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11TH AND DARTMOUTH AVENUES
CLAREMONT, CALIFORNIA 91711

29 November 1972

Dr. Robert J. Behnke
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Dr. Behnke:

I am sorry I did not get to speak to you at the desert fishes meetings in Death Valley but I had to collect some fish in the eastern Sierra and get right back to Los Angeles.

Your comment on the "desert adapted" trout living at 83°F really interested me and I wanted to get some further information on it. I have been studying thermal tolerance in golden trout from the Cottonwood Creek and South Fork of the Kern drainages. We have found that their upper lethal temperature when acclimated at 12°C is about 29.7° 59.4
(=84°F) which is equivalent to the thermal tolerance of brown trout. =85° 53.5 32
Under warmer acclimation conditions, and cycling thermoperiod, I would expect it to be considerably higher. We have also measured diel temperature cycles in the South Fork of the Kern at several localities and daily temperatures in the 80's are quite common.

We are preparing our paper for publication and would like to know if you have published your observations of the trout (I assume they are <u>S. clarkii henshawi</u>) at 83°F, as we would like to site your observation in our paper. If not, could we have your permission to site your observation as a personal communication?

I feel the high temperature tolerance of the golden trout is of considerable interest since it may indicate further similarity to the Gila and Henshawi subspecies that you have previously determined.

Yours sincerely,

C. Robert Feldmeth

C. Robert Feldmeth
Assistant Professor
of Biology

CRF:la

OPTIONAL FORM NO. 10
5010–104

UNITED STATES GOVERNMENT

Memorandum

TO : Bob Behnke, Colorado Cooperative Fishery Unit, Ft. Collins

DATE: October 20, 1972

FROM : Bob Kramer, Utah Cooperative Fishery Unit, Logan

SUBJECT: Hot trout - your 10/12 memo

As you have stated in your memo, it's a bit difficult to draw conclusions regarding the uniqueness of the redbanded trout genotype. The ability to tolerate the 83 F temperatures at which you caught them could be related to acclimation to daily temperature fluctuations to which they were subjected. Perhaps the night temperatures are in the 60 F range and the day temperatures reach 80+ for only a short time. I'm not able to put my finger on any published data which would apply to this question of temperature tolerance, however.

I do have one good bit of evidence, however, which supports your hypothesis that scope-for-activity is genetically controlled within species. This is from Dickson's thesis (2 figures enclosed) and also given in our paper in the JFRBC (enclosed). At 25 C, the DeSmet rainbows had significantly higher active metabolic rates and scope-for-activity than did the domestic trout (both groups reared in a hatchery from eggs taken from respective stocks). Since rearing conditions were nearly the same, the differences observed in metabolism were attributed to genetic differences. The Wild fish were subjected to seasonal low and high temperatures for generations whereas the domestic fish were held in relatively homothermal conditions and continuously selected for growth and survival under those conditions.

In order to draw any meaningful conclusions regarding scope-for-activity of the Chino Creek trout we should get them as eggs or at a very young state and raise them under identical conditions with other cutthroat trout and rainbow trout at various constant temperatures. Periodic scope-for-activity measurements then made over a 12-month period should give us the information you seek. We could also determine upper incipient lethal temperatures in the lab.

The Unit is well-equipped to do this should The Division of Fishery Research give the work high priority.

I have supplied Mr. Leavitt with the necessary materials for preserving trout from the Sevier River drainage and given him some words of encouragement per your letter of September 14.

Thanks for the papers and the rare and endangered species materials. Keep up the good work.

Bob

R. H. Kramer

Enclosures (3)

RHK:gm

STATE OF MONTANA
DEPARTMENT OF FISH AND GAME
~~HELENA, MONTANA 59601~~
BOX 508
Big Timber 59011

BIG TIMBER, MT 59011
MAY 17 PM
1971

Montana —
— Cutthroat Trout

Dr. Robert J. Behnke, Assistant Unit Leader
Colorado Cooperative Unit
Colorado State University
Fort Collins, Colorado 80521

THE UNIVERSITY OF WISCONSIN
MADISON, WISCONSIN 53706

LABORATORY OF LIMNOLOGY

August 29, 1972

Dr. Bob Behnke
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Bob:

In looking through Jr. Fish. Res. Bd. Can., Vol. 29, I finally realized what an excellent work you did in your paper on salmonid systematics in recently-glaciated lakes.

It was really a major paper.

Best regards,

Don C

Donald W. Chapman

DWC/jp

- R. a C letter.
- Bor's list of achla
Library - book store
- Norway - Salvelinus
salmon
- S. salar - Mylters' book

22
1 3 4 4 4 3 1

Photo Lab
Slides

Ecology 45(1)
Kenneth John
fish Chiricaura Mtn
Campostoma ornatum

cue is temp? - decline Rod Van Velson - Mar. 73 -

- or upstream

Ninemile Crk Scotts bluff Co, Nebs.

trib. N. Platte.

- Livingston Stone

Dec. 25

—— never below 40°F

ca 50°-55° in Nov.

- Nov. 10 - saw nest bldg. activity

- ♂ + ♀ on nest -

- some trout enter & spawn in fall - some, particularly ♂ stay in Ninemile Crk overwinter - spawn in spring -

egg taking - propagation

100,000 eggs - taken typically Dec. 15 - Jan 15.

Nov. - Dec. - peak

Jan - very few

late Feb., increase in numbers in 9 mi. Crk. (mostly new run) - mid-Mar mid April peaks for spring spawn

- 15 tags recovered next year - tagged at trap in fall

next year 2 of 15 in spring (13 in fall).

- age structure -

- Maccrimmon (L. Huron)

OFFICE MEMO

TO: **Date**

FROM:

SUBJECT: — There are many subtle differences in "Bear R"

REMARKS: (on Bonneville) cutthroat, *Salmo clarki utah*, both morphologically & ecologically -- They thrive in degraded environments where brown & rainbow trouts can not be established (yet other groups of same subsp. -- in rest of Bonneville basin cannot coexist with other trouts -- they are always eliminated if brook, brown, or rainbows stocked with them -- Behnke, 1981 p. 94-124 Fishes of N. Am. deserts John Wiley) -- Bear L. native cutthroat reaches may 18-20 lb. an effective predator yet all electrophetic data not only cannot distinguish various differentiated forms of Bear R. cutts - it cannot differentiate

S. c. utah from *S. c. bouvieri* (yellowstone cutt) or fine-spotted Snake R. cutt (undescribed subsp.) -- Consider the enormously important genetic diversity present in these three subspecies (intersubsp. & intrasubsp.) that governs distinct life histories and ecology so impt. for fish. mgt. that can not be detected by electrophoresis (which considers all 3 subsp. the same). -- Loudenslager & Kitchin 1979. Copeia (4): 673-678 (for lack of electroph. distinction between fine-spotted & Yellowstone subsp.) + Loudenslager & Gall 1980. Syst. Zool. 29(1): 27-42 for lack of distinction between Yellowstone & *S. c. utah*).

— My rept. & Binns Wyo. bull. are examples of more relevant "genetic" analysis of native trout in regards to stimulating proper management and avoid confusion.

NAVY ENVIRONMENTAL AND PREVENTIVE MEDICINE
UNIT NO. 2
NORFOLK, VIRGINIA 23511

2 refs to
Iotichthys
in Fishes of Utah
re. mosquito control

Code 15:LLS/bm
6250
23 June 1972

Dr. Robert Behnke
Assistant Unit Leader
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Dr. Behnke:

I enjoyed meeting you and discussing the potential role of fish for mosquito control in Colorado. As you suggested, I have forwarded information concerning our studies with Gambusia to the Public Health Department in Colorado Springs.

Regarding the possibility of investigating the two native Fundulus fish species as mosquito predators (for a Ph. D. problem), Dr. Fronk of the Zoology and Entomology Department suggested that a laboratory problem would probably be a safer choice in view of the two year limitation. This is, therefore, the course that I shall pursue should I matriculate at CSU next year. I will, however, continue to keep in contact with the public health people who are conducting the work with mosquito fish in Colorado.

Thank you again for your time.

Sincerely,

L. Lance Sholdt

L. Lance Sholdt
LT MSC USN
HEAD, ENTOMOLOGY DEPARTMENT

Promotes the Conservation, Development and Wise Utilization of the Fisheries

American Fisheries Society

ORGANIZED 1870 | INCORPORATED 1910

SUITE 1040, WASHINGTON BUILDING
15TH STREET AND NEW YORK AVENUE, N.W.
WASHINGTON, D. C. 20005
PHONE: (202) 347-9717

ROBERT F. HUTTON
EXECUTIVE SECRETARY

JOHANNA M. REINHART
ASSISTANT EXECUTIVE SECRETARY-EDITOR

February 28, 1972

Dr. Robert J. Behnke
Colo. Coop. Fishery Unit
Colo. State University
Ft. Collins, CO 80521

Dear Dr. Behnke:

We are pleased to send you the American Fisheries Society Citation awarded to the faculty adviser of the student member who delivered the best paper at our 101st Annual Meeting. The citation to the student was awarded to Carl B. Schreck for his paper entitled "Sex Steroid Levels in Rainbow Trout with Respect to Gonad Development, Stress Castration and Variability." He, in turn, proposed your name to receive the above mentioned citation.

Sincerely yours,

Henry Clepper

Henry Clepper
Acting Executive Secretary

HC/twb

Enclosure

cc: AFS Officers
George Fleener
Richard H. Stroud
Robert M. Jenkins

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Lolo National Forest
2801 Russell Street
Missoula, Montana 59801

REPLY TO: 2610 Cooperative Relations September 1, 1972

SUBJECT: Westslope Cutthroat Trout Samples

TO: Mr. Robert J. Behnke
Assistant Leader
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado

You will soon be receiving samples of westslope cutthroat trout from eighteen various streams and two lakes located in western Montana. The fish are each wrapped in formalin-soaked toweling and placed in a plastic bag. Each plastic bag contains fish from a single stream or lake. Inside each plastic bag is a slip of paper giving the name of the creek, the creek's location (section, range, township), the date of collection, the water temperature, the type of canopy located directly above the stream, and the substrate type of the stream. The information is listed in this order on the individual slips of paper.

Slides of what we feel to be representative fish of each stream will be sent at a later date. Enclosed are maps which will give you a general idea of the location of collection. The location of roads on these maps inaccurate and outdated, but the location of the streams is fairly good.

In our opinion, only the fish collected from Lower Elliot Lake are pure native westslope cutthroat. We make this statement prior to having made any tests on the serum so it is only an opinion. We think most of the other fish are rainbow-westslope cutthroat hybrids.

Also, some streams such as Deer Creek, Little Stony Creek, Big Rock Creek, and almost certainly Overwhich Creek possibly have westslope-Yellowstone cutthroat hybrids present. Again, these are only my personal opinions, and nothing more.

If there is any additional information I could supply you with, please feel free to write me at any time.

Gordon Haugen/cw

GORDON HAUGEN
Fisheries Biologist

Enclosure

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Federal Building
Missoula, Montana 59801

REPLY TO: 2630 Habitat

August 4, 1972

SUBJECT: Cutthroat trout-- Montana Department of Fish and Game. Rare and Endangered Species Collection

TO: Dr. Robert J. Behnke
Colorado Cooperative Fishery Unit
U.S. Bureau of Sport Fisheries and Wildlife
Colorado State University
Fort Collins, Colorado 80521

Dear Dr. Behnke:

Being sent under seperate cover are 15 cutthroat trout to be analyzed under subject collection for pure strain. All of the cutthroat were collected from Little Goose Lake, Park County, Montana, elevation 9800 feet, on the Gardiner Ranger District, Gallatin National Forest.

We would appreciate receiving a copy of your report on these fish when your analysis is completed.

-Salmo clarki

-Montana, Little Goose L. Park Co., Gardiner Ranger Dist. Gallatin Nat. For.

Sincerely Yours

Donald A. Duff

Donald A. Duff
Fisheries Biologist
Division of Range and Wildlife

Little goose-clacier crk-Stillwater creek

~~drainage~~

coll. ___

date ___

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Flathead National Forest
Kalispell, Montana 59901

2600
April 25, 1972

Mr. Robert Behnke
Assistant Unit Leader
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Mr. Behnke:

The Middle Fork of the Salmon River in Idaho has a pure native population of cutthroat trout and a well known steelhead population. The Middle Fork cutthroat looks very much like the cutthroat from Flathead Lake. Don Corley, Salmon, Fishery Biologist for Idaho Fish and Game could give you first hand information on this.

There are several small tributaries to the Portneuf River in eastern Idaho that have cutthroat populations which appear distinct from the Yellowstone cutthroat and Snake River cutthroat.

The head of the Little Malad River, in the Great Basin Drainage, Oneida County had some native cutthroat when Danniels Dam was built. Since then, Yellowstone cutthroat have been planted in the drainage. There still may be some of the unadultrated native stock in the headwaters above beaver dams. Rainbow may have been stocked in these waters some time ago, but I doubt they would have reached the headwaters.

Cherry Creek in Bannock County may have a native cutthroat population remaining. Eastern brook were planted in the area at one time.

Mill Creek on the Fort Hall Indian Reservation has a cutthroat population that co-exists with eastern brook. The fish in Mill Creek should be a pure native strain, unless the Indians stocked it recently. Several streams in the Idaho Primitive area have both cutthroat and steelhead. Big Creek has an excellent cutthroat population (the last time I was there) as well as steelhead.

Pebble Creek, a tributary to the Portneuf River, has an excellent cutthroat population in the headwaters. Rainbow catchables are stocked annually, but the cutthroat maintain themselves very well in the headwaters above beaver dams.

Jacknife Creek and Tincup Creeks, tributaries to Salt River in Wyoming have good Snake River cutthroat populations. They have been stocked with Yellowstone cutthroat and rainbow; but Snake River cutthroat dominate.

The Blackfoot River, above the Blackfoot Reservoir, in eastern Idaho has present both rainbow and Yellowstone cutthroat. There is some hybridation, but the upper Blackfoot is still all cutthroat and the lower river a mixture. The cutthroat in the Blackfoot River held their own while the rainbow population declined because of competition from a spawning run of suckers that followed the rainbow and utilized the same areas to spawn. Rainbow and cutthroats hybrids are common in the reservoir. Hybrids weighing 10-23 lbs. are taken regularly. So much for your questions on Idaho cutthroat.

I will be able to send some more cutthroat from Flathead Forest streams this summer. How many fish do you need from a given stream? It may be possible to collect a few the latter part of May, depending on the spring runoff.

I have located three populations of cutthroat that exist above barriers in the South Fork Flathead River. It will be mid-July before they can be sampled, but it will be interesting to see what is there.

I like your proposal to develop relevant information on the status of the indigenous cutthroat trout of Montana. This information is needed by the Forest Service so they can do the land management job required. It may be well to discuss this with the regional wildlife people in Missoula. I believe they will have some endangered species fund for FY 73.

Sincerely yours,

Osborne E Casey

OSBORNE E. CASEY
Fishery Biologist

Mont. W. slope

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Flathead National Forest
Kalispell, Montana 59901

Dean Crk.
comp. w/
— Idaho cutts

2600
March 10, 1972

Robert Behnke
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Mr. Behnke:

The upper Dean Creek drainage is limited to this one species of trout. There may be Dolly Varden in the lower one mile near the Spotted Bear River, but I have not seen them. No rainbow were found in the Spotted Bear drainage last summer.

Enclosed are three slides of Dean Creek cutthroat for your files. The large group of fish are the ones I sent you. The individual fish picutures were taken in early September.

I find the Dean Creek fish very interesting because of where they spend the winter. They do not appear to move downstream even slightly before the winter freeze-up. In eastern Idaho I found the Snake River cutthroat moved out of streams the size of Dean Creek before they froze over. The cutthroat on the Middle Fork of the Salmon River in Idaho exhibited a downstream movement in the fall, also.

If the Dean Creek cutthroat are the pure "westslope" stock they may be useful for stocking above natural barriers where there are presently no fish. At least we will know where a non-migratory population exists if a need arises.

If you are interested in some more fish from isolated populations in the Bob Marshall Wilderness, let me know and I'll see what we can collect next summer.

Sincerely yours,

Osborne Casey

OSBORNE CASEY
Fishery Biologist

Enclosure

6200-11 (1/69)

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Flathead National Forest
Kalispell, Montana 59901

2600
March 2, 1972

Dr. Robert Behnke
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Dr. Behnke:

Enclosed is a sample of westslope cutthroat trout from the South Fork of the Flathead River drainage, R. 26 N., R. 13 W., Section 34, Montana Meridian. The fish are for your reference collection of native species of the Rocky Mountain Region.

All fish were collected from a $\frac{1}{4}$ mile section of stream near the head of Dean Creek, Flathead County, Montana, caught by hook and line by Osborne Casey, October 22, 1971. Dean Creek flowed approximately 2.5 cfs at this time. Water temperature 34°F; elevation 5100 feet.

The stream had started to freeze over and about half of it was ice covered. The fish were in schools in every pool. Fifty to sixty fish of all sizes were in each pool. They were prepared to spend the winter in the headwater of Dean Creek. I always thought the cutthroat moved downstream in the fall to winter in deeper pools. Evidently this is not always the case.

I would like to know if these fish are the westslope cutthroat. They do not appear to migrate and may be useful for stocking above impassable barriers.

I also have several color slides of Dean Creek fish if they would be helpful.

An information you can give me about species, etc., would be helpful.

Thank you.

Osborne Casey

OSBORNE CASEY
Fishery Biologist

UNION LABEL 2

STATE OF MONTANA

copy to Hanzel

DEPARTMENT OF FISH AND GAME

Helena, Montana 59601
January 11, 1972

— Recd. photos
— mgt. of Hungry Hrse cutt. stocking ??

Dr. Robert Behnke
Assistant Unit Leader
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Bob:

Things have settled down after the Holiday Season so I'll have a chance to answer the letter you wrote me before Christmas.

You asked what the chances are that our Hungry Horse stock has been contaminated with rainbow trout and hatchery cutthroat. The South Fork Flathead River Drainage above Hungry Horse Dam has long been considered an area that should be managed for indigenous cutthroat and Dolly Varden. However, in the early years of fish culture, people with pack strings were given fish and permitted to plant them anywhere they chose. I have indicated on the enclosed map areas where we have found exotic trout through our lake and stream surveys. Happily, the vast majority of the waters still have only native fishes. The Hungry Horse Creek fish trap is also marked on the map.

I asked Joe Huston, project leader on Hungry Horse Reservoir, how many rainbow, Yellowstone cutthroat, and rainbow x cutthroat hybrids he has taken in his Hungry Horse Creek trap (trapping started in 1963) and in his gill netting in Hungry Horse Reservoir (started in 1960). He advised that in the trap he has caught only one fish definitely identified as a rainbow trout. This was five to six years ago. Also in the trap he has taken about two Yellowstone cutthroat for each 1,000 westslope cutthroat trapped. All the Yellowstone cutthroat taken and the one rainbow were killed but Joe is not sure this had any effect. In extensive gill netting on the reservoir, he has taken about one rainbow and one Yellowstone cutthroat for each 2,000 westslope cutthroat netted. He has had two or three that he suspected were rainbow x cutthroat hybrids. The rainbow, Yellowstone cutthroat and rainbow x cutthroat hybrids he has taken in the reservoir were predominantly near the upper end. When fish were selected for spawn taking for the westslope brood stock at Arlee, great care was taken to select only trout that appeared to be pure westslope cutthroat.

It might be concluded that the Hungry Horse trap was not an ideal source of spawn for our hatchery brood stock. However, as indicated in the cutthroat notes I mailed you earlier, our previous efforts to build a westslope brood stock all ended in failure. Then too, the Hungry Horse fish run from a reservoir into a stream to spawn. We feel this should be ideal for our needs, since most of our plants will be lake plants. Genetically we are confident that the fish from the Hungry Horse trap are as pure a pure-strain westslope cutthroat as it is practical for us to get. I hope your analysis doesn't "shoot us down."

You commented also on the White River stock. Actually we don't intend to do much with these fish except leave them in the lake where they've been planted. The eggs from which they originated were one of those dabs that were picked up and brought into a hatchery. They were taken above Needle Falls on White River and, as indicated on the map, it is speculated that they may be descendents of fish planted here many years ago.

I have asked Delano Hanzel to send you a copy of his thesis. You have probably already received it. I believe there is very little difference between it and the paper that appeared in the Proceedings of the Montana Academy of Sciences. He advised me that the specimens he used are either at Montana State University or with him at Kalispell.

We have a meeting of our Fisheries Division later this month. At that time, we will start lining up collections to be made for you during the coming field season. I will advise the men of the collections you would like to have as set forth in your letter and will keep you informed of the suggestions they have as to specific collection sites.

Sincerely,

George

GEORGE D. HOLTON
CHIEF FISHERIES BIOLOGIST

GDH/pl
Encl.

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

January 12, 1972

Mr. George Holton
Montana Department of Fish and Game
Helena, Montana 59601

Dear George:

All of the Montana specimens have been examined and I'll pass on my opinions and a copy of the taxonomic data.

You should be heartened to learn that the new stock of west slope cutthroat from the Arlee Hatchery look like pure or virtually pure cutthroat trout. The new sample from Silver Creek allows for a more confident decision on this population. I believe that these also essentially are pure cutthroat trout - sufficiently pure at least to warrant special attention to protect them.

I can briefly outline the procedure I use to pass judgement on the relative purity of samples of specimens of cutthroat trout to detect effects of possible influence from rainbow trout or mixing of different cutthroat stocks. Basically, I evaluate the genotype from a critical examination of the phenotype. The data is then compared with values obtained from thousands of specimens from over the natural range of western North American Salmo. In situations such as the Montana west slope cutthroat and Silver Creek (upper Missouri basin), I do not have sufficient data to know what are the typical characteristics and the range of variability in the native trout of the area so all I can authoritatively conclude is that they have no evident rainbow trout influence and that they are not Yellowstone Lake cutthroat (the most widely introduced stock). The enclosed data sheet points out some of the key characters I use to detect rainbow trout and Yellowstone Lake cutthroat trout influence. You may note, as I related to you previously, the west slope cutthroat and the upper Missouri cutthroat (Silver Creek) are closer to each other than they are to Yellowstone Lake cutthroat, which probably shares a closer relationship to the large spotted cutthroat trout of the upper Snake River and the Bonneville basin.

1871
1971

You may also note that your hatchery brood stock derived from Yellowstone Lake is significantly different in the number of scales, gillrakers and pyloric caeca from the McBride Lake stock. Since both were raised at the Big Timber Hatchery (assumed to be under identical environments) these differences are real. The higher number of caeca and the lower number of gillrakers may be the result of rainbow introductions in McBride Lake. However, the high scale counts, low vertebral number and 100% occurrence of basibranchial teeth in 15 specimens argues against rainbow trout influence in the genotype. I suspect that McBride Lake contained an indigenous population of cutthroat trout or that the first introductions were from the Slough Creek drainage and not from Yellowstone Lake. I will send a copy of this letter to Jack Dean at Yellowstone and request that he send me any information he can find on trout in McBride Lake.

I have comprehensive data on the Yellowstone Lake cutthroat genotype under different environments, including hatchery rearing (such as the Big Timber stock) and a population under extreme conditions in a small lake in the Snowy Range, Wyoming, which is probably only ice free for 90 days a year and the trout specimens I have are at least 8-10 years old (and average less than 300 mm). Comparison of data from such samples representing basically a single genotype exposed to different environments allows an evaluation of direct environmental modification of the phenotype. Some characters such as the number of scales, fin rays and branchiostegal rays are quite susceptible to environmental modification. Gillrakers, basibranchial teeth, vertebrae and pyloric caeca typically are much less influenced. There is a difference in the caecal counts between your Yellowstone Lake stock at Big Timber Hatchery and the trout of Yellowstone Lake which suggests some selection may have taken place under 15 years of domestication of this stock. However, note the consistancy in basibranchial teeth and gillraker counts.

You mentioned you may have a problem in protecting the native cutthroat population in Silver Creek because of demands for stocking catchable rainbows from fishermen in the Helena area. I hope you can stimulate awareness of the unique situation you have here and get public support to maintain a purely wild fishery for native cutthroat trout. I believe there is a Trout Unlimited chapter in Helena and I'll send a copy of this letter to T.U. headquarters in Denver, requesting that they alert the Helena, or nearest T.U. chapter, to help you publicize the issued involved: to maintain a unique, natural fishery for the rare native trout of the area or to opt out for an artificial commonplace and expensive catchable fishery. The principles and values involved are analagous to setting the goals for community art museum - if you have a choice would you choose an original Rembrandt or 100 pictures clipped from Life Magazine?

Sincerely yours,

Robert Behnke
Assistant Unit Leader

RB:dch
cc: R.P. VanGytenbeek, Trout Unlimited; Jack Dean, Yellowstone;

MONTANA CUTTHROAT

LOCALITY	VERTEBRAE 59	60	61	62	63	64	65	66	VERTEBRAE range (x̄)	GILLRAKERS 15	16	17	18	19	20	21	22	23	24	GILLRAKERS range (x̄)
West slope (Hungry Horse Res) Arlee hatchery	1	4	5						59-61 (60.4)			3	11	3	3					20 17-20 (18.3)
upper Missouri Silver Crk. Nov. 1971 (225-297mm)	0	2	7	1					60-62 (60.9)			4	5	5						17-19 (18.1)
Silver Crk. 1970-1971 (95-158mm)	1	3	0	1	1				59-63 (60.7)			2	2	3						(18.1)
Yellowstone stock at Big Timbers			5	5	5				(62.0)				1	3	4	6	1			(20.5)
Yellowstone L. (several samples over many years		8	25	32	7				N=72 60-63 (61.5)				1	11	18	17	9	5		N=61 18-23 (20.6)
McBride L. stock at Big Timbers		2	4	3					(61.1)			1	3	6	5					15 17-20 (19.0)
Typical hatchery rainbow trout									61-65 (63)											17-21 (19)

LOCALITY	PYLORIC CAECA N RANGE X̄	SCALES, LAT. SER. AND ABOVE LAT. LINE N RANGE X̄	BRANCHIOSTEGAL RAYS N RANGE X̄	PELVIC FIN RAYS N RANGE X̄	BASIBRANCH TEETH N
West slope (Hungry Horse Res) Arlee hatchery	20 27-59 (40.9)	13 37-41 (38.5); 20 141-175 (158.9)	9-11 (10.4); 9-12 (10.9)	20 all 9	20 3-22 (9.45)
upper Missouri Silver Crk. Nov. 1971 (225-297mm)	14 28-37 (33.0)	14 37-41 (40.0); 14 144-162 (155.1)	14 9-12 (10.6); 10-12 (10.9)	14 8-9 (8.9)	14 2 no teeth 12, 1-10 (3.9)
Silver Crk. 1970-1971 (95-158mm)	8 27-45 (32.8)	3 36-38; 145-168	—	all 9	8 3 no teeth 5, 1-7
Yellowstone stock at Big Timbers	15 30-42 (36.6)	14 37-43 (38.2); 156-175 (164.7)	8-11 (9.3); 8-11 (9.5)	9-10 (9.6)	15 15-30 (21.3)
Yellowstone L. (several samples over many years	40 31-51 (42)	30 36-48 (41); 149-202 (174)	(10.6); (10.7)	9	30 10-46 (22.3)
McBride L. stock at Big Timbers	15 40-49 (45.3)	10 37-43 (38.2); 10 168-205 (184.6)	9-11 (10.0); 9-11 (10.2)	9-10 (9.7)	15 13-33 (18.2)
Typical hatchery rainbow trout	40-70 (50-55)	25-30 (21-28); 120-140 (125-135)	9-12	10	no teeth

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

P. O. Box 184
Yellowstone National Park, Wyoming 82190

January 18, 1972

Dr. Robert J. Behnke
Assistant Unit Leader
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Bob:

This letter is in response to your request for information on McBride Lake cutthroats in your letter to George Holton.

We believe cutthroats were native to Upper Slough Creek, McBride Lake, and Lake Abundance. The earliest reference I'm familiar with is Jordan's survey of 1889. He did not visit the northeast corner of the park but reported the presence of trout in the headwaters of Slough Creek and Lake Abundance. At high water levels trout can move from Slough Creek into McBride Lake over beaver dams on both of the lake's outlets.

Both rainbows and cutthroats were stocked in McBride Lake. Here's our stocking information.

Year	Month	Species	Size	Number	Hatchery
1936	Sept.	Rainbow	Fingerling	9,180	Bozeman
1940	July-Sept.	Cutthroat	Ad. fry	7,500	Lake
1941	July-Sept.	Cutthroat	Fingerling	9,650	Lake

The success of these plants is unknown, Bob. A long cascade, located several miles downstream from McBride Lake on Slough Creek, may act as a velocity barrier which prevents the upstream movement of rainbows into this portion of the watershed. During our creel studies we have not observed any rainbows in the Slough Creek watershed above the cascade. I hope this information is of some value to you.

Your mention of additional studies in the park is encouraging, Bob. We'll be pleased to assist in any way possible.

Sincerely,

Jack

Jack L. Dean
Fishery Management Biologist
Yellowstone Fishery Management
Investigations

Found another referrence to trout in Lake Abundance in the 1881 Sup't's report. They reportedly weighed nearly one lb. each and the lake was overstocked.

Mr. Blackmore with the Hayden expedition in 1882 caught over 100 trout from a little lake (probably Lake Abundance) feeding Slough Creek. They averaged from 12 to 15 inches in length, every one poor and thin.

Slough Creek was stocked with several million cutthroats during the fish cultural era from 1921-1954. We don't know where most of these plants were made, however, many of them could have been planted below the cascades.

Grayling were also stocked in McBride Lake in the 1930's but there is no record of survival.

I believe that gold was discovered near Cooke City, Montana (the closest town to Lake Abundance) in 1870. It's possible the cuts there were natives. Sculpins were also reported from the upper Slough Creek watershed by Jordan so it's possible trout could have assended the cascades also.

U. S. DEPARTMENT OF THE INTERIOR
BUREAU OF SPORT FISHERIES & WILDLIFE

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Jack L. Dean
Fishery Management Biologist
Bureau of Sport Fisheries & Wildlife
P. O. Box 184
Yellowstone National Park, Wyoming ~~83020~~
82190

Dr. Robert J. Behnke
Assistant Unit Leader
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

44

Glen Cole - call Jack Dean
5000 344 7381 ext 248

Yellowstone Park
Wyo., 82190

June

THE UNIVERSITY OF TEXAS AT AUSTIN
AUSTIN, TEXAS 78712

Department of Zoology

* - Contract -

May 12, 1972

- cutthroat → taxonomy ← Reeves
methods ←
→ objectives
origins distrib subsp.
Nat. Parks
contig.

- Teton -

Dr. Robert Behnke
Asst. Unit Leader
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Bob:

Thank you for your information about your material of New Mexico Etheostoma. You are correct in your assumption that this is the darter Koster called the Pecos Darter. We have his material and are in the process in working it up. We, of course, have some new material including incidental life history data that might be useful in insuring its survival.

I am aware that U.S. Fish and Wildlife had been considering initiating programs on endangered fishes; in fact, this was one of the stimuli for activiation of our program. As soon as formal information becomes available, I will, of course, forward it to you.

Sincerely yours,

Clark

Clark Hubbs,
Professor

6425 Police

CH/nf

Green R. cutts

- cutts
Pinedale Wyo
Jack Welch
Wildlf. Spec.
BLM Dist. office

Murphy - call

5 DC

Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

June 7, 1972

Mr. Robert Borovica
Bureau of Land Management
8005 S.W. Westgate
Portland, Oregon 97225

Dear Bob:

I'd like to learn of the BLM's activities on the Alvord basin trout. When we talked on the phone you mentioned a crew was going in and survey the area to devise plans for habitat improvement. Did they learn anything more about trout distribution or have an opportunity to investigate waters other than Willow and Whitehorse creeks?

I've summarized all the data I have on the Alvord trout in preparation for describing a new subspecies. A copy of my data summary is enclosed. It appears as though the Willow Creek and Whitehorse Creek populations are slightly differentiated indicating that there has been no opportunity for continuous gene flow for some time. However, I din't have adequate samples from Willow Creek. The only good sample I have consists of the 20 specimens BLM and Oregon Game Commission biologists sent me last year from Whitehorse Creek. I would also like to obtain a aample from Little Whitehorse Creek. I've examined only a single specimen from here.

There is no obvious evidence that introduced trout have hybridized with the Alvord trout, but about 10% of the Willow Creek specimens lack basibranchial teeth and tend to have slightly fewer gillrakers than the Whitehorse Creek specimens.

To describe a new subspecies I would need larger samples from Willow Creek and Little Whitehorse Creek. I would also like to get samples from the most isolated headwaters of Willow and Whitehorse and from the most downstream areas inhabited by trout to evaluate evidence of possible hybridization. I would also like to be able to make a statement on distribution. With what degree of certainty can we say that this trout ihhabits no other stream outside of the Whitehorse-Willow Creek drainage? On a map I note that the very headwaters of Little Trout Creek on the west slope of the Trout Creek Mountains intertwine with the headwaters of Willow and Little Whitehorse draining the east slope. Might there be trout in Little Trout Creek? I know that the headwaters of main Trout Creek (or Virgin Creek) in Nevada has only rainbow trout and had a mixture of rainbows and Lahontan cutthroat in the 1930's, so I have about dismissed any possibilities for that area.

I plan to be in Oregon in July for the Western AFS meeting in Portland. After the meeting I hope to get together with Dick Wilmot of O.S.U. and investigate the possible occurrence of the "red-banded" trout (the undescribed trout with 58 chromosomes) in the Columbia River basin. After that (about mid-July) I would like to arrange a field trip in the Alvord basin to collect the key areas needed to publish a description of *Salmo clarki alvordensis*. Can you supply me with names and addresses and assist with arrangements for a cooperative survey and collecting trip of 2-3 days in July? I noted that the collection from whitehorse Creek last August was made by Art Oakley and Bob Kindschy of BLM and Bill Hosford of the Oregon Game Commission. Mr. Kindschy of the Vale office had been recommended as a contact and I will have a copy of this letter sent to him.

I hope to see you in Portland and perhaps we can finalize arrangements for specific times and with specific people to complete the systematic aspects of the Alvord trout project.

Sincerely yours,

Robert Behnke
Assistant Unit Leader

RB:dch
cc: Campbell; Kindschy

Department of Zoology

University of Montana
Missoula, Montana 59801
(406) 243-0211

8 June 1972

Dr. Robert Behnke
U. S. Department of Interior
Bureau of Sport Fisheries and Wildlife
Colorado Cooperative Fishery Unit
Fort Collins, Colorado 80521

Dear Dr. Behnke:

Enclosed is a supplement to my application to Trout Unlimited. I have written this in response to the many helpful suggestions you have made in your letters. I was pleased to see that you are prepared to support my application to Trout Unlimited, and to see that you have listed me as a collaborator in your project outline.

I appreciate the assistance you have given me and hope that we will be able to cooperate in the future on problems regarding the cutthroat trout.

Sincerely yours,

Gary Reinitz

Gary Reinitz

5 June 1972

Grant Application to Trout Unlimited -- Supplement

Project Title: Biochemical Taxonomy of Salmo in Western Montana

Introduction

The range of the cutthroat trout extends from Alaska to southern California with several populations found east of the Continental Divide, as well as west of it. Originally cutthroat trout were abundant in the mountain streams of Montana on both sides of the Continental Divide,but this is no longer the case. Presently the distribution of native cutthroat trout is restricted to small relict populations in extreme headwaters, sanctuaries that are resistant to the invasion of rainbow trout. The introduction of the rainbow trout and other changes in the environment brought about by man have caused this reduction in the numbers of the cutthroat in Montana. Not only is the rainbow trout a strong competitor with the cutthroat trout, but it readily hybridizes with it to further endanger the purity of the gene pool in any remaining population of the native fish.

Several agencies are concerned with the preservation of any remaining pure populations of cutthroat, but corrective action cannot be taken until such populations are identified and the systematics of this trout receives adequate attention. There exists a critical shortage of data concerning the distribution of cutthroat populations and their distinguishing characteristics. Studies that have been performed to date using classical techniques have not clarified either of these problems to any great extent. For example, a study of the cutthroat trout from three sub-drainages in western Montana (Zimmerman, 1965), failed to demonstrate that populations from three different sites could be distinguished by means of meristic characteristics.

Recent studies involving starch gel electrophoresis have helped solve problems similar to those that concern the cutthroat trout. Electrophoresis has been used to identify hybrids between Salmon, Salmo solar L., and trout, Salmo trutta L. (Nyman, 1970) where morphological methods have failed. Evidence of subspeciation has been revealed by the use of electrophoresis in the Atlantic salmon (Payne, 1971). Biochemical methods proved successful in distinguishing between the white and longnose suckers (Beamish, 1971) where cytological methods had failed. Countless other studies have also used biochemical techniques to successfully answer questions concerning the taxonomy and systematics of various species (eg. Northcote, 1970; Ridgeway, 1970; Wright, 1970). Haldane (1957) estimated that perhaps 1000 gene substitutions were necessary to give rise to a new species, and although the majority of these are unlikely to be detectable by electrophoretic techniques, some of them might well be. Thus one should be able to distinguish between hybrid fish and pure cutthroat trout, and between discrete populations of that species, once species specific and race specific proteins have been identified.

Although biochemical techniques hold a great potential for studies concerned with specific and subspecific differences, one would be naive to neglect the classical techniques of systematics. By taking into account numbers of scales, fin rays, gillrakers, basibranchial teeth, vertebrae and pyloric coeca in addition to the results of biochemical investigation, a study such as I propose would have a higher potential for success. However, the more direct influence that environmental factors have on physical characteristics must be borne in mind.

Methods

During the summer of '72, I will collect trout from various subdrainages of the upper Columbia (Clark Fork, Bitterroot, Flathead, etc.) under the supervision of Gordon Haugen of the U. S. Forest Service, as well as from the upper Missouri, east of the Continental Divide. Other drainages will also be sampled at a later date. Sampling will be concentrated in the headwaters of these drainages. In this program of sampling, I have been promised the assistance of the U. S. Forest Service and the Bureau of Land Management.

A backpack shocker will be used to collect fish, and once netted, the trout will be bled by heart puncture using a pipette to collect the blood. The blood cells and serum will be separated in the field with a portable centrifuge, and the serum and cells will be stored in separate vials in a coller containing dry ice until their return to the laboratory. The fish will be measured, weighed, and stored frozen for later analysis. The precise location of the collecting sites will also be recorded.

Following this period of collection, electrophoresis will be carried out on the serum samples collected using Hiller vertical starch gel apparatus, under the supervision of Dr. Canham. Transferrins, albumins, and other serum proteins will be analyzed first, followed by the various dehydrogenases, esterases, phosphatases and other serum, cell and organ enzyme systems.

Hopefully the data obtained from the biochemical analyses will complement those compiled from a study of variation in the meristic characters previously mentioned.

Information obtained by myself and by Behnke during the summer of

1972 should make it possible to identify populations of particular interest for sampling during the following summer in order to further clarify the systematic status of the cutthroat trout.

Applications

My proposed research could prove valuable to the state and federal agencies concerned with the perpetuation of the westslope cutthroat trout in that it could provide a means of identifying populations of pure westslope cutthroat. Thus management programs could be instituted to expand the present range of endangered cutthroat populations so they would be less liable to go to extinction in the immediate future. When the results of my study are considered in conjunction with those of Dr. Behnke many of the problems which surround the systematics of the cutthroat trout may be solved. The results obtained may lead to other studies which could further elucidate the ecology, taxonomy, and evolutionary origins of the cutthroat trout, and indicate the most promising ways to preserve this fish where ever it is found.

I truly believe that with the cooperation of the U. S. Forest Service, Montana Fish and Game Department, Dr. Behnke and Dr. Canham, I can achieve the goals that I have set in this proposal. I therefore feel that my research is worthy of funding by Trout Unlimited.

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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Kaniksu National Forest
P.O. Box 490
Sandpoint, Idaho 83864

December 1, 1972
2100

Dr. Robert Behnke
Bureau of Sport Fisheries and Wildlife
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Dr. Behnke:

The enclosed two samples I believe are genetically pure strains of cutthroat trout. They were collected from two streams scheduled for timber harvesting (South Fork Granite Creek) and removal of a culvert barrier (Brett Creek).

I realize you may be swamped with samples; however, I would appreciate it if you could give priority to these samples. These is a 11,000,000 board feet timber sale that has been stopped pending your analysis of the South Fork Granite Creek sample. The Brett Creek sample will be exposed to rainbow trout and cutthroat hybrids after removal of a culvert barrier next spring. We cannot stop removal of the culvert barrier since the bridge is too far along, but we can make provisions to construct another migration barrier if the strain is pure.

Also, can you give me field guides with which to identify pure westslope cutthroat or hybrids.

Again, I would appreciate your earliest consideration of the samples.

Sincerely,

James L. Cooper

JAMES L. COOPER
Zone Fisheries Biologist

Granite Ck.

Butte Ck.

Urgent action

cc to Gordon Haugen — Holten

Lolo Nat. For. — McKirdy

Missoula, Mont.

copy
– Gordon Haugen
– Geo. Holton
BLM

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Kaniksu National Forest
P.O. Box 490
Sandpoint, Idaho 83864

2630
December 19, 1972

Dr. Robert Behnke
US Dept. of Interior, BSFW
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Dr. Behnke:

I have identified the sample streams with green ink on the enclosed two maps. Please ignore the other colors; I had only the one Magee map at present.

As you can see, there are a large number of streams; I believe we will find more candidate streams as we complete stream habitat surveys. However, to date, few of the streams represented on either map have been sampled for their fish species.

Thank you for giving priority to the two samples I sent. Also, I am interested in your comments concerning the disappearance of cutthroat from a stream which was clearcut. If there is a report or documentation of the effects of clearcutting on the stream, I would appreicate receiving a copy or knowing where I could obtain one.

Sincerely,

Jim Cooper

JAMES L. COOPER
Zone Fisheries Biologist

Enclosure:

6200-11 (1/69)

Colorado Cooperative Fishery Unit
Fort Collins, Colorado 80521

April 14, 1972

Mr. R. P. Gytenbeek
Trout Unlimited
4260 East Evans Avenue
Denver, Colorado 80222

Dear Pete:

Enclosed is a rather involved reply to Mr. Reinitz to keep you informed on the status of his proposal to T. U. If Mr. Reinitz and his graduate committee at the university can redesign the proposal so I think it might produce relevant imformation useful for Montana Fish and Game to develop a management program for native trout, I will recommend that T.U. find it. As it now stands, the type of study he proposes has little relevance to actual problems of the status of Montana trout.

I was somewhat jolted to see a newspaper picture story of notable T.U. people hunting "shootable hatchery ducks." But thinking it over, if there are similarities to catchable trout, at least you were paying for your game and not freeloading on other license buyers.

Sincerely,

Robert Behnke
Assistant Unit Leader

RB:js
enclosure

Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

May 23, 1972

Mr. Gary Reinitz
Department of Zoology
University of Montana
Missoula, Montana 59801

Dear Mr. Reinitz:

The situation regarding research on the systematics of westslope and eastslope cutthroat trout is looking brighter and I anticipate some significant progress this year. The National Park Service has agreed to provide some funds to finance some of my work directly, and the U.S. Forest Service will cooperate by hiring students to make collections for me (Mr. McKirdy said that you will be one of the students hired).

Enclosed is a copy of an outline prepared for the Park Service. You will note that I have you listed as anpossible collaborator. I envision that your emphasis will be the biochemical approach and I will handle the orthodox examination and evaluation. It would be an asset to you, however, if you do get experience in the rudiments of standard ichthyological research. If the cooperation I've been promised materializes this year, I should have adequate material to be able to pinpoint precise areas and populations that are likely to contain the greatest information content to be investigated by biochemical techniques. By next year's field season, the information developed and made available to you should allow you to zero-in on key populations to help answer the questions posed in the enclosed outline. To do this, you will need information on protein polymorphism in cutthroat trout and an evaluation of what proteins hold the greatest potential to reveal evolutionary divergences and affinities. At present all we can say is that there must be proteins that are useful for this purpose, but they are unknown - it will be your problem to discover them.

There are many aspects to a systematic survey of groups of a geographically diverse fish. Taxonomy, which consists of diagnosing the differentiating characters and ordering the discrete units into a system of classification, is only a part - but a most important starting point. You may note my mention in the outline of various selective pressures that may have influenced the evolution of different life history characteristics, but may not have produced morphological divergence of the type that deserve taxonomic recognition. It is very important, however, for the management of the species or subspecies to explore other facets of the total biology besides morphological or gene frequency data. I expect that I can handle most of the synthesis of ecological information,' but you should be aware of how evolution operates to diversity and adapt local groups under different selective pressures. The great danger of the biochemical approach by a person without an in-depth understanding of evolutionary biology is that his conclusions may be typological. That is, by believing he has made the taxonomy more quantitative and precise, he then assumes that each taxonomic unit man be neatly characterized with a whole set of parameters representative of every member of that taxon. This just is not so unless you have a taxon like <u>Cyprinodon diabolis</u>, the Devil's Hole pupfish, in which the entire species inhabits one small pool and consists of a few hundred individuals. Despite the inconveniences I have caused you, I hope it has been worthwhile in that you have developed a more comprehensive outlook on the problem you are undertaking and have established a clearer outline of your goals and how they may be accomplished. As you may see in my geographical breakdown of the upper Columbia and upper Missouri basins, it is likely that you will have to include specimens from outside of Montana to get at the problem of the number of diverse groups of native cutthroat trout involved, their affinities and taxonomic status. Because you are planning to skip the M.S. thesis and make the study a Ph.D. work, I think it is feasible to expand your original study area to get at a larger problem. I should have some ideas on this matter next year after the specimens collected this year are examined and evaluated and the information synthesized.

I don't underestimate the potential of biochemical methods to make very significant contributions to a better understanding of trout systematics and taxonomy, but studies to date haven't been very useful or relevant to specific problems. The emphasis has been on microevolution (or population genetics) and not an detecting more major evolutionary divergences between geographically isolated groups. I have a paper on systematics of salmonid fishes of recently glaciated lakes scheduled to be published in issue number 6 of the Jour. Fish. Res. Bd. Canada.

In this paper I cite some specific examples where biochemical techniques are likely to provide the information not available from orthodox studies. I maintain an open attitude and it will be up to you to produce convincing evidence that your techniques can provide useful information to complement my morphological, anatomical and zoogeographical information and arrive at a correct interpretation of the evolution and taxonomy of cutthroat trout of the upper Columbia and upper Missouri river systems. If you honestly believe you can accomplish this, I will urge that Trout Unlimited fund your project.

Sincerely yours,

Robert Behnke
Assistant Unit Leader

RB:dch

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

April 14, 1972

Mr. Gary Reinitz
Department of Zoology
University of Montana
Missoula, Montana 59801

Dear Mr. Reinitz:

For your proposed study of Montana cutthroat trout, I would urge that you give serious consideration to expanding the proposal to encompass a more thorough systematic survey that would more likely provide valuable information on the status and management of the native trout than could be had from a population genetic study revealing the allelic frequencies of one or two proteins of a few populations. You will need to sharpen the focus on your goals and objectives. For example, you wrote that your goal: "is to study isolating mechanisms which might exist within and between populations of westslope cutthroat, rainbow trout and their hybrids". You mentioned you would pattern your study of isolating mechanisms after that of Hagan's on sticklebacks. I would agree that the stickleback work of Hagan (and also McPhail) is an instructive model. However, you assume that there are isolating mechanisms between west-slope cutthroat trout and rainbow trout; I doubt that there are. Based on several years of observation, I would predict that you will not find a single example of a population of native westslope cutthroat coexisting in the same habitat with introduced rainbow trout without hybridizing. If you do know of such a situation it would indeed make a worthwhile graduate research project; but, if I am correct, and you find no sympatric, reproductively isolated populations of cutthroat and rainbow trout - then you have no isolating mechanisms to study and you must change your primary goal. I believe the only isolating mechanism between westslope cutthroat and rainbow trout is physical isolation - if they occur together they will hybridize.

You could make a major contribution if your study resulted in providing significant information on the taxonomic status and distribution and abundance of westslope cutthroat trout. For such a study you would not place complete reliance on protein electrophoresis. I have examined samples of westslope cutthroat from the Arlee hatchery and from Dean Creek (both in Flathead River drainage). They agree very closely and are somewhat distinct from most other interior cutthroat trout, particularly in their spotting pattern and a tendency for slightly fewer vertebrae. This suggests to me that a cutthroat trout, slightly differentiated from those I am familiar with from the Rocky Mountain region, is native to the Flathead River drainage. Are the native cutthroat trout of the Clarks Fork and Kootenay drainages of the Columbia River basin essentially identical to the Flathead drainage cutthroat? How much variability is present between pure populations of these drainages encompassing the range of westslope cutthroat? If the westslope cutthroat does seem to comprise a relatively uniform group, how does it compare with the cutthroat native to the headwaters of the Missouri basin and the South Saskatchewan drainage? Should the currently recognized Salmo clarki lewisi be revised into two or more subspecies? What environmental factors favor the flourishing of native cutthroat trout - what ones are innimical to their perpetuation? A research project designed to help answer the above questions will entail much more than biochemical taxonomy. It will take field work and assistance from interested state and federal agencies and the development of knowledge of systematics, zoogeography and the geologic history of the area. You expressed doubts on the efficacy of standard taxonomic methods for trout classification and for recognizing hybrids. I agree that it will take time and practice to develop a thorough familiarity with the specimens you work with, but once you have adequate experience you can recognize characteristics of different closely related groups much as you could pick out your close friends and relatives in a crowd of other Homo sapiens. Enclosed are copies of some reports and correspondence relating to character analysis of closely related groups of trout and of hybrids. With the information I have now, I believe I would have no trouble in separating westslope cutthroat trout (Flathead R. drainage at least) from rainbow trout, Yellowstone cutthroat trout and any combination of their hybrids. Your reference to Gordon Hartman's thesis and the fact that he fould little difference between rainbow trout and cutthroat trout in scale counts and pyloric caecal counts was due to his choice of parental stock. There is much variability in polytypic species such as S. gairdneri and S. clarki. If the fine scaled Kamloops trout are included in S. gairdneri, then, as Hartman found, S. gairdneri may have more scales than some coarse scaled populations of cutthroat trout. There still were specific diagnostic characters, such as basibranchial teeth, the cutthroat mark and vertebral number that would have served to distinguish the samples of the two species used by Hartman. In Montana, the native cutthroat may be differentiated from the introduced rainbow trout by having 25-50 more scales in the lateral series, 10-15 more scales above the lateral line (it takes some practice to make these counts with any accuracy), 1-3 fewer vertebrae, typically 9 vs. 10 pelvic rays, the presence of basibranchial teeth in cutthroat (alizarin red staining and binocular scope necessary for accurate counts). Also, with some practical field experience you will observe quite distinct differences in spotting, coloration and development of the cutthroat mark between cutthroat trout, rainbow trout, and their hybrids. You wondered why, if these characters really work to distinguish cutthroat from rainbow trout and to recognize hybrids, no one in Montana

Fish and Game and the BLM has used them. The reason is simply that these agencies do not employ anyone knowledgeable in systematics or taxonomy. Besides myself there is only one other person, Dr. R.R. Miller of the Univ. of Michigan, who is actively engaged in the study of the classification of North American trouts. We have the field pretty much to ourselves, but there is so much to be done, I certainly wouldn't try to discourage anyone from joining us.

I do not suggest that you abandon protein taxonomy, but the real opportunity to excel in your field is to develop a sound knowledge and experience in systematic biology and utilize protein taxonomy to answer specific questions posed from detailed systematic studies. I would view this much like using a rifle to hit a clear target instead of shooting a shotgun at the side of a barn in hopes that something interesting turns up. Very few researchers publishing on biochemical taxonomy of fishes, are well grounded in systematic principles, nor do they fully comprehend the subtle differences between systematics (study of evolution) and taxonomy (the art of classification). I attempted to emphasize this point in my 1970 paper in the Transactions of the American Fisheries Society (99:237-248). You must keep in mind how one should evaluate the evolutionary implications of protein information as applied to a system of classification. This is not always critically and wisely done. For example, the paper noted in your letter by Payne, Child and Forrest on Atlantic salmon concluded that the allelic frequency data on transferin demonstrated that North American and European salmon did not interbreed. Knowing anything at all about salmon biology, this is not an astounding conclusion. However, these authors extended their findings to the taxonomy of Atlantic salmon and named two new subspecies. The names are not valid because of their ignorance of the rules of taxonomy, but beyond this, to formally revise the taxonomy of salmon based on information of a single gene locus is complete nonsense.

Dr. James Wright (Penn. St. Univ.) told me that he found differences in allelic frequencies in brook trout sampled from different areas of the same stream. This is an interesting demonstration that the brook trout in this particular stream do not form a freely interbreeding population, but in fact consists of semi discrete units. Evidently, ecological conditions inhibits gene flow in this situation. The fact remains, however, that this information tells us nothing about the taxonomy of Salvelinus fontinalis. Let us suppose that you found different allelic frequencies between samples of Montana cutthroat from an upstream site and a downstream site in the same stream. How would you interpret such results?

Perhaps the best reference to illustrate how protein data can be used to provide vital supplementary evidence for fish taxonomy concerns the sympatric pairs of whitefish (Coregonus clupeaformis) in several North American lakes. Lindsey, Clayton and Franzien. 1970. Zoogeographic problems and protein variation in the Coregonus clupeaformis whitefish species complex. In: Biology of Coregonid Fishes (Lindsey, C.C., and C.S. Woods, ed.) Univ. Manitoba Press, discusses their findings on allelic frequency of three proteins in whitefishes to answer the question concerning the origin of sympatric pairs. Are two ancestral species involved or did each member of a pair evolve independently in each glacial refuge area? This was a situation that could not be adequately handled with orthodox taxonomic study. However, carefully note how the plan of study was developed and carried out so that: specific questions concerning specific populations from specific areas were posed for the biochemical technique to be applied. This is an example illustrating the analogy I mentioned above of using a rifle instead of a shotgun to zero in on the target. It was the systematic and zoogeographic knowledge that made the target clearly definable.

There have been several good papers published in recent years on biochemical studies as applied to the interpretation of evolution, particularly in such journals as American Naturalist, Systematic Zoology and Comp. Biochem. and Physiol. (1971, no. 2, vol. 39B:195-202 has an article by Ronald and Tsuyuki on hemoglobins of cutthroat and rainbow trout). The recent literature should help stimulate new ideas. For example, I have noted that where ecological separation of cutthroat trout and rainbow trout exists in the same river system, the cutthroat populations are always associated with higher elevations (about 10,000+ ft in Colorado) and the rainbows at lower elevations. The most reasonable explanation is that the cutthroat genotype is better adapted to optimally function at lower temperatures. An article by Somero and Hochachka (1969. Nature, 223:194-195). reported that rainbow trout have two sets of LDH enzymes, which function at different temperatures (one adapted for high temperatures, one for low). If cutthroat trout are more finely adapted for colder waters I would suspect that their LDH enzymes would optimally function at lower temperatures than the LDH of rainbow trout - and this should be detected by electrophoretic patterns. This type of "functional" biochemical analysis is an exciting area of study. Plant geneticists have been active in relating protein polymorphism to adaptations for specific ecological niches. Richard Koehn has attempted to interpret his biochemical data on suckers (*Catostomus*) in relation to selective advantages of the allelic condition. I have my doubts about his conclusions but it is interesting. You can read the paper by Smith and Koehn (1971. Systematic Zoology, 20(3):282-297) for a review of his views and as an example of using standard techniques and biochemical data in a numerical taxonomic study of suckers.

You cited Nyman, 1970, Jour. Fish. Res. Bd. Canada, 27:229-236. Evidently, this citation is in error. I could find no paper by Nyman on electrophoretic analysis of salmon and brown trout in the Jour. Fish. Res. Bd. Canada. I would appreciate the correct citation.

Mr. Richard DeLong is the person who has been working on his Ph.D. research on salmonid proteins. DeLong has been using immunoelectrophoresis and double diffusion. He teaches at Graceland College, Lamoni, Iowa, and continues his research during the summer. He was recently here for a visit and I asked him to write to you about his work.

It is apparent that a M.S. thesis can't fully complete the type of systematics project I envision would be necessary to adequately determine the status of all the native trout of Montana. However, I believe you can design a proposed plan of study that would at least set the stage for a more comprehensive study (perhaps a subsequent Ph.D. thesis) and at the same time provide valuable information on the distribution, abundance and status of the indigenous cutthroat trout of Montana.

I have agreed to examine and render an opinion on samples of Montana cutthroat trout (as time allows) sent to me by state and federal agencies. I would also be willing to examine samples used in your study. I think it is evident that if I did not want to encourage you I wouldn't have taken the time to write this letter. However, I do not want to encourage another simple allelic frequency thesis; university library shelves are filling up with too much trivia. To do such a project without the systematic knowledge necessary to interpret and evaluate the results is analagous to encouraging a graduate student in art to duplicate a classical painting by dabbing in colors over numbered zones. For your own educational experience and as a foundation for your future career, I would urge you expand your proposal to develop relevant information on the status (both taxonomic and vulnerability to extinction) of the indigenous cutthroat trout of Montana. George Holton, and personnel of the Forest Service, Park Service and BLM should be most willing to help make the project a success. Key areas must be mapped out where surveys can be made to determine the distribution and abundance of cutthroat trout. Samples taken and analyzed until a semblance of the evolutionary history is apparent. Mr. Delano Hanzel of the Kalispell office of Montana Fish and Game, should be helpful with his field experience and graduate study of Montana cutthroat trout. Then if you find electrophoretic patterns to be a useful tool, all to the good. If not, you still have plenty of material for a valuable thesis.

I talked with Andy Sheldon about the problem of an acceptable proposal that might resolve two conflicting points of view - macroevolution and microevolution. Of prime importance in your case, is to have the goals and objectives of your proposal designed to conform to the goals and objectives of the funding agency - Trout Unlimited. I believe I could phrase a major T.U. goal to be the promotion and perpetuation of native trout populations. In Montana, as far as native cutthroat trout are concerned, the goals of T.U. and Montana Fish and Game are the same. They both desire a management policy that would expand the populations of native trout. The overwhelming obstacle to initiate an intelligent management program for native trout is their confused taxonomic status.

A research project designed to provide information on the systematics of the native trout - their diagnostic characters, degree of variability, within and between major drainage basins, distribution, abundance, and taxonomic status, would be a worthy contribution to the goals of T.U. and Montana Fish and Game. This would essentially be a macroevolutionary study. The cutthroat populations of the headwaters of the various major drainage basins may have been genetically isolated for several thousand years and the Yellowstone group has likely been separated from direct continuity with other Montana cutthroat since before the last glaciation or perhaps 25,000-50,000 years. The type of population genetics study you have proposed to determine allelic frequencies in local populations is not likely to make a contribution toward solving taxonomic problems and providing insight into the evolutionary events of the past 50,000 years.

The ideal situation would be to have one graduate student conducting a standard systematic-zoogeographic project while you would concomitantly emphasize the biochemical aspect but with particular reference to proteins useful for interpreting evolution and genetic differentiation during the past 10,000-50,000 years or more. By a copy of this letter, I will inquire with George Holton about the possibilities of the U.S. Forest Service funding a systematic project of Montana cutthroat trout, designed to complement your proposal. I would request that you discuss the points raised in this letter with your committee and Andy Sheldon and send a revised proposal with objectives that more realistically are aimed at a better understanding of the systematics of Montana cutthroat trout.

Sincerely yours,

Robert Behnke
Assistant Unit Leader

RB:dch

STATE OF MONTANA

DEPARTMENT OF
FISH AND GAME

District One
Kalispell, Montana 59901
January 6, 1972

Dr. Robert Behnke
Asst. Unit Leader
Colorado Cooperative Fisheries Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Dr. Behnke:

George Holton passed the request to send you one of my thesis.

All the fish collected during the survey work (east slope of divide only) are in the Montana State University fish collection. Since graduating I have been working on the west side and have made collections of cutthroat in the upper portions of the Middle and South Forks of the Flathead River in the Bob Marshall Wilderness. These fish are here at the Kalispell headquarters.

Yours truly,

Delano A. Hanzel

Delano A. Hanzel
Special Project Biologist

DAH/ea

Encl.

Department of Zoology

University of Montana
Missoula, Montana 59801
(406) 243-0211

31 March 1972

Dr. Robert Behnke
United States Department of Interior
Bureau of Sport Fisheries and Wildlife
Colorado Cooperative Fishery Unit
Fort Collins, Colorado 80521

Dear Dr. Behnke:

I recently received a copy of your letter to Mr. R. P. Gytenbeek and I appreciated your constructive criticisms. My application was put in laymen's terms to facilitate its understanding by officials of Trout Unlimited, and I am sure that this is the source of many of your questions.

In your letter you asked me to detail my research plans. My goal is to study isolating mechanisms which might exist within and between populations of westslope cutthroat, rainbow trout and their hybrids. My program will be designed in a manner similar to that of Hagen (1967) who studied isolating mechanisms in the threespine sticklebacks (Gasterosteus). The first step in such a program will be the investigation of allelic distributions and frequencies in local rainbow and cutthroat trout populations. This may lead to the detection of "species specific proteins" for the rainbow and cutthroat trout. If so, this information could be used by the Montana Fish and Game Department and the Bureau of Land Management to distinguish between populations of the two species and their hybrids. I would anticipate that there would be a reasonable liklihood of detecting such proteins: Haldane (1957) estimated that perhaps 1000 gene substitutions were necessary to give rise to a new species, and although the majority of these are unlikely to be detectable by electrophoretic techniques, some of them might well be. Electrophoresis has, of course, been used to distinguish between very closely related species of copepods (Manwell et al. 1967) and holothurians (Manwell and Parker, 1963). Even if I cannot demonstrate species specific proteins, my research would still be of value to these two departments. Allelic frequency differences undoubtedly exist between the different populations in a stream. If a headwaters population of cutthroat is isolated which the Fish and Game Department consider to be purebred cutthroat, I will be able to tell them how far downstream the population extends using allelic frequency data collected from samples. This approach is similar to that suggested by Gray and McKenzie (1970).

I fully agree with your point about the necessity of a large sample size and feel that this will not be a problem. Both the Bureau of Land Management and the Fish and Game Department have agreed to assist me in obtaining the large numbers of specimens needed for my research.

I realize the difficulties envolved in my study, but I will be able to use some of the best equipment available: Hiller vertical starch gell apparatus, (3 sets), and a Hewlett-Packard 600V power supply. Also, I will have the advice of Dr. Raymond Canham, who has previously studied biochemical variation and taxonomy in small rodents (Canham, 1972).

For the past two quarters I have been a teaching assistant and I have had little free time for my research. A grant would, of course, relieve me of these duties. However, I did process 26 serum samples from rainbow and cutthroat trout from the hatchery at Arlee, Montana. I have enclosed photographs (Figs. 1, 2, and 3) of gels upon which the serum proteins from these samples were separated and stained. I realize that since hatchery trout were used the results will be atypical of wild populations. I also realize that only a small sample size was involved. I do feel, however, that the results which I obtained suggest that isolating species specific proteins for the two species is a realistic goal. Much of my time has been spent perfecting buffering systems to give the best separations for transferrins and other serum proteins, and although I still have much work left in perfecting buffering systems for various enzymes, this will be facilitated by the experience I have gained to date.

I am confident that a study of the biochemical taxonomy of the westslope cutthroat, rainbow trout, and cutthroat and rainbow hybrids is the best approach to resolving many of the problems surrounding the westslope cutthroat species. You personally have stated many of these problems (Behnke, 1971) and I believe that in many cases their solution may be in a biochemical-taxonomic approach. I do not feel this is an unrealistic belief in view of the success of similar studies on other species of fish (Payne, Child and Forrest, 1971; Wright and Atherton, 1970; Ridgeway, Sherburne and Lewis, 1970; Northcote, Williscroft and Zeuyuki,1970). I feel biochemical methods may sometimes be better for classifying a specimen than cytological methods. I base this statement on the results of a study made by Beamish and Tsuyuki (1971). They found cytological studies inconclusive with respect to genetic differences between various forms of white suckers, while consistent differences were found between George and Lumsden suckers by the electrophoretic separation of serum samples. I also believe that in many cases biochemical taxonomy is preferable to the methods of classical taxonomy. Nyman (1970) found biochemical methods to be consistently superior to morphological methods in detecting natural hybrids between *Salmo salar* L. and *Salmo trutta* L. In the F_1 of a hybrid cross he found only one biochemical character to be similar or identical to one parent, while 36 meristic characters were either similar or identical to one parent. Also in the F_1 he found 17 biochemical characters to be distinctive while only 4 meristic characters could be used used to distinguish between parent and offspring. Needham and Gard (1959) point out that apparently every morphological character they analyzed in rainbow trout could be readily modified by the environment. This complication would seem much less likely to occur when biochemical characters are involved.

Finally, I would like to ask if you would clarify a few points of your letter. I would like to know which standard taxonomic methods of evaluating the genotype have been used successfully to identify the progeny of rainbow and cutthroat hybrids which have been backcrossed one or several times to one of the parental stocks. Am I not correct in assuming that the F_1 of a rainbow and cutthroat cross will possess characteristics intermediate between the parental characteristics

(Hartman, 1956) with the exception of those characters which resemble the female parent type (such as vertebral and ray counts)? If so, I would assume that backcrossing a hybrid would result in an approach of meristic characteristics to those of the parental stock, which would complicate classification by means of standard methods. Also, according to Hartman (1956) most of the meristic characters of purebred rainbow and cutthroat trout do not differ significantly, and thus it would appear unlikely that a statistically significant difference could be demonstrated between hybrid and purebred trout using meristic characters. If suitable meristic characteristics exist, I am surprised the the Bureau of Land Management and Montana Fish and Game Department have not employed them to isolate native cutthroat trout.

I would like to know which methods your student has used in his study of rainbow and cutthroat hybrids and the parental stocks. As I have said, I am currently using vertical starch gel electrophoresis similar to that described by Smithies (1959). This apparatus allows me to process 80 serum samples at one time.

I hope I have clarified some of the points that you mentioned. I am also looking forward to further correspondence with you since I am sure that you can greatly assist me in my research.

Sincerely yours,

Gary Reinitz

Gary Reinitz

Copy to: Dr. Tom Huff
Mr. R. P. Van Gytenbeek

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S. FK.
Coll. Dean Crk. Mont., Flathead R. T26N R.13W S34
Oct. 22, 1971 Mr. Casey U.S.F.S.

Vert.

59	60	61	62
1	2	8	1

60.75

rakers

16	18	19
1	1	8

18.6

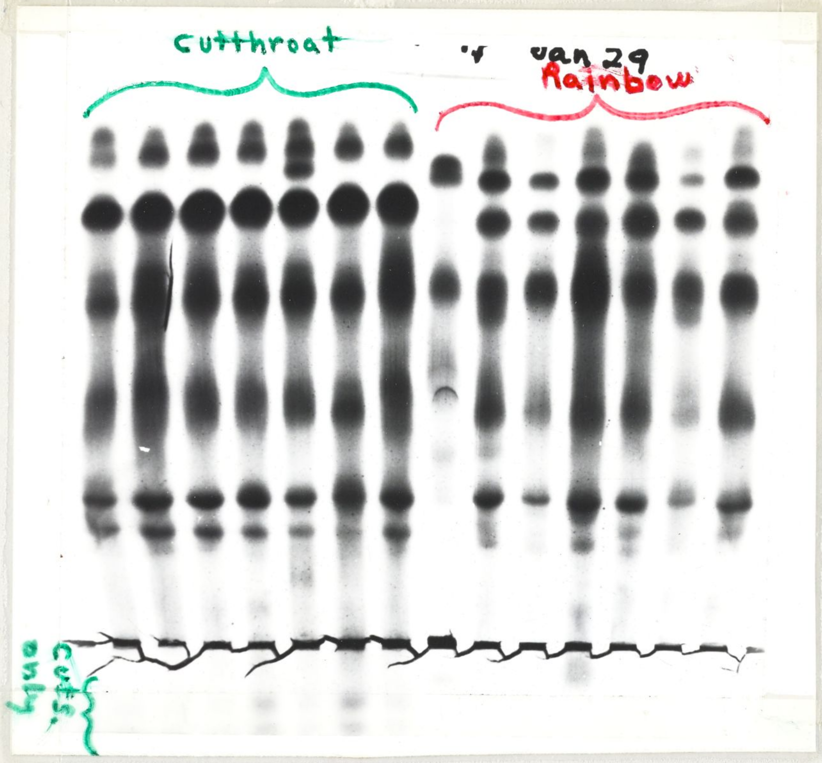
Branch. 10-12 10.6
10-13 11.3

N=10
Scales 40-42 41.0
158-191 172.4
pelvics - all 9
Caeca 29-43 36.0
teeth 10 - 4-17 (9.9) all w/ teeth

- rainbow x cutt
  - life colors (in field) > erratic
  - spotting patter great variability
  - cutt mark
  - basibranchial teeth
  - scales
  - pelvic rays
  - vert.
  - caeca fe

Yellowstone - spotting - rakers - teeth

Fig. 1



7 cutthroat samples and
7 rainbow samples
using Buffer A

Fig. 2

same 14 serum samples using
Buffer B

Fig. 3

same 14 serum samples using Buffer C.

Form 10-226
(April 1966)

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

INVESTIGATOR'S ANNUAL REPORT

(Natural Sciences Research)

This form is to be completed by the researcher and returned to the Superintendent of the Park by JANUARY 1. See reverse for additional instructions.

TO SUPERINTENDENT	PARK Yellowstone National Park	REGION Midwest

1. Project Title

Systematic Investigations of Indigeneous Trouts of National Parks and Contiguous Waters

2. Name(s) of Researcher(s) and Institution(s)

Dr. Robert Behnke, Colorado State University

3. Source(s) and Amount(s) of Funds Other Than NPS, if Any Equipment supplied by Colo. Coop. Fish. Unit.; Manpower and vehicles supplied by Wyoming and Montana departments of fish and game and U.S. Forest Service.

4. Starting Date of Project	5. Percent Completion of Project to Date:	6. Est. Additional Time Required for Completion Beyond January 1st:
July 1, 1972	25	1 Years 6 (?) Months

7. Summary: (a) of progress; (b) of significant findings, if any, to date; (c) recommendations regarding future course, i.e., on basis of work so far, should it proceed as planned, be reoriented, expanded, reduced, time schedule and support level adjusted, etc.;

Significant progress was made in achieving the objectives of determining how many distinctive groups of native trout occur in the Colorado, South Platte, Upper Columbia and upper Missouri river basins of National Parks and contiguous areas. Also more was learned of their distribution, diagnostic characters and present status. A source of pure greenback cutthroat trout, Salmo clarki stomias, is available for further introductions in Rocky Mountain Park and preliminary plans for their re-introduction in a large area of the Park have been discussed with Park biologist, Dave Stevens. Several collections of Colorado River drainage trout were made and analysis of these specimens will attempt to find a source of a pure stock of native Colorado River cutthroat for re-introduction into Park waters of the Colorado River drainage.

A successful field trip in Yellowstone Park and contiguous waters contributed much new information on the distribution of the two forms of cutthroat trout native to the upper Snake River (large spotted and fine spotted cutthroat trout). Apparently only the large spotted form is native to the Snake River drainage above Jackson Lake. The fine spotted form probably does not occur in any waters of Yellowstone Park as has been commonly believed. The downstream distribution of the large spotted form extends to Spread Creek. The next tributary to the South (Gros Ventre) and all other waters below ~~Spring~~ Spread Creek, at least to Palisades Reservoir, have only the fine spotted form. The large spotted cutthroat trout is again encountered in lower Snake River tributaries (Henry's Fork, Idaho; Raft River, Utah; Idaho, and Goose Creek, Idaho, Nevada). The factors that operate to maintain reproductive isolation between two groups of a single species,

(Use Additional Sheets if Necessary)

8. Signature of Investigator	Date
Robert Behnke	

9. RSP Number Y E L L N 7 0

in a continuous environment, are unknown. Below Shoshone Falls of the Snake River, and in other upper Columbia River tributaries (Salmon R., Clarks Fork, Flathead, etc.) another differentiated race of native cutthroat trout occurs. This trout is commonly called the Montana westslope cutthroat trout. Collections were obtained from the upper Missouri drainage for comparison with westslope specimens to determine if the name S. c. lewisi should apply to the native trout of both the upper Missouri and upper Columbia river basins (excluding the Snake River drainage above Shoshone Falls).

Further collections were made from several disjunct localities in the Yellowstone River drainage to test the assumption that the native trout of the Yellowstone drainage were derived from the upper Snake River and not from the upper Missouri, and to determine the degree and rate of evolutionary divergence of the Yellowstone Lake cutthroat trout during approximately 8,000 years under selective pressures for lacustrine adaptation.

The specimens collected will be analyzed this winter and plans will be formulated on areas to be investigated next year that are likely to yield significant information for a revision of the taxonomy of these native trouts, their distribution patterns and present status.

Except for the upper Snake River and the Yellowstone drainage in Yellowstone Park, pure populations of native cutthroat trout are extremely rare in the region. They have been replaced by introduced species and with rainbow x cutthroat hybrids. It is evident that the cutthroat trout of the upper Columbia and upper Missouri basins are extremely vulnerable to the effects of habitat degradation. A stream where cutthroat trout were recorded in a 1967 Montana survey was found to have only introduced eastern brook trout in 1972 after a clear cutting operation increased erosion and raised stream temperatures.

Proposal for a comprehensive study of the systematics of the westslope cutthroat trout: A basic prerequisite for their preservation and management.

INTRODUCTION

Two years of collections of specimens and accumulation of data has prepared the foundation to initiate a graduate student thesis project on the systematics of westslope cutthroat trout, which should provide definitive conclusions on diagnostic characters and the taxonomic position of this fish.

Formerly, the westslope cutthroat was listed as an endangered, but undescribed species in the U.S. Dept. Interior's "red book." Currently (1973), because of its uncertain taxonomic status, it has been assigned an "undetermined" status. There is no doubt, however, that pure populations of the cutthroat trout indigenous to the upper Columbia River system have been eliminated from the bulk of their former range, are rare and in need of special attention to preserve the remaining stocks.

The basic problem obstructing efforts to protect or manage the westslope cutthroat is the taxonomic confusion surrounding this fish. How can a pure population be recognized if it is found when no adequate published description exists? The native cutthroat trout of the upper Columbia River system are a subspecies of *Salmo clarki*, but to what subspecies they should be assigned is not yet known.

The information necessary to answer these questions will be developed from this proposed study.

STUDY PLAN

Collections, including museum material, consisting of more than 50 samples and almost 1000 specimens are now available in the Systematics

Laboratory of the Colorado Cooperative Fishery Unit. These samples are from diverse areas of the upper Columbia, South Saskatchewan and upper Missouri river basins. Several characters, such as the number of vertebrae, scales, gillrakers, pyloric caeca and spotting pattern are recorded, compared and evaluated to reveal consistant modes of similarity providing a definition of the characters possessed by the cutthroat trout native to the upper Columbia River drainage and allow for the recognition of essentially pure populations. Comparisions with samples of cutthroat trout from the upper Missouri River system of Montana will determine if the name Salmo clarki lewisi also applies to the westslope cutthroat. Comparisons of museum specimens from diverse segments of the Columbia basin will determine the original distribution of westslope cutthroat and provide an indication to the possibility that more than one subspecies of cutthroat trout (excepting S. c. clarki) is native to this large drainage.

Supplementary data on protein polymorphism should be available from research on biochemical analysis of westslope cutthroat trout by Mr. Gary Reinitz, a graduate student at the University of Montana. Mr. Reinitz' research, however, will not provide definitive information on the diagnosis of westslope cutthroat trout. This is due to the minute fraction of the total genotype that is surveyed by biochemical techniques and to the fact that almost certainly no qualitative differences between the proteins of westslope cutthroat trout and other cutthroat (and probably rainbow) trout will be found. That is, the genes governing the proteins are not specific to the cutthroat trout native to the upper Columbia River basin, but are shared with other cutthroat and most likely, rainbow trout. The best evaluation of the total genotype, for systematic purposes, is still a critical study of several phenotypic characters.

PROGRESS TO DATE

The determination of the diagnostic characters is largely completed. Consistant similarities of several characters from many samples allows us to place quantitative values on characters expected to be found in pure westslope cutthroat trout populations. From this data, the effects of hybridization with rainbow trout and/or Yellowstone cutthroat trout can be detected. Samples can now be run through the examination process and their relative pureness determined.

A compilation and synthesis of information available from field biologists and from the literature on ecological and life history aspects of westslope cutthroat trout will be made. Bringing diverse bits of information together on the biology of this trout, including such items as habitat preference, migratory tendencies, lacustrine populations, age, growth, food habits, etc., will be a valuable source of data for the management of this trout.

During the past year, Mr. James Roscoe has been assigned to the westslope cutthroat project while he was employed as a work-study student. Mr. Roscoe is now enrolled as a graduate student and plans to complete the project for his graduate research and thesis. Mr. Roscoe is presently supported by work-study funds, supplemented by a modest grant from the National Park Service.

Dr. Richard Wallace, Department of Zoology, University of Idaho has long been interested in the native cutthroat trout of Idaho. Dr. Wallace has made numerous significant collections from key segments of the Columbia River basin and plans to bring his collection to Colorado State University during a sabbatical leave this winter and spring and collaborate in this study. His contribution should insure comprehensive authoratative treatment of a difficult systematic problem.

OUTLINE FOR FIELD STUDIES AND COLLECTIONS OF CUTTHROAT TROUT IN THE YELLOWSTONE - TETON PARK AREA

Robert Behnke
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado

A major segment of a comprehensive systematic study of western trouts concerns the native trout of the headwaters of the Missouri and Snake river basins in the Yellowstone-Teton Park area. This area appears to hold a significant amount of information on the systematics and evolution of cutthroat trout and the taxonomy of *Salmo clarki*. This summer I plan to obtain collections that will contribute toward a better understanding of the systematic problems involved. At present, all of the native cutthroat trout of the upper Columbia and Missouri river basins are considered as a single subspecies, *Salmo clarki lewisi*. I suspect that perhaps several evolutionary divergences are represented under this inclusive category. Previous collections in the Snake River drainage leave no doubt that there are two recognizably distinct forms of cutthroat trout native to the upper Snake River basin; one of these (the fine spotted form) should be described as a new subspecies. My samples and base of information are too meager, however, to make definitive statements on the precise distribution and taxonomic characters of the two forms of cutthroat trout of the upper Snake River basin. The same lack of specimens and information also applies to the upper Missouri basin cutthroat trout.

I would like to obtain collections this year that would adequately pin point the distributional limits of the fine spotted and large spotted forms of cutthroat trout of the upper Snake drainage and to establish their diagnostic taxonomic characters. I also suspect that the fine spotted Snake River cutthroat trout is not a single, homogeneous entity, but consists of local stocks with varying degrees of migratory behavior. Comparisons of samples of populations from various tributaries should support or negate this assumption.

Samples from the Yellowstone drainage below the falls are important for comparison with the upper Missouri and large spotted Snake River cutthroat. I believe the entire Yellowstone drainage received its native trout from the Snake River and not the Missouri--an important consideration if the taxonomy of S. c. lewisi is revised.

Past stocking policies have introduced non-native trouts into virtually every tributary of the region. Most of these trout were Yellowstone Lake cutthroat trout. Fortunately, the Yellowstone Lake cutthroat possesses a set of diagnostic characters that can be recognized, even after many generations in new waters. I believe I can avoid the mistake of considering an introduced Yellowstone population as representing a pure, native stock.

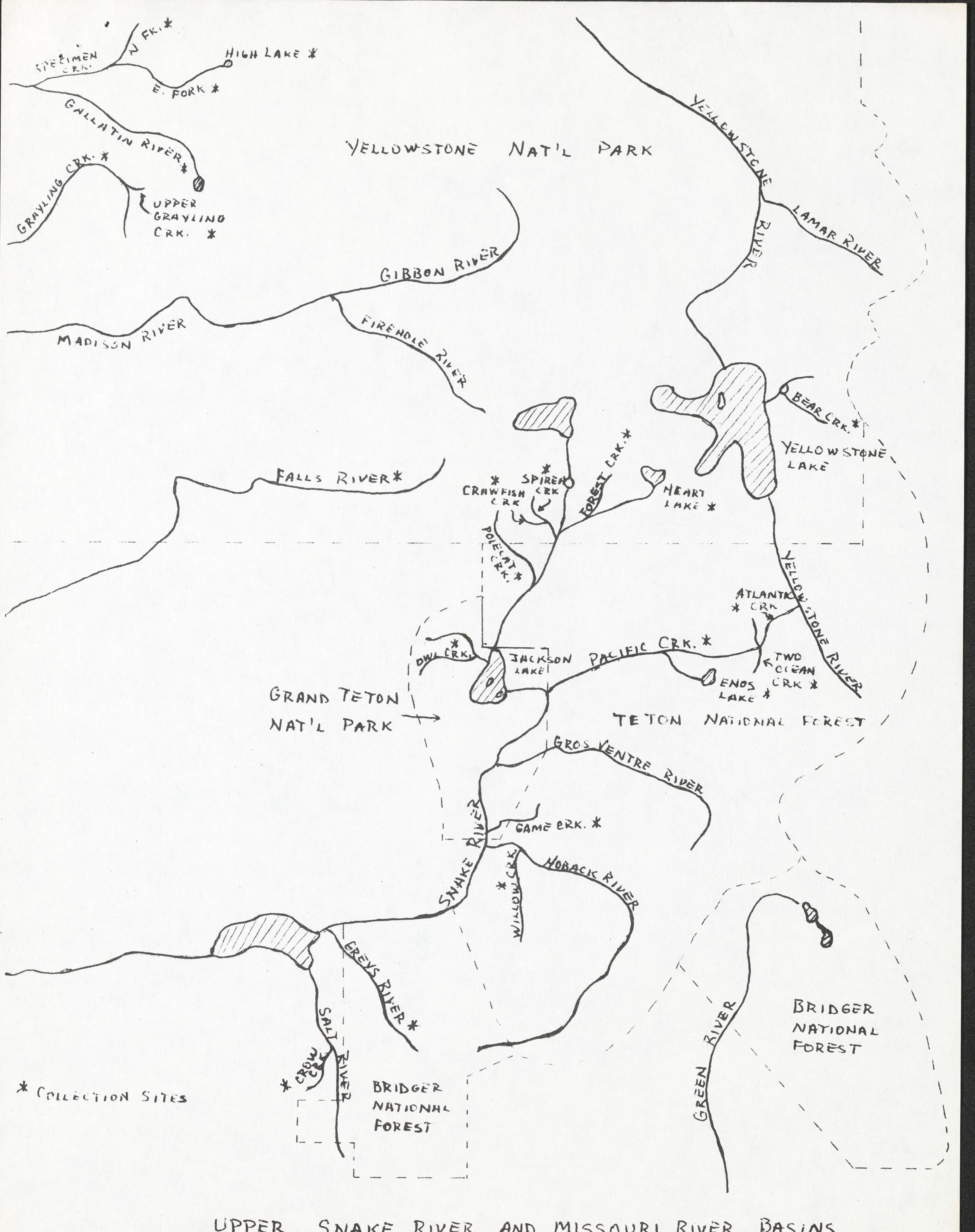
Apparently, the large spotted cutthroat trout was always native to the headwaters of the Snake River above Jackson Lake. Jordan in 1889 and Evermann in 1891, collected trout in the headwater of the Snake (Evermann's route took him down the Lewis and Snake rivers to Jackson Lake and up Pacific Creek over Two Ocean Pass). Both Jordan and Evermann found only the typical large spotted form and made no mention of the distinctive fine spotted cutthroat which, evidently has always been restricted to waters below Jackson Lake. The large spotted form is also found further downstream in the Snake drainage, but the precise distribution of the large spotted and fine spotted cutthroat has never been delineated. Are there any streams where they occur naturally together? What factors allow them to segregate and avoid hybridization? These are questions I hope we can begin to answer this year.

I will need samples (hopefully of at least 10 specimens) from various sites of the Snake drainage above Jackson Lake and samples from below Jackson Lake (I have virtually no material from the Gros Ventre, Hoback and Salt river drainages).

The enclosed map and list of collections I now have, indicates the present status of the study. It can be observed that very few samples consist of 10 or more specimens and that large gaps need to be filled in order to arrive at authoritative conclusions.

COLLECTIONS FROM UPPER SNAKE RIVER AND MISSOURI RIVER DRAINAGES

Site of Collection	No. of Specimens
Snake R. above Jackson Lake	
1. Heart Lake	5
2. Crawfish Crk.	13
3. Spirea Crk.	10
4. Forest Crk.	16
5. Owl Crk.	6
6. Polecat Crk.	16
Snake R. below Jackson Lake	
7. Pacific Crk.	8
8. Game Crk.	12
9. Willow Crk.	6
10. Greys R.	8
11. Crow Crk.	2
12. Falls R. (Henrys Fork)	7
Upper Missouri	
13. Grayling Crk.	7
14. Gallatin R.	8
15. N. Fk. Specimen Crk.	4
16. E. Fk. Specimen Crk.	9
17. High Lake	7



UPPER SNAKE RIVER AND MISSOURI RIVER BASINS


S. Saskatchewan
Kootenay
Flathead
Milk
Marais
Clarks Fk.
Blackfoot
Bitterroot
Clarks Fork
Jefferson
Madison
Gallatin
Yellowstone
Big Horn

5a

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

June 7, 1972

Mr. Frank Dodge
Nevada Fish and Game
P.O. Box 1109
Ely, Nevada 89301

Dear Mr. Dodge:

I plan to be in Nevada this summer gathering material to complete the description and publication of two new subspecies of cutthroat trout - the Mt. Wheeler cutthroat and the Humboldt River drainage cutthroat. I hope we can arrange a specific time to get together and perhaps with the cooperation of Nevada Fish and Game, the BLM and the U.S. Forest Service we can complete the field work for the taxonomic aspects of these fish - getting them officially named and recognized as rare or endangered.

Thanks to your previous collections and information gathering, we're in a good position to finish the work on the Mt. Wheeler cutthroat. I'll briefly summarize the situation and point out what should be accomplished this summer to provide me with sufficient material to publish a description of a new subspecies and to discuss origins and distribution with some degree of authority.

In 1952 Ted Frantz found cutthroat trout in Pine Creek on the west-slope of Mt. Wheeler, draining into Spring Valley, a desiccating basin. Frantz sent specimens to Dr. R.R. Miller. In 1959 I collected a sample from the Pine Creek population. Both Miller and I agreed that the Pine Creek trout, although introduced from the Bonneville basin, are distinct from the Bonneville cutthroat trout recognized as Salmo clarki utah. The most apparent distinctions are in the higher number of gill-rakers and basibranchial teeth, the spotting pattern and the morphology (the distinctive morphology may be due to the conditions of life in Pine Creek, not under genetic control). It appears relatively certain that the Pine Creek population originated from an early introduction from the Trout Creek drainage of the Bonneville basin or the Deep Creek drainage just to the north and west - both of these drainages were once tributary to an arm of Lake Bonneville of what is now the Great Salt Lake Desert. The precise source of the original introduction into Pine

Creek is not known, but as early as 1876 cutthroat trout from Trout Creek, Utah, were transplanted into barren Nevada streams on the west slopes of the mountains forming the border of the Bonneville basin. Two specimens collected in 1938 from Lehman Creek, on the Bonneville side of Mt. Wheeler appear to be identical to the Pine Creek trout and the present population in Hendrys Creek, of the Trout Creek drainage on Mt. Moriah, although hybridized with rainbow trout, still show strong affinities to the Pine Creek trout. Surveys of other streams of the Snake Mountains and the Deep Creek Mountains have failed to uncover any cutthroat populations (with the exception of six unusual specimens from Mill Creek). Johnson Creek, of the Deep Creek drainage on the Goshute Indian Reservation still has a recognizable cutthroat trout influence in the population but this population is in an advanced state of hybridization with rainbow trout and can contribute little information on the characteristics of the original trout. It seems unlikely that pure populations of the western Bonneville cutthroat trout in their native range still exist unless they are in other tributaries to the Great Salt Lake Desert such as the Toana Mountains west of Wendover, the Thousand Springs drainage, north of Wells, Nevada, or in isolated streams of the Grouse Creek Mountains or Raft River Mountains of extreme northwestern Utah. It can be stated with some certainty that a trout identical to the Pine Creek cutthroat once inhabited the Trout Creek drainage of Utah, but we may never know the limits of the original distribution. It is likely that many of the tiny, intermittant, precipitous streams of the Trout Creek drainage were barren of fish in historical times. In a 1953 letter to Dr. Miller, Ted Frantz mentioned than an "old timer" claimed that only Hendrys Creek had cutthroat trout and other streams such as Snake Creek and Lehman Creek were stocked from Hendrys Creek. You wrote, however, that the testimony of the Robinson brothers claimed fishing was good for native trout in Lehman Creek in the 1890's and that Mill Creek received its trout when a canal carrying water from Lehman Creek to the other side of the mountain, broke and spilled into Mill Creek. Frantz also wrote that Hendrys Creek had been stocked in its headwaters with both Yellowstone cutthroat and rainbow trout. Frantz mentioned that Muncy Creek and the North Fork of the Cleve Creek had cutthroat x rainbow hybrids in 1953. Have you ever seen trout from the headwaters of these streams? If you can add anything to the above account, or hear of any possibilities that native trout might persist in any areas north of the Snake-Deep Creek Mountains, I'd appreciate the information.

I would like to get sufficient material to bring my collections up to 20-25 specimens from each locality I would discuss in the publication. This would require additional samples from Pine, Goshute and Hampton creeks to diagnose the characteristics of the new subspecies and evaluate non-genetic influence on essentially the same genotype in three different streams. Mill Creek specimens are abberant in their characters, but I only have 6 specimens and because you feel confident the stream was never stocked, we should obtain a larger sample from Mill Creek. A larger sample from the uppermost headwaters of Hendrys Creek would be desirable because of all known populations in the Trout Creek drainage they appear to most closely represent the native trout - but I have only 7 specimens. Because our collecting would occur after the spawning season, the removal of a relatively few specimens from these small streams will not have any long term effect on the populations - if anything, removal of some adults will stimulate growth and survival of young.

I don't know the precise dates I could be in the Ely area. I am going to the Western Division AFS meeting in Portland, Oregon, in early July. Perhaps a few days could be arranged on my way out. If this doesn't work out, I will be there after I complete collections in Oregon and the Humboldt drainage - probably later in July. Perhaps you could suggest some possible dates that would be agreeable with your schedule.

Sincerely yours,

Robert Behnke
Assistant Unit Leader

RB:dch
cc:

7C

Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

June 29, 1972

Mr. Gary Reinitz
Department of Zoology
University of Montana
Missoula, Montana 59801

Dear Mr. Reinitz:

Enclosed is an abstract of a paper presented by Dr. Fred Utter at a symposium on biochemical genetics of fishes at a meeting of the American Society of Ichthyologists and Herpetologists last week in Boston. Dr. Utter has probably been the most active worker in biochemical genetics of salmonine fishes and I would urge that you write to him concerning your project on trout proteins. Preliminary work by Dr. Utter suggests that peptidase may be a species specific protein between rainbow trout and cutthroat trout. I am sure that Dr. Utter can provide a wealth of information on potentially useful proteins for your study. I would suggest that sometime during the year you should try to arrange a visit for a few days to Dr. Utter's laboratory in Seattle.

The above mentioned symposium which I attended last week would have been most worthwhile for you. The inherent problems of making phylogenetic or taxonomic implications based on protein data was apparent in several of the papers. Examples were cited of two good biological and morphological species that exhibit no differences at 16 loci compared. A polytypic species, Notropis cornutus, exhibited a high degree of protein polymorphism between isolated populations, but no consistent interpretive pattern emerged that would be useful in the taxonomy of the species (you may find a similar situation in Salmo clarki). The buffer system useful for protein analysis of Fundulus heteroclitus does not work for a closely related species, F. majalis. These are just a few of the highlights I picked up at the meeting that have relevance to your project.

Sincerely yours,

Robert J. Behnke
Assistant Unit Leader

RJB:dch
cc/Utter

August 7, 1972

Dr. Carl E. Bond
Department of Fisheries & Wildlife
Oregon State University
Corvallis, OR 97331

Dear Carl:

By letter of July 20 Bob Miller has informed me of the substance of his "very profitable" conversation with you on that date.

After having held you off on the dwarf lamprey for so many years it seems like "adding insult to injury" to burst out so belatedly on the chubs of the Lake Alvord basin. The big job on the "north-central" Great Basin has consumed all the time that Bob and I could squeeze for research in that general direction (that MS is due to go to the printer in September, for a Memoir of the California Academy). As we finally, after three spells of work at Ann Arbor and much between, got in sight of finishing off the big job, we decided that either the Lake Railroad or the Lake Alvord job would come next, and not very long ago definitely got underway on Alvord. In June we made a very definitive start and are scheduling further real work on the problems in the very near future.

It isn't clear from what I recall of our past conversations or from Bob's letter whether or not you have any material of the rather wide-spread Alvord chub that we once gave some thought to the idea of generic separation; but we are now calling it Gila alvordensis. We feel quite sure that the Borax Lake dwarf is a segregate of G. alvordensis. Agreement is good in most respects, but the head profile and proportions are different and the size is much reduced. Not having any clear evidence of overlap or intergradation, and assuming a long isolation in weird Borax Lake, I'm inclined to assign the Borax Lake form full specific status -- but we may end up calling it a subspecies when we have full counts and measurements to compare with those we have finished on part of our alvordensis series. That form we have taken in Trout Creek and about Denio Slough in Oregon and in Nevada in Gridley Spring to the southward and in Italian Camp Spring just off lower Virgin Creek and in Thousand Creek near the confluence with Virgin Creek. If you have any other localities we'd like to hear. This species may well have a few other pockets. We are also anxious to hear from Bob Behnke, as to whether he has any observations or collections of chubs.

Bob relayed your query as to a possible relationship of the Borax Lake fish with Gila copei, and indicated he has sent you a sample of that Bonneville - Upper Snake species. You probably have not seen basic differences, for example the normally 0,5-4,0 rather than 2,4-4,2 dentition, the Rhinichthys-like scales with radii all around, the usual 7-rayed instead of 8-rayed dorsal and anal fins, and, I suppose, the much more numerous rakers. Several characters, including the nuptial-tubercle pattern, lead us to suspect that alvordensis is a spring-inhabiting degenerate of subgenus Siphateles, that first went through lacustrine modification. It certainly wouldn't strain the point to erect a new subgenus for alvordensis and its Borax Lake derivative.

Bob has material of alvordensis for skeletal and karyotype studies, that might change the picture.

When your Borax Lake specimens arrive I'll process the fin-ray, gill-raker, and tooth counts, and the full set of measurements. I will then route them to Ann Arbor for Bob to get scale and pore counts, and radiographs for vertebral counts and skeletal structure. He suggested that we will likely wish to clear and stain a couple. We should both complete our examinations promptly.

Obviously we will not include the trout in our detailed study, though we can hardly avoid mentioning them. I have a few thoughts on them, but no definite data. I did give some study to the trout I took in Whitehorse Creek in 1934 and even stuck the subspecies name of alvordensis on the samples I took in the East Fork of Whitehorse Creek and in Willow Creek. I also took a sample in Trout Creek and Little Trout Creek near their junction, above where I got the first chubs. Local testimony was contradictory re trout in Wildhorse Creek (tributary to ephemeral Alvord Lake).

The foreman of the 22,000-acre Whitehorse Ranch testified that "there is a parting of the waters west of Antelope Cr., that stream and Twelvemile Creek in flood going in Crooked Cr.; those to the west going into Alvord Desert." That certainly isn't what the Adel 1:250,000 map shows. Twelvemile and Antelope creeks are clearly shown crossing the 4100-foot enclosed contour of a separate flat basin, with "Dunes," which is shown as separated by the 4300-foot contour from Alvord Desert. An ephemeral lake is shown in the dune area and it would seem probable that a minor pluvial lake may well have formed here, just east of Lake Alvord. I'd surely like to see that area, and to check a suggestion of a gap in the eastern rim of the Alvord system proper (at ca. lat. 42° 30'). Hence, it may be illogical to call the trout "alvordensis" or the Alvord cutthroat, especially if the types should come from Whitehorse Creek or Willow Creek.

If you happen to be intrigued by the name "Fish Creek" on a stream mapped as entering Whitehorse Creek at the lower end of the indicated flow, note that said foreman indicated that Fish Creek is a dry run, likely named by a cowboy with Western sense of humor.

In 1934 I also took a sample of trout from Virgin Creek and thought they were similar to those from Trout Creek. I did record color notes on the trout and thought that I noticed some introgression from hybridization with rainbows (but not in Virgin Cr.).

Complicated as our problems on chubs may be, those on trout surely are more complicated. In a way I pity the trout taxonomists, beset with problems of exotic stocking and all. My only admonition is for you to repeat the prayer of a much perturbed colored man:

Oh, Lord, come down an' help me,
But don' you sen' your Son.
DIS AIN'T NO JOB FOR A BOY!

Cordially,

Carl L. Hubbs

cc: Robert J. Behnke
Robert Rush Miller

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SCRIPPS INSTITUTION OF OCEANOGRAPHY

POST OFFICE BOX 109
LA JOLLA, CALIFORNIA 92037

August 14, 1972

Dr. Robert J. Behnke
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Co. 80521

Dear Bob:

Bob Miller and I are most happy to have heard, through Carl Bond that you were able to make collections of the Alvord chubs at two localities, namely the reservoir near Hot (Alvord) Lake and at "Red Point".

We are striving hard to get our paper together as rapidly as we can, so we are very hopeful that we may be able to see the specimens that you have collected of the chubs, in the near future. If you have not sent them yet to Michigan, I suggest that you route them through me, so that I can do my stunt on the material. I am doing certain measurements and counts, and Bob is doing others.

I feel quite sure, from my memory of long ago (1934) that the reservoir near Borax Lake has developed since my visit and collecting. I am very anxious indeed to get the lay of the land, and particularly to know the source of the water in the reservoir. I rather suspect that it has been fed from Borax Lake itself, but it will be of importance from the standpoint of the faunal relationships to know just what is what. I hope that you can give rather full details, perhaps ~~for the~~ sketch map. If you took photographs, copies would very likely also be helpful.

Carl Bond sent me two collections from Borax Lake, which he seems to indicate is now called "Hot Lake". These line up with the collections we made in 1934, and up to the present state of our study we feel quite sure that we will recognize the Borax Lake form as either a distinct species or as a subspecies of Gila alvordensis (the name we have been using for the type that exists in several other parts of the basin of pluvial Lake Alvord).

I was thrown for a loop for a time on hearing that you made a second collection at Red Point. I did not remember that name being mentioned, but I finally found on the Adel 1:250,000 Adel Map "Red Point School", which seems to be almost exactly in the position where Bob and I a few years ago made a large collection in Denio Slough. Of course we would also like to have details of the collecting area, perhaps with a xerox copy of your field notes.

I hope that you will be willing to send us your entire collections of the chubs, because there are some very interesting points in the population structure that we will want to analyze and detail. Of course if you wish some of the specimens returned or sent elsewhere than to UMMZ, we will follow your advice and wishes.

Presently it appears that we will treat the Borax Lake chub as a distinct species, but if not, almost certainly as a distinct subspecies. We will keep you informed as the rather extensive material is analyzed.

Although currently we are planning on treating the chubs in detail, along with any evidence on the old hydrographic relations, we will I think feel constrained to make some remarks about the trout so would be very grateful for hearing of your thoughts on the trout of the Lake Alvord basin proper, and of the streams to the eastward that appear not to have actually drained into the Alvord Basin. I do wish that we had a detailed topographic map of the area, ~~so~~ as the Adel sheet seems to indicate, contrary to some local information that was given us in 1934, that flood waters from the streams to the east of Alvord Basin proper lead out into the Snake system. Of course any evidence or thoughts you have along these lines will also be most welcome.

We are still looking forward to a further jaunt into the area before we publish.

Cordially,

Carl L. Hubbs

cc: Dr. Robert Rush Miller

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SCRIPPS INSTITUTION OF OCEANOGRAPHY

POST OFFICE BOX 109
LA JOLLA, CALIFORNIA 92037

August 16, 1972

Dr. Robert J. Behnke
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, CO 80521

Dear Bob:

I was delighted to get your letter of August 9, and am holding up a letter to you I had typed today (the 14th) so that this reply will accompany it. But when I reached your handwritten postscript I was sorely set back. It isn't wholly clear whether you preserved duplicate series, nor from which place the specimens that committed suicide came. Carl Bond wrote, as you will have seen, that you collected in a reservoir near Hot (Borax) Lake and from Red Point.

You mention that the "lake below Borax Lake had no chubs, but they swarm in all the ramifying rivulets between the lakes,"; also that "they appear to be limited to rapidly flowing water at Borax Lake." When I was there in 1934 the only outflow from Borax Lake was through trenches cut through the rim of the lake, apparently to yield some forage. When we crossed what is mapped as Alvord Lake (then usually called Wildhorse Lake), the dust-dry bed exuded so much dust that we seldom could drive more than about 10 feet before vision was completely obliterated because the wind was directly at our back. We had to wait for the dust to clear out or settle, then took another 10 feet forward, to repeat the performance. As I recall we took over an hour to drive a couple of miles! Remember that was the great drought year of 1934. Fancy you making a fish habitat by driving over the area! When we drove up the East Fork of Whitehorse Creek to get the trout collection we accumulated a quarter-inch of alkali dust on the seats of the car, despite driving in the heat with all windows tight closed!

Is what Bond called a reservoir really Alvord Lake, or is there an artificial body in between?

My notes stated that Borax Lake was 7 miles NE of Fields, which would seem to place it at the spring, labeled "Hot" within the NE corner of T. 37 S, R. 35 E on the Adel 1:250,000 quadrangle. Does that jibe with your findings?

Our specimens of the Borax Lake form came in part from the lake margin, but largely from rivulets on the downslope of the natural dam formed by lake deposits at the margin.

Your mention of hearing of large chubs in Borax Lake is intriguing, as all my fish were dwarfs. One small collection sent by Bond had one chub 92.5 mm SL (about twice the length of any other) -- yet it showed virtually to exaggeration the oversized head (especially in the muzzle) and other characters of the Borax Lake endemic. We heard of big ones, and that's why I risked diving into a major inlet cone on the lake bottom (without seeing any fish).

It certainly now seems that the Borax Lake fish is systematically separated -- yet definitely derivable from "Gila alvordensis." We have the stream/spring form from Trout Creek, Pueblo Slough, "Italian Camp Spring" close to the lower course of Virgin Creek, and from Thousand Creek a bit down the Thousand Creek trench not far away, all taken in 1934, and from Gridley Spring on the hill slope above Gridley "Lake" in the generally very dry valley running southward from Continental Lake, and from an artesian-well outflow close to "Red Point School" on the Adel map, and from Denio Slough, taken by us recently. We haven't finished analyzing all these collections, but they looked alike and I believe will be much the same.

Of course the local people believe the chubs live underground and appear wherever a well is sunk. We got led to the artesian well on the insistence that the fish were not there until the well "came in." We did get the chub in the thick Chara beside the artesian outlet, but also, in abundance, in Denio Slough at about the same level nearby -- and we took some in the slough in 1934. Obviously the fish populated the well outlet from the Slough, perhaps at a high-water stage. This experience is coming to be almost regulation!

Study of the topographic maps (Adel and Vya, each 1:250,000; better not yet issued) seems to show that Whitewater and Willow creeks fed in flood, and presumably fed normally in pluvial times, into a separate basin unnamed on the Adel map with apparently a bottom elevation of 4040 feet. The 4300-foot contour seems to intervene between this basin (Whitehorse?) and the rim of the basin of pluvial Lake Alvord. There is, however, a point of possible confusion, near the center of T. 35 S, R. 35 E, which I would like to look over with my 1-ft. Paulin altimeter. I have drawn the margin of Lake Alvord along the 4200-foot contour, as an approximation based on field observations. Hence I seriously doubt that Whitehorse and Willow creeks had any surface connection with Lake Alvord, at least in late Pleistocene time. The contours suggest that in time of great torrential precipitation the depressed-contour area would receive the creeks just mentioned and could have overflowed into the Snake system. I mentioned in the letter to Bond (cc to you) that I was told in 1934 by the foreman of Whitehorse Ranch that there is a parting of the flows, such that Twelvemile and Antelope creeks flowed in flood into the Crooked Creek (Snake) basin, whereas Whitehorse and Willow went in Alvord Desert. Certainly the Adel map must be in excessively gross error, if that be true -- and I have found the new 1:250,000 maps fantastically accurate.

As I have perhaps mentioned, I found with Bob Miller what I thought to be a volcanic barrier that dammed the drainage of Mahogany Creek and Summit Lake, cutting that drainage basin off from Mud Meadow Creek of the Lahontan System, about 10 miles above Soldier Meadows (the unique habitat of Eremichthys acros). An examination of the Vya 1:250,000 sheet plus limited field observation seems to indicate that pluvial Summit Lake never rose as high as the 6,000-ft. contour and very likely never rose high enough to discharge into Virgin Creek. If that is true, and the Virgin Creek trout (which I sampled in 1934) are S. c. henshawi , they may well have stemmed from an early introduction. However, there are 4 gaps in the 6,000-ft. contour between the Summit Lake and Virgin Creek drainages, so only a critical field study, or more detailed topographic maps not yet available, can give a definitive answer.

How trout got into Trout Creek is another problem, assuming that they are not of Lahontan origin. The very name of the creek and local testimony (of 1934) suggest they are native. If their characters have been obfuscated by rainbow blood it may be difficult to interpret the status or origin of the fish. The topographic problem mentioned above indeed needs clarification. The indirect claim of an old resident first stocking Trout Creek is interesting.

I now reread your letter of August 9 to pick up other points.

I found no evidence of chubs in Willow Cr. or Whitehorse Cr. and believe there were none there in 1934. As I believe I mentioned in a letter to Bond my eyes picked up the name Fish Creek (a tributary of lower Whitehorse Cr.), but the local informer insisted Fish Creek is dry and my field notes suggest that cowboy humor was involved. The high distinctness of what we've been calling Gila alvordensis is indicative of prolonged isolation.

It is interesting that you too have heard stories of large chubs in Borax Lake. One collection that Carl Bond sent contains one ripe female 92.5 mm SL and 10 others of usual size, 25-48 mm (collected by Eric Skov Sept. 11, 1957). Carl sent me also 30 specimens 20-48 mm long that he and P. E. Reimers collected Sept. 8, 1967. My collection of July 27, 1934 included only dwarfs (161 specimens 24-39 mm and one 48 mm). Apparently occasional individuals break the bond. The storekeeper at Fields said that some of 7 inches have been seen and some think they are blind (the same old unlikely story that we hear over and over all through the west). It is interesting also that you ran onto the weird idea about fish living underground, thought blind by some, and appearing where wells are sunk. Fish do have a strong tendency to head upstream, and when well water flows out to fish-inhabited water, or when a flash flood connects the well outlet with water having fish, they just head up. Your account of seining hundreds, none over 3 to 3-1/2 inches long, is exciting. Were the 10 or so specimens you put in a jug the ones that committed suicide? Were they the only ones you took at Red Point? I hope not. You must have been close to where Bob and I made a large collection in very thick Chara around the well (maybe the same well?). Your finding of chubs swarming in an excavated pond is interesting (and gratifying), as is the indication of trout cleaning up the chubs in an adjacent pond. All of this is grist to our mill.

We note of course your plan to describe the "Alvord," Humboldt, and Mt. Wheeler cutthroats as a unit. I suggest that you reconsider the names alvordensis and Alvord cutthroat, in view of the seeming probability that they strictly do not pertain to the Alvord system, except for the Trout Creek population, if that be the same.

As to the relation between speed of publication and the preservation of the Alvord chubs: first, your evidence doesn't seem to portend the early endangerment of the two forms; second, we are moving right along and any delay in sight is not envisioned as very many weeks.

Returning to Trout Creek: I just check the detailed map of Oregon in a copy I luckily have of the Rand McNally Atlas of 1881, and find "Trout Creek," leading into a considerable lake in "Alvord Valley," with "Hay Meadows" just to the east; and, farther east, "White Horse Meadows," south of an even larger lake with "Clover Meadows" printed just to the east. Since the material for the 1881 map was likely gathered earlier, we are getting very close to the beginning of any trout mixup. The case for a trout being native in Trout Creek seems very good, but whether that trout and the one I took in 1934 and the one there now are the same can be debated.

You ask if I or Bob want to see your chub samples from Borax Lake and Red Point areas. I believe this is more than answered already -- in fact was when I pleaded for you to get them. Since we are making studies of the sex and size relations as well as characters, we will want to see all available specimens from the area, especially the full series of any collections -- whatever the final disposition of the series will be.

Your tentative reference of a trout in an isolated tributary of the South Fork of the Owyhee is exciting, as is its living at 83° F. I repeat that we will make a few remarks on the trout in our paper on the Lake Alvord basin and its chubs.

We are making final MS changes on our North-Central Great Basin "opus," likely to go to press in about a month. Hence I'd like to have particulars on the "desert dace" (we call them "relict dace," Relictus solitarius) from Steptoe Valley near Ely. Maybe we could add a sentence or two, particularly if you'd loan me the specimens.

We are interested in what you say about the status of the White River fauna, and I'm sure Bob will be interested in the fossil centrarchid from near Whitehorse Ranch. If it had been in the Alvord Basin we would have been even more interested. Bob and his former students are the paleoichthyologists of the West.

Either Bob or I would be very glad to check the unidentified chub from the South Fork of the Owyhee.

We have both seen the evidence on the former outlet of the Fort Rock basin.

This brings me to the "great tragedy" at the end of your letter, the length of which rivals this wandering epistle.

Many thanks.

Cordially,

Carl

Carl L. Hubbs

cc: Robert Rush Miller

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SCRIPPS INSTITUTION OF OCEANOGRAPHY

POST OFFICE BOX 109
LA JOLLA, CALIFORNIA 92037

September 1, 1972

Dr. Robert J. Behnke
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Bob:

Thanks ever so much for your marvellous assistance.

I am in the throes of decision on whether ~~to make~~ the Borax Lake chub (or Borax chub) had better be given subspecific or specific distinction from the more widespread spring-inhabiting form (Gila alvordensis proper). So while in that state I'll just pass by the central problem and rush off, for a hopefully early reply on the problem of the exact location of the Nevada collection, so I can make an entry straight in the "opus." I'll write soon again on the Alvord chubs. We may rush through a diagnosis of them, for David Marshall's use.

The nice little collection of relict dace (Relictus solitarius) from "Steptoe Creek (one mile east of Ely)," so designated in your letter of August 24, is welcome for examination (and return). Your bottle label says "9. Desert Dace - Undescribed Species/Fish pond Springs and Steptoe Crk./Just East of Ely, Nevada, White Pine Co./13 July 1972." I believe that you have repeated one or two of our collections, but to make sure and to map your spot if different let me explain our collections (either 26 or 28 + 29). The locations and other specifics of these two places are cited on pp. 292-294 of our MS (Xerox copies enclosed). Or you may have another spot. You say by letter "one mile east of Ely" but on label give Fish Pond Springs and Steptoe Creek, which, as mapped on the Quadrangles cited lie about 10.5 km SSE of Ely. I can still insert your collection record as I'll be going up to the California Academy in a few days to get in many addenda. So I pray you to make your location clearer, so I can put the addition in proper place and perspective, with a Collection no., likely either 26a or 29a. And if you can give me, from notes or memory, any more ecological or other data of the type we have used, I would be doubly grateful. A prompt reply would be most helpful. Your collection contains 14 specimens 31-75 mm. S.L.

The unidentified chub from the South Fork of Owyhee River, in Malheur County, Oregon, above Three Forks near the Idaho line, which you collected on June 30, 1972, is clearly a half-grown male of Ptychocheilus oregonensis (Richardson), and I have so labelled it for return to you. I have checked the 166-mm. specimen with the literature and with series of specimens in the Scripps Collection from British Columbia. It has the key characters of 2,5--4,2 teeth, fine scales, dorsal rays 10 and anal 8, elongate snout and jaws, etc. It is a pudgy-looking, fat specimen, with much abdominal fat, and does look rather less rakish than squawfish usually are, but after all, some squaws are also plump!

Cordially,

Carl

Carl L. Hubbs

P.S. Thanks also for the BLM map SE-23 of the Alvord Desert area. Before we wind up I'll want to map the ancient vs. modern waters of the Alvord Basin and some surroundings, and would find other sheets in the same series highly useful. Tell me to whom I might apply for copies (whether gratis or not).

population over a period of more than a quarter century.

Collection 24 (figs. 8, 14).--Grass Springs, on Lusetti Ranch, 0.4 km. north of ranch house, on western side of valley about 27 km. north of Ely, draining into a slough in the flood drainage of Duck Creek; in Sec. 20, T. 19 N., R. 63 E.; White Pine County. J. E. Deacon and party, June 27, 1962 (JED 62-27, in part); UNLV /169 (155, 21-63 mm.).

Collection 24 was from one of ~~3~~ three separate springs inhabited by this ~~chub~~ dace. A fourth, larger spring supported only Sacramento perch (Archoplites interruptus), but, according to Ellen Vallee, the owner's daughter, it also formerly held minnows.

Collection 25 (figs. 8, 14).--Upper spring ditch on Dairy Ranch, just below McGill (below reservoir used as swimming pool), in Sec. 20, T. 18 N., R. 64 E.; White Pine County. Moderately clear water (bottom visibility more than 1.0 m.); gravel and mud, mostly rather firm; uniformly moderate current; rather thick bottom growth of Potamogeton cf. pectinatus and considerable floating algae on sides; 25° C. (air 32°). Hubbs family, August 23, 1938 (M38-160); UMMZ 124956-57 (367, 13-81 mm.); 15-foot seine with 1/4-inch square mesh.

Goldfish originally very brightly and variably colored according to local testimony, but since planting almost totally reverted to wild type, were common here. John Yelland informed us that goldfish (Carassius auratus) had been present for many years, along with minnows, in a deep hole on the Dairy Ranch.

Collection 26 (figs. 8, 14).--Several small springs and a little creek on Georgetown Ranch, in meadow just north of railroad yards of East Ely; tributary to Murray (sometimes corrupted to "Murry") Creek (open sewer of Ely, used for irrigation on ranch); in Sec. 2, T. 16 N., R. 63 E.; White Pine County. Clear water; spongy bottom; minute pools and riffles; generally choked with Nasturtium and Potamogeton cf pectinatus; water cool. Hubbs family and Earl Mangum (local game warden), August 22, 1938 (M38-158); UMMZ 124954 (403, 15-81 mm.); 6-foot woven-mesh seine. The largest spring, on south side of railroad tracks, was reported to have harbored many of the minnows before it was cleaned out and cemented in.

Collection 27 (figs. 8, 14).--Ruth Pond, just west of Ruth, in T. 16 N. (near middle of north border), R. 62 E. Collected about 1964 by Dale V. Lockard, of Nevada Fish and Game Department, Wheeler District, Ely (6 specimens, not measured, received from him March 29, 1965, and returned). Probably the dace had been introduced here, well above the usual valley-bottom habitats.

Supplementary Collections near Ely.--After the text and maps of this report had been readied for the press, two additional collections of the relict dace have just come to our attention. These were collected by Donald R. Cain of the Ely District Office of the U. S. Bureau of Land Management and Frank N. Dodge of the Nevada Department of Fish and Game. The specimens were submitted to Miller for identification. The specimens have been sent to Japan, through Dr. Teruo Uyeno. The first collection, of 10 specimens, of both sexes, 43-55 mm. long, was taken in Steptoe Creek 1 mile (1.6 km) south of Ely, on May 24, 1971. The second collection, of 10 specimens, of both sexes, 36-73 mm. long, was collected at Fish Pond Spring, on C-B. Ranch, at the same spot as Collections 28 and 29, described below. Mr. Cain raised the question of the possible need for providing a sanctuary under Federal ownership for the protection of the fish at the C-B Ranch, in view of the danger to the fish imposed by irrigation practices and the removal of the aquatic vegetation. Miller had already discussed the question with

James M. Vaughn at C-B Ranch in 1969. A sanctuary here for Relictus would indeed be a propitious prospect for the perpetuation of this unique endemic fish.

Collection 28 (figs. 8, 14).--Springs on "3C" or "CCC" (Consolidated Copper Company) Ranch about 1.6 km. north of ranch house, at base of truncated cones close to Steptoe Creek, about 10.5 km. south-southeast of Ely, near Sec. line 5-8, T. 15 N., R. 64 E.; White Pine County. Very clear water, of good taste; firm gravel to extremely soft organic mud; slight to moderately swift, occasionally swift, current; generally choked with vegetation (Nasturtium, Chara, and Potamogeton cf pectinatus); 9° C. (air 27°). Hubbs family, August 23, 1938 (M38-159); UMMZ 124955 (209, 17-89 mm.); 6-foot woven-mesh seine.

Collection 29 (figs. 8, 14).--In same springs sampled by Collection 28; shown as Fish Pond Springs on Ely 15-minute and Comins Lake 7.5-minute quadrangles; ranch now named C-B Ranch. Very clear water, but easily muddied; gravel, sand, and deep mud; slight current; dense Chara, Nasturtium, and Potamogeton cf pectinatus; 15° C. (air 27°). Miller family, August 17, 1969 (M69-15); UMMZ 188959 (286, 20-79 mm., plus 3 skeletonized, 70-82 mm.; plus some kept alive for chromosome study); 12-foot woven-mesh nylon seine. Clearly the relict dace had maintained abundance here. A more recent Collection at the same place is mentioned above.

Additional Evidence on the Presence of Absence of Relictus at Several Localities in Steptoe Valley Not Represented by Collections.

UNIVERSITY OF CALIFORNIA, SAN DIEGO

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SCRIPPS INSTITUTION OF OCEANOGRAPHY
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LA JOLLA, CALIFORNIA 92037

September 14, 1972

Dr. Robert J. Behnke
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Co. 80521

Dear Bob:

Thanks for your explanatory letter of September 11. It is good to hear of the status of the dace in the different areas. You did just about what I figured you probably had done, as we have combed the whole valley pretty thoroughly. Where we collected nearest to El~~e~~y is in springs just north of the railroad switch yards on the north edge of East Eley, but I assume that this is not where you were. The El~~e~~y 7.5 minute~~s~~ quadrangle shows some ponds about one mile east of East El~~e~~y, which is about one half the way to the course of Steptoe Creek.

On Monday the 11th, I telephoned to a student at the University of Nevada, Reno, named Thomas P. Lugaski, because ~~he~~ we heard that he had in press the description of a Rhinichthys that we were fearful would be one that we had in our big manuscript. It turned out to be from Big Smok~~e~~y Valley, however, from a spring that I worked in 1934, and the form is a rather dubious subspecies whereas he named it as a species for La Rivers, under the name of Rhinichthys lariviersi. But then I asked about other things and he popped right out in saying that he had in press the dace from Steptoe Valley. This was like a six ton blow on the head. I rather hinted that we would like to have him hold up the publication, but he said that on Friday previous to the call on Monday the press was actually running his paper, and it would be distributed probably on September 15 or 16. And he figured it would be impossible to get in touch with the press, although he seemed to be cooperative and willing, quite unlike La Rivers himself. He did give me the name that he is publishing, which instead of the sweet name Relictus solitarius is Cyphogrypus antius. So we've got another hugh job in revising our big manuscript, which we have planned to do in San Francisco beginning October 5. Tom has several other papers in press, but I rather think none others that are going to immediately mess things up for our Memoir, though the poor lad, was seemingly pleasant and cooperative, has obviously been struggling without any sound leadership. I do hope that neither he nor anyone else will jump into the Alvord country.

Cordially,

Carl L. Hubbs

cc: Dr. Robert Rush Miller

University of Montana
Missoula, Montana 59801
(406) 243-0211

26 December, 1972

Dr. Robert Behnke
Colorado Cooperative Fishery Unit
Colarado State University
Fort Collins, Colorado 80521

Dear Dr. Behnke:

My student, Gary Reintz, recently received a duplicated letter from William A. Luch, Chairman of the Research and Projects Committee of Trout Unlimited. The letter stated that the committee was about to re-evaluate the projects they had considered for funding, before a final decision was made. A summary of the Committee's initial evaluation was included in the letter. It appears that seven projects have been considered, one of them being that submitted by Mr. Reintz. The Committee's comments on his request were as follows:

"Mr. Gary Reintz's request for a biochemical taxonomy study on cutthroat trout sounds like a good study to be tried, but the Committee felt that Mr. Robert Behnke of the U.S. Fish and Wildlife Service, was conclusive in giving this a very low priority in his point of view, and would want a wider response on the efficacy of this proposal before recommending any type of funding."

This summary of your evaluation of the project came as a surprise to Mr. Reintz and myself, in view of your listing Gary as a collaborator in the outline of your own project proposed for the Park Service, and of your statement (May 23, 1972) that you would urge Trout Unlimited to fund his project. In the event that the summary from Trout Unlimited is based upon your earlier views, rather than those expressed in May, I would request that you so inform Mr. Luch, of the Portland Headquarters of Trout Unlimited so that Gary's project has some chance of being funded.

Yours sincerely,

Raymond P. Canham

Raymond P. Canham
Assistant Professor
Zoology Department

RPC:lp

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

May 23, 1972

Mr. Gary Reinitz
Department of Zoology
University of Montana
Missoula, Montana 59801

Dear Mr. Reinitz:

The situation regarding research on the systematics of westslope and eastslope cutthroat trout is looking brighter and I anticipate some significant progress this year. The National Park Service has agreed to provide some funds to finance some of my work directly, and the U.S. Forest Service will cooperate by hiring students to make collections for me (Mr. McKirdy said that you will be one of the students hired).

Enclosed is a copy of an outline prepared for the Park Service. You will note that I have you listed as a possible collaborator. I envision that your emphasis will be the biochemical approach and I will handle the orthodox examination and evaluation. It would be an asset to you, however, if you do get experience in the rudiments of standard ichthyological research. If the cooperation I've been promised materializes this year, I should have adequate material to be able to pinpoint precise areas and populations that are likely to contain the greatest information content to be investigated by biochemical techniques. By next year's field season, the information developed and made available to you should allow you to zero-in on key populations to help answer the questions posed in the enclosed outline. To do this, you will need information on protein polymorphism in cutthroat trout and an evaluation of what proteins hold the greatest potential to reveal evolutionary divergences and affinities. At present all we can say is that there must be proteins that are useful for this purpose, but they are unknown - it will be your problem to discover them.

There are many aspects to a systematic survey of groups of a geographically diverse fish. Taxonomy, which consists of diagnosing the differentiating characters and ordering the discrete units into a system of classification, is only a part - but a most important starting point. You may note my mention in the outline of various selective pressures that may have influenced the evolution of different life history characteristics, but may not have produced morphological divergence of the type that deserve taxonomic recognition. It is very important, however, for the management of the species or subspecies to explore other facets of the total biology besides morphological or gene frequency data. I expect that I can handle most of the synthesis of ecological information, but you should be aware of how evolution operates to diversify and adapt local groups under different selective pressures. The great danger of the biochemical approach by a person without an in-depth understanding of evolutionary biology is that his conclusions may be typological. That is, by believing he has made the taxonomy more quantitative and precise, he then assumes that each taxonomic unit can be neatly characterized with a whole set of parameters representative of every member of that taxon. This just is not so unless you have a taxon like *Cyprinodon diabolis*, the Devil's Hole pupfish, in which the entire species inhabits one small pool and consists of a few hundred individuals. Despite the inconveniences I have caused you, I hope it has been worthwhile in that you have developed a more comprehensive outlook on the problem you are undertaking and have established a clearer outline of your goals and how they may be accomplished. As you may see in my geographical breakdown of the upper Columbia and upper Missouri basins, it is likely that you will have to include specimens from outside of Montana to get at the problem of the number of diverse groups of native cutthroat trout involved, their affinities and taxonomic status. Because you are planning to skip the M.S. thesis and make the study a Ph.D. work, I think it is feasible to expand your original study area to get at a larger problem. I should have some ideas on this matter next year after the specimens collected this year are examined and evaluated and the information synthesized.

I don't underestimate the potential of biochemical methods to make very significant contributions to a better understanding of trout systematics and taxonomy, but studies to date haven't been very useful or relevant to specific problems. The emphasis has been on microevolution (or population genetics) and not ~~an~~ for detecting more major evolutionary divergences between geographically isolated groups. I have a paper on systematics of salmonid fishes of recently glaciated lakes scheduled to be published in issue number 6 of the Jour. Fish. Res. Bd. Canada.

In this paper I cite some specific examples where biochemical techniques are likely to provide the information not available from orthodox studies. I maintain an open attitude and it will be up to you to produce convincing evidence that your techniques can provide useful information to complement my morphological, anatomical and zoogeographical information and arrive at a correct interpretation of the evolution and taxonomy of cutthroat trout of the upper Columbia and upper Missouri river systems. If you honestly believe you can accomplish this, I will urge that Trout Unlimited fund your project.

Sincerely yours,

Robert Behnke
Assistant Unit Leader

RB:dch

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

April 14, 1972

Mr. Gary Reinitz
Department of Zoology
University of Montana
Missoula, Montana 59801

Dear Mr. Reinitz:

For your proposed study of Montana cutthroat trout, I would urge that you give serious consideration to expanding the proposal to encompass a more thorough systematic survey that would more likely provide valuable information on the status and management of the native trout than could be had from a population genetic study revealing the allelic frequencies of one or two proteins of a few populations. You will need to sharpen the focus on your goals and objectives. For example, you wrote that your goal: "is to study isolating mechanisms which might exist within and between populations of westslope cutthroat, rainbow trout and their hybrids". You mentioned you would pattern your study of isolating mechanisms after that of Hagan's on sticklebacks. I would agree that the stickleback work of Hagan (and also McPhail) is an instructive model. However, you assume that there are isolating mechanisms between westslope cutthroat trout and rainbow trout; I doubt that there are. Based on several years of observation, I would predict that you will not find a single example of a population of native westslope cutthroat coexisting in the same habitat with introduced rainbow trout without hybridizing. If you do know of such a situation it would indeed make a worthwhile graduate research project; but, if I am correct, and you find no sympatric, reproductively isolated populations of cutthroat and rainbow trout - then you have no isolating mechanisms to study and you must change your primary goal. I believe the only isolating mechanism between westslope cutthroat and rainbow trout is physical isolation - if they occur together they will hybridize.

You could make a major contribution if your study resulted in providing significant information on the taxonomic status and distribution and abundance of westslope cutthroat trout. For such a study you would not place complete reliance on protein electrophoresis. I have examined samples of westslope cutthroat from the Arlee hatchery and from Dean Creek (both in Flathead River drainage). They agree very closely and are somewhat distinct from most other interior cutthroat trout, particularly in their spotting pattern and a tendency for slightly fewer vertebrae. This suggests to me that a cutthroat trout, slightly differentiated from those I am familiar with from the Rocky Mountain region, is native to the Flathead River drainage. Are the native cutthroat trout of the Clarks Fork and Kootenay drainages of the Columbia River basin essentially identical to the Flathead drainage cutthroat? How much variability is present between pure populations of these drainages encompassing the range of westslope cutthroat? If the westslope cutthroat does seem to comprise a relatively uniform group, how does it compare with the cutthroat native to the headwaters of the Missouri basin and the South Saskatchewan drainage? Should the currently recognized Salmo clarki lewisi be revised into two or more subspecies? What environmental factors favor the flourishing of native cutthroat trout - what ones are innimical to their perpetuation? A research project designed to help answer the above questions will entail much more than biochemical taxonomy. It will take field work and assistance from interested state and federal agencies and the development of knowledge of systematics, zoogeography and the geologic history of the area. You expressed doubts on the efficacy of standard taxonomic methods for trout classification and for recognizing hybrids. I agree that it will take time and practice to develop a thorough familiarity with the specimens you work with, but once you have adequate experience you can recognize characteristics of different closely related groups much as you could pick out your close friends and relatives in a crowd of other Homo sapiens. Enclosed are copies of some reports and correspondence relating to character analysis of closely related groups of trout and of hybrids. With the information I have now, I believe I would have no trouble in separating westslope cutthroat trout (Flathead R. drainage at least) from rainbow trout, Yellowstone cutthroat trout and any combination of their hybrids. Your reference to Gordon Hartman's thesis and the fact that he fould little difference between rainbow trout and cutthroat trout in scale counts and pyloric caecal counts was due to his choice of parental stock. There is much variability in polytypic species such as S. gairdneri and S. clarki. If the fine scaled Kamloops trout are included in S. gairdneri, then, as Hartman found, S. gairdneri may have more scales than some coarse scaled populations of cutthroat trout. There still were specific diagnostic characters, such as basibranchial teeth, the cutthroat mark and vertebral number that would have served to distinguish the samples of the two species used by Hartman. In Montana, the native cutthroat may be differentiated from the introduced rainbow trout by having 25-50 more scales in the lateral series, 10-15 more scales above the lateral line (it takes some practice to make these counts with any accuracy), 1-3 fewer vertebrae, typically 9 vs. 10 pelvic rays, the presence of basibranchial teeth in cutthroat (alizarin red staining and binocular scope necessary for accurate counts). Also, with some practical field experience you will observe quite distinct differences in spotting, coloration and development of the cutthroat mark between cutthroat trout, rainbow trout, and their hybrids. You wondered why, if these characters really work to distinguish cutthroat from rainbow trout and to recognize hybrids, no one in Montana

Fish and Game and the BLM has used them. The reason is simply that these agencies do not employ anyone knowledgeable in systematics or taxonomy. Besides myself there is only one other person, Dr. R.R. Miller of the Univ. of Michigan, who is actively engaged in the study of the classification of North American trouts. We have the field pretty much to ourselves, but there is so much to be done, I certainly wouldn't try to discourage anyone from joining us.

I do not suggest that you abandon protein taxonomy, but the real opportunity to excel in your field is to develop a sound knowledge and experience in systematic biology and utilize protein taxonomy to answer specific questions posed from detailed systematic studies. I would view this much like using a rifle to hit a clear target instead of shooting a shotgun at the side of a barn in hopes that something interesting turns up. Very few researchers publishing on biochemical taxonomy of fishes, are well grounded in systematic principles, nor do they fully comprehend the subtle differences between systematics (study of evolution) and taxonomy (the art of classification). I attempted to emphasize this point in my 1970 paper in the Transactions of the American Fisheries Society (99:237-248). You must keep in mind how one should evaluate the evolutionary implications of protein information as applied to a system of classification. This is not always critically and wisely done. For example, the paper noted in your letter by Payne, Child and Forrest on Atlantic salmon concluded that the allelic frequency data on transferin demonstrated that North American and European salmon did not interbreed. Knowing anything at all about salmon biology, this is not an astounding conclusion. However, these authors extended their findings to the taxonomy of Atlantic salmon and named two new subspecies. The names are not valid because of their ignorance of the rules of taxonomy, but beyond this, to formally revise the taxonomy of salmon based on information of a single gene locus is complete nonsense.

Dr. James Wright (Penn. St. Univ.) told me that he found differences in allelic frequencies in brook trout sampled from different areas of the same stream. This is an interesting demonstration that the brook trout in this particular stream do not form a freely interbreeding population, but in fact consists of semi discrete units. Evidently, ecological conditions inhibits gene flow in this situation. The fact remains, however, that this information tells us nothing about the taxonomy of Salvelinus fontinalis. Let us suppose that you found different allelic frequencies between samples of Montana cutthroat from an upstream site and a downstream site in the same stream. How would you interpret such results?

Perhaps the best reference to illustrate how protein data can be used to provide vital supplementary evidence for fish taxonomy concerns the sympatric pairs of whitefish (Coregonus clupeaformis) in several North American lakes. Lindsey, Clayton and Franzien. 1970. Zoogeographic problems and protein variation in the Coregonus clupeaformis whitefish species complex. In: Biology of Coregonid Fishes (Lindsey, C.C., and C.S. Woods, ed.) Univ. Manitoba Press, discusses their findings on allelic frequency of three proteins in whitefishes to answer the question concerning the origin of sympatric pairs. Are two ancestral species involved or did each member of a pair evolve independently in each glacial refuge area? This was a situation that could not be adequately handled with orthodox taxonomic study. However, carefully note how the plan of study was developed and carried out so that: specific questions concerning specific populations from specific areas were posed for the biochemical technique to be applied. This is an example illustrating the analogy I mentioned above of using a rifle instead of a shotgun to zero in on the target. It was the systematic and zoogeographic knowledge that made the target clearly definable.

There have been several good papers published in recent years on biochemical studies as applied to the interpretation of evolution, particularly in such journals as American Naturalist, Systematic Zoology and Comp. Biochem. and Physiol. (1971, no. 2, vol. 39B:195-202 has an article by Ronald and Tsuyuki on hemoglobins of cutthroat and rainbow trout). The recent literature should help stimulate new ideas. For example, I have noted that where ecological separation of cutthroat trout and rainbow trout exists in the same river system, the cutthroat populations are always associated with higher elevations (about 10,000+ ft in Colorado) and the rainbows at lower elevations. The most reasonable explanation is that the cutthroat genotype is better adapted to optimally function at lower temperatures. An article by Somero and Hochachka (1969. Nature, 223:194-195). reported that rainbow trout have two sets of LDH enzymes, which function at different temperatures (one adapted for high temperatures, one for low). If cutthroat trout are more finely adapted for colder waters I would suspect that their LDH enzymes would <u>optimally</u> function at lower temperatures than the LDH of rainbow trout - and this should be detected by electrophoretic patterns. This type of "functional" biochemical analysis is an exciting area of study. Plant geneticists have been active in relating protein polymorphism to adaptations for specific ecological niches. Richard Koehn has attempted to interpret his biochemical data on suckers (<u>Catostomus</u>) in relation to selective advantages of the allelic condition. I have my doubts about his conclusions but it is interesting. You can read the paper by Smith and Koehn (1971. Systematic Zoology, 20(3):282-297) for a review of his views and as an example of using standard techniques and biochemical data in a numerical taxonomic study of suckers.

You cited Nyman, 1970, Jour. Fish. Res. Bd. Canada, 27:229-236. Evidently, this citation is in error. I could find no paper by Nyman on electrophoretic analysis of salmon and brown trout in the Jour. Fish. Res. Bd. Canada. I would appreciate the correct citation.

Mr. Richard DeLong is the person who has been working on his Ph.D. research on salmonid proteins. DeLong has been using immunoelectrophoresis and double diffusion. He teaches at Graceland College, Lamoni, Iowa, and continues his research during the summer. He was recently here for a visit and I asked him to write to you about his work.

It is apparent that a M.S. thesis can't fully complete the type of systematics project I envision would be necessary to adequately determine the status of all the native trout of Montana. However, I believe you can design a proposed plan of study that would at least set the stage for a more comprehensive study (perhaps a subsequent Ph.D. thesis) and at the same time provide valuable information on the distribution, abundance and status of the indigenous cutthroat trout of Montana.

I have agreed to examine and render an opinion on samples of Montana cutthroat trout (as time allows) sent to me by state and federal agencies. I would also be willing to examine samples used in your study. I think it is evident that if I did not want to encourage you I wouldn't have taken the time to write this letter. However, I do not want to encourage another simple allelic frequency thesis; university library shelves are filling up with too much trivia. To do such a project without the systematic knowledge necessary to interpret and evaluate the results is analagous to encouraging a graduate student in art to duplicate a classical painting by dabbing in colors over numbered zones. For your own educational experience and as a foundation for your future career, I would urge you expand your proposal to develop relevant information on the status (both taxonomic and vulnerability to extinction) of the indigenous cutthroat trout of Montana. George Holton, and personnel of the Forest Service, Park Service and BLM should be most willing to help make the project a success. Key areas must be mapped out where surveys can be made to determine the distribution and abundance of cutthroat trout. Samples taken and analyzed until a semblance of the evolutionary history is apparent. Mr. Delano Hanzel of the Kalispell office of Montana Fish and Game, should be helpful with his field experience and graduate study of Montana cutthroat trout. Then if you find electrophoretic patterns to be a useful tool, all to the good. If not, you still have plenty of material for a valuable thesis.

I talked with Andy Sheldon about the problem of an acceptable proposal that might resolve two conflicting points of view - macroevolution and microevolution. Of prime importance in your case, is to have the goals and objectives of your proposal designed to conform to the goals and objectives of the funding agency - Trout Unlimited. I believe I could phrase a major T.U. goal to be the promotion and perpetuation of native trout populations. In Montana, as far as native cutthroat trout are concerned, the goals of T.U. and Montana Fish and Game are the same. They both desire a management policy that would expand the populations of native trout. The overwhelming obstacle to initiate an intelligent management program for native trout is their confused taxonomic status.

A research project designed to provide information on the systematics of the native trout - their diagnostic characters, degree of variability, within and between major drainage basins, distribution, abundance, and taxonomic status, would be a worthy contribution to the goals of T.U. and Montana Fish and Game. This would essentially be a macroevolutionary study. The cutthroat populations of the headwaters of the various major drainage basins may have been genetically isolated for several thousand years and the Yellowstone group has likely been separated from direct continuity with other Montana cutthroat since before the last glaciation or perhaps 25,000-50,000 years. The type of population genetics study you have proposed to determine allelic frequencies in local populations is not likely to make a contribution toward solving taxonomic problems and providing insight into the evolutionary events of the past 50,000 years.

The ideal situation would be to have one graduate student conducting a standard systematic-zoogeographic project while you would concomitantly emphasize the biochemical aspect but with particular reference to proteins useful for interpreting evolution and genetic differentiation during the past 10,000-50,000 years or more. By a copy of this letter, I will inquire with George Holton about the possibilities of the U.S. Forest Service funding a systematic project of Montana cutthroat trout, designed to complement your proposal. I would request that you discuss the points raised in this letter with your committee and Andy Sheldon and send a revised proposal with objectives that more realistically are aimed at a better understanding of the systematics of Montana cutthroat trout.

Sincerely yours,

Robert Behnke
Assistant Unit Leader

RB:dch

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

August 23, 1972

Dr. Richard L. Wallace
Department of Biological Sciences
University of Idaho
Moscow, Idaho 83843

Dear Dick:

Ted Bjorn delivered your letter in Portland. (Thanks for the slides of Priest L. cutthroat). I was happy to hear of the progress being made in collecting samples of suspected pure populations of native cutthroat trout.

You mentioned a problem of clearly defining objectives for a research proposal. I would envision your contribution as a part of a comprehensive systematic study of the genus Salmo in western North America. More precisely your work would cover the middle-upper Columbia River drainage of Idaho to provide information and documentation in the following areas. How many species, subspecies and behavioral types (anadromous, resident fluviatile, migratory fluviatile, lacustrine, etc.) are we dealing with and what were their probable original and present distributions including factors that threaten their perpetuation. At present, it is generally assumed that the native trouts of the upper Columbia River basin consist of anadromous steelhead, S. gairdneri and interior cutthroat trout, S. clarki lewisi. The evidence I've put together reveals that the cutthroat trout probably comprise at least three subspecies and that another species, a fish I call the redbanded trout, is native, at least in the Owyhee drainage. For a firm foundation of factual information on these fishes, we must detail the distribution and diagnostic characters of each. For S. gairdneri, not much needs to be done. Its former distribution is fairly well documented and its present distribution and perpetuation is related to dams blocking migration. The only problem is that some of the populations considered as S. gairdneri may actually be the redbanded trout. If so, the most likely areas where redbanded trout may be native would be the Owyhee, Payette and Boise drainages. It would be important to know the distribution of redbanded trout in the Columbia basin and if they might have anadromous "steelhead" races. The redbanded trout may resemble a highly colored rainbow but have higher scale counts and a chromosome number of 58. For this aspect of the study, samples of probable native trout from the Owyhee, Payette, Boise and lower Snake drainages would be important. The cutthroat trout of the upper Columbia basin are the most complex group, because they have been there longer and have had more opportunity to diversify in different glacial refugia and have utilized diverse invasion routes to inhabit their present distribution. I think we are making progress, however, in delineating the various evolutionary lines involved. The Salmon-Clearwater drainage cutthroat appear to be similar to the Clark Fork-Flathead cutthroat - or what is commonly called the "westslope" cutthroat. Their taxonomic position must await comparisons with the cutthroat trout of the Kootenay, South Saskatchewan and upper Missouri basins. This is the group you have been most actively working on. Above Shoshone Falls, there are two quite distinct forms of cutthroat trout. The large spotted cutthroat, I believe, was derived from the Bonneville basin, and the fine spotted cutthroat perhaps evolved in a glacial ice lake, probably from a "westslope" ancestor. We don't know the precise distribution of these two forms, nor the factors that promote their reproductive isolation in a continuous environment. I will be collecting the upper Snake drainage in September and hope to make some progress on this most fascinating aspect of the overall study. There is one other important group of native cutthroat that about which almost nothing is known. They were native to the isolated streams of the Snake River lava plains. Do they still exist? Are their affinities with the westslope, upper Snake large spotted or upper Snake fine spotted cutthroat?

Collections from probably pure populations, good field notes, color slides and recording of meristic characters will form the basis of the study. Your emphasis has been on the Salmon-Clearwater drainage cutthroat, a most important gap in the overall study. If you were to be funded and expand your work, I would suggest coverage of native populations of the Owyhee, Payette, Boise and lower Snake tributaries to determine distribution and characters of native cutthroat trout and the possibility that redbanded trout are native there. Also, it would be important to learn as much as we can of the native trout of the isolated streams of the lava plains. I will concentrate on the upper Snake River for my samples and may have some more precise information and suggestions for future collections after this year's field trip.

From a practical point of view, the body of information we develop can apply to answer specific questions on threatened native trouts - theirtaxonomic status, degree of purity and distribution and this information would be available for impact statements when a dam is proposed or some other environmental disruptions are anticipated. Don Chapman has suggested you direct a proposal to the Bureau of Sport Fisheries for funding. I would support the justification of your project because it is supplemental to my own studies on rare and endangered fishes - one of the high priority missions of the Bureau. I have just been transferred to the Division of Research, ostensibly to have more time and support to continue and expand my studies on rare or threatened fishes. In my discussions with Bureau people, I pointed out that in a comprehensive study, such as the systematics of western Salmo, no one man or laboratory can do an adequate job in a lifetime--there is just too much ground to cover. I have been receiving excellent assistance from a multitude of contacts in state fishery agencies, Park Service, Forest Service, BLM and Bureau biologists, making key collections from all over the west, and using student help, I have an assembly line operation, recording data from the samples as they come in. Your request would be the first that involved the expenditure of Bureau funds to support my work with outside help, and I can't predict the outcome. A major factor in the appropriation of new funds is the degree of urgency of a situation. My comprehensive survey of western trouts is planned to prepare for and stay ahead of emergencies, so the information is available when a crisis arises. It would seem that your project would make a valid NSF funded teaching type proposal. That is, by collecting the specimens and taking sabbatical leave to spend a winter quarter with me while I teach the ichthyology course, you would develop the refinements and depth of research in systematic biology and learn the content of an ichthyology course, taught by a professional ichthyologist. From this your teaching skills and value to your University would be enhanced.

My summer's field work was most productive. I have sufficient material to complete description of three rare subspecies of cutthroat trout from the Great Basin. Also collections of redbanded trout from Malheur River and South Fork Owyhee drainages in Oregon and Nevada. I made a collection of cutthroat from a tributary of the Raft River near the Idaho-Utah border - they appear to be the large spotted upper Snake form.

Sincerely,

Robert Behnke
Assistant Leader

jrl

Department of Zoology

University of Montana
Missoula, Montana 59801
(406) 243-0211

11 May 1972

Dr. Robert Behnke
United States Department of Interior
Bureau of Sport Fisheries and Wildlife
Colorado Co-operative Fishery Unit
Fort Collins, Colorado 80521

Dear Dr. Behnke:

Many of the points you brought out in your letter were very helpful, and as a result, I am currently revising my thesis proposal. It will consist of a systematic survey using meristic as well as biochemical characters to determine variation within and between trout populations. Meristic characters were originally omitted from my proposal because one person can process only a limited amount of data. Also, I was not aware that information concerning the physical characters of trout from various drainages in western Montana was so limited.

I am still opposed to doing a purely descriptive study of trout using only physical characters, partly because I have a strong interest in the field of genetics, but also because I do think that you have understated the case for a biochemical approach to the problem. You say that using standard taxonomic methods you would have no trouble in separating westslope cutthroat trout from rainbow trout, Yellowstone cutthroat trout, and any combination of their hybrids. I believe that this would be quite impossible if the hybrid was, say, 7/8ths westslope cutthroat and 1/8th rainbow, (i.e. when the fish had one great grandparent of the other species). In other words, there are an infinite number of degrees of hybridization, and classical taxonomic methods are incapable of detecting even relatively high amounts of introgression. This is not the case with biochemical methods, in which one can examine the <u>direct</u> gene products of a large number of loci, rather than the indirect products of the few loci which control morphological and anatomical characteristics. Nevertheless, I do feel that a study combining biochemical and classical methods of analysis could provide valuable information on the systematics of the native cutthroat trout. I would, therefore, propose to use electrophoresis to complement and extend the information provided by the classical techniques.

Your letters and papers have helped me understand the limited value of a microevolutionary study to a management program designed to help preserve the westslope cutthroat trout throughout western Montana. I hope that my new proposal, which should be completed in the near future, will better satisfy your ideas on the type of study that deserves the support of Trout Unlimited.

I am planning to go directly to a Ph.D. from a B.A. and so I will not be concerned with dividing my research into two separate studies. I do realize, however, that to carry out a study to answer even a few of the questions of the type posed in your letter would take a great deal of work. With this in mind I think it would be wise for me to plan an intensive study of meristic characters of various populations, to be followed by an electrophoretic study to further clarify any interesting and important problems that arise much as you have suggested. This should help me get directly at key problems in the systematics of westslope cutthroat trout, without narrowing my research at an earlier stage to questions which may prove unimportant.

When I spoke of isolating mechanisms between rainbow and cutthroat trout, I did not have in mind using sympatric, reproductively isolated populations of rainbow and cutthroat trout. I believe that you are probably correct in stating that no such population exists in western Montana. I was suggesting a study to better understand the geographical and ecological isolating mechanisms which separate the two species, and thereby to better discover the environmental factors that favor the perpetuation of native cutthroat trout. I am sure that you will agree that a detailed knowledge of such factors could prove valuable to any management program.

I would like to apologize for citing Nyman's article incorrectly. The correct citation is Nyman, 1970, Trans. Amer. Fish. Soc., 99: 229-236.

Thank you for your cooperation. You will soon receive a revised copy of my research proposal and I trust you will judge it worthy of T.U. support.

Sincerely yours,

Gary Reinitz

Gary Reinitz

Copies to: Dr. Tom Huff
Mr. R. P. VanGytenbeek

COPY

January 17, 1972

Joseph A. Rooney
& John P. Poston
P.O. Box 417
Elliston, Mt. 59728

Dear Jay and John:

Enclosed, find a letter from Dr. Robert Behnke of the Bureau of Sport Fisheries and Wildlife to your George Holton of Montana Department of Fish and Game. I think it is rather self explanatory and I would hope that after you have had a chance to look at it, you would use your influence to protect what apparently is a pure strain of cutthroat trout in Silver Creek. As you two are well aware, there are precious few pure strains of anything left and if we have an opportunity to preserve this particular population, I think it is encumbant upon us to do so.

I look forward to hearing from both of you, especially as to your plans for 1972 and specifically what I can do to assist.

Sincerely,

R. P. Van Gytenbeek
Executive Director

RPVG/ll

cc: Mr. George Holton
Dr. Robert Behnke

TROUT
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Dr. Robert Behnke
U. S. Dept. of the Interior
Bureau of Sport Fisheries and Wildlife
Colorado State Univ.
Fort Collins, Co. 80521

Coop Units

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4260 E. EVANS
DENVER, COLO. 80222

United States Department of the Interior
NATIONAL PARK SERVICE
Glacier National Park
West Glacier, Montana 59936

IN REPLY REFER TO:

N1423

April 6, 1972

Dr. Robert J. Behnke,
Assistant Leader
Colorado Cooperative Research Unit
Colorado State Univ.
Fort Collins, Colorado 80521

Dear Dr. Behnke:

Mr. George Holton of the Montana Fish and Game Department has recently contacted me concerning your request for cutthroat trout collections. In particular, we discussed the need for specimens from the Saskatchewan River drainage and I indicated to him that we would make every effort to collect from this area in Glacier National Park.

In addition to this area, we would also be interested in making collections from both the Missouri River drainage and Flathead River drainage. As you are aware, the status of the cutthroat in certain sections of the Missour River drainage is unknown and we are quite concerned that the Missouri River cutthroat may no longer exist in their pure form in Glacier. Status in the Flathead River drainage appears to be considerably stronger.

With regard to the Flathead River drainage, we have a number of drainages with large lakes in which the cutthroat appears to be indigenous. Several of these lakes have received only minor numbers of planted fish some 40 years ago and I feel it would be of real value to know the genetic status of these populations. With your concurrence, I would like also to submit collections from these areas of the Flathead River Drainage.

You indicate in your information leaflet that you can provide Ional to assist in preserving specimens. In addition to this chemical, I was also interested in the method for killing fish following capture.

I am looking forward to hearing from you.

Sincerely yours,

CJMartinka

Clifford J. Martinka
Research Biologist

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
GLACIER NATIONAL PARK
WEST GLACIER, MONTANA 59936

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1872 — 1972

U.S.MAIL

Glacial Park

Dr. Robert J. Behnke,
Assistant Leader
Colorado Cooperative Research Unit
Colorado State Univ.
Fort Collins, Colorado 80521

44

DEPARTMENT OF ZOOLOGY

QUAECUMQUE VERA

THE UNIVERSITY OF ALBERTA
EDMONTON 7, CANADA

July 18, 1973

Dr. R. Behnke
Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado
U.S.A. 80521

Dear Bob:

Many thanks for your letter of July 6. I was extremely interested to learn of your hybrid sucker finds and pleased to receive the reprints of your fine work. I hope some of the hybrid specimens were saved.

Most cutthroat trout populations in Alberta are regrettably not native in the strictest sense of the word. In addition, our collections are poor. On August 15, 1961 I made a collection of what appeared to be native cutthroats (27) from Lower Wasootch Beaver Pond, Kananaskis system (you should have my 1965 paper in JFRBC 22(3) on the fishes of that system). The collection is being sent under separate cover on loan by the museum staff. The original label was somehow lost from the bottle but I do recognize the fish.

I believe that Cas Lindsey had two students (Pletcher and Ricker) collect high altitude trout in eastern B. C. in the early sixties. Those specimens plus others should be at University of British Columbia. Tom Northcote may also have collected some.

Needless to say I'll greatly look forward to the results of your studies.

Very best wishes.

Yours sincerely,

for J. S. Nelson,
Associate Professor

JSN:wk

cc: Mr. N. Panter,
Museum Curator

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Kaniksu National Forest
P.O. Box 490
Sandpoint, Idaho 83864

2100
March 1, 1973

Dr. Robert Behnke
U.S. Dept. of Interior FW5
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Dr. Behnke:

Thank you for your prompt analysis of the Brett Creek and South Granite Creek samples.

I do not know the status of the culvert on Brett Creek. I recommended that the Brett Creek population be kept separate from the Coeur d' Alene River population. The timber sale on South Granite Creek has been cancelled. Also, there has been pressure by a sportsmen club to plant South Granite Creek above the falls. Hopefully, the club will rescind their recommendation once it is explained that these cutthroat are possibly one of two pure native fisheries in extreme eastern Washington. The South Fork Salmo Creek is suspected to have a pure strain.

As I come across suspected pure cutthroat strains, I will send them to you. North Idaho and Western Montana offer several possibilities. I should be able to get samples from the Kootenai drainage.

Sincerely,

James L. Cooper

JAMES L. COOPER
Zone Fisheries Biologist

6200-11 (1/69)

University of Idaho
College of Letters and Science
Department of Biological Science
Moscow, Idaho/83843
Phone (208) 885-6280

April 12, 1973

Dr. Robert Behnke
Cooperative Fishery Unit
Colorado State University
Ft. Collins, Colorado 80521

Dear Bob:

I am enclosing a list of cutthroat I collected last summer and others available to me in the collection here. I hope to get additional material this summer and fall. Thank you for the progress report on the westslope cutthroat.

I have a few questions and problems that need some clarification in my mind. First, I have the feeling that I am not moving forward as fast as you would like. I teach 2 courses per semester, advise about 50 undergraduate students and do the many other chores as required of a university teacher. I also have a mountain whitefish study, a sculpin study and am involved for most of the summer with a sediment transport study (OWRR funds) in cooperation with Ted Bjornn. I do not have much time right now to spend on the cutthroat. I have started to make some of the specific counts on cutthroat, but have not progressed very far as yet. If you feel this will be too slow to meet deadlines for your overall study, let me know and I will send you some of the samples to analyze. I envision that part of my sabbatical research would include obtaining the meristic data on various populations of cutthroat from central and northern Idaho. This would appear to be the first order of business. Next, in cooperation with you, this data needs to be analyzed in relation to that from other populations of "westslope cutthroat", mainly from Montana. I would judge that next we can draw some conclusions as to the formal designations of subspecies, which should open further areas of study.

I have generally anticipated that I would come to Ft. Collins and spend most of the spring of 1974 there helping to do this work. I had not planned, at this time, to bring~~ing~~ my family because of the short duration of my leave. I thought I could find an inexpensive place to stay for the 4-5 months I would be there. I had hoped that you will be there most of this time and we would work together on parts of this project. Is this general plan about as you see it?

The more I think of the overall plan, the more I believe that I should make a trip to Colorado to see you sometime this June. By then I could have made some of the counts and could be checked out on accuracy. I could bring some samples also.

My last question involves a possible project after some of the systematic studies are completed. We have a new cell biologist, specializing in muscle physiology, in our department. He is capable and interested in doing a biochemical taxonomic study of proteins of fish. I gave him some of your publications to read and he agrees completely with you that such studies must be conducted only in conjunction with sound classical systematics studies. He agrees that this is only one of many tools available to a taxonomist. Further, he stated that with the equipment we have here, he can study and determine molecular weight differences of highly purified protein sub-units of 300-500 daltons or so. He also can determine differences in electrical charges in the native proteins. His first thoughts were of muscle protein, but since reading your articles, he thinks the same thing could be investigated using blood (Haemoglobin) and maybe other proteins (LDH). I think a study of this has some promise after there is a better understanding of the basic relationships of the various populations of native cutthroat in the upper Columbia basin. What do you think? He and I will probably initiate some preliminary analyses of muscle protein of North Idaho cutthroat this summer to work out procedures. I could probably get some coastal cutthroat for additional preliminary work. He has looked at some of the literature in this area (Canadian work) and believes we could do the same thing with cutthroat, once the overall problem comes into better focus. Once a definite study is outlined along these lines, do you think there would be funding available? I am afraid that unless we can show some very obvious immediate practical application, such a study may be too sophisticated for Idaho Fish and Game.

Thank you for any time you can give in answering the above questions.

Sincerely,

Dick

Richard L. Wallace
Assistant Professor of
Zoology

RLW: pdw

P. S. I have shown the cell biologist copies of your two letters to Mr. Reinitz at Montana.

Wallace
Cutthroat Specimens
Available
April, 1973

I have collected the following samples of cutthroat trout last summer and fall:

1. King's Lake Washington - 20± specimens supposedly a pure stock, originally from Priest Lake, Idaho. Stocked in King's Lake in 1940.

2. Rochat Cr. - above a waterfall - diversion dam built in the 1920's. Presumably a pure stock of cutthroat in the St. Joe-Spokane System. 20± specimens; presumably no past association with rainbow trout.

3. M.F. Salmon River - 15 ± specimens

4. Fish Lake - upper N. F. Clearwater River 10± specimens - presumably above barriers to steelhead migration

5. Ball Cr., Trib. Kootenai R. - 20± Supposedly pure, above a waterfall

I have the following additional specimens available for study.

1. Pack Cr., tributary Locksa R., Clearwater River, ∓ 50 specimens. Evolved in association with steelhead.

2. N.F. Clearwater River 15 ± specimens. Steelhead have been in the system.

3. Elizabeth Cr., Trib. N.F. Clearwater R., 20 ±

4. Upper St. Joe River, 15+ specimens in two collections, main river and a tributary; Rainbow used to be stocked in this area.

Wallace

— list of samples

— possible collaboration w/ biochemist

University of Idaho
College of Letters and Science
Department of Biological Science
Moscow, Idaho/83843
Phone (208) 885-6280

February 7, 1973

Dr. Robert Behnke
Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado

Dear Bob:

After a long delay I have finally found some time to drop you a line and fill you in on what I have been doing. First, my sabbatical leave proposal was accepted by the committee and sent on to the faculty council. They also recommended approval. So, unless there are some very significant funding problems, I assume that I have been granted the leave for next spring semester. I have not sent the proposal to the BSF & W as yet. I am thinking along the lines of asking for funds for the summer months following the sabbatical leave.

I have found out about a stream in the North Fork of the Coeur d'Alene River that has been untouched by man. The Forest Service man ~~in~~ and the state biologist believe~~s~~ that there may be a pure cutthroat population inhabiting it. I will get a collection from there this summer or fall.

I am enclosing a slide of cutthroat taken last fall from Ball Cr., trib. Kootenai River, Boundary Co., Idaho. You may add this to your collection.

About all for now. I will keep you posted on my activities.

Sincerely,

Dick

Richard L. Wallace
Assistant Professor of
Zoology

RLW:pdw

IN REPLY REFER TO

6500

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Dillon District
P.O. Box 1048
Dillon, Montana 59725

February 13, 1973

Dr. Robert J. Behnke
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Dr. Behnke:

We are very appreciative of the literature pertaining to status and taxonomy of cutthroat trout.

We are enclosing a map which depicts land administration in Montana. We are concerned primarily with lands in the Dillon District, though I'm sure other Districts would be interested in cooperating.

Please indicate areas which may be significant for native trout studies. We anticipate additional sampling this summer, as part of the input to our planning system.

Sincerely yours,

Jack A. McIntosh

Jack A. McIntosh
District Manager

Enclosure: (1)
Map

Dept. of Zoology
University of Montana
Missoula, Montana
August 24, 1973

Dear Dr. Behnke:

Thank you for the copy of Wernsman's thesis. As to your report on the westslope cutthroat, I am in complete agreement with the distributions that you have suggested for the westslope and Yellowstone cutthroats. My data does indicate more similarities between the cutthroat found in the head waters of the Missouri and Clarkfork drainages than either fish has for the cutthroat found in Yellowstone Lake.

As for the techniques used, populations sampled, and degree of separation found, I will gladly send you a copy of my thesis in the near future.

I did not receive any support from T.U., but did get a grant from the Montana Cooperative Wildlife Unit.

Sincerely yours,

Gary Reinitz

Gary Reinitz

Dept. of Zoology

University of Montana
Missoula, Montana 59801

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P.B. METER
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Dr. Robert Behnke
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado
80521

Jim — note & put info on back of appropriate data sheets

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

March 5, 1973

Dr. Robert Behnke
Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Bob:

Fish and Game personnel feel that the specimens from Crater Lake may well represent an "uncontaminated" native stock. The specimens from Iron Mine Creek are believed to probably be pure, while the stock from Rock Creek might have been "contaminated" by plants.

Sincerely,

Bill

William R. Gould, Assistant Leader
Montana Cooperative Fishery Unit

WRG/ls

DEPARTMENT OF ZOOLOGY

QUAECUMQUE VERA

THE UNIVERSITY OF ALBERTA
EDMONTON 7, CANADA

July 19, 1973

Dr. R. Behnke
Co-operative Fishery Unit
Colorado State University
Fort Collins, Colorado
U.S.A. 80521

Dear Dr. Behnke:

Specimens to be sent:

Salmo clarki - 26 specimens - UAMZ #52 Lower Wasootch Beaver Ponds, Kananaskis River, Alberta, August 15, 1961.

Collected by J. S. Nelson.

Yours sincerely,

Wayne Roberts

Wayne Roberts,
Acting Curator of Fishes
Museum of Zoology

WR:wk

CUSTOMS DECLARATION - DÉCLARATION EN DOUANE

ADDRESS OF PARCEL — *ADRESSE DU COLIS*

Dr. R. Behnke
Co-operative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Gross Weight—*Poids brut*	
lb. - *liv.*	oz.
4	8

ITEMIZED LIST OF CONTENTS — *DÉSIGNATION DÉTAILLÉE DU CONTENU*

	Value / *Valeur* $ c.	Net Weight / *Poids net* lb.-*liv.*	oz.
Preserved biological specimens	NCV	4	8
For research purposes			

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Signature et Adresse de l'expéditeur University of Alberta

/J.Bendle

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Edmonton T6G 2E1 Alberta

Cit...

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Mont. westslope collections

Jim Roscoe
check these
samples - do we
have them all?

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

Flathead National Forest
Kalispell, Montana 59901

2610
February 7, 1973

Mr. Robert Bohnke
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Bob:

The westslope cutthroat collection should have included a sample from Gateway Creek. I did not collect the fish but I have a slide of fish from Gateway Creek, so they were collected. They may have been listed as "Big River Meadows" which is a meadow on Gateway Creek.

O.K.

The cutthroat from Whale Creek were probably stocked above the falls. The information from Fish and Game indicates cutthroat were stocked in 1948, 1949 and 1952. Whale Creek, below the falls, is closed to fishing and should have a good population of migratory fish from Flathead Lake. Lower Whale Creek could be sampled to see if the "westslope" cutthroat dominates below the falls. Let me know if you think this is desirable.

Fish from the following streams on the Flathead Forest were sent to you:

> Big Creek, Coal Creek, Hay Creek, Whale Creek, Tuchuck Creek, Upper Twin Creek, Puzzle Creek, Spotted Bear River, Bunker Creek, Harrison Creek, Miner Creek, Clack Creek, Trail Creek, Gateway Creek (Big River Meadow), Basin Creek, (Alder Creek - Good Creek), and Griffin Creek.

This list may help you determine the unknown stream.

In addition to the fish samples collected, five streams were checked where no cutthroat could be found. Silvertip Creek and the Spotted Bear River above Dean Falls had no fish present. These are wilderness streams and natural barriers have prevented fish from entering them. Both streams are large drainages and could support significant fish populations.

Hand Creek had only brook trout. Lost Johnny Creek and Lost Jack Creek did not have any fish in the areas checked. The lower 3/4 mile of Lost Johnny Creek has cutthroat from Hungry Horse Reservoir. Lost Jack Creek is mostly dry and no fish could be found.

If you find you need some more samples from the Flathead, let me know. I would like to have better inventory information and this is one way to get it.

If you have any more questions or need assistance to collect additional samples, do not hesitate to ask.

Sincerely,

Osborne Casey

OSBORNE CASEY
Fishery Biologist

UNITED STATES GOVERNMENT

Memorandum

TO : Dr. Robert Behnke
Colorado Cooperative Fishery Unit

DATE: March 9, 1973

FROM : John D. Varley, Fishery Management Biologist
Yellowstone Fishery Services, Wyoming

SUBJECT: Restoration of Grayling in Grayling Creek

While in Cheyenne last week we meant to get together and talk over a few more items in greater detail. We looked for you on Friday but to no avail.

Attached is a copy of our proposal for the restoration of grayling in Grayling Creek. It assumes that we will be able to find and identify the endemic stream-dwelling/stream-spawning from of grayling in the Lower Gibbon-Upper Madison system (as opposed to the lake-dwelling/ stream-spawning strain in Grebe and Wolf Lakes).

If we were to initiate a study on these two forms (morphological) could you help us in developing a criteria for study? Evidently you told Jack that you have a system where by it is possible to make this distinction with some forms of cutthroat. Any aid you might be able to give us would certainly be appreciated.

You might also be interested in knowing that there is strong evidence that the Tepee Creek system above Tepee Falls (see the attached grayling report) is "clean" of any known introductions and reputedly harbors a cutthroat similar to the one above the falls in Grayling Creek. We hope to look at it next summer.

Can we expect to see you in these parts next summer? If so, would you mind jotting down a list of waters you may be interested in collecting in so that we can plug it in our planning.

Also, if you have any "new handouts" on your current thinking about this cutthroat thing, we would appreciate your sending us a copy.

Well, thanks for any help you can give us on the grayling business and best regards.

John D. Varley

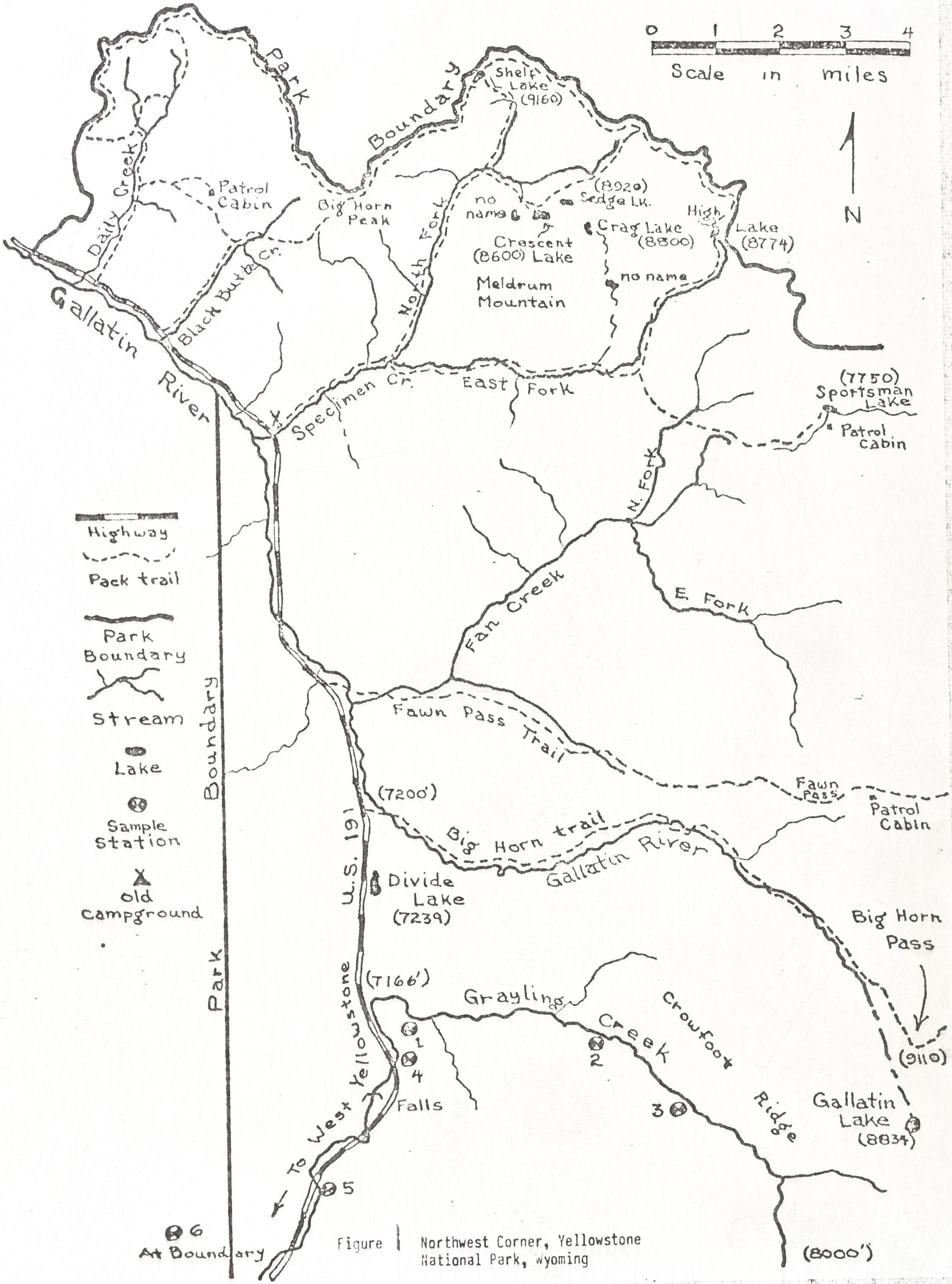

Figure | Northwest Corner, Yellowstone National Park, Wyoming

A Proposal for the Restoration of Grayling (Thymallus arcticus) in Grayling Creek, Yellowstone National Park and the Gallatin National Forest.

This report explains the concept, rationale and offers a proposed approach for the restoration of the grayling, Thymallus arcticus, in a portion of Grayling Creek in Yellowstone National Park and the Gallatin National Forest in Montana. The proposed plan suggests the destruction of all fish life in 15.3 miles of the stream between two falls on Grayling Creek and below the falls on Tepee Creek, followed by plantings of the native grayling genotype. Preliminary work is suggested to begin in the spring of 1973 and would ultimately require the cooperation of four agencies: the Bureau of Sport Fisheries and Wildlife, the National Park Service, the U.S. Forest Service and the Montana Fish and Game Department. The support of local sportsmen, guides and other interested parties would also be actively sought.

Most of Grayling Creek lies in the northwestern corner of Yellowstone Park. The stream issues from a series of peaks in the Gallatin Mountains and flows approximately 16.5 miles within the Park and another 4.5 miles outside the Park before entering the Grayling Arm of Hebgen Lake.

Grayling Creek is considered a good candidate for restoration because it historically held grayling, its chemical, physical and biological characteristics indicate that it is suitable grayling habitat (Appendix I), and there are three natural barriers (low falls) which should prevent recontamination by non-native species. The fishery in the section proposed to be restored is a stretch of roadside stream (primarily) which has been overexploited by anglers and is presently considered a poor sport fishery.

There has been some question in the past as to whether or not the section of stream within the Park indeed ever had grayling stocks. It is suggested that the circumstantial evidence gives strong support to the idea that the upper limit of grayling distribution included that section of the creek in the Park in the vicinity of US Highway 191:

1. The name Grayling Creek suggests that the species was once present (Appendix II).
2. A National Park Service Fish Distribution map appended to the 1940 Annual Fish Planting Report shows the species as occurring in Grayling Creek within the Park (see Appendix II for a discussion of this point).
3. In 1891, the emminent icthyologist David Starr Jordan included grayling on his fish distribution map as being in the Park (see Appendix II for a discussion of this point).
4. "Old-timers" in and about West Yellowstone speak of the old days of great grayling populations in Grayling Creek at least as high as the present-day Parade Rest and Atwood Ranches (see Appendix II).
5. Kendall (1915) and Smith and Kendall (1921) include grayling in Grayling Creek in the publications "The Fishes of Yellowstone National Park" (see Appendix II).

Even if it were conclusively shown, or there was reasonable doubt that grayling did not historically exist in the portion of Grayling Creek within the Park, there remains a significant point: the endemic Madison River (system) grayling race (genotype) may be the most endangered native fish form in the Park. This native stream-dwelling/stream-spawning form is either extinct altogether or remains in some form as a threatened reminant population in the Upper Madison-Lower Gibbon Rivers. The grayling stocks of Grebe and Wolf Lakes in Yellowstone Park are thought to be descendants of the Red Rock Lakes (Montana) genotype and would be thus, a lake-dwelling/stream-spawning form. There is evidence that natural selection has produced a stream-dwelling/stream-spawning genetic form from the Grebe-Wolf Lake stocks and that it now exists in the Upper Gibbon River. If there has been reproductive isolation between the Upper Gibbon form and the Lower Gibbon-Upper Madison remnant group then the native genotype still exists. If there has been emigration from the Upper Gibbon to the Lower Gibbon-Upper Madison then the present genotype is probably an admixture. In any event, the Lower Gibbon-Upper Madison grayling is distinctive in that it should be the closest known form to the original genotype and deserves protection and/or a more secure niche in which to live. Middle Grayling Creek should provide the conditions necessary for that purpose. Within Yellowstone Park, this section of stream could restore the endemic cutthroat-grayling-sculpin species complex that was once common to the area and now exists in no known water.

There are three known falls on the Middle Grayling Creek system which are complete or partial barriers to the upstream migration of fishes (Figure 1). Above the falls on both Tepee and Grayling Creeks there is good evidence that the original fine-spotted cutthroat exists in its pure form. Below these falls there are known to be rainbow-cutthroat hybrids and brown trout. Trout are not reported to be present in Little Tepee Creek although it appears that it is large enough to support them. Below lower Grayling Falls (Figure 1) a diverse mixture of native and non-native species and hybrids exist. Grayling have not been reported anywhere in the system for many years.

Proposed Plan and Time-Table

1. Spring and summer, 1973. Initiate feasibility studies regarding the collection of prespawners, the possible taxonomic differences between the Lower Gibbon-Upper Madison stock and the Grebe Lake-Upper Gibbon stock, and continued assessment of the Grayling Creek watershed. Project to be terminated or revised based on the results of the 1973 studies.

2. Spring, 1974. Make an intensive effort ~~ot~~ to collect pre-spawning grayling from the Upper Madison and Lower Gibbon Rivers. Hold in live-cars until they can be artificially spawned. Eggs to be transported to a hatchery and reared there for approximately one year.

   In the event that too few pre-spawners and eggs are collected from the Lower Gibbon and Madison area, supplemental eggs may be needed from the Upper Gibbon if the mixing of genotype is desirable or

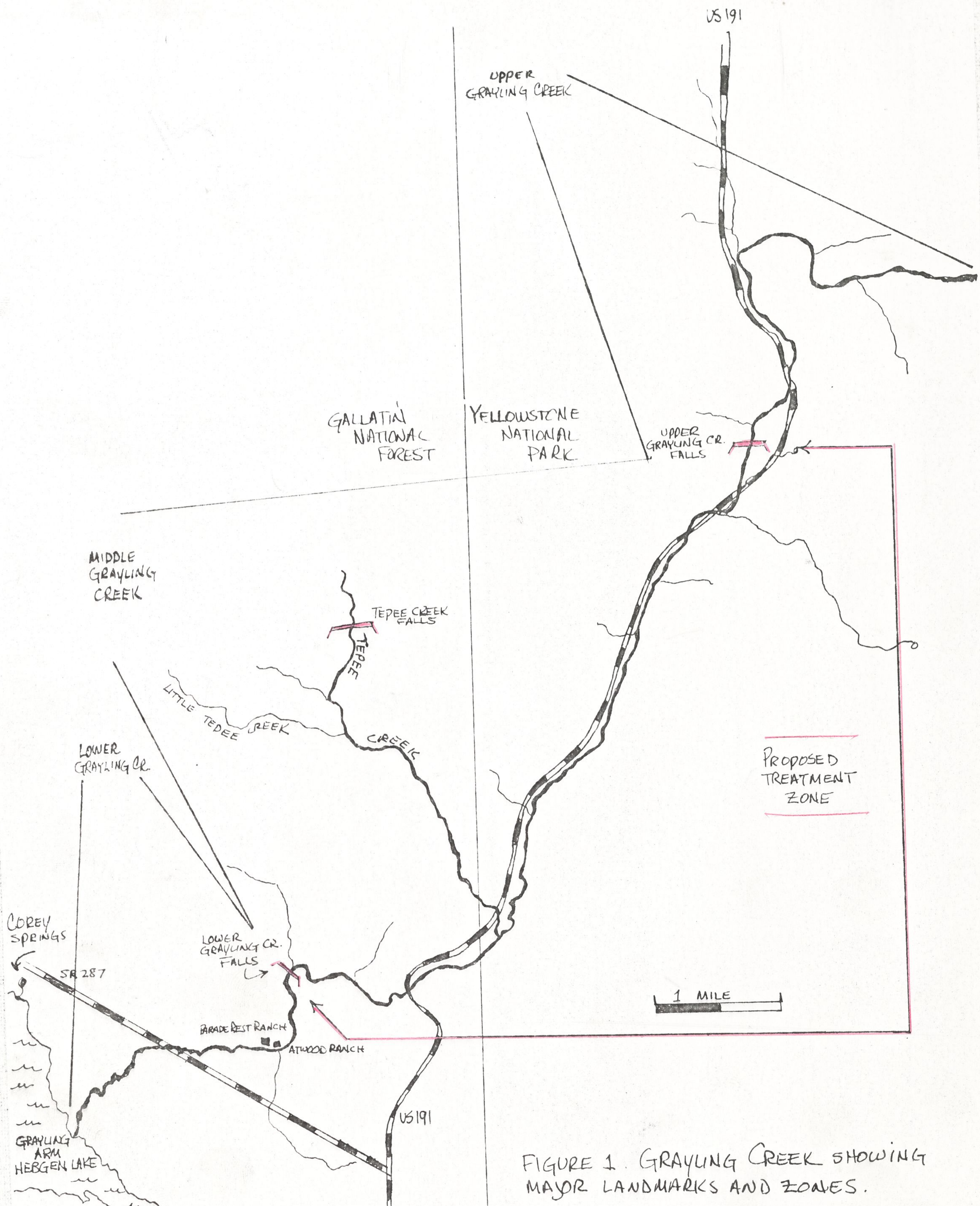

FIGURE 1. GRAYLING CREEK SHOWING MAJOR LANDMARKS AND ZONES.

necessary.

3. Summer, 1974. Continue feasibility studies of the Grayling Creek system including further fish distribution surveys, flow studies, bioassays, etc. If it is determined that the project is no longer feasible, the grayling in the hatchery should be planted into the Lower Gibbon as yearlings.

4. Late summer-early fall, 1974. Eradicate the sections of Grayling and Tepee Creeks between the three falls with liquid antimycin to remove all fish life.

5. Fall, 1974. Survey treated sections with electrofishing gear to ascertain the success of the kill.

6. Spring, 1975. Again attempt to collect pre-spawning grayling from the Lower Gibbon-Upper Madison system and transport these adults directly to the barren sections of Grayling Creek.

7. Early summer, 1975. Plant yearling grayling (from the hatchery) in the sections between the falls.

8. Late summer-early fall, 1975. Post-restoration evaluation sampling.

Discussion

The proposal to restock using both hatchery-reared and older aged wild grayling is justifiable on several points:

1. There is good evidence to support the idea that there will be rapid colonization by the cutthroat of the barren section from above (especially young-of-the-year). It would be desirable for the introduced grayling to have a "head-start" in terms of size and age. This, in turn, should guarantee the grayling having prime food and space-linked territories.
2. To expect success in the experiment it would be necessary to stock enough individuals to provide for both a minimum population size in the genetic sense and a minimum population size in the numerical sense. It is not expected that enough adult transplants could be obtained to satisfy these two requirements without the input of hatchery-reared fish.
3. The poor survival of grayling eggs, fry and fingerlings in lotic waters is well-documented. It is thought that yearlings, of suitable size and from a suitable strain, in a semi-barren stream should produce a significant first year survival. It is further assumed that little or no first year mortality would take place with the adult transplanted fish.
4. Among animal populations the negative effects produced by small, isolated, inbreeding populations have been shown many times. An introduced grayling population of sufficient size and with at least four age groups present should protect the genotype from major genetic drift. If it is desirable to protect the Madison genotype then it will be necessary to secure and stock a large enough population to have all of the variation available in the planted stock that is present in the donor stock.

A large number of yearlings from assortive matings plus at least three older age groups will enhance the probability of most of the natural variation being present. The overall genetic factors which require consideration include the need to approach, meet or exceed the effective population size, the need to minimize the rate of inbreeding in succeeding years, the need to reduce the generation time, the desirability of increasing the average age of fish spawning (to increase fecundity) and perhaps most importantly, to provide enough age-groups to allow more varied matings between successive overlapping generations.

With yearlings and three older age-groups present in the initial summers plant, it would then be possible to have 32 different assortive matings between generations by the second spring following introduction. Any additional age-groups in the initial population would enhance this effect in a positive manner.

As the grayling is known to be extremely vulnerable to the angler it is proposed that Grayling Creek (at least that portion near US 191 in the Park) be closed to angling for an indeterminate period. This closure will insure the continued existence of valuable older aged fish in the stock and will enhance the probability of rapid population growth into suitable habitat. This aspect will be important if there are interspecific pressures placed on the grayling by recolonizing cutthroat. Here the native Grayling Creek cutthroat is assumed to be far better adapted to the stream than the introduced grayling would be.

Antimycin is a highly toxic but short-lived piscicide and fungicide. It has no effect on other aquatic life nor terrestrial life in the proposed treatment concentrations. Its effectiveness is shown by the small quantity needed for this project (1.5 gallons). Fishes do not detect the presence of the chemical in the water and once the fish take it into the gills, the effect is irreversible. Its effectiveness as an agent in soft-water streams and against salmonids is well-documented.

The proposed treatment would annihilate the fishes and fungi in the stream. It is reasonably expected that repopulation by both groups from the untreated upper section will be rapid. No long-range ecological damage can be anticipated.

The proposed intentional treatment area includes approximately 8.0 miles of Grayling Creek above the lower falls, 2.6 miles of Tepee Creek above its confluence with Grayling Creek, and approximately 4.7 miles of small spring-fed brooklets (subject to revision as more information is collected) tributary to Grayling and Tepee Creeks.

A partial and temporary removal of existing beaver dams would expedite the treatment and increase the probability of a total fish kill.

A 3.0 mile section of Grayling Creek below the lower falls would be subject to an unintential kill to some unknown degree. This stretch of stream presents a problem for special consideration. The treatment would be scheduled after the spring-spawning runs (from Hebgen Lake) and prior to the fall-spawning run. There is apparently, a substantial resident fish population of valuable native and non-native game species but also non-game species. Attempts could be made to reduce the effect of this kill by raising the pH of the stream which would lower the biological half-life of the chemical. There are also two small tributaries below the lower falls which would aid dilution. Irregardless of "best-efforts" to detoxify or no effort, a substantial kill could be expected. The killing of non-game species in the stream would probably enhance subsequent sport-fish populations. The recolonization by pure-strain cutthroat and grayling from the above sections may enhance the quality of the fishery but recolonization by game and non-game species from Hebgen Lake would also likely be rapid. In any event, if the treatment were carried out and no stocking or other management measures are taken, the lower stretch of Grayling Creek would be lost as a sport fishery for several years.

The effects of "hot" toxicant reaching the Grayling Arm of Hebgen Lake are thought to be minimal. Apparently this arm of the lake in late summer is primarily occupied by Utah chub and other non-game fish species.

In the event that treatment is deemed unfeasible after the egg-taking operation, it would be desirable to stock the hatchery-reared yearlings into the Lower Gibbon-Upper Madison Rivers.

It would also be desirable to divide the grayling eggs taken between two hatcheries to minimize the chance of total loss due to disease or other unexpected events.

Appendix II

A discussion of the evidence supporting the idea that grayling are native to Grayling Creek within the boundaries of Yellowstone National Park.

1. The name Grayling Creek suggests that the species was once present: Up to the late 1800's the stream was known as the North Fork of the Madison River. The name, Grayling Creek, was in common use by the early 1900's. Our assumption is that a major name change such as this had a substantive basis.

2. A National Park Service Fish Distribution map appended to the 1940 Annual Fish Planting Report shows the species as occurring in Grayling Creek within the Park. Mills in Dean and Mills (1971) discuss this map in detail and he concluded that it was doubtful that grayling (or the exotic rainbow and brown trout) ever existed above the upper falls. He further speculated that the author of that map may have known of the upper falls but misplaced it on the map because distribution lines for grayling and non-native species all ended at the same point.

   Whether one accepts the fish distribution of the anonymous author of the map or Dean and Mills (1971) speculation about the misplacement of the upper falls on that map, it is moot to the issue of grayling having been native in Grayling Creek within the Park: if the upper falls on the 1940 map were indeed the upper limit of the grayling within the stream then they would have occurred in approximately 8 miles of Park water: If one goes by the falls on the present map, they would have occurred in 6.5 miles of the stream within the Park. The current proposed program would restore the grayling in the 6.5 mile section within the Park.

3. David Starr Jordan included the grayling on his 1891 fish distribution map as being within the Park. It is known that Jordan did not actually tour and sample the extreme northwestern corner of the Park. The distribution of fishes in areas he did not personally sample were based on the information given by three men, each of which had first hand personal knowledge of the Park: Mr. Elwood Hofer, back-country guide and avid fisherman; Mr. Arnold Hague of the U.S. Geological Survey, and Capt. F.A. Boutelle, U.S. Army, Superintendant (and fisherman).

   Dr. Jordan, generally considered to be a scientist of impeccable qualifications, placed the upper limit of grayling in Grayling Creek at approximately 10 to 12 miles above the Park boundary.

4. Historical accounts place abundant grayling stocks in the area on Grayling Creek at least as high as the present day Parade Rest and Atwood Ranches.

   In 1891, the noted fishery scientist, Barton Evermann, noted the abundant grayling population in the Horse-thief Springs (present day Corey Springs) area, which was, prior to the completion of

Hebgen Dam, a tributary to Grayling Creek.

According to Mr. Bud Morris of West Yellowstone, Montana, one Fred Kerzenmacher related to him that he used to collect wash-tubs full of grayling from a pool in Grayling Creek for the use of feeding the passengers stopping at the stage station at Grayling (now abandoned). This pool was approximately 1/2 mile below the lower falls (Figure 1).

If brown and rainbow trout ascended the lower falls (there are no reports of them having been stocked above the lower falls) then could not grayling have done so also? If they (brown and rainbow) were stocked and the lower falls is a complete barrier to fish migration then how did the indigenous cutthroat and sculpin get above the falls? There were probably only two routes: From the Gallatin River through Divide Lake and Pass, or up from the Madison River. Both stream systems had grayling as coexisting species with cutthroat and sculpin. If two species (one large and one small) could penetrate the upper reaches of Grayling Creek at some historical moment then couldn't the grayling have done the same?

One conclusion that can be legitimately drawn is that the grayling, cutthroat, and sculpin coexisted historically in Grayling Creek. It is not unreasonable to assume that the grayling became extinct in this water because of human exploitation. Its extinction over most of its historical range implies that it is a species easily damaged by mans activities (exploitation and stocking non-native species)..

Grayling Creek lies in the area of historical trails and an early road. It has been exploited by sport-fishermen and used by locals for food gathering purposes for at least 100 years. Poaching of all types was common in the area. Cattle grazed in the drainage as early as 1881 probably reducing the carrying capacity of the stream. Hebgen Lake and its addition of exotic game and non-game fish species in the 1920's probably placed intense environmental pressures on the endemic forms in lower Grayling Creek.

5. Kendall's (1915) book on "The Fishes of the Yellowstone National Park" states that the grayling: "In the Park it occurs naturally in Madison and Gallatin Rivers and branches, Fan Creek, Grayling Creek, and the Firehole River below the falls". Emphasis added. The 1921 edition by Smith and Kendall also includes the above sentence verbatim.

With a highly specialized, sensitive and exploitable species as is the grayling, coupled with the probable requirement of large numbers to meet the minimum effective population size criteria, it should come as no surprise that they are presently extinct in Grayling Creek or anywhere else in their native range.

APPENDIX I

REPRODUCED FROM DEAN and MILLS (1971)

GRAYLING CREEK

Grayling Creek lies in the northwestern corner of Yellowstone Park. Its name implies that it once contained the native grayling. Cutthroat were known to be native to upper Grayling Creek while grayling were known to occur at least in the lower sections. A comprehensive survey was conducted on Grayling Creek in September 1970 and yielded unexpected results. The stream was found to contain what may prove to be the original cutthroat genotype for the area, a rare occurance in watersheds that have been subjected to intensive fish stocking.

Physical Characteristics

Geography

Grayling Creek, tributary to the Madison River via Hebgen Lake in southwestern Montana, heads in the northwestern part of Yellowstone on the south side of the Gallatin River divide. It flows northwesterly between two mountain areas called the Crags and Crowfoot Ridge for about 5 miles then flows west for another 3 miles before turning to the southwest where it leaves the park 5 miles downstream (Figure 7). It leaves the park about 7 miles due west of its headwaters but slices a gentle arc 5 miles to the north in the process. Total stream mileage in the park is about 16.5 miles.

Access

Grayling Creek is reached by U. S. Highway 191, eleven miles north of West Yellowstone, Montana. Inside the park, the road parallels the stream for approximately 6 miles. At that point it turns east from the road. A trail has not been established along the upper course of the stream, but remnants of fishermen trails and a fire trail are occasionally in evidence. Wildlife trails are common along the banks.

Gradient

Six sampling stations were established on Grayling Creek (Figure 7) and are numbered 6, 5, 4, 1, 2, and 3 proceeding upstream from the park boundary. Gradient along the entire course of the stream was moderate. The upper mile was not visited and the gradient there is shown by topographic maps to be somewhat steeper. Occasionally valley endings pinched down to the stream and gradients increased somewhat, but along the 16.5 miles of stream within the park elevation fell 1,428 feet, an average of 86.5 feet per stream mile. Though the gradient of the stream channel is only moderate, the watershed is steep. Mountains towering to nearly 10,000 feet parallel the stream within 1 to 1.5 miles on either side along the uppermost 5 or 6 miles.

Barriers

A vertical falls was observed in a canyon approximately 4.9 miles north of the park boundary. It falls about 4 to 5 feet during low water and appears to be an effective barrier to fish migrations (Figure 9). Its effectiveness as a barrier during high water is unknown.

Several small log jams were observed along the upper course of the creek, but none were found that would inhibit fish movements.

Water Flow and Supply

Water is supplied mainly from heavy snow packs. Additional water is supplied by many cold springs and ground water seeps. Four of five major tributaries carry water to the creek and countless numbers of small streams were observed. Many of these tributaries appeared ideal as spawning and nursery areas.

Volume flows were measured using a pigmy current meter at each of the six sampling stations. Flows measured at near base levels in September ranged from 20.6 cfs at the uppermost station to 48.3 cfs at station 6 near the park boundary (Table 20). Seasonal flooding and some scouring was evident, but did not appear excessive and the stream channel appeared stable.

Bottom Materials

Bottom materials consisted primarily of rubble and gravel throughout the stream (Table 20). Some areas contained small quantities of sand and small amounts of organic detritus collected in quiet pools. Large boulders were present in a few areas.

Pool-Riffle Ratios

Pool-riffle ratios in Grayling Creek were poor (Table 20). Long stretches were observed where it was difficult to find pool areas and the average ratio appeared in excess of 1 to 25. Stations 2, 3 and 4 had ratios of approximately 1:5, 1:3, and 1:2 respectively and were considered good, but not representative of a large percentage of the stream. Generally, Upper Grayling Creek had a better pool-riffle structure than did the lower sections.

Stream Temperatures

Stream temperatures fluctuated with time of day and location of springs. Generally the temperatures ranged between 40 and 60°F.

Chemical Characteristics

As expected, dissolved oxygen determinations showed saturated values from 9 to 10 ppm at all stations.

pH determinations were consistently 7.6 when measured in the field. Some variation was found in water samples obtained for laboratory analysis, but these never varied greatly.

Water quality generally is indicative of soil conditions in the watershed. Mountains in the area are part of uplifted blocks of limestones, shale, and sandstones (Bauer, 1948).

Grayling Creek water contains amounts of dissolved minerals similar to the upper Gallatin area but greater quantities than do the headwaters of Specimen Creek further to the north. Geologic formations in that area are younger and more resistant. Subsequently, that water contains fewer dissolved substances. Chemical composition of Grayling Creek water appears in Table 21. The general load of electrolytes is not indicative of high productivity.

Biological Characteristics

Aquatic Vegetation

Little vegetation was found in the stream proper. Some filamentous algae was observed in isolated pools near station 3 but was sparse. The banks of Grayling Creek provide excellent cover. The stream flows through meadows over about one-half of its distance, and its banks are covered with dense stands of grass and willow. Coniferous forests border the remainder of the stream.

Aquatic Invertebrates

Overall, productivity of Grayling Creek is poor and typifies mountain streams in the area. Invertebrates were collected from each of the sample stations and a checklist appears in Table 22. Immature insects predominated. Most commonly observed were several species of mayflies, stoneflies, caddisflies, and midges. Although the number of forms decreased upstream, no great differences occurred.

Fish Species Composition

Initial fish sampling occurred about 1 mile from the point where the stream turns away from the road (station 1). Only one fish was taken the first day, but it was an exciting catch because it was clearly cutthroat, but clearly different. It seemed impossible that the original genotype (of Upper Missouri River stock) could have survived against the many stockings of Yellowstone Lake cutthroat. The specimen was fine-spotted however, marked differently, and was highly colorful with various shades of red along its sides and opercules. A gill net was set overnight and yielded three specimens ranging in size from 3.4 to 8.0 inches. Eleven additional specimens were obtained upstream. All specimens were preserved and sent to Dr. Robert Behnke at Colorado State University for taxonomic evaluation. Dr. Behnke reported that specific morphological or meristic characters do not definitely separate this fish from many other inland cutthroat, but that they are pure cutthroat and did not originate from Yellowstone Lake (Personal communication). In addition there was no evidence of hybridization with rainbow. It is therefore probable that these fish are the original genotype occurring in the area. This is a unique discovery because most of the waters in Yellowstone have been heavily planted with cutthroat stocks originating from Yellowstone Lake. More amazing is how Upper Grayling Creek escaped.

Stocking History

Official records show that Grayling Creek was stocked with a total of 630,050 cutthroat trout fry from hatcheries at Yellowstone Lake, Bozeman, Montana and McAllister, Montana (Table 23). Brood stock at the latter two hatcheries probably originated from Yellowstone Lake. These plants occurred from 1930 through 1934 at which time grayling plants from the Grebe Lake hatchery began. From 1934 through 1944 a total of 861,538 grayling fry were planted.

No grayling were taken or observed during this survey. Brown trout were observed and captured from the lower reaches of the stream below the previously mentioned barrier. Sculpin were taken throughout the stream.

That barrier may have proved to be the saving factor for the Grayling Creek cutthroat. Old maps show that the highway now paralleling Grayling Creek did not always do so along the section above the barrier. It was located slightly to the west, in view of the stream, but far enough away that hatchery personnel may have preferred to release their fish where they could get closer to the stream. If this is the case, they probably released them from the first crossing, about one mile to the south which would have put them below the barrier. This is a point of speculation that needs to be pursued.

Early reports show grayling native to Grayling Creek. Most, however, indicate they were present on lower Grayling Creek and were concentrated near the stream inlet at Hebgen Lake. It is possible that grayling did not occur above the falls. Had they been native to upper Grayling Creek, it would seem reasonable to assume that they would have evolved and coexisted with the indigenous cutthroat. In the absence of heavy fishing pressure it would then be difficult to explain their disappearance from the stream. It is doubtful that they occurred there or that they were ever planted above the barrier. It is also possible that heavy mortality of the fry precluded their successful establishment even if planted above the barrier.

A Park Service fish distribution map appended to the Annual Fish Planting Report for 1940 shows Grayling Creek containing grayling, cutthroat, rainbow and brown trout to a point approximately 1 mile east of where the stream currently turns from the highway. This would place all of these species above the falls. No rainbows or browns have been reported stocked in Grayling Creek, and it is believed that the author of that map assumed that fish migrated up the creek from Hebgen Lake. It is further postulated that the author of that map may have known of the barrier, but mislocated it on his map because the distribution lines all stop at the same point. If fish were present to the point where he had them, there is no reason why they would not have been present upstream.

If the barrier was indeed effective, the presence of cutthroat and sculpin above it can be explained in one of two ways: (1) They were above the barrier prior to its formation or; (2) Grayling Creek may have had affinities with the Gallatin River at one time through Divide Lake. A south-flowing stream tributary to Grayling Creek above the barrier passes within one-fourth mile of Divide Lake with only a low divide separating them. If this connection existed, it is possible these fish entered from that drainage. Grayling may or may not have occurred with them. At this point it seems reasonable to doubt that they did.

There are many unanswered questions and much supposition regarding the cutthroat found in Grayling Creek. Additional work needs to be completed prior to establishing much of the foregoing as fact.

Spawning Habitat

Much of Grayling Creek is not considered ideal spawning habitat for species that spawn during spring. There are however, several smaller tributaries along the course of the stream that contain excellent spawning habitat and should serve as good nursery areas for small trout.

Angling Pressure

Angling pressure is sufficiently heavy along the section of stream next to the road that is nearly impossible to catch fish with rod and reel. The upper portion of stream is visited by only an occasional fisherman. It is suspected that most of the pressure on the upper stream is from local anglers.

Management Analysis and Recommendations

Because it is possible that the original cutthroat genotype still exists in Grayling Creek, it is imperative that additional studies be conducted to (1) Determine if the cutthroat is indeed of the original stock and (2) To learn the details of his survival.

~~HIGH LAKE~~

~~High Lake, at the head of the East Fork of Specimen Creek, is well~~ known to local anglers. Although originally barren, it now contains a good population of cutthroat trout. It was the only lake surveyed in the Gallatin River watershed that contained fish. Further, it was found to offer some of the habitat characteristics desired for grayling.

Physical Characteristics

Geography

High Lake is located on the north park boundary at the head of the East Fort of Specimen Creek (Figure 7). It lies in a large meadow at an elevation of 8,774 feet. Access to the lake is provided by pack trail from the Specimen Creek trail head, the Sportsman Lake trail, or from the Cinnabar Basin north of the park. The boundary trail is located just to the north of High Lake (Figure 7). High Lake is approximately 10 miles from the Specimen Creek trail head and 18 miles from the Sportsman Lake trail head.

Water Supply

Water is supplied to High Lake from snowmelt and five springs. Three springs arise in close proximity to one another just west of the lake. They flow only a short distance and together were contributing less than 1/2 cfs during the survey. Water temperature was 42°F. Another spring flows several hundred yards from the northwest. The stream ~~channel is small but contains deposits of pea-sized gravel. Its flow~~

Table Physical Characteristics at Six Sampling Locations on Grayling Creek, 1970.

	STATION LOCATION PROCEEDING UPSTREAM FROM PARK BOUNDARY (Station length 350 feet)					
	6	5	4	1	2	3
Gradient	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Elevation (feet)	6,750	7,020	7,100	7,200	7,300	7,480
Maximum depth pools (feet)	2.4	3.0	4.5	1.5	3.2	2.0
Width (min-max in feet)	34-59.5	22-38	14.5-49.5	24-45	15.5-31	13-30
Pool - riffle ratio	1:6	1:25	1:2	1:5	1:5	1:3
Volume flow (c.f.s.)	48.3	47.1	45.4	36.7	32.9	20.6
Temperature (°F)	42°	46°	45°	50°	55°	55°
Spawning habitat	Marginal	Marginal	Fair	Fair	Good	Good
Bottom materials						
Riffles	Bedrock Rubble Gravel	Rubble Gravel	Rubble Gravel	Rubble Gravel	Rubble Gravel Sand	Rubble Gravel
Pools	Bedrock Rubble Gravel Silt O.D.[1]	Rubble Gravel Silt O.D.	Rubble Gravel	Sand Silt O.D.	Gravel Sand Silt O.D.	Gravel Sand Silt

1. Organic detritus

Table 2 Chemical Characteristics of Grayling Creek, 1970.

	STATION NUMBER Proceeding upstream from park boundary					
	6	5	4	1	2	3
Dissolved oxygen (mg/l)	11.0	11.0	10.0	9.0	12.0	9.0
pH	7.6	7.6	7.6	7.6	7.6	7.6
Specific conductance μ mhos/cm	145	147	160	125	119	118
ANIONS:						
Bicarbonate HCO_3 (mg/l)	81.16	85.43	90.92	76.89	68.34	65.29
Chloride Cl (mg/l)	0.25	0.25	0.55	0.65	0.35	0.25
Silicon dioxide SiO_2 (mg/l)	14.4	13.0	11.2	9.0	8.9	8.5
Sulfate SO_4 (mg/l)	6.51	5.58	7.31	5.39	6.84	5.94
Floride F (mg/l)	0.01	0.03	0.01	0.01	0.01	<0.01
CATIONS:						
Calcium Ca (mg/l)	19.44	19.04	20.04	15.43	14.43	14.43
Magnesium Mg (mg/l)	3.04	3.65	4.38	3.65	3.65	3.65
Potassium K (mg/l)	1.09	1.37	1.45	1.09	1.06	0.98
Sodium Na (mg/l)	1.84	2.07	1.84	1.61	2.30	1.61

Table 3 Checklist of Aquatic Invertebrates Frequently Observed during Survey of Grayling Creek, 1970.[2]

CLASS ORDER FAMILY GENUS	Common name	STATION NUMBER Proceeding from park boundary upstream 6	5	4	1	2	3
Annelida[1]	Aquatic earthworms					X	
Hirundinea	Leaches					X	
Insecta		X	X	X	X	X	X
Ephemeroptera	Mayflies	X	X	X	X	X	X
Heptageniidae		X	X	X	X	X	X
Iron sp.		X	X		X	X	
Rhithrogena sp.		X	X	X	X	X	X
Cinygmula sp.		X			X	X	
Heptagenia sp.		X			X	X	
Baetidae		X	X	X	X	X	X
Baetis sp.		X	X		X		X
Baetodes sp.					X		
Ephemerella sp.		X	X	X	X	X	X
Centroptilum sp.		X					
Plecoptera	Stoneflies	X	X	X	X	X	X
Perlidae			X	X	X	X	
Atoperla sp.					X	X	
Acroneuria sp.				X	X		
Perlodidae		X			X	X	X
Isoperla sp.					X		
Arcynopteryx sp.						X	
Isogenus sp.		X				X	
Chloroperlidae		X	X	X		X	X
Alloperla sp.							
Trichoptera	Caddis flies	X	X	X	X	X	X
Hydropsychidae		X	X	X	X		
Arctopsyche sp.		X	X	X	X		

Table 3 (continued)

CLASS ORDER FAMILY GENUS	Common name	STATION NUMBER Proceeding from park boundary upstream 6	5	4	1	2	3
Rhyacophilidae		X	X	X	X	X	X
Glossoma sp.				X	X	X	X
Rhyacophila sp.		X	X				
Limnephilidae		X			X	X	
Leptoceridae					X	X	X
Leptocella sp.						X	
Philopotamidae						X	
Psychomyiidae		X			X		
Brachycentridae		X	X	X	X	X	X
Diptera	Flies, midges	X	X	X	X	X	X
Chironomidae	Midges	X	X	X	X	X	X
Ceratopogonidae	Biting midges	X				X	
Simuliidae	Black flies	X			X	X	
Blepharoceridae	Net-winged midges				X		
Bibliocephala sp.					X		
Tabanidae	Horse flies	X					
Tipulidae	Crane flies	X	X	X		X	
Hexatoma sp.			X	X		X	
Rhagionidae	Snipe flies	X					
Coleoptera	Beetles	X	X		X	X	X
Elmidae		X			X	X	
Dytiscidae		X					
Odonata	Dragonflies & Damselflies				X		
Hemiptera	True bugs					X	
Hymenoptera	Ants, wasps					X	
Hydracarina	Water mites	X				X	

1. Phylum
2. All invertebrates were keyed from Pannak (1953) and Usinger (1968).

Table 4 Fish Stocking Summary for Grayling Creek, Yellowstone National Park, Wyoming

Year	Species	Number	Size	Source
1930	Cutthroat	81,250	Fry	Lake Hatchery
1932	"	40,000	"	McAllister, Mont.
1932	"	10,000	"	"
1933	"	223,200	"	Bozeman, Mont.
1934	"	336,000	"	"
1934	Grayling	220,000	"	Grebe Lake
1935	"	101,000	"	"
1936	"	75,000	"	"
1937	"	62,500	"	"
1938	"	8,000	"	"
1939	"	103,992	"	"
1940	"	107,850	"	"
1941	"	100,696	"	"
1942	"	20,000	"	"
1944	Cutthroat	12,000	"	Bozeman, Mont.

Total cutthroat fry planted 630,050
Total grayling fry planted 861,538

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

February 9, 1973

Dr. Robert Behnke
Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Great Falls
type locality of S. c. lewisi
Missouri
Smith R

Dear Bob:

I'm sending you, on loan, the following three collections of cutthroat trout from the Smith River drainage:

M.S.U. catalogue no.

5712	(3 specimens)
5713	(4 specimens)
and 5714	(13 specimens)

Thanks for the copy of your report on the westslope cutthroat trout.

Sincerely,

Bill Gould

William R. Gould, Assistant Leader
Montana Cooperative Fishery Unit

WRG/ls

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Flathead National Forest
Kalispell, Montana 59901

REPLY TO: 2620 Planning October 17, 1973

SUBJECT: Fish Samples

TO: Dr. Robert Behnke
Bureau of Sport Fisheries and Wildlife
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

This is the information on the fish I called you about.

Westslope? Cutthroat Trout from Griffin Creek, Flathead National Forest, Montana.

Sample collected in T28N R25W Sec. 2

This is an isolated population in the head of Griffin Creek. Montana Fish and Game records show cutthroat were planted in Griffin Creek in 1951. If these fish came from that plant they will indicate the cutthroat type used for stocking at that time.

If the cutthroat are the "Westslope" variety or something different they could be a pure native population.

Griffin Creek has a very low fish population above the barrier. Cutthroat are the only species present.

The sculpins in the sample came from 17 Mile Creek, a tributary to the Yaak River in the Kootenai River drainage. You may want them for your fish collection.

The stream contains aquatic vegetation and fresh water shrimp. It is grazed by domestic livestock and heavily silted.

I sent you some cutthroat from Griffin Creek last year, and as I recall, they did not look like these fish. The pictures of this sample will be back in a week and I will send you some.

If you could determine what variety of cutthroat these are it would help. The Forest is in the process of doing land use allocation in the Griffin Creek drainage. If there is a unique fish present, the planning will reflect some concern.

Attached is a list of the fish samples I sent in from the Flathead National Forest last summer. Hank McKirdy indicated the taxonomic information for them is available. I would like the information so we can start applying it to our long range planning and management.

I am now a zone Fisheries Biologist working the Flathead and Kootenai National Forests. This will enable me to collect fish from the Kootenai River Drainage in Northwest Montana. If you would like some additional samples from that area, please let me know and we will get them for you. I would like to have a reading on fish samples from several Kootenai Forest streams this fall. However, it may be too late to collect samples.

If I can be of any help or you need more information on what I sent you, please call.

Osborne Casey

OSBORNE CASEY
Fisheries Biologist

Enclosure

Whale Crk - big spots

Good Crk - int. -

October 23, 1973

Mr. Osborne Casey
Fisheries Biologist
Flathead National Forest
Kalispill, Montana 59901

Dear Osborne:

Your latest collection from Griffin Creek has not been analyzed yet, but I can provide opinions on the other collections on your list.

Of those in the North Fork of the Flathead drainage--Big, Coal, Hay, Whale, Tuchuck, Spotted Bear, Bunker, Harrison and Upper Twin Creeks--most look like good westslope cutthroat--that is the spotting pattern is similar and the mean values for meristic characters fall within the following range--vertebrae, 61 $\pm$ 0.5; gillrakers, 19 $\pm$ 1.0; pyloric caeca, 35-40; scales, 165 $\pm$ 7.0 and basibranchial teeth present in all specimens. The following exceptions are noted: Whale Creek--spots large, sparse, round and pronounced in outline (atypical of westslope pattern). Also scale counts and vertebrae counts are higher (182.7 and 61.8) than expected. I doubt that the Whale Creek cutthroat population represents a pure, native stock. The fact that 4 of 10 specimens from Bunker Creek lack basibranchial teeth and the mean scale count is 193 for this sample, leads me to the conclusion that Bunker Creek trout have been influenced by hybridization. The other samples are quite uniform but there is some variability in vertebrae and gillraker numbers which leads me to suspect that slight introgression has occurred in the migratory stocks. The samples from Spotted Bear River, Harrison Creek and Upper Twim Creek look like the best bets for pure populations. Only 2 specimens make up the Tuchuck Creek sample and I can't say much about them except that there is nothing to indicate a hybrid influence in these 2 fish.

The Middle Fork Flathead drainage samples (Puzzle, Miner, Clack, Trail, Gateway and Basin Creeks), are generally similar to the North Fork samples. Clack Creek and Basin Creek appear to have the strongest hybrid influence. Puzzle Creek has a high number of gillrakers (20.5) for westslope cutthroat.

Good Creek and Griffen Creek (of Stillwater drainage); Good Creek trout have suspiciously large, round spots and 1 of 8 specimens lack basibranchial teeth, otherwise, the characters are typical of westslope cutthroat. The 3 specimens from Criffen Creek appear to be typical westslope cutthroat but I'll await the analysis of the new, larger, sample before giving you an opinion on them.

One point is obvious from the samples discussed above and that is that many of the samples are from migratory populations which most likely intermingle in the main rivers, but return to their home tributary for reproduction, and this results in different degrees of hybrid influence in the separate stocks. I hope you will be able to obtain samples from the Kuotenai drainage.

Sincerely,

Robert Behnke

RB:vv

cc: Mr. Henry McKirdy
Jim Roscoe

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Flathead National Forest
Kalispell, Montana 59901

2610
January 3, 1973

Mr. Robert Behnke
Assistant Unit Leader
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, CO 80521

Dear Mr. Behnke:

The cutthroat trout collection on the Flathead Forest were sent to you earlier this fall. This letter is to give you the information about the areas sampled. Not all of the waters checked had cutthroat trout present, but a variety of streams were sampled.

No fish were collected east of the Continental Divide because of problems with the pack horses. No cutthroat were collected from the Kootenai River drainage; an attempt in July was unproductive, and I did not get back to the area this fall. The areas can be checked next year if you are still interested.

Colored slides were taken of fish from most streams. Enclosed are the better pictures. They may give you a better idea of the true color.

Several areas were sampled where no cutthroat have been stocked and above barriers where the population is presently isolated. Bunker Creek and Gateway Creek are the most isolated population, and no record of fish planting in these areas exists (Holton's letter dated August 17, 1972). The Bunker Creek fish certainly look different than the Spotted Bear River fish.

The fish from Bunker Creek look more like Yellowstone Blackspots than westslope cutthroat to me.

The migratory fish were not sexually mature in August and September, whereas resident (non-migratory fish) located above barriers appear to have a later spawning period. Males were still ripe in August or September.

The non-migratory fish look like the Bunker Creek, Dean Creek, Hay Creek, and Good Creek fish, while the migratory cutthroat from Big Creek, Harrison Creek, Coal Creek, and Spotted Bear River look similar to Hungry Horse Creek fish or the cutthroat I've seen from Flathead Lake.

Joe Huston, Fish Biologist of the Montana Fish and Game Department, does not agree. He believes they all look like migratory fish from Hungry Horse Creek. My only question is how he knows the two separate-looking fish are both migratory. Maybe your analysis will reveal some other difference (if there is one). I do not have enough data to show there is any real difference. The non-migrators spawn much later, but this may be due to elevation and water temperatures.

There are differences in behavior such as the Dean Creek fish staying in the small headwaters areas. Puzzle Creek cutthroat do not stay in the headwaters in the same numbers. There is evidently a downstream drift during the late fall and an upstream movement by August and September.

Except for Whale Creek above Whale Falls, the streams with non-migratory fish populations, such as Hay Creek, Tuchuck Creek, Bunker Creek, Upper Twin Creek, and Gateway Creek appeared to have the largest standing crop of fish. Streams that contained migratory populations, such as Puzzle Creek, Big Creek, Coal Creek, Harrison Creek, and Spotted Bear River generally had a smaller standing crop of cutthroat. This is only a general observation, and a number of factors influence the number of fish present in a stream. However, it appears there may be some density differences between the migratory and non-migratory fish populations.

The streams that showed evidence of heavier fishing pressure had fewer fish with the exception of Hay Creek. As easy as the cutthroat are to catch, it is easy to see how fishing pressure would reduce them.

If you find anything significant and need some more information, let me know.

Sincerely,

Osborne Casey

OSBORNE CASEY
Fishery Biologist

Enclosures

NAMES AND LOCATION OF STREAMS
SAMPLED ON THE FLATHEAD FOREST - 1972

North Fork of Flathead Tributaries

Big Creek, T. 33 N., R. 21 W., Section 29.? Species present include whitefish, grayling, Dolly Varden, suckers, and cutthroat. Fish from Flathead Lake migrate into Big Creek to spawn. This drainage has been closed the entire year to all fishing since 1956.

Coal Creek, T. 34 N., R. 21 W., Section 29. Species present include whitefish, Dolly Varden, grayling, cutthroat, squawfish, and suckers. Fish migrate into Flathead Lake. This stream was closed to fishing in 1956 also. There appears to be excellent fish population present.

Hay Creek, T. 35 N., R. 22 W., Section 32. Cutthroat. Stocked in 1953. Fish can migrate into the North Fork, however, they apparently stay in Hay Creek their entire life. This stream is open to fishing. Males still ripe for spawning on 8/23/72. This drainage heavily clearcut with some increase in water temperatures documented. Fish population excellent; caught 20 cutthroat in 45 minutes. No pictures available, as fish were caught very late in the day.

Whale Creek, T. 36 N., R. 24 W., Section 36. Cutthroat. Stream has a natural falls, which prevents fish from the river entering the headwaters. Planted in 48 and 49, cutthroat; 1950, Dolly Varden; 1951, Dolly Varden and cutthroat, and 1952 with cutthroat. Stream is open to fishing above Whale Falls. Male cutthroat were still ripe for spawning on 8/24/72. No Dolly Varden found above the Falls.

Tuchuck Creek, T. 37 N., R. 23 W., Section 33. Cutthroat and Dolly Varden only species recovered. Stocked in 1952 with cutthroat. Fish may migrate upstream during high water, but, cannot move downstream in the late summer and fall because the entire flow goes underground for several miles.

Spotted Bear River, T. 25 N., R. 13 W., Section 16. This stream has whitefish, Dolly Varden, cutthroat, northern squawfish, and suckers. Cutthroat from Hungry Horse Reservoir migrate up to Dean Falls. Cutthroat appear similar to Hungry Horse Creek cutthroat. Silver fish with spotting over entire back. Whitefish and squawfish very abundant.

Silvertip Creek, T. 25 N., R. 13 W., Sections 28, 33, and 34. No fish. Planted in 1958 with cutthroat. Limestone fault in Section 21 blocks access from the Spotted Bear River. (Stream was probably planted below the falls in 1958.)

Bunker Creek, T. 24 N., R. 16 W., Section 13. Cutthroat. (No stocking records.) Non-migratory fish taken above the Falls. Males appear ready to spawn on 8/28/72. Fish have most of spots back by tail similar to Yellowstone cutthroat. Stream open to fishing. Excellent population; caught 11 cutthroat in 15 minutes. Bunker Creek cutthroat look similar to Hay Creek cutthroat in markings and color.

Lost Jack Creek, T. 24 N., R. 14 W., Section 15. No fish. Stream dry a short distance from the South Fork. Never stocked.

Harrison Creek, T. 24 N., R. 14 W., Section 10. Squawfish, Dolly Varden, and cutthroat - never stocked. Migratory fish from the South Fork. Fish did not appear ready to spawn. Very similar to Spotted Bear fish. Stream fished very heavily near the South Fork.

Upper Twin Creek, T. 26 N., R. 16 W., Section 22.? Cutthroat only, planted 48, 49, and 50. Non-migratory above falls. Fish appear to have spawned earlier than other streams. Stream open to fishing and has good population.

Middle Fork of Flathead River

Puzzle Creek, T. 28 N., R. 13 W., Section 3 and 10. Dolly Varden, whitefish, cutthroat - never planted; migratory fish from the Middle Fork drainage. Stream closed to fishing and has a poor cutthroat population. Dolly Varden spawners from Flathead Lake utilize Puzzle Creek. Found very few cutthroat on July 12. Population had increased when checked again on September 6, 1972.

Miner Creek, T. 27 N., R. 13 W., Section 30. No fish stocked. Non-migratory above the Falls. These fish probably influenced by Scott Lake and Flotilla Lake.

Clack Creek, T. 26 N., R. 12 W., Section 24, 9/15/72. Dolly Varden, cutthroat. Migratory fish. Many Dolly Varden spawners in the Creek.

Strawberry Creek, T. 26 N., R. 11 W., Section 9. No fish collected--could not catch them. Appear to be in the stream, however.

Trail Creek, T. 26 N., R. 11 W., Section 15. Dolly Varden and cutthroat. Planted in 1952 with cutthroat. Migratory population. Fish population dominated by Dolly Varden when sampled.

Gateway Creek, T. 27 N., R. 11 W., Section 35. Cutthroat - no fish stocked. Non-migratory in Big River Meadows. Waterfalls in Gateway Creek Gorge blocks upstream migration. Stream overstocked with small cutthroat. Stream borders the Continental Divide on the west. Should be a "pure" westslope cutthroat. Look like Dean Creek fish.

Basin Creek, T. 25 N., R. 11 W., Section 5. Whitefish, Dolly Varden, cutthroat. Migratory. This is about as far up the Middle Fork as a fish could get from Flathead Lake. This stream borders the Continental Divide on the west.

Stillwater River Drainage

Alder Creek-Good Creek, T. 31 N., R. 25 W., Sections 3 and 9. Eastern brook trout and cutthroat, suckers? Planted in 49 and 50 with cutthroat. Migratory within the Stillwater River most likely. Eastern brook trout dominate the fish population in September, at least. Cutthroat resemble Bunker Creek fish. Stream is open to fishing. Has lots of clearcuts in the upper Alder Creek drainage.

Griffin Creek, T. 30 N., R. 25 W., Sections 25 and 35. Eastern brook trout, suckers, and cutthroat, (planted in 1951 with cutthroat). Fish probably migratory within the Logan Creek drainage above Tally Lake. Eastern brook trout dominate the fish population when sampled. Cutthroat comprised approximately 20% of the fish population. Cutthroat have more the appearance of Flathead Lake fish than Good Creek cutthroat. (Logan Creek planted in 67, 68, and 69 with cutthroat. These fish could get into Griffin Creek.)

Hand Creek, T. 30 N., R. 25 W., Section 32. Eastern brook. Never stocked. No cutthroat. Shocked 100 yards of stream. Overstocked with small brook trout.

NAMES AND LOCATION OF STREAMS
SAMPLED ON THE FLATHEAD FOREST - 1972

North Fork of Flathead Tributaries

*10

60.5 19.9 36.7 42.2, 169.5

Big Creek, T. 33 N., R. 21 W., Section 29. Species present include whitefish, grayling, Dolly Varden, suckers, and cutthroat. Fish from Flathead Lake migrate into Big Creek to spawn. This drainage has been closed the entire year to all fishing since 1956.

*11

8.1 61.5 19.8 37.5 42.4, 169.7

Coal Creek, T. 34 N., R. 21 W., Section 29. Species present include whitefish, Dolly Varden, grayling, cutthroat, squawfish, and suckers. Fish migrate into Flathead Lake. This stream was closed to fishing in 1956 also. There appears to be excellent fish population present.

*12

6.6 1 + 2.0 w/o ~~N 2 8-12~~ 61.75 17.9 35.4 41.4 173.5 9.1 2-8 4.5

Hay Creek, T. 35 N., R. 22 W., Section 32. Cutthroat. Stocked in 1953. Fish can migrate into the North Fork, however, they apparently stay in Hay Creek their entire life. This stream is open to fishing. Males still ripe for spawning on 8/23/72. This drainage heavily clearcut with some increase in water temperatures documented. Fish population excellent; caught 20 cutthroat in 45 minutes. No pictures available, as fish were caught very late in the day.

*11

61.8 big spots 19.0 37.9 41.6, 182.7 9-10 ≥11 10.9

Whale Creek, T. 36 N., R. 24 W., Section 36. Cutthroat. Stream has a natural falls, which prevents fish from the river entering the headwaters. Planted in 48 and 49, cutthroat; 1950, Dolly Varden; 1951, Dolly Varden and cutthroat, and 1952 with cutthroat. Stream is open to fishing above Whale Falls. Male cutthroat were still ripe for spawning on 8/24/72. No Dolly Varden found above the Falls.

*3

N 2 O.K.

Tuchuck Creek, T. 37 N., R. 23 W., Section 33. Cutthroat and Dolly Varden only species recovered. Stocked in 1952 with cutthroat. Fish may migrate upstream during high water, but, cannot move downstream in the late summer and fall because the entire flow goes underground for several miles.

*10

60.5 19.3 38.3 41.4 164.7 ≥11 6.0

Spotted Bear River, T. 25 N., R. 13 W., Section 16. This stream has whitefish, Dolly Varden, cutthroat, northern squawfish, and suckers. Cutthroat from Hungry Horse Reservoir migrate up to Dean Falls. Cutthroat appear similar to Hungry Horse Creek cutthroat. Silver fish with spotting over entire back. Whitefish and squawfish very abundant.

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*10

Bunker Creek, T. 24 N., R. 16 W., Section 13. Cutthroat. (No stocking records.) Non-migratory fish taken above the Falls. Males appear ready to spawn on 8/28/72. Fish have most of spots back by tail similar to Yellowstone cutthroat. Stream open to fishing. Excellent population; caught 11 cutthroat in 15 minutes. Bunker Creek cutthroat look similar to Hay Creek cutthroat in markings and color.

10 61.0 18.2 37.4 169.7 42.4, 193.1 × 44.1 × 4.2 10 w/o

~~Lost Jack Creek, T. 24 N., R. 14 W., Section 15. No fish. Stream dry a short distance from the South Fork. Never stocked.~~

*9

Harrison Creek, T. 24 N., R. 14 W., Section 10. Squawfish, Dolly Varden, and cutthroat - never stocked. Migratory fish from the South Fork. Fish did not appear ready to spawn. Very similar to Spotted Bear fish. Stream fished very heavily near the South Fork.

60.25 19.3 36.1 43.4, 165.1 1 of 9 w/o

*10

Upper Twin Creek, T. 26 N., R. 16 W., Section 22. Cutthroat only, planted 48, 49, and 50. Non-migratory above falls. Fish appear to have spawned earlier than other streams. Stream open to fishing and has good population.

60.5 19.7 10 35.6 41.2, 166.0 #11 7.8

Middle Fork of Flathead River

*18

Puzzle Creek, T. 28 N., R. 13 W., Section 3 and 10. Dolly Varden, whitefish, cutthroat - never planted; migratory fish from the Middle Fork drainage. Stream closed to fishing and has a poor cutthroat population. Dolly Varden spawners from Flathead Lake utilize Puzzle Creek. Found very few cutthroat on July 12. Population had increased when checked again on September 6, 1972.

F-61.5 N=16 20.5 33.3 41.3-166.0 9.1 #11 5.5

*6

Miner Creek, T. 27 N., R. 13 W., Section 30. No fish stocked. Non-migratory above the Falls. These fish probably influenced by Scott Lake and Flotilla Lake.

60.5 N=6 18.3 43.7 37.7, 167.7

43

Clack Creek, T. 26 N., R. 12 W., Section 24, 9/15/72. Dolly Varden, cutthroat. Migratory fish. Many Dolly Varden spawners in the Creek.

61.7 19.0 37.8 42.3 178.7 ×9.5 1 of 6 w/o

Strawberry Creek, ~~T. 26 N., R. 11 W., Section 9. No fish collected--could not catch them.~~ Appear to be in the stream, however.

#9

Trail Creek, T. 26 N., R. 11 W., Section 15. Dolly Varden and cutthroat. Planted in 1952 with cutthroat. Migratory population. Fish population dominated by Dolly Varden when sampled.

9 61.2 19.2 36.6 41.7, 162.4 1 w/o (3.5) 9-10

Gateway Creek, T. 27 N., R. 11 W., Section 35. Cutthroat - no fish stocked. Non-migratory in Big River Meadows. Waterfalls in Gateway Creek Gorge blocks upstream migration. Stream overstocked with small cutthroat. Stream borders the Continental Divide on the west. Should be a "pure" westslope cutthroat. Look like Dean Creek fish.

61.1 18.5 39.7 39.7, 160.3 #11 8.8

(4) 62.0 20.0 38.7 40.7-177.2 11-7.0 8-9(86) *

Basin Creek, T. 25 N., R. 11 W., Section 5. Whitefish, Dolly Varden, cutthroat. Migratory. This is about as far up the Middle Fork as a fish could get from Flathead Lake. This stream borders the Continental Divide on the west.

Stillwater River Drainage

Alder Creek-Good Creek, T. 31 N., R. 25 W., Sections 3 and 9. Eastern brook trout and cutthroat, suckers? Planted in 49 and 50 with cutthroat. Migratory within the Stillwater River most likely. Eastern brook trout dominate the fish population in September, at least. Cutthroat resemble Bunker Creek fish. Stream is open to fishing. Has lots of clearcuts in the upper Alder Creek drainage.

8 (4)-61.0 49.1 38.9 169.5 47.4, 10-8 w10 *3

Griffin Creek, T. 30 N., R. 25 W., Sections 25 and 35. Eastern brook trout, suckers, and cutthroat, (planted in 1951 with cutthroat). Fish probably migratory within the Logan Creek drainage above Tally Lake. Eastern brook trout dominate the fish population when sampled. Cutthroat comprised approximately 20% of the fish population. Cutthroat have more the appearance of Flathead Lake fish than Good Creek cutthroat. (Logan Creek planted in 67, 68, and 69 with cutthroat. These fish could get into Griffin Creek.)

N=2 60,61 N=3 18.7 35.3 39-157 9-10 3-12.0

~~Hand Creek, T. 30 N., R. 25 W., Section 32. Eastern brook. Never stocked. No cutthroat. Shocked 100 yards of stream. Overstocked with small brook trout.~~

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
RIVER BASIN STUDIES
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INT 423

Robert J. Behnke
Colorado Cooperative Fishery Unit
USDI
Room 102, Cooperative Units Bldg.,
Colorado State University
Ft. Collins , CO 80521

OCT 3, 73

Dear Dr. Behnke

THESE ARE THE COEUR d'ALENE RIVER SYSTEM CUTTHROAT I CALLED YOU ABOUT. I WILL APPRECIATE WHATEVER HELP YOU CAN GIVE ON DETERMINING WHICH RACE THEY ARE.

PHIL LAUMEYER

Phil Laumeyer

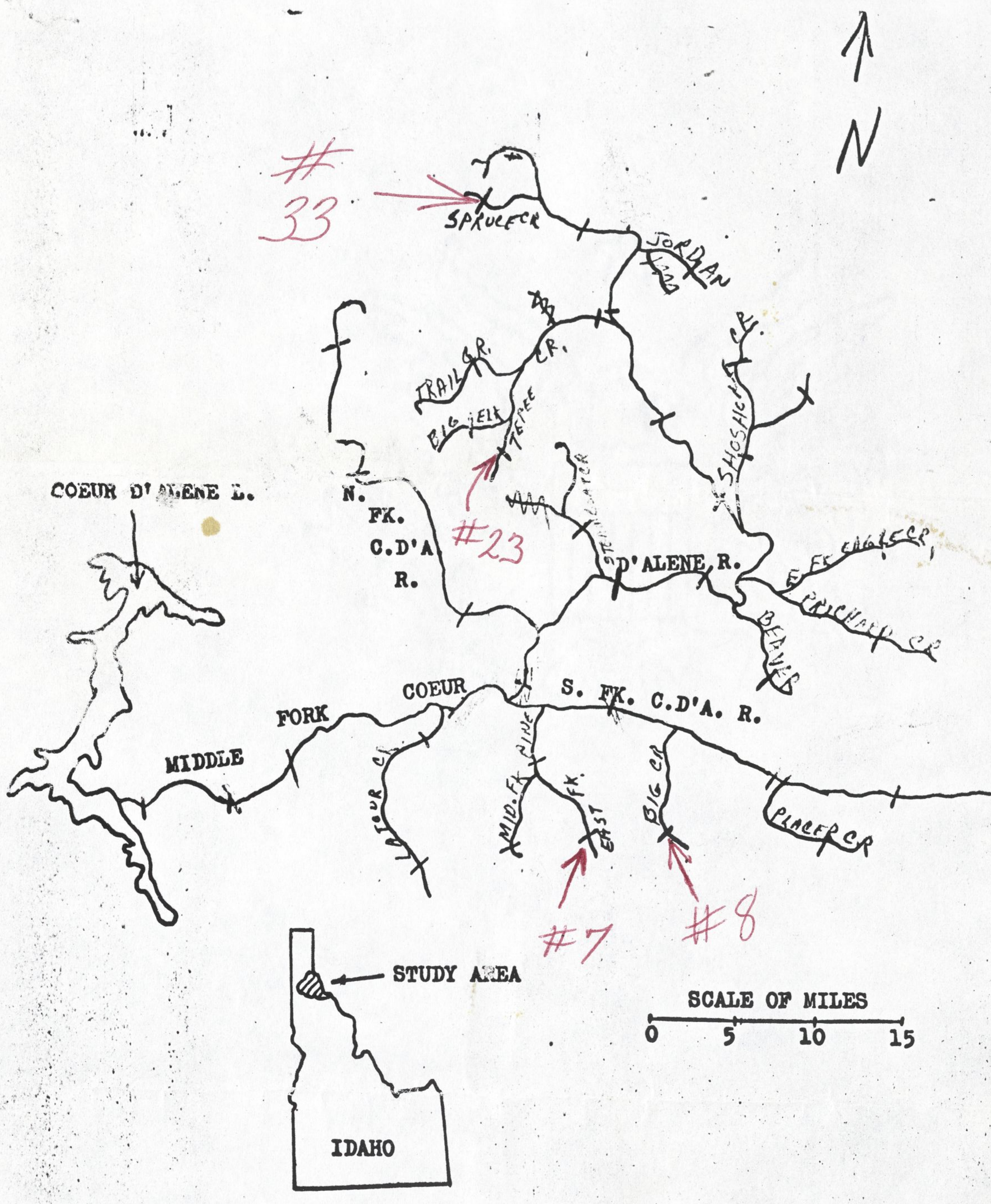
River Basin Studies

RM. 317 P.O. BLDG.

SPOKANE. WA

99201

PHONE 509-456-3832



N
#33
SPRUCE CR
JORDAN
TRAIL CR.
TEPEE CR.
BIG ELK
#23
SHOSHONE CR.
COEUR D'ALENE L.
N.
FK.
C.D'A
R.
D'ALENE R.
PRICHARD CR
BEAVER
COEUR
FORK
MIDDLE
S. FK. C.D'A. R.
PINE
MID. FK
EAST
FK.
BIG CR
PLACER CR
#7
#8
STUDY AREA
IDAHO
SCALE OF MILES
0
5
10
15

COEUR D'ALENE R. FISH

STATE OF MONTANA

DEPARTMENT OF

FISH AND GAME

Route 3, Box 274
Bozeman, Montana 59715

December 17, 1973

Dr. Robert J. Behnke, Assistant Leader
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Dr. Behnke:

We are mailing samples of cutthroat trout that were collected by Mr. Bill Hill. If you need any additional information, you can contact Bill at Box 296, Choteau, Montana 59715.

Sincerely,

LEROY ELLIG
REGIONAL COORDINATOR

John J. Gaffney

By: John J. Gaffney
Regional Fisheries Manager

JJG:plj

cc: George Holton

CUTTHROAT SPECIMENS Collected by Bill Hill

Ref. No. 1
Haywood Creek (Pondera County) T28N-R10W-Sec21
20 miles west of Dupuyer (on Blackfeet Indian Reservation)
Tributary to No. Fk. Birch Creek - Marias Drainage
No other species present.
Barrier present, CT above barrier.
Total lengths of specimens (inches) 7.4, 5.6
Collected August 2, 1972

Ref. No. 2
Sheep Creek (Teton County) T27N-R9W-Sec6
17 miles west of Dupuyer (½ mile below Forest Service boundary)
Tributary of Dupuyer Creek - Marias Drainage
Brook trout also present
Water temp 47°F. TDS 150 ppm NaCl
Lengths (in.) and weights (lbs.) of specimens: 6.7 0.13
Collected August 2, 1972 9.0 0.32
10.8 0.59

Ref. No.3
So. Fk. Dupuyer Creek (Teton County) T27N-R9W-Sec35
15 miles Southwest of Dupuyer (¼ mile above Forest boundary)
Tributary to Dupuyer Creek - Marias Drainage
No other species present.
Barrier present, CT above barrier.
Water temp 47°F. TDS 150 ppm NaCl
Length and weight of specimens: 6.5 0.09
Collected August 3, 1972 7.5 0.15
9.0 0.25

Ref. No. 4 No.Fk. Dupuyer Creek (Teton County) T27N-R9W-Sec14
14 miles Southwest of Dupuyer (1½ miles below Forest boundary)
Tributary to Dupuyer Creek - Marias Drainage
Brook Trout also present
Water temp 46°F. TDS 170 ppm NaCl
Length and weight of specimen: 9.1 0.32
Collected August 3, 1972

Ref. No. 5
No. Fk. Little Badger Creek (Glacier County) T30N-R11W-Sec25
18 miles Southwest of Browning (½ mile above Forest boundary)
Tributary to Badger Creek - Marias Drainage
No other species present.
May be yellowstone cutthroat since this species occurs in Kiyo Lake
on a side drainage and have access to the collection site.
Lengths and weights of specimens: 6.7 0.11
Collected August 31, 1972 7.8 0.17
7.5 0.14
7.6 0.17
9.9 0.38

STATE OF MONTANA
DEPARTMENT OF FISH AND GAME
HELENA, MONTANA 59601

Dr. Robert J. Behnke, Assistant Leader
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
IDAHO PANHANDLE NATIONAL FORESTS
(KANIKSU, COEUR D'ALENE AND ST. JOE)
COEUR D' ALENE, IDAHO 83814

ADDRESS REPLY TO
FOREST SUPERVISOR
AND REFER TO

2630

July 25, 1973

Dr. Robert Behnke
Bureau of Sport Fisheries and Wildlife
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Dr. Behnke:

I am sending five samples collected from streams which have migration blocks. If most are pure strains, we have more pure westslope cutthroat than I thought. There is nothing urgent about analyzing these samples. I may have a few fish from the Kootenai Drainage later this summer.

If you have any suggestions concerning my sampling, send me a line.

Sincerely,

Jim Cooper

JIM COOPER
Fisheries Biologist

Tumbledown Crk. T54N R1W (Sandpoint map)
Careywood Crk. T 24N ? R2W (T54N?)
Bayview Crk + Old Maid Crk (Sandpoint) T54N R2W
Kalispell Crk T36N R45E S.6
W. Gold Crk T53N R1W (Spokane map)

– West Slope

– propagation

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

711 Central Avenue
Billings, Montana 59102

October 12, 1973

– taxonomy
– biology
ST. repts
lit. – Thesis
– life history
~~ana~~ migrato
non m.
– coexistence
– food
– growth
etc
– propagation
– Mont.
– Idaho
– Wash.
– feder govt.

Dr. Robert Behnke
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Bob:

Thank you very much for the reports on rare and endangered species. At this time my discussions with many of those who have worked with Westslope cutthroat trout in this area have only served to confuse me and I am hopeful that you will eventually be able to clear up the taxonomic confusion that now exists.

By copy of this letter I am requesting that Bob Piper of Bozeman Fish Cultural Development Center send to you copies of those portions of our reports dealing with propagation of Westslope cutthroat trout. Most of the cutthroat trout that we have available from Bureau hatcheries in Montana are used in stocking programs on the Flathead Indian Reservation. If you wish, we can provide stocking records over the past several years which will note exactly where hatchery produced fish were placed.

Sincerely,

Jack Larmoyeux

Jack D. Larmoyeux
Hatchery Supervisor

cc: Bob Piper, Bozeman FCDC, Bozeman, MT

DEPARTMENT OF MINES AND NATURAL RESOURCES
ROUTE SLIP

TO Robert Behnke

TO

FROM J J Keleher

FROM

☐ For your approval or revision
☐ For your information
☐ Please take action
☐ Extracts of minutes for your information and action
☐ Please draft reply for signature of

☐ Reply direct with copy to me
☐ Please supply data for my reply
☐ Return with comments and/or recommendations
☐ Investigate and report

☐ Please sign
☐ Please return
☐ Please see me
☐ Please phone

Date Feb. 26/71 Subject

Message Thanks for your letter re splake.
I'm circulating your letter for definite information and will reply at a later date.
Meanwhile here are reprints you requested. Supplement
is out of print but I am hoping to have it reprinted & will

MNR-A-94 Use reverse side if necessary

sent when this occurs.

J J Keleher

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

Larry C. Peterson, Fishery Mgt. Biologist
Bureau of Sport Fisheries & Wildlife
Adams Block, Room 1
P. O. Box 567
Kalispell, Montana 59901

OFFICIAL BUSINESS

[ca 1973]

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

Post Office Box 567
Kalispell, Montana

March [illegible]

Dr. Robert Behnke
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Dr. Behnke,

During the past year I have had the opportunity to collect fish specimens from the Pacific and Hudson Bay drainages of Montana. Sampling of the Hudson Bay drainage (Kennedy Creek Forks and Divide Creek) has not yielded cutthroat specimens to date. We do feel that cutthroat trout currently inhabit this system within the Black feet Indian Reservation and even though no specimens were obtained in that area during 1972 a continuing effort for collection is planned.

Sampling in the Flathead drainage of the Flathead Indian Reservation area has yielded a number of cutthroat specimens over the years. I am specifically interested in the taxonomy of cutthroat specimens from several small drainages but only possess specimens from two of these drainages. Cutthroat trout specimens from Revais and Crow Creeks are being mailed to your Unit for reference.

I realize that you have never expressed interest in obtaining fish specimens through our Kalispell Montana Office. Hopefully, the submission of the above cutthroat to your laboratory will be acceptable.

Sincerely yours,

Larry C. Peterson
Fishery Management Biologist

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
COLORADO COOPERATIVE FISHERY UNIT
COLORADO STATE UNIVERSITY
FORT COLLINS, COLORADO 80521

February 28, 1974

Mr. George Holton
Montana Department of Fish and Game
Helena, Montana 59601

Dear George:

I received several reports regarding Hungry Horse Reservoir and Flathead Lake cutthroat trout. Many thanks. We'll incorporate some generalized life history and ecology data in the thesis on westslope cutthroats. Which reminds me that there is really a paucity of detailed information on their ecology in various environments. Has any thought been given to expanding the Hungry Horse investigations to obtain data on feeding habits and degree of niche separation and overlap with the Dolly Varden, whitefish and suckers? What you need to know for intelligent management and effective utilization of hatchery raised fish would be: is natural recruitment fully adequate to maintain the Hungry Horse Reservoir cutthroat trout fishery at maximum levels (if so, then adding hatchery raised trout would be like pouring water into a bucket already full)? If not, what size fish stocked at what time and in what place, would provide the best return per dollar invested? Do you have any data on the contribution to the catch from stocked trout vs wild trout in the Hungry Horse fishery?

I received an abstract from Gary Reinitz. His conclusions support ours that the westslope and eastslope cutthroat are very similar and both are distinct from Yellowstone cutthroat. Reinitz has gone a step too far however, in the implication that the westslope cutthroats is more closely related to the rainbow trout than it is to the Yellowstone cutthroat trout. I suspect he based this on analysis of the esterase enzyme, which is subject to rapid evolutionary change and convergent evolution--much like the phenomenon that lacustrine populations of a species tend to increase the number of gillrakers (given several thousand years of isolation). This type of character (rapid evolutionary change and convergence) can lead to highly erroneous conclusions on relationships and taxonomy. I just thought I should tell you this so you aren't led to make a statement or give a news release that "modern technology" demonstrates that westslope cutthroats are derived from S. gairdneri and not S. clarki. Enclosed is a copy of my letter to Reinitz. You note Gary is looking for a job and I suggest he contact you if he already hasn't. I also suggest that a group interested in Montana native trout might be assembled at the Montana Academy of Sciences meeting for a session.

I haven't seen the cutthroat from Little Belt Creek. I note that Hanzel listed rainbow from the creek and cutthroat from two tributaries. A sample from a tributary of the Judith River, nearby, are obvious hybrids, so before an introduction is made into a barren stream it would be a good idea to send a sample down to check the purity.

Yes, I would like to review and edit Vincent's paper. It looks like his work is finally bearing fruit after all these years.

As I told you in my last letter I will be resigning from the Bureau. I have no firm commitments for the future. My desire to continue working with rare trouts, which just couldn't be done if I accepted a transfer, led to my decision. This action has caused some people to view the situation as simply incredible (with which I must agree)--that the Bureau of Sport Fisheries, who is charged with protection and research on rare and endangered fishes, is forcing the termination of their only employee actively doing research on rare fishes, because he wants to continue and expand this work.

I am always the optimist however, and the situation may not be as bleak as it appears. In fact, it is probable that I can continue and expand my work and do more for rare fishes as a non-Bureau employee. I base this on the 1973 Endangered and Threatened Species Act, P.L. 93-205, which provides strong incentives for states (or groups of contiguous states to implement their own program for the management and preservation of all species deemed threatened within their boundaries. If a state develops an acceptable program they may recieve federal funds to cover 2/3-3/4 of the costs of administering this program (research, managment, and aquisition, etc.) Colorado may be elligible for $300,000 in federal funds under this law. If a state fails to act, the federal government assumes control of the program. States in the Rocky Mountain region are in the fortunate position that several subspecies of native trout are threatened (subspecies are treated equally as species under the law). This means that research and recovery programs for these trouts are elligible for federal funding and can also be worked into the regular fisheries managment plans of the state. For example, Montana and Idaho may join in a project on westslope cutthroat and Montana and Wyoming on eastslope cutthroat.

The most obvious way for a state to develop a viable plan for threatened fishes would be by contracting for research with a University and with my past experience and present involvement I beleive I am best qualified to handle these projects. This would entail complete documentation of all potentially threatened fishes, game and non-game. The geographical area I am considering is large, the threatened fishes numerous and the problems many. Presently, Dr. Richard Wallace of the University of Idaho is on sabbatical leave and working here with me and the students on the systematics of the westslope cutthroat. We have standardized our methods and techniques of making counts and measurements of specimens so our data is repeatable and interchangeable. This will allow Dr. Wallace to supervise studies similar to my own at the University of Idaho and in the future it is likely we would work as a team to tackle large scale projects such as our present cooperative venture on the westslope cutthroat, where the species crosses state boundaries. Once the systematic research is completed, pure stocks can be selected for re-introductions in cooperative programs with federal agencies such as the Forest Service, Park Service, and B.L.M. This would be a strong lever to have these agencies institute good habitat managment plans in areas selected to restore or protect a threatened species.

Another venture I am proposing is to develop a series of brood stock ponds on C.S.U. lands to hold pure stocks of several forms of threatened western trouts (See enclosed abstract of talk presented to C.S.U. Experiment Station Research Conference). These ponds would be designed to produce 100,000 to 1,000,000 eggs per year for propagation to establish new populations and for ecological evaluation to obtain data on their potential role in fisheries management. I believe, if the states involved contribute to this project, we can take and ship eggs for a threatened fish program more economically than the states can do it individually--and provide basic information on the ecological potential of these trout at the same time.

The states must submit threatened species plan to the Dept. of Interior within about a year (November 28, 1974 in Colorado). Are Montana Fish and Game administrators and commissioners fully aware of the implications of the 1973 Endangered and Threatened Species Act? I will go to Denver on April 1 for a meeting where I hope to get the latest word on the implementation and ramifications of this act.

I am hoping that I can organize research on rare fishes to provide information to various states and help these states develop and run their programs based on financial support contracted through the university and funded under the 1973 Endangered and Threatened Species Act.

Sincerely,

Robert Behnke

RB:vv

Enclosures

THE UNIVERSITY OF MICHIGAN
ANN ARBOR, MICHIGAN, U. S. A. 48104

MUSEUM OF ZOOLOGY

May 23, 1974

Dr. Robert Behnke
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Bob:

Thank you very much for writing to Fred Kircheis about Sunapee trout introductions. I appreciate your taking care of this.

About two weeks ago I had a letter from Tony Echelle stating that he had just received and sent back to the editor galley proof of the Cyprinodon bovinus paper. Presumably, therefore, this will be out this coming summer.

Clark was a bit mixed up on who is describing what species of Cyprinodon but I don't blame him. Tony will describe the Pecos pupfish but I have no idea what is the status of the manuscript. I intend to describe the Devil's River pupfish but there is no manuscript yet. Doug Jester prepared a life-history paper of the Tularosa pupfish which was to go along with the description of this new species by myself and Echelle. Our paper was accepted for publication in the Southwestern Naturalist but Doug's was rejected. I have heard nothing from the editor for over a year so I don't anticipate that the description of the Tularosa pupfish x will appear in that journal before 1975 or even 1976. They appear to be even farther behind in publishing manuscripts than is COPEIA (a letter just received from Clark Hubbs states that the 1975, No. 3, issue of COPEIA is already filled).

We will be glad to have the trout specimens although I am not quite sure what you mean by the provisional designation of a type specimen for Salmo clarki alvordensis. Our cataloguing system is such that if you are not sure you wish to use this specimen for the holotype, then we will enter the data in pencil so it can be changed when your manuscript is completed. Do you have some kind of a rough estimate as to when that might be?

I am much interested in what you say about the subspecies of Salmo clarki, and am pleased that you were able to get good material of this species from the South Saskatchewan River basin. What you say about the invasion of Salmo gairdneri and the appearance of genes of that species within populations of Salmo clarki makes a lot of sense in explaining the peculiar scale and other counts recorded by Evermann and Gilbert in their early investigations of the trout of the upper Columbia basin. Your reference to these specimens as probably representing redband trout is an interesting suggestion to ponder. I am wondering whether this group might represent a complex.

When may we expect to see a published description of the undescribed fine-spotted cutthroat trout of the upper Snake River? This form has been known

x common name we use is White Sands pupfish to scientists and fishery biologists for almost 15 years and I would hope that the description would be forthcoming soon. We have a fine collection of it here and if there is anything I can do to expedite getting it described let me know. But remember I am still on sabbatical leave and will not be doing any research other than that on Mexican fishes until September 3, at which time this leave terminates. I will be leaving here on June 16 for the Ottawa meetings and will then go back to USNM for the rest of the summer. If there is anything there in the way of trout specimens that I can check let me know. I did find perhaps the only extant specimen of the native trout that once occurred in Deep Creek, Utah. The specimen is FMNH 260, collected by Yarrow in August, 1884. It is in a jar catalogued as *Salmo mykiss*. Unfortunately the specimen was once badly dried; it is about 134 mm S.L., has *at least* 32 basibranchial teeth and *at least* 12 gill rakers on the lower rim plus one in the angle plus an undetermined number on the upper limb. It looks as if the specimen were received (or catalogued) in December, 1895; it came as a gift from USNM. I obtained these data on April 26, 1974, when I was visiting FMNH.

*

Sincerely,

Bob

Robert R. Miller
Curator of Fishes

RRM:mw

cc: Carl L. Hubbs

P.S. Don Seegrist commented on March 11 that he heard you were leaving the Fish & Wildlife Service. Wherever did he get that information?

R. R. Miller
THE UNIVERSITY OF MICHIGAN
MUSEUM OF ZOOLOGY
ANN ARBOR, MICHIGAN, U. S. A. 48104

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UNITED STATES

VIA AIR MAIL

Dr. Robert Behnke
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Kendall's coll.?
steel tank

- coll. Col. R. –
Snake R. – downstream
limits, fine spotted.
- red band? -

-
Deep Ck. vitaly
spec.

Cyprinodon

state of utah

DIVISION OF WILDLIFE RESOURCES

JOHN E. PHELPS
Director

1596 West North Temple / Salt Lake City, Utah 84116 / 801-328-5081

December 12, 1974

Dr. Robert Behnke
Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Dr. Behnke:

We understand that you have the most complete accumulation of information on cutthroat trouts of the Great Basin. To allow the Division to maintain an up-to-date position and best carry the responsibilities of management, we are interested in acquiring the knowledge now available regarding the species and subspecies in the Great Basin. We would very much appreciate receiving the information that is available through your work and your conclusions and thinking on this group as it now stands. We would be happy to obtain any reports, papers, significant presentations, or the sources of such, prepared by you or fellow workers.

A few (but by no means all) of the questions we have relate to the presently known locations of alleged Utah cutthroat. We also understand that there are known populations of alleged Colorado River cutthroat from California, Wyoming, and Colorado other than the Utah location on Little West Fork Blacks Fork River. We understand considerable information is available on the meristematic and genetic characters of these two fishes and the Snake Valley cutthroat, and that you feel a subspecies in western Utah and eastern Nevada (Snake Valley cutthroat) is justified.

I realize that these types of requests often entail a considerable amount of time and effort. However, since the material may be useful to us, we will appreciate any effort you can make to provide the data requested.

Sincerely,

John E. Phelps, Director

D.

Donald Andriano
Chief of Fisheries

STATE OF UTAH
Division of Wildlife Resources
1596 West North Temple
Salt Lake City, Utah 84116

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1974

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Dr. Robert Behnke
Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

THE DENVER POST
THE VOICE OF THE ROCKY MOUNTAIN EMPIRE
DENVER, COLORADO 80201

May 3, 1974

Mr. Bob Behnke
Cooperative Fishery Unit
Colorado State University
Fort Collins, Colo.

Dear Bob:

Thanks for the information on the Pyramid trout and for your comments on the hatchery vs wild trout question.

I wonder if you would give me permission to send copies of the letter to Withers Cool and Jack Grieb, or in lieu of that, have you write your own letter to those two men. Coming from a man who commands the respect you do in fisheries circles, the comments might sink in.

Let me know what you think of the idea.

Sincerely,

Bob Saile

Bob Saile

Mr. Bob Saile
The Denver Post
P.O. Box 1709
Denver, Colorado 80201

Dear Bob:

I would have no objections if you made ~~used~~ copies of my last letter for Mr. Cool (and other commissioners) with a copy to Jack Grieb. It might be a beginning at gaining acceptence of a more rational and scientifically based fish management program.

~~There is~~ I see no problem ~~to~~ for the ~~implementing~~ implementation of sound programs with Jack Grieb. Jack has the most impressive scientific credentials of any fish and game director in the country. Nor is there a lack of competence, or ideas in the staff of biologists ~~with~~ employed by the department. The fact is, however, that policies and programs are largely governed by the commission and often the comissioners, beleiving they are acting in the best interests of their constituents, assume a stand antagonistic to the position of the professional staff of the department.

In the matter of the role of catchable trout in the fisheries management program, I think it would help if the commissioners ~~had~~ understood the facts already compiled by the fisheries people. ~~Then~~ After many years of turmoil, the commissioners in Montana finally accepted the data compiled over many years by fisheries biologists and prepared a new ~~guide~~ policy on the use of hatchery trout. Essentially, the Montana policy states that ~~streams~~ high quality streams with adequate natural reproduction ~~be~~ will be managed for wild trout.

~~fisheries.~~ Hatchery ~~Catchable~~ trout will be stocked mainly in ponds, lakes and reservoirs and in lower, more marginal sections of streams, particularly along roadsides, campgrounds and urban areas.

I think it would be enlightening if the Colorado commissioners had all the facts and understood the reasons ~~behind~~ which led the Montana commissioners to come up with their new policy.

The question is not one of ~~hatcheries~~ of yes or no with hatchery trout. The ~~It is~~ pertinent questions to be faced are: ~~how~~ what proportion of the budget should ~~be~~ taken up to produce catchables? How can costs ~~to~~ be ~~so~~ more equitably distributed ~~the costs of catchables~~ among ~~to~~ those who derive the benefits of catchables and/or how to spread the catch among ~~ms~~ a greater proportion of the license buyers?! Implied in these questions is the degree of emphasis to be given to environmental protection and improvement in relation to fisheries based on wild, self-maintaining trout populations.

Sincerely yours,

Saile--Sports

THE
DENVER
POST

P.O. BOX 1709
DENVER, COLORADO 80201

THE
VOICE
OF THE
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EMPIRE

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337280

Mr. Robert Behnke
Cooperative Fishery Unit
Colorado State University
Fort Collins, Colo. 80521

STATE OF MONTANA

DEPARTMENT OF

FISH AND GAME

Helena, Montana 59601

May 6, 1974

Dr. Robert J. Behnke
Colorado State University
Fort Collins, Colorado 80521

Dear Bob:

It was good seeing you Saturday. I am extremely sorry I didn't have more time to get together with you, Dr. Wallace, John, Jim and Dave. I had talked to John and knew he and Jim were on the program. However, I did not realize anything had been firmed up on your coming or that Dr. Wallace would accompany you. By the time I realized you were there I was completely bound up with a commitment to judge student papers, and a noon meeting of bird counters from across the State. And then, of course, the Montana Academy of Sciences meeting lasted until 4:30 p.m. instead of terminating in early afternoon as in previous years. I regret we did not have an evening meeting or even one on Sunday morning and feel that not getting together with you was indeed an opportunity missed. This is particularly true since we are now trying to get a nongame and threatened species program underway due to the impetus given by the new Federal law.

As you know, I am a member of a group headed by Dr. Bill McConnell and Dr. Eric Bergersen that is exploring the application of computer modeling to lake management. I assume this will involve a trip to Fort Collins sooner or later. Perhaps at that time we could have a meeting on Montana cutthroat. We most appreciate the fine work you and your students have done on cutthroat taxonomy.

Kindest personal regards,

George

GEORGE D. HOLTON
ASST. FISHERIES DIVISION ADMINISTRATOR

GDH/pl

STATE OF MONTANA
DEPARTMENT OF FISH AND GAME
HELENA, MONTANA 59601

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DR. ROBERT J. BEHNKE
COLORADO STATE UNIVERSITY
FORT COLLINS, COLORADO 80521

[Mar, 1974]

Dept. of Zoology
University of Montana
Missoula, Montana 59801
(406) 243-0211

Dear Dr. Behnke,

I received your letter this morning and I understand the point you are making. I am fully aware of the problems of denoting the phylogenetic affinities of trout merely on the basis of a few characters whether they be biochemical or morphological. However, when serum protein frequencies were examined with complete disregard for esterase frequencies the same affinity of westslope cutthroat trout for rainbow trout was noted. It is for this reason that the relationship was emphasized. I will send you a complete copy of my thesis next week as the printing service has informed me that it should be available this Friday. I hope once you have read it that many of the misunderstandings that we have had in the past will be cleared up.

I would be very interested in having an informal discussion on the native trout of Montana. I am going to try to attend the meeting in Bozeman if time permits and I will look forward to speaking with you then. Also I would appreciate it very much if you would send me a copy of the thesis or report that deals with the trout that I collected for the Forest Service in the summer of 1972 which were subsquently sent to you.

Sincerely yours,

Gary Reinitz

Gary Reinitz

cc: G. Holton

Dept . of Zoology
University of Montana
Missoula, Montana 59801

MISSOULA MONT. MAR-5'74 U.S. POSTAGE 13 PB METER 636125

Dr. Robert Behnke

Colorado Cooperative Fishery Unit

Colorado Stat e University

Fort Collins, Colorado 80521

VIA AIR MAIL

STATE OF MONTANA

DEPARTMENT OF

FISH AND GAME

Helena, Montana 59601
February 20, 1974

Dr. Robert J. Behnke
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Bob:

I am enclosing a copy of our D-J report F-34-R-6 Job III-a, and have asked our people at the regional office in Kalispell to send you copies of other reports on westslope cutthroat.

I do hope you make the Montana Academy of Sciences meeting. Gary Reinitz has completed his study at the U of M so this meeting would be an excellent time to evaluate what has been accomplished and set our future course.

A copy of our guidelines for planting catchable trout in streams is enclosed. Vincent's paper on the Madison-O'Dell study is in the second draft stage. We are going to polish it up a bit more and then send it to several fisheries scientists across the country for review. Would you have the time and inclination to take a good, hard look at it? If so, we'd gladly send you a copy of the review draft.

Your idea of using ponds and reservoirs in reclaimed strip-mined land for research on native trouts may have potential. Some coal companies have already included ponds in their reclamation contracts, apparently feeling this is an easy out. If there are a great number of ponds, we certainly won't be able to manage them all with catchables so using some for experimental ponds may well be feasible.

I am glad to hear you plan to stay at CSU. Incidentally, Dick Johnson our fisheries manager at Great Falls wants to establish a population of pure strain native cutthroat in South Fork Birch Creek above an existing fish barrier. To our knowledge, there have never been trout above this barrier. He plans to gather stock for transplanting from Little Belt Creek. Little Belt Creek is in a remote area and has never been stocked, so as far as we can tell the cutthroat here are uncontaminated. If we were able to get a sample, would you be able to examine them for us and give your opinion as to their purity?

?

Kindest personal regards,

George

GEORGE D. HOLTON
ASST. FISHERIES DIVISION ADMINISTRATOR

GDH/pl
Encls.

MONTANA DEPARTMENT OF FISH AND GAME
FISHERIES DIVISION

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

State Montana — Title Reservoir Investigations

Project No. F-34-R-6 — Title Life History Studies of Westslope Cutthroat trout

Job No. III-a

Period Covered July 1, 1971 through June 30, 1972

ABSTRACT

A fish trap was operated on Hungry Horse Creek from May 25 through July 27, 1971. An estimated 703 adult westslope cutthroat trout (Salmo clarki subsp.) entered the creek for spawning. The 1971 spawning run included 131 repeat spawners that had spawned in Hungry Horse Creek in 1968, 1969 or 1970. Downstream escapement of spent fish was 256 including 52 repeat spawners. The downstream trap also caught 1,951 juvenile cutthroat trout as they moved toward Hungry Horse Reservoir.

Sex ratio of the adult fish was 1.0 males to 6.2 females. Several females caught in the downstream trap were examined internally and found to contain eggs starting to be reabsorbed. Concern is expressed that insufficient adult males may be present. Sex ratio of cutthroat trout gill netted in the reservoir in 1970 was determined to be 1.0:1.8 males to females while sex ratio of 103 outmigrant juveniles caught in 1971 was determined to be 1.0:1.9.

The wooden inlet structure regulating flows into the bypass channel was replaced with a concrete structure.

BACKGROUND

An upstream-downstream fish trap has been operated in Hungry Horse Creek annually since 1968. Numbers of westslope cutthroat trout spawning in Hungry Horse Creek and numbers of outmigrant juvenile fish leaving the creek during the period of peak outmigration have been determined yearly. The long term objectives of this project have been to delineate some of the spawning and rearing characteristics of the westslope cutthroat, their movement patterns in the reservoir environment and the reservoir population of cutthroat trout.

OBJECTIVES

The objectives of this job were to: (1) determine numbers of adult cutthroat spawning in Hungry Horse Creek, (2) determine downstream escapement of spent adult fish, (3) determine downstream escapement of juvenile cutthroat trout during period of greatest movement, (4) correlate upstream and downstream cutthroat movement with stream volumes and temperatures and (5) replace the wooden bypass channel headgate with a concrete structure and perform other needed maintenance.

PROCEDURES

The upstream fish trap was operated continuously from May 25 through June 26, 1971. Adult fish captured were measured in total length, sexed, had scale samples taken (some fish), were examined for identifying marks and released upstream. Spent fish released from the trap in 1968, 1969 and 1970 were each given a fin-clip or tag singular to that year. Captured repeat spawners bearing a tag would, in addition, be given a fin-clip signifying the year. As an example a fish re-entering the trap to spawn in 1971 could have a fin-clip from 1968, plus a jaw-tag and fin-clip from 1969 plus another fin-clip from 1970.

Juvenile fish released from the downstream trap in 1969 and 1970 were marked by fin removal or jaw-tags. The jaw tags were color coded or numbered so that they were different from tags used in spent adult fish. Fin-clips were selected so that chance of mixing between the juveniles and spent adults would be minimized. Noting of marks and tags on fish in 1971 enabled project personnel to determine fish that were first-time spawners in Hungry Horse Creek, spawners marked as smolts returning to the natal stream to spawn or repeat spawners.

In 1971, adult fish entering the upstream trap were marked by removal of the right posterior tip of the pre-maxillary bone.

The downstream trap was placed into operation and fished continuously from June 18 through July 27, 1971. Spent adult fish caught were measured, sexed and examined for identifying marks. If a fish carried a combination of marks which included the pre-maxillary clip, it was released downstream. Fish with only the pre-maxillary clip were tagged with a numbered jaw-tag and released. All adult trout were given a pre-maxillary clip either passing upstream or downstream and a numbered jaw tag passing downstream.

Juvenile trout caught in the downstream trap were enumerated and released downstream. A large sample were measured for total length. A total of 104 were killed and sex determinations made.

Stream temperatures through the period of trapping were collected using a 31-day continuous recording thermograph. Stream volumes during the same period were obtained from a U.S. Geological Survey continuous flow recorder. These data will not be included in this report but are on file at Regional Headquarters, Montana Department of Fish and Game, Kalispell, Montana.

FINDINGS

The upstream trap was fished from May 25 through June 26, 1971 and the first ripe adult cutthroat trout was captured May 26th. A total of 81 males and 562 females (determined by external characteristics) were captured by the upstream trap and the estimated total run was calculated to have been 97 males and 606 females. The estimated total spawning population was calculated from the ratio of unmarked to marked (pre-maxillary clip) fish caught in the downstream trap. Spent fish caught in the downstream trap totaled 256. There were 30 males of which two were unmarked and 226 females of which 16 were unmarked.

Male fish averaged 13.8 inches total length and ranged from 9.0 to 16.2 inches. Females averaged 14.1 inches and ranged from 12.4 to 16.1 inches total length. Average size of the females and range of size of females and males conformed closely to data collected in 1970. Average size of the males measured in 1971 was 0.3 inches smaller than that found in 1970.1/ It was noted that in 1971 most of the males were either less than 13.0 inches or larger than 15.0 inches. Most of the female fish were closely arrayed around the average size.

Sex ratio of the 1971 spawning run was calculated to be 1.0 males to 6.2 females. Several female fish were caught in the downstream trap in mid- and late July that had not spawned or that appeared to be only partially spent. Internal examination confirmed that they had not completed spawning and that eggs were being reabsorbed.

The percent of females in the cutthroat sex ratio of Hungry Horse Creek has been increased yearly. The sex ratio in 1963 was 1.0 : 1.8 males to females, compared to the 1971 ratio of 1.0 : 6.2. No logical explanation can be given for this change. Gill netting in the reservoir in 1970 yielded a ratio of 1.0 : 1.8 for both immature and mature fish. Sexing of 104 outmigrant juveniles caught by the Hungry Horse Creek downstream trap in 1971 resulted in a sex ratio of 1.0 : 1.9 males to females. Size of juveniles examined ranged from 3 to 7 inches total length.

Data collected in 1970 indicate that cutthroat trout spawning in Hungry Horse Creek exibited some alternate year spawning. This was further substantiated in 1971. The 1970 spawning run included 57 fish that spawned in 1968 and 1970 in Hungry Horse Creek while the 1971 spawning run included 57 fish that spawned in 1969 and 1971 in Hungry Horse Creek.2/

Little evidence has been collected to indicate that fish marked in Hungry Horse Creek spawn in other reservoir tributary streams except Emery Creek. Creel census data collected during the opening two or three week-ends of angling included some fish caught at Emery Creek which has been marked at Hungry Horse Creek. Both creeks drain into the same reservoir bay and Emery Creek was a tributary of Hungry Horse Creek prior to impoundment of Hungry Horse Reservoir in 1952.

1/ Huston, Joe E. 1971. Life cycle studies of westslope cutthroat trout and mountain whitefish. Job Prog. Report, Federal Aid to Fish Restoration Project F-34-R-5, Montana Department of Fish and Game, Job II-a, 7pp. mimeo.

2/ Ibid.

The total spawning run was estimated at 1,003 fish in 1970 and 703 fish in 1971. Data on spawning populations prior to 1970 indicate a gradual decline in numbers of spawners but no year so dramatic as from 1970 to 1971. The 1971 spawning data indicate that poor survival of cutthroat while in the reservoir may be a major cause of their decline.

An analysis of repeat spawning the following year by "new" fish spawning the first time in either 1969 or 1970 showed marked changes. A "new" fish is one that is spawning in Hungry Horse Creek for the first time. The estimated downstream escapement of "new" fish from the 1969 spawning run totaled 298 fish of which 182 returned to spawn in 1970. The return was 61 percent. A total of 308 "new" fish escaped following spawning in 1970 but only 38 of these fish returned to spawn in 1971. Return of these fish was only 12 percent; a decided reduction.

The potential for alternate year spawning was considered as a possible reason for the low return of the 1970 "new" fish in 1971. Preliminary analysis of the 1972 spawning run data indicated that only about 56 "new" fish from the 1970 downstream escapement spawned in Hungry Horse Creek in 1972 as alternate year spawners.

The 1970 spawning run included 239 fish (24 percent) which were repeat spawners and 764 (76 percent) which were "new" fish. The 1971 spawning run included 131 (19 percent) repeat spawners and 572 (81 percent) "new" fish. These data suggest no great change in make-up of the spawning run between "new" and repeat spawners. They do suggest a general decline affecting both groups of fish.

The most numerous age-groups as determined by scale reading in the spawning runs has been four year-old fish which migrated out of the natal stream at two years of age. The most numerous age-group of juvenile fish moving downstream out of Hungry Horse Creek into Hungry Horse Reservoir has been two year-old fish. The majority of fish entering Hungry Horse Creek for first-time spawning in 1970 should have been from the juvenile outmigration of 1968 while "new" fish entering for spawning in 1971 should have been from the juvenile outmigration in 1969.

Capture of juvenile cutthroat during the peak of outmigration in 1968 was about 2,200 fish. The number caught during the same period in 1969 was about 2,300 fish. These data would indicate similar downstream escapement between the years which with similar reservoir survival should have resulted in similar numbers of "new" fish entering the spawning run. However, as discussed above, the 1971 spawning run was markedly less than the 1970 run.

Operation of Hungry Horse Reservoir for flood control and production of electrical power has changed. Prior to 1965 average annual drawdown was about 60 feet. For the years of 1965 through 1971, average annual drawdown has increased to about 100 feet. Drawdown in these later years has also occurred at different times of the year than before 1965. Early years' drawdown usually did not start until November or December and filling was accomplished by late June. Time of drawdown since 1965 has varied from August to October and filling has not been completed until early or mid-July.

The downstream trap was placed into operation June 18 and fished through July 27, 1971. A total of 256 spent, partially spent and unspawned fish were captured and released downstream. Of these fish 226 were females and 30 were males.

Spawning survival (For period from passing through trap going upstream until return to trap) for males was 31 percent compared to 37 percent for females. The downstream trap also captured 1,951 juvenile cutthroat trout as they moved downstream toward the reservoir.

In September 1971, the wooden headgate structure controlling flows into the bypass channel was replaced with a concrete headgate. The new structure is ten feet wide divided into two equal bays. The old structure was eight feet wide divided into two equal bays. The new structure is aligned with the stream so that additional bays can be added if needed. The new structure was also designed to draw water away from the main velocity barrier (which includes the fish trap) and insure fish passage after the velocity barrier is removed in fall 1972. Soundness of the design will be determined in spring 1973.

RECOMMENDATIONS

The Hungry Horse Creek fish trap should be operated to enumerate the upstream movement of adults into the creek for spawning and the downstream escapement of juveniles into Hungry Horse Reservoir in 1972. It is planned that this structure will be removed in early fall 1972 and the downstream trap will be operated up to the time of removal.

Work should be started on a final job report covering all activities on this project since 1963. It is expected that write-up of this report will entail work in fiscal years 1973 and 1974.

Hungry Horse Creek has considerable volume and velocity in the area of the trap site. Trap removal will be done in the best manner possible leading to the least environmental disturbance. It was noted in an Environmental Impact Statement that some creek bottom disturbances were unavoidable. Work in the area may by needed in future years to stabilize channel characteristics.

Prepared by Joe E. Huston

Date April 30, 1973

Waters referred to:

1-08358001
1-08886005

New York State Department of Environmental Conservation

Henry L. Diamond
Commissioner

Fish Research & Development
Ray Brook, New York 12977
January 17, 1973

Dr. Robert J. Behnke
Colorado Cooperative Fishery Unit
102 Cooperative Units Building
Colorado State University
Fort Collins, Colorado 80521

Dear Dr. Behnke:

Thank you very much for the requested reprint and manuscript.

Enclosed are Job Progress Reports for a lake trout study and four brook trout studies relating to wild and hybrid "strains". I am preparing a manuscript on the lake trout work and Walter Keller is doing likewise for co-authorship on the Black Pond brook trout work.

We are now evaluating two hybrid strains of brook trout in Black Pond under special regulations. 1972 has been our first year under special regulations at Black Pond and we are encouraged by this approach for wild and hybrid (wild x domestic) strains of brook trout exposed to any quantity of fishing pressure.

I hope these reports help to fill you in on our work.

Sincerely,

Daniel S. Plosila

Daniel S. Plosila
Associate Aquatic Biologist

DSP/njk
Encs. (5)

STATE OF ALASKA

KEITH H. MILLER, GOVERNOR

DEPARTMENT OF FISH & GAME

P. O. BOX 466 — SITKA 99835

January 28, 1974

Dr. Robert Behnke
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Bob:

Thank you for your assistance on the bibliography and its editing. We are quite satisfied with the finished product, only wish it had not taken so long.

I am enclosing several copies for your use and distribution. Please see that your library gets a copy.

I have postponed my plans for graduate study for the time being. I have been working temporarily here for sport fish division, but will be leaving soon.

I have permanent job offers with ADFG in Homer and NMFS in Juneau or Kodiak. I have not decided on either yet. I would prefer a job as a biologist, but they are few and far between. The ADFG job is as a technican in the saltwater rearing experiment and the NMFS job is as a marine enforcement agent.

I have not lost my interest in taxonomy and genetics, but see little future in jobs in the field.

Thanks again.

Sincerely yours,

Jim

James R. Dangel

P.S. Please send Ray Simon a copy as I have lost his address.

STATE OF CALIFORNIA—RESOURCES AGENCY RONALD REAGAN, Governor

DEPARTMENT OF FISH AND GAME
1416 NINTH STREET
SACRAMENTO, CALIFORNIA 95814

January 22, 1973

Dr. Robert J. Behnke
Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Bob:

Thank you for the material on trouts of the Southwest and the reprint on Salmo platycephalus. The other reports on your list I would like to receive are the Gila and Apache Trouts (1967), New Information on Gila Trout (1970), and The Zoogeography, Systematics and Management of Cutthroat Trout (AFS, 1971). Thank you.

Sorry I forgot to define those abbreviations for you; however, you interpreted them correctly for all except one: SH ≠ Shasta, SH = Steelhead trout.

How are you coming on your redband trout manuscript? Any plans to do any collecting of these or other threatened trouts in California this year? I plan to spend most of the summer in the field working with the regions on our threatened trout management programs. I'll try to keep you appraised of our progress and any significant developments that occur.

Sincerely,

Stephen J. Nicola
Sa

Stephen J. Nicola
Associate Fishery Biologist

SJN:wf

117
326 Heede gully plugs (Am. Spt. club pres.)
130 145

IN REPLY REFER TO

U.S. DEPARTMENT OF THE INTERIOR
March 3, 1849

United States Department of the Interior 7240 (D-350)

BUREAU OF LAND MANAGEMENT
DENVER SERVICE CENTER
DENVER FEDERAL CENTER, BUILDING 50
DENVER, COLORADO 80225

Mr. Robert Behnke
Dept. of Fishery & Wildlife Biology
Colorado State University
Fort Collons, Colo. 80523

MAY 22 1978

Dear Sir:

The Bureau of Land Management has recently completed a two-year study of mechanisms affecting salt pickup and transport in surface runoff from rangelands, and possible means of reducing this salinity. Copies of the report are being sent to you for your use. Additional copies may be obtained by writing this office.

Investigations are continuing into diffuse sources of salinity of the Colorado River System from groundwater and possible means of control. Additional basic hydrologic information is continuing to be collected on small ephemeral watersheds in Colorado and Utah. This information will add to our present knowledge.

Yours truly,

Acting Glen D. Fulcher
Director, Denver Service Center

Enclosure
"Salinity Report" (I) copy(s)

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

IN REPLY REFER TO

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
DENVER SERVICE CENTER
DENVER FEDERAL CENTER, BUILDING 50
DENVER, COLORADO 80225

Dear Mr. Behnke:

Our present supply of reportBBMM/YA/TR-78/0/, "The Effects of Surface Distrubance on the Salinity of Public Lands in the Upper Colorado River Basin" has been exhausted. The report, however, can be obtained from NTIS using the above-mentioned number.

I am sorry we could not be of service to you.

Sincerely,

Ora M. Wagoner

Ora M. Wagoner
Librarian

AMERICAN REVOLUTION BICENTENNIAL 1776-1976