# The Distribution of Fishes and Fish Habitat in the Elkhorn Mountain portion of the Helena National Forest

Prepared for the

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Submitted by:

Wayne F. Hadley

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## ABSTRACT

Seventy-four localities on 29 streams and 4 lakes were sampled. Twenty-two streams and all four lakes were found to be inhabited by fish. Over 52 miles of stream supported trout. More than 14 miles of stream were unoccupied, but appeared to be suitable habitat. Streams with apparent fish habitat which were not sampled totaled more than 8 miles.

White suckers were found in only one stream, where they occupied a little more than a mile of habitat. Mottled sculpins were collected in five streams over a distance of some 8 miles. Brown trout occurred in about 1 mile of a single stream. Rainbow trout occupied about 10 miles of habitat in five streams, in addition to a lake population. Brook trout were found in two lakes, are known to occur in a third, and occupied nearly 46 miles of habitat among 21 streams. Cutthroat trout were collected from 11 streams where they extended over 12 stream miles. Yellowstone cutthroats inhabited one lake.

Cutthroat specimens from three localities were subjected to electrophoretic analysis by Phelps and Allendorf at the University of Montana. They found two populations to be pure and one hybrid. Behnke at Colorado State University examined specimens from 11 study area streams. He suggested that as many as eight of these, including the two considered pure by Allendorf, could be hybrids. Three populations seemed to be pure. At present, native cutthroats occupy less than 4 miles of relatively secure habitat, or less than 10 percent of the original range in the study area. The total population of pure strain fish is probably fewer than 500 individuals.

Management of the study area waters should first secure the preservation of native cutthroats. Transplants of fish from Hall, Staubach and Prickly Pear creeks should be placed in unoccupied suitable habitats. As much as 23 miles of this habitat in 14 streams could result in a 600 percent increase in miles of cutthroat occupation. This would expand the miles of stream fishery in the study area by about 45 percent. A breeding population of native cutthroats should be established in the South Fork of Crow Creek lakes after removal of the existing rainbow and brook trout populations. The stock of cutthroats developing could then serve as a source of fish for introduction into other areas. The Elkhorn study area could become the most diverse and secure upper Missouri cutthroat habitat presently known to exist.

Brown trout should be introduced into Crow Creek until a naturally self-sustaining population is established. This would provide a trophy fishery potential not currently available within the study area.

Additional studies which should be included in the formulation of an Elkhorn fisheries management plan include: extension of the present study to include the unsurveyed streams in the Helena Forest and the Elkhorn portion of the Deer Lodge Forest; a survey of active and inactive mine influences on water quality and fisheries; an evaluation of livestock grazing effects on riparian vegetation and streambank-streambottom materials; a comprehensive survey of recreational use of riparian habitats.

## INTRODUCTION

This study was undertaken as an initial step in the formulation of a fisheries management plan for that portion of the Elkhorn Mountains administered by the Helena National Forest. Since little information was available on the study area waters, the goal of the investigation was to determine the kinds of fishes occurring there, their distribution and the general quality of the environment in which they were found. Special attention was to be directed toward any native cutthroat trout populations remaining and their degree of genetic purity.

The report is intended to serve as a necessary precursor and source document for Elkhorn fisheries management. While a number of specific management practices are recommended, most of these require additional investigations. Other pertinent information should also be developed to ascertain the status of various environmental parameters and their current and potential effects on Elkhorn fisheries. No management plan can be functionally complete until reliable data exist on the totality of the ecological and sociological setting in which that plan is to be implemented.

It is not the prerogative of the author to determine policy decisions affecting Elkhorn waters. However, the responsibility to emphasize the uniqueness and potential value of the resource is inescapable. Those persons and agencies on whose judgments the future of the Elkhorn fisheries must rest should be cognizant of the full significance of the resource at issue and seek to perpetuate the native cutthroats and the environments on which they depend.

## METHODS

As Figure 1 suggests, there were far more streams than could be sampled within the timespan available. Since the intent was to sample qualitatively all waters supporting fish within the study area, several sources of information were utilized to identify inhabited waters. Equally important was the elimination from consideration of streams unsuitable for fish.

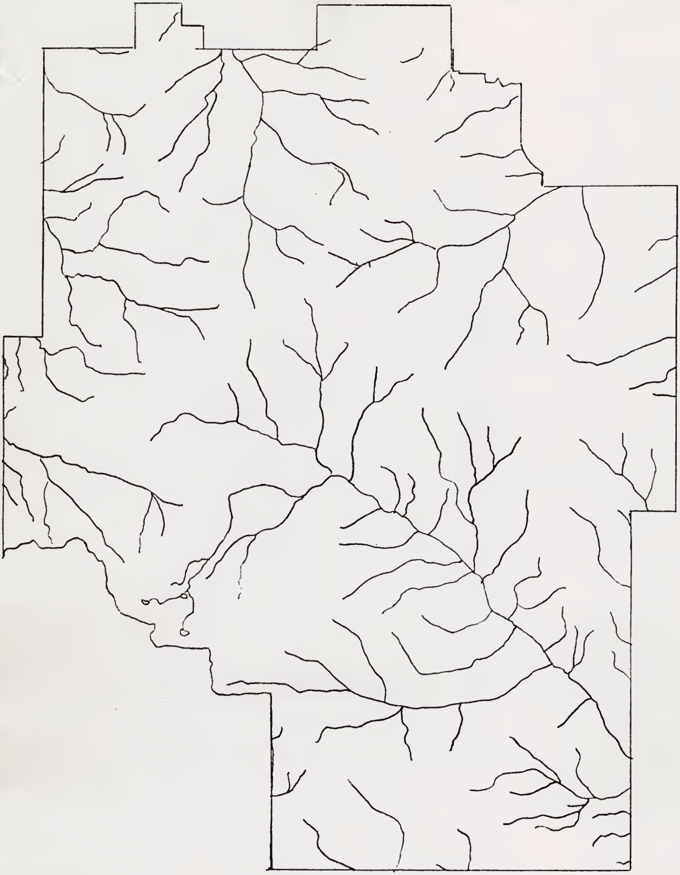

Figure 1. Inclusive map of study area drainages.

A helicopter flight was made on July 8 during which all major drainages were viewed from the Forest boundary upstream to the apparent limit of suitable habitat. The aerial inspection was then compared to on-site observations from the ground, and the results used to select study streams. This procedure was extremely valuable in reducing unproductive effort.

The available data on Elkhorn fishes are meager. The data files from Fish, Wildlife & Parks Fisheries Division were examined for information on study area waters. These data were from field collection records, stocking records, angler logs and occasional information notes. The greatest impediment to the utilization of these sources is the lack of precise localities. Since many Elkhorn streams flow beyond the Forest boundary, determining whether a datum originated within or beyond the limits of this investigation is frequently impossible. Angler log records referring to Prickly Pear Creek are a good example of this problem. Streams whose total courses lie within the Forest such as the South Fork of Crow Creek and the lakes are not subject to this confounding. Data sources marred by locality insufficiency are usually angler logs and stocking records. Field collection forms and notes typically give definite localities.

Conversations were held with a variety of individuals concerning inhabited Elkhorn waters. Fish, Wildlife & Parks enforcement personnel, anglers, backpackers and landowners were questioned and some interesting and useful information gained. While considerable misinformation was also encountered, some particularly valuable historical perspectives were discovered in this fashion.

In order to broaden the area sampled, a group of interested persons was assembled as volunteer surveyors. The individuals attended an informational briefing, were supplied with collecting materials and allowed to choose streams which they would sample by angling and report the results. The product received from this effort was variable in the extreme. A very minor fraction of the cooperators promptly returned usable reports. The majority failed to do anything. The few good reports were, however, a material asset to the project. Reports on streams indicating the presence of fish were then followed by electroshocking collections.

Stream collections during the first weeks of the project were made by angling. This was due to the lack of availability of a functional electrofishing unit. Ultimately a Coffelt Electronics model BP-III was secured. It proved to be an excellent item for the purposes of this study; i.e., limited shocking time in small streams.

Electrofishing collections were made for qualitative purposes. In sampling a stream, the most downstream accessible point, or the Forest boundary, in the case of streams with easy access, was selected for the first collection. Since, with the exception of several streams that may have been subject to mine drainage, all streams examined had water quality conditions apparently suitable for trout in the lower reaches, the major factor determining trout presence was water quantity. No water temperatures in excess of 54 F were recorded. Streams with fish populations in upstream sections had fish in downstream areas. Hence, by sampling downstream reaches first, it was possible to determine whether additional collections at upstream sites should be made. If fish were present at the downstream site, collections were made at intervals upstream until the limits of fish distribution were ascertained. The reason for the absence of fish in upstream sections was recorded when known and the suitability of uninhabited reaches for possible introduction was noted.

At a given site, electrofishing was concentrated on the habitats most likely to support fish. The length of stream shocked and the duration of shocking varied with the size of the stream. Larger streams usually were shocked for longer periods than small ones. Small streams were normally sampled over a greater linear distance than large ones. These generalities were varied as circumstances warranted. The primary determinant was the satisfaction of the requirement that all species present be observed and identified and a general knowledge of their numbers, size and proportional representation be gained.

When a cutthroat population was encountered, samples for morphometric examination were preserved in 10 percent formalin. Ten specimens were sought from each population discovered, but the numbers and sizes taken were determined by the population size. While larger specimens were more desirable for specimens, they were also the more important fraction of the population as breeders. In small populations, fewer and smaller specimens were preserved. Cutthroat specimens were sent to Dr. R. Behnke at Colorado State University for his evaluation of their genetic integrity. His reports are appendices A, B and C. Electrophoretic analysis of cutthroat taxonomic status was done by Dr. Phelps and Dr. F. Allendorf at the University of Montana. Specimens were taken by electroshocking using helicopter transport on September 10. The iced specimens were then flown to Missoula and given to Allendorf. Their report is appendix D.

Lakes were sampled by helicopter placement of mountain gill nets fished for 24 hours.

A final helicopter flight was made to sample the streams in the upper Crow Creek drainage. This was done to improve efficiency, since no facilities were available in the relatively inaccessible headwater area for recharging shocker batteries.

## HISTORICAL PERSPECTIVE

A thorough historical review of the fish fauna of the study area would be a valuable adjunct to the present investigation. Unfortunately, it was precluded by both temporal and budgetary constraints. It would, under any circumstances, have been of dubious success, since there appears to be no significant body of information from which a review might have been drawn.

The indigenous fish fauna of the study area can only be inferred. Fishes most likely to have been native to the Elkhorns include mottled sculpin (Cottus bairdi), white sucker (Catostomus commersoni) and cutthroat trout (Salmo clarki). Mountain whitefish (Prosopium williamsoni), grayling (Thymallus arcticus), longnose sucker (C. catostomus) and mountain sucker (C. platyrhynchus) were endemic to the region, and their habitat requirements would seem to have been met by some of the streams of the study area. Whether these species originally inhabited the area probably could not be satisfactorily documented now. If these five species were endemic, they appear to have been extirpated, since none were taken in this study. The three foregoing species are currently present, and were taken in this study. Their status will be discussed in detail in the "Results" section of this report.

The cutthroat trout native to the Elkhorns would appear to have been the form S. clarki lewisi of Behnke (1979). Zimmerman (1965), Roscoe (1974) and Behnke (1979) considered the cutthroat native to the Missouri drainage as being identical with the cutthroat occupying the headwaters of the Columbia in Idaho, Montana and Alberta on the western slope. These forms, while currently considered as a single subspecies, are called upper Missouri (Missouri) cutthroat and westslope cutthroat, respectively. Owing to flaws in methodology, particularly the possibility that the Missouri populations studied were not genetically intact, the author is not ultimately persuaded of the adequacy of the data base on which the "identical" westslope and Missouri judgment was based. Taxonomic hair-splitting is not germane to the goals of this report, except to the extent that the naive might be led to conclude that the extirpation of a Missouri cutthroat population represented no loss, since they might be replaced by introduction of individuals from a population of the "identical" westslope form. This is clearly not the case. Behnke (1979) noted in this regard that "each native stock is uniquely adapted through evolutionary programming for its own specific environment."

It follows that introductions from another environment are unlikely to be as well adapted as the native form. Hence, the preservation of native populations should be a high priority goal of an Elkhorn fisheries management plan. In discussing the status of S. c. lewisi, Behnke (1979) stated that "pure populations of S. c. lewisi are very rare in the upper Missouri and South Saskatchewan basins."

Introduced fishes include brook trout (Salvelinus fontinalis), rainbow trout (Salmo gairdneri), brown trout (Salmo trutta) and the Yellowstone cutthroat (S. c. bouvieri). All presumably originated from stocking by Department of Fish, Wildlife & Parks directly in Elkhorn streams or adjacent waters. The original introductions have been widely dispersed, particularly in the case of brook trout, by sportsmen. Arctic grayling may have been planted in Hidden Lake, but the records are unclear and they do not seem to have persisted to the present. Brook, rainbow, brown and Yellowstone cutthroats are now Elkhorn residents. It is unlikely that any of these introductions would take place under current management policy.

Within the confines described in the "Results" section, the information in Fisheries Division files is summarized below.

## Lakes

Glenwood Lake. Stocked in 1972, 1975, 1976 and 1979 with Yellowstone cutthroats. An angler log in 1956 recorded four brook trout. If the locality for the 1956 brook trout catch were not confused, this species must have been introduced, but unable to sustain itself.

Hidden Lake. Stocked in 1945 with rainbows and in 1969 with Yellowstone cutthroats. Reportedly subject to winter kill, this lake was suggested for grayling planting, owing to their tolerance to low winter oxygen. It is unclear whether the grayling introduction was ever made. Angler log data from 1973 and 1975 report brook trout, presumably stocked by sportsmen.

South Fork Crow Creek lakes. Apparently stocked with cutthroats in 1940. The only other available data are from angler logs. They report brook trout from the lower lake in 1976 and 1977. A 1975 log reported rainbow trout from the upper lake. The rainbows must have been introduced, since an apparently impassable barrier exists between the two lakes. Brook trout were probably introduced as well, although upstream travel to the lower lake might have been possible.

Tizer Lakes. These small lakes are connected by Tizer Creek. Stocked with cutthroat in 1939 and rainbow in 1947. Angler logs reported brook trout in 1951-1955 and in 1968. Cutthroat were taken in 1955 and 1964. A 1962 field report noted brook trout in both lakes.

Streams

Beaver Creek. No data exist that are unequivocally from the study area. The information to which definite localities can be ascribed is from beyond the Forest boundary. Rainbows were planted in 1928 and brook trout in 1940, but the localities are indeterminate.

Crow Creek. Cutthroat were planted in 1928, 1931, 1934, 1935, 1937, 1940, 1944 and 1948. Stocking of catchable rainbows took place annually from 1953-1970. Plants were of about 2,000 fish per year and seem to have been made downstream from the forest. The first rainbow introduction of record was in 1948. Brook trout were stocked in 1938, 1948 and placed below the Forest in 1953. Angler log data exist from 1953-1977. Rainbow and brook trout comprised the catch in all years except 1953, 1956, 1962 and 1967, in which cutthroats were reportedly taken. A brown trout catch was reported in 1956. In the light of the current investigation, it is probable that the cutthroat catches were on the Forest and the brown trout were outside the boundary.

Crystal Creek. A stocking in 1948 of 2250 cutthroat could have been made at this locality. There is some possibility of error.

Indian Creek. A single angler log record reported brook trout in 1958.

Jackson Creek. Six thousand, seven hundred and fifty cutthroats were reportedly released in this stream in 1948.

Maupin Creek. Beaver ponds on upper Maupin were stocked with brook trout in 1962, 1963 and 1967. Cutthroats were placed in this stream in 1948.

McClellan Creek. Field collection records indicate the presence of brook, rainbow, cutthroat and cutthroat X rainbow trout hybrids as well as mottled sculpins in collections on the Forest in 1962 and 1964. Angler logs report brook, brown, rainbow and cutthroat from 1967-1978. Cutthroats were stocked in 1932, 1934, 1937 and 1948. Rainbow trout were stocked in 1964 downstream from the study area.

Prickly Pear Creek. No data seem to exist that were taken on the study area. A large volume of material from below the Forest recorded brook, brown, rainbow and cutthroat trout as well as a single grayling.

South Fork of Crow Creek. Angler log data report brook trout in 1951-1954 and 1957. Rainbows and cutthroat were taken in 1953 and cutthroat in 1952. A 1954 log reported 13 browns averaging 7 inches. Unless these brown trout originated from an unreported stocking, the report is probably from another locality. A single angler log reported brook trout in 1978. An introduction of cutthroats was reported in 1931.

Warm Springs Creek. An angler log report for 1977 recorded two rainbow X cutthroat hybrids. It is likely that this catch was made downstream from the Forest boundary. In 1938, brook trout were released; probably below the Forest.

Wilson Creek. An angler log from 1955 found brook and cutthroat trout.

## RESULTS

The discussions which follow were taken from the field collections and laboratory examinations described previously. It should be recalled that observations on fish numbers, sizes and habitat were qualitative and subject to bias by observer error. The field season during which data were collected was a source of difficulty, owing to above average precipitation. While no direct measurements of precipitation were available for the study area, adjacent National Weather Service stations provide some insights. Stations at Helena, Townsend and Boulder recorded for the 12-month period October 1979 through September 1980 precipitation of 26 percent, 35 percent and 41 percent above normal, respectively. For the 5 month period including the field portion of this study, May through September 1980, Helena, Townsend and Boulder had precipitation 57 percent, 57 percent and 43 percent above the average, respectively. Partial streamflow records for Prickly Pear Creek at Clancy were available from the Department of Natural Resources and Conservation. These showed the streamflow during the May through October 1980 period to have been about 38 percent above average. Streams which might have been dry or very low in a year of low or even average moisture may have appeared to be suitable fish habitat in 1980. An attempt has been made to avoid interpretational error, but the possibility cannot be overlooked.

Table 1 presents the collection data from this study. They are arranged in the sequence in which they were made. Included are the collection code number, the date of collection, the locality to single-section accuracy and the species taken.

In Table 2 are the summary figures for stream miles and fish distribution. Each stream found to contain fish, unoccupied suitable habitat or having unknown but possibly suitable habitat is recorded. It should be noted that the miles of

Table 1. Elkhorn collection sites.

| Number | Date | | Locality | Species |
|---|---|---|---|---|
| WFH-80-1 | 5 July | 1980 | South Fork Crow Creek Lakes S14, T6N, R2W | upper lake rainbow, lower lake brook |
| WFH-80-2 | 6 July | 1980 | Crow Creek S14, T6N, R1W | rainbow |
| WFH-80-3 | 12 July | 1980 | Beaver Creek S21, T8N, R1W | brook and cutthroat |
| WFH-80-4 | 16 July | 1980 | Beaver Creek S21, T18N, R1W | brook and cutthroat |
| WFH-80-5 | 23 July | 1980 | East Fork McClellan Creek S10, 15, 14, T18N, R2W | brook and cutthroat |
| WFH-80-6 | 31 July | 1980 | Glenwood Lake S5, T6N, R2W | Yellowstone cutthroat |
| WFH-80-7 | 31 July | 1980 | Hidden Lake S6, T6N, R2W | brook |
| WFH-80-8 | 1 August | 1980 | Muskrat Creek S31, 32, 33, 34, T7N, R3W | brook and cutthroat |
| WFH-80-9 | 13 August | 1980 | Main Fork Warm Springs Creek S26, T8N, R3W | brook |
| WFH-80-10 | 13 August | 1980 | Junction Middle and North Forks Warm Springs Creek S24, T8N, R3W | brook |
| WFH-80-11 | 13 August | 1980 | Middle Fork Warm Springs Creek S30, T8N, R2W | brook |
| WFH-80-12 | 13 August | 1980 | Middle Fork Warm Springs Creek S29, T8N, R2W | barren |
| WFH-80-13 | 13 August | 1980 | Middle Fork Warm Springs Creek S30, T8N, R2W | brook |
| WFH-80-14 | 13 August | 1980 | Willard Creek S21, T8N, R2W | brook and cutthroat |
| WFH-80-15 | 19 August | 1980 | McClellan Creek S16, T18N, R2W | brook and cutthroat |
| WFH-80-16 | 19 August | 1980 | Tepee Creek S21, T8N, R2W | cutthroat |
| WFH-80-17 | 19 August | 1980 | McClellan Creek S28, T8N, R2W | cutthroat |
| WFH-80-18 | 20 August | 1980 | East Fork McClellan Creek S10, 15, T8N, R2W | cutthroat |
| WFH-80-19 | 20 August | 1980 | East Fork McClellan Creek S9, T8N, R2W | brook and cutthroat |
| WFH-80-20 | 20 August | 1980 | Crystal Creek S4, T8N, R2W | brook |
| WFH-80-21 | 20 August | 1980 | Crystal Creek S3, T8N, R2W | cutthroat |
| WFH-80-22 | 20 August | 1980 | Crystal Creek S2, T8N, R2W | brook and cutthroat |
| WFH-80-23 | 20 August | 1980 | McClellan Creek S4, T8N, R2W | brook and sculpin |
| WFH-80-24 | 21 August | 1980 | Whitehorse Creek S1, T7N, R1W | barren |

Table 1 continued.

| | | | | |
|---|---|---|---|---|
| WFH-80-25 | 21 August | 1980 | Beaver Creek S21, T8N, R1W | brook and cutthroat |
| WFH-80-26 | 26 August | 1980 | South Fork Warm Springs Creek S26, T8N, R3W | brook |
| WFH-80-27 | 26 August | 1980 | South Fork Warm Springs Creek S25, T8N, R3W | brook, brown, cutthroat |
| WFH-80-28 | 26 August | 1980 | Hogan Creek S36, T8N, R3W | cutthroat |
| WFH-80-29 | 26 August | 1980 | South Fork Warm Springs Creek S31, T8N, R3W | barren |
| WFH-80-30 | 28 August | 1980 | Prickly Pear Creek S23, T7N, R3W | cutthroat |
| WFH-80-31 | 28 August | 1980 | Prickly Pear Creek S24, T7N, R3W | barren |
| WFH-80-32 | 28 August | 1980 | Prickly Pear Creek S15, T7N, R3W | brook |
| WFH-80-33 | 29 August | 1980 | Maupin Creek S32, T9N, R2W | brook and sculpin |
| WFH-80-34 | 29 August | 1980 | Maupin Creek S5, T8N, R2W | brook and sucker |
| WFH-80-35 | 3 September | 1980 | North Fork Dutchman Creek S2, T7N, R3W | cutthroat |
| WFH-80-36 | 3 September | 1980 | South Fork Dutchman Creek S3, T7N R3W | cutthroat |
| WFH-80-37 | 3 September | 1980 | South Fork Dutchman Creek S3, T7N R3W | cutthroat |
| WFH-80-38 | 3 September | 1980 | Main Fork Dutchman Creek S3, T7N, R3W | brook, rainbow, cutthroat |
| WFH-80-39 | 4 September | 1980 | West Fork Maupin Creek S7, T8N, R2W | barren |
| WFH-80-40 | 4 September | 1980 | East Fork Maupin Creek S8, T8N, R2W | barren |
| WFH-80-41 | 5 September | 1980 | Whitehorse Creek S6, T7N, R1E | barren |
| WFH-80-42 | 5 September | 1980 | Staubach Creek S4, T8N, R1W | cutthroat |
| WFH-80-43 | 9 September | 1980 | Staubach Creek S4, T8N, R1W | cutthroat |
| WFH-80-44 | 10 September | 1980 | South Fork Beaver Creek S28, T8N, R1W | barren |
| WFH-80-45 | 10 September | 1980 | North Fork Beaver Creek S29, T8N, R1W | brook and cutthroat |
| WFH-80-46 | 10 September | 1980 | Dutchman Creek S3, T7N, R3W | cutthroat |
| WFH-80-47 | 10 September | 1980 | McClellan Creek S28, T8N, R2W | cutthroat |
| WFH-80-48 | 18 September | 1980 | Crow Creek S25, T6N, R1W | brook, rainbow and sculpin |
| WFH-80-49 | 18 September | 1980 | Slim Sam Creek S26, T6N, R1W | barren |
| WFH-80-50 | 18 September | 1980 | South Fork Crow Creek S14, T6N, R2W | brook |
| WFH-80-51 | 18 September | 1980 | South Fork Crow Creek S13, T6N, R2W | brook |
| WFH-80-52 | 18 September | 1980 | South Fork Crow Creek S9, T6N, R1W | brook, rainbow and sculpin |
| WFH-80-53 | 18 September | 1980 | Jenkins Gulch S4, T6N, R1W | barren |
| WFH-80-54 | 18 September | 1980 | Crow Creek S4, T6N, R1W | brook, rainbow and sculpin |
| WFH-80-55 | 23 September | 1980 | Hall Creek S31, T7N, R1W | cutthroat |
| WFH-80-56 | 23 September | 1980 | Hall Creek S32, T7N, R1W | brook, rainbow and sculpin |
| WFH-80-57 | 23 September | 1980 | Crow Creek S32, T7N, R1W | brook, rainbow and sculpin |
| WFH-80-58 | 24 September | 1980 | Eureka Creek S32, T7N, R1W | brook and rainbow |

Table 1 continued.

| | | | | |
|---|---|---|---|---|
| WFH-80-59 | 24 September | 1980 | Eureka Creek S29, T7N, R1W | brook and rainbow |
| WFH-80-60 | 24 September | 1980 | Eureka Creek S29, T7N, R1W | barren |
| WFH-80-61 | 24 September | 1980 | Longfellow Creek S29, T7N, R1W | barren |
| WFH-80-62 | 24 September | 1980 | Crow Creek S25, T7N, R2W | rainbow |
| WFH-80-63 | 24 September | 1980 | Crow Creek S30, T7N, R1W | brook and rainbow |
| WFH-80-64 | 25 September | 1980 | East Fork Indian Creek S24, T7N, R1W | brook |
| WFH-80-65 | 25 September | 1980 | East Fork Indian Crekk S14, T7N, R1W | brook |
| WFH-80-66 | 25 September | 1980 | West Fork Indian Creek S35, T7N, R1W | barren |
| WFH-80-67 | 2 October | 1980 | Wilson Creek S16, T7N, R2W | brook |
| WFH-80-68 | 2 October | 1980 | Wilson Creek S17, T7N, R2W | brook |
| WFH-80-69 | 2 October | 1980 | Moose Creek S9, T7N, R2W | barren |
| WFH-80-70 | 2 October | 1980 | Moose Creek S15, T7N, R2W | brook |
| WFH-80-71 | 2 October | 1980 | Wilson Creek S15, T7N, R2W | brook |
| WFH-80-72 | 2 October | 1980 | Clear Creek S14, T7N, R2W | brook |
| WFH-80-73 | 2 October | 1980 | Little Tizer Creek S28, T7N, R2W | barren |
| WFH-80-74 | 2 October | 1980 | Tizer Creek S22, T7N, R2W | brook |

Table 2. Distribution of fishes and fish habitat in Elkhorn streams.

| Stream | Miles of Habitation by Fish Species | | | | | | Total Miles of Occupied Habitat | Miles of Unoccupied Suitable Habitat | Miles of Unknown but Possibly Suitable Habitat | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | Brook Trout | Cutthroat Trout | Rainbow Trout | Brown Trout | Mottled Sculpin | White Sucker | | | | |
| Maupin Creek | 2.0+ | | | | 0.1+ | 1.2+ | 2.0+ | | | 2.0+ |
| McClellan Creek | 4.1+ | 2.6+ | | | 0.9+ | | 5.4+ | | | 5.4+ |
| E. Fk. McClellan Creek | 0.7 | 1.5 | | | | | 1.5 | 1.3+ | | 2.8+ |
| Willard Creek | 0.3 | 0.3 | | | | | 0.3 | 0.2 | | 0.5 |
| Tepee Creek | | 0.8+ | | | | | 0.8+ | | | 0.8+ |
| Jackson Creek | ? | | | | | | ? | ? | 1.5+ | 1.5+ |
| Crystal Creek | 2.1 | 0.8+ | | | | | 2.1 | | | 2.1 |
| Stauback Creek | | 0.5 | | | | | 0.5 | 1.6+ | | 2.1+ |
| Beaver Creek | 2.2+ | 1.6+ | | | | | 2.2+ | | 0.8+ | 3.0+ |
| S. Fk. Beaver Cr. | | | | | | | | 2.6+ | | 2.6+ |
| Whitehorse Creek | | | | | | | | 1.0+ | | 1.0+ |
| Indian Creek | 2.2 | | | | | | 2.2 | | | 2.2 |
| Crow Creek | 10.5 | | 8.4+ | | 6.4+ | | 10.5 | | | 10.5 |
| S. Fk. Crow Cr. | 5.8 | | 0.8+ | | 0.8+ | | 5.8 | | | 5.8 |
| Hall Creek | 0.1+ | 0.9+ | 0.1+ | | 0.1+ | | 1.0+ | 0.9+ | | 1.9+ |
| Eureka Creek | 0.5+ | | 0.5+ | | | | 0.5+ | 2.1+ | | 2.6+ |
| Longfellow Cr. | | | | | | | | 0.8+ | | 0.8+ |
| Crazy Creek | | | | | | | ? | ? | 1.8+ | 1.8+ |
| Clear Creek | 0.3+ | | | | | | 0.3+ | 1.5+ | | 1.8+ |
| Moose Creek | 0.2+ | | | | | | 0.2+ | 1.0+ | | 1.2+ |
| Wilson Creek | 3.7+ | | | | | | 3.7+ | | | 3.7+ |
| Tizer Creek | 6.1+ | | | | | | 6.1+ | | | 6.1+ |
| Little Tizer Cr. | ? | | | | | | ? | ? | 2.5+ | 2.5+ |
| Prickly Pear Cr. | 1.0+ | 1.5+ | | | | | 2.5+ | 0.5+ | | 3.0+ |
| Black Canyon Cr. | | | | | | | ? | ? | 2.0+ | 2.0+ |
| Dutchman Creek | 0.1 | 0.8+ | .1 | | | | 0.9+ | | | 0.9+ |
| Warm Springs Cr. | 0.6 | | | | | | 0.6 | | | 0.6 |
| N. Fk. Warm Sp. Cr. | 0.1+ | | | | | | 0.1+ | | | 0.1+ |
| M. Fk. Warm Sp. Cr. | 1.5 | | | | | | 1.5 | | | 1.5 |
| S. Fk. Warm Sp. Cr. | 1.8 | 1.3 | | 1.1 | | | 1.8 | 1.0+ | | 2.8 |
| TOTAL | 45.9+ | 12.6+ | 9.9+ | 1.1 | 8.3+ | 1.2+ | 52.5+ | 14.5 | 8.6 | 75.6+ |

habitation category for each species do not always equal total miles of occupied habitat. This results from overlap in ranges of the various species. Reference to Table 2 should be made for all the following accounts of specific waters.

Figure 2 shows collecting sites. Several sites were omitted from the map to reduce confusion. It may be noted that the drainages seen in Figure 2 are much simplified from those in Figure 1. Omitted drainages were either intermittent or too small for fish habitation. The map version seen in Figure 3 represents those drainages known or believed to possess fish populations or suitable habitat presently unoccupied.

Figure 4 depicts the inhabited waters in the study area. All occupied waters were inhabited by one or more trout species; i.e., nontrout species were always sympatric with trout. The hatched areas are either known to support fish as a result of collections made in this study or inferred to be inhabited since collections both above and below have shown fish to be present. Cross hatching is interrupted in some cases to avoid obscuring stream names. Areas where hatching is closed; e.g., Indian Creek, represent known limits of distribution. Areas with open hatching indicate that the exact limit of fish distribution is unknown; e.g., Beaver Creek headwaters.

Stream reaches in which no fish were found, but where the habitat appeared suitable for trout are shown in Figure 5. This category represents a visual evaluation by the investigator.

In Figure 6 are shown stream reaches which may have fish or suitable unoccupied habitat, but for which no definitive data exist. These areas were not sampled during this study, but merit further investigation.

Drainages

Crow Creek drainage. The Crow Creek drainage is the largest and most complex in the Elkhorns. Six lakes inhabited by fish and eight named streams comprising 28.1 miles with fish populations are within this system. In the drainage are some 6 miles of unoccupied suitable habitat and more than 4 miles of unknown habitat. Cutthroat, rainbow and brook trout were taken, as well as mottled sculpins.

Crow Creek. Collections WFG-80-2, 48, 54, 57, 62, 63. The upper portion of the Crow Creek drainage is within the Tizer Basin. The basin is separated from all downstream areas by Crow Creek falls. The falls serve as an impassable barrier to upstream fish passage. It must be assumed that the waters above the falls were naturally barren, and that all fish populations there have resulted from human activities. The main stream of Crow Creek is formed by the confluence of Tizer and Wilson creeks. The stream flows over Crow Creek Falls and leaves the Forest some 10.5 miles from its origin.


Figure 2. Study area collecting sites.

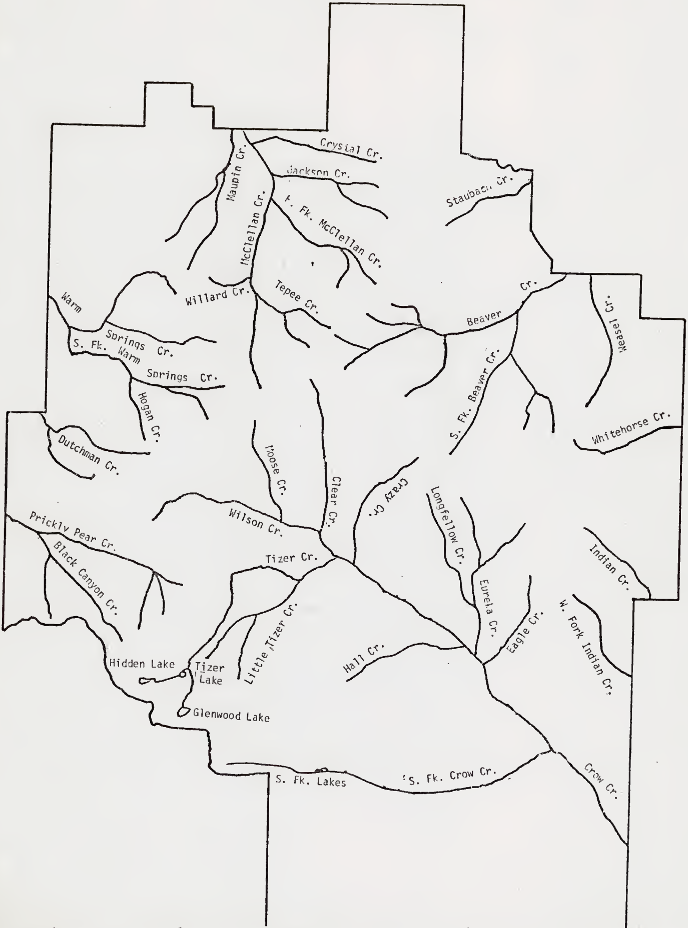


Figure 3. Study area drainages known or believed to support fish.

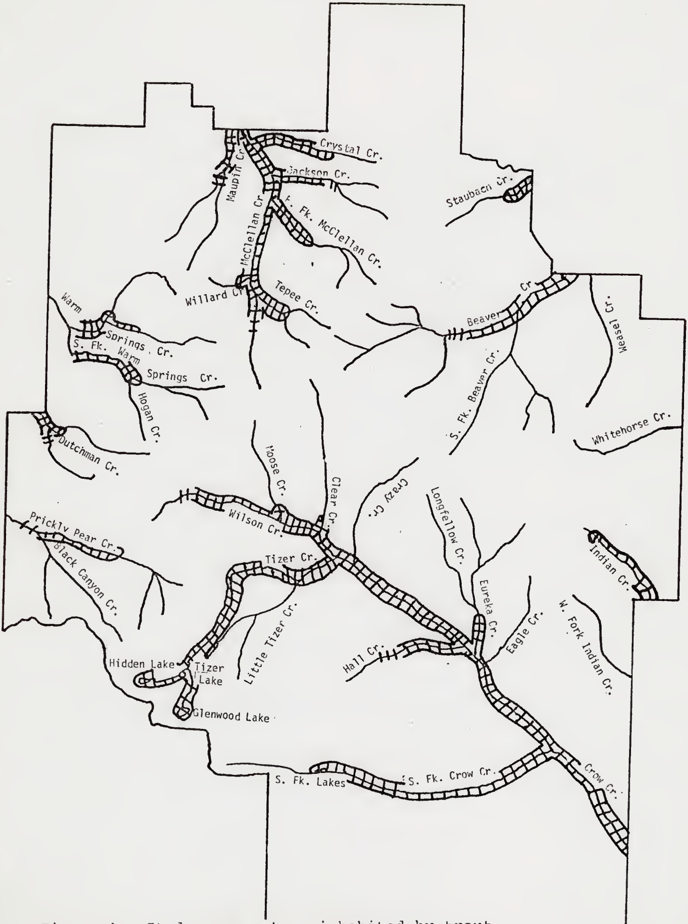


Figure 4. Study area waters inhabited by trout.


Figure 5. Study area waters barren of fish, but apparently suitable habitat.


Figure 6. Study area waters of unknown but potential trout habitat.

This stream provides some of the best trout habitat and largest fish in the study area. Brook trout are found throughout the length of Crow Creek. The condition of this species appeared good, but the average size was only about 8 inches. The largest brook trout were less than 1 foot in total length. Rainbow trout inhabit Crow Creek from the Forest boundary to an undetermined point above the falls. This comprises in excess of 8.4 stream miles of rainbow habitat.

The rainbows in Crow Creek were consistently larger than the brook trout, with an approximate average length of 12 inches and a maximum of about 15 inches. Mottled sculpins were taken in the lower 6.4 miles of the stream. The lower reaches were populated with an abundance of sculpins. Several verbal reports from anglers of brown trout taken in Crow Creek prompted intensive efforts to collect this species. If they are present, it is at a very low density. The habitat and the sculpin forage base appear well suited to brown trout. Crow Creek seems to be one of the most intensively fished streams in the Elkhorns.

South Fork Crow Creek. Collections WFH-80-1, 50, 51, 52. The South Fork of Crow Creek is some 7.5 miles in length. The upper 1+ mile was not sampled, but is reputedly barren. The South Fork lakes are dealt with in the lake discussions. From Lower South Fork Lake to its mouth at Crow Creek (5.8 miles) the stream is infested with small, average 6 inch brook trout (Table 2). The lower mile or a bit less supports a small rainbow population of about 10 inches average length. Mottled sculpins occur in the same area as rainbows. The lower stream reaches contain considerable sediment, which could be the result of cattle grazing. Despite the modest proportions of the brook trout, the upper and middle stretches of the South Fork seem to bear a substantial amount of angling pressure. This angling is probably in part due to the accessibility of attractive, but undeveloped, camping areas along the stream.

Hall Creek. Collections WFH-80-56, 57. This small stream has about 2 miles of habitat (Table 2). Of this distance, more than 0.1 mile just upstream from the mouth at Crow Creek is occupied by brook trout, a few rainbows and fewer sculpins. Brook trout were observed to be spawning above the mouth on September 23, 1980. Cutthroat trout were collected in an upstream section presumed to be nearly 1 mile in length. Owing to the small size of the habitat, this population is small in both numbers of individuals and average size (6 inches). Specimens sent to Behnke were reported by him to be "pure cutthroat or very close to it" (appendix B). Since the downstream rainbow population does not seem to have hybridized with the cutthroats, there must be an effective barrier between the two species. No records of stocking were found and due to the small size of Hall Creek, it is unlikely that any were made. The Hall Creek cutthroats seem to be

the only Crow Creek drainage population remaining. Despite the accessibility provided by two road crossings, Hall Creek is too small to be of much interest to most anglers.

Eureka Creek. Collections WFH-80-58, 59, 60. The lower 0.5 miles of Eureka Creek above its mouth on Crow Creek are populated with fair numbers of brooks (6 inches) and rainbows (10 inches). The stream becomes quite precipitous at the 0.5 mile vicinity, and this region seems to be an effective barrier to upstream migrants. Above there are more than 2 miles that are barren, but seem suitable for trout. This section would be an appropriate locality for native cutthroat introduction.

Longfellow Creek. Collection WFH-80-61. This Eureka Creek tributary seems barren, but provides about 1 mile of suitable habitat.

Crazy Creek. Collections - none. This Crow Creek tributary was not sampled due to difficult access and time limitations. From the air it appeared to have nearly 2 miles of potential habitat. It is likely barren, since stocking would have been quite difficult and upstream access by fish from Crow Creek would presumably be limited by Crazy Creek's apparently precipitous character.

Clear Creek. Collections WFH-80-72. The lower 0.3+ miles of Clear Creek above its mouth at Wilson Creek support a few small brook trout. Some 1.5 miles above are seemingly suitable for trout, but presently uninhabited.

Moose Creek. Collections WFH-80-69, 70. A tributary of Wilson Creek, Moose Creek is small, but apparently good quality habitat. About 0.2 miles of stream above the mouth are inhabited by a few small brook trout. A mile or more of upstream habitat is apparently uninhabited, but seems capable of supporting fish.

Wilson Creek. Collections WFH-80-67, 68, 71. This Tizer Basin stream is inhabited by a good population of 6 inch average brook trout throughout the more than 3.7 miles of suitable habitat. Low gradient sections in the upper portion of the stream appear to be subject to degradation from mining activity.

Tizer Creek. Collections WFH-80-74. Tizer Creek receives the outflow from Glenwood and Hidden lakes, and connects the Tizer lakes. Its length provides in excess of 6 miles of small (average 6 inches) brook trout habitat. In spite of the relative inaccessibility of this stream, it and the associated lakes receive a fair amount of fishing pressure.

Little Tizer Creek. Collection WFH-80-73. The single collection made from Little Tizer Creek revealed no fish. A report (V. Yannone pers. com.) that it contains brook trout in the upper reaches prompted the question marks in Table 2. There may be more than 2.5 miles of suitable habitat. If it is barren, it could be a suitable locality for cutthroat introduction.

Lakes

Glenwood Lake. WFH-80-6. This lake was found to contain Yellowstone cutthroats. The net had been pulled by a fisherman and contained only two fish of 13 inch length. Two specimens of about 11 inches were seen on the bottom near the net. The lake does not seem suitable for natural reproduction.

Hidden Lake. Collection WFH-80-7. Although stocked with rainbows and possibly grayling, the only fish taken were brook trout. These presumably resulted from stocking, since upstream travel appears impossible. Brook trout netted ranged from 5.8-10.7 inches, with an average of 8.5 inches. Forty-one specimens were taken. Since a substantial size range of fish was collected, it seems that reproduction has been successful. It would be interesting to determine whether winter kill occurs, as has been reported, and whether it is complete or partial.

Lower South Fork Crow Creek Lake. Collection WFH-80-1. This small, shallow lake is populated by big-headed, slack-bellied brook trout. Maximum size of these fish is about 9 inches, and the average near 7 inches. A fair number of anglers seems to utilize this lake.

Tizer lakes. Collections - none. Known to be infested with brook trout and therefore unsampled. Subject to a fair amount of fishing.

Upper South Fork Crow Creek Lake. Collection WFH-80-1. The upper lake is separated from the immediately adjacent lower lake by a boulder field which seems to be a complete barrier. No brook trout were collected or observed in the upper lake. Fish in the upper lake are naturally reproducing rainbows originating from an unreported stocking. The lake appears to be rather deep and is extremely clear. Rainbows taken were 6-10 inches with heads large in proportion to bodies. Fish to 15 inches were seen. Like the lower lake, there appears to be a fair amount of angler activity. Both lakes have potential for rehabilitation and introduction of native cutthroats.

Prickly Pear drainage. The Prickly Pear drainage is composed of the headwaters of Prickly Pear Creek and Black Canyon Creek. Much of the better habitat on Prickly Pear is on private lands lying within the Forest boundary. The road into the Tizer Basin parallels Prickly Pear Creek, but owing to the primitive nature of the road, it is less heavily used than might otherwise be the case. This, as well as the inholdings, serves to reduce fishing pressure on Prickly Pear Creek drainage streams.

Prickly Pear Creek. Collections WFH-80-30, 31, 32. Suitable habitat on this stream constitutes over 3 stream miles. Brook trout are in the lower stream reach, mostly on private land, and apparently prevented from upstream movement by natural barriers. A cursory examination of brook trout habitat revealed what appeared to be old habitat improvement structures. The cutthroat population is upstream from the brook trout, and is relatively small. Most fish taken were less than 8 inches, with the largest about 10 inches. Upstream spread of cutthroats appears to be limited by several small falls and rapids. Specimens examined by Behnke were reported by him to have "no indication of hybrid influence" (appendix A).

Black Canyon Creek. Collections - none. This creek is reportedly barren, but said to contain suitable habitat (V. Yannone pers. com.); perhaps as much as 2 miles. It should be examined as potential cutthroat habitat.

Dutchman Creek drainage. The Dutchman Creek drainage is composed of North and South Forks of Dutchman Creek, which are here treated together. Only about 1 mile of habitat lies on the forest. Access into the forest in this drainage can only be secured by vehicle across private land. Access from within the forest is not possible by vehicle. This access difficulty results in very little angling pressure on the public portion of the drainage.

Dutchman Creek. Collections WFH-80-35, 36, 37, 38, 46. The upper 0.8 miles of Dutchman Creek are occupied by small cutthroats. Most fish taken were less than 6 inches, and this size presumably reflects the limited size of the habitat. Specimens sent to Phelps and Allendorf (appendix D) were reported by them to be identical with west slope samples. Behnke (appendix A) stated that 7 of 10 specimens he examined lacked basibranchial teeth. He assumed that basibranchial tooth suppression resulted from rainbow hybridism. While that is not impossible, no access from below would be possible to rainbows, since a very effective boulder field barrier exists at the lower end of the cutthroat habitat. Only a human activity could have placed any rainbows above the barrier, and the water is so small as to render that introduction unlikely. The alternative is that no fish occurred naturally

above the barrier, and that the present population is derived from stocking. If that is the case, then the relative impurity of some former hatchery stock could account for the observed reduction in basibranchial teeth. No stocking records were found for Dutchman Creek. Below the boulder field barrier, a mixture of small brook, rainbow and cutthroat exists in the remaining 0.1 mile before the creek leaves the forest.

Warm Springs Creek drainage. While this drainage is complex, as illustrated by the number of collecting sites, it is quite small in terms of water. The system comprises about 5 miles of habitat. Warm Springs Creek ultimately feeds Prickly Pear Creek about 2 miles below the Forest boundary. Access to the North and Middle Forks is easy, since these are paralleled by good roads.

Warm Springs Creek and North and Middle Forks. Collections WFH-80-9, 10, 11, 12, 13. This portion of the Warm Springs drainage is quite small. The North and Middle Forks unite on the Forest to form Warm Springs Creek. The junction of the South Fork with the main stream lies beyond the Forest boundary. The combined total habitat, excluding the South Fork, is about 1.5 miles. The only fish taken were brook trout. The largest specimen was only 8 inches, and the average near 5 inches. Whether the small average size reflects the size of the habitat or fishing pressure is not clear. Even though the stream is quite small, the easy access results in a surprising amount of angler use. Brook trout distribution in the Middle Fork is limited in the upstream sections by a large area of mine spoils. No fish were found in or above the section of stream flowing through the spoils. Whether the absence of fish is due to the poor quality of the habitat or results from toxic chemical effects is unknown.

South Fork Warm Springs Creek. Collections WFH-80-26, 27, 28, 29. The South Fork is a larger stream than the combined flow from the North and Middle Forks. Hogan Creek, a small South Fork tributary, is treated here since it has only about 0.1 mile of habitat. The lowest portion of the South Fork on the Forest is occupied by brook trout up to 8 inches. An anomalous collection of a single 9 inch brown trout occurred about a mile above the Forest boundary. Another brown trout specimen was observed, but not collected. No others were seen in this drainage. Upstream access from Prickly Pear Creek might be possible, but the collection site seemed an unlikely habitat for brown trout, owing to its small, declivitous nature. Brook trout distribution extended from the Forest boundary upstream to an impassable barrier 1.8 miles above. Cutthroats were found over a distance of 1.3 miles downstream from the boulder field barrier and in the 0.1 mile of Hogan Creek habitat. As much as 1 mile above the barrier appears barren, but of suitable nature for trout. Cutthroat specimens examined by Behnke

(appendix A) included two said to have "hybrid spotting pattern." This could be the result of upstream migration of rainbows or hatchery cutthroats. Private land must be crossed to reach the South Fork by vehicle. Public access across the forest entails a half-mile walk. The South Fork probably receives little angling.

McClellan Creek drainage. The McClellan Creek system includes seven named streams populated by fishes. The only white suckers found in the Elkhorns occur here, as well as mottled sculpins, brook trout and cutthroat trout. More than 15 miles of habitat exist in this drainage, 1.5 of which are unknown and 1.5 are unoccupied. This is the closest major Elkhorn stream system to Helena. It seems to receive less use than might be expected, apparently because much of the lower reach of McClellan Creek flows through private lands.

Maupin Creek. Collections WFH-80-33, 34, 39, 40. Maupin Creek provides about 2 miles of limited habitat. A few mottled sculpins were taken near the mouth and several young-of-the-year white suckers were collected. The suckers presumably are the product of a spawning run from lower McClellan Creek, although no white suckers were taken in McClellan Creek in the Forest. Brook trout occupy all suitable habitat with the exception of upstream beaver ponds. The ponds were previously stocked with brook trout, but these were eliminated during a dry year (DFWP file note). The Maupin Creek brook trout are a text book example of their undesirability. The population is very dense, and few fish reach even 6 inches. Despite the dismal angling potential, a surprising amount of fishing activity takes place.

McClellan Creek. Collections WFH-80-15, 17, 23, 47. The stream includes in excess of 5.4 miles of habitat, all of which is occupied. The lower portion, 4.1 miles, supports brook trout. More than 2.6 miles are inhabited by cutthroats. A dense sculpin population occurs for about a mile upstream from the Forest boundary. This lower reach of McClellan is filled with brook trout of about 6 inch average length and a maximum of 9 inches. Upstream, cutthroats increase in numbers, and ultimately are the only fish present. Cutthroats average about 8 inches and reach a 10 inch maximum. An interesting feature of the stream is the remains of a small hydropower dam on private land about 3 stream miles upstream from the Forest boundary. This facility was constructed in 1948 (Dr. T. C. Betzner, pers. com.). A log dam was placed

across the creek and served as a complete barrier to upstream fish movement. The dam was partially breached in 1978 by high flows and the effectiveness of the barrier reduced. The presence of the dam seems to have kept brook trout out of upper McClellan, and thus served to protect the upstream cutthroat populations. This is no longer the case, and brook trout are now well established above the dam. Fish from upper McClellan were sent to Behnke for morphological examination. He reported that hybrid spotting patterns were found in the larger specimens and that basibranchial teeth, while present, were reduced in number (appendix A). He suggested that this could have been the result of rainbow genes. Phelps and Allendorf (appendix D) reported no electrophoretic differences between this population and westslope samples. No stocking records indicate either cutthroat or rainbows as having been planted above the barrier dam. However, the ambiguity of stocking localities allows some possibility that such introductions actually took place. No public vehicular access is available to the upper reaches of the creek. It seems that little angling occurs here. The lower portion flows over private land that is unavailable for access by the general public. The short stretch of public water in the lower creek receives rather heavy use.

East Fork of McClellan Creek. Collections WFH-80-5, 18, 19. The East Fork enters the main stream at a point below the barrier dam mentioned in the foregoing section. Just above the confluence, the East Fork flows through a stepped culvert which probably limits upstream fish passage. The East Fork offers in excess of 2.8 miles of suitable habitat, 1.5 miles are occupied and 1.3 miles are barren. The barren portion is upstream and is isolated by a series of small falls and rapids. This reach seems to be good quality small habitat. Below the barren portion the stream is occupied by cutthroat averaging 6 inches and reaching 10 inches in length. A few small brook trout were found in the .7 mile above the junction with McClellan Creek. This cutthroat population was examined by Behnke (appendix A), who stated that a 10 percent rainbow hybrid influence occurred. No stocking data support this conclusion, but it certainly cannot be discounted as a possibility. Road access to the East Fork is available only at the mouth. Private land bars access to the lower .7 mile of stream. Very little public angling seems to occur.

Willard Creek. Collections WFH-80-14. A very small tributary entering McClellan Creek above the hydro dam. It constitutes about .3 mile of habitat occupied by a few very small brook trout and juvenile cutthroats. An additional .2 miles of beaver ponds in the upper portion are apparently barren. Willard Creek, as evidenced by the juvenile cutthroats, probably serves as a spawning area for McClellan Creek cutthroats. Behnke (appendix A) noted the absence of hybrid spotting patterns in these fish, but observed a lack of basibranchial teeth in 5 of 8 specimens.

Tepee Creek. Collections WFH-80-16. Tepee Creek has about .8 mile of habitat for cutthroats up to 8 inches. This is small, rather steep habitat. No brook trout were collected. It is too small to offer much fishing potential. Behnke (appendix A) considered this population, like that of the East Fork, to have a 10 percent rainbow hybrid influence. No stocking records were found. Rainbow access from below would be difficult or impossible, but stocking remains a possibility. The stream seems very small to have received any hatchery fish.

Jackson Creek. Collections none. Since Jackson Creek flows almost entirely through private holdings, it was not sampled. It is reported to contain brook trout throughout about 1.5 miles of its length. It enters McClellan Creek below the hydro dam site. An artificial pond along the upper portion contains cutthroats of unknown origin. Whether these fish remain from a 1948 hatchery introduction or are remnants of a natural population is unknown.

Crystal Creek. Collections WFH-80-20, 21, 22. A small tributary entering McClellan Creek downstream from the mouth of Jackson Creek. In 2.1 miles of habitat it supports a population of small brook trout with maximum size less than 8 inches. In the upper .8 mile a cutthroat population exists. Average size of these fish is about 6 inches, with some achieving 8 inches. These fish were said by Behnke (appendix A) to have some hybrid influence. Crystal Creek, like Jackson Creek, was reportedly stocked with cutthroats in 1948. If this stocking report is accurate, the origin of the current cutthroat population is impossible to determine. Even though the stream is quite small, an undeveloped campsite near the mouth tends to encourage some angler use.

Staubach Creek Drainage. This is a very small, isolated drainage flowing northeasterly from the Forest into Pole Creek.

Staubach Creek. Collections WFH-80-42, 43. The available habitat in Staubach Creek, although small, is of high quality and somewhat more than 2 miles in extent. Only .5 mile of habitat is occupied. The cutthroat trout population of Staubach Creek is made up of fish less than 6 inches in length and perhaps as few as 50 individuals. The population seemed so small that only six specimens were sent to Behnke for analysis. He reported (appendix A) that rainbow genes might be as much as 5 percent. Since Staubach Creek is so small as to make past stocking unlikely and access from downstream would be exceedingly difficult, it seems probable that the analysis by Behnke may have reflected genetic drift rather than hybridism.

Beaver Creek Drainage. This drainage is second only slightly to Crow Creek in water flow. Nearly 6 miles of habitat occur; some 2.6 of those are apparently barren. The drainage is subject to little public use, since vehicular access is via private land and the road is in very poor condition. Habitat quality appears to be excellent throughout the drainage.

Beaver Creek. Collections WFH-80-3, 4, 25, 45. Beaver Creek has more than 3 miles of habitat on the Forest. Somewhat less than 1 mile may be barren, while the remainder is occupied by brook trout (2.2 miles) and cutthroat trout (1.6 miles). The brook trout extend from the Forest boundary upstream to the apparent limit of fish distribution. Cutthroat are absent in the lower .6 mile of habitat and increase in abundance upstream. Cutthroat numbers are in inverse relation to brook trout abundance. Behnke (appendix A) and Phelps and Allendorf (appendix D) examined Beaver Creek cutthroats, and both concluded that some rainbow hybridization had taken place. Behnke suggested that 10 percent hybridism could have occurred. The brook trout population of Beaver Creek is the best in the Elkhorns with an average size of 8 inches and a maximum size of 12 inches. The cutthroats also reach a 12 inch maximum.

South Fork of Beaver Creek. Collections WFH-80-44. The South Fork presents something of a puzzle. The single collection reported done by shocking, as well as an angling effort not designated by a collection number, revealed no fish present. Both attempts were intense because the size and apparent quality of the habitat appeared favorable for trout and because conversations with landowners yielded reports of successful angling. It is not impossible that somewhere in the South Fork trout do exist, but none could be located in this study and the chance of fish being present seems very remote. Water quality could be responsible for the absence of fishes, since an abandoned mine exists in the drainage. It was not examined, so its influence in the South Fork cannot be defined.

Whitehorse Creek Drainage. This is an isolated drainage on the east side of the Elkhorns. The flow is so small as to disappear completely outside the Forest.

Whitehorse Creek. Collections WFH-80-21, 41. This very small stream was sampled on two occasions because of reports of fish. J. Bird (pers. com.) reported that fish were seen just downstream from the Forest boundary. No fish were taken and the creek is probably barren. About a mile of small, but suitable, habitat exists.

Indian Creek Drainage. This system is comprised of the East and West Forks of Indian Creek. Both are small and the combined flow is not large. The junction of the forks is below the Forest. Both streams are, and have been, subjected to severe degradation from mining and apparent overgrazing by livestock.

East Fork of Indian Creek. Collections WFH-80-64, 65. The East Fork is much the larger of the two branches. It includes 2.2 miles of marginal habitat occupied by small (average 5 inches) brook trout. They are found from the Forest boundary upstream to a point at which water flow is limiting.

The majority of the stream course appears to have been mined and at least one active mine is situated at the head of the fish-supporting section. Streambank condition is poor and seems to be the result of overuse by cattle.

West Fork of Indian Creek. Collection WFH-80-66. This stream is so small that under the best of conditions it might not be suitable for fish. Like the larger East Fork, it has an active mine in the upper reaches and seems to be detrimentally affected by cattle. Much of the streambed is silt, presumably originating from mining, livestock grazing or both.

## RESULTS

### Species Distribution and Status

White Sucker. White suckers are apparently limited to lower Maupin Creek. The few specimens observed were juveniles and probably the result of upstream migrant spawners from McClellan Creek (Figure 7).

Mottled Sculpin. Mottled sculpins were found in the extreme lower reach of Maupin Creek in small numbers and in abundance in the lower portion of McClellan Creek. A few sculpins were taken in lower Hall Creek and the South Fork of Crow Creek. The most dense sculpin population occurred in the 6-mile stretch of Crow Creek above the Forest border. This species is presumably taken by larger trout wherever sculpins occur. Lower Crow Creek in particular might support a considerable predator biomass on the sculpins found there. About 8.3 miles of study area streams were inhabited by sculpins (Figure 8).

Brown Trout. This introduced species was taken only in the South Fork of Warm Springs Creek - an unlikely brown trout habitat. Brown trout were reported by anglers to be, or perhaps have been, present in Crow Creek. No specimens could be taken there in this study despite intensive efforts to secure them. The habitat and forage resource in Crow Creek seem appropriate for this species (Figure 9).

Rainbow Trout. An exotic species in the Elkhorns, rainbows were taken in the upper South Fork of Crow Creek Lake, lower Dutchman Creek and in the lower reaches of the South Fork of Crow Creek, Hall Creek and Eureka Creek. The main Crow Creek supported the major rainbow population in the study area, with more than 8.4 miles of habitat. The total Elkhorn study area rainbow habitat is something over 9.9 miles (Figure 10).

The South Fork Lake population is self-sustaining, although spawning habitat appears to be quite limited. Angler reports suggest the presence of larger individuals, but observation in


Figure 7. Distribution of white suckers on the study area.


Figure 8. Distribution of mottled sculpins on the study area.


Figure 9. Distribution of brown trout on the study area.

this study showed no fish in excess of 15 inches. Since the lake is extremely clear, observations were relatively accurate. The rainbows taken had large heads in relation to total body length and did not appear to be exhibiting good growth.

The rainbow populations in Hall Creek and Dutchman Creek are restricted to such small areas as to be of little significance for recreation. Eureka Creek and South Fork of Crow Creek produce rainbows in sizes and numbers capable of providing a desirable angling opportunity. Crow Creek contains the major rainbow population in the study area. Fish in Crow Creek were in good condition and reached respectable sizes (up to 15 inches). This species provides the major stream fishery in the Elkhorns for fish in excess of 10 inches. Rainbows are, in all likelihood, presently stable in distribution. They have occupied all suitable habitat that is accessible to them.

Brook Trout. This is, unfortunately, the most widely distributed species in the Elkhorns. It is found in 4 lakes and 21 streams; cumulatively, more than 46 miles of stream habitat (Figure 11). This introduced species appears to compete with the native cutthroat to the detriment of the latter. Brook trout frequently do not reach desirable sizes in small habitats, and this is sadly illustrated in Lower South Fork of Crow Creek Lake, Warm Springs Creek and Maupin Creek, among others. Under these conditions, they have only marginal recreational potential. Nonetheless, brook trout, by virtue of their widespread distribution, are probably the most important sport fish in the area in terms of numbers taken. The only brook trout habitats producing fish in excess of 8 inches in significant numbers are Hidden Lake and Beaver Creek. This species is probably expanding its range naturally. In McClellan Creek, where they recently surmounted a former barrier dam, they are likely to extend their range throughout the headwaters of the drainage. The McClellan range expansion, like that which is apparently occurring in Beaver Creek and perhaps the South Fork of Warm Springs Creek, will probably be achieved at the competitive expense of the cutthroat.

Cutthroat Trout. During this study, cutthroat populations were found in 1 lake and portions of 11 streams where they occupied less than 13 miles of habitat (Figure 12). The Glenwood Lake population is of hatchery produced Yellowstone cutthroats and is not self-sustaining. The number of streams inhabited is rather deceiving. Several factors contribute to this confusion. First, the miles of stream inhabited are only 12.6 or a little more. Second, many of the cutthroat populations listed among the 11 may not represent native cutthroats in the strict sense, due to hatchery introductions of cutthroats of various genetic integrity. This situation is compounded by rainbow introductions, subsequent rainbow-cutthroat hybridization and the resultant breach of the native cutthroat gene pool.

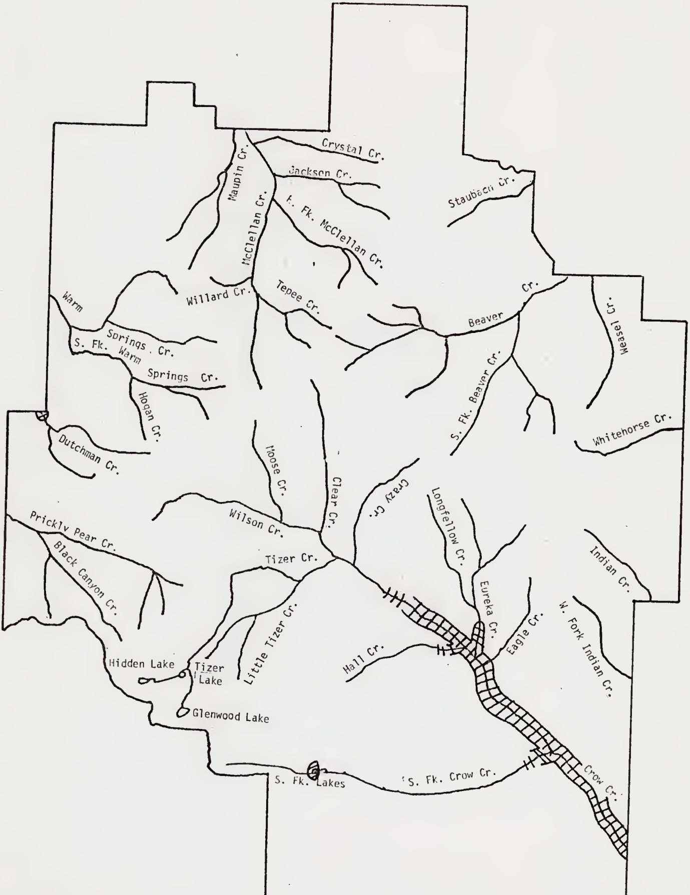


Figure 10. Distribution of rainbow trout on the study area.

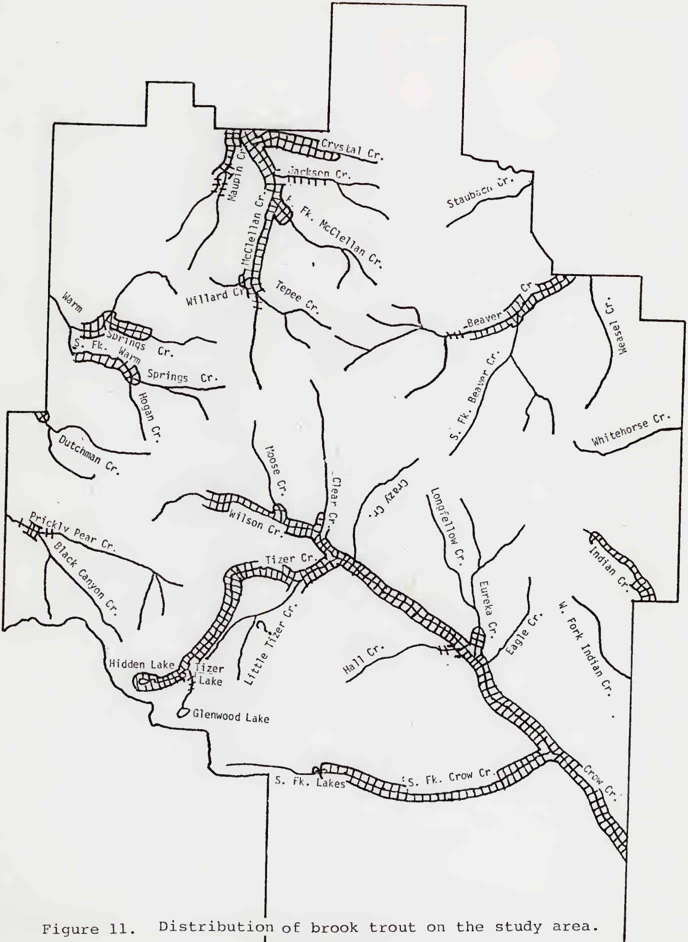


Figure 11. Distribution of brook trout on the study area.


Figure 12. Distribution of cutthroat trout on the study area.

The third source of clouding is the brook trout-cutthroat interaction. It seems that brook trout may competitively reduce or eliminate cutthroats. If this is the case, then cutthroat populations sympatric with or accessible to brook trout may have poor prospects for survival. When these factors are considered, the Elkhorn cutthroat situation is not bright.

If 13 stream miles of cutthroat habitation is accepted as a reasonable appraisal of present distribution, then a comparison may be made with their previous distribution. Assume for purposes of comparison that, prior to the introduction of exotic trouts, cutthroats occupied all suitable accessible habitat in the study area. In Table 2, some 53 miles of habitat currently occupied by all species of trout are noted. Since Crow Creek Falls would probably have prevented cutthroats from natural access to the Tizer basin streams, the mileage of those habitats (about 12 miles) must be subtracted from the 53 currently inhabited. Thus, about 40 miles of stream habitat could have been occupied by native cutthroat trout prior to the activities of European man. Seventy percent of that habitat was barren of cutthroats during this study.

The second factor discussed above, genetic integrity, may be assessed in part by the evaluations done by Behnke and Phelps and Allendorf (appendices A-D). Those investigators considered the Beaver Creek cutthroats to have some degree of rainbow hybridism. Behnke and Phelps and Allendorf apparently disagree on the population of McClellan Creek. Behnke examined specimens from the McClellan tributaries East Fork of McClellan Creek, Willard Creek, Tepee Creek and Crystal Creek, as well as a series of upper McClellan. He expressed the opinion that up to 10 percent rainbow hybridism might be present among these populations. Phelps and Allendorf dealt only with specimens from upper McClellan Creek, and found them to be indistinguishable from westslope samples. If Behnke's appraisal of hybridism in the McClellan Creek drainage is accepted in the interest of conservatism, then this system must also be eliminated from the currently occupied native cutthroat range. The McClellan Creek drainage and Beaver Creek have 7.6 miles of streams which must be subtracted from the total cutthroat habitation due to hybridism. Thus only 5 stream miles of habitat remain to native cutthroats, or about 13 percent of the presumed original range.

The third factor, brook trout competition, impacts the 1.3 miles of cutthroat habitat on the South Fork of Warm Springs Creek. If brook trout compete as effectively as it appears and can thereby eliminate native cutthroats, then the Warm Springs cutthroats must be removed from a relatively secure category.

The foregoing factors serve to reduce the range of native cutthroat in relatively secure habitats in the Elkhorn study area to about 3.7 stream miles, or less than 10 percent of the

apparent original range. Security must be understood as relative. While Staubach Creek, Hall Creek, Prickly Pear Creek and perhaps Dutchman Creek support apparently genetically intact native cuttroats with barriers preventing natural access by other species, human activities could nullify this relative security. Other species could easily be transported above existing barriers by anglers and environmental degradation could result from mining or timber harvest. Any of these could eliminate the remnant native cutthroats. A gross, but perhaps not unreasonable, estimate of numbers of individuals, both juveniles and adults, would be Staubach Creek <50, Hall Creek <100, Prickly Pear <200, Dutchman <100. The total of all populations of integral native origin is probably fewer than 500 individuals.

## Available Habitats

In Table 2 are shown two categories of habitat not known to be occupied by fish. The first of these is unoccupied suitable habitat. Stream reaches included in this section were examined during this study, no fishes were taken and the sections considered barren, although water volume and habitat quality seemed favorable for trout. In most cases, a barrier downstream precluded upstream movement and colonization.

The second category is unknown, but possibly suitable, habitat. These areas were not surveyed, usually because of access difficulty and time limitations. Placement in this category resulted from aerial observations of water flow which suggested potential for trout survival. In the case of Little Tizer Creek, V. Yannone (pers. com.) reported brook trout in the upper section, but an electrofishing effort downstream yielded no fish. It is probable that no stream reach included in this category now supports fish, but this is not a certainty.

Unoccupied suitable habitats and unknown, but possibly suitable, habitats comprise respectively 14.5 and 8.6 stream miles. Although these are typically small streams, they constitute over 23 miles of potential fish habitat and recreational area. If these stream reaches supported trout, the Elkhorn study area stream fishery would be increased by about 45 percent.

# RECOMMENDATIONS

## Management

Goals. Management of Elkhorn fisheries should be predicated on two dominant principles. The first of these is preservation of the native species present, the Missouri cutthroat. The second is to maximize recreational opportunity consistent with maintenance of the existing high environmental quality. This requires minimizing negative impacts on fish populations and the character of the area as a whole.

Preservation of the remnant populations of Missouri cutthroats should be a high priority goal for all management agencies. Within the Montana portion of their range, perhaps fewer than 20 genetically intact populations are at present known to exist. At least three of these are within the study area. Other populations in Montana may well exist, but are either not recorded or are of unknown purity. Behnke (appendix A) states in this regard that, "management strategy for S. c. lewisi should include the preservation of the genetic diversity of both ecological and geographical forms. The significance of the present collection of specimens is that they represent the upper Missouri drainage, a geographical area from which previous studies have indicated the native cutthroat trout to be very rare." He says further (op. cit.) that, "a management plan for S. c. lewisi in Montana should give priority to securing the preservation of representative populations in the upper Missouri and South Saskatchewan drainages." The opportunity to achieve these goals exists in the Elkhorn study area. However, owing to the restricted distribution of apparently pure cutthroats, less than 4 stream miles divided among three or four streams, and the small number of individuals (fewer than 500 total), that opportunity may be fleeting.

Maximizing recreational angling opportunity while preserving the quality of the angling experience clearly requires a balance between the two. An increase in opportunity need not necessarily involve an increase in utilization. Before an overview of this second management goal can be appropriately addressed, it is necessary to examine the context in which it occurs.

The Elkhorn study area has little user data available. It is therefore necessary to adopt several assumptions of apparent validity to develop the resource/user relationship. These assumptions are inherent in the following discussion. While the intensity of current use of the fishery resources of the study area is not known with precision, use is likely to be relatively light. At present, the user population, presumably originating mostly from the Helena area, has available a variety of angling opportunities. The Missouri and its reservoirs provide large river angling and boat fishing of high quality and attract users from a wide area. Small stream fisheries are less available, due to limited public access, dewatering of streams, a lack of suitable environments and travel costs. The Elkhorn study area provides small stream fishing in a setting of relative isolation. This is the closest area to the Helena population complex offering this recreational combination. It seems reasonable to assume that demand for this type of recreation will increase, particularly as rising travel costs make nearby areas more attractive.

The components of recreational angling quality are diverse and vary with the character of the individual user and user population. Among the most commonly accepted factors contributing to user satisfaction are catch, fish size, and the environment in which the angling takes place. The Elkhorn area does not have habitats of sufficient size to produce significant numbers of large fish. It does, however, have the ability to produce satisfactory catches of small-to-medium fishes of several species in a relatively pristine environment. It is these two aspects of the angling experience where management can be most effective. Enhancement of the existing resource can be accomplished by increasing the resource diversity, dimensions and quality. Specific strategies for achieving these goals are presented in the following section.

Strategies. Missouri Cutthroat Preservation. Actions to secure the future survival of the remnant native cutthroat populations should be taken immediately. All activities having any potential for environmental damage to watersheds supporting cutthroats should be halted until the following management plan is implemented. The simplest, quickest and most economical step in this process is the introduction of specimens from pure populations (Prickly Pear, Staubach and Hall creeks, appendix C ) into unoccupied suitable habitats. If this process were carried out maximally, some 23 miles of additional stream habitat could be occupied by native cutthroats. This would be an increase of some 600 percent over their current range. In addition, the extant three stream distribution would be expanded to as many as 17 separate localities. Clearly, this would constitute a significant improvement in security for this species. It is, unfortunately, likely that present populations are too small to provide sufficient numbers of individuals for the suggested introductions. A more thorough estimate of the numbers of fish in Staubach, Hall and Prickly Pear creeks should be made to allow an estimate of the numbers of fish available for introduction. These should then be placed in the best quality unoccupied habitats available.

A second thrust in the native cutthroat management effort would be to establish them in the South Fork of Crow Creek lakes. It would be necessary to survey the headwaters of the South Fork of Crow Creek to ascertain the absence of fish above the lakes. When this was established, the stream section below the lower lake should be examined to determine whether upstream fish passage is possible. If it were, then the construction of an artificial barrier would be appropriate. If it were not possible, then no action would be required. The two lakes and any stream sections accessible to fish from the lakes should be treated with fish toxicant. It is imperative, owing to the potential for survivors of rainbow populations in the upper lake to breach the genetic integrity of an introduced cutthroat population, that a complete eradication be achieved. When

assurance of the removal of all rainbow and brook trout could be made, cutthroats from the Hall, Staubach and Prickly Pear populations could be introduced. Since naturally sustaining trout populations now occur in both lakes, it is reasonable to assume that the cutthroats would also be self-sustaining. Fish from the lakes would then be available for introductions in unoccupied Elkhorn streams, and perhaps elsewhere as well.

Hidden Lake now supports apparently naturally reproducing brook trout of unknown origin. The outlet of this lake should be closely examined to determine whether fish access from below is possible. Potential spawning habitat should also be surveyed in order to determine whether a native cutthroat population could be established by the methods described above for the South Fork lakes.

The Elkhorns could very well become the most diverse and secure upper Missouri cutthroat habitat within the entire original range.

Expanded distribution of Missouri cutthroats would also be a material contribution to the second general goal previously discussed. The occupation of currently unoccupied habitats would be about a 45 percent increase in stream miles of trout angling opportunity within the study area. It is noteworthy that the native cutthroat is a very desirable species from the recreationists' perspective. Cutthroats seem to be less subject to overpopulation than brook trout, and therefore provide larger fish in a given environment. Cutthroats by introduction would increase the physical dimensions of the fishery resource, increase the diversity of species contributing to the anglers' catch, and improve angling quality by yielding larger individuals than would brook trout.

Those cutthroat populations in which some degree of hybridism or introgression of nonnative cutthroat genes is suspected to have occurred are nonetheless deserving of protection. These stocks are found in seven streams. What they represent taxonomically is somewhat problematical, as alluded to in the section on historical perspectives (page 6 ). Whether some of these populations are, in fact, pure strains of the native cutthroat or are to some degree infused with nonnative genes is from a management perspective relatively extraneous. They represent a reservoir of native genes selectively adapted for Elkhorn environments and, as Behnke (appendix A) observes, "these populations should be recognized as S. c. lewisi because they overwhelmingly retain the native genotype." No direct management practices are feasible for the perpetuation of these groups in a positive sense, but they should be afforded protection from the negative influences of environmental degradation.

These populations offer angling of higher quality than would (or do) brook trout in the same environment, so they represent a decided asset to the fisherman.

Brown Trout. The portions of Crow Creek inhabited by sculpins seem to be suitable habitat for brown trout. These areas now support many small brook trout and smaller numbers of rainbow. It is probably worthwhile to attempt to establish a naturally reproducing brown trout stock in this area. Moderate numbers of this species could be stocked annually over a period of years to this end. While a potential for failure exists, the positive gains from successful establishment are worth the risk. Brown trout in this environment might have some suppressive effect on the brook trout present, but more importantly, could add not only diversity to the fishery, but increase angling quality by providing a trophy potential now completely absent. This would add a major facet to the Elkhorn fisheries resource.

Brook, rainbow and Yellowstone cutthroat. Every effort should be made to discourage the expansion of the ranges of these forms. While transport by anglers is practically impossible to regulate, management agency activities should not augment these fishes where the latter two might contribute to additional degradation of the native cutthroat gene pool or brook trout infest more cutthroat habitat. Since it is at this moment impractical to remove these forms, containment is the best available alternative. Yellowstone cutthroats are not self-sustaining in their only study area habitat, Glenwood Lake. They pose a very minor threat to the upper Missouri cutthroat now. It might, however, be prudent to remove any potential for genetic contamination by halting this stocking program if a satisfactory substitute can be found. If grayling hatchery production can produce a sufficient supply, Glenwood Lake could be converted to this species. Grayling would add to the angling diversity of the area, as well.

Environmental perturbations. As mentioned in the foregoing section on Missouri cutthroat management, sources of significant environmental disturbance should be discouraged wherever possible. This is particularly critical in occupied cutthroat habitat and areas having potential for cutthroat introduction. Cutthroats require extremely high environmental quality and are quite vulnerable to angling pressure. Among the perturbations having negative impacts on native cutthroats would be mining, logging, increased livestock grazing and roading. These factors contribute to decreased environmental quality in a variety of ways and could result in cutthroat extirpation through direct mortality, reproductive failure, increased hybridization, or reduced competitive ability with brook trout. Behnke (appendix A) states that "from past experience, I have found that land use practices such as clear-cutting, grazing, mining, road building, etc. that increase

sediment loads and temperature will act to stimulate and increase a hybrid influence and/or replace the native trout with nonnative trout if they have access to the habitat. These considerations should be taken into account for any multiple use activity in these watersheds that may modify the present environmental regime that currently favors the maintenance of the native cutthroat trout." Improved access that results in increased angling intensity can have serious negative consequences for cutthroats, particularly when the populations are already in such reduced circumstances as those in the Elkhorns.

Additional Studies. A number of additional investigations should be made in order to develop a comprehensive plan for management of the Elkhorn fisheries.

Monitoring. The most crucial of these is the implementation of the recommendations above. Continued monitoring of the status of these activities would be required to evaluate the degree to which the management goals were achieved.

Deer Lodge Elkhorns Survey. The present investigation should be extended to the waters within the Elkhorns administered by the Deer Lodge Forest. The Elkhorns should be treated as a single ecological entity and managed under a single, comprehensive plan.

Helena Elkhorns Survey. Streams and stream sections listed in Table 2 as being unknown but having possibly suitable habitats should be surveyed. This information is necessary as an adjunct to the cutthroat management plan previously outlined.

Mining Effects. There seem to be no conclusive data on the influence of active or inactive mines on water quality in the Elkhorns. A water quality survey centered on mining effects is recommended. There can be no doubt that negative effects are being experienced; e.g., the Middle Fork of Warm Springs Creek, but at this time there is no means by which these effects can be accurately assessed, and therefore no adequate remedial measures may be designed or instituted.

Livestock Grazing Effects. During the course of this investigation, several areas were observed where riparian vegetation and streambank-streambottom materials seemed to have been negatively influenced by grazing. Since the study was conducted in a period of above average precipitation, the extent of grazing impacts was probably minimized. A study should be planned to evaluate grazing practices as they relate to riparian environments in the Elkhorns. Such an investigation should extend through a number of field seasons to ensure that a reasonable sampling of precipitation variation was included.

Recreational Use. Management of a resource can hardly be judged thorough without a comprehensive knowledge of the user population. A multi-year survey of recreational users of the riparian habitats should be carried out. From a fisheries perspective, this should include surveys, either by personal interview, mail or both, of user population characteristics and perceptions. In addition, the more traditional information on angler numbers, distribution and harvest should be generated. These data contribute an essential element in the preparation of comprehensive fisheries management plans.

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## APPENDICES

A. Report on samples of cutthroat trout from the upper Missouri River basin, Montana. Behnke.

B. Additional report: Hall Creek cutthroats. Behnke.

C. Recommendation for cutthroat transplant stocks. Behnke.

D. Genetic comparison of upper Missouri cutthroat trout to other *Salmo clarki lewisi* populations. Phelps and Allendorf.

E. Photographs of Elkhorn study area cutthroats and environmental features.

# REPORT ON SAMPLES OF CUTTHROAT TROUT FROM THE UPPER MISSOURI RIVER BASIN, MONTANA

Robert J. Behnke

October 1980

Two subspecies of cutthroat trout are native to Montana. Both subspecies have suffered enormous declines and have been almost completely replaced by non-native trouts in most waters of the state. The trout native to the upper Missouri drainage (excluding Yellowstone drainage), Salmo clarki lewisi, has a broad and disjunct distribution on both sides of the Continental Divide. Within this distribution, S. c. lewisi manifests distinct ecological specializations--lacustrine, resident small stream, and migratory from small streams to larger rivers. A management strategy for S. c. lewisi should include the preservation of the genetic diversity of both ecological and geographical forms. The significance of the present collection of specimens is that they represent the upper Missouri drainage, a geographical area from which previous studies have indicated the native cutthroat trout to be very rare.

## STATUS OF S. c. lewisi

Since the completion of Roscoe's (1974) thesis on S. c. lewisi I have been involved in further study on this trout and new publications (Loudenslager and Thorgaard 1979; Loudenslager and Gall 1980) have contributed new information on the systematics of S. c. lewisi.

Cutthroat trout became fractioned into three major groups prior to the last glacial epoch. East of the Cascade Mountains, the interior cutthroat trout separated from the coastal cutthroat and then divided into

two basic forms, one in the northern parts of the Columbia River basin and one in the Snake River division of the Columbia. The differences between these two interior forms are apparent in coloration and spotting pattern and in chromosome numbers. The northern Columbia form of cutthroat trout has small, irregular shaped spots, the genetic potential to develop brilliant coloration (if crustaceans are common in the diet), and 66 chromosomes. The Snake River form of cutthroat trout has large, roundish spots, lacks the genetic basis for brilliant colors, and has 64 chromosomes.

From the Snake River drainage, the ancestral cutthroat trout gave rise to several subspecies in the Great Basin, Colorado River, South Platte River, and in the Rio Grande. After the last glaciation, the large-spotted Snake River cutthroat trout crossed the Continental Divide into the Yellowstone drainage and became established downstream to the Tongue River. Also after the last glaciation (about 7,000 to 10,000 years ago), the small-spotted upper Columbia River cutthroat trout crossed the Continental Divide to become established in the South Saskatchewan and upper Missouri basins. In the Missouri, continuous distribution, in historical times, extended downstream to about Fort Benton. No trout were native to the Black Hills near the junction of the Missouri and Yellowstone. Thus, there has always been a substantial gap in distribution between the two subspecies east of the Continental Divide.

Despite the clear-cut distinctions between the two subspecies of cutthroat trout native to Montana there has been a great deal of taxonomic confusion surrounding them. A specimen of cutthroat trout collected near Great Falls was named "Salar lewisi" in 1856. Thus, the name lewisi is the correct subspecific name for the trout native to the upper Missouri

drainage and for all cutthroat trout sharing their most recent common ancestry with the upper Missouri cutthroat (as interpreted from the taxonomic characters). Besides the upper Missouri drainage, S. c. lewisi is native to the upper Columbia (Kootenai, Pend Oreille-Flathead, and Spokane-St. Joe drainages) in Montana, British Columbia, and Idaho, the Salmon and Clearwater drainages of the Snake River division of the Columbia in Idaho, the John Day River drainage of the middle Columbia basin in Oregon (identified in 1980), and to the South Sakatchewan drainage of Montana and Alberta. There is considerable variability in some taxonomic characters among S. c. lewisi from widely scattered parts of its range, but its spotting pattern is consistently uniform and unique, readily distinguishing it from all other trouts.

Throughout its range, S. c. lewisi has suffered great declines in distribution and abundance but it is much more common in the Columbia River basin than in the South Saskatchewan and Missouri drainages. A management plan for S. c. lewisi in Montana should give priority to securing the preservation of representative populations in the upper Missouri and South Saskatchewan drainages.

## RESULTS OF EXAMINATION

Thirteen samples consisting of 95 specimens collected in the Elkhorn Mountain area (Jefferson River drainage?) were examined and evaluated for relative purity. All samples are predominantly S. c. lewisi (about 90% or more pure). The effects of a slight introgression from rainbow trout is indicated by the spotting pattern and lack of basibranchial teeth in some samples. This may be due to a gradual infiltration of rainbow trout

genes from a predominantly rainbow trout population downstream in the watershed. Unless the hybrid influence is of recent origin, I assume that the overwhelming predominance of the native genotype indicates that the present environment strongly favors the native genotype, and any disruption of this environment would likely stimulate and greatly increase the hybrid influence.

In Montana, introductions of rainbow trout and of Yellowstone cutthroat trout result in hybridization with S. c. lewisi. A hybrid influence from rainbow trout, depending on the magnitude, can be detected by a change in the spotting pattern (spots are larger, particularly anteriorly, spots occur anteriorly below the lateral line and on top of the head), loss and reduction of basibranchial teeth, increased numbers of pyloric caeca and decreased numbers of scales (rainbow trout lack basibranchial teeth, have about 50 to 60 caeca and about 25 to 30 scales above the lateral line and 120 to 140 scales in the lateral series). Yellowstone cutthroat trout have large, roundish spots, more-or-less evenly distributed over the sides of the body, have 20-21 gillrakers (with good development of posterior rakers), typically 20-25 basibranchial teeth and 40-45 caeca.

Most specimens are less than 100 mm which makes accurate assessment of spotting pattern and basibranchial teeth difficult. Typically, a hybrid spotting pattern is not apparent until a fish is about 150 mm and basibranchial teeth continue to arise until a fish is about 100 mm.

The precise manifestation of a hybrid influence can not be predicted. No two hybrid populations are the same--the unlimited potential for recombination makes for uneven expression of characters. Typically, in S. c. lewisi, spotting pattern and basibranchial teeth are the most sensitive

indicators of a hybrid influence, but they may not be concordant. For example, most of the specimens from Dutchman Creek lack basibranchial teeth but the spotting pattern and all other characters indicate pure S. c. lewisi. On the other hand all 11 specimens from upper McClellan Creek have basibranchial teeth but some specimens have an obvious hybrid spotting pattern.

Evaluation of each sample is as follows:

Prickley Pear Creek (N=6) lowest gillraker count (17.6) and highest lateral series scale count (196), but no indication of a hybrid influence. All specimens have basibranchial teeth and spotting pattern is very typical of pure S. c. lewisi.

Muskrat Creek (N=1) Only one specimen. The number of gillrakers (21) and basibranchial teeth (14) would suggest a Yellowstone cutthroat influence, but the spotting pattern is typical of S. c. lewisi.

Silver Creek (N-5) Lateral series scale counts are low (158) and mean number of basibranchial teeth are somewhat low (3.4), but all specimens have teeth and there is no indication of a hybrid influence in the spotting pattern.

Dog Creek (N-10) Although scale counts are somewhat low (42 above lat. line and 161 in lat. series), spotting and other characters are typical of pure S. c. lewisi.

Stauback Creek (N=6) One specimen lacks basibranchial teeth and the other 5 have only 1 to 3 teeth. However, spotting and other characters typical of S. c. lewisi. I suspect this population has a very slight influence (ca .5% or less) from rainbow trout, but the rainbow trout genes are only expressed by a slight suppression of basibranchial teeth.

Main Fork Beaver Creek (N=6) Four specimens lack basibranchial teeth and some specimens have spots below lateral line anteriorly and have unusual parr marking. This population may have about 10% rainbow trout hybrid influence.

Dutchman Creek (N-10) Seven of 10 specimens lack basibranchial teeth but all other characters typical of pure *lewisi*. All four specimens less than 100 mm lack basibranchial teeth and three of six specimens more than 100 mm lack teeth. I assume that some hereditary influence from rainbow trout suppresses the development of basibranchial teeth in this population, but does not affect other characters.

East Fork McClellan Creek (N=10) Four of 10 specimens lack basibranchial teeth (all more than 100 mm), some specimens with hybrid spotting pattern (larger spots, anterior spots below lateral line and on top of head). Probably at least 10% rainbow trout influence in this population.

Upper McClellan Creek (N=11) The larger specimens in this collection have a hybrid spotting similar to the sample from the East Fork of McClellan Creek, but all 11 specimens from upper McClellan Creek have basibranchial teeth. The number of teeth is low (1-5 [2.2]), suggesting a slight suppression effect from rainbow trout genes.

Crystal Creek (N=8) Slight hybrid spotting pattern. Largest specimen with spots on top of head. Second largest specimen with hybrid type of body spots. Other characters typical of *S. c. lewisi*.

Teepee Creek (N=8) Largest specimen with large spots on body and on top of head; aberrant parr marks. Two of three specimens more than 100 mm with basibranchial teeth; four of five specimens less than 100 mm lacking basibranchial teeth. Perhaps 10% hybrid influence from rainbow trout.

Willard Creek (N=8) No indication of hybrid influence in spotting pattern but five of eight specimens lack basibranchial teeth (3 of 6 specimens more than 100 mm lack teeth).

South Fork Warm Springs (N=6) Two largest specimens with hybrid spotting pattern. All specimen with basibranchial teeth and other characters typical of *S. c. lewisi*.

## FINAL COMMENTS

Most of the samples have some indication of a hybrid influence from rainbow trout and because of the small size of the samples and the small size of the specimens I would not certify any sample as pure *S. c. lewisi*. However, the hybrid influence is small, probably not exceeding 10% of the hereditary background in any of the populations that these samples were drawn from. For identification purposes these populations should be recognized as *S. c. lewisi* because they overwhelmingly retain the native genotype.

Native cutthroat trout are rare in the upper Missouri basin and the Elkhorn Mountain region appears to be a stronghold for populations that are predominantly *S. c. lewisi* with some streams probably containing pure populations. From past experience, I have found that land-use practices such as clear-cutting, grazing, mining, road building, etc. that increase sediment loads and temperature will act to stimulate and increase a hybrid influence and/or replace the native trout with non-native trout if they have access to the habitat. These considerations should be taken into account for any multiple use activity in these watersheds that may modify the present environmental regime that currently favors the maintenance of

the native cutthroat trout.

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Table 1. Selected meristic characters.

| Locality | Gillrakers | Scales above l.l. and lateral series | Pyloric caeca | Basibranchial teeth | Remarks |
|---|---|---|---|---|---|
| Prickley Pear Crk. N=6 | 16-19 (17.5) | 40-47 (42)<br>192-199 (196) | 28-39 (33) | 2-9 (5) | Spotting typical of Lewisi |
| Muskrat Crk. N=1 | 21 | 41<br>185 | 36 | 14 | Typical lewisi spotting |
| Silver Crk. N=5 | 17-19 (18.0) | 37-42 (40)<br>153-166 (158) | 29-34 (31) | 2-5 (3.4) | Typical lewisi spotting |
| Dog Crk. N=10 | 16-21 (18.6) | 36-41 (35)<br>148-174 (161) | 27-43 (33) | 1-16 (6.2) | Typical lewisi spotting |
| Stauback Crk. N=6 | 18-21 (19.6) | 42-45 (43)<br>189-195 (192) | 26-29 (27) | 1 no teeth<br>5 w/1-3 (2) | Typical lewisi spotting |
| Main Fk. Beaver Crk. N=6 | 17-21 (18.8) | 38-44 (41)<br>172-204 (188) | 27-36 (33) | 4 no teeth<br>2 w/1-2 | Some hybrid spotting |
| Dutchman Crk. (Above forks) N-10 | 17-19 (18.0) | 36-43 (40)<br>179-199 (191) | 29-35 (32) | 7 no teeth<br>3 w/3 each | Typical lewisi spotting |
| E. Fk. McClellan Crk. N=10 | 18-20 (19.2) | 39-47 (43)<br>174-203 (190) | 29-39 (33) | 4 no teeth<br>6 w/1-6 (3) | Some hybrid spotting |
| Upper McClellan Crk. N=11 | 17-19 (18.3) | 40-47 (44)<br>185-209 (194) | 28-34 (31) | 1-5 (2.2) | Some hybrid spotting |
| Crystal Crk. N=8 | 18-20 (18.8) | 32-44 (39)<br>163-191 (179) | 26-36 (31) | 1-8 (3) | Slight hybrid spotting |
| Teepee Crk. N=8 | 18-22 (19.6) | 43-46 (44)<br>178-195 (187) | 26-35 (29) | 5 no teeth<br>3 w/1-2 | Some hybrid spotting |

Table 1. (continued)

| Locality | Gillrakers | Scales above 1.1. and lateral series | Pyloric caeca | Basibranchial teeth | Remarks |
|---|---|---|---|---|---|
| Willard Crk N=8 | 17-19 (18.0) | 35-40 (38)<br>178-195 (187) | 24-33 (28) | 5 no teeth<br>3 w/2-11(6) | Typical _lewisi_ spotting |
| So. Fk. Warm Springs Crk. N=6 | 17-20 (18.5) | 39-46 (42)<br>182-203 (192) | 31-38 (36) | 2-7 (3.2) | Slight hybrid spotting |

C
O
P
Y

Feb. 18, 1981

Dear George:

Mr. Hadley sent 3 samples of cutthroat in December. I told him I wouldn't have time for a written report, but would take a look at specimens and send my opinion. Here it is:

(1) N. Fk. Little Belt Crk. (Baldy Crk.) Cascade Co. Belt Mtns. 10 specimens.

Very similar to some of collections from Elkhorn Mtn. area. All specimens look like pure, native trout (spotting pattern uniform and wholly typical of S. c. lewisi). Numbers of scales, caeca, and gillraker, also typical but 5 of 10 specimens lack basibranchial teeth.

(2) N. Fk. Dry Crk. (Deep Crk.) of Smith R. T15N, R5E, S20 one sample of 6 specimens & one of 4 specimens. All specimens with basibranchial teeth, meristic characters typical of native trout, spotting uniform and typical.

This population is likely pure.

(3) Hall Crk.
> specimens

Appear identical to #2 except for slightly fewer basicbranchial teeth ($\bar{x}$ of 3 vs. $\bar{x}$ of 6) but all specimens have teeth. Probably pure or very close to it.

Thanks for the information on fish propagation in Montana. I had noted in U.S. Bur. Fish. Reps. that Madison R. was used first for cutthroat egg taking, then rainbow egg taking, but million of hybrids must have been produced during those years the rainbow was replacing (& hybridizing) with the cutthroat in Madison.

Sincerely,

/s/ Bob Behnke

Hadley

Appendix C

Department of Fishery and Wildlife Biology

Colorado State University
Fort Collins, Colorado
80523

March 2, 1981

Mr. George Holton
Montana Dept. Fish, Game, Parks
1420 East Sixth Ave
Helena, MT 59601



Dear George:

Mr. Hadley requested I send a letter with recommendations for transplanting native cutthroat trout in the Elkhorn Mtn. area.

As I al~~tten~~lu**ded** to in my report, a program to preserve a taxon of native cutthroat trout should be designed to perpetuate and enhance representative geographical groups within a subspecies in order to maintain a range of genetic diversity. This is particularly relevant with a taxon such as Salmo clarki lewisi with an original distribution in the Columbia, South Saskatchewan, and Missouri river basins.

I would give top priority to a project that would first find small, headwater drainages above a barrier falls. If the stream is barren, a transplant can be made with little effort or expense. Some habitat improvement may be needed to create deep holding areas in small headwater streams for adequate overwinter survival. Other streams with barriers and non-native trout can be treated to eliminate the non-native fish.

My recommendations for stocks for transplants based on degree of purity, are not as sound as I would like them to be because of the small sample size of specimens (discussed in my report sent in October).

From my notes and report I would suggest that Prickley Pear Creek, Dog Creek, Silver Creek, Stauback Creek, and perhaps Hall Creek (mentioned in recent letter) could serve as sources to obtain essentially pure, native cutthroat trout for transplants. It might also be suggested to the Forest Service that, if a suitable site can be found, a small lake might be constructed as a native cutthroat trout lake. Such action would greatly Increase the abundance of native trout of the Jefferson River drainage.

Enclosed is a copy of a report I wrote recently concerning a population of native cutthroat trout in Crazy Fish Lake on the Flathead Indian Reservation.

Sincerely,

Bob

Robert Behnke

RB:sl

Enclosure

13 March 1981

Appendix D



# Genetic comparison of upper Missouri cutthroat trout to other *Salmo clarki lewisi* populations

Phelps, S. R., and F. W. Allendorf

## INTRODUCTION

There are two distinct groups of interior cutthroat trout native to the Columbia and upper Missouri basins. One group is native to the Snake River drainage and the Yellowstone basin. This form is commonly called yellowstone cutthroat trout and is classified as a subspecies of cutthroat trout, Salmo clarki bouvieri (p. 57, Behnke 1979). The other group is native to the Kootenay, Clark Fork, and Spokane River systems on the west side of the Continental Divide; this form has also apparently crossed to the east side of the Continental Divide and is native to the headwaters of the south Saskatchewan River drainage and to the upper Missouri basin. This cutthroat trout is commonly called the westslope cutthroat, S. clarki lewisi (Behnke 1979).

There are populations within the ranges of each of the two cutthroat subspecies which have morphological and genetic characteristics that result in ambiguous taxonomic classifications. Cutthroat trout populations in some areas are thought to be distinct varieties by some taxonomists, while others consider them to be races, (see references in Behnke, 1972, 1965, 1979, and Loudenslager and Gall 1980). The upper Missouri cutthroat trout represent a population whose taxonomic status is in question. There has been no comprehensive biochemical genetic comparison of the S. c. lewisi populations of Montana on the east side of the Continental Divide with those on the west side. Thus, there is no estimate of the amount of genetic differentiation resulting from the reproductive isolation between these groups.

Previous studies on the upper Missouri cutthroat trout indicate that these trout are similar to westslope cutthroat trout populations west of the Continental Divide. Zimmerman (1965) found only minor morphological

differences between S. c. lewisi populations on both sides of the Divide and concluded that they should be classified as the same subspecies. Roscoe (1974) also found that S. c. lewisi of the upper Columbia River basin and upper Missouri River system are morphologically similar and belong to the same taxon. Reintz (1974) examined serum proteins and esterases from both S. c. lewisi and S. c. bouvieri and found that cutthroat trout from the headwaters of the Missouri River are more similar to S. c. lewisi from west of the Continental Divide than to the yellowstone cutthroat trout. Loudenslager and Gall (1980) sampled an upper Missouri cutthroat trout population from Cougar Creek, Wyoming, and found that its genetic identity (Nei, 1972) at 35 gene loci with the Kings Lake S. c. lewisi hatchery stock (Idaho) is similar to genetic identities between S. c. bouvieri populations within Yellowstone National Park and also between S. c. henshawi populations within the Great Basin.

There is presently much interest in preserving native salmonid fish stocks. It is necessary to document the extent of genetic diversity within S. c. lewisi and to use this information to manage this species effectively. In this paper, we present the results from the examination of four upper Missouri cutthroat trout populations in the Lewis and Clark National Forest near Helena, Montana, to (1) compare these populations to S. c. lewisi populations in Western Montana and Canada, and to (2) determine the extent of introgression from rainbow trout and yellowstone cutthroat trout.

## METHODS

Cutthroat trout were collected from four creeks in the Lewis and Clark National Forest by personnel from the Montana Department of Fish, Wildlife, and Parks and the Bureau of Land Management during the fall of 1980. Sample

area and sample sizes are: Beaver Creek (T 8N, R 1W, S29), N = 19; Dutchman Creek (T 7N, R 3W, S3), N = 10; McClellan Creek (T 8N, R 2W, S28), N = 13; and the North Fork of the Dry Fork of the Smith River (T 15N, R 5E, S20), N = 29. The samples were frozen at -40 C prior to electrophoretic analysis.

We conducted horizontal starch gel electrophoresis according to the methods of Utter, Hodgins, and Allendorf (1974). Allendorf et al. (1977) describe the buffer systems and staining methods used in this study.

The nomenclature used to describe the gene loci and the allele variants encoding the enzymes surveyed follows the system proposed by Allendorf and Utter (1979). A capitalized abbreviation is chosen to represent each protein. That abbreviation with only the first letter capitalized followed by a hyphenated numeral represents different loci coding for this protein. The locus with the least anodal mobility is designated as the first locus. Additional loci are numbered 2,3,4, and so on, toward the anode. The alleles are desiguated according to their relative mobility in relation to the mobility of the common rainbow trout (Salmo gairdneri) allele at that locus. The migration distance of the most common rainbow trout isozyme is assigned a mobility of 100. A different allele at the same locus is assigned a number which corresponds to the ratio of its migration distance to that of the rainbow trout common allele. Thus, an allele of the least anodal lactate dehydrogenase (LDH) locus, coding for an enzyme migrating one half as far as the common allele is deisgnated Ldh-1(50).

We used muscle, liver and eye tissues for the analysis, and chose enzymes on the basis of adequate resolution and enzyme activity. The tissue and buffer system combinations with the best activity and resolution generally agree with Allendorf et al. (1977).

## RESULTS

We examined 20 enzymes from the four upper Missouri cutthroat trout populations for genetic variation coded by 45 gene loci (Table 1). Three of these populations were genetically variable at only Idh-3,4 and showed no evidence of any introgression from rainbow trout or yellowstone cutthroat trout (Table 2). These three populations will be compared to other "pure" westslope cutthroat trout populations in the south Saskatchewan River drainage and to populations west of the Continental Divide.

Beaver Creek cutthroat trout contain genetic variation at seven gene loci (Table 2). This variation is apparently due to hybridization with both rainbow trout and yellowstone cutthroat trout. This hybrid population is made up of 55% westslope cutthroat trout, 40% rainbow trout, and 5% yellowstone cutthroat trout genes based on the differences presented in Table 3. (See Phelps and Allendorf in preparation for discussion and use of biochemical genetics to detect hybridization among these taxa).

Genetic similarity relationships based on allele frequencies among the three upper Missouri westslope cutthroat trout populations and 29 other westslope cutthroat trout populations in Northwestern Montana and Canada are demonstrated by the dendrogram in Figure 1. (See Table 4 for the area and sample number of the 29 populations used for comparison). There are two major groupings in the dendrogram. These groupings are due to the Idh-3,4 allele frequency differences. The populations in the lower group (#17-32) are fixed for the Idh-3(100) allele. All but three of these populations occur in Canada. The upper grouping (#1-16) are the populations with the Idh-3(40) allele. The upper Missouri populations are in this group, along with many of the populations from Glacier Park and the populations from which the MDFWP derived the westslope cutthroat trout brood

stock. The dendrogram indicates that the upper Missouri populations have a closer affinity to the Western Montana populations than to the south Saskatchewan populations east of the Continental Divide.

## DISCUSSION

Westslope cutthroat trout have a low amount of genetic variation in comparison with other salmonids (Allendorf and Utter 1979). The only commonly variable system is the duplicated Idh-3,4 locus. Variation at this locus has been found in most populations, except for the ones from the South Saskatchewan River drainage. Rare allelic variants confined to one or a few populations account for a large proportion of the variation in this subspecies (Phelps and Allendorf, unpublished data). Most of the genetic variation is between, not within, populations (see Allendorf and Phelps (in press) for a general discussion of this). This is similar to what has been found in European brown trout (Salmo trutta) populations (Ryman in press, Ferguson in press, Ryman and Ståhl in press). Rainbow trout, on the other hand, have most of the variation within populations (Allendorf and Phelps in press). This demonstrates the need to use a different management scheme to preserve the genetic variation in westslope cutthroat trout than that used for rainbow trout.

Each population of westslope cutthroat trout represents a potentially valuable source of genetic variation. Once a population is lost, the variation within that population is also lost. The loss of a rainbow trout population in contrast, does not account for as great of loss of the proportion of genetic variation, because most of the variation in the lost population is also contained in others.

Thus, even though we found no electrophoretic differences between these three upper Missouri and other S. c. lewisi populations, there undoubtedly are populations in the upper Missouri drainage which contain genetic variation absent in populations west of the Continental Divide. These upper Missouri cutthroat trout populations represent a valuable source of genetic variation for the westslope cutthroat trout. Genetically pure populations should be identified and preserved.

## CONCLUSION

Cutthroat trout from the Lewis and Clark Forest in the upper Missouri drainage are not genetically different from S. c. lewisi populations west of the Continental Divide. There is no indication that any taxonomic distinction should be made between upper Missouri cutthroat trout and other westslope cutthroat trout. The cutthroat trout on opposite sides of the Continental Divide in Montana are more similar to each other than either of them are to cutthroat trout populations in the south Saskatchewan River drainage.

Table 1. Enzymes and loci examined.

| Enzyme | E.C. Number | Abbreviation | Loci | Tissue |
|---|---|---|---|---|
| Aspartate aminotransferase | 2.6.1.1 | AAT | m1,2 | M,L |
| | | | s1,2 | L |
| | | | s3 | M |
| | | | s4 | E,M |
| Alcohol dehydrogenase | 1.1.1.1 | ADH | 1 | L |
| α-glycerophosphate dehydrogenase (Glycerol-3-phosphate dehydrogenase) | 1.1.1.8 | AGP | 1,2 | M |
| Creatine kinase | 2.7.3.2 | CK | 1,2 | M |
| | | | 3 | E |
| Esterase | 3.1.1.1 | EST | 1 | L |
| Glyceraldehyde phosphate dehydrogenase | 1.2.1.12 | GAPDH | 1,2 | M |
| | | | 3,4 | E |
| Glutamate dehydrogenase | 1.4.1.2 | GDH | 1 | L |

Table 1 continued.

| Enzyme | E.C. Number | Abbreviation | Loci | Tissue |
|---|---|---|---|---|
| Isocitrate dehydrogenase | 1.1.1.42 | IDH | 1,2 | M |
| | | | 3,4 | L |
| Lactate dehydrogenase | 1.1.1.27 | LDH | 1,2 | M |
| | | | 3 | E,M |
| | | | 4 | E,L,M |
| | | | 5 | E |
| Malate dehydrogenase | 1.1.1.37 | MDH | 1,2 | M |
| | | | 3,4 | L |
| Malic enzyme (Malate dehydrogenase NADP) | 1.1.1.40 | ME | 1,2,3 | M |
| | | | 4 | L |
| Mannose phosphate isomerase | 5.3.1.8 | MPI | 1 | L |
| 6-Phosphogluconate dehydrogenase (Phosphogluconate dehydrogenase) | 1.1.1.44 | 6PGDH | 1 | L |
| Phosphoglucose isomerase (Glucose-phosphate isomerase) | 5.3.1.9 | PGI | 1,2 | M |
| | | | 3 | E,L,M |
| Phosphoglucomutase | 2.7.5.1 | PGM | 1 | L,M |
| | | | 2 | M |

Table 1 continued.

| Enzyme | E.C. Number | Abbreviation | Loci | Tissue |
|---|---|---|---|---|
| Sorbitol dehydrogenase (Iditol dehydrogenase) | 1.1.1.14 | SDH | 1 | L |
| Superoxide dismutase | 1.15.1.1 | SOD | 1 | L |
| Xanthine dehydrogenase | 1.2.3.2 | XDH | 1 | L |

Table 2. Genetic variation in upper Missouri cutthroat trout populations

| | Alleles Present (Frequency) | | | |
|---|---|---|---|---|
| Locus | Beaver Creek | Dutchman Creek | McClellan Creek | Smith River |
| Aat-s1 | 100, 200<br>(.26, .74) | 200 | 200 | 200 |
| Ck-2 | 100, 84<br>(.08, .92) | 84 | 84 | 84 |
| Idh-1 | 100, 75<br>(.97, .03) | 100 | 100 | 100 |
| Idh-3 | 100, 40<br>(.18, .82) | 100, 40<br>(.60, .40) | 100, 40<br>(.31, .69) | 100, 40<br>(.55, .45) |
| Pgi-3 | (100, 88)<br>(.26, .74) | 88 | 88 | 88 |
| Sdh-1 | 100, 40<br>(.03, .97) | 40 | 40 | 40 |

Table 3. Loci differentiating westslope cutthroat trout, yellowstone cutthroat trout and rainbow trout.

| Loci | Allelic Mobility* Rainbow | Westslope | Yellowstone |
|---|---|---|---|
| Aat-1 | 100 | 200 | 165 |
| Ck-2 | 100, 70 | 84 | 84 |
| Idh-1 | 100 | 100 | -75 |
| Idh-3,4 | 100, 40 71,114 | 100, 80 40 | 100, 71 |
| Me-1,2 | 100, 20 | 88 | 100 |
| Me-3 | 100 | 100 | 84 |
| Me-4 | 100 | 100 | 110 |
| Pgi-3 | 100 | 88 | 100 |
| Pgm-1 (muscle) | Activity | Activity | No Activity |
| Sdh-1 | 100 | 40 | 100 |

*Numbers represent proportional electrophoretic mobility relative to the standard common allele of rainbow trout.

Table 4. Location and sample size of the 29 westslope cutthroat trout populations used in the similarity comparison with the upper Missouri cutthroat trout populations in Figure 1.

| Drainage | Population number | Name | Location | | | | Sample Size |
| --- | --- | --- | --- | --- | --- | --- | --- |
| | | | North | | West | | |
| | | | degrees | minutes | degrees | minutes | |
| Flathead River | 7 | Akakola Lake | 48 | 53 | 114 | 12 | 30 |
| | 17 | Avalanche Lake | 48 | 39 | 113 | 47 | 32 |
| | 12 | Cerulean Lake | 48 | 52 | 114 | 03 | 30 |
| | 8 | Harrison Lake | 48 | 31 | 113 | 47 | 22 |
| | 14 | Howe Lake (lower) | 48 | 36 | 113 | 59 | 20 |
| | 13 | Howe Lake (upper) | 48 | 36 | 114 | 00 | 3 |
| | 5 | Hungry Horse Creek | 48 | 21 | 113 | 53 | 75 |
| | 26 | Isabel Lake | 48 | 25 | 113 | 29 | 27 |
| | 27 | Isabel Lake (upper) | 48 | 25 | 113 | 30 | 8 |
| | [illegible] | Lincoln Lake | 48 | 35 | 113 | 46 | 16 |
| | 16 | Logging Lake | 48 | 45 | 114 | 05 | 34 |
| | 4 | North Fork Flathead River | | | | | 24 |
| | 3 | Ole Lake | 48 | 23 | 113 | 23 | [illegible] |
| | 14 | Quartz Lake (lower) | 48 | 48 | 114 | 06 | 27 |
| | 15 | Quartz Lake (middle) | 48 | 49 | 114 | 09 | 27 |
| | 13 | Quartz Lake (upper) | 48 | 50 | 114 | 11 | 29 |

Table 4 continued.

| Drainage | Population number | Name | Location: North degrees | North minutes | West degrees | West minutes | Sample Size |
|---|---|---|---|---|---|---|---|
| Flathead River continued | 18 | Rogers Lake | 48 | 40 | 113 | 56 | 2 |
| | 19 | Snyder Lake (lower) | 48 | 38 | 113 | 48 | 33 |
| | 20 | Trout Lake | 48 | 41 | 113 | 55 | 30 |
| Kootenay River | 31 | Floe Lake | 51 | 03 | 116 | 08 | 4 |
| South Saskatchewan | 29 | Black Lake (upper) | 51 | 22 | 115 | 50 | 25 |
| | 30 | Connor Lake | 50 | 18 | 115 | 05 | 10 |
| | 32 | Elk Lake | 51 | 17 | 115 | 39 | 35 |
| | 21 | Fish Lake #1 | 51 | 38 | 115 | 10 | 14 |
| | 22 | Fish Lake #2 | 51 | 39 | 115 | 11 | 25 |
| | 28 | Fish Lake #3 | 51 | 39 | 115 | 12 | 25 |
| | 23 | Marvel Lake | 50 | 52 | 115 | 33 | 25 |
| | 24 | Mystic Lake | 51 | 16 | 115 | 44 | 25 |
| | 25 | Twin Lake (lower) | 51 | 12 | 115 | 58 | 14 |

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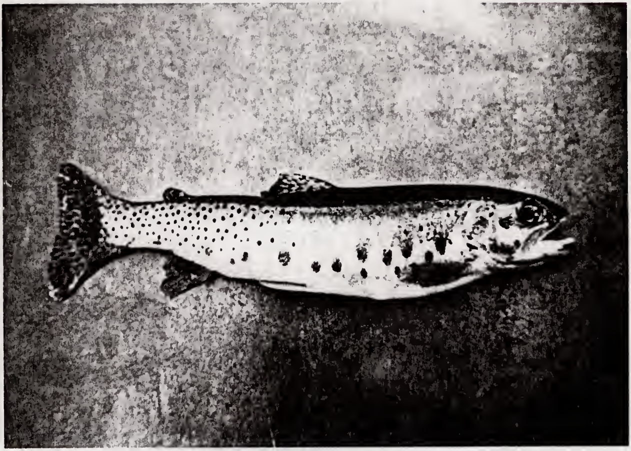
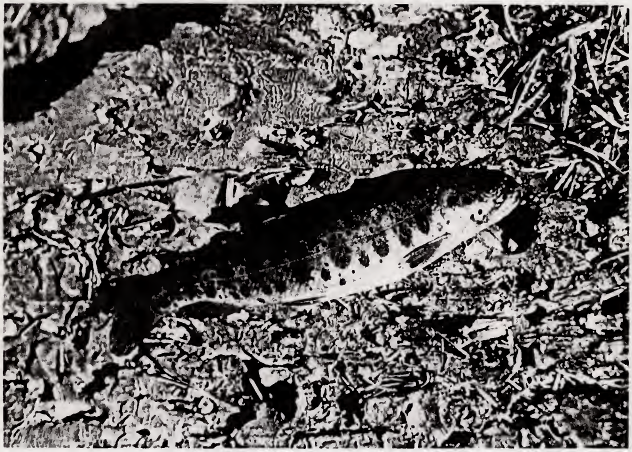
## Appendix E. Photographs of Elkhorn Study Area Environmental Features and Cutthroat Trout

Cutthroat trout from Dog Creek, a Columbia drainage stream. This specimen conforms to the color patterns said by Behnke (1979) to be typical of both westslope and upper Missouri cutthroats.



Cutthroat trout, WFH-80-55, from Hall Creek. Reported by Behnke (appendix B) to be pure or very close to it. Note spots on head and compare spotting to that on Dog Creek specimen on preceding page.



Cutthroat trout from South Fork of Warm Springs Creek, WFH-80-27. Behnke reported (appendix A) this population to have hybrid spotting. Note spots on head.

Cutthroat trout from McClellan Creek, WFH-80-17. Phelps and Allendorf (appendix D) considered this population to have no introgression from Yellowstone cutthroats or rainbows. Behnke (appendix A) suggested that a slight rainbow influence was present. Note spots on head and venter.

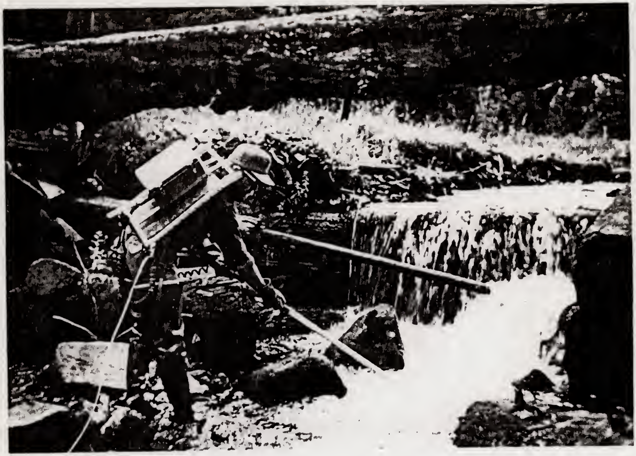
Cutthroat trout from the East Fork of McClellan Creek, WFH-80-18. Behnke (appendix A) considers this population to have at least 10 percent rainbow influence. Note the difference in spot size and distribution of spots between this specimen and the McClellan Creek fish.

Cutthroat trout from Prickly Pear Creek, WFH-80-30. Behnke (appendix A) noted no indication of a hybrid influence in this population. Compare to Dog Creek specimen.

Cutthroat trout from Beaver Creek, WFH-80-3. Phelps and Allendorf (appendix D) and Behnke (appendix A) reported rainbow hybridism in this population.

Cutthroat trout from Beaver Creek, WFH-80-4. Compare to Beaver Creek specimen on preceding page.

Cutthroat trout from Yellowstone River in Yellowstone National Park. Probably with some rainbow introgression. Compare to westslope specimen from Dog Creek.



Remnant of hydropower dam on McClellan Creek, S16, T18N, R2W. Formerly a complete barrier to upstream passage of brook trout.

Natural log and rock barrier on the East Fork of McClellan Creek. A series of these features may serve to completely eliminate upstream trout passage.