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Systematic study of the native trout

of the Bonneville basin.

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CURRENT STATUS OF CUTTHROAT TROUT SUBSPECIES IN THE WESTERN BONNEVILLE BASIN

Terry J. Hickman[1] and Donald A. Duff[2]

ABSTRACT.— Recent discoveries of native cutthroat trout populations in desert mountain ranges on the western fringe of the Bonneville Basin have prompted intensified management efforts by state and federal agencies. Analysis of Snake Valley cutthroat specimens in Trout Creek, Deep Creek Mountain Range, Utah, indicate this is a pure strain of the trout which once inhabited Pleistocene Lake Bonneville and which was thought to be extinct in Utah. The Snake Valley cutthroat is similar to *Salmo clarki utah* of the eastern Bonneville Basin; however, electrophoretic and morphomeristic analysis show unique genetic differences brought about by long-term isolation (8,000 years) from the remainder of the Bonneville Basin cutthroat. This cutthroat is a common ancestor to several other limited cutthroat populations within the basin in Nevada. In May 1977 the BLM withdrew from mineral entry about 27,000 acres within the Deep Creek Mountains for protection of this salmonid cutthroat and other unique resources on the range. Results of 1977 stream surveys on the Pilot Peak Mountain Range, Utah, indicate the presence of the threatened Lahontan cutthroat, *Salmo clarki henshawi,* in one isolated stream.

The ancient Pleistocene Lake Bonneville in the Great Basin once supported a cutthroat trout, native to the Snake Valley area of Utah-Nevada, which abounded in the area's several streams upon the lake's decline (Hickman 1977). Because of deteriorating habitat the cutthroat population rapidly diminished in the twentieth century to a point where it was believed to be extinct within its native range (Behnke 1976a) (Fig. 1).

In 1953 Ted Frantz, Nevada Fish and Game Department, discovered a cutthroat trout population in Pine Creek on Mt. Wheeler, Nevada (Frantz and King 1958). Samples were sent to Dr. Robert Miller, who indicated they represented pure cutthroat trout. But Dr. Miller was unable to assign them to any described subspecies (letter from Dr. Miller to F. Dodge, 26 May 1971). Though it was assumed this cutthroat was introduced from Trout Creek drainage of the Snake Valley area (Miller and Alcorn 1946), this seems unlikely when one considers that there were streams closer to Pine Creek which probably contained cutthroat trout (Lehman, Baker, Snake, and Hendrys creeks). Behnke (1976a) indicates the most logical origin of the Pine Creek cutthroat was from Lehman Creek (Mt. Wheeler tributary of the Snake Valley region) via the Osceola Ditch, constructed as a pioneer waterway.

During 1953 the Nevada Fish and Game Department introduced 44 fish from Pine Creek into Hampton Creek, Nevada. A second transplant of 54 cutthroat from Pine Creek was made into Goshute Creek, Nevada, in 1960. The Nevada Fish and Game Department, assuming these were Utah cutthroat, *Salmo clarki utah,* closed these streams to fishing and listed *S.c. utah* as an endangered species in Nevada. Mr. Frank Dodge, Nevada Fish and Game Department, in 1972 found a population of cutthroat trout in the headwaters of Hendrys Creek (Mt. Moriah tributary of the Snake Valley region) which resembled those found in Pine Creek. Following this, several unsuccessful attempts were made by the Nevada Fish and Game Department to locate additional pure populations of cutthroat trout in the Snake Valley area of Utah and Nevada.

In 1973 the BLM (Utah) began stream habitat surveys in the Deep Creek Moun-

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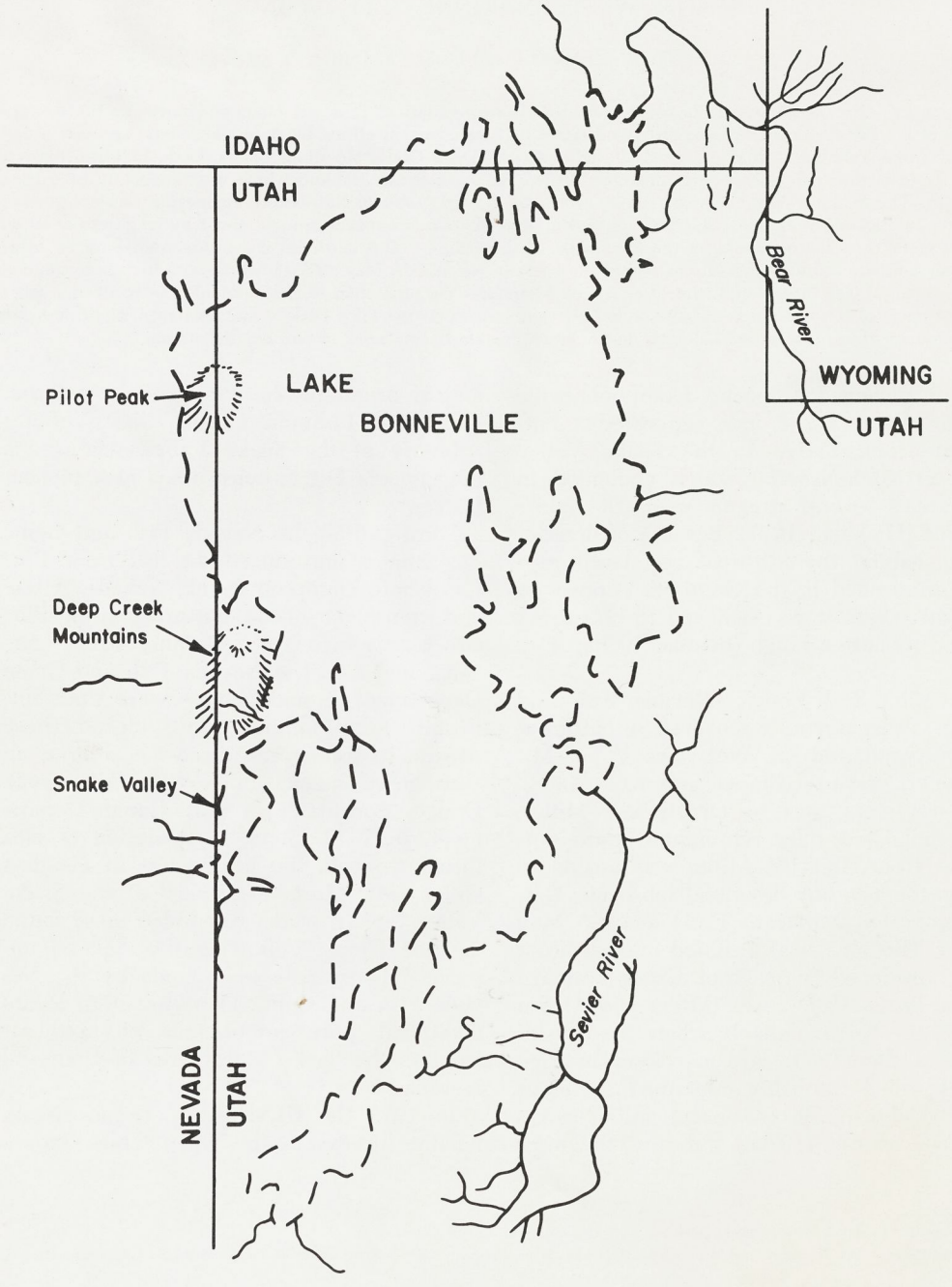

Fig 1. Area map location showing the western Bonneville Basin area.

STATUS OF THE BONNEVILLE CUTTHROAT TROUT, *SALMO CLARKI UTAH*

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ABSTRACT. The Bonneville cutthroat trout, *S. c. utah*, once abundant in the vast Bonneville basin of Utah, Wyoming, Idaho and Nevada, suffered a catastrophic decline from habitat loss and alteration combined with massive introductions of non-native trouts. There are only 14 known pure populations, from primarily small headwater streams, of *S. c. utah* remaining today. Despite increased awareness of these populations over the past few years, numbers are still declining. Sufficient information has been compiled to warrant protective status for *S. c. utah*.

INTRODUCTION

The original form of cutthroat trout (large-spotted type) invaded the upper Snake River from the Columbia River system prior to the formation of Shoshone Falls. From here it radiated into the Bear, Yellowstone, Colorado and other interior river drainages (Roscoe 1974). During late Pleistocene (ca. 25,000-35,000 yrs. ago) lava intrusion in a canyon of the Bear River, tributary to the Snake River, diverted the Bear River into the Bonneville basin (Bright 1963; Broecker and Kaufman 1965; Malde 1968). At this time the ancestrial large-spotted

cutthroat trout, from the upper Snake River, had access to the Bonneville basin. This relatively recent invasion may explain the small degree of differentiation apparent between S. c. utah and the large-spotted cutthroat (Yellowstone variety) of the upper Snake River (Murphy 1974).

The final desiccation of Lake Bonneville occurred about 8,000 years ago (Broecker and Kaufman 1965) at which time the cutthroat were forced into streams, forming several isolated disjunct populations throughout the Bonneville basin.

S. c. utah once abounded in the Bonneville basin but has suffered a catastrophic decline, in the Twentieth Century, to a point where many authors believed it to be extinct (Miller 1950; Cope 1955; Platts 1957; Sigler and Miller 1963). Efforts by several individuals and agencies, in the past 30 years, have added new hope for the future of S. c. utah (Behnke 1970, 1973, 1975, 1976a, b, c Hickman 1977; Hickman and Duff 1977).

The factors influential in reducing the number of cutthroat trout populations in the Bonneville basin are: introductions of non-native trouts, climatic conditions (floods and droughts), irrigation practices and habitat loss and degradation (Hickman and Duff 1977).

TAXONOMY

The first recording of the Bonneville cutthroat trout was made by Suckley (1874) from explorations made in the late 1850's. The fish were collected from Utah Lake and given the provisional name "Salmo utah." Suckley described them as a variety of "Salmo virginalis," whose range at the time was considered to be the southern Rocky Mountains, Utah and New Mexico. Suckley intended the name utah only for the cutthroat trout of Utah Lake, whose distinctive characteristics were probably almost wholly a reflection of direct environmental influence caused by the conditions of Utah Lake and not due to genetic differentiation (Behnke 1976b).

Jordan (1891) collected trout in the Bonneville basin that he considered "Salmo mykiss (variety virginalis)." He also collected some specimens from Utah Lake and noted that they resembled the trout of Twin Lakes, Colorado ("variety macdonaldi"). The name virginalis was mistakenly applied to Bonneville cutthroat trout for many years, until Jordan (1920) pointed out that virginalis correctly applied to the Rio Grande cutthroat and the name utah was then reestablished for Bonneville trout.

Although Suckley's description of Salmo utah is inadequate for separating utah from any other form of cutthroat trout, this published account of Salmo utah fixes the name utah as the earliest name applied soley to trout of the Bonneville basin. The spotting pattern and coloration of adult trout from Utah Lake are atypical of Salmo

clarki utah, therefore it is unfortunate that Jordan (1920) used it to describe and illustrate the characteristics of the Bonneville cutthroat trout (Behnke 1976b).

Questions have been raised concerning the taxonomic validity of S. c. utah. Although overlap in taxonomic characters exists among the cutthroat subspecies, there are consistent significant differences in genotypic and phenotypic analysis. S. c. utah exhibits large, sparse spots, evenly distributed over the body and lack the vivid coloration expressed by some subspecies. The following meristic mean values are typical of S. c. utah: vertebrae, 62-63; gillrakers, 18-20; pyloric caeca, 35-45; scales in the lateral series, 155-165; scales above the lateral line, 36-41; basibranchial teeth present in more than 90% of the population.

The taxonomic conclusions separating S. c. utah from other cutthroat subspecies have been supported by computer analysis (Hickman and Duff 1977; Hickman and Miller 1977).

Comparisons of various cutthroat subspecies using biochemical techniques has not proven fruitful. There is no known gene (as observed by analysis of the gene product - the protein), unique to cutthroat subspecies. It has even been difficult to get a separation between rainbow and cutthroat trout by electrophoresis (using protein patterns) studies (Wydosky et al. 1976). Investigation into karyotypes for separating trout has also met with little success. The most useful

means of separating various cutthroat trout subspecies is through an eclectic taxonomic and zoogeographic analysis.

Distribution of Pure Populations of S. c. utah

Table 1 lists the 14 known pure populations of S. c. utah, the impacts upon these populations and a rough estimate of abundance in each stream.

To avoid further taxonomic confusion and costly delays the cutthroat trout, native to the Snake Valley region of the Bonneville basin Utah-Nevada, have been considered a relict form of S. c. utah. This doubles the total known number of pure populations from seven to 14.

There are several other creeks in the Thomas Fork and Smith Fork drainages, Wyoming (Coal, Salt, Smithfield, Huff and Rock) that contain good phenotypic S. c. utah representatives (slight genotypic hybridization with rainbow and other cutthroat subspecies can be detected). Nowhere else in the Bonneville basin, in a drainage as large as Thomas Fork, can trout resembling S. c. utah be found dominating the trout fauna of the area. In all other areas of the basin native cutthroat trout have been replaced by non-native trouts.

The Bonneville cutthroat are not abundant in most of the streams because of the generally poor trout habitat exhibited by these streams (low flow, lack of pools, etc.).

Table 1. Summary of information on pure populations of S. c. utah.

Stream	Origin	Estimated Abundance	Impacts and Present Condition
Nevada			
Hendrys Crk. (White Pine Co.)	Native	400-~~800 (prior to 1977)~~ in 5 miles	About 50% mortality in 1977 due to drought; poor fish habitat (lack of pools, small size, etc.)
Pine Crk. (White Pine Co.)	Derived from Lehman Crk.	200 in 1.5 miles	Not capable of supporting many fish due to small size irrigation, water fluctuations
Hampton Crk. (White Pine Co.)	Introduced from Pine Crk. in 1953	300-~~600 (prior to 1977~~ in 3 miles	About 50% mortality in 1977 due to drought; poor fish habitat (low flow, lack of pools, small size)
Goshute Crk. (White Pine Co.)	Introduced from Pine Crk. in 1960	~~700/mile~~ Now 500/mile ~~800/mile~~ (prior to 1977) in 4 miles	38% mortality in 1977 due to drought; livestock, flooding ~~(wiped out fish in late 1950's)~~
Water Crk. (White Pine Co.)	Introduced from Goshute Crk. in 1977	41 in 4 miles	Not determined livestock, (flooding) water fluctuations
Clear Crk. (White Pine Co.)	Introduced from Goshute Crk. in 1977	20 in 1 miles	Small stream subject to drought and flooding, livestock
Wyoming (Thomas Fork Drainage			
Raymond Crk. (Lincoln Co.)	Native	300-800 in 3 miles	Livestock grazing, mineral exploration, non-native trout
Giraffe Crk. (Lincoln Co.)	Native	300-600 in headwaters /mile	Livestock grazing, mineral exploration, non-native trout

Table 1. (continued)

Stream	Origin	Estimated Abundance	Impacts and Present Condition
Utah			
Trout Crk. (Juab Co.)	Native	800 in 1.5 miles	Rainbow trout, mineral exploration
Water Canyon (Washington Co.)	Introduced from Bonneville basin	200 in .5 miles	Rainbow trout, livestock, small stream
Reservoir Canyon (Washington Co.)	Introduced from Bonneville basin	500 in 2 miles	Rainbow trout, livestock, small stream
Willow Crk. (Salt Lake Co.)	Native		Urban development
Birch Crk. (Beaver Co.)	Native	~~300-500~~ 200/mile	About 30% mortality in 1977 due to drought; livestock; small stream
Sam Stow Crk. (Beaver Co.)	Introduced from Birch Creek in 1977	—	—

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Bruce May, Fish. Biol., U.S. For. Ser. (supplied some info. on So. Utah region while employed by DWR).
Behnke 1976b and personal comm.
Hickman 1977
Hickman and Duff 1977

Efforts have been made by the Nevada Fish and Game Department to reclaim two streams per year for S. c. utah. U. S. Bureau of Land Management in Utah, Nevada, and Wyoming have also been active in programs to preserve the Bonneville cutthroat trout. During the past year Wyoming Game and Fish Department and Utah Division of Wildlife Resources have initiated management programs pertaining to S. c. utah.

STATUS

Awareness of existing S. c. utah populations by State and Federal personnel has not yet resulted in security and protection for this cutthroat trout. An increase in abundance has not been documented despite recent discoveries and introductions. Populations of S. c. utah are still declining because of hybridization, habitat degradation, droughts, etc.

The taxon S. c. utah is within the province of the Endangered Species Act of 1973. It comprises a "subspecies, smaller taxa or a viable segment" of the species Salmo clarki, as defined by the Endangered Species Act. There is sufficient information to demonstrate that S. c. utah has suffered greater declines and is just as rare or rarer than many species listed as endangered or threatened. Many fear the Endangered Species Act as a possible encroachment of states rights but to ignore the native trout or debate over the taxonomic validity of scientific names can be detrimental to the fish in question. It might be best to consider a species native to a particular

geographical area as an evolutionary reality and a part of our biological heritage which should be preserved. The rationale for species preservation are diverse and, at times, philosophical. Early reasons to conserve fish and wildlife were economic. Although economics is important today, genetic, environmental, esthetic and moral considerations are also given as reasons for species preservation. No longer should we measure the value of a fish by its creel potential but rather by its uniqueness and role in the ecosystem. The object of the Endangered Species Act is to increase the abundance of a species by environmental protection and improvement. Once a particular form of fish becomes extinct, problems of nomenclature, management and responsibility are meaningless.

The following organizations and agencies have given S. c. utah protective recognition: The International Union for the Conservation of Nature lists it as rare; Holden et al. (1974), in a publication generated by the Bonneville Chapter of the American Fisheries Society, considered it endangered; the Parent Society, the American Fishes Society, in its new listing, will list it as threatened (Personal comm. with Dr. J. Deacon, Chairman of the Endangered Species Committee); State of Nevada has considered it rare and is protecting the streams inhabited by S. c. utah; Wyoming Game and Fish Department lists it as a rare species; U. S. Bureau of Land Management Wyoming has considered it a "sensitive" species warranting special considerations on public lands. As a result of the limited distribution and present impacts on S. c. utah I would consider it threatened.

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INTRODUCTION

Historically, the ancient Pleistocene Lake Bonneville in the Great Basin once supported a cutthroat trout, native to the Snake Valley area of Utah-Nevada. This trout once abounded in the area's several streams upon the Lake's decline (Hickman, 1977). The cutthroat population rapidly declined because of deteriorating habitat in the Twentieth Century to a point where it was believed to be extinct within its native range (Behnke 1976a) (Refer Figure 1).

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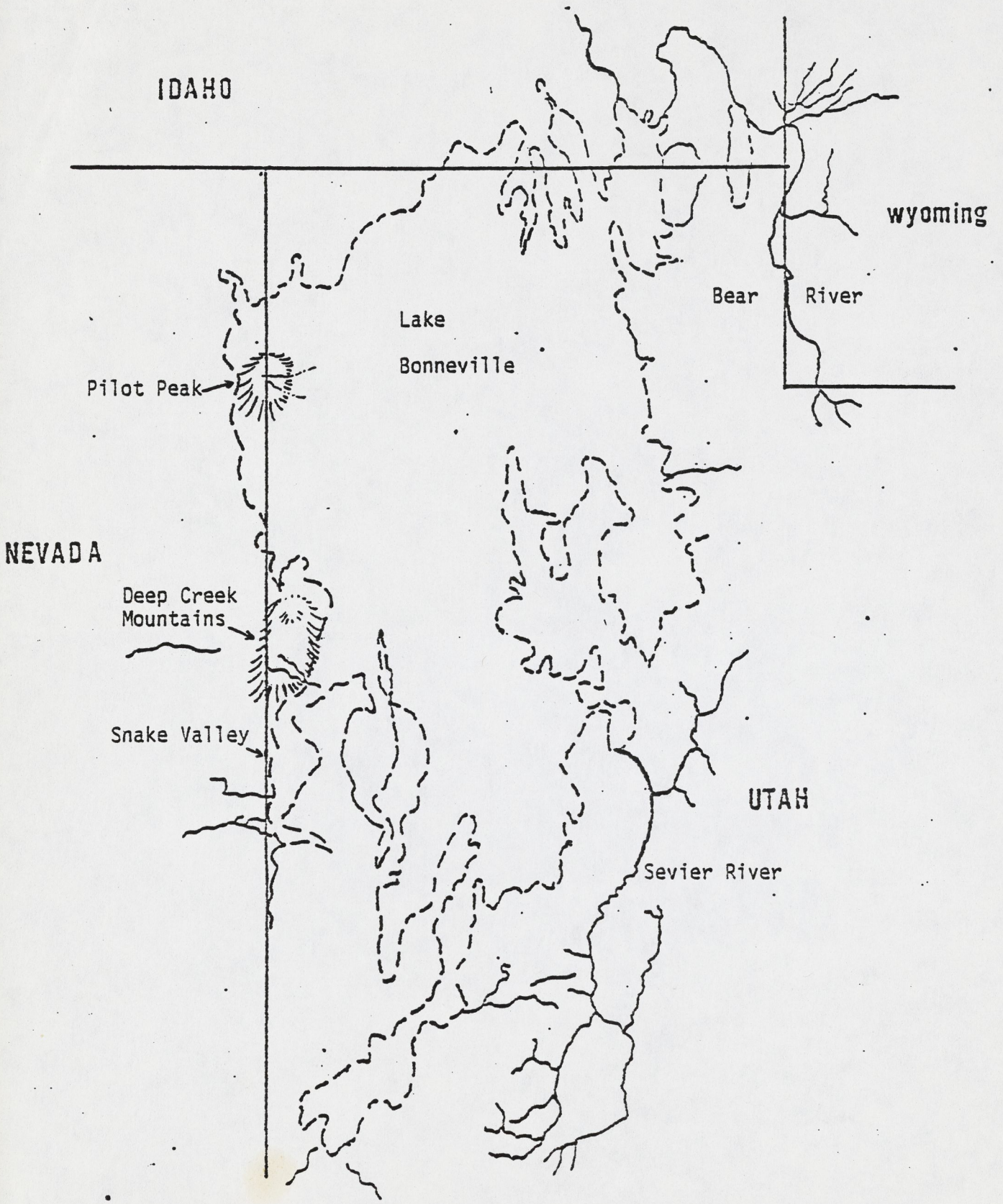

Figure 1. Area Map Location Showing The Western Bonneville Basin Area.

that they represented pure cutthroat trout. But Dr. Miller was unable to assign them to any described subspecies (letter from Dr. Miller to F. Dodge, May 26, 1971). It was assumed that this cutthroat was introduced from Trout Creek drainage of the Snake Valley area (Miller and Alcorn, 1946). This seemed unlikely when one considers that there were streams closer to Pine Creek which probably contained cutthroat trout (Lehman, Baker, Snake and Hendrys Creeks). Behnke (1976a) indicates the most logical origin of the Pine Creek cutthroat was from Lehman Creek (Mt. Wheeler tributary of the Snake Valley region) via the Osceola Ditch, constructed as a pioneer waterway.

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In 1973 the BLM (Utah) began stream habitat surveys in the Deep Creek Mountain Range in an attempt to define critical habitats and possible remnant populations of the cutthroat. In the spring of 1974, BLM biologists Don Duff and Josh Warburton discovered cutthroat in the extreme headwaters of Trout Creek, Utah, above a natural barrier falls. Subsequent sampling and analysis by the BLM, Utah Division of Wildlife Resources and Colorado State University (under contract funded by BLM) determined that Trout Creek specimens were pure strain fish of the Bonneville Basin. Inventories have coninued to date and the only stream found to contain a pure population was Trout Creek. Hybridized populations (with rainbow trout) were found in Birch Creek and Johnson Creek (Hickman, 1977) (Refer to Figure 2).

REASONS FOR DECLINE

When the Snake Valley arm of Lake Bonneville dried up there were relatively few perennial streams in the area. In addition to this, since the mid 1800's, introductions of non-native trouts, climatic conditions, irrigation practices and habitat loss and degradation have been influential in reducing the number of cutthroat populations in the Snake Valley area. Replacement and hybridization from introductions of exotic rainbow trout (Salmo gairdneri) has posed the most

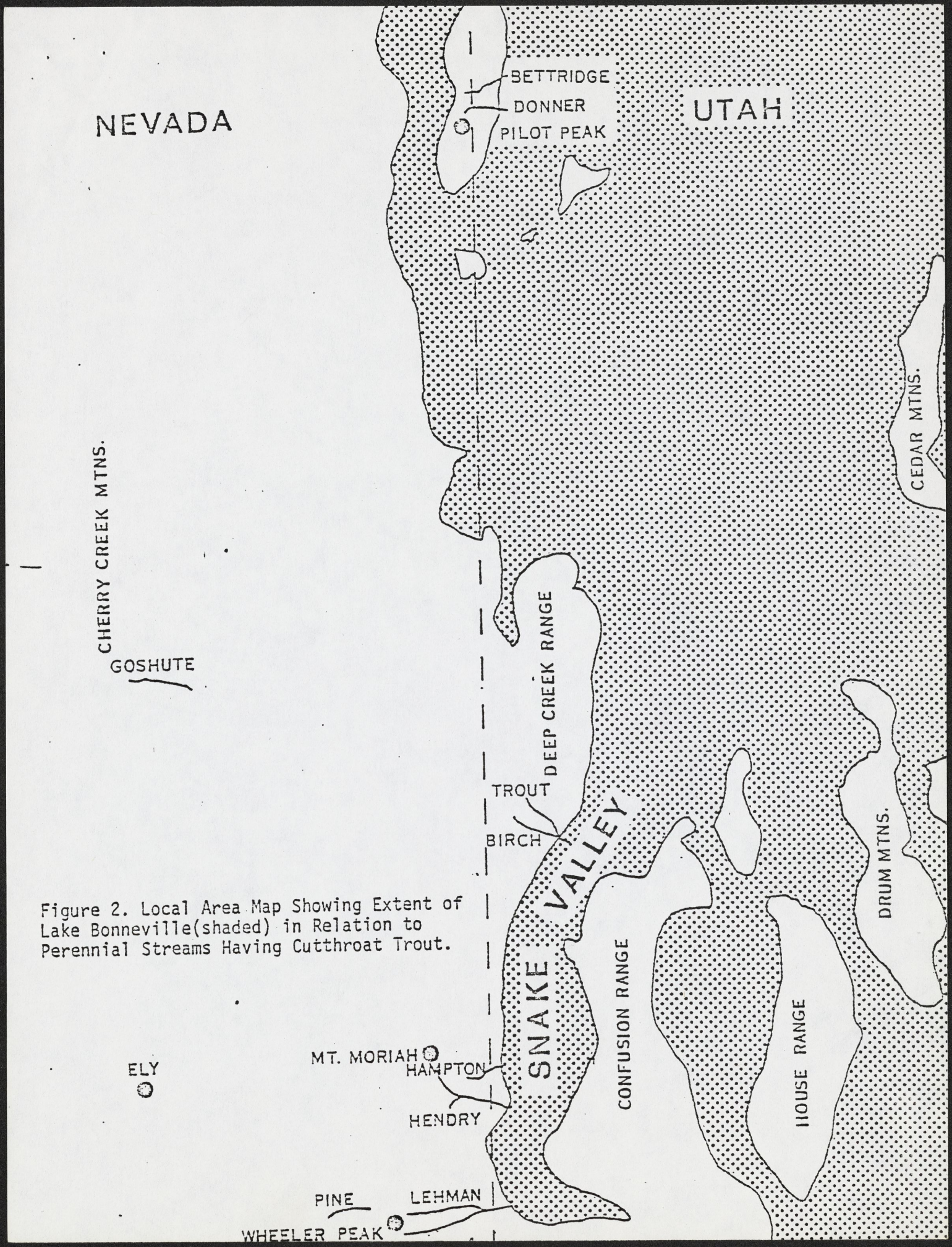

Figure 2. Local Area Map Showing Extent of Lake Bonneville(shaded) in Relation to Perennial Streams Having Cutthroat Trout.

significant impact to the survival of the Snake Valley cutthroat. Virtually every stream in the Snake Valley region, capable of supporting trout, has been stocked with rainbows. Brook trout are also capable of replacing the cutthroat through competition because of earlier spawning periods and it's ability to become better adapted to life in small spring-fed headwater streams.

Exploitation, though not likely a limiting factor by itself, can reduce the number of catchables and may act to favor other exotics such as the brooks, browns, and hybirds. It has been documented that cutthroat trout are highly vulnerable to angling mortality (Behnke and Zarn 1976.)

Livestock grazing imposes a serious and subtle threat to the survival of the cutthroat trout, in the arid Snake Valley region. Grazing becomes significant when discussing sites for reintroductions, since much of the prime grasslands exist in headwater meadow areas. Livestock interests in the Bonneville Basin have been unconcerned about stream protection of rare trout populations. These problems have made the BLM very cautious in planning for additional habitat sites for future reintroductions of the Snake Valley cutthroat. Many studies have shown that livestock grazing destroys and degrades riparian vegetation, and streambanks soil stability resulting in alterations of channel morphology, loss of cover, and a reduction in numbers and biomass of fish particularly older and larger trout (Behnke 1977). Studies and management of livestock impacted areas should be made in order to rehabilitate the grazed areas either through improvement of the existing grazing system, or livestock exclusion (Platts 1977). The BLM in Utah and Nevada has been involved in stream side fencing programs to protect the riparian habitat of streams containing sensitive, or rare trout populations from continued livestock damage (Goshute Creek, Nevada, and Birch Creek, near Beaver, Utah).

Droughts and violent thunder storms may have historically eliminated cutthroat populations from some high gradient streams, since natural recolonization could not be effective after desiccation of the pluvial lake in Snake Valley. This may account for the high number of barren streams found in the Snake Vally region prior to rainbow trout introductions.

Past surface disturbance impacts from mining have been slight and of short duration, the main damage resulting from equipment movement and road construction to and from the mine site. There exists little room for trails or roads in some of the narrow canyons, therefore, the streambed may be utilized for such purposes, in some areas. Recent uranium mining activities in Utah's Deep Creek Mountains have caused concern over the future impacts of mining to the resources of this fragile desert island ecosystem environment.

The effects of all these environmental impacts on the cutthroat trout populations are greatly magnified when considered collectively. Many of the streams in the Snake Valley region have been affected by all of these major impacts at some point in time during the recent past history of the area.

UNIQUENESS OF SNAKE VALLEY CUTTHROAT TROUT

Ancient Lake Bonneville went through several periods of fluctuations in which water levels which were closely associated with climatic conditions (Gilbert 1879). According to Broecker and Kaufman (1965), four low levels occurred between 8,000 and 22,000 years ago, including one period of complete desiccation followed by refilling that took place about 11,000 years ago. The final desiccation occurred approximately 8,000 years. This final desiccation of Lake Bonneville resulted in ten or twelve independent basins being formed, one of which was the Snake Valley basin (Gilbert 1890). The northern portions of Snake Valley shows a lake level elevation of about 5,100 feet. This would have prevented water from flowing out of Snake Valley and into the Great Salt Lake Basin. In addition to such physical isolation, the cutthroat were forced to seek refuge in the streams to overcome the increased saline conditions brought on by the desiccation (Hunt et al 1953). Thus, many populations of cutthroat in the Bonneville Basin have been isolated from contact with each for about 8,000 years.

Wydoski et al (1976) conducted a study of the electrophoretic patterns of proteins in cutthroat located in the Bonneville Basin, as well as with several other groups of cutthroat, and rainbow trout. No protein was unique or distinctive for S. c. utah specimens, but an unusual variation for muscle lactate dehydrogenase (LDH) was found in cutthroat from Trout and Goshute Creeks, indicating a common ancestor. This unusually complex variation seems to indicate the presence of a variant allele. A unique evolutionary event, or series of events, occurred in the Snake Valley cutthroat trout LDH, which would indicate long-term isolation from the rest of the Bonneville Basin cutthroat trout.

Comparison of samples of the least chub, Iotichthys phlegethontis in the western Bonneville Basin add credence to the assumption of incipient speciation in fishes isolated in Snake Valley. Samples from Donner Springs (Pilot Peak Area) have the typical fin ray counts given by Sigler and Miller (1963). These found in Snake Valley have one less ray in the dorsal (7), anal (6) and pelvic (7) fins.

Smith (1966) stated that the mountain suckers, (Pantosteus platyrhynchus) of Deep Creek, in the Deep Creek Mountain area, is differentiated from the typical Northern Bonneville form.

The Snake Valley cutthroat trout differs from other cutthroat trout of the Bonneville Basin by having more basibranchial teeth and gillrakers, and fewer scales in the lateral line series. The spotting pattern is more uniformly distributed over the body, and not so concentrated posteriorly as in other Bonneville Basin cutthroat. The head appears longer and deeper with the body being more compressed and caudal peduncle deeper, all of which gives it a more chunky body appearance (Behnke 1976 a, b).

STATUS OF THE SNAKE VALLEY CUTTHROAT TROUT

Pure populations are found in Pine, Goshute, Hampton, and Hendrys Creeks

of Nevada and in Trout Creek, in Utah (refer to Figure 2). Hybridized populations are found in Muncy and Mill Creeks, Nevada, and Birch and Johnson Creeks, in Utah (Behnke 1976a, Hickman 1977).

Goshute Creek probably has the highest number of Snake Valley cutthroat, having about 1,500 in 4 miles of stream (McLelland 1975). The Nevada BLM, and Nevada Fish and Game Department (NFG), have been instrumental in protecting and enhancing the habitat in Goshute Creek. During the 1977 drought Goshute Creek lost about 38% of the cutthroat population per mile. Because of these conditions a concerned NFG took 71 cutthroat from Goshute Creek and transplanted them proportionately into Water Canyon Creek (four stream miles habitat) and Clear Creek (one stream mile habitat).

Pine Creek, a very small stream with little habitat, has about 100 cutthroats (excluding fry), as does Hampton Creek, which is also a small stream (McLelland 1975). Pine Creek suffered some mortality as a result of the 1977 drought. Mile Creek, another creek with transplanted cutthroat, lost its entire population as the creek dried up from the drought.

Hendrys Creek had about 200 cutthroat in the headwater area in 1973. In 1974 eradication of rainbow trout below the barrier was conducted on Hendry's Creek to aid the fish's survival. Hendrys, Goshute, and Pine Creeks have now closed to angling use. Goshute and Hampton Creeks have past histories of losing all of their fish from flash floods, and this is the reason they were barren in 1953 and 1960. Because of its small size Pine Creek is also vulnerable to flash flooding. Therefore, the potential exists that the cutthroat populations in these streams could be lost in the future. During the 1977 drought NFG estimates that 50% of the cutthroat populations in Hendry's and Hampton Creeks were lost because of dry stream sections. In the interest of managing these unique fish, NFG has identified about 25 streams suitable for reintroductions. They plan to rehabilitate about two to four streams per year in this effort.

During 1977, one of the most significant items to take place in the basin for the protection of desert fishes, and the environment occurred in the Deep Creek Mountains when the BLM filed for an emergency withdrawal of a 27,000 acre area of critical environmental concern within the mountain range because of increased uranium mining activity, which threatened to destroy many of the unique resources of the mountain area. A significant item in justifying this action was the presence of the rare Snake Valley cutthroat in only about 1¼ miles of critical habitat on Trout Creek as well as the presence of the rare giant stonefly (Pteronarcys princeps). The area was withdrawn from mineral entry on May 3, 1977 by the Secretary of the Interior under section 204(e) of the Federal Land Policy and Management Act of 1976 (PL 94-579). This withdrawal stays in effect for a 3-year period, and allows time for study of all resources to ascertain their values.

In September, 1977, the BLM (Utah) funded a contract to the Utah Division of Wildlife Resources to provide for an inventory of all fish and wildlife resources on the mountain range. The contract will last until April, 1979, and will provide BLM with inventory data necessary to evaluate the future withdrawal status. Hopefully, the contract will define possible other streams inhabited by the cutthroat on the mountain.

In late October, 1977, the Utah Division of Wildlife Resources(DWR), eradicated the rainbow trout below the natural falls barrier on Trout Creek as a start to implement management plans designed to expand the cutthroat population. Future plans call for the transportation cutthroat from Trout Creek into the headwaters of Red Cedar Creek a remote stream on the mountain, which was given first priority for transplant efforts. The DWR plans to rehabilitate about seven additional east slope streams to enhance cutthroat survival back into their historic range. A habitat management plan (HMP) is being developed for the entire mountain ecosystem by the BLM, in cooperation with the Utah Division of Wildlife Resources, will specify management of all east slope streams for the cutthroat. The complete HMP is scheduled for completion in 1978-79 for all of the mountain resources, of which the cutthroat is an integral part of the fauna. At present the BLM has developed a HMP for Trout Creek and began implementation of this plan in 1977 using Sikes Act (P.L. 93-452) authorities. Using Youth Conservation Corps (YCC) workers, some 75 long-type stream improvement structures were constructed in July in Trout Creek to aid the bank stabilization and pool quality enhancement for the cutthroat. Stream improvement work is scheduled again in 1978 by BLM using the YCC.

Although there are differences in the taxonomic characters between S. c. utah and the cutthroat found in Snake Valley, there also exists much overlap. Basibranchial teeth counts, which seem to be a distinctive characteristic separating the two forms, were found to be similar in number in one S. c. utah sample from Willow Creek, Jordan River drainage, Utah (Hickman 1977). With the analysis of more samples from the Bonneville Basin the degree of overlap between these cutthroat becomes more obvious. This overlap is further substantiated through the use of a computer-aided discriminant function analysis, which evaluates the similarities and differences between samples (Hickman 1977). Sixteen(16) morphomeristic character measurements (refer to Table 1) from samples of various described and undescribed subspecies of cutthroat trout, and one sample of rainbow trout, were compared (refer to Figure 2). The closer the group centroid (represented by dot in Fig. 3) the more similar the samples. The cutthroat trout in Snake Valley and S. c. utah are closely situated, indicating a high degree of similarity. Of interest is the similarity depicted in the discriminate function plot between S. c. pleuriticus (Colorado River Cutthroat) and S. c. stomias (Greenback cutthroat). 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.

Table 1. Morphomeristic Characters Used in the Discriminant Function Analysis, 1977.

Head Length
Upper Jaw Length
Snout tip to dorsal fin origin
Dorsal fin length
Caudal peduncle depth
Caudal peduncle length
Gillrakers upper
Gillrakers lower
Gillrakers total
Branchiostegal rays right
Branchiostegal rays left
Scales above latera line
Pelvic fin rays
Pyloric caeca
Basibranchial teeth

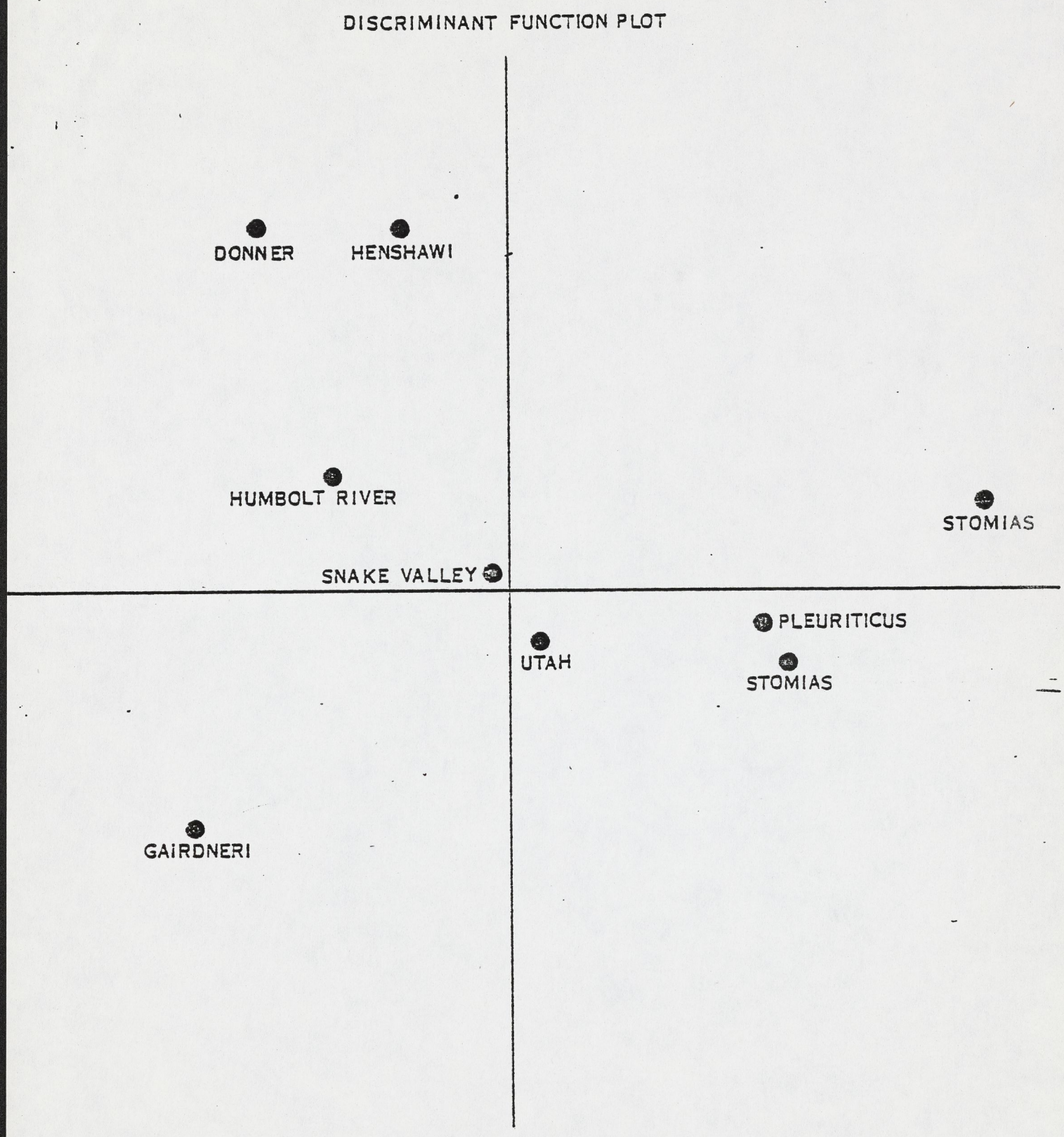

Figure 3. Discriminant Function Plot Analysis Chart Showing Relationship of Cutthroat Subspecies Based on Morphomeristic Characters.

To avoid taxonomic confusion, which has led to subspecies classification delays, the cutthroat trout in Snake Valley should be considered a unique form of S. c. utah. S. c. utah is not abundant in any portion of its native range, and at one point was thought to be extinct as a pure form (Miller 1950, Cope 1955, Platts 1957, and Sigler and Miller 1963). The 1973 version of the U.S. Department of Interior's "Red Book" of endangered and threatened species listed S. c. utah as "status undetermined;" the International Union for the Conservation of Nature (1969) listed it as rare; Holden et al (1974) considered it endangered; the Wyoming Game and Fish Department lists it as rare, the Nevada Fish and Game Department considers it endangered, and Behnke (1973, 1976b) considers it to be rare with a highly restricted distribution.

CUTTHROAT DISCOVERY IN THE PILOT PEAK RANGE

In an effort to locate additional populations of Bonneville Basin cutthroat trout, a survey of the Pilot Peak Range (North of Wendover on the Utah-Nevada border) was conducted in 1977 by the BLM and Colorado State University (under a contract funded by BLM).

As a result of these surveys only two streams were found containing sufficient annual flows to support trout populations. One stream, to the north of Pilot Peak, Bettridge Creek has an abundant population of rainbow trout which were first stocked by the Utah Division of Wildlife Resources in the 1940's, or early 1950's. The other stream, located in the adjacent canyon to the south of Bettridge Creek, is unnamed (for the present we have called it Donner Creek since it historically drained into Donner Springs). The city of Wendover, Utah obtains a portion of its water supply from this creek.

Mr. Kent Sumners, Utah Division of Wildlife Resources, discovered the presence of the cutthroat in Donner Creek in April, 1977 while sampling the stream at the request of the BLM. Subsequent collection of specimens by the authors and their later analysis at Colorado State University confirmed this classification. Taxonomic analysis of the 17 trout sampled from Donner Creek proved most interesting. They are pure strain cutthroat trout (no sign of hybridization) and have a higher gillraker count than any other cutthroat population (24-29, avg. 26.1).

The origin of this cutthroat is uncertain, however Mr. Howard Gibson, retired water master for the city of Wendover, indicated that the cutthroat were in Donner Creek when he commenced work on the stream in 1952 (personal comm. with H. Gibson, Wendover Utah). None of the other local residents contacted could provide any information pertaining to the cutthroat, and most were unaware of its existence in Donner Creek. The Nevada Fish and Game Department has no record of cutthroat stockings in the Pilot Peak Range (letter to Don Duff, BLM, SLC from Pat Coffin, Nevada Fish & Game Dept., Elko, October 1977). The only cutthroat exhibiting such high gillraker numbers is the Lahontan cutthroat trout (S.c. henshawi)

(Behnke and Zarn, 1976). The most probable origin of the Donner Creek cutthroat is Pyramid Lake, since from the late 1890's to 1930 cutthroat trout from Pyramid Lake were stocked extensively in Nevada. In 1910 Elko County received a large shipment of eggs but no records exist on where these fish were stocked. Little stocking of Lahontan cutthroat occurred from 1931-1942, but in 1950 Lahontan trout from Summit Lake, Nevada were used for stocking. After 1930 S.c. henshawi was considered rare and it seems unlikely that a creek in the Pilot Range would be stocked with this cutthroat subspecies.

The discriminant function analysis (Table 1 and Figure 3) indicates that the cutthroat from Donner Creek are the most similar to S.c. henshawi.

SUMMARY

The Snake Valley cutthroat, a form of S.c. utah, is a unique desert fish resource located in the western Bonneville Basin which is worthy of protection and management for the scientific community as well as the American public. S.c. utah has promising possibilities for enhancing the basin's states fisheries programs for wild trout management. The 1975 listing of endangered and threatened fishes of the western U.S. by the Desert Fishes Council did not consider this subspecies. We feel adequate habitat and species data now exists on which to base subspecies naming and status recommendations for this cutthroat. It is our recommendation to the Council that this subspecies be listed on the Council's list as threatened throughout its range in Utah, Nevada, and Wyoming. This classification should serve as an aid to organizations and agencies responsible for management of habitat and species in the future. The ultimate management design for this subspecies, and all others so classified is to provide management to a degree whereby survival and protection of the species and its habitat is assured, so critical status classification can be removed. However, should environmental conditions continue to deteriorate and this subspecies eventually be listed by the U.S. Fish and Wildlife Service as threatened, then this classification would provide the necessary protective status while still allowing for recovery programs to function.

The interest in desert fishes management has intensified by agencies and the scientific community by the discovery in 1977 of S.c. henshawi in Donner Creek of the Pilot Peak Mountain Range. The major significance of this find of S.c. henshawi is that it very likely represents the original Pyramid Lake genotype - the largest trout native to western North America and long believed to be extinct (Trojnar and Behnke, 1975, Behnke and Zarn, 1976). This find is worthy of intense management effort by the Utah Division of Wildlife Resources (DWR) and the BLM, since the existence of this pure strain fish is extremely limited as indicated by its official threatened status by the U.S. Fish & Wildlife Service. Colorado State University is continuing contract studies on this mountain range for the BLM. The BLM plans to implement the Pilot Peak Mountains HMP in 1978 under Sikes Act authorities in cooperation with the DWR. Stream habitat improvements are being planned for Bettridge Creek which at present has a natural reproducing population of rainbow trout. This creek could

serve in the future as a possible transplant site for the Lahontan cutthroat in Donner Creek. Both creeks have good stream habitat being in a relatively undisturbed state from man and livestock activities and located in a remote area adjacent to the arid wastes of the Great Salt Lake desert salt flats.

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