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A PRELIMINARY STUDY

OF

THE PROPOSED WHITEFISH TRANSPLANTING

IN

WESTERN COLORADO WATERS

March 1938

Submitted by:

C. N. Feast, Jr. Aquatic Biologist,
United States Forest Service.

Approved by:

A. A. McCutchen, Range Examiner,
United States Forest Service.

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(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 percent 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	3½	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 Whito 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 developod.

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

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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

Prosopium williamsoni (Girard)

Coregonus williamsoni

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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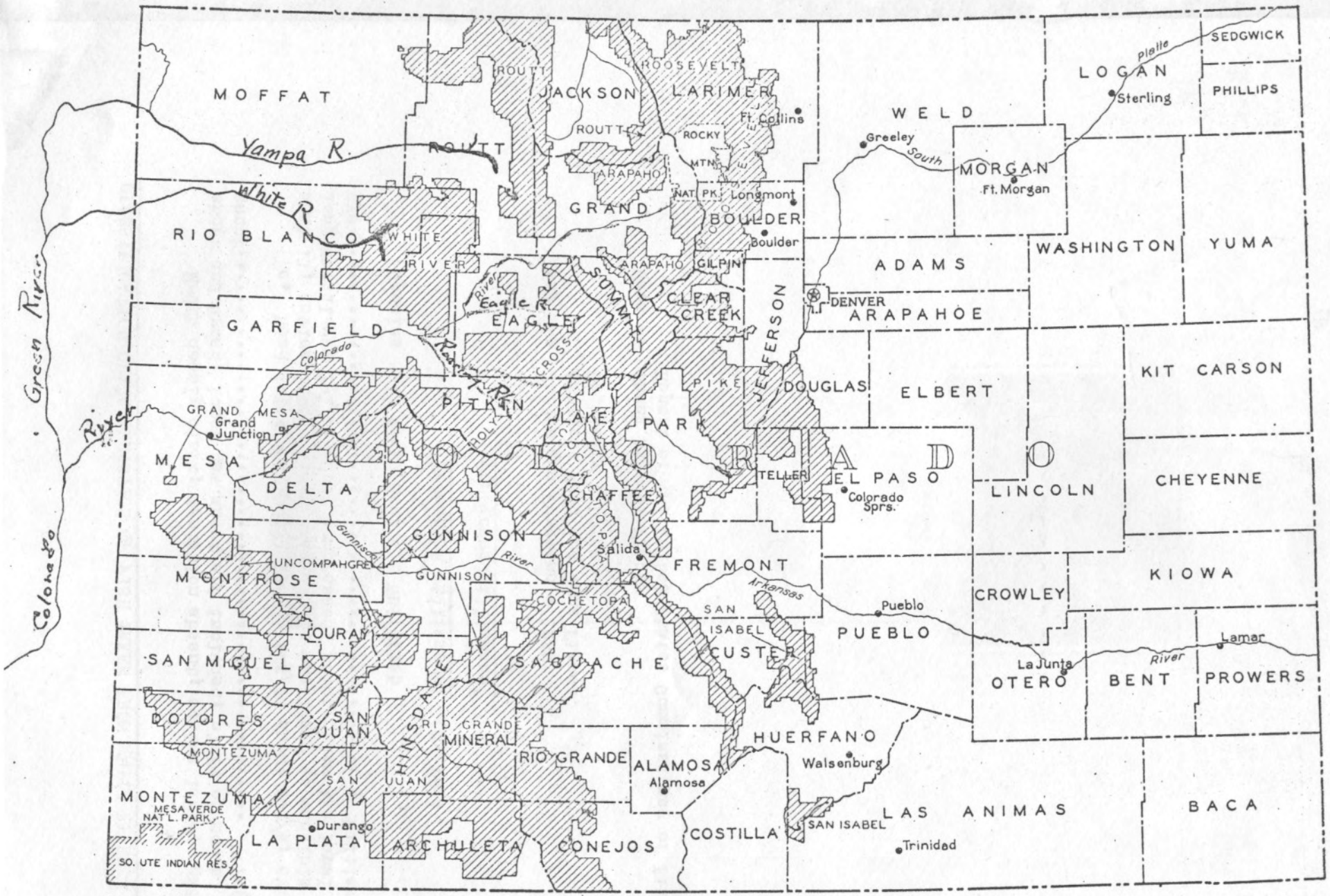

Nativewhitefish waters

Waters where it is proposed to plant whitefish

Waters where it is possible for whitefish to migrate