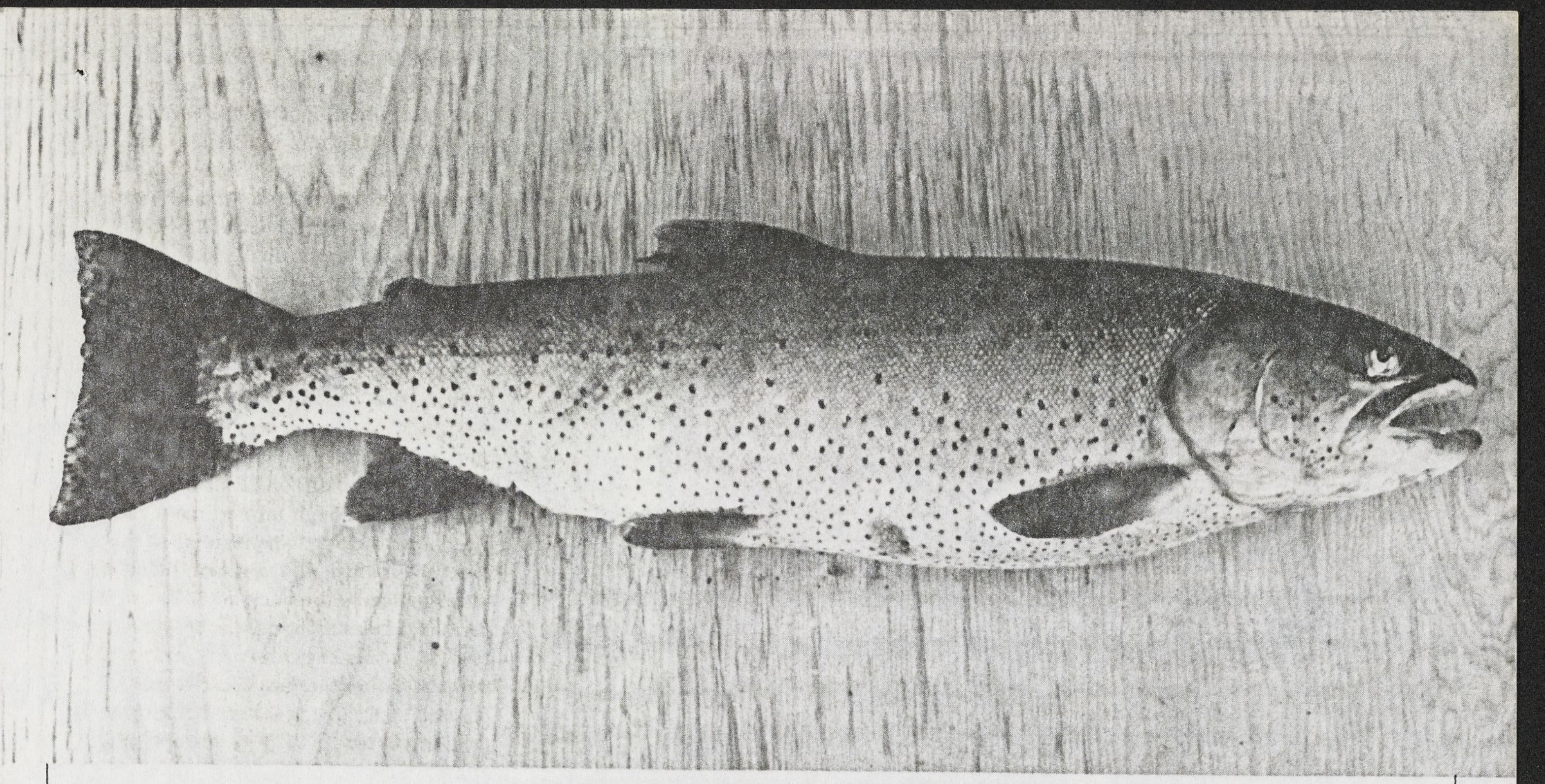


Scientific detective work reveals surviving remnants of an extinct species.

Rediscovery of Lost Lahontan

Terry J. Hickman and Robert J. Behnke, biologists with the Department of Fishery at Colorado State University, have discovered a specie of cutthroat trout thought to be members of the extinct Pyramid Lake strain. By combining their knowledge and expertise with detective-like investigation, laboratory research, and even a computer program, Hickman and Behnke have accumulated convincing circumstantial evidence which supports the theory that a population of Lahontan cutthroat, isolated in a small, unnamed stream in the Pilot Peak Range of Utah-Nevada, represent the original Pyramid Lake genotype of *S. c. henshawi*. The significance of this find to "big game" fishermen is enormous.

Lahontan cutthroat were historically the largest native trout ever to cruise the liquid recesses on this corner of the planet. The official world record cutthroat taken from Pyramid Lake weighed 41 pounds. Many larger fish were reportedly taken on numerous occasions, but official proof is lacking. A crumpled old photograph taken in 1916 depicts an Indian fisherman holding, nearly aloft, a cutthroat estimated at 62 pounds. During the observed final spawning run of cutthroat in 1938, the recorded average weight of these remarkable fish was 20 pounds. Because of dams and water diversion projects, pure Lahontan cutthroat completely disappeared by 1940.

A hybrid version of Lahontan cutthroat (a cutthroat-rainbow cross) is used today as stock for planting desert lakes and rivers. This hatchery produced Lahontan, which is derived from Heenan Lake, California, is a much less vigorous predator. Consequently, it fails to grow even a fraction of the size of the genuine Lahontan cutthroat.

Pyramid Lake cutthroat evolved in an ancient lake the size of Lake Erie. As the massive Lahontan basin drained, the Lahontan cutthroat were isolated in Pyramid Lake. *S. c. henshawi* survived and persisted in this continuous lake environment for 50,000 to 100,000 years. Unique adaptation to a strict lake environment endowed the native trout with an appetite for the coarse fish which commonly abound in high desert, alkaline lakes. The rich diet provided by the congregated schools of forage fish (many "scrap" fish attain lengths of 15 to 18 inches – larger than the heftiest trout in many waters) was responsible for creating the most awesome native trout in North America.

First evidence of a remnant population of genuine Lahontan cutthroat was gathered and reported by the Bureau of Land Management in Utah in the summer of 1977. The finding of any new trout, much less a supposedly extinct race of "giants," is incredible in itself. The stream in which the trout were caught is one of the many extremely steep drainages in the watershed. Most

Information courtesty of Department of Fishery, Colorado State University.

of the streams in the Lahontan and Bonneville basin were barren of fish in historical times. Due to the severity of the gradient in these watersheds, the small streams are susceptible to the scouring effects of "gully-wash" rainstorms. Obscure populations of trout in these streams are normally short-lived. The first inevitable flash flood completely flushes all stream life out into the braod expanses of the desert landscape.

Hickman and Behnke confirmed the identity of 17 specimens gathered by the B.L.M. in the Pilot Peak area and they immediately began an investigation into the origins of the displaced *S. c. henshawi*. Through numerous personal interviews of long time residents (there were not many), conservation officers, water masters, ranchers, and even sheep herders, Hickman and Behnke appropriated the necessary information to reason that the Lahontan cutthroat were planted after an egg taking operation, utilizing Pyramid Lake cutthroat, was completed in 1929. Although there are no official records to support this contention, all of the evidence suggests that it is likely that a local rancher or sheepherder conducted his own wildcat stocking operation.

Logic would also suggest that this isolated, anonymous creek was stocked with Lahontan cutthroat long before the demise of the Pyramid Lake fish in 1940 since public records kept from the early 40's to the present do not make mention of a stocking program in the Pilot Peak area (except with the conventional rainbow species). Obviously the fish had to have been stocked before their sudden extinction, as well as before the conscientious keeping of public records. To further cement their case, Hickman and Behnke added a computer to their investigative inventory. Taxonomic, laboratory analysis of the collected specimens, and historical evidence was then backed with programmed data. The computer (multiple discriminant function analysis) compared the Pilot Peak specimens with several other cutthroat trout subspecies. The result was an affirmation of a clear association with the original *S. c. henshawi* of Pyramid Lake.

The first surface traces of a supposedly expired population of "water giants" should lead to projects of considerable impact in the West. Vigorous rehabilitation and management schemes must surely conspire to revive a population of trout that were once the original, natural denizens. Such a project would reintroduce fish of the extraordinary size and character needed to master the bleak, desert waterscapes of the West.

Robert Behnke

Wild Salmonid Genetics: An Impending Crisis?

In 1991 the American Fisheries Society published a list of 214 stocks of anadromous Pacific Coast salmonids that are already extinct or in various stages of endangerment. Since 1991, four races or stocks of Pacific salmon have been listed for protection under the Endangered Species Act. These include the winter run chinook salmon of the Sacramento River, the spring-summer and fall chinook of the Snake River, and the sockeye salmon of Redfish Lake, Idaho. The American Fisheries Society's publication warning of the precarious state of wild anadromous salmonids of the Pacific Coast stimulated a rash of petitions to list numerous races of Pacific salmon, steelhead, and coastal cutthroat trout for protection under the Endangered Species Act. The sheer number of petitions received contributed to an overload of the system. Many petitions are rejected for lack of information; others pile up in a backlog and will probably never receive adequate reviews.

The perceived urgency of the problem of conserving the genetic diversity of wild salmonid fishes is reflected in a list of priorities prepared by Trout Unlimited's Natural Resource Board at the 1994 annual meeting. Priority number four is "wild salmonid genetics." This is certainly a worthy issue for TU involvement, but I would ask: if one million or ten million dollars were made available to address the issues and problems concerning "wild salmonid genetics," how would it be spent and would the expenditures have any real benefits for conserving the genetic diversity of wild salmonids?

"Genetic research" is a classic example of a nebulous term often resulting in large expenditures with no tangible results. This is because most fisheries biologists and administrators have no more understanding of the subject matter than they do of plasma physics. They lack the understanding necessary to phrase the right questions in need of answers and thus are vulnerable to diverting large amounts of funds to obtain precise answers to irrelevant or wrong questions. Thus, it is basic for the goal of maintaining the genetic diversity of wild salmonids to have credibility, to ask the right questions, and then understand the limitations of any method or technique to answer the question before any method or technique is chosen.

A most important question we must confront was asked in a recent newsletter of the Society for Conservation Biology: "Why do we want to conserve biodiversity, anyway?" The newsletter goes on to point out that conservationists have not been highly successful in getting out our message, such as, why is wild salmonid genetics important? We have a failure in communications at various levels of society. This lack of effective communications became obvious in the outcome of the November 1994 Congressional elections. Helen Chenoweth was elected to represent Idaho in the new Congress. Ms. Chenoweth's environmental platform was essentially provided by the Wise Use Movement. To celebrate her victory, Ms. Chenoweth spoke at an "endangered salmon bake" in Stanley, Idaho (headwaters of the Salmon River, which contains three races of endangered salmon). She asked, "How can I take the salmon's endangered status seriously when you can buy a can at Albertson's?" Such a statement ignores the difference in values between meat in a can and live, wild salmon in a river, and also the fact that the dams that have made live wild salmon so rare in Idaho export most of their benefits outside the state. Her statement does, however, emphasize our failure to communicate on the question, "Why do we want to preserve biodiversity anyway?"

To counter the anti-environmental message in relation to conservation of wild salmonid genetic diversity, two common fallacies should be understood concerning causes of extinction and the "adaptiveness" of intraspecific diversity (genetic diversity within a species). These fallacies were widely propagandized during the last election in

(1) quotes ?

ne way or another. Their arguments enerally follow these lines of reasoning: xtinction is a natural process, it is a built-in" attribute of species to become xtinct, and man shouldn't interfere with ie laws of nature; and, minor variation mong populations and races of a species ; nonadaptive, the different parts of a pecies are interchangeable; therefore, iere is no need to save all the parts. The illacious extinction theory is based on ie outdated evolutionary theory of rthogenesis, which presumed a built-in iechanism causing extinction. Modern volutionary theory has long rejected rthogenesis as lacking any valid basis. i the past, most species became extinct irough evolutionary change. That is, iey gave rise to new species through me. Their genes were modified and assed on to maintain evolutionary iversity. In contrast, man-induced ccelerated extinctions result in termina- on of evolutionary lines before they can ve rise to new species.

The argument against adaptiveness of itraspecific variation is based on the itdated evolutionary theory of early eneticists concerning evolution of new becies by "saltation." Genetic mutations ere thought of as "macromutations," hich could result in a new species in ie generation, and "micromutations," hich caused the "minor variations" nong populations and races of a ecies. In this theory, Darwinian natur- selection, the basis for adaptiveness by owly perfecting of survival, generation generation, only played the role of cepting or rejecting the new species ising from a macromutation; "adap- eness" played no role in the speciation ocess. Micromutations only supplied e "minor variations" observed within a ecies and were assumed to be non- aptive. This theory has also been long ected by most modern evolutionary neticists. The fallaciousness of the ltation" theory of evolution and its ociated arguments against adaptive- ss of intraspecific diversity has been arly demonstrated in salmonid fishes. the 1930s with the beginning of dam ilding on the Columbia River and ocking of salmon and steelhead runs, was assumed that the abundance of mon and steelhead could be main- tained by substituting a few generic hatchery stocks for the great diversity of wild populations lost to dams under the mistaken notion of "interchangeable parts." We now realize, too late, that intraspecific diversity (the "minor variations") is indeed adaptive. The sockeye salmon spawning in Redfish Lake and the races of chinook salmon spawning in the headwaters of the Salmon River, Idaho, may show only minor variation in genetic structure to other populations of their species which spawn in rivers near the ocean. The fact that the Redfish Lake sockeye and the Salmon River chinook migrate almost 900 miles from the ocean (adults upstream, smolts downstream) means that they have very different life histories and physiologies compared to other populations of their species. These differences are "adaptive" for their specific spawning environments; they are not interchangeable.

Man-induced extinctions terminate evolutionary lines before they can give rise to new species.

Thus, a goal for the conservation of genetic diversity of wild salmonids would be to preserve the "range of adaptiveness" within a species. For anglers and fisheries managers, prioritizing the types of adaptations we want to preserve and utilize might be based on "trophy" fish. What populations or races have adaptive specializations that result in exceptionally large fish? For example, the world's largest steelhead are produced by populations native to the Skeena River basin. The world's largest chinook salmon are from the Kenai River, Alaska, populations. The world's largest rainbow trout is the Gerrard population of Kamloops rainbow of Kootenay Lake. The world's largest cutthroat trout is the Lahontan cutthroat trout native to Pyramid Lake (*Trout*, Summer 1993). The world's largest brook trout was the coaster population of the Nipigon River (*Trout*, Autumn 1994). Most would agree that these are the types of intraspecific adaptiveness we want to preserve. Let us now return to the issue of wild salmonid genetics and the need to ask the right questions.

All of the examples of important types of adaptations found within species of trout and salmon mentioned above — the longest migrations, the largest size, etc. — have evolved during relatively recent evolutionary times, perhaps about 10,000 years. All of the most modern, state-of-the-art techniques of genetic analysis would find all of these important types of diversity to be quite "insignificant" in terms of their quantitative degree of divergence within their respective species because they have not been separated and isolated for a sufficiently long period of time. The important differences in life history and ecology, the "adaptiveness" of a particular form of trout or salmon, cannot be understood or predicted from the tiny fraction of hereditary material sampled and analyzed by modern genetic techniques. The most important attributes of adaptiveness lie within what is called the regulatory genome, which is not sampled. We can only understand these attributes from observing the life history of an organism.

Thus, I foresee the danger that research on wild salmonid genetics, although of the best intentions, can have a negative influence on the conservation of the most important aspect of genetic diversity — preserving the range of adaptations. This danger will be manifested if people involved in decision-making substitute "data" and quantitative indices for knowledge and critical thinking and fail to ask the right questions.

There are analogies between evaluating and defining significant units of genetic diversity and critical assessment of significance in works of art, literature, and music. Just as artistic critiques require more than a quantitative assessment of colors, notes, and sequences of letters, understanding genetic diversity requires much more than a knowledge of DNA sequences. ■

Robert Behnke

Ecological Integrity and the Angler

In May 1997 the largest rainbow trout ever caught in Colorado was caught and released in the Taylor River in a no-kill regulation section below Taylor Reservoir. Based on length and girth measurements, this trout was estimated to weigh 22 ½ pounds. What might be surprising is that everything about this state record rainbow violates and contradicts the scientific principles of ecological integrity. The rainbow trout is a non-native species to Colorado and was stocked from a hatchery; Taylor Reservoir is an artificial impoundment; the controlled flow regime from the reservoir is quite unnatural; and the *Mysis* shrimp from the reservoir that supplies most of the food for the fast-growing and abundant non-native trout living in the river, is also a non-native species.This situation illustrates how terms such as ecological integrity, ecosystem health, and protection and restoration of native biodiversity can have quite different perceptions among different people and why changes in controlled flow regimes expected to benefit ecosystem health or endangered species can generate controversy.

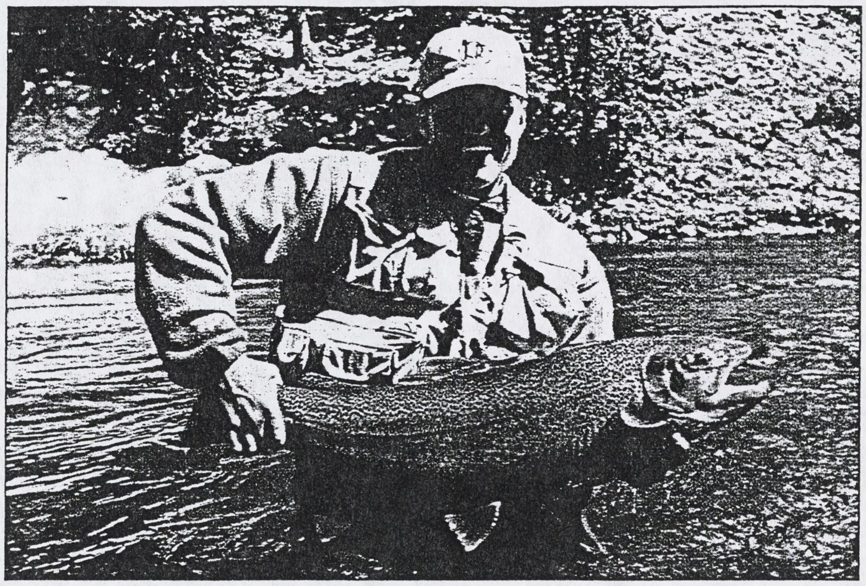
It could be considered an innate desire of humans to exert dominance and control over nature – to bring order out of chaos by modification and regulation of nature for perceived human benefit. The perceived wants and needs of society become public policies of governments. In the United States, the control, alteration and regulation of rivers as dictated by public policy at the local, state and federal levels can be traced to colonial times. River regulation has now been implemented on such a grand scale that virtually no major river and its watershed in the U.S. retains its historically high ecological integrity. That is, the natural flow and temperature regimes, and the composition of native species of plants and animals, have have been dramatically altered.

The history of river modification in this country extends back to the mid-17th century when the earliest settlers in New England began building dams to power mills. This resulted in the loss of Atlantic salmon in most New England rivers by the mid-19th century (see my New England salmon column in the autumn 1996 *Trout*).

In 1824 Congress created the Army Corps of Engineers, whose primary purpose was to make rivers navigable by channelization. This mission later expanded to include flood control. Swamps were considered to be unhealthy and uneconomical, and to meet societal wants and needs in the mid-19th century, Congress began to appropriate funds for massive wetland drainage projects. The Reclamation Act of 1902 established the Bureau of Reclamation to "reclaim" arid lands by building dams and diverting water from rivers for irrigated agriculture. The very first Bureau of Reclamation project, the Newlands Project on the Truckee River, Calif., led to the demise of the world's largest cutthroat trout, the giants of Pyramid Lake (see my summer 1993 column in *Trout* on Lahontan cutthroats).

By the same token, agencies such as the Bonneville Power Administration

In a 20-minute fight on May 6, 1997, Brian Byerly of Golden, CO. caught this 22½ pound behemoth on the Taylor River. The former Colorado rainbow trout record was a mere 18½ pounds.



BOB BYERLY

of flows characteristic of unaltered watershed conditions. In reality, however, there are severe constraints for completely implementing "natural flow" regimes on most rivers. It is beyond the realm of reason to believe that many dams will be dismantled, even if it were technically feasible. And, if it could be done, would it always be in the "public good" to do so? For example, I might prefer the Taylor River in its pristine condition, when the beautiful Colorado River cutthroat trout inhabited its waters. Many of the anglers currently fishing the Taylor River below the reservoir for the large and numerous non-native trout, I suspect, would strongly disagree. Further, the reservoirs impounded by dams and the tailwaters below dams have enormous recreational and economic values of their own. As such, there are advocacy groups that would challenge tampering with the status quo. Plans to restore a natural flow regime to a river for the sake of restoring ecological integrity would meet strong opposition in such situations where river regulation and reservoirs are popularly conceived to be in the best interests of society. Trout Unlimited as a salmon and trout conservation organization (without reference to native or non-native species) stands to catch flak from both sides of the issue.

and the Tennessee Valley Authority were created to harness rivers to generate electricity from hydropower. The various agencies had different primary purposes as a basis for modifications and control of rivers for the "public good" – power, irrigation, navigation, flood control. Fish, wildlife and environmental quality were of little concern in the original "intent of Congress" when all of those river modifying agencies were set in motion. This is understandable because, at the time, there was little in the way of scientific studies or factual information that might have predicted the ecological or economic consequences of "control" of rivers. Large rivers such as the Missouri and Mississippi were channelized, straightened and confined by levees. Such confinement breaks the connection between a river and its flood plain. When this happens, the efficient functioning of a river is disrupted. Fishes and other aquatic life lose vast spawning and nursery areas. Plants and animals dependent on wetlands disappear. The wetlands' natural water filtering and purifying process is diminished. Until relatively recent times the federal government funded large-scale eradication of riparian vegetation in the West (phreatophyte control) with the sole purpose of increasing flows in rivers (for irrigation) by reducing plant transpiration. At the time, no consideration was given to the ramifying impacts that the elimination of riparian vegetation would cause in loss of bank stability, loss of fish and wildlife habitat, erosion, and degraded water quality. Another common practice was "clearing and snagging" – the removal of fallen trees (large woody debris) from stream channels to speed flow and/or enhance navigation. Today, we know better, and there is considerable activity to restore and protect riparian vegetation and to put large woody debris back into streams to create high quality fish habitat.

Presently, with a better scientific understanding of how streams and watersheds function, a more holistic perspective reveals that our former single purpose actions for managing water were truly not in the public interest. For example, we now know that controlling and confining rivers speeds flow from upstream areas and when floods do occur, they are of a greater magnitude than under pristine, natural conditions. When these structurally-enhanced floods breech levees, enormous economic damage and human suffering result. The tremendous power of a flooding river can make a mockery out of all human attempts to control, confine and regulate.

Based on past mistakes and a vast body of knowledge on rivers, watersheds and aquatic biology, a new paradigm for river management has started to emerge. Essentially, it is that nature knows best. Natural flow regimes are critical to the restoration of the ecological integrity of rivers because the full range of natural habitats available for aquatic and riparian species that contribute to ecological integrity are maintained by a wide range

Political compromises for river regulation might occur, but mostly these would be what I'd call the bandaid or aspirin effect. A highly publicized event occurred in March 1996 when Secretary of Interior Bruce Babbitt pushed a button to release a torrent of water from Lake Powell at Glen Canyon dam on the Colorado River. Press releases claimed this greatly increased flow from the dam was to restore ecosystem health to the Grand Canyon. For about two weeks (March 22 to April 7), the artificial flood, peaking at 45,000 cubic feet per second (cfs), roared down the Colorado River through the

Grand Canyon (at a cost of about 3 million dollars in lost electrical generation). This artificial flood flow, however, was hardly a ripple compared to the virgin flow of the Colorado River. Under pristine conditions, the average flood flow in the Grand Canyon was about 100,000 cfs, and in big flood years, could exceed 300,000 cfs. The peak came in June and gradually rose and declined over a period much longer than two weeks.

A flow of 40,000 to 45,000 cfs for a few days is sufficient to create turbulence suspending sand from the bottom of the river and deposit it along shorelines. It creates or restores sandy beaches, and rafters through the Grand Canyon in the summer of 1996 benefited from finding more beaches. I suspect, however, that most of the beaches created by last year's artificial flood have already eroded back into the river. Some anglers and angling businesses located at the famous trout fishing site at Lee's Ferry below Glen Canyon dam were outraged. They feared ruination of the trout fishery (for non-native trout — no salmonid species inhabited the lower Colorado River before Glen Canyon dam changed the flow and temperature regime). I doubt there was much to fear. Although 45,000 cfs might look like a torrential flow, the turbulence beneath the surface creates low velocity microhabitats where fish find refuge.

Even if the pristine natural flow of the Colorado River in the Grand Canyon could be restored, would it be in society's interest, the public good, to do so? Besides the irrigation water, the electricity and the recreational benefits derived from Glen Canyon dam, the great reduction of historical flood flows has dramatically changed the terrestrial environment along the Colorado River through the Grand Canyon compared to what John Wesley Powell encountered in 1869. An annual flood of 100,000 cfs or greater scoured the banks of vegetation. Virtually no animal or plant life occurred. After river regulation eliminated the great annual scouring flows, riparian vegetation became established, mostly the exotic salt cedar tree. The plants created habitat complexity and attracted insects and other invertebrates. Birds and mammals soon followed and now inhabit the formerly barren riparian zone, with 214 species of birds recorded. Two species of birds, including the Southwestern willow fly catcher and the peregrine falcon, are protected by the Endangered Species Act. The diversity of life along the Colorado River is certainly much greater than it was under pristine conditions, but it is dependent on river regulation and non-native vegetation. On the other hand, the native fishes, including the endangered Colorado squawfish, razorback sucker, and bonytail chub, are gone. Their marvelous adaptations evolved to cope with the extreme conditions of the natural flow regime of the Colorado River, but place them at a great disadvantage in the new, controlled environment in competition with non-native fishes.

The "public good" is a synthesis of values held by individuals in society.

There's the economic side (electrical generation, recreation, etc.), as well as the environmental side, which is subject to change over time as scientific understanding increases and as things become rarer in nature. We didn't value Atlantic salmon runs in pioneer days when salmon were abundant, but today we expend great efforts to restore them. It's the same with endangered species: The public has decided it is worthwhile to spend a lot of money to save species from extinction. By modifying natural flows, we lose uniquely adapted species and replace them with widespread generalized species (take the Grand Canyon, for example). We now are beginning to understand that the best way to ensure long-term survival of species is to have high ecological integrity and natural ecosystems. Letting rivers run more naturally is a good way to accomplish that.

A flow regime can be broken into five components: Magnitude, frequency, duration, timing, and rate of change of flow conditions. Natural flows occur in rivers with little or no watershed alterations. Natural flow regimes can't be completely restored on heavily regulated rivers; however, incremental steps to help ecosystems and salmonids can be taken. We know enough about the benefits provided by flows to restore certain aspects of flow regimes to help improve ecological integrity. The licensing of many dams is contingent upon maintaining favorable environmental conditions, and reasonable efforts to restore aspects of the natural flow regime should be pursued. For example, TU chapters across the country are involved in modifying hydroelectric practices that cause frequent and rapid fluctuations in flow below dams, which are highly unnatural and harm benthic insects and fish, including trout. The altered timing of high flows can harm anadromous salmonids by slowing down the time it takes smolts to reach the ocean. In the Columbia River Basin, a major recommendation of an independent scientific review community is to restore some of the seasonal high flows to recover Pacific salmon. In regulated rivers that severely dampen high flows, fine silt can accumulate in downstream gravel beds. Occasional high flows can flush the silt away, enhancing benthic insect production and improving spawning habitat for salmonids.

There is a danger that anglers voicing outrage at any attempt to modify flows in regulated rivers to benefit ecological integrity or endangered species will come across as selfish and environmentally insensitive. However, anglers should have input into the process for any plans to change a flow regime of a popular fishery. To be effective, they should be knowledgeable about all of the issues and should not automatically assume that any tampering with established flows will be disastrous to trout. As a whole, I believe efforts to restore some semblance of natural flows to regulated rivers will do trout more good than harm: Helping the ecosystem function more naturally will benefit salmonids, which, after all, exist in an ecosystem context. ■

Writing for Laypeople:
Getting Out the Message

By Robert Behnke

In 1983, I began a series of columns, "About Trout," in Trout Unlimited's magazine *Trout*. I found my attempts to transform scientific writings on various subjects into an understandable common language to be an enjoyable but challenging task. Most of my popular articles have a basic theme of conservation such as the preservation of native fishes and the harm of land use practices. To gain and hold the reader's interest, I liberally incorporate historical or humorous anecdotes and peripheral items that add a bit of color and drama, without concern that peer reviewers will excise all "extraneous" text.

I will take an advocacy position on an issue with, perhaps, some editorializing, but I try to present a balanced account and, above all, to be **accurate.** I regard credibility to be the greatest asset an author can have when communicating in both the professional and lay media.

The degree of advocacy and balance in an article can be determined by the choice of descriptive words and phrases. Monty Montgomery writes a column for *The Boston Globe*. Montgomery is also an angler who has fished much in the West. He is completing the second book on his western angling experiences, which aims to promote preservation of races of native trout. Montgomery noted that government reports he read are characterized by "masterful understatement." From his experience, he concluded that *substantial impact* actually means *total impact*, and *habitat degradation* means *habitat destruction*. Note how the change from *substantial* to *total* and from *degradation* to *destruction* shifts and clarifies an advocacy position.

I sometimes use my forum to express personal opinions. In a recent issue of *Trout* (Winter 1994), I have an article on the "Charrs of New England," in which I explain why *charr* is preferable to the official American Fisheries Society (AFS) spelling of *char;* I also use the opportunity to express my displeasure with the general ignorance of fisheries biologists and administrators in matters of genetics and decisions based on genetic data. However, I try to substantiate my opinions in a credible manner.

For authenticity and credibility, I stress the need to use original source material rather than rely on the authority of conventional wisdom and faulty second-hard knowledge. A few years ago I published an article in the *American Fly Fisher* (journal of the American Museum of Fly Fishing) correcting 100 years of common belief that the first rainbow trout propagated in hatcheries came from the McCloud River. Reading the 1872 account by Livingston Stone in the first report of the U.S. Fish Commission and the early biennial reports of the California Fish Commission left no doubt on the matter—the first hatchery brood stock of rainbow trout came from the San Francisco Bay area. All one had to do to discover this was to go to the original sources.

I found my experience with semi-popular writing to be a big help in writing my AFS monograph on western trout, especially when attempting to lighten rather dull taxonomic accounts. Any success I might have had in this endeavor, however, I attribute to journalist Dan Guthrie, who thoroughly edited my manuscript with an eye toward making it reader-friendly. Peer review by a journalist or popular writer can be useful in producing articles to inform the public.

I urge fisheries professionals to seek opportunities to distribute our message well beyond our circumscribed peer group. You will find it rewarding and a good learning experience.

Robert Behnke is professor of fisheries biology at Colorado State University.

10·26·94
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(Logan County)
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Clipping Service
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303-571-5117 · FAX 303-571-1803

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What is a species? Question goes beyond word

By ROBERT BEHNKE
CSU Fishery Biology

What is a species? A species is a species is a species, stupid! Such a response might be expected for such a question. Species is one of those elusive words that everyone understands, but can't clearly define the meaning.

Lack of precise definition is understandable because among the experts who study the classification of plants and animals, called taxonomists, considerable disagreement exists on what species are and how species should be defined.

The implications of the meaning of species goes much beyond playing word games. It is basic for proper implementation of the Endangered Species Act.

The act now is up for re-authorization by Congress and among the many points of contention, the definition of "species," what should be eligible for protection, is a major focus of debate. Congress instructed the National Academy of Sciences to appoint a committee to write a definition of species for the act.

All of us should be concerned about how "species" is ultimately defined. This definition will guide how the act can be applied and will impact future development and natural-resource management nationwide.

The goal of the act is to prevent or reduce the rate of extinctions and preserve biodiversity. Biodiversity consists of diversity among species, which is called interspecific diversity, and diversity within a species which is intraspecific diversity.

It is intraspecific diversity, meaning a segment of a species, that is the point of contention for defining what is now protected under the act. Thus, a small part of a species can be listed for protection under the act even if the species as a whole is widespread and abundant.

This has been done for populations of chinook salmon and sockeye salmon. Such listings raise the question of how fine can the line be drawn. Would a population of squirrels in a city park, isolated by urban sprawl from neighboring squirrel populations, be eligible for listing?

The federal agencies responsible for implementing the act, the U.S. Fish and Wildlife Service and the National Marine Fisheries Service have recognized the futility of defining "species" for the act and instead developed a concept called Evolutionary Significant Unit as a way to implement the intent of the act. These agencies look for ways to quantify the significance of a particular part of a species' contribution to the diversity of that species as a whole.

I have studied at Colorado State University for many years the evolution of trout species and sub-

tionary significant — the type of diversity most desirable to preserve — focuses most on the replacibility of a given species or specific part of a species. If a particular population became extinct, to what extent might it be replaced by another unit of the species?

For example, if a population of squirrels was lost from a city park, it could be fully replaced by introduction of squirrels from neighboring populations. They would not qualify for listing under the act.

However, the sockeye salmon of Redfish Lake, Idaho, is another matter. The sockeye salmon of Redfish Lake are the most inland population in the world of this species. The fish are located more than 900 miles from the ocean. The life history and physiological adaptations necessary for these fish to survive so far inland makes it highly unlikely that any of the sockeye salmon populations along the Pacific Coast could replace the Redfish Lake sockeye if it became extinct.

Thus, it qualifies as a significant evolutionary unit because it cannot be fully replaced by any other form of the species.

It is this irreplaceable type of intraspecific adaptations that should be accounted for in any modified definition of species for the re-authorization of the Endangered Species Act. Let's hope Congress asks some hard questions about the definition of species in relation to how the act will be revised before approving any final changes.

— Robert Behnke is a authority on the classificati salmonid fishes, the auth many scientific papers translator of Russian fisher erature into English.