THE NATIVE CUTTHROAT TROUTS OF WYOMING
III: Evaluation of 1977 Collections from
The Green River and Bear River Drainages

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In parts 1 and 2 of this series of reports written in 1975, I pointed out that six subspecies of cutthroat trout are native to Wyoming: *Salmo clarki lewisi* of the upper Missouri River (mainly restricted to the drainages above Great Falls, Montana) is native only to a small area of the northwest tip of the state forming the headwaters of the Madison and Gallatin rivers in Yellowstone National Park; *S. c. utah*, the Bonneville basin cutthroat trout, is native to the Bear River drainage in a narrow strip along the Idaho border in southwest Wyoming; the large-spotted cutthroat trout native to the upper Snake River system and to the entire Yellowstone drainage downstream to the Tongue River, I recognize as *S. c. bouvieri*; *S. c. pleuriticus* is the native trout of the Green River system; *S. c. stomias* once inhabited a small area of the South Platte River drainage south of the Laramie-Cheyenne region along the Colorado border; the only subspecies still holding its own in its native range, is the fine-spotted Snake River cutthroat trout, an undescribed subspecies.

No trout are native to the eastern half of the state in areas drained by the Powder, Belle Fourche, Cheyenne and North Platte systems. To assist in understanding the original distribution of the subspecies native to Wyoming, I have included a distribution map (figure 1).

It has been long obvious that most of the native trouts of Wyoming have suffered rapid declines and have long disappeared from most of their original range. The major factors causing the decline have been replacement by brook trout and hybridization with rainbow trout and mixing of various subspecies of cutthroat trout in fish propagation and stocking practices. Man-induced habitat alterations have a synergistic effect, greatly speeding up the process of replacement and hybridization.

The greenback cutthroat trout, *S. c. stomias*, is now extinct in Wyoming. The Madison and Gallatin rivers and their tributaries are now dominated by brown, rainbow and brook trouts. In Wyoming, I know of only one pure population of *S. c. lewisi*--in Cougar Creek, an isolated tributary of the Madison. The large-spotted cutthroat trout is still the only trout found above the falls in the Yellowstone drainage and is still a dominant trout in much of the Snake River drainage above Jackson Lake, but below the falls of the Yellowstone, I have identified only one pure population--in South Paint Rock Creek, north of Tensleep in the Bighorn drainage. The fine-spotted cutthroat trout native to the Upper Snake River, evolved in a big river environment, evolutionarily programmed by interactions with a rich native fish fauna and ecologically is very different from the other native subspecies in respect to successful competition with other fishes in diverse environments.

The Bonneville cutthroat trout and the Green River cutthroat trout are both virtually gone as pure populations from their former large ranges in several states. What is left in Wyoming can be considered as "strongholds" of these two rare subspecies.

It is apparent that the basis for any program designed for native trout management is the recognition and identification of the remnant populations of the native subspecies. This is not a simple matter as I have discussed in previous reports. The six subspecies can be correctly identified on differences in their coloration, spotting pattern and mean differences in characters such as scale counts and pyloric caecal counts. Slight hybrid influence, however, is difficult to detect and there are no absolute criteria by which a population can be "certified pure." Because of this, and because of the rareness of populations resembling rare native subspecies such as *S. c. pleuriticus* and *S. c. utah*, I previously recommended a "sliding scale" of purity recognition. I judge as "pure" those collections which approximate the "idealized" version of the spotting pattern and show no sign of hybridization in their meristic characters. For those populations showing no outward indication of hybridization but have other, more subtle indicators of hybrid influence such as reduction or loss of basibranchial teeth, I have called "virtually pure" or "good phenotypic representatives," depending on the magnitude of the hybrid influence. Binns (1977) has taken my data and further refined the purity ranking system from A (pure) to F (hybrid swarm), to provide a more quantitative basis for Wyoming's native trout program.

In this present report, I have examined 8 collections of 85 specimens (4 collections from Upper Green River and 4 from Little Snake drainage) for an evaluation of their purity as *S. c. pleuriticus*, and 51 specimens of 2 collections from the Bear River drainage for evaluation of *S. c. utah* purity.

Of particular interest is the verification of the phenomenon of spotting distinction, noted in previous reports, between the *S. c. pleuriticus* native to the Upper Green River basin and those native to the Little Snake headwaters. This unique spotting pattern, illustrated in Binns (1977), facilitates the evaluation of Little Snake drainage *pleuriticus*. As with previous studies, all of the Little Snake collections rank as virtually pure (perhaps an A-grade). Although the geographical area is small and the habitat miniscule, the occurrence of a cluster of many populations in the headwaters of the North Fork of the Little Snake (and in Deep Creek and Douglas Creek headwater tributaries to Big Sandstone Creek, just to the north), makes for the greatest known concentration of pure or virtually pure *S. c. pleuriticus* in the entire Colorado-Green River basin. The Middle Fork and South Fork of the Little Snake are in Colorado and have not yet been investigated for the occurrence of native trout.

Also of significance is the occurrence of a pure or virtually pure population of *S. c. utah* (equal in purity to the Raymond Creek population) in upper Giraffe Creek, and a probable pure population of this subspecies in Lake Alice. As discussed below, the Lake Alice trout have recognizeable differences from typical *S. c. utah*, but these differences are opposite from the direction expected from hybrid influence with rainbow trout or Yellowstone or Henry's Lake cutthroat trout and are more likely the result of long isolation and independent evolution of a population exposed to a very different environment (lacustrine vs. fluvial). Lake Alice represents the only lacustrine population of *S. c. utah* in the Bonneville basin and tremendously enlarges the area (in surface acres of water) where this subspecies is known to exist.

The collection of specimens from Lead Creek of the Upper Green River drainage represents the most consistent uniformity of the idealized *pleuriticus* spotting pattern of any sample I have yet examined. The specimens are virtual mirror images of each other.

The meristic data taken from the 1977 specimens are listed in Table 1.

Comments on Methods of Classification and Identification

In recent years it has become apparent to me that among professional biologists and administrators a naive faith has developed in the belief that the confusion surrounding trout taxonomy can be swept away by modern technology with the use of biochemical, cytogenetic and computer techniques. Much time, effort and funds can be wasted in projects which ultimately only add to the confusion. It is a matter calling for the judicious exercise of common sense.

For a better understanding of some of the limitations different techniques may have in relation to providing answers to specific evolutionary questions, it is helpful to understand the basic premises on which a classification system is based and the interpretation of the manifestations of evolutionary divergences within the phylogeny in question.

The classification of species and subspecies of a genus and of genera in a family is based on points in a network of divergent evolutionary lines. The goal of a system of natural classification is to detect unique genetic events that occur in one evolutionary line, but not another since they separated from a common ancestor. The longer the time period involved from the present to any particular branching point in a phylogeny, the more time for unique events to accumulate and the better the chance to detect these events by taxonomic methods. No matter what method is used (traditional morphological, biochemical or cytogenetic), they all depend on the detection of these unique events for their efficacy.

The branching point in time separating the ancestor of the family Salmonidae from other families in the order Salmoniformes, is perhaps of 2000 fold greater magnitude than the time since the separations leading to the present subspecies of *Salmo clarki*. With this in mind, it should be understandable why it is not likely to detect the relatively few unique genetic changes accumulated during the last 10,000 to 50,000 years in cutthroat trout subspecies by examining the products of a few gene loci (out of 100,000's) in electrophoretic studies. This is particularly true in light of the types of gene loci amenable to delineation by modern techniques--they govern protein and enzyme systems not likely to be strongly selected for under different selective pressures. That is, the small differences in gene frequencies found are more of a random nature and not of the adaptive, directional genetic change guided by natural selection (the type of change useful for taxonomy).

A recent manuscript written by Mr. Eric Loudenslager of the University of Wyoming and based on his M.S. thesis, reveals no differences in 23 gene loci between the fine-spotted Snake River cutthroat trout and the large-spotted cutthroat trout of the upper Snake River and Yellowstone Lake. Yet a small child could readily identify and accurately separate these two subspecies on the genetic based differences governing their distinctly different spotting patterns.

Mr. Loudenslager's study does verify the close genetic relationships between these subspecies and supports my previous contention that the fine-spotted Snake River cutthroat trout was derived from the large-spotted ancestor in the Upper Snake River, probably while isolated in a glacial ice-dam lake, and not from a *S. c. lewisi* ancestor transferred from the headwaters of the Salmon River drainage across the present Snake River lava plains.

Another point of great interest discovered by Mr. Loudenslager is that there is virtually no heterozygosity detectable in the 23 loci he examined in the fine-spotted Snake River cutthroat. It is a common belief that heterozygosity (more than one form of a gene [allele] at any one gene locus) is of predictive significance to detect inbreeding or for considering the probable success of an introduction into new waters in relation to the adaptability a particular genotype has to survive and flourish in new environments. To date, the trout with the highest heterozygosity index is the California golden trout, *Salmo aquabonita*. Considering only Wyoming experiences of use of fine-spotted Snake River cutthroat trout and of golden trout in fisheries management, it is obvious that heterozygosity indices must be viewed with some skepticism as a practical fisheries management test.

It has also become popular in recent years to attempt to quantify relationships between subspecies of a species and species of a genus based on degree of gene loci similarity and expressed as genetic similarity or genetic identity scores. The limitations of this sort of quantification for taxonomy is apparent from the genetic similarity values showing a greater divergence between subspecies of the house mouse than between man and the chimpanzee--a tremendous amount of information incorporated by unique genetic events in the phylogenies in question was not uncovered by electrophoretic techniques.

The evolution of the races of man and of subspecies of cutthroat trout have much in common in relation to the geological time span involved, the magnitude of genetic differentiation and how we detect the manifestation of this differentiation. It would not be difficult to recognize and quantify the morphological distinctions between a pure Australian aborigine and a person typifying the Nordic race. There are, however, no consistent differences in gene loci yet examined which can do this--the races of man have recently evolved and have little genetic differences, but these differences are expressed in easily recognized characteristics.

The use of computers offers the opportunity to handle enormous amounts of data and to quantify similarities and differences by various programs in a manner not otherwise possible. My students and I have been experimenting with different computer programs to handle trout taxonomic data. Figure 2 is based on a two dimensional discriminant function analysis comparing 14 morphological and meristic characters of all the specimens of *S. c. pleuriticus* and *S. c. utah* examined for this report.

Two points must be kept in mind when considering "computer taxonomy": the computer does not create new characters and it cannot differentiate between genetic and non-genetic differences--that is three groups of trout from the same parents, raised under different conditions influencing growth rate would have morphological differences (body proportions) and be grouped as three distinct clusters in a program utilizing these morphological criteria.

Although, essentially, the computer print-outs do not tell me something I do not already know from my examination of the specimens and my familiarity with trout taxonomy, it can be a useful tool of communication to make my taxonomic conclusions more understandable to others and to attempt to place some quantifiable, but arbitrary, limits on subspecies and purity rankings of a subspecies.

In general then, the unique evolutionary changes that have accumulated in the period of relatively recent geological time to produce the six subspecies of cutthroat trout native to Wyoming, are most readily detected in genetic differences manifested in spotting pattern and coloration associated with trends in meristic characters such as number of scales, gillrakers, pyloric caeca and basibranchial teeth. My most astute advice to agencies considering taxonomic work associated with management programs for native trout is to ask the right questions and then critically consider the probability that the proposed technique will answer these questions.

Evaluation of *S. c. pleuriticus* Purity

All 38 specimens from the four streams in the Little Snake drainage are identical to previous samples of specimens from this drainage which I have judged to be virtually pure *S. c. pleuriticus*. The Little Snake native trout are, however, recognizably different from *S. c. pleuriticus* native to the upper Green River in their larger spots on the caudal peduncle area. In comparison between fish of the same size from Lead Creek (upper Green) with any of the Little Snake collections, the largest spots on the caudal peduncle of Little Snake drainage cutthroat trout are almost twice the size of those spots on upper Green River specimens. All other characters are essentially similar and I would not propose new subspecies recognition for the Little Snake (Yampa River system) cutthroat trout. It is likely that when *S. c. pleuriticus* inhabited all tributaries of the Green River, a transition in spotting size existed in tributaries upstream from the mouth of the Yampa.

The collections consist of 7 specimens from Rabbit Creek, 11 specimens from the West Branch of the North Fork, 10 specimens from Rose Creek (N. Fork Little Snake drainage) and 10 specimens from Deep Creek (tributary to Big Sandstone Creek). They are consistently uniform in appearance and show no outward sign of hybridization in any specimen. The only substantial evidence that these populations have been slightly influenced by hybridization with rainbow trout is the absence of basibranchial teeth in 10% to 27% of the three collections from the North Fork drainage (9 of 10 specimens from Deep Creek have basibranchial teeth). I have previously identified obvious rainbow-cutthroat hybrids in the lower North Fork of the Little Snake and in Big Sandstone Creek (grade D or F of Binn's ranking) and brook trout also occur in these drainages. There are no physical barriers preventing the spread of hybrid influence nor the replacement of the cutthroat trout by brook trout as has occurred throughout most of the range of the subspecies. Undoubtedly, the preservation of essentially pure *S. c. pleuriticus* genotypes in this area is due to their superiority in their particular environments resulting in negative selection against hybrid influence. This situation, however, is fragile and precarious. Any changes in the environment (flows, temperature, turbidity, etc.) may destroy the present balance and lead to the rapid spread of hybrid influence and/or replacement by brook trout.

The collection from Lead Creek of the upper Green drainage may represent a pure population of *S. c. pleuriticus*, but number of pyloric caeca are slightly higher than expected and 2 of 17 specimens lack basibranchial teeth. The 15 specimens with basibranchial teeth have from 5-18 (10.7) teeth--the greatest number of any sample examined for this report. In a sample of 12 specimens collected from Lead Creek in 1970, all specimens have basibranchial teeth (5-17 [11.1]). When combined, 27 of 29 specimens from Lead Creek (93%) have basibranchial teeth, meeting my criteria of at least 90% occurrence of these teeth in pure populations of *pleuriticus*.

As mentioned above, the spotting pattern of the Lead Creek cutthroat trout is the most consistently uniform of any sample yet examined. Hybrid influence is typically first noticeable in loss and reduction of basibranchial teeth (rainbow trout influence) and in greater variability in size, shape and position of the spots (rainbow trout and non-native cutthroat trout influence). Based on its ideal *pleuriticus* phenotype, the Lead Creek cutthroat trout might be considered for propagation and introductions into other waters.

The sample of 8 specimens from Rock Creek, a direct tributary to the Green River, below Kendall (not the Rock Creek of previous reports which is tributary to La Barge Creek) and the sample of 8 specimens from Dead Cow Creek, tributary to South Horse Creek are ranked as B in Allan Binn's rating system. All of the 8 specimens from Dead Cow Creek have basibranchial teeth, and the meristic characters are typical of *S. c. pleuriticus* but the spotting pattern, in size, shape and distribution indicates influence of probably both Yellowstone cutthroat and the fine-spotted Snake River cutthroat in this population. Two of the 8 specimens from Rock Creek lack basibranchial teeth and the spotting pattern (rough, jagged edges vs. smooth, rounded spots of *pleuriticus*) indicates rainbow trout and fine-spotted Snake River cutthroat trout influence. The meristic characters, however, indicate that both of these populations, although not pure, are overwhelmingly of the *S. c. pleuriticus* genotype. This assumption can be checked by observing the living coloration of these trout. Only *S. c. pleuriticus* genotypes can develop the brilliant red, orange and yellow hues. Rainbow trout, Snake River and Yellowstone cutthroat trout lack the genetic basis to express these bright colors on the body.

The collection from August Lake, comprising 14 specimens, is certainly predominantly *S. c. pleuriticus*, but may have been influenced by introductions of Yellowstone Lake cutthroat. All specimens have basibranchial teeth, scale counts and caecal counts are typical of *pleuriticus*, the spots are smooth and rounded in outline, but the distribution of spots is highly variable. Some specimens have only a few spots on the caudal peduncle while others have them all over the sides of the body.

I cannot find August Lake on my Forest Service map but from the geographic locality I note it is in the Boulder Creek watershed, east of Pinedale, and most of that quadrant is drained by North Boulder Creek. I point this out because of my previous identification of the cutthroat trout in lakes of North Boulder Creek drainage (Lakes Victor, Lower Pipestone Lake) as introduced Yellowstone Lake cutthroat trout. In 1969 it was believed that only pure *S. c. pleuriticus* occurred in the North Boulder Creek drainage above a lower barrier falls. After my determination of specimens as Yellowstone Lake cutthroat, Galen Boyer found Forest Service records of stocking these formerly barren waters with Yellowstone cutthroat trout in 1937.

August Lake cutthroat are definitely not Yellowstone Lake cutthroat trout (but they may have been slightly influenced by introductions from Yellowstone Lake). Is the population in August Lake natural or originally introduced by man? Are there any records of stocking? There is no way to decide if the variability in spotting pattern is a completely natural phenomenon (as it does not correlate with any of the other characters, which are typical of *pleuriticus*) or if it is caused by a slight influence from Yellowstone Lake cutthroat trout. The August Lake cutthroat trout can be considered as good, possibly pure *pleuriticus*; my reservations concern the variability in spotting pattern and an extreme gillraker count of 23. The living colors of these trout should be noted. Yellowstone trout influence would act to subdue the brilliant *pleuriticus* colors.

Evaluation of *S. c. utah* Purity

Since my last reports written in 1975 concerning the Bonneville basin native trout, *S. c. utah*, I have obtained considerably more information on this trout through a 1976 collecting trip and report written on the Thomas Fork drainage for the Rock Springs BLM office and through a study on *S. c. utah* funded by the BLM Utah State office, leading to a M.S. thesis on *S. c. utah* by my graduate student, Mr. Terry Hickman.

Previously, I had assumed that the higher number of pyloric caeca consistently associated with cutthroat trout of the Bear River drainage when compared to values of *S. c. utah* from the rest of the Bonneville basin, was a result of rainbow trout influence. I now realize that the Bear River was always a large fluvial environment, even when tributary to Lake Bonneville, and as such it would be expected that selective pressures would favor the evolution of a fluvial adapted cutthroat trout for the populations native to the Bear River (that is, they were not exposed to lacustrine selection in Lake Bonneville). This same phenomenon also occurred in the Lahontan basin to a greater degree where the cutthroat trout native to the Humboldt River drainage is distinctly different from the native trout of the rest of the Lahontan basin.

Much of both the Humboldt drainage of the Lahontan basin and the Bear River drainage of the Bonneville basin are in semiarid foothill regions characterized by highly fluctuating and unstable environments in respect to flows and temperatures. Evidently the selective pressures and evolutionary adaptations of Humboldt and Bear River cutthroat trout are similar. Both are found in habitat that would be considered completely unfit for cutthroat trout. Yet, in badly degraded habitat, in streams subjected to great extremes of flood and drought, I found the native cutthroat trout of the Thomas Fork and Smith Fork drainages of the Bear River to completely dominate the introduced brook trout and brown trout. Also the native *S. c. utah*, even along roadside areas, had resisted hybridization from past introductions of Yellowstone cutthroat and the fine-spotted Snake River cutthroat trout to an amazing degree. It appears obvious that Bear River system *S. c. utah* have adaptations superior to any other trout for the degraded conditions of the Thomas Fork and Smith Fork drainages, and as such, have a real potential for fisheries management.

In my report to the BLM I mentioned that in 1969, I sampled 30 specimens from the Smith Fork near the mouth of Hobble Creek and 22 of the 30 fish were hatchery raised fine-spotted Snake River cutthroat trout. In 1976 we sampled this same area (stocking had ceased in 1972) and all 16 trout I observed were typical of *S. c. utah*. Of 91 specimens examined from the Thomas Fork drainage in 1976, only one showed a small patch of irregular spots to indicate a lingering influence of past introductions of the fine-spotted Snake River cutthroat. Although Wyoming Game and Fish records show no introductions of rainbow trout into the Thomas Fork drainage, the absence of basibranchial teeth in several specimens, definitely indicates a slight influence of past hybridization with rainbow trout.

In my previous reports to the Wyoming Game and Fish Department and to the BLM, I rated the collections of *S. c. utah* from the Thomas Fork and Smith Fork drainages as good phenotypic representatives (B rating of Binns) and selected the more isolated population in Raymond Creek of the Thomas Fork as the purest *S. c. utah* population known from the Bear River system. In 1976, I suggested to Wyoming Game and Fish biologist Don Miller that a collection should be made from upper Giraffe Creek, which led to the 1977 collection.

In Table 1, a comparison is presented between the 34 specimens collected from upper Giraffe Creek in 1977 and 15 specimens from lower Giraffe Creek made in 1973. There are some genetic based differences in these two samples with the population in upper Giraffe Creek representing a pure or virtually pure population of the *S. c. utah* native to the Bear River system. I would now assign an "A" *S. c. utah* rating to both Raymond Creek and upper Giraffe Creek. Basibranchial teeth were found in 33 of 34 (97%). The spotting pattern is consistent and uniform, with relatively large, round spots sparsely distributed over the sides of the body.

It is not known if the trout in upper Giraffe Creek are physically isolated from the slightly hybridized population occurring near the mouth, or if, the absence of detectable hybrid influence is due to strong negative selection against non-native genes. In any event, upper Giraffe Creek (in both Idaho and Wyoming) assumes a special significance in relation to the preservation of pure *S. c. utah*.

The spotting pattern and particularly the coloration of *S. c. utah* is quite distinct from *S. c. pleuriticus* (but not very different from their closest relatives, the large-spotted cutthroat trout native to the upper Snake and Yellowstone drainages). *S. c. utah* does not develop brilliant coloration. The colors are dull and subdued. Faint traces of pink and yellow may appear on some specimens, but I have never observed the bright red, orange, or brilliant gold-yellow colors characteristic of *pleuriticus*.

Lake Alice, a lake of about 237 surface acres, was formed at some unknown time by a landslide across Hobble Creek isolating the area and converting the headwaters of the drainage into a mountain lake. The original trout population isolated above the slide gave rise to the present lacustrine population. Lake Alice cutthroat trout were formerly used for egg taking and propagation. Existing records list past introductions of non-native cutthroat trout (probably of Yellowstone Lake or Henry's Lake origin) into Lake Alice. It is also probable that, officially listed or not, rainbow trout were stocked into Lake Alice.

The 17 Lake Alice specimens are recognizably differentiated from other *S. c. utah*. They have fewer spots on the body (typically 25-30 vs. 40-50). Yellowstone or Henry's Lake cutthroat trout influence or rainbow trout hybrid influence in a *S. c. utah* population would result in more, not fewer spots. The lateral series scale count averages about 10 less in Lake Alice specimens than in collections from Raymond Creek and upper Giraffe Creek, but either Yellowstone Lake or Henry's Lake cutthroat influence would increase, not decrease, scale numbers. Basibranchial teeth are well developed and occur in 16 of 17 (95%) of the specimens.

The Lake Alice collection averages two fewer gillrakers than Yellowstone Lake or Henry's Lake cutthroat. There is no detectable evidence of non-native cutthroat trout or rainbow trout hybrid influence in the Lake Alice specimens. The differences noted between the Raymond Creek and upper Giraffe Creek *S. c. utah* and Lake Alice specimens are more likely the result of long isolation under quite different selective pressures between the populations. At least the recent evolutionary history of the Lake Alice population has been associated with a more typical pristine mountain environment and in the absence of any other native fishes (generalized type of cutthroat environment) rather than the harsh and unstable environment guiding the selection of the populations in the foothills and lowland areas. With this in mind, the Lake Alice genotype might perform quite differently from the Raymond Creek genotype when introduced into different environments. For introductions where the establishment of new populations is not intended, some creative propagation techniques might be tried, such as crosses between Lake Alice and Raymond Creek trout to broaden the base of genetic diversity.

The Bear River drainage in Wyoming has suffered enormous loss of trout habitat quality from water diversions and livestock grazing (accelerated by herbicide spraying) and is presently under the threat of energy exploration.

There is a great potential to restore quality habitat by better range management practices and livestock exclosures. The result should be a great increase in abundance of the native trout in the Thomas Fork and Smith Fork drainages, which in turn, would attract greater fishing pressure. Because of the vulnerability to angling of cutthroat trout in streams, it is likely that about 50 hrs./acre/yr. of angling pressure will remove 50% of catchable size fish. When angling pressure reaches this point, special protective regulations should be seriously considered for main-stem, easily accessible areas to maintain a quality fishery.

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Table 1. Character analysis of 1977 collections of cutthroat trout from the Green River and Bear River basins.

Locality	Gillrakers	Pyloric caeca	Scales above lat. line & lat. series	Basibranchial Teeth
Green R. Tributaries				
Rock Crk. N=8 R106W, T34N	18-22 (20.1)	28-38 (33.5)	41-46 (43.8) 168-196 (186.5)	2 no teeth 6 with 1-7 (3.2)
Dead Cow Crk. N=8 Trib. to So. Horse Crk.	18-22 (19.6)	32-46 (40.4)	39-45 (42.7) 159-192 (180.7)	2-10 (5.9)
August Lake N=14 R106W T34N	16-23 (19.1)	32-48 (39.6)	38-46 (43.3) 172-200 (186.2)	2-16 (9.3)
Lead Crk. N=17 Trib. to Horse Crk.	17-21 (19.8)	36-48 (42.1)	39-47 (42.6) 158-202 (180.2)	2 no teeth 15 with 5-18 (10.7)
Little Snake drainage				
Upper W. Br. N. Fork N=11	17-21 (19.3)	24-44 (33.2)	38-48 (42.5) 166-201 (181.3)	3 no teeth 8 with 2-8 (4.1)
Rabbit Crk. N=17	17-21 (19.1)	34-40 (36.4)	40-46 (43.0) 183-193 (187.3)	2 no teeth 5 with 3-8 (5.4)
Rose Crk. N=10	18-20 (19.0)	32-47 (38.4)	39-44 (41.7) 162-181 (174.1)	1 no teeth 9 with 2-11 (6.7)
Deep Crk. N=10 Trib. Big Sandstone	18-21 (19.6)	31-36 (33.7)	39-45 (41.9) 168-192 (181.6)	1 no teeth 9 with 1-11 (5.6)

Table 1 Continued

Locality	Gillrakers	Pyloric caeca	Scales above lat. line & lat. series	Basibranchial Teeth
Bear River drainge of Bonneville basin				
Upper Giraffe Crk. N=34	16-21 (18.5)	35-49 (41.0)	34-44 (38.9) 149-181 (168.5)	1 no teeth 33 with 1-30 (9.4)
Lower Giraffe Crk. 1973 N=15	18-21 (18.5)	34-64 (48.3)	33-44 (38.1) 141-176 (159.1)	2 no teeth 13 with 1-26 (6.9)
Raymond Crk. 1976 N=31	16-20 (17.6)	39-54 (44.8)	36-44 (39.2) 156-183 (168.6)	1 no teeth 30 with 1-21(5.1)
Lake Alice N=17	17-20 (18.7)	41-57 (47.1)	34-42 (37.7) 145-171 (157.0)	1 no teeth 16 with 1-17 (8.6)

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Probable Discovery of the Original Pyramid Lake Cutthroat Trout

Salmo clarki henshawi, the cutthroat trout native to the Lahontan basin of Nevada and California, evolved in pluvial Lake Lahontan, a late Pleistocene lake, comparable in size to present day Lake Erie.

As the only larger predator among several potential cyprinid and catostomid forage species, the selective pressures determining the evolutionary divergence of *S. c. henshawi* perhaps resulted in the largest and most highly predacious trout native to western North America (Behnke and Zarn 1976). Only the population in Pyramid Lake, Nevada, continued to coexist with the full array of the Lahontan basin fish fauna after the final dessication of Lake Lahontan about 8000 years ago. Stocks of *S. c. henshawi* persisting in streams of the Lahontan basin evidently were ill adapted by virtue of an evolutionary heritage as a large, lacustrine predator and rapidly disappeared after nonnative trouts were introduced. Only a few small headwater streams isolated by barrier falls still contain *S. c. henshawi,* and two native lacustrine populations still exist in Independence Lake, California, and in Summit Lake, Nevada. Although "*S. c. henshawi*" has been propagated in large numbers since the 1950's, the bulk of hatchery-produced Lahontan cutthroat trout are derived from Heenan Lake, California, from a stock originating from the Carson River, but which is slightly hybridized with rainbow trout (Behnke and Zarn 1976). The taxon *S. c. henshawi* was formerly recognized as an endangered species under the 1973 Endangered Species Act, but its status was changed to "threatened" in 1975 to facilitate management and to allow angling.

The uniqueness of the Pyramid Lake population lies in the fact that this stock persisted in a continuous lake environment for 50,000 to 100,000 years. Pyramid Lake is the only lake in the Lahontan basin that has maintined a direct continuity from pluvial Lake Lahontan with a retention of the original fish fauna. The evolutionary programming associated with a continuous environment endowed the native trout of Pyramid Lake with specialized adaptive features reflected in their behavior and physiology to maximize efficiency of energy conversion and use of the entire environmental resources.

The evolutionary selective factors acting to specialize the Pyramid Lake cutthroat trout for the large-lake environment and to feed on the abundant schools of large forage fish, which attain lengths of 375-450 mm (15-18 in.), were responsible for making this fish the largest trout native to western North America. The official world record cutthroat trout, taken from Pyramid Lake, weighed 18.6 kg (41 lb), but it is a common belief among the older Paiute Indians around Pyramid Lake that much larger trout were once regularly caught by the Indian fishermen. Wheeler (1969) reported a trout of 28.2 kg (62 lb) taken in 1916 in the Indian fishery. Summer (1940), observing the final spawning run of cutthroat trout from Pyramid Lake in 1938, recorded the average weight of the trout in the run as 9.1 kg (20 lb). Since 1955, millions of *S. c. henshawi* of Heenan Lake origin (in more recent years, supplemented by the offspring of Summit Lake trout), have been stocked into Pyramid Lake to support a trophy fishery, but relatively few specimens larger than 9.1 kg have been taken in the last 20 years.

The demise of the original Pyramid Lake trout began in 1906 with the closure of Derby Dam, part of the Newlands Irrigation Project of the Bureau of Reclamation. This dam blocked the Truckee River, the only spawning stream tributary to Pyramid Lake, about 50 km (30 mi) above the lake. In the 1920's, more and more of the Truckee River was diverted at the dam and complete dewatering frequently occurred. Successful spawning became sporadic; the last known run left the lake during the high-water year of 1938. No water was