THE NATIVE CUTTHROAT TROUT, SALMO CLARKII, OF THE BONNEVILLE BASIN AND THE GREEN RIVER TRIBUTARIES OF UTAH

by

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I. Introduction

A. Purpose of Investigation

The primary purpose of this investigation was to determine if more than one subspecies of native cutthroat trout occur in the Bonneville Basin and the Green River tributaries of Utah. Jordan, 1920, (16, p.72-73); Snyder, 1922, (27, p.23-28); and Hildebrand, 1949, (11, p.7), the most recent literature on the cutthroat series, list two subspecies for these areas: *Salmo clarkii utah* Suckley, occuring in the Bonneville Basin and *Salmo clarkii pleuriticus* Cope, occuring in the Green River drainage.

Such a division, however, has been questioned for many years by anglers and biologists; and at the present time opinions concerning the number of subspecies inhabiting these regions vary considerably. No adequate study has ever been made, although occasional notes pertaining to this trout have been published since 1776. In addition, past taxonomic work with these two subspecies is antiquated, because additional information regarding the differentiation of subspecies has been developed through experimentation during recent years.

Secondary purposes of this investigation were as follows:

1. To summarize briefly the geological and hydrographical history of Bonneville Basin and the Uinta Mountains.

2. To summarize the available evidence concerning the migrational routes of cutthroat trout into Utah.

3. To show that the population of native cutthroat trout in Utah during a period of approximately one hundred years has been reduced by neglect and indifference from an abundance once thought to be limitless to near extinction.

Such a disregard for a member of the native fauna whose requirements conflict with the interests of civilization is not new, for a number of species have experienced similar exploitation in other areas. When the danger of extermination is publicized, however, oftentimes an attempt is made to maintain the threatened animal in sufficient numbers to insure its perpetuation.

B. Importance of Investigation

If two or more subspecies of cutthroat trout were found to be present in these drainages, perhaps their life histories and the physical, chemical, and biological components of the environments of the streams and lakes would be so different that transplanting might be unsuccessful. On the other hand, if it could be proved that only one subspecies were present, stocking one drainage from the other could possibly be practiced indiscriminately.

It is also hoped that this study will direct the attention of those individuals who have been entrusted with the responsibility of conserving the fish resources of Utah to the depletion in numbers of this trout and cause them to institute an effective management program.

C. Study Procedure

In an attempt to solve the primary problem a collection of approximately two hundred native cutthroat trout was made from representative streams and lakes of Bonneville Basin and from tributaries of Green River in Utah. One hundred and four specimens were examined in detail for structural characters currently used by taxonomic ichthyologists to differentiate subspecies.

In addition, all of the literature dealing with these subspecies was studied, and where possible local residents were asked to contribute information concerning the past and present abundance of these fishes.

II. Bonneville Basin and the Uinta Mountains

A. General Description

Bonneville Basin occupies, according to Pack (24, p.15), approximately 54,000 square miles in Utah with small extensions into eastern Nevada, southern Idaho, and southwestern Wyoming. This basin is one of two divisions of the Great Basin which comprises most of Utah, Nevada, and a fringe of California, Oregon, Idaho, and Wyoming.

Roughly the area occupied by Bonneville Basin is three hundred and forty-six miles long between 37° 40' and 42° 20' north latitude and one hundred and forty-five miles wide between 111° 35' and 114° 15' of west longitude. It is bounded by the Uinta and Wasatch Mountains on the east, high plateaus on the south, and by less extensive highlands on the west and the north.

The Uinta Mountains, which have the unique distinction of being the only major range in the United States having an axis in an east-west direction, lie in the northeastern corner of Utah between 110° and 111° of west longitude and near the 41° of north latitude. This range is not a part of the Bonneville Basin, and streams originating in these mountains, although flowing both to the north and to the south, eventually empty their waters into Green River, a tributary of the Colorado River.

B. Lake Bonneville

According to Blackwelder (2, p.10) crustal folding of the surface of the earth during the Pleistocene, approximately two million years ago, formed the Wasatch and Uinta Mountains. Pack (24, p.26) reported that he did not clearly understand the causes, but the very dry climatic conditions prior to the Pleistocene and the formation of the Bonneville Basin were followed by low temperatures and high rainfall. It was during this period that ice sheets covered a portion of the North American continent at least four times; and several canyons within Bonneville Basin and the Uinta Mountains show unmistakable evidence of glaciation.

Evaporation of water during the glacial epochs of the Pleistocene, Blackwelder writes (2, p.12), decreased below the inflow; and as the waters melted and flowed into basins, lakes formed, merged, and gradually formed over a period of thousands of years, a great inland lake. The changes were gradual, Pack believed (24, p.27); and if man inhabited the area, he was likely unaware of the small differences as they appeared.

Most of the drainage during this period emptied into the area now occupied by Great Salt Lake, immediately west of Salt Lake City, Utah; but gradually arms of this inland sea extended into many of the canyons of the high mountains to the east and spread out into the flatter hills to the south, west and north (24, p.28-29).

The waters of this large lake, according to Pack (24, p.29 and p.104) were fresh and particularly favorable for fish life. The shores were covered with luxuriant vegetation; and numerous animals, many of them very different from the familiar species of today, were abundant.

Pack (24, p.31) believed that the time required to fill Bonneville Basin cannot be accurately determined, but he estimated the time to be approximately 2000 years. Dr. Pack (24, p.31-33) proved, however, that the water reached a level about one thousand feet above the present Great Salt Lake where it remained constant long enough to construct a very marked terrace, sufficiently distinct that even today the casual observer cannot mistake its presence on the slopes of the mountains.

Again after a very long time, according to Pack (24, p.33), probably not more than several thousand years, the climate changed, and added moisture raised the level of the lake until water overflowed at the north end of Cache Valley, Utah, at a point commonly referred to as Red Rock Pass (24, p.35). The outflow successively passed into Marsh Creek, Portneuf River, Snake River, and finally into the Columbia River.

Gilbert (9, p.176) thought that the outlet channel attained a width of approximately six hundred feet and carried water equal to that of the present Niagara River. He also reported that water flowed for twenty-five years until the level of the lake had been reduced three hundred and seventy-five feet; but Pack (24, p.37) disagreed, and attempted to show that a much longer period of run-off existed, probably about two thousand years, after which the climatic conditions became warmer and drier, and water ceased flowing through the gap at Red Rock Pass.

During the twenty-five centuries of the post-Bonneville period (24, p.44 and p.86-103) Lake Bonneville has become smaller and smaller, finally splitting into separate lakes which in turn have shrunk until many of them have disappeared. It is this subsequent isolation in distinct drainages that has caused superficial differences to appear among these trouts, differences which have produced speculation concerning the number of subspecies inhabiting these waters. Fortunately, however, the cutthroat trout have found the cold mountain streams and the remaining lakes favorable habitats; and, except for man's intervention, exist there today.

III. Migrational Routes of Trout into Bonneville Basin

A. Jordan's Theory

The routes followed by the original cutthroat trout into western North America and the geological period dating their invasion are uncertain.

Jordan (18, p.489) believed that this trout was originally an inhabitant of the North Pacific. "It seems not improbable that the American trout originated in Asia, extended its range southward to the Upper Columbia, thence to the Yellowstone and Missouri; from the Missouri southward to the Platte and the Arkansas, then from the Platte to the Rio Grande and the Colorado, from the Colorado across the Sierra Nevada to the Kern River, thence northward and coastwise, the sea-running forms passing from streams to streams."

Certainly the fact that various species of Salmo now inhabitating the waters of Alaska, the Pacific coast, Bonneville Basin, and other drainages are closely related gives support to this theory. The presence also of other species belonging to the genera Richardsonius, Rhinichthys, Pantosteus, Catostomus, and Cottus in the Columbia River, Snake River, and Bonneville Basin seem to indicate that such a movement of fishes did occur.

B. Invasion of Marine Fishes

It is possible but not probable that cutthroat trout came inland during the Cretaceous period when oceanic waters covered western North America. Fossils of Salmo have been recovered from the Pliocene in Idaho, and many fossils of other bony fishes have been removed from the earth's crust as far back as the Triassic and Jurassic Periods.

Fossil Salmo specimens, however, have never been found in Bonneville Basin; and, therefore, it is impossible to assign a definite period during which this fish came into this area; but the absence of fossils is in no way conclusive that they will not be found in future excavations.

Tanner, Woodward, and associates (29, p.81-89) have discovered sixteen species of fossil fishes from the Devonian, Triassic, and Tertiary Periods, but they were all marine types.

C. Migration to the Colorado River Basins

Although the migration of cutthroats into Bonneville Basin has been rather satisfactorily explained, the routes followed to the Green River drainage are uncertain.

Keyes (20, p.358-362) believed that the Snake River was once the headwaters of the Virgin River which flowed through Utah into the Colorado. The fact that the fish faunas, according to Hubbs (13, p.31), of the Colorado and Snake Rivers are not similar and the fact that most geologists do not accept this theory make such a possibility unacceptable even though it would explain the dispersal of cutthroat trout to the Colorado River.

Evermann(7, p.29-34) in his description of

Two-Ocean Pass, described how a stream may transfer its water from one river system to another. Perhaps similar stream-captures occurred along the Wasatch Mountains; for as the present study shows, the cutthroats of the two regions are identical except for minor differences. Such a migration was, in all probability, by way of a surface water connection. Transfers by means of waterspouts and sub-surface water channels have proved to be very rare.

There remains the possibility, however, that fertilized cutthroat trout eggs or the actual fish could have been carried to the Green and Colorado Rivers by wading or predaceous birds; for tributaries of the two drainages are separated in several instances by short distances, one of which is less than one mile.

No one has made a study of this specific problem, but perhaps proof of stream-capture by the Green River tributaries will be established in the future.

IV. Early Observers and Ichthyologists

A. Introduction

Explorations and colonization of basins formerly inundated by Lake Bonneville are connected with the present problem; therefore, a chronological history of comments of early explorers and settlers and the records of ichthyologists who collected in the areas under consideration are presented in order that a clear conception can be obtained concerning the former abundance of this trout and the scientific names under which it has been classified. It is also important to determine the characters upon which these classifications were based.

No attempt has been made at this point of this investigation to refute the evidence and conclusions advanced by these early workers. A critical analysis of the data, however, is presented in a subsequent portion of this thesis.

B. Comments of Early Explorers and Colonists

Father Escalante (see Tanner, Vasco M., 30, p.162-163) with a group of Spanish priests departed from Santa Fe, New Mexico, with the purpose of exploring a new route to Monterey, California. According to his diary the Father and his companions crossed Green River near the present Dinosaur National Monument, Jensen, Utah, journeyed westward and entered Bonneville Basin near Spanish Fork, Utah, in the summer of 1776.

In the valley he discovered a fresh-water remnant of Lake Bonneville which he said the local Indians called Timpanogus but which was later renamed Utah Lake by the Mormon pioneers.

The priests lingered in the valley for several days visiting with the Indians and making observations concerning the region for possible future colonization. One day the group camped on a mountain stream; and the subsequent white inhabitants have deduced from the Father's description of the area that it was American Fork Creek, one of the streams from which fish were collected during this investigation.

Father Escalante made an interesting observation of wildlife then present at Utah Lake. "The lake of the Timpanogotizis has great quantities of various kinds of food fish, geese, beaver, and other amphibious animals which we had no opportunity to see. Round about it are a great number of these Indians who live on the abundant supply of fish in the Lake. For this reason the Yutas Sabnaganas call them 'Fish Eaters'."

Colonel John C. Fremont (8, p.273) in 1844 explored the Great Basin and wrote concerning the fish of Utah Lake: "A few miles below us was another village of Indians, from which we obtained some fish, among them a few salmon trout, which were very much inferior in size to those along the California mountains. May, 1844."

The Mormons began settling in 1847 many of the valleys, and several of these colonists noted in their diaries the abundance of fish, birds, and mammals. Apparently, however, no one had the time or inclination to study the fishes of the region, nor for many years was an attempt made to conserve a resource which had so materially aided the pioneers.

C. Lieut. E. G. Beckwith and Charles Girard

Lieut. E. G. Beckwith, Capt. J. W. Gunnison, and a Mr. Kreuzfeld (1, p.66-78) with a large group of men explored portions of Colorado and Utah for a possible railroad route to the Pacific coast during the summer and fall of 1853. Only casual reference is made to the collection of fishes, but the Salmo specimens obtained were later described by Girard in 1859 (10, p.320-321). From three cutthroat trout taken by Mr. Kreuzfeld, August 13, 1853, in Utah Creek, near Sangre de Cristo, Colorado, Girard named a new subspecies, Salmo virginalis (Girard).

The name, Utah Creek, in literature has occasionally been confused with locations in the Bonneville Basin having similar names; and this has led some workers to include the trout of Utah Lake under the name Salmo virginalis. It should be remembered, however, that Utah Creek is a part of the Rio Grande River drainage, flowing into the Gulf of Mexico, and is not to be confused with tributary streams of Utah Lake, one of the remnant lakes of Lake Bonneville in the state of Utah.

Why Beckwith and companions failed to collect trout from Utah Lake and nearby streams is not understood, for cutthroats were being seined by the tons from these waters by the Mormons at that time. Undoubtedly the massacre by Indians of Capt. Gunnison, Mr. Kreuzfeld, botanist for the expedition, and six other party members on the Sevier River, central Utah, upset the interests and plans of the group; for after recovering their horses, weapons, instruments, and records from the Indians, the group retired immediately to Salt Lake City, passing on the way the shores of Utah Lake where Dr. Suckley (28, p.135-138) in 1859 collected cutthroats which were later classified under the subspecific name, Salmo utah Suckley.

D. George Suckley

Dr. George Suckley (28, p.135-138), surgeon, United States Army, collected fish in Utah in 1859, which he then recognized as being closely related to those previously described by Girard. In as much as the description of his specimens, especially the characters which he used to designate a new subspecies, directly concerns this investigation, Dr. Suckley's report in part is quoted:

"A variety of Salmo virginalis occurs in Lake Utah, a large sheet of fresh water about fifty miles south of Salt Lake City. The fish are less spotted than those caught in the mountains streams near by, and attain a much larger size. They ascend the Timpanagos River for spawning purposes; at the proper time, according to the accounts of the Mormons, leaving the lake simultaneously in great numbers. They are said to be occasionally seen a yard in length. A friend--Lieutenant Williams, of the United States Army, caught one of this kind in the Timpanagos, about seven miles from the lake, which weighed seven pounds. I myself have caught smaller fish in the same stream, which varied considerably from those caught on the eastern side of Bear Mountains.

"In the Smithsonian collection two fish, obtained by Captain Simpson, United States Army, seem to be of that variety. They are simply labeled as from Utah, and appear to have been salted and dried before being thrown into alcohol.

"For this variety or kind we will, for the present, apply the provisional name Salmo utah.

"CHARACTERS.--Highest point of convexity of dorsal profile rather anterior to the same on S. virginalis; scales appear somewhat larger, (but this may be more apparent than real, owing to the insufficient material for comparison;) appearances of fish more silvery, spots much smaller in size and more irregular in shape; in other respects resembling S. virginalis.

In 1859 the writer crossed the continent via Salt Lake. In the course of this journey many notes were made concerning objects of interest in nature, most of which, however, are, from force of circumstances, necessarily excluded from these pages.

"None of the Salmonidae were found along our route on the eastern slope of the Rocky Mountains; but in most of the streams of Utah, most especially Black's Fork, near Fort Bridger, Weber River, and the Timpanagos, (flowing into Lake Utah through Provo Canyon,) the Salmo virginalis, a very handsome trout, was plentiful. In its habits and general appearance it much resembles the brook-trout of the Middle States, (S. fontinalis). It is abundant in Black's Fork, from which, on the 25th of August, we caught half a dozen, and on the following day about forty, with the artificial fly, to which they rose exactly in the manner of their more eastern relatives, and greedily seized, like unsophisticated fish, as they were, scarcely learning caution or timidity until pricked once or twice by the alluring and deceitful bait. Probably but few artificial flies, if any, have ever before been cast on those waters. One specimen, about ten inches in length, caught with a red-hackle, was selected for examination and description. In general outline it was, perhaps, slightly more stout than the brook-trout of New York, (S. fontinalis). The curve from the nose to the anterior insertion of the dorsal fin was very regular. The anterior point of insertion of said fin was but slightly in front of a point at the middle of a line drawn from the tip of the nose to the insertion of the tail.

"COLORS.--Ground color of back, pale brown, tinged with red; spotted above the lateral line with small spots of black, which were but sparingly distributed anterior to the dorsal fin; a few spots of the same colors were also found on the opercula and on the top of the head. In shape, the spots anterior to the dorsal fin were nearly round and quite small; those in the vicinity of the same fin, but farther back, were stellate, but slightly larger, and those posterior to a vertical line drawn from the anus were much larger, more numerous, and quite irregular in form, somewhat resembling those of _S. stellatus_. Anterior to the anus there were scarcely any spots below the lateral line except near the head, where there were about half a dozen; posteriorly, however, they were equally numerous both below and above.

"The general style of the spots, their size and distribution in individuals of this species, are well displayed in the figure given in Volume x, Plate lxxiii, Figure 1-4. Indeed, in the markings, spots &x., of this species, I noticed great uniformity in all the specimens observed. The color of the dorsal, adipose, and caudal fins was the same as that of the back, but thickly studded with oval and roundish spots of black. The prevailing reddish-brown color of the back extended to the nose but was of a slightly different shade on the head. From the median line of the back extended down the sides, filling up two-thirds of the space of the lateral line. The silvery-white of the belly was separated from the prevailing color of the back by a faint golden band, of irregular width; (in some specimens this extends from the iris to the base of the tail). The lateral line was distinct. Irides, golden bronze, with several roundish spots of black upon them of the size of a pin's head. The under fins were of a pale red, their external rays of a deeper color. Patches of bright vermilion, about one-eighth of an inch in width, were found extending back from the chin to a point opposite the middle of the opercula. The chin was white, like the belly. (The vermilion bands above spoken of exist normally in all the specimens seen of this species, and are present also in other species, for example, the S. stellatus of Oregon). The tail was but slightly emarginate. Angle of mouth about opposite (below) the posterior border of the pupil.

"The general hues of the Fort Bridger trout, when freshly taken, were silvery, glistening with bright reflections; the scales are somewhat larger than those of S. fontinalis; the point of greatest girth being reached by the tips of pectoral fins when stroked back. Upon inquiry at Fort Bridger, we learned that 17 or 18 inches might be considered the maximum size in those waters, and out of forty or fifty fish it is rare to find one over a foot in length.

"The species in the Timpanagos River appeared, upon careful examination, to be identical with that of Black's Fork, but much larger. They retreat to the quiet and deep waters of Lake Utah, from whence they ascend the Timpanagos at certain seasons of the year. A friend there caught, in August, 1851, one trout which weighed some five or six pounds, (approximately) and was 26 inches in length. They are said to grow occasionally to 30 inches in length, and are an active, fine fish, affording much sport to the fly-fisher, and a delicacy to the epicure.

"About the 1st of September last, we caught three trout from the same stream. Two of these were of good size, weighing from 1-3/4 to 2-1/4 pounds, respectively. They rose freely to large, dark hackles, but refused gaudy or light-colored flies. Owing to poor flies, which had been in our possession for several years, the whipping of the hooks having shrunk so that they were easily pulled off, we caught but three out of many fish that jumped at them.

"The trout of Weber River seemed to vary from those of Black's Fork, in having the lower fins much more tinged with yellow. The stomachs of all, when examined, were found to contain insects, such as wasps, beetles, ants, &c.

"We are inclined to believe that the geographical range of the species extends to the west as far as Gravelly Ford, on the Humboldt. Specimens were examined which were caught at Deep Creek, one hundred and fifty miles west of Great Salt Lake. Approaching so nearly to the trout of all other places in general appearance, and trout-like habits so peculiar and unmistakable, we cannot refrain from again expressing entire want of faith in the so-called genus Salar."

E. Edward Drinker Cope

During the summer of 1870 Campbell Carrington and E. M. Dawes of the United States Geological Survey, directed by F. V. Hayden, collected seven cutthroat trout from Wyoming streams, two from Henry's Fork and two from near Fort Bridger, tributary streams of Green River. Cope (3, p.433) examined the collection in 1871 and classified them as _S. virginalis_, but noted that the branchiostegals numbered 11-11 instead of 9-9 as previously given for _S. virginalis_. Cope also remarked that the specimens showed short, broad, longitudinal red bars along the lateral line.

The following year, 1872, Cope (4, p.471) described a new subspecies, _S. pleuriticus_, from cutthroats collected by the Hayden expedition from Green River, Wyoming; Medicine Lodge Creek, Idaho; and Junction Creek, Montana.

His description of this new subspecies is as follows:

"This is the abundant mountain trout of the headwaters of the Green and Platte Rivers, and even of the Yellowstone. It is rather a stout species; with obtusely descending muzzle, and large eye entering the head only four times. The cranial keel is a marked character; its elevation is greater between the orbits than on the posterior part of the frontal bones. The interorbital width is 1.33 times the long diameter of the interpalpebral opening of the eye. The dorsal fin is nearer the origin of the marginal rays of the caudal fin than to the end of the muzzle, but is midway between the latter and the termination of the scales on the sides of the fin. Radii, D. II. 11-12 and 13; A. II. 11. Br. XI. The scales range from 40 to 45 below the first dorsal ray to the lateral line. The maxillary bone extends to a little behind the orbit, and is not expanded.

"This is a spotted species, and the spots are found chiefly above the lateral line and on the whole caudal peduncle, and on the dorsal and caudal fins. They are usually rather scattered, less numerous on the peduncle than in S. spilurus, and more so anteriorly; those on the fins are smaller and less numerous. There is, however, variation in the size and number of the spots. The sides are ornamented with short, broad, longitudinal bars of crimson; a band of the same color occupies the fissure within each ramus of the mandible and skin on the median side of it. The fins are all more or less crimson; but none of these are black-bordered. The largest specimens are 10-12 inches long.

"Seven specimens of this species are in the collection from the heads of Green River; from Medicine Lodge Creek, Idaho, (two specimens); four from the Junction, Montana. A specimen each from Yellow Creek and the Gallatin Fork of the Missouri, Montana, represent at least a color variety of this fish. The spots are much smaller and much more numerous, though destributed over the same region, they are less numerous on the caudal fin. In the Gallatin specimen there are 51 scales above the lateral line; in the other 44. Another variety from the Yellowstone Basin is only represented by young specimens. They have no spots on the caudal fin.

"A number of dried specimens from the Yellowstone Lake, of larger size than the specimens above described, probably belong to this species. They are rather more closely spotted on the caudal peduncle and fin, but are similar in all important respects. The only discrepancy I find is the relatively smaller eye, which enters the head five times, and the greater prolongation of the maxillary bone. These characters are due to the larger size attained by the individuals. They are from a foot to eighteen inches in length."

F. Edward Drinker Cope and H. D. Yarrow

In 1875 Cope and Yarrow (5, p.682-694) summarized the subspecies then recognized in the genus *Salmo*, but their classification differs greatly from those listed by modern investigators. *S. virginalis*, at present used to designate the cutthroat trout of Utah Creek, a tributary of the Rio Grande River, was employed by Cope and Yarrow to describe the trout of Utah Lake. Likewise, *S. pleuriticus* was used to designate the trout of Nevada, rather than the cutthroat trout of the Green and Colorado River drainages.

That portion of their report which concerns this investigation is quoted:

SALMO, Linn.

"Of this genus, quite a number of species are found in the lakes and streams of the Rocky Mountains, and are very nearly allied: *Salmo virginalis* being the characteristic fish of the lakes of Utah; *S. pleuriticus* of Nevada, Montana, and Colorado; and *S. spilurus* of Western Colorado and New Mexico. These all belong to the group *Salar*.

"The following brief synopsis of the Salmonidae of the regions under discussion may prove useful for purposes of identification:

Depth 5.75 in length; eye 4.5 times in head; snout obtuse; caudal fin scarcely emarginate; Br. 9 .... *S. virginalis*

Depth 4.75 in total (to point of caudal); eye 5 times in head; muzzle acute; scales larger, 26 below dorsal fin; cranium not keeled above; head one-fourth length; dorsal fin nearer muzzle than end of caudal scales; caudal fin scarcely emarginate; Br. 10.............................. S. spilurus

Head large, broad, flat, not keeled, 4.25 in total, equal depth of body; muzzle obtuse; eye nearly 5 times in head; scales 42 below first dorsal ray; dorsal fin equidistant; caudal fin not notched.................... S. stomias

Head smaller, 4 times in length to notch of caudal (which is well emarginated); upper surface keeled; muzzle obtuse; eye 4 times in length; depth 4.5 in length to end of caudal scales; dorsal midway between latter and end of muzzle; scales small, 40-43 below dorsal first ray; Br. 11....... S. pleuriticus

Head acuminate, keeled above 4.6 times in length to notch of caudal fin, which is well marked; eye 0.2 of head; depth 5.25 to caudal notch; dorsal nearer muzzle than end of caudal scales; scales large, 33 below dorsal first ray; spots large, distinct; Br. 12.......... S. carinatus

"S. spilurus and S. carinatus of those above enumerated, are readily distinguishable by their smaller orbits and large scales; as in S. stomias and S. pleuriticus resemble each other in the presence of the strong median carina of the superior aspect of the cranium. S. stomias may be readily known by the large mouth and head. Its habitat, as far as known, is the Kansas River, far to the eastward of the Rocky Mountains."

The following description of Salmo virginalis, used by Cope and Yarrow to describe the Utah Lake cutthroat trout, is confusing because it is actually Girard's description of the cutthroat trout of Utah Creek, Colorado.

"Specific characters.--Body subfusiform in profile, otherwise compressed; head 4 times in total length; the caudal fin excluded; anterior margin of the dorsal nearer the extremity of the snout than the insertion of the caudal fin. Grayish-brown, with a purplish reflection and subcircular black spots, beneath olivaceous, unicolor.

"Br. 9:9; D. 12:0; A.11; C.7,1,9,8.1,8; V. 8; P. 14.

"A comparison of specimens in the collection of the survey gives the following results: Length of two specimens 14½ and 15½ inches. Head enters total length, caudal fin included, about 4 1/3 times. Posterior extremity of the maxillary extends to and intersects a vertical line drawn 1/5 of an inch in rear of posterior rim of orbit; anterior margin of dorsal nearer insertion of caudal than snout. Eye large, subcircular, entering 8-7 times in greatest length of side of head, and over twice in advance of anterior rim of orbit. Caudal 5 2/3 in total length. Line vertical drawn from insertion of ventral reaches the 6th spine of dorsal; 36-36 rows of scales above lateral line, 40-41 below. Br. 11-11; D. 12;

A. 12; C. 7,7,9,8,1,8; V. 9-9; P. 14-14. The characters here given we find are constant in a number of specimens, and it may be noticed some grave differences exist between our own and Girard's specific characters. It may be mentioned that the dark spots which are found on the dorsal aspect of this species frequently run into the conjunctiva of the eye; this fact as far as known has not been observed in other species.

"By an extended examination of specimens, we are ready to state that this species certainly maintains its distinctness from S. pleuriticus Cope, from the streams which flow from the mountains on both sides in its more slender form of head and body. The depth enters the length 5.75 and 6 times, and equals the length of head to the pre-operculum. In S. pleuriticus of equal size, it enters the length 4.66 times, and nearly equals the length of the head."

G. David Starr Jordan and Associate Ichthyologists

Five years had passed since the Hayden Survey when Jordan and Gilbert (17, p.460) visited Utah for the first time in 1880. After examining numerous specimens from Utah Lake these ichthyologists added to the growing number of scientific names for this fish when two names, Salmo purpuratus Pallas and Salmo clarkii Rich, were used to describe this trout:

"Very abundant in Utah Lake; a food-fish of much value. Specimens obtained do not differ in any visible respect from others taken in salt water in Puget Sound. This is apparently the parent stock from which S. spilurus, S. irideus, and S. gairdneri Rich., (S. truncatus Suckley) have scarcely yet become completely differentiated. S. henshawi Gill and Jordan is a marked local variety of S. purpuratus."

During the summer of 1889, Jordan with Evermann and several students (15, p.14-15) collected in Utah and Colorado. Their schedule for central Utah was as follows:

> Aug. 4,5.--At Provo; seined Provo River and assisted by Peter Madsen and his sons, drew a long net in Utah Lake.
>
> Aug. 6,7.--Salt Lake City; seined Jordan River.
>
> Aug. 9,10.--At Juab; seined Sevier River and Chicken Lake.

Travel in 1889 was rather crude, chiefly horse-drawn vehicles; and the group could spend only a very limited time at each location. However, Jordan was very enthusiastic about the collecting at Utah Lake, but he added still another scientific name, Salmo mykiss Walbaum, for this trout.

> "Salmo mykiss Walbaum, var. virginalis Girard. Trout. P., V. (Salmo virginalis Girard; Salmo utah Suckley.)

"Very abundant in Utah Lake; spawning in the shallow parts of the lake and in the tributary streams which it ascends to the headwaters. The Utah trout have the coloration of the Oregon trout, var. clarkii, but the dark spots are usually somewhat smaller. The only differential character lies in the greater size of the scales, the number of these in a horizontal series being usually about 150.

"The large trout of the lakes are deep green in color, the sides silvery, and the dark spots small and faint. Lower fins red. Upper fins yellowish. The usual red dash under the throat is never absent in this species.

"No better trout for the table exists than those of the Utah Lake variety. They reach a weight of 3 to 10 pounds. In a single haul on the large seine made in a channel on the south side of the lake, fifty trout ranging from 2 to 3½ pounds were taken."

Jordan and his students then moved to the streams of eastern Utah but failed to take trout from Green River but did collect cutthroats in the tributaries of the Colorado River. The trout were described as follows:

"S. mykiss pleuriticus (Cope) Colorado River Trout.

"The common trout of the basin of Colorado, its range extending to the mountains of Arizona. Variable in color, size, and form, with its surroundings, and in most respects substantially identical with lewisi, the chief difference being that in this form, as in spilurus, stomias, and macdonaldi, the black spots are usually much more numerous on the posterior part of the body, while the head is usually free from spots. This is, however, not universally true.

"In one specimen, from Trapper's Lake, the entire body from head to tail is closely and coarsely spotted. Generally the black spots are rather large, but in some specimens the spots are small, smaller than in any of the other forms except var. macdonaldi.

"In var. pleuriticus there is almost always a very distinct red lateral band, and the lower fins are more or less red."

In 1896 Jordan and Evermann (18, p.495-496) again redescribed these two subspecies:

"Salmo mykiss virginalis (Girard) (Trout of Utah Lake)

"Profusely but rather finely spotted, the spots being numerous anteriorly as well as posteriorly, confined to the back rather than to the tail. Scales a little larger than in other forms, 140 to 150 in lengthwise series, anteriorly less crowded than in spilurus and stomias. In practically alkaline or milky waters, as in Utah Lake, this form reaches a large size--8 to 12 pounds--and is very pale in color, the dark spots few and small, mostly confined to the back. Similar variations are shown by the other forms of trout in other lakes. Lakes and streams west of the Wahsatch range, especially Bear, Provo, Jordan, and Sevier Rivers, and in Utah Lake; locally very abundant and important as a food-fish.

"Salmo mykiss pleuriticus (Cope) (Colorado River Trout)

"Operacle short, 4 3/5 to 5 in head. Scales small, 185 to 190. Close to the typical mykiss, but the black spots chiefly gathered on the posterior part of the body, the head nearly immaculate; extremely variable, the lower fins usually red, but sometimes orange; usually a red lateral band. Basin of the Colorado. A large, handsome, and variable trout, sometimes profusely speckled, sometimes with large spots, and occasionally with strong golden shades. Abundant throughout Western Colorado and in all clear mountain streams throughout Arizona; specimens from the Colorado Chiquito similar to those from the Eagle and the Gunnison, in Colorado."

It is interesting to note that in a subsequent publication by Jordan and Evermann in 1908 (19, p.182 and 186) that the Utah cutthroat trout was designated as S. virginalis (Girard) and the Colorado River cutthroat as S. pleuriticus (Cope).

In 1920 Jordan (16, p.72-73) once more reclassified the trout of the Rio Grande River and Bonneville Basin. In this publication the Rio Grande Trout were designated as S. virginalis Girard, instead of S. spilurus Cope, and the trout of the Bonneville Basin as S. utah Suckley rather than S. mykiss virginalis. Jordan admitted that the error had previously existed because of the uncertainty regarding the type locality of S. virginalis, which is Utah Creek, a tributary of the Rio Grande River, a drainage which has no connection with the waters of Bonneville Basin.

H. John O. Snyder

Two years later, in 1922, Snyder (27,p.23-28) also attempted to standardize the taxonomy of the cutthroat trout of Utah Lake and the Rio Grande River. "Through some oversight Jordan and Evermann have used the name S. virginalis for the trout of the Utah Lake and Bonneville Basin generally, and also Evermann and Kendell have accepted S. spilurus for the Rio Grande trout, not following Cope, however, for they regard S. virginalis as synonymous with S. spilurus. It now appears that the Rio Grande trout should be known as S. virginalis (ignoring Cope's contention that two species inhabit the Sangre de Cristo and Utah Creeks), while Suckley's name, S. utah, is restored to the Bonneville form."

I. Vasco M. Tanner and Students

The most recent work on the cutthroat trout of Utah has been done by Dr. Vasco M. Tanner and students (30, p.155-183) and (31, p.163-164). In a private communication to the author, Dr. Tanner indicated that he believes *S. utah* and *S. pleuriticus* constitute one subspecies.

J. Samuel F. Hildebrand

In November, 1949, Hildebrand (11, p.7) summarized the cutthroat trout series as it now exists. *S. utah* Suckley was used to designate the trout of Utah Lake and adjacent waters and *S. pleuriticus* Cope the trout of the Green-Colorado River drainage.

K. Summary of Classification

As a result of the several attempts to classify the cutthroat trout of the Bonneville Basin and the tributaries of the Green River in Utah, the many scientific names may be confusing; therefore, a summary, Table 1, page 33, of the available information is presented to clarify the situation.

Table 1.--Chronological summary of ichthyologists, dates of description, location of collections, and scientific names of the cutthroat trout of Bonneville Basin and the Green River tributaries of Utah.

Ichthyologists	Date	Location	Scientific Name
Beckwith, Girard	1853	Utah Creek, Colo.	*S. virginalis*
Cope	1871	Green River	*S. (salar) virginalis*
Cope	1872	Green River, Medicine Lodge Creek, Idaho Junction Creek, Montana	*S. pleuriticus*
Suckley	1874	Utah Lake	*S. utah*
Cope, Yarrow	1875	Utah Lake	*S. virginalis*
		Nevada, Colorado, Montana	*S. pleuriticus*
		Western Colorado, New Mexico	*S. spilurus*
Jordan	1880	Utah Lake	*S. purpuratus*
			S. clarkii
Jordan, Evermann	1889	Utah Lake	*S. mykiss* var. *virginalis*
		Colorado River	*S. mykiss pleuriticus*
Jordan, Evermann	1896	Utah Lake	*S. mykiss virginalis*
		Colorado River	*S. mykiss pleuriticus*
Jordan, Evermann	1908	Utah Lake	*S. virginalis*
		Colorado River	*S. pleuriticus*
Jordan	1920	Rio Grande River	*S. virginalis*
		Utah Lake	*S. utah*
Snyder	1922	Rio Grande River	*S. virginalis*
		Utah Lake	*S. utah*
Tanner	1933	Utah Lake	Did not classify
		Green River	Did not classify
Hildebrand	1949	Utah Lake	*S. utah*
		Green River	*S. pleuriticus*

V. Present Collection

A. Introduction

During August and September, 1949, approximately two hundred specimens of cutthroat trout were collected for this investigation from the two regions previously discussed. Permission to collect was granted by the Utah State Fish and Game Commission. Whenever possible the fish were taken with artificial flies; but where the stream banks were choked with vegetation, earthworms were used as bait.

B. Measurement Methods, Scale and Ray Counting

Many investigators in the past have failed to state definitely the manner in which their measurements were taken, a fact which has caused subsequent students of work to question its value. The present study, in general, follows accepted proceedure in that those characters by which species are identified are considered. Because most American ichthyological workers use the more familiar English system of measurements, all distances are expressed in inches or fractions thereof.

In all instances where the following terms have been abbreviated in the tables of characters, the abbreviated forms appear in parentheses following the terms.

1. Sex (F--Female; M--Male) The gonads were examined in all specimens except the four trout from Utah Lake and the two mounted trout from Strawberry Lake and Currant Creek. Unfortunately the cutthroats from Utah Lake had been eviscerated, and in only one fish could the remains of the gonads be found.

Sex was easily determined in the adults, and the testes and ovaries of all juveniles were magnified ninety times where in all cases it was felt that identification was certain.

2. Standard Length (Stand. Lgn.) is the distance between the snout and the most anterior end of the middle caudal rays. The anterior end of the middle caudal rays was found in a number of specimens by dissection until it was believed that this point could be determined without dissection by placing the caudal fin under high magnification with strong light from below, meanwhile moving the fin from side to side. The standard length distance, likewise true of other measurements of length, is represented by a straight line and does not follow the curve of the fish body.

The snout was used as the most anterior point with this subspecies because in all instances the 'nose' did represent the extreme anterior point of the head. In those species where the lower jaw projects beyond the snout, it would appear reasonable to start length measurements with the point of the mandible.

3. Fork Length (Fork Lgn.) is the distance from the snout to the most posterior point of the middle rays of the caudal fin.

4. Total Length (Total Lgn.) is the distance from the snout to the most posterior end of the caudal fin with the edges of the fin squeezed together.

5. Scales on the Lateral Line (Sc. L. Line). The first scale counted was that directly posterior to the operculum and the last the scale directly over the anterior point of the middle caudal rays. If the greater part of a scale appeared on the transverse ridge which arose on the skin when the caudal fin was moved from side to side, it was counted.

Where scales in the lateral line were absent or were embedded and could not be easily seen, an estimate was made of the number of missing scales. Those scales which turned upward and paralleled the shoulder girdle and those scales posterior to the point of standard length were not counted because their number and shape were not consistent and reliable.

6. Diagonal Scale Rows (Sc. D. Rows). The diagonal scale rows were counted approximately fifteen rows above the lateral line until the adipose fin area was

reached, and then the count was continued five rows above the lateral line. The first row counted was that row immediately behind the operculum and the last that row which runs diagonally through the posterior point of standard length. Fifteen rows above the lateral line was selected because the diagonal rows frequently divide as the rows approach the lateral line; and, therefore, it was believed that such a count approximately one-third up the side of the fish would more accurately represent the mean number of rows.

The possibility of one too many or one too few scale rows exists because of the uncertainty in many cases of where the count should begin and end.

7. Scales Above the Lateral Line (Sc. Above). This count began with the first clearly defined row of scales immediately anterior to the dorsal fin and directly atop the dorsal surface, then downward and backward, counting in a natural scale row and ending with the scale above the lateral line.

8. Scales Below the Lateral Line (Sc. Below). This count began with the scale at the junction of the pelvic 'accessory scale' and the pelvic fin, counting upward and backward to the lateral line in a diagonal row and ending with the scale below the lateral line.

9. Scales Before the Dorsal Fin (Sc. B. Dor.).

This count represents the number of scales in a straight line from the dorsal fin to the occiput. The count is facilitated by enumerating the scales slightly to the side of the midline.

10. Pyloric Caeca (Pyloric C.). The intestine and stomach were lifted from the body cavity and each caecum was removed with small forceps. Each caecum was placed in a thin film of water which made the surrounding tissue transparent and the counting certain. All caeca, regardless of size, were counted. Where caeca were divided they were counted as one. Only two such cases of division were found.

11. Gill Rakers. The number of projections on the upper portion of the gill arch is given first, followed by that on the lower portion. In nearly all instances a raker lay in the curve of the arch, and this raker was counted with the lower portion. All rakers, no matter the size, were counted. The first gill on the left side was used for this enumeration.

12. Rays in the Dorsal and Anal Fins (Rays Dorsal) and (Rays Anal). These fins, as in all cases of ray counting, were spread under magnification with strong light from beneath. All rays were counted except those in the anterior portion of the fins which were less than one-half the height of the longest rays. The last

two posterior rays, appearing to originate from the same base, were counted as one ray.

13. Rays in the Pectoral (Rays Pect.) and Pelvic Fins. All rays were counted, including the very small rudiments at the posterior margins of the fins.

14. Branchiostegal Rays (Rays Branch.) The various segments were counted under magnification, care being taken with small fish to count the very short rays adjoining the isthmus.

15. Head Length (Head Lgn.) is the distance from the snout to the most posterior edge of the opercular membrane.

16. Head Depth is the distance from the point of the occiput to the ventral surface of the head.

17. Eye Diameter (Eye Dia.) is the horizontal oblique distance between the rims of the orbit.

18. Snout Length (Snout Lgn.) is the distance from the snout to the anterior edge of the hard orbital ring of bones.

19. Snout to Occiput (Snout-Occ.) is the distance from the snout to the point of the occiput.

20. Snout to Dorsal Fin (Snout-Dor.) is the distance from the snout to the origin of the dorsal fin.

21. Snout to Pelvic Fin (Snout-Pel.) is the distance from the snout to the origin of the pelvic fin.

22. Body Depth is the greatest vertical distance on the body between the dorsal and ventral surfaces, usually found immediately anterior to the dorsal fin.

23. Body Width is the greatest lateral width of the body, usually found in the vicinity of the abdominal cavity.

24. Caudal Peduncle Length (Caud. P. Lgn.) is the distance from a point on the lateral line directly above the posterior end of the anal fin to the anterior point of the middle caudal fin rays.

25. Caudal Peduncle Width (Caud. P. Wid.) is the least depth of this body region.

26. Height of Dorsal (Dorsal Ht.) and Anal Fins (Anal Height) is the greatest height attained by the rays (usually those rays near the anterior margin) from their insertion in the body of the fish.

27. Length of Dorsal and Anal Fin Base is the over-all distance measured at the base of the fin from the anterior margin of the first ray to the point where the membrane following the last ray joins the body.

28. Length of Pectoral (Pect. Lgn.) and Pelvic Fins (Pelvic Lgn.) is the distance measured from the point where the fin contacts the body to the extreme tip of the fin.

29. Caudal Fin Length (Caud. Lgn.) is the distance

from the point of standard length to the extreme end of the fin with the rays squeezed together.

30. Teeth on the Basibranchial Bone (Teeth Basi.), sometimes referred to as the teeth on the Hyoid Bone, is the total number of teeth which occur on this bone. Usually these teeth are visible to the naked eye. Their absence was always verified by dissection and magnification.

31. Teeth on the Glossohyal (Teeth Gloss.) and Vomer. The teeth on these bones were counted under magnification, and care was taken to reveal those teeth buried in the flesh.

32. Teeth on the Dentary (Teeth Dent.), Pre-Maxillary (Teeth P. Max.), Maxillary (Teeth Max.), and Palatine Bones (Teeth Pal.) Teeth on these bones were counted under magnification, and only those teeth which protruded from the flesh and could be pricked with a teasing needle were counted.

33. Vertebrae. All centra were counted except the last segment, the urostyle, which turns upward in the hypural plate. To facilitate the counting the flesh was removed from the right side of the specimen and the head sectioned longitudinally to the right of the mid-line of the vertebral column. Then alizarine in an alcohol solution was brushed on the centra, and after several

minutes the fish returned to the formalin preservative. Twenty-four hours later specimens were removed for enumeration.

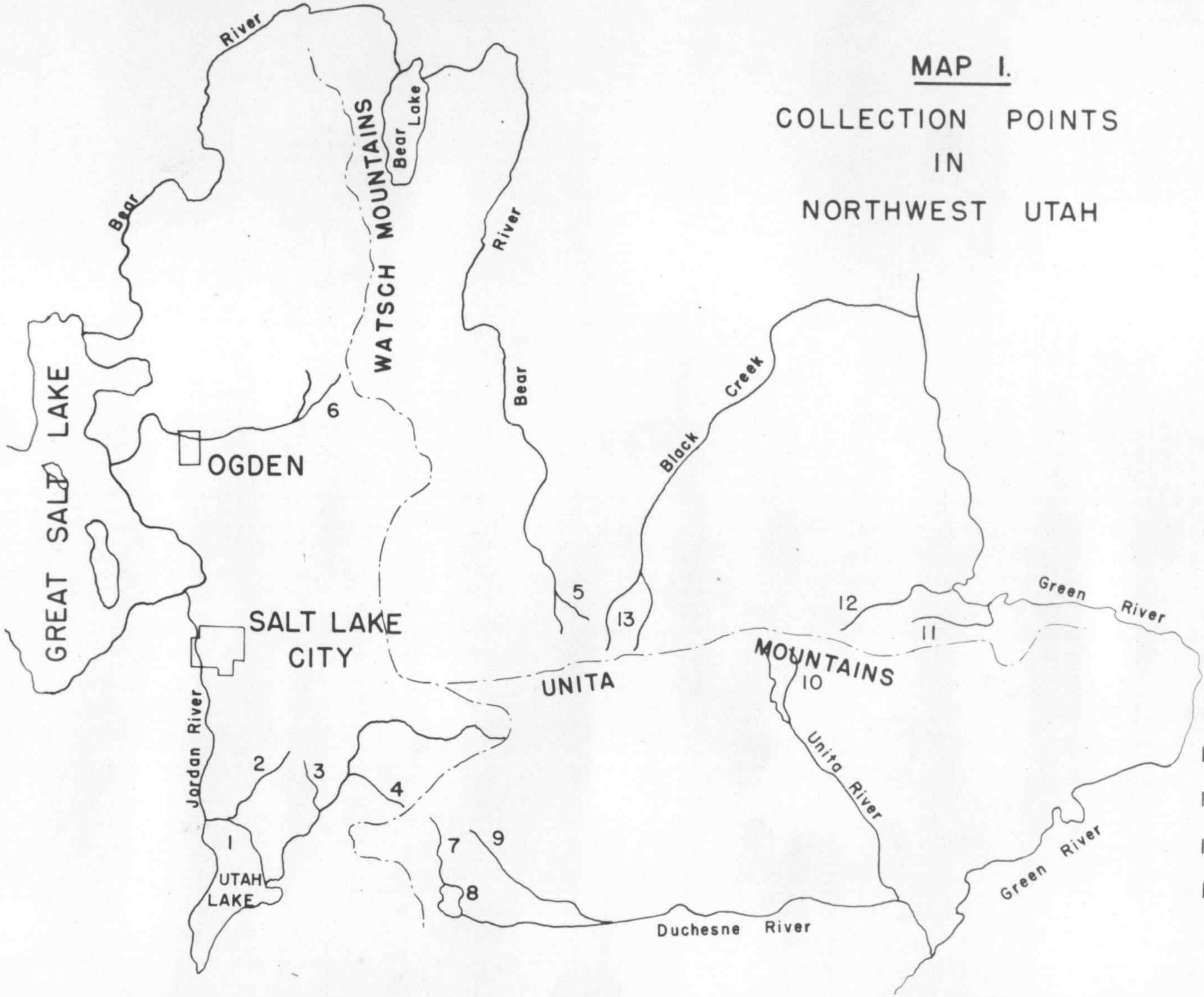
The possibility of an error of one too many or one too few in the number of vertebrae may exist in a few counts because of the occasional irregularity of the centra near the posterior end of the vertebral column.

C. Collection Stations

The thirteen stations from which cutthroat trout specimens were collected are listed below in Table 2, and the approximate location of these stations are indicated on Map 1, page 43.

Table 2.--Streams and lakes of the Bonneville Basin and the tributaries of Green River in Utah from which cutthroat trout were collected.

	Name	Number Specimens	
Bonneville Basin:			
1.	Utah Lake	4	
2.	American Fork Creek	1	
3.	West Fork, Deer Creek	3	
4.	McGuire Creek	12	
5.	Mill Creek	15	
6.	Lost Creek	8	
		43	
Green River:			
7.	Willow Creek	10	
8.	Strawberry Lake	1	
9.	Currant Creek	14	
10.	Pole Creek	10	
11.	Elk Park Creek	14	
12.	Sheep Creek	9	
13.	Black's Fork	3	
		61	104 Total



MAP I.

COLLECTION POINTS
IN
NORTHWEST UTAH

STATIONS

1. Utah Lake
2. American Fork
3. Deer Creek
4. McGuire Creek
5. Mill Creek
6. Lost Creek
7. Willow Creek
8. Strawberry Lake
9. Currant Creek
10. Pole Creek Lake
11. Elk Park Creek
12. Sheep Creek
13. Black's Fork

1. Utah Lake. The four specimens from Utah Lake examined in this study were collected prior to 1936 by an unknown person and forwarded to the Fish and Game department, Oregon State College. Native cutthroat trout can no longer be taken from this lake; for, as shown later, this trout is now probably extinct in this water. Utah Lake, one of the remnant lakes of Lake Bonneville, lies approximately thirty miles south of Salt Lake City, Utah, is irregular in shape but roughly measures twelve miles in width and twenty-five miles in length with a surface measurement of about 100,000 surface acres.

2. American Fork Creek rises at an elevation of 10,000 feet and after a steep descent of about twelve miles discharges into Utah Lake.

3. West Fork of Deer Creek, also a tributary of Utah Lake, rises at an elevation of 9,000 feet and at a distance of approximately twenty miles from the lake.

4. McGuire Creek, a tributary of the Provo River and, therefore, a part of the Utah Lake drainage, rises at an elevation of 8,500 feet and after a distance of two miles discharges into Daniel's Creek.

5. Mill Creek rises at an elevation of 10,400 feet and joins Bear River at the 8,500 foot level.

6. Lost Creek rises at an elevation of 9,000

feet and discharges into Weber River, a tributary of Great Salt Lake, at an elevation of 5474 feet.

7. Willow Creek rises at an elevation of 9,500 feet and, after a distance of five miles, discharges into Strawberry River, a tributary of Green River.

8. Strawberry Lake. Technically this body of water is a reservoir, an impoundment of the waters of Strawberry River. This lake is approximately four miles wide and six miles long with a very irregular shore line and a fluctuating water level. One mounted specimen was examined from this location, a trout collected by the author during July, 1940.

9. Currant Creek rises at an elevation of 9,000 feet and joins Strawberry River at a distance of approximately twenty miles from the source of the creek. One of the fourteen specimens taken from this station was collected and mounted by the writer in 1940.

10. Pole Creek and Pole Creek Lake. This stream rises at an elevation of 10,500 feet, widens in several places to form small lakes, one of which is Pole Creek Lake. Specimens were collected from the stream and adjoining lake at an elevation of 9,800 feet.

11. Elk Park Creek rises on the north slope of the Uinta Mountains at an elevation of 9,500 feet; and after a distance of about four miles, this stream discharges

into Carter Creek, a tributary of Green River.

12. Sheep Creek rises at an elevation of 10,000 feet and discharges into Green River at an elevation of 6,000 feet.

13. Black's Fork, a tributary of the Green River, rises at an elevation of 9,700 feet. The specimens were collected at an elevation of 9,000 feet.

In Utah, as is true also of many other states, exotic trout have been planted. Consequently, the collector is never absolutely certain that he is taking 'native fish.' To complicate the situation planting records are incomplete or missing, and in many instances it is not known when or where the Yellowstone cutthroat, *S. clarkii lewisi* Girard, and the Pyramid Lake cutthroat, *S. clarkii henshawi* Gill and Jordan, have been introduced. The problem became even more puzzling when rainbow trout were planted and, reportedly, hybridized to a limited extent with the cutthroat trout.

Thus, the only possibility of securing native cutthroats is to know intimately the small and almost inacessible mountain streams and lakes in which, according to local ranchers, loggers, and game department officials, plants of exotic trout have never been made.

The third station, West Fork of Deer Creek, a very small tributary of Provo River, is typically such a stream. Not one boot track was visible for a distance of approximately one and a half miles of the stream while collecting for the present investigation on August 19, 1949, evidence of its seclusion in rugged terrain. Probably only a very few ranchers and deer hunters know ot its existence. That is fortunate, too, for in a 'fish-hungry state' like Utah there are few obstacles which impede the fishing crowds. But fortunately this tiny stream exists, and at intervals the water has been impounded by beavers, and cutthroat trout lurk in the deep pools. In the thick brush and aspens bordering the creek occasional flocks of ruffed grouse are flushed, birds that have become so rare that to see them is an exciting experience.

D. Tables of Characters

The following thirteen tables represent a summary of information gained through an examination of 104 cutthroat trout from six streams and lakes of the Bonneville Basin and seven streams and lakes of the Green River tributaries of Utah. The specimens are numbered consecutively throughout the tables.

Table 3.--Structural counts of four cutthroat trout from Utah Lake. Date of collection: prior to 1936.

	1	2	3	4	Mean	Range Limits
1. Sex	F	*	*	*		
2. Stand. Lgn.	18.8	18.0	14.2	14.2		
3. Fork Lgn.	21.0	20.4	16.0	16.0		
4. Total Lgn.	21.7	21.3	16.8	16.5		
5. Sc. L. Line	125	122	125	124	..124.0	122-125
6. Sc. Above	36	44	44	44	.. 42.0	36-44
7. Sc. Below	38	40	41	41	.. 40.0	38-41
8. Sc. D. Rows	173	173	187	190	..180.8	173-190
9. Sc. B. Dor.	79	77	81	100	.. 84.3	77-100
10. Rays Branch.	12	12	12	10	.. 11.5	10-12
11. Rays Dorsal	12	11	11	12	.. 11.5	11.12
12. Rays Anal	13	13	12	12	.. 12.5	12-13
13. Rays Pect.	15	15	15	15	.. 15.0	15-15
14. Rays Pelvic	9	9	9	9	.. 9.0	9-9
15. Gill Rakers	7+13	7+13	7+13	7+13	.. 7+13	7+13
16. Pyloric C.	---	---	---	---	.. ---	---
17. Vertebrae	63	62	62	60	.. 61.8	60-63
18. Head Lgn.	4.6	4.6	3.7	3.4		
19. Head Depth	3.0	3.0	2.5	2.4		
20. Eye Dia	.7	.6	.5	.5		
21. Snout Lgn.	1.1	1.0	.8	.7		
22. Snout-Occ.	2.85	2.9	2.3	2.2		
23. Snout-Max.	2.7	2.6	2.0	1.9		
24. Snout-Dor.	9.2	9.2	6.8	7.1		
25. Snout-Pel.	11.0	9.7	8.0	8.1		
26. Body Width	2.0	2.2	1.8	1.6		
27. Body Depth	4.0	4.3	3.6	3.2		
28. Caud. P. Lgn.	2.4	2.5	2.0	2.2		
29. Caud. P. Wid.	1.7	1.7	1.3	1.3		
30. Dorsal Ht.	2.2	2.2	1.8	1.5		
31. Dorsal Base	2.3.	2.1	1.2	1.8		
32. Anal Height	2.1	2.2	1.6	1.6		
33. Anal Base	2.2	2.1	1.4	1.9		
34. Pect. Lgn.	2.7	2.7	2.2	2.1		
35. Pelvic Lgn.	2.0	2.2	1.8	1.8		
36. Caud. Lgn.	2.9	3.3	2.6	2.3		
37. Teeth Basi.	4	2	5	13	.. 6.0	2-13
38. Teeth Gloss.	5+5	5+5	6+5	4+4	.. 5+4.8	
39. Teeth Dent.	16+16	15+15	14+15	12+13	. 14+15	
40. Teeth P. Max.	6+4	4+4	6+5	6+5	.. 5+5	
41. Teeth Max.	22+23	20+21	25+21	17+18	. 21+21	
42. Teeth Vomer	12	14	12	10	.. 12	10-14
43. Teeth Palat.	13+13	12+11	13+12	12+13	. 12+12	

* Gonads missing

Table 4.--Structural counts of one cutthroat trout from American Fork Creek. Date of collection: August 18, 1949.

	5
1. Sex	M
2. Stand. Lgn.	6.8
3. Fork Lgn.	7.9
4. Total Lgn.	8.1
5. Sc. L. Line	124
6. Sc. Above	37
7. Sc. Below	35
8. Sc. D. Rows	167
9. Sc. B. Dor.	85
10. Rays Branch.	11
11. Rays Dorsal	11
12. Rays Anal	11
13. Rays Pect.	11
14. Rays Pelvic	10
15. Gill Rakers	7+13
16. Pyloric C.	51
17. Vertebrae	61
18. Head Lgn.	1.7
19. Head Depth	1.4
20. Eye Dia.	0.35
21. Snout Lgn.	0.35
22. Snout-Occ.	1.1
23. Snout-Max.	0.85
24. Snout-Dor.	3.5
25. Snout-Pel.	4.0
26. Body Width	1.8
27. Body Depth	1.05
28. Caud. P. Lgn.	0.95
29. Caud. P. Wid.	0.75
30. Dorsal Ht.	0.85
31. Dorsal Base	0.7
32. Anal Height	0.9
33. Anal Base	0.7
34. Pect. Lgn.	1.1
35. Pelvic Lgn.	0.9
36. Caud. Lgn.	1.3
37. Teeth Basi.	5
38. Teeth Gloss.	4+4
39. Teeth Dent.	13+13
40. Teeth P. Max.	5+6
41. Teeth Max.	18+18
42. Teeth Vomer	14
43. Teeth Palat.	13+16

Table 5.--Structural counts of three cutthroat trout from West Fork of Deer Creek. Date of collection: August 19, 1949.

					Mean	Range Limits
1.	Sex	6 F	7 M	8 F		
2.	Stand. Lgn.	7.6	7.5	7.2		
3.	Fork Lgn.	8.6	8.4	8.1		
4.	Total Lgn.	8.9	8.7	8.4		
5.	Sc. L. Line	131	130	127 ..	129. 3	127-131
6.	Sc. Above	44	41	37 ..	40.7	37-44
7.	Sc. Below	41	39	37 ..	39.0	37-41
8.	Sc. D. Rows	194	182	192 ..	189.3	182-194
9.	Sc. B. Dor.	101	98	90 ..	96.3	90-101
10.	Rays Branch.	12	11	11 ..	11.3	11.12
11.	Rays Dorsal	11	11	11 ..	11.0	11-11
12.	Rays Anal	11	11	11 ..	11.0	11-11
13.	Rays Pect.	14	14	14 ..	14.0	14-14
14.	Rays Pelvic	9	9	9 ..	9.0	9-9
15.	Gill Rakers	7+12	7+13	7+12..	7+12.3	
16.	Pyloric C.	43	44	39 ..	42.0	39-44
17.	Vertebrae	62	62	62 ..	62.0	62-62
18.	Head Lgn.	1.85	1.9	1.65.		
19.	Head Depth	1.3	1.3	1.3		
20.	Eye Dia.	0.35	0.35	0.35		
21.	Snout Lgn.	0.35	0.35	0.35		
22.	Snout-Occ.	1.2	1.15	1.1		
23.	Snout-Max.	1.0	1.05	0.9		
24.	Snout-Dor.	3.9	3.6	3.6		
25.	Snout-Pel.	4.2	4.0	3.9		
26.	Body Width	1.0	1.0	0.9		
27.	Body Depth	1.8	1.7	1.6		
28.	Caud. P. Lgn.	1.1	1.1	1.0		
29.	Caud. P. Wid.	0.75	0.75	0.7		
30.	Dorsal Ht.	1.0	0.9	0.9		
31.	Dorsal Base	1.0	0.9	0.8		
32.	Anal Height	0.9	0.85	0.85		
33.	Anal Base	0.8	0.8	0.75		
34.	Pect. Lgn.	1.1	1.1	1.0		
35.	Pelvic Lgn.	1.0	1.0	0.9		
36.	Caud. Lgn.	1.3	1.2	1.2		
37.	Teeth Basi.	7	5	6 ..	6	5-7
38.	Teeth Gloss.	3+3	2+3	4+4 ..	3+3	
39.	Teeth Dent.	15+13	15+15	13+15..	14+14	
40.	Teeth P. Max	4+4	7+8	4+5 ..	5+6	
41.	Teeth Max.	21+21	22+18	18+14..	20+18	
42.	Teeth Vomer	10	6	8 ..	8	6-10
43.	Teeth Palat.	13+10	16+16	14+13..	14+13	

Table 6.--Structural counts of twelve cutthroat trout from McGuire Creek. Date of collection: August 21, 1949.

	9	10	11	12	13	14	15
1. Sex	M	M	M	M	M	M	M
2. Stand. Lgn.	7.3	6.7	6.4	5.6	4.9	4.8	4.6
3. Fork Lgn.	8.3	7.7	7.3	6.4	5.5	5.5	5.2
4. Total Lgn.	8.7	8.0	7.5	6.6	5.8	5.8	5.4
5. Sc. L. Line	117	123	126	127	121	120	119
6. Sc. Above	39	38	45	43	40	44	42
7. Sc. Below	40	34	43	42	37	34	40
8. Sc. D. Rows	159	176	185	187	184	180	182
9. Sc. B. Dor.	85	98	92	93	87	86	79
10. Rays Branch.	10	11	11	11	11	10	12
11. Rays Dorsal	10	11	11	11	11	10	11
12. Rays Anal	11	11	12	10	11	10	11
13. Rays Pect.	15	14	15	15	15	15	15
14. Rays Pelvic	10	9	10	9	9	10	9
15. Gill Rakers	7+12	9+12	8+13	8+12	8+12	7+13	8+12
16. Pyloric C.	48	36	37	48	43	41	43
17. Vertebrae	62	62	62	61	61	66	--
18. Head Lgn.	1.8	1.8	1.7	1.2	1.2	1.2	1.1
19. Head Depth	1.3	1.1	1.3	1.0	0.9	0.8	0.8
20. Eye Dia.	0.3	0.35	0.3	0.25	0.2	0.25	0.2
21. Snout Lgn.	0.4	0.35	0.4	0.2	0.2	012	0.2
22. Snout-Occ.	1.3	1.1	1.1	0.8	0.8	0.7	0.7
23. Snout-Max.	1.0	0.95	0.9	0.7	0.6	0.6	0.5
24. Snout-Dor.	3.8	3.5	3.2	2.6	2.4	2.6	2.2
25. Snout-Pel.	4.1	3.8	3.7	3.2	2.8	2.7	2.5
26. Body Width	1.1	0.8	0.8	0.7	0.6	0.6	0.6
27. Body Depth	1.8	1.8	1.8	1.3	1.3	1.2	1.2
28. Caud. P. Lgn.	1.1	1.0	1.0	0.8	0175	0.75	0.8
29. Caud. P. Wid.	0.7	0.7	0.7	0.55	0.5	0.5	0.5
30. Dorsal Ht.	1.0	1.0	1.0	0.8	0.7	0.7	0.7
31. Dorsal Base	0.8	0.8	0.8	0.6	0.6	015	0.5
32. Anal Height	1.0	1.0	1.0	0.7	0.6	0.6	0.7
33. Anal Base	0.8	0.8	0.7	0.5	0.5	0.5	0.5
34. Pect. Lgn.	1.2	1.1	1.0	0.9	0.8	0.7	0.75
35. Pelvic Lgn.	0.9	0.9	0.7	0.6	0.6	0.6	0.6
36. Caud. Lgn.	1.0	1.0	0.9	0.8	0.6	0.7	0.6
37. Teeth Basi.	3	7	3	6	2	3	4
38. Teeth Gloss.	4+3	4+4	4+4	3+3	3+3	5+5	3+3
39. Teeth Dent.	11+10	16+15	15+14	12+12	12+12	16+16	12+10
40. Teeth P. Max.	6+6	6+6	6+6	5+5	5+5	7+7	5+5
41. Teeth Max.	16+18	23+19	22+24	14+15	16+16	14+16	15+14
42. Teeth Vomer	13	12	12	8	8	12	7
43. Teeth Palat.	13+15	13+13	14+14	11+11	11+10	16+15	10+11

Table 6.--(Continued)

	16	17	18	19	20
1. Sex	F	M	F	M	M
2. Stand. Lgn.	4.6	4.4	4.4	4.1	4.0
3. Fork Lgn.	5.2	5.1	5.0	4.8	4.5
4. Total Lgn.	5.4	5.3	5.3	5.1	4.7
5. Sc. L. Line	125	120	119	125	126
6. Sc. Above	46	40	45	43	40
7. Sc. Below	36	37	36	39	36
8. Sc. D. Rows	202	191	185	182	183
9. Sc. B. Dor.	97	77	85	94	80
10. Rays Branch.	11	11	11	12	11
11. Rays Dorsal	11	10	11	11	11
12. Rays Anal	11	11	11	11	11
13. Rays Pect.	14	15	15	15	14
14. Rays Pelvic	9	9	9	9	9
15. Gill Rakers	7+11	8+12	7+12	+ 7 12	+ 7 12
16. Pyloric C.	39	45	44	42	44
17. Vertebrae	--	--	--	--	--
18. Head Lgn.	1.1	1.2	1.1	1.1	1.0
19. Head Depth	0.8	0.8	0.7	0.7	0.7
20. Eye Dia.	0.2	0.25	0.25	0.2	0.2
21. Snout Lgn.	0.2	0.2	0.15	0.2	0.2
22. Snout-Occ.	0.7	0.75	0.7	0.7	0.7
23. Snout-Max.	0.5	0.6	0.6	0.5	0.5
24. Snout-Dor.	2.2	2.1	2.2	2.0	2.0
25. Snout-Pel.	2.5	2.6	2.5	2.4	2.3
26. Body Width	0.6	0.6	0.6	0.5	0.5
27. Body Depth	1.2	1.1	1.1	1.0	1.0
28. Caud. P. Lgn.	0.8	0.7	0.75	0.7	0.6
29. Caud. P. Wid.	0.5	0.4	0.4	0.5	0.4
30. Dorsal Ht.	0.7	0.7	0.6	0.6	0.6
31. Dorsal Base	0.5	0.5	0.5	0.4	0.5
32. Anal Height	0.7	0.7	0.6	0.6	0.5
33. Anal Base	0.5	0.45	0.5	0.5	0.4
34. Pect. Lgn.	0.75	0.8	0.7	0.7	0.65
35. Pelvic Lgn.	0.6	0.6	0.6	0.5	0.5
36. Caud. Lgn.	0.6	0.7	0.6	0.7	0.5
37. Teeth Basi.	5	8	4	6	3
38. Teeth Gloss.	4+4	5+5	3+3	3+3	4+4
39. Teeth Dent.	10+10	12+12	8+9	9+9	13+14
40. Teeth P. Max.	7+7	5+5	5+5	5+4	6+6
41. Teeth Max.	12+12	14+15	14+13	14+12	12+10
42. Teeth Vomer	9	10	8	10	9
43. Teeth Palat.	10+9	11+11	10+9	10+10	12+11

Table 6.--(Continued)

	Mean	Range Limits
1. Sex		
2. Stand. Lgn.		
3. Fork Lgn.		
4. Total Lgn.		
5. Sc. L. Line	122.3	117-127
6. Sc. Above	42.1	38-46
7. Sc. Below	37.8	34-43
8. Sc. D. Rows	183.0	159-202
9. Sc. B. Dor.	87.8	77-98
10. Rays Branch.	11.0	10-12
11. Rays Dorsal	10.8	10-11
12. Rays Anal	10.9	10-12
13. Rays Pect.	14.8	14-15
14. Rays Pelvic	9.3	9-10
15. Gill Rakers	7.6+12.1	
16. Pyloric C.	42.5	36-48
17. Vertebrae	61.6	61-62
18. Head Lgn.		
19. Head Depth		
20. Eye Dia.		
21. Snout Lgn.		
22. Snout-Occ.		
23. Snout-Max.		
24. Snout-Dor.		
25. Snout-Pel.		
26. Body Width		
27. Body Depth		
28. Caud. P. Lgn.		
29. Caud. P. Wid.		
30. Dorsal Ht.		
31. Dorsal Base		
32. Anal Height		
33. Anal Base		
34. Pect. Lgn.		
35. Pelvic Lgn.		
36. Caud. Lgn.		
37. Teeth Basi.	4.5	2-8
38. Teeth Gloss.	3.8+3.8	
39. Teeth Dent.	12.2+12.0	
40. Teeth P. Max.	5.6+5.6	
41. Teeth Max.	15.5+15.5	
42. Teeth Vomer	9.8	7-13
43. Teeth Palat.	11.8+11.3	

Table 7.--Structural counts of fifteen cutthroat trout from Mill Creek. Date of collection: August 29, 1949.

	21	22	23	24	25	26
1. Sex	F	M	F	M	M	M
2. Stand. Lgn.	5.5	5.5	5.5	5.3	5.3	5.2
3. Fork Lgn.	6.2	6.2	6.2	6.1	6.0	5.9
4. Total Lgn.	6.5	6.5	6.5	6.4	6.3	6.2
5. Sc. L. Line	122	122	123	123	124	122
6. Sc. Above	42	43	42	37	41	44
7. Sc. Below	39	40	40	32	40	40
8. Sc. D. Rows	195	185	184	178	185	176
9. Sc. B. Dor.	82	87	81	88	86	81
10. Rays Branch.	11	11	11	11	12	11
11. Rays Dorsal	10	10	11	10	11	11
12. Rays Anal	10	10	11	10	11	11
13. Rays Pect.	15	15	15	15	16	15
14. Rays Pelvic	9	9	9	9	9	10
15. Gill Rakers	6+12	7+12	7+12	7+12	7+12	6+12
16. Pyloric C.	44	44	38	44	49	49
17. Vertebrae	61	61	60	61	61	--
18. Head Lgn.	1.4	1.4	1.4	1.4	1.35	1.3
19. Head Depth	1.0	1.0	0.9	0.9	0.9	0.9
20. Eye Dia.	0.3	0.3	0.3	0.3	0.3	0.3
21. Snout-Lgn.	0.2	0.25	0.25	0.25	0.25	0.25
22. Snout-Occ.	0.9	0.9	0.9	0.9	0.85	0.85
23. Snout-Max.	0.7	0.75	0.7	0.7	0.7	0.7
24. Snout-Dor.	2.7	2.7	2.8	2.6	2.8	2.6
25. Snout-Pel.	3.2	3.1	3.1	3.1	3.1	3.0
26. Body Width	0.7	0.6	0.7	0.6	0.6	0.6
27. Body Depth	1.3	1.2	1.4	1.3	1.3	1.3
28. Caud. P. Lgn.	0.85	0.8	0.8	0.75	0.85	0.85
29. Caud. P. Wid.	0.55	0.55	0.5	0.5	0.5	0.5
30. Dorsal Ht.	0.8	0.85	0.8	0.8	0.85	0.8
31. Dorsal Base	0.7	0.7	0.6	0.65	0.7	0.65
32. Anal Height	0.7	0.7	0.7	0.65	0.7	0.7
33. Anal Base	0.5	0.55	0.5	0.5	0.5	0.5
34. Pect. Lgn.	0.9	0.9	0.85	0.8	0.8	0.8
35. Pelvic Lgn.	0.8	0.7	0.7	0.7	0.7	0.7
36. Caud. Lgn.	1.0	1.0	1.0	1.1	1.0	1.0
37. Teeth Basi.	3	6	3	5	2	5
38. Teeth Gloss.	4+4	4+4	4+3	4+4	3+3	5+4
39. Teeth Dent.	12+12	11+10	13+13	12+12	12+12	10+10
40. Teeth P. Max.	6+6	5+5	5+5	6+7	5+5	5+5
41. Teeth Max.	14+15	16+15	17+14	19+19	15+14	20+19
42. Teeth Vomer	9	10	10	11	7	11
43. Teeth Palat.	12+12	11+12	12+12	13+13	10+12	13+13

Table 7.--(Continued)

	27	28	29	30	31	32
1. Sex	F	F	M	M	F	M
2. Stand Lgn.	5.1	5.0	4.9	4.8	4.8	4.8
3. Fork Lgn.	5.8	5.7	5.6	5.5	5.5	5.4
4. Total Lgn.	6.1	5.9	5.9	5.8	5.8	5.7
5. Sc. L. Line	123	122	122	124	117	119
6. Sc. Above	41	45	41	41	41	44
7. Sc. Below	39	40	39	38	39	35
8. Sc. D. Rows	178	180	176	179	181	187
9. Sc. B. Dor.	82	88	82	83	82	91
10. Rays Branch.	11	11	11	11	11	11
11. Rays Dorsal	10	10	10	10	10	10
12. Rays Anal	10	10	10	10	10	10
13. Rays Pect.	14	14	15	15	15	14
14. Rays Pelvic	9	9	9	9	9	9
15. Gill Rakers	7+12	6+12	6+12	6+11	7+11	6+11
16. Pyloric C.	49	45	47	45	41	52
17. Vertebrae	--	--	--	--	--	--
18. Head Lgn.	1.3	1.2	1.3	1.25	1.3	1.2
19. Head Depth	0.9	0.9	0.8	0.9	0.85	0.9
20. Eye Dia.	0.3	0.25	0.3	0.25	0.3	0.3
21. Snout Lgn.	0.25	0.25	0.25	0.25	0.25	0.25
22. Snout-Occ.	0.9	0.8	0.85	0.8	0.8	0.8
23. Snout-Max.	0.65	0.65	0.65	0.65	0.65	0.65
24. Snout-Dor.	2.6	2.6	2.5	2.4	2.4	2.4
25. Snout-Pel.	2.9	3.1	2.8	2.8	2.8	2.8
26. Body Width	0.6	0.6	0.6	0.6	0.6	0.6
27. Body Depth	1.2	1.2	1.2	1.2	1.2	1.2
28. Caud. P. Lgn.	0.8	0.7	0.7	0.7	0.7	0.7
29. Caud. P. Wid.	0.5	0.5	0.5	0.45	0.45	0.5
30. Dorsal Ht.	0.8	0.7	0.7	0.7	0.8	0.8
31. Dorsal Base	0.6	0.6	0.6	0.6	0.6	0.6
32. Anal Height	0.7	0.7	0.7	0.65	0.7	0.6
33. Anal Base	0.5	0.5	0.5	0.5	0.5	0.45
34. Pect. Lgn.	0.8	0.8	0.8	0.8	0.8	0.8
35. Pelvic Lgn.	0.7	0.7	0.65	0.6	0.7	0.6
36. Caud. Lgn.	1.0	0.9	1.0	1.0	1.0	0.9
37. Teeth Basi.	6	7	7	4	3	0
38. Teeth Gloss.	3+3	4+4	5+5	4+5	4+4	4+4
39. Teeth Dent.	11+11	8+8	10+11	13+13	11+12	13+11
40. Teeth P. Max.	6+6	5+4	5+5	6+6	6+6	5+5
41. Teeth Max.	16+14	16+17	15+15	18+18	17+15	17+16
42. Teeth Vomer	10	9	8	8	11	11
43. Teeth Palat.	13+12	12+14	12+13	13+14	10+11	13+12

Table 7.--(Continued)

	33	34	35		Mean	Range Limits
1. Sex	M	F	M			
2. Stand. Lgn.	4.5	3.2	2.9			
3. Fork Lgn.	5.0	3.7	3.1			
4. Total Lgn.	5.4	3.9	3.4			
5. Sc. L. Line	121	121	117	..	121.5	117-124
6. Sc. Above	39	39	41	..	41.4	37-45
7. Sc. Below	35	37	38	..	38.1	32-40
8. Sc. D. Rows	179	172	183	..	181.2	172-195
9. Sc. B. Dor.	90	83	85	..	84.7	81-91
10. Rays Branch.	11	12	11	..	11.1	11-12
11. Rays Dorsal	11	10	10	..	10.3	10.11
12. Rays Anal	10	10	10	..	10.2	10-11
13. Rays Pect.	15	15	15	..	14.9	14-16
14. Rays Pelvic	9	9	9	..	9.1	9-10
15. Gill Rakers	7+13	6+11	7+12	..	6.5+11.8	
16. Pyloric C.	38	39	44	..	44.5	38-52
17. Vertebrae	--	--	--	..	60.8	60-61
18. Head Lgn.	1.2	0.9	0.75			
19. Head Depth	0.8	0.6	0.5			
20. Eye Dia.	0.25	0.25	0.2			
21. Snout Lgn.	0.25	0.15	0.15			
22. Snout-Occ.	0.8	0.6	0.55			
23. Snout-Max.	0.65	0.4	0.35			
24. Snout-Dor.	2.2	1.6	1.5			
25. Snout-Pel.	2.6	1.75	1.6			
26. Body Width	0.5	0.4	0.35			
27. Body Depth	1.1	0.8	0.7			
28. Caud. P. Lgn.	0.6	0.5	0.45			
29. Caud. P. Wid.	0.4	0.3	0.3			
30. Dorsal Ht.	0.7	0.5	0.4			
31. Dorsal Base	0.55	0.4	0.3			
32. Anal Height	0.7	0.4	0.4			
33. Anal Base	0.45	0.35	0.3			
34. Pect. Lgn.	0.7	0.6	0.5			
35. Pelvic Lgn.	0.6	.45	0.4			
36. Caud. Lgn.	0.9	0.7	0.5			
37. Teeth Basi.	4	5	2	..	4.1	0-7
38. Teeth Gloss.	4+4	4+4	4+4	..	4 4	
39. Teeth Dent.	11+11	9+9	11+12	..	11.1+11.1	
40. Teeth P. Max.	5+4	6+6	6+6	..	5.5+5.4	
41. Teeth Max.	14+16	13+16	15+15	..	16.1+15.8	
42. Teeth Vomer	9	8	10	..	9.5	7-11
43. Teeth Palat.	13+13	10+12	9+9	..	11.7+12.3	

Table 8.--Structural counts of eight cutthroat trout from Lost Creek. Date of collection: September 11, 1949.

	36	37	38	39	40	41
1. Sex	F	M	F	M	M	F
2. Stand. Lgn.	6.2	6.2	5.8	5.6	5.3	5.1
3. Fork Lgn.	7.2	7.2	6.6	6.4	6.0	5.8
4. Total Lgn.	7.5	7.5	7.0	6.7	6.4	6.2
5. Sc. L. Line	117	117	123	119	117	130
6. Sc. Above	38	36	39	39	36	40
7. Sc. Below	36	35	35	34	31	39
8. Sc. D. Rows	177	163	163	174	160	173
9. Sc. B. Dor.	80	82	80	77	78	80
10. Rays Branch.	11	11	11	11	11	11
11. Rays Dorsal	11	11	11	11	11	11
12. Rays Anal	11	11	11	11	11	11
13. Rays Pect.	15	14	15	14	15	15
14. Rays Pelvic	9	9	9	9	9	9
15. Gill Rakers	7+11	7+11	6+12	7+12	7+11	7+12
16. Pyloric C.	36	45	48	48	48	41
17. Vertebrae	60	61	61	60	61	--
18. Head Lgn.	1.7	1.6	1.5	1.5	1.5	1.4
19. Head Depth	1.1	1.0	0.9	0.8	0.9	0.8
20. Eye Dia.	0.34	0.3	0.35	0.3	0.3	0.3
21. Snout Lgn.	0.35	0.35	0.3	0.3	0.3	0.3
22. Snout-Occ.	1.1	1.0	1.0	1.0	1.0	0.9
23. Snout-Max.	0.9	0.85	0.8	0.8	0.8	0.7
24. Snout-Dor.	3.1	3.1	3.0	2.8	2.7	2.7
25. Snout-Pel.	3.7	3.6	3.2	3.1	3.0	2.9
26. Body Width	0.7	0.75	0.6	0.7	0.6	0.6
27. Body Depth	1.4	1.45	1.3	1.3	1.3	1.2
28. Caud. P. Lgn.	0.8	0.9	0.8	0.8	0.7	p.7
29. Caud. P. Wid.	0.6	0.6	0.6	p.5	0.5	0.5
30. Dorsal Ht.	0.8	0.8	0.8	0.8	0.8	0.8
31. Dorsal Base	0.8	0.8	0.8	0.7	0.8	0.6
32. Anal Height	0.9	0.9	0.8	0.8	0.8	0.8
33. Anal Base	0.7	0.7	0.6	0.7	0.6	0.5
34. Pect. Lgn.	1.1	1.1	1.0	1.0	0.9	0.9
35. Pelvic Lgn.	0.8	0.9	0.8	0.8	0.8	0.8
36. Caud. Lgn.	1.3	1.3	1.2	1.1	1.1	1.1
37. Teeth Basi.	3	8	5	2	5	4
38. Teeth Gloss.	4+4	6+5	5+4	3+3	3+4	3+4
39. Teeth Dent.	14+14	13+14	15+15	14+12	11+10	15+12
40. Teeth P. Max.	6+6	6+7	4+4	8+7	7+6	6+6
41. Teeth Max.	19+20	14+15	20+21	22+21	18+20	18+20
42. Teeth Vomer	9	15	16	13	12	11
43. Teeth Palat.	13+13	12+12	14+13	14+13	14+15	14+13

Table 8.--(Continued)

	42	43			
1. Sex	M	?			
2. Stand. Lgn.	4.6	4.0			
3. Fork Lg.	5.3	4.6			Range
4. Total Lgn.	5.6	4.8		Mean	Limits
5. Sc. L. Line	117	120	...	120.0	117-130
6. Sc. Above	40	43	...	38.9	36-43
7. Sc. Below	35	36	...	35.1	31-39
8. Sc. D. Rows	167	184	...	170.1	160-184
9. Sc. B. Dor.	77	83	...	79.6	77-83
10. Rays Branch.	11	11	...	11.0	11-11
11. Rays Dorsal	11	11	...	11.0	11-11
12. Rays Anal	11	11	...	11.0	11-11
13. Rays Pect.	14	15	...	14.6	14-15
14. Rays Pelvic	9	10	...	9.1	9-10
15. Gill Rakers	7+12	7+12	...	6.9+11.6	
16. Pyloric C.	37	45	...	43.5	36-48
17. Vertebrae	--	--	...	60.6	60-61
18. Head Lgn.	1.3	1.05			
19. Head Depth	0.8	0.7			
20. Eye Dia.	0.3	0.25			
21. Snout Lgn.	0.25	0.2			
22. Snout-Occ.	0.85	0.7			
23. Snout-Max.	0.7	0.5			
24. Snout-Dor.	2.4	2.9			
25. Snout-Pel.	2.6	2.2			
26. Body Width	0.5	0.5			
27. Body Depth	1.1	0.85			
28. Caud. P. Lgn.	0.7	0.7			
29. Caud. P. Wid.	0.4	0.45			
30. Dorsal Ht.	0.7	0.75			
31. Dorsal Base	0.6	0.5			
32. Anal Height	0.65	0.6			
33. Anal Base	0.55	0.45			
34. Pect. Lgn.	0.8	0.7			
35. Pelvic Lgn.	0.7	0.6			
36. Caud. Lgn.	1.0	0.8			
37. Teeth Basi.	2	4	...	4.1	2-8
38. Teeth Gloss.	5+5	4+3	...	4.1+4	
39. Teeth Dent.	13+13	12+12	...	13.4+12.8	
40. Teeth P. Max.	4+6	6+5	...	5.9+5.9	
41. Teeth Max.	21+20	16+18	...	18.5+19.4	
42. Teeth Vomer	12	12	...	12.5	9-16
43. Teeth Palat.	12+12	13+15	...	13.3+13.3	

Table 9.--Structural counts of ten cutthroat trout from Willow Creek. Date of collection: August 22, 1949.

	44	45	46	47	48	49
1. Sex	M	M	M	M	M	M
2. Standard Lgn.	9.8	8.7	8.0	7.3	7.1	6.2
3. Fork Lgn.	11.2	9.8	9.1	8.2	7.9	6.9
4. Total Lgn.	11.4	10.1	9.4	8.4	8.3	7.2
5. Sc. L. Line	?	125	127	124	125	127
6. Sc. Above	42	41	40	44	40	44
7. Sc. Below	40	42	40	44	36	42
8. Sc. D. Rows	195	183	181	181	180	186
9. Sc. B. Dor.	91	90	96	86	84	94
10. Rays Branch.	12	12	11	10	10	11
11. Rays Dorsal	11	11	11	11	11	11
12. Rays Anal	11	11	11	11	11	11
13. Rays Pect.	14	14	15	15	15	16
14. Rays Pelvic	9	9	9	9	10	9
15. Gill Rakers	7+13	8+13	8+12	8+13	8+12	7+13
16. Pyloric C.	45	48	44	42	53	43
17. Vertebrae	--	60	61	61	61	61
18. Head Lgn.	2.5	2.4	2.0	1.9	1.9	1.5
19. Head Depth	1.7	1.4	1.3	1.1	1.1	1.1
20. Eye Dia.	0.4	0.4	0.4	0.4	0.35	0.3
21. Snout Lgn.	0.5	0.45	0.4	0.4	0.35	0.3
22. Snout-Occ.	1.6	1.5	1.25	1.2	1.1	1.0
23. Snout-Max.	1.45	1.3	1.2	1.0	0.9	0.8
24. Snout-Dor.	4.8	4.2	4.0	3.7	3.8	3.2
25. Snout-Pel.	5.5	5.2	4.4	3.9	3.8	3.6
26. Body Width	1.1	1.1	1.1	0.9	0.8	0.8
27. Body Depth	2.4	2.2	2.0	1.7	1.8	1.6
28. Caud. P. Lgn.	1.2	1.1	1.1	1.1	1.0	0.85
29. Caud. P. Wid.	0.9	0.9	0.8	0.75	0.7	0.8
30. Dorsal Ht.	1.4	1.1	1.1	1.1	0.9	0.9
31. Dorsal Base	1.2	1.0	1.0	0.9	0.8	0.8
32. Anal Height	1.2	1.0	1.0	0.9	0.8	0.8
33. Anal Base	1.0	0.9	0.85	0.8	0.7	0.7
34. Pect. Lgn.	1.6	1.5	1.3	1.2	1.15	1.0
35. Pelvic Lgn.	1.3	1.2	1.0	0.9	0.9	0.9
36. Caud. Lgn.	1.6	1.4	1.4	1.1	1.2	1.0
37. Teeth Basi.	6	5	13	6	5	7
38. Teeth Gloss.	3+2	4+4	4+4	5+4	3+3	3+3
39. Teeth Dent.	14+13	13+15	13+13	13+13	12+13	13+12
40. Teeth P. Max.	6+7	5+5	5+4	5+5	7+7	6+6
41. Teeth Max.	16+18	27+25	18+18	18+20	16+18	18+19
42. Teeth Vomer	10	10	12	8	13	9
43. Teeth Palat.	13+13	13+14	13+13	13+13	14+15	13+13

Table 9.--(Continued)

	50	51	52	53		Mean	Range Limits
1. Sex	M	M	M	M			
2. Stand. Lgn.	5.6	5.3	4.7	4.0			
3. Fork Lgn.	6.2	5.9	5.4	4.4			
4. Total Lgn.	6.6	6.2	5.6	4.7			
5. Sc. L. Line	122	123	128	126	..	125.2	122-128
6. Sc. Above	45	44	42	42	..	42.4	40-45
7. Sc. Below	38	38	42	41	..	40.3	36-42
8. Sc. D. Rows	177	182	177	185	..	182.7	177-195
9. Sc. B. Dor.	86	88	84	89	..	88.8	84-96
10. Rays Branch.	12	11	10	10	..	10.9	10-12
11. Rays Dorsal	11	11	11	11	..	11.0	11-11
12. Rays Anal	11	11	11	12	..	11.1	11-12
13. Rays Pect.	15	15	15	14	..	14.8	14-16
14. Rays Pelvic	9	9	9	9	..	9.1	9-10
15. Gill Rakers	8+13	8+13	7+12	8+11	..	7.7+12.5	
16. Pyloric C.	36	44	36	43	..	43.4	36-53
17. Vertebrae	--	--	--	--	..	60.8	60-61
18. Head Lgn.	1.3	1.3	1.1	1.0			
19. Head Depth	0.9	0.9	0.7	0.7			
20. Eye Dia.	0.25	0.25	0.25	0.25			
21. Snout Lgn.	0.25	0.2	0.2	0.15			
22. Snout-Occ.	0.9	1.3	0.75	0.7			
23. Snout-Max.	0.7	0.6	0.5	0.5			
24. Snout-Dor.	2.8	2.6	2.4	1.9			
25. Snout-Pel.	3.1	2.9	2.5	2.3			
26. Body Width	0.6	016	0.5	0.45			
27. Body Depth	1.3	1.8	1.2	0.7			
28. Caud. P. Lgn.	0.7	0.7	0.6	0.45			
29. Caud. P. Wid.	0.55	0.5	0.5	0.45			
30. Dorsal Ht.	0.7	0.8	0.7	0.6			
31. Dorsal Base	0.6	0.65	0.5	0.45			
32. Anal Height	0.7	0.7	0.7	0.5			
33. Anal Base	0.6	0.6	0.5	0.4			
34. Pect. Lgn.	0.9	0.9	0.8	0.7			
35. Pelvic Lgn.	0.9	0.7	0.7	0.5			
36. Caud. Lgn.	1.0	0.9	0.9	0.7			
37. Teeth Basi.	4	5	2	6	..	5.9	2-13
38. Teeth Gloss.	4+3	4+4	3+3	4+4	..	3.7+3.4	
39. Teeth Dent.	11+13	11+12	12+12	10+9	..	12.2+12.5	
40. Teeth P. Max.	6+5	5+5	5+5	4+5	..	5.4+5.4	
41. Teeth Max.	15+14	15+19	16+18	13+13	..	17.2+18.2	
42. Teeth Vomer	9	12	8	6	..	9.7	6-12
43. Teeth Palat.	12+13	12+14	10+11	13+13	..	12.6+13.2	

Table 10.--Structural counts of one cutthroat trout from Strawberry Lake. Date of collection: July, 1940.

		54
1.	Sex	?
2.	Stand. Lgn.	15.0
3.	Fork Lgn.	16.9
4.	Total Lgn.	17.2
5.	Sc. L. Line	121
6.	Sc. Above	43
7.	Sc. Below	43
8.	Sc. D. Rows	174
9.	Sc. B. Dor.	82
10.	Rays Branch.	?
11.	Rays Dorsal	10
12.	Rays Anal	11
13.	Rays Pect.	15
14.	Rays Pelvic	9
15.	Gill Rakers	?
16.	Pyloric C.	?
17.	Vertebrae	?
18.	Head Lgn.	3.25
19.	Head Depth	2.5
20.	Eye Dia.	0.5
21.	Snout Lgn.	0.6
22.	Snout-Occ.	2.1
23.	Snout-Max.	1.8
24.	Snout-Dor.	7.4
25.	Snout-Pel.	8.2
26.	Body Width	3.6
27.	Body Depth	?
28.	Caud. P. Lgn.	2.3
29.	Caud. P. Wid.	1.5
30.	Dorsal Ht.	1.8
31.	Dorsal Base	1.7
32.	Anal Height	1.6
33.	Anal Base	1.6
34.	Pect. Lgn.	2.0
35.	Pelvic Lgn.	1.8
36.	Caud. Lgn.	2.2
37.	Teeth Basi.	?
38.	Teeth Gloss.	?
39.	Teeth Dent.	?
40.	Teeth P. Max.	4+?
41.	Teeth Max.	24+?
42.	Teeth Vomer	?
43.	Teeth Palat.	?

Table 11.--Structural counts of fourteen cutthroat trout from Currant Creek. Date of collection: August 23, 1949.

	55	56	57	58	59	60	61
1. Sex	?	M	M	M	F	F	F
2. Stand. Lgn.	14.6	7.9	7.1	7.1	6.8	6.6	6.0
3. Fork Lgn.	16.4	8.85	8.1	8.0	7.8	7.4	6.8
4. Total Lgn.	16.4	9.2	8.4	8.3	8.1	7.6	7.1
5. Sc. Lat. L.	120	121	121	120	118	122	118
6. Sc. Above	38	48	43	44	43	45	41
7. Sc. Below	30	49	41	42	41	41	34
8. Sc. D. Rows	154	207	180	169	178	179	161
9. Sc. B. Dor.	78	99	81	83	83	80	78
10. Rays Branch.	12	11	11	11	11	10	11
11. Rays Dorsal	11	10	10	11	10	11	11
12. Rays Anal	11	11	10	10	10	11	11
13. Rays Pect.	15	16	14	15	15	15	15
14. Rays Pelvic	9	9	9	9	9	9	9
15. Gill Rakers	?	7+13	7+12	7+12	7+12	7+12	7+11
16. Pyloric C.	?	51	32	41	40	48	38
17. Vertebrae	?	60	61	59	62	60	--
18. Head Lgn.	3.5	1.8	1.7	1.75	1.6	1.6	1.55
19. Head Depth	2.3	1.2	1.2	1.2	1.2	1.1	1.0
20. Eye Dia.	0.5	0.4	0.3	0.35	0.3	0.35	0.3
21. Snout Lgn.	0.9	0.4	0.35	0.35	0.3	0.3	0.25
22. Snout-Occ.	2.4	1.1	1.1	1.15	1.1	1.0	0.9
23. Snout-Max.	1.8	1.0	0.9	0.9	0.9	0.8	0.8
24. Snout-Dor.	7.5	4.2	3.6	3.6	3.3	3.4	3.1
25. Snout-Pel.	8.3	4.4	3.9	3.6	3.7	3.6	3.3
26. Body Width	?	0.9	0.9	0.9	0.8	0.8	0.8
27. Body Depth	3.25	1.1	1.8	1.9	1.7	1.6	1.5
28. Caud. P. Lgn.	2.0	1.2	1.15	1.1	1.15	1.0	0.9
29. Caud. P. Wid.	1.5	0.8	0.7	0.7	0.7	0.7	0.65
30. Dorsal Ht.	1.5	1.0	1.0	1.0	1.0	0.7	0.85
31. Dorsal Base	1.75	0.9	0.9	1.0	0.9	0.9	0.8
32. Anal Height	1.5	1.0	0.9	0.9	0.9	0.9	0.8
33. Anal Base	1.4	0.8	0.75	0.8	0.7	0.8	0.7
34. Pect. Lgn.	2.0	1.2	1.1	1.1	1.1	1.0	1.0
35. Pelvic Lgn.	1.6	1.0	1.1	1.1	0.9	0.8	0.8
36. Caud. Lgn.	1.8	1.9	1.3	1.2	1.3	1.0	1.1
37. Teeth Basi.	?	0	0	2	0	1	2
38. Teeth Gloss.	?	5+5	4+3	4+4	3+3	3+3	3+3
39. Teeth Dent.	?	17+18	13+13	17+16	14+14	13+13	13+13
40. Teeth P. Max.	7 ?	4+4	6+5	7+6	4+5	6+6	5+5
41. Teeth Max.	23 ?	20+19	21+20	21+20	18+17	18+17	16+16
42. Teeth Vomer	?	10	12	13	13	11	10
43. Teeth Palat.	?	12+13	14+14	13+14	13+13	13+11	15+15

Table 11.--(Continued)

	62	63	64	65	66	67	68
1. Sex	M	M	F	M	M	M	F
2. Stand. Lgn.	5.5	5.4	5.3	5.1	5.0	4.8	4.7
3. Fork Lgn.	6.2	6.1	5.9	5.7	5.7	5.5	5.3
4. Total Lgn.	6.5	6.3	6.2	5.9	5.9	5.7	5.5
5. Sc. L. Line	115	111	115	122	116	113	111
6. Sc. Above	41	40	43	44	43	43	40
7. Sc. Below	39	39	44	38	44	40	35
8. Sc. D. Rows	177	166	177	188	178	184	190
9. Sc. B. Dor.	82	81	82	89	86	84	85
10. Rays. Branch.	11	10	11	11	10	11	11
11. Rays Dorsal	11	11	10	11	11	10	11
12. Rays Anal	11	10	10	11	11	11	11
13. Rays Pect.	14	14	15	15	15	15	15
14. Rays Pelvic	9	10	9	9	9	9	9
15. Gill Rakers	8+11	7+11	7+13	7+13	6+11	6+12	7+12
16. Pyloric C.	45	40	42	42	50	44	30
17. Vertebrae	--	--	--	--	--	--	--
18. Head Lgn.	1.3	1.3	1.2	1.25	1.2	1.7	1.1
19. Head Depth	1.0	0.9	0.8	0.8	0.7	0.8	0.8
20. Eye Dia.	0.25	0.25	0.25	0.25	0.25	0.25	0.25
21. Snout Lgn.	0.2	0.25	0.2	0.2	0.2	0.2	0.2
22. Snout-Occ.	0.75	0.85	0.8	0.75	0.8	0.75	0.75
23. Snout-Max.	0.65	0.7	0.6	0.65	0.6	0.6	0.6
24. Snout-Dor.	2.8	2.8	2.2	2.3	2.5	2.4	2.2
25. Snout-Pel.	2.9	2.9	2.8	2.7	2.75	2.6	2.7
26. Body Width	0.8	0.7	0.7	0.6	0.6	0.5	0.6
27. Body Depth	1.4	1.4	1.4	1.2	1.3	1.3	1.2
28. Caud. P. Lgn.	0.9	0.9	0.9	0.8	0.8	0.75	0.7
29. Caud. P. Wid.	0.55	0.6	0.5	0.55	0.5	0.5	0.5
30. Dorsal Ht.	0.8	0.8	0.7	0.8	0.7	0.7	0.7
31. Dorsal Base	0.8	0.85	0.6	0.8	0.6	0.6	0.6
32. Anal Height	0.8	0.7	0.75	0.7	0.7	0.75	0.65
33. Anal Base	0.6	0.6	0.5	0.6	0.5	0.5	0.5
34. Pect. Lgn.	0.8	0.85	0.9	0.8	0.8	0.8	0.8
35. Pelvic Lgn.	0.7	0.8	0.7	0.7	0.7	0.7	0.65
36. Caud. Lgn.	1/0	0.9	0.9	0.8	0.9	0.9	0.8
37. Teeth Basi.	0	0	0	0	3	3	0
38. Teeth Gloss.	5+5	3+4	4+4	4+5	4+4	5+5	3+3
39. Teeth Dent.	11+10	10+11	10+11	13+13	11+10	14+13	12+12
40. Teeth P. Max.	5+5	5+5	5+5	5+5	4+4	5+5	5+5
41. Teeth Max.	17+16	14+14	17+18	15+17	12+13	17+18	14+15
42. Teeth Vomer	11	7	13	9	9	10	11
43. Teeth Palat.	11+11	12+12	12+13	13+12	10+13	13+10	12+12

Table 11.--(Continued)

		Mean	Range Limits
1. Sex			
2. Stand. Lgn.			
3. Fork Lgn.			
4. Total Lgn.			
5. Sc. L. Line	..	117.4	111-122
6. Sc. Above	..	42.6	38-48
7. Sc. Below	..	39.8	30-49
8. Sc. D. Rows	..	177.7	154-207
9. Sc. B. Dor.	..	83.6	78-99
10. Rays Branch.	..	10.9	10-12
11. Rays Dorsal	..	10.6	10-11
12. Rays Anal	..	10.6	10-11
13. Rays Pect.	..	14.9	14-16
14. Rays Pelvic	..	9.1	9-10
15. Gill Rakers	..	6.9+11.9	
16. Pyloric C.	..	41.8	30-51
17. Vertebrae	..	60.4	59-61
18. Head Lgn.			
19. Dead Depth			
20. Eye Dia.			
21. Snout Lgn.			
22. Snout-Occ.			
23. Snout-Max.			
24. Snout-Dor.			
25. Snout-Pel.			
26. Body Width			
27. Body Depth			
28. Caud. P. Lgn.			
29. Caud. P. Wid.			
30. Dorsal Ht.			
31. Dorsal Base			
32. Anal Height			
33. Anal Base			
34. Pect. Lgn.			
35. Pelvic Lgn.			
36. Caud. Lgn.			
37. Teeth Basi.	..	.85	0-3
38. Teeth Gloss.	..	3.9+4.1	
39. Teeth Dent.	..	12.9+12.5	
40. Teeth P. Max.	..	5.2+5.0	
41. Teeth Max.	..	17.4+16.9	
42. Teeth Vomer	..	10.7	7-13
43. Teeth Palat.	..	12.5+12.5	

Table 12.--Structural counts of ten cutthroat trout from Pole Creek and Pole Creek Lake. Date of collection: August 24, 1949.

	69	70	71	72	73	74	75
1. Sex	M	F	M	M	M	F	F
2. Stand. Lgn.	6.4	6.1	5.8	5.8	5.3	5.3	5.3
3. Fork Lgn.	7.3	6.8	6.6	6.6	6.2	6.1	6.0
4. Total Lgn.	7.6	7.1	6.8	6.8	6.5	6.4	6.3
5. Sc. L. Line	118	128	122	121	125	121	118
6. Sc. Above	45	47	49	43	43	44	43
7. Sc. Below	45	44	47	40	40	43	40
8. Sc. D. Rows	196	215	213	192	192	194	202
9. Sc. B. Dor.	95	103	102	96	94	97	101
10. Rays Branch.	11	12	11	11	10	11	11
11. Rays Dorsal	10	11	11	11	11	10	10
12. Rays Anal	11	11	10	10	10	10	10
13. Rays Pect.	15	15	15	15	15	15	15
14. Rays Pelvic	8	9	9	9	9	9	9
15. Gill Rakers	6 11	+6 12	+7 11	+6 12	+7 12	7+12	6+11
16. Pyloric C.	52	39	39	39	35	34	35
17. Vertebrae	60	59	60	60	--	--	--
18. Head Lgn.	1.7	1.45	1.5	1.5	1.4	1.3	1.3
19. Head Depth	1.1	1.0	1.0	1.0	0.9	0.9	0.9
20. Eye Dia.	0.35	0.3	0.3	0.3	0.3	0.3	0.3
21. Snout Lgn.	0.35	0.3	0.3	0.3	0.3	0.25	0.25
22. Snout-Occ.	1.1	1.0	0.95	1.0	0.9	0.9	0.85
23. Snout-Max.	0.9	0.8	0.75	0.8	0.7	0.7	0.7
24. Snout-Dor.	3.4	3.1	3.0	3.0	2.7	2.8	2.6
25. Snout-Pel.	3.4	3.3	3.1	3.2	3.0	2.9	2.9
26. Body Width	0.8	0.7	0.7	0.7	0.7	0.7	0.7
27. Body Depth	1.7	1.4	1.5	1.3	1.3	1.3	1.2
28. Caud. P. Lgn.	0.9	0.9	0.9	0.9	0.8	0.8	0.7
29. Caud. P. Width	0.7	0.6	0.6	0.6	0.55	0.55	0.55
30. Dorsal Ht.	1.0	0.9	1.0	0.9	0.9	0.8	0.9
31. Dorsal Base	1.8	0.7	0.8	0.7	0.7	0.6	0.7
32. Anal Height	0.9	0.8	0.8	0.9	0.85	0.7	0.8
33. Anal Base	0.8	0.6	0.6	0.65	0.6	0.6	0.55
34. Pect. Lgn.	1.2	1.0	1.0	1.0	1.0	0.9	0.9
35. Pelvic lgn.	1.0	0.8	0.8	0.8	0.85	0.7	0.8
36. Caud. Lgn.	1.2	1.0	1.0	1.0	1.2	1.1	1.0
37. Teeth Basi.	4	5	4	4	7	4	4
38. Teeth Gloss.	4+4	4+4	4+4	5+5	4+4	4+4	5+5
39. Teeth Dent.	12+12	12+12	11+12	15+14	14+14	14+14	14+12
40. Teeth P. Max.	5+5	6+6	6+7	5+5	5+6	4+5	5+6
41. Teeth Max.	16+19	16+15	17+16	15+15	16+15	18+20	20+20
42. Teeth Vomer	12	8	8	10	9	11	6
43. Teeth Palat.	14+11	13+12	12+13	12+12	12+14	12+14	12+12

Table 12.--(Continued)

	76	77	78		Mean	Range Limits
1. Sex	M	F	M			
2. Stand. Lgn.	5.3	4.9	4.3			
3. Fork Lgn.	6.1	5.6	4.9			
4. Total Lgn.	6.3	5.9	5.1			
5. Sc. L. Line	123	121	217	..	122.4	118-128
6. Sc. Above	46	46	45	..	45.1	43-49
7. Sc. Below	42	43	43	..	42.7	40-47
8. Sc. D. Rows	205	208	190	..	200.7	190-215
9. Sc. B. Dor.	100	96	96	..	98.1	94-103
10. Rays Branch.	11	11	10	..	10.9	10-12
11. Rays Dorsal	10	11	10	..	10.5	10-11
12. Rays Anal	10	11	11	..	10.4	10-11
13. Rays Pect.	15	15	15	..	15.0	15-15
14. Rays Pelvic	9	9	9	..	8.9	8-9
15. Gill Rakers	6+12	6+11	6+12	..	6.3+11.6	
16. Pyloric C.	37	34	34	..	37.8	34-52
17. Vertebrae	59	--	--	..	59.6	59-60
18. Head Lgn.	1.4	1.25	1.1			
19. Head Depth	0.9	0.9	0.7			
20. Eye Dia.	0.25	0.3	0.2			
21. Snout Lgn.	0.3	0.25	0.2			
22. Snout-Occ.	0.9	0.8	0.75			
23. Snout-Max.	0.75	0.6	0.55			
24. Snout-Dor.	2.6	2.1	2.2			
25. Snout-Pel.	3.0	2.65	2.5			
26. Body Width	0.7	0.6	0.5			
27. Body Depth	1.2	1.2	1.0			
28. Caud. P. Lgn.	0.8	0.75	0.65			
29. Caud. P. Wid.	0.6	0.5	0.4			
30. Dorsal Ht.	0.9	0.8	0.7			
31. Dorsal Base	0.7	0.6	0.5			
32. Anal Height	0.7	0.8	0.6			
33. Anal Base	0.55	0.5	0.4			
34. Pect. Lgn.	1.0	0.9	0.7			
35. Pelvic Lgn.	0.8	0.7	0.6			
36. Caud. Lgn.	1.0	1.0	0.8			
37. Teeth Basi.	7	6	3	..	4.8	3-7
38. Teeth Gloxx.	4+4	5+4	4+4	..	4.3+4.2	
39. Teeth Dent.	12+10	10+10	9+8	..	12.3+11.8	
40. Teeth P. Max.	4+5	5+5	4+6	..	4.9+5.6	
41. Teeth Max.	16+15	15+12	14+12	..	16.3+15.9	
42. Teeth Vomer	8	10	8	..	9.0	6-12
43. Teeth Palat.	12+12	11+9	12+11	..	12.4+11.9	

Table 13.--Structural counts of fourteen cutthroat trout from Elk Park Creek. Date of Collection: August 26, 1949.

	79	80	81	82	83	84
1. Sex	F	F	M	M	F	F
2. Stand. Lgn.	6.2	6.2	5.8	5.6	5.5	5.4
3. Fork Lgn.	7.0	7.1	6.7	6.5	6.4	6.3
4. Total Lgn.	7.3	7.3	7.0	6.8	6.7	6.5
5. Sc. L. Line	122	122	118	115	120	117
6. Sc. Above	50	47	49	49	44	48
7. Sc. Below	45	38	41	46	44	44
8. Sc. D. Rows	100	210	197	196	181	202
9. Sc. B. Dor.	105	98	99	93	95	102
10. Rays Branch.	11	11	11	10	10	10
11. Rays Dorsal	11	11	10	11	11	10
12. Rays Anal	11	11	11	11	10	11
13. Rays Pect.	15	15	15	15	16	16
14. Rays Pelvic	10	10	9	9	9	10
15. Gill Rakers	6+13	5+13	6+13	5+12	5+12	5+13
16. Pyloric C.	37	40	42	41	38	42
17. Vertebrae	62	--	--	61	61	--
18. Head Lgn.	1.5	1.6	1.55	1.5	1.4	1.4
19. Head Depth	1.1	1.0	1.0	1.0	1.0	0.9
20. Eye Dia.	0.3	0.35	0.3	0.3	0.3	0.3
21. Snout Lgn.	0.3	0.35	0.25	0.3	0.3	0.3
22. Snout-Occ.	0.9	1.05	1.0	0.9	0.9	0.9
23. Snout-Mas.	0.8	0.9	0.9	0.9	0.75	0.8
24. Snout-Dor.	3.0	3.1	2.9	2.8	2.9	2.8
25. Snout-Pel.	3.2	3.2	3.2	2.9	3.0	3.0
26. Body Width	0.7	0.5	0.7	0.7	0.7	0.7
27. Body Depth	1.5	1.4	1.4	1.5	1.5	1.3
28. Caud. P. Lgn.	0.95	0.9	0.9	0.9	0.9	0.9
29. Caud. P. Wid.	0.6	0.55	0.5	0.6	0.6	0.55
30. Dorsal Ht.	1.0	0.85	0.8	0.9	0.9	0.8
31. Dorsal Base	0.8	0.8	0.7	0.8	0.7	0.7
32. Anal Height	0.85	0.9	0.8	0.8	0.75	0.7
33. Anal Base	0.7	0.7	0.7	0.75	0.6	0.6
34. Pect. Lgn.	1.0	1.1	1.0	1.0	1.0	0.9
35. Pelvic Lgn.	0.9	0.9	0.85	0.8	0.8	0.8
36. Caud. Lgn.	1.1	1.1	1.2	1.2	1.2	1.1
37. Teeth Basi.	6	2	0	2	3	4
38. Teeth Gloss.	5+5	6+6	4+4	4+4	5+5	6+6
39. Teeth Dent.	15+12	13+16	12+12	15+15	15+15	14+13
40. Teeth P. Max.	7+8	7+6	5+5	6+6	5+5	7+6
41. Teeth Max.	19+16	18+18	17+18	20+20	15+16	17+19
42. Teeth Vomer	12	12	12	10	11	15
43. Teeth Palat.	16+14	14+12	14+14	13+13	14+13	15+14

Table 13.--(Continued)

	85	86	87	88	89	90
1. Sex	M	M	F	M	F	M
2. Stand. Lgn.	5.4	5.4	5.3	5.2	5.1	4.9
3. Fork Lgn.	6.1	6.1	6.0	5.9	5.8	5.7
4. Total Lgn.	6.4	6.4	6.3	6.2	6.1	5.9
5. Sc. L. Line	122	121	121	117	121	121
6. Sc. Above	47	46	48	45	48	48
7. Sc. Below	44	46	42	44	44	45
8. Sc. D. Rows	195	196	194	212	195	196
9. Sc. B. Dor.	100	99	96	106	95	97
10. Rays Branch.	11	10	11	10	10	10
11. Rays Dorsal	11	11	11	10	10	11
12. Rays Anal	11	11	11	11	11	11
13. Rays Pect.	15	15	15	16	15	16
14. Rays Pelvic	10	9	10	10	10	9
15. Gill Rakers	4+13	6+13	5+12	4+12	5+13	5+12
16. Pyloric C.	42	36	38	36	40	38
17. Vertebrae	61	--	--	--	61	--
18. Head Lgn.	1.45	1.35	1.3	1.35	1.3	1.3
19. Head Depth	0.9	0.9	0.9	0.9	0.9	0.9
20. Eye Dia.	0.3	0.3	0.3	0.3	0.3	0.25
21. Snout Lgn.	0.3	0.3	0.25	0.25	0.25	0.25
22. Snout-Occ.	0.9	0.85	0.85	0.9	0.8	0.8
23. Snout-Max.	0.8	0.75	0.75	0.85	0.7	0.7
24. Snout-Dor.	2.9	2.6	2.5	2.7	2.6	2.4
25. Snout-Pel.	2.9	3.0	2.9	2.8	2.6	2.6
26. Body Width	0.6	0.6	0.6	0.6	0.6	0.5
27. Body Depth	1.4	1.25	1.3	1.3	1.2	1.1
28. Caud. P.Lgn.	0.85	0.85	0.85	0.85	0.8	0.8
29. Caud. P.Wid.	0.55	0.5	0.5	0.5	0.6	0.5
30. Dorsal Ht.	0.8	0.8	0.9	0.8	0.85	0.8
31. Dorsal Base	0.7	0.7	0.7	0.7	0.65	0.6
32. Anal Height	0.7	0.7	0.7	0.7	0.7	0.7
33. Anal Base	0.55	0.5	0.6	0.55	0.55	0.55
34. Pect. Lgn.	0.9	0.9	0.9	0.95	0.9	0.9
35. Pelvic Lgn.	0.8	0.8	0.8	0.75	0.75	0.8
36. Caud. Lgn.	1.0	1.0	1.0	1.0	1.0	1.0
37. Teeth Bask.	2	2	0	1	3	0
38. Teeth Gloss.	6+6	4+4	5+5	4+4	5+4	4+4
39. Teeth Dent.	15+16	13+14	15+15	12+13	14+15	13+13
40. Teeth P.Max.	5+7	6+7	6+7	5+6	7+6	5+6
41. Teeth Max.	17+18	15+16	15+15	18+20	15+15	15+16
42. Teeth Vomer	13	12	11	12	14	13
43. Teeth Palat.	12+13	15+15	14+15	14+14	17+17	12+11

Table 13.--(Continued)

	91	92			Range
1. Sex	M	F		Mean	Limits
2. Stand. Lgn.	4.2	3.9			
3. Fork Lgn.	4.8	4.5			
4. Total Lgn.	5.0	4.7			
5. Sc. L. Line	119	118	..	119.6	115-122
6. Sc. Above	48	48	..	47.5	44-50
7. Sc. Below	47	47	..	44.1	38-47
8. Sc. D. Rows	200	199	..	197.4	181-212
9. Sc. B. Dor.	91	94	..	97.9	91-106
10. Rays Branch.	11	10	..	10.4	10-11
11. Rays Dorsal	11	11	..	10.7	10-11
12. Rays Anal	11	11	..	10.9	10-11
13. Rays Pect.	16	16	..	15.4	15-16
14. Rays Pelvic	9	10	..	9.6	9-10
15. Gill Rakers	6+12	6+12	..	5.2+12.5	
16. Pyloric C.	37	38	..	38.9	36-42
17. Vertebrae	--	--	..	61.2	61-62
18. Head Lgn.	1.1	1.0			
19. Head Depth	0.7	0.7			
20. Eye Dia.	0.25	0.25			
21. Snout Lgn.	0.2	0.2			
22. Snout-Occ.	0.7	0.65			
23. Snout-Max	0.55	0.55			
24. Snout-Dor.	2.2	1.95			
25. Snout-Pel.	2.3	2.0			
26. Body Width	0.6	0.4			
27. Body Depth	1.0	0.9			
28. Caud. P. Lgn.	0.75	0.6			
29. Caud. P. Wid.	0.6	0.4			
30. Dorsal Ht.	0.7	0.7			
31. Dorsal Base	0.5	0.5			
32. Anal Height	0.55	0.5			
33. Anal Base	0.45	0.4			
34. Pect. Lgn.	0.7	017			
35. Pelvic Lgn.	0.6	0.55			
36. Caud. Lgn.	0.8	0.8			
37. Teeth Basi.	5	3	..	2.4	0-6
38. Teeth Gloss.	6+4	5+5	..	4.9+4.7	
39. Teeth Dent.	12+12	15+15	..	13.8+14.0	
40. Teeth P. Max.	6+6	6+6	..	5.9+6.2	
41. Teeth Max.	13+15	16+16	..	16.4+17.0	
42. Teeth Vomer	11	9	..	11.9	9-15
43. Teeth Palat.	13+13	14+13	..	14.1+13.6	

Table 14.--Structural counts of nine cutthroat trout from the West Fork of Sheep Creek. Date of collection: August 27, 1949.

	93	94	95	96	97	98	99
1. Sex	F	F	F	F	F	F	F
2. Stand. Lgn.	6.4	6.3	5.3	5.1	5.1	5.0	4.8
3. Fork Lgn.	7.3	7.2	6.0	5.8	5.8	5.7	5.5
4. Total Lgn.	7.6	7.6	6.3	6.1	6.1	6.0	5.8
5. Sc. L. Line	128	127	121	117	120	121	---
6. Sc. Above	45	45	46	43	45	43	--
7. Sc. Below	46	39	43	42	43	42	--
8. Sc. D. Rows	193	191	184	---	186	186	---
9. Sc. B. Dor.	92	99	97	--	96	93	--
10. Rays Branch.	10	11	11	12	11	11	10
11. Rays Dorsal	10	11	11	12	12	11	11
12. Rays Anal	10	11	11	11	11	12	10
13. Rays Pect.	15	14	14	15	15	15	15
14. Rays Pelvic	9	9	9	99	9	10	9
15. Gill Rakers	7+13	6+13	6+12	7+13	7+11	8+12	8+14
16. Pyloric C.	40	37	42	37	43	37	38
17. Vertebrae	61	60	60	--	59	--	--
18. Head Lgn.	1.55	1.5	1.25	1.25	1.2	1.2	1.15
19. Head Depth	1.0	1.0	0.9	0.85	0.9	0.8	0.8
20. Eye Dia.	03	0.3	0.3	0.25	0.25	0.3	0.25
21. Snout Lgn.	0.3	0.3	0.25	0.25	0.2	0.25	0.2
22. Snout-Occ.	0.9	0.9	0.9	0.9	0.85	0.9	0.8
23. Snout-Max.	0.8	0.75	0.75	0.6	0.55	0.65	0.65
24. Snout-Dor.	3.2	3.1	2.8	2.5	2.6	2.6	2.6
25. Snout-Pel.	3.5	3.1	2.75	2.8	2.65	2.6	2.6
26. Body Width	0.7	0.8	0.65	0.6	0.6	0.7	0.6
27. Body Depth	1.55	1.6	1.8	1.2	1.2	1.3	1.2
28. Caud. P.Lgn.	1.0	1.0	0.85	0.85	0.8	0.8	0.8
29. Caud. P. Wid.	0.65	0.6	0.55	0.55	0.55	0.55	0.5
30. Dorsal Ht.	0.9	1.0	0.8	0.85	0.8	0.8	0.8
31. Dorsal Base	0.75	0.9	0.7	0.7	0.75	0.6	0.6
32. Anal Height	0.85	1.0	0.8	0.8	0.7	0.8	0.7
33. Anal Base	0.75	0.7	0.6	0.55	0.6	0.6	0.6
34. Pect. Lgn.	1.0	1.1	0.9	0.9	0.8	0.85	0.8
35. Pelvic Lgn.	0.85	0.9	0.7	0.7	0.7	0.7	0.7
36. Caud. Lgn.	1.2	1.3	1.0	1.0	1.0	1.0	1.0
37. Teeth Basi.	5	5	2	8	3	1	4
38. Teeth Gloss.	5+5	5+5	5+5	6+5	4+4	5+4	4+4
39. Teeth Dent.	12+11	15+14	14+14	13+11	11+12	13+15	14+13
40. Teeth P.Max.	6+5	5+5	5+6	7+7	6+6	7+6	6+8
41. Teeth Max.	20+18	16+17	22+20	15+14	16+17	17+18	24+24
42. Teeth Vomer	8	12	8	10	7	14	11
43. Teeth Palat.	12+12	12+13	14+14	12+11	12+13	13+13	16+15

Table 14.--(Continued)

	100	101			Range
1. Sex	M	F		Mean	Limits
2. Stand. Lgn.	4.5	4.1			
3. Fork Lgn.	5.2	4.6			
4. Total Lgn.	5.5	4.9			
5. Sc. L. Line	117	---	..	121.6	117-128
6. Sc. Above	45	--	..	44.6	43-46
7. Sc. Below	43	--	..	42.6	39-46
8. Sc. D. Rows	191	---	..	188.5	184-193
9. Sc. B. Dor.	88	--	..	94.2	88-99
10. Rays Branch.	11	11	..	10.9	10-12
11. Rays Dorsal	12	11	..	11.2	10-12
12. Rays Anal	11	11	..	10.9	10-12
13. Rays Pect.	15	14	..	14.7	14-15
14. Rays Pelvic	9	9	..	9.1	9-10
15. Gill Rakers	7+13	6+12	..	6.9+12.6	
16. Pyloric C.	40	32	..	38.4	32-43
17. Vertebrae	59	--	..	59.8	59-61
18. Head Lgn.	1.1	1.05			
19. Head Depth	0.7	0.8			
20. Eye Dia.	0.25	0.25			
21. Snout Lgn.	0.2	0.2			
22. Snout-Occ.	0.8	0.7			
23. Snout-Max.	0.6	0.55			
24. Snout-Dor.	2.2	2.1			
25. Snout-Pel.	2.4	2.2			
26. Body Width	0.5	0.5			
27. Body Depth	1.1	1.0			
28. Caud. P. Lgn.	0.9	0.75			
29. Caud. P. Wid.	0.45	0.4			
30. Dorsal Ht.	0.8	0.7			
31. Dorsal Base	0.7	0.5			
32. Anal Height	0.7	0.6			
33. Anal Base	0.5	0.4			
34. Pect. Lgn.	0.8	0.7			
35. Pelvic Lgn.	0.7	0.6			
36. Caud. Lgn.	1.0	0.8			
37. Teeth Basi.	6	3	..	4.1	1-8
38. Teeth Gloss.	5+5	5+5	..	4.9+4.7	
39. Teeth Dent.	13+11	13+13	..	13.0+12.7	
40. Teeth P. Max.	7+7	6+7	..	6.1+6.3	
41. Teeth Max.	17+17	16+16	..	18.1+17.9	
42. Teeth Vomer	8	10	..	9.8	7-14
43. Teeth Palat.	12+12	16+16	..	13.3+13.2	

Table 15.--Structural counts of three cutthroat trout from the West Fork of Black's Fork. Date of collection: August 28, 1949.

	102	103	104			
1. Sex	F	M	?			
2. Stand. Lgn.	8.4	6.1	4.6			
3. Fork Lgn.	9.6	6.9	5.2			
4. Total Lgn.	10.0	7.3	5.5			
5. Sc. L. Line	124	125	124	..	124.3	124-125
6. Sc. Above	52	42	42	..	45.3	42-52
7. Sc. Below	40	40	40	..	40.0	40-40
8. Sc. D. Rows	211	171	195	..	192.3	171-211
9. Sc. B. Dor.	117	92	91	..	100.0	91-117
10. Rays Branch.	11	10	10	..	10.3	10-11
11. Rays Dorsal	11	12	11	..	11.3	11-12
12. Rays Anal	10	10	10	..	10.0	10-10
13. Rays Pect.	15	14	14	..	14.3	14-15
14. Rays Pelvic	9	9	9	..	9.0	9-9
15. Gill Rakers	7+13	7+12	6+11	..	7+12	-- --
16. Pyloric C.	37	47	38	..	40.7	37-47
17. Vertebrae	61	60	61	..	60.7	60-61
18. Head Lgn.	1.95	1.45	1.1			
19. Head Depth	1.3	1.0	0.7			
20. Eye Dia.	0.35	0.3	0.25			
21. Snout- Lgn.	0.35	0.25	0.2			
22. Snout-Occ.	1.3	0.95	0.7			
23. Snout-Max.	1.0	0.7	0.55			
24. Snout-Dor.	4.3	3.2	2.3			
25. Snout-Pel.	4.5	3.15	2.5			
26. Body Width	1.1	0.7	1.0			
27. Body Depth	1.9	1.4	1.0			
28. Caud. P. Lgn.	1.2	1.1	0.6			
29. Caud. P. Wid.	0.8	0.6	0.4			
30. Dorsal Ht.	1.3	0.8	0.7			
31. Dorsal Base	1.1	0.7	0.6			
32. Anal Ht.	1.1	0.8	0.6			
33. Anal Base	0.9	0.7	0.5			
34. Pect Lgn.	1.35	0.9	0.75			
35. Pelvic Lgn.	1.1	0.85	0.6			
36. Caud. Lgn.	1.6	1.2	0.9			
37. Teeth Basi.	11	2	2	..	5.7	2-11
38. Teeth Gloss.	5+5	5+5	5+5	..	5+5	
39. Teeth Dent.	18+17	19+18	16+16	..	17.7+17.0	
40. Teeth P. Max.	5+5	5+5	5+6	..	5.0 + 5.3	
41. Teeth Max.	17+18	17+17	16+15	..	16.7+16.7	
42. Teeth Vomer	15	10	11	..	12.0	10-15
43. Teeth Palat.	15+13	15+15	14+15	..	14.7+14.7	

Table 16.--Summary of means of structural counts of cutthroat trout from stations of the Bonneville Basin in Utah.

	Utah Lake	Am. Fork	Deer Cr.	McG. Cr.	Mill Cr.	Lost Cr.
1. Sc. L. Line	124.0	124.0	129.3	122.3	121.5	120.0
2. Sc. Above	42.0	37.0	40.7	42.1	41.4	38.9
3. Sc. Below	40.0	35.0	39.0	37.8	38.1	35.1
4. Sc. D. Rows	180.8	167.0	189.3	183.0	181.2	170.1
5. Sc. B. Dor.	84.3	85.0	96.3	87.8	84.7	79.6
6. Rays Branch.	11.5	11.0	11.3	11.0	11.1	11.0
7. Rays Dorsal	11.5	11.0	11.0	10.8	10.3	11.0
8. Rays Anal	12.5	11.0	11.0	10.9	10.2	11.0
9. Rays Pect.	15.0	16.0	14.0	14.8	14.9	14.6
10. Rays Pelvic	9.0	10.0	9.0	9.3	9.1	9.1
11. Gill Rakers	7.0 + 13	7.0 + 13	7.0 + 12.3	7.6 + 12.1	6.5 + 11.8	6.9 + 11.6
12. Pyloric C.	-- -	51.0	42.0	42.5	44.5	43.5
13. Vertebrae	61.8	61.0	62.0	61.6	60.8	60.6
14. Teeth Basi.	6.0	5.0	6.0	4.5	4.1	4.1
15. Teeth Vomer	12.0	14.0	8.0	9.8	9.5	12.5

Table 17.--Summary of means of structural counts of cutthroat trout from stations of the Green River tributaries in Utah.

	Willow Creek	Straw. Lake	Curr. Creek	Pole Creek	Elk Creek	Sheep Creek	Black Fork
1. Sc. L. Line	125.2	121.0	117.4	122.4	119.6	121.6	126.3
2. Sc. Above	42.4	43.0	42.6	45.1	47.5	44.6	45.3
3. Sc. Below	40.3	43.0	39.8	42.7	44.1	42.6	40.0
4. Sc. D. Rows	182.7	174.0	177.7	200.7	197.4	188.5	192.3
5. Sc. B. Dor.	88.8	82.0	83.6	98.0	97.9	94.2	100.0
6. Rays Branch.	10.9	----	10.9	10.9	10.4	10.9	10.3
7. Rays Dorsal	11.0	10.0	10.6	10.5	10.7	11.2	11.3
8. Rays Anal	11.1	11.0	10.6	10.4	10.9	10.9	10.0
9. Rays Pect.	14.8	15.0	14.9	15.0	15.4	14.7	14.3
10. Rays Pelvic	9.1	9.0	9.1	8.9	9.6	9.1	9.0
11. Gill Rakers	7.7	---	6.9	6.3	5.2	6.9	7.0
	+		+	+	+	+	+
	12.5	---	11.9	11.6	12.5	12.6	12.0
12. Pyloric C.	43.4	---	41.8	37.8	38.9	38.4	40.7
13. Vertebrae	60.8	---	60.4	59.6	61.2	59.8	60.7
14. Teeth Basi.	5.9	---	0.9	4.8	2.4	4.1	5.7
15. Teeth Vomer	9.7	---	10.7	9.0	11.9	9.8	12.0

Table 18.--Drainage means, drainage range limits, and over-all range limits by drainage of the cutthroat trout of the Bonneville Basin and the Green River tributaries of Utah.

	Drainage Means		Drainage Range Limits		Over-all Range Limits	
	Bonn.	Green	Bonn.	Green	Bonn.	Green
1. Sc. L. Line	123.52	121.93	120.0 to 129.3	117.4 to 126.3	117.0 to 131.0	111.0 to 128.0
2. Sc. Above	40.35	44.36	37.0 to 42.1	42.4 to 47.5	36.0 to 46.0	38.0 to 52.0
3. Sc. Below	37.50	41.79	35.0 to 40.0	39.8 to 44.1	31.0 to 43.0	30.0 to 49.0
4. Sc. D. Rows	178.57	187.61	167.0 to 189.3	174.0 to 200.7	159.0 to 202.0	154.0 to 215.0
5. Sc. B. Dor.	86.28	92.07	79.6 to 96.3	82.0 to 100.0	77.0 to 101.0	78.0 to 117.0
6. Rays Branch.	11.15	10.72	11.0 to 11.5	10.3 to 10.9	10.0 to 12.0	10.0 to 12.0
7. Rays Dorsal	10.92	10.76	10.3 to 11.5	10.0 to 11.3	10.0 to 12.0	10.0 to 12.0
8. Rays Anal	11.10	10.70	10.2 to 12.5	10.0 to 11.1	10.0 to 13.0	10.0 to 12.0
9. Rays Pect.	14.88	14.87	14.0 to 16.0	14.3 to 15.4	14.0 to 16.0	14.0 to 16.0
10. Rays Pelvic	9.25	9.11	9.0 to 10.0	8.9 to 9.6	9.0 to 10.0	8.0 to 9.0
11. Gill Rakers	7.00	6.66	6.5 to 7.6	5.2 to 7.7	6.5 to 7.6	6.2 to 7.7
	+ 12.30	+ 12.18	+ 11.6 to 13.0	+ 11.6 to 12.6	+ 11.6 to 13.0	+ 11.6 to 12.6

Table 18.--(Continued)

12. Pyloric C.	44.70	40.17	42.0 to 51.0	37.8 to 43.4	36.0 to 52.0	30.0 to 53.0
13. Vertebrae	61.30	60.42	60.6 to 62.0	59.6 to 61.2	60.0 to 63.0	59.0 to 62.0
14. Teeth Basi.	4.95	3.96	4.1 to 6.0	0.9 to 5.9	0.0 to 13.0	0.0 to 13.0
15. Teeth Vomer	10.97	10.52	8.0 to 14.0	9.0 to 12.0	6.0 to 16.0	6.0 to 15.0

VI. Discussion of the Subspecies of Cutthroat in Utah

A. Characters for Identifying Species and Subspecies

Although taxonomists for centuries have endeavored to define the characters which will separate groups of similar organisms, modern zoologists are still not in full agreement, and the word <u>species</u> has often been used so loosely that it is valueless except when accompanied by explanation.

Linnaeus tried to differentiate between animals on a morphological basis and occasionally made the mistake, as have modern investigators, of classifying juvenile and adult, male and female as different species. Moreover, after decades of intensive work with many groups of animals, workers have found that very often intergradations connect animal groups that had formerly been designated as distinct species. The extreme ends of such a geographical group may appear quite different externally, may never interbreed, and when mated artificially, may not produce young. Various divisions within such a species living in close proximity, on the other hand, are often not easily differentiated by the usual morphological characters and may interbreed and produce fertile offspring.

What, then, are the characters which will identify species? An example of the many definitions to be found in current literature is illustrated by a quotation from Emerson (6, p.153): "A species is a genetically distinctive, reproductively isolated, natural population."

Upon inspection this definition is found to be rather weak and of little use to the present investigation All animals, except in rare instances, are 'genetically distinctive'; brothers may be quite different, and parents are often unlike their progeny in some characteristics. 'Reproductively isolated' fails to account for the interbreeding of animal groups in close proximity, meanwhile decreasing as the groups are progressively separated. The words 'natural population' are likewise ambiguous.

Of the numerous definitions examined Mayr's (21, p.253) quotation from Timmofeef-Ressovsky is most satisfactory: "A species is a group of individuals that are morphologically and physiologically similar (although comprising a number of groups of the lowest taxonomic category) which has reached an almost complete biological isolation from similar neighbouring groups of individuals inhabiting the same or adjacent territories. Under biological isolation we understand the impossibility or nonoccurrence of normal hybridization under natural conditions."

The fact that a group of organisms must be morphologically and physiologically similar appears satisfactory until the phrase is examined closely. Often 'good' species are quite similar in these respects, as, for example, two species of insects, Drosophila pseudoobscura and D. miranda; while links in a geographical chain of subspecies, separated by distance, may be quite different (17, p.254-255).

Could it be that the word species is an artificality necessarily having flexible limits or bounds? Perhaps, and when one remembers that he is working with animal groups which throughout millions of years of evolution have become modified through mutation, some of them greatly, he begins to realize that intergradation must necessarily exist. Those exhibiting large differences we classify as orders, families, and genera; those, on the other hand, showing small changes we group as species, subspecies, and races.

The trout groups in the family Salmonidae are probably very closely related and occasionally may hybridize under natural conditions; but perhaps after a few million years, baring the intervention of man, they may become completely non-breeding units.

In this connection the writer knows of no experiment to determine whether subspecies of cutthroat trout will interbreed under natural conditions. It is true, however, that rainbow and cutthroat trout have been crossed in hatcheries, but the number of 'good' species which can be crossed artificially is amazing.

What then, should be the criteria for designating a species? Those individuals who have worked a lifetime with animals should be the authorities, and the following list in general summarizes the criteria recognized by these taxonomists:

1. Mate at different times and locations.
2. Consume different foods.
3. Occupy distinct ecological habitats.
4. Do not interbreed except for minor units which intergrade.
5. Differ morphologically and physiologically.

It is apparent that these criteria are not of equal value, and occasionally one or more are unsatisfactory. In practice, workers have usually used two or more of these principles to differentiate animal groups. Perhaps further taxonomic work must await additional investigation as, for example, biochemical or cytological tests for identification of species currently being developed.

Disagreement concerning the subspecies level is even more puzzling. Certainly modern workers are at variance with the original taxonomic ichthyologists; and there is no better example than the naming of the trout groups. It has been the practice in the past to create a new subspecies whenever a group of fish differed from all others within the species in one or more of the criteria listed above. Usually variations of colors, spotting, pattern markings, and body proportions were used, characters which may be the result of environment. Certainly size and coloration are inadequate if not used in conjunction with other characters. It is also unlikely that two subspecies will exist in the same drainage unless the fish have been isolated by an impassable barrier.

B. Inadequacy of Former Criteria

A number of characters which have generally been considered by taxonomic ichthyologists to be very stable have recently been proved to be somewhat unreliable. In fact, the constancy of the number of scales in trout was questioned as early as 1887. Mottley (22, p.255) quotes an English publication written by Day: "As to the number of scales along the lateral line it is remarkable that in the American Salmo fontinalis they would seem to have decreased in numbers in some which have been introduced into the freshwaters of this country and bred artificially....Although the differences in the size of the scales has been held as one of the most constant and important characters in salmonids, one cannot resist the conclusion that such a belief is found on error."

Mottley (22, p.254-263) likewise questioned the constancy of scale counts, and in 1934 he organized an experiment to determine the possible variations in the number of diagonal scale rows. He secured early in the season, when the water was relatively cold, 216 wild adult and 50 fingerling Kamloops trout, *S. gairdnerii kamloops* Jordan. These specimens showed a mean diagonal scale count of 144.61. He also collected a number of fingerlings, the progeny of adults which had spawned later, when the water temperatures were warmer. This second group of fingerlings had an average of 135 scales in diagonal rows and were noticably different in other respects from their parents and the population as a whole.

To further substantiate his evidence Mottley reared one hundred fish, the offspring of the late spawners, and subjected them during their embryological development to a temperature 5° C. above the normal hatchery temperature. The average number of scales was further reduced by 5, or to a total of 127, a decrease of approximately 17 from the mean diagonal scale count of the early spawning wild trout. The group, as a whole, showed a range limit from 130 to 160 scales in diagonal rows.

The number of vertebrae, considered by systematists to be a very fundamental structure and not generally subject to environmental controls, has also been questioned by recent workers. Schmidt (25, p.61-67), a Danish zoologist, found that the number of vertebrae in several species of fish, including the Brown trout, <u>S. trutta</u> Linnaeus, was influenced by environment. Schmidt accomplished a diallel cross (each female was mated with every male), and from each mating he secured 50 juveniles for vertebral counts. Male parents, designated as X, Y, and Z, and female parents, designated as A, B, C, and D showed the following number of vertebrae:

X 59 Y 60 Z 59

A 61 B 59 C 57 D 58

The average number of vertebrae in the offspring (50 specimens of each mating combination) and the adults are summarized statistically as follows: (The top figure represents the average number of vertebrae of the young, and the second figure the average number of vertebrae of the adults.)

XA	XB	XC	XD
61.4 60.0	59.06 59.0	58.29 58.0	59.03 58.5
YA	YB	YC	YD
61.35 60.5	59.22 59.5	58.59 58.5	59.28 59.0
ZA	ZB	ZC	ZD
60.65 60.0	58.48 59.0	57.90 58.0	58.55 58.5

Hubbs (12, p.260-372) also found that the total number of vertebrae, as well as the number of scales in the lateral line, and the number of branched and anal rays in the Emerald Shiner, Notropis atherinoides, varied when the eggs and young were subjected to different temperatures.

It remained, however, for Mottley (23, p.169-176) to prove conclusively that the number of vertebrae in Salmo is very unstable--fluctuating, he believed, because of differences in environmental conditions. As shown by the statistical data on the following page, Table 19, wild and hatchery trout vary considerably in the number of vertebrae, and trout subjected experimentally to variations in temperature during their embryological development showed even greater range limits.

That characters in addition to those previously

Table 19.--Frequency of number of vertebrae of four species of Salmo as determined by Mottley.

Number of Sp'mens	Species	56	57	58	59	60	61	62	63	64	65	66	67	Mean
Wild Fish														
50	kamloops							4	22	21	3			63.46
12	kamloops									12				64.00
25	kamloops							1	7	11	5	1		63.92
49	wh'housei							7	17	17	6	2		63.57
Hatchery Fish														
25	gairdnerii									14	10	1		63.48
25	clarkii						1	12	10	2				62.58
25	trutta		3	12	9	1								58.32
25	salar			5	15	14	1							59.04
25	kamloops							4	10	8	3			63.40
50	wh'housei							6	25	15	4			63.34
25	wh'housei								4	11	6	4		64.40
17	kamloops							1	5	6	5			63.88
25	kamloops								2	11	9	2	1	64.56
Experimental Fish														
150	Kamloops								17	66	58	9		64.39
50	kamloops								11	36	3			63.84
50	kamloops								5	39	6			64.02
25	wh'housei							3	9	12	1			63.44
200	wh'housei	1	1	2	6	15	14	25	47	57	29	3		62.90
50	wh'housei			2	1	3	4	11	13	14	1	1		62.54

enumerated can be influenced by environmental factors was also shown by Hubbs (14, p.75-84). Working with Platygobio gracilis, Hubbs found that a heavy infestation of parasites, particularly Proteocephalus, a tapeworm, during the early developmental stages of the juveniles caused the fish to be pale in color, soft in general consistency, to possess weak fin rays, anterior rays of vertical fins longer than normal, pot-bellied, pop-eyed, snouts little produced, mouths reduced in size, barbels absent or rudimentary, nostrils frequently joined together on each side, gill-membranes sometimes more or less free from the isthmus, lateral lines often rudimentary or absent, and scales that were generally reduced in size and caused, therefore, an increase in the number of scales.

The work of Day, Hubbs, Mottley, and Schmidt has been reviewed in an effort to prove that the characters generally used by taxonomic ichthyologists, with specific reference to the work of Suckley and Cope, to differentiate subspecies of cutthroat trout is inadequate. This evidence, the writer believes, is sufficient to prove that the differences which exist in the structural counts between S. utah and S. pleuriticus might easily have been caused by factors in the environment.

C. Comparison of Structural Characters

The means and the range limits of the number of scales in the lateral line of these two groups of trout vary slightly, as shown by the following summary:

	Bonneville Basin	Green River
Number of Specimens	43	61
Means	123.52	121.93
Range Limits	117-131	111-128

The fact, however, that nearly all of the 104 trout from all stations of both drainages show wide range limits, both above and below the means, would seem to indicate that there exists no important differences.

When the mathematical means of the number of scales above the lateral line, as determined from all specimens of this study, are examined, there at first appears to be a marked contrast: Bonneville, 40.35 and Green River, 44.36. However, again the range limits correspond very closely: Bonneville, 36-46 and Green River, 38-52. It will also be recalled from Cope's original description of S. pleuriticus that he gave the range limits from 40-51 for the number of scales above the lateral line, indicating that there were wide differences even among his specimens.

The number of scales below the lateral line, the number of scales in diagonal rows, and the number of scales before the dorsal fin likewise differ, as shown by the following statistical summary:

	Bonneville Basin	Green River
Number of Specimens	43	61
Scales Below Lateral Line	37.50	41.79
Scales in Diagonal Rows	178.57	187.61
Scales Before Dorsal Fin	86.28	92.07

These variations are probably not significant; for trout, as shown by Mottley's experiment (22, p.254-263), are subject to a change in number of diagonal scale rows (considered by him to be the most important scale count) as much as 17. It is apparent from Table 19, page 85, that none of the scale count means of the fish of the present study differ as markedly as those shown by the fish of Mottley's experiment.

Cope placed much emphasis upon variation in the number of branchiostegal rays in identifying subspecies, listing 9 for S. utah and 11 for S. pleuriticus. The present investigation shows, however, an average of 11.5 branchiostegal rays for the four specimens from Utah Lake, type locality for S. utah. The 61 Green River specimens are also in close agreement, showing a mean of 10.72. Both groups of trout have identical range limits of 10-12.

The following statistical summary also shows how closely the means and range limits of the number of dorsal, anal, pectoral, and pelvic fin ray counts of the specimens of the two drainages correspond:

	Bonneville Basin	Green River
	Means	
Number of Specimens	43	61
Dorsal Fin Rays	10.93	10.76
Anal Fin Rays	11.10	10.70
Pectoral Fin Rays	14.88	14.87
Pelvic Fin Rays	9.25	9.11
	Range Limits	
Dorsal Fin Rays	10-12	10-12
Anal Fin Rays	10-13	10-12
Pectoral Fin Rays	14-16	14-16
Pelvic Fin Rays	9-10	8-9

Another important structural character in which these two groups of fish correspond closely is the number of gill rakers. The 43 specimens from the Bonneville Basin do exhibit a slightly higher number of rakers on the upper portion of the gill arch, 7.00 as compared with

6.66 for the 61 trout from the Green River drainage; but the number of rakers on the lower portion for the same number of specimens was almost identical: 12.30 as compared with 12.18. The range limits of gill rakers for both groups of fish likewise correspond very closely:

	Bonneville Basin	Green River
Upper, gill arch	6.5-7.6	5.2-7.7
Lower, gill arch	11.6-13.0	11.6-12.6

Both groups of fish show wide range limits in the number of pyloric caeca: Bonneville, 36-52 and Green River, 30-53. The means vary somewhat: Bonneville, 44.70 as compared with 40.17 for the Green River group. This difference is probably not too significant in view of the fact that the pyloric caeca counts of the fish of most of the stations range both above and below the means.

Specimens of the present study show a small difference in the number of vertebrae; however, as proved by Schmidt (25, p.61-67), Hubbs (12, p.360-372), and Mottley (23, p.169-176) these small variations are probably caused by environmental factors. The following statistical summary shows the close correspondence of vertebrae existing between the cutthroat trout of the two drainages under consideration:

	Bonneville Basin	Green River
Number of Specimens	43	61
Means	61.30	60.42
Range Limits	60-63	59-62

Because closely related groups of fish sometimes show differences in the number, size and arrangement of teeth, an effort was made during this study to ascertain if any such differences were present between the trout of these two regions. In spite of the fact that teeth on the basibranchial, glossohyal, dentary, pre-maxillary, maxillary, vomer, and palatine bones were studied under magnification, no wide differences were discovered. However, in as much as dentures in the specimens examined were apparently being constantly replaced and because the enumeration of teeth in this species cannot always be accurately determined, for the reason that they are often buried in the flesh or missing, little weight was attached to this part of the investigation.

Do the cutthroat trout of these two localities spawn at different times, eat different foods, and occupy different habitats? Fish from the streams and lakes in both study areas have been observed by the writer to spawn at approximately the same time. Small variations in time, however, might possibly be accounted for by differences in temperature caused by differences in altitude. An examination of stomach contents indicates that types of food eaten was very similar among all of the groups collected, and quantity varied only in proportion to availability. Habitats of the several groups differ--as for lake and stream life--but each group seems able to adapt itself equally well to both lentic and lotic situations.

D. Suckley and Cope

Dr. George Suckley, describer of *S. utah*, was not an ichthyologist but rather a physician; and perhaps he was not as qualified for taxonomic work as others of his time who had been schooled for fish classification. His investigation reflects a lack of training, not the least of which was the naming of 24 species of salmon on the Pacific Coast.

In his description of the Utah cutthroat trout, Suckley (28, p.135-138) used color and spotting almost exclusively to describe this new subspecies. The convexity of the dorsal profile was said to be more anterior and the scales larger than in *S. virginalis*, the cutthroat trout of Utah Creek, Colorado; yet apparently there were no counts and measurements made of structural characters. It will also be recalled from Suckley's description of S. utah that he made the following statement: "The species in the Timpanagos (Provo River) appeared, upon careful examination, to be identical with that of Black's Fork (a tributary of the Green River)."

Edward Drinker Cope (4, p.471) who described the other subspecies under consideration, S. pleuriticus, was more scientific than Suckley and attempted to base his classification upon structural characters, but he failed to state his methods of counting and measuring. Cope used as the bases for describing the subspecies, S. pleuriticus, the following criteria: the marked cranial keel, the differences in the interorbital width, the position of the dorsal fin, the number of dorsal, anal, and branchiostegal rays, the scales above the lateral line, the length and width of the maxillary bone, the spotting, and the coloration of the isthmus, the sides of the body, and the fins. Using these criteria as a basis for comparison, the writer did not find any marked differences between Cope's specimens and the trout collected from the Bonneville Basin.

There were available for Cope's study only fifteen specimens; and what is most remarkable, seven were collected from the Green and Platte Rivers, two from Idaho, and four from Junction, Montana. These specimens represent four distinct drainages from widely separated geographical areas, regions from which at least two other subspecies of cutthroat trout have subsequently been described.

E. Summary and Conclusions

While engaged in this investigation, the writer has examined critically 104 specimens of cutthroat trout from the Bonneville Basin and the tributaries of the Green River of Utah. Approximately 100 additional specimens from these drainages were also examined for variations in body proportions, spotting, and color differences.

Based on the facts presented in the preceeding discussion, it is the opinion of the author that Suckley and Cope did not have sufficient evidence to describe the following subspecies of cutthroat trout in Utah: *S. utah* Suckley for the Bonneville Basin and *S. pleuriticus* Cope for the tributaries of the Green River. This belief is founded on the fact that the structural characters of the cutthroat trout of the above drainages are identical or do not differ to a significant degree.

What scientific name should be used to describe the cutthroat trout of the Bonneville Basin and the Utah tributaries of the Green River? The name, *S. clarkii pleuriticus* Cope, is correct; for, although Suckley collected specimens of *S. utah* in 1859, he did not publish the results of his work until 1874. Cope published his

his description of S. pleuriticus in 1872, even though the specimens upon which he based his work were not collected until 1870.

VII. Exploitation and Management of the Utah Cutthroat Trout

A. Causes of Depletion

As previously explained, the first explorers and colonists in Utah found large numbers of Indians using the cutthroat trout as a principal food item. Nevertheless, these redmen probably lacked the mechanical means of greatly reducing the trout population or were innately conservative; for when the Mormons came into the Bonneville Basin in 1847, they found the fish very numerous and were quick to take advantage of the trout in Utah, Panquitch, and Bear Lakes, and tributary streams. These settlers, after their long journey to reach Utah territory, were poverty stricken. Bulbs and succulent plants, waterfowl, and wild animals were often the difference between hunger and a very meager ration. It is unlikely that any people under similar circumstances would have done differently, but it is regretable that once the crisis was past that adequate measures were not taken to insure a thriving population of this native trout.

The total poundage is not known, but incomplete records indicate that hundreds of tons of trout were taken from Utah Lake between the years 1847 and 1900. There were no laws for a number of years to regulate the fishery and statutes that were eventually passed by the legislature were ineffectual. Fishing operations continued during the entire year, but probably the most destructive phase of all commercial fishing methods was the practice of placing long seines across the mouths of rivers through which the trout passed on their way to the spawning grounds. The mesh of the nets was often small enough to take even immature trout.

However, the plow was probably the most single destructive force upon the cutthroat trout in Utah Lake. The rich, dry soil was unproductive without irrigation. Creeks that once meandered from the canyons to the lake were diverted, leaving dry waterways; and the myriads of spawning trout which once swam up the streams enroute to the canyons were compelled to remain in the lake which, because of an almost total absence of gravel, was quite useless for spawning purposes. When the use of the streams for agriculture became extensive, the lake always shallow, decreased in depth with a subsequent increase in temperature; and the water retreated until for several years at a time smelly, muddy shores were present.

As the cutthroat trout became fewer and fewer, David Starr Jordan and others whose opinions were respected recommended that the exotic catfish and carp be introduced. The extinction of the cutthroat was now almost certain, and within a few years only rarely was a trout taken; but the carp, catfish, and native suckers increased to such numbers that finally there seemed to be no end to the many tons of these coarse fish which were removed for poultry, mink, and fox food.

The climax came during the winter of 1936 when, after several years of unusual drought, the normal surface area of the lake of approximately 100,000 acres was reduced to about 50,000. Unfortunately, thick ice formed, further decreasing the available water, and hundreds of tons of fish, mostly carp and suckers, died, and with them, in all likelihood, the remainder of the Utah Lake trout. The author has not seen a cutthroat specimen from this lake since 1930.

Cities and industries on the shores of the lake were equally unconcerned with the destruction of this trout. Domestic and industrial wastes were dumped into the streams or piped to the lake until the water became contaminated and unsafe for bathing which for many years had been a popular recreation.

At present most of the inhabitants in the valley are resigned to the fact that Utah Lake will never be anything except a large mud hole; but occasionally an old conservationist, yearning for days that were better, will demand that conditions be returned to their former abundance. But that is impossible. Agricultural crops are so much more valuable, we are told, that only the foolish would dream of such a venture. Then, too chemists from the industrial plants point out that the lake, once an alkaline type, is now saline. In the twenty years from 1916 to 1936 the salinity increased four times.

Conditions in Panquitch and Bear Lakes were similar. Andrew L. Siler (26, p.51) in a letter to Prof. S. F. Baird in 1884 wrote: "I intend devoting the most of my time to fish-growing, as it is only a question of time, and that, at the present rate of depletion, a very short time, when the food-fishes inhabiting our waters will become so scarce that they will not be found in our market. In Panquitch Lake, near this place, the fish are being rapidly exhausted, although the fishermen that fish that body of water say they are as plenty as they were ten years ago; but at present the average weight of the fish caught out of that lake is 1 pound, while the fish caught eight or ten years ago averaged eight or ten pounds.

"The time is near at hand when, if we have fish from Panquitch Lake, we will have to stock it with Schoodic (or land-locked) salmon or white-fish, or both.

"I add an extract from the Desert News (a Salt Lake City newspaper) in regard to the fish of Bear Lake. The same thing that has taken place there will certainly take place in the lakes of Utah unless our Territorial legislature takes steps to restock our waters.

"'The famed Bear Lake covers some 150 square miles, and washes on three sides the rolling hills. It used to be full of finy beauties, splendid speckled trout. Some weighing nearly 20 pounds have come from there; but, alas, through unlawful methods and at unseasonable as well as seasonable times, it is now only a pleasant memory of the past. Mullet and suckers roam the unfathomed depths and glide the tributaries and outlet of the lake.' Hillsdale, Utah. January 21, 1884."

Conditions in many of the mountain streams were somewhat better, but there too they were often deplorable. Mines poured their wastes into the water; sawmills depleted the steep mountains of necessary forests to retain the moisture; too many sheep and cattle grazed the ranges; and, worst of all, men, who referred to themselves as sportsmen merely because they could afford a fishing rod, boasted of taking sacks of fish from the rivers and lakes.

Few individuals were interested in the future destiny of the cutthroat trout, and even some of the biologists lacked basic information in the management of this fish. They failed to see that this native cutthroat would usually survive and produce larger crops under existing conditions than exotic species dumped into the waters with apparently no regard for their future. The paramount aim seemed to be the greatest possible hatchery production of fry and fingerlings, and almost always the species were rainbow, brown, and cutthroat trout from Yellowstone Park.

Criticism is often heaped upon the native cutthroat because of the small size to which it grows in mountain creeks. It is true that specimens up to fifteen and one-half pounds were captured in Utah Lake, and perhaps larger in Bear Lake, but the same resident subspecies often matures and dies in high cold streams well below the present legal limit of seven inches.

It has also been shown that the cutthroat is more difficult to raise in hatcheries than other trout. But these exotic fishes, when planted in mountain creeks, frequently disappear or fail to reproduce. The native cutthroats in some locations may be so small that they are not considered a good sporting fish, but the mere fact that they are present in the streams means something.

The first station collected, American Fork Creek, illustrates a typical error of judgment in that brown trout have been planted. Nowhere along its course does the stream become a slow, meandering waterway, the type generally preferred by this fish. From its very beginning it is a churning, noisy creek. Perhaps under the relentless badgering of an insistent fishing public the browns were stocked in this stream where they have reproduced and maintained a limited population.

B. Recommendations

Although it is not the primary purpose of this thesis to suggest measures that will restore the rivers and lakes of Utah to their former abundance, the author, because of a familarity with the trout waters, gained through the present investigation and a long residence in the state, wishes to make the following recommendations:

1. That a complete life history study be made of the Utah cutthroat trout. A small amount of information is available, but it is fragmentary and based upon casual observations.

2. That the present angling regulations be revised: first, to permit the taking of small trout which mature

well below the present legal limit of seven inches in creeks and lakes at high elevations; and, secondly, to reduce the present daily and seasonal creel limits or close those waters in which the population of native cutthroat trout has been greatly reduced.

3. That the present practice of stocking exotic fish in waters now having a population of native cutthroats be discontinued until it has been proved that such fish are the superior species for that particular waterway.

4. That an attempt be made to develop a race of native cutthroats which will spawn over a short period of time, are fast growing, and in all respects equal to other trouts and chars currently being propagated in state hatcheries.

5. That, because of the abundant evidence that fry and fingerlings do not survive in large numbers to the anglers' creels in heavily fished waters, legal-sized fish be planted.

6. That one or two waters now having a thriving population of native cutthroats be closed to further angling and to transplanting of exotic species in order that this subspecies may be saved from possible extinction and hybridization.

7. That all waters not suitable for trout be

stocked with warm-water game fish and populations maintained to reduce fishing pressure in trout creeks and lakes.

8. That those waters running through or bordered by private property which have been posted by the owners be closed to all fishing.

9. That punitive measures be taken against those property owners, private or corporate, who because of excessive grazing, croping, or mining pollute the waters with silt and wastes. Cities which contaminate rivers and lakes likewise should be included.

After the damages have been appraised, not only to the fish actually destroyed but also to the productive capacity of the waters, measures should be taken to recover full compensation, and, what is more important, to secure an injunction against future destruction. In the event that such private property cannot be reasonably prevented from polluting public waters, the state should be impowered to assist property owners in the reclamation of their lands.

10. That the state department of fish and game exert every possible influence to prevent the transfer of the public domain to private ownership.

11. That the state department of fish and game exert every possible influence to prevent the construc-

tion of dams for the manufacture of electricity and for irrigation where such impoundments will damage the fishery resources of the state.

12. That the present staff of two fisheries biologists be increased to such a number that the streams and lakes of the state can be adequately managed.

13. That the public be kept informed of all departmental policies, results of research, and additional pertinent matters which will help create in them the desire to assist in stream improvement, stocking, law enforcement, and other acts to further the conservation of the fishery resources within the state.

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