A REPORT ON THE GREENBACK CUTTHROAT TROUT INVENTORY PROGRAM, JULY TO OCTOBER, 1977

Prepared for
Colorado Division of Wildlife

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INTRODUCTION

A total of 24 streams in the Arkansas and South Platte River drainages was surveyed for the identification of new populations of Salmo clarki stomias (greenback cutthroat trout). Taxonomic analysis of seven samples of 78 specimens from these streams and statistical comparisons of these trout with other known pure populations of greenback cutthroat trout and with other subspecies of cutthroat trout were made.

Historically, the greenback cutthroat trout was the only game fish on the eastern slope of Colorado. Its original distribution included the headwaters of the South Platte and Arkansas River basins in Colorado and a small area in southeastern Wyoming, but permanent trout habitat did not extend much beyond the foothills region. The greenback cutthroat trout probably gained access to the South Platte drainage via an ancient headwater transfer from the Colorado River basin; a later transfer occurred from the South Platte basin to the Arkansas basin (Behnke 1976). Behnke (1976), Wernsman (1973), and Behnke and Zarn (1976) have discussed the status of the greenback cutthroat trout up to this time.

To date, there is still the problem of better defining the characteristics of S. c. stomias. This results from the scarcity of old museum specimens and the extreme rareness of pure populations. Therefore, the natural range of variability of diagnostic characters can only be roughly estimated. No authoritative method exists which would determine if a population with slightly aberrant characters is within the natural range of variability or due to slight hybridization with introduced rainbow trout or other subspecies of cutthroat trout (Behnke 1976). Continued search for pure populations is the best hope for better defining the taxonomic attributes of S. c. stomias. It is not likely that many pure populations of S. c. stomias remain, but good representatives should be identified for special recognition in relation to perpetuation and protective efforts. It was our purpose to initiate a systematic survey of isolated headwater areas of the South Platte and Arkansas River drainages in order to find and identify other pure or virtually pure greenback trout populations, as well as, determine potential sites for reintroduction. Very few streams have been inventoried in the Arkansas River basin for the presence of greenback trout. For this reason our sampling effort concentrated more in the Arkansas drainage rather than the South Platte drainage.

No pure populations of S. c. stomias were identified from this survey. There exists one good representative of S. c. stomias from S. Apache Creek in the Arkansas drainage; however, S. c. stomias was absent from Hourglass and Black Hollow Creeks.

Included in this report are the use of computer analytical techniques (a numerical taxonomy program). This analysis offers some interesting potential to better quantify the diagnostic characters of subspecies of cutthroat trout and perhaps define acceptable limits of variation in "pure" populations (Behnke 1977).

SURVEY OF STREAMS

The following is a list of streams that were surveyed during August and September 1977. Fish were collected by either hook and line or backpack electroshocker. Table 1 summarizes the results of the survey.

Arkansas River Drainage

Wahatoya: The Wahatoya and its tributaries (Spanish Peaks quad., R68W T30S Secs. 25,26) were surveyed on 2 August 1977. The flow was approximately 2.5 c.f.s. The stream fish fauna consisted only of brook trout. Brook trout persisted until a natural bedrock barrier was encountered 1.2 miles upstream from the Wahatoya camp. Above this barrier the Wahatoya and its tributaries were barren. The small percipitous tributaries probably never had native cutthroat trout. The steep inclines and intermittent flows have kept all fish from these tributaries. We talked withproperty owners at the Wahatoya Camp who said they have stocked rainbow and brook trout since 1939. Also, Division of Wildlife records show that rainbows have been stocked.

There are numerous small deep pools in the main channel both above and below the barrier. This stream may be considered for greenback introduction upon eradication of the brook trout. However, the stream receives moderate fishing pressure and the habitat is not ideal.

Greenhorn Creek: The discharge of this stream (San Isabel quad., R68W T24S Secs. 31,32) was approximately 2.5 c.f.s. on 10 August 1977. This stream is reasonably isolated and the headwater area is barren of fish. About three miles downstream (drop of 2500-3000 ft. elevation) brook trout occur on private lands. The headwater area had many deep pools. The available trout habitat is excellent with many good redd areas. Several natural barriers exist which prevent brook trout from entering the upper reaches. This stream would be excellent for introduction of greenback cutthroat trout.

Turkey Creek: The headwater region of this creek (San Isabel quad., R69W T25S Secs. 1,2) was surveyed on 10 August 1977. The discharge was approximately 2 c.f.s. The top 1.5 miles of the stream were barren but brook trout inhabit the rest of the stream. There exists no natural barrier to prevent brook trout from reaching the top. The canyon has a gentle gradient. The stream is impacted by cattle grazing.

South Apache Creek: Cutthroat trout were collected from this stream (Hayden Butte quad., R69W T25S Secs. 22,23,25) on 11 August 1977. The cutthroat population began about 200 yards below the Apache Falls tributary and continued sporadically down to the mouth of the canyon. Specimens were collected from this upper area in order to compare those specimens collected in the lower area on BLM land in June, 1977. The cutthroat trout were in good condition; however, as a result of the drought many trout were located in deep pools and not too many trout were found elsewhere. The habitat appeared good and the discharge was approximately 2.5 c.f.s.

Table 1. Streams Surveyed for S. c. stomias

San Isabel National Forest (Arkansas drainage)	Cutthroats	Barren	Other
Wahatoya Creek			brook
Price Canyon			brook
Greenhorn		X	
North Muddy Creek		X	
Middle Muddy Creek		X	
North Apache Creek	X		rainbow
South Apache Creek	X		
Turkey Creek			brook
Newlin Creek		X	
Hiltman Creek		X	
Cottonwood Creek		X	
Venable Creek		X	
South Colony Creek			brook
Cascade Creek	X*		
Hennequin Creek		X	
St. Charles River			rainbow/brook
Roosevelt National Forest (South Platte drainage)			
Nunn Creek (North Platte)	X		brown
Middle Rabbit Creek	X		
Sawmill Creek	X		brown
Roaring Creek	X		
Black Hollow Creek			brook
Hourglass Creek			brook
Upper Joe Wright Creek		X	
Montgomery Creek		X	

*--not personally collected

North Apache Creek: This stream (Hayden Butte quad., R68 T25S Secs. 22,23,24) was surveyed on 16 August 1977. The discharge was approximately 1.5 c.f.s. The upper reaches of the stream were barren of fish but one mile downstream from where Bartlett's trail crosses the stream rainbow trout were dominant and rainbow/cutthroat hybrids were dominant near the bottom of the canyon. The rainbow were found above several barriers (log and waterfall). There were a number of old mining shacks suggesting the rainbows were packed above the barriers. Apparently the cutthroats come from South Apache Creek since both the north and south branches meet in the foothills-plains region. Perhaps during high water (spring runoff) the cutthroats are able to enter the north fork and then are prevented from returning when the lower reaches dry up.

Newlin Creek: We surveyed Newlin Creek (Rockvale quad., R70W T20S Sec. 25) on 18 August 1977. Water at present is being diverted by the city of Florence. We found no fish and a discharge of about one c.f.s.

North and Middle Muddy Creeks: Both streams (San Isabel quad., R68W T24S Secs. 16,17,20,21) were very small with very few deep pools; mostly riffle areas about 3-4 inches deep. The flow in both was approximately 0.5 c.f.s. on 17 August 1977, but even during spring runoff there is apparently not much of a flow. Some parts of the stream were starting to silt in. It is extremely doubtful if cutthroat trout were ever native to these streams. As it was, both streams were barren of fish.

Price Canyon: Brook trout were found the first 1.5 miles of the stream (Cuchara quad., R69W T30S Secs. 9,16) with the last mile or so barren of fish (due mainly to the steep gradient). The stream had a discharge of only one c.f.s. and the brook trout were not numerous. It appears that the cutthroat population that was there in the 1930's (according to Les Denton) was eliminated via heavy fishing (due to the limited habitat it wouldn't take much to deplete the population) rather than competition with brook trout. The stream would not be very suitable for greenback introductions.

St. Charles River: Sections of this stream above Lake San Isabel were surveyed on 17 August 1977 (San Isabel quad., R69W T24S Secs. 11,15). Rainbow trout and brook trout were found. Stocking records show numerous stockings of rainbow trout. With such stockings and the presence of brook trout it is doubtful that native greenback cutthroat trout exist either above or below Lake San Isabel on the St. Charles River.

Cascade Creek: No cutthroats were personally collected from this stream (Mosca Pass quad., R72W T28S) since specimens had been collected and analyzed earlier (Behnke 1977). These trout were found to be virtually pure greenback cutthroat trout. The discharge was approximately one c.f.s. on 25 August 1977. Brook trout were found above the falls. The falls has been described as a cascading falls but is actually a straight drop of 90-100 feet. No trout could have been native above the falls; therefore, the greenbacks that are present were probably backpacked above the fall using the existing trail. The Division of Wildlife does not have any records of stocking for Cascade Creek. The source of the fish in Cascade Creek may be the many "natives" that were stocked in the past above the South Fork confluence to the Huerfano River. However, "natives" from stocking records are not true natives -- mainly yellowstone cutthroats.

The cutthroat trout were in some of the pools which occurred every 5-10 feet. They were not numerous but then the stream is such that it couldn't support many fishes.

Hiltman, Hennequin, Cottonwood, Venable, South Colony Creeks: These streams are located on the east slope of the Sangre de Cristos near Westcliffe, Colorado. The survey of these streams occurred on 23 August 1977 and 24 August 1977. South Colony contained brook trout while the other four creeks were barren. All of these streams have steep gradients and flows of 3-4 c.f.s. Most of the streams draining the east side of the Sangre de Cristos are too steep to support much of a fisheries even though flows are excellent. The high mountain lakes are stocked regularly (usually Pikes Peak brood) so greenback trout, if at all present in the past could not have persisted. The only areas where greenback trout would have consistently survived are the lower reaches which have been susceptable to angling pressures and livestock grazing.

South Platte Drainage

Nunn Creek: This stream was surveyed on 10 September 1977 (Deedman quad., R75W T9N Secs. 9,10). This stream is actually part of the North Platte drainage, but its headwaters are close to the South Platte drainage (Roaring Creek). Cutthroat trout and brown trout were found together. The brown/cutthroat trout ratio was approximately 9/7. The stream is impacted by cattle grazing, but good deep pools exist with a gradual gradient. Cutthroat trout are apparently being pushed upstream by the ever-increasing brown trout population. Cutthroat trout were not found in the lower reaches of Nunn Creek; they were only found in the very headwaters. Eventually cutthroat trout will probably be eliminated by the brown trout. There does not appear to be heavy fishing pressure. Access to areas of cutthroat trout is accomplished only by 4-wheel drive vehicles.

Roaring Creek: This stream was also surveyed on 10 September 1977 (Deedman quad., R75W T9N Sec. 11). Dieffenbach (1966) originally sampled this population. Behnke (1976) describes this cutthroat population as a good representative of greenback cutthroat trout (refer to taxonomy section). We found small-sized cutthroat trout and no other species. There were few good pools; however, one large pool (remnant of a beaver dam) contained 8-10 cutthroat trout. Access is by a 4-wheel drive jeep trail. The area appears well traveled by hunters and fishermen and livestock grazing is apparent.

Middle Rabbit Creek: This stream was sampled on 18 September 1977 (Livermore Mountain quad., R71W T10N Sec. 21). A small population of cutthroat trout was found in a one-quarter mile section of a severely degraded stream. Above the cutthroat population the stream went underground. The flow was extremely minimal with trout only existing in a few good pools. The cutthroat trout population is probably less than 30 in number for that one-quarter mile section. The habitat is such that overwintering of trout seems unlikely. The stream segment with the cutthroat trout was on private property about one-half mile from the Cherokee Park Wildlife Preserve fence line.

Montgomery: This stream was surveyed on 30 September 1977 (Clark Peak quad., R76W, T7N Sec. 24). The flow was approximately 0.5 c.f.s. The stream was barren of fish and did not represent good trout habitat.

Upper Joe Wright: This stream was also surveyed on 30 September 1977. The flow was approximately one c.f.s. It was also barren of fish and the habitat was poor (lacked cover and pools).

Sawmill: The flow was 2.5 c.f.s. on 30 September 1977. Cutthroat trout and brown trout were found. The stream provided good trout habitat; several deep pools (some 6 ft. deep) were seen. Clear-cutting occurs in the area.

Black Hollow and Hourglass: Both streams were surveyed as a follow up to past stockings of greenback cutthroat trout (Hourglass - Commanche Peak quad., R79W, T7N Secs. 13,14; Black Hollow Kinikinik quad., R74W, T8N Secs. 2,10,11,14). See Behnke (1976) for history of past stockings in these creeks. Hourglass Creek was found to contain only brook trout and these were not numerous. No cutthroat trout were found. Black Hollow represented the same situation. Brook trout were found to be numerous above the barrier that was built in 1967. No cutthroat were found. If greenback cutthroat trout are to be re-established in Black Hollow Creek another reintroduction is necessary upon eradication of brook trout.

Glacier Creek: This stream was not surveyed by us personally but specimens of cutthroat were sent to us for taxonomic analysis. Glacier Creek is located near Twin Lakes (Leadville, Colorado).

TAXONOMIC ANALYSES

The taxonomic analyses of all of the trout mentioned in this report were carried out at Colorado State University, either by the authors or by Dr. Behnke and his graduate students.

Morphological measurements were made according to the procedure described by Hubbs and Lagler (1958). Gillrakers were stained with alizarin and counts were made from the first gill arch. Alizarin stain was also used on the basibranchial teeth to facilitate counting, all teeth on the basibranchial plate were counted. Scale counts in the laterial series were made by counting the scales two rows above the laterial line (scale counts of the pored scales are similar in many of the trouts). Pyloric caeca counts were made by pulling every complete tip loose from the intestine. Where applicable all counts and measurements were made on the left side of the fish.

Hybridization between various species and subspecies of Salmo usually can be detected in populations by noting the meristic characters. Hybridization with rainbow trout (Salmo gairdneri) is usually detected by an absence of basibranchial teeth, lower scale counts, higher pyloric cacea counts and a profusion of spots (posterior to anterior, above and below the laterial line).

Table 2 presents data from five selected meristic characters from populations of S. c. stomias (Como Creek, headwaters of Little South Poudre, South Huerfano Creek, Cascade Creek and Albion Creek), S. c. pleuriticus (Rock Creek and headwaters of the Colorado River), S. c. virginalis (Indian Creek) and typical hatchery S. gairdneri (Ruby Valley, Nevada), as well as cutthroat trout collected during this study. Computer analysis, using Hubbs and Hubbs diagrams (Andreasen 1976), (Figs. 1a, 1b, 1c, 1d, 1e) were used to display the data in Table 2 in a more graphic comparison. The program was modified at Colorado State University for use with a CDC 6400 computer. The diagrams indicate the mean (center point), 95 percent confidence limits of the mean (black lined rectangle), one standard deviation on either side of the mean (outer limits of open rectangle), and sample range (basal line). The size of the population sample is indicated prior to the name of the collecting site or subspecies.

S. c. stomias, the native trout of the South Platte and Arkansas drainages, is characterized by high scale counts (185-216, in laterial series and 45-55, above the laterial line), low pyloric caeca counts (29-35), basibranchial teeth present (but low in number) and large spots concentrated posteriorly, compared to other Salmo species (Behnke 1976, Behnke and Zarn 1976).

The most pertinent information obtained from the comparisons in Table 2 and Figure 1 (a,b,c,d,e) is the detection of rainbow and non-native cutthroat hybridization. The trout from Rabbit and Nunn Creeks are obvious rainbow x cutthroat hybrids (note the scales in the lateral series and above the lateral line and the absence of basibranchial teeth). Slight rainbow influence can be detected in the South Apache fish (note scales in the lateral series and above lateral line). Although no rainbow trout were collected from South Apache Creek, North Apache Creek, (at one time joined with South Apache, and still may during flooding), supports numerous rainbow and rainbow x cutthroat hybrids, which may account for this slight rainbow influence in the South Apache Creek cutthroat trout.

The trout collected from Sawmill Creek are good genotypic representatives of S. c. stomias, with the exception that one of nine lacked basibranchial teeth (the small sample size renders this difficult to interpret). Phenotypically (spotting pattern) they are not characteristic S. c. stomias, but rather Yellowstone or rainbow trout hybrids. Two hours of electrofishing over about 0.5 mile of stream, produced only nine cutthroat and two brown trout. We were unable to determine if reproduction was occurring, no young of the year were collected.

The trout collected from Glacier Creek are probably Yellowstone cutthroat, based upon their coloration, spotting pattern, low scale counts and high basibranchial teeth counts.

Behnke (1976) indicated that the Roaring Creek trout were "good representatives" of S. c. stomias. The collection we made was not significantly different from past Roaring Creek collections. Genotypically they are good S. c. stomias except for the absence of basibranchial teeth in one of eight specimens. Phenotypically (based upon spotting pattern) there is a recognizable influence by past introductions of rainbow trout and/or non-native cutthroat trout (the spots are smaller and more numerous than those of S. c. stomias). It has been assumed that these cutthroat were stocked into Roaring Creek since it is unlikely that S. c. stomias was native to this stream. There is a steep gradient barrier separating Roaring Creek from the Cache La Poudre River.

Sixteen morphomeristic character measurements (Table 3) from 422 specimens of S. c. stomias, S. c. pleuriticus, S. c. virginalis, S. c. utah, S. c. henshawi and an undescribed subspecies from the Humbolt River drainage were analyzed statistically to compare the evolutionary affinities between various subspecies of cutthroat trout. This was accomplished by the use of a computer - aided discriminant function analysis, with the utilization of an SPSS computer program (Nieetal 1975). The program was modified for a CDC 6400 computer at Colorado State University by Mr. Steve Culver. This discriminant analysis gives individual fish a weighted score and prints out a two-dimensional plot along a horizontal axis (best set of diagnostic characters) and along a vertical axis (next best set of diagnostic characters). The result is a group centroid plot (Fig. 2) for each population (group) of trout. In addition to the evaluation of similarities and differences between populations, the discriminant function analysis identifies the population to which each individual in the study is most closely related (Table 4) and which characters have the best discriminating power (Wilks lambda analysis, Table 5).

Table 2. Character Analysis

Locality	Gillrakers	Pyloric Caeca	Scales above Lateral Line	Scales in Lateral Series	Basibranchial Teeth
Nunn Creek 1977 N=11	17-20 (18.5)	28-41 (35.0)	37-44 (39.3)	166-189 (176.7)	0- 5 (1.9) 6 of 11 w/o teeth
Sawmill Creek 1977 N=9	18-22 (19.7)	30-38 (34.2)	40-47 (44.2)	170-206 (193.3)	0-16 (6.7) 1 of 9 w/o teeth
Roaring Creek 1977 N=8	17-20 (18.7)	30-41 (36.6)	43-49 (45.3)	182-207 (195.7)	0- 6 (3.6) 1 of 8 w/o teeth
Rabbit Creek 1977 N=6	18-22 (19.3)	34-44 (39.5)	38-42 (40.8)	164-184 (174.5)	-0-
Glacier Creek 1977 N=10	19-20 (19.9)	33-44 (38.6)	37-40 (38.6)	163-175 (168.9)	3-18 (12.1)
South Apache Creek 1977 N=26	17-21 (19.0)	30-39 (34.4)	36-46 (40.0)	154-186 (174.0)	0-20 (6.7) 1 of 26 w/o teeth
Como Creek* 1969 N=18	17-21 (19.0)	24-42 (29.4)	46-53 (48.4)	174-205 (189.3)	3-12 (6)
Albion Creek* 1955-1963 N=22	17-20 (18.5)	29-46 (34.1)	41-47 (44.6)	168-203 (189.3)	1-23 (8)

Table 2. Character Analysis (cont'd)

Locality	Gillrakers	Pyloric Caeca	Scales above Lateral Line	Scales in Lateral Series	Basibranchial Teeth
Headwaters of Little So. Poudre* 1965,1970 N=18	19-23 (21.3)	27-50 (35.2)	53-60 (56.7)	205-236 (216.5)	2-17 (11.1)
So. Huerfano headwaters* 1976 N=15	17-22 (19.4)	30-48 (38.4)	39-49 (43.9)	163-210 (191.2)	1-13 (5.9)
Cascade Creek* 1976 N=15	17-21 (19.0)	30-48 (39.2)	42-49 (44.5)	179-207 (193.6)	4-21 (9.3)
Rock - Upper Green River, Wyo.* 1974 N=8	17-20 (18.7)	27-46 (37.0)	39-43 (41.0)	175-200 (194.6)	2-11 (6.0)
Headwater Colo. R.* 1970 N=10	18-23 (20.3)	32-43 (37.1)	44-49 (45.1)	187-226 (195.1)	6-33 (14.0)
Indian Creek, N. Mex. *S. c. virginalis* 1958 N=16	18-21 (19.3)	36-42 (39.3)	38-45 (40.6)	146-186 (163.8)	0- 6 (2.3) 2 of 16 w/o teeth
Ruby Valley, Nevada *S. gairdneri*	17-22 (19.7)	50-60 (55)	24-33 (28.5)	104-137 (123.8)	Absent

*Data obtained from Behnke 1976 & 1977

Table 3.

Morphomeristic Characters Used in the Discriminant Function Analysis

1. Head length
2. Upper jaw length
3. Snout tip to dorsal fin origin
4. Dorsal fin length
5. Caudal peduncle depth
6. Caudal peduncle length
7. Gillrakers upper
8. Gillrakers lower
9. Gillrakers total
10. Branchiostegal rays right
11. Branchiostegal rays left
12. Scales above lateral line
13. Scales in the lateral series
14. Pelvic fin rays
15. Pyloric caeca
16. Basibranchial teeth

Characters 1-6 were recorded in thousandths of the standard length.

Table 4. Group Classification Results

ACTUAL GROUP	CODE	N	Predicted Group GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6
Utah	1	270	245 (91%)	---	3 (1.1%)	20 (7.4%)	2 (.7%)	---
Stomias	2	73	1 (1.4%)	59 (80.8%)	12 (16.4%)	1 (1.4%)	---	---
Pleuriticus	3	26	---	2 (7.7%)	23 (88.5%)	1 (3.8%)	---	---
Virginalis	4	16	---	1 (6.3%)	---	15 (93.8%)	---	---
Humbolt	5	22	---	---	---	---	22 (100%)	---
Henshawi	6	15	---	---	---	---	---	15 (100%)

90% of the groups (subspecies) were correctly classified.
Henshawi and Humbolt subspecies had all specimens correctly classified.
The closer the subspecies (taxonomically) the greater the chance of misclassification.

Table 5. Wilks Lambda and Univariate F-Ratio

CHARACTER	WILKS LAMBDA	F-RATIO
Scales in lateral series	.29825	195.76
Pyloric caeca	.16765	64.65
Basibranchial teeth	.09329	66.00
Head length	.07746	16.87
Branchiostegal rays right	.06472	16.21
Gillrakers upper	.05534	13.93
Dorsal fin length	.04793	12.66
Scales above lateral line	.04226	10.98
Gillrakers lower	.04099	2.51
Branchiostegal rays left	.03986	2.31
Upper jaw length	.03903	1.73
Caudal peduncle depth	.03829	1.56
Caudal peduncle length	.03344	1.46
Snout tip to dorsal origin	.03285	1.40
Pelvic rays	.03245	.98
Gillrakers total	.03238	.16

The higher the Wilks lambda score the greater the discriminating power.

Figure 1a. Hubbs Diagram, Scales Above Lateral Line

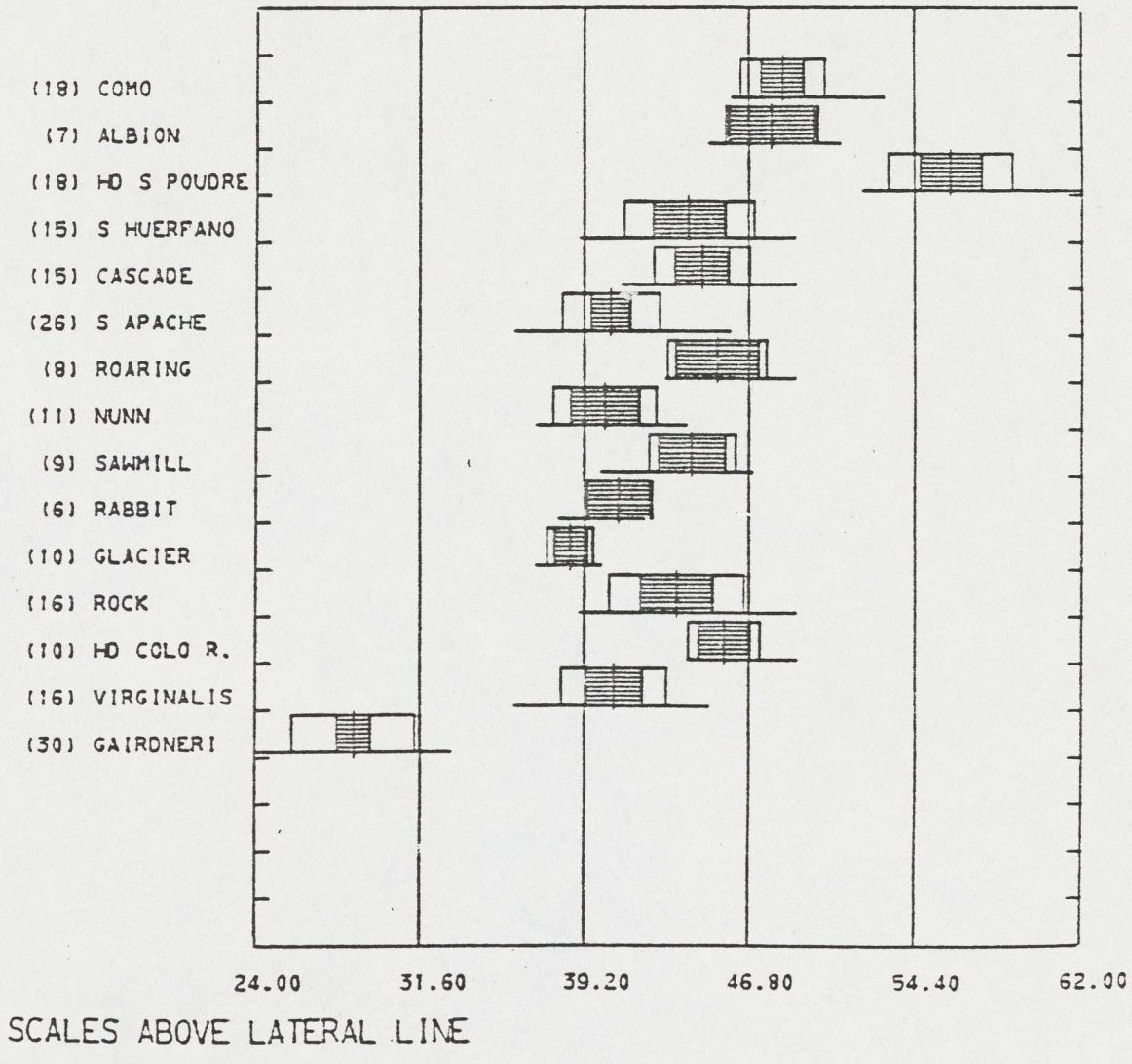

Figure 1b. Hubbs Diagram, Scales in Lateral Line Series

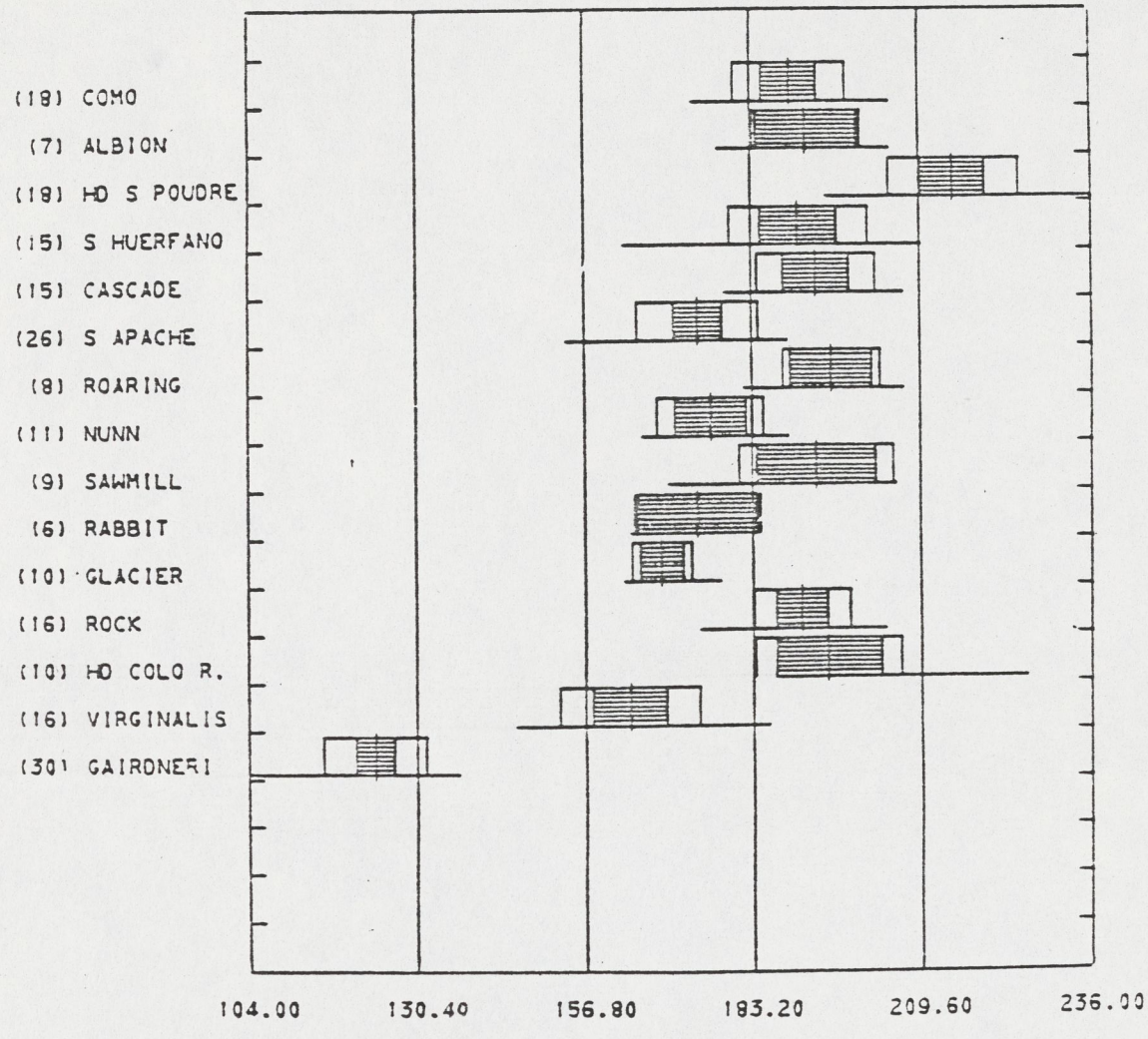

Figure 1c. Hubbs Diagram, Basibranchial Teeth

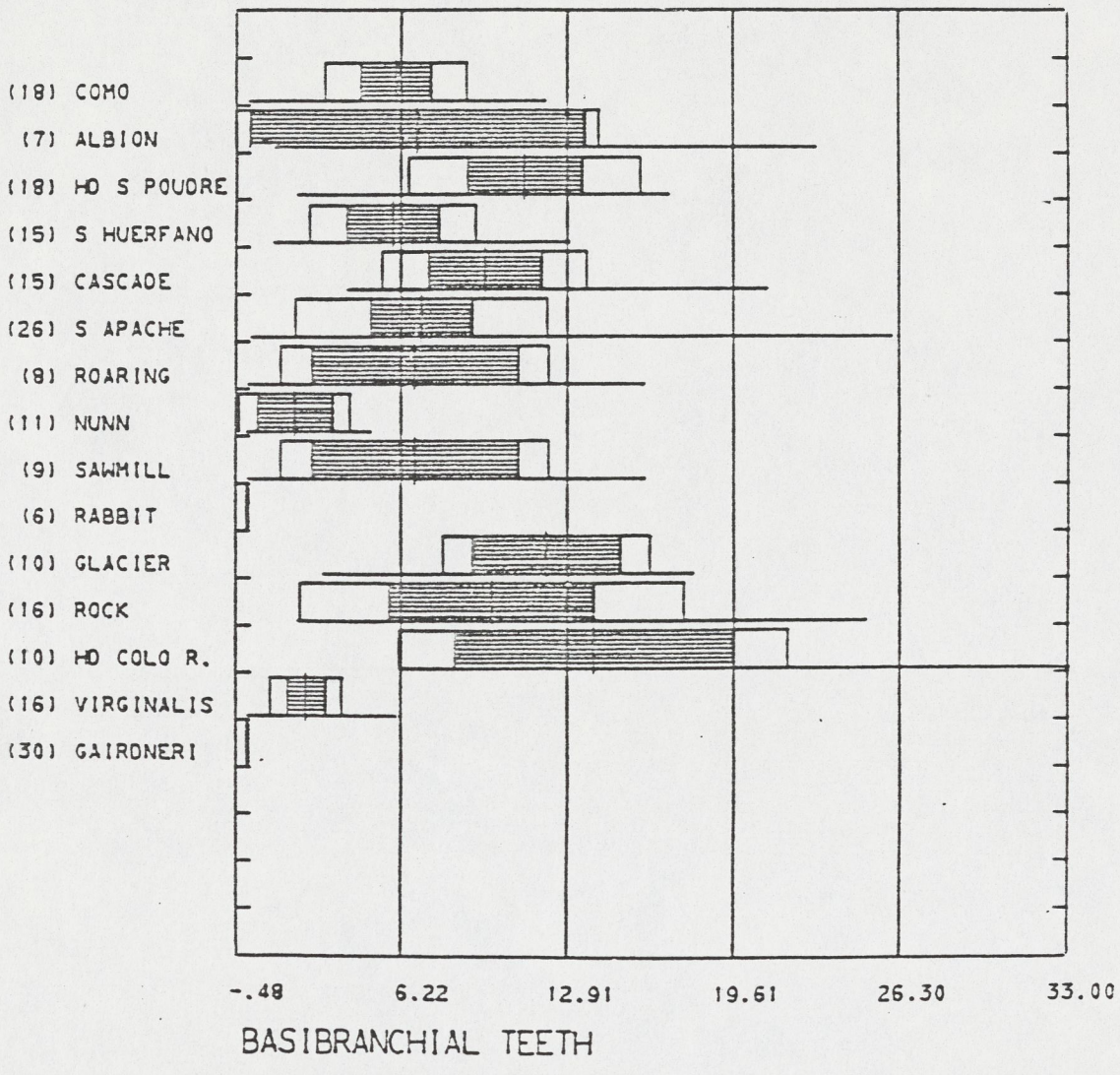

Figure 1d. Hubbs Diagram, Pyloric Caeca

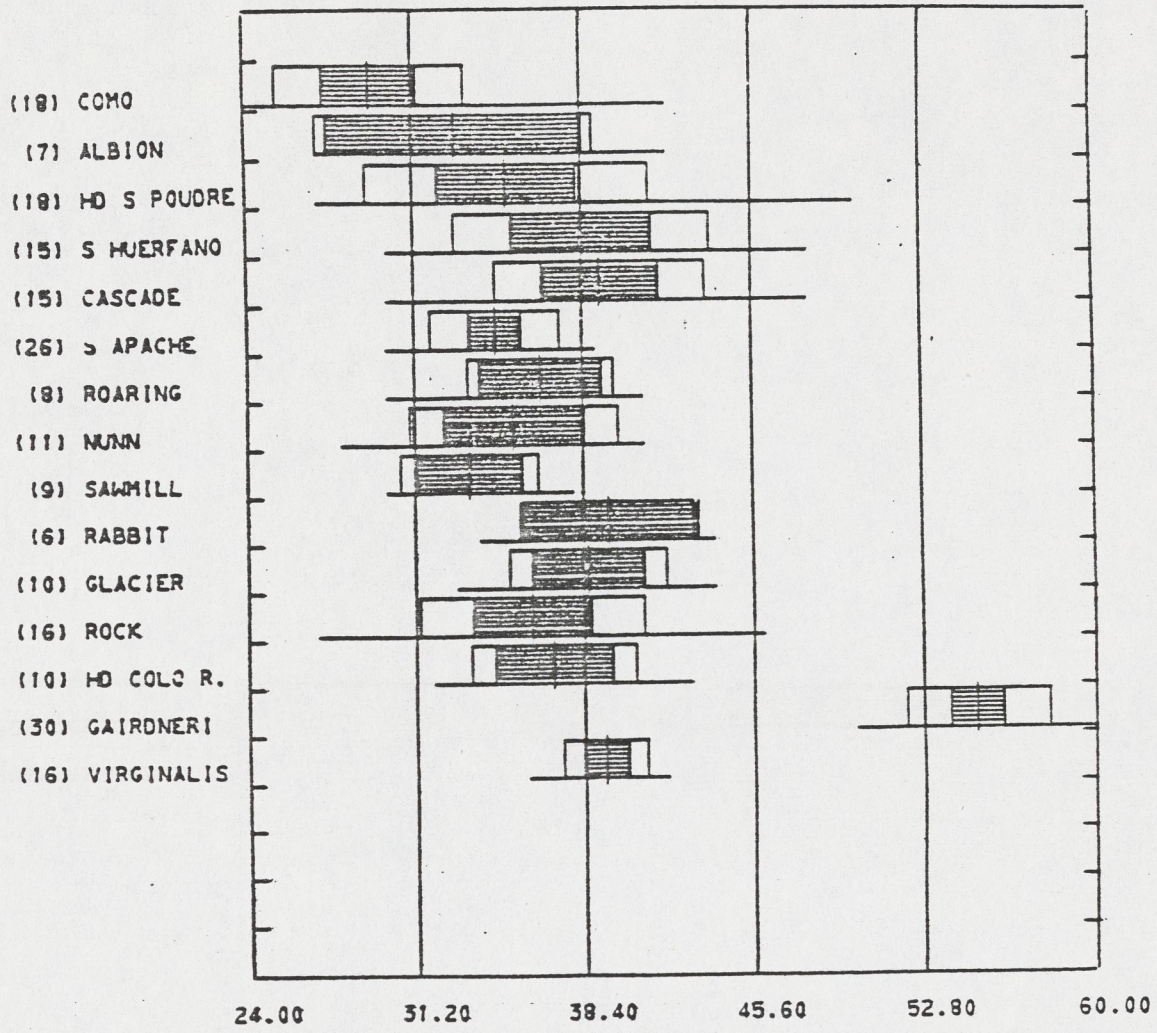

Figure 1e. Hubbs Diagram, Gillrakers Total

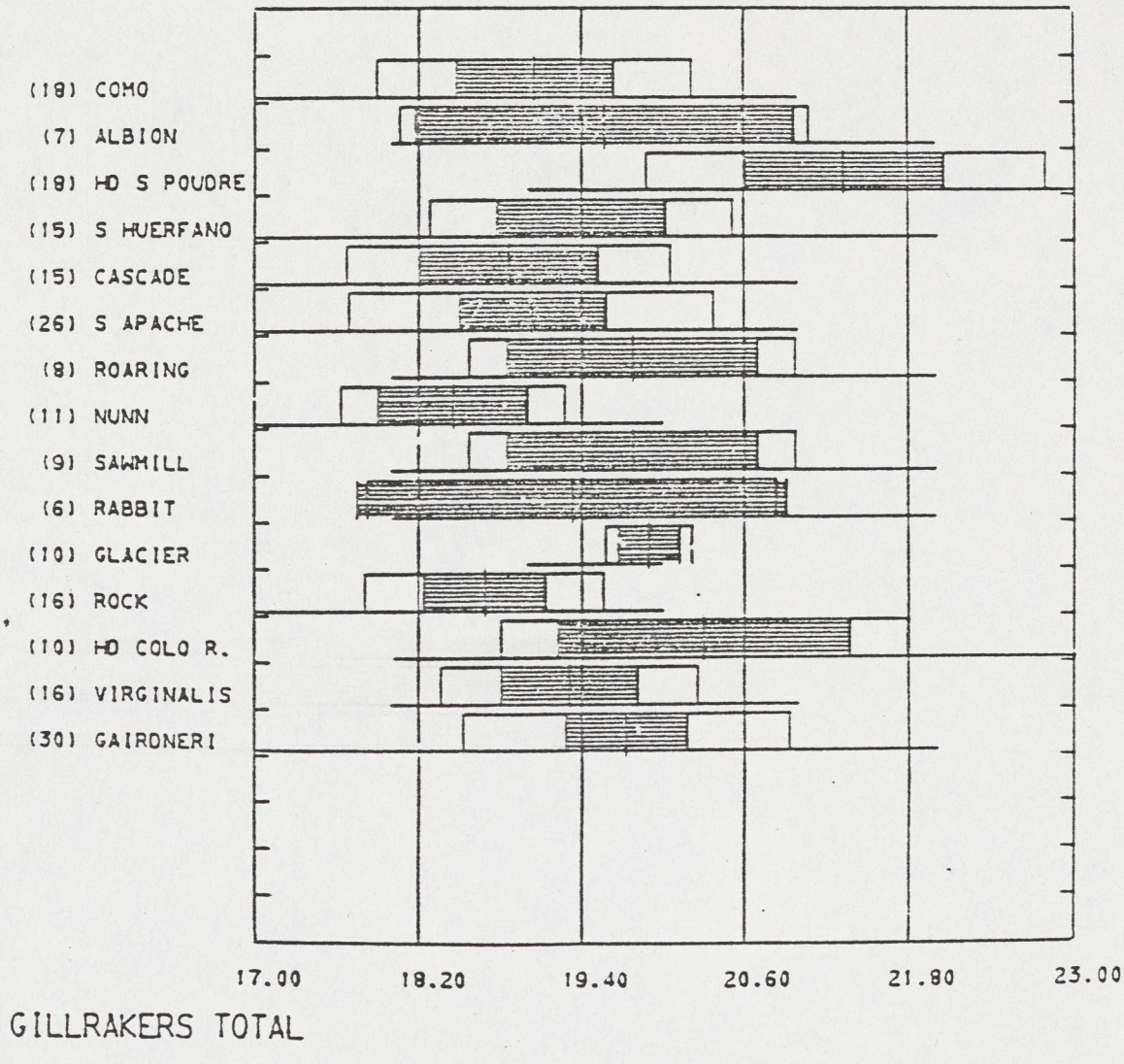

Figure 2. Discriminant Function Plot

Of significance to this study is the similarity depicted in the discriminant function plot between S. c. stomias and S. c. pleuriticus (the closer the group centroid the closer the relationship); the same results were obtained by Hickman and Duff (1977). This supports the taxonomic evaluations of Behnke and Zarn (1976) that S. c. pleuriticus gave rise to S. c. stomias via an ancient headwater transfer and that there exists little taxonomic difference between the two subspecies. Behnke (1976) indicates that modern taxonomists would not likely describe the South Platte cutthroat trout as a subspecies distinct from the Colorado River cutthroat trout. But the names for the two subspecies have already been established and are useful to associate native trout with specific geographical areas. Because of the degree of isolation between pleuriticus from the Upper Green River (type locality) and those from the headwaters of the Colorado River, there are more similarities between stomias of the South Platte drainage and pleuriticus of the headwaters of the Colorado River than between the two pleuriticus populations. There also is more difference between stomias of the South Platte and stomias of the Arkansas drainage than between the South Platte and headwaters of the Colorado River population. This seems reasonable if it is assumed that the ancestrial cutthroat made its way from the Green River to the Colorado River into the South Platte drainage and from there into the Arkansas drainage.

There exists a degree of similarity between S. c. utah and S. c. virginalis (mainly due to low scale counts) but phenotypically the large spots concentrated in the caudal region and bright coloration separates virginalis from utah. Although the spotting pattern or coloration were not among the characters used in the discriminant analysis, there is little difference in spotting pattern between pleuriticus and stomias.

Caution should be employed in the interpretation of any type of computer program. The computer can not create any new genetic information about the fish than that which has already been determined by standard taxonomic evaluations.

Misinterpretations can also result from the use of too few specimens in the analysis. Because of the degree of isolation involved with each population of cutthroat subspecies and the high degree of intraspecific variability exhibited by these subspecies, there can be a large amount of genetic variation among populations of cutthroat trout. For example, if the population from the headwaters of the Little South Poudre River were used as a representative of S. c. stomias in a comparison among several Salmo species, S. c. stomias would differentiate from all other trout because of their high scale counts. This difference would not be as significant had other populations of S. c. stomias been considered (see Hickman and Duff 1977 as an example).

Errors are frequently committed when trying to determine which characters are most responsible for separation in the group discrimination process (Table 5). In this study scales in the lateral series was the most important character separating the subspecies, with pyloric caeca and basibranchial teeth also of importance but less than lateral series scale number. Any conclusions on the relative importance of the remaining variables (characters) would be highly speculative and unsupportive (see Nie et al 1975 for further discussion).

MANAGEMENT CONSIDERATIONS

1. Protection and enhancement of greenback cutthroat populations in the Huerfano River headwaters (Cascade Creek and headwaters of the South Huerfano).

Brook trout are located at the base of the waterfalls on Cascade Creek and may have already inundated the headwaters of South Huerfano. Eradication of the non-native trout and extension of the greenback cutthroat populations throughout the headwater area of the Huerfano River should be of top priority in greenback recovery efforts.

2. The South Apache Creek cutthroat should be managed as a "good pnehotypic representative" of S. c. stomias. This population is important because of the rareness of S. c. stomias in the Arkansas drainage. A combined management effort between the Colorado Division of Wildlife, U.S. Bureau of Land Management and U.S. Forest Service could be implemented. Eradication of the rainbow hybrids and subsequent stocking of South Apache cutthroat into North Apache Creek would serve to preserve the cutthroat gene pool. Stocking of these cutthroat into some of the barren streams on Greenhorn Mountain would also provide several new populations in the area. Stocking on a large scale, in the Arkansas drainage, should probably be done with the S. c. stomias from the Huerfano River headwaters, since Behnke (1977) indicated that these were pure stomias and the South Apache cutthroat are slightly hybridized.

3. Continuous monitoring of the stomias population in Como Creek and the headwaters of Little South Poudre River. Since these populations represent the most important source of greenback cutthroat trout, yearly inventory analysis should be conducted. The update status of the Little South Poudre population should be made; this has not been done since 1975.

4. Black Hollow Creek should again be considered for restocking of Como Creek brood stock. Obviously, eradication of the brook trout is a prerequisite. Once restocking occurs the stream should be monitored more closely because it appears that the brook trout were transported above the barrier by the hand of man. Hourglass Creek represents an unusual situation. Restocking of this stream may not be worthwhile to the restoration of greenback cutthroat trout. Perhaps other streams might be considered.

5. A most unusual situation is represented in Nunn Creek. In this creek is one of only a few instances of brown trout and cutthroat trout apparently co-existing. Although the cutthroat there are not greenbacks, the situation may be indicative of a typical interaction between these two species. It may be worthwhile to monitor this stream to see if brown trout will indeed extirpate the cutthroat trout. There are few instances of this brown/cutthroat interaction reported. The lack of riparian vegetation along this stream may allow higher temperatures during the summer which would favor brown trout. Therefore the brown trout could exist at the elevation they are now at. If the cutthroat trout are extirpated there would be no loss of a pure native genotype.