Hat Creek Fish Population Monitoring Report
Hat Creek Project
FERC Project 2661
2005

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EXECUTIVE SUMMARY

This report represents a compliance document pursuant to Article 407 of Pacific Gas and Electric Company's (PG&E) license issued by the Federal Energy Regulatory Commission (FERC) on November 4, 2002 for the Hat Creek Hydroelectric Project (FERC No. 2661). Article 407 specified that PG&E prepare a plan to monitor fish populations in the bypass reaches during the first, second, fifth, and sixth years of the new flow regime to verify the predicted improvements to spawning success of rainbow trout and to determine the effectiveness of the gravel augmentation program specified in Article 405. PG&E subsequently prepared and filed the plan with FERC in April, 2003. On August 12, 2003, FERC approved the plan and PG&E proceeded with its implementation.

In 2005, the second consecutive year of fish population and trout spawning surveys was conducted on the Hat 1 and Hat 2 bypass reaches. Generally, fish population characteristics in both bypass reaches were similar to those collected in 2004 as well as in 1996 and 1997 during the project relicensing. Pit sculpin and rainbow trout continued to be the most dominant species found in both bypass reaches. Six fish species were collected during the 2005 survey, representing a decrease in species richness compared to the eight species collected during 1996 and 1997 and seven species collected during 2004.

Rainbow trout populations were similar to previous years' estimates. The most notable exceptions in 2005 were at Stations 2-5 and 2-6, where there were shifts from a dominance of young-of-the-year (YOY) fish to one-year-old and older (1+) individuals compared to 2004. The shift was even more dramatic compared to the 1996–1997 population and structures. Brown trout continued to inhabit the Hat 2 Bypass Reach in low numbers, but demonstrated a slight population increase under the new license. The most dramatic population change involved Pit sculpin at Station 2-1. Nearly absent from this station in 1996–1997, Pit sculpin was the most abundant species in 2004 and 2005. Conversely, big-eye marbled sculpin numbers dropped dramatically at Station 2-1 between 2004 and 2005.

Spawning trout and active redds were observed in the Hat 1 Bypass Reach from early November 2005 through early January 2006, and in the Hat 2 bypass Reach from early November 2005 through late January 2006.

The Hat 1 Bypass Reach was used primarily by hatchery rainbow trout, presumably migrating from Baum Lake. The Hat 2 Bypass Reach was also used primarily by rainbow trout, but brown trout were also observed there. Spawning activity in the Hat 1 Bypass Reach was lower in 2005–2006 than in 2004–2005, but was similar to levels observed in 1996 and 1997 under the previous license. Spawning activity in the Hat 2 Bypass Reach was higher in 2005–2006 than in 2004–2005 or 1996–1997, but all of the known redds were scoured and destroyed by high flows before the end of the survey period.

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1 INTRODUCTION

Pacific Gas and Electric Company's (PG&E) Hat Creek Project (FERC No. 2661) diverts water from Hat Creek for power generation at the Hat Creek No. 1 and Hat Creek No. 2 powerhouses. The Hat 1 diversion occurs at Cassel Pond, and the Hat 2 diversion occurs at Baum Lake. The Hat 1 and Hat 2 bypass reaches of Hat Creek result from the two diversions (Figure 1). On November 4, 2002, the Federal Energy Regulatory Commission (FERC) issued a new license for the Hat Creek Project (project). As stipulated in the new license, minimum instream flows in the Hat 1 Bypass Reach were increased from 2 cfs to 8 cfs. In addition, the flow release at the Baum Lake Dam (a minimum of 8 cfs) and accretion flow from the Hat 2 Springs must provide a minimum flow in the lower portion of the Hat 2 Bypass Reach of 43 cfs (measured at the Joerger Diversion Dam). The response of fish populations to the new flow regime and future spawning gravel augmentation in the Hat 2 Bypass Reach is the subject of the Hat Creek fish monitoring effort.

Hat Creek begins as a small stream formed by groundwater accretion flows on the north side of Mt. Lassen. Most of the flow in lower Hat Creek, where the project is located, originates from large, cold springs that provide consistent year-round base flow. As a result, the native fish of Hat Creek are coldwater species dominated by rainbow trout (*Oncorhynchus mykiss*) and Pit sculpin (*Cottus pitensis*). There are also self-sustaining populations of non-native brown trout (*Salmo trutta*). Rainbow trout, brown trout, and brook trout *(Salvelinus fontinalis)* are raised at the Crystal Lake State Fish Hatchery and are stocked in Baum Lake (Figure 1). Native non-game fish species include three species of sculpin, several species of minnow, one species of sucker, and one species of non-predaceous lamprey. Table 1 provides a list of all reported fish species occurring in the project vicinity. Some of these species are specifically adapted to lentic (still water or lake) habitats and would not be expected to occur in the project bypass reaches.

The Hat 1 Bypass Reach extends from Cassel Pond to the upstream end of Baum Lake, adjacent to the Hat No. 1 Powerhouse (Figure 1). This reach is characterized by a well-confined channel with large substrates and generally dense riparian vegetation. It has several very steep gradient sections where water flows beneath large boulder substrates. The water comes to the surface for the last time about 1,300 feet (400 meters) upstream of Baum Lake. This lower portion of the Hat 1 Bypass Reach is a perennial, step-pool stream that is accessible for fish moving upstream from Baum Lake.

The Hat 2 Bypass Reach extends from Baum Lake to the Hat No. 2 Powerhouse, located at the upstream end of the Wild Trout Area (Figure 1). The reach has a lower gradient than the Hat 1 Bypass Reach, a less-confined channel, smaller substrates, and a dense canopy of riparian vegetation. The reach receives a flow of 20–30 cfs from the Hat 2 Springs, located in the upper portion of the reach. The lower 2,650-foot (900-meter) section of the Hat 2 Bypass Reach is accessible to fish from the Wild Trout

Area (WTA) downstream of the Hat No. 2 Powerhouse. The Joerger Diversion Dam creates a barrier to upstream fish passage, except during high flows, at the top of the reach.

1.1 Study Approach

Article 407 of the license requires that PG&E prepare a fish monitoring plan for the Hat 1 and 2 bypass reaches. The fish monitoring plan will evaluate the response of the fish populations to the spawning gravel augmentation program in the Hat 2 Bypass Reach, and the new flow regime in both bypass reaches.

The fish monitoring plan consists of two components—fish population surveys and trout spawning surveys. PG&E filed the Hat Creek Fish Monitoring Plan (PG&E 2003) with FERC on May 1, 2003. FERC issued an order modifying and approving that plan on August 12, 2003. With the plan approved, PG&E will monitor fish populations during the first, second, fifth, and sixth years of the new flow regime. Spawning surveys will be monitored annually during the first five consecutive years of gravel augmentation. A report for the two respective components will be filed annually according to monitoring requirements. This report presents the results of the second year's monitoring of both components.

The first component of the fish monitoring plan consists of population surveys using multi-pass electrofishing. Eight previously established 30-meter stations were sampled by PG&E using standard electrofishing methods in the two bypass reaches. The result of the electrofishing effort provide estimates of the number of trout and other fish species and an estimate of juvenile trout production in the two bypass reaches. These stations were previously sampled in 1979–1986 and 1996–1997 (PG&E 1998) under varying flow regimes. Data obtained from the 2005 survey are compared to similar surveys conducted in 2004 and 1996-1997.

The second component of the fish monitoring plan consists of trout spawning surveys in the two bypass reaches to determine the timing and relative use of the Hat Creek bypass reaches by spawning trout and to document current conditions of spawning substrate. Data obtained from these surveys are compared to similar surveys conducted in 2004 and between November 1996 and February 1997.

2 METHODS

2.1 Population Surveys

Four 30-meter stations were sampled in each of the two bypass reaches during August 2–5, 2005. The four stations in the Hat 1 Bypass Reach were designated 1-1, 1-4, 1-5, and 1-6 (Figure 1) and are nearly identical to the 2004 stations. Station 1-1 is at the top of the reach, just downstream of Cassel Pond. Station 1-4 is in a short section of stream between two sections with subterranean flow. Station 1-4 was slightly shorter than the 30-meter station sampled in 2004. Because of increased flows in the reach (17 cfs) due to a maintenance outage, the upper net could not be set in the same location as in 2004. As a result, the net was placed at 26 meters, the next available location. A similar situation was encountered

at Station 1-5, where the net could not be placed at the 30-meter mark. As a result, the station measured 33 meters in length for 2005. Stations 1-5 and 1-6 are in the lower portion of the reach and are accessible to fish from Baum Lake (Figure 1). Stations 2-1, 2-4, 2-5, and 2-6 were sampled in the Hat 2 Bypass Reach (Figure 1). Station 2-1 is between Baum Lake and the inflow from the Hat 2 Springs. Station 2-4 is in the middle of the bypass reach, downstream of the Hat 2 Springs. It is immediately upstream of the Joerger Diversion Dam, which is part of an old, out-of-service agricultural diversion system. The dam is a barrier to upstream passage of most, if not all, trout, except perhaps during high spill flows. Stations 2-5 and 2-6 are in the lower portion of the Hat 2 Bypass Reach and are accessible to trout from the WTA downstream of the bypass reach.

Sampling was conducted using Smith-Root Type 12 backpack electrofishing units. The stations were blocked off with 1/8-inch mesh nets to prevent fish from entering or leaving during sampling. Three sampling passes were made through the station from the downstream net to the upstream net. The sampling was conducted simultaneously by two electrofishers, each accompanied by two netters at Stations 2-4, 2-5, and 2-6. At the remaining stations, one electrofishing unit with two or three netters was used due to the small size of the stream at these stations. Fish encountered in the station were stunned (electrotaxis), netted, and placed in buckets to recover. At the end of each pass, all fish were identified to species and, in the case of trout, categorized as wild or hatchery origin (based on worn, rounded, or clipped fins). Fork lengths (FL) of all fish were measured in millimeters. Total biomass for each species was estimated volumetrically by displacement of water in 1000-ml graduated cylinders (i.e., 1 ml of displaced water = 1 gm of fish). Fish were then released a short distance downstream of the lower block net to eliminate repeat capture during subsequent passes, or within the station confine if no more passes were needed. With this type of depletion sampling, significant declines in the number of fish collected should occur with each pass. Population estimates for each species were calculated using the computer program Removal Sampling (Pisces Conservation 2004) based on the number collected during each pass. If sufficient numbers of rainbow trout were collected, separate population estimates were made for two age categories (i.e., young-of-the-year = YOY; 1+ and older trout = non-YOY). The length selected to separate YOY from older trout was based on inspection of the length-frequency distribution of captured rainbow trout.

The following physical features of each station were characterized at the time of sampling. Air and water temperatures were recorded with the time of measurement. Dissolved oxygen, pH, and conductivity were measured and recorded. Ten stream widths, spaced equally through the station, were measured. Along each width transect, depths were measured at the mid- and quarter points. Substrate composition was visually estimated in terms of percent bedrock, boulder, cobble, gravel, sand, and silt. General habitat within the station was described by estimates of percent pool, riffle, and run. Visual estimates were also made of cover provided by overhanging vegetation, in-stream structure, and surface turbulence. The percentage of the stream substrate that appeared to be suitable for spawning was also estimated, as was

the percent coverage of the station by canopy. Photos were taken of each station for visual documentation and to pinpoint the locations of the block nets.

2.2 Spawning Surveys

The lower Hat 1 Bypass Reach was surveyed for spawning trout, redds, and habitat every two weeks from November 4, 2005 through January 25, 2006. Surveys were conducted in an upstream direction by one snorkeler and one data recorder starting at Baum Lake and ending at the top of the perennially watered portion of the channel.

The lower Hat 2 Bypass Reach was surveyed for spawning trout, redds, and habitat every two weeks from November 3, 2005 through February 9, 2006. Surveys in the Hat 2 Bypass Reach were conducted by two snorkelers and one data recorder moving in a downstream direction from the Joerger Diversion Dam to the Glory Hole (the large pool where the Hat 2 Spillway enters Hat Creek). Higher flow in the Hat 2 Bypass Reach compared to that of the Hat 1 Bypass Reach prevented surveying in an upstream direction. The locations of spawning trout, redds, and habitat within the two monitoring segments established in the Hat 2 Bypass Reach for the *Hat Creek Flushing Flow and Gravel Augmentation Plan* (Spring Rivers 2006) were also noted.

Data collected during the spawning surveys included observations of redds (nests characterized by depressions of lighter colored, clean gravel), areas of worked substrate (areas of cleaner gravel without distinct redds), and adult trout (appearing to be 200 mm total length (TL) or greater). When possible, the species, origin (wild or hatchery), estimated length, and condition (e.g., worn fins or fungus) of any observed fish were documented. Only fish with tattered fins and/or exhibiting spawning behavior were considered to be actively spawning (in this report, called “spawners”). To determine the quality of spawning substrate and characteristics of the specific areas used for spawning in each of the bypass reaches, the following field measurements or observations were recorded: 1) redd size, 2) substrate composition (dominant and subdominant size categories), and 3) degree of siltation (low, moderate, or high). Redd size and substrate sizes were estimated using a 30-cm graduated measuring rod. Degree of siltation was qualitatively estimated by gently fanning the substrate within the pit to suspend accumulated fines. The presence and condition of any eggs observed during this process was noted.

All redds identified in the Hat Creek bypass reaches were mapped, and redd substrate was characterized using the following size categories: very small gravel (VSG) = 2–8 mm; small gravel (SG) = 8–32 mm; large gravel (LG) = 32–64 mm; small cobble (SC) = 64–128 mm; and large cobble (LC) = 128–180 mm. These categories were based on data from the 1996–1997 spawning surveys (Ellis and Cook 1998) and consistent with those used in the *Hat Creek Flushing Flow and Gravel Augmentation Plan* (Spring Rivers 2006).

3 RESULTS

3.1 Population Surveys

Of the twenty-six species of fish reported from the project vicinity, six were collected in the Hat 1 and 2 bypass reaches in 2005 (Table 1). Of these six, the brown trout was the only introduced species. Four species (all native) were collected in the Hat 1 Bypass reach, while five species of fish (four native and one introduced) were collected in the Hat 2 Bypass Reach. Although the rough sculpin (*C. asperrimus*), which is state-listed as threatened and a fully protected species, has been collected in Baum Lake (PG&E 1998), none were collected in the bypass reaches during this effort or previous efforts.

A summary of the water quality data collected at each station is presented in Table 2. Based on data collected during prior years, however, the bypass reaches are characterized by cold, well oxygenated water with relatively high pH levels. The YSI 85 meter used to collect water quality parameters malfunctioned during the 2005 sampling effort; therefore the water quality data is missing for many of the stations.

Table 3 presents the combined results from all electrofishing stations for all sampling efforts from 1996–1997 and 2004–2005. It lists the numbers of individuals of each species collected during each pass and the resulting population estimates with the lower and upper 95% confidence intervals by year and station. Population estimates were not calculated when only one individual was collected during all passes or when fish were collected only on the first pass. In such cases, the value shown in Table 3 as the population estimate is equal to the number of fish collected. This number is a meaningful estimate of the number of fish in the station, even though it was not possible to calculate confidence intervals. Typically, the tightest confidence intervals occur when the catches decrease consistently on consecutive passes. When catches are higher on subsequent passes than on previous passes, confidence intervals can be quite large, as shown in Table 3. The results for each of the two bypass reaches are discussed in more detail below.

3.1.1 Hat 1 Bypass Reach

Species composition and relative abundance (%) of all fish species collected in 2005 is presented graphically in Figure 2. Four native fish species [rainbow trout, Sacramento pikeminnow (*Ptychocheilus grandis*), bigeye marbled sculpin (*C. klamathensis macrops*), and Pit sculpin] were collected in the Hat 1 Bypass Reach during the 2005 sampling effort (Table 3, Figure 2). Rainbow trout (n = number captured = 1), Pit sculpin (n=11), and Sacramento pikeminnow (n=2) were collected at Station 1-1, while only Pit sculpin (n=18) were collected at Station 1-4. Station 1-5 contained rainbow trout (n=8) and Pit sculpin (n=20), and rainbow trout (n=14). Both marbled sculpin and Pit sculpin (n=2 and n=26, respectively), as well as rainbow trout (n=13), were collected at Station 1-6.

Rainbow trout

As in 2004, rainbow trout was the second most abundant fish species collected in the Hat 1 Bypass Reach during the 2005 sampling effort (Figure 2). The majority of rainbow trout were collected at the lower two stations (1-5 and 1-6), which are isolated from the rest of the stream reach by a very steep section of large boulders that begins about 335 meters upstream from the powerhouse (Table 3). The stream flow is subterranean in the steep section, except during high-flow events. Upstream movement of fish from the lower stations past this first section of sub-surface flow is unlikely. The relatively low numbers of fish found at Station 1-4, located in the first section of surface flow above this sub-surface flow area, supports a lack of upstream movement of fish past this barrier. Fish may move downstream into this isolated section during high flow events. One YOY rainbow trout was collected at Station 1-1, which is located just downstream of Cassel Pond (Table 3).

The length frequency distribution of rainbow trout from the 2005 sampling effort in the Hat 1 Bypass Reach is shown in Figure 3, illustrating a break between 120 mm and 150 mm. This would seem to indicate the difference between YOY and 1+ fish. However, the small sample size (n=23) makes interpretation difficult. Rainbow trout collected in the Hat 2 Bypass Reach show a more distinct bimodal distribution, with a break between YOY and 1+ fish at 110 mm (Figure 4). Because of the larger sample size of Hat 2 rainbow trout, the distinction between YOY and 1+ fish was based on these data. The majority of the rainbow trout collected in the Hat 1 Bypass Reach fall into the YOY cohort. Separate population estimates for YOY, non-YOY, and total rainbow trout were calculated and are listed in Table 4. Rainbow trout were primarily collected at the lower two stations (1-5 and 1-6), which suggests that this part of the reach is being used by Baum Lake rainbow trout for spawning and rearing habitat. As mentioned previously, one YOY rainbow trout was collected at Station 1-1. This may be indicative of trout spawning upstream of Cassel Pond, and subsequent downstream movement by young fish.

Sculpin

As in previous years' efforts, Pit sculpin dominated the catch throughout the Hat 1 Bypass Reach (Table 3, Figure 2). Catch data and population estimates for Pit sculpin are shown in Table 3. Length frequency distribution for Pit sculpin collected in the Hat 1 Bypass Reach during the 2005 sampling effort are shown in Figure 6, illustrating a break between YOY and non-YOY Pit sculpin within the range of 30–55 mm. In 2005, two bigeye marbled sculpin were collected at Station 1-6.

Other Fish

In addition to rainbow trout, Pit sculpin, and bigeye marbled sculpin, two Sacramento pikeminnow were collected at Station 1-1 (Table 3) in 2005. No other fish species were collected in the Hat 1 Bypass Reach during the 2005 sampling effort.

3.1.2 Hat 2 Bypass Reach

Four stations were sampled in the Hat 2 Bypass Reach during the 2005 sampling effort. The station locations are shown in Figure 1 and replicate those sampled in 2004. The numbers of fish collected and population estimates for each species at each station are presented in Table 3. Figure 5 illustrates the species composition and relative abundance of all fish collected in the Hat 2 Bypass Reach during the 2005 sampling effort.

Four native species were collected in the Hat 2 Bypass Reach during the 2005 sampling effort [rainbow trout, Pit sculpin, bigeye marbled sculpin, and Pit-Klamath brook lamprey (*Lampreta lethophaga*)]. In addition, non-native brown trout were collected in the Hat 2 Bypass Reach. Rainbow trout (n=11), brown trout (n=2), Pit sculpin (n=41), and bigeye marbled sculpin (n=2) were collected at Station 2-1. Station 2-4 yielded rainbow trout (n=11), brown trout (n=1), and Pit sculpin (n=51). Rainbow trout (n=25), brown trout (n=15), Pit sculpin (n=116), and Pit-Klamath brook lamprey (n=2) were collected at Station 2-5. At Station 2-6, rainbow trout (n=33), brown trout (n=5), and Pit sculpin (n=130) were collected (Table 3; Figure 5).

Rainbow Trout

As was the case in 2004, rainbow trout was the second most abundant species in the Hat 2 Bypass Reach, next to Pit sculpin (Figure 5). Catch data and population estimates are provided in Table 3. Table 5 presents a comparison of population estimates for YOY and non-YOY rainbow trout collected during the 2005 sampling effort.

The rainbow trout population in the middle and lower sections of the Hat 2 Bypass Reach consists primarily of YOY fish. In contrast, the upper section (Station 2-1) supports a higher percentage of 1+ rainbow trout (Figure 5). The differences appear to be attributable to the presence or absence of adult habitat in the two sections. The middle and lower sections consist almost entirely of riffle habitat. The riffles provide spawning and rearing habitat but little adult trout habitat. Trout from the WTA, located just below the bypass reach, migrate into the reach during the fall and winter to spawn and then return to the WTA. Juvenile trout appear to move downstream to the WTA after spending about one year in the bypass reach. The presence of a few 1+ trout indicates that some may spend up to, and possibly more than, two years in the bypass reach. The Joerger Diversion Dam appears to be the upper limit that can be reached by spawning trout from the WTA. The large pool formed by the dam, however, provides some habitat for resident adult trout. The YOY trout collected at Station 2-4, just upstream of this pool, may be the progeny of the adult trout in the pool. Some of the YOY trout may also move into this section from upstream. In contrast to the lower section, the upper section of the reach (Station 2-1) consists of pool and run habitat that is more suitable for adult trout. Barriers upstream (Hat Creek No. 2 Dam) and downstream (steep cascade) may discourage migration behavior in this section of the reach.

Brown Trout

Low numbers of brown trout were collected in the Hat 2 Bypass Reach in 2005, as was the case in 2004. Population estimates and catch data for brown trout at all stations are presented in Table 3. Length frequency distributions for brown trout collected in the bypass reach during 2005 is presented in Figures 7-1 through 7-4. Station 2-6 yielded four fish that were larger than 300 mm in length. These fish may have moved up from the WTA in preparation for spawning in the fall.

Sculpin

As in 2004, both Pit sculpin and bigeye marbled sculpin were collected in the Hat 2 Bypass Reach during the 2005 sampling effort. Population estimates and catch data for Pit sculpin are presented in Table 3. Length frequency distributions are provided in Figure 8 for Pit sculpin and Figure 9 for marbled sculpin.

Pit-Klamath Brook Lamprey

Two Pit-Klamath brook lamprey were collected at Station 2-5 during the 2005 sampling effort. No population estimate could be calculated due to the fact that none were collected during the first pass, yet one was collected during each of the second and third passes. Catch data is presented in Table 3.

3.2 Comparison with the 2004 and 1996–1997 Population Surveys

3.2.1 Hat 1 Bypass Reach

For the most part, rainbow trout populations in the Hat 1 Bypass Reach showed similar patterns as in previous years. One YOY trout was collected at Station 1-1. Relatively low numbers of rainbow trout were collected during the 1996–1997 and 2004 surveys at this station (Figure 10.1). Station 1-4 had no trout, as has been the case each year. A higher number of YOY trout were collected at Station 1-5 than during previous years' efforts (Figure 11.1). Station 1-6 had numbers similar to those seen in previous years (Figures 10.3 and 11.2).

As in previous years, Pit sculpin was the most abundant species collected in the Hat 1 Bypass Reach in 2005 (Figure 2). With the exception of Station 1-4, fewer Pit sculpin were collected at each station than in 2004. Station 1-1 had a population estimate of 12 individuals, less than half of the estimate at this station during 2004 (Figure 12.1). However, this estimate fits within the 1996 and 1997 estimates (16 and 8). The population estimate for Pit sculpin at Station 1-4 is similar to the 2004 data (Figure 12.2), which is less than half of that during the 1996–1997 surveys. Stations 1-5 and 1-6 had similar numbers to the 1996–1997 surveys (Figures 12.3 and 12.4, respectively). Two marbled sculpin were collected at Station 1-6. Considering their small size (30 and 27 mm), it is possible that these individuals were misidentified in the field, and may have been Pit sculpin. Marbled sculpin have been collected previously at this station in 1985, however (PG&E 1998); none have been found in recent surveys. Given the close proximity of station 1-6 to Baum Lake, where marbled sculpin are known to exist, it is reasonable to assume marbled sculpin may occupy the riverine area in the vicinity of this station.

As in 2004, two adult Sacramento pikeminnow were collected at Station 1-1.

3.2.2 Hat 2 Bypass Reach

Rainbow trout populations were similar to those during the 2004 surveys, with one exception. Station 2-1 had less than half the number of trout as in 2004 (Figure 13.1). Rainbow trout populations showed a similar decline from 1996 to 1997. Few YOY trout were collected at Station 2-1 (Figure 14.1). Rainbow trout populations at Station 2-4 were similar to 2004, down from the 1996–1997 numbers (Figure 13.2). The age structure seems to fit with 2004 results; however, overall YOY abundance is substantially lower than that observed in 1996 and 1997 (Figure 14.2). Population estimates for Station 2-5 were similar to previous years (Figure 13.3). The number of YOY trout collected was less than half of that in 2004. However, 1+ trout numbers were almost identical. Additionally, the number of 1+ trout in 2004 and 2005 was more than double of those in 1996–1997 (Figure 14.3). Station 2-6 trout numbers were nearly identical for 1997, 2004, and 2005. The number of trout collected at Station 2-6 in 2005 was slightly less than in 2004 (Figure 13.4), and showed a similar pattern in age structure as Station 2-5, but to a lesser extent (i.e., more adults and fewer YOY than the 1996–1997 surveys [Figure 14.4]).

Two brown trout were collected at Station 2-1, as was the case in 2004. No brown trout were collected during the 1996–1997 surveys (Figure 15.1). One brown trout was collected at Station 2-4 in 2005. Either one or two brown trout have been collected at this station in each survey (Figure 15.2). The same number of brown trout was collected at Station 2-5 during 2005 as in 2004. However, due to the high standard error in 2005, the population estimate was nearly double that of 2004. The 1996–1997 surveys found very low numbers of brown trout at this station (Figure 15.3; Table 3). Station 2-6 brown trout population estimates were similar in 2004 and 2005 (Figure 15.4), with a slight drop from 1996 numbers. In 1997, only two brown trout were collected at this station.

Pit sculpin populations changed dramatically at Station 2-1 between the 1996–1997, and 2004–2005 surveys (Figure 16.1). Specifically, population estimates have increased from 2 in 1996 and 1 in 1997 to 62 and 42 individuals during 2004 and 2005, respectively. The marbled sculpin population was dramatically smaller during the 2005 survey than in previous years. Stations 2-5 and 2-6 showed slight increases in Pit sculpin populations in 2004–2005 (Figures 16.3 and 16.4). No marbled sculpin were collected at Stations 2-4, 2-5, or 2-6 during the 2004–2005 surveys. This is not surprising, because few or no marbled sculpin were collected at each of these stations during the 1996 and 1997 surveys (Table 3).

Two Pit-Klamath brook lamprey were collected in the Hat 2 Bypass Reach in 2005 (Table 3). Compared to the 2004 surveys, total numbers collected decreased (six were collected in 2004). Unfortunately, due to the low number of individuals collected in 2005, population estimates cannot be calculated to produce a better comparison among sample years. Nevertheless, Station 2-5 appears to provide suitable habitat for Pit-Klamath brook lamprey.

3.3 Spawning Surveys

3.3.1 Hat 1 Bypass Reach

On November 4, 2005, 11 adult trout were observed in the Hat 1 Bypass Reach: 7 were rainbow trout, 3 were brook trout, and 1 was an unidentified trout (Table 6). They all appeared to be of hatchery origin. Two of the rainbow trout and all three of the brook trout were considered active spawners based on their behavior and the tattered condition of their fins. The unidentified trout was also believed to be a spawner, because it was observed near a fresh, cobble-dominated redd located just upstream of the lower boundary of the large woody debris survey area (Figure 17). No other redds were observed on this date, but three additional areas of cleaned substrate were found in the farthest upstream pool where the three brook and two rainbow spawners were observed. The approximate size, substrate composition, and degree of siltation for all redds observed in the Hat 1 Bypass Reach are presented in Table 7.

On November 15, 2005, 10 adult rainbow trout were observed, and 4 appeared to be active spawners (Table 6). No other trout species were observed in the Hat 1 Bypass Reach on this date. All of the spawning trout and five of the non-spawning trout were identified as hatchery rainbows, but one 250-mm rainbow trout in good condition looked like a wild fish. All spawning trout were observed near new redds or patches of spawning substrate. One 300-mm rainbow trout spawner was observed in the farthest downstream pool over a patch of very small and small gravel substrate, and a pair of spawning rainbows (400–500 mm) was observed holding over a patch of substrate just downstream from a fresh redd (Table 7; Figure 17). The downstream redd was constructed in large gravel and small cobble substrate, and pink eggs were observed in the crevices between the surface cobbles (Figure 21). One 400-mm rainbow trout spawner was holding near a second redd located in the farthest upstream pool, where digging was observed on November 4. The upstream redd was dominated by very small and small gravel substrate, and dead eggs were observed in the tailout of the pit (Figure 22).

On November 29, 2005, seven adult rainbow trout were observed, and four appeared to be active spawners (Table 6). All were of hatchery origin. Although the number of spawning trout observed was not significantly higher than on previous or subsequent surveys, four new redds and three additional areas of test digging were observed on this date (Table 7; Figure 17). Consequently, peak spawning activity in the Hat 1 Bypass Reach was considered to be in late November. Three of the new redds observed on this date were fresh, and two of these had eggs visible at the surface. The fourth redd did not appear to be fresh, but was considered new, because it was not present on the previous survey date. One dead egg was visible in the pit of this redd, which was constructed in very small and small gravel substrate with some small cobble.

On December 12, 2005, six adult rainbow trout were observed, and four appeared to be active spawners (Table 6). All four spawning trout and one of the non-spawning trout were identified as hatchery rainbows. The second non-spawning trout appeared to be the same 250-mm wild rainbow trout that was observed on November 15. Two areas of test digging were found on this date, but no new redds. All of

the older redds had low to moderate silt coverage. One 400-mm rainbow trout spawner was observed near an older redd in the farthest downstream pool, and a pair of rainbows (400–450 mm) was actively guarding an older redd in the farthest upstream pool. No spawners were observed near the remaining five older redds.

On December 28, 2005, no live fish were observed, however, one dead hatchery rainbow trout spawner with pink gills was found near a fresh redd with newly deposited eggs (Tables 6 and 7; Figure 17). Visibility was very poor on this date, because the water was unusually high and turbid. Recent scouring of the bed and mobilization of cobble and boulder substrate made detection of redds difficult. One additional fresh redd with newly deposited eggs was discovered, however, in a patch of small gravel and small cobble substrate behind a large boulder near the center of the reach.

On January 9, 2006, the number of adult trout observed was higher than on previous survey dates, with 13 adult rainbow trout and 1 adult brown trout (Table 6). All of the rainbow trout were identified as hatchery fish, but the origin of the brown trout was not determined. Six of the larger rainbow trout appeared to be active spawners. In addition, one dead male rainbow trout spawner was found at the top of the survey reach near a redd discovered on November 15 (Figure 17). The adult brown trout (300 mm) was in good condition and did not appear to be an active spawner. It was holding in the lake-influenced portion of the Hat 1 Bypass survey reach, which on this date was extended above the first riffle beneath the Hat 1 Penstock. Water velocity was still very high, but visibility was improved somewhat from the previous survey date. Pink eggs were still visible in the two redds discovered on December 28. These redds were being actively guarded by rainbow trout spawners. No spawners were observed near redds discovered prior to December 28, all of which had accumulated moderate to high levels of fine sediment and leaf litter. One new redd was discovered in large gravel and small cobble substrate at the bottom of a deep, mid-channel pool where a pair of spawning rainbow trout was observed (Table 7).

On the final survey date of January 25, 2006, 14 adult rainbow trout were observed, but only 2 of these appeared to be active spawners. Both of the spawning trout and 11 of the non-spawning trout were identified as hatchery fish. One non-spawning trout appeared to be the same 250-mm wild rainbow that was observed on November 15 and December 12. Both of the spawning trout were observed in the upstream-most pool where a redd was discovered on November 15. Of the 10 redds discovered during the 2005–2006 surveys, 8 were found and examined on this date, and 6 of these were thought to contain potentially viable eggs (Figure 18). Two of the redds examined had high silt coverage and/or contained dead eggs and were not considered productive.

3.3.2 Hat 2 Bypass Reach

On November 3, 2005, eight adult rainbow trout, four adult brown trout, and one large unidentified trout were observed in the Hat 2 Bypass Reach (Table 6). Two of the rainbow trout, the four brown trout, and the unidentified trout appeared to be active spawners. The turbid conditions and relatively high water velocity in the Hat 2 Bypass Reach made close examination of fish difficult. Consequently, origin (i.e.,

hatchery or wild) was not determined for any trout observed in the Hat 2 Bypass Reach during the 2005–2006 survey period. In total, three areas of test digging were observed in the two monitoring segments established for the *Hat Creek Flushing Flow and Gravel Augmentation Plan* (Spring Rivers 2006), but the two areas in the upper monitoring segment were too embedded for successful redd construction. Substrate was less embedded in the lower monitoring segment, where a 400-mm brown trout spawner was observed near an area of fresh digging. Several redds were discovered in this area on subsequent surveys.

On November 16, 2005, 10 adult rainbow trout and 2 adult brown trout were observed (Table 6). Four of the rainbow trout and both of the brown trout appeared to be active spawners. The four rainbow trout spawners were observed in the upper half of the reach near patches of very small and small gravel substrate. The two brown trout spawners were observed in the lower monitoring segment near a fresh redd that was constructed in small and large gravel substrate (Table 8; Figure 19). One of the brown trout spawners (400 mm) appeared to be the same fish that was observed near this patch of substrate on November 3.

On November 30, 2005, nine adult rainbow trout and one adult brown trout were observed (Table 6). Two of the adult rainbow trout and the adult brown trout appeared to be active spawners. All but one of the spawners were observed near areas of test digging, but only one of these areas (lower monitoring segment) contained suitable substrate for spawning. The remaining areas were too embedded for successful redd construction. No new redds were found on this date, and no spawners were observed near the redd discovered on November 16. The old redd was still clean, however, and a 400-mm brown trout spawner was observed about 50 meters downstream.

On December 13, 2005, 11 adult rainbow trout were observed and 3 appeared to be active spawners (Table 6). No other species of adult trout were observed on this date, but the water was more turbid than on previous surveys, and visibility was very poor. No redds or areas of fresh digging were observed on this date.

On December 29, 2005, all of the 10 adult rainbow trout and 2 adult brown trout observed were active spawners (Table 6). In addition, one dead male rainbow trout spawner was found downstream from a fresh redd constructed in the tailout of the brown trout redd that was discovered on November 16 (Table 8; Figure 19). A 400-mm rainbow trout was observed holding over this new redd, and at least one rainbow trout spawner was guarding this area on subsequent surveys. A second new redd was discovered in the inner bend of the braided reach just downstream of the lower monitoring segment. This redd was constructed in a shallow gravel bar in very small and small gravel substrate downstream of a downed tree. Eggs observed near the surface of the pit were being washed downstream. For this reason, and because the gravel bar is exposed in lower flows, the redd was not considered to be productive (Figure 20). Three dead brown trout spawners and one dead rainbow trout spawner were

observed downstream of the Glory Hole at the base of the powerhouse, but these were not included in the total spawner count because they were not within the survey reach.

On January 10, 2006, numbers of adult trout and hatchery spawners were higher than on previous or subsequent survey dates. In total, 19 adult rainbow trout and 9 adult brown trout were observed; 11 of the rainbow trout and 3 of the brown trout appeared to be active spawners (Table 6). All spawners were aggressive, and most were observed digging or actively defending redds. Flow was lower than on the previous survey date, and new deposits of spawning substrate were discovered in locations previously too embedded for redd construction. In the upper monitoring segment, new patches of spawning substrate were discovered between some logs that were repositioned, and three rainbow trout spawners were observed near these new substrate patches. No spawners were observed in this section on previous survey dates. Despite the new substrate patches in the upper monitoring segment, the seven new redds discovered on this date were found in the lower half of the survey reach, and six were within the lower monitoring segment (Table 8; Figure 19). Two of the new redds were constructed in small and large gravel substrate in the upstream portion of the river-right side channel. A pair of brown trout spawners in very poor condition was guarding these two redds, which were less than a meter apart. Rainbow trout spawners were observed on or near the remainder of the new redds.

On January 24, 2006, 10 adult rainbow trout and 6 adult brown trout were observed (Table 6). Six of the rainbow trout and three of the brown trout appeared to be active spawners. In addition, one dead brown trout spawner was found just downstream of the Joerger Diversion Dam. The majority of rainbow trout spawners and one of the brown trout spawners were guarding the redds discovered on January 10. No new redds were observed on this date; but one spawning pair of rainbow trout was observed holding over a patch of clean gravel substrate just downstream from the lower-most island.

On February 9, 2006, seven adult rainbow trout and two adult brown trout were observed, but none appeared to be active spawners (Table 6). Four dead rainbow trout spawners were observed downstream of the lower monitoring segment. No new redds were observed on this survey date, and all of the redds discovered on January 10 appeared to have been scoured by subsequent high flows. All of the old redds, which were only distinguishable by shallow depressions in embedded substrate, were devoid of eggs and loose gravel/cobble substrate. Flow on this date was substantially lower than on previous survey dates; and three of the seven redds discovered on January 10 were in less than 2 inches of water. Throughout the Hat 2 Bypass Reach, patches of spawning substrate that were observed on previous survey dates were no longer present, including the patch downstream of the lowermost island where a pair of active rainbow trout spawners were observed on January 24. Some new deposits of very small and small gravel substrate were observed just upstream of the Glory Hole on the river-right, but these deposits were shallow and silty.

3.4 Comparison with the 2004 and 1996–1997 Spawning Surveys

The flow release in the Hat 1 Bypass Reach was 2 cfs during the 1996–1997 surveys, compared to the new license-required release of 8 cfs during the 2004–2005 and 2005–2006 surveys. In the Hat 1 Bypass Reach, numbers of spawning trout and redds observed were highest during the 2004–2005 surveys. A maximum of 21–27 spawners and 25 redds were observed in 2004–2005, compared to 12 spawners and 10 redds in 1996–1997, and 7 spawners and 10 redds in 2005–2006 (Table 9). Of the 25 redds identified in 2004–2005, however, only 12 were estimated to contain viable eggs (Figure 18). Redd productivity was not estimated in 1996–1997, only six of the redds constructed in 2005–2006 were estimated to contain viable eggs.

Although more redds were discovered in the Hat 1 Bypass Reach during the 2004–2005 surveys, the approximate locations of potentially productive redds were similar in all study years (Figure 18). Very small and small gravel were important spawning substrates in all study years, but more of the redds found in 2004–2005 and 2005–2006 were dominated by large gravel and small cobble, and some redds contained large cobble. Hatchery rainbow trout were the most abundant spawning species in all study years, and peak spawning activity occurred in late November in 1996, late December in 2004, and late November 2005 (Table 9). Two brook trout and six brown trout spawners were observed in the Hat 1 Bypass Reach in 1996–1997, five brook trout and no brown trout spawners were observed in 2004–2005, and three brook trout and no brown trout spawners were observed in 2005–2006.

During the 1996–1997 surveys, the flow release in the Hat 2 Bypass Reach was 8–9 cfs, augmented by spring accretion to a minimum of approximately 30 to 40 cfs downstream of the Joerger Diversion Dam. During the 2004–2005 and 2005–2006 surveys, the new license required that the flow release from Baum Lake Dam (8 cfs minimum) and accretion flow from the springs must provide a minimum flow in the lower portion of Hat 2 Bypass of 43 cfs, as measured at the Joerger Diversion Dam. In the first year of the five-year gravel augmentation program (required by License Article 405), 5 cubic yards of small gravel (≤1.5-inch median diameter) were placed in the Hat 2 Bypass Reach before the flushing flows in September 2005.

Numbers of spawning trout and redds observed in the Hat 2 Bypass Reach were higher during the 2005–2006 surveys than during the 2004–2005 or 1996–1997 surveys. A maximum of 11 spawners and 10 redds were observed in 2005–2006, compared to 5 spawners and 8 redds in 2004–2005, and 7 spawners and 5 redds in 1996–1997 (Table 9; Figure 20). Spawning activity during the 2005–2006 surveys spiked during a period of high flows that mobilized and redistributed small and large woody debris and created new patches of spawning gravel and cobble substrate. These patches and their associated redds were flushed out, however, during another high flow event that occurred between the January 25 and February 9 surveys. Consequently, no redds observed in 2005–2006 were considered to be productive. Redd productivity was not estimated in 1996–1997, but only one of the eight redds discovered in 2004–2005 was not considered productive, and this was due to high silt accumulation in the pit following a period of

low flows. During the 2004–2005 surveys, redds were not examined after January 13, but some likely produced fry, because young-of-the-year rainbow trout were observed and captured in the Hat 2 Bypass Reach in 2005–2006.

In all study years, redds in the Hat 2 Bypass Reach were located in marginal and/or side channel habitats, where water velocity was lower than in the main channel (Figure 20). The marginal habitats in the upper monitoring segment that supported one redd in 1996–1997 and three redds in 2004–2005 were too embedded in 2005–2006 for redd construction. During the 2005–2006 survey period, all redds were found in, and downstream of, the lower monitoring segment. Rainbow trout was the most abundant spawning species in all survey periods, followed by brown trout. No brook trout spawners were observed in the Hat 2 Bypass Reach during any survey period. In 1996–1997, the rainbow trout and brown trout observed during the survey were identified as wild spawners. In 2004–2005 and 2005–2006, encounters with spawning trout were brief, and visibility was limited by high turbidity, so snorkelers were unable to determine the origin of spawning trout.

4 SUMMARY

4.1 Populations Surveys

Fish population characteristics in 2005 were relatively similar to those in 1996–1997 and 2004. Six species were collected during the 2005 survey, compared with eight collected during the 1996–1997 surveys and seven collected during 2004. Pit sculpin and rainbow trout were the dominant species in both bypass reaches. As in 2004, Sacramento pikeminnow were collected at Station 1-1. Additionally, two Pit-Klamath brook lamprey were collected at Station 2-5.

Rainbow trout numbers were, in general, similar to previous years' numbers. Relative abundance of YOY versus older fish did change at Stations 2-5 and 2-6, causing a shift in the age structure. Fewer YOY were collected at each station, whereas the number of 1+ trout collected increased slightly compared to 2004, and more dramatically when compared to the 1996–1997 data.

Brown trout continue to occur in the Hat 2 Bypass Reach in low, but increasing numbers. Station 2-1 has seen a slight increase in numbers (from 0 to 2 fish) since the 1996–1997 surveys. The lower stations seem to provide adequate habitat for brown trout, because numbers have increased at this location. In contrast, marbled sculpin populations dropped dramatically at Station 2-1 between 2004 and 2005.

4.2 Spawning Surveys

In 2005–2006, spawning trout and active redds were observed in the Hat 1 Bypass Reach from early November through early January, and in the Hat 2 bypass Reach from early November through late January. Data from the 1996–1997 surveys indicate that the onset of spawning in these reaches may occur in October. In 2005–2006, spawning activity in the Hat 1 Bypass Reach appeared to be greatest in late November, while spawning activity in the Hat 2 Bypass Reach was greatest in early January. High

December flows in the Hat 2 Bypass Reach resulted in significant redistribution of spawning gravels, which may have resulted in the boom of spawning activity observed in early January. The Hat 1 Bypass Reach was used primarily by hatchery rainbow trout, but some hatchery brook trout also used spawning substrate in this reach. The Hat 2 Bypass Reach was also used primarily by rainbow trout, but at least three redds were being guarded by brown trout spawners. The origin of spawning trout in the Hat 2 Bypass Reach was not determined, but only wild spawners were observed during the 1996–1997 surveys. The occurrence of hatchery trout should be low, because the Wild Trout Area of Hat Creek is not stocked.

In the Hat 1 Bypass Reach, spawning activity in 2005–2006 was lower than in 2004–2005. During both survey years, about half of the known redds were estimated to be productive. Four of the 10 redds found in 2005–2006 and 13 of the 25 redds found in 2004–2005 were smothered with fine sediment by the end of the survey period and were thus unlikely to contain viable eggs. Spawning activity in the Hat 1 Bypass Reach in 1996–1997 was similar to that observed in 2005–2006. Spawning activity in the Hat 2 Bypass Reach was higher in 2005–2006 than in 2004–2005 or 1996–1997, but all of the redds found in 2005–2006 were scoured and destroyed before the end of the survey period. All but one of the redds found in 2004–2005 were estimated to be productive.

In 2005–2006, fish were spawning in larger substrate in the Hat 1 Bypass Reach than in the Hat 2 Bypass Reach. Although many redds in the Hat 1 Bypass Reach were constructed in patches of very small to large gravel, five redds contained larger gravel and small cobble substrate, and two contained only small and large cobbles. Cobble-dominated redds were also found during the 2004–2005 survey period, and these redds were in the same location as those found in 2005–2006. In the Hat 2 Bypass Reach, some of the small gravel substrate placed in the reach as part of the gravel augmentation program prior to the flushing flow in September may have been utilized by spawning trout in late December and January before being flushed out of the reach in early February.

5 REFERENCES

Ellis, M. J. and J. D. Cook. 1998. *Survey of trout spawning activity and habitat in the lower Hat Creek drainage, northeastern California*. Prepared for Pacific and Electric Company, Technical and Ecological Services, San Ramon, CA. 53 pp

Pacific Gas and Electric Company. 2003. *Fish monitoring plan addressing license Article 407, Hat Creek Project, FERC Project No. 2661*. Technical and Ecological Services. San Ramon, California. April.

_____. 1998. *Application for new license for the Hat Creek Project (FERC 2661)*. Submitted to the Federal Energy Regulatory Commission. Technical and Ecological Services. San Ramon, California. September.

_____. 2005. *Hat Creek Fish Population Monitoring Report 2004 (FERC 2661)*.. Technical and Ecological Services. San Ramon, California. March.

Pisces Conservation, Ltd. 2004. *Removal Sampling*. Pennington, UK.

Spring Rivers. 2006. *Hat Creek flushing flow and gravel augmentation plan 2005 annual report, Hat Creek Project, FERC Project No. 2661*. Prepared for Pacific and Electric Company, Technical and Ecological Services, San Ramon, CA. 31 March 2006. 57 pp.

Tables

Table 1. Fish Species Present in the Hat Creek Project and Vicinity[1]					
Common Name	**Scientific Name**	**Collected in 2005**		**Collected in 2004**	
Native species		**Hat 1 Bypass Reach**	**Hat 2 Bypass Reach**	**Hat 1 Bypass Reach**	**Hat 2 Bypass Reach**
Rainbow trout	*Oncorhynchus mykiss*	X	X	X	X
Sacramento sucker	*Catostomus occidentalis*				
Sacramento pikeminnow	*Ptychocheilus grandis*	X		X	
Hardhead	*Mylopharodon conocephalus*				
Tui chub	*Gila bicolor*				X
Speckled dace	*Rhinichthus osculus*				
Tule perch	*Hysterocarpus traski*				
Bigeye marbled sculpin	*Cottus klamathensis macrops*	X	X		X
Pit sculpin	*C. pitensis*	X	X	X	X
Rough sculpin[2]	*C. asperrimus*				
Pit Klamath brook	*Lampreta lethophaga*		X		X

[1] From Gerstung 1975, Moyle and Daniels 1982, PG&E 1990, PG&E 1987–1995, and PG&E unpublished data.

[2] Listed species.

Table 1. Fish Species Present in the Hat Creek Project and Vicinity[1]					
Common Name	**Scientific Name**	**Collected in 2005**		**Collected in 2004**	
lamprey					
Pit roach	*Hesperoleucus symmetricus mitrulus*				
Introduced species					
Brown trout	*Salmo trutta*		X		X
Brook trout	*Salvelinus fontinalis*				
Coho salmon	*Oncorhynchus kisutch*				
Channel catfish	*Ictalurus punctatus*				
Brown bullhead	*Ameiurus nebulosus*				
Black bullhead	*A. mela*				
Green sunfish	*Lepomis cyanellus*				
Bluegill	*L. macrochirus*				
Largemouth bass	*Micropterus salmoides*				
Smallmouth bass	*M. dolomielui*				
Black crappie	*Pomosis nigromaculatus*				

Table 1. Fish Species Present in the Hat Creek Project and Vicinity[1]					
Common Name	**Scientific Name**	**Collected in 2005**		**Collected in 2004**	
White crappie	*P. annularis*				
Carp	*Cyprinus carpio*				
Golden shiner	*Notemigonus crysoleucas*				

Table 2. Hat Creek Water Quality Parameters, 2005					
Station	**Air Temp (ºC)**	**H2O Temp (ºC)**	**DO (mg/L)**	**Sp. Conductivity**	**pH**
1-1	29.0	18.5	-----	125	----
1-4	24.0	17.8	8.27	132	----
1-5	24.5	15.9	----	132	----
1-6	24.0	14.6	----	133	----
2-1	28.0	14.7	----	126	----
2-4	26.5	15.9	----	135	----
2-5	27.0	16.1	----	134	----
2-6	27.0	16.3	----	129	----

Table 3. Fish Catch Data and Population Estimates for Electrofishing Stations in the Hat Creek 1 and 2 Bypass Reaches, 1996–1997 and 2004-2005

			Numbers Collected							
Year	**Station**	**Species**	**Pass 1**	**Pass 2**	**Pass 3**	**Pass 4**	**Total Catch**	**Population Estimate**	**Lower Confidence Limit**	**Upper Confidence Limit**
1996	1-1	Rainbow Trout	2	1	0	-	3	3	3	4
		Pit Sculpin	10	4	2	-	16	16	16	18
		Speckled Dace	1	0	0	-	1	1	-	-
	1-4	Rainbow Trout	1	0	1	-	2	2	2	15
		Pit Sculpin	29	14	6	-	49	53	49	60
		Pit-Klamath Brook Lamprey	0	1	0	-	1	1	-	-
	1-5	Rainbow Trout	11	2	0	-	13	13	13	13
		Brown Trout	3	0	0	-	3	3	-	-
		Pit Sculpin	24	17	10	-	51	67	51	92
	1-6	Rainbow Trout	12	1	0	-	13	13	13	13

Table 3. Fish Catch Data and Population Estimates for Electrofishing Stations in the Hat Creek 1 and 2 Bypass Reaches, 1996–1997 and 2004-2005										
			Numbers Collected							
Year	Station	Species	Pass 1	Pass 2	Pass 3	Pass 4	Total Catch	Population Estimate	Lower Confidence Limit	Upper Confidence Limit
		Pit Sculpin	32	18	9	-	59	68	59	81
		Pit-Klamath Brook Lamprey	1	0	0	-	1	1	-	-
	2-1	Rainbow Trout	15	4	4	2	25	26	25	29
		Bigeye Marbled Sculpin	7	4	6	2	19	24	19	38
		Pit Sculpin	1	0	1	0	2	2	2	9
		Tui Chub	1	0	0	0	1	1	-	-
	2-4	Rainbow Trout	19	9	3	-	31	32	31	36
		Brown Trout	0	1	1	-	2	2	2	26
		Pit Sculpin	24	18	4	-	46	51	46	60
		Sacramento Sucker	0	0	1	-	1	1	-	-
	2-5	Rainbow Trout	20	12	6	-	38	44	38	55
		Brown Trout	1	0	0	-	1	1	-	-

Table 3. Fish Catch Data and Population Estimates for Electrofishing Stations in the Hat Creek 1 and 2 Bypass Reaches, 1996–1997 and 2004-2005										
			Numbers Collected							
Year	Station	Species	Pass 1	Pass 2	Pass 3	Pass 4	Total Catch	Population Estimate	Lower Confidence Limit	Upper Confidence Limit
		Pit Sculpin	70	25	14	-	109	117	109	126
		Sacramento Sucker	0	0	1	-	1	1	-	-
	2-6	Rainbow Trout	45	12	16	7	80	86	80	95
		Brown Trout	4	2	1	1	8	8	8	10
		Pit-Klamath Brook Lamprey	1	1	0	0	2	2	2	4
		Bigeye Marbled Sculpin	1	0	0	0	1	1	-	-
		Pit Sculpin	120	64	49	21	254	287	265	309
		Sacramento Sucker	1	0	0	0	1	1	-	-
1997	1-1	Rainbow Trout	7	1	0	-	8	8	8	8
		Pit Sculpin	4	3	1	-	8	8	8	10
	1-4	Pit Sculpin	25	19	7	-	51	60	51	74
	1-5	Rainbow Trout	4	2	0	-	6	6	6	7

Table 3. Fish Catch Data and Population Estimates for Electrofishing Stations in the Hat Creek 1 and 2 Bypass Reaches, 1996–1997 and 2004-2005										
			Numbers Collected							
Year	Station	Species	Pass 1	Pass 2	Pass 3	Pass 4	Total Catch	Population Estimate	Lower Confidence Limit	Upper Confidence Limit
		Brown Trout	0	0	1	-	1	1	-	-
		Pit Sculpin	7	4	2	-	13	14	12	19
	1-6	Rainbow Trout	6	2	4	0	12	12	12	14
		Pit Sculpin	9	8	4	5	26	36	26	59
	2-1	Rainbow Trout	10	2	1	-	13	13	13	14
		Bigeye Marbled Sculpin	5	4	2	-	11	12	11	18
		Pit Sculpin	0	1	0	-	1	1	-	-
	2-4	Rainbow Trout	20	11	10	5	46	54	46	67
		Brown Trout	0	1	0	0	1	1	-	-
		Pit Sculpin	25	13	4	2	44	45	44	48
		Bigeye Marbled Sculpin	0	1	0	0	1	1	-	-
	2-5	Rainbow Trout	18	8	5	-	31	34	31	41
		Brown Trout	0	1	1	-	2	2	2	26

Table 3. Fish Catch Data and Population Estimates for Electrofishing Stations in the Hat Creek 1 and 2 Bypass Reaches, 1996–1997 and 2004-2005										
			Numbers Collected							
Year	**Station**	**Species**	**Pass 1**	**Pass 2**	**Pass 3**	**Pass 4**	**Total Catch**	**Population Estimate**	**Lower Confidence Limit**	**Upper Confidence Limit**
		Brook Trout	1	0	0	-	1	1	-	-
		Sacramento Sucker	6	0	2	-	8	8	8	10
		Pit Sculpin	43	24	10	-	77	86	77	98
		Bigeye Marbled Sculpin	1	0	0	-	1	1	-	-
		Pit-Klamath Brook Lamprey	0	1	0	-	1	1	-	-
	2-6	Rainbow Trout	26	8	5	-	39	41	39	46
		Brown Trout	2	0	0	-	2	2	-	-
		Brook Trout	1	2	0	-	3	3	3	6
		Pit Sculpin	76	39	12	-	127	137	127	148
		Sacramento Sucker	5	2	0	-	7	7	7	8
		Tui Chub	0	0	1	-	1	1	-	-
2004	1-1	Sacramento	1	0	1	-	2	2	-	-

Table 3. Fish Catch Data and Population Estimates for Electrofishing Stations in the Hat Creek 1 and 2 Bypass Reaches, 1996–1997 and 2004-2005										
			Numbers Collected							
Year	Station	Species	Pass 1	Pass 2	Pass 3	Pass 4	Total Catch	Population Estimate	Lower Confidence Limit	Upper Confidence Limit
		Pikeminnow								
		Pit Sculpin	15	10	2	-	27	30	27	36
	1-4	Pit Sculpin	13	3	3	-	19	20	19	24
	1-5	Rainbow Trout	1	0	0	-	1	1	1	1
		Pit Sculpin	11	11	9	-	31	123	31	596
	1-6	Rainbow Trout	5	1	2	-	8	10	8	16
		Pit Sculpin	16	8	3	-	27	30	27	36
	2-1	Rainbow Trout	14	2	4	2	22	23	22	27
		Brown Trout	0	2	0	0	2	2	2	6
		Tui Chub	2	1	0	0	3	3	3	3
		Pit Sculpin	41	16	3	1	61	62	61	63
		Bigeye Marbled Sculpin	9	2	3	0	14	14	14	16
	2-4	Rainbow Trout	9	4	2	-	15	17	15	21

Table 3. Fish Catch Data and Population Estimates for Electrofishing Stations in the Hat Creek 1 and 2 Bypass Reaches, 1996–1997 and 2004-2005										
			Numbers Collected							
Year	Station	Species	Pass 1	Pass 2	Pass 3	Pass 4	Total Catch	Population Estimate	Lower Confidence Limit	Upper Confidence Limit
		Brown Trout	2	0	0	-	2	2	2	2
		Pit Sculpin	32	27	8	-	67	82	67	101
	2-5	Rainbow Trout	19	16	6	-	41	53	41	73
		Brown Trout	7	5	3	-	15	21	15	39
		Pit Sculpin	47	29	17	-	93	119	93	148
		Pit-Klamath Brook Lamprey	2	1	3	-	6	6	-	-
	2-6	Rainbow Trout	20	10	7	-	37	46	37	61
		Brown Trout	5	1	0	-	6	6	6	6
		Pit Sculpin	84	39	16	-	139	152	140	165
		Pit-Klamath Brook Lamprey	0	0	2	-	2	2	-	-
2005	1-1	Rainbow Trout	1	0	0	-	1	1	1	1
		Pit Sculpin	7	2	2	-	11	12	11	17
		Sacramento	1	0	1	-	2	2	-	-

Table 3. Fish Catch Data and Population Estimates for Electrofishing Stations in the Hat Creek 1 and 2 Bypass Reaches, 1996–1997 and 2004-2005										
			Numbers Collected							
Year	Station	Species	Pass 1	Pass 2	Pass 3	Pass 4	Total Catch	Population Estimate	Lower Confidence Limit	Upper Confidence Limit
		Pikeminnow								
	1-4	Pit Sculpin	9	5	4	-	18	25	18	43
	1-5	Rainbow Trout	4	2	2	-	8	12	12	27
		Pit Sculpin	11	8	1	-	20	22	20	26
	1-6	Rainbow Trout	11	2	1	-	14	14	14	15
		Pit Sculpin	15	8	3	-	26	29	26	35
		Bigeye Marbled Sculpin	2	0	0	-	2	2	2	2
	2-1	Rainbow Trout	7	4	0	-	11	11	11	13
		Brown Trout	2	0	0	-	2	2	2	2
		Pit Sculpin	31	6	4	-	41	42	41	45
		Bigeye Marbled Sculpin	2	0	0	-	2	2	2	2
	2-4	Rainbow Trout	6	4	1	-	11	12	11	17
		Brown Trout	1	0	0	-	1	1	1	1

Table 3. Fish Catch Data and Population Estimates for Electrofishing Stations in the Hat Creek 1 and 2 Bypass Reaches, 1996–1997 and 2004-2005										
			Numbers Collected							
Year	**Station**	**Species**	**Pass 1**	**Pass 2**	**Pass 3**	**Pass 4**	**Total Catch**	**Population Estimate**	**Lower Confidence Limit**	**Upper Confidence Limit**
		Pit Sculpin	31	12	8	-	51	57	51	67
	2-5	Rainbow Trout	12	9	4	-	25	32	25	48
		Brown Trout	5	6	4	-	15	58	15	366
		Pit Sculpin	63	40	13	-	116	132	116	149
		Pit-Klamath Brook Lamprey	0	1	1	-	2	2	-	-
	2-6	Rainbow Trout	17	9	7	-	33	44	33	64
		Brown Trout	5	0	0	-	5	5	5	5
		Pit Sculpin	75	34	21	-	130	150	131	169

Table 4. Rainbow Trout Population Estimates, Hat 1 Bypass Reach, 2005					
Species: Rainbow Trout – All sizes combined					
Station	**Total # Collected**	**Population Estimate**	**Upper Confidence**	**Lower Confidence**	**Standard Error**
Hat 1-1	1	1	1	1	0.000
Hat 1-4	0	0	0	0	-
Hat 1-5	19	19	19	21	0.812
Hat 1-6	14	14	15	14	0.579

Species: Rainbow Trout, YOY (YOY ≤ 110 mm)					
Station	**Total # Collected**	**Population Estimate**	**Upper Confidence**	**Lower Confidence**	**Standard Error**
Hat 1-1	1	1	1	1	0.000
Hat 1-4	0	0	0	0	-
Hat 1-5	17	18	19	17	0.955
Hat 1-6	10	10	12	10	0.954

Table 4. Rainbow Trout Population Estimates, Hat 1 Bypass Reach, 2005					
Species: Rainbow Trout, Non YOY (Non YOY > 110 mm)					
Station	**Total # Collected**	**Population Estimate**	**Upper Confidence**	**Lower Confidence**	**Standard Error**
Hat 1-1	0	0	-	-	-
Hat 1-4	0	0	-	-	-
Hat 1-5	2	2	2	2	0.000
Hat 1-6	4	4	4	4	0.000

Table 5. Rainbow Trout Population Estimates, Hat 2 Bypass Reach, 2005					
Species: Rainbow Trout—All sizes combined					
Station	**Total # Collected**	**Population Estimate**	**Upper Confidence**	**Lower Confidence**	**Standard Error**
Hat 2-1	11	11	12	11	0.816
Hat 2-4	11	12	17	11	2.238
Hat 2-5	25	32	48	25	7.841
Hat 2-6	33	44	33	64	10.180

Species: Rainbow Trout, YOY (YOY ≤ 110 mm)					
Station	**Total # Collected**	**Population Estimate**	**Upper Confidence**	**Lower Confidence**	**Standard Error**
Hat 2-1	2	2	4	2	0.739
Hat 2-4	7	8	12	7	2.075
Hat 2-5	18	25	43	18	9.112
Hat 2-6	19	20	22	19	1.102

Table 5. Rainbow Trout Population Estimates, Hat 2 Bypass Reach, 2005					
Species: Rainbow Trout, Non YOY (Non YOY > 110 mm)					
Station	**Total # Collected**	**Population Estimate**	**Upper Confidence**	**Lower Confidence**	**Standard Error**
Hat 2-1	9	9	10	9	0.620
Hat 2-4	4	4	6	4	1.045
Hat 2-5	7	8	12	7	2.075
Hat 2-6	14	--	--	--	--

Table 6. Summary Data for the 2005–2006 Hat 1 and Hat 2 Bypass Surveys (RT = rainbow trout; BRN = brown trout; BK = brook trout)												
				Non-Spawning Trout				Spawning Trout				
Date	# New[1] Redds	Total # Adult Trout	Total # Spawners[2]	RT	BRN	BK	?	RT	BRN	BK	?	Dead Spawner
Hat 1 Bypass Reach												
11/04/05	1	11	6	7	0	3	1	2	0	3	1	
11/15/05	2	10	4	10	0	0	0	4	0	0	0	
11/29/05	4	7	4	7	0	0	0	4	0	0	0	
12/12/05	0	6	4	6	0	0	0	4	0	0	0	
12/28/05	2	0	1	0	0	0	0	0	0	0	0	1 RT
01/09/06	1	14	7	13	1	0	0	6	0	0	0	1 RT
01/25/06	0	14	2	14	0	0	0	2	0	0	0	
Hat 2 Bypass Reach												
11/03/05	0	13	7	8	4	0	1	2	4	0	1	
11/16/05	1	12	6	10	2	0	0	4	2	0	0	
11/30/05	0	10	3	9	1	0	0	2	1	0	0	
12/13/05	0	11	3	11	0	0	0	3	0	0	0	
12/29/05	2	12	13	10	2	0	0	10	2	0	0	1 RT
01/10/06	7	28	14	19	9	0	0	11	3	0	0	
01/24/06	0	16	11	10	6	0	0	6	4	0	0	1 BRN
02/09/06	0	9	4	7	2	0	0	0	0	0	0	4 RT

[1] Redds not previously observed (may be clean or silty).
[2] Number includes dead spawners.

Table 7. Descriptions of Redds Observed in the Hat 1 Bypass Reach During the 2005–2006 Surveys (RT = rainbow trout)

Date	New[1] Redd #	Area (cm^2)	Substrate Composition[2]	Degree of Siltation[3]	Redds with Potentially Viable Eggs	Nearby Spawners
11/04/05	1	1600	SC/LC	None on 11/04. Scoured and no longer visible on 11/29.	0	1 ~250-mm fish nearby on 11/04
11/15/05	2	3600	LG/SC with some LC	None on 11/15. High by 1/09. Dead eggs in pit on 1/25.	0	
11/15/05	3	4900	VSG/SG with some LC	Low on 11/15 with some dead eggs visible outside of pit. Moderate thereafter.	1	RT spawners nearby on 11/15, 12/12, and 1/28. Dead RT spawner nearby on 1/09.
11/29/05	4	3600	VSG/SG	None on 11/29. High thereafter.	0	
11/29/05	5	2500	SC/LC	None on 11/29. Moderate thereafter.	1	2 RT spawners nearby on 12/12 and 1/09. Dead RT spawner nearby on 12/28.
11/29/05	6	3600	LG/SC with some LC	None on 11/29. Moderate thereafter. Pink eggs still visible on 1/25.	1	2 RT spawners nearby on 12/12 and 1/09. Dead RT spawner nearby on 12/28.
11/29/05	7	4200	VSG/SG with some SC	Low on 11/29. High thereafter. Dead eggs in pit on 11/29.	0	
12/28/05	8	4800	LG/SC	None on 12/28. Low thereafter. Pink eggs still visible on 1/25.	1	Dead RT spawner nearby on 12/28. 2 RT spawners nearby on 1/09.
12/28/05	9	4200	LG/SC with some LC	None on 12/28. Moderate thereafter. Pink eggs still visible on 1/09.	1	2 RT spawners nearby on 1/09.
01/09/06	10	4200	LG/SC	Low on 1/09 and 1/25.	1	2 RT spawners nearby on 1/09.

[1] Redd not previously observed (may be clean or silty).
[2] Substrate size estimated or roughly measured.
[3] Degree of siltation based on ocular estimate.

Table 8. Descriptions of Redds Observed in the Hat 2 Bypass Reach During the 2005–2006 Surveys (RT = rainbow trout; BRN = brown trout)

Date	New[1] Redd #	Area (cm^2)	Substrate Composition[2]	Degree of Siltation[3]	Redds with Potentially Viable Eggs	Nearby Spawners
11/16/05	1	1600	SG/LG with some SC	None. New digging in this redd on 12/29.	0	2 BRN spawners nearby on 11/03 and 11/16
12/29/05	2	1600	SG/LG with some SC	None	1	RT spawner on redd constructed in tailout of old brown trout redd
12/29/05	3	2500	VSG/SG with some LG	None. Shallow pit, with eggs at surface getting washed downstream.	0	3 RT spawners immediately upstream of redd
01/10/06	4	3600	LG/SC with some LC	None	1	350-mm RT spawner nearby on 1/10
01/10/06	5	3600	LG/SC	None	1	400-mm RT on redd on 1/10. 300-mm RT near redd on 1/24.
01/10/06	6	3300	LG/SC	None	1	Same RT spawners observed near redd #5
01/10/06	7	3300	LG/SC	None	1	Same RT spawners observed near redd #5
01/10/06	8	3000	SG/LG with some SC	None on 1/10. Moderate on 1/24.	1	BRN spawning pair in very poor condition actively guarding 2 redds
01/10/06	9	3000	SG/LG with some SC	None on 1/10. Moderate on 1/24.	1	BRN spawning pair in very poor condition actively guarding 2 redds
01/10/06	10	2500	LG/SC	None	1	300-mm RT released eggs nearby when startled by surveyor

[1] Redd not previously observed (may be clean or silty).
[2] Substrate size estimated or roughly measured.
[3] Degree of siltation based on ocular estimate.

Table 9. Summary of Hat Creek Spawning Surveys Conducted in 1996–1997, 2004–2005, and 2005–2006						
	Nov 1996 to Feb 1997		Nov 2004 to Jan 2005		Nov 2005 to Feb 2006	
	Hat 1 Bypass	Hat 2 Bypass	Hat 1 Bypass	Hat 2 Bypass	Hat 1 Bypass	Hat 2 Bypass
Spawning Activity						
Maximum # of Spawners[1]	12	7	21-27	5	7	11
Date of Peak Spawning Activity	23-Nov	14-Feb	22-Dec	23-Dec	29-Nov	06-Jan
Primary Spawner Species	Rainbow trout	Rainbow trout	Rainbow trout	Rainbow trout	Rainbow trout	Rainbow trout
Secondary Spawner Species	Brown trout	Brown trout	Brook trout	Brown trout	Brook trout	Brown trout
Redds						
Total # Redds Observed	9	5	25	8	10	10
Total # Productive Redds[2]	9	5	12	7	6	0
Average Area (cm^2)	2787	3716	3080	4475	3720	2800
Substrate Size Range (mm)	1-100	10-100	10-100	10-100	1-150	1-130
Dominant Substrate Size Class	VSG and SG (2–15 mm)	SG and LG (16–64 mm)	SG and LG (16–64 mm)	SG and LG (16–64 mm)	LG and SC (32–128)	SG and LG (16–64 mm)

[1] The maximum number of spawning trout (including dead spawners) observed during a single survey.
[2] Those redds estimated to contain viable eggs (i.e., not scoured or silted over).

Figures

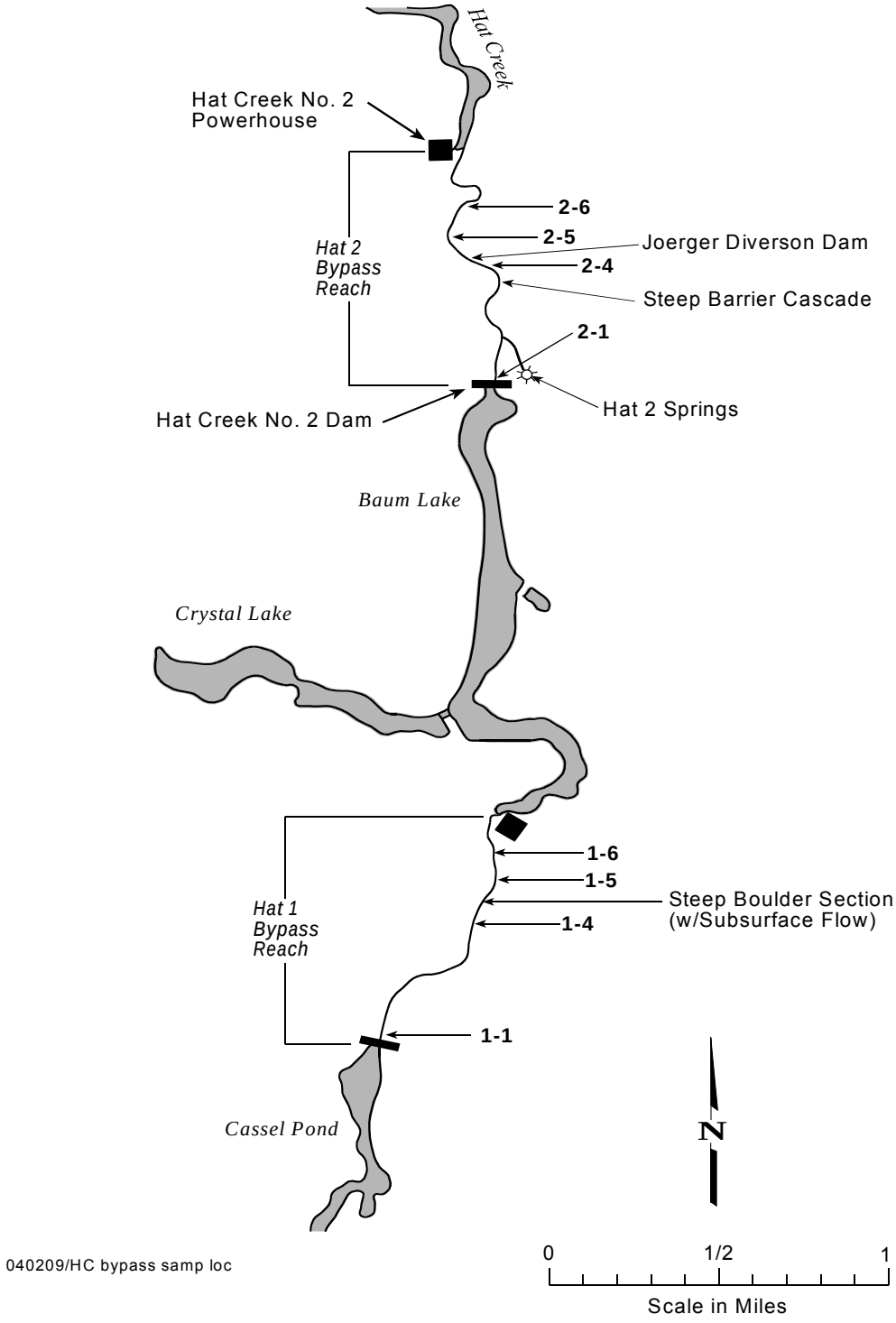


Figure 1. Hat Creek Project with location of sampling stations.

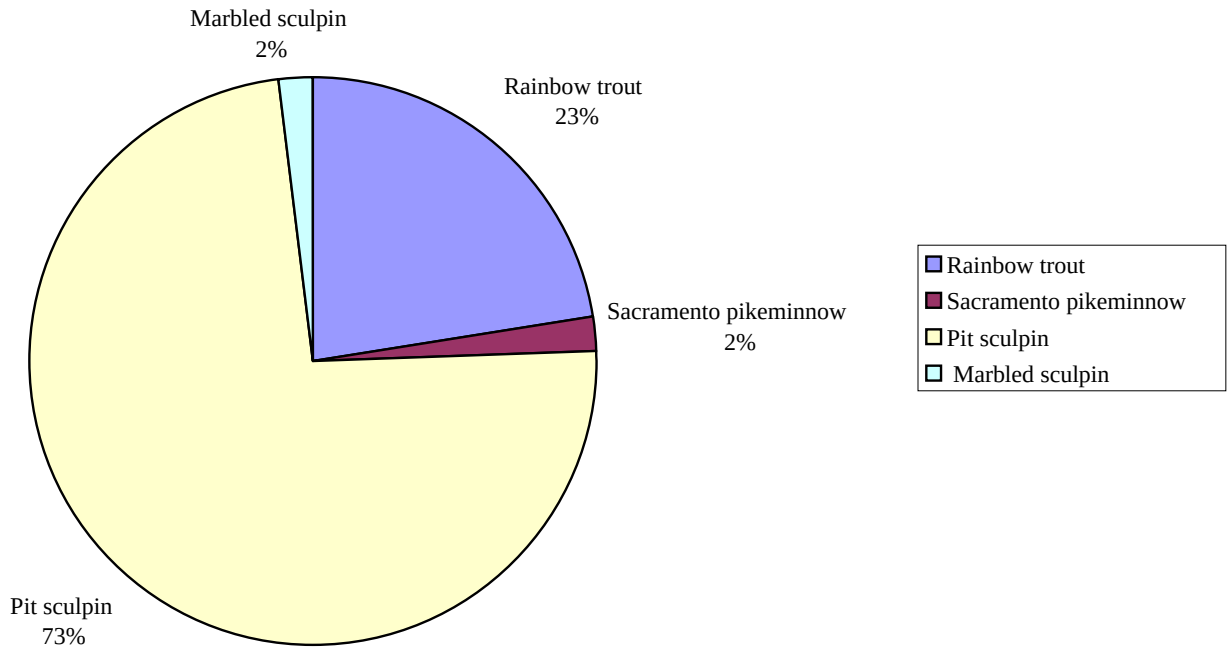


Figure 2. Relative abundance (%) of all fish species collected at all stations in the Hat 1 Bypass Reach (2005).

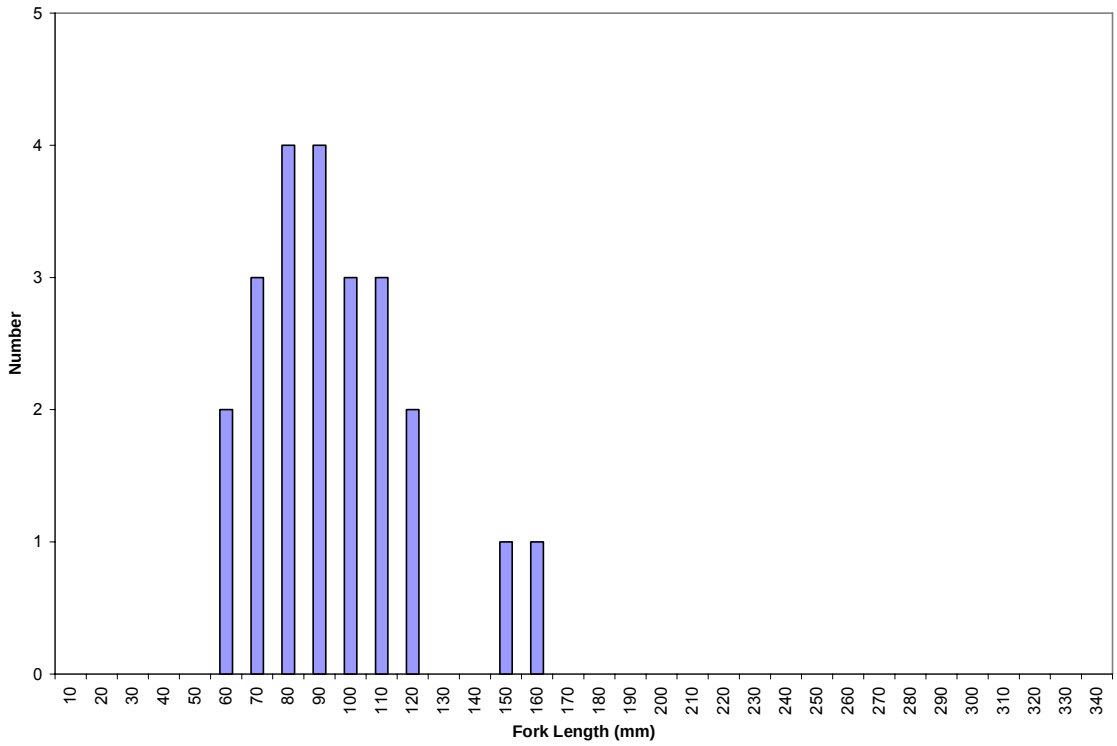


Figure 3. Rainbow trout length frequencies in the Hat 1 Bypass Reach (2005).

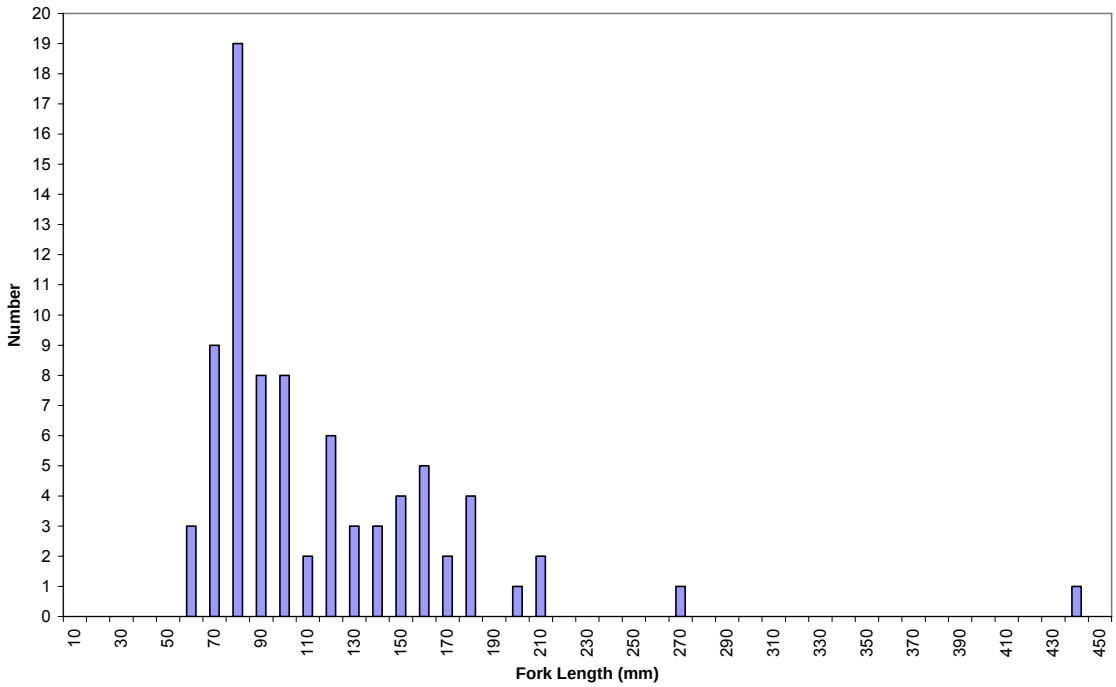


Figure 4. Rainbow trout length frequencies in the Hat 2 Bypass Reach (2005).

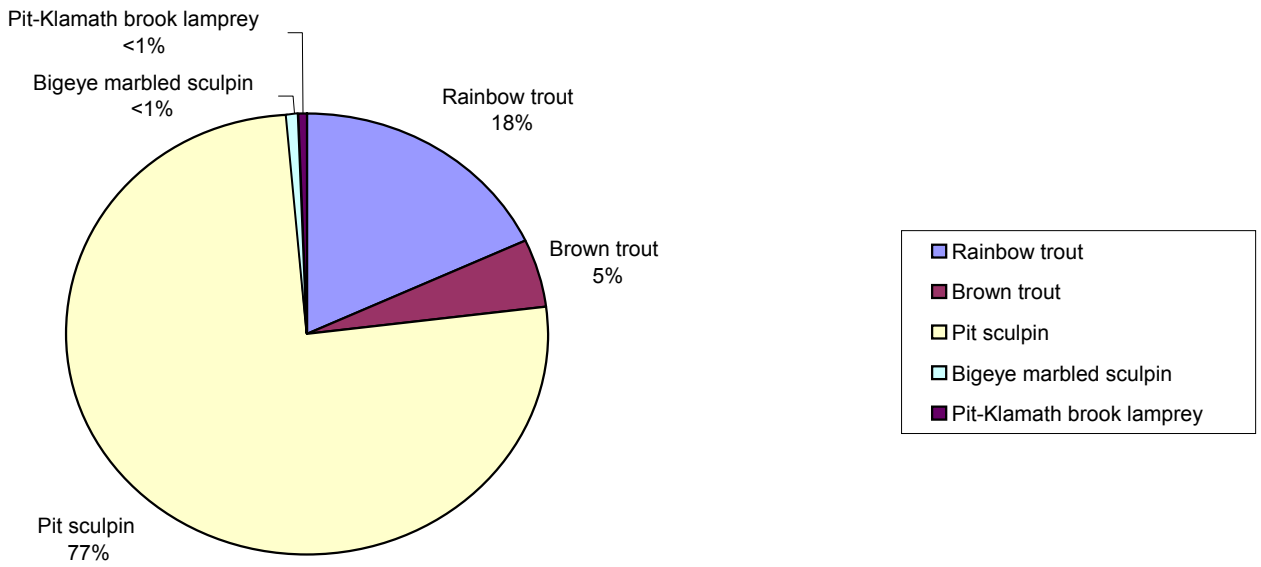


Figure 5. Relative abundance (%) of all fish species collected at all stations in the Hat 2 Bypass Reach (2005).

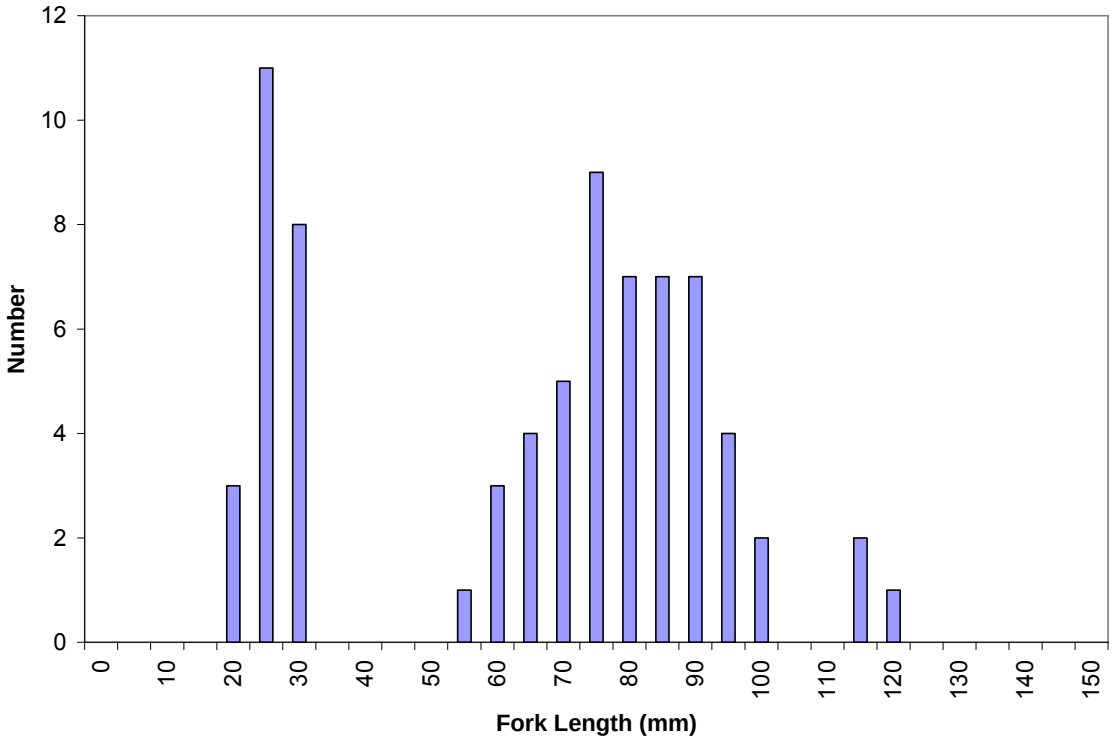


Figure 6. Length Frequencies for all Pit sculpin collected in the Hat 1 Bypass Reach (2005).

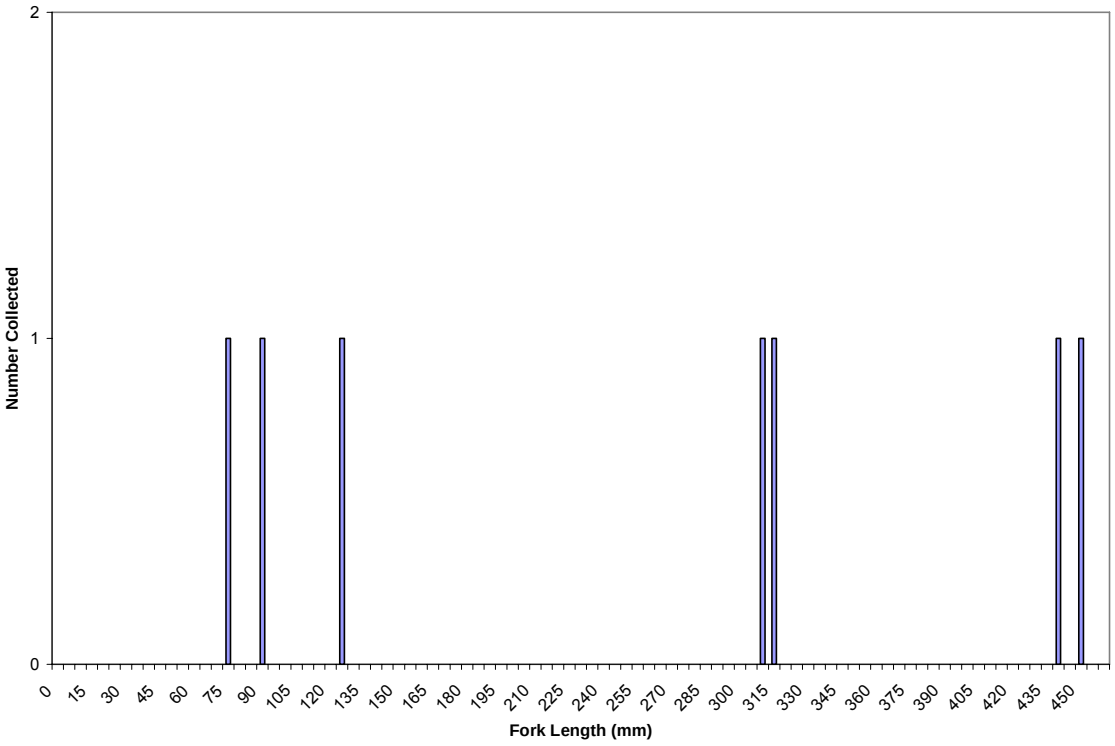


Figure 7.1. Length frequency for brown trout collected at Station 2-1 (2005).

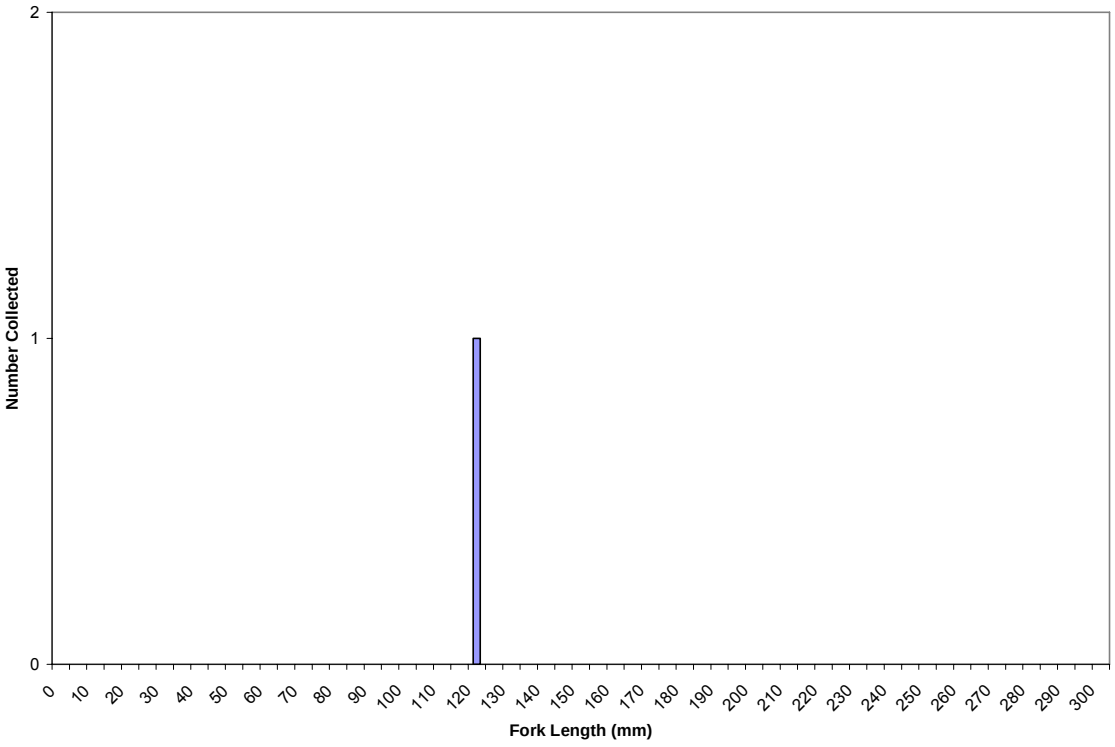


Figure 7.2. Length frequency for brown trout collected at Station 2-4 (2005).

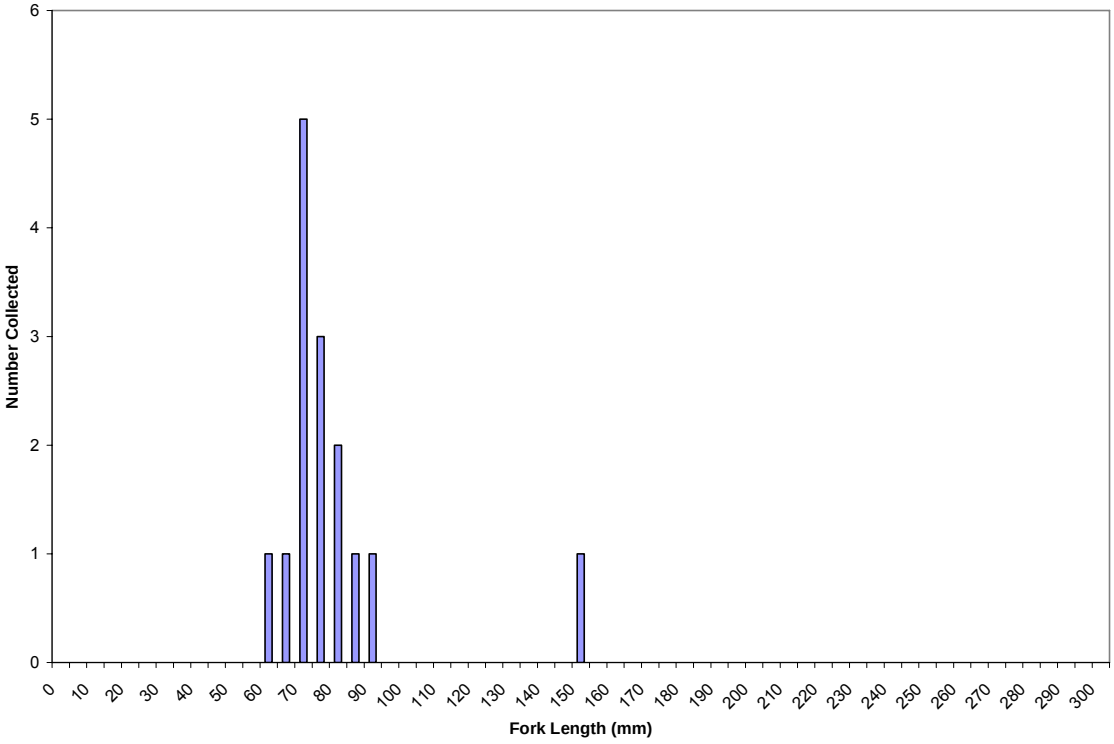


Figure 7.3. Length frequency for brown trout collected at Station 2-5 (2005).

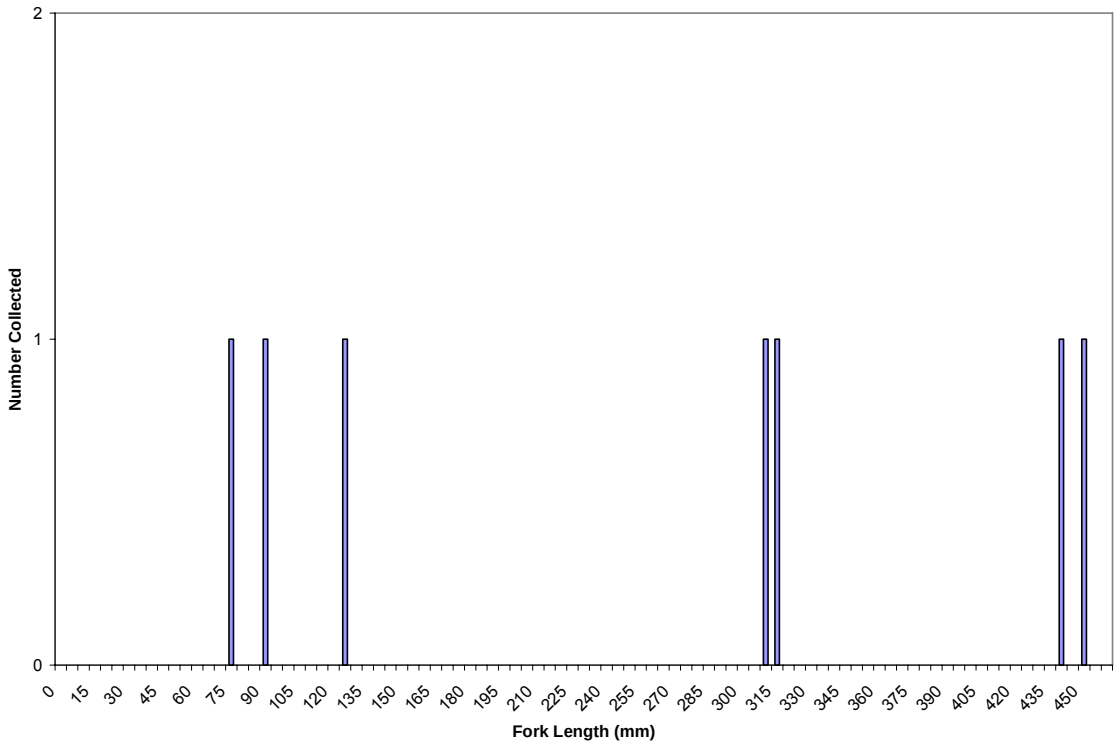


Figure 7.4. Length frequency for brown trout collected at Station 2-6 (2005).

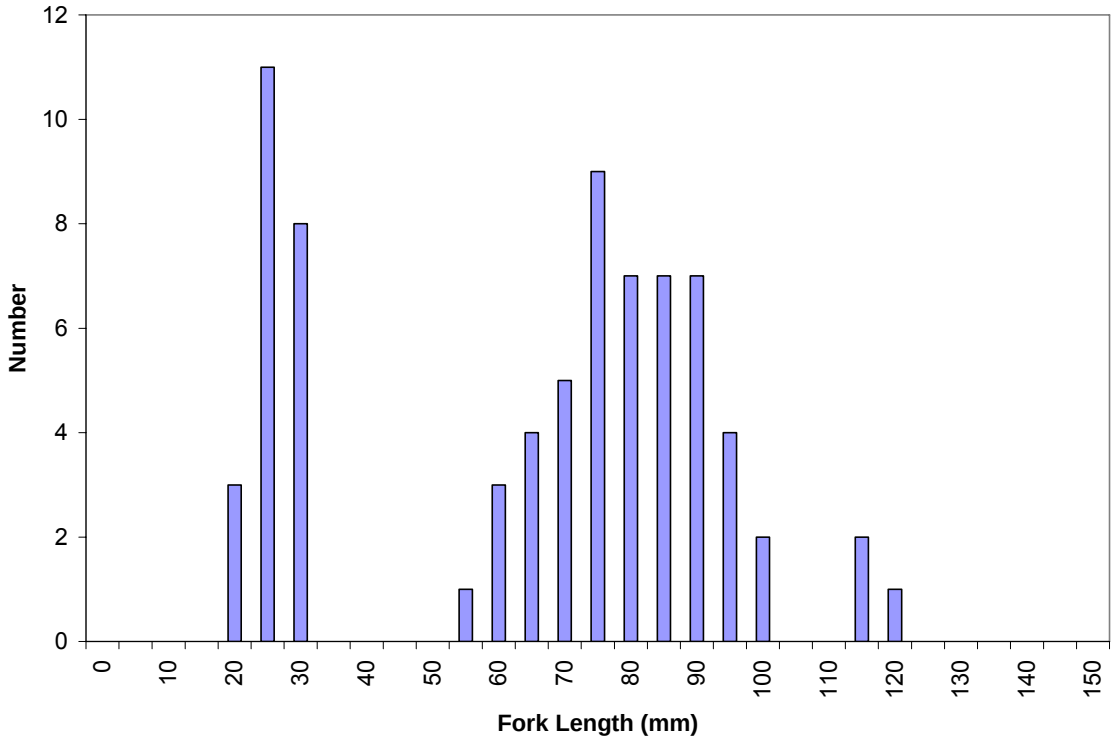


Figure 8. Length frequency for all Pit sculpin collected in the Hat 2 Bypass Reach (2005).

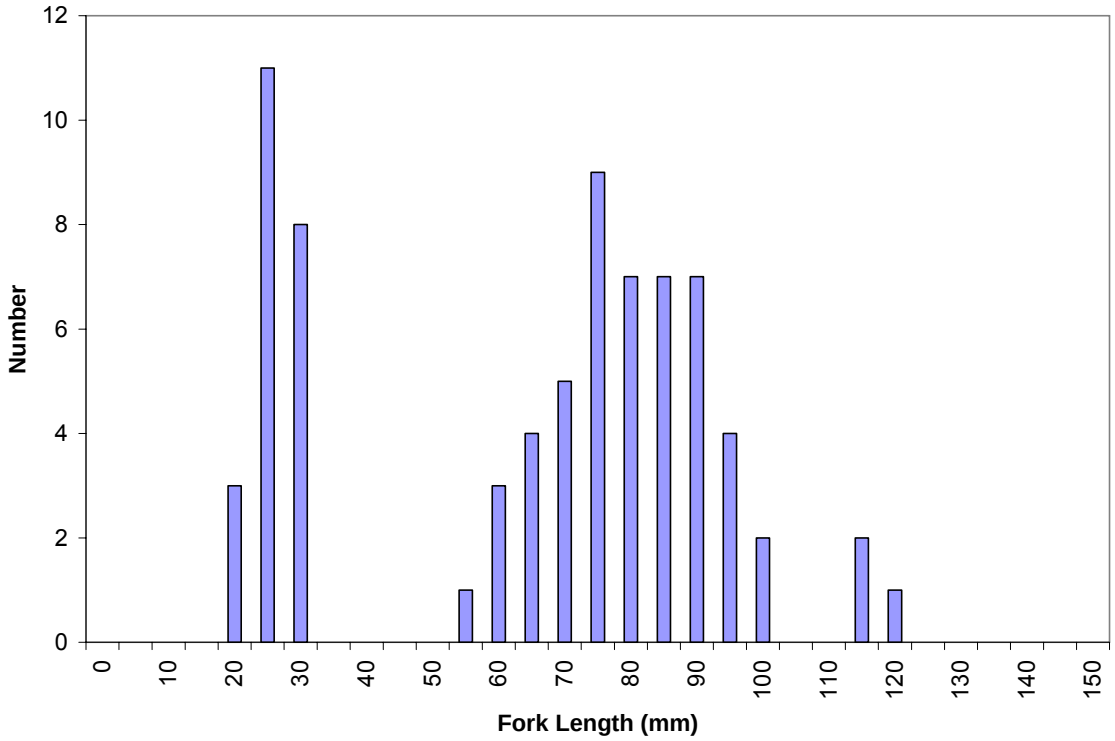


Figure 9. Length frequency for all big-eye marbled sculpin collected in the Hat 2 Bypass Reach (2005).

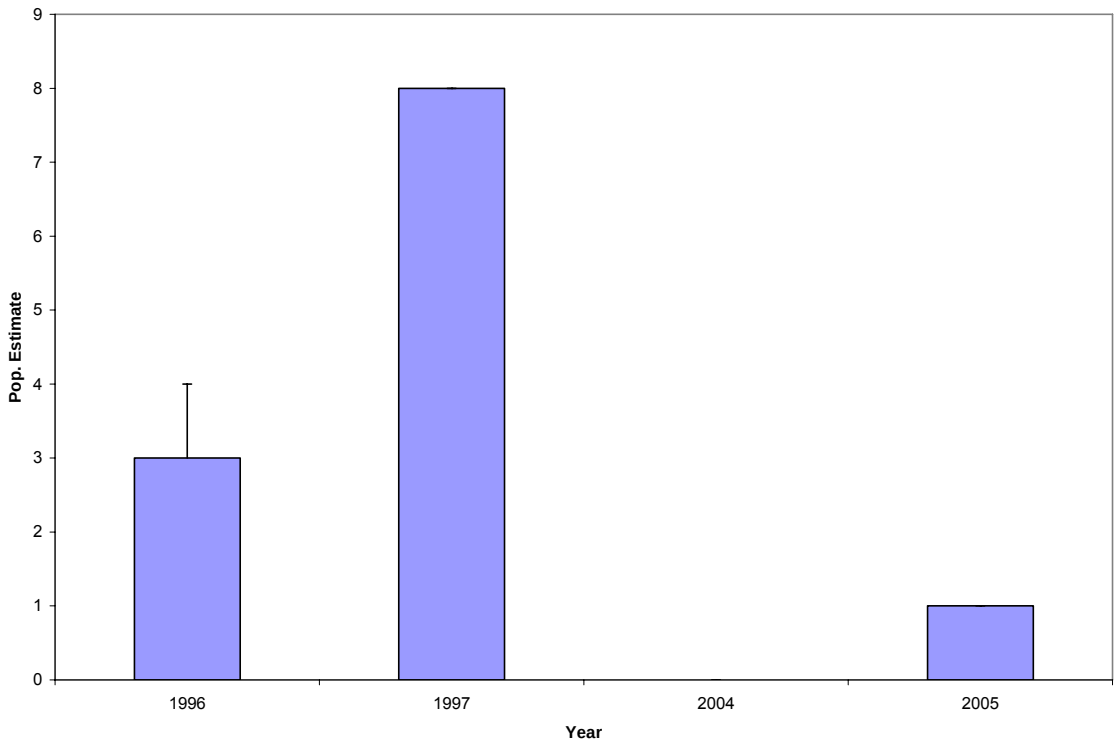


Figure 10.1. Population estimates for rainbow trout collected at Station 1-1 (1996, 1997, 2004, and 2005).

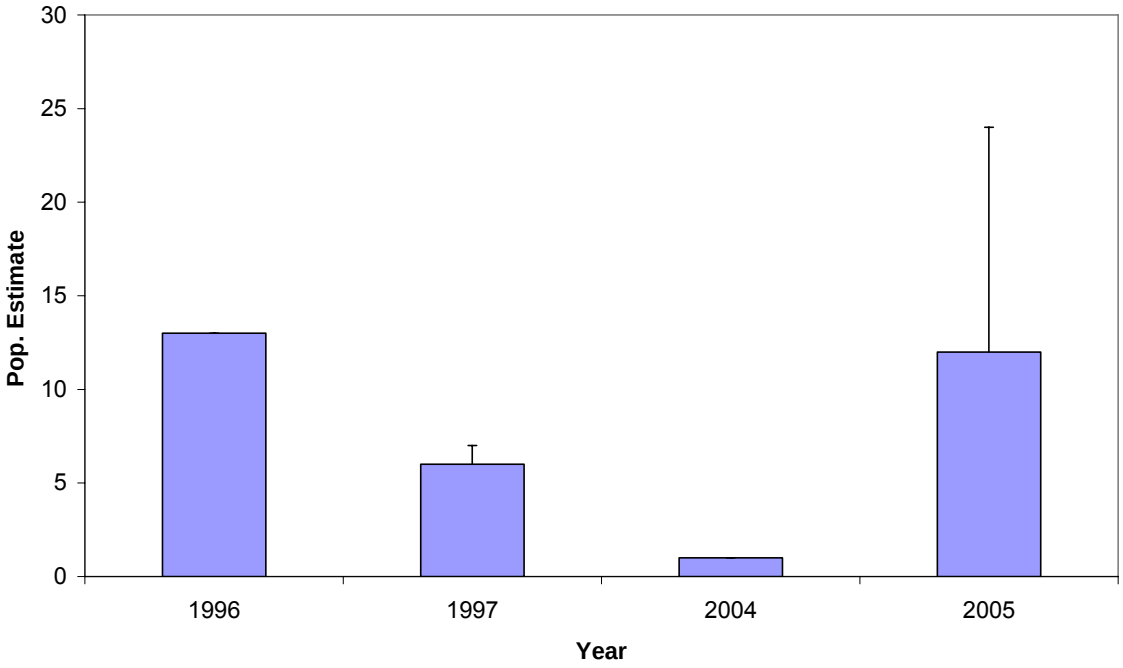


Figure 10.2. Population estimates for rainbow trout collected at Station 1-5 (1996, 1997, 2004, and 2005).

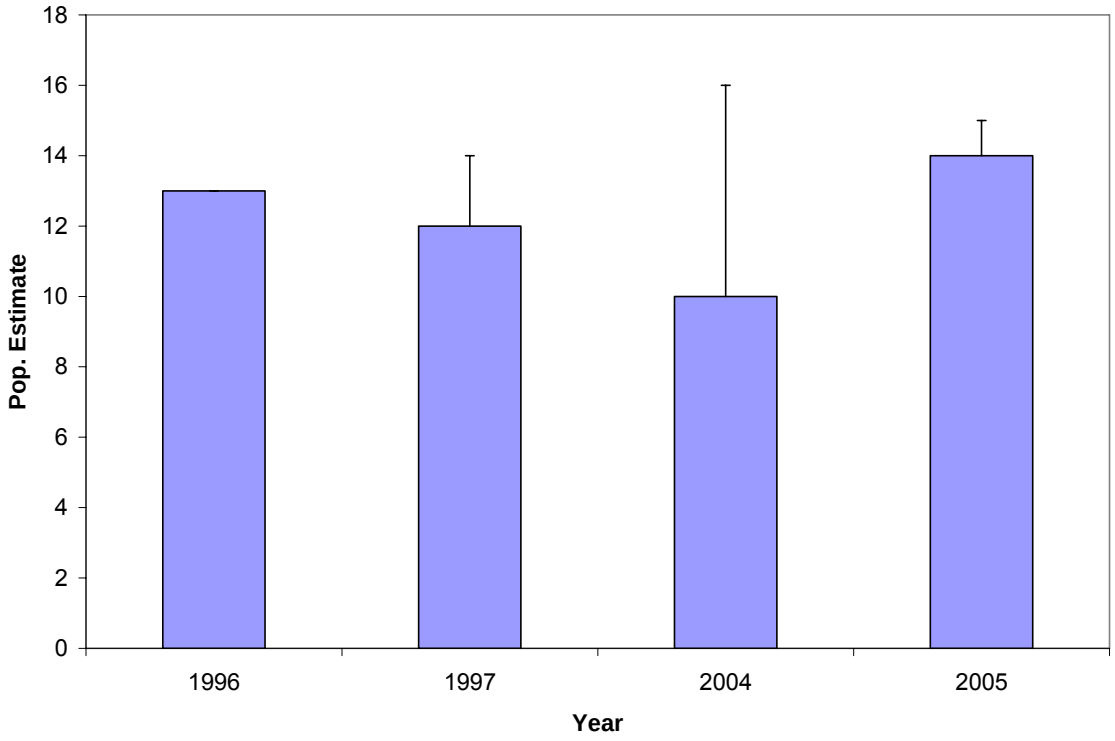


Figure 10.3. Population estimate for rainbow trout collected at Station 1-6 (1996, 1997, 2004, and 2005).

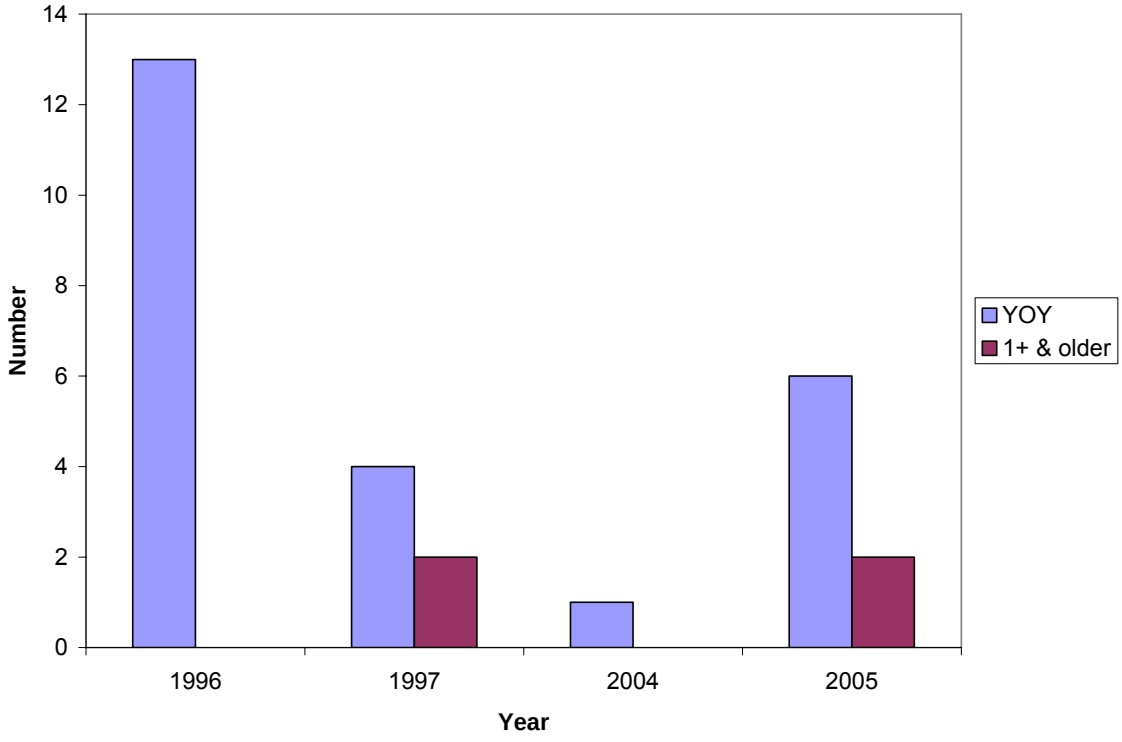


Figure 11.1. Age structure comparison of rainbow trout collected at Station 1-5 (1996, 1997, 2004, and 2005).

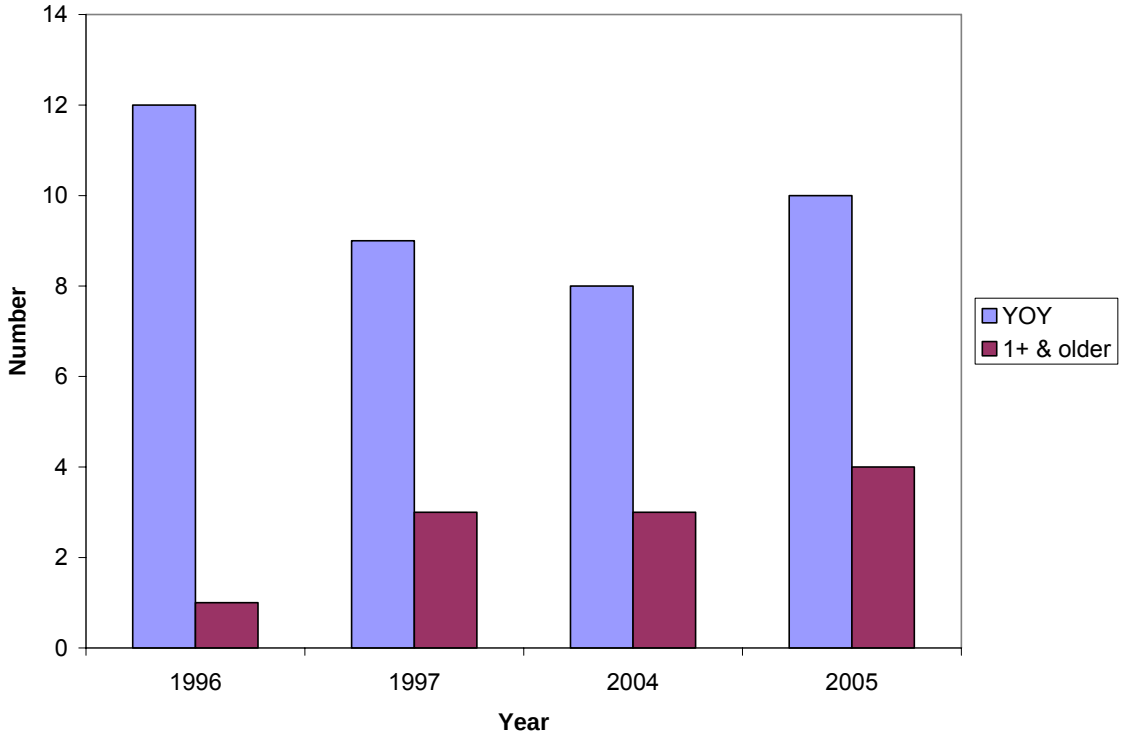


Figure 11.2. Age structure comparison of rainbow trout collected at Station 1-6 (1996, 1997, 2004, and 2005).

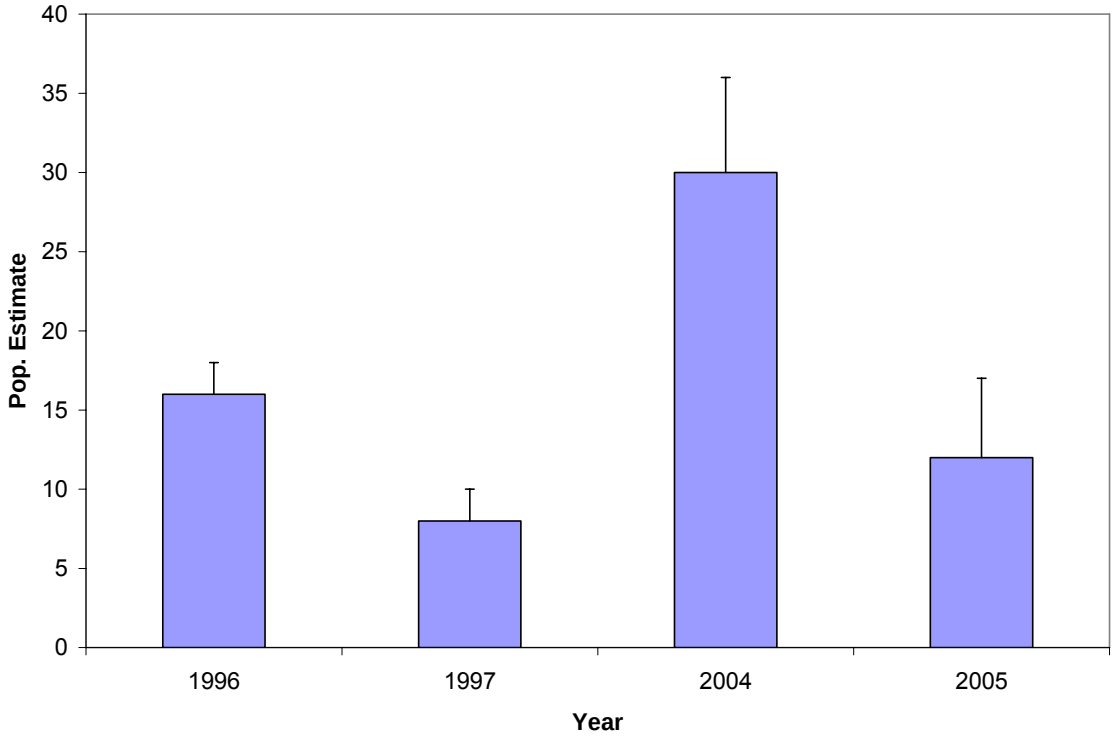


Figure 12.1. Population estimates for Pit sculpin collected at Station 1-1 (1996, 1997, 2004, and 2005).

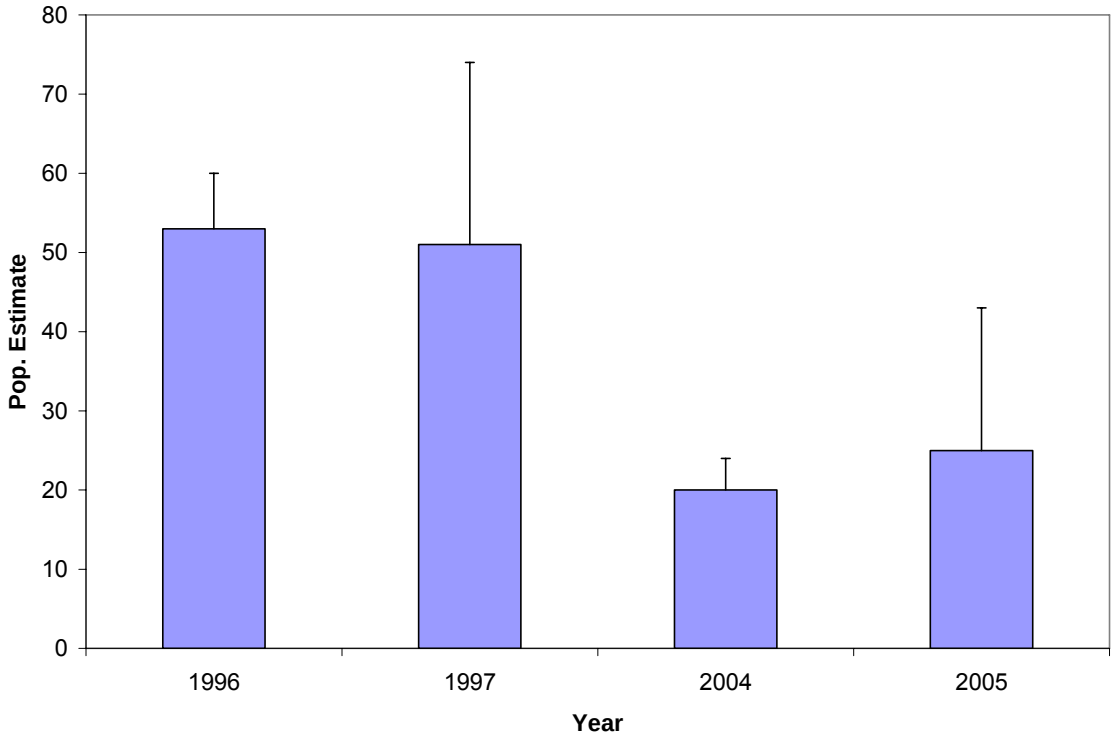


Figure 12.2. Population estimates for Pit sculpin collected at Station 1-4 (1996, 1997, 2004, and 2005).

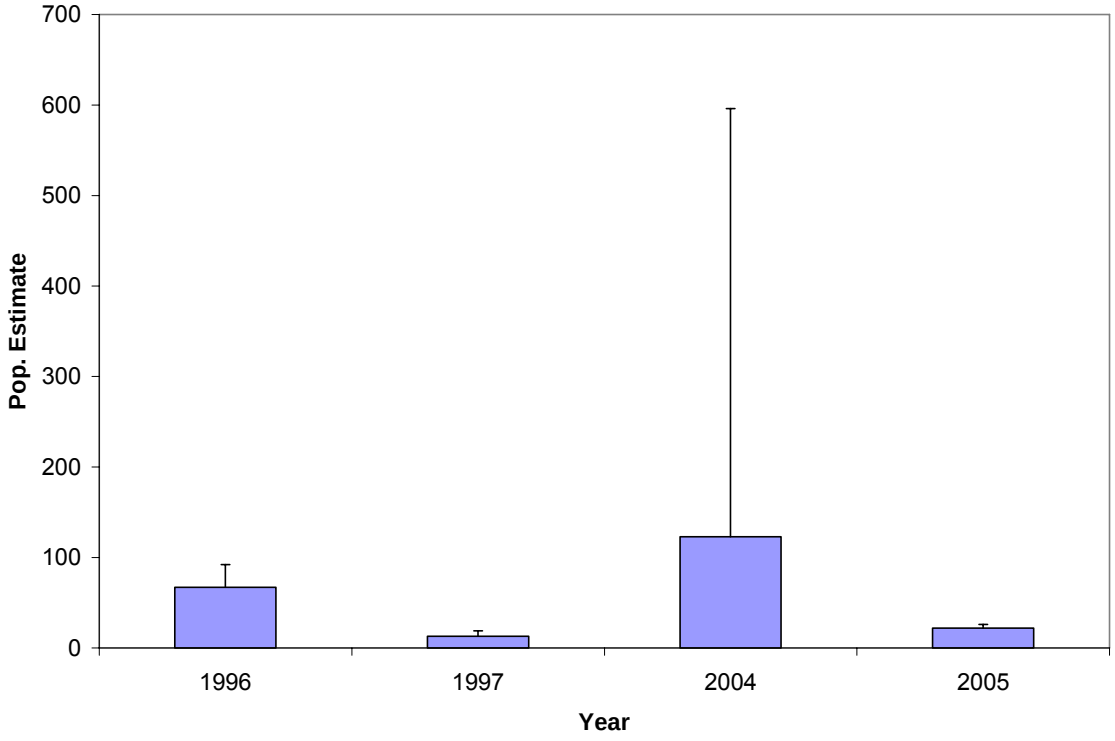


Figure 12.3. Population estimates for Pit sculpin collected at Station 1-5 (1996, 1997, 2004, and 2005).

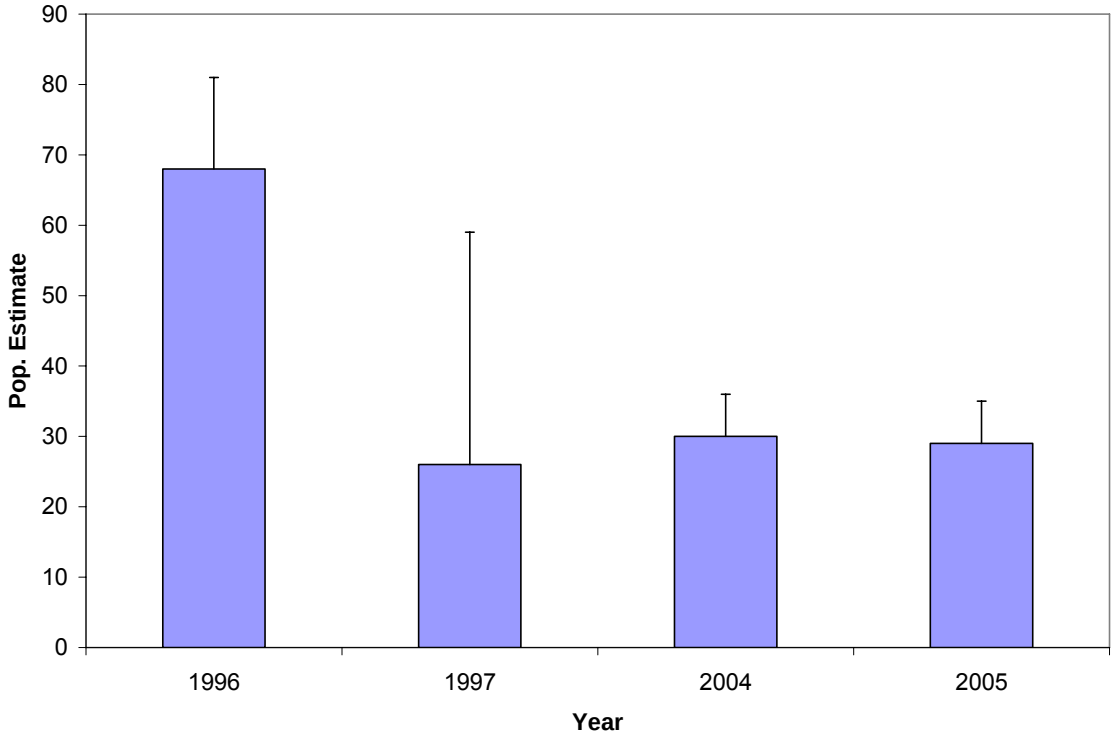


Figure 12.4. Population estimates for Pit sculpin collected at Station 1-6 (1996, 1997, 2004, and 2005).

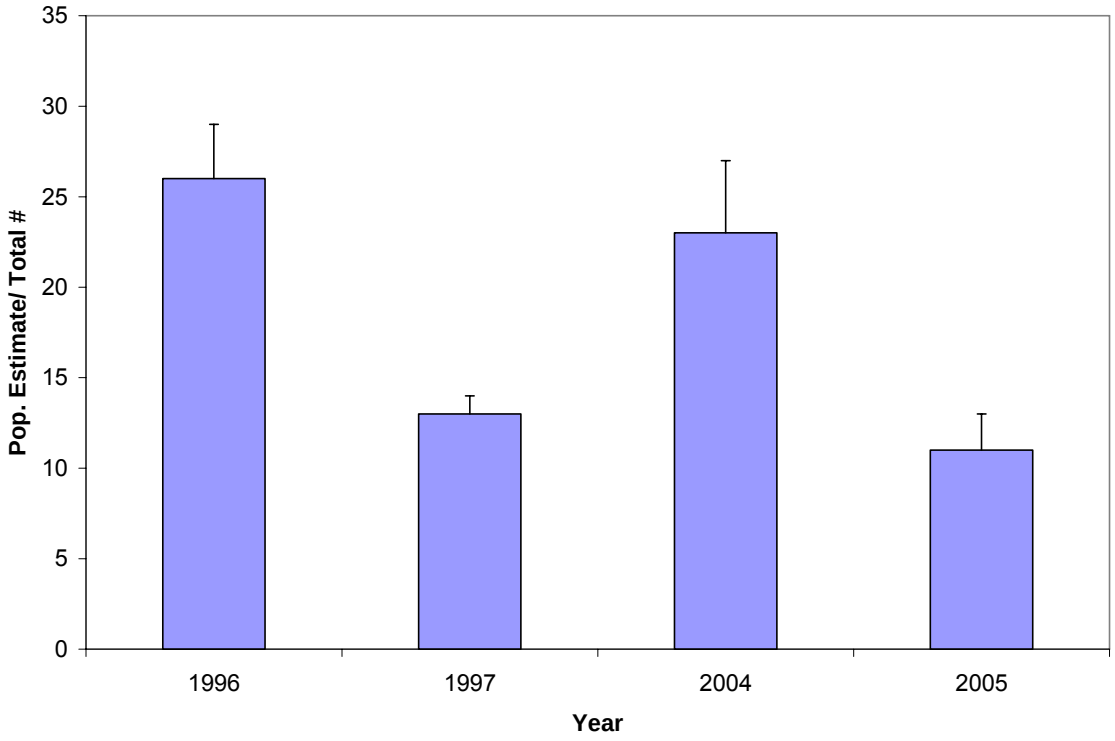


Figure 13.1. Population estimates for rainbow trout collected at Station 2-1 (1996, 1997, 2004, 2005).

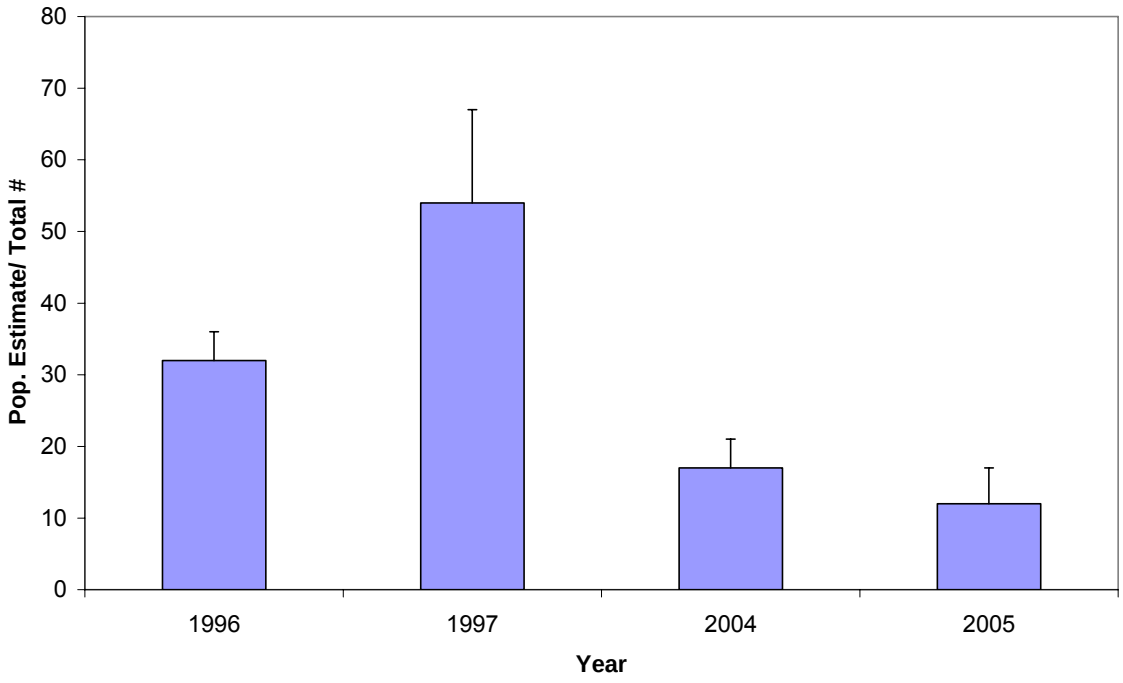


Figure 13.2. Population estimates for rainbow trout collected at Station 2-4 (1996, 1997, 2004, and 2005).

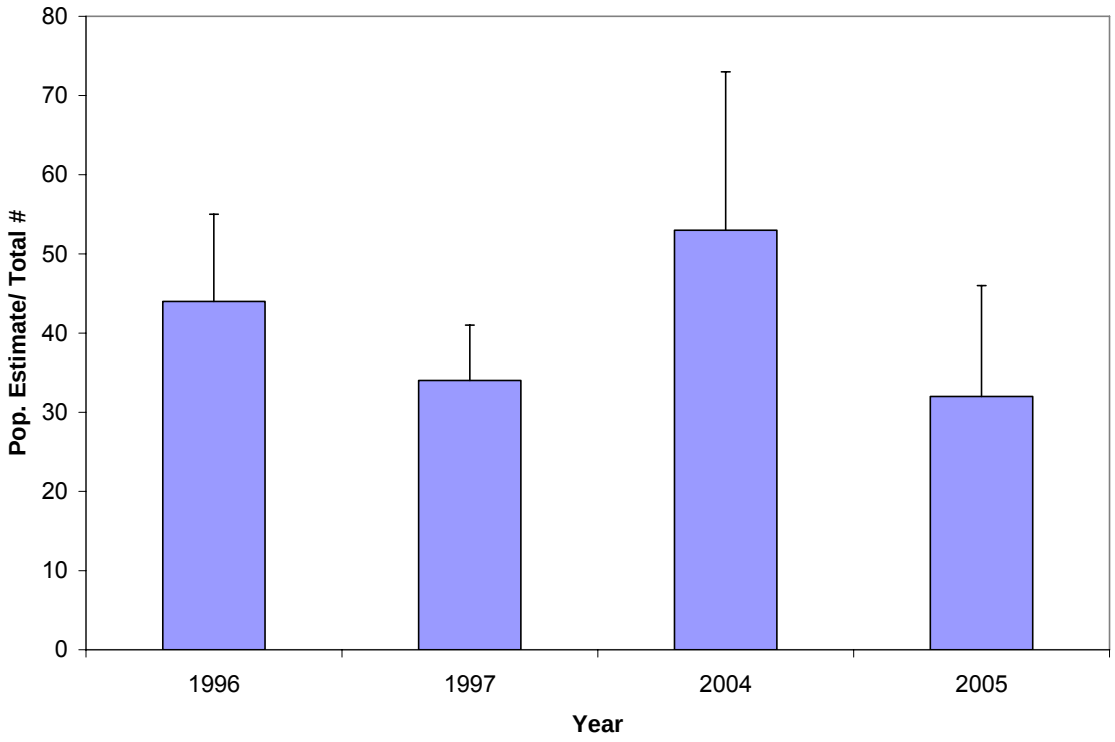


Figure 13.3. Population estimates for rainbow trout collected at Station 2-5 (1996, 1997, 2004, and 2005).

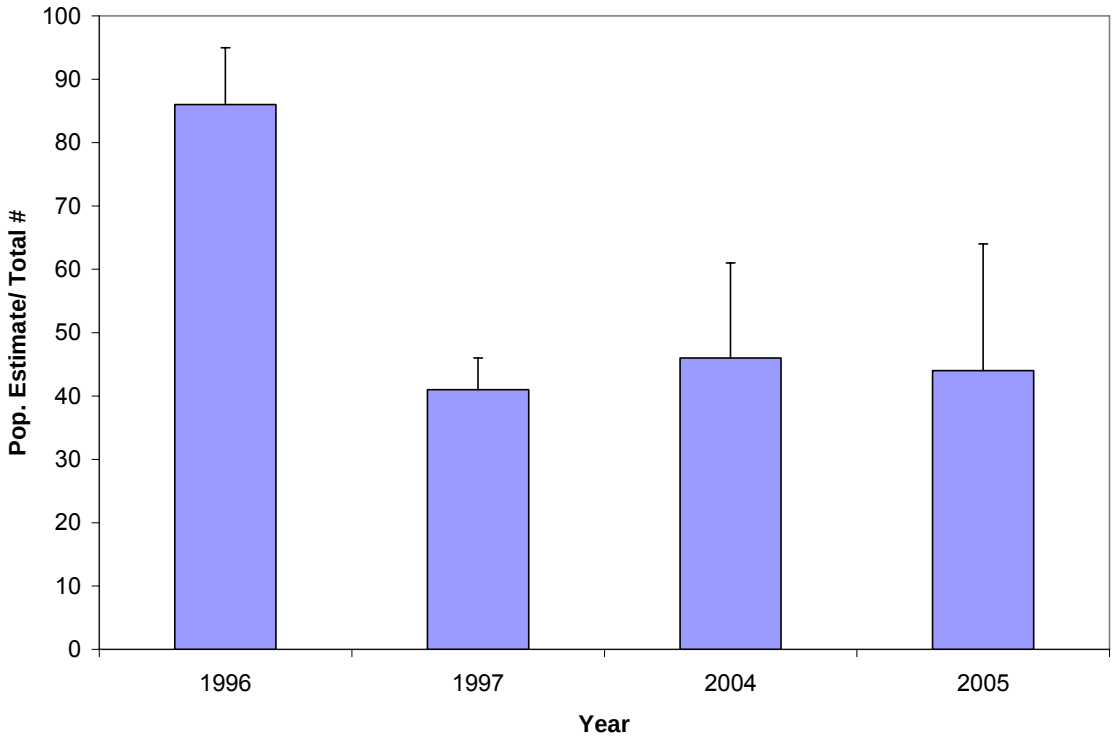


Figure 13.4. Population estimates for rainbow trout collected at Station 2-6 (1996, 1997, 2004, and 2005).

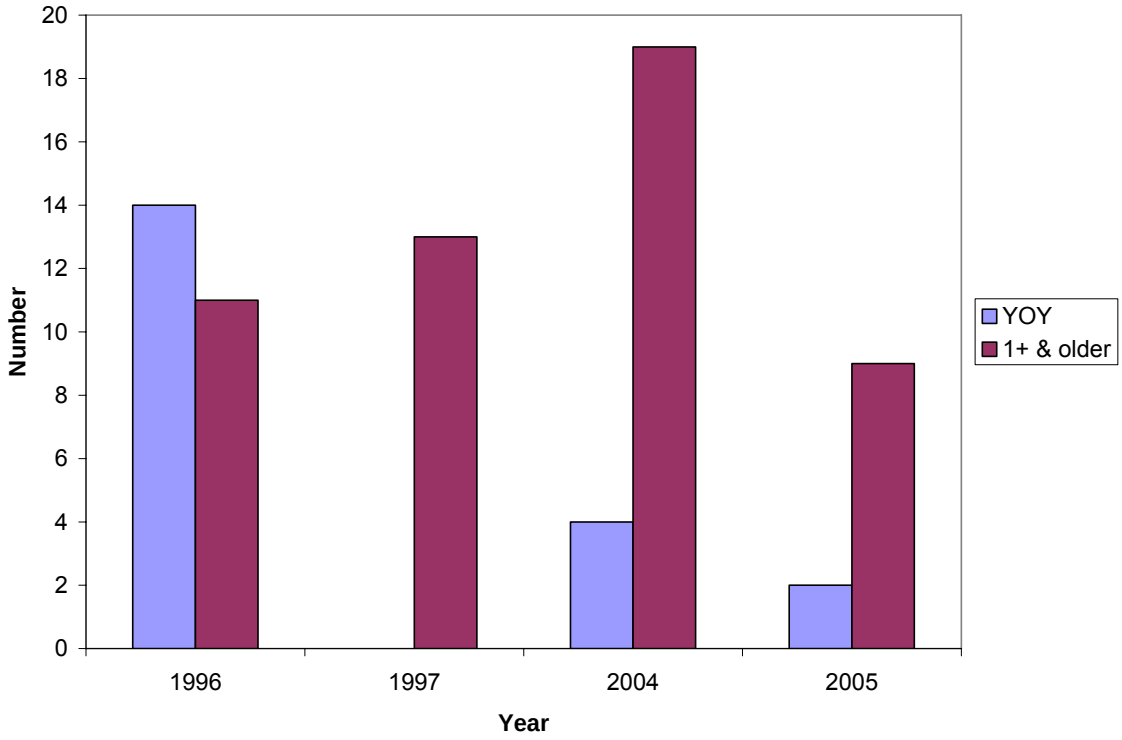


Figure 14.1. Age structure comparison of rainbow trout collected at Station 2-1 (1996, 1997, 2004, and 2005).

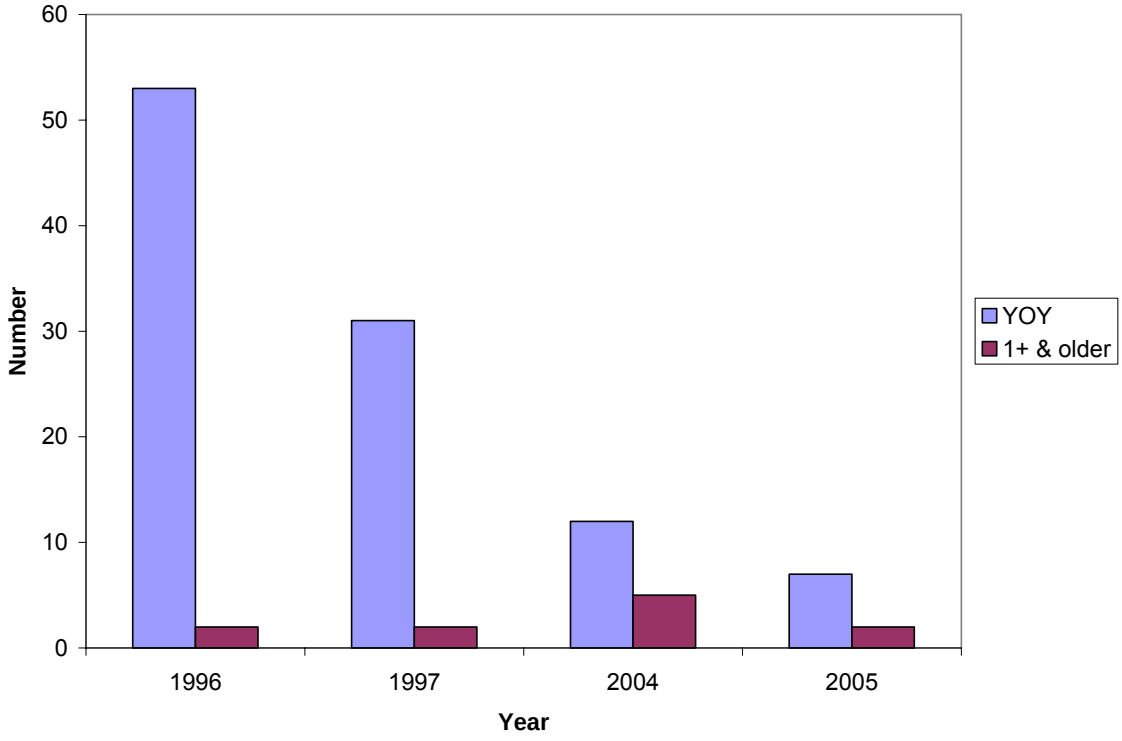


Figure 14.2. Age structure comparison of rainbow trout collected at Station 2-4 (1996, 1997, 2004, and 2005).

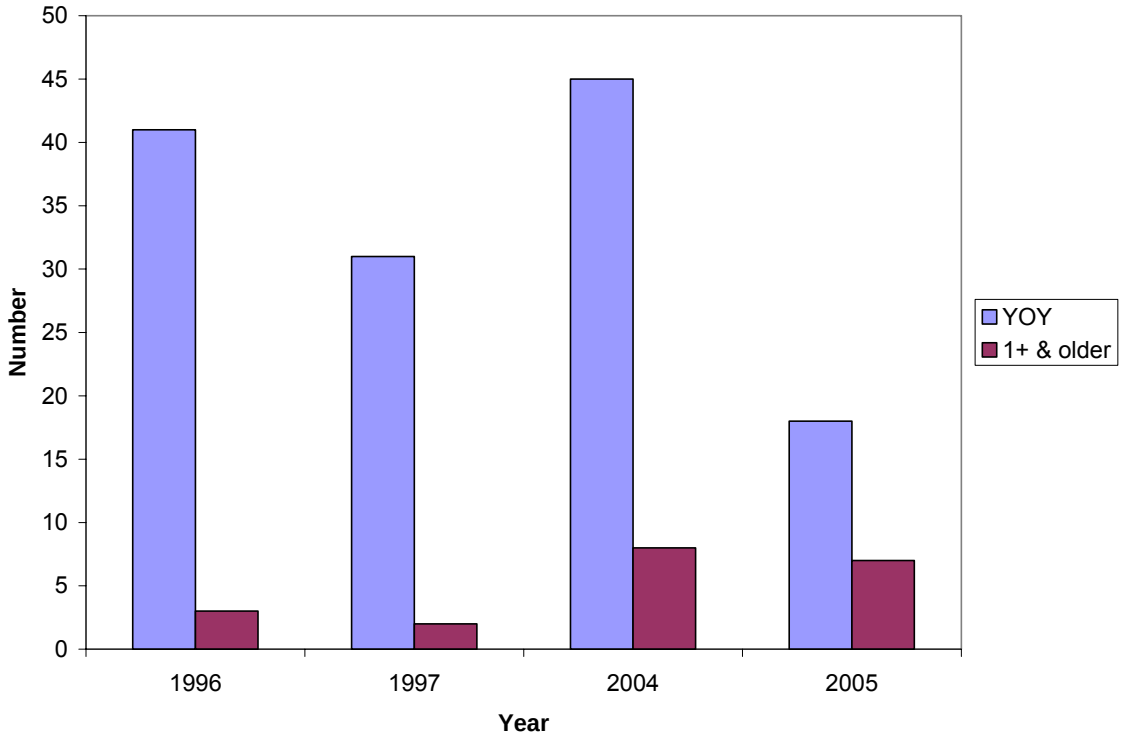


Figure 14.3. Age structure comparison of rainbow trout collected at Station 2-5 (196, 1997, 2004, and 2005).

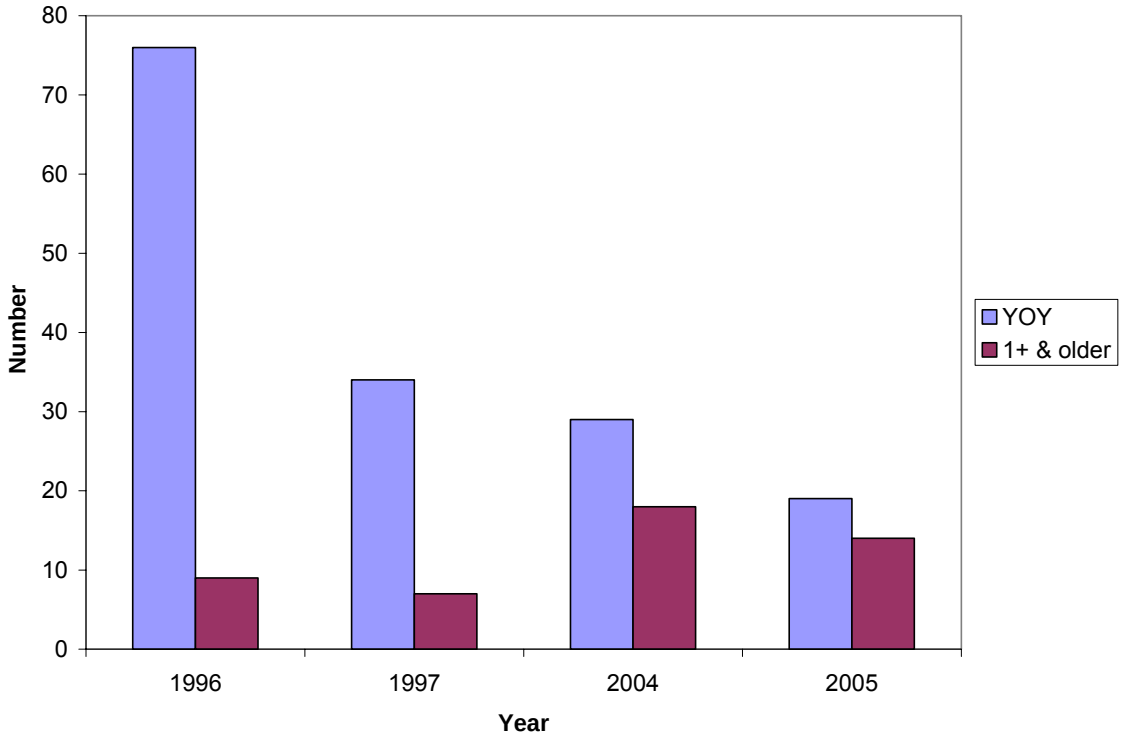


Figure 14.4. Age structure comparison of rainbow trout collected at Station 2-6 (1996, 1997, 2004, and 2005).

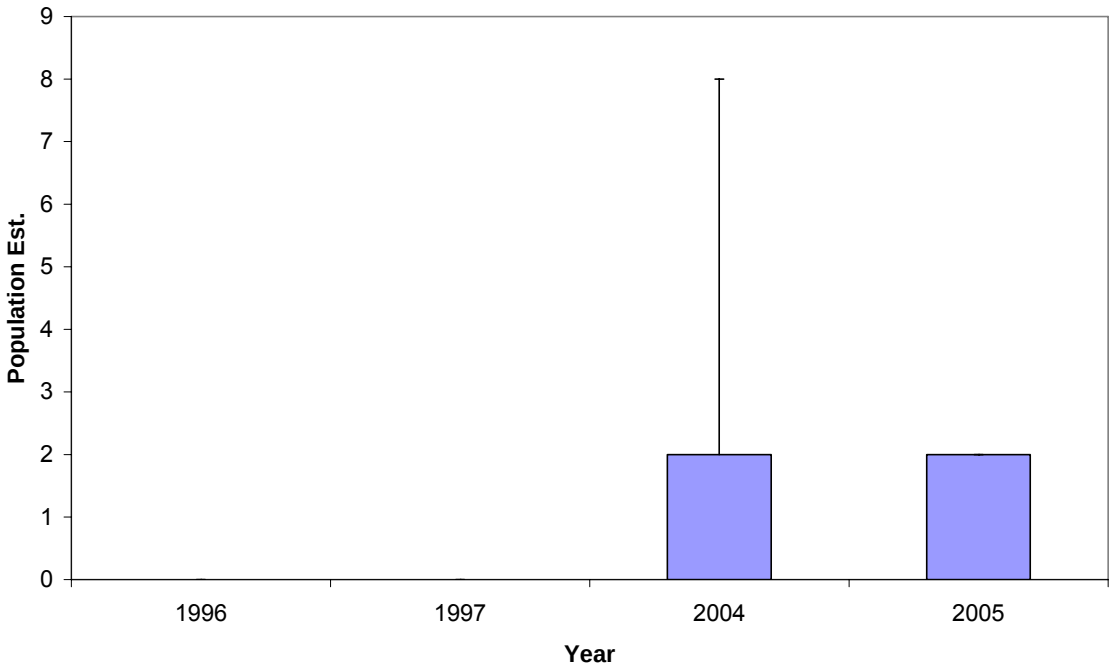


Figure 15.1. Population estimates for brown trout collected at Station 2-1 (1996, 1997, 2004, and 2005).

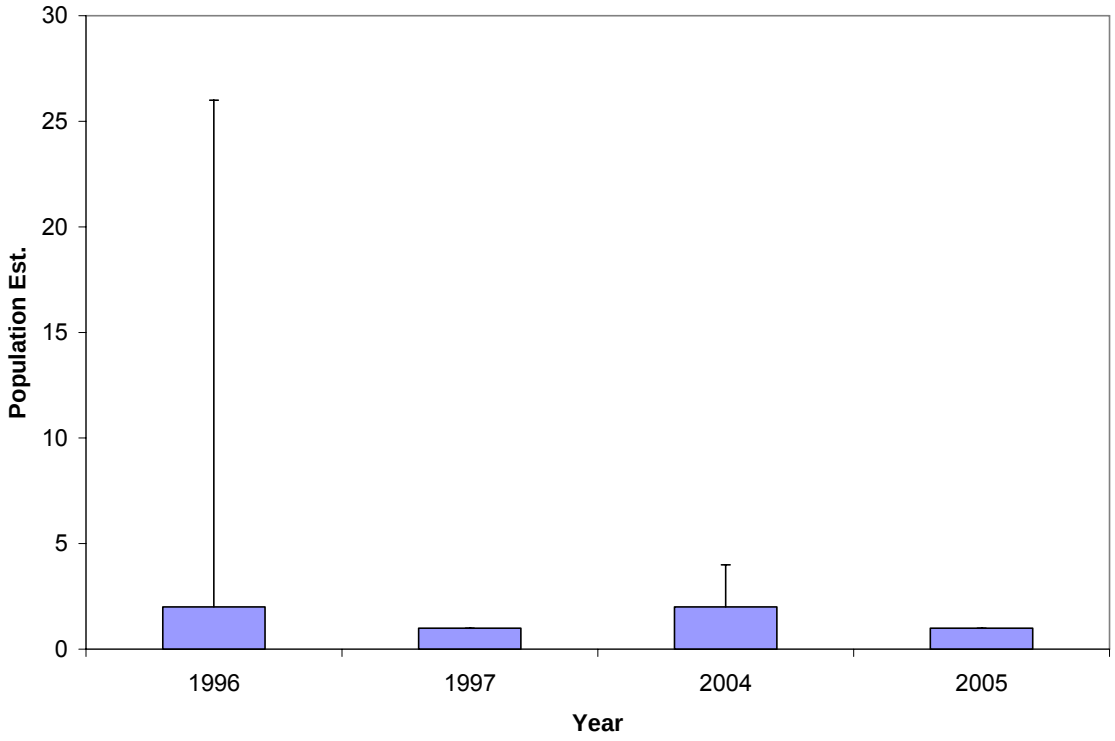


Figure 15.2. Population estimates for brown trout collected at Station 2-4 (1996, 1997, 2004, and 2005).

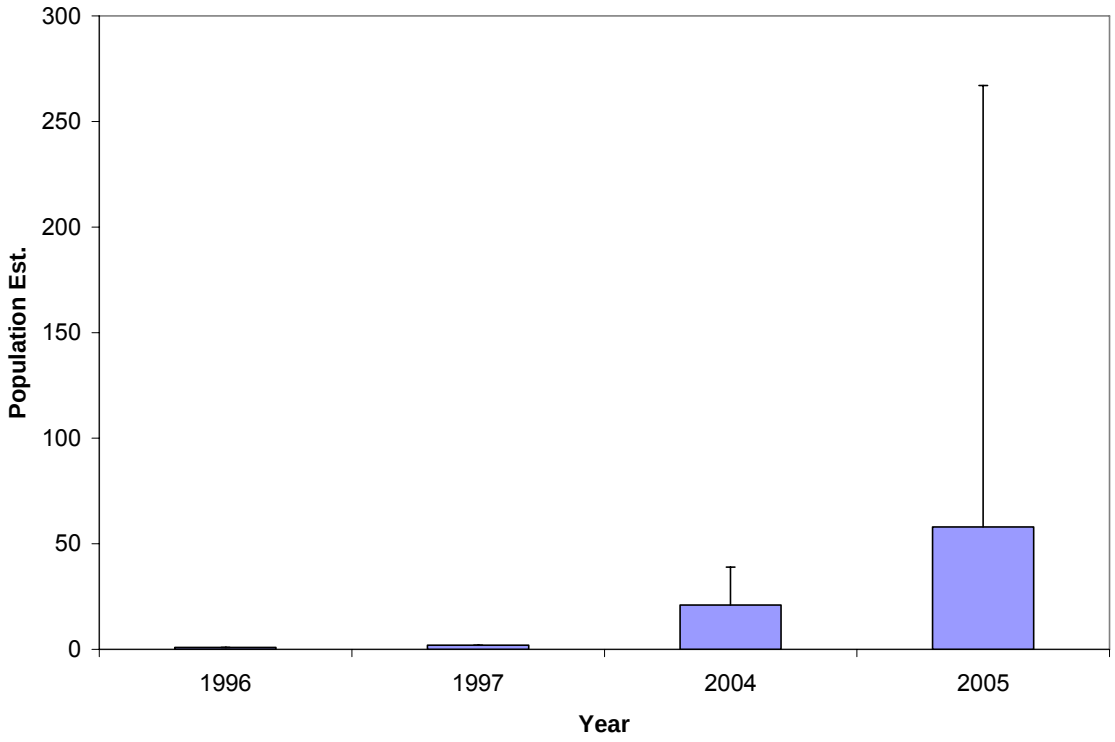


Figure 15.3. Population estimates for brown trout collected at Station 2-5 (1996, 1997, 204, and 2005).

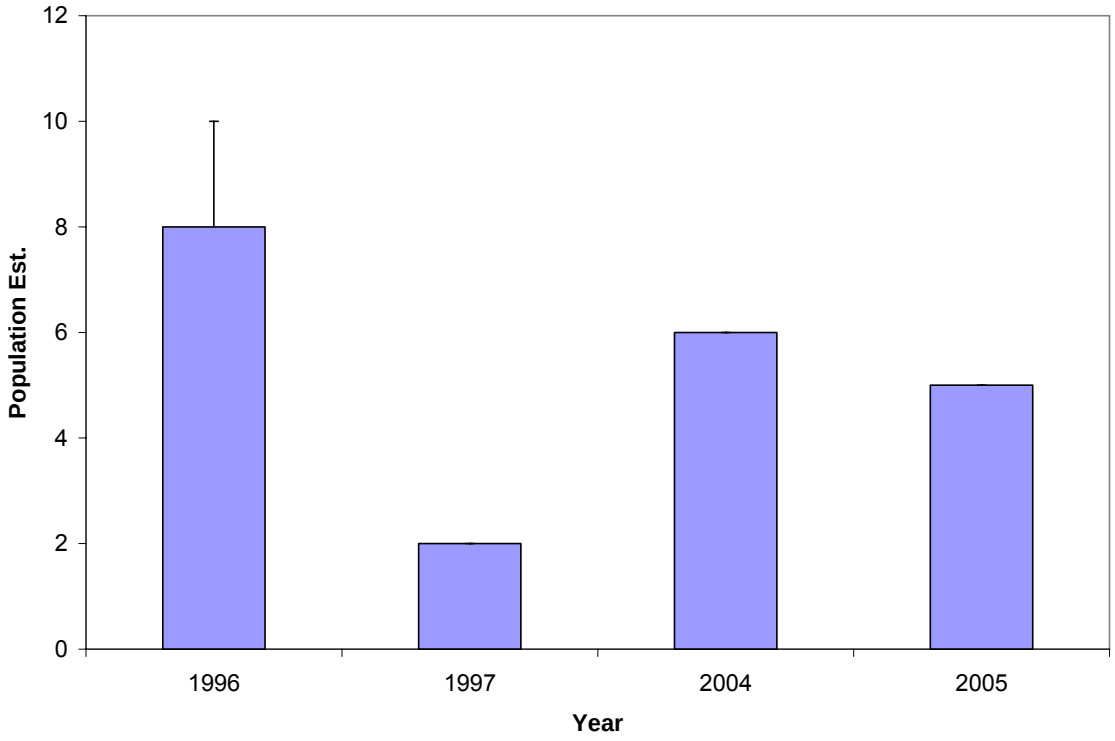


Figure 15.4. Population estimates for brown trout collected at Station 2-6 (1996, 1997, 2004, and 2005).

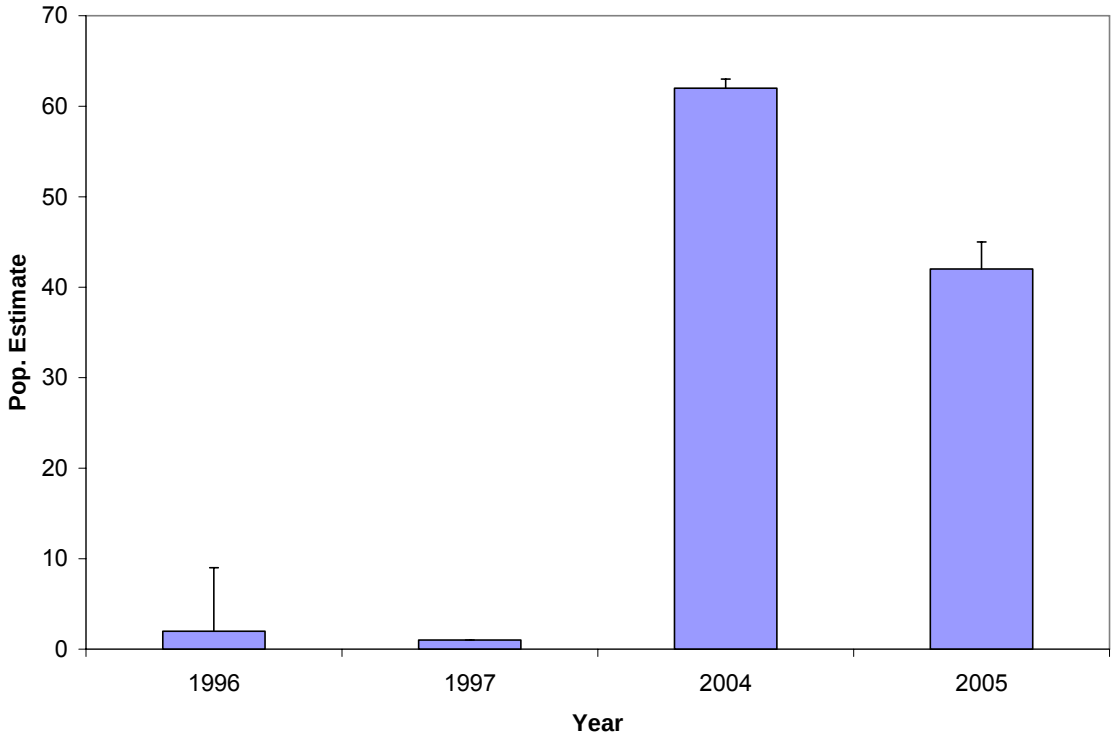


Figure 16.1. Population estimates for Pit sculpin collected at Station 2-1 (1996, 1997, 2004, and 2005).

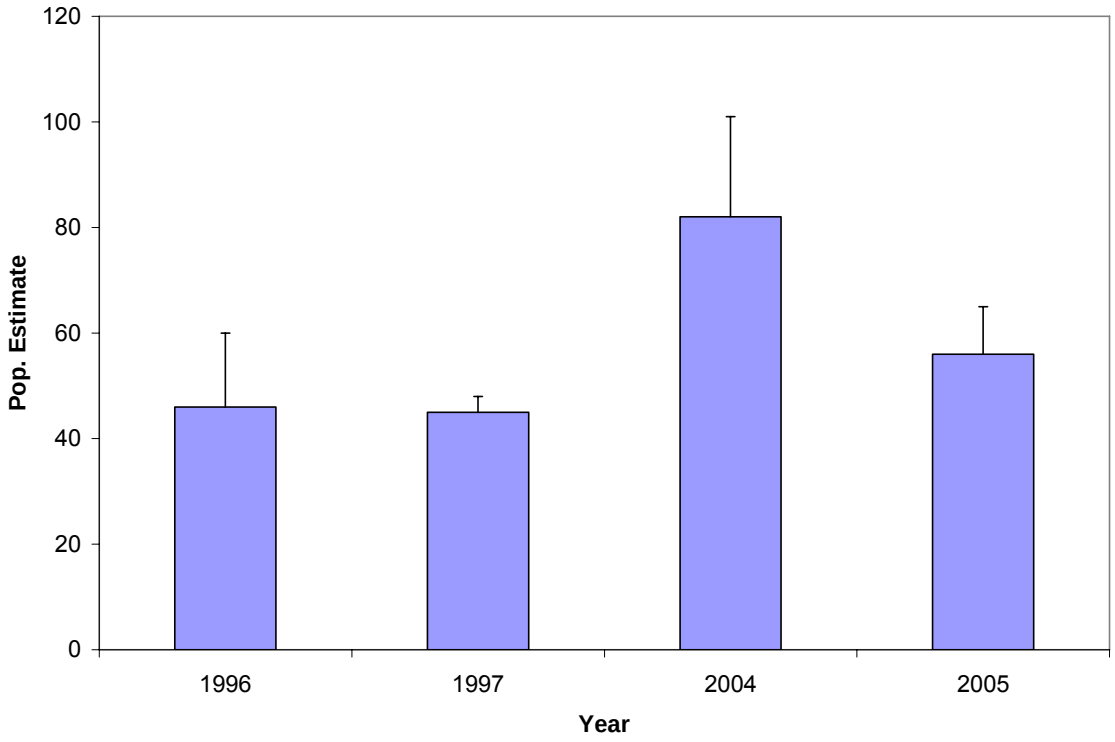


Figure 16.2. Population estimates for Pit sculpin collected at Station 2-4 (1996, 1997, 2004, and 2005).

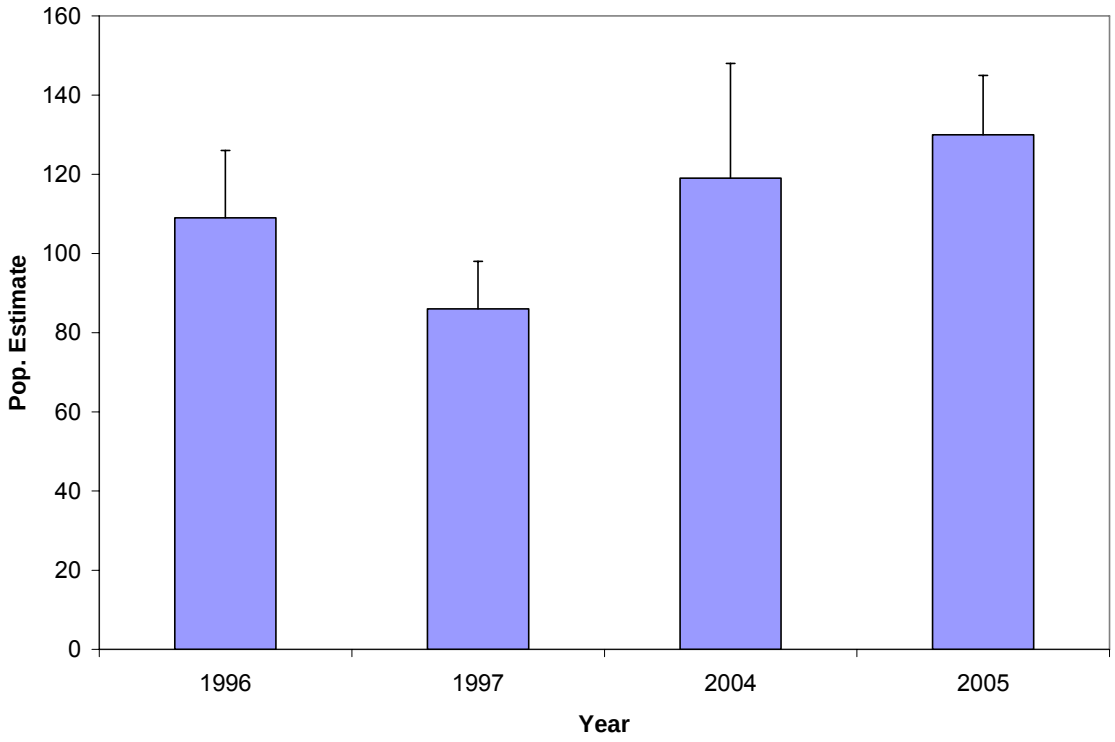


Figure 16.3. Population estimates for Pit sculpin collected at Station 2-5 (1996, 1997, 2004, and 2005).

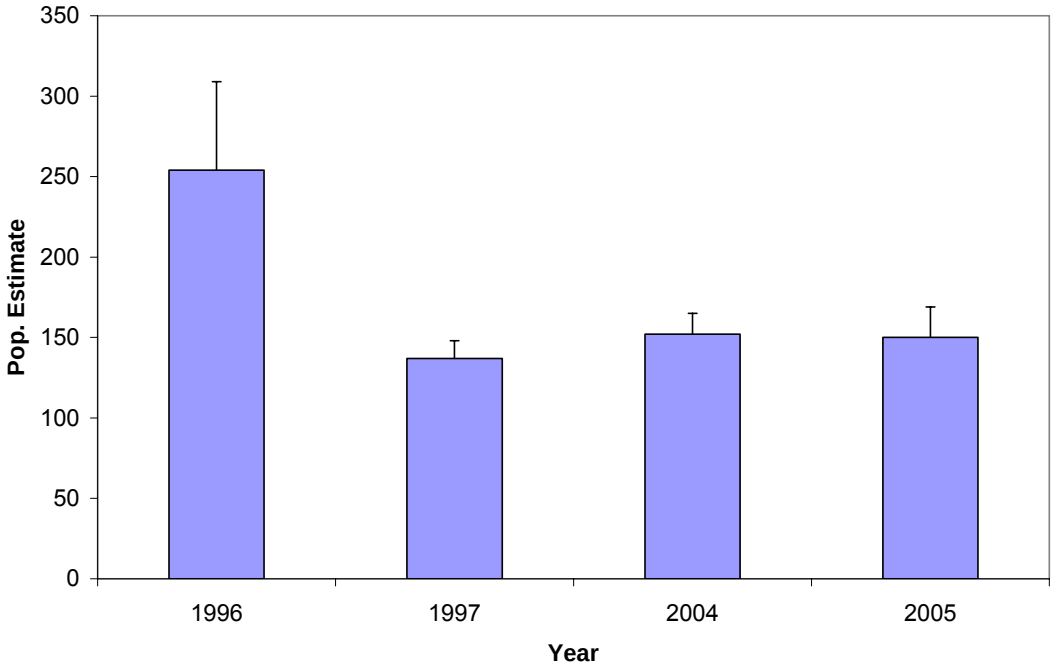
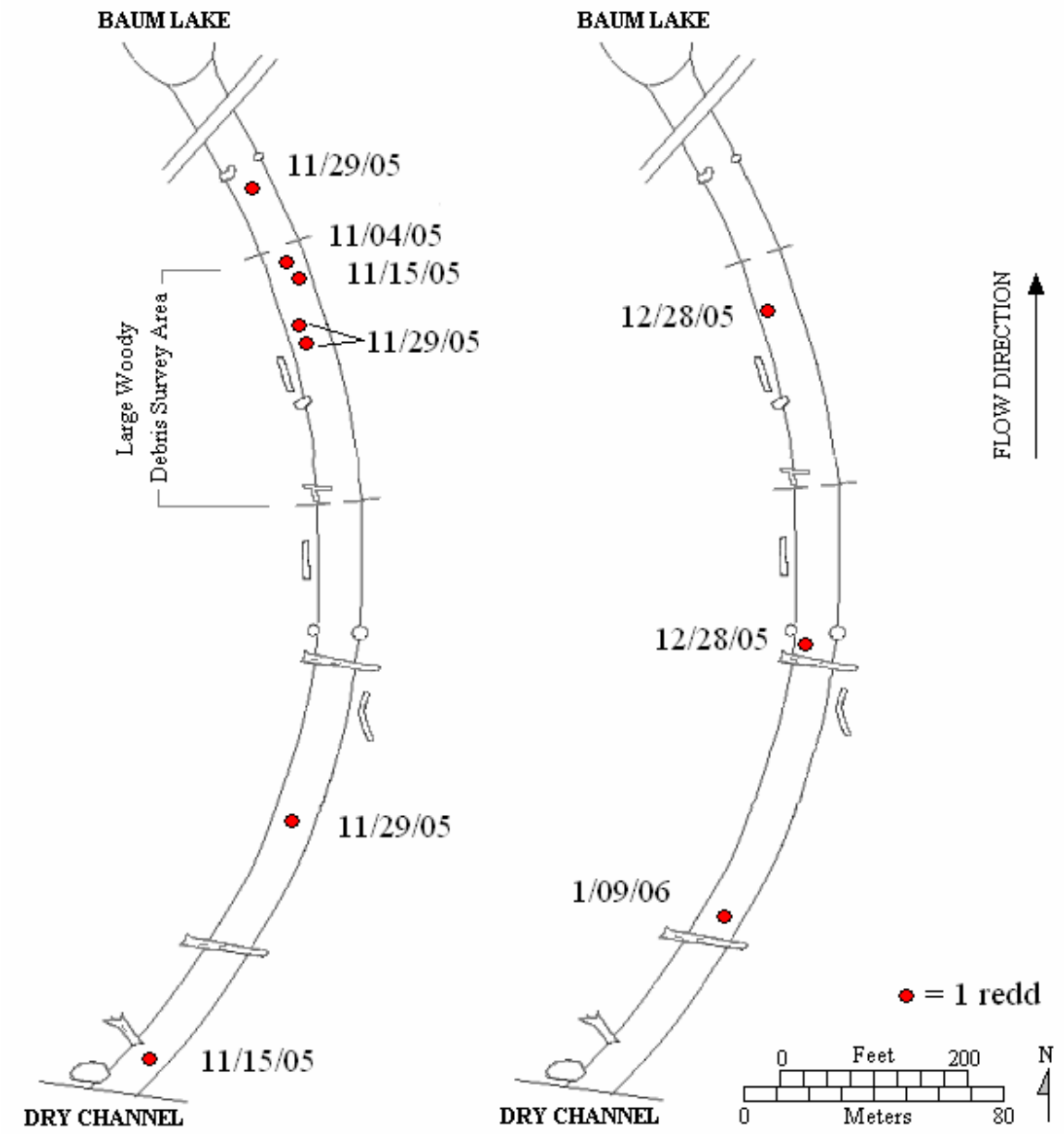


Figure 16.4. Population estimates for Pit sculpin collected at Station 2-6 (1996, 1997, 2004, and 2005).



Summary All Dates	11/04	1 redd	12/12	None	1/09	1 redd
	11/15	2 redds	12/28	2 redds	1/25	None
	11/29	4 redds				

Figure 17. Numbers and locations of redds observed in the Hat 1 Bypass Reach during the 2005–2006 spawning surveys.

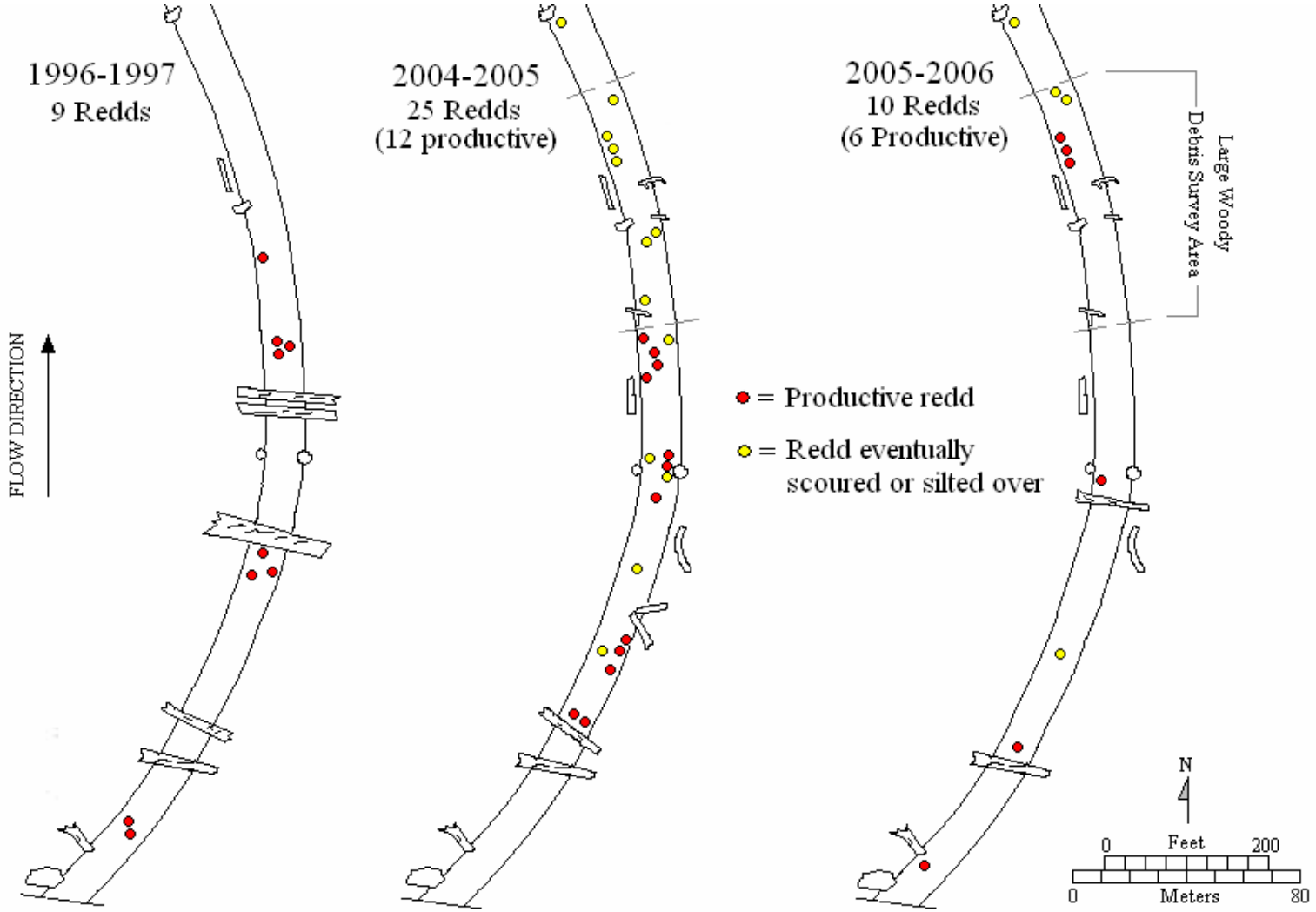
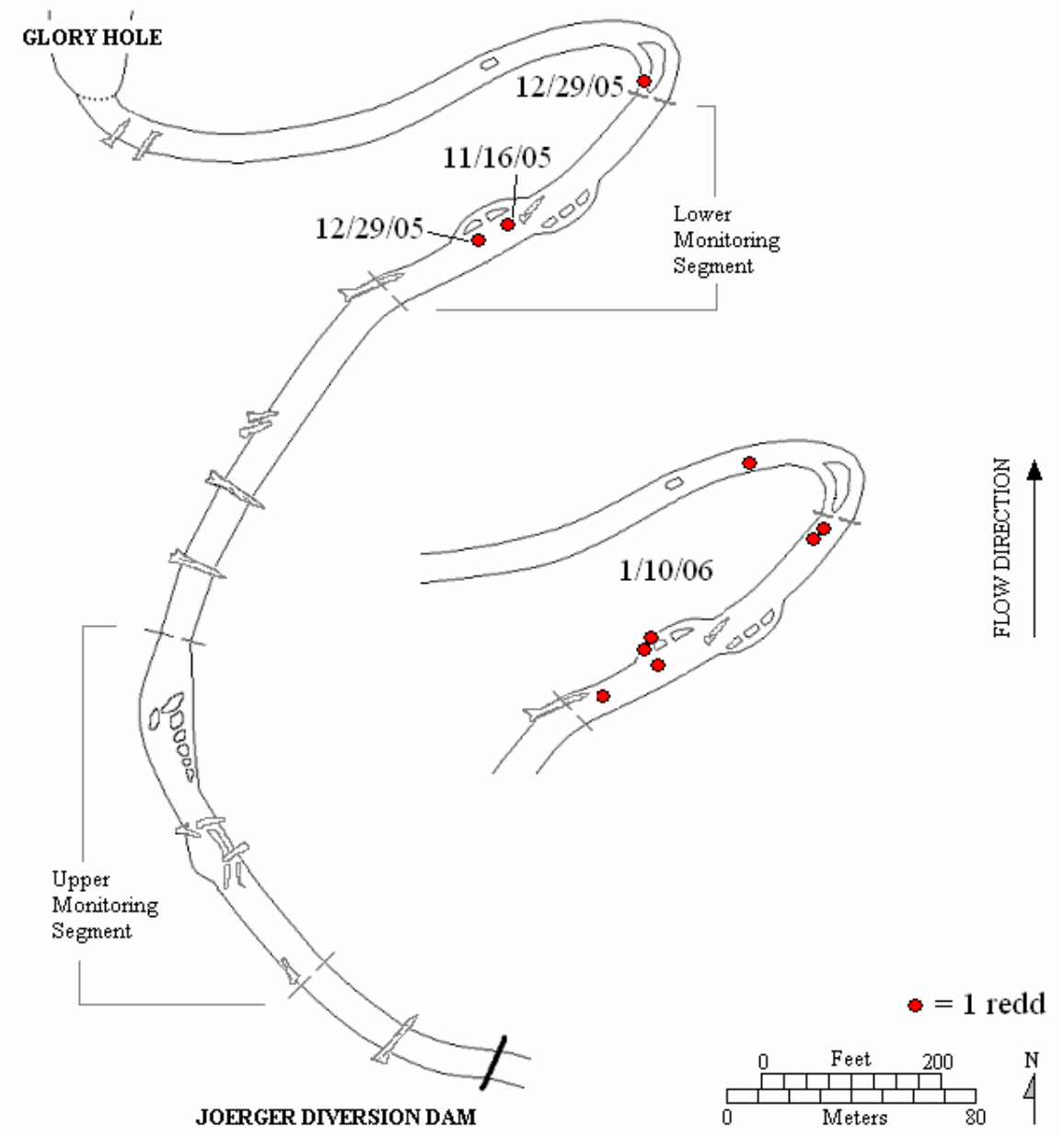


Figure 18. Numbers and locations of redds observed in the Hat 1 Bypass Reach during three seasons of spawning surveys.



Summary	11/03	None	12/13	None	1/10	7 redds
All Dates	11/16	1 redd	12/29	2 redds	1/24	None
	11/30	None				

Figure 19. Numbers and locations of redds observed in the Hat 2 Bypass Reach during the 2005–2006 spawning surveys.

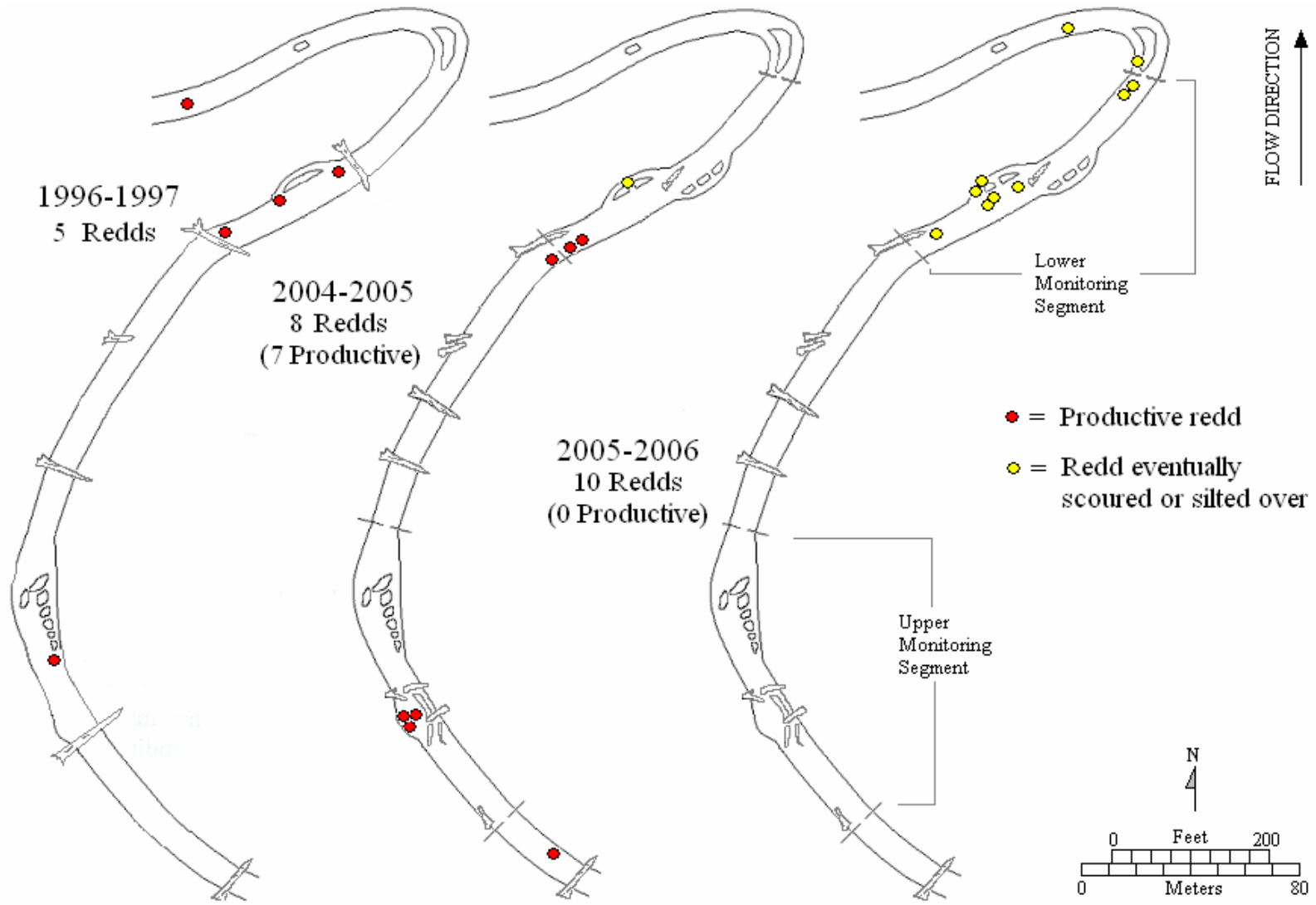


Figure 20. Numbers and locations of redds observed in the Hat 2 Bypass Reach during three seasons of spawning surveys.

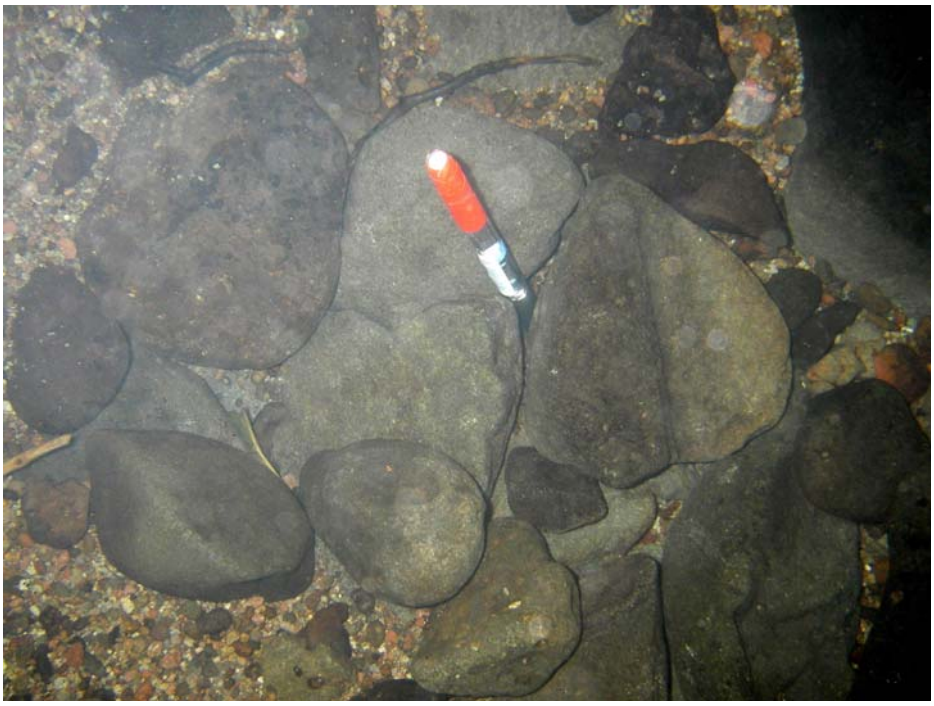


Figure 21. Photos of two cobble-dominated redds observed in the Hat 1 Bypass Reach.

Figure 22. Photos of a redd #3, showing gravel substrate with some small surface cobbles.