 mm (3 – 7”), that appeared to fall into two age classes: 1+ and 2+. Most rainbow trout were smaller than the “1/2 pound” trout stocked by CDFG, indicating that stocked fish or transported ELRT spawners reproduced successfully in 2005 and 2006. In spring 2008 we plan to track the migration of PIT-tagged ELRT spawners using a series of 5 antennas located along Pine Creek. We also plan to transport ELRT spawners to both Pine Creek and Bogard Spring Creek to test whether the removal of brook trout from Bogard Spring Creek affects the ability of the ELRT to spawn and rear successfully.

Introduction

Pine Creek has historically provided critical spawning and rearing habitat for Eagle Lake Rainbow Trout (ELRT, *Oncorhynchus mykiss aquilarum*). Over the past 100+ years modifications of Pine Creek watershed (e.g., overgrazing, timber harvest, passage barriers, culverts) decoupled the ELRT from its stream habitat. The 1940 introduction of brook trout (*Salvelinus fontinalis*) led to competition for habitat in the upper watershed. Passage barriers were constructed at the mouth of the Eagle Lake tributaries to prevent ELRT from spawning in degraded habitat. Since 1950 the fishery has been maintained by artificial spawning, after fish are trapped at the mouth of Pine Creek. Offspring are reared in hatcheries and released into Eagle Lake. Since 1987 the Pine Creek Coordinated Resource Management Planning Group (CRMP) has lead changes in grazing management, reconstruction of culverts, and other conservation projects that have resulted in marked improvement of habitat, but ELRT have been prevented from attempting their natural spawning migration by the construction of the velocity barrier (Young 1989, Platts and Jensen 1991, NRST 1999, Pustejovsky 2007).

Research Questions

One of the stated goals of the Pine Creek CRMP has been to restore the ELRT fishery in upper Pine Creek, which could logically be defined as a successful and repeatable natural spawning migration of ELRT, and spawning and juvenile rearing of ELRT in upper Pine Creek. After years of restoration efforts in the Pine Creek watershed, there still remain key questions relating to ELRT. The first of these is:

1. Are ELRT able to migrate to the headwaters of Pine Creek/Bogard Springs Creek?

Several factors relate to this question. The movement of a single ELRT spawner upstream of the Highway 44 culvert would indicate that upstream passage is possible, at least for some ELRT. However, in low water years a smaller proportion of ELRT spawners may be able to make the journey. A proportion of ELRT may make part of the journey, then succumb to predation, or retreat back to the lake without spawning. Snowpack, flow, runoff patterns (timing and duration), and stream temperature may play a role in determining how far ELRT can migrate. The gender, number of fish released, ripeness and/or timing of release above the weir may also be important. The condition of potential spawning streams in the upper watershed may also be a factor in where ELRT that successfully migrate choose to spawn (and thus also relates to the total distance that fish must migrate). Upper Pine Creek and Bogard Spring Creek may have different habitat characteristics such as flow, temperature, spawning gravels that may cause ELRT to prefer one stream over the other.

The second key question is:

2. If ELRT are able to migrate to the perennial headwaters and spawn, would there be a successful recruitment of young-of-the-year and juvenile ELRT given the apparent high level of competition from brook trout?

Several factors relate to this question. It should be possible to test the impact of brook trout on ELRT rearing by decreasing the population of brook trout in part of the upper watershed (e.g., Bogard Spring Creek) and comparing the number of ELRT in the sections with high and low brook trout densities. Electrofishing has been suggested as a potential way to decrease brook trout numbers, but this has not been tested in Pine Creek watershed. It is unlikely that electrofishing would remove all brook trout, and it is uncertain that electrofishing would cause a large enough decrease in the brook trout population, nor for how many years the reduction would last. Furthermore, repeated electrofishing may be hard on native species. Assuming that electrofishing can substantially suppress brook trout, another uncertainty is the ability of ELRT to hatch out and grow in the wild, given years of hatchery rearing. Electrofishing should allow us to determine the brook trout population numbers and biomass in Bogard Spring Creek. This may help to predict how many ELRT could rear in the stream, but the carrying capacity of the stream (maximum population size) may differ for the two species depending on their habitat and food preferences.

Objectives

The overall goal of the current project is to test whether the numerous watershed restoration activities conducted in the Pine Creek watershed have provided conditions under which a proportion of ELRT can complete their natural life cycle, including migration, spawning, and rearing. This involves two main objectives.

Objective 1. Track the upstream migration of ELRT spawners from the mouth of Pine Creek, and relate movement to environmental factors such as water temperature and flow.

This work follows in the path of the radio telemetry studies initiated by CDFG and USFS in 1999. To date, we have demonstrated that passive integrated transponder (PIT) tagging is an easier, quicker procedure compared to radio tags, and that the antenna systems, while somewhat fussy and requiring regular maintenance, do record tags in the field. For the current project we will tag a group of ELRT with PIT tags to test their ability to migrate from the mouth of Pine Creek to the upper watershed (upstream of Highway 44). ELRT movement will be tracked with multiple PIT antennas along the length of Pine Creek. We will examine the relationship between the number of ELRT moving past each antenna, and to the upper watershed, with environmental factors such as snowpack, flow, runoff patterns (timing and duration), and temperature. This information could help us better understand how flow and temperature dynamics affect ELRT migration even if fish do not make it all the way to the perennial reaches. We can also examine the spawning habitat preference of ELRT by comparing how many spawners choose Bogard Spring Creek vs. main-stem Pine Creek, and comparing the available habitat (e.g., flow, temperature, gravel) in each stream. Assuming ELRT spawners reach upper Pine Creek either on their own, or in a fish truck, the ratio of fish migrating up the two streams could be determined with antennas placed above the confluence. This information could also help prioritize future management and restoration efforts in the upper reaches.

Objective 2. Test the ability of ELRT to spawn and rear in Bogard Springs Creek following the temporary removal of competing non-native brook trout.

In spring 2007 we PIT tagged a group of ELRT and transported them by truck to the upper watershed to see if they would spawn successfully (e.g., dig redds, produce young-of-the-year ELRT). We monitored the outcome of spawning by conducting a monthly summer survey of habitat use and fish distribution (by snorkeling).

We are assuming that brook trout pose formidable competition to the establishment and productivity of ELRT in the perennial reaches of Pine Creek and Bogard Spring Creek. We started an experiment to decrease the brook trout population in Bogard Spring Creek by electrofishing in August 2007. We can continue the habitat use and fish distribution survey in 2008 to test whether the depletion of brook trout would increase the likelihood that ELRT would successfully spawn and rear in 2008. We can compare brook trout and ELRT young-of-the-year population density and biomass in reference reaches before and after brook trout removal. In future years we may be able to determine how long the reduction in brook trout population will persist (e.g., 1-3 years).

Additional information that may be gained from the electrofishing experiment includes an estimate of the current population size, biomass (carrying capacity), and spatial distribution of brook trout and rainbow trout in Bogard Spring Creek. We will also be able to compare the efficiency of our snorkel surveys with that of electrofishing. Electrofishing generally results in higher counts of fish than snorkeling, but snorkeling is faster and less stressful to fish. We may be able to calculate correction factors to apply to our monthly snorkeling data. This would have relevance for future attempts to estimate species composition of small streams including Pine Creek.

Methods

Spawner Migration

The spawning migration of ELRT in Pine Creek has been studied for several years using radio-tracking, by members of the Pine Creek CRMP group including the California Department of Fish and Game, Eagle Lake Ranger District, Susanville Indian Rancheria, and UC Cooperative Extension. Based on the results of prior radio-tracking studies, in 2006 the group decided to switch to tracking the migration of ELRT spawners using a new tagging method. Fish were tagged with passive integrated transponder (PIT) tags. Movement of fish may be detected as they swim past a stationary PIT antenna loop placed across the river. The advantages of using PIT tags are that they are much smaller than radio tags (12 – 32 mm; 1/2" – 1 ¼" long), PIT tags can be injected subcutaneously, and the surgery procedure is faster than radio tagging. Fish behavior should be less affected by the PIT tagging procedure than with surgical implantation of a radio tag into the body cavity with a trailing wire antenna. Each PIT tag has a unique code, so each tagged fish is individually identified. Because the tags do not have to contain a battery, but get their charge from passing through the charged antennas loop, the tags last the life of the fish. In 2007, we intended to expand on the PIT tagging pilot study of 2006, by releasing PIT tagged ELRT just upstream of the fish trap and monitoring their upstream migration using channel spanning PIT antennas. However, low flows in Pine Creek and resulting hatchery priorities precluded the availability of ELRT spawners for this part of the study in 2007.

In preparation for the migration we installed three PIT antennas along the length of Pine Creek (Figure 1). We installed PIT antennas with a Texas Instruments receiver at Rankin "Heights" and Logan Springs (Figure 2). Each of these antennas was approximately 10 m wide and 1.5 m high (30' X 4.5') and was constructed of a single loop of 8 gage wire. We installed a smaller PIT antenna with an Allflex receiver at the McKenzie Meadow site on the mainstem of Pine Creek upstream of Highway 44 Bridge (Figure 3). The antenna was 3 m wide and 0.9 m high (9' X 2') and spanned the channel. Each antenna was powered by two deep cycle marine batteries and recorded data onto a handheld Palm m130 datalogger with an SD memory card. All antennas were manufactured by Mauro Engineering, Mount Shasta, CA.

Spawning and Tagging

Based on prior radio-tracking studies, we anticipated that even if ELRT spawners were released into Pine Creek just upstream of the fish trap, few fish would make it all the way to the upper watershed (i.e., to the area with perennial flow upstream of Highway 44). In order to test the ability of ELRT spawners to successfully spawn we transported a group of fish to the upper watershed to spawn. We PIT tagged these fish in order to monitor whether they attempted to swim downstream to Eagle Lake after spawning.

On 30 March 2007 we tagged ELRT that had arrived at the Spalding fish trap on Pine Creek. Each fish was captured by netting from the stream just upstream of the Alaskan weir, and carried in a cooler of stream water to the tagging site near the stream (Figure 4). Each fish was transferred to a cooler containing carbon dioxide anesthetic. The anesthetic solution was produced by adding 27 g $NaCO_3$ (sodium bicarbonate) and 10 mL glacial acetic acid to 10 L water (Peake 1998). Swimming capabilities and opercular movement were monitored. Once the fish reached stage 4 anesthesia (total loss of swimming motion with weak opercular movement) it was removed from the cooler and placed on a measuring board to have its length measured, then in a padded V-shaped surgery tray to be tagged. The measuring board, surgery tray, and researchers' hands were kept wet to minimize stress to fish.

We used 32 mm long half duplex PIT tags (Allflex, 860010-001 ISO RFID PIT Needle assy – sterile 32mm HDX; RI-TRP-RR2B), each supplied in an injection needle in a sterile package (Figure 5). Tags were injected subcutaneously on the left side about 3 cm (1.2") from the dorsal line, near the posterior end of the dorsal fin. A handheld stainless steel injection gun was used to inject the tag in a posterior to anterior direction so that the posterior end of the tag was 1 cm (2.5") from the injection site. A drop of Nexaband ® veterinary glue was used to seal the injection site. In order to make possible visible detection of marked fish, we also tagged each fish with either a yellow or mauve Floy ® tag, on the right side near the back of the dorsal fin. Following tagging each fish was placed in a cooler of stream water to recover, then transported in a cooler up to the parking lot where there was shade. Freezer packs were used to keep the water at the same temperature as the stream, and temperature was monitored using a YSI 550A meter. Small battery operated oxygen bubblers were used in the coolers.

The ELRT were transported by truck and released in upper Pine Creek at the McKenzie Meadow site, upstream of Highway 44. Fish were carried to the stream in coolers, and released upstream of the PIT antenna so that we could detect whether fish attempted to swim downstream to the

lake immediately after release. We made approximately weekly visits to the McKenzie Meadow and Logan Springs PIT antenna sites to substitute charged batteries, and to check for fish detections. The Rankin Heights site was almost dry by the time we transported spawners to the upper watershed, so this antenna was not operated in 2007.

We walked along sections of Pine Creek and Bogard Spring Creek on 30 March 2007 to monitor the condition of the spawners immediately after release. We also walked along the creeks on 5-6 April, 2-3 May, and 29-31 May to check for the presence of spawners and redds.

Habitat and Rearing Survey

Survey sites 50 m long (~150') were chosen at 6 locations on Pine Creek, and 3 locations on Bogard Spring Creek (Figure 6). We began monthly sampling at 2 sites (3-PC, 2-BS) on 6 April, and added additional sites in subsequent months to establish an upper watershed survey. Sampling for 2007 was completed on 29 September.

At each site the following variables were measured: GPS location, elevation (from GPS), reach length, average width, and maximum depth. Overhead cover was measured at the midpoint of the reach, in the middle of the stream, with a spherical densitometer. Water clarity was measured with a transparency tube (Global Water, 120 cm). At each site we sampled water flow by measuring stream width and depth to calculate cross-sectional area, and measuring velocity with a hand held Global Water® flow meter. Water temperature and dissolved oxygen (at time of sampling) were measured with a YSI 550A meter. Overnight monitoring of water temperature and dissolved oxygen was done at sites 3-PC and 2-BS on some visits, using a YSI 556 meter. We collected triplicate water samples for total phosphorus, soluble phosphorus, total Kjeldahl nitrogen, ammonia, and nitrate. Samples were kept on ice during transport to the University of California at Davis, then frozen. Samples will be analyzed in early 2008 by the lab of Dr. Kenneth Tate, Plant Sciences Department, UC Davis.

One air temperature logger and two water temperature loggers (Onset Optic Stowaway®) were installed at each site for the duration of the survey. Temperature was recorded at 30-minute intervals to allow the calculation of period mean and maximum temperatures.

A single pass snorkel survey was conducted by one snorkeler at each site, beginning at the downstream end of the reach and moving upstream. Fish were identified to species where possible. To ensure consistency of counts, species identification, and size estimates the same person conducted all snorkel surveys.

Brook Trout Removal Experiment

The influence of brook trout on the potential spawning and rearing of ELRT in upper Pine Creek watershed has been a long-standing question. Brook trout may prey upon juvenile ELRT, and/or compete with them for food. In 2007 we began an experiment to test whether decreasing the population of brook trout in Bogard Spring Creek would increase the ability of ELRT to spawn and rear. This experiment uses a **before-after control-impact** (BACI) experimental design. Both Bogard Spring Creek and Pine Creek were monitored in 2007 ("before") and should be

monitored again in 2008 (“after”). Bogard Spring Creek is the treatment, or “impact” stream. The treatment is to remove brook trout from Bogard Spring Creek in late 2007. Pine Creek is the “control” stream for the experiment, and brook trout in Pine Creek will be left there.

It is important to note that the two streams do not have to be identical in 2007 in order for Pine Creek to be the control. We compare the two streams in 2007, and see how much they differ (e.g., in terms of rainbow trout density). Then we treat Bogard Spring Creek by removing brook trout. In 2008 we compare the two streams again. If rainbow trout density in Pine Creek stays the same, but rainbow trout density in Bogard Spring Creek increases, this would suggest that removing brook trout from Bogard Spring Creek has an effect (Figure 7). However, if rainbow trout density in BOTH streams increases then this suggests that the change in rainbow trout density in Bogard Spring Creek is NOT due to brook trout removal (Figure 8).

In August 2007 we conducted triple pass electrofishing along the entire length of Bogard Spring Creek, including the 3 habitat/snorkel sampling sites (Figure 9). The stream is approximately 3 km, or 1.86 miles long. Most sections were 100 m long (~300’), but some sections were somewhat shorter in order to accommodate the 3 habitat sampling sites (each 50 m long; ~150’). The wetted width and maximum depth were recorded at 20 m (~60’) intervals along each section, in order to allow us to calculate habitat volume.

Electrofishing of Bogard Spring Creek took place from 20-24 August (Figure 10). There were two crews working simultaneously. One crew started at the confluence of Bogard Spring Creek and Pine Creek and moved upstream. The second crew started at section 10 and worked upstream. Prior to electrofishing, block nets were placed across the creek at the upstream and downstream boundary of each section. These nets were moved upstream as sampling progressed. Double nets were placed across Bogard Spring Creek at the confluence with Pine Creek, and across the bottom section of the second crew, for the duration of the electrofishing operation, in order to prevent fish from entering or leaving these sections.

During and after each pass, all fish (including ELRT, BK, cyprinids and catostomids) were anesthetized with carbon dioxide (Alka-Seltzer^{TM}). Fork length (FL, nearest mm) and weight (nearest 0.1 g) were recorded (Figure 11). Scales were collected from all ELRT, from a point above the lateral line just behind the dorsal fin, by scraping from the head of the fish toward the tail with the blade of a knife from an area previously cleaned of mucus. Scales were deposited in a labeled envelope and left in a dry location to air dry before being transported to UC Davis for analysis. Scale readings of ELRT will allow us to determine ages and to relate year class strength to water year type. All brook trout were euthanized with a blow to the head, and permanently removed from the creek. All other fish species (ELRT, cyprinids, and catostomids) processed were held in live wells in the creek. After the three passes were completed and the fish were fully recovered, ELRT, cyprinids, and catostomids were released in the same site from which they were caught. The lower block net was removed only after the fish had been released into the creek. The top net was left in place and used as the bottom net for the next electrofishing site upstream. At the end of each day, the top net of the last site electrofished was secured to keep it in place until the following morning.

The habitat/snorkel sampling sites on Pine Creek were also electrofished on 24 and 29 August to allow us to compare fish density and biomass between the two streams. Furthermore, fish data obtained through electrofishing will be compared with the data previously collected from snorkeling. The protocols for Pine Creek were the same as for Bogard Spring Creek with the exception that all fish species, including brook trout, were returned unharmed to the stream. Because site PC-1 was dry in August it was not electrofished.

Results

Spawning and Tagging

On 30 March 2007 a total of 36 ELRT were tagged (16 male, 20 female), with both a PIT tag and a Floy tag (Table 1). Male ELRT had an average length of 45.1 cm (18.6”), and females had an average length of 48.5 cm (20.0”) (Table 2). The average total time for anesthetizing, measuring length, PIT and Floy tagging a fish was 7 minutes 34 seconds (Table 3). Fish took an average of 1 minute 55 seconds to reach stage 4 anesthesia, and measurement and surgery combined took 1 minute and 5 seconds. Once we reached upper Pine Creek watershed the oxygen levels in the coolers were low so we released the fish immediately at the McKenzie Meadow site, rather than attempting to transport fish to sites further upstream on Bogard Spring Creek and Pine Creek. Sixteen fish survived the transport process, and all these fish were subsequently observed swimming in the creek. Two female ELRT were observed actively digging redds in the McKenzie Meadow area, and 4 redds were observed, as well as a number of less substantial “practice redds”.

Habitat and Rearing Survey

Fish snorkel data indicate that all sites sampled contained fish, unless the sites became dry in late summer. As of June we had established 9 sites in the upper watershed. However, from July onward site PC-1 (McKenzie Meadow) was dry, and on 29 August Site PC-3 (Bogard Campground) was reduced to two isolated pools. Brook trout was the most predominant species throughout the upper watershed and were present at high densities (e.g., over 250 fish per 50 m reach) (Figure 12). At some sites in some months speckled dace were also present in large numbers. Other species observed were Tahoe sucker and Lahontan redside. Rainbow trout were present in low numbers (e.g., 1 – 7 per 50 m reach). In at least one month rainbow trout were observed at the following sites: BS-2, PC-1, PC-3, PC-4, PC-5. All rainbow trout observed by snorkeling at PC-4 and PC-5 were “1/2 pound” planters (during the electrofishing survey one wild rainbow trout was captured at PC-4). However, no young-of-the-year rainbow trout were observed at any sites in 2007. This suggests that the transported ELRT spawners did not spawn successfully, in spite of digging redds, but this may be due to the poor spawning gravel in the locations where the fish were released.

Data from this survey, including habitat data, are still being analyzed, and will form the basis for the M.S. thesis of Gerard Carmona Catot.

Brook Trout Removal Experiment

Electrofishing data confirmed the general patterns of fish distribution observed by snorkeling. In the electrofishing surveys conducted on Pine Creek the density of brook trout ranged from approximately 125 to over 175 fish per 50 m reach (Figure 13) (0.8 – 1.2 brook trout per foot). The total biomass of brook trout per reach ranged from approximately 1.5 – 5.5 kg (0.02 – 0.08 pounds per foot). We also caught 1 wild rainbow trout at site PC-4 (Arch Culvert) and 1 rainbow trout planter at PC-5 (Stephens Meadow).

A total of approximately 4,887 brook trout were removed from Bogard Spring Creek (2,627 brook trout per mile), with an approximate biomass of 110 kg (approximately 242 pounds total, or 130 pounds per mile). A total of 170 rainbow trout were observed in Bogard Spring Creek. The density of brook trout tended to be lower at the upstream sites, 18-30 (Figure 14) but at least some brook trout were captured at all sites. Rainbow trout density was also lower at the upstream sites, and no rainbow trout were captured upstream of site 24 (Figure 15). Both species were present in higher densities from about sites 6–16. These density patterns may be related to habitat factors, but these data have not yet been analyzed.

Rainbow trout lengths in Bogard Spring Creek ranged from 75 to 171 mm (approximately 3 – 7”). Based on length frequency data (Figure 16) the rainbow trout appeared to fall into two age classes: 1+ and 2+. An examination of the scales of one fish of length 140 mm suggested that it was age 2+, which is consistent with the size frequency data. Most rainbow trout were smaller than the “1/2 pounder” trout stocked by CDFG, indicating that they were wild spawned. This suggests that stocked rainbow trout “1/2 pounders” and/or transported ELRT spawners reproduced successfully in 2005 and 2006. Rainbow trout weighed between approximately 5 and 65 g (Figure 17). The upper end of this weight range converts to 0.143 pounds, or 2.3 ounces.

Data from this experiment are still being analyzed, and will be presented in the M.S. thesis of Gerard Carmona Catot, but we will present some preliminary results here. We plan to continue this experiment in 2008.

Discussion

In 2007 we transported and released sixteen ELRT spawners to upper Pine Creek watershed and confirmed that they are able to exhibit natural spawning behavior such as digging redds. Some transported spawners were observed in the upper watershed as late as May. In spring 2008 we plan to transport ELRT spawners to both Pine Creek and Bogard Spring Creek to test whether the removal of brook trout from Bogard Spring Creek affects the ability of the ELRT to spawn and rear successfully. Due to the high dissolved oxygen needs of large salmonids such as ELRT spawners, it is critical to improve our methods of oxygenating water during spawner transport. We will coordinate with CDFG to use their specialized aquaculture truck equipped with a water tank and lines for oxygen tanks. Fish destined for the mainstem of upper Pine Creek, and for Bogard Spring Creek, could be PIT tagged on separate trips (to avoid mixing of different groups of tagged fish in the truck tank), and transported close to each release site, then carried to the creek in coolers. The UC Davis Center for Aquatic Biology and Aquaculture also has an aquaculture truck that could be used if necessary.

The preliminary results of the habitat and rearing survey indicate that brook trout are present throughout upper Pine Creek and Bogard Spring Creek. They occur in high densities and outnumber all other species, with the occasional exception of speckled dace at some sites on Pine Creek. Rainbow trout are also widespread, but are present in very low numbers. The electrofishing survey indicates that rainbow trout density is about 3.5% of brook trout density in Bogard Spring Creek, and less in Upper Pine Creek. In both the snorkel surveys and electrofishing surveys we observed rainbow trout of two types. A few fish in Pine Creek appeared to be "1/2 pounder" planters, based on their size, and fin condition. Some rainbow trout in Pine Creek, and all rainbow trout in Bogard Spring Creek, were smaller than the minimum planter size, and appear to have resulted from the successfully spawning of planters and/or transported ELRT spawners in 2005 and 2006. Thus, while the ELRT spawners that we transported in 2007 did not spawn successfully, ELRT strain fish have apparently done so in the recent past. However, it is not clear whether this success was due to environmental factors such as water year, or to the condition of transported ELRT spawners. It may be that planters acclimatize to the upper watershed and spawn in the year after they are planted. Alternatively, transported ELRT spawners may spawn immediately after transport, or may rear in the upper watershed for a year and attempt to spawn the following spring.

The success of the first year of the brook trout removal experiment depended heavily on the collaboration, cooperation, and dedication of many groups, agencies, and volunteers. A large amount of data has been collected and it will allow us to determine: the number and age of rainbow trout in Bogard Spring Creek, the number of brook trout that were supported in Bogard Spring Creek, and the reach-scale habitat preferences of the two species. Observations in 2008 will allow us to determine whether the removal of brook trout has had positive effects on rainbow trout in Bogard Spring Creek, in comparison with the untreated Pine Creek.

Acknowledgements

We thank all those who assisted with the various components of this project in 2007, including members of: California Department of Fish and Game, Eagle Lake Ranger District, Susanville Indian Rancheria, United States Forest Service, USFS Fire Crew, University of California Cooperative Extension, University of California Davis - Department of Wildlife, Fish, and Conservation Biology, and numerous volunteers.

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TABLES

Table 1. Numbers of ELRT tagged by tag type, and sex. Fish were tagged on 30 March 2007 and were transported to the upper Pine Creek watershed the same day by truck, in coolers. Fish were released into Pine Creek just upstream of the Highway 44 culvert, at the McKenzie Meadow site.

	Number Tagged		
Tag Type	**Male**	**Female**	**Total**
PIT + Floy	16	20	36

Table 2. Lengths (cm) of tagged ELRT.

Statistic	**Male**	**Female**	**Both Sexes**
Average	45.1	48.5	47.0
St. dev.	4.0	3.6	4.1
n	16	20	36

Table 3. Tagging times for fish marked with both PIT and Floy tags on 30 March.

	Time (mm:ss)			
Statistic	**Anesthesia**	**Measure + Surgery**	**Recovery**	**Total**
Average	01:55	01:05	04:34	07:34
St. dev.	00:31	00:23	01:17	01:26
n	36	36	35	35

FIGURES

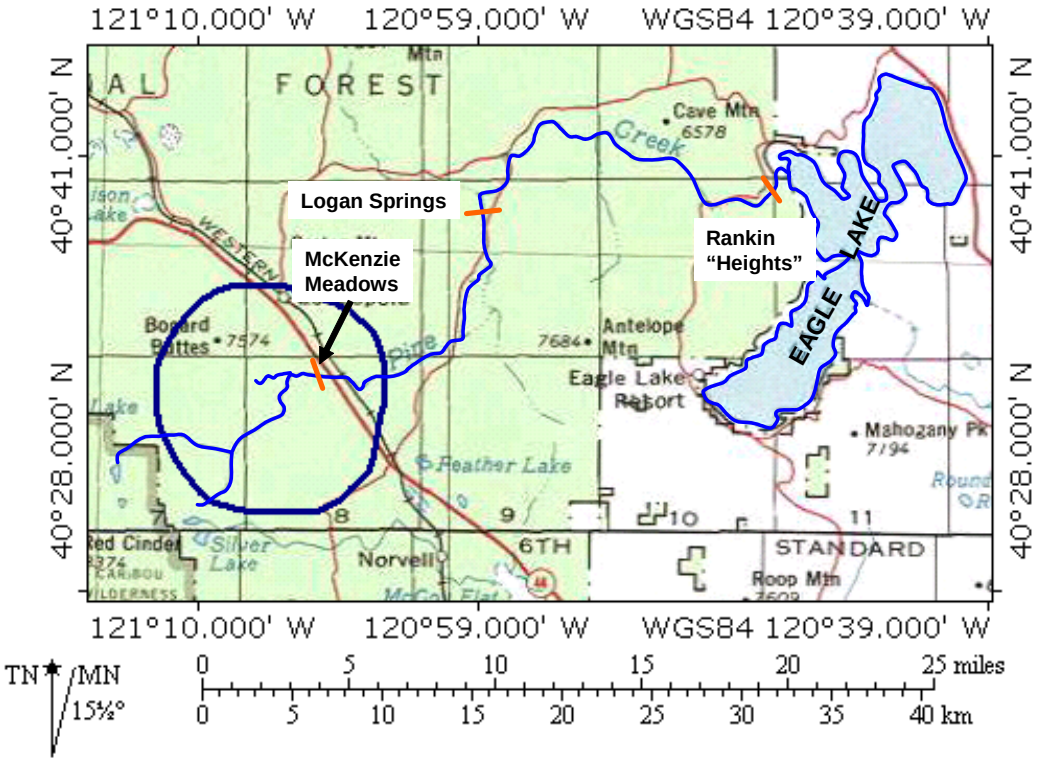

Figure 1. Locations of PIT antennas on Pine Creek.

Figure 2. PIT antenna operating at Logan Springs site on Pine Creek. Antenna cable is the green wire supported by the rope. The white objects in the creek are sandbags holding the antenna wire in place.

Figure 3. Gerard Carmona Catot and David Lile at the McKenzie Meadow PIT antenna site on 29 March 2007.

Figure 4. PIT tagging equipment set up at the mouth of Pine Creek near the Alaskan weir on 30 March 2007.

Figure 5. PIT tag (32 mm; 1.3”) shown with a dime coin for size comparison.

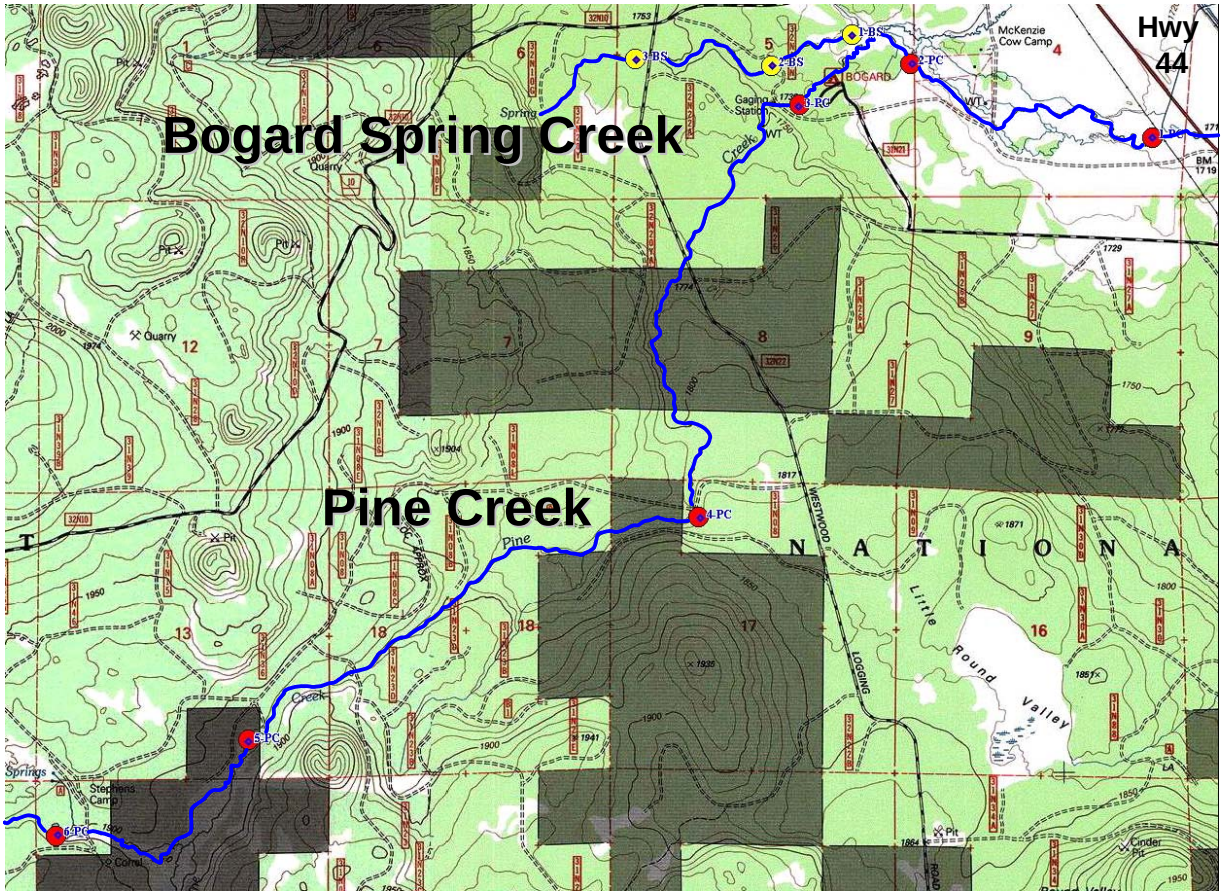

Figure 6. Map of habitat and snorkel survey sites in upper Pine Creek watershed.

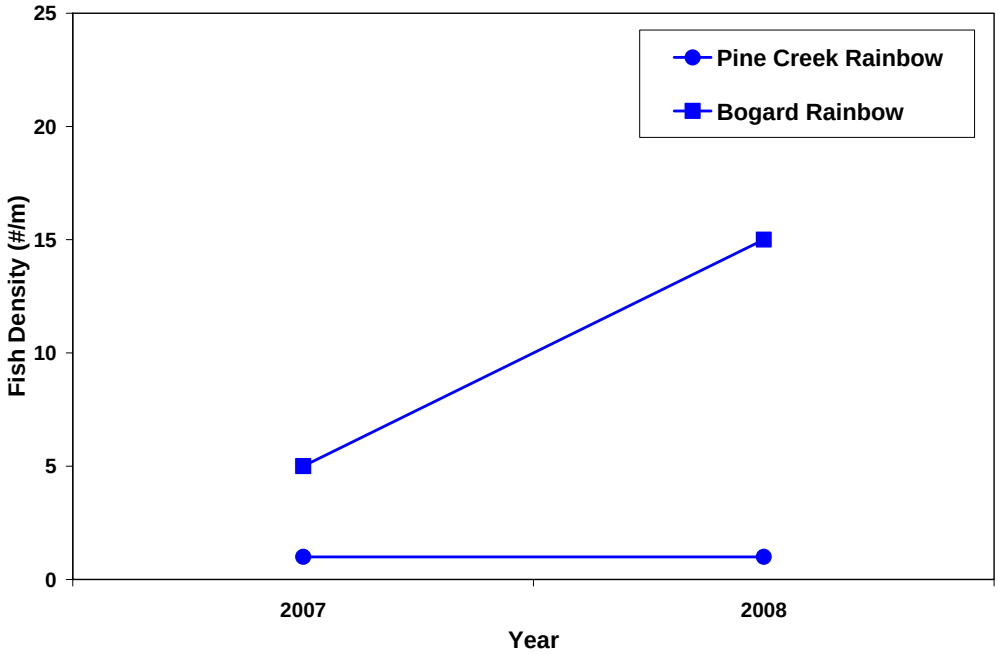

Figure 7. Potential response of rainbow trout to removal of brook trout from Bogard Spring Creek. If there is no change in rainbow trout density in Pine Creek, this suggests that the increase of rainbow trout in Bogard Spring Creek is due to brook trout removal.

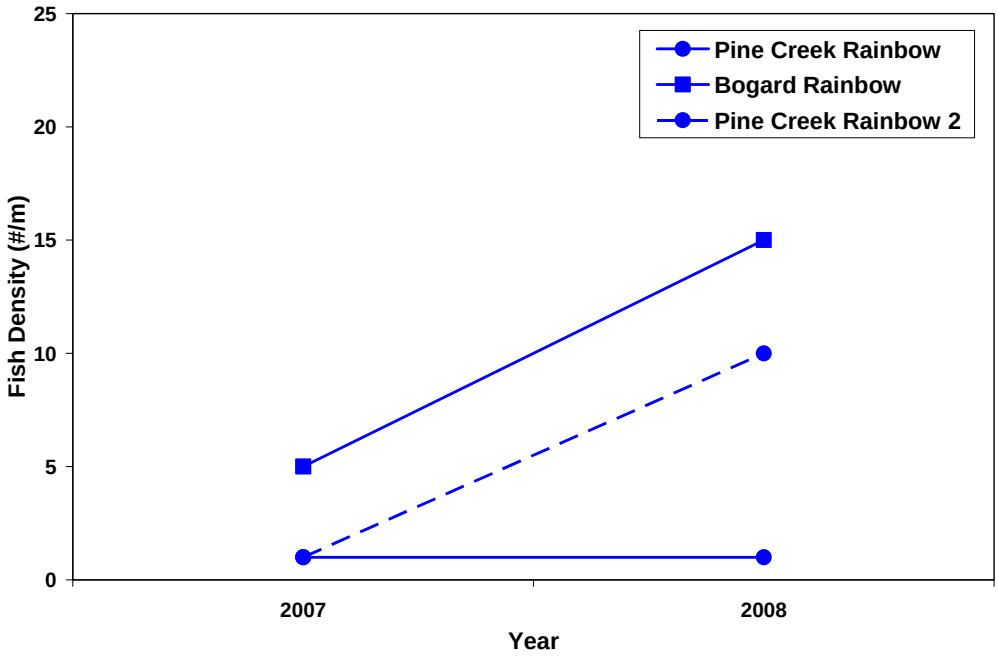

Figure 8. Potential response of rainbow trout to removal of brook trout from Bogard Spring Creek. If rainbow trout density in Bogard Spring Creek increases, but density in Pine Creek also increases (dashed line), this suggests that the increase of rainbow trout in Bogard Spring Creek is NOT due to brook trout removal.

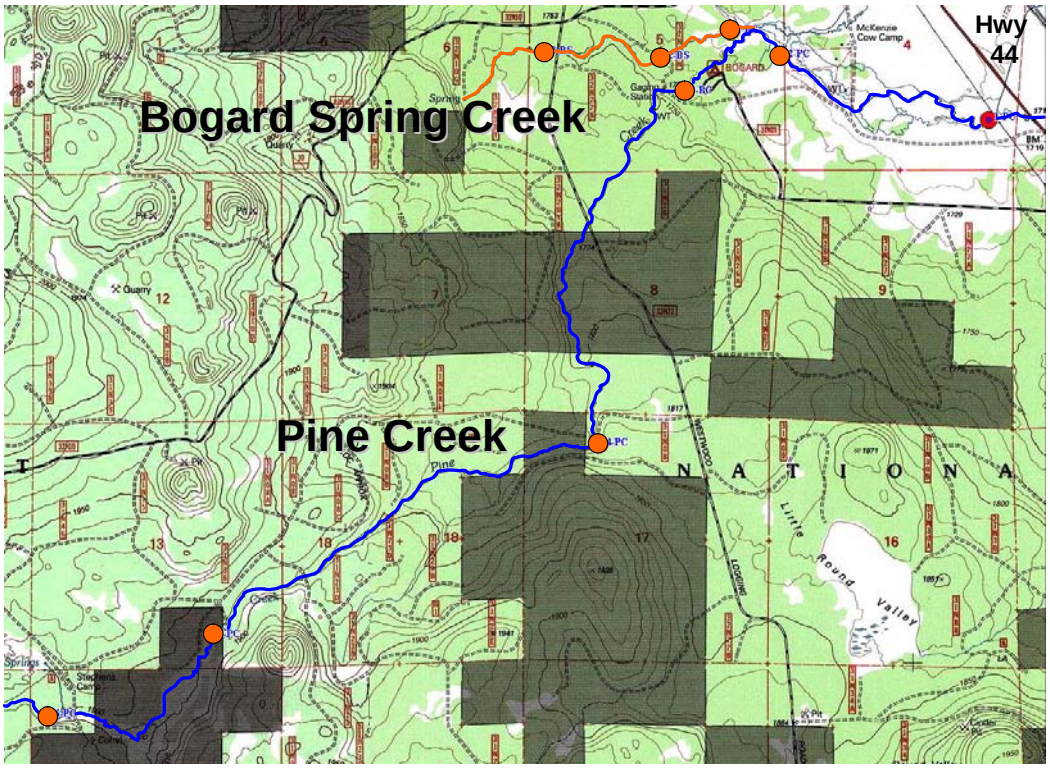

Figure 9. Electrofishing sites on Bogard Spring Creek and Pine Creek, shown in orange. Site PC-6, near Highway 44, was not electrofished because it was dry by late August. Sites indicated by an orange dot are 50 m (~150') long and are the same sites used in the habitat/snorkel survey.

Figure 10. Electrofishing crew working on Bogard Spring Creek.

Figure 11. Crew measuring lengths and weights of captured fish from Bogard Spring Creek.

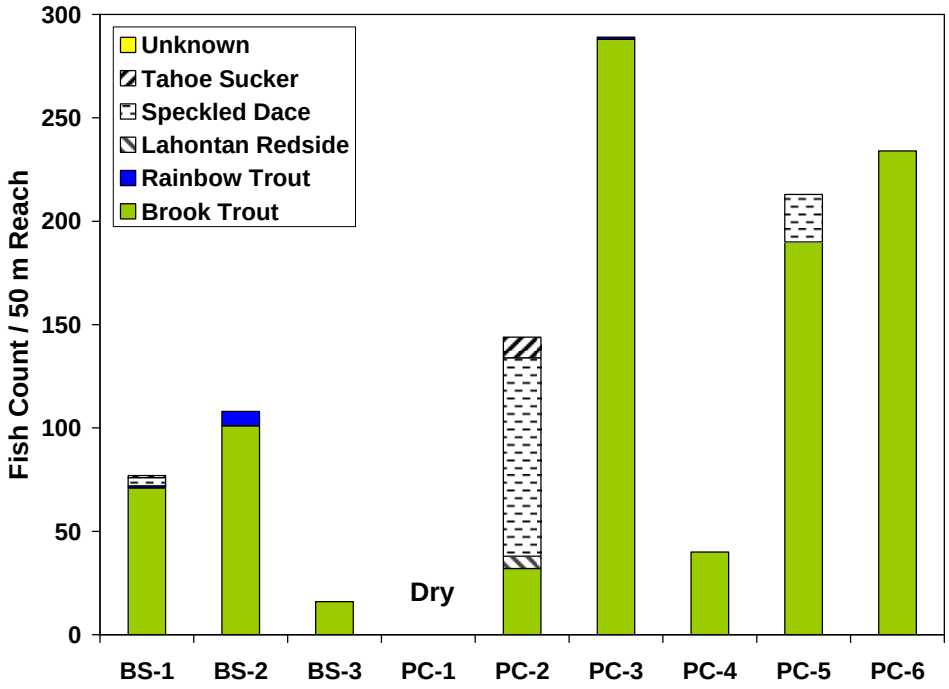

Figure 12. Fish snorkel counts in upper Pine Creek and Bogard Spring Creek in July 2007.

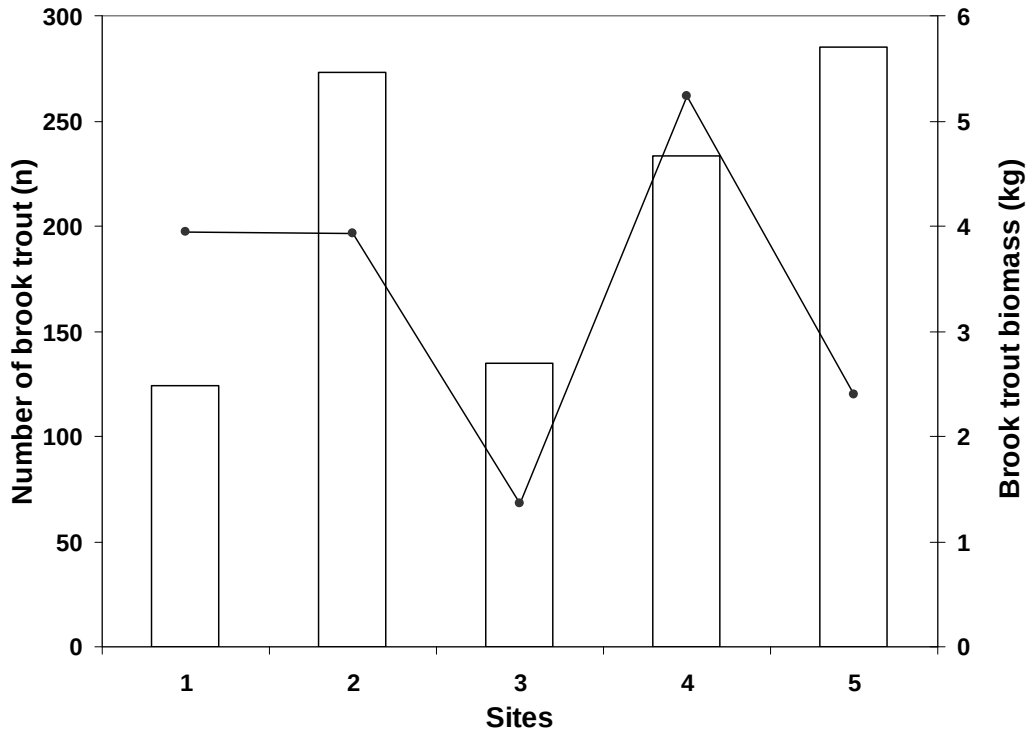

Figure 13 Brook trout numbers (bars) and biomass (line) at electrofished sites in Pine Creek, August 2007. Note: 1 kg = 2.2 pounds.

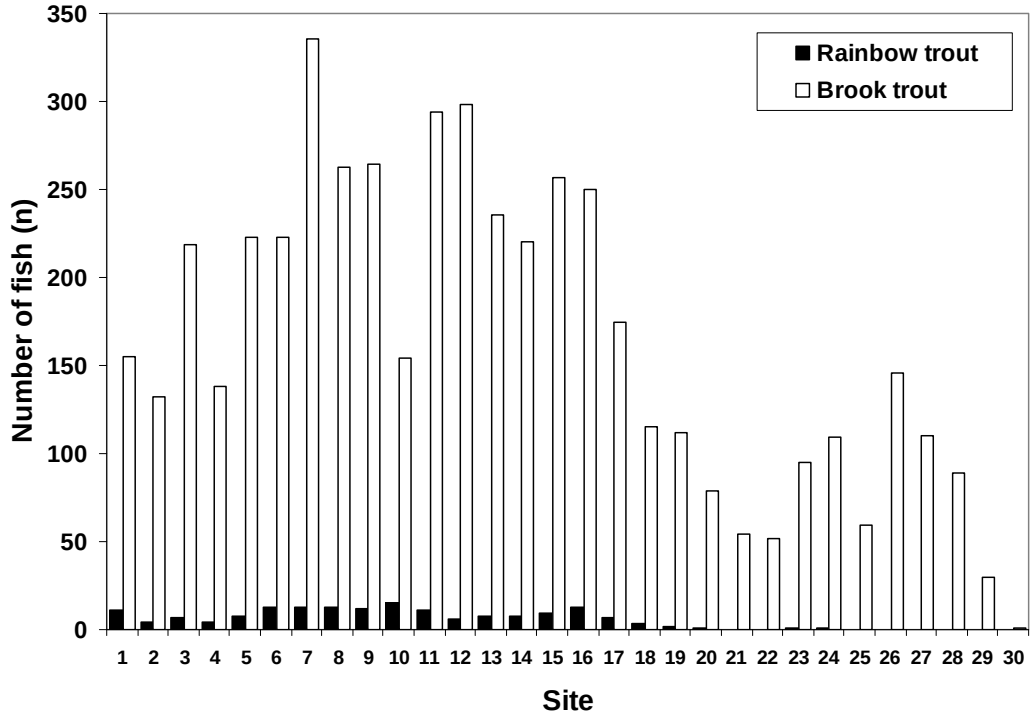

Figure 14. Numbers of brook trout and rainbow trout at electrofished sites in Bogard Spring Creek, August 2007.

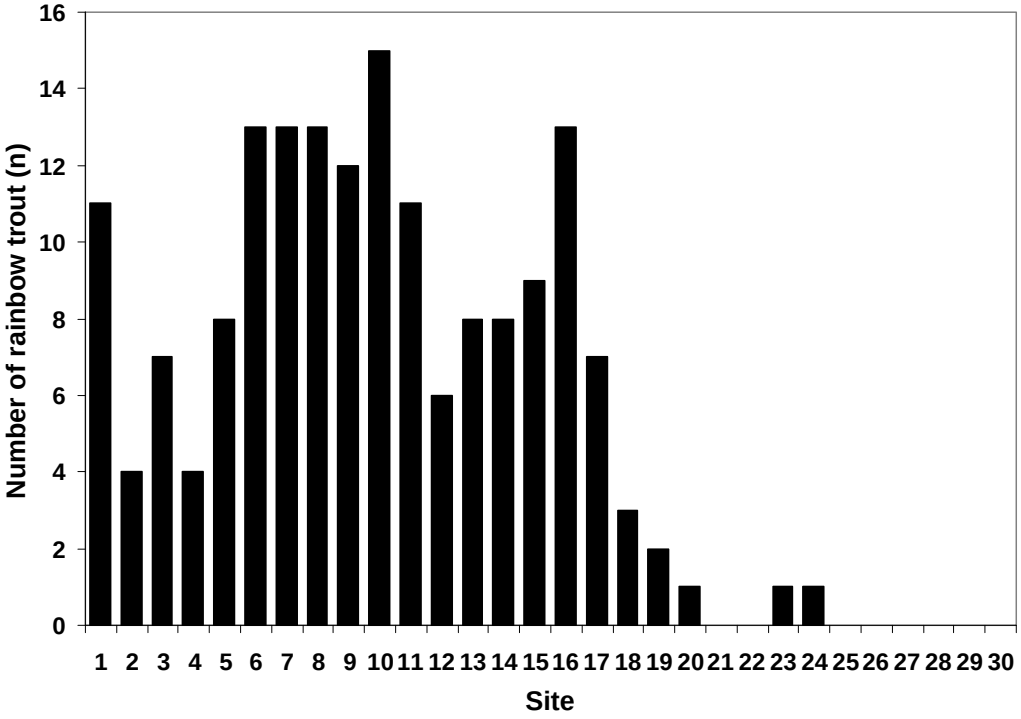

Figure 15. Numbers of rainbow trout at electrofished sites in Bogard Spring Creek, August 2007.

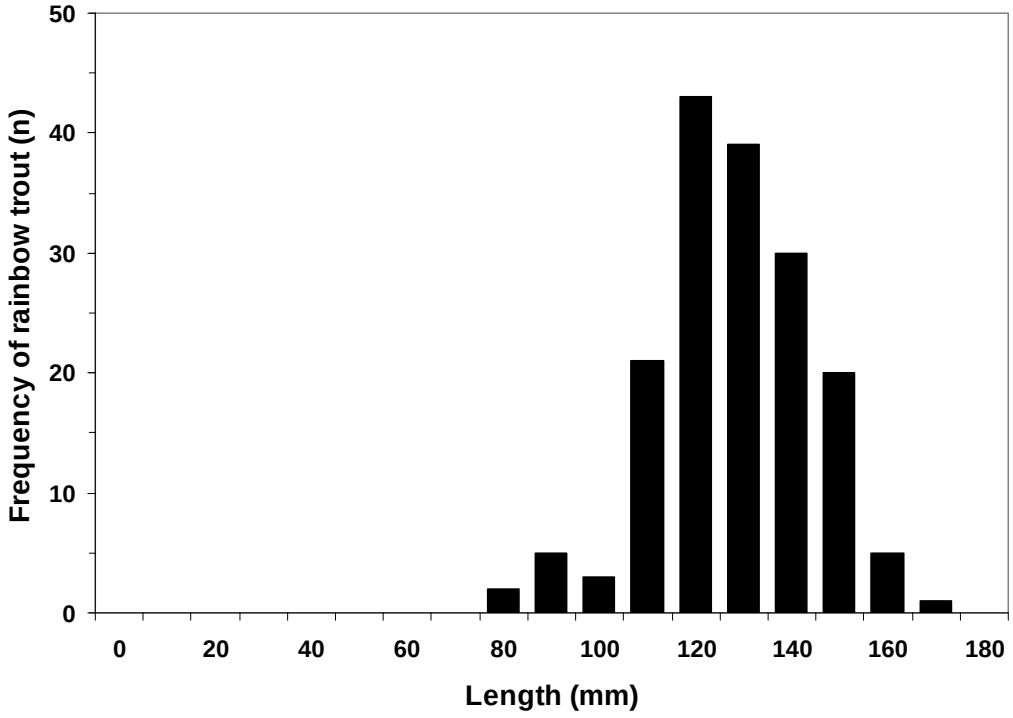

Figure 16. Length frequency distribution of rainbow trout in Bogard Spring Creek. Note: 100 mm = 4”.

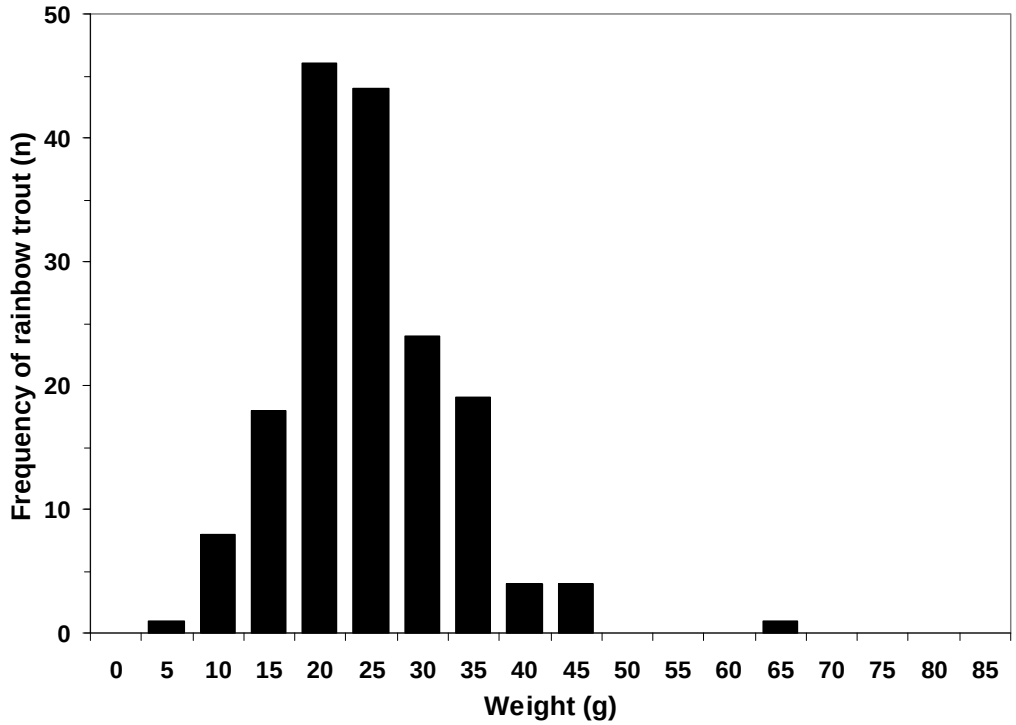

Figure 17. Weight frequency distribution of rainbow trout in Bogard Spring Creek. Note: 30 g = 1 ounce.