An evaluation of the brown trout population in Upper Silver Creek, Idaho, and an evaluation of its effect on that fish community

A progress report to:

The Nature Conservancy, Idaho Field Office

From:

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Species Composition and Abundance

Methods

Five sites in Upper Silver Creek (Figure 1) were electrofished in fall 1992 and summer 1993 to obtain data for estimation of game fish species composition and abundance (density and biomass). The sites were electrofished during the period 3 October through 15 November 1992 and 3 June through 21 July 1993. Population data from 1992-1993 were collected during the same periods in which researchers in 1986-1987 had sampled. A 7-10 day period was allotted between electrofishing runs to minimize electrofishing bias in population estimates. Length and weight were recorded for all game fish collected. Nongame fish were enumerated and lengths were recorded for samples of each species. Using multiple mark-recapture data collected from each site, population estimates of game fish larger than 150 mm were calculated using the Chapman modification of the Schnabel estimate for brown trout (Salmo trutta), rainbow trout (Oncorhynchus mykiss), and brook trout (Salvelinus fontinalis). The 150 mm length limit for population estimates was used to prevent underestimating smaller fish that did not appear to be fully recruited to the electrofishing gear. Population data were evaluated to determine the extent to which electrofishing was size-selective.

Abundance estimates (number of fish per site) for the five sites were used to calculate density estimates (number of fish per hectare) for fall 1992 and summer 1993. Biomass estimates

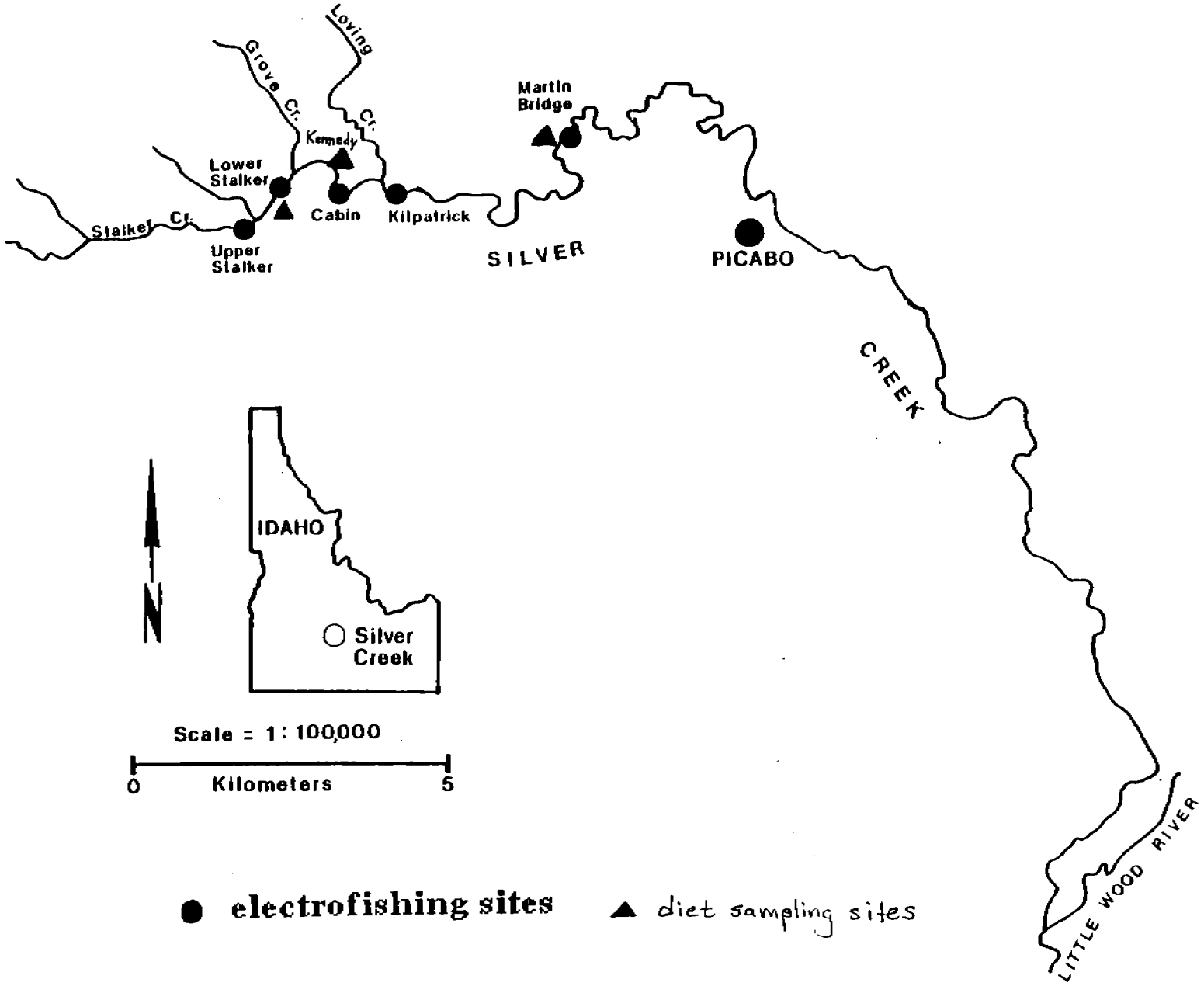


Figure 1. Location of electrofishing sites and diet sampling sites on Silver Creek for the 1992-1993 field seasons.

(kilograms per hectare) were determined by utilizing density estimates and mean weights for each species.

Results

Rainbow trout comprised from 32% to 78% of game fish (by number) sampled in fall 1992 and between 30% and 76% of game fish sampled in summer 1993 (Figures 2-4). Brown trout accounted for from 12-68% of game fish sampled in the sites in fall 1992 and from 14-69% of game fish collected in summer 1993. The Martin Bridge site was the only site in which brown trout percent composition was higher than that of rainbow trout for both sampling periods. In evaluating changes in species composition in Silver Creek through comparisons with data from 1976-77 and 1986-87, it was possible to directly compare three of five sites sampled in 1992-93. Species composition in Silver Creek has changed since 1976-77. Rainbow trout percent composition in Upper Stalker Creek decreased by 11% since 1986-87. In the Martin Bridge site rainbow trout percent composition of the sample decreased by 33% since 1976-77. Brown trout percent composition increased in all three sites from zero in 1976-77 to as much as 68% of the sample in the Martin Bridge site. In the Cabin site, mountain whitefish (Prosopium williamsoni) comprised 40% of the sample in 1976-77 but accounted for only 3% of the sample in 1992-93.

Summer Density Estimates

Rainbow trout density had decreased to near 320 fish/hectare

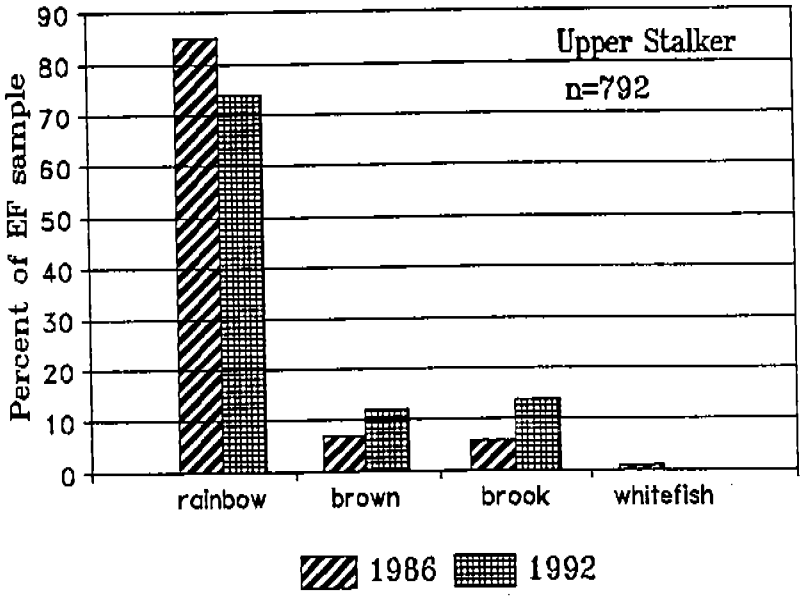


Figure 2. Game fish species composition (percent of the electrofishing sample) in the Upper Stalker electrofishing site from sampling conducted in 1986-1987 and 1992-1993.

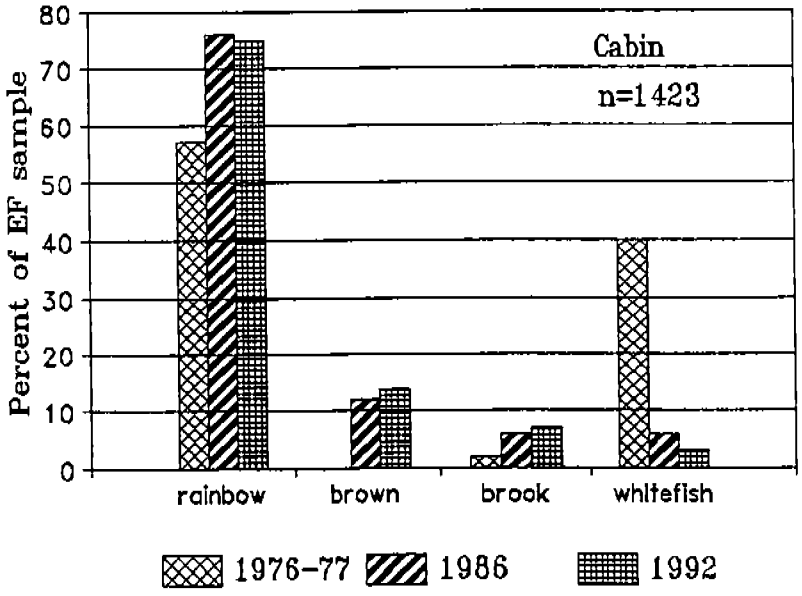


Figure 3. Game fish species composition (percent of the electrofishing sample) in the Cabin electrofishing site from sampling conducted in 1976-1977, 1986-1987, and 1992-1993.

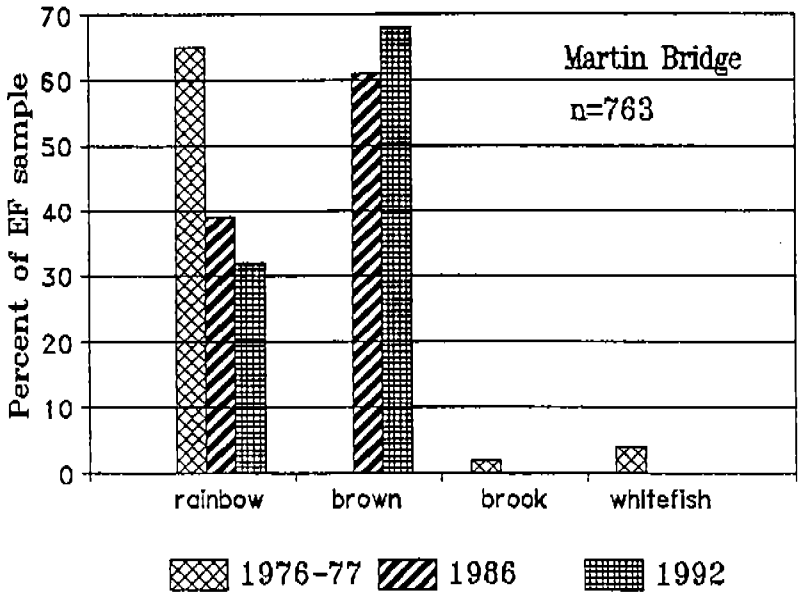


Figure 4. Game fish species composition (percent of the electrofishing sample) in the Martin Bridge electrofishing site from sampling conducted in 1976-1977, 1986-1987, and 1992-1993.

in the Lower Stalker site since 1986-87 when it was estimated at about 1220 fish/hectare. Rainbow trout density in the other sites remained essentially unchanged in the other three sites (Figure 5). Brown trout densities, on the other hand, increased in three sites since 1986-87 and remained unchanged in the Cabin site. Overall, however, rainbow trout densities for all sites sampled were consistently higher than brown trout densities in 1986-87 and 1993. For example, rainbow trout density in the Cabin and Kilpatrick sites in 1993 was between 200-300 fish/hectare, while brown trout density in these sites ranged below 50 fish/hectare.

Fall Density Estimates

Fall density estimates for brown and rainbow trout were compared to earlier data for three of the five sites sampled in 1992 (Figure 6). Rainbow trout density has decreased in the Upper Stalker Creek site and increased in the Martin Bridge and Cabin sites since 1986-87. Rainbow trout increased from approximately 200 fish/ha in 1986 to nearly 600 fish/ha in 1992 in the Cabin site. Fall brown trout densities for 1992 in these three sites ranged from 116-525 fish/ha. Brown trout were present in such low numbers in 1986-87 that in two of the three sites densities could not be estimated. In the one site in which an estimate could be made, brown trout increased from 158 fish/hectare in 1986 to 525 fish/ha in 1992. In fall 1992 in the Martin Bridge site, brown trout density was higher than rainbow trout density, while rainbow trout density was higher than brown

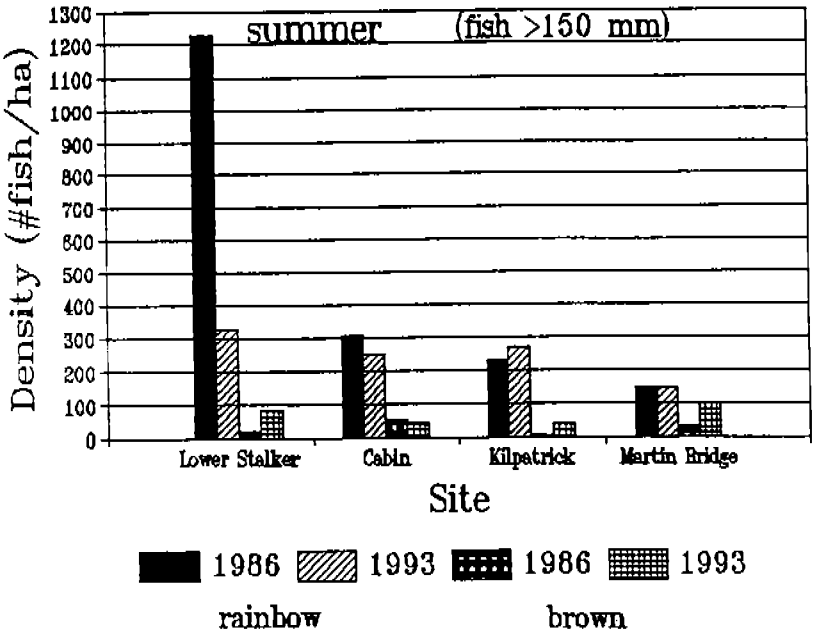


Figure 5. Density estimates for brown and rainbow trout (>150 mm) from four electrofishing sites on Silver Creek for summer 1986 and summer 1993.

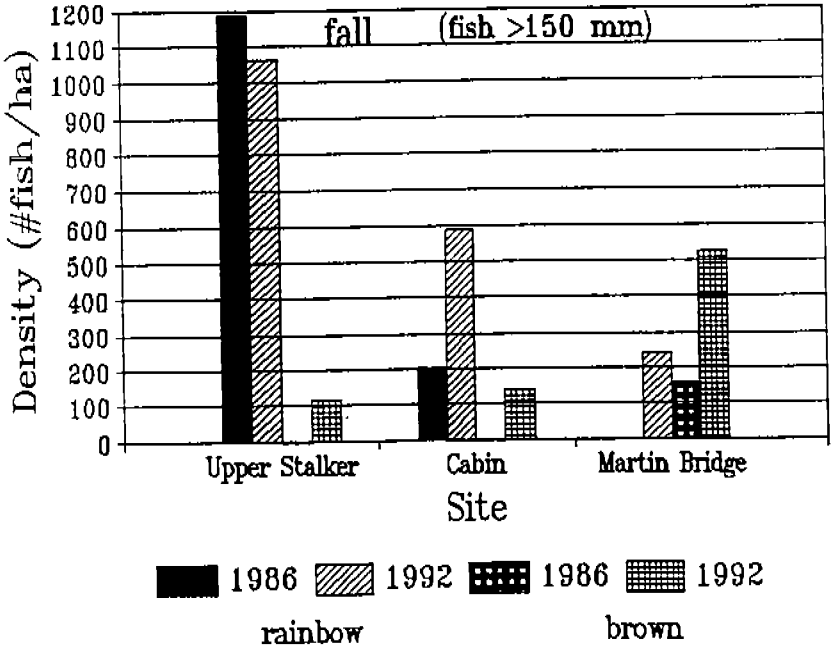


Figure 6. Density estimates for brown and rainbow trout (>150 mm) from three electrofishing sites on Silver Creek for fall 1986 and fall 1992.

trout density in the Upper Stalker and Cabin sites during this period.

Summer Biomass Estimates

Summer estimates of biomass for four of the five sites indicate that in the Lower Stalker Creek site rainbow trout biomass has decreased substantially, from 216 kg/ha in 1986 to 63 kg/ha in 1993 (Figure 7). Rainbow trout biomass in the Cabin and Kilpatrick sites essentially was unchanged, while it increased in the Martin Bridge site from 27 kg/ha in 1986 to 57 kg/ha in 1993. Brown trout summer biomass increased in all four sites since 1986. In the Cabin and Kilpatrick sites, brown trout biomass was estimated to be less than 4 kg/ha in 1986. In 1993, biomass of brown trout in these two sites was estimated at 37 kg/ha and 41 kg/ha, respectively. The largest increase in brown trout biomass since 1986 occurred in the Lower Stalker Creek site where biomass was estimated at 17 kg/ha in 1986 and 101 kg/ha in 1993. Brown trout in the Martin Bridge site increased from 31 kg/ha in 1986 to 82 kg/ha in 1993. In 1986, rainbow trout biomass equalled or exceeded brown trout biomass in all four of the sites. In 1992, rainbow trout biomass exceeded brown trout biomass in the Cabin and Kilpatrick sites and was lower than brown trout biomass in the Lower Stalker and Martin Bridge sites.

Fall Biomass Estimates

Fall biomass estimates for brown and rainbow trout were compared for three sites for 1986 and 1992 (Figure 8). Rainbow

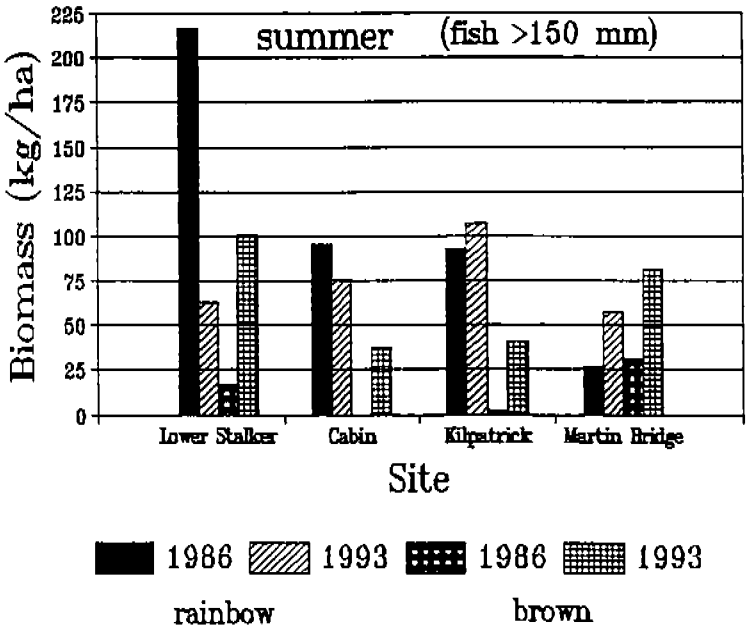


Figure 7. Biomass estimates for brown and rainbow trout (>150 mm) based on density estimates from four electrofishing sites on Silver Creek for summer 1986 and summer 1993.

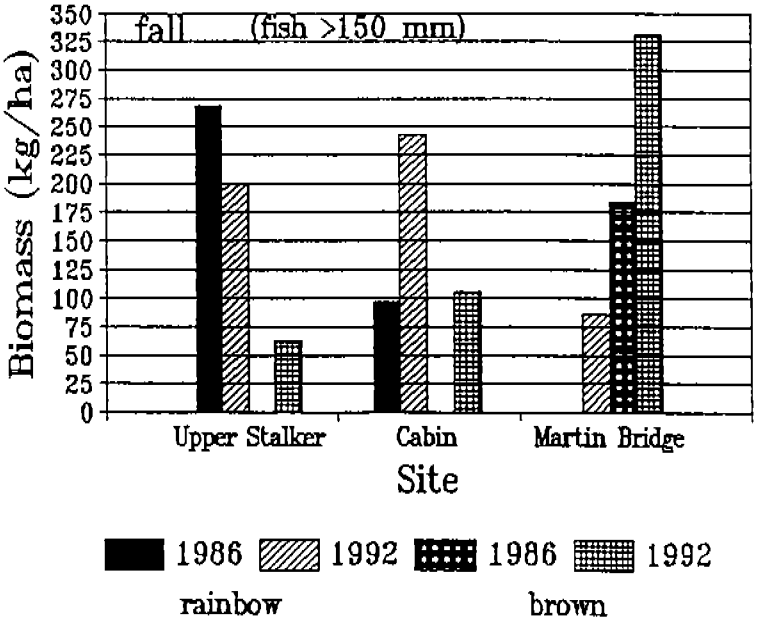


Figure 8. Biomass estimates for brown and rainbow trout (>150 mm) based on density estimates from three electrofishing sites on Silver Creek for fall 1986 and fall 1992.

trout biomass increased in the Cabin and Martin Bridge sites since 1986. In the Upper Stalker site, rainbow trout biomass decreased from 268 kg/ha in 1986 to 199 kg/ha in 1992. Brown trout biomass in the Upper Stalker and Cabin sites increased from levels that were too low to estimate in 1986 to 62 kg/ha and 105 kg/ha, respectively in 1992. In fall 1986, biomass of brown trout in the Martin Bridge site was 184 kg/ha, compared with 331 kg/ha in fall 1992. Fall brown trout biomass estimates were considerably higher than summer biomass estimates in all sites. Overall, rainbow trout biomass was found to be consistently higher than brown trout biomass in the Upper Stalker and Cabin sites, while rainbow trout biomass was consistently lower than brown trout biomass in the Martin Bridge site. The fall biomass estimates for both rainbow and brown trout were found to be among the highest reported for streams in the western United States.

Length-Frequency Histograms

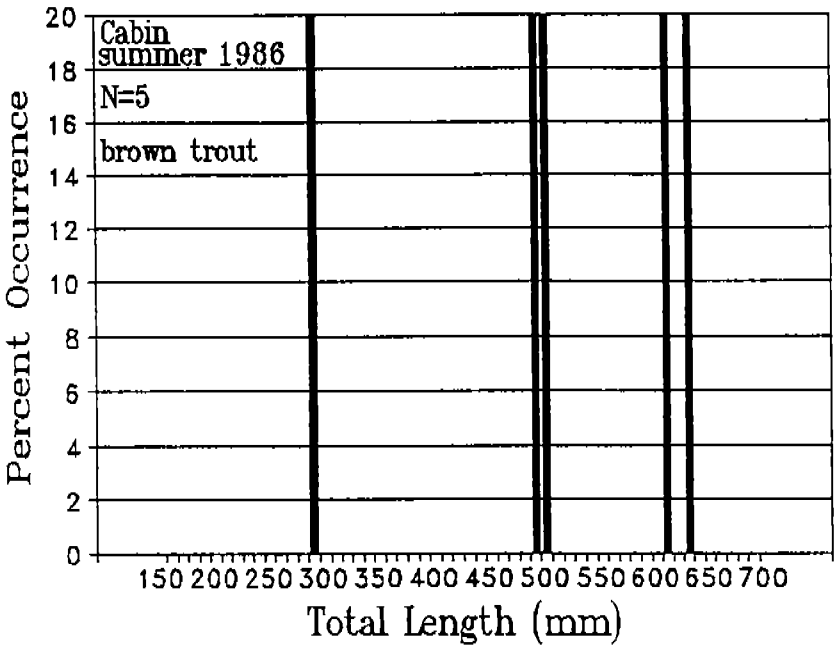
Length-frequency data were analyzed for the five electrofishing sites to evaluate the size distribution of brown and rainbow trout. Where possible, 1992-93 length-frequency histograms were compared to data from 1986-87 to assess changes in density and biomass.

Summer

In 1986, researchers from ISU captured a total of 5 brown trout in the Cabin site. Four of these fish were >500 mm total length. In 1993, 59 brown trout were captured in this site and,

from the spread in the length-frequency distribution, it appears that brown trout have become well established in this site (Figure 9). Rainbow trout length distribution in the Cabin site, however, has not changed considerably since 1986 (Figure 10). A similar situation to the one described above exists in the Lower Stalker Creek site for brown trout. In 1986, 14 brown trout were collected in this site and 12 were > 340 mm. In summer 1993, 65 brown trout were sampled in Lower Stalker and the range of the distribution was greater than the 1986 distribution. However, the length distribution for brown trout in this site differed from the Cabin site in that there were far fewer fish in the < 250 mm class. The length distribution of rainbow trout in the Lower Stalker site has changed since 1986. In 1986, 234 rainbow trout were collected compared to 86 in 1993 under a similar amount of effort. Rainbow trout < 250 mm total length comprised 75% of the sample in 1986 while accounting for 51% of the rainbow trout sampled in 1993. Recall, this site was also the site that experienced the largest decrease in rainbow trout biomass over the six-year period.

In summer 1986 of the 37 brown trout that were captured in the Martin Bridge site 30 were > 400 mm total length (Figure 11). In 1993, the brown trout distribution looks considerably different with a bimodal distribution in length (Figure 11). Brown trout < 200 mm in this site accounted for 6% (n=132) of the brown trout sampled in 1993. No brown trout < 200 mm were captured in the 1986 samples. It appears that the brown trout have become better established in this site as well and are



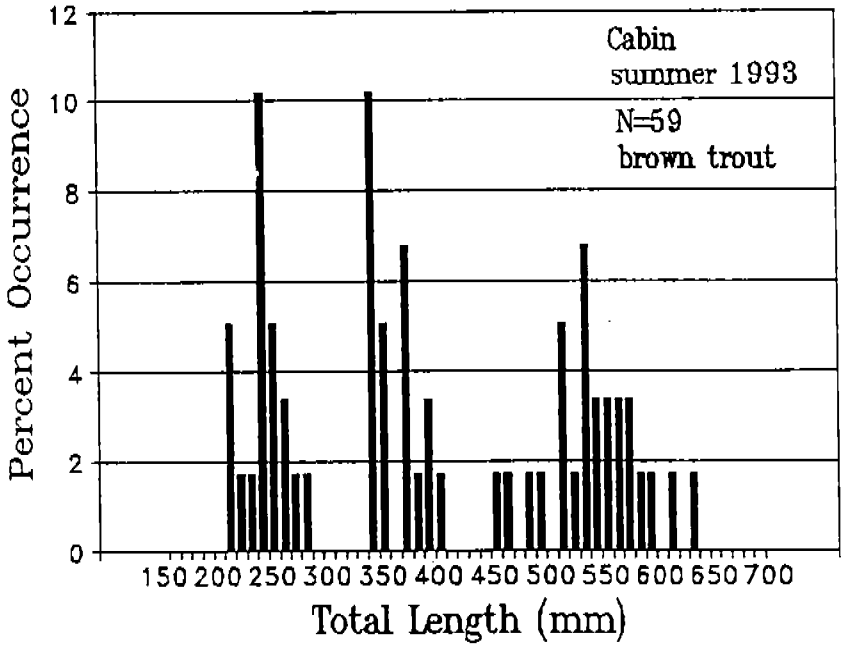
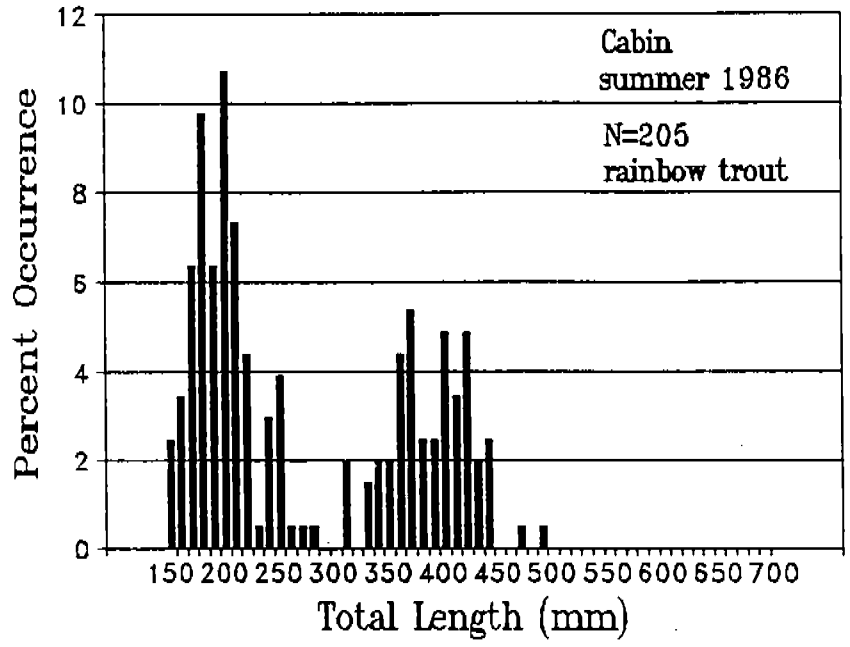


Figure 9. Length-frequency histograms for brown trout sampled in the Cabin electrofishing site during summer 1986 and summer 1993.



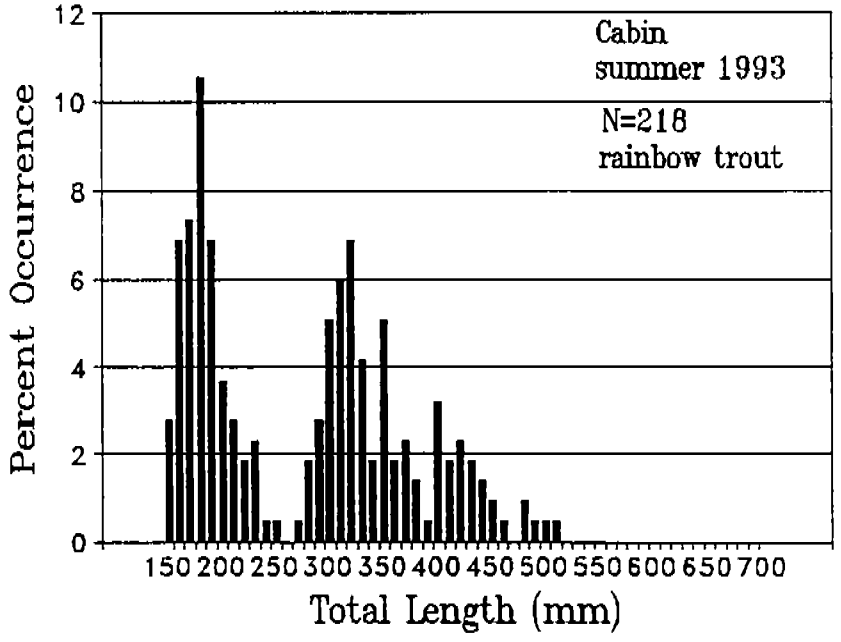
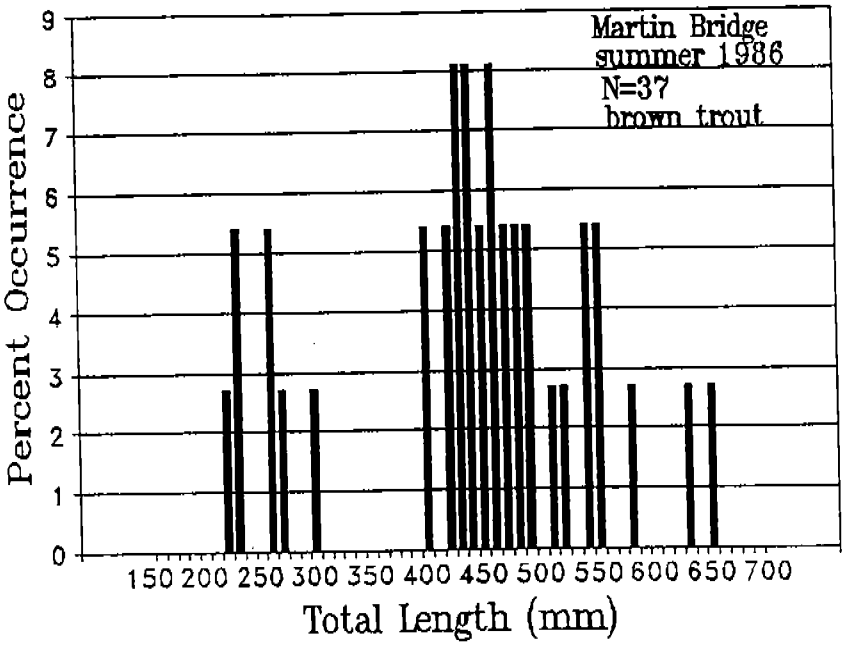


Figure 10. Length-frequency histograms for rainbow trout sampled in the Cabin electrofishing site during summer 1986 and summer 1993.



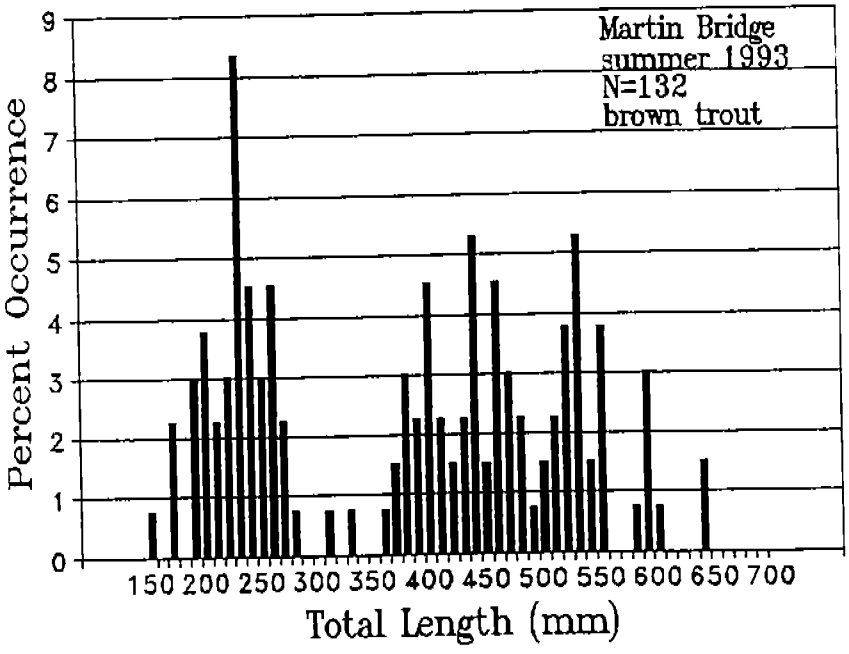


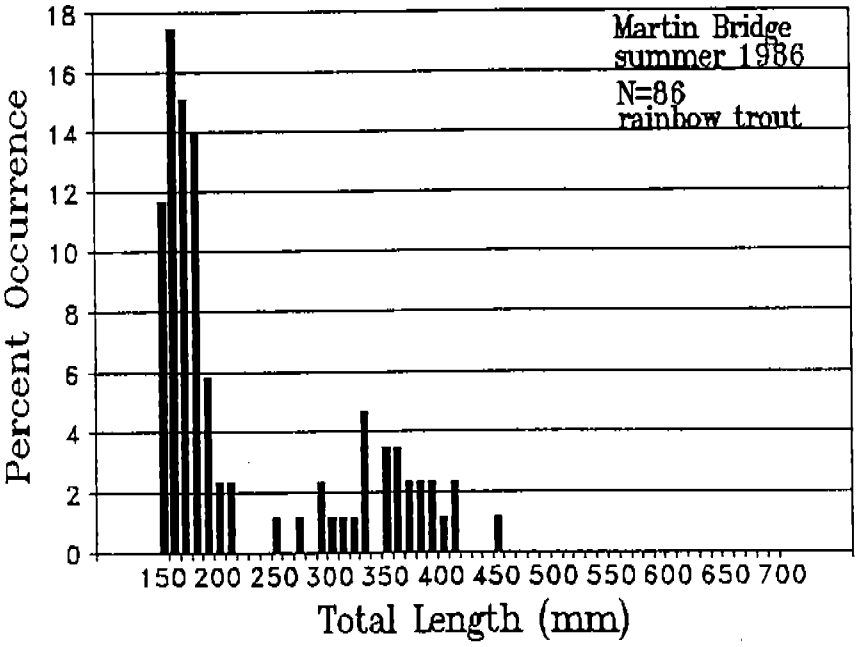
Figure 11. Length-frequency histograms for brown trout sampled in the Martin Bridge electrofishing site during summer 1986 and summer 1993.

reproducing successfully. The rainbow trout length-frequency histograms for the Martin Bridge site indicate that a dramatic change has occurred since 1986 (Figure 12). Rainbow trout < 200 mm total length made up 64% of the sample in 1986 but decreased to 16% of rainbow trout sampled in 1993. It is interesting to note that the Martin Bridge and Lower Stalker sites experienced the largest increases in brown trout density and biomass of the five sites sampled.

Fall

Brown trout length-frequency histograms for the Cabin site for fall 1992 revealed that fish < 200 mm comprised approximately 22% of the sample while accounting for 62% of the brown trout sampled in 1986 (Figure 13). Apparent from these histograms is the large increase in the number of fish in the 250-350 mm and 450-600 mm size ranges. Length distributions for rainbow trout in the Cabin site suggest a rather different situation than that for brown trout (Figure 14). These distributions show that in 1992 fish in the 200-300 mm range comprised a much larger fraction of the sample than they did in 1986. In 1986 and 1992 rainbow trout < 300 mm accounted for 38% and 84% of the sample, respectively.

Of 111 brown trout captured in the Martin Bridge site in 1986, approximately 6% were < 250 mm total length (Figure 15). In fall 1992, about 45% (n=258) of the brown trout sampled were < 250 mm (Figure 15). The number of smaller brown trout in this site appears to have increased considerably since 1986. From the



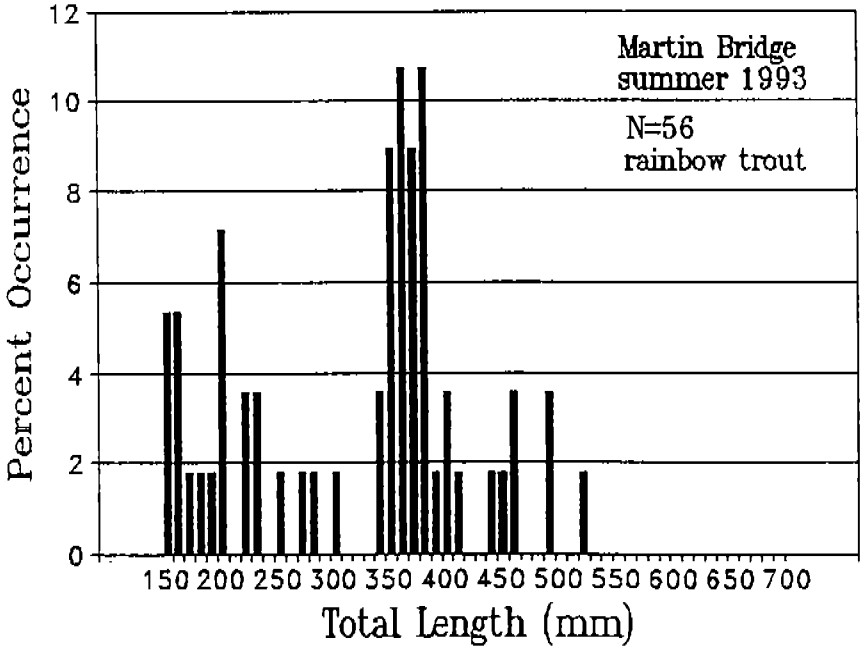
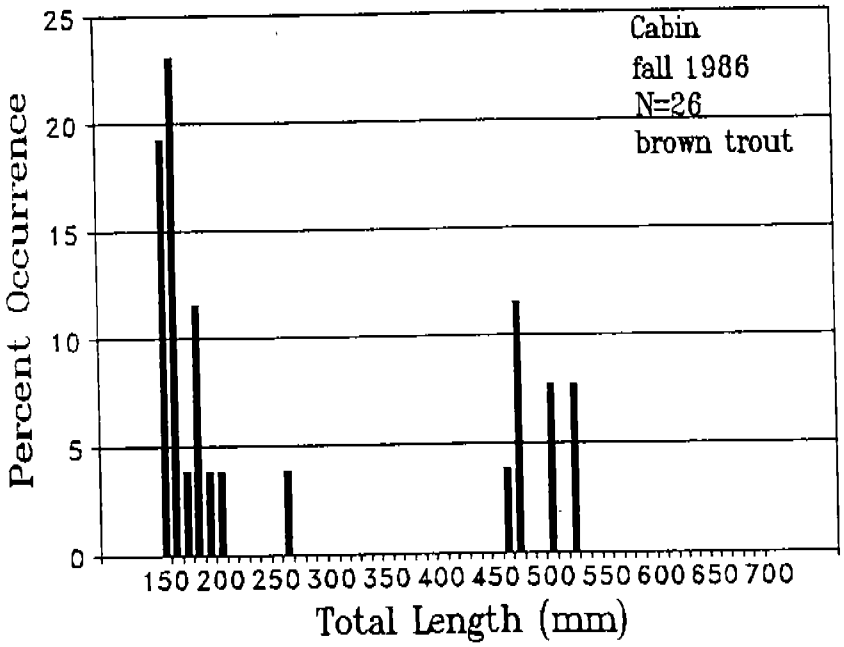


Figure 12. Length-frequency histograms for rainbow trout sampled in the Martin Bridge electrofishing site during summer 1986 and summer 1993.



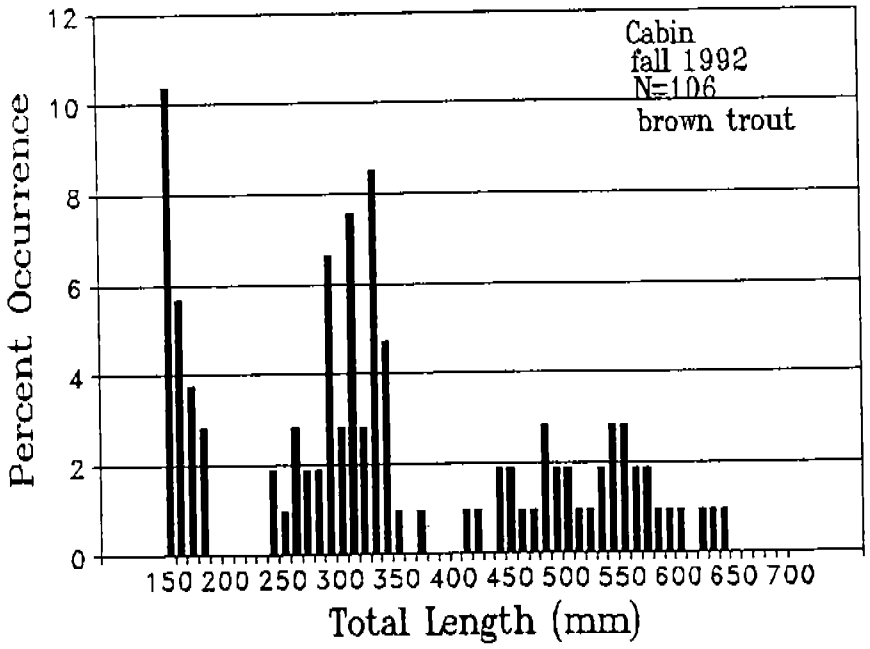
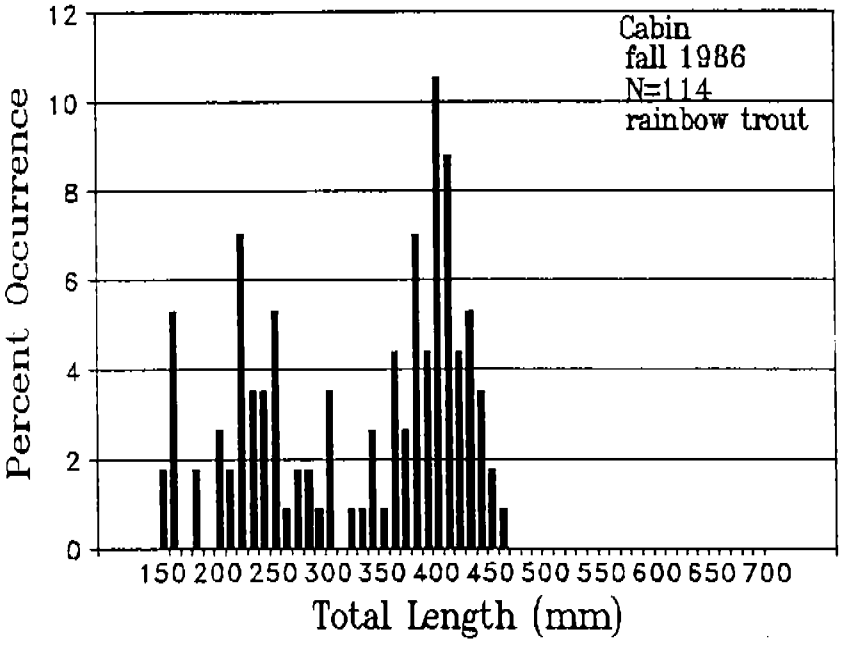


Figure 13. Length-frequency histograms for brown trout sampled in the Cabin electrofishing site during fall 1986 and fall 1992.



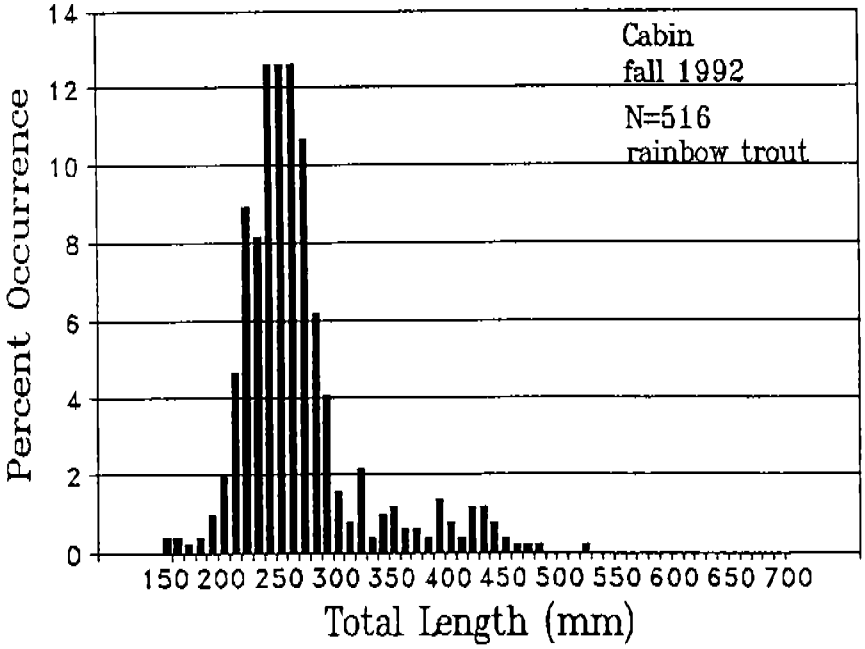
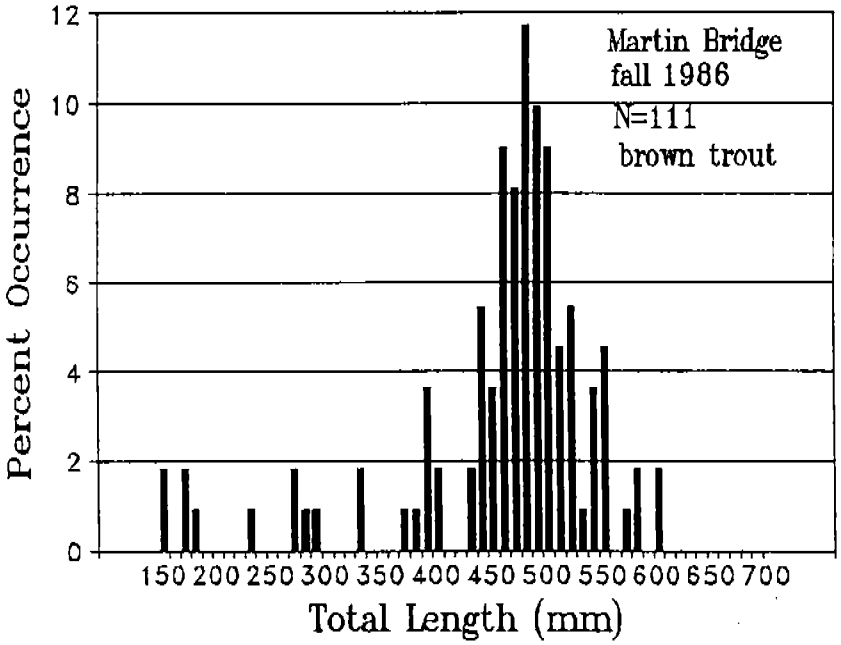


Figure 14. Length-frequency histograms for rainbow trout sampled in the Cabin electrofishing site during fall 1986 and fall 1992.



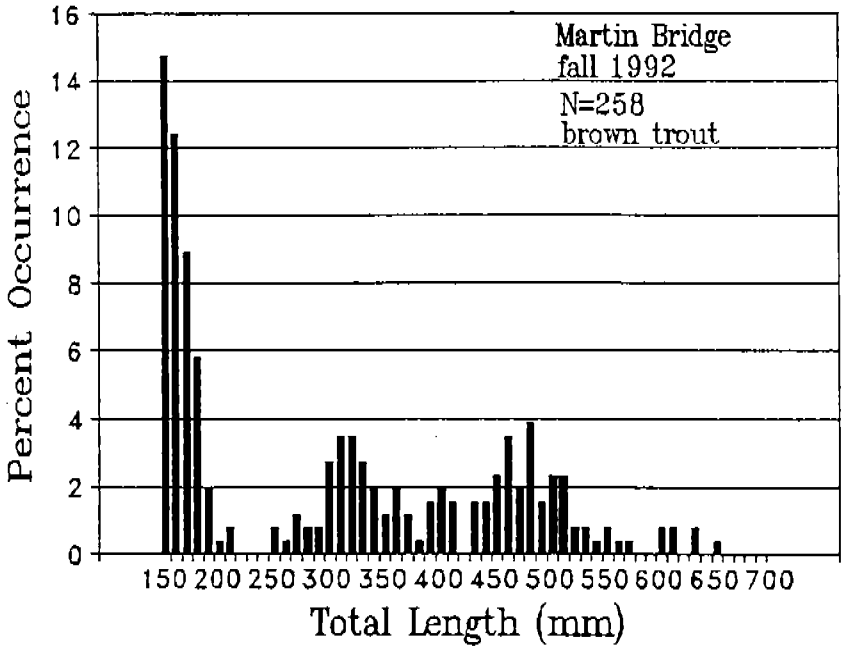


Figure 15. Length-frequency histograms for brown trout sampled in the Martin Bridge electrofishing site during fall 1986 and fall 1992.

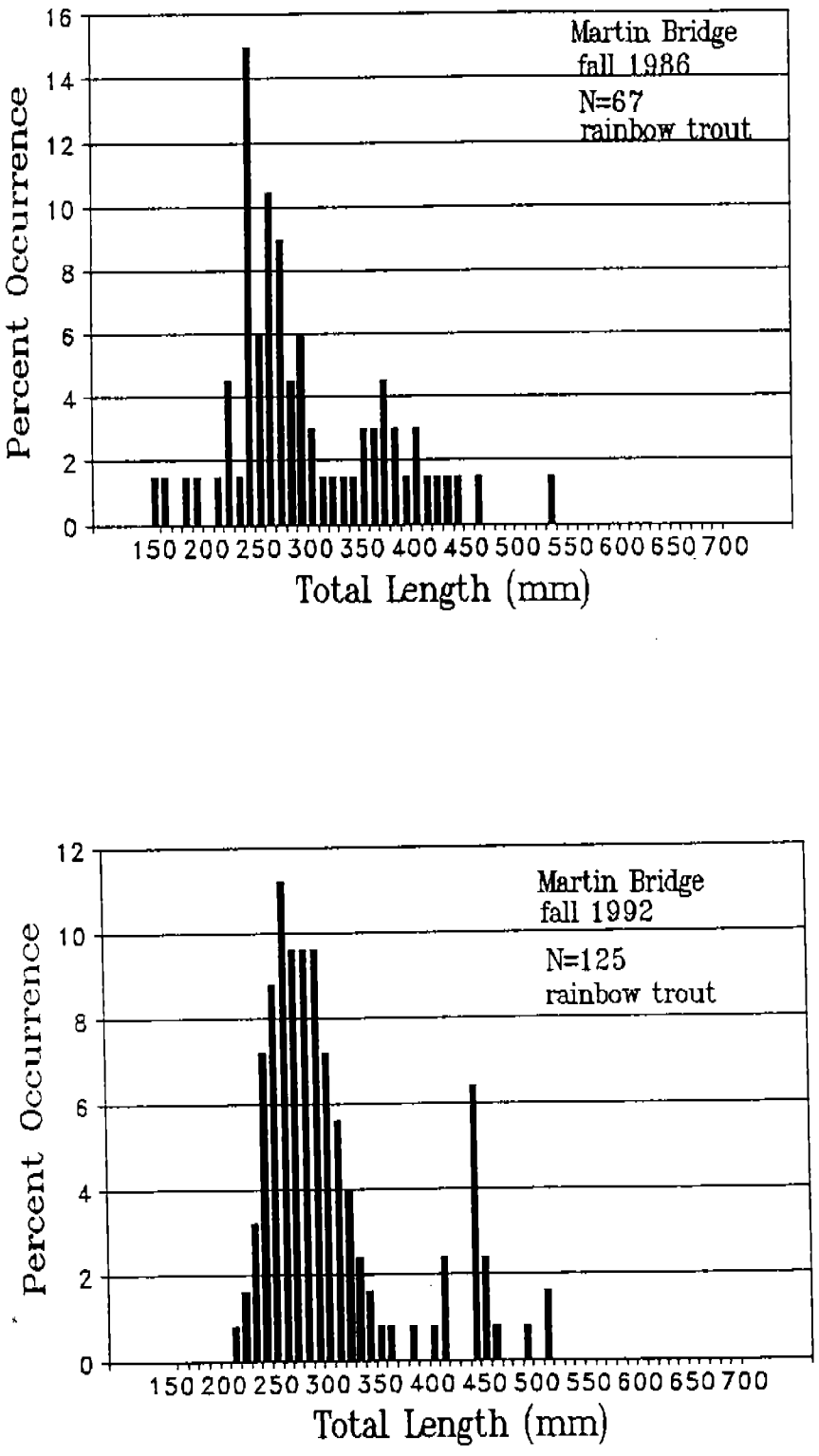


Figure 16. Length-frequency histograms for rainbow trout sampled in the Martin Bridge electrofishing site during fall 1986 and fall 1992.

length-frequency histograms for rainbow trout in the Martin Bridge site, it does not appear that there has been considerable change in the length distribution since 1986 (Figure 16). Rainbow trout < 300 mm comprised 64% and 61% of the sample in 1986 and 1992, respectively.

Diet of Large Brown Trout

Methods

Diet sampling of large (>300 mm) brown trout, and to a lesser extent smaller brown trout, was conducted in June, August, and October, 1993 and February, 1994. Brown trout were collected by electrofishing in three sites that differed primarily in terms of the composition of potential prey fish species (<200 mm) available to brown trout. A pulsed gastric lavage technique, traditionally used with smaller fish, was modified and successfully used on brown trout ranging in size from 220-720 mm total length. In the field, stomach contents were flushed, collected, and preserved for later examination. Total length, weight, and sex were recorded for all brown trout sampled.

A diagnostic bone key for all fish species in Silver Creek was developed to aid in identification of partially digested fish in the stomachs of brown trout. The key was constructed by collecting prey species (rainbow trout, brown trout, brook trout, mountain whitefish, longnose dace (Rhinichthys cataractae), speckled dace (Rhinichthys osculus), bridgelip sucker (Catostomus

columbianus), piute sculpin (Cottus beldingi), Wood River sculpin (Cottus leiopomus), redside shiner (Richardsonius balteatus)) < 200 mm and creating sketches of bones that have been found to persist during digestion. The key was used to identify fish in the gut of brown trout and to back-calculate their original lengths based on measurements taken on the diagnostic bones. Bone keys have been used successfully for identification to the species level in other predation studies where the number of prey species was three to four times the number present in Silver Creek.

Brown trout larger than 350 mm captured for diet sampling during each period were tagged with a small alpha-numeric plastic tag to allow for identification of individual fish in later samples. Additionally, brown trout larger than 450 mm captured during abundance sampling were tagged with a visible implant tag. The 1 mm x 3 mm biocompatible plastic tag was injected near the posterior margin of the fish's eye in the clear adipose tissue. Tagged fish were also adipose fin-clipped for easier researcher and angler identification. Additionally, the location of capture, length, weight, and sex were recorded for all tagged fish.

Preliminary Results

Brown trout stomach samples from June, August, and October were analyzed to determine the percent (by number) of brown trout that had consumed fish, invertebrates, or were empty (Figure 17). The proportion of brown trout consuming fish declined from 46% in

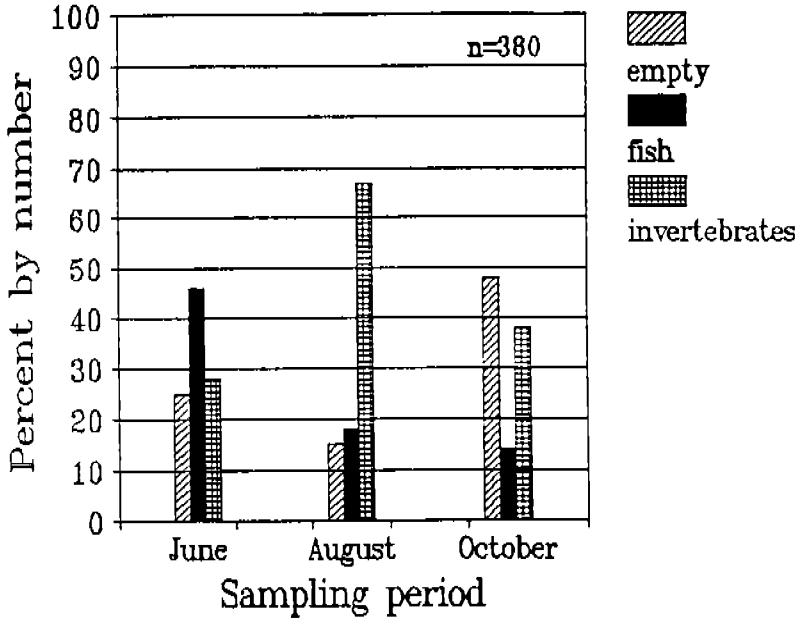


Figure 17. Percentage of brown trout stomach samples from three sampling periods which contained invertebrates or fish or were empty. Stomach samples which contained invertebrates and fish were grouped with brown trout that had consumed only fish.

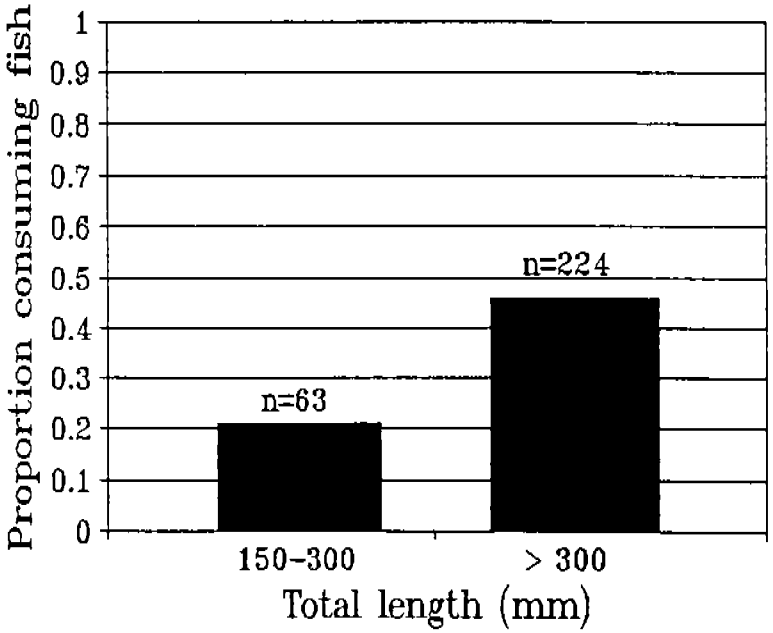


Figure 18. Proportion of brown trout < 300 mm and > 300 mm that contained fish in their stomachs for June, August, and October samples combined.

June to 18% in August and declined again to 14% in October. The percentage of fish that had consumed invertebrates increased from 28% in June to 67% in August and declined to 38% in October. In June, a greater percentage of brown trout had consumed fish than had consumed invertebrates or were empty. In August, a greater percentage of the fish sampled were consuming invertebrates than were consuming fish or were empty. The largest percentage of brown trout sampled in October were empty (48%) followed by fish that had eaten invertebrates (38%) and fish (14%). Males, in particular, appeared to be empty more often than females.

Stomach contents from brown trout for June, August, and October were examined to determine the extent of piscivory in brown trout smaller than 300 mm and greater than 300 mm. From a sample of 224 brown trout > 300 mm, 46% had consumed fish while only 21% of the 63 brown trout < 300 mm sampled had consumed fish (Figure 18).

Fish species composition in the diet of brown trout for the three sampling periods in 1993 was examined by determining the percent by number that nongame fish and each game species comprised in stomach samples from 202 brown trout that had consumed fish (Figure 19). Nongame fish species became less abundant in the diet, decreasing from 98% of the fish consumed in June to less than 45% of the fish consumed in October. Rainbow trout were not present in any of the fish sampled in June but comprised 23% of the fish eaten in August and 39% of fish eaten in October. Except for brown trout in August, brook trout, brown trout, and whitefish each comprised less than 10% of the fish

consumed in all three months. Brown trout accounted for 14% of the fish consumed in August.

Evaluation of the composition of fish in the diet of brown trout for each of the three sites separately revealed that brown trout from the Martin Bridge site consumed only nongame fish in June, August, and October (Figures 20-22). Nongame fish comprised 86% of the fish consumed by brown trout in the Lower Stalker site in June while comprising 44% and 27% in August and October, respectively. The increase in the occurrence of game fish in the diet in Lower Stalker from June to October coincided with an increase in the percent composition of rainbow trout in the diet. Rainbow trout were not found in samples collected in June but comprised 33% of the fish consumed in August and 45% of the fish consumed in October. A similar situation was observed in the Kennedy site for August and October samples. Nongame fish accounted for about 30% of the fish consumed in the Kennedy site in August and October. Rainbow trout comprised 20% of the fish eaten by brown trout in the Kennedy site in August and 57% of the fish consumed in October.

Additional brown trout diet samples were collected in February 1994. These data are currently being analyzed and will be presented, along with April 1994 samples, in a final report to be submitted upon completion of the project.

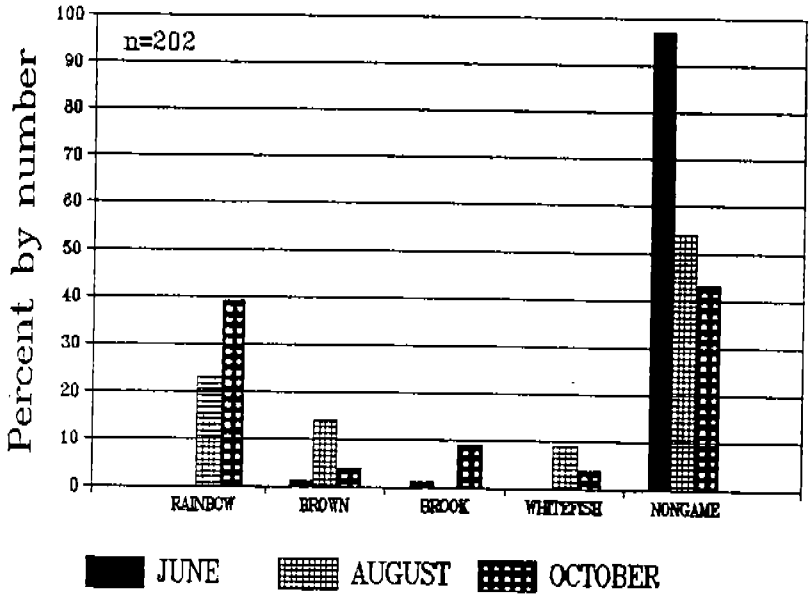


Figure 19. Fish species composition in the brown trout diet (n=98) for three sampling periods in 1993. Nongame species have been combined.

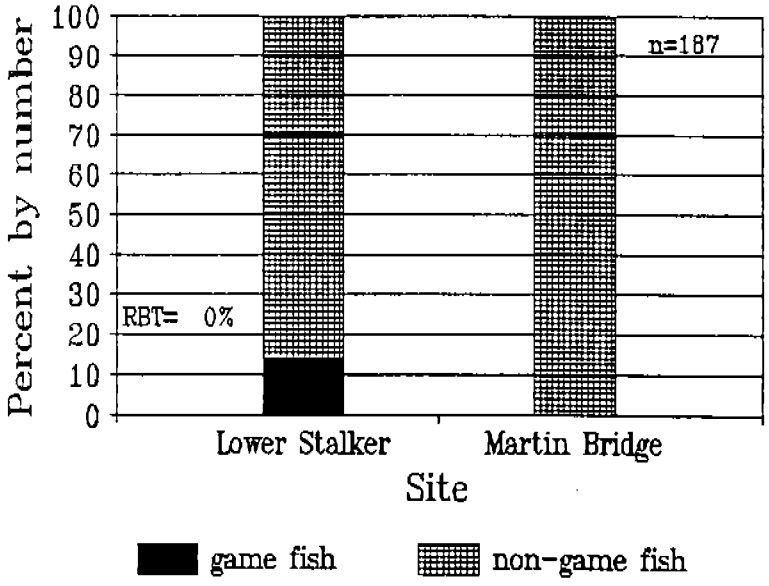


Figure 20. Composition (percent by number) of fish in the diet of brown trout (TL > 200 mm; n=76) from two diet sampling sites for June 1993 in Silver Creek, Idaho.

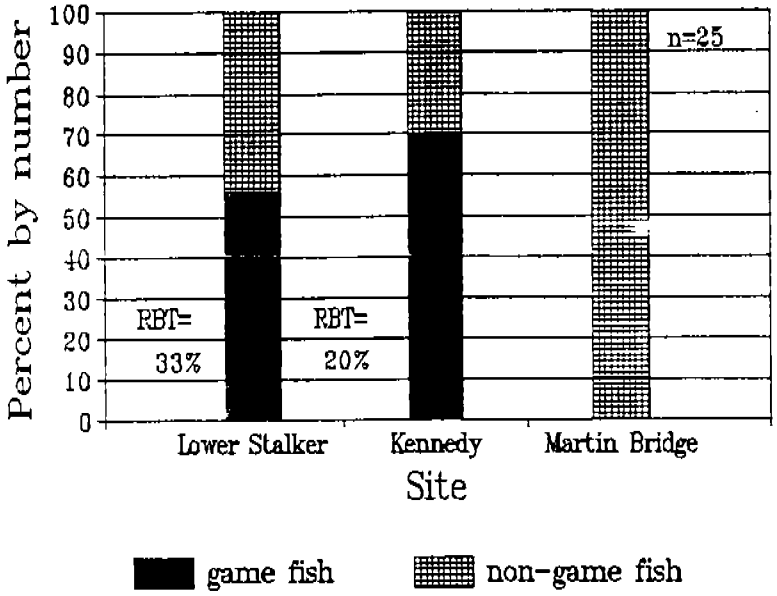


Figure21. Composition (percent by number) of fish in the diet of brown trout (TL > 200 mm; n=16) from three diet sampling sites for August 1993 in Silver Creek, Idaho.

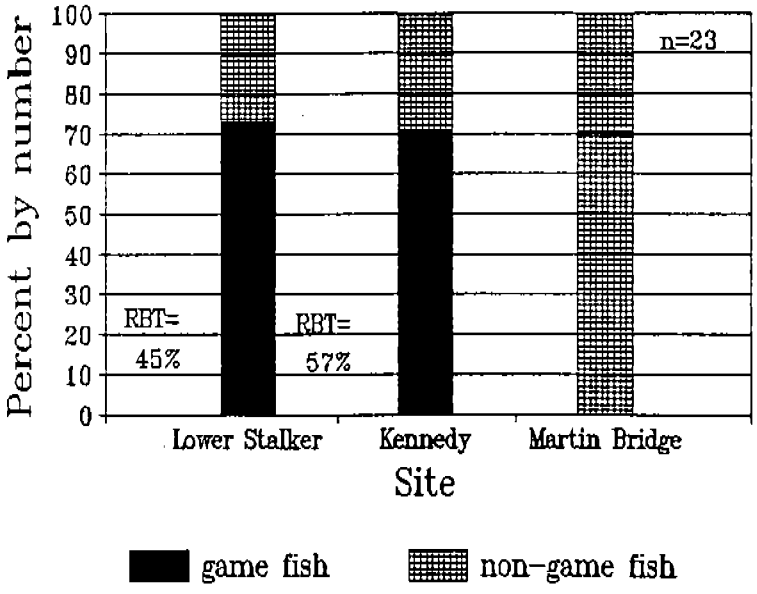


Figure22. Composition (percent by number) of fish in the diet of brown trout (TL > 200 mm; n=21) from three diet sampling sites for October 1993 in Silver Creek, Idaho.

Prey Fish Species Composition and Abundance

The percent composition (by number) of potential game and nongame prey fish species for brown trout in each of the three diet sampling sites was estimated in summer and fall 1993 (Figures 23 & 24) by snorkeling and electrofishing representative 80 m reaches within each site. These data indicate that nongame species account for the largest fraction of the prey fish species in the Martin Bridge site in summer and fall. Nongame species in this site comprised as much as 85% of the potential prey species by number. In Lower Stalker and Kennedy sites, on the other hand, game species made up 50% or more of the potential prey species in August and November. Game species in the Lower Stalker site in November accounted for 82% of the prey species present.

The density (number of fish/100 m^2) of rainbow, brown, and brook trout < 200 mm total length was estimated in the three diet sampling sites in August and November 1993 (Figures 25 & 26). Rainbow trout densities decreased in the Lower Stalker and Kennedy sites from August to November, while brown trout density did not change in the Lower Stalker site and decreased in the Kennedy site over this same period. Brook trout density in these two sites was essentially unchanged from August to November. In the Martin Bridge site, rainbow trout density increased from 1.4 fish/100 m^2 in August to 2.2 fish/100 m^2 in November (Figure 27). Brown trout density also increased in this site from 1.6 fish/100 m^2 in August to 4.4 fish/100 m^2 in November.

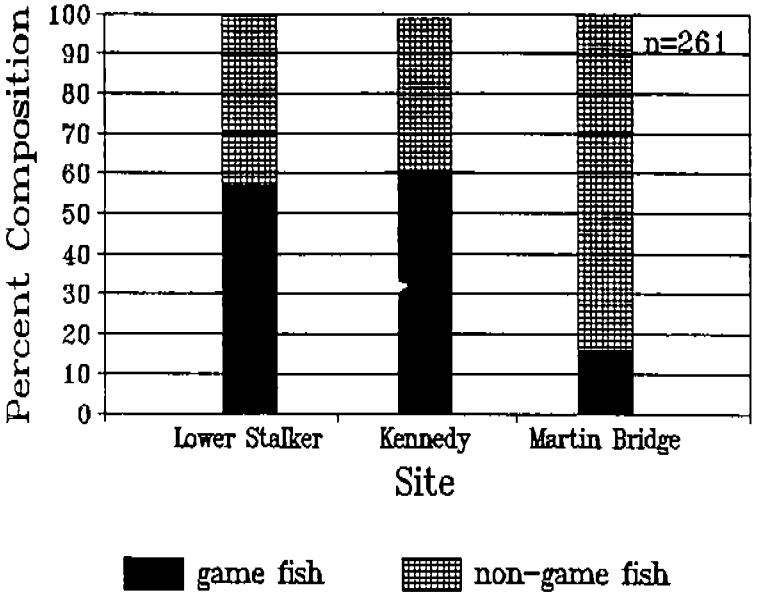


Figure 23. Composition (percent by number) of potential prey fish species (< 200 mm) for brown trout in three diet sampling sites for summer 1993 in Silver Creek, Idaho.

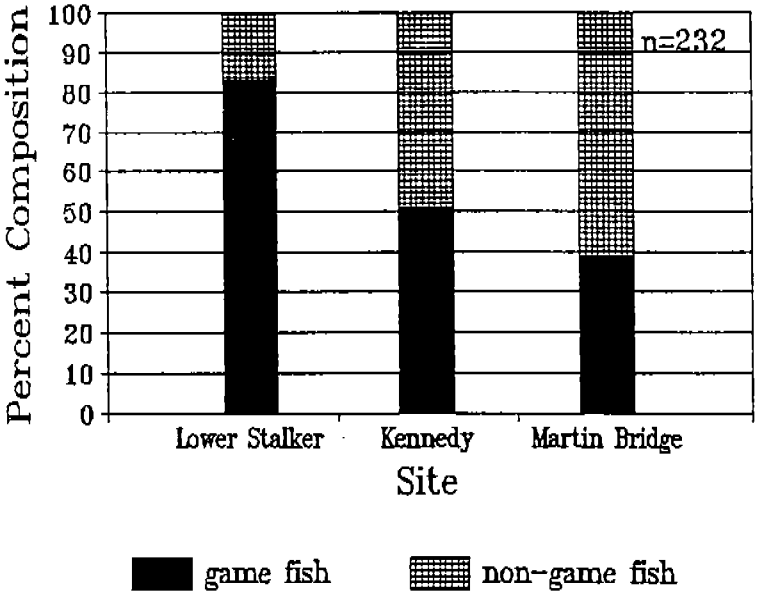


Figure 24. Composition (percent by number) of potential prey fish species (< 200 mm) for brown trout in three diet sampling sites for fall 1993 in Silver Creek, Idaho.

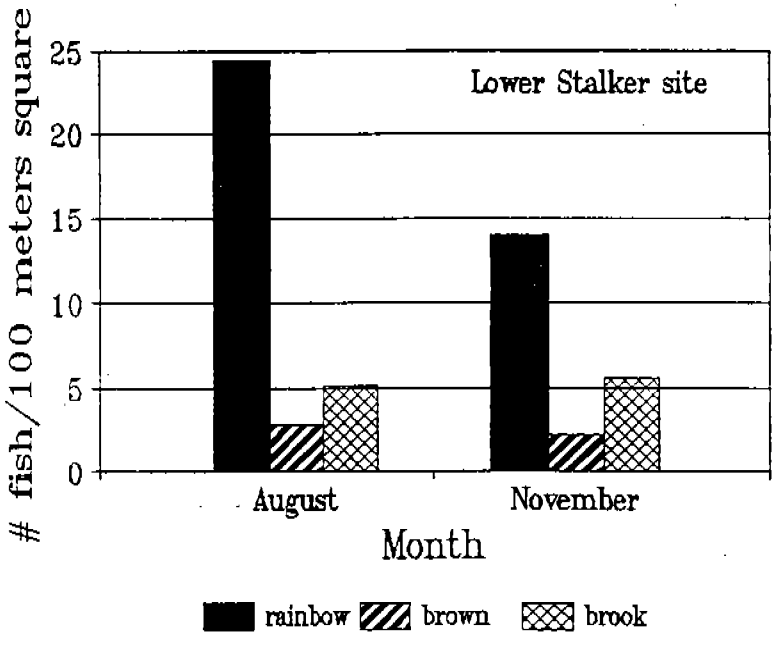


Figure 25. Density estimates (# fish/100 m^2) for rainbow, brown, and brook trout < 200 mm total length in the Lower Stalker diet sampling site for August and November 1993.

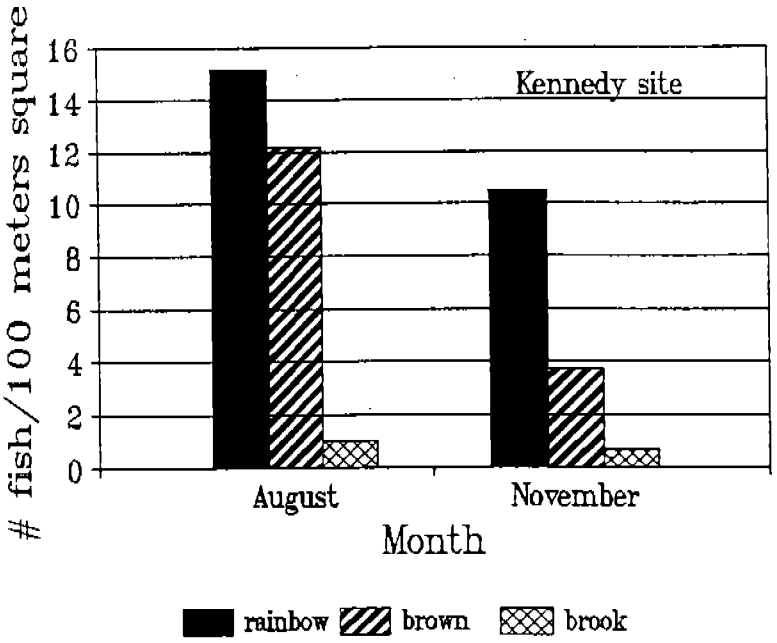


Figure 26. Density estimates (# fish/100 m^2) for rainbow, brown, and brook trout < 200 mm total length in the Kennedy diet sampling site for August and November 1993.

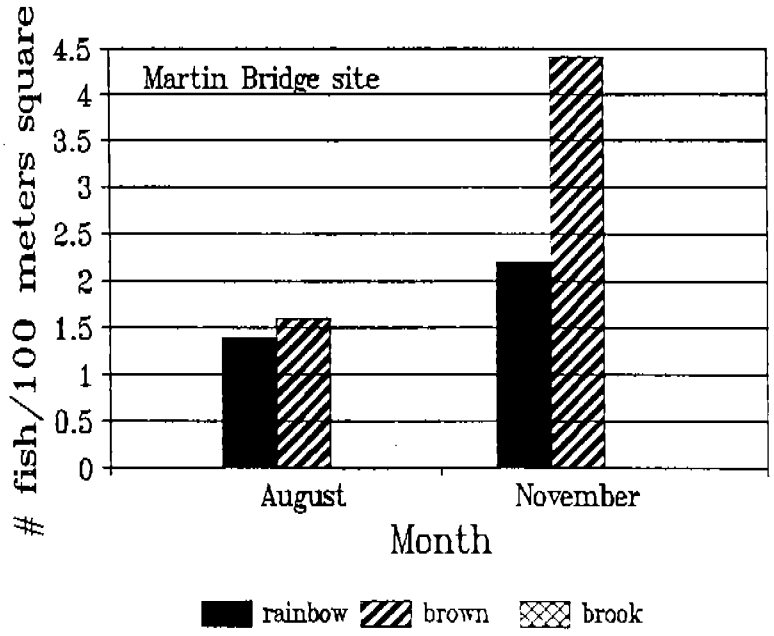


Figure 27. Density estimates (# fish/100 m^2) for rainbow, brown, and brook trout < 200 mm total length in the Martin Bridge diet sampling site for August and November 1993.

Prey species composition and abundance sampling in the three sites was conducted in February 1994 and will again be performed in April 1994. Data from these samples will be included in the final report to be submitted at the conclusion of the project.

Species Interactions

In July 1993, pilot experiments were conducted in Silver Creek to evaluate whether large, piscivorous brown trout might affect microhabitat use of smaller fish species that could serve as potential prey for the larger fish. These early observations suggest that, indeed, predatory brown trout are affecting the microhabitat use of smaller fish in the Silver Creek study sections. If these smaller fish are forced to use habitat that is less profitable than habitat they would use in the absence of large brown trout, survival of these smaller fish may be affected to a significant degree.

In summer 1994, the feasibility of conducting an experiment to test for these potential effects will be determined.

Redd Counts

Redds were observed from the bank and by floating in a rubber raft during fish abundance sampling in 1992-93. While floating in the raft, observers standing on the raft frame were

able to see redds clearly and could enumerate them. However, there was some uncertainty as to which species an individual redd belonged because there were three species spawning at nearly the same time in the fall (brown trout, brook trout, fall-spawning rainbow). Fall-spawning rainbow trout did not appear to be particularly abundant in Silver Creek, however, several ripe individuals were collected in fall 1992 and researchers observed rainbow trout near or over redds at this same time.

The feasibility of gathering accurate species redd counts and the utility of these data was determined to be minimal. As such, counts of redds were not performed in fall 1993. Because of our interest in brown trout reproduction in Silver Creek, the reproductive condition of adult brown captured while electrofishing in fall 1992 were recorded. These data might provide limited insight into the extent of brown trout reproduction, assuming that spawning habitat is not a limiting factor.