Colo. introductions

Mysis, whitefish, white bass

Kokanee

Stream & lake survey sheets (ex.)

/ Seaman

A PRELIMINARY STUDY

OF

THE PROPOSED WHITEFISH TRANSPLANTING

IN

WESTERN COLORADO WATERS

March 1938

Submitted by:

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Approved by:

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A PRELIMINARY STUDY OF THE PROPOSED WHITEFISH TRANSPLANTING IN WESTERN COLORADO WATERS

Date of Survey - March 1938

(C. N. Feast, Jr. Aquatic Biologist)

INTRODUCTION

The family of fishes, Salmonidae, contains two well marked subfamilies: the Coregoninae (whitefishes and herrings), and the Salmoninae (salmons, charrs and trouts).

Coregoninae.

a. Mouth not deeply cleft, the mandible articulating with the quadrate bone under or before the eye; dentition more or less feeble or incomplete; scales large or moderate.

b. Jaws toothless or nearly so; scales large; maxillary short and broad, with broad supplemental bone.

c. Premaxillaries broad; the lower jaw short and more or less included; cleft of mouth short........................... Prosopium.

(1) Head $4\frac{1}{2}$ to 5; depth 4 to 5; D. 10 to 12; A. 10 to 12; scales 9 or 10 - 78 to 88 - 7 or 8; maxillary short and very broad, reaching orbit... Williamsoni.

The Rocky Mountain whitefish, Prosopium williamsoni, is, among other waters of the western part of the United States, native to the White and Yampa Rivers, which are tributary to the Green River, which flows into the Colorado. This species attains a length of a foot or more and a weight of about four pounds, though the average is very much less.

The most common local name for the whitefish in the region of these waters is "grayling." This is strictly in error, as the grayling belongs to an entirely different family, namely, the Thymallidae, and in order to clarify this error, the following description of the grayling is given:

Body oblong, somewhat compressed; head rather short; mouth moderate, terminal, the maxillary extending beyond the middle of the eye, but not to jaw; vomer short with small patch of teeth; teeth on palatines; tongue nearly toothless; dorsal fin long, rather wavy and colored with red and red-orange spotting.

OBJECT OF STUDY

A movement is under way among many of the sportsmen of the Colorado River drainage to secure the transplanting or stocking of whitefish from the White River to the upper waters of the Colorado, mainly the Roaring Fork and Eagle Rivers.

A preliminary survey was conducted to ascertain the feasibility of this transplant and to arrive at conclusions that would be for or against the proposal, or that would specify alternate action.

METHOD OF STUDY

An effort was made to study the whitefish environment of White River and compare the results with the findings of similar studies in the upper Colorado tributaries. The feeding habits of the whitefish were studied in order to determine the kind of food they preferred and to gain some knowledge as to what extent they are competitors to the trout.

Each stream was divided into lower and upper sections for analysis, and where possible, the main tributaries were studied. At each section a station study was made, which included a physical study to determine the flow, pool grade, shade and shelter grade, extent of riffles and widths and velocities of the stream in general. The pools were graded according to type most desirable to whitefish, with size being a supporting factor. The general conditions of the watersheds were studied and compared.

Chemical tests were made, which included the hydrogen ion concentration (pH), the percent of saturation of dissolved oxygen and the contents of both free and bound carbon dioxide.

Square-foot food counts of the number and volume of aquatic organisms were made on the bottom in a riffle section of the stream. Averages were computed. The percent of riffles in the section was estimated to arrive at a figure of food production per acre. The organisms were recovered by agitating and washing all rocks, etc., within the square-foot area. Water velocity washed all disturbed organisms into a collecting net placed immediately below. Food volume was figured by displacement.

The type of stream bottom was noted in each case.

The color and turbidity of the stream were noted, and particular attention was given to presence of mine pollution, if any.

The presence or absence of parasites was noted.

Many local sportsmen were contacted to obtain their viewpoints on the desirable or undesirable qualities of the whitefish. Also, their opinions regarding the whitefish in comparison with the trout were solicited. They were asked for information concerning the life and food habits of the whitefish insofar as they had observed.

GENERAL DESCRIPTION OF DRAINAGES SURVEYED

The White River.

The White River heads in the White River National Forest in northwestern Colorado, draining waters of the White River Mountains westward into the Green River and thence into Colorado River. The watershed of the headwaters is moderately covered with pine, spruce and aspen, while the slopes of the lower reaches are rather steep and are sparcely covered with oak brush and aspen. The main tributaries are South Fork, North Fork and Marvine Creeks. Trappers Lake, famous for its native trout, is located at the headwaters of North Fork. The White River is an excellent stream from a fish environment standpoint. It changes its direction often, and is well supplied with productive riffles and pools. As to rainbow trout waters, the lower section would probably be classified as one of the best.

The whitefish is native to this stream, together with the black spotted cutthroat trout, the rainbow and eastern brook being introduced. The whitefish are very abundant and their evident prolific habits have kept up the population from year to year. They are very popular in the White River Valley, as they provide a great sport to the winter fishermen, and large numbers have been taken during past months of January and February. It is locally reported that one famous pool provided 5,000 fish by fair count to the fishermen during the winter of 1937 and 1938.

The Yampa River.

The Yampa River heads in northwestern Colorado in the Routt National Forest. It drains waters of the north slopes of the White River Mountains and the Continental Divide at this section, into the Green River, which flows into the Colorado. The drainage, as a whole, is very similar to that of the White River, the thicker vegetative covering being at the headwaters only.

The whitefish is also native to this stream, the upper limits of its range probably being near the town of Steamboat Springs, Colorado.

The Upper Waters of the Colorado River.

The Colorado River flows through the west central part of Colorado, and its principal upper tributaries are the Roaring Fork and Eagle Rivers, which head in the Holy Cross Forest.

The Roaring Fork drains the north slopes of the Elk Mountains and the west slopes of the Sawatch Mountains. The town of Aspen is located near its headwaters. The Frying Pan and the Crystal Rivers are its principal tributaries.

The headwaters are principally covered with pine, spruce and aspen, and gneiss or granite is the basic geologic structure. The lower slopes are comparatively steep and moderately covered with pinon and oak brush. The geologic structure is principally red sandstone. There is evidence of a good deal of erosion occurring on the lower slopes and of quite a variation in seasonal run-off.

The Eagle River drains the west slopes of the Gore range and the general watershed conditions are quite similar to those of the Roaring Fork.

The black spotted native trout is reported as being indigenous to these waters, and no occurrence of the whitefish was noted. It is possible that the excessive muddiness of the lower waters of the Green River and of the Colorado River prevents the migration of the whitefish from the Yampa and White Rivers to the waters of the Roaring Fork and Eagle Rivers. The Shoshone Power Dam, located on the Colorado River above Glenwood Springs, Colorado, constitutes an impassable barrier to fish migration. Accordingly, no fish can now migrate from the waters of the Roaring Fork to the upper waters of the Colorado; however, it is believed that above this point, migration in the upper Colorado is possible, even to the waters of Grand Lake.

These waters are famous for their trout production and a great deal of stocking has been done to maintain them. In late years, however, the grade of fishing is reported as deteriorating, the reason for which is probably improper management according to yield and demand. Also, mine tailings which are dumped into Roaring Fork above Aspen have absolutely ruined the trout fishing in this stream for many miles.

PHYSICAL, CHEMICAL AND BIOLOGICAL CONDITIONS

In the forepart of this section, general discussion only will be presented. A complete tabulation will be given at the end. This method is adopted to eliminate duplication and to offer comparison at a glance.

White River.

Two stations were selected for study: one about three miles above the town of Meeker, and the other about five miles below Buford. Mud and snow made it impossible to reach the headwaters by trucks for survey at the time.

This river drops about thirty feet per mile between these stations, and is abundant in riffles and pools. Shelters or fish retreats are abundant, but shade is comparatively sparce.

The food grade is excellent, the average sample yielding about 4.1 cc per square foot. It is estimated from this food count that the White River will support about 5,000 adult fish per mile, considering a practical allowance for food supply carry-over and reproduction. The bottom is principally rock and rubble, which is very productive in stone fly nymphs, May fly nymphs and caddis fly larvae. The sculpin fish (cottus) was found to be quite abundant.

The water is high in bound carbonates and is of a high pH. It is predicted that the temperatures are not too low in the summer and that the potential growth factor of the fish is high. The per-cent of dissolved oxygen is satisfactory.

Several whitefish were taken on the hook and line, using small stone fly nymphs as bait on a No. 10 snell hook. T he fish were taken on March 7, 1938, by a licensed fisherman and donated to the observer for his study. The stomach contents of two of the fish taken are listed as follows:

No. 1 - Caught five miles below Buford in a deep pool.

125	-	Caddis larvae	4.5 cc
4	-	May fly nymphs	0.2 "
3	-	Stone fly "	0.5 "
1	-	Midge larvae	0.0 " +
			5.2 "

Length - 15 inches

Weight - 1 lb. - 4 oz.

Condition factor $c = \frac{2300 \times W}{L^3}$

$= .89$

Annulus - 4 +

Sex - Male

No. 2 - Caught in same place.

40	-	Caddis larvae	0.6 cc
46	-	Diptera	0.1 "
3	-	Stone fly nymphs	1.0 "
9	-	May fly nymphs	0.6 "
		Miscellaneous	0.5 "
			2.8 "

Length	-	12 inches
Weight	-	1 lb. - 0 oz.
Condition factor	-	1.35
Annulus	-	3 ⁄
Sex	-	Female

Studies of scales presented evidence that the whitefish is a rather consistent feeder and evidently does not have a pronounced growing or abstaining season. The annulus was quite plain, however.

Considering the stomach and scale analyses, it is concluded that the whitefish is a definite food competitor to the trout.

While netting for bottom organisms, several sculpin fish (cottus) were captured. These fish are small and are excellent large trout food. The stomach of one cottus, eight cms. in length, was examined, in which the following organisms were contained:

4 Stone fly nymphs - 0.15 cc

In a very small way, this fish is a competitor to other fish, but due to the fact that it provides a source of bulky food to the large trout, it should be protected.

The White River is an excellent stream for rainbow, due to the high grade of pools and riffles and favorable food and temperature conditions. It now contains whitefish, rainbow trout, native trout and the sculpin. For the most part, the rainbow are restricted to the lower waters and the natives to the upper waters, especially in Trappers Lake. The whitefish range from Meeker to what is locally known as Stillwater, on the North Fork. Local fishermen report that the whitefish spawn in Stillwater in latter September.

Yampa River.

No chemical or physical studies were made of this river, except to measure the pH and note the general character of the watershed. The pH of the water graded 7.4 and the drainage is very similar to that of the White River.

The whitefish is also a native of this river and its range is from the lower waters to about Steamboat Springs. Elk Creek is probably one of its important spawning streams.

The reporter talked with several of the sportsmen in the town of Steamboat Springs, and their general opinion was that most of the sportsmen in their vicinity do not favor the whitefish and do not desire to fish for it. They also expressed the opinion that there is increasing opposition to the open season in the winter months.

As to the habits of the whitefish, local sportsmen informed the reporter that they preferred the deep pools adjacent to swift waters and that their food consisted principally of stone fly nymphs and caddis fly larvae.

Several sportsmen were questioned and they stated that no whitefish had been taken out of Williams Fork to their knowledge.

Roaring Fork of the Colorado.

Tests were made of this stream at three stations: (1) of the lower waters about four miles above Glenwood; (2) of the central waters in the vicinity of Woody Creek road bridge; and (3) of the headwaters just below Aspen, Colorado.

The gradient of the river is about forty-two feet per mile and is abundant in riffles, but is not so high in the deep pool grade as the White River. In fact, there is a great difference in the two rivers in this respect. Shade is rather sparce, but shelter would be regarded as good.

The water color is rather whitish, and the turbidity is slightly murky. This is due to colloidal sediments in suspension as a result of mine tailings which are dumped into the river out of Castle Creek. The bottom is principally rock and rubble, with very little gravel.

The watershed of the lower portion is principally red sandstone, moderately covered with pinon, cedar and some oak brush. The slopes are quite steep and there are evidences of erosion. The volume of the river at the lower station on the day observed was approximately 450 cubic feet per second. From high water marks and estimated velocities, it is estimated that as much as 15,000 cubic feet per second may flow during periods of high run-off.

The pH of the water is high and the bound carbonate content is also high. Food counts were high, samples averaging about 7.8 cc per square foot of bottom, of the lower sections.

All evidence points to the fact that the whitefish may do well in the Roaring Fork. All conditions, except pool grade and high variation of run-off, are very similar to the White River, and if mine pollution continues, the whitefish may even do better than the trout, as the history of the upper Green River indicates that the whitefish do better in whitish water than the trout.

The intermediate station study demonstrated that pollution sedimentation took place to quite an extent, as far as ten miles below Aspen, and that the settling of the colloids took place throughout the entire stream below the pollution source. The stream bottom at this section was a decided white color, which is very undesirable from a trout environment standpoint.

The volume of the flow was measured at 160 cubic feet per second.

Bottom samples produced an average of 2.5 cc of organism per square foot. The bottom is principally rock and rubble.

The station study just below Aspen revealed a good deal of sewage pollution. The bottom is principally rubble, granite and gneiss rock, indicating that the geologic structure of the upper water is of these rocks. The watershed is covered principally with pine, spruce and aspen.

The pool grade at this location is fair. Shelter and shade grade would be classified as average. At this point of the stream the pH and the bound carbonate contents are considerably lower; however, they are well above the neutral stages.

The food count average was not so high, the production per square foot of bottom being 1.75 cc. It is estimated that low summer temperatures may be a contributing factor to slow fish growth. This should be further studied by actual survey, however.

This section of the river did not appear so suitable for the whitefish.

Castle Creek.

This creek is a tributary to the Roaring Fork a short way below Aspen. It is the stream into which gold milling tailings are dumped. Two stations were selected for study in this stream: (1) just above the source of pollution; and (2) just below the source of pollution.

The water above the pollution is clear and free of sediment. The pool grade is fair and the shade is good. Probably the temperature is low throughout the year, as average food counts produced only 0.3 cc per square foot of bottom. The bottom is principally rock and rubble.

The oxygen content is satisfactory. The free and bound CO_2 concentrations are both high. The pH was measured at 7.6.

The flow was measured as thirty cubic feet per second. The snow in the timber was scaled at thirty-six inches deep.

The mill tailings that are dumped into the stream are very thick and are of a light white-gray color. Chemical tests failed to detect the presence of cyanide, but revealed that 14.1 ounces of sediment by weight are being carried by the stream per cubic foot of flow. From the report, it may be seen that many tons of mill tailings are being dumped into the Roaring Fork each hour the mill is in operation.

The pollution does not change the chemical conditions of the water, with the exception that the pH is raised from 7.6 to 8.0. There were about six inches of sediment covering the entire bottom of the stream and tests indicated that no food organisms are growing in the stream at this section.

During the test for oxygen content, it was noted that when the alkaline potassium iodide was added to the manganous solution of the water, the resulting precipitate took up all of the sediment, leaving the balance of the water clear of turbidity. This may suggest that chemical treatment may be possible to rid the water of its sediments before it is admitted to the stream. This assumption is only hypothetical, however.

Frying Pan River.

The Frying Pan River is one of the important tributaries of the Roaring Fork, and is one of the famous trout streams of this section of Colorado. It traverses a watershed very similar to the Roaring Fork itself, the upper drainage being granite and gneiss and covered with fir, spruce and aspen, and the lower slopes composed principally of red sandstone, covered with cedar, oak brush and pinon.

The station for study was located at the Holy Cross Forest boundary line. The flow was measured at twenty-five cubic feet per second, with a good deal of evidence of a high flow in periods of high run-off. The pool and shelter grade was judged as average, and the bottom is composed of rock, rubble and gravel. The stream at this point was clear in color and turbidity.

The water is fairly high in oxygen and bound carbonates. Food organisms averaged 3.00 cc per square foot of bottom.

This stream may be suitable for whitefish. Chemical conditions are similar and there is a reasonable amount of deeper pools. Also, above the forest boundary the stream flows through a flat area and creates a long stillwater section for several miles that is very similar to the stillwater section of the White River. This section may be satisfactory for whitefish breeding grounds. This fact should not be taken as positive, however, until further knowledge is gained regarding the breeding habits of the whitefish.

Eagle River.

There is also a good deal of enthusiasm among many of the sportsmen in this vicinity to introduce the whitefish into this river. It flows through similar country to the Roaring Fork, but its lower waters get rather muddy during rainstorms and spring run-off.

A station study was made above the town of Eagle at the mouth of Red Canyon. The flow was measured at approximately 100 cubic feet per second. The pool grade is average but shade is sparce. The pools are relatively deep and shelter may be classed as averaged. The oxygen and bound CO_2 content is satisfactory. Food organisms average 1.62 cc per square foot of bottom.

This section of Eagle River may be suitable for whitefish, but on account of an apparent lower food content, they may be a very detrimental competitor to the trout.

Gore Creek.

This stream is one of the important tributaries of the Eagle River. It is a good trout stream and the reporter noted a good many fairly deep holes and productive riffles. The shade and shelter were graded as average. The volume of flow was estimated as thirty cubic feet per second. The pH measured 8.0/.

Average food counts produced 1.50 cc per square foot of bottom. On one of the tests, a five-inch sculpin fish was captured. This discovery pretty well establishes the fact of the range of the cottus throughout the Colorado River drainage.

This stream may be suitable to some extent for the whitefish.

SUMMARY OF SURVEY FINDINGS - PHYSICAL

Name of Stream	Section	Av. Width	Av. Velocity	Volume Cu. Ft. Per Sec.	Pool Grade	Shade Grade	Shelter Grade	Bottom	Color	Riffle Grade
White River	Lower	100	1	250	1	3	2	Ro-Ru	Clear	1
	Upper	100	1	200	2	3	2	Ro-Ru-Gr	Clear	1
Yampa River	No physical survey made									
Roaring Fork	Lower	50	6	450	2	3	2 +	Ro-Ru	Whitish	1
	Intermediate	50	$3\frac{1}{2}$	160	2 -	3 +	2 -	Ro-Ru	Whitish	1 - 2
	Upper	15	3 - 3	37	2 -	2	2	Ru	Clear	1 - 2
Castle Creek	Above pollution	15	3	30	3	1	2	Ro-Ru	Clear	2
	Below pollution	15	3	30	3	1	2	Ro-Ru	White	-
Frying Pan River	Near forest boundary	25	4.0	75	2	2	2	Ro-Gr	Clear	1
Eagle River	Mouth of Red Canyon	40	2.5	100	2	3	2	Ro-Ru	Clear	2
Gore Creek	One mile above mouth	15			2 +	2	2	Ro-Ru	Clear	2

SUMMARY OF FINDINGS - CHEMICAL AND BIOLOGICAL

Name of Stream	Section	Date 1938	Hour	Temp. Air Deg. F	Temp. Water	O_2 ppm.	Free CO_2 ppm.	Bound CO_2 ppm.	pH	Food Organisms cc Per Sq. Ft.
White River	Lower	3/6	3 p. m.	45	40	10.3	1.0	44	8.0 +	6.0
	Intermediate	3/7	11 a. m.	43	38	11.0	1.5	44	8.0 +	2.3
Yampa River	Near Craig	3/8							7.4	
Roaring Fork	Lower	3/9	10 a. m.	44	39	10.5	Trace	59	8.0 +	7.8
	Intermediate	3/10	4 p. m.	32	40				8.0 +	2.5
	Upper	3/10	11 a. m.	43	40	9.2	6.0	25	7.4	1.75
Castle Creek	Above pollution	3/10	3 p. m.	32	40	9.2	15.5	44	7.6	0.3
	Below pollution	3/10	3:30p.m.	32	40	9.2	5.0	44	8.0 +	0.0
Frying Pan River	Near forest boundary	3/9	2 p. m.	40	38	8.7	1.0	29	7.4	3.0
Eagle River	Near mouth of Red Canyon	3/11	11 a. m.	50	43	10.2	17.5	48	7.6	1.60
Gore Creek	One mile above mouth								8 +	1.50

S U M M A R Y

The results of the survey regarding the whitefish in the White and Yampa Rivers and the transplanting of this fish to the upper Colorado River are summarized as follows:

1. The fish environment and food grade of the White River are excellent.

2. Whitefish are abundant in this stream, but it is estimated that the stream does not have so large a trout population as it should.

3. The whitefish are native to the White River.

4. They are also native to the Yampa River.

5. The food grade and trout environment of the Roaring Fork are excellent, except for the mill tailing pollution.

6. Indications are that the Roaring Fork can support whitefish.

7. Indications are that the Frying Pan can support whitefish as well as furnish spawning beds.

8. The food grade in the Frying Pan is good.

9. The upper waters of the streams are not so productive as the lower.

10. Indications are that the Eagle River can support whitefish.

11. The food in the Eagle River is not so abundant as that in the Roaring Fork.

12. Serious pollution of Roaring Fork is occurring by mill tailings being dumped into Castle Creek, which is a tributary to Roaring Fork.

13. The sculpin fish (cottus) was found to inhabit all of the waters of the Colorado that were surveyed.

14. Nematodes~~parasites~~ were found in the Roaring Fork below Aspen.

15. The sport of winter fishing for whitefish is gaining in popularity.

CONCLUSIONS

The following conclusions are given that are based on observations and results of the survey:

1. Attempts should be made to increase the trout population of the lower waters of the White River, the fish to be planted being large fingerling rainbow.

2. Due to the increasing sport of winter fishing for whitefish on the White River, plans for future management should be organized. It is reported that a noticeable reduction has been observed over the last two or three years, and if the popularity of the sport continues, plans for restocking whitefish may need to be prepared. Close record should be kept of the change in census or apparent population.

3. The life history of the whitefish should be made an administrative study to determine complete facts as to its habits of feeding, habitat, migration, growth and breeding.

4. Possible method of spawn taking and hatching of whitefish should be developed.

5. Whitefish should not be transplanted to the upper waters of the Colorado.

Reasons:

Pro.

1. They may adapt themselves to development in the lower waters of the Roaring Fork and Eagle Rivers, with the Frying Pan as a possible spawning station.

2. They may provide an accessible and desirable winter fishing sport to a few local fishermen.

Con.

1. They are a food competitor of the trout and in streams where food is a factor of limitation, no introductions should be made where the best development of the trout is threatened.

2. More knowledge of their habitat, breeding and migration habits should be obtained, for it may be possible for them to migrate up the Colorado into the very upper tributaries and lakes, which will be undesirable.

3. They may become so abundant as to threaten the very existence of trout, from a food competition standpoint.

4. A good many localities where whitefish are now present in the streams favor the trout over the whitefish and do not recommend their general transplanting.

5. The value of the trout in our mountain stream is readily recognized, and everything should be done to preserve this value, even to the exclusion of exotic species, if necessary.

6. Better management calls for the development of native species in native waters and to soft-pedal transplants and inter-mixings without complete knowledge of all consequences.

7. Efforts should be made to reduce or eliminate, if possible, the pollution by mill tailings of the Roaring Fork River.

8. The whitefish is not classed as a game fish equal to the trout, and should not be mixed with the trout, unless they have been so mixed by native conditions.

APPENDIX

Mouth deeply cleft; dentition absent; scales large, maxillary short and broad; lower jaw short and included; cleft of mouth short.. Coregonus.

a. Head 4-1/4; depth 4-1/2; eye 4-3/4; snout 3-1/4; dorsal 11; anal 11; scales 11-85-8; pectoral 1-1/5; maxillary 4; mandible 3-1/2; long dorsal ray 1-1/2; snout compressed, point below the level of the eye.. Williamsoni.

Species -- Rocky Mountain Whitefish

<u>Prosopium williamsoni</u> (Girard)

<u>Coregonus williamsoni</u>

Key -- Jordan and Evermann - 1935
American Food and Game Fishes
Doubleday - Doran

Name -- Check List of Fishes
Report of the United States Commissioner of Fisheries - 1928

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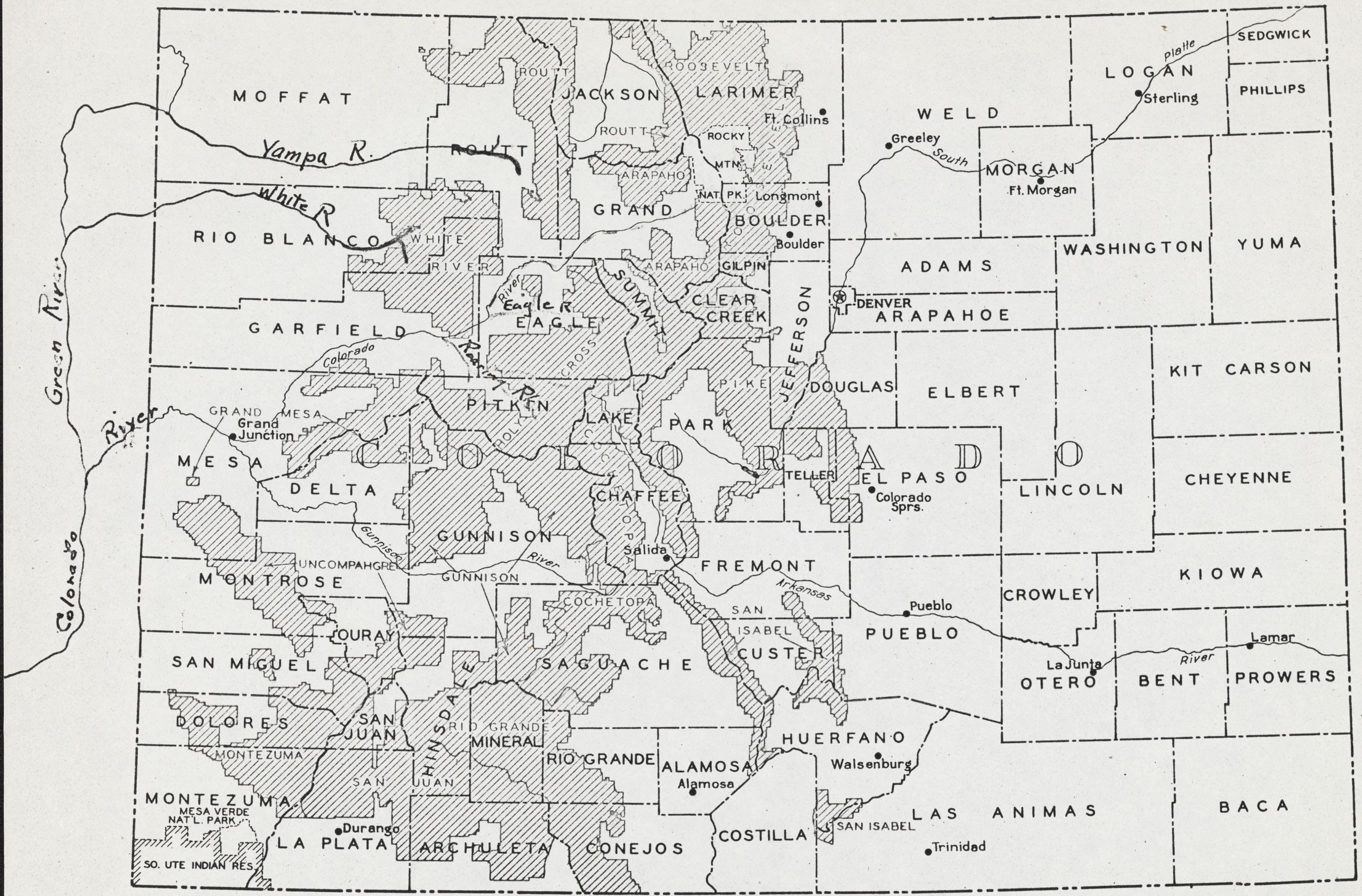

Nativowhitefish waters
Waters where it is proposed to plant whitefish
Waters where it is possible for whitefish to migrate

/. Mr. Hess.

Behnke

I. Title: The possible Introduction of the Yellow Pike-Perch in the warm water fishing areas of Colorado.

II. Date: April 9, 1948

III. Supervisor: Ray H. Hess, Supt. Research and Distribution

IV. Investigator: T. M. Lynch

V. Introduction:

In view of the Department's program for the improvement of warm water fishing, a number of phases must be considered for a possible solution.

There has been some interest on the part of some members of the Research Section as well as some Sportsmen's groups concerning the possible introduction of the yellow pike-perch or walleye. After investigation by members of the Research Section, it is thought that the introduction of this fish might prove to be of some value for the improvement of fishing in our warm water areas. However, their initial introduction should be conducted as a controlled experiment until it has been definitely decided that this fish is valuable.

VI. Summary:

In the introduction of any new fish species, certain biological effects must be considered, two of these are:

1. The direct effect, either as a predator or competitor.

2. The indirect effect, introduction of parasites or the alteration of the habitat.

Considering the direct effect, either as predator or competitor, that is exactly why the introduction of this fish should prove of value. Since most of our warm water areas are infested with carp, their fishing value is practically nil, therefore some cannibalistic fish is needed not only to retard the carp, but also to provide the fishermen with fishing worth their while.

Stocking these water areas with the walleye will not reduce the adult carp population, but the walleye will retard the development of a future carp population by eating the eggs and the young.

According to Mr. H. C. Howard, Supervisor of the Nebraska State Fish Hatchery, the walleye and carp adults can live in mutual association in the same waters, and propagate their young. However, the young carp do not last long because of the walleye population's cannibalistic nature.

Considering the indirect effect, possible introduction of new parasites is improbable. Alteration of the habitat by these fish would be a trivial matter because water already infested with carp is of little or no value.

Arrangements have been made with Mr. Norman L. Moe, Supervisor, Fish Propagation Unit, Minnesota Bureau of Fisheries, to trade them some Rainbow eggs for 100,000 walleyed pike eggs. Since we do not have the equipment nor the facilities needed to hatch these eggs, we are trying to make arrangements to exchange the walleyed pike eggs with Nebraska for some fry or have them hatch the eggs for us.

Mr. H. C. Howard states that the stocking of fry in natural waters has not been very successful. The State of Nebraska makes it a policy of stocking fingerling walleyes.

If and when we receive some walleyed pike fry, they will be stocked in some lake where they will have every chance for safe development. If a reasonable number of these fish are reared they could be used as the initial stock for future stocking in other waters.

Respectfully submitted:

T. M. Lynch

T. M. Lynch
Fisheries Technician

[VIS a VIS Colorado]

January 5, 1955

Special Purpose Report No. 18

OBSERVATIONS CONCERNING THE KOKANEE IN MONTANA

by

R. L. Moore

The following notes concern the trip made to Montana by Neil Van Gaalen and R. L. Moore to observe the kokanee at Flathead Lake.

Source of the Spawning Kokanee

Most of the eggs taken by the Montana department come from Flathead Lake, which covers 126,320 surface acres and has a shoreline of 127 miles. There are several bays on both east and west shores which are seined for spawning fish. These spawning populations have apparently been maintained through annual plantings, which are always made in the same bays that are seined, since the spawners apparently migrate back to the same bay in which they were planted. There were two or three bays which outwardly possessed the necessary requirements for lake spawning that had no kokanee "run" of either naturally or artificially produced fish. For spawn taking purposes, these bays can be managed very simply by planting them - four years later, there probably will be a large number of spawners. Whether these fish would successfully establish a "run" that would continue without plants would, of course, depend upon such factors as the amount of seepage present, water level fluctuation, and type of bottom. Montana circumvents these requirements at Flathead Lake by stripping the eggs and hatching them at two hatcheries located on the shores of the lake. The fry are then planted back into the lake before they begin feeding, so the cost of artificial production is relatively small. Montana men took over 10 million eggs from the lake in 1954. Between $1\frac{1}{2}$ and $2\frac{1}{2}$ million fry are placed back into the lake each spring. The remainder are either planted in other lakes or tributaries, or sent to other states. Montana does not get natural reproduction in many of the lakes in which kokanee have been planted, but considers the fish valuable enoughtto warrant annual plants from spawn taken at Flathead Lake or its tributaries.

It is to one of these tributaries, McDonald Creek, that an enormous number of kokanee migrate each year. By mid-December, the peak of this migration was past, but thousands of kokanee could still be seen just below McDonald Lake in Glacier National Park. This point is 52 miles above Flathead Lake. It appeared that overcrowding in the stream would prevent many fish from spawning successfully; but perhaps this is fortunate, for it would seem that the "run" could build up to the point where too many kokanee would reduce the average size. As far as was known, none of these migrants moved on through McDonald Lake to the good streams above. Failure to do this is inconsistent with the habits of the kokanee's closest relative, the sockeye salmon, which characteristically moves through a lake to a higher tributary for spawning. The Montana men did not know how this run got started, although they believed someone planted kokanee below McDonald Lake many years ago.

At present, Montana is trapping kokanee in McDonald Creek in order to establish a migratory kokanee population in Fort Peck Reservoir, their new huge reservoir on the Missouri River. They feel that the chances for starting a kokanee "run" up the Missouri are better if they start with spawn from fish which exhibit a strong migratory instinct. However, there was no factual data cited to support this contention. Perhaps kokanee fry from fish spawning in Flathead Lake would show the same migratory instinct as fry from McDonald Creek fish, providing the fry were planted above the Fort Peck Reservoir.

Colorado has a similar problem, since it is desirable to establish a "run" above some of the reservoirs in which kokanee have been planted. The hatcherymen in Montana stated conclusively that Colorado has received eggs from only lake spawners up to the present time. They also stated that they could provide eggs to Colorado from stream spawners if requested. Experimenting with some kokanee from stream migrants is recommended.

SPAWN-TAKING PROCEDURES

Six to eight men were used as a spawn-taking crew during the observed operations on Flathead Lake. A 200-foot seine, 10 feet wide in the center without a bag, and having a 1-inch mesh, was used to collect the fish to be stripped. A large live box was used to hold the fish immediately offshore. From this box, the fish were netted into a smaller wooden box as they were needed by the men stripping the eggs. Two men worked with each stripping pan, and the eggs were transported back to the hatchery in a 10-gallon can. Only two or three females were stripped before stripping a male; the hatchery men stated that it was necessary to fertilize the eggs quickly in order to get good results.

The number of eggs taken is calculated on the basis of 264 eggs per ounce for kokanee in Flathead Lake, and the Somers Hatchery Foreman stated that 400 eggs per female was generally considered average for kokanee from this lake. Approximately 1,000 eggs per female were taken from Lake Ronan kokanee, which were from 16 to 18 inches in length.

The first kokanee eggs were taken in 1954 on November 5, and the last on December 15. Many of the early November fish were "green", while many of those in mid-December were spent. The peak fell in the latter part of November, about two weeks later than usual, according to the hatchery foreman.

HATCHING AND PLANTING

The water in the two hatcheries on Flathead Lake is quite cold, but this seems to work as an advantage, since the hatching date is delayed to about the time they wish to plant the fry. These hatcheries handle some natives in addition to kokanee, but the trout are in the unit during the warmer months of spring and summer.

Planting kokanee back into Flathead Lake is a simplified precedure, its huge size notwithstanding. The fry are merely placed back into the bays in which the spawn is regularly taken. Since 1951, only the bays on one side are planted in a given year; the alternate side is planted the following year. By this method, they expect to be able to tell by their seining success whether continued spawn taking every year is dependent upon the fry that are planted.

GENERAL OBSERVATIONS

One of the most surprising aspects of the northern Montana kokanee country was its openness -- no part of Flathead Lake or its tributaries was frozen over up to mid-December, which is well past the peak of the kokanee spawning period. Another big difference in comparison with Colorado is the enormous amount of water present. McDonald Creek, where the huge number of kokanee spawned, was flowing a volume of water estimated to be greater than normally found in our largest rivers after the runoff period. Many lakes were present in the Flathead country which would be considered large by Colorado standards.

February 25, 1955

Special Purpose Report No. 23

CRAYFISH INTRODUCTIONS

by

W. D. Klein

Crayfish are beneficial to many game fish for food, and the dispersion of these animals to suitable waters is encouraged. At Parvin Lake, crayfish entered the diet of rainbow trout to the extent of 7.3 per cent by occurrence and 19.8 per cent by volume.

Crayfish do not seem capable of natural distribution over appreciable distances in reasonable periods of time. Therefore, artificial distribution is important. R. W. Pennak, in his book "Fresh-Water Invertebrates of the United States", makes the following pertinent statements concerning crayfish:

"In general, crayfish are omnivorous but seldom predacious. They eat all kinds of succulent aquatic vegetation and animal food is usually a minor part of the diet when there is abundant vegetation. They also prefer fresh to stale meat, and in the laboratory they have been fed raw and cooked meats of all kinds, prepared fish foods, hay, whole seeds, cottonseed meal and soybean meal. Ecologically, they are usually considered scavengers.

Crayfish are generally inhabitants of shallow waters, seldom being found deeper than three to five feet.

Most species tolerate normal but wide ranges in temperature, hydrogen ion concentration, and free and bound carbon dioxide, though stream species are usually less tolerant than lake and pond species.

Population densities vary greatly, depending on the species and habitat. Pond populations usually amount to less than 100 pounds per acre, but in exceptional cases may attain 500, 1,000 or even 1,500 pounds per acre.

The depth of a burrow ranges from a few inches to as much as eight or ten feet and is partially determined by the level of the water table, since the burrow must contain water to keep the gills wet. Burrows close to the edge of a pond or stream are shallow; those farther away are deeper.

Dry land forms an effective barrier to the migration and geographical spread of lake and stream species.

Fish are the most important enemies of the crayfish, although wading birds, frogs, turtles, raccoons, otter and mink consume appreciable numbers.

Occasionally crayfish become a nuisance in small reservoirs when their lateral burrows through earthen dams and dikes drain the reservoirs."

Insofar as I can determine, there is little liklihood of damage from crayfish burrows. The State Engineer's office did not feel that any danger was involved. Also, Tom Lynch has had an opportunity to observe crayfish activities in the Arkansas Valley and does not feel that the crayfish burrows enough under ordinary circumstances to endanger dams. He has noted that they will burrow extensively when trying to reach water from a basin that has been dried up. The species at Parvin Lake has been identified as one that normally does not burrow. It would be advisable to use the Parvin Lake species in places such as Grand Mesa, where the dams are small and water fluctuations sometimes severe.

The crayfish seems to be able to adapt itself to a large number of environmental conditions, and therefore trial and error introductions are in order on a great many Colorado lakes. However, the crayfish does seem to require a certain amount of protection, either in the form of rooted aquatic plant growth or rocks. The alpine and sub-alpine lakes are probably unsuitable, and experimental plantings will be made in this type of environment before widespread introductions are attempted.

Crayfish are not recommended for Trappers Lake.

Some indications of suitable environment for crayfish may be obtained from the following list of mountain lakes which, to the writer's knowledge, contain established crayfish populations:

1. Parvin Lake - Larimer County
2. Evergreen Lake - west of Denver
3. Crosho Lake - near Yampa
4. DeWeese Reservoir - near Westcliffe
5. Seaman Reservoir - Larimer County

In the fall of 1954, crayfish were introduced into the following waters;

		County
1.	Vallecito Reservoir --------------------	La Plata
2.	Jackson Gulch Reservoir------------------	Montezuma
3.	Summit Reservoir ------------------------	Summit
4.	Narraguinnep Reservoir ------------------	Montezuma
5.	Denny Lake ------------------------------	Montezuma
6.	Groundhog--------------------------------	Dolores
7.	Gourly Reservoir -----------------------	San Miguel
8.	Island Lake -----------------------------	Delta
9.	Harvey Gap Reservoir --------------------	Garfield
10.	Antero Reservoir -----------------------	Park
11.	Eleven Mile Reservoir ------------------	Park
12.	Tarryall Reservoir ----------------------	Park
13.	Sweitzer Reservoir ---------------------	Delta

The above plants should be repeated for two years. It is advisable to make introductions in each body of water for three years in succession before considering an attempted introduction a failure. Spring plants are probably preferable to fall plants. Each introduction should consist of 100 or more crayfish.

Crayfish can be easily transported for long distances in a tank truck containing the crayfish and an abundance of moist aquatic vegetation. Moist gunnysacks would work as well as the vegetation. Also, the use of G.I. cans in a pickup would be a suitable means of containing and transporting the animals. In some cases, planting from a plane might be the most satisfactory method. The crayfish should withstand a free fall from a plane without difficulty.

The fall plants of crayfish made last year were handled by Joe Gray from the Las Animas hatchery. However, it is felt that the matter of crayfish introductions is better suited to regional operation and administration than to any single division or section, and it is recommended that introductions be handled on a regional basis in the future.

It is suggested that records of the crayfish plants be maintained on the "Weekly Record of Fish Planted" forms and that a copy of these records be submitted to the Denver office along with the fish planting records. Source of the crayfish transported should be noted on the records.

* * *

April 15, 1955

Special Purpose Report No. 28

A PROGRESS REPORT ON THE SUCCESS OF THE WHITE BASS (Lepibema chrysops) IN COLORADO RESERVOIRS

By

T. M. Lynch
Supt. Warm Water Fisheries

The majority of the warm water reservoirs in Colorado contain forage and rough fish species in abundance, but few of them have adequate populations of predatory fish species. For many years largemouth black bass have been planted to provide for the necessary predation. However, the environmental conditions existing in many of the impoundments are not quite suited for the production of black bass in enough numbers to control the forage or rough fish species. There existed a need for a fast-growing, prolific, predacious fish which could survive in large numbers under the conditions prevailing in these reservoirs. An ecological study of a number of different predatory fish showed that the white bass (Lepibema chrysops) might find the conditions in these bodies of water suitable for successful survival and as a result of a good deal of effort upon the part of Mr. R. M. Andrews, Fish Manager, 278 adult white bass were obtained from the State of Texas, for introduction into Colorado waters.

Thirty-two adult white bass were introduced into John Martin Reservoir, which is located on the main channel of the Arkansas River near the town of Hasty, Bent County, Colorado. The white bass reproduced successfully in 1949, 1950 and 1951 and they made up over 30% of the total game fish taken by the fishermen during 1951 and 1952. Due to extreme drought conditions prevailing over southeastern Colorado, this impoundment was completely drained in 1952 and has not been refilled. It may be assumed that a white bass population no longer exists in this reservoir.

A total of 246 white bass ranging from 7 to 12 inches in length were planted in Adobe Creek Reservoir which is located about 15 miles northwest of the town of Las Animas, Colorado, in Bent County. These fish reproduced successfully during a four year period, 1951 through 1954, and by 1952 these fish made up over 50% of the total game fish taken by the anglers in their annual catch.

In 1952, a total of 540 white bass were transplanted from John Martin and Adobe Creek Reservoir's to Bonny Reservoir, Yuma County, Colorado. The fish spawned during 1953 and 1954, and began to enter the fishermen's catch during 1953 and 1954 in ever increasing numbers.

White bass brood fish were also planted in Upper Queen Reservoir, which is located about 15 miles north of Lamar, Colorado. A total of 165 brood fish ranging from 6 to 15 inches in length made up the initial plant in 1952. The fish reproduced in June 1954, shortly after a 10 day run of storage water into the impoundment, the first inflow in several years. Anglers, began to take young-of-the-year averaging 6.5 inches in length by September of 1954.

During 1951 and 1952, a total of 1,200 white bass were removed from John Martin and Adobe Creek Reservoirs for transplanting to other waters in the State. Brood fish were stocked at a rate of 100 or more in the following waters:

Reservoir	County
Meredith	Crowley
Horse Creek	Bent
Holbrook	Otero
Prewitt	Washington
Jackson	Morgan
Loveland	Larimer

Although, the fish should have reproduced either during 1953 or 1954, no young-of-the-year have been found in these waters.

DISCUSSION

There is much evidence available which indicates that the white bass are unable to reproduce successfully unless there is an inflow of fresh water into a reservoir during June or the first part of July each year. Natural reproductive success has been excellent in those impoundments which have inflows during these months. But, in the reservoirs where irrigation is normally stored during the winter months and drawn out in the early summer, the white bass have failed to spawn. Upper Queen Reservoir, is an exception, for it received an inflow at the right time and the fish spawned. There is probably always a possibility that inflows may occur at the right time in the other reservoirs, but, erratic spawning success cannot be depended upon to provide the desirable results.

Stomach analyses made of a number of white bass taken from John Martin Reservoir, indicated that the fish fed mainly upon young Centrarchids (sunfish) plus some minnows. Their growth rate was excellent. Young-of-the-year reached an average size of 7.9 inches in length by October each year. The sunfish of this impoundment reproduce at least four times a year and minnows were extremely abundant. In addition the white bass suffered little food competition from the other fish species found in the reservoir.

In Adobe Creek Reservoir, the main food of the white bass consists of aquatic insects and minnows. The growth rate of the fish in this impoundment is not as good as the growth of the fish in John Martin Reservoir. Food competition between species is much more prevalent in this body of water and the minnow supply is very seasonable. The young-of-the-year reaches 4.8 inches in length by October each year during 1953 and 1954.

Plankton and aquatic insects made up 70% of the white bass diet at Bonny Reservoir. The main diet of white bass is fish, but evidently the food competition between species in this impoundment prevents the white bass from obtaining suitable food. Stomach samples taken from large walleyes show that white bass are being consumed by these fish. Large black bass also frequently take a white bass.

In the future care should be exercised in transplanting white bass, fresh water inflows in June or July are evidently necessary for good reproduction, and an abundant food supply without undue competition from other predacious fish species is also a requirement which should be considered before these fish are introduced into a new body of water.

The growth rate, average weight, sex ratio, number of sample, etc. for each age-group of white bass collected from John Martin, Adobe Creek and Bonny Reservoirs during the past few years, is presented in Table I, on the following page.

Table I. - The rate of growth, length range, sex ratio, average weight, number of samples and the percentage of the total sample of each age-group for white bass collected from John Martin, Adobe Creek and Bonny Reservoirs.

Name of Reservoir	Age Group	Smallest Length	Largest Length	Average Length	Length Range	Average Weight	Number of Samples	Percent of Males	Percent of Samples
John Martin	0	4.9	9.5	7.9	4.6	4.6 oz.	91	44%	78%
	I	11.5	13.3	12.3	2.4	20.0 "	12	50%	10%
	II	11.5	15.9	13.8	4.4	25.7 "	13	60%	11%
	III	15.8	17.0	16.2	1.2	49.0 "	3	*	*
Adobe Creek	0	2.3	7.2	4.8	4.9	2.5 oz.	73	I*	45%
	I	6.4	12.9	9.7	6.5	11.0 "	58	25%	35%
	II	12.5	16.7	14.9	4.2	23.5 "	19	40%	15%
	III	17.0	17.1	17.0	0.1	40.0 "	2	*	*
Bonny	0	4.8	5.9	5.4	1.1	1.5 oz.	18	I*	35%
	I	5.1	9.4	7.2	4.3	2.5 "	24	40%	47%
	II	9.8	15.4	12.6	5.6	22.0" "	9	50%	18%

* (Sample too small for accuracy)
I* (Indicates immature sexually)

June 8, 1955

Special Purpose Report Number 31

A PROGRESS AND EVALUATION REPORT ON THE SUCCESS OF THE WALLEYE (Stizostedium vitreum) IN COLORADO WATERS.

By
T. M. Lynch
Supt. Warm-Water Fisheries

INTRODUCTION

The walleye or yellow pike-perch was first introduced into Colorado waters during the spring of 1949. Over 8,000 fingerlings were obtained from the State of Nebraska in exchange for rainbow trout, through the efforts of Mr. R. M. Andrews, Fish Manager for Colorado. Since 1949, a total of 15,059,756 walleye fry and fingerlings have been planted in 21 impoundments located in 15 Colorado counties.

The two main reasons for the introduction of this exotic species was to obtain a voracious predatory species to aid in the control of rough fish species and to furnish a large size game fish for the larger warm water impoundments of the State. A certain amount of success has been attained in both respects since the introduction of this species, however, it is believed that a leveling off point has been reached as far as the stocking program is concerned.

If it is to be determined that the walleyes can sustain themselves in enough numbers to provide good rough fish control and fishing, the present program of stocking should be greatly curtailed. A walleye, upon reaching

15 inches in length and 3 years of age is ready to reproduce naturally and most of the larger warm water reservoirs contain walleyes of age-groups ranging from 3 to 6 years of age. So, theoretically there is a potential number of brood fish available in at least 8 reservoirs, which should reproduce naturally.

Walleye Survival Rate

Of a total of 4,731 walleye fingerlings planted in Nee Granda Reservoir, Kiowa County, in 1949, a total of 408 fish averaging 3-1/2 pounds each have been removed by fishermen (345 fish) and departmental personnel (63 fish) during a five year period, 1951 through 1955. This indicates a 8.05% return of the original plant and at current Super-Market prices (65¢ per pound) the 408 fish could be valued at $1,007.50, which is a fair return for the original investment.

Survival figures for both fry and fingerling walleyes in Colorado waters varies from less than 1% to over 25%, with an average of around 10%. In general it is believed that the walleyes have become well established, with the exception of two or three waters, in the waters in which they have been planted.

Walleye Food Habits

Stomach analysis of over 200 walleyes taken from 7 reservoirs, shows that they are voracious predatory feeders. They not only feed upon forage and rough fish species, but also include other game fish species in their diet. At Nee Granda Reservoir, their control of the rough fish population has been adequately demonstrated, for certain age-groups of carp are becoming increasingly scarce. The lack of certain size carp has forced one commercial carp seiner to cease operations at the reservoir.

Walleye Age and Growth

Scale samples were taken from 624 walleyes collected from 5 reservoirs during a five year period, 1951 through 1955, for age and growth determinations. A comparison of the growth rate of the walleyes of the five Colorado waters with that of the same species of one lake in Iowa and one lake in New York, is presented in Table I.

TABLE I

Age-Group O

Reservoir or Lake	County or State	Av. Length (Inches)	Length Range (Inches)	Av. Weight (Ounces)	Number of Samples
Nee Granda	Kiowa	8.7	7.2 - 11.6	5	33
North Sterling	Logan	9.8	-	-	13
Bonny	Yuma	7.3	4.8 - 10.8	2	64
Horse Creek	Bent	8.1	6.6 - 8.4	5	3
Adobe Creek	Bent	4.1	3.2 - 4.8	-	14
Clear Lake	Iowa	4.2	3.4 - 5.8	-	89

Age-Group I

Reservoir or Lake	County or State	Av. Length (Inches)	Length Range (Inches)	Av. Weight (Ounces)	Number of Samples
Nee Granda	Kiowa	10.4	8.1 - 13.1	8	98
North Sterling	Logan	14.0	-	-	35
Bonny	Yuma	12.7	9.0 - 16.5	5-1/2	134
John Martin	Bent	15.9	14.7 - 17.2	32	9
Adobe Creek	Bent	7.0	6.0 - 8.1	2	19
Neff	Weld	10.2	-		6
Seeley	Weld	9.8	-		1
Ontario Lake	New York	9.3	8.5 - 10.2	4	14
Clear Lake	Iowa	8.0	6.9 - 10.7	-	68

Age-Group II

Reservoir or Lake	County or State	Av. Length (Inches)	Length Range (Inches)	Av. Weight (Ounces)	Number of Samples
Nee Granda	Kiowa	16.4	15.2 - 16.8	26	48
North Sterling	Logan	18.9	-	-	11
Bonny	Yuma	17.8	16.0 - 19.7	32	47
Ontario Lake	New York	13.0	10.4 - 15.4	12	19
Clear Lake	Iowa	11.3	8.6 - 14.4	-	68

Age-Group III

Reservoir or Lake	County or State	Av. Length (Inches)	Length Range (Inches)	Av. Weight (Ounces)	Number of Samples
Nee Granda	Kiowa	18.8	18.3 - 19.2	39	75
North Sterling	Logan	22.3	-	-	7
Ontario Lake	New York	17.0	13.4 - 20.0	27	14

Age-Group IV

Reservoir or Lake	County or State	Av. Length (Inches)	Length Range (Inches)	Av. Weight (Ounces)	Number of Samples
Nee Granda	Kiowa	20.7	19.6 - 21.9	48	6
North Sterling	Logan	26.2	-	-	1
Ontario Lake	New York	17.9	16.3 - 19.5	36	4

Age-Group V

Reservoir or Lake	County or State	Av. Length (Inches)	Length Range (Inches)	Av. Weight (Ounces)	Number of Samples
Nee Granda	Kiowa	22.7	21.0 - 24.5	78	4
Ontario Lake	New York	19.7	16.6 - 23.1	40	6

Walleye Production

Evidence is available which indicates that the walleyes reproduced successfully in Nee Granda Reservoir, in 1953, but natural spawn has not been found in other warm water impoundments of the State. Potential brood fish capable of reproducing should be available in the following waters for spawning by 1956:

Reservoir	County	Number of Age-Groups present that are capable of reproduction
Nee Granda	Kiowa	4
North Sterling	Logan	3
Bonny	Yuma	2
Seaman	Larimer	1
Queens	Kiowa	1
Adobe Creek	Bent	1
Holbrook	Otero	1
Loveland	Larimer	1

During the spring of 1955, walleyes from Nee Granda Reservoir, were spawned artificially. About 250,000 eggs were taken from 4 female fish, a 3.3% successful hatch was returned from the eggs by the Las Animas Hatchery. It is believed that between one and three million eggs could be taken artificially from the fish in Colorado waters, if enough ripe fish could be obtained during the spawning season.

Fish Technician, Robert Evans, reports that the State of Ohio will allow walleye eggs to be taken from fish in it's waters provided that a man is sent to do the work. Colorado should take advantage of this arrangement not only to obtain walleye eggs, but to get a man trained in the art of taking the eggs.

Walleye Planting Plans

Stocking plans, for the establishment of walleye populations in various waters, has in the past been based upon making a plant of fry or fingerlings for three consecutive years in each body of water. Ordinarily this method is quite successful, when used to establish fish populations.

The following list shows which impoundments have received their three yearly plants:

Reservoirq	County	Number of Plants
Neff	Weld	3
Seeley	Weld	3
Seaman	Larimer	3
Queens	Kiowa	3
Holbrook	Otero	3
North Sterling	Logan	4
Adobe Creek	Bent	3
Bonny	Yuma	4
Nee Granda	Kiowa	4

Stocking of walleyes should be discontinued in these impoundments until it has been determined whether or not the fish can reproduce successfully.

Listed below are the reservoirs which will require further plants of walleyes:

Reservoir	County	Number of plants Already Made	Number of Plants Required.
Sweitzer	Delta	1	2
Jumbo	Sedgwick	1	2
Cowdrey	Jackson	1	2
Lonetree	Larimer	1	2
Summit	Dolores	1	2
Sloans	Denver	1	2
Loveland	Larimer	2	1
Horse Creek	Bent	1	2
Two Buttes	Baca	2	1
Prospect	El Paso	1	2

Approximately one million fry will be needed each year to carry out the stocking plans for these waters. Even with the event of stocking new waters, the planting program for walleyes could be maintained upon less than five million walleye eggs per year.

Walleye Angling Success

Actually the walleyes found in the warm water reservoirs, fills the niche of the big spectacular fish, taken once in awhile during the season by the average fisherman. The average Colorado fisherman, who generally possesses little skill, cannot expect to take walleyes upon the same basis as they would such easy fish as small trout, yellow perch or bullheads. The small minority of skilled anglers who consistently take large trout, black bass, etc., will probably catch the walleyes more readily.

It has been observed that the anglers have great difficulty in taking walleyes in waters where natural foods are very abundant, but, in waters where natural foods are limited or seasonal, walleyes ranging from 10 to 16 inches in length seem to bite more readily. Live bait appears to be the best lure for the walleyes in most of the impoundments of the State. Fishing in deep water from a boat produces the best walleye fishing success during the daytime, while shore fishing in the shallows at night produces much better results for most anglers seeking to take the wary walleye.

Crawfish. Bosceni. 1961. T. Am. Mic. Soc. 80(3): 266–
p. 285: Oronectes virilis – common in coves & bays in weed beds. – This sp. was stocked in several other Colo lakes
now abundant in Granby.

– Trout utilization ?:
utilized in Parvin – 26% vol. B.B.
– overall 17–18%
– Williams, H. J. – 1949–52. diet of rainbows in Parvin L.

Approximately 2 million fry will be needed each year to carry out the stocking program for these waters. Even with the event of stocking new waters, the planting program for walleyes could be maintained upon less than five million walleye eggs per year.

Walleye angling success

Actually the walleyes found in the warm water reservoirs fill the niche of the big spectacular fish, taken once in a while during the season by the average fisherman. The average Colorado fisherman, who generally possesses little skill, cannot expect to take walleyes upon the same basis as they would such easy fish as small trout, yellow perch or bullheads. The small minority of skilled anglers who consistently take large trout, black bass, etc., will probably catch the walleyes more readily.

It has been observed that the anglers have great difficulty in taking walleyes in waters where natural foods are very abundant, but, in waters where natural foods are limited or seasonal, walleyes ranging from 16 to 18 inches in length seem to bite more readily. Live bait appears to be the best lure for the walleyes in most of the impoundments of the State. Fishing in deep water from a boat produces the best walleye fishing success during the daytime, while shore fishing in the shallows at night produces much better results for most anglers seeking to take the wary walleye.

February 7, 1957

Dr. L. Joseph Hendricks
State Teachers College
Minot, North Dakota

Dear Dr. Hendricks:

I very much enjoyed your letter and the manuscript on "Changes in the Fish Fauna of Boulder County, Colorado". There are several of the species that I have some information on and I think I will confine my remarks to points of interest concerning the species in the study. I think generally speaking the manuscript is very well prepared and if there are any corrections your former professor Dr. Pennak will do a very thorough job of editing them.

In discussing the species recorded by early workers as collected in the county in 1903, I found considerable difficulty in identifying the species because of the numerous name changes that have occurred in the past 54 years. I think that I am at least clear on the genera involved but still have some suspicions that I have not identified those that are being described as to species. I suggest that you might improve the manuscript by indicating the present accepted scientific names for those species presently described only by ther obsolete names.

I never did decide what Juday meant by the genus Richardsonius or the genus Leuciscus and for a point of interest wish you would take the time to drop me a note and tell me exactly what groups of fishes they are describing. I was very much interested in some of the records of fish collected in 1950, namely Chrosomus erythrogaster and Hybognathus n. nuchalis. I have collected only one Chrosomus since I have been in Colorado; also from the Platte Drainage, and we do not have representatives of Hybognathus n. nuchalis in the collection here at Colorado A & M. I believe you refer to the Western silvery minnow. The appearance of Phenacobius in Western Boulder County was also of interest. While Phenacobius is taken quite frequently, we have never taken it in large numbers.

I have some additional information on the native trout, Salmo clarkii stomias, which I think would be of interest to you. Members of the Colorado Museum Staff called me a little over a year ago in the fall indicating that they believed that they had located a population of these native trout. The location was in the Boulder City Watershed on Albion Creek. With a sampling expedition and a member of the Museum Staff, we made a fairly extensive collection of native trout from that stream. These fish were forwarded to Dr. Robert Miller at the University of Michigan and a copy of his reply is attached. I will let you judge for yourself whether or not you wish to conclude that these fish were really Salmo clarkii stomias.

So much for species presently on the Eastern Slope. Now to your question of whether or not species of the Western Slope of Colorado are coming through the diversions of the Big Thompson Project. One of my graduate students has just completed a Master's degree on the life history of suckers in Shadow Mountain Reservoir. You will recognize this as a body of water located in the Big Thompson diversion system and connected to Grand Lake by a channel providing ready access for fish populations moving between these lakes. As a part of his study he collected fish with gill nets, trap nets, seines, electrical shockers and rotenone. These collections disclosed that the fish population of Shadow Mountain Reservoir was made up almost entirely of introduced species, most of which are present naturally or through introductions on the Eastern Slope of Colorado. The sucker population consisted of about 80% Western white suckers, Catostomus commersoni suckleyi, and about 20% Western longnose suckers, Catostomus catostomus griseus, together with a few of what appeared to be a hybrid between these two genera. This hybridization has been noted by others and is very interesting if it is confirmed. He took no Pantosteus or Gila in Shadow Mountain Reservoir. Cottus of both species were present but rare. The only Rhinichthys he took was cataractae. Other species present in Shadow Mountain were all introduced species and included grayling, kokanee salmon, brook trout, brown trout, rainbow trout, and cutthroat trout. The cutthroat were classed as introduced in as much as they were fish from Yellowstone Lake.

From this rather indirect information I would conclude that the chances of the Western Slope species moving to the Eastern Slope through the Big Thompson Project are remote. The most likely to occur are the two species of Cottus and I am sorry to say that I can only add to Tom Lynch's conclusions that sooner or later they very likely will move through the diversion system. Tom is correct in saying that many fish are coming through, but apparently most of these are the two species of suckers; the Western white and the Western longnose, neither of which are native to the Western Slope.

I hope my comments have been of interest and of some value to your paper. I would be interested in having the information that I have requested above. If I can be of any further assistance please contact me.

Sincerely yours,

Howard A. Tanner, Unit Leader

HAT:ds

Encl.

STATE TEACHERS COLLEGE
MINOT, NORTH DAKOTA

DIVISION OF SCIENCE

February 2, 1957.

Dr. Howard A. Tanner
Dept. Forest Recreation and Wildlife Conservation
Colorado A and M College
Fort Collins, Colorado

Dear Dr. Tanner:

I have taken the liberty of sending you a carbon of a MS that I plan to offer to Copeia for publication as an Ichthyological note. I would greatly appreciate your efforts if you would read this over, being critical of any of the statements I have made or the names I have used. The material is a little old and for this reason I believe that it should be criticized by someone in touch with the situation. I have also sent a copy to Dr. Pennak at the University of Colorado, the man who advised me on my masters work. I know that Dr. Pennak will be critical of the style and grammar as well as content, but I thought that you might be better informed as regards the fish facts.

Recently I asked Tom Lynch to clarify some statements he once made to me about the finding of western slope species on the eastern slope in regard to the Big Thompson diversion. I wasn't quite clear on his answer - ~~he~~ specifically said no sculpins had been noted to date, but said, "Everything else has come through so it is possible the sculps made the grade". Have any western slope endemics been taken on the eastern slope?

I felt at the time I did this work that the material was interesting and should be published. Time has dulled the feeling somewhat but I still believe the information worth publishing. Today, when the fish faunas of so many areas are undergoing changes for the reasons I have listed and others also (the minnow bucket, for example), it seems worthwhile to compare old species lists with recent collecting records and to reflect on the possible causes of the changes.

Please feel to criticize fully, even to the point of saying you don't believe the item is worth publishing, if that is your opinion. I have enclosed a stamped addressed envelope for ready return of the manuscript.

Thank you very much.

Very sincerely yours,

Joe Hendricks

L. Joseph Hendricks

CHANGES IN THE FISH FAUNA OF BOULDER COUNTY, COLORADO

Boulder County, located in north-central Colorado, is a rectangular area approximately 25 miles wide in a north-south direction and about 35 miles long from east to west. The southeast corner of the county is about 10 miles northwest of Denver. The elevation ranges from 4,900 feet above mean sea level at the eastern border of the county to over 14,000 feet along the continental divide which forms the western boundary. The eastern half of the county consists of rolling plains which break rather abruptly into the foothills at an elevation of about 5,500 feet. The foothill and mountain area is highly dissected by stream drainage and is rugged and precipitous.

A list of the fishes, collected in the plains area of the county, was published by Chancey Juday in 1904 (Univ. of Colo. Stud., 2: 113-114). The fishes of the county were also included in studies published by T. D. A. Cockerell in 1908 (Ibid, 5: 159-178) and M. M. Ellis in 1914 (Ibid, 11: 5-136). I made a study of the fishes of Boulder County and presented the findings in a masters thesis (Hendricks, Unpubl. Masters Thesis, Univ. Colo.). As a result of that work several changes in, and items of interest concerning, the fish fauna were noted and are herein reported.

A total of 33 species were found present in Boulder County in 1950. Of this number, 23 were found only in the plains and lower foothills area, while 2 species were taken only in waters of the mountain area. Eight species, more widely distributed, were collected in both plains and mountain areas. Two species from the latter group, _Pimephales p. promelas_ Raf. and _Poecilichthys exilis_ (Girard), were taken in abundance from a pond near Lake Eldora at an altitude of 9,300 feet. The presence of these two species at this altitude is definitely unusual.

Five species collected in the county in 1903 are now apparently absent.

These are Carpiodes velifer (Raf.), Couesius plumbeus dissimilis (Girard), Nocomis biguttatus (Kirtland) Juday used the synonym Hybopsis kentuckiensis (Raf.) , Notropis bifrenatus (Cope) Synonym N. cayuga Meek , and Richardsonius evermanni (Juday) described by Juday as Leuciscus evermanni . The last named is a doubtful species based on 3 specimens collected in 1903 from Boulder Creek in Boulder County. No additional specimens have ever been recorded and the original specimens could not be located. The presence of N. bifrenatus was based on 6 specimens taken in Boulder Creek in 1903. If the identification were correct (the original specimens could not be located for checking) the range of the species would be extended considerably beyond its known range which is limited on the west to the waters of the Lake Ontario drainage (Hubbs and Lagler, Fishes of the Great Lakes Region, 1949, p. 68).

Four species were rare in recent collections and were taken only in a few deep holes in streams near the eastern edge of the county. Two of these species, Chrosomus erythrogaster (Raf.) and Hybognathus n. nuchalis Agassiz, were collected in 1903 in the western portion of the plains area as well as in the eastern. The other two species, Phenacobius mirabilis (Girard) and Notropis l. lutrensis (Baird and Girard), were collected only near the eastern edge of the county in 1903 as they were in 1950. From the information available it is not possible to state whether or not these species were more abundant in 1903 than at present.

The native trout, Salmo clarkii stomias Cope, was not taken during any of the recent collecting nor was it reported in 1903. However, Juday mentioned that he had made no effort to obtain trout from the mountain courses of the streams in the county. The native trout may have been abundant and widespread in the streams of this area at one time (and there is considerable evidence that they were) but they are now definitely scarce, if existant at all, asstream fish.

Three species were recorded that are new to the county since the work of Juday. Their presence is the result of introductions. Notemigonus crysoleucas auratus (Raf.) is found in some of the plains reservoirs in the northeast corner of the county where it has been introduced as a bait minnow. Lepomis gibbosus (Linn.) is present in several of the reservoirs and also in deeper holes and oxbows of the eastern section of Boulder Creek. The carp, Cyprinus carpio Linn., is present in many of the plains reservoirs and also in holes along the streams.

Several factors are of importance in producing changes in the fish fauna of this area. The first and most important is removal of water from the streams for irrigation and domestic uses. The need for water in this area has become acute resulting in a considerable reduction in the flow of the streams coming from the mountains, particularly during the summer and fall. Another factor of major importance is the practice of straightening stream channel's, resulting in the elimination of the meanders and oxbow ponds. The consequence of these practices is the production of shallow streams, lacking pools and meanders, and frequently deficient in streamside vegetation. These conditions are unfavorable for the larger species of fishes, for those requiring deep, quiet water, and for those requiring cool water. The pollution of the streams with municipal and domestic waste further reduces the suitability of the streams for many of the native fish species.

The completion of the transmontane water diversion of the Big Thompson Project may permit access of species from the western slope of the continental divide to the Big Thompson River of the eastern slope. The streams of Boulder County connect with the Big Thompson at a point about 20 miles north and east of the northeast corner of the county. This nearness to the diversion water makes it appear probable that species endemic to the western slope will be able to find their way into the Boulder County streams. West slope species which should be looked for are Catostomus latipinnis Baird and Girard, Pantosteus d. delphinus (Cope), Gila robusta Baird and Girard, Rhinichthys *nubilus* (Jordan and Evermann), *Cottus bairdi punctulatus* (Gill), and *Cottus annae* Jordan.

L. Joseph Hendricks, Minot State Teachers College,
Minot, North Dakota.

[ca 1960s]

COLORADO GAME, FISH AND PARKS DEPARTMENT

MANAGEMENT SERVICE BULLETIN - NUMBER XII

The Silver Salmon Story

By - W. D. Klein

The Colorado Game, Fish and Parks Department has been alert to the use of various exotic fishes for a number of years and some success has been achieved with a few species, i.e., white bass, drum, kokanee salmon, walleye and northern pike. The process of obtaining and testing new species is not easy as the original stock is often difficult to obtain and handle. After they are made available, observations on their progress must continue for a substantial period of time to determine the suitability of the fish for a particular body of water. It is also advisable to make experimental plants in several types of water since the new species may be suitable in one situation but not in another.

The Department was fortunate enough to receive a shipment of silver salmon eggs in 1962 and experimental plants were subsequently made in Parvin Lake and in Lake Granby. The plants in both lakes are under careful observation by biologists and details on the progress of the fish will be available in a few years.

Reports from the various states where the silvers are used in lakes suggests that they may not make any better growth than rainbow or other trout in the same water. However, one article concerned with sea run silver salmon in Alaska indicates that in some circumstances they will go to a fish diet when small in size in the lakes where they spend a portion of their life cycle. Sockeye salmon were the principle forage fish involved in the Alaska lake. Since the kokanee is a subspecies of the sockeye it was thought that there was a possibility of silvers using the kokanee or the very abundant sucker population in Lake Granby for forage. Should this occur, the silvers could be expected to make rapid growth and reach a comparatively large size thus providing a badly needed big fish for Lake Granby, and possibly other similar reservoirs.

Incidentally, the silvers pose no threat as an established and unwanted fish since they will disappear with the cessation of stocking upon completion of their life cycle.

The plant of silvers was made in Parvin to obtain some information on their habits in a lake of this type. It is possible that they may display differences from trout that would be valuable. For example, there are some slack periods during the day and season when the trout cannot be taken in appreciable numbers. Perhaps the silvers could be harvested during these periods and thus fill in the gap and permit a greatly improved fishery.

Silver salmon, like the kokanee, are a true salmon and they die after spawning, normally in their third, fourth or fifth year of life. They have been successfully landlocked in various freshwater lakes in the United States and in several foreign countries. Silvers have a fine reputation as a game fish under these circumstances as they readily take artificial lures and put up an excellent battle when hooked.

They have many habits similar to trout including temperature tolerances. Silvers can be readily handled in a routine manner at our hatcheries with perhaps a little more care in feeding than we normally give rainbow. Strong migratory tendencies can be expected in any of the salmon and silvers will probably leave a lake if a surface outlet exists. The salmon at Parvin have not attempted to migrate as yet and the fish with one summer in the lake are seven inches long. It is anticipated that they will attempt to migrate during next spring's high water period. There are reports of silver salmon being successfully raised to maturity and spawned in a hatchery. We have retained a few silvers at the Bellvue hatchery in an attempt to repeat this procedure. It is not unusual for them to attempt to spawn in the middle of winter in the various landlocked situations. They do not spawn successfully and the time of year virtually prohibits capture and artificial spawning of the mature fish. There is a possibility that the unusual circumstance of open water in the Shadow Mountain Reservoir spilling basin may permit silver spawn taking at this location. Some of the Granby Reservoir silvers were planted in the spilling basin with the hope that they would return to spawn. Any local source of eggs would be most fortunate since the states on the west coast are very reluctant to part with silver salmon eggs. This is understandable because of the difficulty in maintaining good runs of this valuable game and food fish in the face of the in-roads of civilization, dams, pollution, etc.

[ca mid 1960s]

MANAGEMENT SERVICES BULLETIN

OBSERVATIONS ON NORTHERN PIKE IN TWO MOUNTAIN RESERVOIRS

by W. D. Klein

A number of Colorado trout lakes and reservoirs contain heavy populations of rough fish, usually suckers. Northern pike (Esox lucius) feed voraciously on fish and it was thought that this species might be of value in reducing rough fish populations. Northern pike fingerlings were stocked in Skaguay and Tarryall Reservoirs to permit an evaluation of the use of this predator in two types of trout water.

Skaguay Reservoir is located on the south slope of Pikes Peak near the town of Victor. It is used for power production and the water level fluctuates annually. This small (90 acre) reservoir is normally void of rooted aquatic vegetation and contains a substantial population of suckers and perch. Rainbow trout and kokanee salmon are the principle game species in the reservoir.

Tarryall Reservoir, located in South Park near the town of Jefferson, is owned by the Game, Fish and Parks Department and is operated to provide fishing. The lake is held at spillway level throughout the year and dense beds of rooted aquatic vegetation have developed in the shoal areas, particularly in the vicinity of the inlet. The sucker population in Tarryall is extremely heavy and stocked rainbow trout are the principle game fish.

Two plans of northern pike were made in Skaguay; 6,352 fish 4-5 inches in length in June of 1959 and 3,125 stocked in June of 1960 at 6-7 inches in length. Tarryall Reservoir was stocked with 1,000 northerns 6-7 inches in length in June of 1960.

The following observations were made on the 1959 plant of northern pike in Skaguay Reservoir:

1. The northern grew well in Skaguay averaging 15.4 inches in May of 1960, 16.7 inches in July of 1960, 20.8 inches in September of 1960, 22.5 inches in May of 1961, 27.2 inches in October of 1961 and 31.5 inches in June of 1963.
2. The sex ratio was unbalanced with males being much more plentiful than females.
3. Female northerns were larger than the males.
4. The males reached sexual maturity in May of 1960. These ripe fish averaged 15.4 inches in length when recovered on May 21 and 22.
5. The first ripe female (26.3 inches in length) was recovered on May 11, 1961.
6. The northern pike stomachs, examined in May of 1960, contained nine perch, three suckers and one trout. The perch eaten were 3 to 4 inches in length while the suckers and trout ranged from 4.8 to 6.0 inches.
7. Eight to nine inch kokanee and trout were found in the stomachs of the northerns in September of 1960. The stomachs also contained one 8 inch sucker and several 4 to 5 inch perch.
8. Fishermen were able to catch northerns during the spring and summer of 1960, primarily with hardware. The fish were much more difficult to catch after 1960 and comparatively few of the larger pike were taken by fishermen. It was illegal to fish with live minnows in Skaguay. There is a possibility that large northerns could have been taken with minnows.
9. There has been no evidence of successful natural reproduction of

northern pike at Skaguay. Suitable spawning beds were lacking and it is also probable that water temperatures during and after the spawning period were not correct for successful reproduction.

10. Northern pike were successfully spawned artificially at Skaguay but the time that the eggs could be obtained was bad from the standpoint of water temperatures at our warm-water hatcheries. The water was too warm at the hatchery by the time the eggs were available from Skaguay.

The 1960 plant of northern pike in Skaguay was evidently not as successful as the first. A few fish were recovered from the second plant during the various samplings at the reservoir, but the recoveries were too sparse to provide information of value.

Data from the small plant of northern pike made in Tarryall Reservoir is limited. Gill nets were set on September 25, 1960 and 11 northerns were recovered. These fish averaged 15.4 inches in length. One additional northern was picked up in a gill net on October 12, 1961. This female was 23.5 inches in length. The growth of the northern pike in Tarryall appears to be as good or better than encountered at Skaguay. The 250 foot experimental gill net (3/4 - 2 inch mesh) set in Tarryall in September of 1960 recovered 11 northern pike, 8 rainbow trout, 110 western white suckers and 8 longnose suckers. It may be significant that in spite of the abundant sucker population each of four pike stomachs contained a five inch rainbow, one contained a small sucker and the others were empty.

The conservation officer stationed at Tarryall reported that northern pike were frequently recovered by fishermen below the dam. A fisherman also reported catching a pike in the South Platte River and northern pike were recovered in gill nets set in Cheeseman Reservoir in 1963. Tarryall Creek runs into the South Platte River about 15 miles below Tarryall Reservoir. The South Platte empties into Cheeseman Reservoir, some 10 miles below the junction of Tarryall Creek and the South Platte. The northern pike reported from the South Platte River and the pike taken in the gill net in Cheeseman had to come from the plant made in Tarryall Reservoir.

To the best of our knowledge, the northerns have not successfully reproduced in Tarryall. Small northerns have not been reported by fishermen and gill netting and seining in the spring of 1963 failed to recover small pike. The abundant vegetation beds in Tarryall seemed to offer some possibility for successful natural reproduction but other factors, perhaps water temperatures may not have been suitable.

The observations made on the plants of northern pike in Skaguay and Tarryall Reservoirs are summarized as follows:

1. Northern pike will leave a lake via a surface spillway and travel downstream for substantial distances.
2. Natural reproduction of northerns in our trout lakes is not likely to occur.
3. Northern pike will feed on salmonids, possibly to a detrimental degree, even though other rough or unwanted fish species are numerous.
4. Northern pike are capable of good growth in our mountain lakes providing there is an adequate supply of forage fish.
5. A good start of northerns can be obtained with a single plant of fingerlings.
6. Eggs obtained from northern pike in mountain waters cannot be satisfactorily propagated with our existing warm water hatching and

rearing facilities.

It is the author's opinion that it is not good management to use northern pike in conjunction with trout or salmon even though rough fish are abundant. There appears to be a distinct possibility that the northerns will eat the salmonids in preference to rough fish. Abandonment of trout stocking and the planting of northern pike is a possible management approach in certain extreme situations where dense rough fish populations are seriously interfering with the trout fishery. The resultant northern pike fishery would be of dubious value.

ACKNOWLEDGEMENTS

Roger Barnhart, Donald Nolting, Donald Wurm and Rolf Nittmann collected data that contributed to the contents of this bulletin. Members of the Fish Management Division of the Department also supplied information, particularly in connection with the northern pike spawn taking at Skaguay Reservoir.

5/27/69

High Mountain Stream Survey Sheet

Personnel:

Date:

1. Stream__________ Code No.__________ Photo No.__________

2. Location - County__________ Elevation__________

3. Tributary To__________ From (Lake)__________

4. Location of Survey Section__________ R_____ T_____ S_____

5. Length of Survey Section__________ No. of Survey Section__________

Estimated Water State__________ Snow in immediate area__________

6. Weather - Present__________ Just previous__________

7. Immediate Watershed - Topography__________ Vegetation__________

Soil Type__________ Use__________ Watershed Condition__________

Effect on Stream__________

8. Bank Condition__________ Streamside Vegetation__________

9. Beaver - No. of Lodges__________ Extent of Cutting__________

Beaver Dams - Number__________ Condition__________

Importance of Fishery__________

10. Velocity (sluggish, rapid, etc.)__________ Volume Flow_____ C.F.S._____

Depth Avg.__________

11. Water Type - Pools__________ Depth Max.__________

Depth Avg.__________

Flats__________ Depth Max.__________

Riffles__________ Mid Channel Depth__________ Cascades__________

12. Fish Shelter__________

13. Spawning Conditions__________

14. Aquatic Vegetation - Submerged__________

Emergent__________

15. Aquatic Invertebrates - Sampling Method__________

Abundance__________

Food Grade__________

16. Physical and Chemical - Time__________ Air Temperature__________

Water Temperature__________ pH__________

Oxygen__________ Alkalinity__________ CO_2__________

17. Fish Collection - Length Sample Section__________

Method__________

Species	Avg. L.	Range	Avg. Wt.	Range	Condition	Number

Calculations, Recommendations and Comments:__________

OPTIONAL FORM NO. 10
5010-104

UNITED STATES GOVERNMENT

Memorandum

TO : Dave Foster, Div. Fishery Services, Albuquerque, New Mexico

DATE: 3/6/72

FROM : Robert Behnke, Colo. Coop. Fishery Unit, Colo. State Univ., Ft. Collins, Colorado

SUBJECT: Future of Genetics Lab

To modify the fish genetics lab with a goal of establishing a productive research facility that will provide useful and significant information of direct relevance to Bureau programs will require a bold new direction and new talent of the calibre to generate intellectual leadership and national and international recognition in the field of fish genetics.

Previous research at the lab has emphasized heritability of single traits - perhaps of some usefulness in raising fish in hatcheries. I don't believe, however, that any basic, new information has been created by the research that could not be found in, or predicted from, any text book on genetics. Not a single publication of sufficient significance to attract wide attention among geneticists has ever come out of all the years of effort at the lab.

The cogent question is: what direction should a new research program take that will provide information of a type yielding viable input into Bureau programs and attracting favorable attention from the scientific community?

When applying principles and drawing analogies between fish husbandry and selective breeding of domesticated animals and plants, a very important point is often ignored. This concerns the fact that unlike domesticated species which receive care and protection from their origin to the market place, fishes are stocked in natural environments to compete and survive and return to the fishery over a period of time - perhaps for several years. Under such circumstances the genetics of the fish play a major role in the total interaction of the organism to the environment governing the growth, survival and contribution to the fishery. It is this type of genetics research, emphasizing what a fish does after it is stocked - that will yield the necessary information to better integrate the goals of the divisions of fish hatcheries, management and research and produce the basic data for sophisticated fisheries management programs of the future.

I can suggest a few ideas on the type of projects I have in mind that should generate directly applicable information to fish hatcheries and fisheries management.

1. The federal hatchery system produces enormous numbers and pounds of trout, particularly rainbow trout. Certain waters such as Flaming Gorge Reservoir receive millions of rainbow trout from various hatchery sources. Does anyone have the slightest idea if there is differential survival, growth, and relative yield to the fishery from the different stocks used? Would crossing of inbred hatchery strains boraden the base of genetic heterozygosity and increase survival in the wild without increasing production costs, or perhaps even lowering them? Could we achieve desirable survival traits by crossing wild strains with hatchery strains? What wild genotypes, possessing certain life history traits suggesting certain management potentials could be evaluated under various environments? Polytypic species such as rainbow trout and cutthroat trout possess an enormous amount of genetic variability in natural populations occurring throughout the range of the species. Genetic variability has been programmed by natural selection for optimal performance under specific environmental conditions. The utilization of this genetic variability to take advantage of differences in such traits as time of spawning, temperature, habitat and food preferences, etc., is virtually an untapped source of the raw materials of fisheries management. A potentially powerful tool of fisheries management is the establishment of sympatric intraspecific populations in a body of water to more efficiently exploit the resources and increase the total biomass of the desired species. That this technique is practical and that it does indeed work has been demonstrated by a Coop. Unit research project on a lake in Colorado with different strains of cutthroat trout.

2. Concerning other trout raised in federal hatcheries such as the Snake River cutthroat and the Lahontan cutthroat - what do we know about the environments that these genotypes are best adapted for? The Coop. Unit study on the Snake River cutthroat revealed some remarkable differences in the relative contribution of this trout to a fishery when it coexisted with another race of cutthroat in the same lake. Would the Snake River cutthroat be a valuable management fish for stocking below high dams with release of water at less than optimum temperature for growth and survival of rainbow trout?

The trout currently being propagated as Lahontan cutthroat trout does not attain one half the maximum size of the original population in Pyramid Lake, Nevada. The difference in growth and maximum size is most readily explained by genetic differentiation. I believe much progress could be made by experimenting with new stocks derived from remnant pure populations of Lahontan cutthroat trout.

3. There are some forms of trout not yet officially described, such as the "red-banded" trout of the desert basins of southern Oregon and the cutthroat trout native to the Humboldt River system of Nevada. These trouts have been subjected to natural selection under harsh and varying environmental conditions for several thousand years. They are likely to have the type of genetic variability that would prove useful to fisheries management programs.

   The demonstration of the practical aspects of perpetuating genetic variability for potential management use would provide a stimulus for more active rare and endangered species programs.

A fish genetics lab should direct and carry out experimental introductions and evaluate the performances of genetically diverse stocks. Stocks could be held at the lab, experimental crosses undertaken, and an overall body of information developed on several genotypes actually used or of potential use in fisheries management. This information would encompass the environmental potential of each genotype and have predictive value to answer the question: what fish for what water? New ideas on improving hatchery stocks and suggestions on sources of new stocks should originate from a genetics lab.

I would like to see all this come to pass, but I have sincere doubts that a new era can be brought forth under the present policies and administrative structure of the Bureau. What must be recognized is that it will be the intelligence and enthusiasm of the director and his associates that will make a new program go. Creative and innovative research of the type necessary for a successful fish genetics lab is not adequately recognized nor promoted under current Bureau policies. If the positions are filled merely on the basis of a list of Bureau employees qualified for certain GS levels - there will be no change and the lab should be closed.

It may be necessary to hire outside the Bureau to get a person with an in-depth understanding of fish genetics - particularly evolutionary biology. This person should have national and international recognition or at least the strone indication that he has the potential to achieve such recognition. The criteria for qualification should be identical to those that would be set by a major university if they were establishing a similar research facility.

One point is certain, and that is it will be a waste of money to run a fish genetics lab with uninspired and mediocre talent.

Robert Behnke
Assistant Unit Leader

RB:dch

Form 1542–4
(April 1976)
(formerly 4–1123)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

ROUTING AND TRANSMITTAL SLIP

CODE	TO NAME	ORGANIZATION	ACTION	ROOM NO.
	Bob Behnke			
	CSU			

Indicate Action by Number

1. Necessary action
2. Approval
3. Signature
4. Prepare reply
5. Your comment and return
6. Note and surname
7. Note and return
8. Your information
9. See me
10.

From	Date	Room No.
Don Duff	4/13	

Office	Phone
BLM	

Remarks

Bob - here's some materials on the Deep Creek Mtns. Be aware of these proposals. We could use some support "urging" BLM to continue the withdrawal on May 3, 1980 & urging them to prepare congressional report as required by Organic Act Sect 204(c)(2) to meet deadline in order to continue protection of the area. Don't quote me or Larry - Keep in touch.

☆U.S. Government Printing Office-1978-778-985/20

UNITED STATES GOVERNMENT

Memorandum

DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

IN REPLY REFER TO:

7210
(U932)

TO : Ed Smith, Chief Branch of Biol. Resources   Date: April 13, 1979

FROM : Don Duff, Staff Fisheries Biologist

SUBJECT : Comments on Richfield District's proposal for Management of the Deep Creek Mtns. under Interim Wilderness Guidelines rather than a Protective Withdrawal

These comments are precipitated as a result of the March 16, 1979 meeting in our office with the Richfield district manager and the state director and concerns of the district's subject proposal.

We have been working (district and state office) since May 3, 1977 on protective measures for the unique and diverse desert mountain ecosystem in the Deep Creek Mtn. range. The emergency withdrawal of 27,000 acres of an area of critical environmental concern (ACEC) by the Secretary of the Interior has provided this interim protection but as you are aware, the area could become open again to mineral entry on May 3, 1980 unless permanent protection is implemented.

The present proposal of the district which is not to continue the protective withdrawal but manage under interim wilderness guidelines deviates from the current management direction which we have been proceeding with since May 1977. Larry Lee attended the March meeting and his staff report is attached. I support Larry's report and recommendations for future management direction for the area. I am not aware of any management decision by the SD to deviate any way from the course set to provide permanent protection to the Deeps. I feel the district's proposal is a poor one not displaying a responsible management concern for the area's valuable natural resources. Their proposal would negate all past efforts of BLM, staff individuals, and citizens working to provide a viable management program for the area. I view the proposal also as a way the district manager sees to get out of doing his job of providing a report on the 3 year emergency withdrawal. As you recall, he was opposed to the initial withdrawal proposal because of the increased workload it brought and he felt he was forced into the situation by the state office. But you will also recall that he and his staff reaped all the glory after the withdrawal was made. His staffs who worked on the Congressional report received special achievement awards and recognition but Larry and myself who were the primary supporters of the withdrawal, and provided a significant amount of input to the report for the district, got not one letter of thanks or an award for our efforts! And, now the district wants to override all past efforts by not seeking a permanent withdrawal.

Should their proposal be accepted by the SD, I feel it would be a gross injustice to resource management, significantly devalue BLM's integrity and that of professional staffs who provided management input, and place BLM in a court suit situation by possibly both the mineral interests and the public. The current proposal in essence says to me that all the funds and efforts put into this present 3-year study evaluation are for naught. The $63,000+ for the Utah Divsiion of Wildlife Resources Contract study for us on fish and wildlife resources on the Deeps means nothing if the proposal stands! The same applies to funds for other resource studies being done also.

The data is valuable but could have been better if this was not such a 'rush' study! DD

I cannot see how interim wilderness management can help the Deeps. It has not been court tested and it still allows for mineral entry. Unless permanent protection is afforded/recommended by May 3, 1980, the area will again be open to mineral entry and you can be assured that Atlas Minerals and other companies will be right in there exploring and staking claims with their "temporary roads". As a responsible resource management agency we cannot allow this to happen. Certainly future management as wilderness should be our goal but in the interim we should proceed with ACEC protection until that time arrives.

We have taken management actions for native fish and wildlife resources in the Deeps to assure their protection and that of their habitats. The trout Creek Habitat Management Plan (HMP) is providing management for the sensitive Snake Valley cutthroat trout and a HMP is underway for the entire Deeps for fish and wildlife. The DWR is actively involved now in the cutthroats management there although now the district is opposed to DWR's efforts, a complete turn-a-round from their initial support. The SD, in my opinion, has allowed the DM to make inappropriate management decisions for the Deeps with no accountability. We must maintain some semblance of management decision integrity or else the resource will go down the tube along with BLM. I can assure you that if protection is not afforded the Deeps and their resources, the BLM's management decisions will be challenged by the public. The Snake Valley cutthroat, in all probability, will be nominated for official listing under the Endangered Species Act should the withdrawal protection expire. This will certainly complicate state and federal managementof the Deeps then, but at least it would then make BLM protect the species habitat! But we have this mandate now by the ESA, Organic Act and our manual policy so why does the district disregard these directives?

I recommend you support the original withdrawal study schedule and management objective to provide permanent protection of the Deeps and its resources. The position of the Division of Resources and other state office divisions should be in support of the original protective proposal and against the district's present proposal.

Don Duff

Enclosure

IN REPLY REFER TO
2310
(U-931)

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Utah State Office
University Club Building
136 East South Temple
Salt Lake City, Utah 84111

MAR 22 1979

BRIEFING REPORT

Extending the Deep Creek Mountain Withdrawal

By
Larry Lee

March 19, 1979

On March 16, 1979, the Richfield District met with the State Office on the Deep Creek Mountain Area. The purpose of the meeting was to discuss the options available for the future protection of the values identified with that area during the emergency withdrawal. Discussions centered around two options that may be available.

1. Protection under interim wilderness management, and 2. Extension of the existing withdrawal beyond three years.

It was determined that protection under interim wilderness management is required. We must do this since the area will fall out as a WSA. In fact, more than the 27,000 acres must be studied. This does not preclude extension of the withdrawal.

<u>Protection Under Wilderness Interim Management</u>

Under interim wilderness management, we are required to protect only the wilderness values of solitude, unconfined recreation, and naturalness. By assignment from Max Nielson, I discussed the topic with the Regional Solicitor. He pointed out that interim management for wilderness has not been tested in the courts. He believes it will be. Interim management does not preclude the staking and filing of new mining claims. We should expect a rush to the area to stake claims if the withdrawal expires. If claim staking is not done by Atlas minerals, it will be by other speculators based on the interest shown to date by the Atlas Company. We will not be able to control this under the 1870 mining laws. The draft guidelines state that discovery and location work will not be prohibited (page 15 9.b.). Also "Patents to mining claims will continue to be processed and issued in WSA's" (page 15 9.c.).

The interim management guidelines use terms such as temporary impacts and undue degradation to wilderness values. Many of the examples provided in the guidelines of activities that may be permitted could if properly controlled, protect most wilderness values but would not provide any degree of protection to the unique ecological values we have identified with the area. For example, temporary roads are allowed. Any structures or facilities that could later be removed would be allowed.

The guidelines should be applied equally to all WSA's. It appears that due to the identified values in the Deep Creek Mountain Area, we will want to provide protection in a greater degree than we would be willing to enforce in other WSA's.

Section 3802.4-2 (access) of the proposed new 43 CFR 3800 "Mining Claims Under the Gen. Mining Laws" give an operator non-exclusive access to his mining operations consistent with the mining laws. Paragraph (b) provides that the authorized officer shall specify the location of access routes, but it does not say he can deny access.

Extension of the Existing Withdrawl

Since Interim management is required, the withdrawal will only provide additional protection. In the event the Secretary of the Interior does not go along with us on the extension, we have not lost anything except the time required to submit the report. At the time we processed the original emergency withdrawal the decision was made that we would inventory to obtain additional information, and we would update our planning. The purpose for these was to provide the additional justification for extending the withdrawal. We have funded the inventories but were unable to update the planning. The inventories have supported our original report. They have even identified some critical things that fell outside the withdrawal boundary.

By assignment from Max Nielson, I discussed the question of what would be required to extend the withdrawal with the Regional Solicitor. He reviewed both FLPMA and the Congressional Record on the subject. Our authority for the emergency withdrawal is in FLPMA, Sec. 204 (e). This section states that the withdrawal "may not be extended except under the provisions of subsection (c)(1). This subsection provides that withdrawals which terminate after the date of the act may be extended "only for a period of not more than 20 years by the Secretary on his own motion or upon request by a department or agency head." He must notify both houses of congress no later than the effective date. They have 90 days to consider it. The Solicitor said it would be required that we provide the Secretary with an updated report of the 12 points in Section 204 (c)(2). He did not believe an ES would be required. He felt a negative declaration could be made.

I asked the Solicitor if a report is required if the State Director decided not to ask for a withdrawal extension. In this event, subsection f is applicable. It requires all withdrawals and extensions "shall be reviewed by the Secretary toward the end of the withdrawal period. He felt we should make a report giving the reasons why a withdrawal is no longer needed.

Wilderness Management vs. Management of an ACEC or Other Protective Designation

Prior to FLPMA under the management of the Salt Lake District, unique values were identified in association with the Deep Creek Mountains. Primitive area management appeared to be compatible and would provide justification for withdrawal and protection of the unique values. This was supported by the MFP. Withdrawal was the decision and it was submitted but not acted upon by the W.O. until the emergency withdrawal situation came up. The intent of management until the meeting on March 16, 1979 has been first for protection of the unique values and then primitive or since FLPMA wilderness management. This is a departure from everything we have presented to the public and our 12 point report to Congress.

Withdrawal as an ACEC or perhaps a research study area under the authority to FLPMA would not preclude management as wilderness. The two are compatible. The only problem exists in the interim management and additional protection that wilderness cannot provide but that withdrawal could provide. Commitment to provide protection under wilderness interim management and eventual wilderness designation is shakey at best. A lot of questions are unanswered about our capabilities, authorities, how much will the "Interim Management Policy and Guidelines for WSA's" change from the current draft to the final? How much will 43 CFR 3800 draft be changed when it is final? How long will it take to get these issued in final, and how well will they hold up when tested in court?

The withdrawal, if extended, will provide more sure proven protection. It would not open the area to speculative mining claims. It would eliminate the foreseeable problems and work of reviewing and approving mining plans, monitoring mining activities, and opening discussions about access and etc. for assessment work and other mineral activity in an area where there is very slight chance that mineral values exist in quantities to be economically worth going after.

Requirements to Extend the Withdrawal

It would be highly desirable to update the planning, but this is apparently not possible. The withdrawal action is supported by the original MFP prepared by the Salt Lake District Office, so a new MFP is not essential. An ES could be required but more likely an EAR is all that will be needed. An update of the earlier EAR would probably be sufficient. There is probably very little change if any in the lands report. The mineral report may have to be revised based on new inventory data. The one critical thing is the updating of the 12 point report required by Sec. 204 (c)(1) and even this based on new information should not be a big job.

Recommendation

I recommend we proceed to prepare for withdrawal extention. Though it will require some work during the next 6 months, I feel this will save us work in the long run if we plan to continue protection of the unique values associated with the Deep Creek Mountain Area.

Larry L L

UNITED STATES
DEPARTMENT OF THE INTERIOR
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21

The Gardner L. Grant Company, Inc.

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WHITE PLAINS, N.Y. 10601

914 - 428-5553

August 8, 1983

Dr. Robert J. Behnke
Dept. of Fisheries and Wildlife Biology
Colorado State University
Fort Collins, CO 80523

Dear Bob:

It was good to see you at the TU meeting. Thanks for loaning me your Rio Blanco study. I found it most interesting. (It seems there is a page missing following the paragraph under the heading "Stream Modifications". If you can locate that page and send me a Xerox of it, I would appreciate it.)

I will discuss our Beaverkill stream improvement matters with my partners (which may take some time and ~~in~~ doing) and if there is sufficient interest on their part, I will get back in touch with you to determine how you may be of assistance to us.

Best regards.

Yours sincerely,

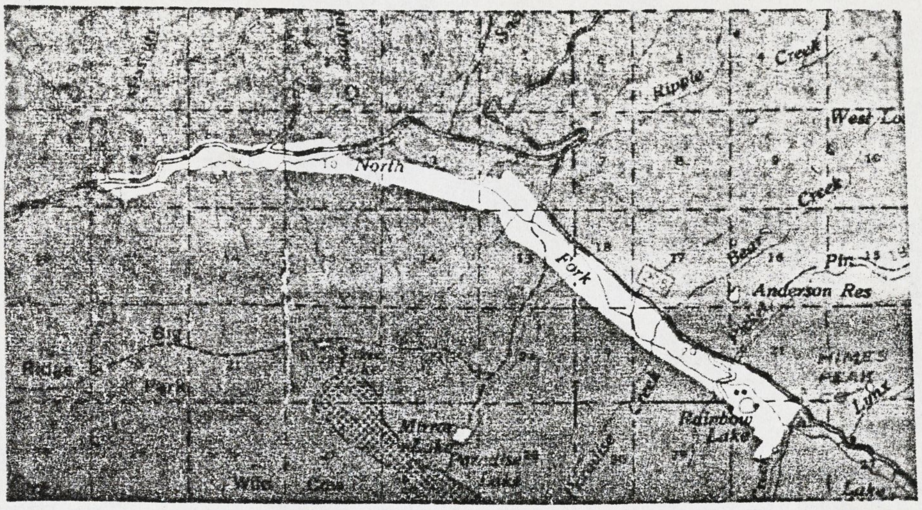
Gardner

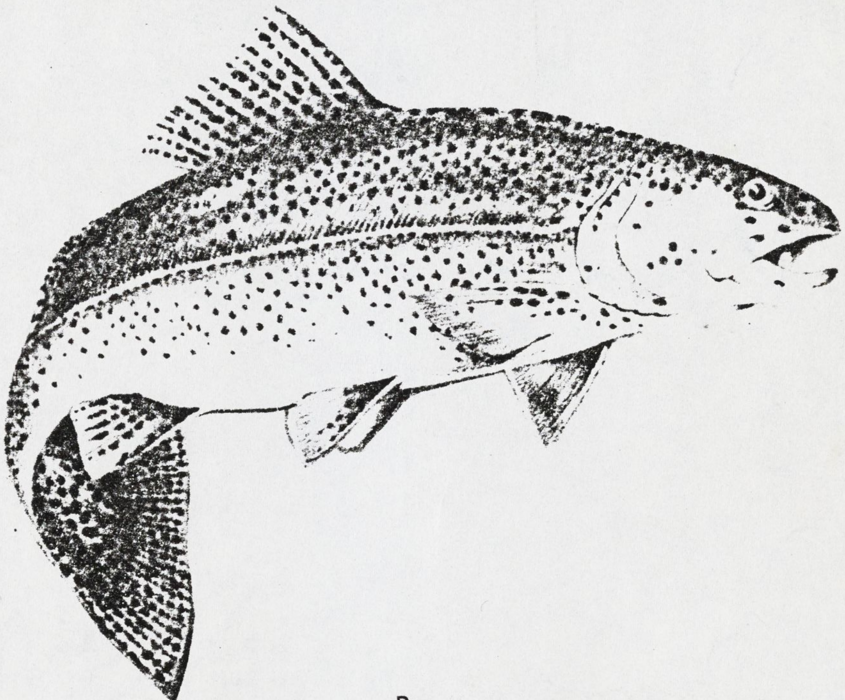
Gardner L. Grant

GLG:cw
Enclosure

[Colorado]
1980

Preliminary Analysis of the Rio Blanco Ranch Trout Habitat and Fishery





By
Dr. Robert J. Behnke
and
Dr. Robert F. Raleigh

INTRODUCTION

A cursory sampling and survey program was conducted on the North Fork of the White River on the property of the Rio Blanco Ranch September 27-28, 1980. The objective of our analysis of information and observations is to diagnose the factors limiting trout production and propose options designed to maximize the quality of the trout fishery. The term "quality" can be elusive and perhaps it should best be defined by the user group -- the club members. In general, "improving fishing quality" means to increase fish abundance, which can be quantified as catch-per-man-hour, and/or an increase in the average size of the fish and proportion of fish in the catch that exceed a certain length; for example, 12 or 14 inches.

This goal could be quickly achieved by stocking large numbers of large-size hatchery trout, but to most serious anglers, the word "quality fishing," is synonymous with wild trout. Thus, our emphasis is placed on improving conditions for wild trout. The first concern to be addressed is to determine if the trout abundance in the North Fork of the White River is food limited or habitat limited. That is, would the trout population increase if food production was increased, or, is there already a surplus of food that is not utilized because of a lack of suitable trout habitat? There is no doubt in our minds that the trout population is primarily limited by habitat and not food. This is obvious from the high trout density found in the pools created by gabion dams. These pools have almost certainly decreased food production in comparison to the fast water riffle area they replaced, but they provide much needed trout resting habitat that is presently in short supply so trout can utilize the invertebrates mainly produced in the fast riffles above the pools. In general, rubble found in riffle areas supports more aquatic insects than other substrate types. This is followed by aquatic vegetation, gravel, and large boulders. Sand and silt are the poorest habitat for invertebrate production. Even in riffle-run areas the presence of sand reduces the invertebrate fauna.

The steep gradient of the river results in a natural river channel consisting almost exclusively of shallow, high velocity water with a rubble and boulder substrate (rock of about 4 to 18 inches in diameter). Such an environment is good for invertebrate production, but is lacking in sites of slow, deep water with associated protective cover that are preferred by trout. The steep gradient and high velocity also causes a scarcity of suitable spawning gravel (¼ to 2 inch size gravel) and calm, protected areas favorable for survival of fish in their first year of life. The annual flow regime and water quality of the river are excellent for trout, which indicate some options to increase the abundance of wild trout.

THE RIVER ENVIRONMENT

During our brief visit we did not observe all of the river on the Ranch property, but we did examine most of it. Because of the relative consistently steep gradient, a reach of about ¼ to ½ mile of river appears to be representative of the entire river through the Ranch. That is, the characteristics of flow velocity, depth, and substrate at any reach is repeated with little significant variation throughout the Ranch (except for man-made modifications).

The U.S. Geological Survey maintains a gauging and water quality monitoring station on the North Fork at Buford. The data collected at Buford is generally applicable to the North Fork through the Ranch except that flow volume of the North Fork, is about twice as great at Buford as it is through the Ranch (Lost Creek and Marvine Creek, tributaries below the Ranch contribute about 40% of the annual flow volume at the gauge).

Figure ~~2~~ 1 illustrates the annual flow regimes for 1977 (a dry year, only 50% of normal), 1978 and 1979 (wet years with flows 10% to 15% above the long term average). In relation to flows favorable to trout, the striking feature of the North Fork hydrograph is that even in the lowest flow period of the lowest flow year, the average daily flow is still 36% of the long term average daily flow. The long term average daily flow is 308 cubic feet per second (cfs). The average daily flow is the total annual flow volume passing the gauging station divided by 365. The mean daily flow during September, 1977 a low flow year, was 11~~2~~4 cfs (3~~6~~7% of 308 cfs).

Based on numerous studies, there is a definite relationship between the annual flow regime and the quality of a trout fishery. The most critical period is typically the base flow (lowest flows of late summer, fall, and winter). A base flow of 50% to 55% of the average daily flow is considered excellent for maintaining the quality of trout habitat. A base flow of about 25% to 30% is considered fair. The lowest base flows in the fall of 1978 and 1979 equalled about 55% of the average daily flow.

The water quality parameters of the North Fork -- temperature, oxygen, pH, nutrient levels, sediment load, etc. also indicate an excellent trout environment. If such a flow regime with such excellent water quality flowed as a low gradient, meadow type of stream, a biomass of wild trout of 300 to 400 pounds per acre would be expected. Because of the steep gradient, the North Fork can produce and maintain a trout population at only a fraction of its biological potential. Between Trappers Lake and Buford the North Fork drops from 9600 feet to 7100 feet for an average gradient of about 1.5%. In comparison, artificial spawning channels, designed to maintain optimum flow velocities for spawning and egg incubation have gradient of .25% or less.

STREAM MODIFICATIONS

The action taken of construction of log dams in earlier years and gabion dams in recent years is a correct reponse to the lack of suitable trout resting and holding habitat in the natural stream channel. This "stair-stepping" effect creates deep, low velocity water and has been successful in achieving the desired results -- trout are concentrated in the artificial pools. A future concern is that, eventually, much of the pool areas above the structures will be lost from the natural action of at least one adequate spawning area should be available between each pair of dams, or fish must be provided access to adequate spawning areas located in other reaches of the stream. The few sites where gravel does occur are found where the velocity is disrupted and diminished (allowing the deposition and maintenance of smaller diameter substrate). Such sites are typically found next to the downstream end of an island and at the head and tail ends of riffle areas. Such sites can be observed and ways considered to duplicate these conditions in an attempt to create spawning areas. Areas near the head of gabion pools (tail of riffle coming into pool) or near a gabion dam at the downstream end of pools appear to maintain the proper current velocities that would permit the establishment of spawning gravel. A gravel bed of two to three square yards will provide space for several redds. The artificial S-shaped channel offers areas where spawning gravel could be established, perhaps with the assistance of in-stream structures designed to maintain optimum velocities (1-3 feet per second) (Figure $\overset{4}{5}$). The problem associated with the S-shaped channel is that the banks are not vegetated and the channel morphology has not yet stabilized. This can result in high sediment loads.

We found several young-of-the-year brook trout (born in 1980), averaging about 3 inches. Only two young-of-the-year rainbow trout (about 1½ inches) were observed in small, shallow side channels. Our cursory observations indicate a probable shortage of suitable spawning sites but we would point out that with trout reproduction there can be "too much of a good thing." Streams where trout have excellent reproductive success and relatively high survival of young are characterized by dense populations of small, slow-growing trout. Improvement of spawning and rearing areas should be approached cautiously.

Rearing or Nursery Habitat. During the first year of life, small trout (1 to 3 or 4 inches) seek protected areas of low velocity where they can find food and avoid predation. Pockets of slow water with vegetation, side channels, old beaver ponds, and small tributaries can provide good nursery habitat. Some of the gabion pools have created some areas of good nursery habitat but they also contain dense populations of large trout that are potential predators. The potential for improvement of side channels and small channels with seeps from beaver ponds might be examined. The objective would be to create areas of low velocity more than six inches deep with protective in-stream and overhead cover.

In our electrofishing and angling survey we sampled about 100 rainbow trout in the North Fork. Only two juvenile rainbows one year of age (completing the second season of growth) were observed. Our survey was much too brief to make firm statements on the limitations of nursery and rearing habitats, but our observations lead us to believe that there may be a scarcity of adequate habitat for young trout.

Observations should be made next year on the potential for use of the artificially created S-shaped channel by young fish. This channel with some modifications, could become an important spawning and rearing area.

We originally believed that we could accurately separate wild from hatchery trout by general appearance (short, blunt heads and frayed, deformed fins characterizing hatchery trout). We could not do this with much confidence. Evidently, the hatchery fish stocked were of good quality and were in the river long enough to assume a "wild"trout appearance. The scales from nine rainbow trout (six from the "laundry" pool and three from the "lower pigpen" pool) were examined to discriminate hatchery from wild trout. The scales of trout raised in a hatchery typically are characterized by a zone of regeneration and widely and evenly spaced circuli (due to rapid and uniform growth). Three, possibly four of the nine rainbow trout were judged to be hatchery trout and five, possible six were wild trout (one speciment had both regenerated scales but with "wild" type circuli -- possible a hatchery trout surviving from the 1979 stocking). Interpretation of age from the "wild" scales indicates that the smallest trout of $10\frac{1}{4}$ inches is age 3 (fourth year of growth), three specimens of 13, $13\frac{1}{2}$, and $14\frac{1}{2}$ inches are age 4, and a specimen of $15\frac{1}{2}$ inches is age 5. This is good growth for rainbow trout in a cold, high elevation stream (Figure 5).

This very limited amount of data would suggest that perhaps 30% to 40% of the late season catch of rainbow trout might consist of hatchery fish, at least in the "laundry" pool and the "lower pigpen" pool.

If the majority of the members are in favor of a fishery based entirely on wild trout, we recommend that hatchery trout not be stocked in the future. With no further stream improvements, the present CPMH might decrease by about 30%. The common arguments against the stocking of hatchery fish can be summarized as follows:

1. Hatchery trout are of inferior quality in comparison to wild fish; the artificiality of "factory"-made fish is not considered to be compatible with a quality angling experience in natural surroundings.

2. Stocking of hatchery trout can depress the population of wild trout. This was found to be the case in the Madison River, Montana. The factual content of this statement depends on the density of stocking and the rate of catch. If stocking density is high (about 50 to 100 pounds per acre in stocked sections) and removed by anglers low (10% to 15%), then the sudden creation of abnormally high densities would likely result in a stressful situation on wild fish causing them to abandon their territories and increase natural mortality.

3. Hatchery trout breed with wild trout leading to a "weakening" or "dilution" of the wild population by making them less fit to cope with the harsh environmental conditions. Theoretically this may be a problem, but under natural selection, very few hatchery fish will survive to reproduce. In each generation the environment acts as an effective sorting device, eliminating less fit genetic combinations.

4. There have been a few cases where hatchery trout have introduced disease pathogens into wild trout populations.

We recommend that the quality of the fishery be monitored in 1981 during June, July, and August to document an average catch-per-man-hour and size of the trout caught by species. If some members believe that stocking is necessary in 1981, stocking should be limited to a section of the river with only a few of the most accessible pools. This would allow for both a wild trout and hatchery trout fisheries as a comparison basis for an informed management decision.

THE LAKE FISHERY

We fished in the lake briefly and caught several brook trout averaging 14 to 15 inches and several cutthroat trout of 15 to 17 inches (and one rainbow trout of 14 inches). The condition of the trout in the lake is excellent, denoting an abundance of readily available food (probably consisting mainly of the amphipod *Gammarus* commonly called freshwater shrimp or scud).

The cutthroat trout found in the lake is the fine-spotted Snake River (Wyoming) cutthroat trout. This particular cutthroat trout can give excellent results when stocked into lakes because of its wide range of feeding. The combination of Snake River cutthroat trout and brook trout will increase the total trout production beyond that possible with either species alone. This is due to the phenomenon of ecological or interactive segregation whereby each species becomes more specialized in its exploitation of the resources when occurring in the presence of other species with somewhat similar niches. This, in turn, reuslts in more efficient utilization of all of the resources.

We recommend that stocking of young Snake River cutthroat trout be made every other year. A stocking density of 3,000 to 5,000 two-three inch trout should be sufficient. The physical features are present to create spawning sites in the inlet channel to the lake by structures designed to modify flow velocity so that clean gravel beds would be maintained. If this were done, stocking would not be necessary, but ~~S~~some control of spawning population size might be needed to prevent the improved spawning conditions from causing overpopulation and stunting of brook trout in the lake.

The introduction of crawfish into the lake might be considered. The crawfish, if it could become established, would provide a large food item and would promote rapid growth of large trout. If crawfish became abundant, four and five pound trout should become more common. Crawfish can also exert effective control of rooted vegetation. Biological control of vegetation would be preferable to chemical control.

A small, red-sided fish is reported to occur in the lake. We did not see this fish but we would like to know what it is. If specimens could be obtained and preserved or frozen, we could identify the species. In general, introductions of "forage" fish into a trout lake is an unwise management practice. Most minnows eat the same invertebrates that trout feed on and, when abundant, these "forage" fish can greatly decrease trout production.

The mottled sculpin, Cottus bairdi, was identified from the river. Although the sculpin's diet is similar to that of the trout, and sculpins prey to some extent on small trout, they are a preferred food for larger trout. We do not consider the sculpin to be any threat to a quality trout fishery. The sculpin impact on the trout population is probably negligible either as a predator-competition with young trout or as a food source for adult trout.

REGULATIONS

We do not have sufficient information on which to base recommendations for the type of regulations needed ~~designed~~ to maximize angling quality. Regulations based on scientifically sound data should be a priority for a future fisheries management policy. We assume that most members indulge mainly in a non-consumptive fishery (releasing all or most of the catch) but some of the members all of the time and all of the members some of the time want to keep some fish to eat.

A self-sustaining trout population in a good environment can sustain a considerable harvest by angling without significant depletion of the population. This is due to the fact that angling mortality and natural mortality are largely compensatory. That is, the more fish killed by fishermen, the fewer that die from natural causes. A population with good recruitment of young fish and high production (for example, where the biomass replaces itself annually, the production/biomass ratio is 1.0) can sustain a relatively high yield to the creel with only a short-term depletion of numbers. For example, a fishery that averages a biomass of 100 pounds of trout per acre might yield a harvest of 25 to 50 pounds per year and in the following year the biomass and size-age structure might remain unchanged because fishing mortality has replaced natural mortality as the main source of total mortality (Figure ~~7~~ 6). A good rule-of-thumb is to watch the CPMH and the average size of fish caught. A noticeable reduction in either is a danger signal.

Information would be needed on recruitment, production, size-age structure, mortality rates, angling pressure, and angler preferences, before the "best" type of regulations could be proposed to maximize angling quality. Types of regulations that can be considered include: 1) a minimum size limit (all fish below a certain size be released), this insures that all fish have an opportunity to spawn; 2) a maximum size limit (all fish over a certain size released), this will stockpile large fish for a trophy fishery; and 3) a "slot" limit (all fish between certain sizes be released -- for example, release all fish between 10 and 14 inches) a combination of the above. Each type of regulation is designed to work best in response to certain combinations of the inter-action between fishing pressure, population dynamics, and the desires of the fisherman.

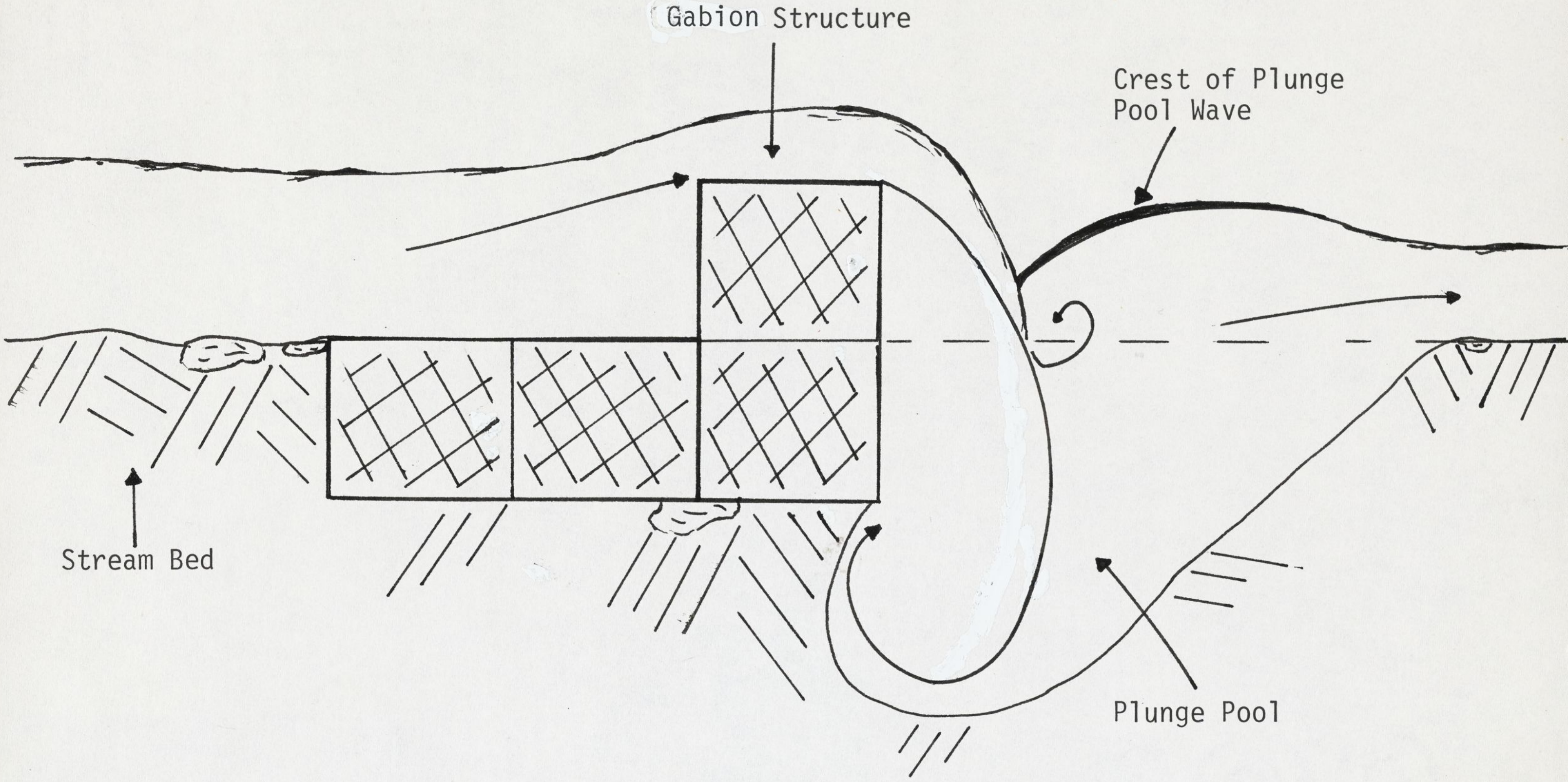


Figure 3. Plunge pools created and maintained below stream structure.

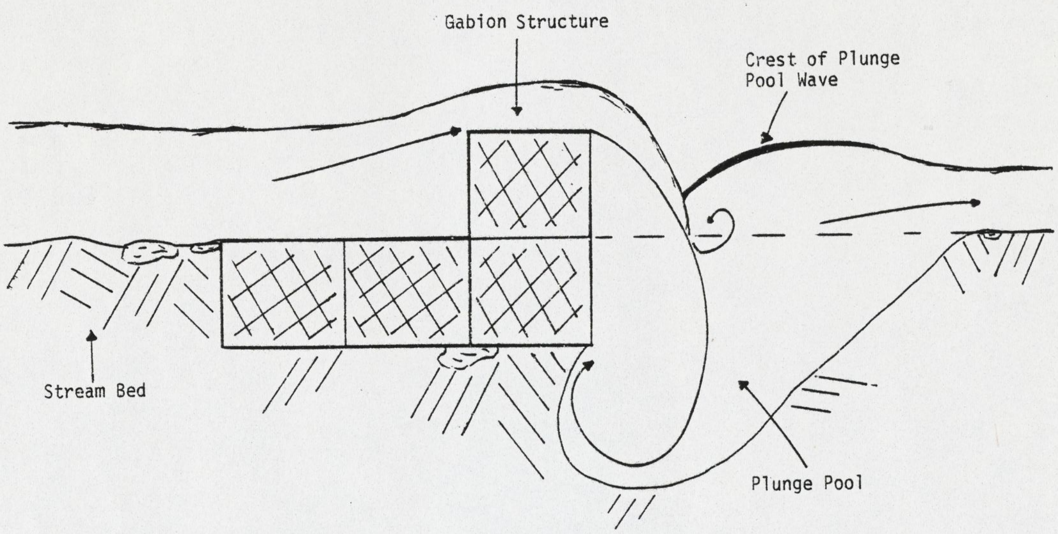


Figure 3. Plunge pools created and maintained below stream structure.

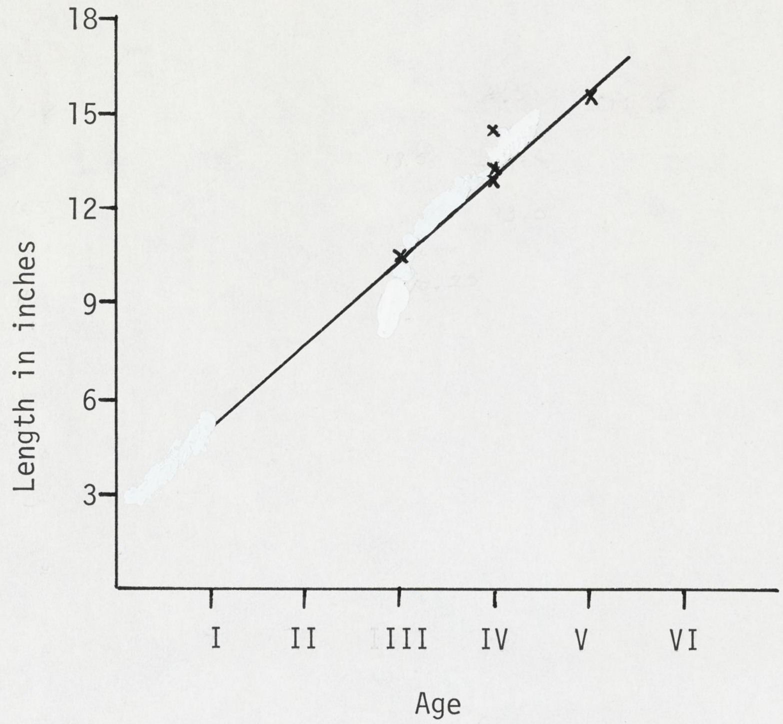


Figure 6. Probable average growth of rainbow trout in North Fork White River based on limited scale analysis.

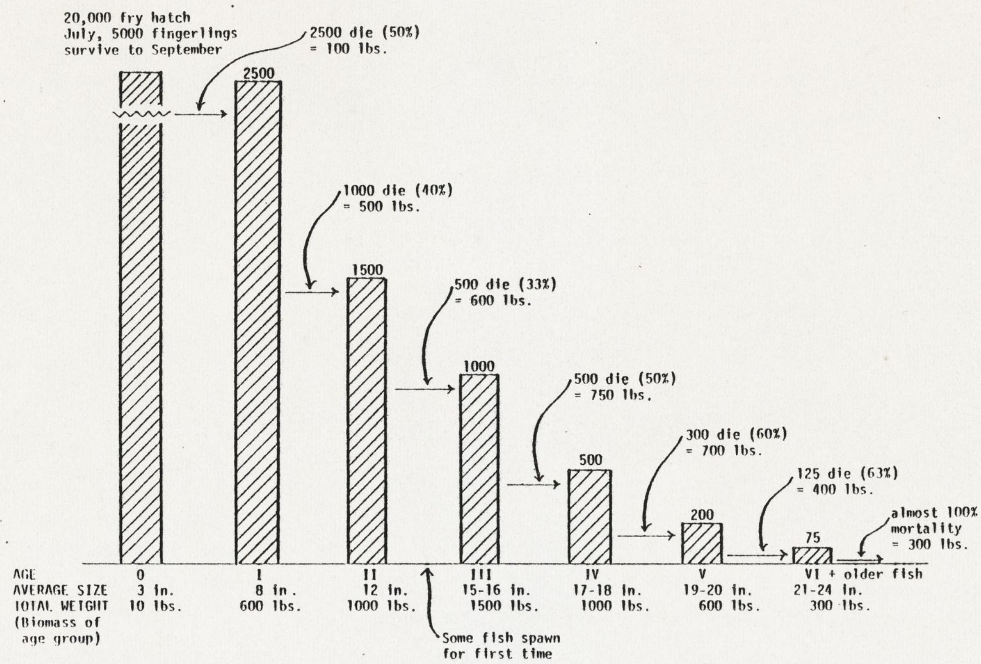


Figure 7. Hypothetical and idealized size and age structure of a trout population at the end of the growing season.

Assumptions for this model are that natural mortality rates are relatively low, growth and reproduction are good to excellent. Anglers remove only surplus production, 80% or less of the average annual natural mortality (overexploitation does not occur). In general angling mortality can substitute for about 80% of natural mortality (about 20% of natural mortality is "density independent" and would occur depsite angling mortality).

Overexploitation by anglers will occur if the number of trout removed by anglers equals or exceeds the numbers in the surplus production.

United States Department of the Interior
FISH AND WILDLIFE SERVICE
AREA OFFICE COLORADO—UTAH
1311 FEDERAL BUILDING
125 SOUTH STATE STREET
SALT LAKE CITY, UTAH 84138

IN REPLY REFER TO:

2 JAN 1981

MEMORANDUM

To: Regional Director, Water and Power Resources Service
Lower Missouri Region, Denver, Colorado

From: ACTING Area Manager, Fish and Wildlife Service,
Salt Lake City, Utah

Subject: Biological Opinion for Colorado - Big Thompson Project,
Colorado

In response to your November 9, 1980, request for formal consultation on the Colorado-Big Thompson Project, this biological opinion has been prepared as prescribed in the Section 7 Interagency Cooperation Regulations (50 CFR-402), published in the January 4, 1978, Federal Register and the Endangered Species Act, of 1973, 16 U.S.C. 1531 et seq.

BIOLOGICAL OPINION

The continued operation of the Colorado-Big Thompson Diversion Project is not likely to jeopardize the continued existence of the bald eagle (*Haliaeetus leucocephalus*), whooping crane (*Grus americana*), peregrine falcon (*Falco peregrinus*), Colorado squawfish (*Ptychocheilus lucius*), bonytail chub (*Gila elegans*), and humpback chub (*Gila cypha*).

When the Colorado River Fishes Study is complete, we may wish to meet with your agency and discuss modification of all WPRS projects operation for the preservation of endangered fish species.

Project Description

The Colorado Big-Thompson Project (CBT) is located in Grand, Summit, and Larimer Counties in north central Colorado. It diverts water from the Colorado River and its tributary Willow Creek in Grand County and sends it via a transbasin tunnel to the Big Thompson River in Larimer County. In the Colorado River watershed, the project includes Granby and Willow Creek Reservoirs, Shadow Mountain Lake, and Grand Lake. Water from Willow Creek Reservoir is pumped to Granby Reservoir. Water in Granby Reservoir is pumped to Shadow Mountain Lake, flows through Grand Lake and then into the diversion tunnel to the eastern slope. Storage capacity of Willow Creek Reservoir is 10,550 acre feet while Granby Reservoir is 542,500 acre feet. Another part of the CBT project is the Green Mountain Reservoir on the Blue River in Summit County. This reservoir is used to replace water which is diverted from the Colorado River as well as power generation. This reservoir has a capacity of 152,000 acre feet, 52,000 of which is for replacement purposes, and 100,000 is for peaking power production. This water is also available for replacement purposes. The Colorado-Big Thompson Project provides supplemental water to some 720,000 acres of land.

In addition to irrigation, the 260,000 acre feet of water diverted to the east slope annually, is used for municipal and industrial purposes and power production on the eastern slope.

Basis for Opinion

Colorado Squawfish, Humpback Chub, and Bonytail Chub

These species were once abundant throughout the Colorado River System from the Gulf of California to southwestern Wyoming. Presently, the squawfish is limited to the upper mainstem and major tributaries of the Colorado River System. The humpback chub and the bonytail chub are found only in limited areas within the system in Colorado, Utah, and Arizona. The primary cause of decline for these fish species is human alteration and degradation of the river environment. Major impoundments and water diversions have depleted water supplies and altered temperature, turbidity, and stream flows, thus reducing habitat for endemic fishes.

A less important cause of decline may be the increased number of exotic fishes, but this increase in exotics also is a function of habitat changes. Although correlations exist between declining native fish populations and increasing populations of exotic fish, cause and effect are not fully understood. However, we believe that fewer exotic fishes would be present if the river more closely resembled its natural state.

Although we do not know all the specific requirements and distribution of the Colorado squawfish, humpback chub, and bonytail chub, we are rapidly gathering additional information on these three species, as well as the razorback sucker which is also considered in a precarious state but is not under Federal protection. Knowledge of these fishes has been limited partly because they have been of little interest to society until recent years. Also, these fishes are difficult to capture or observe because the waters they inhabit are usually swift and turbid, and access is limited in many of the canyon reaches.

A Colorado River Fishes Investigation Team was established in April 1979. This team is staffed with Fish and Wildlife Service (FWS) personnel and has funding from the FWS, Water and Power Resources Service (WPRS), and the Bureau of Land Management (BLM). Other participants are the Utah Division of Wildlife Resources and the Colorado Division of Wildlife. Major objectives of the study are to learn additional life history requirements of the listed fishes. Because WPRS and BLM are providing funds, most of the field work is in the Green and Colorado Rivers where the fishes reproduce and where impacts from WPRS and BLM projects will be the greatest. Information obtained during the study via field, laboratory, and hatchery work will make it possible to provide specific recommendations to maintain and develop more favorable habitat for the listed fishes in the Green and Colorado Rivers.

Reports show that the squawfish, bonytail and humpback chub have been declining throughout the Colorado River drainage. However, recent FWS surveys have identified populations of squawfish and humpback chubs in the Black Rocks area of Ruby Canyon and in the Westwater Canyon along the main Colorado River. Additionally, the Walter Walker Wildlife Area, just downstream from Grand Junction, Colorado, has historically supported numerous squawfish. Several investigators have readily captured squawfish in this area in recent years.

Capture of endangered fishes in this area has been sporadic but with enough frequency to suggest use of available habitats by these fish. Until recently, occurrence of endangered fishes above the Highline Diversion was questionable because the diversion may be a fish barrier and has been in place since 1909. Also, several collection efforts had failed to capture endangered fish in this area. However, during the summer of 1980, the FWS captured 14 adult humpback chubs in Debeque Canyon a few miles above this diversion. The extent and exact distribution of this population is unknown but its existence adds significance to this river section. Protection of the population strongholds throughout this entire area of concern is essential for the maintenance and recovery of these endangered fishes.

A continuation of the historical operation of the Colorado-Big Thompson Project will not jeopardize the continued existence of the Colorado squawfish, humpback chub or the bonytail chub. The CBT project has been in existence since the early 1940's. The first transbasin diversion took place in 1947. Since that time, there is evidence that the Colorado squawfish and the humpback chub have successfully reproduced in the Colorado River and appear to be maintaining their numbers, albeit much lower than what is needed to remove them from the endangered species list. At the present time we have no evidence of bonytail chub reproduction in the Colorado River. Without any increased diversions by the CBT project from the Colorado River Basin, there is no reason to assume that the continued historic operation of the project would result in a further decline of these species.

Peregrine Falcon

Continued historic operation of the Colorado-Big Thompson Project will not jeopardize the existence of the peregrine falcon. The peregrine is found along the Colorado River and on the east slope project areas at all times of the year. The possibility exists that one or more eyries are located between Grand Lake and the Gunnison River; however, the location of any specific nests is not known at this time. The continued historic operation of the project will not cause a decrease in habitat which the peregrine is dependent upon for its existence.

Bald Eagle

Most bald eagle use in Colorado is by wintering birds. Major concentrations are found along the Green, White, Yampa, Colorado and South Platte Rivers. A group estimated to peak at 40 to 50 birds is located along the Colorado River between Debeque and Silt, Colorado. This area also contains three nest sites at which eagles were observed in early 1980, but which produced no eggs. Lesser numbers of bald eagles winter at Green Mountain, Shadow Mountain, Granby Reservoir and Grand Lake. Continued historic operation of the Colorado-Big Thompson Project will not jeopardize the existence of bald eagles. Essential habitat will not be impacted by the continued operation of the project.

Whooping Crane

Whooping cranes are seldom found in the South Platte drainage in Colorado. However, the Platte River and associated wet meadows in Nebraska are important resting and feeding areas for migrating cranes. The increased flows in the South Platte River as a result of the CBT project may have helped to maintain whooping crane critical habitat along the Platte River in Nebraska. The continued operation of the Colorado-Big Thompson may help to maintain habitat for the whooping crane in Nebraska.

It should be recognized that this biological opinion covers the continued historic operation of the Colorado-Big Thompson Project. Should there be any change in project operation which may affect any endangered or threatened species, it will be necessary for you to consult with us again.

William P. White

He praised the 8-year-old foundation as "a pretty good group of people. They know the departments." The report is "valuable because it is all concrete recommendations rather than generalities, something we can agree with or disagree or modify. We can get our teeth into it."

Feulner said Meese had told him the Reagan team "would be relying heavily on it."

The $100,000 study, entitled "Mandate for Leadership," considered individual programs in all the cabinet departments and independent agencies in nearly a year of volunteer labor by 250 present and former government workers, consultants, scholars, ex-administration officials and researchers, Feulner said. If its first objective was "to roll back big government," the second was "to show that conservatives do have new ideas," he said.

It is clearly a hope chest of the mainstream right wing, predictably coming down hardest on environmentalists and on minority programs, restrictions on the military, the intelligence communities and free enterprise. As a step-by-step road map to realization of most of Reagan's campaign promises, much of it could serve as a handy guide for a later check on his performance.

There are several noteworthy omissions. There is no call for constitutional amendments prohibiting abortion or requiring a balanced budget. "We took a departmental approach," recommending action within the executive branch, Feulner explained. Neither does the foundation call for elimination of the Department of Education, which had been demanded by some conservative groups, although it does propose stiff budget and program cutbacks.

Instead, the study pinpoints. For example, several administrations have called for acceleration of offshore oil leasing programs. The foundation's analysis of the Interior Department describes the existing Outer Continental Shelf five-year plan as "timid" and goes so far as to pick certain lease parcels—Nos. 53 and 68 in California and No. 63 in the Gulf of Mexico, among others—to be moved up in the schedule, outlining the various regulations on advance notice and spotlighting paper-shuffling bottlenecks.

Such detailed proposals are everywhere in the study and, if accepted, would save the incoming administration months of learning the bureaucratic ropes and deciding how best to achieve its goals. "This will be the first time a president has ever been this well prepared to take over," said Robert Terrell, a House Interior Committee staff member who chaired the Interior Department report task force.

There is realism. "The political fallout will be great. Opposition will be savage" to the general downgrading proposed in the poverty program review, the analysis says. A civil rights division chief is needed in the Justice Department who can "take the heat" that will follow his proposed dropping of ongoing civil rights lawsuits.

Along with the repeal of affirmative action orders on minority groups and the handicapped, the analysis of the Justice Department would require "clear proof of intent to discriminate" and not just a headcount showing a pattern of past abuses in order for legal action to be taken. "It is inherently wrong to penalize those who have earned their reward by giving preferential treatment and benefits to those who have not," the report says.

The study advised Reagan to recognize "the reality of subversion and [to put] emphasis on the un-American nature of much so-called 'dissidence.'" Recommending abolition of many specific restrictions on domestic intelligence work, the report said, "It is axiomatic that individual liberties are secondary to the requirement of national security and internal civil order."

Some positions reflect division within the right. For instance, the Justice study calls for legislation to abolish the so-called exclusionary rule that prohibits use in criminal trials of evidence taken illegally, an idea opposed by the National Rifle Association.

The Interior report would return to the states control over most mining, reclamation and water rights, but does not specifically endorse legal action to transfer land to the states, a goal of the so-called Sagebrush Rebellion that Reagan has applauded.

The Department of Energy would be reduced to a form much like its predecessor, the Energy Research and Development Agency, with some of its functions reassigned to Commerce or Interior and others, like the Economic Regulatory Administration, simply dropped. All federal involvement in energy sales and distribution would end, and the department itself would be removed from cabinet status in 1983. "The mere existence of the department implies too much federal involvement in energy," said DOE study team leader Milton Copulos.

The Environmental Protection Agency would lose its enforcement function to the states and its research arm to other agencies, becoming mainly a coordinating and transmission point for policy recommendaitons and arbitration of interstate disputes.

A detailed approach to rewriting the Clean Air and Clean Water acts is outlined, while "zero emissions" goals would be dropped in favor of a "total human environment" guideline requiring equal consideration of jobs, recreation and other economic factors, according to EPA study chief Lou Cordia. "All programs and policies will have to be reappraised under a cost-benefit, risk-benefit analysis," he said.

The foundation called its report a draft and said it would be published as a book in January.

CONFERENCE REPORT ON H.R. 7724

Mr. YATES submitted the following conference report and statement on the bill (H.R. 7724) making appropriations for the Department of the Interior and related agencies for the fiscal year ending September 30, 1981, and for other purposes:

CONFERENCE REPORT (H. REPT. NO. 96-1470)

The committee of conference on the disagreeing votes of the two Houses on the amendments of the Senate to the bill (H.R. 7724) making appropriations for the Department of the Interior and related agencies for the fiscal year ending September 30, 1981, and for other puurposes, having met, after full and free conference, have agreed to recommend and do recommend to their respective Houses as follows:

That the Senate recede from its amendments numbered 10, 29, 50, 81, 101, 102, 106, 115, 118, 126, 127, and 131.

That the House recede from its disagreement to the amendments of the Senate numbered 2, 5, 11, 14, 18, 21, 28, 33, 38, 39, 40, 41, 47, 59, 63, 76, 77, 79, 89, 90, 92, 97, 98, 104, 114, 117, 120, 121, 122, 125, 129, and 130, and agree to the same.

Amendment numbered 1: That the House recede from its disagreement to the amendment of the Senate numbered 1, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$343,962,000"; and the Senate agree to the same.

Amendment numbered 3: That the House recede from its disagreement to the amendment of the Senate numbered 3, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$103,000,000"; and the Senate agree to the same.

Amendment numbered 4: That the House recede from its disagreement to the amendment of the Senate numbered 4, and agree to the same with an amendment, as follows: In lieu of the sum named by said amendment insert "$58,200,000"; and the Senate agree to the same.

Amendment numbered 7: That the House recede from its disagreement to the amendment of the Senate numbered 7, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$15,980,000"; and the Senate agree to the same.

Amendment numbered 8: That the House recede from its disagreement to the amendment of the Senate numbered 8, and agree to the same with an amendment, as follows: Restore the matter stricken by said amendment amended to read as follows:

URBAN PARK AND RECREATION FUND

For expenses necessary to carry out the provisions of the Urban Park and Recreation Recovery Act of 1978 (title 10 of Public Law 95-625), $20,000,000, to remain available until expended.

And the Senate agree to the same.

Amendment numbered 9: That the House recede from its disagreement to the amendment of the Senate numbered 9, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$378,593,000"; and the Senate agree to the same.

Amendment numbered 13: That the House recede from its disagreement to the amendment of the Senate numbered 13, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$80,211,000"; and the Senate agree to the same.

Amendment numbered 19: That the House recede from its disagreement to the amendment of the Senate numbered 19, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$37,897,000"; and the Senate agree to the same.

Amendment numbered 20: That the House recede from its disagreement to the amendment of the Senate numbered 20, and agree to the same with an amendment, as follows: Restore the matter stricken by said amendment amended to read as follows:

MIGRATORY BIRD CONSERVATION ACCOUNT

For an advance to the migratory bird conservation account, as authorized by the Act of October 4, 1971, as amended (16 U.S.C. 715k 3, 5), $1,250,000, to remain available until expended.

And the Senate agree to the same.

Amendment numbered 26: That the House recede from its disagreement to the amendment of the Senate numbered 26, and agree to the same with an amendment, as follows: In lieu of the sum named by said amendment insert "$200,000"; and the Senate agree to the same.

Amendment numbered 27: That the House recede from its disagreement to the amendment of the Senate numbered 27, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$43,367,000"; and the Senate agree to the same.

Amendment numbered 36: That the House recede from its disagreement to the amendment of the Senate numbered 36, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$107,001,000"; and the Senate agree to the same.

Amendment numbered 45: That the House recede from its disagreement to the amendment of the Senate numbered 45, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$139,428,000"; and the Senate agree to the same.

Amendment numbered 46: That the House recede from its disagreement to the amendment of the Senate numbered 46, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$107,736,000"; and the Senate agree to the same.

Amendment numbered 48: That the House recede from its disagreement to the amendment of the Senate numbered 48, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$93,833,000"; and the Senate agree to the same.

Amendment numbered 49: That the House recede from its disagreement to the amendment of the Senate numbered 49, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$82,458,000"; and the Senate agree to the same.

Amendment numbered 51: That the House recede from its disagreement to the amendment of the Senate numbered 51, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$813,739,000"; and the Senate agree to the same.

Amendment numbered 53: That the House recede from its disagreement to the amendment of the Senate numbered 53, and agree to the same with an amendment, as follows: In lieu of the matter proposed by said amendment insert:

EASTERN INDIAN LAND CLAIMS

For payment to the Eastern Indian Land Claims Settlement Fund, $81,500,000, to remain available until expended, to settle the land claims of the Passamaquoddy Tribe, the Penobscot Nation, and Houlton Band of Maliseet Indians in the State of Maine.

And the Senate agree to the same.

Amendment numbered 56: That the House recede from its disagreement to the amendment of the Senate numbered 56, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$72,284,000"; and the Senate agree to the same.

Amendment numbered 57: That the House recede from its disagreement to the amendment of the Senate numbered 57, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$68,000,000"; and the Senate agree to the same.

Amendment numbered 60: That the House recede from its disagreement to the amendment of the Senate numbered 60, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$18,313,000"; and the Senate agree to the same.

Amendment numbered 61: That the House recede from its disagreement to the amendment of the Senate numbered 61, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$37,619,000"; and the Senate agree to the same.

Amendment numbered 68: That the House recede from its disagreement to the amendment of the Senate numbered 68, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$122,200,000"; and the Senate agree to the same.

Amendment numbered 69: That the House recede from its disagreement to the amendment of the Senate numbered 69, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$73,116,000"; and the Senate agree to the same.

Amendment numbered 70: That the House recede from its disagreement to the amendment of the Senate numbered 70, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$66,136,000"; and the Senate agree to the same.

Amendment numbered 71: That the House recede from its disagreement to the amendment of the Senate numbered 71, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$879,814,000"; and the Senate agree to the same.

Amendment numbered 72: That the House recede from its disagreement to the amendment of the Senate numbered 72, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$197,262,000"; and the Senate agree to the same.

Amendment numbered 73: That the House recede from its disagreement to the amendment of the Senate numbered 73, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$378,586,000"; and the Senate agree to the same.

Amendment numbered 75: That the House recede from its disagreement to the amendment of the Senate numbered 75, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$353,662,000"; and the Senate agree to the same.

Amendment numbered 83: That the House recede from its disagreement to the amendment of the Senate numbered 83, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$423,300,000"; and the Senate agree to the same.

Amendment numbered 103: That the House recede from its disagreement to the amendment of the Senate numbered 103, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$12,857,000"; and the Senate agree to the same.

Amendment numbered 105: That the House recede from its disagreement to the amendment of the Senate numbered 105, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$117,665,000"; and the Senate agree to the same.

Amendment numbered 107: That the House recede from its disagreement to the amendment of the Senate numbered 107, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$7,539,000"; and the Senate agree to the same.

Amendment numbered 109: That the House recede from its disagreement to the amendment of the Senate numbered 109, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$24,314,000"; and the Senate agree to the same.

Amendment numbered 111: That the House recede from its disagreement to the amendment of the Senate numbered 111, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$125,860,000"; and the Senate agree to the same.

Amendment numbered 112: That the House recede from its disagreement to the amendment of the Senate numbered 112, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$113,960,000"; and the Senate agree to the same.

Amendment numbered 116: That the House recede from its disagreement to the amendment of the Senate numbered 116, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$13,450,000"; and the Senate agree to the same.

Amendment numbered 123: That the House recede from its disagreement to the amendment of the Senate numbered 123, and agree to the same with an amendment, as follows: In lieu of the sum proposed by said amendment insert "$2,443,000"; and the Senate agree to the same.

The committee of conference report in disagreement amendments numbered 6, 12, 15, 16, 17, 22, 23, 24, 25, 30, 31, 32, 34, 35, 37, 42, 43, 44, 52, 54, 55, 58, 62, 64, 65, 66, 67, 74, 78, 80, 82, 84, 85, 86, 87, 88, 91, 93, 94, 95, 96, 99, 100, 108, 110, 113, 119, 124, 128, 132, 133, 134, 135, and 136.

SIDNEY R. YATES,
GUNN MCKAY,
CLARENCE D. LONG,
R. DUNCAN (except as to amendment No. 14),
JOHN P. MURTHA,
NORMAN D. DICKS,
JAMIE L. WHITTEN,
JOSEPH M. MCDADE,
RALPH S. REGULA,
SILVIO O. CONTE,
Managers on the Part of the House.

ROBERT C. BYRD,
BIRCH BAYH,
J. BENNETT JOHNSTON,
WALTER D. HUDDLESTON,
PAT LEAHY,
DENNIS DECONCINI,
QUENTIN BURDICK,
JOHN A. DURKIN,
TED STEVENS,
MILTON R. YOUNG,
MARK HATFIELD,
HENRY BELLMON,
JAMES A. MCCLURE,
Managers on the Part of the Senate.

JOINT EXPLANATORY STATEMENT OF THE COMMITTEE OF CONFERENCE

The managers on the part of the House and the Senate at the conference on the disagreeing votes of the two Houses on the amendments of the Senate to the bill (H.R. 7724), making appropriations for the Department of the Interior and Related Agencies for the fiscal year ending September 30, 1981, and for other purposes, submit the following joint statement to the House and the Senate in explanation of the effect of the action agreed upon by the managers and recommended in the accompanying conference report:

TITLE I—DEPARTMENT OF THE INTERIOR

BUREAU OF LAND MANAGEMENT

Amendment No. 1: Appropriates $343,962,000 for management of lands and resources instead of $349,662,000 as proposed by the House and $339,162,000 as proposed by the Senate. The net decrease under the amount proposed by the House consists of the following: decreases of $300,000 for coal leasing; $200,000 for geothermal leasing; $2,400,000 for energy offshore (environmental studies); $3,000,000 for soil, water, and air management (Federal water rights); $500,000 for law enforcement; $100,000 for equal employment opportunity; and increases of $100,000 for recreation resources; and $700,000 for withdrawal review and processing.

The managers are in agreement on the following: That $500,000 be transferred from energy-related realty to the nonenergy sector to meet changing workload demands; and that the Bureau make available sufficient funds in FY 1981 for necessary studies at the San Simon watershed project to determine a more appropriate dam site.

Amendment No. 2: Appropriates $14,768,000 for acquisition, construction, and maintenance as proposed by the Senate instead of $14,568,000 as proposed by the House.

Amendment No. 3: Appropriates $103,000,000 for payments in lieu of taxes instead of $85,000,000 as proposed by the House and $108,000,000 as proposed by the Senate.

Amendment No. 4: In lieu of the sum named by said amendment, insert the following: "$58,200,000".

The managers are in agreement that the Appropriations Committees of the House and Senate will undertake a thorough review of the effect of the grazing amendment on grazing lands to determine whether future legislation is needed.

The managers are concerned with the current method of appropriating funds from the O & C account. Presently, monies are appropriated from the account based upon projections of 25 percent of current fiscal year timber sale receipts, presenting a recurring difficulty for the BLM and Congress to operate a sound, well planned program. The managers recommend the administration consider that subsequent appropriation bills fund the O & C program based upon prior year timber sales receipts deposited in the fund, thereby removing the speculation which has plagued so much of the current program.

Amendment No. 5: Deletes House language as proposed by the Senate.

Amendment No. 6: Reported in technical disagreement. The managers on the part of the House will offer a motion to recede and concur in the amendment of the Senate which provides that an appeal of any proposed grazing allotment reduction in excess of 10 per cent be suspended pending final action on the appeal and prohibiting the Bureau from making funds available to determine the suitability or nonsuitability for wilderness on which a sheep experiment station is located.

HERITAGE CONSERVATION AND RECREATION SERVICE

Amendment No. 7: Appropriates $15,980,000 for salaries and expenses instead of $15,755,000 as proposed by the House and $16,005,000 as proposed by the Senate. The increase over the amount proposed by the House is $225,000 to continue a contract with Washington State University for study of the Ozette Village on the Makah reservation.

The total amount available includes funds necessary to conduct a feasibility study of alternatives of the Illinois-Michigan Canal and the Des Plaines river valley corridor. The Service should work closely with industrial and commercial interests in conducting the study.

Amendment No. 8: Appropriates $20,000,000 for the Urban Park and Recreation Fund instead of $45,000,000 as proposed by the House which was deleted by the Senate. This sum, along with $45,000,000 deferred from fiscal year 1980, will provide total obligational authority of $65,000,000.

Amendment No. 9: Appropriates $378,593,000 for the Land and Water Conservation Fund instead of $394,185,000 as proposed by the House and $351,368,000 as proposed by the Senate. This includes $1,000,000 for Federal program administrative expenses and $6,550,000 for State program administrative expenses.

Amendment No. 10: Provides $1,135,000 for the Bureau of Land Management as proposed by the House instead of $700,000 as proposed by the Senate.

Amendment No. 11: Provides $39,416,000 for the Forest Service as proposed by the Senate instead of $37,166,000 as proposed by the House.

Amendment No. 12: Reported in technical disagreement. The managers on the part of the House will offer a motion to recede and concur in the amendment of the Senate with an amendment providing $21,520,000 for the Fish and Wildlife Service instead of $16,420,000 as proposed by the House and $15,520,000 as proposed by the Senate. The managers on the part of the Senate will move to concur in the amendment of the House to the amendment of the Senate. The net increase above the House includes a decrease of $1,500,000 for Atlantic Coastal areas and an increase of $6,600,000 for the Bogue Chitto NWR.

Amendment No. 13: Provides $80,211,000 for the National Park Service instead of $103,011,000 as proposed by the House and $59,421,000 as proposed by the Senate. The net reduction below the House includes decreases of $300,000 in preauthorization and $25,000,000 for Redwood NP and increase of $1,500,000 for New River NR, and $1,000,000 for economic and special studies for Redwood NP.

Amendment No. 14: Deletes House language that prohibited use of other Federal funds as a match for Land and Water Conservation Fund grants to states.

Amendment No. 15: Reported in technical disagreement. The managers on the part of the House will offer a motion to recede and concur in the amendment of the Senate which provides that revenues from recreation fee collections shall hereafter be paid into the Land and Water Conservation Fund.

Amendment No. 16: Reported in technical disagreement. The managers on the part of the House will offer a motion to recede and concur in the amendment of the Senate which authorizes the Secretary of Interior to seek and acquire lands for the Kaloko-Honokahau NHP by acquiring Federal surplus lands of equivalent value from the GSA and then exchanging those lands with the owners of the lands to be acquired for the Park.

UNITED STATES FISH AND WILDLIFE SERVICE

Amendment No. 17: Reported in technical disagreement. The managers on the part of the House will offer a motion to recede and concur in the amendment of the Senate with an amendment providing $225,566,000 for resource management instead of $225,354,000 as proposed by the House and $225,424,000 as proposed by the Senate. The managers on the part of the Senate will move to concur in the amendment of the House to the amendment of the Senate.

The net increase over the amount proposed by the House consists of the following increases and decreases: increases of $200,000 for the instream flow analysis group, $150,000 for expanded wetlands mapping in Alaska, $250,000 for interpretation and recreation previously provided through a fee collection account, $175,000 for Snake River fish restoration activity, $1,000,000 for fishery assistance to the State of Washington, $100,000 for a study of endangered fishes on the Yampa River; and decreases of $600,000 for operation of new or expanded refuges because of delayed land acquisition, $500,000 for operation and maintenance of Snug Harbor NWR, $6,000 for hunting and fishing compliance regulations on Alaska Wildlife Monuments, $275,000 for Southeast fish hatchery operations, $165,000 for endangered species law enforcement officers, and $117,000 in executive direction for promotion of public involvemnt in Service activities.

The managers expect the Service to use the authority provided in 31 USC 685 and any other authorities available to obtain reimbursement for the activities of the instream flow analysis group. Within available resources the Service is to provide $70,000 to the Norfork NFH, $155,000 for the Sheridan, Wyo., field station, and to complete an environmental assessment of Protection Island in Washington State. The managers egree (1) that Service employees should not negotiate with foreign governments without appropriate authorization and notification, and (2) that tribal enhancement projects may be eligible for funding even though the tribe may not have entered into a long term comprehensive plan with the State of Washington. The managers are pleased that $174,000 is to be provided to the animal damage control field station at Hilo, Hawaii. This is an increase of $18,000 over the 1980 level.

The managers have agreed to a total of $3,883,000 to administer new areas in Alaska by the National Park Service and the Fish and Wildlife Service. These funds are available only for those areas designated by the Alaska National Interest Lands Conservation Act which has been passed by both Houses of the Congress.

It is the express intent of the managers that this money be concentrated on mineral's management, search and rescue, the preparation of management plans and initial management functions. No funds are intended to police non-Federal activities in the new areas except where there is a demonstrably serious threat to significant resource values.

Amendment No. 18: Appropriates $8,500,000 for the National Wildlife Refuge Fund as proposed by the Senate instead of $9,500,000 as proposed by the House.

Amendment No. 19: Appropriates $37,897,000 for construction and anadromous fish instead of $34,581,000 as proposed by the House and $40,405,000 as proposed by the Senate. The increase over the amount proposed by the House consists of the following increases: $186,000 to replace office and visitor facilities at Maxwell NWR, N.M., $1,000,000 for anadromous fish grants to States, $100,000 for high priority energy conservation items for the Leetown Laboratory, $1,250,000 for an administrative and visitor facility for the Upper Mississippi River NWR at MacGregor, IA., $700,000 for design of a fish hatchery for the Nisqually Tribe of Washington State, and $100,000 for a water treatment feasibility study for the White River NFH, Vt.

Amendment No. 20: Appropriates $1,250,000 for the Migratory Bird Conservation Account instead of $2,000,000 as proposed by the House which was deleted by the Senate. The managers request the Congress and members of the Migratory Waterfowl Commission to express to the Commission the strong concern of the Committees on Appropriations that the Commission is committing to land acquisition well in advance of having funds available. The managers are also concerned that the Nature Conservancy is establishing the acquisition priorities of the Commission. This concern will be addressed during hearings on the fiscal year 1982 budget.

Amendment No. 21: Deletes recreation fee collection account as proposed by the Senate.

NATIONAL PARK SERVICE

Amendment No. 22: Reported in technical disagreement. The managers on the part of the House will offer a motion to recede and concur in the amendment of the Senate with an amendment providing $444,823,000 for operation of the National Park System instead of $415,153,000 as proposed by the House and $440,743,000 as proposed by the Senate. The managers on the part of the Senate will move to concur in the amendment of the House to the amendment of the Senate.

The net increase over the amount proposed by the House consists of the following increases and decreases: increases of $14,000,000 for interpretation and visitor services previously provided through a fee collection account, $150,000 for the Harpers Ferry, WV, police force, $16,330,000 for maintenance, $415,000 for acquisition and maintenance of the Frederick Law Olmsted library collection, $100,000 for a cooperative agreement to preserve the Falls of Clyde vessel of the Bishop Museum of Hawaii, $1,000,000 for a grant to the National Symphony Orchestra, and $20,000 to assist the Makah Tribe to interpret and protect the Ozette Village archeological site; and decreases of $250,000 in concessions management, $200,000 in visitor protection and safety, $1,500,000 in resource management, and $400,000 for general management planning.

The managers agree that within available funds $55,000 is for the Yosemite NP Native per habitat and 800 affected in a comparable amount of sagebrush-greasewood, 2,200 birds would be affected in the riparian habitat. In times of peak abundance, these figures are approximately 1,400, 1,900, and 5,000, respectively. The loss of these birds would be important because they are an integral part of the riparian ecosystem.

Alternative 1 would adversely affect raptors by eliminating prey base for 14 species that hunt in the riparian habitat. Shelter and roosts for these raptors would also be lost. Those nesting species impacted for the long term would be great horned owls and Cooper's hawks. A red-tailed hawk nest would be affected during construction but no long-term effects would be expected since the next site is located above the reservoir level.

The most serious adverse impact to raptors would be the loss of prey base during drought conditions. During the 1977 drought, when upland prey base was at low density, the riparian habitat became the prime area for the raptors' food resource. Undoubtedly prey production near the reservoir shores would not equal production from the current riparian habitat.

The transmission lines could electrocute raptors which use the poles for roosting.

The reservoir would impact the Canada goose by eliminating nesting habitat for 13.5 miles (22 km) in the reservoir basin and by eliminating or reducing nesting habitat for 50 miles (80 km) to the White River's confluence with the Green River.

Surveys by the UDWR indicate that 6 nesting pairs of geese averaging 6 young per brood utilize the reservoir basin. Another 7 nesting pairs utilize the White River below the proposed dam (Drobnick 1980). Additional nonnesting adult geese also utilize these areas. Therefore, habitat for 6 nesting pairs and an annual production of 36 young geese would be lost from the reservoir basin and an unquantifiable loss of downstream habitat for nesting would also occur. An unquantifiable number of nonnesting adults would also lose summer habitat.

Game birds that would be enhanced by the reservoir are migrant waterfowl and snipe. The reservoir, based on expected turbidity and lack of emergent vegetation, would not support nesting waterfowl except in the tailwaters. Those nesting would occur at low abundance.

MITIGATION

Loss of nongame birds and raptors which use riparian habitat cannot be mitigated. Mitigation would require re-establishment of a riparian system. The transmission line associated with the proposed White River Dam would be required to be constructed to prevent electrocution of raptors. Losses to geese could be partially mitigated by intensively managing the river above and below the reservoir, i.e., providing nest platforms and construction of artificial islands for nesting geese downstream from the proposed dam.

The USFWS has not submitted their Fish and Wildlife Coordination Act Report for inclusion in this EIS. The report will be available for the Final EIS and may contain mitigation measures for geese and other birds.

UNAVOIDABLE ADVERSE IMPACTS

Nongame bird populations would be reduced due to loss of the riparian habitat. Raptors would be reduced in the general area due to loss of prey species, especially during and immediately after droughts. Loss of Canada goose nesting habitat in the reservoir basin would result in the loss of a yearly production of 36 geese. Losses of goose nesting habitat would occur downstream for 50 miles (80 km), affecting an annual production of 42 geese. Additional small but unquantifiable goose losses would be attributable to the loss of nonnesting goose habitat in the reservoir basin and below the reservoir.

THREATENED, ENDANGERED, AND SENSITIVE BIRD SPECIES

ANTICIPATED IMPACTS

The whooping crane and peregrine falcon are so transient to the area that they would not be affected. Bald eagles winter in the area. The reservoir and tailwaters which would be ice-free for a considerable distance below the dam could enhance the wintering eagles' habitat. The formal consultation for this project, as required by Section 7 of the Endangered Species Act, has not been completed by the USFWS. This consultation is continuing and the Biological Opinion will be included in the Final EIS.

MITIGATION

None.

UNAVOIDABLE ADVERSE IMPACTS

None.

APPLICATION OF AN INDEX OF BIOTIC INTEGRITY TO THREE COLORADO FRONT RANGE STREAMS

Progress Report for May 1985-January 1986

by

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Fish communities have been measured in three Colorado Front Range rivers, the Cache la Poudre River, Big Thompson River, and St. Vrain Creek, during the last five years with the purpose of monitoring water quality. However, to date these data on the number of fish species and their relative abundances at various sites have not been adequately analyzed, because tools to relate the characteristics of fish communities to water resource quality have not been available. The index of biotic integrity (IBI; Karr 1981, Fausch et al. 1984, Karr et al. 1984, Karr et al. 1985, Angermeier and Karr in press, Karr et al. MS) is a tool designed to analyze precisely these data to assess water resource quality via biotic integrity. The purpose of this report is to summarize our progress in developing and modifying the IBI for use in streams and rivers of the South Platte River Basin (SPRB) in northeastern Colorado.

Our research objectives fell naturally into six steps:

1. A list of the ecological characteristics of SPRB fishes.
2. Development of "maximum species richness" lines for the SPRB.
3. Development of appropriate IBI metrics for the SPRB.
4. Outside review of research objectives 1-3 by advisory committee.
5. Calculation of IBI scores for the three rivers.
6. Relating IBI scores and component metrics to environmental variables and other indices.

Work Accomplished to Date

1. Ecological Characteristics of SPRB fishes

The first step in developing the IBI for a new basin is to determine a number of ecological characteristics of the fish fauna, including whether species are native or introduced, their general diet (trophic class), and whether they are tolerant or intolerant to the degradation of water quality present in the basin. In addition, we assessed the current status of populations from collection records, and determined species spawning requirements and type of parental care of eggs and young (Table 1).

Information on the populations of species in the SPRB and on whether species were native or introduced was garnered from Propst's (1982) thesis on fishes of the Platte River in Colorado, which also included a detailed summary and analysis of earlier collection records. Trophic classes, tolerance or intolerance to degradation, and spawning requirements were compiled from regional ichthyological references such as Pflieger (1975), Scott and Crossman (1973), Smith (1979), Trautman (1981), and Becker (1983). This list of ecological characteristics was sent to eight ichthyologists and fish ecologists (Angermeier, Behnke, Clemmer, Cross, Karr, Miller, Platania, Stasiak) familiar with the fishes of SPRB for review, and their comments were incorporated. Following is a brief discussion of each of the categories of information for SPRB fishes shown in Table 1.

Native or Introduced

The historical record of ichthyofauna of the SPRB is complicated because very few collections were made before the aquatic environment was degraded by agriculture and before a number of fishes were introduced by early settlers. However, Propst's (1982) compilation and analysis of early collection records and review by other ichthyologists allowed a fairly accurate description of the original fish community.

The fish community is relatively depauperate (Table 2). Of 43 species that reproduce in running water, 32 are native and 11 are exotic species that were introduced. Four of the native species are extirpated and four more are rare. In addition, another 10 species occur in lakes and reservoirs in the basin and appear sporadically in streams or rivers, usually only as adult fishes. The purpose of classifying fishes as native or introduced was for development of one metric (see below), and to show that the original fish community has changed due to the introduction of exotic species and the extirpation of several native ones.

Population Status

The status of each species was determined from Propst's (1982) collection records for sites in the transition zone and plains regions (see Fig. 1) of the SPRB. The prevalence of individual species was based on the number of sites at which they occurred and their abundance at each site (see footnotes to Table 1). This information is ancillary, but shows that a number of native species are rare or extirpated, especially those that are glacial relics. More recent collections of common shiner (*Notropis cornutus*), northern redbelly dace

(Phoxinus eos), a northern redbelly dace-finescale dace hybrid (Phoxinus eos X P. neogaeus), stonecat (Noturus flavus), and johnny darter (Etheostoma nigrum) have shed further light on the distribution and abundance of these species.

Trophic Class

Fish species were placed in trophic classes based on diet information compiled from the regional ichthyological references listed above. Information on diet of several species was incomplete or missing, but professionals that reviewed the list were able to classify most of these. A summary of diet studies for each species was compiled in an appendix that will be included in the final report.

In addition to the trophic classes outlined by previous researchers (Karr 1981, Fausch et al. 1984) we added a general invertebrate feeder class to aid in differentiating between specialized invertebrate feeders (insectivores) and omnivores, because a number of species fell distinctly between these two groups. The footnotes of Table 1 list our criteria for assigning fish to trophic classes based on the percent composition of their diet. This is the first time that such criteria have been developed, which should improve standardization of trophic class definitions. Trophic classes are used in two of our IBI metrics.

Tolerance and Intolerance to Environmental Degradation

Tolerant and intolerant species must be defined for a specific region in response to the question "Tolerant or intolerant to which forms of environmental degradation?" We define tolerant species as those that persist despite degradation of water quality, spawning and cover habitat, and food resources due to erosion and siltation, organic and inorganic pollution, channelization, and flow fluctuations. Intolerant species are those that disappear for these same reasons, and are the first species extirpated when lotic habitats are degraded by man.

Nine species in the SPRB are tolerant, five of which are of the minnow family (Cyprinidae) and one of which is introduced. The high proportion of tolerant species is likely due to historical variable flow regimes and modern agricultural practices of irrigation and channelization that have allowed only the most adaptable species to persist in many reaches. Six species are intolerant, all but one of which are either rare or extirpated for the same reasons. This information was used in developing two IBI metrics.

Spawning Requirements and Parental Care

Karr (1981) suggested that fish might be classified into guilds according to spawning requirements, but no further work has been done on this subject. We classified fish according to the substrate (stream bottom type) required for spawning and the degree of parental care during spawning (see footnotes in Table 1).

We suspected that this information might show that species requiring specific substrates, such as clean gravel, vegetation, or cavities, were extirpated or declined in abundance sooner than those able to spawn in a variety of conditions. Similarly, we thought that species giving parental care, such as fathead minnow (*Pimephales promelas*), would have better spawning success in silted habitat because they constantly clean their eggs. Thus, general substrate spawners and/or those with parental care should have the best chance of spawning success and survival in habitats degraded by siltation. Although these general relationships appear to hold for the SPRB fish fauna, we did not use the information to develop a metric because it is largely redundant with information contained in the tolerant and intolerant species metrics.

2. Maximum Species Richness Lines

A second requisite in modifying the IBI for use in a new region is to develop maximum species richness (MSR) lines that describe the number of species expected in an undegraded stream of a given size. We used stream order and watershed area as measures of stream size, and assumed that sites where the most species were collected represent the best conditions in the region.

Plots of the number of species as a function of stream order (Fig. 2) and $\log_{10}$ watershed area were used to draw MSR lines for the total number of species metric, using data from each of Propst's (1982) sample sites for the SPRB. The line that forms the upper bound for 95% of the points was fit by eye, according to the guidelines in Fausch et al. (1984). Similar plots and lines were drawn for five other metrics that are based on specific taxa. These taxa were chosen based on their ecological importance to fish communities of the region.

The effects of increased gradient and elevation in the transition zone (5000-6000 ft. elevation; Fig. 1) was investigated by plotting number of fish species as a function of stream size separately by gradient and elevation categories. However, none of the maximum species richness lines changed substantially with elevation or gradient, except for the number of sunfish species metric (Fig. 3). In the transition zone, no sunfish were found at second, third, or seventh order sites, so the MSR line shown overestimates the number of sunfish species expected in transition zone streams of these orders. The effects of this change on criteria for scoring this metric will be discussed below.

This difference between the two zones may result from lower water temperatures in the transition zone which may prevent sunfish from reproducing in these waters. A similar decline in sunfish species occurs in the midwestern U. S. from Illinois to Wisconsin (K. Fausch, unpublished data). Alternatively, the small sample size for some stream orders coupled with degraded conditions in many transition zone streams may prevent sunfish from surviving there.

3. Developing IBI Metrics

We developed 12 IBI metrics for use in the SPRB (Table 3). Of these, eight were used in the original IBI (Karr 1981; metrics 1-4, 6, 8, 10, and 12), and four (5, 7, 9, and 11) have been changed to better reflect the ichthyofauna of the SPRB. Following is a discussion of the purpose and value of each metric, as well as their sensitivity and whether they are inapplicable in certain size streams. When a metric is inapplicable, we propose assigning the average score of all metrics to the inappropriate metric for this site, so that the resulting overall IBI score is not biased. In addition, all metrics are applicable only in the plains and transition zones of the SPRB.

A. Species Richness and Composition

1. Total Number of Fish Species

This metric evaluates the species richness component of diversity, and has been shown to be highly correlated with overall IBI scores (P. Yant, unpublished data). This indicates that if only one measure of the fish community could be used, this should be the one. The MSR line (Fig. 2) shows that the number of species (including both native and introduced) expected at an undegraded site increases from 5 at second order sites to 16 at eighth order sites in the SPRB. Because no fish are expected at any first order sites, all of which are likely intermittent or dry, metric criteria were not developed for streams of this order. To determine the score for this metric at a particular site, lines are drawn dividing the right triangle of points in thirds, and these regions designated as 5 (top third), 3, or 1 (bottom).

2. Number and Identity of Darter Species

This taxon is sensitive to degradation of benthic habitats where darters feed on invertebrates, and reproduce in cavities or gravel nests. Darters also require high levels of dissolved oxygen. Thus, degradation due to channelization, siltation, or reduced oxygen can be partially monitored by loss of darter species.

The SPRB has only two darter species, although the orangethroat darter (Etheostoma spectabile) probably was also native to the basin because it occurs in the Republican and North Platte Rivers nearby but was likely extirpated early due to its specificity for habitat with springflow. Despite the paucity of this taxon, the metric is sensitive at third through seventh order sites throughout the plains and transition zones. Both species (johnny and Iowa darters, E. nigrum and E. exile) must occur for the site to receive a score of 5; one species receives a 3; and the site is scored 1 if no darters are present.

3. Number and Identity of Sunfish Species

Sunfish species include all members of the sunfish family (Centrarchidae) except for black bass (Micropterus) such as largemouth bass (Micropterus salmoides). This taxon is sensitive to reduced pool habitat or instream cover, both of which are affected by man's modifications of stream channel morphology such as channelization. This metric is sensitive to degradation until nearly all habitat structure is removed.

This metric is applicable to second through eighth order streams in the plains region, but is applicable only to fourth through sixth order streams in the transition zone as described above in the section on MSR lines (Fig. 3). Further sampling may show that sunfish species are more widely distributed in transition zone streams, so a different MSR line may be unnecessary. In second through fourth order streams of the plains region, sites are scored 5 if one sunfish species is sampled and 1 if none are captured (see Fig. 3). In fifth through seventh order plains streams, sites with two sunfish species are scored 5, sites with one species are scored 3, and sites with none are scored 1. Sites in eighth order plains streams are scored 5 if three species are present, 3 if one or two species are present, and 1 if none are present. Criteria for fourth through sixth order transition zone streams are the same as for plains streams.

4. Number and Identity of Sucker Species

This metric is useful in assessing degradation of both habitat and water chemistry because members of this taxon prefer pool habitat and include a variety of benthic invertebrates in their diet. Their relatively long lifespan also allows insight into previous stream conditions.

All three members of the sucker family (Catostomidae) found in the SPRB (Table 1) are included in this metric, but the river carpsucker (Carpiodes carpio) occurs only in the downstream reaches of the main South Platte River. Both other suckers are found throughout the basin. Sites are scored 5 if two species are captured, 3 if only one occurs, and 1 if no sucker species occurs.

5. Number and Identity of Cyprinid Species

Because few darters, sunfish, and suckers occur in the SPRB, the number of minnow (Cyprinidae) species was selected as a metric because the family has a relatively large number of species that are broadly distributed throughout the basin. The MSR line for this taxon increases from 3 species for second order sites to 10 for eighth order sites, and thus is applicable throughout the basin. This metric should be sensitive to a wide range of degradation because cyprinids have a wide range of food and habitat preferences, and thus should add to the ecological perspectives provided by other taxa.

6. Number and Identity of Intolerant Species

Because intolerant species are the first to disappear upon degradation of water quality or habitat, this metric is sensitive only at sites of higher quality. We defined six species as intolerant in the SPRB (Table 1), but two are extirpated and greenback cutthroat trout (Salmo clarki stomias) and northern redbelly dace occur in isolated refuges only. Common shiner and Iowa darter are the only intolerant species with a relatively wide distribution, even though they are rare.

This metric is applicable to third through eighth order sites, where a score of 5 is assigned if two species are found, 3 if one is found, and 1 if none are found. No intolerant species were found at second order sites, so the average of other scores is assigned. We assume that undisturbed eighth order sites should support at least two intolerant species, even though Propst (1982) found none.

7. Proportion of Individuals as White Suckers

Tolerant species increase in relative abundance at degraded sites because they can adapt to a variety of conditions. This metric evaluates the evenness component of species diversity, or the degree to which one tolerant species dominates the community.

In the midwestern U. S. Karr (1981) used the proportion of individuals that were green sunfish (Lepomis cyanellus) as a metric to describe the dominance by one tolerant species. In the SPRB the white sucker (Catostomus commersoni) appears to fill this role. It is among the most tolerant species to degradation of spawning substrate and structural habitat, and is found over a wider distribution than other tolerant species such as fathead minnow, sand shiner (N. stramineus), and carp (Cyprinus carpio). Moreover, Becker (1983) considers white sucker more tolerant of a wide range of environmental variables than any other fish species in Wisconsin.

This metric is applicable throughout second through eighth order streams in the basin. Preliminary criteria for scoring are: sites with <5% white suckers are scored 5, 5-20% are scored 3, and >20% are scored 1.

B. Trophic Composition

8. Proportion of Individuals as Omnivores

Omnivores are defined as species that regularly include at least 25% plants and/or detritus in their diets (Schlosser 1982, see footnotes in Table 1). Karr (1981) proposed that omnivores increase under degraded conditions because, as habitat and water quality are degraded, invertebrate and fish food supplies fluctuate or decline in abundance while algae and periphyton frequently increase. As a result, specialized invertebrate feeders disappear while opportunistic omnivores are more successful under these conditions.

Ten species in the SPRB are omnivores of which only one was introduced, which reflects the original harsh environmental conditions of the region. Preliminary scoring criteria are the same as proposed by Karr (1981, see Table 3), but may need to be modified because some fish he classified as omnivores we defined as general invertebrate feeders. The metric is applicable at second through eighth order sites.

9. Proportion of Individuals as Specialized Invertebrate Feeders

Specialized invertebrate feeders are species with diets of at least 90% invertebrates (see footnotes to Table 1). Just as omnivores increase under degraded conditions, invertebrate feeders decrease in response to declining and fluctuating invertebrate populations.

Karr (1981) used the proportion of insectivorous cyprinids as the basis for a metric, but we included all specialized invertebrate feeders because the SPRB has relatively few cyprinids that specialize only on insects or invertebrates, which we thought would reduce the sensitivity of the original metric. However, Propst's (1982) data show that at most sites the majority of specialized invertebrate feeders are cyprinids, so criteria for scoring are the same as Karr's (1981) original metric (Table 3). This metric is applicable at second through eighth order sites throughout the basin.

C. Fish Abundance and Condition

10. Number of Individuals in the Sample

The number of individuals captured at a site is an indicator of its general quality, since perturbations are likely to cause a decrease in numbers of fish. Number of individuals should be expressed as catch-per-unit-effort (e.g. fish/meter/minute) so that scores can be assigned on a relative basis. Scoring criteria will be based on the relative numbers of individuals captured at sites on the three rivers sampled, and will not apply to streams of other orders.

11. Proportion of Individuals as Introduced Species

This metric is used to evaluate the deviation of the fish community from its original state. Thus, the introduction of a species is viewed as a perturbation to the ecosystem. More significantly, however, introduced species often are highly adaptable and have broad tolerance, which allows them to increase in degraded habitat and displace native species that occupy similar niches.

This metric is applicable to second through eighth order sites throughout the basin. Scoring criteria are: <1% individuals of introduced species is scored 5, 1-9% is scored 3, and >10% is scored 1.

12. Proportion of Individuals with Disease, Tumors, Fin Damage, or Anomalies

In very degraded conditions fish communities often exhibit a marked increase in the percent of individuals with some type of external disease or anomaly. This is likely due to inorganic pollution causing direct irritation of tissue and organs, or organic pollution providing abundant nutrients for parasite and bacteria growth.

Because few investigators record incidence of disease and other anomalies, little data is available to set scoring criteria for this metric. However, data collected thus far suggest appropriate criteria are: < 2% individuals with disease or anomalies is scored 5, 2-5% is 3, and > 5% is 1. This metric is applicable at second through eighth order sites throughout the basin.

Other Metrics

The original IBI described by Karr (1981) included two other metrics, proportion of individuals as top carnivores, and proportion of individuals that are hybrids. We chose not to use the top carnivore metric because very few species that could be considered top carnivores occur in the basin, and few individuals of these species ever occur in the three rivers we sample. The walleye (Stizostedion vitreum) is the only top carnivore that might have been native to the basin (Dr. Robert Behnke, pers. comm.), but is now extirpated from flowing waters there. Largemouth bass are the only top carnivore now inhabiting these rivers and streams, but we have never captured an adult bass in three

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years of sampling. Thus, because scores for this metric would be 1 at every site we judged it not to be a sensitive metric.

Although hybrids occur in our samples, especially of sunfish and minnows, they are difficult to identify without extensive taxonomic experience. We therefore decided to eliminate this metric as well.

Future Work

5. Calculation of IBI Scores for the Three Rivers

The sequence of steps in IBI calculation (Fig. 4) shows that after collections are made and summarized by species and numbers (work already done), the next steps are to summarize this information by metrics, rate the metrics, and calculate the IBI. For instance, once the number of sunfish species captured at a given site is known, the sunfish metric can be scored according to criteria above (Fig. 3). All metric scores are then summed to give the IBI score, and the site is rated as Excellent, Good, Fair, Poor, Very Poor, or No Fish by comparing the IBI score to ranges proposed by Karr (1981, see Table 4). The IBI scores will be calculated for all collections made in each of the three rivers from 1979, 1980, or 1981 to the present (Table 5).

6. Relating IBI Scores and Component Metrics to Environmental Variables and Other Indices

As time permits, we plan to relate IBI scores and values of selected component metrics to other environmental variables such as flow, water chemistry, and habitat. For instance, relating the IBI to the coefficient of variation of daily flows might lend insight into whether flow fluctuation affects biotic integrity. Critical chemical constituents such as unionized ammonia will be related to the IBI and some component metrics to determine whether these are correlated. We suspect that limiting concentrations of chemical constituents may affect fish communities for some time, so that appropriate correlations might be between some critical level of ammonia at some prior date and fish community attributes thereafter.

Habitat diversity has been measured at all sites on all three rivers spring and fall of 1985, and will be measured again during spring 1986 to determine the influence of this variable on biotic integrity. We hope these analyses will lend insight into the variables controlling fish communities in these river reaches.

Finally, it seems appropriate to correlate the species diversity of benthic macroinvertebrates, as well as evenness and redundancy, to the IBI scores where the former have been calculated. Correlating one index to another may tell little about the true quality of the biotic communities or the ecosystem. But the comparison will lend insight into whether these indices deviate significantly from one another, and whether one performs more consistently under certain conditions.

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Table 1. Ecological Characteristics of South Platte River Basin Fishes

Scientific name	Native or introduced[a]	Population status[b]	Trophic class[c]	Tolerant or intolerant[d]	Spawning requirements[e]	Parental care[f]
Clupeidae						
Dorosoma cepedianum	N[g]	R	O		A	O
Salmonidae						
Prosopium williamsoni	I	N	I		G	O
Salmo clarki stomias	N	N	I/P	I	G	H
Salmo gairdneri	I	R	I/P		G	H
Salmo trutta	I	R	I/P		G	H
Salvelinus fontinalis	I	R	I/P		G	H
Cyprinidae						
Campostoma anomalum	N	C	H		G	O
Couesius plumbeus	N	E	I		A	O
Cyprinus carpio	I	C	O	T	A	O
Hybognathus hankinsoni	N	U	O		V	O
Hybognathus placitus	N	R	H		A	O
Nocomis biguttatus	N	E	I	I	G	H
Notropis cornutus	N	R	GI[h]	I	G	H
Notropis dorsalis	N	C	GI[h]	T	G[i]	O
Notropis heterolepis	N	E	I[h]	I	A[i]	O
Notropis lutrensis	N	C	O	T	A	O
Notropis stramineus	N	C	O	T	A	O
Phenacobius mirabilis	N	U	I		G[i]	O
Phoxinus eos	N	R	O	I	V	O
Phoxinus neogaeus	Ng	N	I[h]		V	O
Pimephales promelas	N	C	O	T	C	N
Rhinichthys cataractae	N	C	I		G	H
Semotilus atromaculatus	N	C	GI		G	H
Catostomidae						
Carpiodes carpio	N	R	O	T	A	O
Catostomus catostomus	N	C	O		G	O
Catostomus commersoni	N	C	O	T	G	O
Ictaluridae						
Ictalurus melas	N	R	GI	T	A	N
Ictalurus punctatus	N	R	GI/P		C	N
Noturus flavus	N[g]	N	GI/P		C	N

Scientific name	Native or introduced[a]	Population status[b]	Trophic class[c]	Tolerant or intolerant[d]	Spawning requirements[e]	Parental care[f]
Cyprinodontidae						
Fundulus sciadicus	N	U	I[h]		V	O
Fundulus zebrinus	N	C	GI		A	H
Gasterosteidae						
Culaea inconstans	N[g]	U	GI		V	N
Centrarchidae						
Lepomis cyanellus	N	C	GI/P	T	A	N
Lepomis gibbosus	I	N	I		A	N
Lepomis humilis	N	R	I		A	N
Lepomis macrochirus	I	R	GI		A	N
Micropterus salmoides	I	U	I/P		A	N
Pomoxis annularis	I	N	I/P		A	N
Pomoxis nigromaculatus	I	U	I/P		A	N
Percidae						
Etheostoma exile	N	U	I	I	V	O
Etheostoma nigrum	N	U	I		C	N
Perca flavescens	I	U	I/P		A	O
Stizostedion vitreum	N[g]	E	P		A	O

Introduced species restricted to lakes and reservoirs.

Oncorhynchus nerka
Thymallus arcticus
Esox lucius
Carassius auratus
Notemigonus chrysoleucas
Ictalurus nebulosus
Morone chrysops
Morone saxatilis
Micropterus dolomieui
Aplodinotus grunniens

a. N = native, I = introduced

b. Population status according to Propst (1982) for transition zone and plains regions of the South Platte River basin. higher gradient, higher altitude reaches in the mountains were not sampled.

E = extirpated
R = rare (collected at 10 or fewer sites and generally less than 50 per site)
U = uncommon (collected at 11 to 25 sites and generally less than 100 per site)
C = common (collected at more than 25 sites and generally more than 100 per site)
N = not captured by Propst (1982)

c. Diet of adult fish

P = piscivore (more than 90% fish)
I/P = invertivore/piscivore (more than 10% fish, plus invertebrates only)
GI/P = general invertivore/piscivore (more than 10% fish, 10-25% plants and detritus, and the remainder invertebrates
I = invertivore (more than 90% invertebrates)
GI = general invertivore (75-90% invertebrates, 10-25% plant/detritus)
O = omnivore (25-90% plant/detritus, 10-75% invertebrates)
H = herbivore (more than 90% plant/detritus, less than 10% invertebrates)

	Percent of diet		
	fish	invertebrates	detritus/plants
P	>90	<10	i*
I/P	10-90	10-90	i
GI/P	>10	remainder	10-25
I	i	>90	<10
GI	i	75-90	10-25
O	i	10-75	25-90
H	i	<10	>90

*incidental

d. T = tolerant species are adaptable to degraded water quality, spawning and cover habitat, and food resources due to erosion/siltation, organic and inorganic pollution, channelization, and flow fluctuations.
I = intolerant species are converse of tolerant, and are the first species extirpated when lotic habitats are degraded by man.

e. G = fishes requiring clean gravel for spawning
V = fishes requiring vegetation for spawning
C = fishes requiring cavities for spawning
A = fishes with generalized spawning requirements (e.g. spawn on silt, sand, or organic debris)

f. O = nonguarding, open substrate spawners
H = nonguarding, brood hiders
N = guarding, nest spawners

g. Status uncertain due to lack of early collection records.

h. Trophic class uncertain due to lack of information in literature.

i. Spawning requirements uncertain due to lack of information in literature.

TABLE 2. SOUTH PLATTE RIVER BASIN FISHES

FAMILY	NATIVE SPECIES TOTAL	T&E	EXTIRPATED	EXOTICS
HERRING	1?			
TROUT	1	1		4
MINNOWS	16(1?)+	2	3	1
SUCKERS	3			
CATFISH	3	1?		
KILLIFISH	2			
STICKLEBACK	1?			
SUNFISH	2			5
PERCH	3(1?)+		1	1
	32	4	4	11

+10 EXOTIC FISH RESTRICTED TO LAKES AND RESERVOIRS

Table 3. Metrics used in assessment of fish communities of the South Platte River basin in Colorado (modified from Karr 1981 and Fausch et al. 1984). All metrics are applicable to second through eighth order streams, except number of darter species (orders 3-7) and number of intolerant species (orders 3-8). In the transition zone the number of sunfish species metric is applicable only to fourth through sixth order streams (see text).

Category	Metric	Scoring Criteria 5(best)	3	1(worst)
Species Richness and Composition	1. Total number of species			
	2. Number and identity of darter species	Varies with stream size		
	3. Number and identity of sunfish species	Varies with stream size		
	4. Number and identity of sucker species	Varies with stream size		
	5. Number and identity of cyprinid species	Varies with stream size		
	6. Number and identity of intolerant species			
	7. Proportion of individuals as white suckers	<5%	5-20%	>20%
Trophic Composition	8. Proportion of individuals as omnivores	<20%	20-45%	>45%
	9. Proportion of individuals as specialized invertebrate feeders	>45%	20-45%	<20%
Fish Abundance and Condition	10. Number of individuals in sample	Varies with stream size		
	11. Proportion of individuals as introduced species	<1%	1-10%	>10%
	12. Proportion of individuals with with disease, tumors, fin damage, and other anomalies	<2%	2-5%	>5%

Table 4. Biotic integrity classes used in assessment of fish communities along with general descriptions of their attributes (from Karr 1981).

Class	Attributes	IBI Range
Excellent	Comparable to the best situations without influence of man; all regionally expected species for the habitat and stream size, including the most tolerant forms, are present with full array of age and sex classes; balanced trophic structure.	57-60
Good	Species richness somewhat below expectation, especially due to loss of most intolerant forms; some species with less than optimal abundances or size distribution; trophic structure shows some signs of stress.	48-52
Fair	Signs of additional deterioration include fewer intolerant forms, more skewed trophic structure (e.g., increasing frequency of omnivores); older age classes of top predators may be rare.	39-44
Poor	Dominated by omnivores, pollution-tolerant forms, and habitat generalists; few top carnivores; growth rates and condition factors commonly depressed; hybrids and diseased fish often present.	28-35
Very Poor	Few fish present, mostly introduced or very tolerant forms; hybrids common; disease, parasites, fin damage, and other anomalies regular.	23
No fish	Repetitive sampling fails to turn up any fish.	

Table 5. Fish community collections for which the index of biotic integrity will be calculated.

River	Site name	Site river mile	Collections years	Collections seasons			Collections n[a]
Cache la Poudre	Farmers Spur	14.5	1980-1986	Sp	S	F[b]	16
	Sharkstooth	20.5	1980-1986	Sp	S	F[c]	15
	Law Ditch	21.5	1980-1986	Sp	S	F	16
	Staff Gauge	22.5	1980-1986	Sp	S	F	16
	Windsor Packing	25.5	1980-1986	Sp	S	F	16
	392 Bridge	30.0	1980-1986	Sp	S	F	16
	Timnath	35.0	1980-1986	Sp	S	F	16
	Boxelder	37.0	1980-1986	Sp	S	F	16
	Mulberry St.	41.0	1980-1986	Sp	S	F	16
	Martinez Park	45.0	1980-1986	Sp	S	F	16
Big Thompson	County Rd. 35	18.3	1979-1986[d]		S	F	13
	County Rd. 9E	23.1	1979-1986		S	F	13
	River Rd.	24.4	1979-1986		S	F	13
	Wilson Ave.	28.7	1979-1986		S	F	13
St. Vrain Creek	County Rd. 13	11.3	1981-1986[e]		S	F	10
	County Line Rd.	18.9	1981-1986		S	F	10
	Wastewater Plant	22.0	1981-1986		S	F	10
	Airport Rd.	25.9	1981-1986[f]		S	F	6

a. Includes spring 1986 sample.

b. All sites on the Cache la Poudre River sampled only summer and fall during 1980 and only fall during 1983 due to high flows.

c. Site not sampled during fall 1982.

d. All sites on the Big Thompson River were sampled only once during the fall of both 1979 and 1980.

e. All sites sampled only fall during 1981.

f. Airport Road site not sampled during 1983 or 1984.

Figure 1. Major regions of the South Platte River basin in Colorado (after Propst 1982).

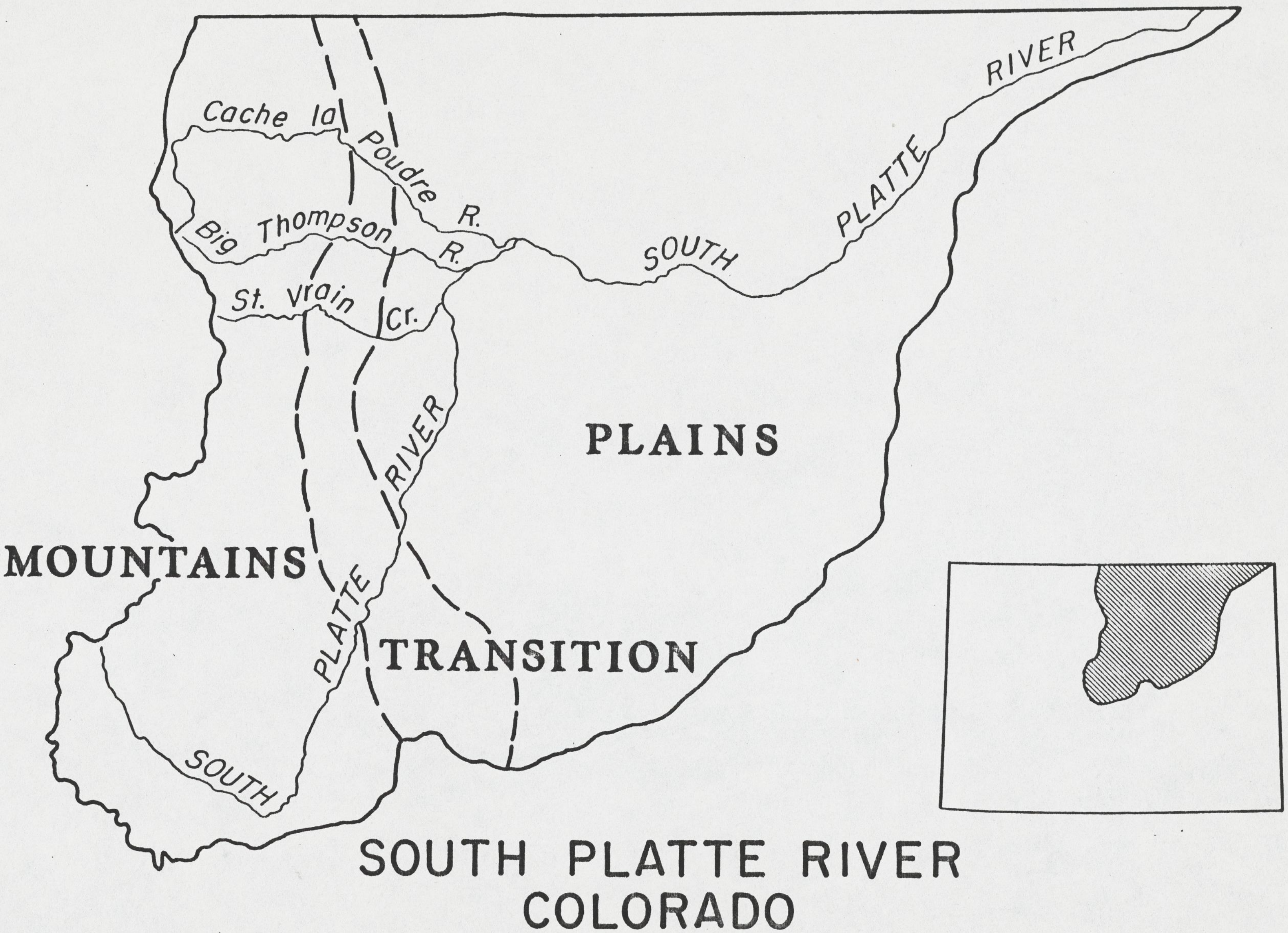


Figure 2. Number of fish species at different stream orders for 125 sites in the South Platte River basin sampled by Propst (1982). The maximum species richness line and three regions for assigning IBI metric scores are shown.

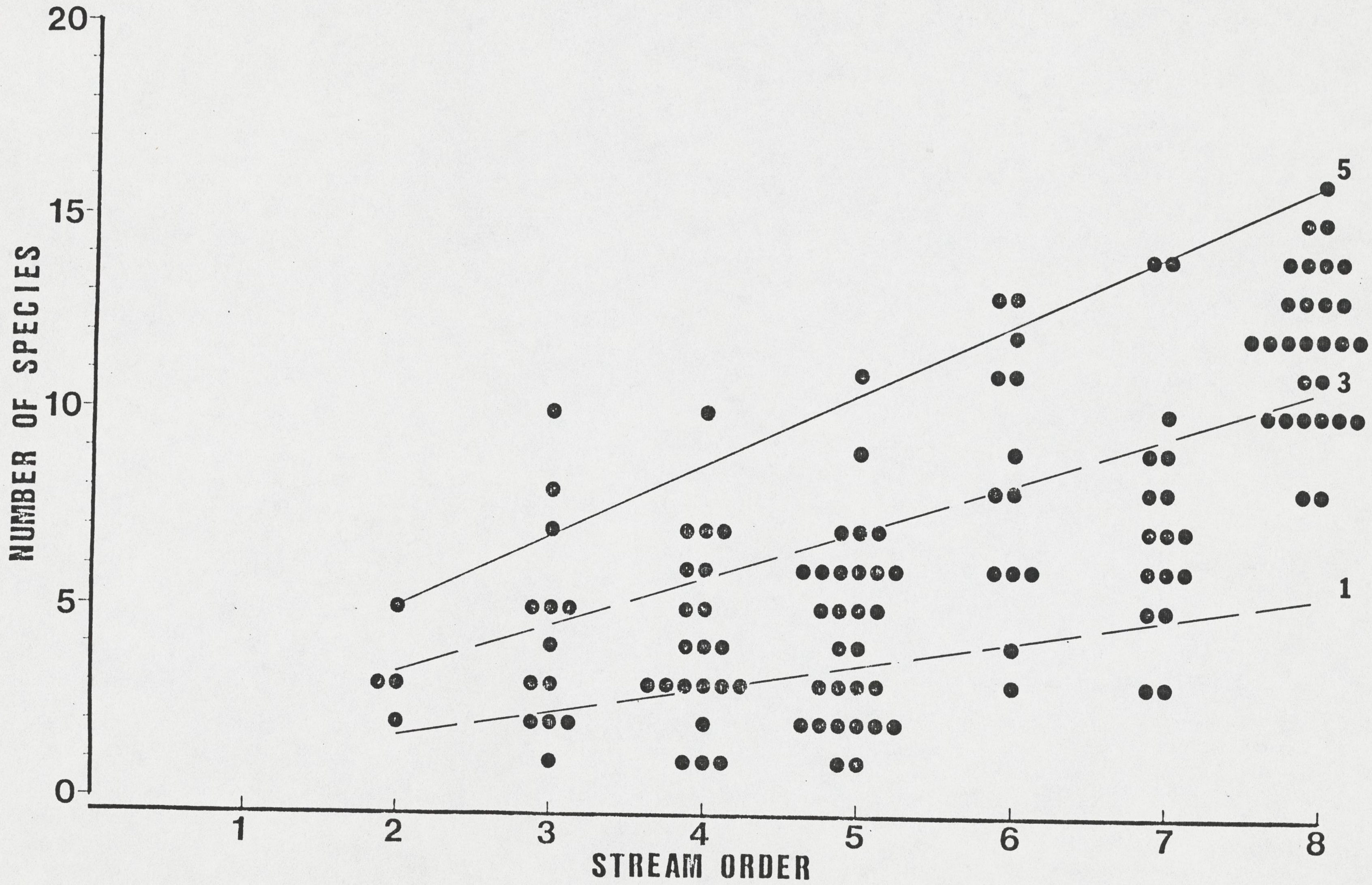
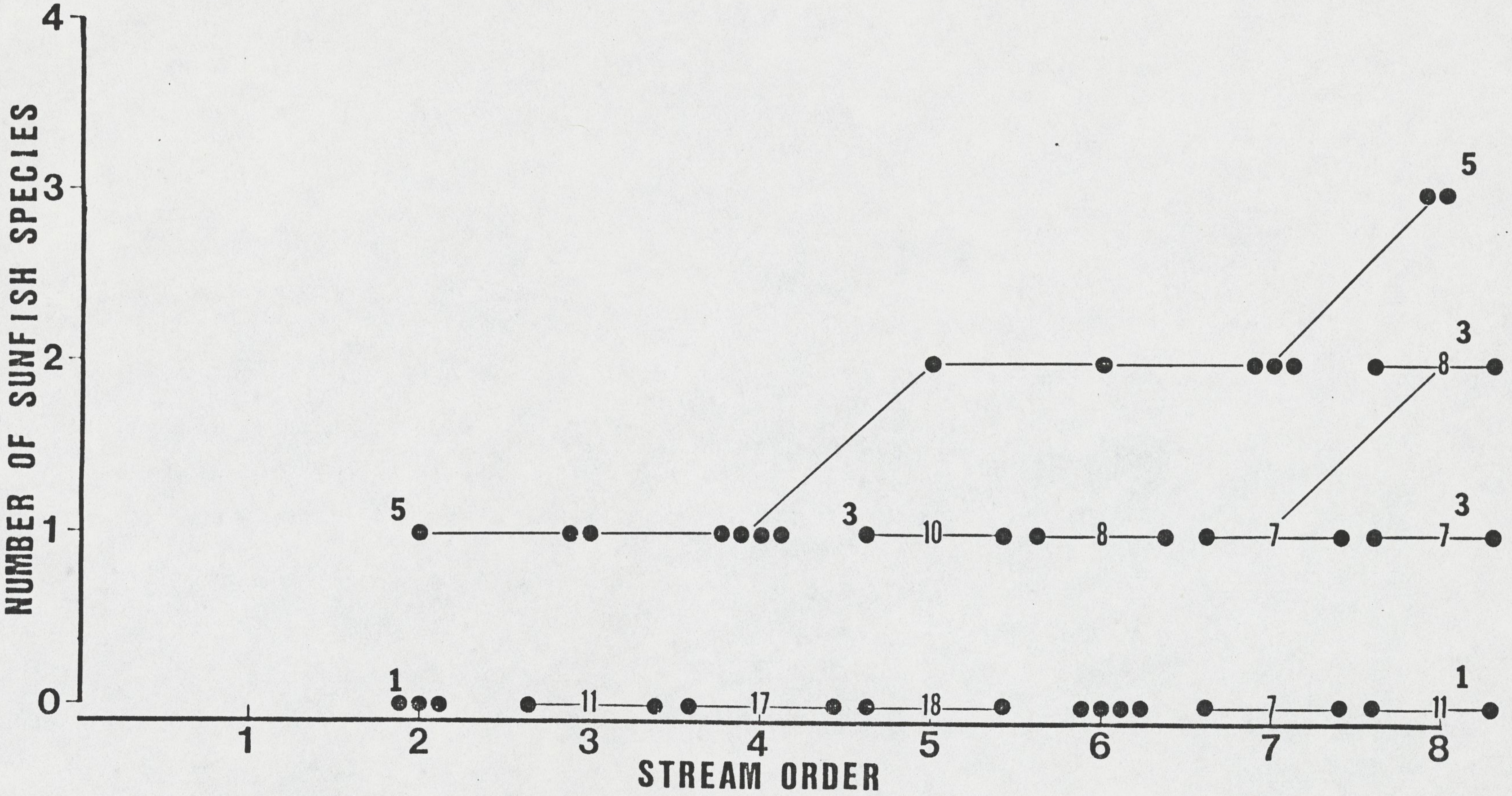


Figure 3. Number of sunfish (Centrarchidae excluding Micropterus) species at different stream orders for 125 sites in the South Platte River basin sampled by Propst (1982). Numbers between points show sample size, and numbers near points refer to scoring criteria for this IBI metric.



FISH
COMMUNITY
▼
COLLECTION
▼
SUMMARIZATION
by
SPECIES & NUMBERS
▼
SUMMARIZATION
by
METRICS
▼
RATING of METRICS
▼
IBI

Figure 4. Sequence of activities involved in stepwise calculation of Index of Biotic Integrity for a stream segment.

Appendix Table 1. Scientific and common names of South Platte River basin fishes.

Scientific name	Common name
Clupeidae	
Dorosoma cepedianum	gizzard shad
Salmonidae	
Oncorhynchus nerka	kokanee
Prosopium williamsoni	mountain whitefish
Salmo clarki stomias	greenback cutthroat trout
Salmo gairdneri	rainbow trout
Salmo trutta	brown trout
Salvelinus fontinalis	brook trout
Thymallus articus	Artic grayling
Esocidae	
Esox lucius	northern pike
Cyprinidae	
Campostoma anomalum	central stoneroller
Carassius auratus	goldfish
Couesius plumbeus	lake chub
Cyprinus carpio	common carp
Hybognathus hankinsoni	brassy minnow
Hybognathus placitus	plains minnow
Nocomis biguttatus	hornyhead chub
Notemigonus crysoleucas	golden shiner
Notropis cornutus	common shiner
Notropis dorsalis	bigmouth shiner
Notropis heterolepis	blacknose shiner
Notropis lutrensis	red shiner
Notropis stramineus	sand shiner
Phenacobius mirabilis	suckermouth minnow
Phoxinus eos	northern redbelly dace
Phoxinus neogaeus	finescale dace
Pimephales promelas	fathead minnow
Rhinichthys cataractae	longnose dace
Semotilus atromaculatus	creek chub
Catostomidae	
Carpiodes carpio	river carpsucker
Catostomus catostomus	longnose sucker
Catostomus commersoni	white sucker

Scientific name	Common name
Ictaluridae	
Ictalurus melas	black bullhead
Ictalurus nebulosus	brown bullhead
Ictalurus punctatus	channel catfish
Noturus flavus	stonecat
Cyprinodontidae	
Fundulus sciadicus	plains topminnow
Fundulus zebrinus	plains killifish
Gasterosteidae	
Culaea inconstans	brook stickleback
Percichthyidae	
Morone chrysops	white bass
Morone saxatilis	striped bass
Centrarchidae	
Lepomis cyanellus	green sunfish
Lepomis gibbosus	pumpkinseed
Lepomis humilis	orangespotted sunfish
Lepomis macrochirus	bluegill
Micropterus dolomieui	smallmouth bass
Micropterus salmoides	largemouth bass
Pomoxis annularis	white crappie
Pomoxis nigromaculatus	black crappie
Percidae	
Etheostoma exile	Iowa darter
Etheostoma nigrum	johnny darter
Perca flavescens	yellow perch
Stizostedion vitreum	walleye
Sciaenidae	
Aplodinotus grunniens	freshwater drum

TABLE 1.—Number of trees sampled (N) and mean number of spadices produced by individuals of Washingtonia filifera (± SD). Means followed by the same letter are not significantly different ($p > 0.05$) using ANOVA and Duncan's Multiple Range Test.

Category	N	$\bar{x}$ no. of spadices/palm ± SD
Unburned	135	7.0 ± 2.8 a
Burned palms	131	11.1 ± 3.1 b
Ornamental palms	84	13.2 ± 2.2 b

Reduction in competition, reduced parasitism and a stable supply of ground moisture could cause increased spadix production among palms. Oasis fires usually remove competing plant species, possibly leaving more moisture, nutrients, and sunlight for the fire-tolerant palms. Fire also can kill larvae of *Dinapate wrightii* that have tunneled close to the trunk exterior. These beetles are known to weaken or even kill desert fan palms (Cornett, 1984).

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FIRST VERIFIED RECORD OF THE STONECAT, *NOTURUS FLAVUS* (ICTALURIDAE), IN THE SOUTH PLATTE RIVER SYSTEM, COLORADO, WITH NOTES ON AN ALBINISTIC SPECIMEN

The stonecat (*Noturus flavus* Rafinesque) is widely distributed throughout much of the Ohio, Missouri and Mississippi river drainages in the central United States and southern Canada and extends farther west than any other member of the genus (Taylor, 1969). In the lower Missouri River drainage it has been collected in the North Platte River in Nebraska and Wyoming (Taylor, 1969) and the Republican River system in Kansas, (Collins, pers. comm., Univ. Kans. Mus. Nat. Hist.) Nebraska (Taylor, 1969) and Colorado (Cancalosi, 1980). Its apparent absence in the South Platte River system, Colorado, was noted by Taylor (1969; Map 8).

We report the first verified record of the stonecat in the South Platte River system, Missouri River drainage, Colorado, and a westward range extension of 271 km at 40°N latitude. At approximately 1300 hours on 7 April 1984, while electrofishing a segment of St. Vrain Creek near the Longmont Wastewater Treatment Plant, Longmont, T5N, R68W, Sec. 19, Boulder County, Colorado, we collected a single juvenile (41 mm TL) stonecat (FC/BS 3668). The specimen was rousted from under a disjunct tuft of vegetation adjacent to an eroding shoreline. Three additional stonecats were seined from the aforementioned site on 3 September 1984 between 2115 and 2230 hours (FC/BS 3669). The first, an albinistic individual (172 mm TL), was collected in the main channel in an eddy formed by a small cottonwood (*Populus* sp.) stump lodged in the streambed. The other two specimens, 105 and 109 mm TL, were taken from beneath an undercut bank and a shallow unvegetated rubble-substrate pool. All specimens were deposited in the ichthyological collection of the Fort Collins Section of the Denver Wildlife Research Center-Fort Collins/Biological Survey (FC/BS).

The albinistic individual, when collected, had pink eyes, a yellow hue to the skin and lacked the typical dark gray pigmentation on the dorsal surface and dorsal, adipose and caudal fins. After preservation, it was uniformly opaque-white with yellowish eyes but otherwise appeared normal. Albinism was reported in the genus *Ictalurus* by Aitken (1937), Menzel (1944) and McLane (1950) and was first discovered in the genus *Noturus* by Stasiak and Evans (1978) in the tadpole madtom, *Noturus gyrinus*. To our knowledge, this is the second report of albinism in the genus and the first for the stonecat.

There is little published literature on the ichthyofauna of the South Platte River system in Colorado. Cockerell (1908) was the first to report the stonecat in the South Platte River but failed to provide locality data identifying the state of collection as Colorado, Nebraska or Wyoming or elaborate on the procurement of specimens. Beckman (1952) considered it a possible inhabitant of the South Platte River in eastern Colorado but had no corroborative material. Propst (1982) recently surveyed the warmwater fishes of the Platte River Basin, Colorado, but did not collect the stonecat. In his historical synopsis of the indigenous fishes of this system, Propst (1982) cited previous works which mentioned the presence of the stonecat and noted the lack of voucher specimens but did not speculate on its resident status.

There has been a 76 year lapse between the first reference to the stonecat in the South Platte River (Cockerell, 1908) and its documentation with voucher specimens. We believe these four fish represent a self-reproducing native population. Taylor (1969) stated that this fish is infrequently obtained except through intensive surveys. Since all recent collections have been made during the daytime, there is the distinct possibility that the stonecat was overlooked because of sampling bias against nocturnal forms. While range extensions for several species of *Noturus* have been ascribed to bait-bucket introductions (Taylor, 1969; Robison and Winters, 1978), it seems unlikely that the discovery of stonecat in St. Vrain Creek can be attributed to anthropogenic activities. The two nearest known populations are 198 km N in the Laramie River, Wyoming (Baxter and Simon, 1970) and 248 km E in the Republican River, Colorado (Cancalosi, 1980); the latter population being represented by the collection of a single specimen (Cancalosi, 1980). Distance, scarcity and difficulty in obtaining stonecats make it doubtful that these populations served as stock for the St. Vrain Creek population. Finally, the stonecat has been collected in most of the major tributaries of the Missouri River drainage and its presence as a native of the South Platte River system is not a zoogeographic anomaly. Additional collections are planned to determine the distribution and relative abundance of this fish in the South Platte River system.

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TEMPORAL FORAGING ACTIVITIES OF *SOLENOPSIS INVICTA* (HYMENOPTERA: FORMICIDAE) AND OTHER PREDOMINANT ANTS OF CENTRAL TEXAS

Foraging schedules of six predominant ant species of the Edwards Plateau in central Texas were determined during the summer of 1983. This study was conducted on the Allert Ranch ca. 10 km SW of Bandera in Bandera Co. and on the Texas Tech University Center at Junction in Kimble Co. These localities are separated by ca. 100 km and are similar in both geology and vegetation (Correll and Johnston, 1979). Although Bandera Co. has been infested for at least ten years with the red imported fire ant, *Solenopsis invicta* Buren, the westernmost edge of this species' distribution has not reached Kimble Co. (Francke et al., 1983). Therefore, the objective of this study was to provide baseline information on the ant faunal composition and *S. invicta* temporal foraging behavior in these areas. With these data, future investigations may determine the impact of *S. invicta* on native ants of that region. Some researchers believe that this species, a pest throughout nine southeastern states (Lofgren et al., 1975) simplifies the arthropod fauna of an area, thereby decreasing the stability of the ecosystem (Whitcomb et al., 1972).

Three straight line transects, each consisting of 20 bait stations ca. 10 m apart, were established in improved pasture land at each site. Each station contained three bait types located 2-3 m apart: dog food containing meat (Ken-L Ration; ca. 25 g), soybean oil (Wesson; ca. 5 ml) and honey (generic; ca. 5 ml). The latter two were presented as bait on saturated cotton balls. Each bait was placed on an inverted plastic cup lid (diameter = 10 cm) and was retrieved by snapping a 440 ml plastic cup onto the lid at the end of the sampling period. Baits at every other station were replaced every 3 hrs (permanent), whereas baits at the remaining stations were left for 30 min (temporary) starting at the beginning of each sampling period. This procedure allowed for the capture of ants attracted to different food sources. Also, ant species that rapidly find food sources but become displaced by more dominant species were collected, as well as those species causing the displacement. Samples were taken and baits replaced every 3 hrs, beginning at 1000 hrs (CDT) and continuing for one 24-hr period. Observations were initiated on 19 July, 4 and 10 Aug., 1983 in Kimble Co. and 4, 7, and 13 July 1983 in Bandera Co. The numbers of ants within each species were normalized using a logarithmic transformation. These transformed data were subjected to analysis of variance followed by Duncan's multiple range test (SAS) for a comparison of means among time periods within each species at both localities. All species were analyzed separately.

Twelve ant taxa were identified from the samples collected from both counties. Of the eight taxa of ants detected in Bandera Co., 99.4% were *Solenopsis invicta* Buren (65.4%), *Monomorium minimum* (Buckley) (5.3%), *Forelius pruinosus* (Roger) (23.2%), and *Pheidole* spp. (5.5%). The remaining 0.6% detected in Bandera Co. were *Paratrechina bruesi* (Wheeler), *Pachychondyla harpax* (F.), *Solenopsis (Diplorhoptrum)* sp. and *Crematogaster laeviuscula* Mayr. Of the seven taxa detected in Kimble Co., four constituted 97.0%: *Forelius foetidus* (Buckley) (36.7%), *M. minimum* (15.7%), *Solenopsis geminata* (F.) (16.4%), and *Pheidole* spp. (28.2%). The remaining 3.0% included *P. harpax, Conomyrma* spp. and *Pogonomyrmex barbatus* (F. Smith).

Data presented in Table 1 indicate that, while not significantly different ($P > 0.05$), more *S. invicta* were collected during the cooler night and early morning temperatures than during the higher temperatures recorded at mid-day. Those *S. invicta* collected during the mid-day sampling periods were perhaps the result of continued recruitement to the rich bait sources, even during the relatively high late-afternoon soil tempertures. Often dead *S. invicta* were observed on the baits during the afternoon, perhaps indicating that recruitment continued even when temperatures were high enough to cause fatalities. Significantly more *S. geminata* were collected during the night than during the day. However, significantly greater numbers of *M. minimum*

Table 1—Mean numbers of ants detected by three bait transects during eight 3-hr sampling periods in two counties of central Texas. All values are rounded to the nearest whole number.

	TIME PERIOD (CDT) Beginning at:[1]							
	0700 hr	1000 hr	1300 hr	1600 hr	1900 hr	2200 hr	0100 hr	0400 hr
BANDERA COUNTY								
Mean temperature	26°C	27°C	30°C	31°C	31°C	29°C	28°C	27°C
Solenopsis invicta	2121a	896a	1125a	566a	2605a	2409a	2566a	1519a
Monomorium minimum	522a	171a	247a	244a	2b	0b	3b	3b
Forelius pruinosus	677ab	2190a	1842a	1308ab	84abc	9bc	77abc	0c
Pheidole spp.	7b	60ab	36ab	283ab	238ab	369a	175ab	55ab
KIMBLE COUNTY								
Mean temperature	22°C	27°C	28°C	29°C	27°C	26°C	24°C	23°C
Solenopsis geminata	0b	20ab	72ab	50ab	50ab	268a	375a	139ab
Monomorium minimum	300a	108ab	260ab	75ab	75ab	25ab	33ab	0b
Forelius foetidus	796ab	409ab	961a	2cd	2cd	52bc	0d	20bcd
Pheidole spp.	722ab	158ab	40ab	328a	328a	155ab	74ab	0b

[1] Values within a row followed by the same letter are not significantly different when transformed (log x + 0.5) and compared with Duncan's multiple range test. (d.f. = 16; $P > 0.05$). Temperatures measured ca. 2 cm beneath soil surface.

REPRESENTING ALL DISCIPLINES OF FISHERY SCIENCE

American Fisheries Society

COLORADO-WYOMING CHAPTER

February 11, 1987

TO: Steve Puttmann, Mike Stone, Bob Behnke, Gordon Reeves

FROM: John Baughman, Program Chairman B

COPIES: Tom Annear, Session Chairman

SUBJECT: Colorado/Wyoming AFS Meeting

Your presentations have been scheduled for the 8:30-10:10 am session on March 12. Please send or bring a brief biographical sketch to your session moderator, Tom Annear. Tom's address is State of Wyoming, Game and Fish Department, Cheyenne, Wyoming 82002. His phone number is 307-777-7686.

The meeting will be held at the Albany County Fairgrounds which are one mile south of Laramie on Highway 287.

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Submitted to Southwestern Naturalist. 20 Nov. 1989.

Kevin R. Bestgen
Department of Fishery and Wildlife Biology
Colorado State University
Fort Collins, CO 80523

Rediscovery of lake chub, *Couesius plumbeus*, in Colorado

The lake chub, *Couesius plumbeus* (Agassiz), is distributed primarily in north-temperate latitudes of the United States in the upstream reaches of the Missouri River basin, the Great Lakes region, and northern Atlantic slope drainages, and is widely distributed across Canada (Wells 1980). Relict southern populations of lake chub occur in eastern Iowa, northern Nebraska, and north-central Colorado. The Nebraska population was thought to be extinct (Morris et al. 1974) until 1987 when a single specimen was captured (R.H. Stasiak, Univ. of Nebraska, Omaha, pers. comm.).

The southernmost Colorado populations of lake chub were historically restricted to the South Platte River drainage, and only two verified records exist. A single specimen (110 mm standard length [SL]) was collected in 1903 in Boulder Creek, near Boulder, and 34 specimens (55-115 mm SL) were taken in 1904 from St. Vrain Creek, near Longmont (Ellis 1914). Although Beckman (1952) stated that lake chub was "fairly common in Colorado in the Platte River drainage", no corroborative collection locality or specimen data were available and his conclusions are, therefore, discounted. Other subsequent surveys

(Ellis 1914, Hendricks 1950, Li 1968, Woodling 1985, Propst and Carlson 1986, Bestgen 1989) failed to reveal the presence of lake chub throughout the South Platte River drainage and the species was presumed extirpated from Colorado.

After an 85 year absence in collections, a single lake chub was captured while electrofishing the South Fork of the St. Vrain Creek, Boulder County, Colorado (T2NR72WS22), on 15 September 1989. The specimen was a tuberculate female 95.3 mm SL, had 62 lateral line scales, 9 dorsal and 8 anal fin rays, pharyngeal teeth were 2,4-4,2, and a small barbel was located just anterior of the end of the maxillary.

At the capture locality, the South Fork of St. Vrain Creek has a mean width of 5.6 m, has a moderately high-gradient (2.4 %), and habitat consists mostly of riffles. Riffles were 5 to 10 cm deep, average pool and run depth was 15 cm, maximum pool depths was 75 cm at baseflow (0.21 m3/sec, August 1987), and substrate is predominantly cobble and boulder. Water remains seasonally cold and the resident fish assemblage is predominantly (85 %) composed of brown trout, *Salmo trutta*, brook trout, *Salvelinus fontinalis* and rainbow trout, *Onchorynchus mykiss*, in nearly equal proportion. Longnose sucker, *Catostomus catostomus*, represent the remaining 15 % of the fauna. The specimen was captured in a plunge pool downstream from a log stream improvement structure.

Lake chub are known to migrate from large lakes into streams to spawn in early spring, and return to the same lake following spawning (Brown et al., 1970). It is possible that this specimen is a vagrant from one of the many upstream reservoirs in the St. Vrain Creek drainage. Alternatively, there could be a resident stream population of lake chub, but habitat conditions and the resident fish community are atypical of that usually associated with the species (Scott and Crossman, 1973; Becker, 1983). Lack of additional lake chub specimens during extensive sampling in the past two years also suggests that this may be a transient individual. Bait-bucket transfer is discounted due to absence of a nearby source population, and lack of local fishing areas where baitfish would be used.

Habitat in portions of the St. Vrain Creek drainage is relatively pristine and supports other fishes that are rare in Colorado (Propst and Carlson, 1986; Platania et al., 1988; Bestgen, 1989). Further surveys of the fish assemblage in the St. Vrain Creek drainage are warranted.

Funding for this project was provided by the Colorado Division of Wildlife through Federal Aid in Fish Restoration project F-88-R. We thank S. Shuler and D. Proebstel for field assistance, and R. J. Behnke for specimen verification. The comments and suggestions of anonymous reviewers are appreciated. This paper is contribution no. 46 of the Colorado State University Larval Fish Laboratory.

Also R.R. Miller?

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Transactions of the American Fisheries Society 120:752–769, 1991

Variable Fish Communities and the Index of Biotic Integrity in a Western Great Plains River

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Abstract.—We applied the index of biotic integrity (IBI) to the portion of the Arkansas River basin within the Southwestern Tablelands ecoregion, located on the Great Plains of southeastern Colorado. Only nine IBI metrics were appropriate for this region, largely because of the depauperate and tolerant ichthyofauna. The modified index was then used to assess effects of U.S. Army mechanized infantry training on biotic integrity of the Purgatoire River at 12 sites adjacent to the Piñon Canyon Maneuvers Site, a remote and relatively undisturbed canyon reach on a seventh-order Arkansas River tributary. Decrease in abundance of adult red shiners *Cyprinella lutrensis,* a tolerant omnivorous species, over a 6-year period (1983–1989) caused marked increases in the IBI at 9 of 12 sites despite lack of obvious changes in environmental quality after training began in 1985. Neither sampling variation nor the magnitude and timing of floods were sufficient to explain the large decrease in red shiner abundance. Other attributes of the biota, such as presence of long-lived fishes and lack of introduced species, provided no evidence for detrimental change. The majority of potential IBI metrics were hampered by the low fish species richness, the preponderance of trophic and habitat generalists, or other attributes of the depauperate ichthyofauna. Moreover, human perturbations that cause change in fish communities of midwestern U.S. streams are suspected in many cases to mimic natural disturbances in this system, so they may have relatively little effect. Conversely, some perturbations considered benign in more mesic environments are likely to cause dramatic changes. We therefore propose that our understanding of the structure, function, and natural variation of fish communities in western Great Plains streams must increase substantially before we can define fully appropriate measures of biotic integrity for these lotic systems.

The index of biotic integrity (IBI; Karr 1981) is an ecologically based index used to assess degradation of aquatic ecosystems. It was originally developed for use in midwestern U.S. streams characterized by mesic environments and relatively rich fish faunas (Karr et al. 1986). Recently, many investigators have modified the IBI to assess degradation in a variety of ecoregions throughout the USA and Canada (Leonard and Orth 1986; Thompson and Fitzhugh 1986; Hughes and Gammon 1987; Ohio EPA 1988; Miller et al. 1988; Steedman 1988; Schrader 1989; Fausch et al. 1990). However, the naturally depauperate fish faunas found in certain regions of the southwestern (Schrader 1989), northwestern (Hughes and Gammon 1987), and northeastern USA (Miller et al. 1988) and in many small streams (Leonard and Orth 1986), present challenges in applying the index in these systems. Problems arise because the ecological framework of the IBI relies on nominal levels of taxonomic diversity, as well as on diversity in trophic guilds and levels of tolerance to environmental degradation.

Western Great Plains streams may present unique challenges to application of the IBI because their naturally variable flow regimes and low habitat diversity have resulted in fish communities that are not only depauperate, but are also generally tolerant to wide fluctuations in physicochemical conditions (Cross et al. 1986; Cross and Moss 1987; Matthews 1987, 1988; Bramblett and Fausch 1991; Fausch and Bramblett 1991). Moreover, relatively little is known about the ecology of fish communities in Great Plains streams (Matthews 1988), which may hamper suitable modification of the IBI to detect degradation in these systems.

In this paper we attempt to modify the IBI to assess impacts of U.S. Army mechanized infantry training activities on a relatively undisturbed reach of a western Great Plains river. We show that variation in relative abundance of one fish species caused large increases in the IBI despite lack of obvious environmental change, and we discuss the effectiveness of the index in these sorts of systems.

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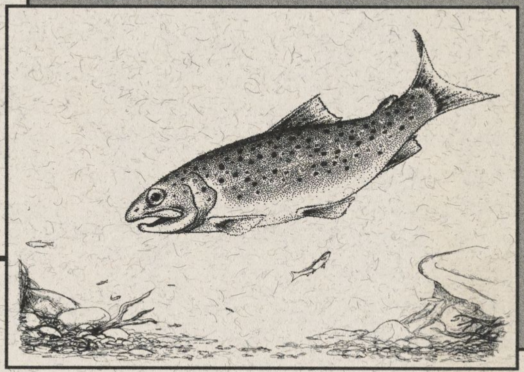
FHR Currents...

Fish Habitat Relationships Technical Bulletin
Number 18 April 1995



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Resident Trout and Movement: Consequences of a New Paradigm

Michael K. Young

Rocky Mountain Forest and Range Experiment Station
222 S. 22nd Street,
Laramie, Wyoming 82070

Abstract

Trout living in streams have been thought to move very little throughout their entire lives. Recent research has demonstrated that adult brown trout, Colorado River cutthroat trout, brook trout, and rainbow trout were far more mobile than previously believed. The mobility of trout has probably affected estimates of fish abundance, perceptions of habitat quality, and the delineation of populations, and could nullify the desired outcome of restrictive angling regulations. Also, by fragmenting streams we may be reducing the probability of persistence of native trout populations by restricting movement and thus restricting population size.

Restricted Movement: The Prevailing Paradigm

Unlike their anadromous relatives, stream-resident trout are often considered to be relatively immobile. For example, Northcote (1992) stated that the "home ranges for [such] yearling and older salmonids are ... usually a few tens of meters." The notion of restricted movement of stream-dwelling trout has persisted for over 50 years (Hoover and Johnson 1937; Gerking 1959), and has been applied to trout species as different as cutthroat trout *(Oncorhynchus clarki)* (Miller 1957; Heggenes et al. 1991) and brown trout (*Salmo trutta)* (Stefanich 1952; Bachman 1984).

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The USDA Forest Service Fish Habitat Relationships Program was established to further the development of fisheries technology and transfer this technology to field biologists. With ever increasing demands for natural resources, protection and management of aquatic communities requires biologists to be knowledgable of current research findings and state-of-the-art techniques. The purpose of *FHR Currents* is to provide a vehicle to quickly disseminate information important to field-level biologists in the USDA Forest Service.

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Unfortunately, the methods used in movement studies favor relocating immobile fish (Gowan et al., in press). The procedure for most studies was to mark fish in relatively short reaches of streams, return to these same reaches weeks to a year later to resample them, then discuss only the recapture of marked fish. Usually few if any areas outside the selected reaches were sampled. Because most marked fish that were recaptured came from the reaches where they were originally marked, the authors considered this evidence for a lack of movement. But they typically failed to address the fate of the 15 to 90% of marked fish that were never recaptured, or attributed their absence to mortality or lost marks. Studies employing other techniques, such as direct observation, were handicapped because fish were not followed during all seasons or at night (e.g., Bachman 1984). Until the last five years, potential movement had been inadequately evaluated.

New Views of Movement

Recent research in the Midwest and the Rocky Mountains has disputed the paradigm of immobility of stream-dwelling trout. Clapp et al. (1990) and Meyers et al. (1992) used radiotelemetry to monitor the positions of large brown trout in Michigan and Wisconsin, and observed seasonal movements of over 30 km. Similarly, Young (in press) implanted transmitters in over 50 adult brown trout in tributaries of the North Platte River in Wyoming. I observed fish moving as far as 96 km and hypothesized that fish began spawning migrations from the river to the tributaries in late July, wintered in the tributaries (often in deep pools), and returned to the river during spring high flows (Figure 1). Young (in review) used the same technique to monitor much smaller Colorado River cutthroat trout (*O. c. pleutiticus)* and

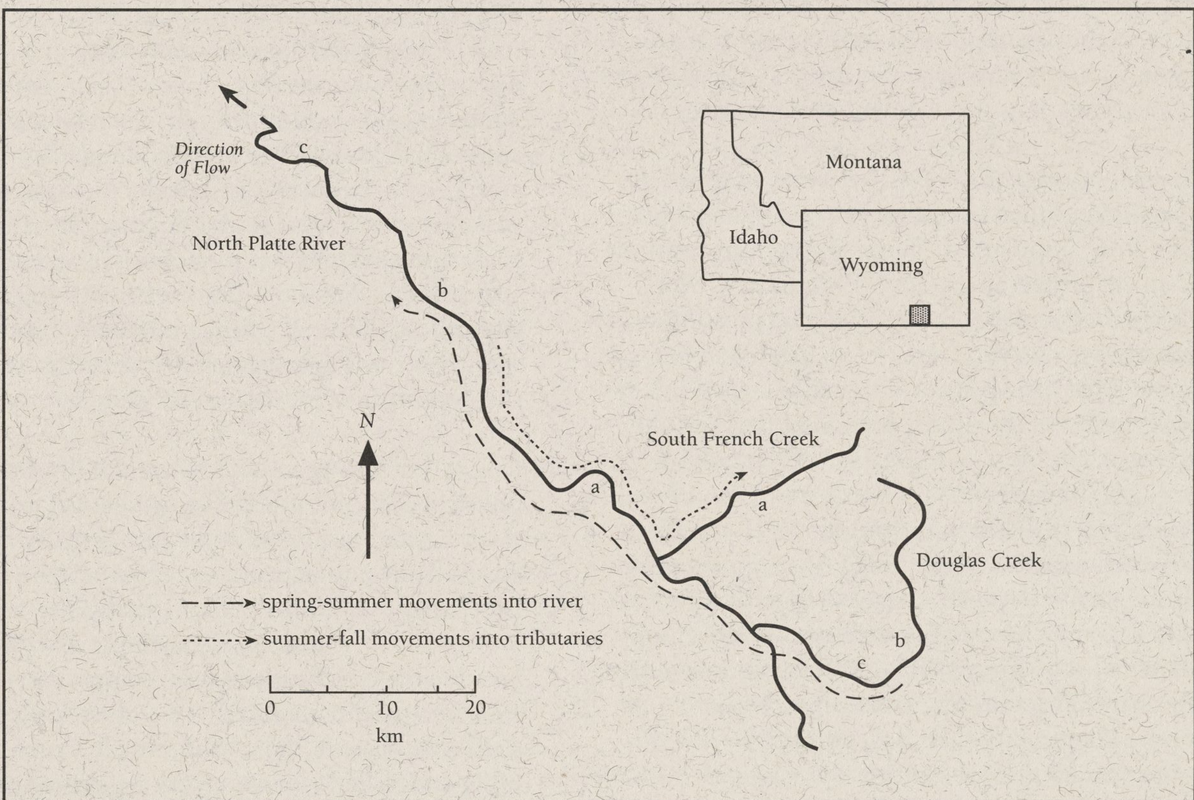

Figure 1. Brown trout movements in the North Platte River drainage. The dotted line represents hypothesized summer-fall movements into the tributaries, and the dashed line represents hypothesized spring-summer movements into the river. Small letters represent observed movements of three brown trout: fish "a" moved 23 km, fish "b" moved 66 km, and fish "c" moved 96 km.

detected movements averaging over 300 m (and up to 2.4 km) in mid-summer. Twenty-four-hour observations of both species revealed numerous movements of over 100 m and up to 1.1 km (Young, unpublished data). Using two-way fish traps to monitor movement, Riley et al. (1992) observed extensive, continuous movements of brook trout *(Salvelinus fontinalis)* in mid to late summer in small Colorado streams. Investigations of these species, as well as rainbow trout *(O. mykiss)* in Idaho (Middle Fork Salmon River, Bjornn and Mallet 1964; Silver Creek, Young, unpublished data), continue to demonstrate that movement is far more commonplace among adult trout than previously believed.

Consequences of Movement

Many aspects of resident trout biology implicitly rest on the assumption of immobility. If this assumption is invalid, it challenges several tenets of current trout management and research.

Special regulations.—Restrictive regulations are usually designed to reduce harvest of some or all of a trout population. These regulations presume that the protected groups will remain within designated stream reaches. But this presumption is not always correct; Clapp et al. (1990) noted that some large brown trout, originally tagged in a no-kill section of the South Branch of the Au Sable River, spent most of their time in a standard-regulation reach. In Wyoming, a slot limit has protected 254-406 mm trout in the North Platte River since 1982 (Mike Snigg, Wyoming Game and Fish Department, personal communication), and this may have led to increases in the abundance of spawning adults in the tributaries during the spawning run. The tributaries, however, are under standard regulations, and fluvial fish are unprotected once they enter the tributaries (often as early as July). If anglers harvest these large fish in the tributaries (and anecdotal evidence suggests that they do), future gains to the overall population may be limited.

Up- and downstream effects.—Another belief is the overriding importance of local habitat on fish populations. For example, structural rehabilitation has been thought to increase the abundance of trout in a treated reach by increasing survival, but this assumption has never been verified. In contrast, Riley and Fausch (in press) attributed the increased abundance of trout in structurally enhanced reaches of six Colorado streams to greater retention of mobile fish arriving from outside the treated reaches. This implies that the absence of a critical habitat outside an "enhanced" reach may be responsible for suboptimal trout densities within the reach. Consider that suitable edge habitat for fry of Colorado River cutthroat trout was usually unoccupied unless spawning habitat was nearby (Bozek 1990).

The possibility of fish movement is frequently ignored when building in-stream structures not intended to enhance trout populations (e.g., water diversions or dams). One consequence is that fish may be blocked from seasonally critical habitats up- or downstream (e.g., spawning or overwintering sites). Alternatively, such barriers may cause the extinction of mobile life history forms, and if these forms are genetically distinct, their genetic contribution to the population will be lost. A genetic contribution to mobility is plausible but speculative (Jonsson 1985; Northcote 1992). Regardless, these structures fragment populations that then run a greater risk of extinction without the opportunity for natural recolonization.

Up- and downstream effects are not limited to physical disruptions. The stocking of non-native trout has led to the eventual loss of many indigenous trout populations, except where barriers prevented migration of the invading species (see Young 1995). For example, a single stocking of brook trout in a headwater lake apparently led to their eventual replacement of Colorado River cutthroat trout in most of the Battle Creek, Wyoming watershed, except where a polluted stream prevented their invasion into unpolluted tributaries (Eiserman 1958). Ironically, the relatively rapid spread of introduced populations was apparently disregarded as evidence that trout were mobile.

Sampling fish abundance and population characteristics.—Most estimates of fish abundance in streams are derived from one or a few short reaches of a stream, typically only once each year (or less often). Movement of fish through these reaches would render counts suspect, in part by violating an assumption of mark-recapture estimates. Decker and Erman (1992), after repeatedly electrofishing adjoining reaches of one stream throughout a summer, noted that the abundance of several trout species varied asynchronously. They attributed this variability to species-specific movements, and questioned the value of one-time sampling for estimating fish abundance. Over 50 years earlier, Shetter and Hazzard (1938) similarly concluded that "populations of stream fish are relatively unstable in specific areas of a stream during the summer months, and ... calculations of stream populations from counts made on one or two short sections of stream at only one period of the year are not reliable." Long-term modelling of population fluctuations (Platts and Nelson 1988) or community composition (Ross et al. 1985) are especially sensitive to annual or species-specific variation in mobility. Even one-time basin-wide inventories cannot account for trout mobility. Herger et al. (in review) performed two basin-wide surveys one month apart on each of two streams, and noted that the redistribution of Colorado River cutthroat trout led to different estimates of habitat-specific densities and overall trout abundance within each stream.

This unreliability can extend to other kinds of sampling. For example, meristic and morphometric analyses were used to determine the genetic purity of Colorado River cutthroat trout from two tributaries and the mainstem of the North Fork Little Snake River in southern Wyoming (Binns 1977). The analyses indicated that fish in the mainstem were genetically pure, fish from Harrison Creek were obviously contaminated by hybridization, and fish from Green Timber Creek were assumed to be intermediate. However, in movement studies conducted in 1992 (Young, in review), a single radio-tagged adult occupied all three locations within 23 days. Moreover, nearly all the fish originally captured in Harrison Creek and Green Timber Creek eventually migrated to the North Fork Little Snake River and could have been thought to represent the putatively isolated populations in any of the three streams. Because of the potential seasonal and annual variability in population composition, we should consider the consequences of one-time sampling for describing population genetic structure (Fausch and Young, in press).

Habitat modelling.—Modelling may also be confounded by trout movement. Many habitat-based models, constructed from physical or biological data often collected at a single point in time, attempt to predict the abundance or biomass of salmonids (see Fausch et al. 1988 for examples). The inability to incorporate temporal variation in stream characteristics has been recognized as a shortcoming of such models i.e., habitat characteristics change seasonally without apparent concurrent changes in fish abundance (Conder and Annear 1987). Yet rarely considered is the potential temporal variation in fish abundance produced by mobility, which could add substantially to the unexplained variation in such models. Additionally, that species (e.g., brown trout) may not be in feeding positions when sampled by electrofishing (Young, personal observation) may further degrade the performance of these models.

Arbitrary definition of populations.—Perhaps because of a perceived lack of mobility in fishes, biologists often attempt to geographically, but not biologically, define populations. That is, we often designate the trout in a small stream as a single population (in a sense, isolated by immobility). Yet rarely is this designation merited, because trout may immigrate to the small stream (to reproduce, feed, or escape floods) or emigrate from it (to overwinter or escape desiccation). That the range of a single population may include far more waters than the "type location" is consistent with the emerging concept of metapopulations. Metapopulations consist of a collection of subpopulations that are linked by immigration and emigration (Hanski and Gilpin 1991). The individual subpopulations may thrive, suffer losses of genetic variation, or go extinct, but individuals from other subpopulations within the metapopulation can contribute to the growing subpopulations, restore genetic variation to small subpopulations, or found new subpopulations after extinction. To persist, metapopulations must consist of periodically mobile individuals in habitats without continuous barriers to movement (Gilpin 1987). Whether metapopulation theory explains trout population structure remains to be investigated, but it seems likely that most populations of salmonids have been founded by mobile individuals from large populations (cf. Milner and Bailey 1989).

Conclusions

A new paradigm for stream-dwelling trout considers (but does not mandate) mobility as one of the possible responses to food, growth, competition, predation, environmental disturbance, and daily and seasonal cycles. Movement may be minimal under some circumstances e.g., abundant macroinvertebrates, complex habitats, and environmental stability (cf. Bachman 1984). But because most streams are spatially and temporally heterogeneous, trout may elect to move frequently and extensively. The challenge for managers and researchers is to recognize when and where movement will be advantageous or necessary for maintaining wild trout populations.

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☆U.S. GOVERNMENT PRINTING OFFICE: 1995—683-075

BIG THOMPSON RIVER
HISTORICAL FISH SAMPLING INFORMATION
STANDARD REGULATION LOCATIONS

CHUCK'S PLACE STATION				
YEAR	SPECIES / BIOMASS	% COMPOSITION	AVERAGE LENGTH (CM)	NUMBER OVER 12"
1989	RBT = 184 TOTAL LOC = 30 214	70 9	20.3 19.2	2 2
1991	RBT = 226 TOTAL LOC = 63 289	74 16	21.1 23.4	2 7
1995	RBT = 184 TOTAL LOC = 68 252	76 18	21.2 25.0	5 11
1997	RBT = 181 TOTAL LOC = 107 289	74 13	21.3 24.5	8 10
1998	RBT = 361 TOTAL LOC = 70 431	83 12	19.6 24.9	16 14
1999	RBT = 298 TOTAL LOC = 70 368	82 16	22.4 23.7	18 8

NEW HABITAT IMPROVEMENT SITE BELOW DAM

YEAR	SPECIES / BIOMASS	% COMPOSITION	AVERAGE LENGTH (CM)	NUMBER OVER 12"
1993 (BEFORE PROJECT)	RBT = 65 TOTAL LOC = 31 96 HAT = 36* +36 = 132	60 18 13	17.5 17.5 26.6	4 3 4
1995 (BEFORE PROJECT)	RBT = 37 TOTAL LOC = 44 81 SRN* = 10 +10 = 91	47 17 27	18.7 17.5 26.8	4 1 0
1996 (BEFORE PROJECT)	RBT = 120 TOTAL LOC = 54 174	62 29	21.2 24.2	26 14
1998 (AFTER PROJECT)	RBT = 177 TOTAL LOC = 78 255	64 33	21.8 18.2	9 16
1999 (AFTER PROJECT)	RBT = 105 TOTAL LOC = 78 184	54 78	20.6 22.2	19 13

STANDARD REGULATION LOCATIONS

"OLD" HABITAT IMPROVEMENT SITE BELOW DAM

YEAR	SPECIES / BIOMASS	% COMPOSITION	AVERAGE LENGTH (CM)	NUMBER OVER 12"
1993 (BEFORE PROJECT)	RBT = 69 TOTAL LOC = 33 102 HAT = 23* + 23 = 125	64 21 9	19.1 23.4 29.0	3 1 3
1995 (AFTER PROJECT)	RBT = 96 TOTAL LOC = 145 241 SRN = 58* + 58 = 299	42 48 5	19.9 20.5 25.0	5 9
1996 (AFTER PROJECT)	RBT = 147 TOTAL LOC = 168 315	53 34	17.2 22.9	11 19
1997 (AFTER PROJECT)	RBT = 70 TOTAL LOC = 96 166	56 36	13.8 23.9	0 7
1998 (AFTER PROJECT)	RBT = 71 TOTAL LOC = 80 151	47 50	17.6 19.8	6 18

WALTONIA

YEAR	SPECIES / BIOMASS	% COMPOSITION	AVERAGE LENGTH (CM)	NUMBER OVER 12"
1997	RBT = 182 TOTAL LOC = 40 222	72 9	17.7 23.5	3 1
1998	RBT = 354 TOTAL LOC = 84 438	81 10	16.6 22.3	1 6
1999	RBT = 153 TOTAL LOC = 45 198	84 13	17.3 20.9	0 2

SINGLE SAMPLED STATIONS IN STANDARD REGULATION AREAS

YEAR	SPECIES/BIOMASS	%COMPOSITION	AVERAGE LENGTH (CM)	NUMBER OVER 12"
BELOW IDLEWYLD DAM - 1992				
1992	RBT = 86 TOTAL LOC = 77 163	22 35	24.6 19.8	1 0
TURNOUT ABOVE INDIAN VILLAGE - 1992				
1992	RBT = 57 TOTAL LOC = 148 205	10 45	23.8 18.5	2 3
.25 MILE UPSTREAM FROM POWER PLANT AT CANYON MOUTH				
1992	RBT = 25 TOTAL LOC = 69 94	15 68	22.6 18.0	0 1
RIVERVIEW CAMPGROUND				
1992	RBT = 69* TOTAL LOC = 123* 192	22 38	22.4 22.7	10 11

• = INCLUDES FISH WHICH PROBABLY ESCAPED FROM THE FISH KILL ZONE A MILE UPSTREAM

BIG THOMPSON RIVER HISTORICAL SAMPLING INFORMATION
SPECIAL REGULATION LOCATIONS

HANDICAP RAMP				
YEAR	SPECIES/BIOMASS	%COMPOSITION	AVERAGE LENGTH (CM)	NUMBER OVER 12'
1989	RBT = 90 TOTAL LOC = 73 163	36 60	18.9 21.2	1 5
1991	RBT = 118 TOTAL LOC = 77 185	53 41	21.0 22.0	1 6
1997	RBT = 123 TOTAL LOC = 132 255	54 37	20.6 24.6	2 7
1998	RBT = 106 TOTAL LOC = 75 181	64 31	18.3 23.1	2 3
1999	RBT = 89 TOTAL LOC = 76 165	57 39	21.3 24.1	1 8
GRANDPA'S (POOR SAMPLING EFFICIENCY)				
1989	RBT = 116 TOTAL LOC = 29 145	78 17	17.7 18.7	0 0
1991	RBT = 156 TOTAL LOC = 59 215	73 25	19.0 19.7	0 2
1993	RBT = 95 TOTAL LOC = 53 148	76 23	18.0 23.1	0 3
1995	RBT = 106 TOTAL LOC = 27 133	78 15	20.5 24.0	0 2
1997	RBT = 101 TOTAL LOC = 37 138	79 15	19.9 24.7	5 4
TWIN PINES				
1989	RBT = 136 TOTAL LOC = 54 190	72 25	19.7 20.6	2 0
1991	RBT = 140 TOTAL LOC = 72 212	61 34	20.9 20.3	1 1
1995	RBT = 169 TOTAL LOC = 100 269	61 37	22.8 22.5	2 4
1997	RBT = 115 TOTAL LOC = 61 176	66 33	22.4 24.2	8 1
1999	RBT = 162 TOTAL LOC = 128 290	70 28	21.2 23.5	15 5
SINGLE STATION SITES IN CATCH AND RELEASE SITUATIONS				
SYLVAN DALE RANCH				
YEAR	SPECIES / BIOMASS	% COMPOSITION	AVERAGE LENGTH (CM)	NUMBER OVER 12"
1997	RBT = 94 TOTAL LOC = 62 156	24 43	25.4 26.8	21 33
1998	RBT = 55 TOTAL LOC = 71 126	34 54	26.3 26.3	17 27
CROCKER RANCH				
1993	RBT = 159 TOTAL LOC = 40 199	73 14	22.3 24.0	24 10
PRIVATE, CATCH AND RELEASE CEDAR COVE				
1991	RBT = 115 TOTAL LOC = 42 157	59 22	18.8 19.5	2 3
1995	RBT = 22 TOTAL LOC = 67 89	9 50	30.6 24.5	7 9

OBSERVATIONS AND INTERPRETATIONS

NO CLEAR DOWNWARD TRENDS IN EITHER STANDARD OR SPECIAL REGULATION AREAS……WE ARE ACTUALLY IN BETTER SHAPE THAN EARLY 90S

1 NO WHIRLING DISEASE EFFECTS ON A POPULATION SCALE
2 NO "CLASSIC" RESPONSE TO CATCH AND RELEASE REGULATIONS, I.E. RAINBOW NUMBERS ARE NOT DRAMATICALLY HIGHER THAN BROWN TROUT NUMBERS IN COMPARISON BETWEEN AREAS, AND BIOMASS IS NOT GREATER, IT ACTUALLY AVERAGES 20% LESS.
3 BIOMASS TRENDS: SPECIAL REG SITES SHOWED 3 UNCHANGED, 1 SIGNIFICANTLY UP, 1 MILDLY DOWN. STANDARD REG SITES SHOWED 3 UNCHANGED AND 2 SIGNIFICANTLY UP

BIG T DOESN'T GROW BIG FISH VERY OFTEN REGARDLESS OF REGULATION STRATEGY, FISH OVER 12" STD = 7.6 RBT AND 7.7 LOC PER SITE, SPECIAL REG SECTIONS = 5.4 RBT AND 6.7 LOC PER SITE

AVERAGED BIOMASS (KG/HA) SAMPLING SITES OVER THE YEARS				
YEAR	AVERAGE AT STANDARD REG SITES		AVERAGE AT SPECIAL REG SITES	
1989	214	1 SITE	166	3 SITES
1991	289	1 SITE	189	3 SITES
1992	163	4 SITES	--	--
1993	111	2 SITES	174	2 SITES
1995	214	2 SITES	133	2 SITES
1996	245	2 SITES	--	--
1997	226	2 SITES	174	5 SITES
1998	319	4 SITES	152	2 SITES
1999	250	3 SITES	228	2 SITES
TOTAL	197	21 SITES	156	19 SITES

CREEL CENSUS SHOWED CATCH RATE DROPPED FROM 1992 TO 1997, DWM CONTACTS SHOWED CATCH RATE DROPPED BY 50 % AFTER STOCKING CEASED, HAS REMAINED THE SAME SINCE
USE IN STANDARD REGULATION FORMERLY STOCKED AREA HAS DROPPED 42% USE IN SPECIAL REGULATION AREA HAS INCREASED 31%

C.N.H.P.

491-1309

From: "Norejko, Jay" <Jay.Norejko@chs.state.co.us>
To: fwb@cnr.colostate.edu
Subject: Trinchera Ceek fish
Date: Thu, 17 Feb 2000 13:02:11 -0700
X-Mailer: Internet Mail Service (5.5.2232.9)

Dear Robert Behnke,

I'm working with Kevin Black (Assistant State Archaeologist) at the Colorado Historical Society Office of Archaeology and Historic Preservation on the nomination of the Trinchera Cave Area for the Stewardship Trust. The nomination form asks many questions about the wildlife of the area. I haven't had much luck on my web and library searches of the area. On the Trinchera Cave 7.5 minute USGS map the parcel is in the 33S township, 59W range, and in all of section 16. This area lies about 30 miles directly east of Trinidad in Las Animas County. Bruce Rosenlund gave me your name as someone who might be able to help me since you may have done work in the area. I suppose what I would need is a report on any endangered fish in the area or if the area is an important migration corridor or breeding grounds. Any help or leads would be greatly appreciated.

Jay Norejko
Archaeological Aide
Colorado Historical Society
1300 Broadway
Denver, CO 80203
(303) 866-3498
jay.norejko@chs.state.co.us

Mark Bresslor
Trout Rendezvous
Apr. 15
(486) 682 5099

CDOW
Dave
Colo. Springs

dist map 142
p. 171 / 143

520
(520) 367 1955
L. Louise?
F&W.S.
Navajo
Ehuska MTD
no sole pg

AZ
NM

Adrian
Mon 20
10 AM
Rm 130

PROGRESS REPORT

FISHES OF COLORADO

Hiram W. Li
and
Robert J. Behnke

COLORADO COOPERATIVE FISHERY UNIT
COLORADO STATE UNIVERSITY
FORT COLLINS, COLORADO

November, 1967

Introduction

This report summarizes the information available from studies and collections made during this year. It is intended as a preliminary revision of Beckman's Guide to the Fishes of Colorado, pointing out additions, deletions, name changes, and corrected distributional and taxonomic data.

To understand the inadequacies in our knowledge of Colorado's fish fauna it is necessary to be acquainted with the historical background which produced our present sum of information. The U.S. Geological and Geographical Surveys of the 1860's and 70's collected specimens on which many of Colorado's fish species were named. These collections resulted in a proliferation of newly described genera and species to such an extent that the status and validity of many species and the true diversity of the fauna is still not known. No comprehensive critical analysis of the taxonomy of Colorado fishes has yet been made. Through the years, opinions have been based on previous bits of work and all the errors and misinformation have been passed on and incorporated into our present body of knowledge. Our opinions and recommendations for improvement of Beckman's Guide are arranged by family groups and follow the order encountered in the Guide.

Salmonidae

Coregonidae the whitefishes: reduce to subfamily status (Coregoninae) of Salmonidae.

The lake whitefish, *Coregonus clupeaformis*, added to the list of introduced species. A population of unknown origin is established in Cheeseman's Reservoir.

Silver salmon, *Oncorhynchus kisutch* and California golden trout, *Salmo aguabonita*, added as introduced species. Atlantic salmon, *Salmo salar*, deleted. The splake, *Salvelinus fontinalis* x *S. namaycush* is now stocked in Colorado waters.

Presently, _Carpiodes cyprinus_ is the only carpsucker definitely known from

Investigations of the native subspecies of cutthroat are underway. Pure populations of Rio Grande cutthroat were found on the Trinchera Ranch in Costilla County in 1967.

Thymallidae, the graylings: reduce to subfamily (Thymallinae) of Salmonidae. The "American" grayling should be Thymallus arcticus; T. signifer is a synonym of arcticus.

Esocidae

The northern pike, Esox lucius, added to the list of introduced species. The grass pickerel, Esox vermiculatus, should be considered a subspecies of E. americanus.

Catostomidae

The plains carpsucker, Carpiodes forbesi, is a doubtful species. Presently, Carpiodes ~~carpio~~ is the only carpsucker definitely known from Colorado. The white sucker, Catostomus commersoni, is now well established in the west slope tributaries of the Colorado River and a specimen was received from the Rio Grande basin in Conejos County.

The flannelmouth sucker, Catostomus latipinnis, may actually consist of two species: coarse scaled specimens (75-90 scales in the lateral line) were collected in the Black Canyon of the Gunnison River together with the typical fine scaled form (95-125).

Several additions and corrections are necessary for the mountain suckers of the genus (or subgenus) Pantosteus. The name of the widespread bluehead sucker, P. delphinus, should be changed to P. discobolus, according to the work of Smith (1966. Mus. Zool., Univ. Mich., Misc. Publ. 129). The name delphinus is a synonym of P. platyrhynchus. P. platyrhynchus, should be added to the list of native Colorado fish species as Smith found this sucker in a tributary of the Yampa.

The life history information given in Beckman's Guide states that the bluehead sucker is a spring spawner and reaches a length of about one foot. In late August of 1966, bluehead suckers to 16 inches were collected in spawning condition in the Black Canyon of the Gunnison.

Two corrections are necessary to update the information on the Plains Mountain sucker, Pantosteus jordani: 1. P. jordani is currently considered as a synonym of P. platyrhynchus; 2. There is no authentic record of a Pantosteus in the east slope drainage of Colorado outside the Rio Grande basin. P. platyrhynchus has been reported from the North Platte basin in Wyoming and probably occurs in this drainage in Colorado. It is doubtful if any species of Pantosteus was native to the South Platte or Arkansas river basins. With the transportation of water from the Colorado basin through the Continental Divide, it might be expected that species typically found in headwater environments such as members of the genera Pantosteus, Cottus, and Rhinichthys, would be transferred to east slope waters. We know of no specimen, however, of Colorado basin species turning up in any east slope water.

Cyprinidae

Information produced from taxonomic and ecological studies of the genus Gila of the Colorado basin demonstrate that the roundtail chub, Gila robusta, and the bonytail chub, G. elegans, should be considered as full species and not subspecies. The humpback chub, G. cypha, should be added to the list of native Colorado species. This chub is rare and its true systematic position is not yet firmly established.

The Rio Grande chub, Gila nigrescens, should be G. pandorae. G. nigrescens does not occur in the upper Rio Grande basin.

There are differences of opinion on the recognition of subspecies in _Hybopsis gracilis_, but if subspecies are used, the plains flathead chub should be the subspecies _gracilis_ and not _communis_ and the southern flathead chub, _gulona_ and not _physignathus_.

The Colorado speckled dace should be _Rhinichthys osculus_, not _R. nubilus yarrowi_. The use of subspecies in the variable dace species should be avoided unless based on a definitive study. The same advice applies to the use of subspecies in the fathead minnow _Pimephales promelas_ which does not separate into two distinct geographical units in Colorado, as the subspecies names imply. The fathead minnow is now distributed in all major drainage basins of the state.

Notropis deliciosus missuriensis, the plains sand shiner, should be _N. stramineus missuriensis_. The name _deliciosus_ can not be used for the sand shiner because it is a synonym of _N. texanus_, a species which does not occur in Colorado.

The distinctions and true taxonomic status of _Hybognathus placitus_ and _H. nuchalis_ is not fully known. Further collections of _Hybognathus_ are needed from eastern Colorado.

The subspecies of the central stoneroller, _Campostoma anomalum_, should be changed from _plumbeum_ to _pullum_.

The redsided shiner, _Gila (Richardsonius) balteatus_, should be added to the list of introduced species; we have specimens collected from the Yampa River.

A few small specimens of a _Notropis_ minnow new to Colorado were found in an irrigation ditch east of Fort Collins. Apparently, this new minnow is close to _Notropis volucellus_, and may represent a range extension of that species.

Species not listed in Beckman and not collected yet, but which we suspect may be native to Colorado waters are: *Chrosomus neogaeus* and *Notropis heterolepis*.

The type specimens of three cyprinid species of unknown status described from Colorado were examined at the U.S. National Museum. *Leuciscus evermanni* Juday is a synonym of *Semotilus atromaculatus*; *Notropis universitatus* Evermann and Cockerell may be *N. cornutus*, and *Notropis horatii* Cockerell, is probably *N. dorsalis*.

Ictaluridae

The catfish family should be Ictaluridae, not Ameiuridae; and the genus *Ameuirus* becomes *Ictalurus*.

Serranidae

The white bass genus *Lepibema* becomes *Roccus*.

Percidae

The character of cheek scalation used to distinguish *Etheostoma exile* is variable and not absolutely reliable.

Cottidae

The eagle sculpin, *Cottus annae*, is a synonym of *C. beldingi*.

Specimens Desired for Further Study

All native cyprinids of east slope drainages. Chubs of the genus *Gila* in the Colorado basin. Carpsuckers of the genus *Carpiodes*. "Coarse scaled" flannelmouth suckers of the Colorado basin. Any *Pantosteus* from east of the Continental Divide and *Pantosteus platyrhynchus* from the Colorado basin. Observations on behavior or life history of the rare Colorado squawfish, *Ptychocheilus lucius* and the humpback sucker, *Xyrauchen texanus* besides specimens of these species would be welcome.

Allan, R. C. 1958. Lakes Pyramid, Walker and Tahoe investigations. Job Compl. Rept. 2-D, Fed Aid Proj. F-4-R-4. Nev. F. G. :14-18. - Fm. T.A.F.S. 1975(2) - Imler, Webber, Fyak, Colo. Sac. Perch.

Womack, W.R. 1975. Erosional history of Douglas Creek, northwestern Colorado. M.S. Thesis. Colo. St. Univ. 76 p.

Great cattle herd (25,000 head) brought into Douglas Crk. Valley around 1882 - same pattern of overgrazing → gullies, erosion recorded throughout west. (Peterson, 1950. in Trask, ed. Applied sedimentation. John Wiley: 407-434)

Patton & Schumm 75. Geol. 1:88-90.

Leopold, 1951 - Vegetation in SW watersheds in the 19th cent. Geog. Rev. 41: 295-316.

"Once incision has begun in a valley such as this, trib. rejuvenation and the whole complex response seems beyond control until it is complete and a new floodplain has been established. If it is true that such cycles are "built" in" to so systems like this most reclamation projects would have little effect". - as Trib. reach stable gradient, erosion control measures would be appropriate.

Schumm 69 (geomorphic approach to erosion control in semi arid regions'. Trans. Am. Soc. Agr. Eng. 12: 60-68) suggests roads and trails be prohibited in such areas and subsurface barriers might help stabilize alluvium

'James Rector first white man to settle in the valley described 1882 -" It was the best cattle country you ever seen-- no brush and deep gullies like today, but lush grass up to the stirrups of a horse. The creek was right on top of the ground. You could dip out water with a bucket". - Today - Rector's homsite is a vertical walled arroyo more than 10 m. deep - lower water table - grass → sage brush. - Acc. to SCS

Meeker, 27,000 cattle brought to Douglas Crk. Valley fm. Texas in 1885. Resulting overgrazing apparently triggered major gullying soon after. - Area now supports 3000 cattle. - Several bldgs. lost by lateral mvt. of 8-10 m. arroyo since 1937. (aerial photos) -

Kirby, A.D. 1972. "James Rector", in this is what I remember, S. & B. Burg ed. Rio Blanco Co. Historical Soc. Meeker.

Non Game Advis. Council urges BLM .

primary initial goal to ~~restore~~ enhance + restore threat. S. C. p., persist on small no. headw. - write HMP. But ramification - Douglas typical of hundred small - med. watersheds in arid, semi-arid west dramatically altered last 100 yrs with change flora fauna - thus true multiple-use - not realized.

There is ~~little~~ virtually no reasonable doubt on ~~it~~ what happened to Doug

Bromstead

- Present Douglas watershed - Trenched 40 ft. arroyo - lowered water table ~~from~~ from to arid desert com. of greasewood, sage and barren gullied soil ground - much reduced in all value - contribute large silt and salt loading into White R. - - - - -

from historically rel. of since fluvial geog. well document and undisputed series events ~~bringing~~ & repeated

Can be done Heebe -

- thesis Womack (75) = c 1862 James Reeder, 1887 27,000 cattle open range - triggered ~ soon after downward trend continue to present. - The Now all forage alone to sustain an livestock - trout present restabl rip. - continue & accelerated decline. - ~~historical~~ but main changes

Game Non Game values Riparian

now with meltw. - underground - trib. lack of pools, cover, - free ~~water~~ run off - speed amplitude, - banks w/o rip. stabilizing - energy in channel. - to bedrock

Trenched down - water table - Exp. studies - run off - - - , - habitat trout 3-4 - but Douglas mostly gone al typha

- Possible rehab - Camp Ck. Ore. - Trout Ck. Colo. - enclosure

Big Ck. Utah, - Ore. - Rock Ck. Mont. -

options West Ck. - - dike. culvert - raise water table

- livestock must be ~~removed~~ kept from riparian zone - revegetat - plant - woody -

- beavers - cattle lake construction - ~~S~~tream improve, - -

- write HMP aquatic - highest prio multiple use - ~~+~~ trout, water flow raise water table.

- reveg. waters - use by

+ years (reduced sediment trans.

- livestock use again.

rehab waterfowl - countour furrows

- private SCS

NONGAME ADVISORY COUNCIL MEMBERS	DATE APPOINTED	RECOMMENDED TERM EXPIRATION DATE
Dr. Robert Behnke	1975	12/31/78
Dr. Melvin Dyer	1976	12/31/79
Dr. James H. Enderson	1978	12/31/80
Dr. Robert Erickson	1976	12/31/79
Dr. James Fitzgerald	1973	12/31/78
Mr. Ron Lestina	1973	12/31/78
Dr. Michael Monohan	1978	12/31/80
Dr. David Pettus	1975	12/31/78
Mr. Robert Turner	1978	12/31/80
Ms. Jean Widman	1976	12/31/78

See Science – re falcon taxonomy

— Douglas Crk. → BLM fed. N.R.L.

when multiple-use – such paid →

– N.G.A. – ~~project~~ objective – restor – serve as model

– logging, livestock, mining etc – mono use – change directions – – 70-20 in.

– Dougla Crk. – well-documented – Womack – Schumm

– rehab. – Winegar, Heede, ? Rip. ecosystem – (Semin) –

livestock symps. – Reno – . . . what happens – – – – –

– Declare – . – salt → river 6 : 1 $

– Choice – fence ? (inside fence production much greater) Duff

– " If for Private – SCS = . . " "

lake construct. (Sikes) – How Douglas Crk in Hab. Mgt. Plan

– S.C. plan/policies . – goals – game, non game fish & wildlife

water quality, flows –

82 – Rector
1885 – 27,000

– Arroy – 40 ft
water table ↓

grass – greasewood

– Gervais

– request
HMP ?

– respond in/to AMP Plan Hot Spot – future plans?

Nongame Wildlife

Budget Alternatives - Fiscal 1978-79

Priorities		General Fund	Cash Funds 1/	Federal Funds 2/
#1	Maintenance Budget	146,419		
	FTE	(7.0)		
	- Enhancement -			
#2	+ Threatened & Endangered Species Program	100,000	37,803	275,572
	FTE			(16.0)
#3	+ 3.0 Nongame Biologists for NE, NW & SW		80,184	
	FTE		(3.0)	
	+ Enhancement Special Purpose			
#4	1) Urban Wildlife		27,340	
	FTE		(1.0)	
#5	2) Herptile Program		4,704	
	FTE		(.5)	
#6	3) Inventory of Selected Properties		4,704	
	FTE		(.5)	
#7	4) Inventory of Undetermined Species		12,586	
	FTE		(1.0)	
#8	5) Walter Walker Nongame Wildlife Area		7,772	
	FTE		(.25)	
#9	6) Floating Nest Structures		2,400	
	FTE		(.16)	
#10	7) Water Snake and Soft Shell Turtle Study		3,850	
	FTE		(.25)	

Total - Alternative #1 Nongame Budget

General Fund	$246,419
FTE	(7.0)
Cash Funds	181,343
FTE	(6.66)
Federal Funds	275,572
FTE	(16.0)
Total	$703,334
FTE	(29.66)

1/ Check-off Monies

2/ Endangered Spp. Act.

Don Alley
N W Montana Chapter
c/o 810 3rd Ave East
Kalispell, MT 59901
406-755-7317

Robert J. Behnke
Department of Fisheries and Wildlife Biology
Colorado State University
Fort Collins, Colorado 80523

Dear Dr. Behnke,

I am sending you a copy of the draft Upper Flathead System Management Plan, in the hope that you will find it worthwhile to comment on the proposals it contains. As you probably know, this system is a stronghold for an essentially pure strain of Westslope Cutthroat trout and bull trout char.

First, let me give you a little background on the situation and on our chapter's position. A number of factors have resulted in the loss of the system's popular kokanee salmon fishery. Social and political pressures have convinced the state and tribal authorities to make some effort to restore the kokanee fishery. I have always felt that the kokanee did not belong in the Flathead and I feel that efforts to restore this fishery are unwise (at least in terms of ecology, as opposed to politics). However, the political situation is such that attempts to restore kokanee are inevitable. In any event, these attempts are very likely to fail. Our chapter had therefore decided not to oppose attempts to restore kokanee when testifying at public meetings earlier this year.

It is in the area of cutthroat management that we are most concerned and would like most to direct your attention. Investigation of management of these fish in southeastern British Columbia and the wilderness waters of the South Fork of the Flathead suggests to us that the present 5 fish limits now in effect on the upper Flathead system will not protect the fish from overharvest. Fisheries biologists share our concern that the loss of the extremely popular kokanee fishery will result in many fishermen shifting their attention to cutthroat. We believe that the proper response of our fisheries managers is to lower limits on the cutthroat and take a leadership position in educating the public that the future of this wild native trout is largely dependent on nonconsumptive use as opposed to the kokanee fishery type of high harvest, consumptive use. However, as explained in the plan, fisheries managers feel that they can manage cutthroat as a partial replacement for kokanee and <u>increase</u> the harvest. This will be accomplished by adding a million hatchery fish a year to the system.

We question the wisdom of adding hatchery fish to a wild population in order to meet the demands of some fishermen to harvest more fish than a wild fishery can sustain. We also have doubts about the long term genetic integrity of the hatchery broodstock. We are not convinced that enough is known about maintaining hatchery stocks of genetically pure native fish, as opposed to domesticated hybrids, to ensure that the genetic integrity of the native wild fish is not endangered. Furthermore, we wonder if the cutthroat of this large system can be considered as a single genetic entity. Is a fish that leaves the lake in December to eventually spawn in one fork the same as one that leaves the lake in March to spawn in another fork? Are they both identical to the hatchery broodstock derived from fish native to the tributaries of Hungry Horse Reservoir?

By supplementing natural reproduction with hatchery fish to reach a management goal of an increase in harvest, managers assume that the harvest will include the hatchery fish. However, experience in nearby Swan Lake, where an estimated 175 fish were harvested out of a plant of 100,000, raise concerns that fishermen will focus on known seasonal concentrations of wild trout, the hatchery fish may not survive or may behave in such a way as to avoid harvest, and the increased harvest will occur largely, or entirely, at the expense of wild fish.

In general, we fear that the concept of planting hatchery fish in order to maintain increasing levels of harvest will result in larger plants as fishing pressure increases over the years. We fear that eventually our wild and native fish will be overwhelmed by a hatchery fish of dubious genetics.

If you have the time and the interest we would appreciate it if you would comment on the enclosed plan before Nov. 1, 1988. The address to send comments is Montana Department of Fish, Wildlife, & Parks, P.O. Box 67, Kalispell MT 59901. A copy sent to me would be appreciated.

Thank you,

Don Alley

cc: Pam McClelland

Montana Department of Fish, Wildlife & Parks

Region One - Box 67
Kalispell, MT 59903
(406) 752-5501
Ref: JV73.89
October 27, 1988

Dr. Robb Leary
Genetics Lab
Dept. of Zoology
University of Montana
Missoula, MT 59812

Dear Robb:

The Department and the Confederated Salish and Kootenai Tribe have been attempting to develop a fisheries co-management plan for the Flathead Lake/River system. The plan would establish objectives and strategies for managing the major gamefish populations in the system. One proposed strategy, based on public demand during the scoping process, would be to implement the stocking of one million 4-6" westslope cutthroat on an annual basis. The objective would be to replace recruitment lost to the construction of hydroelectric dams as well as to provide new fishing opportunities to compensate for the decline in the kokanee population.

The local Trout Unlimited Chapter is concerned about the genetic implications of hatchery augmentations. They requested an opinion from Dr. Behnke (enclosed). Dr. Behnke also expressed concerns about the genetic implications of this strategy. Since you are probably the person most knowledgeable in the distribution of genetic subpopulations in the Flathead as well as the genetic make-up of our current westslope cutthroat broodstock, I would appreciate your opinion on this strategy. Please keep in mind that the plants are proposed only for Flathead Lake and not for the South Fork above Hungry Horse Dam.

I appreciate any time you can give this matter. We hope to finalize the plan in January so a reply before then would be appreciated.

Best regards,

Jim

Jim Vashro
Regional Fisheries Manager

/bj
c: Don Alley
Dr. Leo Marnell
Dr. Robert Behnke

Colorado State University

Department of Fishery and Wildlife Biology
Fort Collins, Colorado 80523

October 17, 1988

Montana Department of Fish
Wildlife, and Parks
P. O. Box 67
Kalispell, MT 59901

Gentlemen:

Comments on Upper Flathead Fisheries Management Pan:

I was asked to review and comment on this plan by the Northwest Montana Chapter of Trout Unlimited. My comments concern two aspects: (1) probability of useless and wasteful stocking and (2) concern for maintaining remaining natural intraspecific diversity of cutthroat trout.

The plan proposes to stock large numbers of kokanee and cutthroat trout under the assumption that a significant number of the stocked fish will survive, grow, and enter the fishery to maintain certain catch objectives.

If the drastic decline in kokanee is the result of reproductive failure, then such a plan should be successful (if the lake environment is near optimum with an abundant food supply, then only the lack of recruitment is responsible for the decline of adult fish, and stocking of hatchery fish would overcome this problem). I doubt, however, that this is the case. The present limitations on reproduction have been in effect, I believe, for about 30 years, yet kokanee abundance remained high -- a record spawning run occurred as recently as 1985. The drastic decline in 1986 and 1987 evidently coincided with rapid increase in *Mysis* in the lake. Unless the conditions that must have caused virtually 100% mortality in the juveniles produced by the 1981 and later spawning runs (which were the first year-classes exposed to *Mysis* competition) have changed, what results can be expected from stocking millions of hatchery kokanee in the lake and exposing them to the same conditions that caused previous year-class failures?

In Lake Pend Oreille, which also suffered a dramatic decline in its kokanee after *Mysis* became established, the epilimnion warms to about 18^{o} in July and *Mysis* will not enter the surface waters. Under these conditions, *Daphnia* greatly increase in abundance during summer months, and the stocking of hatchery kokanee appears to be a viable management option. If some such strategy is intended for Flathead Lake, it is not apparent in the management plan. Is the relative abundance of *Daphnia* known on a monthly basis for Flathead for the past several years? Is there any idea of what food organisms would be available and in what quantities for the millions of kokanee planned to be stocked, especially at the time of stocking? Most kokanee fisheries are dependent on a single species of *Daphnia* (which is also the preferred food of *Mysis*). Based on my understanding of kokanee and of kokanee-*Mysis* interactions, I see little chance of success for the management option of stocking millions of kokanee in Flathead Lake.

My concerns on the cutthroat trout management option have a similar basis as with the kokanee. Is natural reproduction the major limiting factor controlling cutthroat abundance, or is their abundance more limited by food availability and interactions (competition and predation) with non-native species? I see nothing in the management plan that bears on this critical question. Considering past failures to increase S. c. lewisi abundance by stocking massive numbers of hatchery fish in large lakes in Idaho, what might be different about Flathead Lake that would suggest any hope for success?

A more important matter, however, concerns the maintenance of the genetic integrity of the native Flathead cutthroat trout. Based on what is known of cutthroat trout in other large lakes, it can be assumed that the cuthroat trout native to Flathead Lake is not a homogeneous entity, but is made up of separate populations that spawn in different tributaries. What is known about the spawning runs that leave the lake --- time of the run, area and time of spawning, life history characterizations? I suspect that some of the original diversity in populations was lost when Hungry Horse Dam blocked the South Fork. How many distinct populations remain? This information should be basic to any management plan. The danger of loss of discrete populations by homogenization induced by stocking massive numbers of one genotype of hatchery cutthroat leads me to reject this option as a realistic management strategy.

Sincerely,

Robert Behnke

Robert J. Behnke
Professor, Fishery Biology

RJB/kc

cc: Mr. Don Alley
    Dr. Leo Marnell

Colorado State University

Department of Fishery and
Wildlife Biology
Fort Collins, Colorado 80523

October 17, 1988

Montana Department of Fish
Wildlife, and Parks
P. O. Box 67
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