

**Sculpin (Cottus) Distribution**  
**in the**  
**Kootenai National Forest**  
**and**  
**western portions of the**  
**Lolo National Forest**  
**Montana**

submitted by

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Don Skaar and his staff at the Fish, Wildlife and Parks Libby field office were especially supportive with equipment and lodging. Thanks to rangers and staff at the Cabinet Ranger District and Plains Ranger District for occassional lodging and facilities during the study.

## Summary

A total of 76 sculpin (*Cottus*) samples were taken from the Kootenai National Forest and portions of the Lolo National Forest in northwestern Montana. Slimy sculpins (*Cottus cognatus*) were present in 46 of the collections. Torrent sculpins (*Cottus rhotheus*) appeared in 21 of the samples. Shorthead sculpins (*Cottus confusus*) were present in 14 of the collections. Five of the collections contained more than one sculpin species.

Slimy sculpins had a broad distribution both geographically and longitudinally on the tributary streams of the major rivers in the study area. Based on the limited sampling in this study, torrent sculpin distribution appeared to be restricted to tributary streams of the Kootenai River in close proximity to the main river, although torrent sculpins were present at distances greater than 5 km from the Kootenai on Tobacco River tributaries. Shorthead sculpin distribution was difficult to decipher. There is some speculation that shorthead sculpin distribution is closely linked with Glacial Lake Missoula. It is possible that shorthead sculpins were the first sculpin species to colonize drainages after the draining of Glacial Lake Missoula. Shorthead sculpins appeared to be the only sculpin species inhabiting the St. Regis River watershed. Four additional shorthead sites were found outside this watershed in sympatry with slimy sculpins. Three sites were located in the Yaak River drainage and a fourth site was found on a tributary of the lower Clark Fork River. All three sculpin species occurred at sites within and downstream of lands under multiple use management.

Slimy sculpins were found in sympatry with torrent sculpins at two sites and in sympatry with shorthead sculpins at four sites. Hybridization potentially exists between



these two species but was not confirmed in this study. The extent of resource partitioning by these species in areas of overlap was not studied.

Sculpin habitat was characterized as run or a combination of run/riffle habitat with some degree of rubble substrate. Sculpins were generally found at sites with gradients from 1-2%. Substrate composition might be an important physical factor influencing sculpin distribution. Additional physical, chemical and biological factors most likely influence sculpin density and distribution warranting further study.

Species specific stream habitats were indistinguishable in this study. Qualitative evaluations of stream habitat were used to assess differences between sites. Individual species habitat requirements were similar enough to warrant quantitative measures of a number of physical, chemical, and biological conditions before distinctions can be made for individual species.

Five torrent sculpin age classes were recorded for a site on Libby Creek. Torrent sculpins do not appear to conform to length/weight regressions.

Electroshocking in conjunction with D-nets was the best method for sampling sculpin. Alternate sampling methods may be valuable for obtaining additional information.

## Introduction

Five species of sculpin (genus *Cottus*) occur in Montana (Brown 1971; Holton 1990). Sculpins are bottom dwelling fish typically found in rocky substrates of coldwater streams. They characteristically have large flattened heads and fanlike pectoral fins. The presence of palatine teeth is used to distinguish some species as well as the number of spiny-rays and soft-rays on the pectoral and pelvic fins. However, sculpins do vary in color and structure making field identification difficult. In addition, sculpins are difficult to sample with conventional methods typically used to monitor game fish species in the state. As a result, uncertainty exists concerning the distribution and habitat use of each species within the state. Two sculpin species (*Cottus confusus* and *Cottus ricei*) are listed as Species of Special Concern in Montana (Genter 1992). The U.S. Forest Service Northern Region lists these same two sculpin species as Sensitive Species. As such, these two species receive special consideration for conservation lands administered by the forest service.

This report presents the field work of a six week distributional study of sculpins in northwest Montana. The primary objective of this study was to map sculpin distribution in the Kootenai National Forest and adjacent areas as well as the longitudinal location within a single watershed. Secondly, this study set out to define sculpin habitat as well as assess the degree of impairment resulting from land use practices in the study area. In addition, sculpin age classifications were determined as well as an evaluation of several sculpin sampling techniques.

Samples were taken from tributaries of Koocanusa Reservoir, Clark Fork River, Kootenai River, Yaak River and Tobacco River systems. Stream surveys were conducted from September through October of 1991. A number of basins within these watersheds were sampled intensively to determine longitudinal species distribution in a stream system.

Sculpins are classified as a non-game fish by the Montana Department of Fish, Wildlife and Parks. Funding for research on non-game species is minor. Most distributional information has been collected incidentally while electroshocking for game fishes. As a result, the distribution of sculpin species and abundance has not been officially documented although speculations exist. The purpose of this study was to determine the present location of sculpin species within the Kootenai National Forest and adjacent portions of the Lolo National Forest.

## Study Area

The study area included streams and rivers in northwest Montana (Figure 1) primarily on lands in the Kootenai National Forest. An additional thirty-four sites were sampled on streams in the Lolo National Forest in an area adjacent to Kootenai National Forest lands along the Clark Fork River. Study sites were selected based on geographic and longitudinal placement within the watershed of the Kootenai and Lolo National Forests. Forest maps from these respective National Forests were used to define watershed boundaries within the study area. A broad spectrum of habitat types were sampled. Some of the sample sites were recommended by Don Skaar from the Department of Fish, Wildlife and Parks, Doug Perkinson from the Kootenai National Forest, and Patricia O'Connor from the Lolo National Forest.

## Methods

All study sites were selectively sampled using a Smithroot model 12 electroshocker. Electroshocker output ranged from 40 to 900 volts direct current depending on the conductivity of the sample stream. The frequency of DC output remained at 60 pulses per second for all streams sampled. Each habitat type present at a particular site, i.e. pool, run, riffle, backwater and various substrate types, was sampled with the shocker to assess the micro-habitat preferences of the sculpin species. D-nets were used in conjunction with the electroshocker to capture sculpins.

Several additional sampling techniques were experimented with during this six week study to test their effectiveness at capturing sculpins. These techniques included; minnow

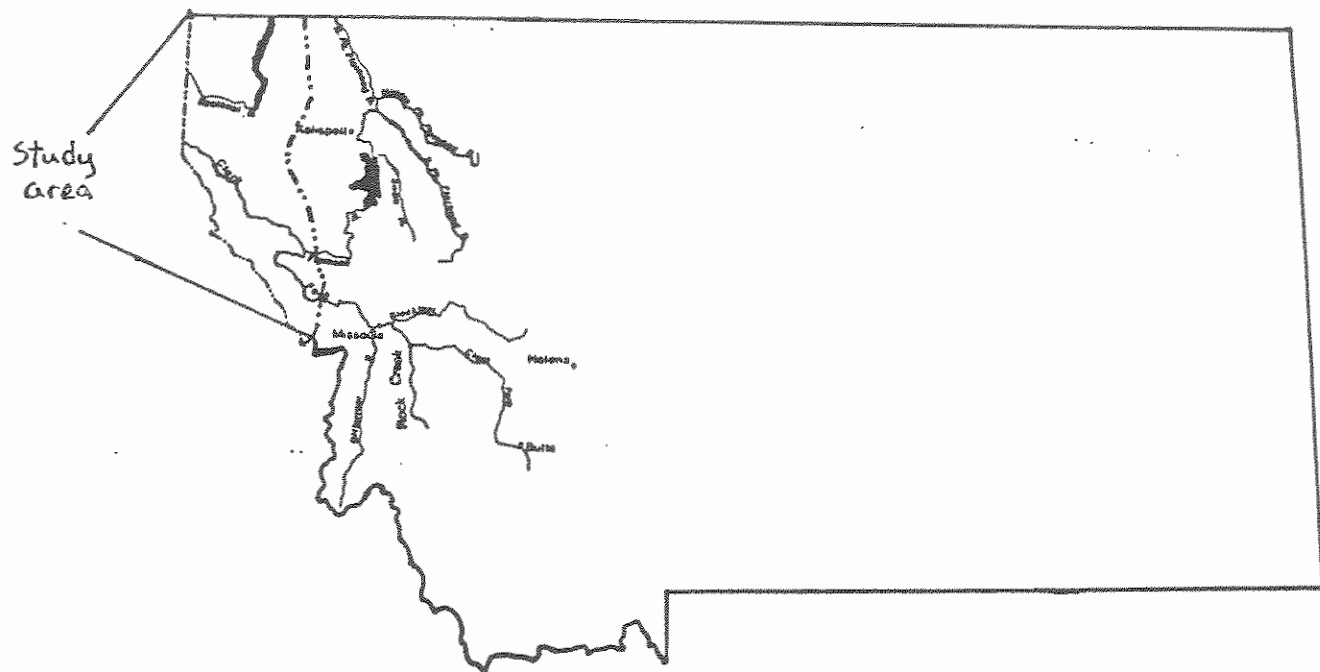


Figure 1: General map of study area in the Kootenai National Forest and western portions of the Lolo National Forest.

traps, D-nets, and kick-screens. These methods were tested at sites with high sculpin densities. Each method was assessed qualitatively based on sampling efficiency which was determined by the catch per unit effort. Catch per unit effort was defined as the number of sculpins caught per unit of time.

D-nets were used to sample sculpins by dragging the net along a diagonal upstream transect while the net holder simultaneously shuffled the substrate with their feet to wash sculpins into the net.

A kick-screen, typically used to sample benthic macroinvertebrates, was used to sample sculpins. Mesh size on the kick-screen was 2 mm. The screen, measuring 0.91 m in length, was placed across the current and a 0.84 m<sup>2</sup> area was disturbed directly upstream by shuffling the substrate using a combination of hands and feet for 1 minute.

Minnow traps, measuring 40.6 cm in length and 22.9 cm in height at the center, were used to sample sculpins. Rubble containing a high density of benthic macroinvertebrates was placed inside the traps which were located in runs. These traps were sampled on 2, 4, 6, and 12 hour intervals.

Sculpins were identified in the field, labeled, and temporarily preserved in formalin. Sample size ranged from 5 to 15 sculpins depending on sculpin abundance and other sample sites longitudinally on the same stream. All samples were shipped in 70% ETOH to Dr. William Gould at Montana State University for verification of field identification. Four samples of 25 sculpins each were sent to the University of Montana for electrophoresis analysis. These sites were chosen for electrophoresis due to the close proximity of two species of sculpins to each other.

Age classification of sculpins was done with samples of torrent sculpins from Libby Creek near the Fish, Wildlife and Parks field office. Sculpins were measured to the nearest

millimeter. Age classes were determined based on the length frequency distribution of the sample population (Jearld 1983).

Habitat parameters were assessed qualitatively. The parameters and methods of evaluation are as follows:

Sculpin Abundance- qualitatively assessed based on catch efficiency using electroshocker: rare (difficult to catch 5 sculpins), uncommon (5 to 10 sculpins caught with concerted effort), common (10 to 15 sculpins caught with minimal effort), abundant (15 or more sculpins caught easily).

Stream Character- dominant stream character where sculpins were captured, i.e., pool, run, and riffle. Pools were identified as the slow, deepwater sections; riffles as the steeper gradient sections with high current velocities and whitewater forming; runs were the sections with moderate current velocities but with smooth surface water typically found at the tail of pools and between riffles.

Habitat Length- length of sample site (m).

Gradient- estimate of percentage of elevation lost over distance traveled.

Substrate Composition- qualitative estimate of percentage of area occupied by silt (< 0.2 cm in diameter), sand (0.2-0.5 cm), gravel (0.5-7 cm), rubble (7-20 cm), boulder (20-50 cm), and bedrock in the sample reach.

Rooted Aquatic Plants- present (yes) or not present (no).

Filamentous Algae- qualitative assessment of area and thickness of algal mat; rare (difficult to discern algal mat on substrate), uncommon (algal mats are patchy), common (algal mats covering much of substrate but underlying rocks remain discernible), abundant (algal mat covering entire substrate, filaments long, mat greater than 5 cm in thickness, substrate not discernible under mat).

Benthic Macroinvertebrates- qualitative estimate of zoobenthos density on rocks (diameter ranging from 10 to 20 cm) pulled from the water; low (less than 10 organisms) , moderate (20 to 40 organisms), or high (50 or more organisms).

water temperature- temperature at sample site (°F).

Reproduction- evidence of sculpin reproduction based on presence (yes) or absence (no) of young of the year sculpins.

Discharge- an estimate of the flow at the sample site.

Vertical Cover- percentage of vegetation, overhanging bank, and woody debris directly over stream surface at a height not greater than 6 feet.

Trout- present (yes) or not present (no).

Land Use Present- visual assessment indicating presence (yes) or absence (no) of land use categories in drainage, i.e., undisturbed, grazing, logging, roads, mining, urbanization, channelization.



## Results

### Species Distribution

Sculpin distribution in the study area appeared to be limited to three species (Figures 2, 3, and 4); slimy sculpins (*Cottus cognatus*), torrent sculpins (*Cottus rhotheus*), and shorthead sculpins (*Cottus confusus*). Qualitative assessments of habitat characters for each site are included in appendix A.

Slimy sculpins had the most widespread distribution of the three sculpin species found in the study area. This species was found in a variety of longitudinal locations on tributary streams of the Clark Fork River, Kootenai River, and Yaak River.

Slimy sculpins were the dominant sculpin species along the lower Clark Fork River with the exception of the St. Regis River watershed, where shorthead sculpins were found exclusively. Longitudinally, slimy sculpins were found at sites on tributary streams in the lower Clark Fork in close proximity to the main river as well as at sites greater than 1 km distance from the main river.

On Kootenai River tributaries, the distributional pattern of slimy sculpins was slightly different. Longitudinally, slimy sculpins appeared to be located higher up in the tributary streams at greater distances from the main river. Torrent sculpins tended to occupy the sites on tributary streams in close proximity to the main Kootenai River. However, several tributaries of the Kootenai contained slimy sculpins in close proximity to the main river and it appears that at least two sites may contain slimy sculpins in sympatry with torrent sculpins.

Slimy sculpins, for the most part, were the only sculpin species present in the Yaak drainage above Yaak Falls with the exception of three samples containing shorthead sculpins in sympatry with slimy sculpins.



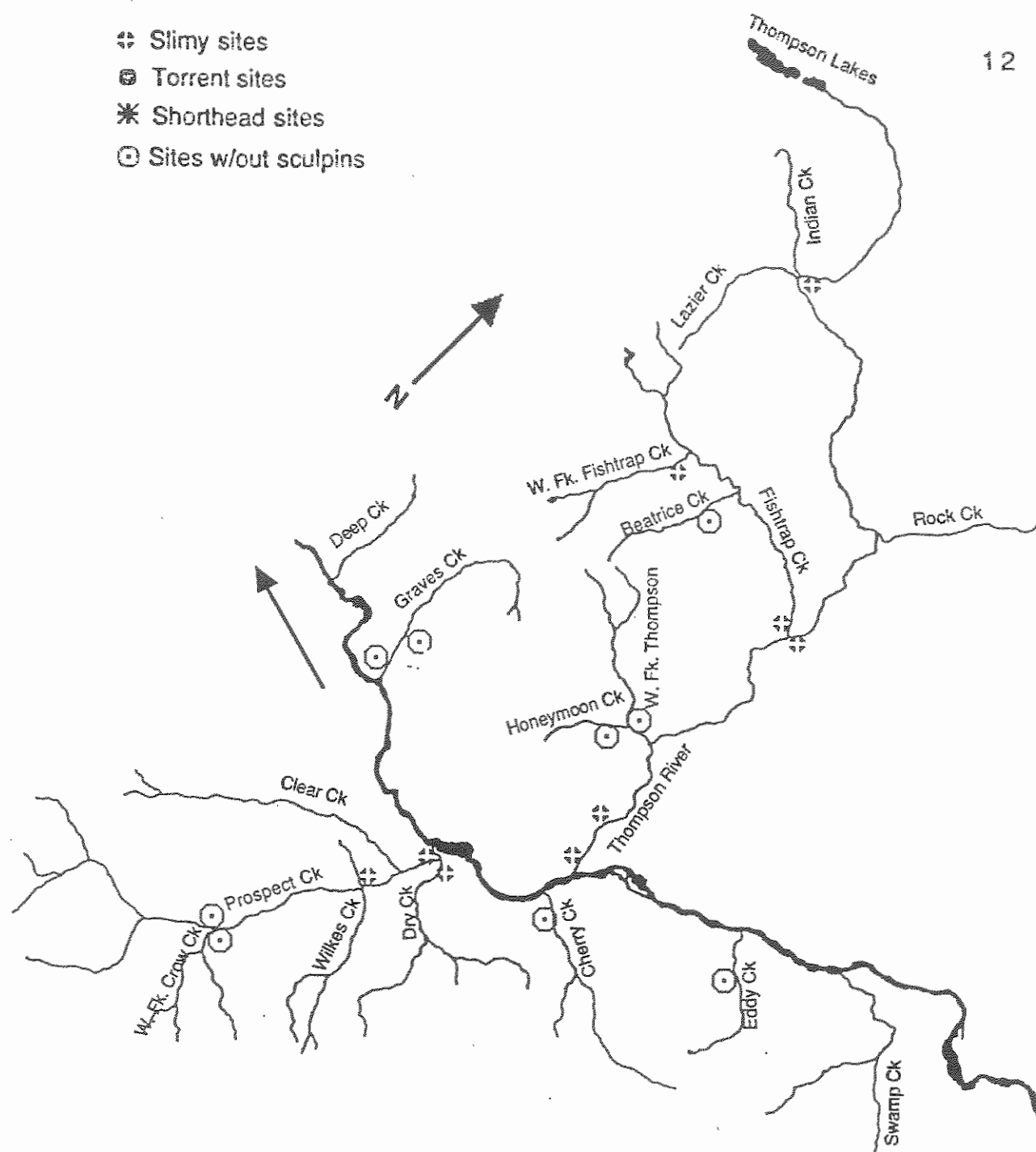


Figure 3: Distribution of slimy sculpins, torrent sculpins and shorthead sculpins in the Thompson River watershed and adjacent tributaries of the Clark Fork River.

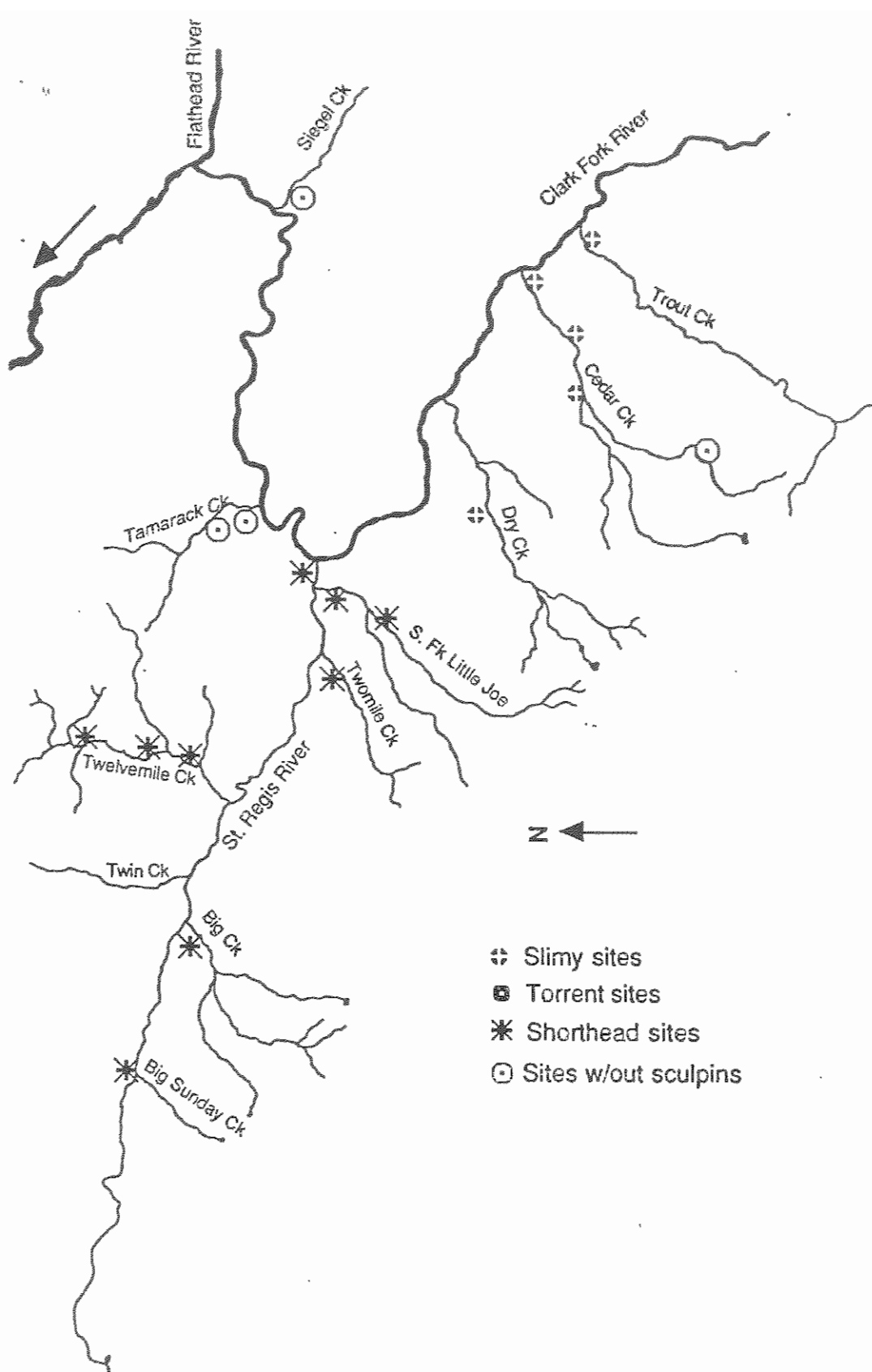


Figure 4: Distribution of slimy sculpins, torrent sculpins and shorthead sculpins in the St. Regis River watershed and adjacent tributaries of the Clark Fork River.

Slimy sculpins and torrent sculpins were found in the same tributary streams of the Kootenai River below Libby Dam but for the most part isolated from each other longitudinally. On streams where both slimy and torrent sculpins were present, slimy sculpins were generally located in the upper end of these tributary streams further from the main Kootenai than the torrent sculpins. Physical and chemical factors influencing this longitudinal displacement of slimy sculpins on streams where torrents were present were not identified.

Torrent sculpin distribution was restricted to the Kootenai River watershed. This species was commonly found on tributaries of the Kootenai River below Libby Dam in close proximity to the main river.

Torrent sculpins were present on two tributaries of the Kootenai River upstream of Libby Dam. No other sculpin species was found above Libby Dam on tributary streams to Koocanusa Reservoir. Torrent sculpins were present on Big Creek as well as the Tobacco River and its tributaries. A total of 8 sites were sampled on tributaries of Koocanusa Reservoir at varying distances from the lake's shoreline.

Shorthead sculpins were found in several watersheds but their distribution appeared to be disconnected. Shorthead sculpins were the only sculpin species present in the St. Regis River and its tributaries. Their distribution in this watershed was widespread. Shorthead sculpins were found at four sites outside the St. Regis River watershed but their distribution and abundance at these additional sites was unclear.

The additional four sites containing shorthead sculpins turned up only after laboratory identification of the samples. These sites appear discontinuous from the shorthead population in the St. Regis River watershed. One site occurred on Prospect Creek, a tributary of the Clark Fork River near Thompson Falls. The other three sites were in the

Yaak drainage; two sites on the West Fork of the Yaak River and one site directly below Yaak Falls on the main Yaak River.

For the most part, sculpins species were allopatric throughout the study area. However, it appeared that sculpins existed sympatrically at six study sites. Each of these six sites involved slimy sculpins possibly in sympatry with either torrent or shorthead sculpins.

Slimy and torrent sculpin species were found together at two sites on tributaries of the Kootenai River below Libby Dam. Generally, torrent and slimy sculpins were separated longitudinally in the same tributary streams of the lower Kootenai River. Torrent sculpins typically were found at sites in the lower end of tributary streams in close proximity to the Kootenai River while slimy sculpins occurred higher up in the drainage on the same tributaries. The two sites, the main Yaak at Highway 2 and Quartz Creek at the River Road, were located in close proximity to the main Kootenai River.

The physical and biological components of the habitat at these two sites were indistinguishable qualitatively from sites in which each species existed in allopatry. Both sites were dominated by a combined rubble and boulder substrate. The stream gradient was between 1 and 2 percent for both sites. Algal abundance was uncommon at the site on Quartz Creek but common on the Yaak. Benthic macroinvertebrate density was low to moderate on Quartz and high on the Yaak. Quartz Creek is a third order stream at the River Road whereas the Yaak is a sixth order river. The variation between these two sites was not unlike the variation recorded between the allopatric sites for each respective species.

Slimy and shorthead sculpins existed sympatrically at four sites. Three sites were located in the Yaak River drainage and the fourth site was on Prospect Creek, a tributary of the Clark Fork River near Thompson Falls. Specimens from these sites were all identified as slimy sculpins in the field. Laboratory identification revealed shorthead sculpins within

the samples. As a result, the ratio of respective species' abundances at the sites as well as placement within the site were not available.

### Physical, Biological and Human Influences on Sculpin Distribution

#### Stream Character

Stream character was separated into three categories; pools, runs, and riffles. Distinguishing the point at which a run becomes a riffle was somewhat subjective (see methods) but there appeared to be a preferred location within these three categories by all three sculpin species.

Sculpins, in general, were predominantly found in runs, and to a lesser degree, in the area of overlap between runs and riffles (Figure 5). Slimy sculpins were found in runs 87.2% of the time compared to 12.8% in run/riffles. Torrent sculpins were located 66.7% of the time in run habitat compared to 33.3% in run/riffle habitat. Shorthead sculpins were located in runs 77.8% of the time compared to 22.2 % in faster moving run/riffles. None of the sculpin species were found in pool habitat although sampling intensity was more extensive in run/riffle habitat since this was where sculpins were most likely to occur.

#### Substrate

Rubble appeared to be the preferred substrate for all three sculpin species although there were variations in the percentage of rubble verses other substrate sizes (Figure 6). Sites with abundant sculpin populations typically were dominated by rubble substrate. There was a corresponding decline in sculpin abundance at sites where substrate particle size decreased shifting to habitat dominated by gravels and sand. It appeared that torrent sculpins were more tolerant of mixed substrate containing some degree of gravel and sand. Sculpins were not present on streams which did not contain at least some degree of rubble substrate.

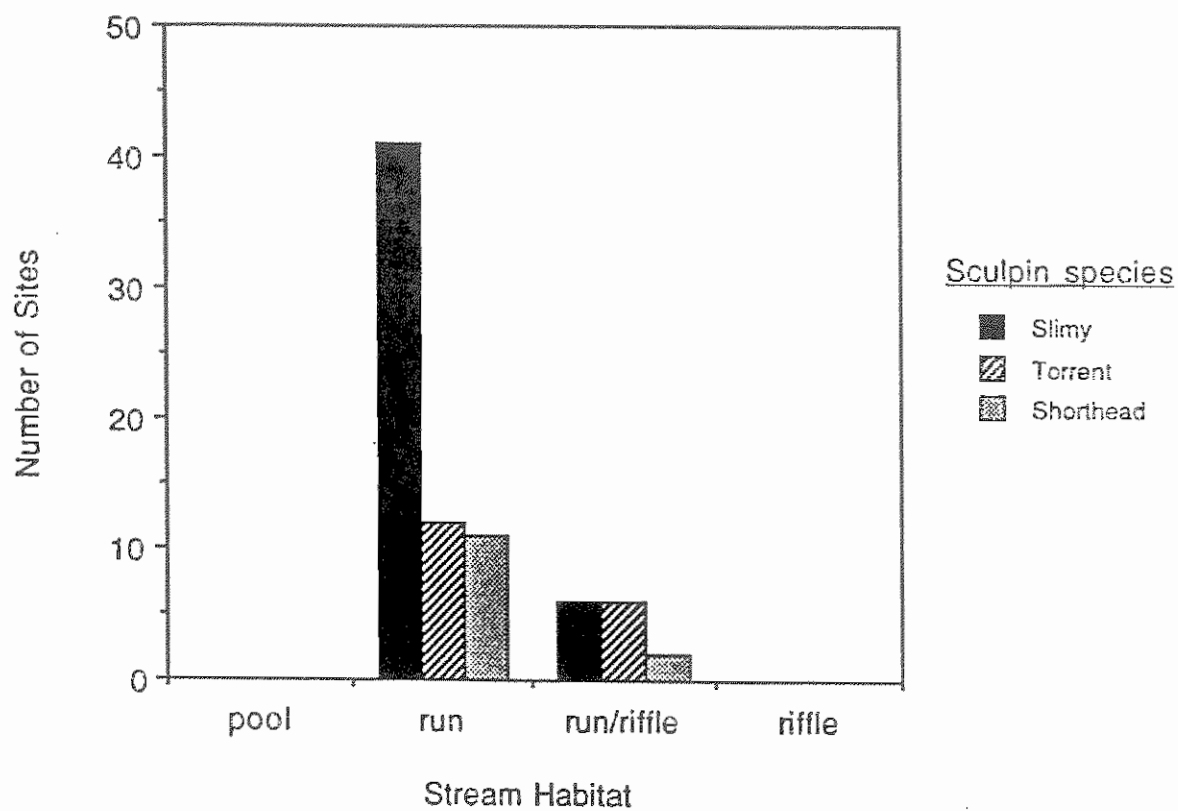


Figure 5: Stream character at sample sites containing slimy sculpins, torrent sculpins and shorthead sculpins in the Kootenai National Forest and western portions of the Lolo National Forest.



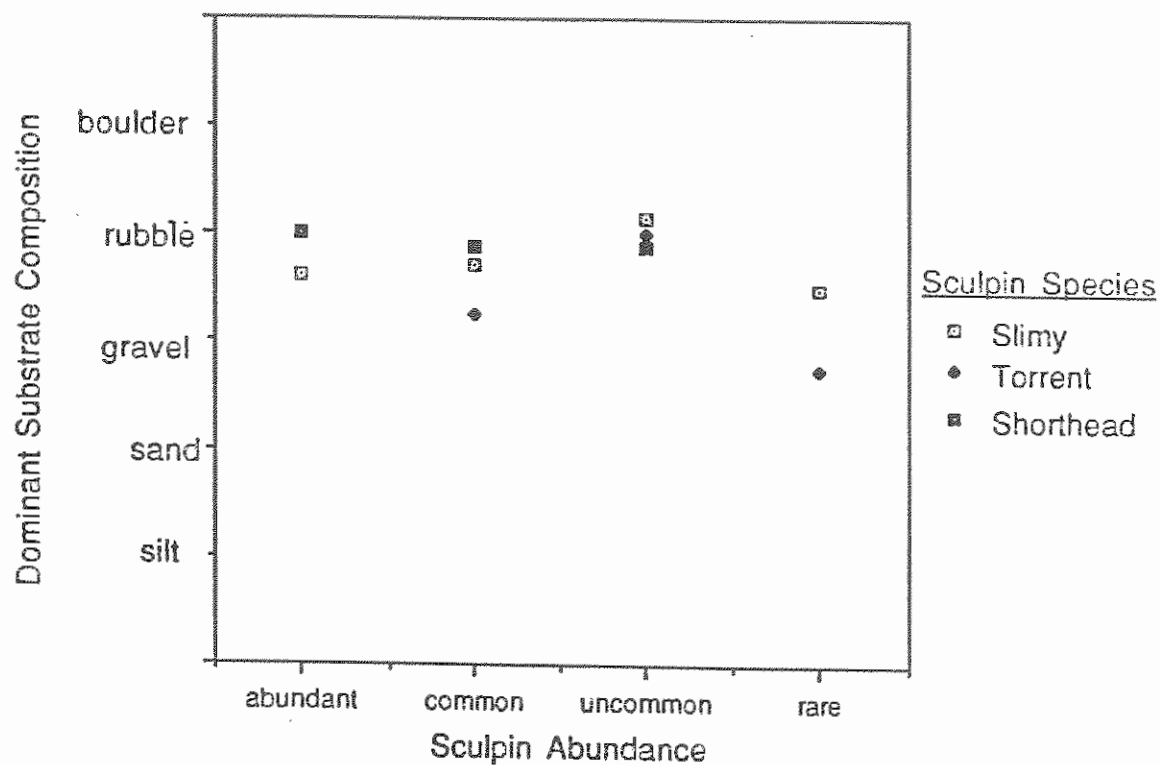


Figure 6: Dominant substrate composition at sample sites containing slimy sculpins, torrent sculpins and shorthead sculpins at four levels of abundance. Sculpin abundance was assessed qualitatively (see p. 8 for definition of sculpin abundance and substrate composition).

### Temperature

Temperature was recorded at random times of day while electroshocking. As a result, comparisons of species specific stream temperatures using statistical analysis were not appropriate. However, temperature trends were distinguishable for each species except at sites where species were rare in occurrence (Figure 7).

Torrent sculpins tended to be found at sites with warmer stream temperatures than the other sculpin species. The observed mean temperature at sites where torrent sculpins were abundant was 52.4°F. This was 4.5° higher than the observed mean temperature at sites containing slimy sculpins. The observed mean temperature where slimy sculpins were abundant was 47.9°F. Shorthead sculpins appeared to prefer sites with cooler stream temperatures. The observed mean water temperature for shorthead sculpins was 44.0°F, 3.9° lower than that for slimy sculpins and 8.4° lower than the observed mean temperature for torrent sculpins.

The warmest temperatures recorded at a site with sculpins present was 62.5°F.. All three sculpin species were found at sites with this stream temperature. However, all three species were either uncommon or rare in abundance at these sites.

### Gradient

Stream gradients appeared to be an important factor influencing sculpin distribution within the study area. Sculpins were found at sites with stream gradients from less than 1 percent to 2 percent (Figure 8). In general, each sculpin species was more likely to be found at sites with approximately a 1% stream gradient. Sculpins were not found at sites with gradients exceeding 2 percent.

Slimy sculpins were able to tolerate the widest range of stream gradients. Fifty-five percent of the sites containing slimy sculpins had a 1% stream gradient. Approximately

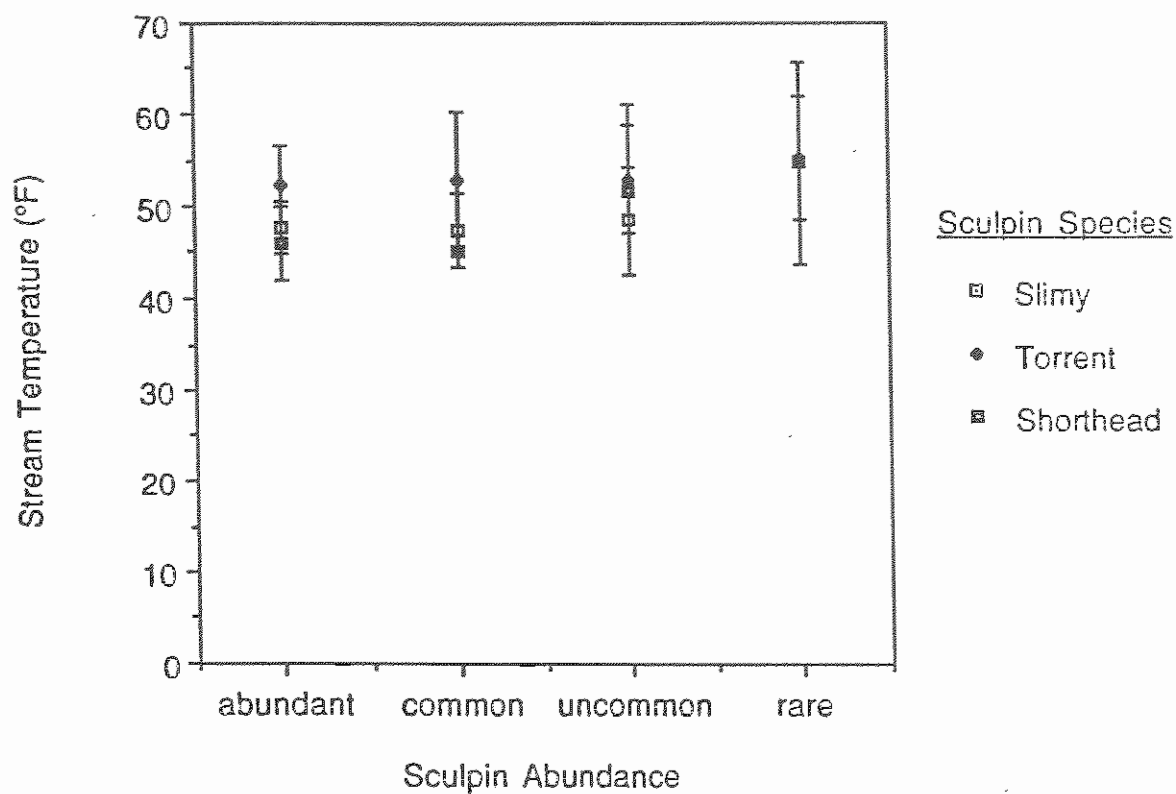


Figure 7: Mean stream temperature at sample sites containing slimy sculpins, torrent sculpins and shorthead sculpins at four levels of abundance. Error bars equal 1 standard deviation. Sculpin abundance was assessed qualitatively (see p. 8 for definition of sculpin abundance).

fifteen percent of the sites containing slimy sculpins had stream gradients less than 1 percent. Nineteen percent of the sites containing slimy sculpins had stream gradients of 1.5%. Another eleven percent of the sites occupied by slimy sculpins had stream gradients of approximately 2%.

Torrent sculpins were found at sites with stream gradients ranging from less than 1% to 1.5%. The majority of sites containing torrent sculpins, sixty-one percent, had a 1% stream gradient. Roughly twenty-two percent of the sites containing torrent sculpins had a 1.5% stream gradient. Approximately seventeen percent of the sites containing torrent sculpins were at sites with a stream gradient of less than 1%.

Shorthead sculpins were evenly distributed at forty-four percent between sites with a 1% gradient and sites with a 1.5% gradient. Roughly eleven percent of the sites containing shorthead sculpins had a 2% stream gradient. Shorthead sculpins were not found at sites with a stream gradient less than 1%.

#### Stream Order

The sampling frequency for each stream order was dictated by the concentration of each stream order in the watershed network as well as seasonal factors. The majority of the sample sites occurred on 3rd and 4th order streams. Most 1st and 2nd order streams were either too small to electroshock or dry during the fall sampling season. In addition, far fewer 5th and 6th order streams exist in the study area, therefore, the number of sample sites for these orders was less than for smaller order streams.

Sculpins were more likely to be found on 4th, 5th, and 6th order streams than at sites on 2nd and 3rd order streams (Figure 9). There was a greater chance of finding sculpins at a given site as stream order increased.

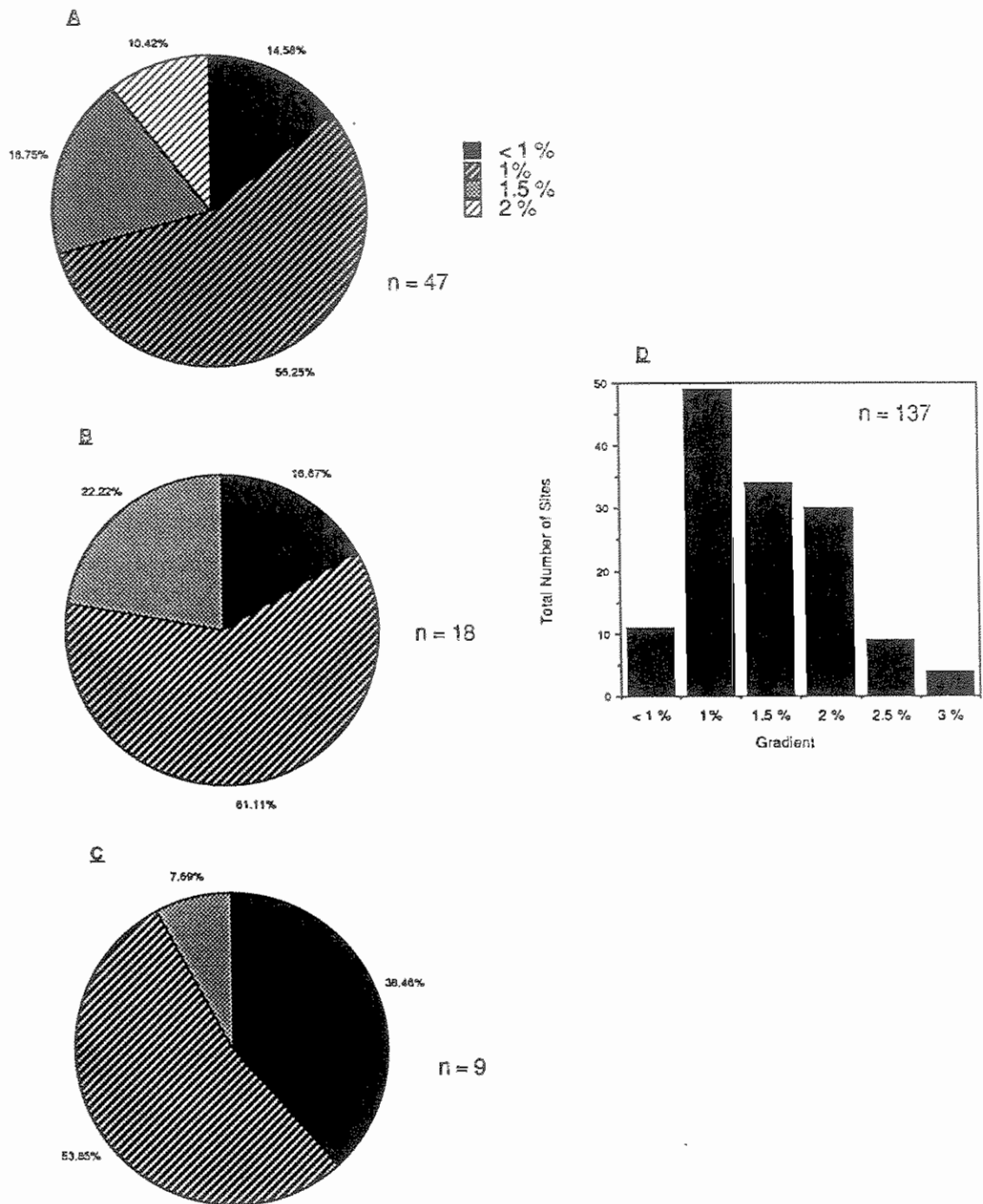


Figure 8: Stream gradients at sample sites containing A) slimy sculpins, B) torrent sculpins, C) shorthead sculpins and D) gradients for the total number of sites sampled.

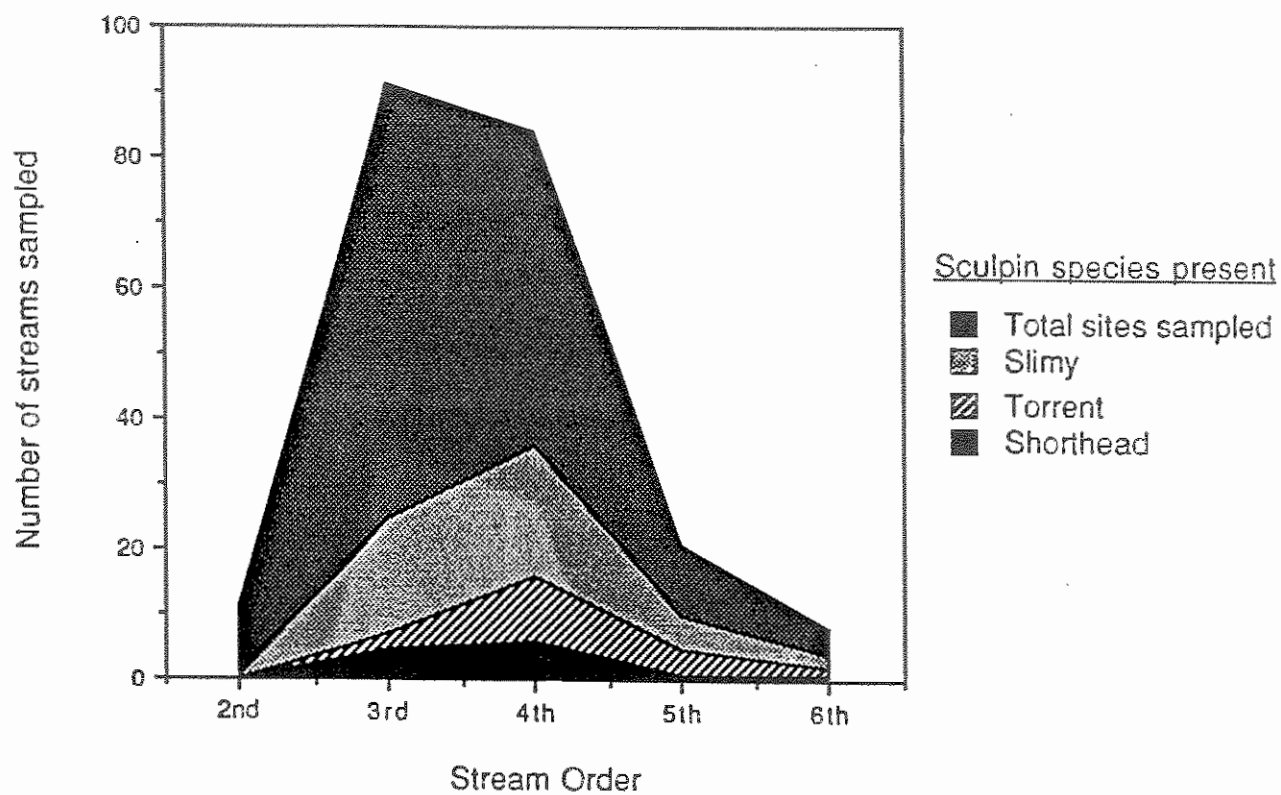


Figure 9: Number of sample sites containing slimy, torrent, and shorthead sculpins for respective stream orders.

Slimy sculpins were most common across the five stream orders sampled being present on 2nd through 6th order streams. Torrent sculpins were found at sites on 3rd, 4th, 5th, and 6th order streams. Shorthead sculpins were present on 3rd, 4th, and 5th order streams only.

#### Benthic Macroinvertebrates

Benthic macroinvertebrate density ranged from moderate to high at sites where torrent, shorthead, and slimy sculpins were abundant (Figure 10). There was no dramatic decrease in benthic macroinvertebrate density at sites where sculpins were less numerous or not present at all. At sites where sculpins were not present, benthic macroinvertebrate density ranged from low to moderate.

#### Algal Density

Filamentous algae density ranged from uncommon to common at sites where torrent, shorthead and slimy sculpins were abundant (Figure 11). As torrent and shorthead abundance decreased, algal density increased. But as slimy sculpin abundance declined, algal density decreased slightly except at sites where slimy sculpins were rare in which case algal density was abundant. Algal density was also abundant at sites where torrent sculpins were rare. At sites where sculpins were not present, filamentous algae was generally uncommon in abundance or not present.

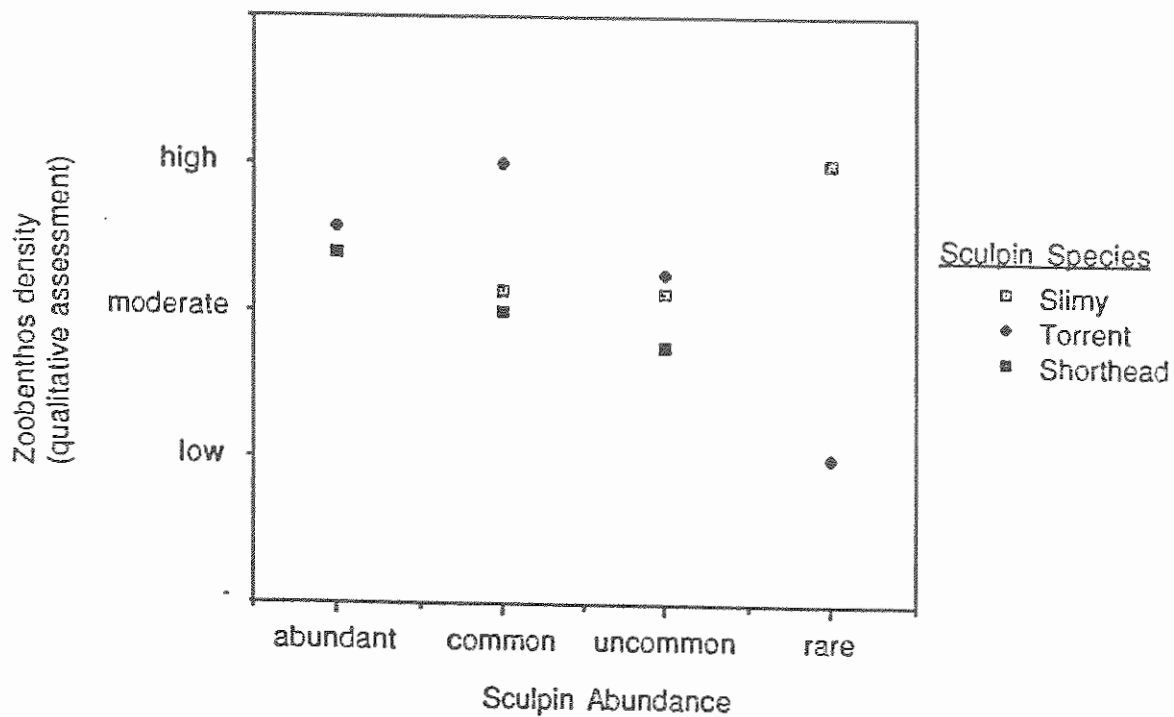


Figure 10: Benthic macroinvertebrate density at sites with four levels of abundance for slimy, torrent, and shorthead sculpins. Zoobenthos densities and sculpin abundance were assessed qualitatively (see p. 8 for definition of sculpin abundance and zoobenthos density).



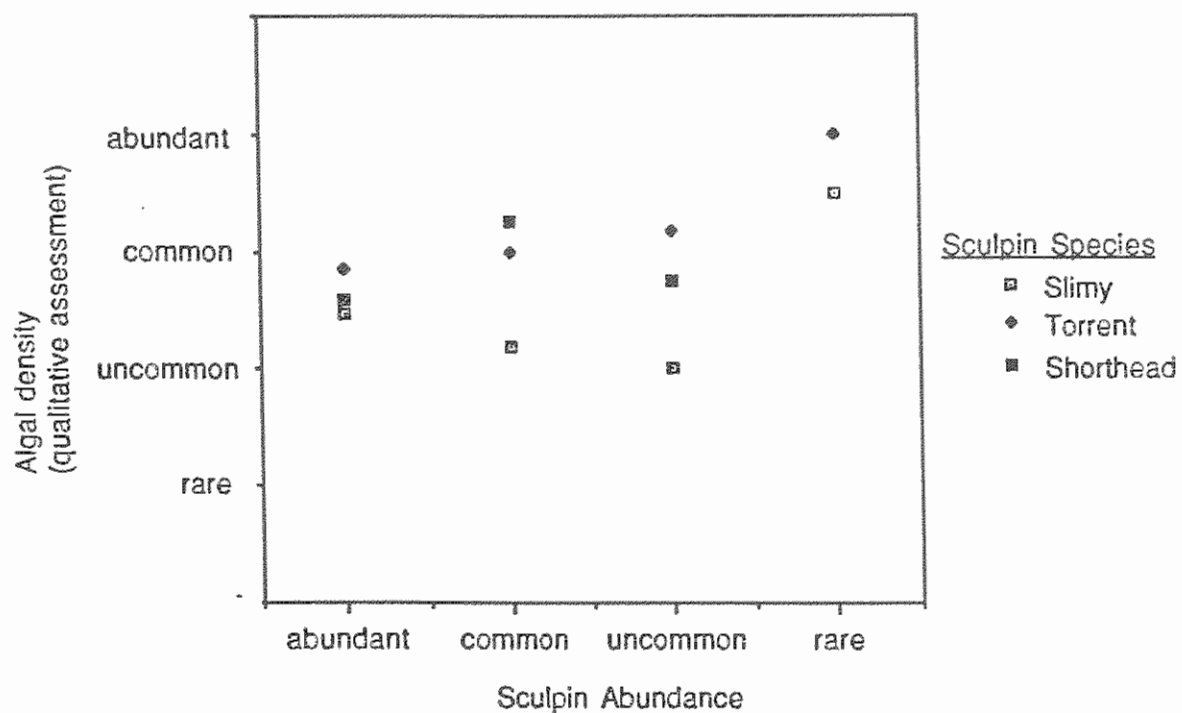


Figure 11: Filamentous algae density at sites with four levels of abundance for slimy, torrent, and shorthead sculpins. Algal densities and sculpin abundance were assessed qualitatively (see p. 8 for definition of sculpin abundance and algal density).

### Reproduction

Reproduction was recorded at sites for the three sculpin species present in the study area (Table 1). Torrent and shorthead sculpins had the highest percentage of sites with young of the year present. Young of the year sculpins tended to occupy backwater areas and were often present in large numbers. Young of the year were easily turned over with the electroshocker but were too small to capture effectively due to their small size relative to the mesh size of the D-nets.

Table 1: Percentage of sample sites with and without reproduction for three sculpin species in the Kootenai National Forest and portions of the Lolo National Forest. Reproduction was determined based on the presence or absence of young of the year (YOY) sculpins at the total number of sample sites for a respective sculpin species between September and October, 1991.

Species	YOY present	YOY not present	Unknown
Slimy	68.1%	25.5%	6.4%
Torrent	77.8%	16.7%	5.6%
Shorthead	77.8%	22.2%	0.0%

### Land Use

All sculpin species found in this study, slimy, torrent, and shorthead, were present at sites in which grazing, logging, roads, and channel structures occurred in varying degrees of magnitude within the watershed (Figure 12). Mining activity was the least frequently encountered disturbance in the study area. All three species were found at respective sites downstream of hardrock mines. Torrent sculpins were also found at urbanized sites. Undisturbed sites were limited in number, were generally found in low order streams, and contained slimy sculpins only.

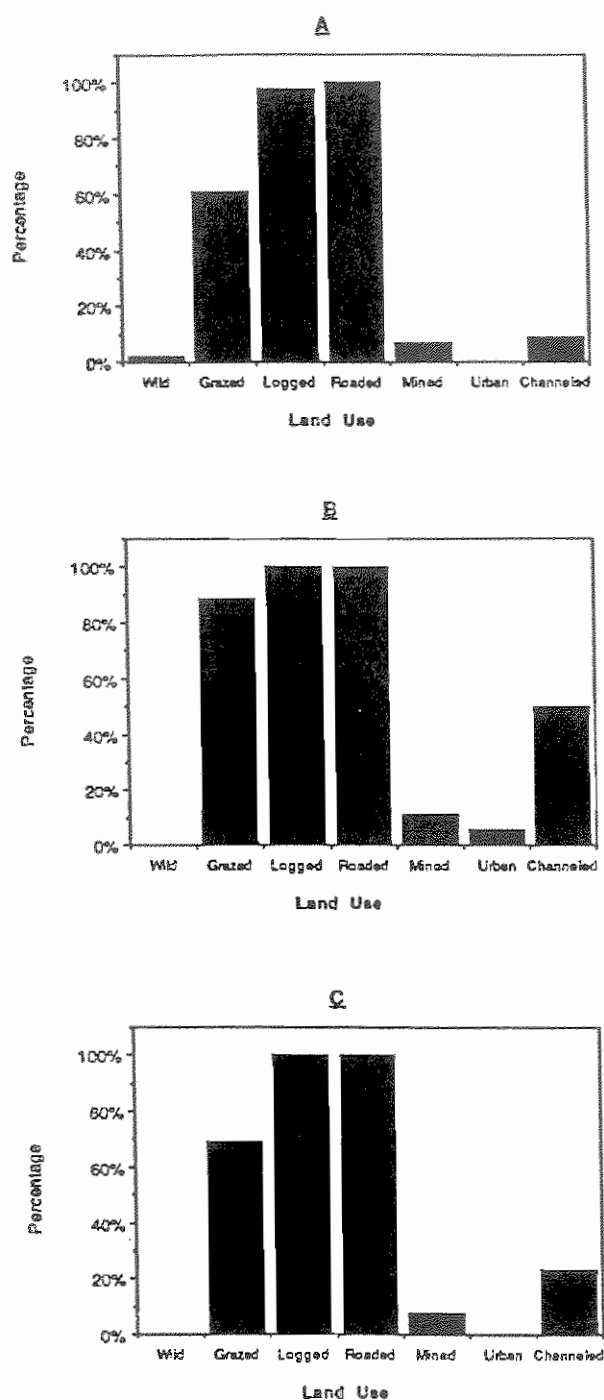


Figure 12: Land use occurring upstream of sample sites containing A) slimy, B) torrent, and C) shorthead sculpins. Land use was listed as present or not present in each watershed with no documentation of the magnitude of the stream habitat impairment.

### Age Classification

Age classifications were determined from a sample of torrent sculpins electroshocked in Libby Creek (T30N R31W sect. 36 SW) on October 18, 1991. Five distinct age classes were evident from the length-frequency histogram of 119 torrent sculpins (Figure 13). Age 0 (young of the year) appear infrequently in the data due to sampling bias. Many age 0 were visible in the backwater areas but slipped through the large mesh of the nets but the general size of the age 0 class appeared to be around 3.0 cm. Age I sculpins ranged from 3.7 cm to 5.2 cm. Age II sculpins ranged in size from 7.0 cm to 8.1 cm. Age III sculpins ranged in size from 8.2 cm to 9.4 cm. Age IV sculpins ranged in size from 9.8 cm to 10.8 cm. Age I sculpins made up the largest percentage of the sample although the age 0 class was not effectively sampled. The population of each progressive age class decreased in the sample. The age IV class contained 6 individuals the largest of which was 10.8 cm.

Length-weight regressions were carried out on age I through age IV class torrent sculpins in Libby Creek. The sample contained a wide range of weights due to the low sensitivity of the scale being used. As a result, length-weight regressions are projected in Appendix B but not included in the results and discussion.

### Sampling Methodology

The electroshocker, in combination with the D-net, yielded the highest catch per unit effort of all the sampling methods employed during this study. The D-net was placed directly downstream of the electroshocker. Sculpins immobilized or attempting to escape the electrical field often drifted or swam into the D-net. Occasionally checking the D-net yielded a sculpin via the "blind grab". Despite the fact that sculpins were typically capable of eluding the electrical field, this technique proved to be the most effective means of sampling sculpins.

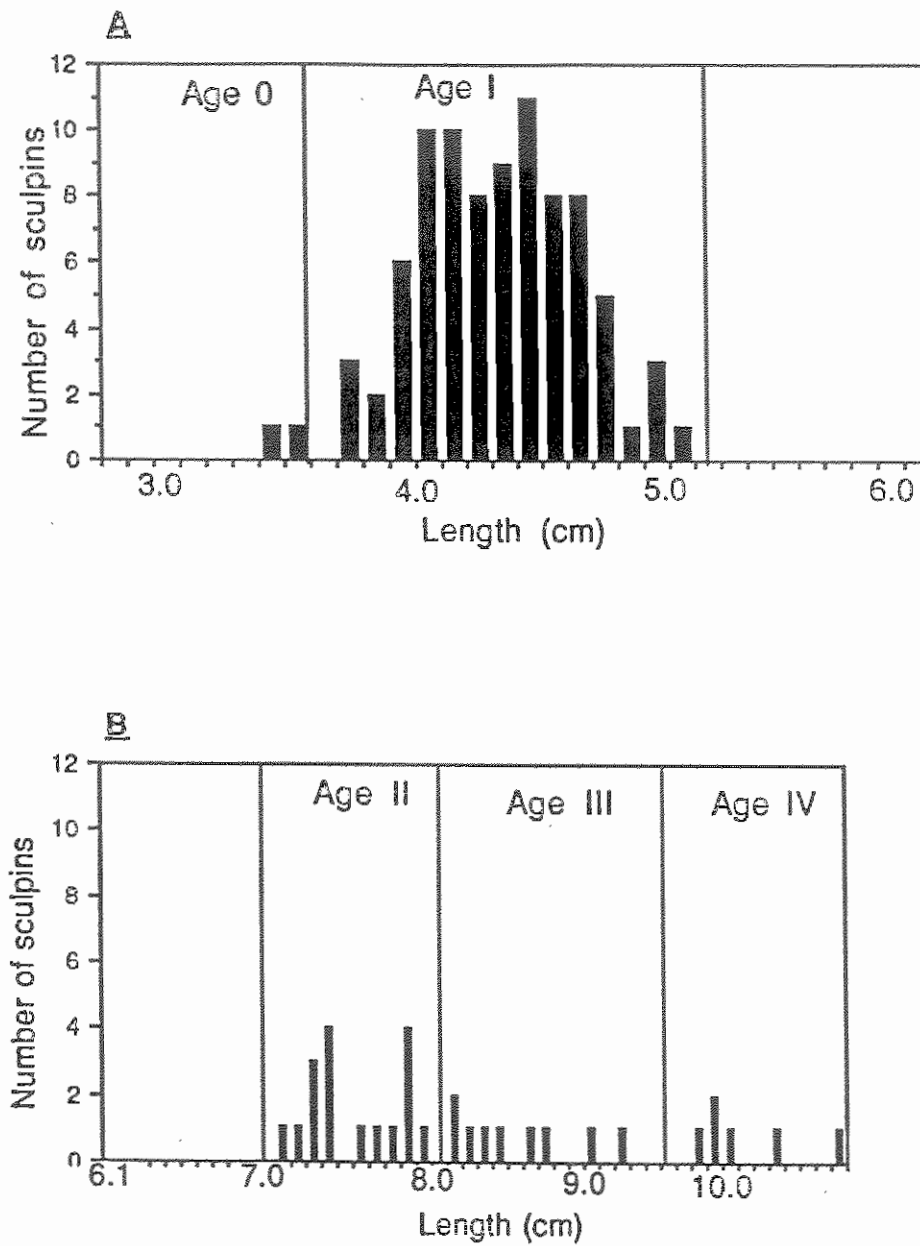


Figure 13: Age classification of torrent sculpins in Libby Creek sampled October 18, 1991. The sample consisted of 119 individuals.

The electroshocker was more effective at immobilizing salmonid species than sculpins. All sculpin species encountered in this study were generally capable of escaping the electrical field whereas salmonids would gravitate toward the positive electrode (galvanotaxis). Only the larger sculpins (usually torrents and some shortheads) displayed galvanotaxis but on a limited basis.

Diagonal transects using D-nets appeared to be an effective sampling technique in riffles containing small rubble and high sculpin densities. This method was used at Upper Ford on the main Yaak and on Libby Creek near the fish hatchery. Three 15 foot transects yielded 3 sculpins per pass at Upper Ford. Two similar transects at Libby Creek netted 2 sculpins per pass. Current velocities typically found in riffles were a prerequisite for this technique to be effective. Sculpins disturbed while shuffling the substrate were swept into the net before orienting themselves in the current. Limited efforts in runs revealed that this technique would not be practical in habitat where current velocities tend to be slower.

The kick-screen proved to be an ineffective method for sampling sculpins. The kick-screen was also used at Upper Ford on the Main Yaak (T36N R31W sect. 6 SE). It appeared that sculpins swept against the screen by the stream current were able to escape before the screen was pulled from the water by re-orienting themselves and swimming against the current. Modifications of the screen such as using mesh cloth with a deep pocket rather than the straight metal screen might make this a more effective sampling method.

Minnow traps were ineffective at catching sculpins. The traps were placed at the Libby Creek site near the fish hatchery (T30N R31W sect. 36 SW). No sculpins migrated into the traps on any sampling interval (2, 4, 6, and 12 hours). The traps were disassembled after running the experiment for 12 hours. It was apparent that some emigration of benthic

macroinvertebrates did occur from the substrate placed in the traps during this 12 hour time period, however, a substantial number remained in the traps attached to the substrate.

## Discussion

Three sculpin species were present in the study area based on the sampling methods employed in this study. The distribution of each species varied greatly. Slimy sculpins were the most widespread species in the study area. This species was present throughout most of the watershed network both geographically and longitudinally. It appears that slimy sculpins are adapted to a broad range of habitat conditions. In the Kootenai drainage, slimy sculpins appear to be displaced longitudinally by torrent sculpins in areas in close proximity to the main river.

Torrent sculpins had a more restricted range in the study area, typically found in tributary streams of the Kootenai River drainage in close proximity to the main river. However, on Tobacco River tributaries, torrent sculpins were found far from the main river. These sites were uncharacteristic of typical low order streams which normally have steeper gradients, coarser substrates, and cooler temperatures relative to 4th and 5th order streams where torrents are generally present. Sites in the Tobacco watershed with typical low-order stream characteristics did not contain sculpins. Those sites in the Tobacco containing torrent sculpins had low gradients and brackish water typically signifying swampy conditions upstream and warmer stream temperatures. The atypical conditions of these sites might explain the abnormal longitudinal location far from the main river for torrents.

Shorthead distribution appears somewhat confusing. Shorthead sculpins were abundant in the St. Regis River watershed and appeared to exist in allopatry throughout the basin. Adjacent Clark Fork River tributaries contained slimy sculpins in what appeared to be allopatry in the field. However, after laboratory identification, four sites, one on a Clark Fork River tributary and three on the Yaak River system, contained slimy and shorthead



sculpins in sympatry. Additional sites may have contained shorheads also but the specimens could have been mistakenly identified as slimys in the field and returned to the stream.

Geologic factors may possibly account for the limited distribution of shorthead sculpins. The shorthead sculpin population in the St. Regis River basin could be a remnant population which previously had a wider distribution. Geologic events leading up to and after the release of Glacial Lake Missoula could have effected the distribution of shorheads in the study area (Doug Perkinson, personal communication).

Shorthead sculpins appear to be the only sculpin species present in the St. Regis River watershed. Physical, chemical, and biological factors in the St. Regis watershed may be advantageous for shorthead sculpins enabling them to competitively exclude other sculpin species. Shorthead sculpins may have had a much larger distribution and density in the study area at one time. In fact, the four sites containing shorthead sculpins in sympatry with slimy sculpins could be indicative of part of the former distribution of this species.

Recent genetic work on sculpins serves to compound the confusion over shorthead distribution even more. This research suggests that distinguishing between mottled sculpins (*Cottus bairdi*) and shorthead sculpins in the Columbia River Basin might be questionable since it is suspected that the two species hybridize (Dr. William Gould, personal communication). Therefore, laboratory identifications suggesting an additional four shorthead sculpin locations outside the St. Regis River watershed could actually be distributional data points for mottled sculpins.

Sympatry between torrent and slimy sculpins appeared to be present at only two sites. Sympatry may be more common between torrent and slimy sculpins than was found in this study. Species specific habitat preferences were not distinguishable. Sites in close proximity to the main Kootenai River appeared to provide suitable slimy habitat as

witnessed by their presence in Pipe Creek. However, slimy sculpins were typically displaced upstream of the torrents on tributaries where both species occurred. Longitudinal overlaps in torrent and slimy distribution on these tributary streams may exist marking areas of transition from dominance by one sculpin species to another. Future studies might examine the habitat conditions marking the transition from slimy habitat to torrent habitat on tributary streams where the two species appear to exist in allopatry longitudinally.

### Factors Influencing Sculpin Distribution

#### Stream Character

All three sculpin species appeared to reside most commonly in runs and to a lesser degree in the area of overlap between runs and riffles. However, stream segments were selectively sampled. Run habitat was sampled more extensively than pools and riffles because runs typically contained sculpins. Pool, riffle and run habitat were not sampled in proportion to the frequency of occurrence of each habitat type in the stream segment. Furthermore, the proportion of riffle, run and pool at a sample site was not quantified. As a result, concluding that all three sculpin species prefer run habitat could be a reflection of sampling methodology bias rather than a valid conclusion.

Stream character preferences between species were not discernible based on qualitative measures of habitat. Future studies might examine current velocities especially at a more sensitive scale to distinguish species specific preferences.

#### Substrate

Substrate composition appeared to be an important habitat parameter influencing the abundance of all three sculpin species at any one particular site. However, there were no identified distinctions between species.

Several explanations for the affinity of sculpins to rubble substrates exist. The interstitial spaces common in rubble substrates offer refuge from predatory fish and birds. Sculpins typically attempted to escape the electroshocker by burrowing into the substrate. In addition, rubble substrates typically support higher concentrations of aquatic insects which is thought to be the primary sculpin food source.

Torrent sculpins appeared more capable of tolerating habitat with some degree of finer substrate material than the other two sculpin species. This may, in fact, be an indirect measure of some other habitat parameter influencing torrent distribution (i.e. torrents might prefer warmer stream temperatures which is a characteristic of slower moving bodies of water in Montana).

### Temperature

Temperature appears to exhibit some influence on species distribution although species specific tolerance ranges were not determined in this study. Basic temperature ranges were identified graphically for the three more common sculpin species in the study area. Torrent sculpins were typically found at sites with warmer stream temperatures. Shorthead sculpins appeared to be associated with sites containing lower stream temperatures. Slimy sculpins appeared to prefer sites between the two mean temperature ranges of torrent and shorthead sculpins.

### Benthic Macroinvertebrates

There was no quantitative data linking sculpin abundance with benthic macroinvertebrate density. Initially, it was hypothesized that a direct relationship would exist between sculpin density and benthic macroinvertebrate density since the literature states that invertebrates are a major component of sculpin diets (Brown 1971). This lack of a direct link might be due more to sampling methodology rather than results contrary to the hypothesis. Rating invertebrate densities qualitatively was marginal at best. In addition, a complete invertebrate taxonomy list with respective densities was not undertaken. Sculpin mouthparts may restrict their diets allowing them to feed on aquatic insects occupying specific micro-habitats within the substrate. Generalized evaluations of zoobenthos density would not illustrate these points. Further investigation should include quantitative sampling of invertebrate densities at sampling sites as well as examinations of sculpin stomach contents.

### Algal Density

The filamentous algae community was also hypothesized to be a critical component for sculpins both as a food resource and as protection from predation. However, no direct relationship between algal density and sculpin abundance was evident. In fact, as sculpin abundance decreased at a number of sites, algal density increased. The inverse also held true, as algal density decreased, sculpin abundance increased. One explanation for this inverse relationship between sculpin abundance and algal density would be that sculpins were possibly cropping the algal community or sculpins were selectively feeding on macroinvertebrate predators of algal grazers. Thus, algal densities would be lower at sites where sculpin densities were high.

The lack of an inverse relationship between sculpin density and algal density at some sites could be attributed to an algal community dominated by a species not palatable to sculpins. However, it was evident, for the most part, that at sites where sculpins were not present, filamentous algae was either rare in abundance or not present.

The inverse relationship between algae and sculpins might better be explained by inefficient sampling methods. High algal densities offer additional concealment for sculpins making it more difficult to net them, thus, possibly leading to interpretations that sculpin abundance was low at these sites.

It is also plausible that sculpins prefer or were relegated to feeding on a particular algal species. Some algae may not be digestible for sculpins or might possibly be too low in necessary proteins for young sculpins to pass through a critical age class. If this were the case then sculpin density and distribution might be greatly influenced by the algal community. Further studies in sculpin distribution should examine sculpin stomach contents as well as the algal community at study sites.

### Land Use

Each sculpin species was capable of tolerating some degree of land use disturbance within the watershed. The most common form of water pollution resulting from these land uses was sedimentation. It was beyond the scope of this study to judge the tolerance of each species to various forms of disturbance. Most of the sites were impacted by the cumulative effects of several upstream land use practices.

Sculpin densities were noticeably impacted by land use at some sites. Sedimentation caused by several forms of land use in the watershed at the lower site on Lake Creek made the habitat basically inhospitable for sculpins. Torrent sculpins were rare at this site. Their presence was limited to the rip-rap structures on the bank where interstitial spaces in the large boulders offered suitable habitat. Mid-channel substrate at this site was heavily embedded with sand and silt. Logging, roads, grazing, mining and channel structures were all recorded in this watershed making it impossible to isolate a single factor impairing the habitat.

The near absence of sculpin species at undisturbed sites was more a reflection of the lack of these pristine areas encompassing larger rivers as well as the limited number of watersheds free of human disturbance rather than the attraction of sculpins to disturbed sites. Undisturbed sites are typically located at higher elevations characteristic of low order streams. Sculpins were generally found in streams of 3rd order and larger in this study. As a result, sculpin presence at a particular site might be more associated with location in the drainage rather than land use.

### Age Classification

Brown (1971) estimated the approximate length of torrent sculpins for the first two years as follows: 1 year - 3.3 cm; 2 years - 5.8 cm. The samples on Libby Creek were

taken in mid-October near the completion of the first year's growth. As a result, The age I class fish in this study correspond more to Brown's 2 year age class. If this is the case then the age I class sculpins in Libby Creek were smaller than Brown's estimate for the 2 year age class but the age 0 class was similar to the 1 year age class. The smaller size in the age I class nearing the completion of 2 years of growth could be due to a number of factors affecting growth rates such as temperature differences between drainages, overcrowding, lack of food resources, or selective predation on larger individuals none of which were monitored in this study.

#### Sampling Methodology

The electroshocker, in combination with the D-net, was by far the most effective method for sampling sculpins. However, this technique did have shortcomings. Sculpins were often capable of eluding the electrical field unlike salmonids which were typically immobilized by the electrical field or exhibited galvanotaxis. This difference was probably due to physiological, morphological, and/or behavioral differences in these two groups. Sculpins often escaped the field by burrowing into the substrate through the interstitial spaces. The larger rocks probably deflected the electrical field to some degree. On numerous occasions, sculpins were immobilized by the shocker but quickly darted away when the power was turned off. Additional research should be conducted on the use of AC power verses DC power to see if one power source is more effective than the other on sculpins.

Electroshockers in combination with block nets are commonly used for obtaining salmonid population estimates on fourth order streams and smaller. Will this same methodology produce reliable results from which land managers can base decisions for land-use in particular watersheds? Based on sampling efforts in this study and

communication with other fisheries Biologists, this method might produce reliable sculpin population estimates if the number of passes are increased. As already noted, sculpins were capable of eluding the electrical field. Those individuals that escaped were often hunted for while passing back through the same section of a stream. The escapee was often caught with greater ease on the second pass. At sites where a large number of sculpins were necessary for electrophoresis analysis, the electroshocker was worked back and forth through a particular section of stream making three and four passes over the same spot. Sculpins continued to be netted at points along the segment even on the fourth pass. These individuals caught on the fourth pass seemed easier to net suggesting that repeated passes of the electrical field have a cumulative effect on sculpins. Doug Perkinson observed an increase in sculpin numbers with each pass of the electroshocker while doing population estimates on salmonids in the Kootenai National Forest. This evidence suggests that methods applied for salmonid population estimates will yield reliable sculpin population estimates provided a sufficient number of passes are taken.

In addition to the higher yield of sculpins per sampling effort, the electroshocker was also a more versatile tool for sampling a variety of habitats which sculpins occupy. Diagonal transects with D-nets and kick-screen techniques are limited to habitats with adequate current velocity, thus, limiting sampling sites. It is evident from this study that sculpins occupy a variety of habitats with varying current velocities. The electroshocker enables one to sample all likely sculpin habitat on streams up to fourth order. The backpack model was limited on larger streams due to the dissipation of the electrical field, ability of the sculpins to escape, as well as water depth for samplers.

Diagonal transects using D-nets were an effective sampling method in riffles containing small rubble and relatively high sculpin densities. However, this method was limited to areas of higher current velocity which biased sampling results. Young of the year sculpins



were found in backwater habitats and younger age classes were typically located in lateral sections of runs and riffles whereas the older age classes were found in higher current velocities more characteristic of the center of the stream channel. In addition, it is not apparent how sculpin species partition themselves at sites where they occur in sympatry. As a result, sampling methods restricted to D-nets may yield data which does not accurately reflect sculpin distribution or habitat use.

The kick-screen proved to be ineffective at sampling sculpins. Sculpins washed against the screen were capable of swimming into the current to escape being caught. Observations of nets used to block the downstream end of a reach being electroshocked for population estimates rarely yielded sculpins. However, trout were commonly found washed against the net by the current. Perkinson (personal communication) attributes this to the different effect of the electroshocker on trout and sculpins. Therefore, extending the length of the screen to block the entire width of the stream, much like a block net or seine net, is not likely to be any more successful.

Hauer and Stanford (1981) developed a kick-net for sampling benthic macroinvertebrates in large river environments. This method might prove effective for sampling sculpins. This sampling device has a large tent shaped net supported by two handles anchored to the substrate. The deep pocket effectively traps aquatic organisms swept by the current. But, as was noted with D-nets, the kicknet technique would also bias sampling because its effectiveness is limited to habitat with higher current velocities.

Minnow traps proved to be ineffective sampling devices for sculpins. However, this sampling method may prove to be useful with the proper bait to attract sculpins. Benthic macroinvertebrates were chosen because the literature lists this as the primary food source for sculpins. Additional studies need to be conducted on the use of minnow traps before this method is considered ineffective.

This preliminary study of sculpin distribution in the Kootenai National Forest and western portions of the Lolo National Forest revealed a broad geographic and longitudinal distribution for slimy sculpins. Torrent sculpins appear to occupy a range restricted to Kootenai River tributaries in close proximity to the main river. The distribution of shorthead sculpins appears to be concentrated in the St. Regis River watershed with scattered occurrence in other parts of the study area. Additional sampling in combination with electrophoretic analysis may shed light on the distribution of this species in western Montana. Future investigations should concentrate on identifying physical, chemical, and biological factors influencing species distribution.

### Literature Cited

- Brown, C. J. D. 1971. Fishes of Montana. Big Sky Books, Montana State University, Bozeman. 207 pp.
- Genter, D. L. 1992. Species of special concern in Montana. Montana Natural Heritage Program, Helena. 11 pp.
- Hauer, F. R. and J. A. Stanford. 1981. Larval specialization and phenotypic variation in *Arctopsyche grandis* (Trichoptera: Hydropsychidae). *Ecology* 62:645-653.
- Holton, G. D. 1990. A field guide to Montana fishes. Montana Dept. of Fish, Wildlife and Parks, Helena. 104 pp.
- Jearld, A. 1983. Age determination. In: *Fisheries Techniques*, eds. L. A. Nielsen and D. L. Johnson, p. 301-324. American Fisheries Society, Bethesda, Maryland.

## Appendices

Creek	Species	Abundance	repro. present	micro habitat	invertebrate density	algal density	stream order	gradient (percent)	Disch. (cfs)	Dominant substrate	temp. (°F)	overhanging vegetation	trout present	land use
Tobacco														
Stillwater @ Olney	slimy	common	yes	run	low	abundant	4	1	40	rubble	46	0%	yes	2,3,4,7
Stillwater @ hwy 93	slimy	common	yes	run	low	common	3	1 to 2	15	rubble	43.5	0%	yes	2,3,4
Kootenai														
Libby	slimy	abundant	yes	run	moderate	NP	4	1 to 2	10	rubble	52.0	0%	yes	2,4,5
Ramsey	slimy	abundant	yes	run	moderate/low	NP	3	2	2	rubble	46.5	5%	yes	2,4
Poorman	slimy	common	yes	run	moderate	NP	2	2	1	rubble	46.5	10%	yes	2,4
Lake @ Bull Lake	slimy	common	yes	run	high	common	4	1	20	rubble	48.5	0%	yes	2,3,4
Quartz @ River Road	slimy & torr	uncommon	yes	run/riffle	moderate/low	uncommon	3	1 to 2	5	rubble	45.0	15%	yes	2,4,7
Pipe @ Timberlane cpd.	slimy	common	yes	run	moderate	uncommon	3	1	5	sand/rubble	45.0	10%	yes	2,3,4
Yaak														
Cool	slimy	abundant	yes	run	?	?	3	1	2	rubble	49	?	yes	2,3,4
Vinal @ FS 746	slimy	abundant	yes	run	?	common	3	1	3	rubble	49	20%	yes	4
Vinal below Falls	slimy	common	no	run	?	NP	3	2	2	rubble	47	30%	yes	1
Meadow	slimy	common	no	run/riffle	?	uncommon	4	2 to 3	5	rubble	51	2%	yes	2,4
Seventeenmile	slimy	uncommon	?	run/riffle	high	common	4	2 to 3	25	rubble	51	5%	yes	2,4
Main Yaak below Falls	slimy & short	uncommon	?	run	high	common	6	1 to 2	150	boulder	62.5	0%	yes	2,3,4
Main Yaak @ Seventeenmile	slimy	rare	?	run	high	abundant	6	1 to 2	150	rubble	62.5	1%	yes	2,4
Main Yaak @ Upper Ford	slimy	abundant	yes	run/riffle	high	common	5	1	50	rubble	47	5%	yes	2,3,4
W. Fk. Yaak @ FS road 92	slimy & short	uncommon	no	run	?	uncommon	4	2	20	rubble	47	5%	yes	2,4
W. Fk. Yaak @ Falls	slimy & short	uncommon	yes	run	low	uncommon	4	1 to 2	20	rub/boul	46	5%	yes	2,4
N. Fk. Yaak @ FS road 5828	slimy	uncommon	no	run	?	uncommon	?	1 to 2	25	rubble	47	5%	yes	2,3,4
N. Fk. Yaak @ FS road 92	slimy	abundant	yes	run	common	uncommon	?	1	25	gravel	?	0%	yes	2,3,4
Clark Fork														
Bull @ F.S. Rd. 410	slimy	abundant	yes	run	moderate	uncommon	4	1.5	8	rubble	49	0%	yes	2,4
S. Fk. Bull	slimy	uncommon	no	run	low	NP	3	1.5	10	rubble	47	5%	yes	2,4
E. Fk. Bull	slimy	common	yes	run	low	NP	4	1	5	rubble	46	5%	yes	2,4
Vermilion @ Clark Fork	slimy	abundant	yes	run	moderate	uncommon	4	1	25	rubble	48	5%	yes	2,4,5
Vermilion @ Cataract Ck.	Slimy	uncommon	no	run	moderate	uncommon	3	2	25	rubble	47	0%	yes	2,4,5
Swamp @ F.S. Rd. 1119	slimy	abundant	yes	run	moderate	common	3	1	5	rubble	48	5%	yes	2,3,4
West Fk. Elk	slimy	common	yes	run	moderate	common	3	1	1	rubble	55.5	5%	yes	2,3,4
East Fk. Elk	slimy	abundant	yes	run	moderate	uncommon	3	1	5	rubble/gr	50	0%	yes	2,3,4
Elk @ Clark Fork	slimy	uncommon	no	run	high	abundant	4	1.5	5	rubble	58	5%	yes	2,3,4
Bull @ Clark Fork	slimy	common	yes	run	high	common	5	1	30	rubble/boul	47	0%	yes	2,3,4
pligim @ Clark Fork	slimy	rare	no	run	high	common	3	1	2	sand/gravel	47	30%	yes	2,3,4
Marten	slimy	abundant	yes	run	high	common	4	1	10	grav/rubb	50	0%	yes	2,3,4
Tussock	slimy	common	yes	run	moderate	uncommon	3	1	1	gravel	56	15%	yes	2,3,4
Trout @ sect. 24	slimy	common	yes	run	moderate	uncommon	4	1	5	rubble	48	5%	yes	2,3,4
White Pine	slimy	common	yes	run	high	common	3	1	2	gravell/rubi	47	0%	yes	2,3,4
Big Beaver @ sect. 30	slimy	abundant	yes	run	high	abundant	3	1	10	sand/gravel	47	5%	yes	2,3,4

Appendix A-1: Physical and biological stream characteristics at sample sites containing slimy sculpins in the Kootenai National Forest and western portions of the Lolo National Forest.

Creek	Species	Abundance	repro. present	micro habitat	invertebrate density	algal density	stream order	gradient (percent)	Disch. (cfs)	Dominant substrate	temp. (°F)	overhanging vegetation	trout present	land use
Lolo														
Prospect @ FS road 2142	slimy & short	abundant	yes	run	high	abundant	4	1	15	grav/rub	50	0%	yes	2,3,4
Prospect @ Dry Ck.	slimy	abundant	yes	run	high	common	5	1	15	grav/rub	47	0%	yes	2,3,4
Thompson @ mouth	slimy	uncommon	no	run	high	abundant	5	1 to 2	150	rub	49	0%	yes	2,3,4,7
Thompson @ Copperking	slimy	common	yes	run	high	uncommon	5	1 to 2	100	rub	46	0%	yes	2,3,4,7
Thompson @ FS 7593 & 56	slimy	common	yes	run	moderate	abundant	4	1	25	sand	47	0%	yes	2,3,4,7
Flehttrap	slimy	uncommon	no	run/riffle	moderate	uncommon	4	1 to 2	25	rub	47.5	5%	yes	2,3,4
W. Fk. Fishtrap	slimy	uncommon	yes	run/riffle	moderate	NP	3	1 to 2	5	rub	44	5%	yes	2,3,4
Trout	slimy	abundant	yes	run	moderate	common	4	1 to 2	20	grav/rub	42	0%	yes	2,4
Cedar @ mouth	slimy	abundant	yes	run	high	common	4	1	10	rub	42	0%	yes	2,3,4
Cedar @ Upham Ck	slimy	uncommon	yes	run	moderate	NP	4	1 to 2	1	rub/bould	40	0%	no	2,4
Cedar @ Oregon Gulch	slimy	common	no	run	moderate	uncommon	4	1 to 2	7	rub	41	0%	yes	2,4

Appendix A-1(cont.): Slimy sculpin sites.

Creek	Species	Abundance	repro. present	micro habitat	Invertebrate density	algal density	stream order	gradient (percent)	Disch. (cfs)	Dominant substrate	temp. (°F)	overhanging vegetation	trout present	land use
Kootenai														
Big	torrent	uncommon	no	run	?	?	4	1 to 2	5	rubble	47.0	5%	yes	2,4
Tobacco	torrent	common	?	run	high	common		1	40	sand/grav	58.0	5%	yes	2,3,4,5
Tobacco @ Graves	torrent	uncommon	yes	run	low	uncommon	5	1 to 2	30	rubble	52.0	1%	yes	2,3,4
Fortine	torrent	uncommon	yes	run	high	abund	4	1	10	rubble	53.0	5%	yes	2,3,4
Swamp	torrent	uncommon	yes	run	moderate	abundant	3	1 to 2	1	rubble	56.0	10%	yes	2,3,4
Yaak														
Main Yaak @ Hwy 2	torrent	uncommon	yes	run	high	common	6	1	150	rub/boul	62.5	0%	yes	2,3,4
Kootenai														
Fisher @ Hwy 37	torrent	uncommon	yes	run	high	abundant	5	1	30	grav/rubb	55.0	0%	yes	2,3,4,5,7
Wolf	torrent	common	yes	run/riffle	high	common	4	1	3	rubble	47.5	5%	yes	2,3,4,5,7
Fisher @ W. FK	torrent	abundant	yes	run/riffle	high	common	5	1	25	rubble	54.0	0%	yes	2,3,4
W. FK Fisher @ Hwy 2	torrent	abundant	yes	run/riffle	high	common	4	1	3	rubble	53.0	0%	yes	2,3,4
W. FK Fisher	torrent	abundant	yes	run	moderate	uncommon	4	1	3	rubble	52.0	0%	yes	2,3,4
Libby @ Hwy 2	torrent	abundant	yes	run	moderate	abundant	4	1	5	rubble	54.0	0%	yes	2,3,4,7
Libby @ hatchery	torrent	abundant	yes	run/riffle	high	common	4	1	20	rubble	59.0	0%	yes	2,3,4,7
Granite	torrent	rare	no	run	low	abundant	4	1 to 2	10	rubble	60.0	0%	yes	2,3,4,7
Callahan @ Hwy 2	torrent	abundant	yes	run	moderate	uncommon	4	1 to 2	10	rubble	48.0	0%	yes	2,3,4,7
Lake @ Hwy 2	torrent	rare	no	run/riffle	low	abundant	5	1 to 2	30	silt/sand	50.5	0%	yes	2,3,4,5,7
Pipe @ River road	torrent	abundant	yes	run	high	common	4	1 to 2	5	rubble	47.0	0%	yes	2,3,4,7
Quartz @ River Road	terr & silty	uncommon	yes	run/riffle	moderate/low	uncommon	3	1 to 2	5	rubble	45.0	15%	yes	2,4,7

Appendix A-2: Physical and biological stream characteristics at sample sites containing torrent sculpins in the Kootenai National Forest.

Creek	Species	Abundance	repro. present	micro habitat	invertebrate density	algal density	stream order	gradient (percent)	Disch. (cfs)	Dominant substrate	temp. (°F)	overhanging vegetation	trout present	land use
St. Regis														
St. Regis @ Satese	shorthead	common	yes	run	moderate	abundant	4	1	20	aval/rubb	?	0%	yes	2,3,4,7
St. Regis @ mouth	shorthead	common	yes	run	high	abundant	5	1	40	rubble	?	0%	no	2,3,4,7
Big	shorthead	abundant	yes	run	moderate	common	4	1	5	rubble	?	0%	yes	2,3,4
Twelvemile @ sect. 26	shorthead	common	no	run/r/life	moderate	abundant	3	2	3	rubble	?	10%	yes	2,4
Twelvemile @ sect. 11	shorthead	uncommon	no	run/r/life	moderate	abundant	3	1.5	2	conglomer	?	10%	no	2,4
Twelvemile @ Cabin City	shorthead	abundant	yes	run	high	uncommon	4	1.5	3	rubb/boul	?	15%	yes	2,3,4
Twomile	shorthead	abundant	yes	run	moderate	uncommon	3	1.5	3	rubble	42.0	15%	yes	2,4
Little Joe	shorthead	abundant	yes	run	moderate	uncommon	3	1	5	rubble	45.0	5%	no	2,3,4
S. Fk. Little Joe	shorthead	common	yes	run	low	rare	3	1.5	2	rubble	45.0	15%	yes	2,4
Clark Fork														
Prospect @ FS road 2142	short & silmy	abundant	yes	run	high	abundant	4	1	15	grav/rub	50	0%	yes	2,3,4
Yaak														
Main Yaak below Falls	short & silmy	uncommon	?	run	high	common	6	1 to 2	150	boulder	62.5	0%	yes	2,3,4
W. Fk. Yaak @ FS road 92	short & silmy	uncommon	no	run	?	uncommon	4	2	20	rubble	47	5%	yes	2,4
W. Fk. Yaak @ Falls	short & silmy	uncommon	yes	run	low	uncommon	4	1 to 2	20	rubb/boul	46	5%	yes	2,4

Appendix A-3: Physical and biological stream characteristics at sample sites containing shorthead sculpins in the Kootenai National Forest and western portions of the Lolo National Forest.

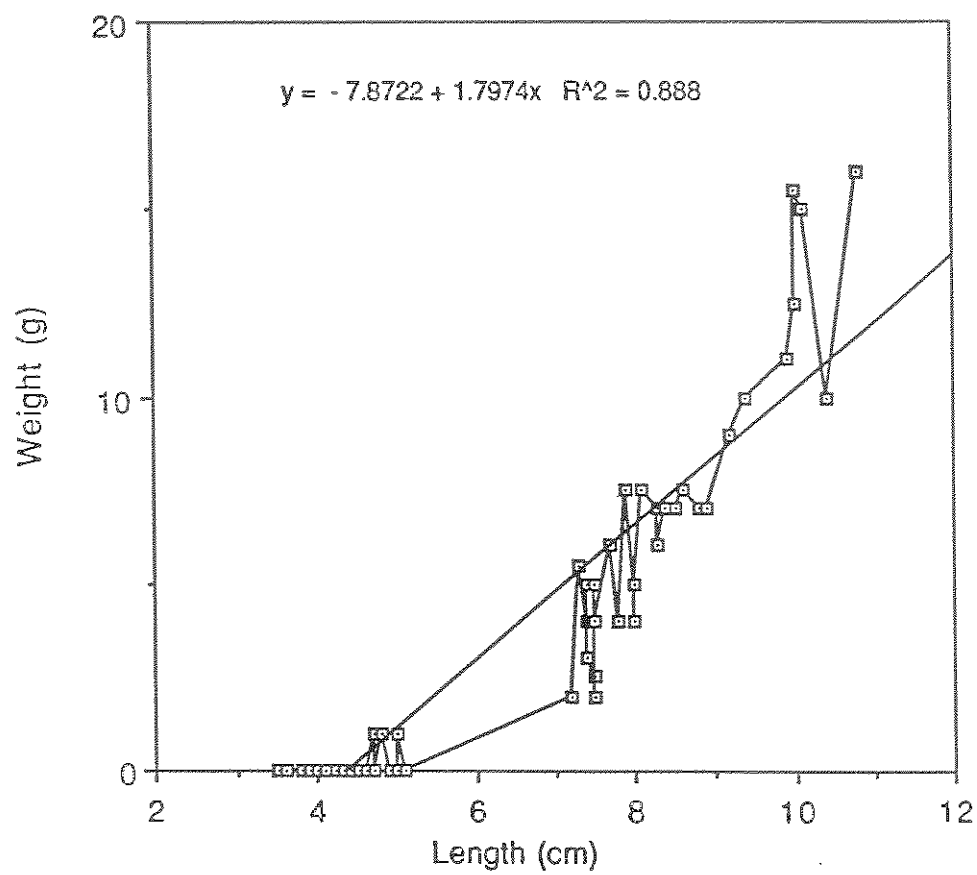


Creek	repro. present	micro habitat	invertebrate density	algal density	stream order	gradient (percent)	Disch. (cfs)	Dominant substrate	temp. (°F)	overhanging vegetation	trout present	land use
<b>Kootenai</b>												
Fisher @ Hwy 2	NA	NA	high	abundant	4	1 to 2	15	sand	?	5%	yes	2,3,4
Bear	NA	NA	moderate	NP	3	1 to 2	3	rubble	47.0	5%	yes	2,4
Callahan @ FS road 414	NA	NA	low	common	4	1 to 2	10	rub/boul	47.0	0%	yes	2,4
Quartz @ FS road 600	NA	NA	low	NP	2	2	3	rubble	44.0	10%	yes	2,4
Tobacco	NA	NA	low	NP	4	2	20	rub/boul	46.0	5%	yes	2,3,4
Graves	NA	NA	low	NP	3	1	2	sand/grav	48.0	10%	yes	2,3,4
Deep	NA	NA	low	uncommon	3	1 to 2	5	sand	41.0	10%	yes	2,4
Sunday	NA	NA	low	uncommon	3	1 to 2	5	sand	41.0	10%	yes	2,4
<b>Kootenai</b>												
Bristow	NA	NA	?	?	3	1	0.5	rubble	?	40%	yes	2,4
Pinkham	NA	NA	?	?	3	3	2	boulder	?	10%	yes	2,4
Cripple Horse	NA	NA	?	NP	3	2	1	rubble	52	20%	yes	2,3,4
Fliverville	NA	NA	?	common	3	1	1	sand/grav	48	25%	yes	2,3,4
Sutton	NA	NA	low	NP	3	2	3	rubble	46	25%	yes	2,3,4
Young	NA	NA	low	NP	4	1 to 2	3	rubble	45	25%	yes	2,3,4
Sullivan	NA	NA	low	NP	3	3	3	rubble	44.5	25%	yes	2,3,4
<b>Lolo</b>												
Deep	NA	NA	low	rare	3	2	3	rubble	44	5%	yes	2,4
Graves @ mouth	NA	NA	low	NP	3	1 to 2	5	rubble	42	5%	no	2,3,4
Graves @ FS road 357	NA	NA	low	NP	3	2	5	rub/boul	42	5%	yes	2,4
Prospect @ Crow Ck	NA	NA	moderate	abundant	3	1	5	rubble	46	5%	yes	2,3,4
Cherry	NA	NA	moderate	NP	4	2	3	rub/boul	46	5%	yes	2,3,4
Eddy	NA	NA	low	abundant	3	2	1	rub/boul	48	10%	yes	2,4
W. FK, Thompson	NA	NA	low	uncommon	4	3	10	rubble	48	5%	yes	2,4
Honeymoon	NA	NA	low	NP	2	3	2	rubble	47	10%	yes	2,4
Beatrice	NA	NA	moderate	NP	3	1 to 2	2	rubble	48.5	25%	yes	2,4
Cedar @ FS 320	NA	NA	moderate	uncommon	3	2	5	rubble	39	5%	yes	2,4,5,7
Tamarack @ sect. 4	NA	NA	low	uncommon	3	1	3	sand/grav	44	10%	yes	2,3,4
Tamarack @ sect. 8	NA	NA	low	uncommon	3	2	5	sand	44.5	30%	yes	2,3,4
Siegel	NA	NA	low	abundant	3	1 to 2	1	grav/rub	42	30%	yes	2,4
<b>Clerk Fork</b>												
Rock @ sect. 27	NA	NA	low	uncommon	3	1.5	3	gravel	46.5	5%	yes	2,4
Canyon Trib. of Vermilion	NA	NA	low	uncommon	3	2.5	2	rubble	47	20%	yes	2,4
Vermilion @ Vermilion	NA	NA	low	NP	3	3	15	rubble	47	20%	yes	2,4
Vermilion @ Willow Ck	NA	NA	low	NP	3	1	10	rubble	48	25%	yes	2,4
Swamp @ Clark Fork	NA	NA	high	uncommon	3	1	1	grav/rub	52	5%	yes	2,3,4
McKay	NA	NA	low	NP	2	2	1	rub/boul	49	25%	yes	2,4
Rock @ Clark Fork	NA	NA	low	abundant	3	1	1	rubble	52	5%	yes	2,3,4
Pilgrim @ sect. 31	no	NA	moderate	NP	3	2	2	sand/grav	48	5%	yes	2,3,4
South Branch Marten	NA	NA	high	uncommon	2	2	1	rubble	48	30%	yes	2,4
Trout @ Clark Fork	yes	NA	low	uncommon	4	2	5	conglomerate	55	0%	yes	2,3,4
Big Beaver @ sect. 15	NA	NA	low	uncommon	2	2	1	rubble	48	25%	yes	2,4

Appendix A-4: Physical and biological stream characteristics at sample sites not containing sculpins in the Kootenai National Forest and western portions of the Lolo National Forest.

Creek	repro. present	micro habitat	invertebrate density	algae density	stream order	gradient (percent)	Disch. (cfs)	Dominant substrate	temp. (°F)	overhanging vegetation	trout present	land use
Yaak												
Phelan	NA	NA	?	NP	3	2 to 3	2	boulder	47	10%	yes	2,4
Clay	NA	NA	?	NP	4	1 to 2	5	rub/boul	58	30%	yes	2,3,4
Fowler	NA	NA	?	yes	3	1	2	rubble	58	35%	yes	2,3,4
Beaver	NA	NA	?	NP	3	2	2	rub/boul	47.5	20%	yes	2,3,4
Bunkerhill	NA	NA	?	NP	2	2	<1	rubble	45	40%	yes	2,3,4
Vinal above Falls	NA	NA	?	NP	3	2 to 3	2	rubble	47	30%	yes	1
Solo Joe	NA	NA	low	NP	3	2 to 3	2	rubble	43	30%	yes	2,4
Hudson	NA	NA	low	NP	2	2 to 3	2	rubble	43	50%	no	2,4
Basin	NA	NA	moderate	NP	4	2 to 3	10	rubble	?	5%	yes	2,3,4
W. Fk. Basin	NA	NA	low	NP	3	3	1	rubble	47	45%	yes	1
E. Fk. Basin	NA	NA	low	NP	3	3	2	rubble	47	15%	yes	1
Portupine	NA	NA	NA	common	3	1	3	sand	46	5%	yes	2,3,4
Caribou	NA	NA	?	?	3	2	3	rubble	49	25%	yes	2,4
Blacktail	NA	NA	?	?	3	2 to 3	2	rubble	47	30%	yes	2,4
Boyd	NA	NA	?	NP	2	2	2	boulder	46	35%	yes	2,4
Koo Koo	NA	NA	?	NP	3	1 to 2	<1	sand	?	15%	yes	2,4
Benelfield	no	NA	?	NP	2	1 to 2	<1	rubble	45	25%	no	2,4
French	NA	NA	low	NP	3	2	3	rubble	45	15%	yes	2,4
Independence	NA	NA	?	NP	3	2 to 3	1	rubble	?	30%	yes	1
Arbo	NA	NA	low	NP	3	2 to 3	2	rubble	47	10%	yes	2,4
E. Fk. Yaak @ FS road 60	NA	NA	low	uncommon	4	1 to 2	25	rubble	44	30%	yes	2,3,4
E. Fk. Yaak @ FS road 92	NA	NA	low	uncommon	4	2	5	sand	48	5%	yes	2,3,4
S. Fk. Yaak @ Zulu	NA	NA	?	NP	4	1 to 2	5	rubble	?	20%	yes	2,3,4
S. Fk. Yaak @ FS road 68	?	NA	?	moderate	5	1	15	sand	?	5%	yes	2,3,4

Appendix A-4(cont.): Sample sites without sculpins present.



Appendix B: Length/weight regression of torrent sculpins in Libby Creek sampled October 18, 1991. The sample consisted of 119 individuals.

Appendix C: Location of sculpin sample sites on the Kootenai and Lolo National Forests in northwest Montana. Samples obtained using a Smithroot model 12 electroshocker. The sampling period was from September through October, 1991.

Sample #	Date	Creek	Map location	# specimens	species
SCU-1	9/9/91	Kootenai River	T30N R31W sect. 3	2	torrent
SCU-2	9/4/91	Big Creek	T35N R29W sect. 33 SE	5	torrent
SCU-3	9/3/91	Silver Butte Creek	T26N R29W sect. 19	4	torrent
SCU-4	9/4/91	S. Fk. Yaak River	T35N R32W sect. 2 NE	5	slimy
SCU-5	9/4/91	Tobacco River	T36N R27W sect. 8 SW	5	torrent
SCU-6	9/11/91	N. Fk. Yaak River	T37N R31W sect. 10 central	5	slimy
SCU-7	9/9/91	Vinal Creek	T36N R31W sect. 23 SW	5	slimy
SCU-8	9/9/91	Vinal Creek	T36N R31W sect. 29 NW	5	slimy
SCU-9	9/11/91	Yaak River	T36N R31W sect. 6 SE	5	slimy
SCU-10	9/5/91	Cool Creek	T35N R32W sect. 9 SW	5	slimy
SCU-11	9/12/91	N. Fk. Yaak River	T37N R31W sect. 23 NW	5	slimy & short
SCU-12	9/12/91	W. Fk. Yaak River	T37N R31W sect. 32 NW	5	slimy & short
SCU-13	9/12/91	W. Fk. Yaak River	T37N R32W sect. 36 N. centra	5	slimy
SCU-14	9/16/91	Meadow Creek	T35N R33W sect. 19 center	5	slimy
SCU-15	9/16/91	Main Yaak	T34N R33W sect. 34 NW	1	slimy
SCU-16	9/17/91	Fortine Creek	T34N R26W sect. 36 SE	5	torrent
SCU-17	9/17/91	Swamp Creek	T33N R26W sect. 19 SE	4	torrent
SCU-18	9/17/91	Tobacco River	T35N R26W sect. 15 NW	5	torrent
SCU-19	9/18/91	Fisher River	T30N R29W sect. 16 SW	4	torrent
SCU-20	9/16/91	Seventeen Mile Cr	T34N R33W sect. 27 SE	3	slimy
SCU-21	9/18/91	Yaak River	T33N R33W sect. 8 NE	5	slimy & short
SCU-22	9/18/91	Yaak River	T32N R34W sect. 5 SE	2	torrent
SCU-23A	9/19/91	Quartz Creek	T32N R32W sect. 24 N. centra	4	slimy & torrent
SCU-23B	9/19/91	Quartz Creek	T32N R32W sect. 24 N. centra	4	slimy & torrent
SCU-24	9/19/91	Libby Creek	T30N R31W. sect. 36 N. centra	10	torrent
SCU-25	9/19/91	Libby Creek	T28N R31W sect. 25 SE	10	slimy
SCU-26	9/19/91	Ramsey Creek	T28N R31W sect. 36 center	10	slimy
SCU-27	9/19/91	Poorman Creek	T28N R31W sect. 35 NE	10	slimy
SCU-28	9/19/91	Pipe Creek	T31N R31W sect. 20 S. centra	9	torrent
SCU-29	9/12/91	White Pine Creek	T23N R31W sect. 15	6	slimy
SCU-30	9/25/91	Wolf Creek	T29N R29W sect. 34NE	10	torrent
SCU-31	9/25/91	West Fork Fisher	T27N R29W sect. 30 SE	13	torrent
SCU-32	9/25/91	Fisher River	T27N R29W sect. 29SW	5	torrent
SCU-33	9/25/91	West Fork Fisher	T26N R 30 W sect. 2 N. centra	5	torrent
SCU-34	9/25/91	Libby Creek	T28N R30W sect. 4 NW	5	torrent
SCU-35	9/25/91	Granite Creek	T30N R31W sect. 23 N. centra	1	torrent
SCU-36	9/26/91	Callahan Creek	T31N R34W sect. 13 NW	10	torrent
SCU-37	9/26/91	Lake Creek	T31N R33W sect. 18 W. centra	5	torrent
SCU-38	9/26/91	Lake Creek	T29N R33W sect. 6 SE	10	slimy
SCU-39	9/26/91	Bull River	T27N R33W sect. 14 NW	10	slimy
SCU-40	9/26/91	S. FK. Bull River	T28N R33W sect. 14 SE	5	slimy

## Appendix C (cont.): Sculpin sample locations.

SCU-41	9/27/91	E. FK. Bull River	T26N R32W sect. 7 SW	10	slimy
SCU-42	9/27/91	Vermillion River	T24N R31W sect. 14 NE	10	slimy
SCU-43	9/27/91	Vermillion River	T24N R30W sect. 8 NE	5	slimy
SCU-44	7/29/91	Tobacco River	T36N R27W sect. 25	3	torrent
SCU-45	9/24/91	Fortine Creek	T34N R26W sect. 36 SE	5	torrent
SCU-46	9/30/91	Swamp Creek	T25N R31W sect. 20 SW	10	slimy
SCU-47	9/30/91	West Fk. Elk Creek	T26N R34W sect. 16 SW	10	slimy
SCU-48	9/30/91	East FK Elk Creek	T26N R34W sect. 16 SW	10	slimy
SCU-49	9/30/91	Elk Creek	T27N R34W sect. 36 SW	5	slimy
SCU-50	10/1/91	Bull River	T26N R33W sect. 3 SW	5	slimy
SCU-51	10/1/91	Pilgrim Creek	T26N R32W sect. 19 SE	2	slimy
SCU-52	10/1/91	Marten Creek	T25N R32W sect. 32 central	10	slimy
SCU-53	10/1/91	Tuscor Creek	T24N R32W sect. 9 NE	10	slimy
SCU-54	10/2/91	Trout Creek	T24N R32W sect. 24 NE	10	slimy
SCU-55	10/2/91	White Pine Creek	T23N R31W sect. 13 SW	10	slimy
SCU-56	10/2/91	Big Beaver Creek	T23N R30W sect. 31 NW	10	slimy
SCU-57	10/3/91	Prospect Creek	T21N R30W sect. 13 SW	10	slimy and short
SCU-7	10/3/91	Prospect Creek	T21N R29W sect. 18 NE	5	slimy
SCU-58	10/3/91	Thompson River	T21N R28W sect. 7 SE	3	slimy
SCU-59	10/7/91	Thompson River	T22N R28W sect. 33 SE	9	slimy
SCU-60	10/7/91	Fishtrap Creek	T23N R27W sect. 33 NE	5	slimy
SCU-61	10/7/91	West FK Fishtrap	T24N R28W sect. 26 NE	5	slimy
SCU-62	10/7/91	Thompson River	T25N R27W sect. 23 NW	5	slimy
SCU-63	10/8/91	Trout Creek	T16N R26W sect. 23 N. centra	10	slimy
SCU-64	10/8/91	Cedar Creek	T16N R28W sect. 3 NE	10	slimy
SCU-65	10/8/91	Cedar Creek	T16N R27W sect. 13 SW	5	slimy
SCU-66	10/8/91	Dry Creek	T17N R27W sect. 28 SE	9	slimy
SCU-67	10/9/91	St. Regis River	T19N R 31W sect. 14 N. centra	10	shorthead
SCU-68	10/9/91	Big Creek	T19N R30W sect. 27 SE	10	shorthead
SCU-69	10/9/91	Twelvemile Creek	T19N R29W sect. 26 SW	10	shorthead
SCU-70	10/9/91	Twelvemile Creek	T19N R29W sect. 11 SE	5	shorthead
SCU-71	10/9/91	Twelvemile Creek	T19N R29W sect. 36 SW	6	shorthead
SCU-72	10/9/91	St. Regis River	T18N R28W sect. 25 NE	5	shorthead
SCU-73	10/10/91	Twornile Creek	T18N R28W sect. 28 NW	10	shorthead
SCU-74	10/10/91	Little Joe Creek	T18N R28W sect. 26 NE	11	shorthead
SCU-75	10/10/91	S. FK. Little Joe	T17N R28W sect. 3 NE	11	shorthead
SCU-76	10/15/91	Stillwater River	T32N R23W sect. 18SE	12	slimy
SCU-77	10/15/91	Stillwater River	T34N R25W sect.36NE	8	slimy