DISTRIBUTION OF FISHES IN ALASKA'S UPPER BIRCH CREEK DRAINAGE DURING 1984 AND 1990

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Alan H. Townsend

Technical Report No. 91-2

Alaska Department of Fish & Game
Division of Habitat

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EXECUTIVE SUMMARY

Mined and unmined streams in the Birch Creek drainage were sampled for the presence/absence of fish in 1984 and 1990. Arctic grayling were found in more streams and in greater numbers in 1990 than in 1984. Substantial improvement in water quality and mining practices resulted in lower turbidity in streams during 1990. It is postulated that increased use by arctic grayling of the upper Birch Creek drainage was the result of improvements in water quality. Decreased levels of instream turbidity were attributed to improved mining practices.

Introduction

Placer gold was discovered in the Birch Creek drainage in 1883, over 100 years ago. Some level of placer mining has occurred since the discovery, though activity was reduced during World War II and the 1960s. Mining activity increased along with gold prices during the mid-1970s and up to 80 operations were active on the upper reaches of Birch Creek during the 1980s (BLM 1988).

In 1984, the Alaska Legislature provided funding to the departments of Fish and Game (ADF&G), Environmental Conservation (ADEC), and Natural Resources (ADNR) to assess the effects of placer mining on water quality and terrestrial and aquatic habitats. The three resource agencies selected the Birch Creek drainage as a study area because of its accessibility by road and the presence of multiple mining operations. Birch Creek is located in the Circle Mining District approximately 100 miles northeast of Fairbanks, Alaska. Birch Creek is a clear, free-flowing stream that originates in the Yukon/Tanana uplands and flows 314 miles to the Yukon River at a point three miles south of the Arctic Circle (U.S. Department of Interior 1974).

The ADF&G component of the Birch Creek study included a determination of fish species presence, an assessment of terrestrial and aquatic habitats, and an evaluation of benthic invertebrate densities and community structure. Results of ADF&G's 1984 field investigations were reported by Weber and Post (1985). They sampled 26 stream reaches on 16 different tributaries in the Birch Creek drainage (Figure 1). Seven of these streams had either not been mined within at least the last 50 years or had not been mined to a noticeable degree, and nine streams had active or recent placer mining operations.

LOCATION OF SITES FOR PLACER STUDIES IN THE BIRCH CREEK WATERSHED

NUMBERS (20) REPRESENT STUDY SITES (SEE TABLE 1.)

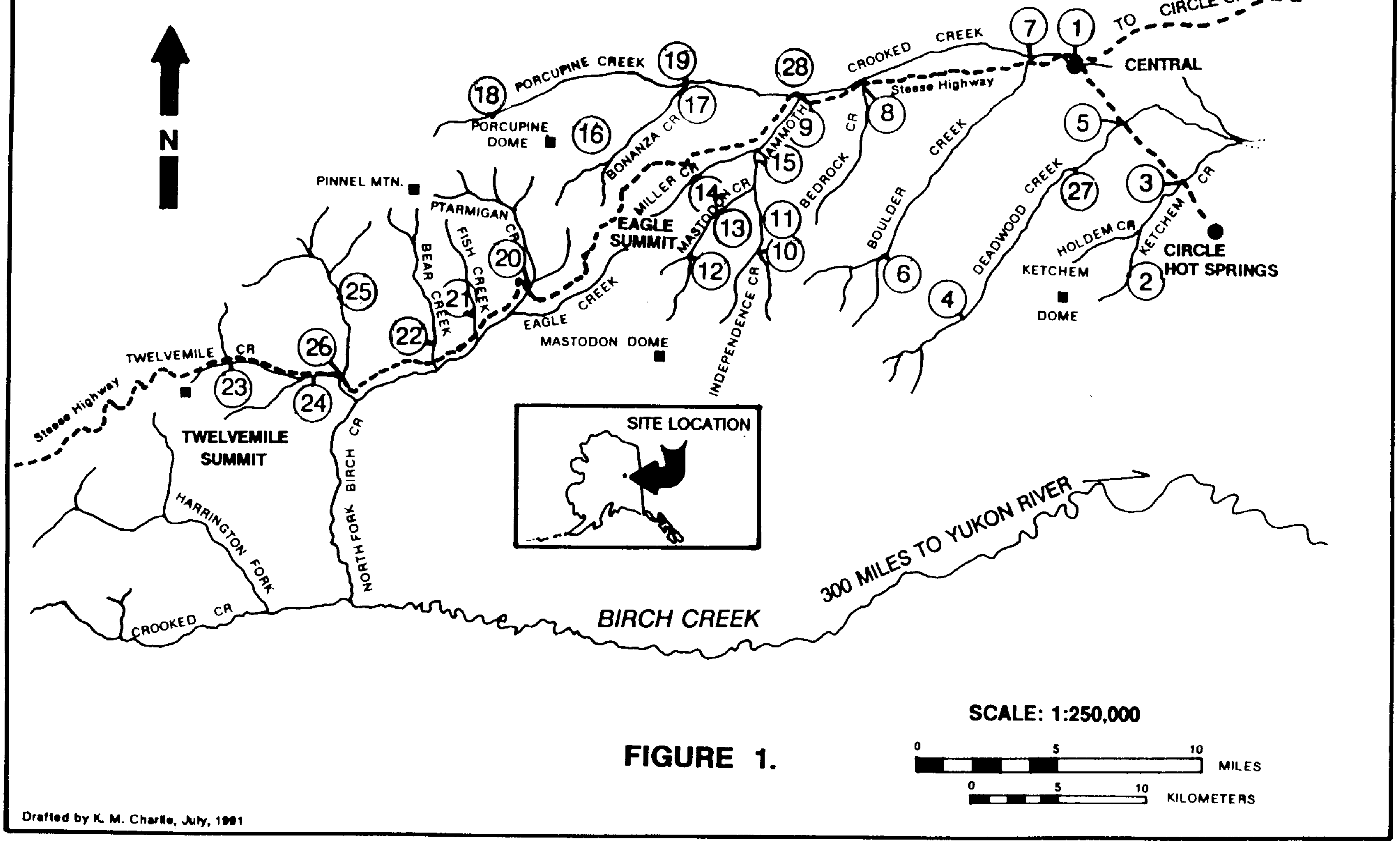


FIGURE 1.

Since 1984, substantial changes have occurred in the technology used in placer mining operations. Recycling of wastewater with reduced discharges to aquatic systems, construction and maintenance of settling ponds outside of the active floodplain, and reclamation of riparian and floodplain areas have been documented. Because of substantial improvements in mining practices, it was postulated that changes in fish distribution within the Birch Creek drainage should have occurred since ADF&G's 1984 field investigation. Therefore, we developed a fisheries sampling program for the summer of 1990 to resample for fish presence at the same study sites worked by Weber and Post in 1984. The objective of our study was to compare the catch, distribution, and species composition of fish in 1990 with those reported by Weber and Post.

Methods and Sample Sites

Weber and Post used upstream and downstream block nets at each sample site. They then electrofished, from the upstream to the downstream block net, a 100 meter reach with a Smith-Root Model 15-A electrofisher capturing all observed fishes. If no fish were observed only a single pass was used. When fish were observed or collected, up to three passes with the electrofisher were made. Six salmon roe baited GEE minnow traps also were set overnight in each sample stream in 1984.

Only the Smith-Root Model 15-A electrofisher was used to sample fish during 1990. Electrofishing was conducted upstream through the sample reach. Block nets were used only at the downstream end of the sample sites on Crooked Creek (Site #1) and Ketchum Creek (Site #2) where turbid water conditions would have prevented samplers from seeing stunned fish. At Sites #1 and #2, electrofishing was performed from the upper end of the sample reach downstream to the block net. Water clarity allowed stunned fishes to be readily visible in the other sample reaches and deleting the use of block nets allowed resampling of the 1984 sites within the limited time available for the 1990 project. The

1990 sampling was conducted July 23 to 25 which corresponds closely with the July 24 - August 29, 1984 sampling period by Weber and Post.

Sample sites for the 1990 study were located in Crooked, Porcupine, Bonanza, Miller, Mammoth, Mastodon, Independence, Bedrock, Boulder, Ketchum, Deadwood, Ptarmigan, Fish, Bear, North Fork, and Twelvemile creeks (Figure 1). Sample sites in 1990 were selected to coincide with the same sites sampled in 1984 except as noted below and in Table 1.

Several readily recognizable changes had occurred within the 1984 sample sites or changes led to the selection of alternative sites for the 1990 sampling. Access to the upper North Fork (Site #25) was gained by helicopter in 1984 and was not accessible by four-wheel-drive vehicle in 1990. Ptarmigan Creek (Site #20) had exploratory placer mining conducted within the sample site after the 1984 study. A placer mine was in operation on Ketchum Creek (Site #2). Placer mining had progressed through sample sites on Mammoth Creek (Site #9), Independence Creek (Sites #10 and 11), Mastodon Creek (Sites #12 and 13), Miller Creek (Site #15), Bonanza Creek (Site #16), and Porcupine Creek (Site #18). No alternate sites could be located to sample for fish presence on Ketchum Creek (Site #2) or Bonanza Creek (Site #16). Alternate sample sites were chosen within approximately 100 meters of the original sites on Independence and Miller creeks. The alternate site on Mammoth Creek was approximately one kilometer upstream from the 1984 site and the alternate site on North Fork Creek was approximately two kilometers downstream from the 1984 site.

Results

Fish were captured at six sites in 1984. In 1990, fish were captured at 12 of the 1984 sites and one fish was captured at a new site below the 1984 sites on Porcupine Creek. Arctic grayling (*Thymallus arcticus*) was the only fish species captured at five of the six

TABLE 1. Fish captured in the Birch Creek drainge, 1984 and 1990.

Sample Site No.	Creek Name	Site Location	1984 AG	1984 Other	1990 AG	1990 Other
1	Crooked Ck	below mining	0	0	8	0
2_A	Ketchum Ck	above mining	0	0	0	0
3	Ketchum Ck	below mining	0	0	0	0
4	Deadwood Ck	above mining	0	0	0	0
5	Deadwood Ck	below mining	0	0	16	0
27_B	Deadwood Ck	mid way	n/s	n/s	0	0
6	Boulder Ck	above mining	0	0	0	0
7	Boulder Ck	below mining	2	0	5	0
8	Bedrock Ck	not mined	0	0	0	0
9_C	Mammoth Ck	below Harrison Ck Road	0	0	9	
10_D	Independence Ck	above Russell site	0	0	0	0
11_D	Independence Ck	below Russell site	0	0	0	0
12_E	Mastadon Ck	above Baker Gulch	0	0	0	0
13	Mastadon Ck	1/4 mi above Mammoth Ck	0	0	0	0
14	Miller Ck	above recent mining	0	0	0	
15	Miller Ck	near mouth	0	0	3	0
16_F	Bonanza Ck	above Revel Ck	0	0	0	0
17	Bonanza Ck	200 m above road	0	0	0	0
18_G	Porcupine Ck	above Yankee Ck	0	0	0	0
19	Porcupine Ck	above road	0	0	0	0
28_H	Porcupine Ck	near mouth	n/s	n/s	1	0
20_I	Ptarmigan Ck	above Steese	0	0	85	29
21	Fish Ck	150m above Steese	0	0	3	2

TABLE 1. continued

Sample Site No.	Creek Name	Site Location	1984 AG	1984 Other	1990 AG	1990 Other
22	Bear Ck	150m above Steese	13	0	15	23
23	Twelvemile Ck	near Reed Ck	5	15	29	13
24	Twelvemile Ck	near mouth	0	21	13	7
25_J	North Fork Ck	1 1/2 mi above Steese	4	7	25	23
26	North Fork Creek	below Steese	2	75	7	22

NOTES:
A = not sampled in 1990 due to low water
B = new sample site in 1990, to determine upper limit of fish distribution
C = site moved upstream in 1990 because 1984 site was flooded by active mining operation
D = sites 10 and 11 were combined in 1990 since mining had progressed to encompass both sites and the reach between sites
E = site not sampled because all water was subsurface at site 12 during 1990 sampling period
F = site inaccessible to fish due to dams, tailings, and ponds from mining activity since 1984, not sampled in 1990
G = access to above Yankee Creek blocked by dams, tailings, and ponds created by mining since 1984 sample period, not sampled in 1990
H = new sample site in 1990, to determine upper limit of fish distribution
I = small scale, about 2 ac disturbed, mining had occurred since 1984
J = ADOT/PF erosion control work had recently been conducted instream immediately upstream from this sample site
n/s = not samples

additional sites in 1990. Arctic grayling and one rainbow trout (*Oncorhynchus mykiss*) were captured in Mammoth Creek in 1990 and no fish were captured in this stream in 1984. The rainbow trout was possibly a stocked fish that escaped from Roy's Lake during a 1989 flood event. In 1984, fish were captured in only one stream, Boulder Creek (Site #7), where past or active mining was evident. In 1990, fish were captured below mining in six of the 1984 sample streams: Crooked, Boulder, Miller, Mammoth, Deadwood, and Ptarmigan creeks. No fish were caught in Fish Creek (unmined) by Weber and Post in 1984 and in 1990 arctic grayling and slimy sculpin (*Cottus cognatus*) were captured at this site. A total of 26 arctic grayling were caught in four streams in 1984 and 219 arctic grayling (includes one grayling from a new site at the mouth of Porcupine Creek) were caught in 11 streams in 1990 (Figure 2).

Water quality data collected from nine of the project streams by the ADNR, Division of Geological and Geophysical Services (DGGS) from 1984-1990 (Table 2) show reduced turbidity in seven streams and increased turbidity in Boulder and Twelvemile creeks. The mean turbidity during August 1984 in Birch Creek at the Steese Highway bridge was 60 Nephelometric Turbidity Units [NTU ($n = 2$)] and improved to 6 NTU ($n = 121$) mean turbidity for June - August 1990.

The number of Annual Placer Mining Applications (APMA's) received by ADEC, ADNR, and ADF&G for permits to mine in the Birch Creek drainage during 1984-1990, ranged from 84 to 41 (ADEC, ADNR, and ADF&G records). No correlation between the number of APMA's and the mean turbidity in Birch Creek was evident [Spearman Rank Correlation, rho = 0.47 (Figure 3)].

Discussion

Arctic grayling were found in more streams and in greater numbers within the Birch Creek drainage in 1990 than in 1984. A substantial decrease in turbidity throughout the

Figure 2. Number of arctic grayling caught in Birch Creek drainage (1984 and 1990).

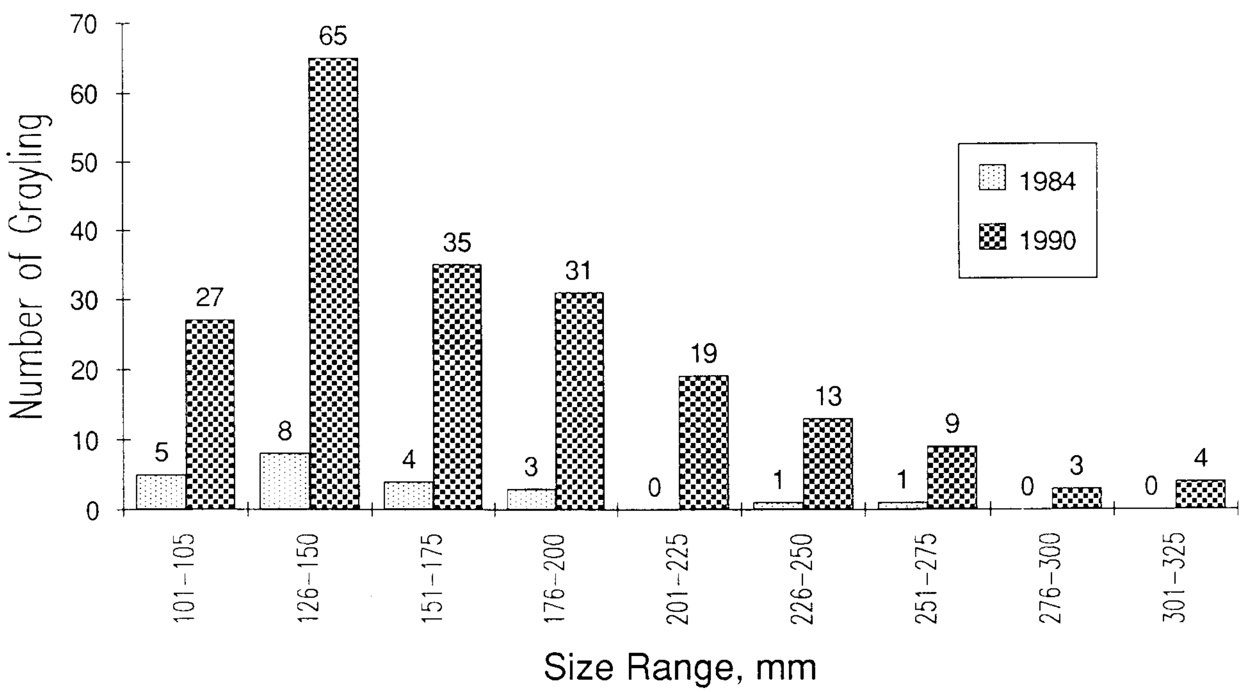
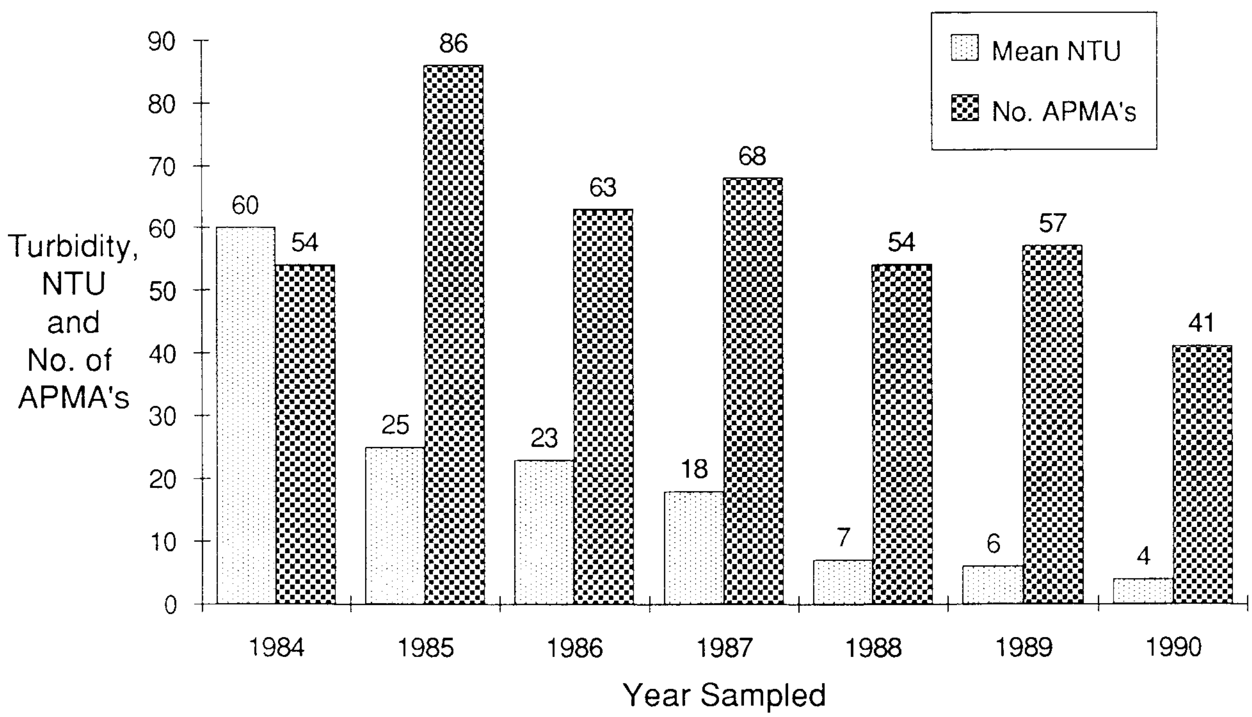


TABLE 2. Mean turbidity (NTU) in Birch Creek drainage during summer 1984 through 1990.*

Stream	1984	1985	1986	Year 1987	1988	1989	1990
Birch Creek at bridge							
- No. samples	2	20	54	106	98	80	121
- Mean NTU	60	31	54	38	11	12	6
Crooked Creek at Central							
- No. samples	7	34	25	3	13	12	17
- Mean NTU	840	410	150	140	120	45	25
Deadwood Creek							
- No. samples	4	35	26	13	14	13	122
- Mean NTU	920	670	65	180	54	43	32
Ketchum Creek							
- No. samples	4	33	25	12	15	13	18
- Mean NTU	880	820	240	620	300	190	148
Mammoth Creek							
- No. samples	8	31	117	4	15	14	17
- Mean NTU	400	350	290	180	260	125	19
Ptarmigan Creek							
- No. samples				1	8	11	17
- Mean NTU	nd	nd	nd	1.4	0.9	1.2	0.9
Twelvemile Creek							
- No. samples				4	13	11	16
- Mean NTU	nd	nd	nd	0.6	0.7	1.8	3.8
Bedrock Creek							
- No. samples	9	23	20	3	15	11	17
- Mean NTU	1	0.8	1.9	0.8	1	8.8	1.5
Boulder Creek							
- No. samples	2	13	88	3	14	11	18
- Mean NTU	2.8	2	2.7	1	0.7	16	8

nd = no data
* All data from Ray (1990 and 1991)

Figure 3. Turbidity (NTU) compared to the number of placer mines, Birch Creek drainage (1984 and 1990).



drainage (Table 2) is a potential reason for increased fish use. Scannell (1988) and Simmons (1984) found that arctic grayling avoid turbid water and Wagener (1984), Weber and Post, and Weber (1986) found decreased numbers of aquatic invertebrates in streams with increased turbidity. Arctic grayling feed primarily on invertebrates and locate their prey by visual stimuli. When the amount of food is reduced and the ability of fish to locate food is impaired by turbidity, fewer arctic grayling probably use the available habitat. Results of fish use of Birch Creek in 1990 appear to substantiate the findings of Scannell (1988), Simmons (1984), Wagener (1984), and Weber and Post (1985) that specific turbidity levels and/or the duration of turbidity can cause a reduction in the use of aquatic habitat by arctic grayling.

The mean turbidity in Crooked Creek was 840 NTU during the summer of 1984 when no fish were found and 25 NTU during 1990 when eight arctic grayling were captured. Similarly, in 1984 the mean turbidity was 400 NTU in Mammoth Creek when no fish were caught and 19 NTU in 1990 when 10 fish were captured. Our data suggest that arctic grayling avoid or abandon aquatic habitat when mean turbidity levels are 400 NTU or greater. Some arctic grayling apparently will use aquatic habitat when the turbidity levels are 25 NTU or lower; however, our data are inconclusive to determine the threshold at which blockage or complete reduction in fish use occurs. Further research also is needed to determine the correlation between turbidity levels less than 25 NTU and fish use.

In 1982, Simmons recorded a mean turbidity in Birch Creek near Twelvemile Creek of 3,436 NTU during August 20-29. Van Nieuwenhuyse recorded a mean turbidity of 745 NTU for the same stream reach between June 1 and August 27, 1983 (Van Nieuwenhuyse 1984). Ray (1991) reported the mean turbidity for the reach to be 293 NTU in 1986, 1,360 NTU in 1987, and 20 NTU in 1990. Turbidity levels in 1982, 1983, 1986, and 1987 probably were high enough to reduce arctic grayling use. Weber and

Post (pers. comm.) measured turbidity during their fish sampling and found that Birch Creek was 1,000 NTU above Twelvemile Creek on September 5, 1984. High turbidity in upper Birch Creek could have prevented arctic grayling from moving through Birch Creek from overwintering habitats to Ptarmigan and Fish creeks (clear water tributaries to Birch Creek) where no fish were found in 1984. In 1990, a total of 88 arctic grayling were caught in Ptarmigan and Fish creeks when the upper reach of Birch Creek was 20 NTU. Our data suggest that highly turbid water in Birch Creek during 1984 may have prevented arctic grayling from entering Ptarmigan and Fish creeks, but that with turbidity levels of 20 NTU in Birch Creek in 1990, fish use of clearwater tributaries was documented.

It is well known that arctic grayling prefer clear water over turbid water (Scannell 1988). When fish distribution among 26 stations during 1984 and 1990 are compared, it appears that turbid water in 1984 prevented arctic grayling from migrating through the turbid water to clearwater tributaries. This scenario suggests that temporary losses [direct and indirect (i.e., migratory blockage)] of fish habitat can occur from chronic turbidity in the water. Exclusion of fish from otherwise suitable habitat represents a limitation to the natural dispersal of fish during the summer months when many fish, particularly arctic grayling, expand their range to take advantage of foraging habitat in ephemeral streams. Furthermore, blockages to fish movement and reduction in fish use of available aquatic habitat could lead to increased competition for space and food resulting in an overall decrease in fish production.

The dramatic improvement in water quality within the Birch Creek drainage is shown by the change from a mean 60 NTU in 1984 to 6 NTU in 1990 at the Steese Highway bridge. Decreased turbidity levels also are reflected by data collected from Crooked, Deadwood, and Mammoth creeks, each of which had arctic grayling present in 1990 but no fish in 1984.

Although slimy sculpin also were collected in both 1990 and 1984, no attempt was made to compare different catch rates because block nets would have to be used to accurately estimate numbers of slimy sculpin present. Neither upstream nor downstream block nets were used at the majority of sample sites in 1990 to accomplish the sampling within the allocated time. Round whitefish (*Prosopium cylindraceum*), another species that should be present in the upper portions of the Birch Creek drainage were captured in low numbers in 1984 and 1990. Round whitefish feed on benthic invertebrates in the stream bed substrate and many of the sample streams still have not returned to a natural and stable condition. The lack of long-term stability in the streams and the development of a stable benthic community probably still limits the number of round whitefish using previously disturbed aquatic habitat.

In summary, it is postulated that the parameter which seems to have allowed arctic grayling to distribute into mined streams in 1990, is lower turbidity. Placer mining was still active on these streams, some turbidity was still present, and in 1990 fish were present. Turbidity changes were not correlated with the number of active mines. Furthermore, flow data collected by DGGS in the Birch Creek drainage were compared with turbidity and no relationship existed between flow and turbidity changes. Decreases in stream turbidity from 1984 to 1990 probably are due to increased recycling of mining water and reduced non-point source runoff water from the mines because reclamation efforts have resulted in more stable overburden, settling pond sediments, and stream channels. Our data suggest that with continued water quality improvement and aquatic and terrestrial rehabilitation, increases in fish use will occur. We recommend that periodic sampling be continued in the upper Birch Creek watershed to document changes in fish distribution, use, and relative abundance as mining practices continue to improve.

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