Summary of information on the status of the greenback cutthroat trout, *Salmo clarki stomias*

Prepared for

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Robert J. Behnke
Colorado State University

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Introduction

This report summarizes the current knowledge regarding the status, distribution and taxonomy of the greenback cutthroat trout. It includes the analysis of several samples of specimens not included in previous reports or theses and a comparison of the specimens of the same genotype (Big Thompson River in Forest Canyon of Rocky Mountain National Park) after establishment in new environments (Caddis Lake, RMP and Florence Creek, Utah), to evaluate the magnitude of non-genetic (environmental) influence on some of the taxonomic characters and reveal what changes might occur in transplanted populations.

The possibility that the greenback cutthroat trout of the Arkansas River system effected a headwater transfer to the Canadian River basin is discussed.

The objectives of this report are to provide a compendium of information and recommendations for protection and restoration basic to a meaningful recovery program, leading to a change in federal status from endangered to threatened.

Historical Review

The greenback cutthroat trout is an example of how the actual survival status of a fish can become confused with its taxonomic status.

As a basic starting point, there is no doubt that a cutthroat trout is indigenous to the headwaters of the South Platte and Arkansas river basins and that this cutthroat trout is given the common name of greenback trout (Jordan, 1891). This trout has suffered a rapid decline in distribution and abundance to the point of extreme rarity as pure populations and is presently classed as endangered on the federal list of endangered and threatened species (Behnke and Zarn, 1976).

The confused taxonomy of the greenback trout is related to the original description and to the degree of differentiation between S. c. stomias and other subspecies of cutthroat trout (how readily and with what consistency can specimens of S. c. stomias be separated from other subspecies).

The taxonomic confusion surrounding the name stomias began with an 1856 Army expedition under the command of Lt. F. T. Bryant from Fort Riley, Kansas to Fort Bridger, Wyoming and return. Dr. W. R. Hammond, an Army surgeon, accompanied the expedition, and as was a common practice at that time, made some natural history collections. The route of the expedition traversed parts of the Kansas, North Platte, South Platte and Green River drainages of Kansas, Nebraska, Colorado and Wyoming. All of the fish specimens collected were simply labeled "Fort Riley, Kansas" and shipped to the Philadelphia Academy of Sciences. Many of these specimens, including two specimens of cutthroat trout, were destined to be described as new species from "Fort Riley, Kansas". Cross and Oland (1961) discussed the confusion this collection has caused to fish taxonomy.

All we know is that Dr. Hammond collected, preserved and shipped at least two specimens of cutthroat trout from Fort Riley, Kansas to the Philadelphia Academy in 1856. Because no trout were known to be indigenous to the Kansas, Republican or North Platte systems, these specimens must have been taken from the South Platte or Green River basins.

Cope (1865) first mentioned these specimens as "Trutta lewisi" from the Kansas River. Later, he described a new species, Salmo stomias, on Dr. Hammond's specimens and gave the locality as the "South Platte River, Fort Riley, Kansas" (Cope, 1872). The diagnostic criteria used by Cope for stomias was "a large mouth" (not diagnostic from other cutthroat trout) and "42 scales above the lateral line" (erroneous for South Platte native trout, in which I typically count 45-55 scales above the lateral line).

Cope and Yarrow (1875) changed the type locality of stomias from the South Platte River to the Kansas River, Fort Riley and in later publications Cope considered the cutthroat trout native to the South Platte basin as "S. pleuriticus" (pleuriticus is the currently accepted name of the Colorado River cutthroat trout).

The original specimens (type specimens) of stomias are in the collection of the Philadelphia Academy of Natural Science (7825 and 7826). I have not seen these specimens but Dr. R. R. Miller, Museum of Zoology, University of Michigan, has examined them and related that although the specimens are in poor condition and accurate scale counts are impossible, he estimated only about 150 scales in the lateral series (about 40 fewer than expected for native South Platte cutthroat trout). It is possible that Cope mixed specimens and #7825 and 7826 are actually specimens of Rio Grande cutthroat trout. It seems apparent from an article by Fowler (1912) that Cope also assigned the name stomias to Rio Grande cutthroat trout specimens collected from Ute Creek, Fort Garland, Colorado.

Thus, we have a situation where we do not know the origin of the type specimens bearing the name stomias (South Platte or Green River if they were collected by Dr. Hammond in 1856 - or possibly the Rio Grande drainage if Cope mixed specimens during his studies), and the original describer (Cope) claimed stomias was not the native trout of the South Platte basin.

Our present concept of the taxon stomias is attributed to David Starr Jordan who qualifies as the "first reviser" of the name (makes current use "legitimate"). Jordan (1891) stated that trout were not native to Kansas and assigned the name stomias to the cutthroat trout native to the South Platte and Arkansas basins of Colorado. Jordan also associated the common name of greenback trout with stomias.

Jordan and Evermann (1896:489) mistakenly assumed that the native cutthroat trout of the South Platte and Arkansas rivers were derived from an ancestor moving downstream from the upper Missouri basin and in turn gave rise to the Colorado River cutthroat trout. The more probable sequence is reversed. If cutthroat trout ever migrated down the Missouri River to become established in the South Platte, it would be expected that populations would have become established in the Black Hills of Wyoming and South Dakota and in the North Platte drainage of Nebraska, Wyoming and Colorado - areas barren of trout until introduced by man. Based on the best evaluation of historical data and examination of specimens, I conclude that the cutthroat trout of the upper Missouri basin were derived from two separate crossings of the Continental Divide. The original distribution of cutthroat trout in the upper Missouri River proper did not extend much below Great Falls, Montana. In the Yellowstone River drainage native trout extended downstream to the Tongue River and the two forms of cutthroat trout (upper Missouri and Yellowstone) never came in contact and never

existed as permanent populations below the junction of the Yellowstone with the Missouri. Thus, the origin of cutthroat trout in the South Platte basin can be attributed to a headwater transfer from the Colorado River system, a later transfer from the South Platte established them in the Arkansas River basin.

Jordan and Evermann (1896) reduced stomias to subspecific status, first as Salmo mykiss stomias and later to the presently accepted, S. clarki stomias (Jordan and Evermann, 1898).

No published work, however, presented adequate diagnostic criteria for stomias and sporadic attempts to do something for the protection and transplant of any remnant populations were stymied by the question: how is stomias to be recognized if it is found?

The early decline of the greenback cutthroat trout can be attributed to loss and degradation of habitat from mining, logging, grazing and irrigation projects - already well underway when Jordan visited Colorado in 1889.

The final squeeze, forcing the native cutthroat trout to the point of extinction was the introduction of non-native trouts. Brown trout replaced it in larger rivers, brook trout replaced it in smaller tributaries, rainbow trout hybridized with the native cutthroat and typically replaced it in streams of intermediate size and elevation between the brook trout and brown trout zones. The indiscriminant mixing of various subspecies of cutthroat trout such as the greenback, Colorado River and Yellowstone Lake cutthroat in fish propagation and their subsequent distribution throughout headwater tributaries and mountain lakes created the present situation where a tremendous diversity of cutthroat trout populations can be found in the South Platte and Arkansas river basins, but few closely resemble the original native trout.

Dieffenbach (1964) attempted to find pure populations of stomias but he was hampered by a lack of diagnostic criteria useful for comparison with specimens he collected. Dieffenbach was misled by Jordan's (1891) statement that stomias has about 140 scales in the lateral line. Most cutthroat (and rainbow and almost all species of the genus Salmo) have about 120-125 scales in the lateral line (number of pores). Occasionally I have found small, isolated populations of cutthroat trout with 130-140 or more lateral line pores - but it is a character exhibiting local variability and not useful in subspecific diagnosis. I examined museum specimens of stomias collected by Jordan in 1889 and found none approaching 140 scales in the lateral line.

When Dieffenbach found a population of cutthroat trout inhabiting Black Hollow Creek, a small tributary of the Poudre River with an average of 137 scales in the lateral line (I counted an average of 133 pored scales to the end of the vertebral column in these specimens), he decided that the Black Hollow Creek cutthroat trout was the best known representative of stomias.

After re-examining Dieffenbach's data and specimens and finding that the cutthroat trout in Black Hollow Creek were not physically isolated from rainbow trout in the Main Poudre River, I concluded that the Black Hollow Creek cutthroat trout was not a pure population of stomias, but was a "good phenotypic" representative of stomias. A photograph of the original Black Hollow Creek cutthroat appears on the cover of a BLM publication (Johnson, 1976). The large, pronounced spotting pattern typical of stomias can be observed. Character values of the Black Hollow Creek cutthroat are presented in Table 1.

The discovery of the Black Hollow Creek trout stimulated a resurgence of interest in stomias restoration, but the original Black Hollow Creek

population was probably lost as a result. In October 1966, 54 cutthroat trout from Black Hollow Creek were transported and stocked into the headwaters of Hourglass Creek (tributary of Little South Poudre River). This section of Hourglass Creek provided about two miles of stream above barrier falls, barren of fish. Evidently no trout remained above the barriers to spawn in Hourglass Creek. In a 1975 survey, Rolf Nittmann, Colorado Division of Wildlife, found no fish above the barriers but reported sighting one large cutthroat trout downstream where brook trout are also found.

In 1967 a cooperative project of the Colorado Cooperative Fishery Unit, the U.S. Forest Service and the Colorado Division of Wildlife constructed a barrier to upstream migration in Black Hollow Creek. About 25 cutthroat trout were removed and held in a small spring seep while rotenone was administered to the creek to eradicate the brook trout. The cutthroat trout were to be placed back into Black Hollow Creek the next day, but they were found to be dead or dying. Electrofishing in 1968 and 1969 found no evidence of survival and in September 1969, the last 10 specimens of cutthroat trout found in Albion Creek (Boulder Creek watershed), which I had judged to be pure stomias, were transported to Black Hollow Creek. Forty trout from Como Creek, a small stream in the Boulder Creek drainage with a trout virtually identical to the Albion Creek greenback, were stocked into Black Hollow Creek in 1970. Natural reproduction was observed in 1971 and 1972.

The lack of taxonomic information concerning stomias was also responsible for the abandonment of an earlier effort to restore native trout into waters of Rocky Mountain National Park.

In the 1950's a cutthroat trout population was found in the headwaters of the Big Thompson River in Forest Canyon of Rocky Mountain National Park. At that time it was commonly assumed that stomias was extinct, because of the statement to that effect made by Greene (1937) in his booklet on Colorado trout. Much interest was generated by the Forest Canyon trout as a possible pure population of stomias. Specimens were sent to Dr. R. R. Miller at the University of Michigan, some life history studies were made (Bulkley, 1959) and a transplant was made into the barren Fay Lakes of Rocky Mountain Park in 1959 in a cooperative restoration project between the U.S. Fish and Wildlife Service and the National Park Service.

This bubble of excitement was burst by the finding of records in Park Service files relating the stocking of cutthroat trout into Forest Canyon in 1922 and 1923. In 1922, 140,000 "spotted native" trout were stocked into Forest Canyon by the Estes Park Sportsman Association. This was followed in 1923 by a stocking of 130,000. The trout were obtained from the Estes Park State Fish Hatchery but almost certainly originated from eggs of Yellowstone Lake cutthroat. Also, Dr. Miller wrote that he could not determine the identity of specimens as stomias because insufficient taxonomic data on stomias existed and he pointed out the confusion surrounding the name stomias. Thus the first "official" restoration efforts for the native trout of the South Platte and Arkansas drainages came to an unhappy termination. The original transplant into Fay Lakes did not perpetuate in Fay Lakes but some individuals must have migrated downstream to establish a self-sustaining population in Caddis Lake, where they were discovered by James Mullan (U.S. Fish and Wildlife Service) in 1972.

The above episodes emphasize the point that adequate taxonomic information is basic to any recovery or restoration plan for cutthroat trout subspecies.

My interests in cutthroat trout taxonomy formally began in 1957 for my M.A. thesis research on cutthroat trout. To establish some baseline data on the characteristics of several subspecies, including stomias, I examined museum specimens, collected mainly during the period of 1870-1900. I noted that although most of the described subspecies of S. clarki lacked clear-cut differences (unique characters), differences in mean values of several characters could be used to separate specimens from different major drainage basins. The native cutthroat trout of the South Platte and Arkansas drainages were characterized by high scale counts, large spots and a tendency for lower numbers of vertebrae and pyloric caeca than most other subspecies of cutthroat trout.

The cutthroat trout native to Yellowstone Lake was the major source of cutthroat trout used in propagation and stocking from a period of about 1900 to 1950. Large series of Yellowstone Lake cutthroat trout were analyzed to detect differences from other subspecies and to evaluate effects of past hybridization between a native cutthroat trout and the introduced Yellowstone cutthroat. A series of characters were also evaluated to detect the effects of hybridization between native cutthroat trout and introduced rainbow trout. Finally, a series of samples representing known parental sources and derived populations established in new environments were compared to evaluate the direct environmental influence (non-genetic) on the taxonomic characters.

With this information, I determined that the Forest Canyon cutthroat trout did not represent an introduced population of Yellowstone Lake cutthroat trout. Although not pure, the Forest Canyon trout are a good representative of stomias. A project initiated by the Colorado Cooperative Fishery Unit in 1964 took Forest Canyon trout to the Leadville National Fish Hatchery for an attempt at artificial propagation. Males

and females did not mature synchronously and the remaining fish were transported and stocked in a small, barren stream (Florence Creek) on the Uinta and Ouray Indian Reservation, Utah in 1967. These fish reproduced and became established in Florence Creek where James Mullan collected a sample of specimens in 1975. The character values of samples from the Big Thompson River in Forest Canyon and the derived populations in Caddis Lake and Florence Creek are presented in Table 1.

The status of S. c. stomias to 1973 was discussed by Wernsman (1973) and Behnke (1973). After evaluating all of the evidence from character analysis we decided that two populations were probably pure and were the best known living representatives of stomias. These were the populations in Como Creek, a tributary of North Boulder Creek, Boulder County, Colorado and in the very headwaters of the Little South Poudre River, Larimer County, Colorado. Both of these sites are completely isolated from invasion by introduced trout and have no known stocking records.

Because of accessibility, the Como Creek trout has been used for introductions into Black Hollow Creek and into Rocky Mountain Park.

Taxonomy

Table 1 presents the data from character analysis of collections of cutthroat trout from the South Platte and Arkansas river basins. Included are data from ancient museum collections and samples from Yellowstone Lake and the headwaters of the Colorado River for comparisons and discussion. Because of the proximity to Colorado State University, the Poudre River drainage is best represented. Every known cutthroat trout population in the Poudre drainage has been sampled. Ideally, for a complete analysis of the present status of S. c. stomias, all major subdrainages of the South Platte and Arkansas basins should be surveyed and cutthroat trout

populations sampled comparable to the Poudre drainage collections. Interpretation of the data from the Poudre drainage samples suggest how this might be accomplished with minimal time and effort and maximal production of useful information. This matter is discussed in the "Recommendations" section.

Most of the old museum specimens were collected from Twin Lakes (Arkansas River drainage) and little information is available on the original range of variability of the taxonomic characters of S. c. stomias. The specimens from the headwaters of the Little South Poudre River were judged pure because of the large, pronounced spots, the extremely high scale counts (higher than any trout of the genus Salmo), bright coloration and the remoteness and isolation of the site. They do have slightly higher values for vertebrae, pyloric caeca and gillrakers than might be expected of a hypothetical "typical" stomias, but it is not likely that these values were influenced by past hybridization with either non-native cutthroat trout or rainbow trout without affecting the scale counts, coloration and spotting pattern also.

The meristic characters of the Como Creek trout may approximate more closely the "typical" original greenback cutthroat. They have the large, pronounced spotting pattern, characteristic of stomias, although one of the 18 specimens examined lacks basibranchial teeth. Basibranchial teeth are not invariably present in all pure cutthroat trout and in most instances I would hesitate to invoke rainbow trout hybridization as an explanation for the absence of these teeth in less than 10% of the population, particularly in a small population where genetic drift may operate.

The best diagnosis at present for the recognition of stomias is as follows: Spotting pattern of large, roundish spots (largest spots noticeably larger than pupil of eye); the largest and most numerous spots

on caudal peduncle area; coloration bright in adults (red, gold and orange colors predominate in sexually mature fish); mean values for vertebrae, 60-62; pyloric caeca, 28-36; scales above lateral line, 45-55+; lateral series, 185-215+; basibranchial teeth present in at least 90% of population.

Examination of the data in Table 1 demonstrates that most of the cutthroat trout populations of the Poudre drainage have a large measure of greenback cutthroat ancestry determining their characters. None are typical Yellowstone Lake cutthroat and none are obvious rainbow x cutthroat hybrids. Closer analysis of the data, however, revealing the amount of variability between the populations demonstrates that almost all of these populations have a recognizeable influence by past introductions of both rainbow trout and non-native cutthroat trout. Of all the samples from the Poudre drainage, only the population in the headwaters of the Little South Poudre is judged pure. Roaring Creek and the original Black Hollow populations are "good representatives" of stomias. The spotting pattern on most of the specimens in the other samples (small, erratic, more profuse) also indicates past hybridization. One sample, however, of 6 specimens collected in 1968 from a tiny unnamed tributary to Long Draw Reservoir (headwaters of Big South Poudre) merits further attention. These fish had not been examined prior to this report. The spotting pattern of these trout is not as distinctive as that found on Como Creek or Little South Poudre specimens, but the scale counts and caecal counts are indicative of stomias and the number of gillrakers are similar to the Little South Poudre sample. Because of barrier falls on the Big South Poudre, it is possible that trout were not native to the headwater areas, but early introductions from nearby waters may have originally established native trout here.

If the present population in the tributary to Long Draw Reservoir represents a population introduced by man, they may not be Poudre River

greenback trout (stomias) but Colorado River cutthroat trout (pleuriticus). Long Draw Reservoir is only a few miles from the very headwaters of the Colorado River. The data from a sample of cutthroat trout found in the headwaters of the Colorado River are presented in Table 1. Note that the meristic characters of this sample is quite typical of stomias. The spots on these Colorado River specimens are relatively smaller than the spots of the Como Creek or Little South Poudre specimens, but it must be assumed that originally there were local populations of S. c. pleuriticus on one side of the Continental Divide in the headwaters of the Colorado River, with "larger than average" spots and populations of S. c. stomias on the other side in the headwaters of the South Platte basins with "smaller than average" spots and both with essentially similar meristic values, thus obliterating any distinction between the two subspecies.

In my taxonomic analysis of S. c. pleuriticus, I found some slight, average differences between pleuriticus of the upper Green River basin and stomias of the South Platte and Arkansas systems, but as more specimens were examined from the Yampa and Colorado River drainages a trend for larger spots and higher scale counts blurred the taxonomic distinctions of pleuriticus and stomias. This is not unexpected because, almost certainly, stomias was derived from pleuriticus by headwater transfer from the Colorado to the South Platte basin. Because of the degree of isolation of trout populations between the upper Green River and the headwaters of the Colorado River (historically the main Green River was not salmonid habitat below the town of Green River), the genetic affinities between pleuriticus of the upper Colorado basin and stomias may be closer than the affinities between pleuriticus of the Upper Colorado and pleuriticus of the Upper Green River.

This matter concerns the point of taxonomic validity raised in the introduction. With the present information, modern ichthyologists would

not likely describe the South Platte (and Arkansas) cutthroat trout as a subspecies distinct from the Colorado River cutthroat trout. However, the names for the two subspecies are long established and are useful to associate native trout with specific geographical areas. Ultimately, the assignment of a native cutthroat trout to the subspecies stomias or pleuriticus rests on the site of origin (South Platte - Arkansas drainages or the Colorado River basin).

Comparison of specimens of the parent population in Forest Canyon with derived populations in Caddis Lake and Florence Creek revealed a high degree of consistency. Aside from the more striking coloration developed in Caddis Lake fish, the only character undergoing recognizeable change is the diminuition of basibranchial teeth in Florence Creek specimens. Three of 15 specimens over 100 mm S.L. (and 2 of 7 less than 100 mm) from Florence Creek lacked teeth. Of the original specimens from Forest Canyon, basibranchial teeth were found in 37 of 40 fish. Also, the teeth are more feebly developed in Florence Creek specimens in comparison with Forest Canyon fish. In similar comparisons of parental and derived populations of cutthroat trout, Wernsman (1973) found basibranchial teeth number to be a stable character. The most likely explanation for a change in basibranchial teeth in the Florence Creek sample is the "Founder's Principle", whereby a new population is founded on a relatively few individuals and these individuals possess modal gene frequencies for some characters different from the modes of the parent population.

This is an indication of what can be expected for other transplants - that the new populations may not be identical to the parents in every character.

Distribution

The original distribution of the greenback cutthroat included the upper parts of the South Platte and Arkansas river systems. Precise details of the distribution are not known, but permanent populations probably did not extend much below the foothill region of the Rocky Mountains (above the city of Pueblo on the Arkansas and to the city of Greeley on the South Platte). Except for a small area in southeast Wyoming (headwaters of Dale and Boxelder creeks) all of the original native trout distribution in the South Platte and Arkansas basins is in Colorado.

A thesis by Stork (1975) and a report by Stork and Behnke (1975) on the native cutthroat trout of the Rio Grande and Pecos basins, discussed the possibility that S. c. stomias may be native to the Canadian River basin via a headwater transfer from the Arkansas basin. This speculation was based on examination of specimens of cutthroat trout from the headwaters of the Pecos basin, New Mexico. Some of the populations of Pecos cutthroat trout exhibited a striking similarity to greenback cutthroat in their spotting pattern and were recognizeably different from typical Rio Grande cutthroat trout, S. c. virginalis. Stork and I suggested that perhaps the native trout of the upper Pecos basin were derived from headwater transfer from the Canadian River basin under the assumption that the Canadian River basin had native trout from a previous headwater transfer from the Arkansas River drainage (greenback trout).

Admittedly these speculations on the origin of Pecos and Canadian River cutthroat lack firm supportive evidence, particularly in view of the fact that no documented evidence exists that trout are native to the Canadian River basin (no museum collections of Canadian River basin trout were made prior to introductions).

A recent collection of cutthroat trout was made from Ricardo Creek, a headwater tributary of the Canadian River system, Costilla County, Colorado. After thorough examination and comparisons I identified the Ricardo Creek trout as Rio Grande cutthroat, S. c. virginalis (Behnke, 1976). It is possible that prospectors or sheepherders could have transplanted trout into Ricardo Creek from a headwater tributary of the Rio Grande, which lies only a few miles to the northwest of Ricardo Creek.

I anticipate further information on Canadian River cutthroat trout (Are they native? If so, are they derived from S. c. stomias or S. c. virginalis?) from the thesis research of C.S.U. student, David Propst, who initiated a study of native cutthroat trout in New Mexico this year.

The present known distribution of pure stomias populations in the South Platte drainage consists of the small stocks in Como Creek and in the headwaters of the Little South Poudre and of transplanted Como Creek trout in Black Hollow Creek and two transplants in Rocky Mountain Park - Hidden Valley Creek and Bear Lake. No pure populations have been identified from the Arkansas River basin (but Arkansas basin collections are few). The best representative Arkansas drainage greenback trout, is the sample from the headwaters of the South Huerfano River.

Life History and Ecology

I can add nothing to my previous remarks on the life history and ecology of greenback trout (Behnke, 1973), that very little information is available. Behnke and Zarn (1976) stressed the point that ecological and life history attributes of trout are highly variable and mainly under direct environmental (non-genetic) influence. Previous data developed by Bulkley (1959) and Nelson (1972) on predominant greenback cutthroat populations (Forest Canyon and Island Lake) could apply to any species of trout

living under similar circumstances.

From all of the information pertaining to the decline of the greenback trout from its native range, the most cogent point for future restoration programs is that the greenback cutthroat is not likely to coexist with other species of trout. Because the greenback once lived in virtually all of the present trout habitat on the eastern slopes of the Rocky Mountains in Colorado, it can be assumed that re-introductions of greenback cutthroat trout will be successful in streams or lakes now holding introduced trouts if all of the non-native fish are eliminated and prevented from reinvasion. This being the case, detailed habitat studies are not a necessary prerequisite for future transplants, as was demonstrated by the successful establishment of Como Creek greenback trout in Hidden Valley of Rocky Mountain Park, a typical beaver pond - brook trout habitat when the brook trout were eradicated.

Protective Measures

As discussed above, the first greenback restoration projects used the slightly hybridized populations of Forest Canyon and Black Hollow Creek. These efforts did establish the Forest Canyon trout in Caddis Lake in Rocky Mountain Park and in Florence Creek, Utah and created a greenback trout sanctuary area in Black Hollow Creek by the construction of a barrier and elimination of brook trout (although the original Black Hollow Creek population was probably lost). Introductions of 10 Albion Creek trout in 1969 and 40 trout from Como Creek in 1970 did establish a thriving population of greenback trout in Black Hollow Creek by 1972. A survey of Black Hollow Creek in 1975 found that brook trout were again established above the barrier falls (probably from angler introductions). A decision on a future course of action for Black Hollow Creek is one of the current

matters facing the Greenback Recovery Team.

In 1971, 40 trout from Como Creek were helicoptered into a barren headwater tributary of the Big Thompson River in Rocky Mountain Park. Evidently, due to severe winter conditions, all of these fish migrated downstream over a barrier falls and have little chance of perpetuating themselves in the dense population of brook trout found there.

In 1973, 80 trout from Como Creek were stocked into Hidden Valley Creek of Rocky Mountain Park after treatment with antimycin to eliminate brook trout. Surveys of Hidden Valley in 1974 and 1975 revealed successful reproduction in both years and no evidence of brook trout survival. The habitat of Hidden Valley Creek consists of about 15 surface acres of water, mostly in beaver ponds which should support several thousand greenback trout when the population expands to carrying capacity (1978-1980).

In 1975, Bear Lake, an 11.2 acre body of water in Rocky Mountain Park, was treated with antimycin to eradicate brook trout and 65 greenback cutthroat trout from Como Creek were transplanted into it. If the inlet and outlet areas of Bear Lake can be modified to induce natural reproduction and the aggregation of spawning fish, it should provide an excellent situation for spawn taking operations providing eggs for an expanded restoration program.

S. c. stomias is listed in the federal register as an "endangered species" under the 1973 Endangered Species Act (PL 93-205) and is endowed with certain protections such as from threats to habitat from any federal or federally-funded project. A Greenback Trout Recovery Team has been established whose mission is to enhance the survival status of the greenback trout so it is no longer "endangered". The members of the Greenback Recovery Team (1976) are: Mr. Dave Langlois, Colorado Division of Wildlife

(replacement for Rolf Nittmann); Mr. Richard Moore, U.S. Forest Service; Mr. Dave Stevens, National Park Service; and Mr. James Mullan, U.S. Fish and Wildlife Service. I (Robert Behnke) serve as Technical Consultant to the team.

In February, 1976, a first draft of a greenback trout recovery plan was written by the team and submitted to the U.S. Fish and Wildlife Service. With the plan, a request was made to declassify S. c. stomias from endangered to threatened. The Recovery Team's reasons for requesting a change in status was based on the fact that the greenback cutthroat trout is not now in imminent danger of extinction because of the recognition and protection of the two indigenous populations in Como Creek and in the headwaters of the Little South Poudre River and the introduced populations in Rocky Mountain Park where the watersheds are completely protected against degradation.

It was also pointed out by the Recovery Team that the endangered status, by prohibiting angling (or any "taking"), inhibited more transplants of greenback trout into public waters because such action would force closure of these waters to anglers, thus alienating fishermen.

Understandably, the Fish and Wildlife Service has a cautious approach to the evaluation of requests for change of status. A reply from Mr. Harvey Willoughby, Director, Region 6, U.S. Fish and Wildlife Service to Mr. Nittmann (April 12, 1976), commented on the recovery plan and a request for a change in status. Mr. Willoughby pointed out the need for continued, long term monitoring and of statements of achievable and quantifiable objectives calling for specific actions and schedules to be carried out. A problem here is that to the present, no funding has been available specifically to carry out projects on greenback trout. All work to date has been done on a piecemeal, sporadic and part-time basis or ancillary to

other projects. For example, I have previously pointed out that we know little of the status of native trout in the Arkansas River drainage because of the paucity of collections. As part of an ongoing D-J project on stream surveys (F-32-D) in the Arkansas drainage, Mr. Don Wurm, regional biologist, Colorado Division of Wildlife, agreed to give special emphasis to collections of potential native trout populations. Colorado Division of Wildlife has obligated funds to handle the identification of collections made in 1976.

The Colorado Division of Wildlife classifies S. c. stomias as "threatened". This classification gives the management responsibility of stomias to the non-game section of the Division. The non-game aquatic biologist of the Colorado Division of Wildlife is Mr. Dave Langlois.

Recommendations

The delegation of administrative authority for endangered and threatened species to the non-game section of the Colorado Division of Wildlife has the advantage of centralizing projects and responsibilities on species whose distribution overlaps into more than one of the administrative regions of the state. Anticipating the eventual granting of matching federal funds for endangered and threatened species programs to the state, the non-game section should draft a proposal for funding a project on the greenback cutthroat trout (or all of the native cutthroat trout of the state). The ultimate goal would be to re-introduce pure greenback trout into several waters until it was no longer endangered or threatened and again comes under the jurisdiction of fish management. Basic to such a project is the inventory, collection and taxonomic analysis of cutthroat trout populations in the South Platte and Arkansas river basins, comparable to what has been accomplished in the Poudre River drainage of the South Platte basin.

To make most effective use of funds and time, collections should be planned from those areas with the greatest potential for the persistence of native trout. Such areas will be remote and isolated headwater situations. Streams with some physical barrier to prevent upstream migration of non-native trout and the watershed above the barrier being sufficiently small or remote so that previous introductions of non-native trout were unlikely. Particular attention should be given to the location of lakes on a watershed. Most mountain headwater lakes have a long history of non-native trout introductions, resulting in hybrid mixtures throughout all parts of a continuous drainage not physically isolated. Consultation with Division employees familiar with a specific drainage or region may provide leads to the location of potential native trout populations. The South Platte and Arkansas basins can be partitioned into sub-drainages and a plan of collection sites noted from topographic maps.

For drafting a proposal, sections 4 (documentation and reporting) and 13 (research and surveys) of the U.S. Fish and Wildlife Service's Federal Aid Manual should be consulted. Objectives should be stated in quantifiable and measureable terms. For example, three months of summer field work will collect a minimum of 30 designated sites and preserve 300-500 specimens for analysis.

Until funding is available to initiate an inventory specifically devoted to greenback trout, the personnel of the non-game section of Colorado Division of Wildlife should capitalize on opportunities whereby federal agencies such as the Bureau of Reclamation, Bureau of Land Management and the U.S. Forest Service, preparing environmental assessments, analysis or impact statements, could make a contribution toward the inventory and collection of cutthroat trout populations in the South Platte and Arkansas basins.

I note that the possible occurrence of native cutthroat trout was not even considered in the final environmental impact statements for timber management (1975) for the Rio Grande, Routt, Uncompahgre, Gunnison and Arapaho National Forests in Colorado.

In Rocky Mountain National Park, the schedule and plans for 1976 and 1977 for green back trout restoration in the Park developed by Park Biologist, Dave Stevens and U.S. Fish and Wildlife Service Biologist, James Mullan, should be formalized and carried out. This includes monitoring the introduced greenback populations in Hidden Valley and Bear Lake, the creation of spawning habitat in Bear Lake, elimination of brook trout and introduction of greenback trout in about 4 miles of West Creek, above a natural barrier, and in 2¼ miles of Cow Creek (construction of a barrier will be necessary). A cutthroat trout population of unknown origin occurs in Pear Reservoir Creek in Rocky Mountain Park. This population should be identified and the habitat assessed. If the present population represents a typical hybrid mixture of non-native trout, the site can be considered for greenback introduction.

In 1975, while obtaining trout from Como Creek for transplant into Bear Lake, members of the Recovery Team made a brief reconnaissance of the Como Creek watershed. An isolated headwater section of the stream above the University of Colorado's Arctic and Alpine Research Station was found to be barren of trout. The habitat appeared to be suitable and it is recommended that an introduction be made in 1976 to extend the range of the trout in Como Creek. The downstream limits of greenback trout in Como Creek has not yet been established. This should be accomplished in 1976 as well as observing any potential threats to the downstream area - for example, the possibility of construction of ponds on private property in the watershed where rainbow trout could possibly gain access to the stream.

The headwaters of the Little South Poudre River should be surveyed in greater detail to estimate population size (evidently small) and to assess the potential for extending the distribution of this trout by introductions into a presently barren western tributary, joining the Little South Poudre just north of the boundary of Rocky Mountain Park. An objective should be scheduled to introduce fish from the Little South Poudre population into the headwaters of Hourglass Creek in an attempt to establish a new population. The original stocking of Hourglass Creek with cutthroat trout from Black Hollow Creek was made in October. The tendency for downstream movement of trout is increased by cold or decreasing temperatures (data reviewed by Behnke and Zarn, 1976) and the prospects for successful establishment in Hourglass Creek should be improved by transplants made during the early-mid summer period.

An excellent site for the establishment of a future brood stock of greenback trout is at the sources of the South Branch Boxelder Creek on the property of Colorado State University's Maxwell Ranch, Larimer County, Colorado. Two series of springs, about one-half mile apart at an elevation of approximately 7200 ft, create the origin of the South Branch and join together about one-half mile downstream, just above the county road crossing. The springs provide a constant source of good quality water (water quality and invertebrate fauna has been studied by graduate student Richard Botorff, Department of Zoology). The flows are less than one c.f.s., but presently support a dense population of small brook trout. This section of the watershed is in excellent condition and is not subjected to flooding or erosion. A construction of a barrier, perhaps just below the junction of the two forks, and eradication of the brook trout would provide an excellent opportunity to restore greenback trout. Boxelder Creek is a tributary of the Poudre River and although no records of cutthroat trout

from this drainage are known, it is assumed that the greenback trout occurred throughout Boxelder Creek before replacement by brook trout. The creation of a small pond by a barrier dam would provide habitat for rapid growth and relatively large adult fish resulting in a source of readily obtainable spawners for future propagation. The area is accessible by a good gravel road, open year-round.

Mr. E. J. F. Early, Manager of the Maxwell Ranch, has expressed interest on the part of Colorado State University for an endangered species refuge on the Ranch. He has pointed out, however, that the University has no funds available to contribute to the project. The major expense would be in the construction of a barrier dam. Possible construction assistance might be available from Army Reserve Units as part of their training requirements.

A greenback restoration project designed for brood stock maintenance on the Maxwell Ranch definitely deserves serious consideration by the Greenback Recovery Team and the non-game section of the Colorado Division of Wildlife.

The following areas are high priority sites for collection of specimens for identification: 1. The headwaters of South Huefano Creek (The 1963 collection was made "above confluence with Dutch Creek"). This sample represents best known greenback population in the Arkansas River drainage. Do cutthroat trout still exist there? Are they isolated? Are there isolated tributaries which may hold pure populations of native trout? 2. The very headwaters of the Purgatoire River near Purgatoire Peak. I know of no records of native trout in the Purgatoire drainage (tributary to the Arkansas River near Las Animas, Colorado). If greenback trout ever gained access to the Canadian River basin, the transfer would most likely have occurred in the Purgatoire Peak area - if the greenback was native to the Purgatoire drainage. I discussed this matter in a report on the cutthroat

trout found in Ricardo Creek, a headwater tributary of the Canadian River basin (Behnke, 1976). 3. The headwaters of the Apishapa River (the drainage between the Huefano River and the Purgatoire River) is also an important site. 4. A larger collection should be made from the unnamed tributary of Long Draw Reservoir (headwaters of Big South Poudre drainage), for detailed analysis as a pure population and evaluate relationships to stomias and pleuriticus.

The Recovery Team should set a goal by 1978 to present documented evidence that the status of S. c. stomias clearly warrants a change from endangered to threatened. This would include: (1) current data on the indigenous populations in Como Creek and the Little South Poudre River and the introduced populations in Hidden Valley Creek, Bear Lake and Black Hollow Creek; (2) verification that brook trout have not re-appeared in Hidden Valley or Bear Lake and a decision on a course of action for Black Hollow Creek regarding treatment for elimination of brook trout; (3) additional transplants to establish new populations such as in Hourglass Creek, Cow Creek, West Creek, Boxelder Creek and extending the distribution into presently isolated, barren sections of Como Creek and the Little South Poudre; (4) update on status of stomias in South Platte and Arkansas basins based on collections made in 1976-77.

Finally, a successful greenback recovery program should emphasize the values of the greenback trout in fisheries management to stimulate more widespread introductions as a fisheries management option to replace stunted brook trout populations with a more desirable trout. In the Yellowstone River, Wyoming and in the St. Joe River, Idaho, special regulation fisheries for native cutthroat trout have been enthusiastically endorsed by fishermen (Behnke and Zarn, 1976). Future data comparing the population structure, size and growth rate of the greenback trout introduced into

Hidden Valley and into Bear Lake with the brook trout populations existing there at the time of treatment will be most valuable for predicting the expected results of replacing brook trout with greenback trout in small stream and mountain lake environments (Dave Stevens and James Mullan recorded data from the brook trout populations in Hidden Valley and in Bear Lake immediately after treatment).

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Table 1. Character analysis.

Locality	Vertebrae	Gillrakers	Pyloric caeca	Scales above lat. line and in lat. ser.	Basibranchial teeth
South Platte Basin Poudre R. drainage				53-60 (56.7)	
Headwaters Little So. Poudre, 1965, 1970 n = 18	60-63 (61.9)	19-23 (21.3)	27-50 (35.2)	205-236(216.5)	~~7 (1) (mean of 50)~~ 2-17 (11.1)
Black Hollow Crk. 1963 n = 40	60-63 (61.9)	-	37 (1) (mean of 50)	41-48 (44.2) 175-216(193.5)	7 (1) (mean of 50)
Roaring Crk. 1962 n = 30	60-62 (60.9)	-	31.2(1) (mean of 30)	41-50 (45.7) 173-209(190.4)	10.3(1) (mean of 30)
Hague Crk. 1967 n = 8	61-63 (61.9)	19-22 (20.4)	23-43 (34.4)	41-48 (44.5) 160-195(179.4)	2-14 (8.9)
Trap Crk. 1967 n = 10	59-63 (61.1)	17-21 (18.7)	31-41 (35.5)	40-49 (45.6) 165-201(186.6)	1 w/o teeth 9 w/ 1-10(5.1)
Neota Crk. 1967 n = 10	61-63 (61.3)	20-22 (20.7)	25-36 (30.7)	37-56 (46.3) 167-201(186.7)	1 w/o teeth 9 w/ 1-10(5.1)
Willow Crk. (above Long Draw Res.) 1969 n = 10	61-64 (62.2)	18-21 (19.5)	24-41 (30.9)	43-49 (45.9) 179-204(187.7)	4 w/o teeth 6 w/ 3-6(4)
Willow Crk. (below Long Draw Res.) 1969 n = 7	60-63 (61.3)	20-22 (20.7)	25-36 (30.7)	37-56 (46.3) 167-201(186.7)	3-7 (5.0)
Corral Crk. 1967 n = 22	61-63 (61.9)	18-20 (18.7)	32-49 (38.8)	42-47 (44.2) 156-193(180.3)	2-20 (8.5)

Locality	Vertebrae	Gillrakers	Pyloric caeca	Scales above lat. line and in lat. ser.	Basibranchial teeth
Trib. Long Draw Res. 1968 n = 6	-	19-21 (20.8)	26-33 (29.5)	47-51 (48.8) 190-208(197.8)	2-15 (8.4)
Thompson R. drainage Forest Canyon 1959-1967 n = 40	59-62 (60.7)	18-22 (19.1)	29-46 (35.9)	44-54 (49.6) 187-204(192.4)	3 of 40 a/o teeth 37 w/ 1-13(7.1)
Caddis L. (introduced frm. Forest Canyon) 1972 n = 6	-	16-22 (19.0)	31-39 (35.3)	46-49 (48.1) 186-202(191.3)	2-13 (8.2)
Florence Crk. (introduced frm. Forest Canyon) 1975 n = 15	-	16-21 (19.0)	26-43 (34.0)	43-51 (47.7) 182-208(190.8)	3 of 15 w/o teeth 12 w/ 1-8(4.4)
Boulder Crk. drainage Como Crk. 1969 n = 18	59-62 (60.2)	17-21 (19.0)	24-42 (29.4)	46-53 (48.4) 174-205(189.3)	1 of 18 w/o teeth 17 w/ 3-12(6.0)
Albion Crk. 1955-1963 n = 22	58-62 (60.1)	17-20 (18.5)	29-46 (34.1)	41-47 (44.6) 168-203(189.3)	1-23 (8.0) n = 12
Island L.[2] (City Boulder Wattershed) 1963 n = 50	59-62 (60.4)	-	36.6[1] (mean of 50)	41-50 (45.0) 167-196(179.8)	7.9[1] (mean of 50)
Bear Crk.(Morrison) 1889 n = 1	59	19	-	44 195	3
Arkansas R. Basin Twin Lakes 1889-1903 n = 20	59-62 (61.3)	18-21 (19.2)	33 (n = 1)	46-53 (46.2) 170-202(186.0)	1 of 14 w/o teeth 13 w/ 6-14(11.0)
Arkansas R. 1889 n = 2	60,62	20,22	31 (n = 1)	46,49 191,213	2,12

Locality	Vertebrae	Gillrakers	Pyloric caeca	Scales above lat. line and in lat. ser.	Basibranchial teeth
Headwaters Brown's Crk. 1972 n = 15	61-64 (62.4)	18-21 (19.3)	33-51 (38.7)	44-50 (46.2) 163-215(184.4)	1 of 10 w/o teeth 9 w/ 9-28(14.0)
Headwaters Muddy Crk. 1970 n = 20	61-62 (61.6)	19-23 (20.1)	27-40 (34.2)	38-48 (42.1) 160-189(174.4)	1 of 10 w/o teeth 9 w/ 7-22(11.5)
So. Huefano Crk. 1963 n = 15	60-63 (61.2)	16-20 (18.4)	25-41 (33.1)	41-51 (45.5) 170-205(185.0)	1 of 10 w/o teeth 9 w/ 1-6(3.0)
Pike's Peak Lk.(2) #5 1970 n = 22	60-62 (61.1)	17-21 (19.4)	32-51 (41.6)	42-48 (44.2) 162-205(181.2)	3-17 (9.0)
Headwaters Colo. R. (S.c.pleuriticus) 1970 n = 14	61-63 (62.1)	18-23 (20.3)	32-43 (37.1)	44-49 (43.1) 187-226(195.1)	6-33 (14.0)
Yellowstone L. n = 30	60-63 (61.6)	18-23 (20.6)	31-51 (41.2)	37-46 (40.6) 161-187(179.2)	9-46 (24.0)

(1) Data from Dieffenbach (1964)

(2) Used in cutthroat trout propagation