Golden Trout in Trouble

by Margaret F. Gold and John R. Gold

A dubious ancestry and an unhelpful boost from fishermen have cast a shadow over a most beautiful fish

Fed by melting snows, the headwaters of California's Kern River form in the shadow of the towering Sierras. Many streams tributary to the Kern also arise from a snow birth. Dropping rapidly away from the cradling heights of the Sierra Crest and Great Western Divide, they flow down wooded slopes and through meadows, uniting, growing, and finally joining the southerly progress of the Kern. In these streams lives *Salmo aguabonita,* the golden trout of the High Sierra—possibly the most beautiful of all the many forms of western North American trout.

Originally, goldens were found only in the upper Kern River drainage. Their narrowly restricted distribution was due, in part, to a cul-de-sac formed by mountain barriers and to an adaptive response to cold and swiftly flowing streams. Through the intensive stocking efforts of numerous people, golden trout distribution now includes many Sierran waters. Nevertheless, dating from the advent of the first naturalist on the Kern River plateau, concern has been expressed—with good reason—for the future of these magnificent fish.

Today the golden trout is a threatened species despite a long history of management intervention. Remedies for this near-tragedy will have to be based partly on an understanding of the past mistakes that contributed to their present status, but equally important will be historical and biological knowledge of the golden trout. Although scientific interest in these fish dates from the late 1800s, little is known about their evolution, behavior, and habitat.

The flow pattern of streams draining into the upper Kern River resembles that of a pinnately veined leaf. Several large veins, specifically the Little Kern River to the west and Golden Trout Creek and the South Fork of the Kern River to the east, radiate from the midrib—the Kern. These major tributaries are intersected many times by smaller streams arising from melting snow, rain, and the seepage of underground springs.

Pure populations of endemic golden trout are found only in waters located in the higher portions of the Little Kern and the South Fork regions. Naturalists have long distinguished between these two regions of the upper Kern River drainage.

Golden trout, Rocky Basin Lake, Tulare County, California

Briefly, the South Fork of the Kern River and the Golden Trout Creek drainages lie on a plateau known generally as the "South Fork"; the Little Kern River drainage is essentially a basin and is called the "Little Kern." The headwaters of each region originate at altitudes of more than 11,000 feet and are separated, in part, by the Great Western Divide.

Streams in the upper, plateau portion of the South Fork region are characterized by a gentle gradient as they fall toward the Kern River. Much of the plateau consists of meadows surrounded by sparse pine forests. Like steps on a gigantic stairway, each large meadow gives way, often with a short, steep descent through forest, to yet another meadow. Sagebrush is encroaching on many of the meadows, largely as a result of overgrazing by domestic stock and the subsequent erosion and lowering of the water table. The soil in this region is primarily coarse, decomposed granite, and vegetation along the stream banks is scanty. Although geographically a part of the South Fork drainage region, the area surrounding Golden Trout Creek is, in contrast, distinguished by denser riparian cover and evidence of volcanic activity. The stream substrates of many South Fork tributaries are composed of granitic sands and dull-red gravel, while the substrate of Golden Trout Creek contains light lemon-yellow tufa, a by-product of vulcanism.

The upper portion of the Little Kern basin is steep and thickly forested by pine and fir. The streams that race down these steep slopes are shaded by dense growths of young willows, alders, and cottonwoods. At higher elevations in the basin, metamorphic rocks overlie the granitic batholith and multicolored surfaces are in evidence along the stream beds. There may be some connection between the coloration of these substrates—the red, orange, and lemon-yellow hues found in section of both upper Kern River drainage regions—and the brilliant colors of golden trout.

Evidence of extensive glaciation persists in the higher reaches of both regions, where the granite peaks are scoured and polished. The retreating glaciers left hanging troughs with steep stream gradients, or waterfalls, which are impassable barriers to invading trout. Until they were artificially stocked, the lakes and streams above these barriers were devoid of fish life.

The streams in both the Little Kern and South Fork regions exhibit char-

E. Philip Pister

acteristics similar to that of other Sierran streams with granitic substrates—notably a pH above 8 and a lack of chemical nutrients. Generally, streams with more than a quarter of a cubic foot per second flow (August-September minimum) are suitable for golden trout. The amount of water flowing in the upper Kern River drainage streams is determined by precipitation, mostly in the form of snow, ranging between 30 and 40 inches annually.

Golden trout do not tolerate warm water temperatures. They are not found in water exceeding 75°F, suggesting that their critical level of temperature tolerance is approximately 70° to 74°. Water temperatures optimal to golden trout range between 40° and 60°. During the dry summer and fall months when ambient temperatures occasionally surpass 80°, cool snow water seeps from underground springs and feeds into the streams. Nights, even in the summer, are cold. In the winter, surface temperatures often drop low enough for ice to form on the streams.

Golden trout have adapted well to this high mountain habitat. Averaging about five to six inches in body length, they are small and sleek, fully able to swim the shallow, cold streams and easily jump small, natural barriers. Goldens seem to be opportunistic feeders, dining on terrestrial insects in the summer and early fall. In the winter and early spring, they probably subsist on a limited supply of water fauna, such as caddis fly and midge fly larvae and small crustaceans.

Golden Trout Creek, Tulare County, California E. Philip Pister

Like most trout, goldens spend much of their time in pools. There is little evidence of dispersal to other stream sections as a direct result of the aggressive behavior of golden trout within their home territory. Some movement away from the home pool may occur during the winter or during the spawning season, but this could be related to population density and food supply. When one pool is filled to its carrying capacity, excess trout must find adequate food elsewhere. Generally, it is the juvenile goldens that emigrate in search of other suitable living space.

Very little is known about the spawning behavior of stream-dwelling golden trout, as they generally spawn before the heavy snows have diminished sufficiently to allow biologists access to the upper Kern River drainage. Nevertheless, extensive information on spawning has been gathered at the inlet and outlet streams of the Cottonwood Lakes by fisheries biologists collecting fertilized eggs for artificial propagation in hatcheries. Although goldens were artificially introduced to these lakes, their spawning habits there probably differ little from those of the stream-dwelling forms. In both instances, swiftly flowing, cold streams with gravel beds are necessary to the successful spawning and hatching of golden trout.

Spawning among lake-dwelling goldens usually begins at the end of their third year. The coloration of the males intensifies and an enlargement of the upper jaw, or maxillary, becomes noticeable.

The female constructs a redd—a slight depression in the gravel of the stream floor—and deposits her eggs as the male extrudes milt. The number of eggs deposited is dependent on the body size of the female. Females of 8.5 inches produce about 300 eggs, while 12-inch females produce about 700. The redd is then covered with gravel. Swift, cold water (between 45° and 55°F) aerates the eggs. Within this temperature range, the water contains enough dissolved oxygen for the developing embryos, but

it is not so cold as to slow down their metabolism.

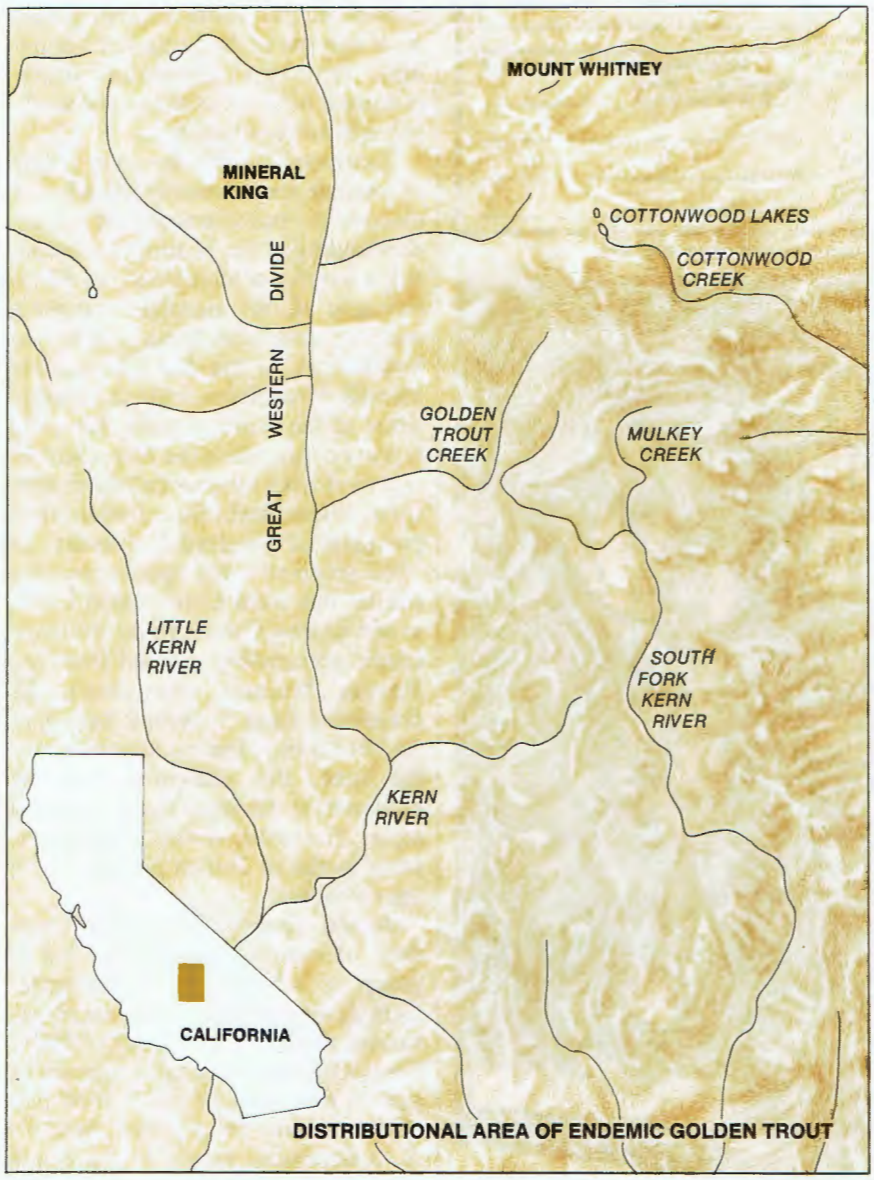
By the end of twelve days, the developing eye shows as a black dot through the egg membrane, and the eggs usually hatch in twenty days. The small fry lie helpless in the gravel, gradually absorbing nourishment from a yolk sac attached to their abdomens. Within eighteen days after hatching, the yolk is absorbed and the fingerlings, now almost one inch in length, emerge swimming freely from the gravel.

Growth during the first summer is rapid while the fingerlings dine voraciously on microscopic organisms. Thereafter, the growth of a fingerling into an adult is dependent on the availability of larger aquatic and terrestrial organisms and, to a lesser extent, on water temperature. Most streams in the upper Kern River drainage exhibit a low level of primary productivity owing to their high pH and lack of nutrients. Moreover, insects and larvae are not abundant. Golden trout in the upper Kern drainage grow slowly and remain small, never attaining the body size of transplanted goldens living in waters with more favorable conditions.

It is unfortunate that golden trout have not been studied, behaviorally and ecologically, to the same extent as many other species. But this is often the case when man's attention is focused on the pursuit of his own pleasure—in this instance, the sport of capturing a rare and beautiful fish. Until recently, much of the interest in golden trout was expressed by puzzling over their taxonomic status and by directing their preservation and propagation as a desirable game fish. While sometimes beneficial, this telescopic altruism has confused scientific understanding of golden trout and has resulted in many of the unfavorable conditions that now threaten them.

Historical and zoogeographical relationships among the original, isolated populations of golden trout in the upper Kern River drainage are confounded by the so-called coffee pot transplants of the late 1800s and early 1900s. Cattlemen carrying supplies and equipment to their summer camps in the high meadows of the Kern River plateau would pause to catch golden trout for the purpose of releasing them in nearby, presumably barren streams. It is not known whether all of these streams were, in fact, barren of other trout nor are the extent and location of these transplants known. However, golden trout travel well, and one can assume that many of these fish survived a variety of conveyances, such as coffee pots and frypans, to populate streams near the stockmen's campsites.

In papers written during the early twentieth century, B.W. Evermann of the U.S. Bureau of Fisheries, substantiated numerous transplants of golden trout. Perhaps the most significant transplant—the source of the only brood stock used in artificial



Two subspecies, or races, of golden trout are now recognized by ichthyologists: Salmo aguabonita aguabonita *and* S. aguabonita whitei. *Perhaps only one pure population of* S.a. whitei *survives in an isolated location in the Little Kern River drainage, where it has not been exposed to rainbow trout. Pure populations of* S.a. aguabonita, *endemic to the South Fork of the Kern River and Golden Trout Creek, are threatened by beavers and livestock grazing (habitat destruction) and by introduced brown trout (food competition). An uncontaminated population of* S.a. aguabonita, *transplanted from Mulkey Creek in 1876, lives in a glacial lake near Cottonwood Creek.*

propagation of golden trout—was made by the Stevens brothers, who in 1876 captured golden trout from Mulkey Creek, a tributary of the South Fork of the Kern River, and transported them to a site in Cottonwood Creek adjacent to their sawmill. Soon these entrepreneurs were joined by anglers and sportsmen's clubs in transplanting golden trout.

In 1909 the California Fish and Game Commission began to take an active role in the transplantation of golden trout to barren waters. Their efforts, along with those of private individuals and groups, were praised in several articles and a popular book. Fear ran high that these remarkably beautiful fish would be exterminated in their limited and fragile habitat. Expanding their distribution seemed desirable and was encouraged. It was only in later years, as pressure to stock grew and rainbow trout were introduced into some original golden trout streams in the Little Kern drainage, that this somewhat indiscriminate policy was seen to be working against its stated aims.

Taxonomic splitting—the giving of separate species names to each new discovery—has also confused our understanding of the historical relationships among golden trout. In 1875, biologist H. W. Henshaw caught a trout of exquisite beauty from the South Fork of the Kern River. He identified it as *Salmo irideus*, an early name of the rainbow trout; his 1878 report on this fish is the first scientific record of what we now call the golden trout. When David Starr Jordan, then president of Stanford University, in 1892 received three specimens of a similar fish from Cottonwood Creek in the nearby Owens River drainage (stock presumably derived from the Stevens brothers' transplant), he christened them *S. mykiss aguabonita*. Following the nomenclature of the time, this indicated that the golden trout belonged to the cutthroat series. However, within a few years, other works of Jordan placed it with the rainbows.

At the request of President Theodore Roosevelt, Evermann led a group of scientists into the upper Kern River drainage. Based on observations made in the summer of 1904, Evermann described three species of golden trout that he considered part of the rainbow trout series: Jordan's *S. aguabonita*, native to the South Fork of the Kern River drainage; *S. roosevelti*, of Volcano (now Golden

Trout) Creek, named by Evermann in honor of the president and called the "real golden trout"; and *S. whitei* of the Little Kern River drainage.

Throughout this taxonomic history, there was no question among scientists that golden trout belong to the genus *Salmo,* which includes, among others, the rainbow and cutthroat trout. However, relationships among the goldens at a species level still are confused by the variety of designations given them by early scientists. Confusion also arises when one considers the frequently obscure and overlapping phenotypic criteria, such as coloration and spotting, which were described in the effort to distinguish different species. For instance, Evermann said of *S. roosevelti,* "[it] is the most beautiful of all the trouts . . . the delicate golden olive of the head, back and upper part of the side, the clear golden yellow along and below the lateral line, and the marvelously rich cadmium of the underparts fully entitle this species to be known above all others as *the* golden trout." He contrasted this species with *S. aguabonita,* the golden trout of the South Fork of the Kern River and its tributaries. Although the two "species" are lightly spotted above the lateral line, Evermann reasoned that geographical isolation, in conjunction with differences in color and spotting intensity, was sufficient to warrant calling them different species. In reality, these differences are so slight that many trained observers have experienced difficulty in distinguishing between populations of golden trout and even between certain populations of rainbows and goldens.

In 1935, biologist Brian Curtis eliminated much of this confusion. He noted that tremendous variation in color and spotting existed among golden trout in the five Cottonwood Lakes. Had Curtis not known that the originally barren Cottonwood Lakes were stocked with golden trout from Cottonwood Creek in 1891, and that the Cottonwood Creek trout were derived from the original Stevens brothers' transplant of goldens from Mulkey Creek, he would have been convinced that he was observing two different species of golden trout, *roosevelti* and *aguabonita.* He concluded that the two species were one and the same and that any differences between the two types could be attributed to the wide range of color variation found in golden trout.

Today, most ichthyologists recog-

nize only one species of golden trout, *S. aguabonita,* consisting of two subspecies, or races: *S.a. aguabonita,* endemic to the South Fork of the Kern River and Golden Trout Creek; and *S.a. whitei,* native to the Little Kern River drainage.

Nevertheless, despite the years devoted to positive statements regarding the golden trout's position in taxonomic classifications, their origins and relationships to other members of the genus *Salmo* remain open to speculation.

Theories now advanced to explain golden trout origins are founded, by and large, on a small, but growing, understanding of relationships among present-day populations of *Salmo.* One school suggests that the two subspecies of golden trout in the upper Kern River drainage originated from "two independent invasions by already divergent forms of the golden trout complex." One invasion, supposedly giving rise to *S.a. aguabonita,* originated in the lower Colorado River system; the other, ancestors of *S.a. whitei,* came from the north and are thought to be similar to the "red-band" trout of northern California and southern Oregon.

Based on a different interpretation of Pleistocene geography, another school holds that migration of trout from the southeast was unlikely and suggests that both golden trout subspecies stemmed from a single ancestral form that originated in the north and entered the Kern River drainage from the Sacramento and San Joaquin valleys.

It is also possible that the golden trout ancestor was hybrid—originating from a cross between ancient forms of the cutthroat trout (now known as *S. clarki*) and the rainbow trout (now know as *S. gairdneri*). There are close affinities among these three species; many of the genetic and morphological characteristics of golden trout are found in either rainbow or cutthroat trout or in both.

Because of the sketchy fossil record and the difficulty involved in tracing golden trout antecedence, one can only speculate about the true age of goldens as a presumably distinct species. It is known that reproductive isolating mechanisms among most species of *Salmo* are far from complete. This invariably raises the question of whether the golden trout is truly a distinct species. If one accepts the criterion that a species must be isolated reproductively from all other

species, then the golden trout is not a separate species nor, for that matter, is the rainbow trout or the inland cutthroat trout. These three groups of trout can interbreed, and their hybrid offspring are fertile.

Yet golden trout are distinct from other species of *Salmo*. For example, they differ in size, body shape, scale number, coloration, spotting patterns, and chromosome number. On the basis of these important characteristics, taxonomists classify golden trout as a separate and distinct species. Perhaps, given time, goldens would have evolved according to the so-called biological definition of a species—that of reproductive isolation. That is, if it were not for the coming of man.

Certainly it appears that man's actions have been directed, for the most part, toward insuring the future stability of golden trout. Taken at face value, most published data argue against the possible extermination of goldens. As a result of the artificial propagation of fertilized eggs harvested annually from trout in the Cottonwood Lakes, transplanted golden trout are abundant throughout many Sierran waters. Moreover, their numbers appear to be relatively stable in the upper Kern River drainage, despite heavy fishing pressure in easily accessible areas. But underlying the "stability" of golden trout are ominous signs. Two very real and pressing threats to the golden trout confront biologists and fishery managers—species elimination and species contamination.

The threat of species elimination stems from the artificial distribution of animal species with which golden trout cannot compete. Goldens are threatened directly by competition from eastern brook trout in lakes, decimation of their juvenile populations by predacious brown trout, and destruction of their stream habitat by beavers introduced into the South Fork region in 1950.

The apparent abundance of golden trout in streams and lakes outside their native habitat is illusory because their numbers are regularly augmented by hatchery-reared fingerlings. Golden Trout Creek and South Fork of the Kern River goldens, *S. a. aguabonita,* are threatened by beaver damage to their stream habitat and spawning beds. Golden trout require shallow, gravelly areas in which to spawn and cannot tolerate the heavy siltation of their spawning beds that

results from dam construction by beavers. Moreover, beavers alter the complexion of the cool, swiftly flowing shallow streams native to golden trout in this drainage by destroying riparian cover, damaging timber, and clogging the waterways. Predacious brown trout, with their insatiable appetite for other, smaller trout, have noticeably reduced golden trout numbers in the South Fork of the Kern headwaters.

Programs of control and eradication are being undertaken against the beaver and brown trout and studies are under way to determine the effects of overgrazing by livestock and resultant erosion of stream habitats in meadows of the South Fork plateau.

Another cause for great concern is the threat of species contamination arising from hybridization between golden and rainbow trout in the Little Kern River drainage. Restoration and protection of *S. a. whitei* in their native southern Sierra waters is of small long-range value unless goldens of pure stock can be definitively identified. From 1931 to 1941, streams in the Little Kern River basin were planted annually with 85,000 to 100,000 rainbow trout. Although a cessation of rainbow trout stocking was recommended in 1941, when the danger of possible hybridization between goldens and rainbows was recognized, the damage had already been done. Goldens and rainbows did hybridize, and the resultant hybrids were viable and fertile.

Geneticists at the University of California at Davis are working to determine relationships among populations of *S. a. whitei* and to develop parameters whereby pure strains of golden trout may be identified. A portion of the trout analyzed in these studies are sacrificed immediately and preserved for future cytogenetic (chromosomal) and biochemical analysis. The remaining trout are allocated for studies of their morphological and meristic characteristics. The data from these studies are gathered and fed into a computer. Elaborate printouts of results are subjected to complicated statistical analyses. These critical results indicate that it is possible to distinguish pure forms of golden trout. Moreover, it is now known that small, isolated populations of these pure forms are in existence above natural stream barriers that prevented migration and subsequent contamination with hybrids.

The dilemma is complicated—that

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of use versus preservation. Golden trout have existed for perhaps thousands of years, gradually migrating, adapting, and changing in accord with the eccentricities of nature. Man, in less than one hundred years, has disrupted this course of evolution and changed the conditions favorable for their existence.

Another possible evolutionary disruption may be at work if a "founder's effect" obtains for those goldens artificially propagated from stocks in the Cottonwood Lakes. These stocks are derived from the original transplant of a few goldens (*S. a. aguabonita*) from Mulkey to Cottonwood Creek by the Stevens brothers in 1876. Trout from this limited gene pool are distributed annually in streams and lakes throughout the Sierra. Although they are definitely golden trout, it is possible that they have begun to differ genetically from other populations of *S. a. aguabonita* within the South Fork drainage.

As the popularity of the golden trout and of the southern Sierra high country increases, so too does man's impact. In this land of thick forests, delicate meadows, and spectacular mountains, the golden trout thrives—eminently suited to the cascading streams of the upper Kern River drainage. This fragile land must be protected. The success of programs designed to restore and preserve native golden trout populations is dependent on this protection. A Golden Trout Wilderness Area was proposed and studied by U.S. Forest Service personnel, but unfortunately, in 1973, the Little Kern drainage region was deleted from the proposal. Crucial to this administrative decision was pressure from logging interests and Mineral King developers seeking to advance their own opportunities for profit by utilizing portions of the Little Kern basin. This conflict has yet to be resolved.

Little is known about the natural history of golden trout despite the attention paid them by conservationists and scientists in recent years. The implementation of studies on their behavior and ecology, as well as further scientific inquiries into the genetics and evolution of golden and other closely related trout species, is vital to any program designed to restore and protect golden trout and their habitat. Surely golden trout, so beautiful, rare, and still threatened, merit this consideration. □