

**EFFECTS OF THE  
1988 RED BENCH FIRE  
on the  
FISH OF GLACIER NATIONAL PARK**

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## INTRODUCTION

Glacier National Park is located astride the Continental Divide in the Rocky Mountains of northwestern Montana, and contains nearly 4,144 square kilometers of rugged mountain country. Nestled among the high peaks are approximately 50 small glaciers and more than 300 lakes. More than 2,414 kilometers of streams form drainages that flow northward to Hudson Bay, eastward to the Gulf of Mexico and westward to the Pacific Ocean.

During 1988, the Northern Rockies of Montana and Wyoming experienced large wildfires that burned over 809,400 hectares. One of these fires, the Red Bench Fire, occurred within the North Fork basin of the Flathead River in northwestern Montana. The burned area extended over nearly 155 square kilometers and encompassed both intensively managed timber lands of the Flathead National Forest as well as pristine lands of Glacier National Park. Many areas within the Glacier National Park burn experienced very hot fire conditions. Temperatures in some high intensity burn areas were hot enough to cause crystallization of the upper soil horizons and these areas tended to occur in creek bottoms. These intense burn areas produced highly erodible soils and riparian areas where the canopy and understory were completely burned to the ground resulting in increased sediment and nutrient transport and increased solar radiation.

## STUDY AREA

On September 6, 1988, the Red Bench Fire broke out on the Flathead National Forest west of the North Fork of the Flathead River. Blown by strong northwest winds, the fire grew and jumped the North Fork and burned into Glacier National Park. The fire burned through parts of three major drainages in the Park; Akokala, Bowman and Quartz Creeks. Akokala and Bowman Creeks both had similar burn patterns with severe burning in the lower sections and no burning in the upper reaches. Quartz Creek suffered no burning in the lower sections and various burning in the upper reaches (Figure 1.).

The Akokala Creek drainage has 64 kilometers of stream and 9.3 hectares of lakes. The stream drains southwesterly into the North Fork. The upper section, Station 1, was above the burn line. The substrate was mostly gravel, cobble and rubble. There was abundant woody debris throughout the section. The entire section was well shaded by large conifers, large deciduous trees and shrubs. The study section is 100 meters in length below the West Lakes Trail bridge. The section is accessed by backpacking approximately 5.3 kilometers on the West Lakes Trail from the Bowman Lake Campground to the bridge across Akokala Creek.

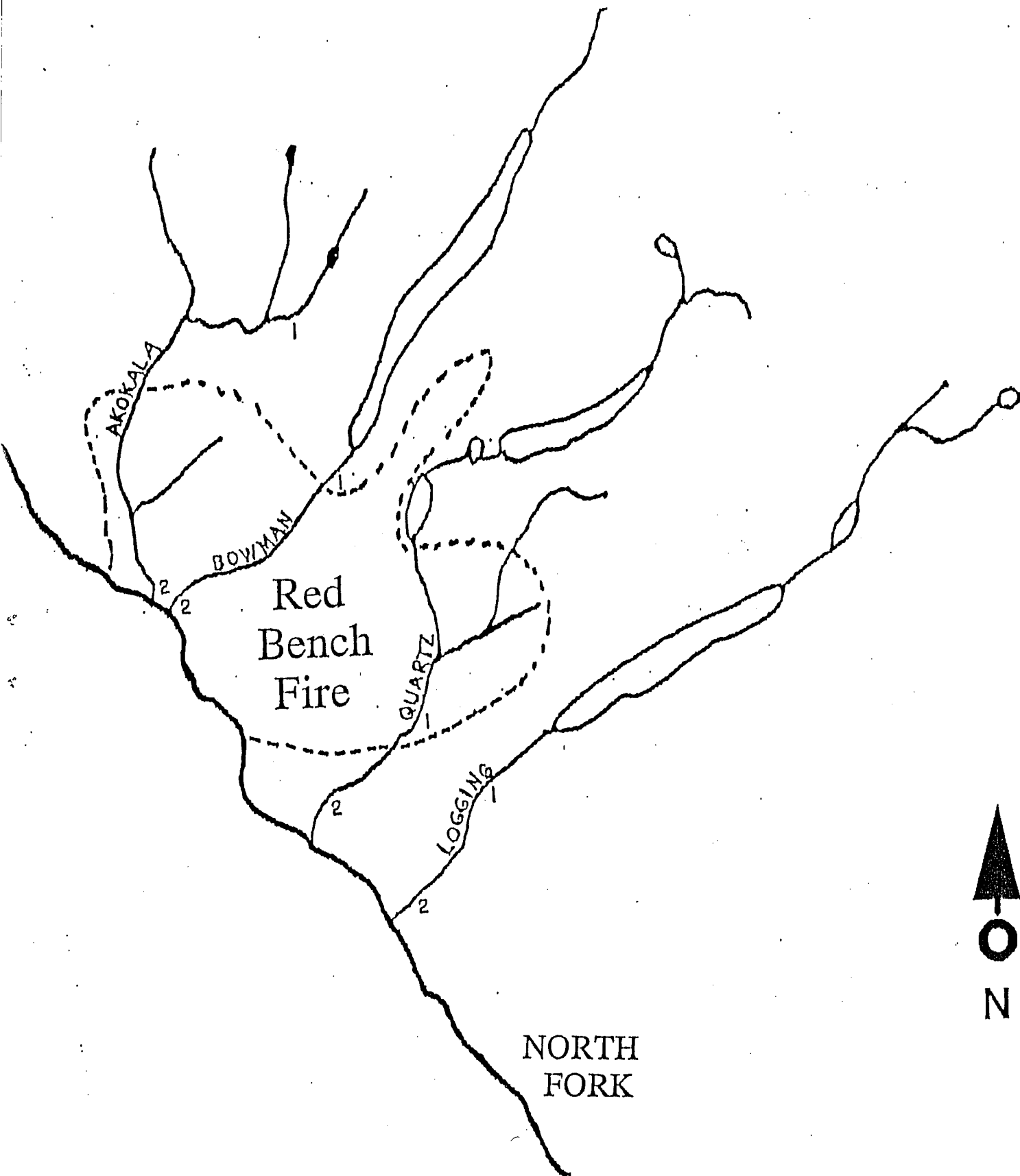


Figure 1. Map of study area.

Akokala Station 2, the lower section, is upstream of the bridge on Glacier Route 7, the Inside North Fork Road, and is also 100 meters long. The stream is slower moving in this area and the bottom consists mainly of gravel, sands and silts with smaller amounts of rubble and cobble. Many large burned conifers had fallen across the stream in this area forming many large debris tangles. Large pools were present at bends in the creek. The stream banks were undercut throughout the section but seemed quite stable. The banks rose vertically two to four feet, then leveled off into a flat blackened landscape. The fire burned hot through this area. There were no live trees left and many of the trees had burned to the ground. During the summer of 1989 the soil was bare, by the summer of 1991, weeds and grasses had come back thick and tall, especially fireweed. By 1992, small conifers less than 20 cm tall, were apparent everywhere.

The Bowman Creek drainage has 67.6 kilometers of stream and 749 hectares of lakes, and drains southwesterly into the North Fork. Of the four streams sampled in this investigation, Bowman Creek is the largest and has the steepest gradient, about two percent. Both study sites were in the stretch of stream between the Bowman Lake and the North Fork of the Flathead River. The substrates in this stretch consist mainly of boulder and rubble with smaller amounts of gravel. The combination of velocity, depth and substrate made this stream very dangerous to electrofish so we scrubbed the fish population survey attempts.

The Quartz Creek drainage has 64 kilometers of stream and 486 hectares of lakes, and drains southwesterly into the North Fork of the Flathead River. The riparian areas in the lower reach of the stream did not burn. The fire burned across Quartz Creek in an area between Cummins Meadows and Lower Quartz Lake. Section 1, the upper section was established on the burn line. The substrate in this section consisted mostly of gravel, rubble and boulder. There were numerous debris piles in the stream composed of burned trees. The streamside vegetation in the section was mostly burned, standing, dead conifers interspersed with an occasional live tree. Many of the willows and alders adjacent to the water escaped the fire. This section is accessed by backpacking up the Quartz Lake Trail to the burn line, approximately 3.9 kilometers.

The lower section on Quartz Creek is upstream of the bridge on Glacier Route 7 adjacent to the Quartz Creek Campground. The stream bottom is composed mostly of rubble, gravel and boulder. There were large logs and woody debris throughout the section. The streamside vegetation was fairly dense consisting of large conifers, large and small deciduous trees and shrubs, mostly willows, alders and cottonwoods, and heavy deadfall.

The Logging Creek drainage has 48 kilometers of stream and 501 hectares of lakes, and flows southwesterly into the North Fork. Logging Creek was untouched by the Red Bench Fire but was selected as a control-comparison due to its similarity and proximity to the Quartz Creek drainage. The upper section, Station 1, was accessed

by backpacking up the Logging Lake Trail approximately 4 kilometers. The stream substrate consisted mostly of rubble and gravel with an occasional boulder. The section had two small debris tangles and two large logs across the stream. Streamside vegetation was dense, consisting of large and small conifers and deciduous trees and shrubs, many of the shrubs overhung the creek making electrofishing difficult.

The lower section, Station 2, is adjacent to the Logging Creek Campground. The stream bottom was mostly rubble, boulder and gravel. There was a small amount of woody debris in the section, a few small logs jutting from the stream banks. Both banks were heavily wooded with conifers and deciduous trees and shrubs with many of the alders and willows overhanging the water.

## METHODS

On all streams the sections are 100 meters in length. The lower sections along the Inside North Fork Road (Glacier Route 7) correspond with sampling stations monitored by the U.S. Fish and Wildlife Service in 1977. The sections were electrofished with a Coffelt BP 1-C backpack electrofisher using pulsed DC electricity and a two-pass removal method (Leathe 1983) to estimate fish populations. All captured fish were measured to the nearest 1 mm and weighed to the nearest 2 grams. Because only a single electrofishing pass was made on the lower sections in 1977, population size could not be estimated. Macroinvertebrate samples were collected in the same sections on the same streams, the results are reported in separate reports (Mangum 1990, 1992).

## RESULTS

### Akokala Creek, Station 1, Upstream Section:

In 1989, 22 westslope cutthroat trout were captured in the section, the population was estimated at 357 cutthroat trout per mile. Mean total length of all cutthroat was 106 mm. Mean weight and condition factor (K) for all cutthroat were 13 grams and 1.09, respectively. Cutthroat biomass was estimated at 0.5 g/m<sup>2</sup>, water temperature was 11.1° C.

In 1990, only four westslope cutthroat trout were captured in this section. The population was estimated to be 72 cutthroat trout per mile. Mean total length was 150 mm. Mean weight and condition factor (K) were 47 grams and 1.39, respectively. Cutthroat biomass was estimated to be 0.33 g/m<sup>2</sup>, water temperature was 11.2° C.

In 1991, four westslopes were captured. The population was estimated at 64 trout per mile. Mean total length was 109 mm. Mean weight was 17 grams, condition factor (K) was 1.31. One mountain whitefish weighing 140 grams and 257 mm long was also captured in 1991. Cutthroat biomass was estimated at 0.12 g/m<sup>2</sup> and water temperature was 9.1° C.

In 1992, 33 cutthroat trout were captured in this section. The population was estimated to be 537 cutthroat trout per mile but the probability of capture was only 0.3. Mean total length was 78.5 mm, mean weight was 5.8 grams and condition factor (K) was 1.2. Cutthroat biomass was estimated to be 0.34 g/m<sup>2</sup> and water temperature was 12.8° C.

Shorthead sculpins have been captured in this section every year.

#### Akokala Creek, Station 2, Downstream Station:

In 1977, nine westslope cutthroat trout were captured in the section. Mean total length was 97 mm. Mean weight and condition factor (K) were 9.5 grams and 1.04, respectively. No population estimate was made. One mountain whitefish was captured weighing 85 grams and 217 mm long. Cutthroat biomass was estimated to be 0.13 g/m<sup>2</sup>. One shorthead sculpin was also caught.

In 1989, one westslope cutthroat trout was captured weighing 10 grams and 108 mm long with a condition factor (K) of 0.79. One mountain whitefish was captured weighing 190 grams and 268 mm long with a K factor of 0.99. A single rainbow trout was captured weighing 8 grams and 100 mm in length with a K factor of 0.8. Two small largescale suckers were captured in the section, one in the first pass, one in the second pass. No salmonids were caught in the second pass. Population was estimated for westslope cutthroat trout, rainbow trout and mountain whitefish at 16.1 fish per mile for each species. Cutthroat biomass was estimated at 0.02 g/m<sup>2</sup>, water temperature was 14.7° C.

In 1991, four westslope cutthroat were captured. Mean total length was 85 mm. Mean weight and K factor were 7.7 grams and 1.25, respectively. Population was estimated at 64 trout per mile but the probability of capture was only 0.5. One mountain whitefish was caught with a weight of 180 grams, length of 280 mm and K factor of 0.82. Cutthroat biomass was estimated to be 0.06 g/m<sup>2</sup>, water temperature was 11.7° C. Three shorthead sculpins were also captured.

In 1992, 7 cutthroat trout were captured in this section. The population was estimated at 85 cutthroat trout per mile. Mean total length was 86.7 mm, mean weight was 88.6 grams and condition factor (K) was 1.32. Cutthroat biomass was estimated to be 0.11 g/m<sup>2</sup>, water temperature was 13.9° C. Forty-nine shorthead sculpins were also captured.

#### Quartz Creek, Station 1, Upstream Station:

In 1990, one westslope cutthroat was captured. Total length was 105 mm, weight was 12 grams and K was 1.04. Population was estimated at 16 cutthroat trout per mile. Two shorthead sculpins were also captured at this site. Cutthroat biomass was estimated to be 0.02 g/m<sup>2</sup>, water temperature was 20.6° C.

In 1991, one westslope cutthroat trout was captured. Total length was 188 mm, weight was 60 grams and K was 0.9. Population was estimated at 16 westslope cutthroat trout per mile. Three mountain whitefish were captured in this section. Mean total length was 137 mm, mean weight was 46 grams and mean K was 1.8. The population was estimated at 32 mountain whitefish per mile. Six shorthead sculpins were also captured at this site. Cutthroat biomass was estimated to be 0.09 g/m<sup>2</sup>, water temperature was 16.4° C.

In 1992, 43 cutthroat trout were captured in this section. The population was estimated to be 72 cutthroat trout per mile, but the probability of capture was 0.3. Mean total length was 62 mm, mean weight was 3.9 grams and condition factor (K) was 1.67. Cutthroat biomass was estimated to be 0.15 g/m<sup>2</sup>. Twenty-four mountain whitefish were captured in this section. The population was estimated to be 201 mountain whitefish per mile, but the probability of capture was 0.4. Mean total length was 71 mm, mean weight was 3.9 grams and condition factor (K) was 1.09. One longnose sucker, three largescale suckers and 50 shorthead sculpins were also captured. The water temperature was 22.2° C.

#### Quartz Creek, Station 2, Downstream Station:

In 1977, 53 westslope cutthroat trout were captured in the section. Mean total length was 43 mm. Mean weight was 1.1 grams and K factor was 1.38. Twelve mountain whitefish were captured with a mean total length of 61 mm, mean weight of 1.9 grams and a mean K of 0.84. Cutthroat biomass was estimated at 0.06 g/m<sup>2</sup>. No population estimate was made.

In 1991, one westslope cutthroat trout was captured. Total length was 151 mm, weight was 32 grams and K was 0.93. The population was estimated at 16 westslope cutthroat per mile. Seventeen mountain whitefish were captured in this section. Mean total length was 93 mm, mean weight 18.8 grams and mean K 2.3, many were young-of-the-year fish. The population was estimated at 72 mountain whitefish per mile. One largescale sucker and three shorthead sculpins were also captured in the section. Cutthroat biomass was estimated at 0.4 g/m<sup>2</sup>, water temperature was 13.3° C.



In 1992, nine cutthroat were captured in this section. The population was estimated at 64 cutthroat trout per mile but the probability of capture was only 0.5. Mean total length was 69.9 mm, mean weight was 4.8 grams and condition factor (K) was 1.4. Cutthroat biomass was estimated to be 0.05 g/m<sup>2</sup>, water temperature was 21.1° C. Also captured were 12 mountain whitefish, 7 shorthead sculpins and 1 largescale sucker.

#### Logging Creek, Station 1, Upstream Station:

In 1990, two westslope cutthroat were captured. Mean total length was 55 mm, mean weight 2 grams and mean K was 1.17. No population estimate was made because both fish were less than 75 mm long. Two mountain whitefish were captured in the section. Mean total length was 71 mm, mean weight 3 grams and mean K 0.82. The population was estimated at 16 mountain whitefish per mile. Two shorthead sculpins and two largescale suckers were also captured in this section. Water temperature was 20.3° C.

In 1991, five westslope cutthroat trout were captured. Mean total length was 115 mm, mean weight 16 grams and mean K was 1.05. The population was estimated at 144 cutthroat trout per mile but the probability of capture was a miserable 0.33. One mountain whitefish was captured with a total length of 185 mm, weighing 54 grams and with a K value of 0.85. Three shorthead sculpins and two largescale suckers were also captured in this section. Water temperature was 20.6° C.

In 1992, 18 cutthroat trout were captured in this section. The population was estimated to be 145 westslope cutthroat trout per mile. Mean total length was 85 mm, mean weight was 8.6 grams and condition factor K was 1.4. One largescale sucker, four shorthead sculpins and nine mountain whitefish were also captured. The water temperature was 18° C.

#### Logging Creek, Station 2, Downstream Station:

In 1977, 37 westslope cutthroat trout were captured in this section. Mean total length was 46 mm. Mean weight and mean K were 1.4 grams and 1.44, respectively. Two mountain whitefish were captured with a mean length of 60 mm, a mean weight of 2 grams and a mean K of 0.93. Six shorthead sculpins were also captured in the section. No population estimates were made. Cutthroat biomass was estimated to be 0.11 g/m<sup>2</sup>.

In 1989, no westslope cutthroat trout or mountain whitefish were captured. Four shorthead sculpins and five largescale suckers were captured. No population estimate was made. Water temperature was 17.2° C.

In 1991, six westslope cutthroat trout were captured. Mean total length was 76 mm, mean weight 8.8 grams and mean K was 2.0. The population was estimated at 48 westslope cutthroat per mile. Seven mountain whitefish were captured, their mean total length was 66 mm, mean weight 2 grams and mean K 0.7. No population estimate was made because all whitefish were less than 75 mm long. Also captured in this section, were two largescale suckers and five shorthead sculpins. Cutthroat biomass was estimated to be 0.07 g/m<sup>2</sup>, water temperature was 16.9° C.

In 1992, 43 westslope cutthroat trout were captured. Mean total length was 62 mm, mean weight 3.98 grams and mean K was 1.67. The population was estimated at 145 westslope cutthroat per mile, but the probability of capture was 0.3. Twenty-four mountain whitefish were captured with a mean weight of 3.9 grams and a mean K of 1.09. The population was estimated at 201 mountain whitefish per mile, but the probability of capture was 0.4. Cutthroat biomass was estimated to be 0.24 g/m<sup>2</sup>. Also captured were 50 shorthead sculpins, 3 largescale suckers and 1 longnose sucker. The water temperature was 22.2° C.

## DISCUSSION

Fisheries information collected in the past on Akokala, Quartz and Logging Creeks indicates these streams have always contained small populations of westslope cutthroat trout (USFWS, 1978). Information collected on other streams in the North Fork drainage, outside the Glacier Park, indicates similar westslope cutthroat densities (Weaver and Fraley, 1991). It is unclear whether the Red Bench Fire had any significant, immediate impacts on these system's fisheries, the fire did have an impact on the streams' macroinvertebrate community (Mangum, 1990). There seemed to be a discernable impact, caused by the 1989 fall flood in Akokala Creek, (the unburned section) to both the fisheries (Table 1) and the macroinvertebrate populations (Mangum, 1990). Since 1989, the trend in fish populations in all streams has been upward (Table 1). All changes in cutthroat biomass (Table 2) have been within natural variations reported by Hall and Knight (1981).

TABLE 1. Westslope Cutthroat Densities (Cutthroat per mile)

Sampling Stations	1989	1990	1991	1992
Akokala Creek 1	357.4	72.3	64.4	536.7
Akokala Creek 2	16.1		64.4	85.9
Quartz Creek 1		16.1	16.1	72.4
Quartz Creek 2			16.1	64.4
Logging Creek 1			144.0	144.9
Logging Creek 2			48.3	144.9

TABLE 2. Westslope Cutthroat Biomass (Grams/m<sup>2</sup>)

Sampling Stations	1977	1989	1990	1991	1992
Akokala Creek 1		0.5	0.33	0.12	0.34
Akokala Creek 2	0.13	0.02		0.06	0.11
Quartz Creek 1			0.02	0.09	0.15
Quartz Creek 2	0.06			0.04	0.05
Logging Creek 2	0.11			0.07	0.24

## RECOMMENDATIONS

In 1989, when this project was initiated it became apparent that there was a lack of information on the biota in the North Fork streams of Glacier National Park. It had been more than a decade since information on macroinvertebrates and fish had been collected (USFWS, 1978) and the information dealt only with species composition and not population indices. Some of the stream reaches may have never been sampled before because of Glacier Park's emphasis on sampling lacustrine biota (Marnell, 1988). This is unfortunate, because when a perturbation such as the Red Bench Fire occurs, there is no recent pre-condition data to adequately assess the biological impacts of an event. Glacier National Park should have some sort of regular lotic biotic monitoring program. An inexpensive and effective program would be to establish permanent stations on streams throughout the park and collect macroinvertebrate samples at these stations every three to five years in accordance with procedures outlined in standard methods (APHA, 1989) or in the U.S. Forest Service Fisheries Habitat Surveys Handbook (USFS, 1985).

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