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Vol. LXXX, No. 1 February, 1941

THE

BIOLOGICAL BULLETIN

PUBLISHED BY THE MARINE BIOLOGICAL LABORATORY

# THE INFLUENCE OF TEMPERATURE UPON THE COMBINATION OF OXYGEN WITH THE BLOOD OF TROUT [1, 2]

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The air breathed by all species of mammals is the same in composition, and the affinity of their blood for oxygen is also much alike. But the water in which fish live differs greatly in oxygen saturation in different places and seasons, and this variability is particularly conspicuous in bodies of fresh water in temperate regions. Under these circumstances it is not surprising to find that the blood of various species of fish varies greatly in affinity for oxygen. Krogh and Leitch (1919) first remarked upon the differences among the eel, carp, plaice, cod, and trout, and regarded these differences in affinity for oxygen as evidence for the adaptation of the blood to the conditions in which each species lived. But only a few species were examined and these were quite dissimilar in form and habit as well as in respect to the habitat which they occupied.

The catfish, carp, bowfin, and sucker were found by Black (1940) to have blood with different oxygen dissociation curves, which were nevertheless related as if in one family. These freshwater fish are similar in form and are all of free swimming habit. Since their respiratory requirements and their physical systems for providing oxygen are much alike, it is reasonable to consider that large differences in the properties of the blood of these species indicate the suitability of the blood for respiration in different environments.

We have now examined the blood of eight species of freshwater fish and find that the affinity for oxygen varies greatly among the species. Furthermore, as Black (1940) pointed out for four of the species, the

[1] We wish to acknowledge the kind assistance of Mr. C. O. Hayford, Superintendent of the New Jersey State Fish Hatchery at Hackettstown, in enabling us conveniently to secure the blood from the trout used in these experiments.

[2] The expenses of this investigation were in part provided by a grant from the Rockefeller Foundation.



Fish — metabolism, dissolved oxygen, trout

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The provending role of large aquatic plants.

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# THE REGULATION OF CARDIAC ACTIVITY IN FISH IN A HYPOXIC ENVIRONMENT[1]

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## INTRODUCTION

Decreasing the partial pressure of oxygen in the water passing over the gills of the tench results in an increase in ventilation volume and, when the oxygen falls below a critical level, a decrease in heart rate (Randall and Shelton, 1963). The functional significance of these changes was explained in terms of the delivery of oxygen to the respiratory surface and saturation of the blood leaving the gills.

There are several ways in which a fish could respond to decreased oxygen levels in the water in order to maintain near saturation of the blood leaving the gills. The ventilation volume could be increased, thus maintaining an adequate delivery of oxygen to the respiratory surface in the face of decreased oxygen content of the water. Ventilation volume can be augmented by an increase in either the rate or the amplitude of the breathing movements. The amount of blood passing through the gills could be decreased by changing either the heart rate or stroke volume; thus blood would flow through the gills more slowly, allowing more time for gas exchange. The amount of oxygen given up by the blood to the tissue could be decreased, raising the oxygen content of the afferent blood and decreasing the amount of oxygen required to insure near saturation of the blood leaving the gills. Furthermore, by increasing the efficiency of gas exchange at the respiratory surface, the maintenance of near saturation of the efferent blood should still be possible in a hypoxic medium with partial pressures of oxygen still sufficiently high to saturate the blood. This could be achieved either by relating the maximum flows of blood and water or by altering the blood-flow pattern through the gills in such a manner as to decrease the diffusion gradient between blood and water.

Willem (1921, 1941) demonstrated a relationship between the heart and breathing rate in teleost fish. Schoenleim and Willem (1894), Lyon (1926), Lutz (1930*a*, 1930*b*), and Satchell (1960) observed the same phenomenon in elasmobranchs. Hughes (1961) and Shelton and Randall (1962) have observed the same tendency for the heart to synchronize with a certain phase of the breathing cycle in the trout and tench, respectively. It is possible that, under hypoxic conditions, this tendency toward synchrony of heartbeat and breathing would be accentuated so that periods of peak blood flow through the gills and maximum oxygen availability would coincide, thus insuring the presence of sufficient oxygen during each part of the breathing cycle to saturate the blood.

Steen and Kruysse (1964) have demonstrated that there are several alternate pathways of blood flow through the gills of teleosts. They present evidence which indicates that the percentage saturation of the blood leaving the gills would be altered by changing the pattern

[1] This work was supported by grants from the National Research Council of Canada and the British Columbia Heart Foundation.

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STATE OF COLORADO
WILDLIFE COMMISSION

POLICY NO. D-6 September 24, 1981

SUBJECT: WILD TROUT

I. WILD TROUT POLICY

WHEREAS

The state of Colorado has a very limited mileage of biologically productive streams capable of supporting all life stages of Wild Trout and whereas Wild Trout hatch, grow and provide sport fishing at a very low management cost and Wild Trout populations are most successful when not augmented with catchable sized hatchery fish.

THEREFORE;

It is the policy of the Wildlife Commission to provide an opportunity for Colorado anglers to observe, or fish for, wild trout in the most natural, aesthetically pleasing, aquatic environment possible. Designated wild trout waters will be protected and managed so they will forever support optimum and viable self-sustaining wild trout populations.

II. DEFINITION

A. Wild trout complete their entire life cycle in the natural environment.

B. A wild trout water is a lake or stream that normally supports a naturally reproducing and self-sustaining trout population without artificial stocking by the Division of Wildlife.

III. WILD TROUT MANAGEMENT GOALS

A. Protection and Enhancement of Wild Trout Habitat

1. Aquatic and terrestrial habitat will be actively protected, rehabilitated, and enhanced through cooperation with State and Federal, public and private agencies.

2. Every effort will be made to seek out and enhance or rehabilitate stream and lake resources that have the potential for management as wild trout waters.

B. Management of Wild Trout Waters

1. Wild trout waters will be managed through the use of fishing regulations designed to protect and enhance wild trout populations. Special regulations may include: size limits, species limits, bag limits, terminal tackle restrictions, season closures, and catch and release regulations.

2. There will be no stocking of hatchery fish in waters designated as wild trout waters.

3. In the event of a natural or environmental calamity trout introductions from hatchery or wild stock may be made by Division of Wildlife fishery personnel with prior approval of the Wildlife Commission.

C. Classification of Wild Trout Waters

1. A stream or selected stream section that does not have the potential to produce 20 pounds/acre standing crop of wild trout cannot be designated as a wild trout water unless it provides spawning and nursery areas essential for support of wild trout populations in adjoining standing waters.

2. A stream or selected stream section with standing crops ranging between 20 and 100 pounds/acre of wild trout that may be at maximum production is eligible for classification as wild trout water by the Wildlife Commission.

3. A stream or selected stream sections with standing crops in excess of 100 pounds/acre of wild trout are automatically eligible for classification as wild trout waters and if so classified by the Commission can not be stocked with hatchery fish.

4. All bodies of water with self-sustaining cutthroat trout populations endemic to the state of Colorado will be eligible for classification as a wild trout water.

5. Standing bodies of water may be designated as wild trout waters if the trout population can sustain a fishery through natural reproduction.

D. The Division will provide recommendations for the classification and management of all wild trout waters to the Wildlife Commission for their consideration and approval.

STATE OF COLORADO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE

Administrative Directive No. D-3 February 1, 1982

SUBJECT: SELECTION AND MANAGEMENT OF WILD TROUT WATERS

I. PURPOSE

The primary objective of this Administrative Directive is to provide direction for the selection, designation and management of wild trout waters as implemented in accordance with the Wild Trout Policy (D-6).

II. PROCEDURES AND RESPONSIBILITY

A. Candidate waters for inclusion into a wild trout management program will be selected by the Regional Manager and his staff in consultation with appropriate research personnel. Existing historical information, current biological inventory data and input from dependable public sources can and should be used in the selection of a given aquatic resource as a wild trout water.

B. Selected candidate trout waters will receive a complete resource inventory prior to final considerations for designation as a wild trout water. This resource inventory will include an evaluation of the physical, chemical and biological characteristics of the selected waters in accordance with standardized sampling guidelines formulated by the Division of Wildlife. Characteristics of the resource such as land and water ownership, current recreational uses and public access will be considered in the selection of wild trout waters. Public input and support to the wild trout water designation process will be solicited. After information regarding the status of the aquatic resource and resident fish population is collected, specific designation criteria can be considered.

III. CRITERIA FOR WILD TROUT WATER DESIGNATION

A. Water Quality Standards

1. The candidate water must be classified by the Colorado Water Quality Control Commission as a Class 1 - Coldwater Aquatic Life or higher designation.

B. Resource Inventory

1. Standing Stock Estimates

a. Any stream or stream section with a potential standing stock of resident wild trout which is lower than 20 pounds per surface acre cannot be designated a wild trout water unless it provides spawning and nursery areas essential for support of wild trout populations in standing waters or unless endemic wild trout populations are present.

b. A stream or selected stream section with standing crops ranging between 20 and 100 pounds/acre of wild trout that may be at maximum production is eligible for designation as wild trout water by the Wildlife Commission.

c. A stream or selected stream sections with standing crops in excess of 100 pounds/acre of wild trout are automatically eligible for designation as wild trout waters.

2. Natural Reproduction

Potential wild trout waters must have natural reproduction sufficient to maintain the trout populations in perpetuity. Aquatic resource inventory and review of past fisheries management programs will be used to determine the presence of natural reproduction.

C. Stream Length

Wild trout water will be a minimum of two miles in length to provide resource continuity and simplify the regulation process.

D. Endemic Wild Trout Populations

Regardless of standing stock estimates any water with original self-sustaining cutthroat trout population endemic to the State of Colorado is eligible to be managed as a wild trout water.

E. Standing Water

Standing bodies of water can be classified as wild trout waters only if tributary streams contain suitable areas for natural reproduction and the resident fish populations of the standing water community has the potential to be entirely self-supporting. Tributaries and standing portions of the system considered for wild trout designation will not be subject to standing-stock classification.

F. Wild Trout Water on Private Property

Wild trout water located entirely on private property must be subject to minimum lease agreements of 10 years or more.

IV. COMMISSION DESIGNATION AND REGULATION

A. Designation

Waters recommended for wild trout designation will be first submitted to Fish Program Management on the established "Wild Trout Water Fact Summary" form. Recommendations will be submitted to the Commission at their established meetings in March and September.

B. Regulations

Wild trout waters will be managed through fishing regulations designed to protect and enhance wild trout populations. Regulations include: Species limits, bag limits, size limits, terminal tackle restrictions including the use of bait, and restricted fishing seasons.

1. Species Management: In certain situations it may be desirable to selectively harvest a given species of fish from a community in favor of another species; i.e. harvest brown trout but not rainbow trout.

2. Bag Limits: Four types of catch restrictions or bag limits are recommended for use in wild trout management. These are:

   a. Catch and release with no kill
   b. 2 fish daily bag and possession
   c. 4 fish daily bag and possession
   d. 8 fish daily bag and possession

3. Size Limits: Four categories are recommended for use in wild trout management.

   a. 12 inch minimum size limit: All fish under twelve inches in total length must be released alive back to the water. Fish above 12 inches may be kept and included in the bag limit.

      12 inch maximum size limit: All fish over twelve inches total length must be released alive back to the water. Fish under 12 inches may be kept.

   b. 16 inch minimum size limit: All fish under 16 inches in total length must be released alive back to the water. Fish above 16 inches may be kept and included in the bag limit.

      16 inch maximum size limit: All fish over sixteen inches in total length must be released alive back to the water. Fish under 16 inches may be kept.

   c. 20 inch maximum size limit: All fish over twenty inches in total length must be released alive back to the water. Fish under 20 inches may be kept.

   d. Experimental slot length limit: In consultation with Fish Program Management, Fish Research and the Fish Coordination Committee, experimental slot length limits may be employed to achieve a desired effect in the fish population.

A slot length limit is a specialized form of size limit under which fish up to a protected zone (i.e. below 10 inches) may be kept, fish within a protected zone (i.e. 8-16 inches) must be released, and fish above a protected zone (i.e. above 16 inches) may be kept.

4. Terminal-tackle restrictions: Restrictions on terminal tackle may be used in the management of wild trout waters. Tackle manipulations could include restrictions on the use of bait, single or multiple hook lures, artificial flies or combinations of these. Use of bait is automatically prohibited in waters managed with size limit regulations and catch and release regulations.

V. SPECIAL CONSIDERATIONS

A. Fishing Seasons

Opening and closing dates, or specialized season closures may be utilized in the management of wild trout waters when such use is intended to enhance or protect a critical life cycle stage (i.e. spawning season) of a wild trout population.

B. Stocking

Unless special circumstances exist, there will be no stocking of hatchery-reared fish in wild trout waters. Under certain extreme conditions, fish introductions from hatchery or wild stock may be made by Division of Wildlife fishery personnel, with prior approval of the Wildlife Commission. These conditions would include:

1. Restocking necessary to replenish wild trout populations which have been lost due to an environmental calamity, such as 1) winter kill, 2) stream degradation, 3) flooding, 4) low flow or stagnant water situations, 5) pollution, or 6) disease.

   If restocking is not effective in re-establishing a wild trout population which has been lost as a result of environmental calamity, the water may be removed from the wild trout list and an alternative management program implemented.

C. Fish Population Sampling

Wild trout populations will be managed on a long term basis by routine population sampling to determine the status and condition of the wild trout resource. Biological sampling of designated wild trout waters should occur a minimum of every three years or more often as time provides. Biological data indices which can be used to determine the status of wild trout populations include: Standing stock estimates, population estimates, condition factors, Proportional Stock Density (PSD), Relative Stock Density (RSD) and Young-Adult Ratios (YAR).

D. <u>Fish Program Management</u>

It will be the responsibility of Fish Program Management to monitor the statewide implementation of the wild trout program in cooperation with Regional Fish Management and Fish Research.

Jack R. Grieb

Jack R. Grieb
Director

(Presented at the 1983 AFS Western Division meeting at Las Vegas, Nevada)

[1982]

# STREAM IMPROVEMENT IN WYOMING FOR INDIGENOUS CUTTHROAT TROUT

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## INTRODUCTION

Prominent red marks under the jaw and black body spots characterize the cutthroat trout (Salmo clarki), which is the only trout native to Wyoming. Early settlers found many cutthroat trout in streams draining western Wyoming, where several subspecies of cutthroat trout have since been identified. These include the fine spotted Snake River (S.c. subsp.) and west slope (S.c. lewisi) cutthroat trouts, as well as three large-spotted varities - the Yellowstone (S.c. bouvieri), Colorado River (S.c. pleuriticus) and Bonneville (S.c. utah) cutthroat trouts (Behnke 1979).

Unfortunately, man's activities have altered the original distribution and abundance of indigenous cutthroat trout. Present day populations of indigenous cutthroat trout are generally much reduced from original levels (Binns 1977, Kiefling 1978, Behnke 1979, Binns 1981). Causes of this decline include habitat alteration, the introduction of exotic trout species and increased exploitation. While competition and hybridization with exotic trouts played an important role in reducing native trout stocks, habitat alteration has had equal impact. Alteration of cutthroat trout habitat has ranged from subtle to flagrant. In some streams, trout can no longer survive because stream characteristics have gradually changed under long-term impact from livestock grazing and herbicides. Other water courses have been channelized or otherwise drastically altered during road construction or flood control activities.

With an increased population in Wyoming has come additional demands on the trout fishery. While regulations and hatchery-reared trout can help meet this need, neither solution really addresses the basic problem. A more appropriate response is to improve the carrying capacity of the habitat so more trout can be raised naturally.

Ideally, stream improvement should correct habitat deficiencies caused by natural limiting factors. When dealing with native cutthroat trout though, habitat improvement has often been more a matter of restoration and repair rather than improvement. In many instances, streams supporting native trout have been damaged by years of abuse. Consequently, there is no easy solution and recovery in most cases will require many years of continuing effort. Several habitat management techniques are being used in western Wyoming to help indigenous cutthroat trout. The primary target species are the Bonneville, Snake River and Colorado River cutthroat trouts.

## BONNEVILLE CUTTHROAT TROUT

In Wyoming, the Bonneville cutthroat trout historically occuppied the Bear River drainage. However, good phenotypic and genotypic representatives of S.c. utah are presently restricted to the Thomas Fork and Smiths Fork drainages (Behnke 1979, Binns 1981). With a few exceptions, streams presently containing this trout offer poor habitat to trout. Warm, silty water and unstable, eroding stream banks are common. Low water flow in late summer is a serious limiting factor in several streams. The riparian vegetation is often dominated by sagebrush and other dryland shrubs. The present habitat contrasts sharply with that available 20-30 years ago when dense willow stands, many beaver ponds and a thriving trout fishery were present (Binns 1981).

Habitat conditions were further evaluated with the Habitat Quality Index (Binns 1979, Binns and Eiserman 1979). The HQI analysis documented cover, bank stability and summer water temperatures, among others, as serious habitat problems (Binns 1981) (Table 1). Since these three habitat components are responsive to habitat restoration techniques, the HQI was used to predict cutthroat trout response if habitat problems were corrected. Predicting habitat potential was valuable both when planning stream restoration work and when setting standing crop goals for managing this fish. As an example, the HQI Score for an unimproved, degraded section of Huff Creek was 1.5 kg/ha. Upgrading cover and eroding banks with stream restoration techniques would boost the trout standing crop to 67 kg/ha. Similar results were logged at other HQI study sites. Since the predicted increases may represent difficult-to-obtain "best-case" situations, we arbitrarily selected 60% of the predicted standing crop as a reasonable management goal.

Streams where habitat and cutthroat trout stocks are still in relatively good condition can offer clues to the habitat requirements of S.c. utah. Such streams often contain: (1) well developed willow growth along the stream banks, (2) clean, cold water, (3) cobble-gravel riffles free from serious silt deposits and (4) many pools, either pools naturally formed by the stream or beaver ponds. Such information is useful when planning stream habitat management for this fish.

Table 1. Comparative importance of nine habitat components in degraded Bonneville cutthroat trout streams, as evaluated by the HQI method at 21 sites in the Thomas Fork River and Smiths Fork River drainages.

| Rank | Habitat Component | HQI Stations with Poor Ratings (%) |
|---|---|---|
| 1 | Trout cover | 95 |
| 2 | Stream bank stability | 57 |
| 3 | Nitrate nitrogen | 52 |
| 4 | Maximum summer water temperature | 48 |
| 5 | Substrate (fish food) | 43 |
| 6 | Annual stream flow variation | 14 |
| 7 | Stream width | 10 |
| 8 | Water velocity | 10 |
| 9 | Late summer stream flow | 5 |

Thus, information from stream assessment and HQI evaluations indicated a need for stream bank stabilization, provision of pools to shelter trout and restoration of willow growth along the stream banks. The first two items can be corrected comparatively quickly by installing instream structures. Restoration of willows will require a longer time frame, but once re-established, they will stabilize stream banks, encourage beaver activity, shade the stream and cool its water. Experimental work at Camp and Willow Creeks in Oregon indicates many positive results can be expected when the riparian vegetation is re-established (Winegar 1977).

Several stream restoration projects are underway on state and federal land in the Thomas Fork River drainage. A cooperative Wyoming Game and Fish Department (WGFD) - Bureau of Land Management (BLM) project has been operative for several years. A Habitat Management Plan (HMP) was written to specify goals and procedures for upgrading S.c. utah habitat and populations on BLM land (Anonymous 1979). To date, two survival enclosures (Coal Creek, 1.2 km in length and Huff Creek, 2 km), two 1 ha study enclosures (Huff and Little Muddy Creeks) and several rest-rotation study pastures (Little Muddy Creek) have been fenced. Also, instream pool forming devices were installed in the Coal Creek and Huff Creek enclosures. Included are log and tie overpours, rock plunges and trash catchers. Eroding stream banks are being armored with rock riprap in the Huff Creek enclosure.

A permanent spring on state land just upstream from the Coal Creek survival enclosure was fenced in 1981 to protect it from heavy cattle grazing. Prior to fencing, water temperature at the spring was 8 C. After flowing only 30 m to Coal Creek, the spring water warmed to 17 C, an increase of nine degrees. Future plant growth within the enclosure should shade and cool the spring flowage, thus giving benefit to cutthroat trout in Coal Creek where summer water temperatures presently exceed 26 C.

Several study stations have been established in the Thomas Fork drainage where fish populations (electrofishing), fluvial habitat conditions (HQI) and riparian ecology are monitored every two years. At Huff Creek, the standing crop of cutthroat trout increased 69% in the ungrazed area from 1976-80 (Binns 1980). In the grazed sections, trout abundance decreased 6%. Trout cover naturally increased 233% with just two years rest from livestock trampling. Huff Creek through the study enclosure has deepened and narrowed its channel to produce a better pool-riffle ratio (Smith and McCuistion 1981). Comparison of benthic macro-invertebrate populations in fenced and unfenced areas indicated an improvement in stream health in the protected stream sections (Binns 1981).

An effort is also being made in the Salt Creek drainage to restore degraded cutthroat trout habitat. A cooperative WGFD - U.S. Forest Service (USFS) project began in 1981 to remedy serious bank erosion on Forest Service land. While the primary emphasis is on bank stabilization, several instream pool-forming structures are also being used. These included wedge dams, log overpours, rock plunges, gabion check-dams and rock channel blocks. Tree retards backed with rock are being used to stabilize eroding banks. Bank stabilization work is scheduled in 1982 for state land downstream from the national forest.

COLORADO RIVER CUTTHROAT TROUT

The Colorado River cutthroat trout historically occuppied the Green and Little Snake River drainages, but its present distribution and abundance are much reduced from former levels. This fish presently occurs in a few small headwater tributaries to the Green, Blacks Fork and Little Snake Rivers. Many populations are associated with beaver ponds, possibly because stream flow is often limited in these small streams. Much of the present habitat is in poor condition, for much the same reasons discussed above (Binns 1977).

Although attempts to aid the Colorado River cutthroat trout through stream habitat management have primarily centered on providing reproductive isolation for pure strain populations, a HMP was written for streams containing this fish on BLM land along the west side of the Green River (Anonymous 1978). Barriers to upstream fish movement were constructed on the North Fork Little Snake River (WGFD), Rock Creek (WGFD), Red Castle Creek (BLM), and in the Beaver Creek drainage (BLM). Gabion check-dams were the primary device used, but a treated wood dam was used at Rock Creek. A joint WGFD-USFS-BLM project is scheduled for 1982 at Hells Canyon Creek in the Little Snake River drainage. Overpour structures will be constructed to provide badly needed deep pool habitat.

One problem with the beaver pond habitat used by the Colorado River cutthroat trout is that beaver traditionally overexploit their habitat. This practice leads to dam abandonment and eutrophication of old ponds. On some streams, inactive beaver ponds are stairstep with little or no running stream between them. Only occasional active beaver ponds are present. Spawning riffles and upstream migration for spawning are distinctly limited by such stagnant complexes. Additionally, trout in eutrophic beaver ponds may suffer winter or summer die-offs.

In 1974, Red Castle Creek was a classic example of this problem. Beaver had overcut the available aspen supply and many of the back-to-back beaver ponds were inactive and eutrophic, and little used by trout. In an experimental attempt to correct this situation, selected beaver dams were dynamited open. Usually, several inactive and stagnant ponds were removed between two active beaver ponds. Breaking a beaver dam allowed the stream to cut a new channel down through the pond substrate to the old stream bed level. Much of this silt removal often occurred with the initial flush of water as the pond drained. A normal riffle-pool sequence with a cobble-gravel substrate usually appeared in a few weeks.

# SNAKE RIVER CUTTHROAT TROUT

The original distribution of the Snake River cutthroat trout is unclear, but it presently occurs in the Snake River and its major tributaries between Jackson Lake and Palisades Reservoir (Behnke 1979). Included are: the Gros Ventre, Hoback, Greys and Salt Rivers. Primarily a riverine fish, this trout is well adapted to a large river environment and is well established in its present range, where it supports a valuable fishery. Although it has not escaped the impact of man's activities, Snake River cutthroat trout abundance and distribution is presently much better than for Bonneville or Colorado River cutthroat trout. Past habitat perturbations have seriously affected Snake River cutthroat trout in some areas. These include levee construction on the Snake River near Wilson, which has had the effect of annual channelization (Kiefling 1978), channelization of the Hoback River and extensive stream alteration of the Salt River (Miller 1971). Habitat preservation has been identified as being very important to maintaining viable populations of Snake River cutthroat trout (Kiefling 1978).

Large volumes of flow and bed load movement make difficult any instream habitat improvement in the Snake River and its major tributaries. Consequently, much stream habitat management effort in Jackson Hole proper has been directed toward improving reproductive success in several spring-fed tributaries. These spring flowages are important spawning areas for cutthroat trout from the Snake River, but unfortunately, a compacted cobble-gravel substrate sometimes hinders spawning potential. Three Channel Spring Creek enters the Snake River just upstream from the Gros Ventre River and is a good example of a WGFD spawning riffle rejuvenation project. Annual surveys at this spring creek indicated that spawning activity exceeded available spawning sites, with much disturbance of previously formed redds. Initial remedial work was done in 1971 to rejuvenate the spawning riffles (Kiefling 1978, Kiefling, 1981). First the riffle was dug out with a backhoe. After the larger cobble was removed by hand, the remaining gravel was redistributed downstream from the hole. Additional gravel was purchased and placed on some riffles. Gravel was piled about 15 cm deep on the new spawning riffle. A dead cottonwood tree was anchored over the hole to provide overhead cover for spawners. Masses of aquatic plants soon grew around the trees and added to their shelter value.

Cutthroat trout response to the new spawning facilities was immediate. Spawning activity, as measured by redd abundance, has greatly increased since 1971 (Figure 1). Increased recruitment from the riffle rejuvenation work will do much to insure a continued fishery for Snake River cutthroat trout. Similar spawning riffle rejuvenation was also done at several other spring creeks.

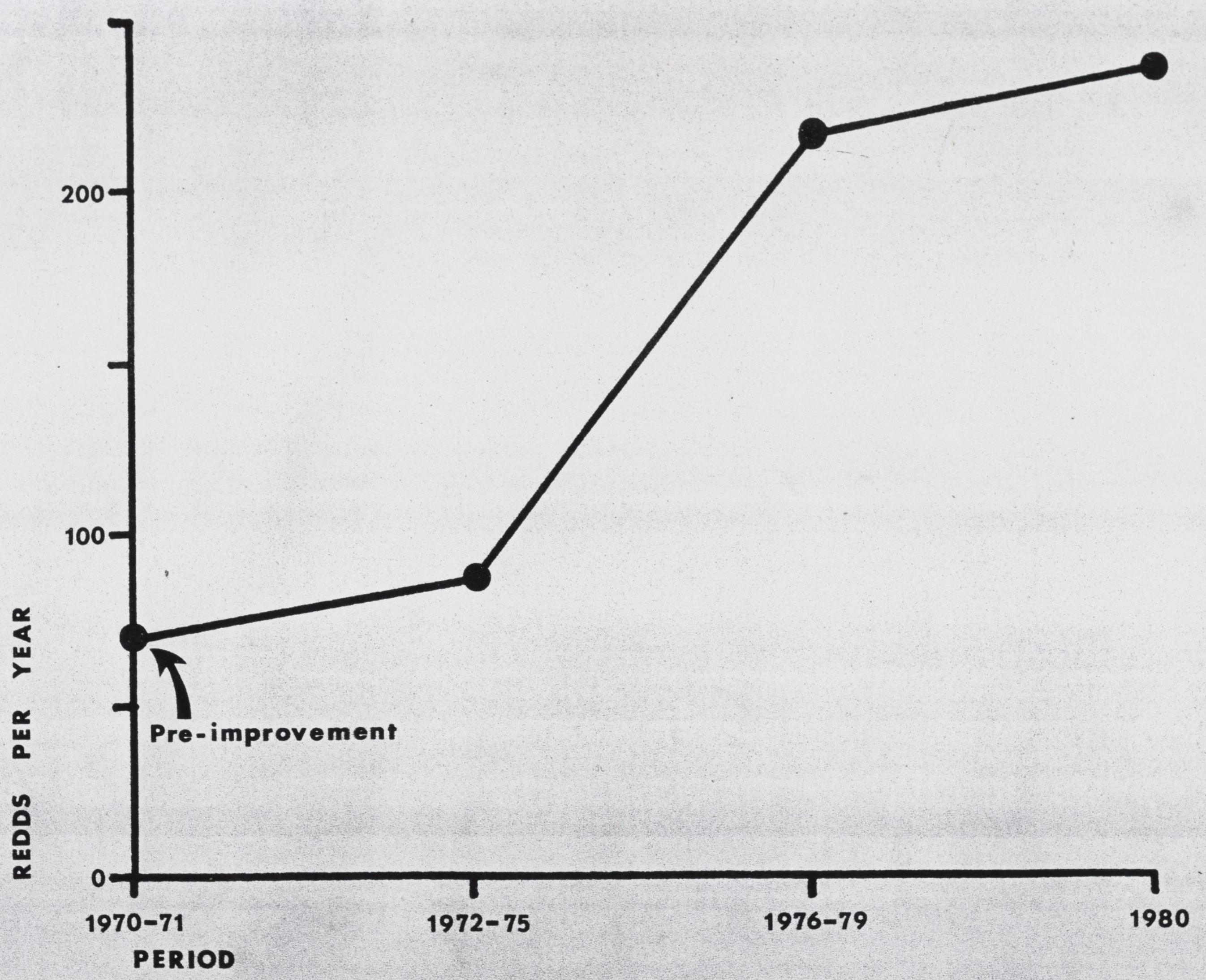


Figure 1. Snake River cutthroat trout spawning activity in Three Channel Spring Creek, as measured by redd counts, before and after the rejuvenation of spawning riffles. Riffle rejuvenation began during the fall of 1971 and was completed in 1975. (Data adapted from Kiefling 1981)

The Salt River flows north along the Wyoming-Idaho state line to Palisades Reservoir. Much stream habitat for trout has been damaged over the years by channelization, man-caused oxbow cuts and improper farming procedures. Stream bank erosion was severe, especially in the lower valley where serious flood damage and cropland loss often occurred. Scattered bank stabilization was done at WGFD public fishing areas in the 1960's and 1970's using rock riprap, tree retards and stream bank fences. However, while locally effective, these efforts were too small and scattered to affect the overall problem. Attempts to alleviate the problem with a large scale restoration project were continually defeated by landowner apathy. Finally the situation became bad enough that even the most stubborn landowners were agreeable to corrective action. In the late 1970's a joint U.S. Soil Conservation Service, WGFD and landowner project was established. The project was funded mostly by federal money.

An ambitious plan was developed for the lower valley in which each eroding stream bank was identified, mapped and scheduled for stabilization work. Tree retards backed with rock were systematically installed to stabilize the eroding banks. Additional strong-limbed conifers were anchored along some stream banks to discourage cattle trampling along bank edges. Work on this project continues in 1982. No formal evaluation data is available, but sections treated several years ago show marked improvement. The river is obviously deeper and narrower along the armored banks. Such changes will undoubtingly benefit native cutthroat trout.

In 1980-81, the USFS added boulder clusters to several swift, shallow riffles in the Greys River. Pocket pools formed around the boulders providing additional shelter for trout in otherwise marginal habitat.

## SUMMARY

Native cutthroat trout (*Salmo clarki*) have declined in Wyoming waters due, in part, to the degradation of stream habitat. To reverse this trend, stream improvement techniques are being used by state and federal agencies at several sites.

Livestock enclosures have been built at several Bonneville cutthroat trout (*S.c. utah*) streams. Instream pool digging structures are being installed to create additional shelter for *S.c. utah*. Devices used include log overpours, wedge dams, rock plunges, gabion check-dams and trash catchers. Eroding stream banks are being treated with tree retards and rock riprap. From 1976-80, the *S.c. utah* standing crop increased 69% in one 0.8 ha study enclosure. Habitat measurements and macro-invertebrate samples point to improved stream health in treated stream sections.

Colorado River cutthroat trout (S.c. pleuriticus) populations have been reproductively isolated with fish barriers. Spawning opportunity has been improved by dynamiting eutrophic beaver ponds. Log overpours are being installed in 1982 to provide pools at Hells Canyon Creek.

In small, spring-fed tributaries to the Snake River, spawning riffles have been rejuvenated by removing compacted cobble, adding gravel and anchoring trees for overhead cover. Spawning activity, as measured by redd abundance, increased dramatically after treatment. On the lower Salt River, tree retards and tree blocks are being systematically applied to stablize all eroding stream banks. Large boulders were placed in the Greys River to create shelter from swift currents. All three projects will benefit Snake River cutthroat trout (S.c. ssp.).

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[1984]

# GOLD MEDAL STREAMS

A stream which is designated as "Gold Medal" by the Wildlife Commission has biological qualities that will provide outstanding angling opportunities for large trout. The streams which qualify for this designation are very limited and represent the highest quality aquatic habitat that exists in Colorado.

The purpose in designating such streams is to better provide for their management and preservation for the future benefit of the angling public. Special regulations may be required to maintain the "Gold Medal" qualities. Also, stocking of trout may be needed to maintain these qualities.

Attached is a list of streams proposed for Gold Medal designation by the Commission. Regulations for Gold Medal streams will be proposed to the Commission at their September, 1982, meeting. Management of Gold Medal streams will meet the intent of the Commission Resolution passed at their September, 1981, meeting.

Divisional Correspondence Only

STATE OF COLORADO

# DIVISION OF WILDLIFE

DEPARTMENT OF NATURAL RESOURCES

DATE: March 23, 1984

TO: Regional Managers

FROM: Ed Prenzlow, Acting Director

SUBJECT: GOLD MEDAL WATERS

At the March Fish Coordination meeting the criteria for Gold Medal standing water was discussed. It was the concensus of all the regional biologist that the .7 catch per man hour objective is to high for lakes and reservoirs. From those discussions Fish Program is now proposing that the catch per man hour objective be set at .2 or greater for all standing water. This will allow selected lakes to be designated as Gold Medal waters that will meet all previous criteria except the CMPH rate. Please begin to consider new water for Gold Medal designation. Submit your recommendations to Fish Program who will be responsible for coordination and review. The final designation will be made at the September Wildlife Commission meeting.

## GOLD MEDAL TROUT STREAMS - CRITERIA

Designation - Designation of Gold Medal trout streams and lakes will be made by the Commission

Stream Criteria and management Objectives:

Length - minimum length of 2 miles

Width - average width of 20 feet

Scenic Qualities - Consideration will be given to selecting streams for Gold Medal designation that have above average scenic qualities when compared to other Colorado streams. Scenic qualities include channel meandering, riparian vegetation and necessary stream flows.

Trout Productivity - A minimum of 20 lbs./acre of existing trout standing crop or the biological potential to reach 40 lbs./acre.

Fish Management Objectives - All Gold Medal fisheries will meet the objective of optimizing numbers of trout 14" (minimum $P.S.D._{14}$ 20 percent)* or greater in total length amd maintain overall catch per man hour of .7 on streams and .2 or greater on standing waters.

Stocking - Stocking of hatchery trout may, or may not, be part of the management of Gold Medal waters; however, all stocking of catchable size fish (8" or larger in length) will first require the prior approval of the Director. When hatchery raised subcatchable trout are stocked, an effort will be made to obtain the eggs from wild brood stock.

Proportional Stock Density Definition - 20 percent of the trout population longer than 8 inches will be 14 inches or longer.

CC: Rolf Nittmann
Clee Sealing
Bill Weiler
Don Wurm
Don Horak
Eddie Kochman

DOW-A-F-8

STATE OF COLORADO
WILDLIFE COMMISSION

POLICY NO.

August 31, 1984

SUBJECT: GOLD MEDAL TROUT WATERS

I. GOLD MEDAL TROUT POLICY

The state of Colorado has a very limited mileage of rivers and streams capable of producing large numbers of "trophy" trout and the majority of anglers in Colorado desire the opportunity to catch at least one trophy trout. It is the policy of the Wildlife Commission to provide an opportunity for anglers to catch a trophy trout in Colorado through establishment of a Gold Medal classification of waters for trout in the highest quality impoundment, river and stream habitat that exists in the state. These populations can be maintained through establishment of specific fishing regulations and supplemental fish stocking.

II. DEFINITION

A. Gold Medal waters are impoundments, rivers, or streams that have all the factors required to produce large trout for use, or observation, by the angling public.

III. GOLD MEDAL MANAGEMENT GOALS

A. Protection and Enhancement of Gold Medal Habitat

1. Aquatic and terrestrial habitat will be actively protected, and enhanced through cooperation with state and federal, public and private agencies.

2. Every effort will be made to seek out and enhance stream or river segments and impoundments that have the potential for management as Gold Medal waters.

B. Management of Gold Medal Waters

1. Waters will be managed through the use of fishing regulations designed to protect and enhance Gold Medal populations. Special regulations may include: size limits, bag limits, terminal tackle restrictions, season closures, and catch and release regulations.

Fish may be stocked by the Division to enhance fish populations in Gold Medal waters.

C. Classification of Gold Medal Waters

1. A Gold Medal trout water must consistently have a trout standing crop level of 40 pounds/acre.

2. To be designated as a Gold Medal trout water a stream or river segment must be more than 2 miles in length with an average width of more than 20 feet.

3. Gold Medal waters must support a density of quality size (14 inch) trout of at least 12/acre on a sustained basis. These trout must be a resident population and not result from spawning migrations from other waters.

4. Waters selected for Gold Medal designation should have above average scenic qualities that include channel meandering, riparian vegetation and adequate water flows.

5. If supplemental trout stocking is utilized as a management scheme the Division should use the following guideline:

   a. If subcatchable fish are stocked, eggs from wild brood stock should be reared to produce the trout needed for planting.

   b. Stocking of catchable size trout requires approval of the Division Director.

D. The Division will provide recommendations for the classification and management of all Gold Medal waters to the Wildlife Commission for their consideration and approval.

E. Mitigation of Gold Medal water loss due to man's activites. If a Gold Medal water is lost to fisherman use through various projects (dam, or highway construction, etc.) the Division will mitigate the loss by working with the agency causing the impact to acquire new Gold Medal waters for access by the angling public. Where access to other Gold Medal waters cannot be obtained to equally mitigate the loss, waters of lower quality may be obtained provided they adequately meet replacement values as determined by the Division.

STATE OF COLORADO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE

Administrative Directive No. D-_ August 31, 1984

SUBJECT: SELECTION AND MANAGEMENT OF GOLD MEDAL TROUT WATERS

I. PURPOSE

The primary objective of this Administrative Directive is to provide direction for the selection, designation and management of Gold Medal trout waters as implemented in accordance with the Gold Medal Trout Waters (Policy (D-_).

II. PROCEDURES AND RESPONSIBILITY

A. Candidate waters for inclusion into a Gold Medal trout management program will be selected by the Regional Manager and his staff in consultation with appropriate research personnel. Existing historical information, current biological inventory data and input from dependable public sources can and should be used in the selection of a given aquatic resource. River, streams, or impoundments may be classified as Gold Medal water.

B. Selected candidate trout waters will receive a complete resource inventory prior to final considerations for designation as a Gold Medal trout water. This resource inventory will include an evaluation of the physical, chemical and biological characteristics of the selected waters in accordance with standardized sampling guidelines formulated by the Division of Wildlife. Characteristics of the resource such as land and water ownership, current recreational uses, public access and scenic qualities (channel meandering, riparian vegetation) will be considered in the selection of Gold Medal trout waters. Public input and support to the wild trout water designation process will be solicited.

III. CRITERIA FOR WILD TROUT WATER DESIGNATION

A. Water Quality Standards

1. The candidate water must be classified by the Colorado Water Quality Control Commission as a Class 1 - Coldwater Aquatic Life or higher designation.

B. Trout Size Requirements

1. A quality size trout is a fish that is longer than 14 inches in length. Gold Medal waters are selected on a basis of consistantly having 12 or more fish per acre that are 14 inches, or more, long.

C. Resource Inventory

1. Standing Stock Estimates

a. Any water with a potential standing stock of resident trout lower than 40 pounds per surface acre cannot be designated as a Gold Medal water.

b. Gold Medal trout waters will be divided into classes according to the following criteria.

| Class | Standing Crop Trout lbs/acre | Number of Trout 14 Inches/Acre |
|---|---|---|
| A | 250 | 200 |
| B | 200-250 | 100-200 |
| C | 100-200 | 20-100 |
| D | 40-100 | 12-20 |

D. Stocking

Gold Medal waters should have sufficient reproduction to maintain required populations. If certain factors are such that natural reproduction is not adequate the Division makes supplemental stock fish plants.

1. If catchable size trout are stocked the director must give prior approval.

2. If subcatchable trout are stocked the eggs used to reared needed fish should be obtained from wild brood stock.

3. If a forage fish is planted the species must be endemic to the drainage.

E. Gold Medal Water on Private Property

Gold Medal water located entirely on private property must have guaranteed public access for 10 years or more.

IV. COMMISSION DESIGNATION AND REGULATION

A. Designation

Waters recommended for Gold Medal designation will be first submitted to Fish Program Management on the established "Gold Medal Water Factor Summary" form. Recommendations will be submitted to the Commission at their established meetings in March and September.

B. Regulations

Gold Medal waters will be managed through fishing regulations designed to protect and enhance trout populations. Regulations include: bag limits, size limits, terminal tackle restrictions including the use of bait, and restricted fishing seasons.

1. Bag Limits: Any type of catch restriction or bag limit may be used in Gold Medal trout management.

2. Size Limits: Three categories are to be used in management of Gold Medal waters.

   a. Catch and release of all trout.

   b. A slot length limit. All fish fro 10-14 inches must be returned to the water. Only one fish greater than 14 inches long may be creeled.

   c. A 14 inch minimum size limit. All trout less than 14 inches long must be returned to the water. Only one. or two, trout, depending on the water may be creeled.

3. Terminal-tackle restrictions: Restrictions on terminal tackle may be used in the management of Gold Medal trout waters. Tackle manipulations could include restrictions on the use of bait, single or multiple hook lures, artificial flies or combinations of these. Use of bait is automatically prohibited in waters managed with size limit regulations, slot limits and catch and release regulations.

V. SPECIAL CONSIDERATIONS

A. Fishing Seasons

Opening and closing dates, or specialized season closures may be utilized in the management of Gold Medal trout waters.

B. Fish Populations Sampling

Gold Medal trout populations will be managed on a long term basis by routine population sampling to determine the status and condition of the trout resource. Biological sampling of designed waters should occur at a minimum of every three years. Biological data indices which can be used to determine the status of wild trout populations include: Standing stock estimates, population estimates, condition factors, Proportional Stock Density (PSD), Relative Stock Density (RSD) and Young-Adult Ratios (YAR).

C. Fish Program Management

It will be the responsibility of Fish Program Management to monitor the statewide implementation of the wild trout program in cooperation with Regional Fish Management and Fish Research.

VI. MITIGATION OF GOLD MEDAL WATER LOSS ATTRIBUTABLE TO MAN'S ACTIVITIES

When a Gold Medal water is lost to fisherman use through any activity the Division will work with the entity causing the loss to aquire replacement waters. Any entity causing such a loss will be required, through a mitigation agreement, to aquire additional Gold Medal waters, through purchase or long term (50 years) access, for public use. Since the Division spends considerable manpower and funds in managing a Gold Medal water, more acres of water will be acquired for public fishing than are lost through any activity. For every acre of Gold Medal water lost through activity the responsible entity will provide two acres of like water in mitigation. If Gold Medal water of a lesser class is proposed as replacement the number of acres to be provided as mitigation will double for each successive lower quality water.

James B. Ruch
Director

[ca 1987]

[collected notated reprints]

297

fm: A review of the EPA Red Book: Quality Criteria for water. 1979. Am. Fish. Soc.

of authors of chapter on Zn & Pat Davies

exhibit (1)

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## Zinc

Table 53-1. Summary of acute and chronic toxicity data on freshwater fish and invertebrates.

| Species | Water Hardness (mg/ℓ as $CaCO_3$) | Acute 96-Hr LC50 (mg/ℓ) | Chronic Toxicity Limits on MATC[a] (mg/ℓ) | References |
|---|---|---|---|---|
| Flagfish | 44 | 1.5 | 0.075-0.139 | Spehar (1976) |
| Fathead Minnow | 45 | 0.5 | 0.078-0.141 | Benoit and Holcombe (1978) |
| Fathead Minnow | 203 | 9.2 | 0.030-0.180 | Brungs (1969) |
| Brook Trout | 45 (2) | 2.0 | 0.532-1.368 (1) | Holcombe and Benoit (1978) |
| Rainbow Trout | 26 | 0.43 | 0.036-0.071[b] | Sinley et al. (1974) |
| Rainbow Trout | 333 | 7.21 | 0.320-0.640[b] | Sinley et al. (1974) |
| Water Flea | 45 | 0.16 | 0.070-0.102[b] | Biesinger and Christensen (1972) |

[a]Maximum acceptable toxicant concentration (M A T C): the hypothetical toxic threshold concentration between the highest concentration tested having no observed effects and the next higher toxicant concentration having significant toxic effects during a life-cycle fish toxicity test (as set forth in Mount and Stephan 1967).

[b]These numbers are not true MATC's as defined above, but are considered to be good estimates of the MATC (McKim 1977).

(1) Note that such levels do not occur, except very rarely below Bear Crk.

(2) ~ 45 mg/ℓ hardness = "soft" water → San Miguel at high flows has 50-100 mg/ℓ hardness & 40-50 alkalinity at low flows = 200-280 " & ≈100 "

That is, when metals most concentrated at low flows, the high hardness - alkalinity compensates (a self-compensating system) - Thus, I would expect no 'impairment' of San Miguel brook trout until Zn exceeds 1.0 mg/ℓ (not recorded below Bear Crk.).

The last group, and probably th
ost sought after of the sunfish fam
, is the black basses. In Colora
ere are two species of black bass —
e largemouth bass and the smal
outh bass.
The largemouth bass is the large
ember of the sunfish family in Col
do. It was introduced from Ohio i
78. The smallmouth is the secon
gest species of sunfish and was in
oduced into Colorado in 1951.
The two fish can be distinguished
the position of the upper jaw bone
relationship to the eye. The large
outh's upper jaw bone extends be
nd the eye while the smallmouth's
bone does not extend much be
nd the middle of the eye.
The largemouth bass attains a length
from 8-10 inches during the second
ar of life. Three- to five-pound
gemouths are fairly common in
lorado and one weighing over ten
unds was observed by Division re
rch biologists. The smallmouth bass
es not grow so big as the large
outh — it rarely gets larger than
ee to four pounds.
Fishing methods and baits are simi
for both the largemouth and small
outh basses. Frogs, minnows, cray
n, surface and underwater lures and
s, and flyrod-sized poppers fished
areas with cover such as brush and
eds should produce some action.
Two other sunfish species have been
oduced into Colorado waters but
of little importance because of
ir limited numbers. The warmouth
introduced in 1894, but the plant
not very successful. This species
still be present in the state, but
ne have been seen for several years.
redear sunfish was introduced on
experimental basis and is present in
a few waters of Colorado.
o, the next time you go warm
er fishing and you're catching only
smaller sunfish species — have pa
ce — their bigger cousins may be
ing nearby.



This 1973 paper and attached 1976 paper by CDOW's leading trout biologist, and published in official organ of CDOW, makes any 1988 claim for stocking catchable rainbow trout in San Miguel as desirable management strategy, appear to be ridiculous!

# Are we Polluting Our Streams with Trout?

By W. D. KLEIN — Klein, now retired,
*Wildlife Researcher* was Colo. Div. Wildlife's most experienced and respected trout biologist.

I HAVE never been famous for tactful approaches to much of anything, and I am sure a change for the better will not be evidenced in this article. I intend to tell you how the cow ate the cabbage in the sacred area of trout stocking and, no doubt, offend nearly everyone in the process. Hatchery fish never really held my attention until I worked on a Division of Wildlife fishery study on the Cache la Poudre River from 1962-1970 that permitted a close look at their contribution to phony fishing.

However, before I can continue making friends and influencing people, the good book on writing articles like this says I have to tell you that the Poudre River starts in the high country of Rocky Mountain National Park and gathers water and fishermen as it flows down the east side of the Rockies to the plains near Fort Collins. It becomes a major stream about where it leaves the back country and hits a surfaced highway some 50 miles to the west of Fort Collins. The highway, which parallels the river to the plains, carries the normal assemblage of vehicular traffic filled with people and fishermen. Among the traffic are fish trucks, which are there because there are fishermen, which are there because there are fish trucks. After all, 'most everyone knows you can't have fish without fish trucks.

In spite of all the good things that

**The costly stocking of trout in some streams, such as the Cache la Poudre, may jeopardize a unique resource and degrade the sporting aspects of fishing**



2A

Exhibit

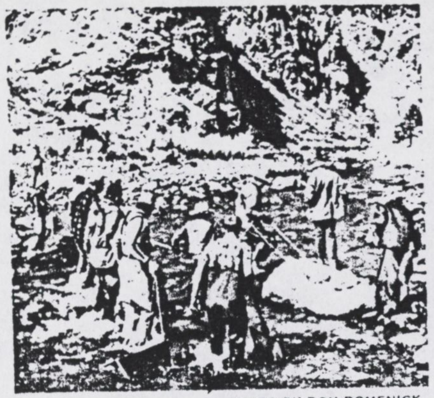

PHOTO BY DON DOMENICK

**Division researchers "electrofished" the Poudre in April and found that a large number of trout had survived the winter.**

have happened to the Poudre River in our progressive society like assorted impoundments on the headwaters, water from other drainages, spastic water releases for irrigation and domestic use, road encroachment and trout pollution, it remains one of the finest trout streams on the Eastern Slope.

Trout pollution consists of dumping a substantial tonnage of domestic trout, like 85 pounds per acre annually, on top of a healthy, happy, resident or wild trout population perfectly capable of sustaining itself with or without fishermen or fish trucks. Feed lot fish can't duplicate the wild product so they don't add to a real stream trout fishery; they clutter it up. Tame trout fishing we have, but wild trout fishing we haven't.

All this may be partly, but not entirely, the product of my warped mind because by the process of electrofishing extensively in the Poudre River in several different sections from 1962-1970 it was possible to thoroughly examine the fish population present.

Electrofishing is a great thing. You can catch fish whether they want to bite or not. All that's needed is a 110 volt A.C. generator, a gadget to convert the 110 A.C. current to pulsating D.C., some suitable cable to connect your power source to two electrodes and you are in business. It also helps to have about five helpers with an affinity for slick rocks and cold water to run the electrodes and dip up stunned fish. The trout revive rapidly with only an occasional mortality.

Our electrofishing revealed that in April, after being fished out by the multitudes who descended on the river the previous summer plus normal winter mortality, approximately 1,300 trout 6.0 inches or over remained per mile of stream. On a weight basis about 425 pounds per mile were present. Roughly half the fish were rainbow trout and half brown trout.

This assemblage of fish is not sufficent to supply the limit to all fishermen who normally use the stream, but neither is it indicative of a poor fishery. Plenty of trout for interesting fishing were present, particularly since a good portion of the population consisted of 9 to 10-inch trout with some from 10 to 12. Fish over 12 inches were rare.

The spring trout population could come from a hatchery, natural reproduction, or both. We found much that said natural reproduction and little that said hatchery. Wherever we looked, from near the mouth of the canyon up, fingerling rainbow and brown trout were found. Only trout of catchable size were stocked. Although an occasional fish appeared to be of feed lot origin, the great majority looked like wild fish. Hatchery trout were not stocked prior to spring electrofishing or after Labor Day in the portions of the river under study, and rapid and near complete harvest of stocked rainbow trout was known to occur. No fish were stocked from 1963-1969 in one stream section electrofished and the population increased in the interval. We concluded that on one of the heaviest-fished



trout streams a fine self-sustaining trout population was present.

If the hatchery product is caught out and the resident fish are not, then they must be different. And why not? Hatchery fish come from domesticated stock that has been selected for good performance under artificial conditions for many years. Progeny of these fish are mass produced for a year prior to stocking. They are crowded in assorted types of containers, fed all they can eat, and in short, thoroughly domesticated. Perhaps you have been to a hatchery and been charged en masse by fish looking for a handout as you approached the rearing pond. You should be getting the picture. No way can you expect these domestic animals to lose behavioral patterns established for over a year in the rearing units upon or soon after their release into a natural environment. The same eager eater attitude remains and any guy who can hit the creek with a baited hook has a good shot at these trained fish. Over 75 percent of some marked plants were removed from the Poudre River within 5½ days after stocking according to Larry Marshall, a graduate student in fisheries at Colorado State University, who has been studying the economics of the tame and wild trout situation. It is true that tame trout fishing requires careful timing. The time that you hit the creek should coincide with the arrival of the fish truck.

In contrast to 75 percent depletion in 5½ days, two years would be required to reduce a creel size group of wild trout to the same extent according to our recoveries of marked wild trout by electrofishing. On this flimsy basis I stand hitched that there is a slight difference between feed lot fish and the natural product.

Trout pollution in streams, therefore, degrades a unique, limited renewable natural resource and the fine sport of stream trout fishing, and at considerable expense. A good share of your license dollar goes to provide tame trout to bury extremely valuable stream resident trout populations in artificiality. Continuation of this nonsense can only convince more fishermen who *can't* fish that they *can* fish and perpetuate a spiral of more fishing pressure and more stocked trout.

We can stand this increased use routine on lakes, but not on streams. Things are tough now and they are going to get worse. Plans are in the mill for additional water development projects on nearly every major trout stream in the state. Each new project in the mountains will reduce stream trout habitat. The last thing we need is more stream trout fishermen for either wild or tame trout.

There are, however, those who say the development of shoulder-to-shoulder fishermen is the name of the game. They say the main management objective is to provide maximum fishing oportunity. These same jerks would also advocate building a road into a wilderness area to achieve maximum recreational use. Obviously, we do need to develop fishing opportunity, but not to the point of destroying what we are trying to enjoy.

The commonly held opinion that our stream fishing would fold without frequent innoculations of put and take trout just isn't so. The situation observed on the Poudre River is not an isolated case. Most major streams that have been checked show ample natural reproduction and fine resident trout populations. In this category are the North and South Platte, Arkansas, Fryingpan, Colorado, Roaring Fork, East and Taylor rivers. Of course, there are some streams or sections of streams that do not have self-sustaining trout populations, normally as a result of water manipulation or channel damage by man or some type of pollution, but not from fishing.

I am for equal rights for wild trout. I believe they are deserving of the same philosophical acceptance of their

Klein 1972

Is this the type of fishing the Anglers of Telluride area really want?

Klein 1973 2 B

capacities and limitations as is now afforded game populations, and the same sound management approaches should apply. We can't have all the game we want so the available supply is wisely managed and harvestable surpluses are divided as equitably as possible among sportsmen. Of course, surpluses for harvest are determined primarily by the species and habitat involved and harvest regulations are adjusted accordingly.

Actually, trout are far more amenable to management than game populations. The former can rapidly recover from natural or artificial adversities because of a very high reproductive potential, and the sport of fishing is not unalterably related to a kill as with game. Over 90 percent survival of released trout can be expected when artificial lures are used. Therefore, in the case of trout, liberal, limited or no harvest can be adopted to fit any situation.

Functioning entirely with wild trout in streams means more complicated and in some cases more restrictive regulations as to fishing method and harvest than are now in force. Further, fishing will be tougher and numbers of trout creeled will drop. This sacrifice in convenience for all and fewer fish for the frying pan is in exchange for the opportunity to fish for the real thing rather than for trained pellet poppers.

But, to each his own. If the choice is for hatchery fish and someone is willing to foot the bill, means can be developed to bury ourselves and the natural fishery with them. I ask only that you don't follow a primrose path paved with tame trout without knowing what is going on. There is a real difference in the type of fishing provided by feed lot fish and wild trout.

As you may have gathered, my appreciation for put and take trout stocking is not profound, but this does not alter several facts of life. The Division of Wildlife happens to raise about 5½ million creel size tame trout a year and this pittance is about to go 'way up. The tame trout super feed lot at Rifle Falls will reopen this year with an anticipated annual production of 2 million catchable fish. The Division is not going to cancel this program because I don't happen to like it, nor are tame trout fishermen going to disappear in the immediate future. Therefore, it is conceivably to my advantage to try to write myself out of this mess I have written myself into.

this is current policy

To this end, why not reroute the trout? Divert more tame trout to lakes and reservoirs, particularly those of low productivity near population centers, and let streams alone to provide wild trout fishing.

There are quite a few inherent advantages to lake stocking over stream stocking. Lake stocking is an easier, less expensive process. Lakes can be blasted with bigger bunches of tame trout all at one spot and still provide satisfactory results. Also, the time of stocking in lakes is not very critical.

For example, ice fishing is popular and creel-size trout planted in winter are well utilized. A switch to more lake stocking will particularly benefit those whose physical condition does not allow stream fishing and those who prefer to keep their fishing skills and effort at some minimum level. I am not implying, however, that trout fishing in lakes is not fine sport or that fishermen who fish lakes are necessarily poor fishermen. In lakes, as in streams, those with fishing knowledge, skill and perseverance catch most of the trout. Nor do I wish it inferred that all lakes should be loaded with large feed lot fish. It would be inadvisable to use put and take fish in many situations, and especially in those few lakes sustained by wild trout.

Naturally, I presume that if you stream tame trout fishermen don't want your fish rerouted to lakes you will say so. Have at it.



**Restrictive fis[h]**
**regulations ha[ve]**
**paid off in m[ore]**
**ways than one**

By T. M. LYNC[H]
*Fish Manager*

# The Ever[green...]

PRIOR TO 1971, Everg[reen Lake] at Evergreen, Colorado, southwest of Denver, was op[en to pub]lic fishing on a nonrestrictiv[e basis;] all types of bait and lures used. In 1971, a "Fly and L[ure"] restriction was applied to [...] Comparison of fishing and [...] before and after the Fly [...] Only fishing restriction wa[s...] showed marked differences.

During 1970, a citizens' c[...] called for the complete clos[ure of the] lake to fishing. This was due to what they termed polluti[on of the] lake. The pollution they re[ferred to] was primarily litter, both on surrounding the lake and in of the lake itself. A meeting with the town council, the committee and E. P. Cook, manager for the Division of [...] to discuss alternatives to clos[ure ...] recommended that the lake [...] under a Fly and Lure Onl[y] fishing regulation rather tha[n ...] fishing entirely. The tow[n ...] and citizens agreed.

The 1971 Fishing Regula[tions ...] fied Evergreen Lake und[er ...] waters listed where Fly and L[ure] fishing would be allowed. C[...] ive information resulting [...] creel census of 1970 when n[o ...] tions were applied to those when restrictive regulations [were in] effect showed that:

1. Fishing pressure (nu[...]

Colorado Outdoors
Nov-Dec 1976

By W. D. KLEIN
*Wildlife Researcher*
PHOTO BY DON DOMENICK

supplying wild trout must be stopped.

We will indeed be poor as a state and as a nation if we exchange natural recreational values for artificial substitutes in pursuit of increased recreation. As an extremely affluent society, we are literally wallowing in recreational opportunity of an artificial nature. Also, these opportunities can be expanded — we can build more TV sets, fishing lakes, bowling alleys,

# Stream Stocking: a Program Not Needed

THIS article is written to encourage those interested in Colorado trout fishing and management to accept the natural productivity of streams and to avoid the expense and artificiality associated with the stocking of creel-size trout into streams with wild trout populations. Most mountain streams in Colorado contain normal self-sustaining populations of wild trout.

There has been a consistent and expanding trend toward the type of fishing provided by stocking artificially reared trout of creel size. This weird phenomenon of domesticating an animal and then releasing it to be hunted, so to speak, offers an expensive means by which man can ignore effects of his actions as a predator and the inherent productive capacity of a body of water. It has the obvious appeal of being able to provide instant fishing. Further, tame trout, particularly when concentrated, provide an easy type of fishing that favors the novice and those unwilling or unable to catch wild trout. Over the years extensive use of put-and-take trout has created an acceptance by the public of the false notion that we cannot have acceptable fishing without them.

Division production of creel-size trout has reached the point where many accessible streams on the Eastern Slope annually receive 135 pounds per surface acre, while those on the Western Slope receive about 70 pounds. This magnitude of stocking, which in many cases far exceeds the capacity of the water involved to produce fish, is sufficient to create a predominately artificial type of fishery. In 1975, trout six inches and larger stocked in streams came to 1,661,948 fish. Their approximate cost was $305,798.

For those exponents of maximum recreational use, the advantages of a deluge of tame trout are perfect — a syndrome of supply and demand is created around the service of stocking which guarantees that lakes and streams will become crowded to capacity. However, for those who prefer the legitimate challenge of fishing for wild trout, particularly on streams, the fishery is largely destroyed by the tame product and all that goes with it. Conversion of fine trout streams to elongated catchout ponds is a fantastic travesty against the sporting aspect of trout fishing. If real values of stream trout fishing are to be retained, creel-size stocking of streams capable of

tennis courts, etc. No one can build another trout stream or duplicate the associated natural fishery.

Unquestionably, a wild trout fishery will not only persist, but prosper without stocking. Lifting the extra burden of artificially stimulated fishing pressure will benefit wild fish as removal of the stresses are created on them by a constant infusion of tame fish.

What the wild trout cannot do is provide fish to the creel to make up for those not stocked. Neither can they help those who do not choose to expend the time and effort necessary to learn to fish a trout stream. Fishing opportunity will remain the same with or without stream stocking, but harvest opportunity will be lessened. However, harvest need not fall to an uninteresting level for serious fishermen. Evidence is available to show that wild trout in streams do sustain a fishery.

Sections of the heavily fished Cache la Poudre River, west of Ft. Collins, provide good fishing for serious fishermen without stocking. While under study, wild trout in a section not stocked creeled at a rate of 0.47 fish per hour. Experienced fishermen in this area can expect to catch four or more fish an hour, mostly in the 8- to 10-inch size group, but capture of an occasional trout over 12 inches is not unusual. The Poudre River is a good although not overly productive, stream; many others will do as well or better and some not so well. A section of the South Platte River from Cheesman Dam downstream three miles (only about 45 miles from Denver) is another example of an excellent trout fishery sustained without stocking. No doubt problem situations will develop without stocking; however, the problems should be solved by regulatory or other means, and not by planting creel-size fish.

The esteem that people place on natural values is attested to by the immense popularity of our National Parks. A natural stream fishery also will receive broad acceptance and heavy use. After a period of adjustment, fishing license sales and business revenues should not be significantly altered as a result of no stocking in streams with resident trout populations.

It is most important to understand that if we agree to no put-and-take stocking that we also automatically agree to live within our means; i.e., live with the inherent capacity of each stream to provide fishing. Any stream, large or small, with high or low fish-producing capacity, regardless of fishing pressure, can be managed to provide at the least catch-and-release fishing. Probably 80 percent or more of the streams with resident trout populations could function satisfactorily under normal regulations. It should indeed be a desperate situation where we would have to give up and call in the hatchery truck. Just as now, there will be disgruntled fishermen and commercial interests who will claim that what is available is not enough, that the fish are too small, and that no one can catch anything.

The present put-and-take stream stocking program has one great redeeming feature. It can be turned off.

Proc. Colo.-Wyo. Chapter Am. Fish. Soc.
19th Ann. Meet. 1984.

Re. Suckers & trout in reservoirs

# MAGIC IN THE BAG: TURNING SUCKERS INTO TROUT

STEVE PUTTMANN — CDOW fish. biol.
(sucker–trout 'specialist')

Exhibit 37

## ABSTRACT

Between 1978-1982 a number of productive northern Colorado trout lakes were chemically renovated to remove sucker populations which had become overabundant. Standardized experimental gillnetting was conducted prior to the fish renovations and annually thereafter to document growth and abundance of restocked trout populations.

Post reclamation gillnetting indicates that trout biomass increased by as much as tenfold after suckers were removed and lakes were restocked with fingerling trout. Some lakes have remained free of suckers up to 5 years after the reclamations while in others, suckers reentered the lake the year following poisoning. The impact of increasing sucker numbers on resident trout populations is being evaluated by annual standardized sampling.

up to 10X more trout w/o suckers than with suckers

Cost analysis done on one 80-acre impoundment, Seymour Reservoir, showed that actual costs of the reclamation were paid back in the reestablished trout fishery during the first year of fishing. Cost per pound of trout harvested dropped from $1.36/pound before reclamation to $0.27/pound after reclamation.

costs of fish (from hatchery to angler) increased 5X with suckers (decreased 5X w/o suckers).

Rocky Mtn. Streamside (Colo. Trout Unlimited)

3B

# Letters to the Editor

Re. fiasco of sucker poisoning in lake Trib. to Ark. R.

*Rocky Mountain Streamside* welcomes your comments and remarks concerning our stories, editorials, reviews and the coldwater resource in general. Send all correspondence to:

*Rocky Mountain Streamside*, Colorado Trout Unlimited, 1557 Ogden Street, Denver, CO 80218.

Dear Editor:
The recent "fish kill" carried out on the Arkansas River solely by employees of the Colorado Division of Wildlife is *inexcusable*, and reflects a common attitude of professional employees that should be examined in depth. For those readers with short memories, this very same thing happened not long ago in the Creede, Colo., area when rotenone was poured into a stream killing countless numbers of trout. Thousands of anglers in this state join and support organizations such as Trout Unlimited, the Federation of Fly Fishermen, support fish conservation programs, assist with stream improvement programs, follow the axiom of catch-and-release and do everything possible to improve the quantity and quality of fishing in this state. Is this our reward from the Division of Wildlife for efforts put forth in their behalf?

Let me suggest that a good environmental attorney bring a suit on behalf of the sportsmen in the state naming the DOW and the employees who instituted the "fish kill," and base the damage on the cost of providing 50,000 mature trout. Should an individual take one more fish than the legal limit, the fine would be a minimum of at least $10 per fish. Now the magnitude of this thoughtless act can be estimated. What assurances do we have from the Division of Wildlife that this will not happen again? In the end, fish will have to be taken from our hatchery system and placed in the Arkansas River instead of the watersheds where they were originally planned for planting. Despite their "after the barn has burned down" attitude, the Division can never replace those big browns and rainbows that have been caught countless times and gently replaced back into the stream by caring sportsmen. It is time that the good sportsmen and conservationists stand up and be heard, and find out what guarantees we can expect from the DOW. If they cannot handle rotenone, prevent them from using the chemical and hire someone that has the common sense to use this "fish killer" as it was originally designed.

H.M. Webster
Louviers, Colo.

Dear Editor:
It's pronounced: McWheenie.

6X
Denver, Colo.

Dear Editor:
I wanted to write to you about an organization that is doing an awful lot to promote the protection of natural resources. I think you know about the Collegiate Peaks Chapter of Trout Unlimited. But I don't know if you are aware of how helpful this organization has been to conservation programs at the Buena Vista School District in Buena Vista.

I am sending an article from the *Chaffee County Times* about their last contribution to fishing education. The article speaks for itself, but it doesn't say how much members of Trout Unlimited have touched the lives of kids. Your members are fantastic! And, Bob Gray, president of the chapter, made all of this possible.

We are looking forward to a long association with this organization. The Buena Vista School District is blessed by so many who want to be involved.

We are now working with the Collegiate Peaks Chapter of Trout Unlimited to develop a learning station that will be permanently placed in the nature area. The learning station will educate the passer-by about fishing, fish habitat improvement, and conservation of wildlife resources.

Chuck Clark
7th Grade Life Science Teacher
Buena Vista, Colo.

After fiasco, CDOW stocked 25,000 unacclimated hatchery rainbow trout in Ark. R.

— Ark. R. at low flows, often has higher Zn + Cd level than San Miguel below Bear Crk

Sm: N. Am. Jour. Fish. Mgt. 1987 vol. 7 no. 3
— Explanation of sucker impact on trout
— why rainbow trout fishery suffered drastic decline in Flaming Gorge Reservoir



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id not differ sig- r any of the fish ted on the fol- inge in 50-mm 1 the indicated es): 76 rainbow ) mm), 132 ko- mm), 275 Utah ) mm), and 252 301–450 mm). ffered from that sites (Table 1). he zooplankton n Utah chubs, white suckers, zooplankton in in the diet of d 12.8% of the imples. *Cyclops* zooplankton in ibow trout and 5.0% of the diet *smina* sp. rep- ton in the water % of the white of the diet. s was indicated 2). In all three tah chubs, and ity indices for or negative in- suckers showed n for *Daphnia*

TABLE 1.—Species composition (percent by number) of identifiable zooplankton in water samples and fish stomachs (all sampling periods, areas, and fish-length intervals combined), Flaming Gorge Reservoir, 1984.

| Form | Water | Rainbow trout | Utah chub | Kokanee | White sucker |
|---|---|---|---|---|---|
| *Daphnia* | 14.0 | 99.7 | 99.9 | 94.4 | 89.8 |
| *Diaptomus* | 12.8 | 0.2 | | 0.6 | 0.8 |
| *Cyclops* | 14.7 | 0.1 | 0.1 | 5.0 | 5.3 |
| *Bosmina* | 0.1 | | | | 4.1 |
| Nauplii | 38.2 | | | | |
| Rotifers | 20.2 | | | | |

(0.71 to 0.83) and also some positive selection for *Bosmina* (0.01 to 0.11).

## *Size Selectivity*

Due to the rare occurrence of zooplankton species other than *Daphnia* in fish stomachs and the intense level of selection for *Daphnia* by all four fish species, we limited our analysis of zooplankton size selection to *Daphnia*. Size-frequency distributions and mean size of *Daphnia* in fish stomachs differed from that in samples from the water (Figure 1).

The average length of *Daphnia* in water samples was 0.99 mm, and about 11% of the organisms were longer than 1.40 mm. Rainbow trout ate the largest *Daphnia* (mean length 1.70 mm); mean daphnid size declined progressively in stomachs of Utah chubs (1.59 mm), kokanee (1.52 mm), and white suckers (1.27 mm). Mean size of *Daphnia* differed significantly among fish species ($P$ = 0.001) when data were pooled for each species. The proportion of large *Daphnia* (> 1.40 mm long) was more than 75% in rainbow trout and Utah chubs, 64% in kokanee, and 34% in white suckers.

Rainbow trout, Utah chubs, and kokanee showed negative selectivity for *Daphnia* less than 1.2 mm long and positive values for all larger *Daphnia*. White sucker values were negative for *Daphnia* up to 1.0 mm long and positive for larger size classes. The deviation in selectivity values, either positive or negative, was less for white suckers than for the other three fish species for every *Daphnia* size-class—indicating that the white sucker diet was more representative of the zooplankton in the water.

Mean size of *Daphnia* eaten by each fish species increased with increases in fish length. By species, the increases in fish and *Daphnia* lengths, respectively, were as follows: rainbow trout, 151–450 mm and 1.62–1.82 mm (*Daphnia* size differed significantly among fish size intervals when data were pooled for each species, $P = 0.013$); kokanee, 101–450 mm and 1.28–1.61 mm ($P = 0.001$); and Utah chub, 101–350 mm and 1.29–1.66 mm ($P = 0.002$). White suckers also ate larger *Daphnia* as fish size increased ($P$ = 0.004); however, the *Daphnia* were similar (1.12 and 1.27 mm) for fish 151–450 mm long and then increased to 1.59 mm for fish 451–500 mm long.

TABLE 2.—Species composition (percent by number) of identifiable zooplankton in fish stomachs (all sampling areas and fish-length intervals combined), with corresponding linear selectivity index values, Flaming Gorge Reservoir, 1984.

| Month | *Daphnia* % | *Daphnia* Index | *Diaptomus* % | *Diaptomus* Index | *Cyclops* % | *Cyclops* Index | *Bosmina* % | *Bosmina* Index | Nauplii % | Nauplii Index | Rotifers % | Rotifers Index |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rainbow trout** | | | | | | | | | | | | |
| May | 99.7 | 0.89 | 0.3 | −0.06 | 0.0 | −0.20 | 0.0 | 0.00 | 0.0 | −0.34 | 0.0 | −0.29 |
| July | 99.6 | 0.83 | 0.0 | −0.12 | 0.4 | −0.14 | 0.0 | 0.00 | 0.0 | −0.01 | 0.0 | −0.35 |
| August | 100.0 | 0.88 | 0.0 | −0.20 | 0.0 | −0.12 | 0.0 | −0.01 | 0.0 | −0.21 | 0.0 | −0.35 |
| **Utah chub** | | | | | | | | | | | | |
| May | 99.6 | 0.89 | 0.1 | −0.06 | 0.2 | −0.19 | 0.0 | 0.00 | 0.0 | −0.34 | 0.0 | −0.29 |
| July | 100.0 | 0.84 | 0.0 | −0.12 | 0.0 | −0.14 | 0.0 | 0.00 | 0.0 | −0.50 | 0.0 | −0.07 |
| August | 100.0 | 0.88 | 0.0 | −0.20 | 0.0 | −0.12 | 0.0 | −0.01 | 0.0 | −0.21 | 0.0 | −0.35 |
| **Kokanee** | | | | | | | | | | | | |
| May | 93.1 | 0.82 | 0.7 | −0.05 | 6.2 | −0.13 | 0.0 | 0.00 | 0.0 | −0.34 | 0.0 | −0.29 |
| July | 100.0 | 0.84 | 0.0 | −0.12 | 0.0 | −0.14 | 0.0 | 0.00 | 0.0 | −0.50 | 0.0 | −0.07 |
| August | 100.0 | 0.88 | 0.0 | −0.20 | 0.0 | −0.12 | 0.0 | −0.01 | 0.0 | −0.21 | 0.0 | −0.35 |
| **White sucker** | | | | | | | | | | | | |
| May–June | 89.3 | 0.74 | 1.3 | −0.08 | 8.0 | −0.08 | 1.4 | 0.01 | 0.0 | −0.44 | 0.0 | −0.15 |
| July | 87.7 | 0.71 | 0.1 | −0.12 | 1.7 | −0.12 | 10.5 | 0.11 | 0.0 | −0.50 | 0.0 | −0.07 |
| August | 95.3 | 0.83 | 0.6 | −0.19 | 3.2 | −0.09 | 0.9 | 0.01 | 0.0 | −0.21 | 0.0 | −0.35 |

— before suckers and chubs became abundant, trout had all the "water fleas" to themselves and flourished — x̄ size of food was larger then, but now reduced because of feeding of chubs and suckers.

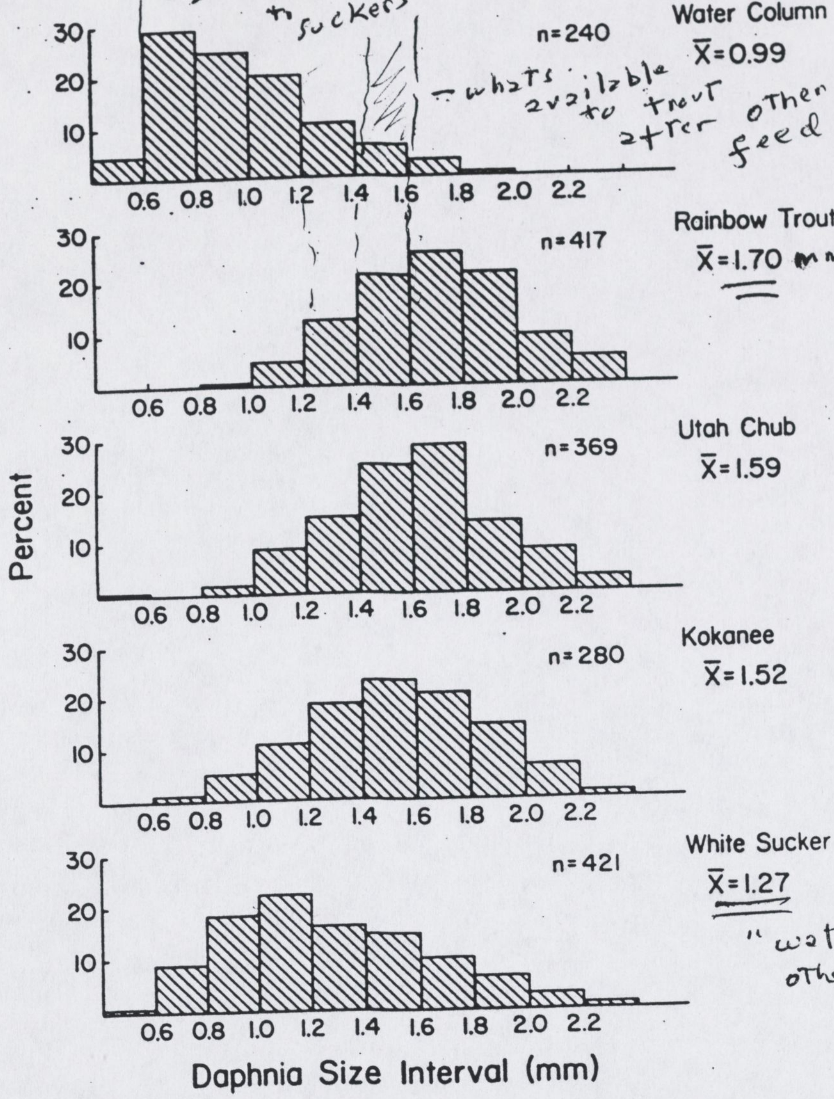


FIGURE 1.—Mean length ($\bar{X}$, mm) and size-frequency distributions of *Daphnia pulex* in fish stomach samples and in the water column for all sampling periods (areas and fish-length intervals combined), Flaming Gorge Reservoir, 1984; n = number of *Daphnia* measured.

*Diet Overlap*

Zooplankton diet overlap was indicated among the four fish species. Overlap values were highest between rainbow trout and Utah chubs (99.7%), and were slightly lower but similar between kokanee and all other species (94.7–95.4%). Similarly, overlap values between rainbow trout and white suckers and between Utah chubs and white suckers were nearly identical—90.1 and 89.9%, respectively.

Diet overlap also was measured in terms of the size of *Daphnia* eaten. The greatest size overlap occurred between rainbow trout and Utah chubs (87.0%) and between kokanee and Utah chubs (87.0%). Substantial overlap also occurred between rainbow trout and kokanee (79.4%). For white suckers, the *Daphnia* size overlap with the other species ranged from 51.6 to 68.1%.

## Discussion

Rainbow trout in Flaming Gorge Reservoir are similar to other stocks of the species in their use

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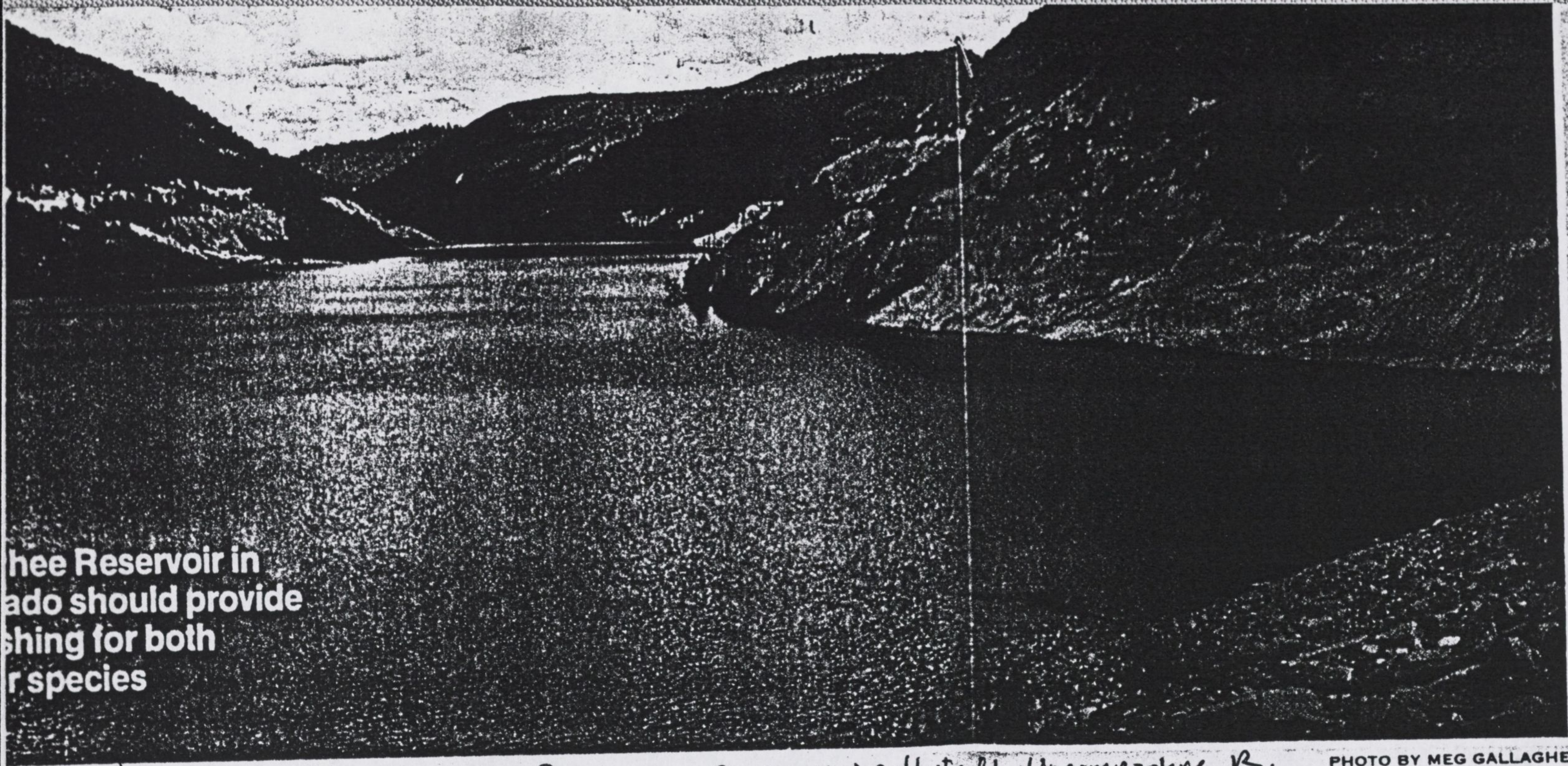

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PHOTO BY MEG GALLAGHER

New Re. Ridgway Res. & 'polluted' Uncompaghre R.

# …W RESERVOIR COMES TO LIFE

— McPhee Res. (and tailwaters) recreational wonderland created from dirty, polluted, Dolores R.

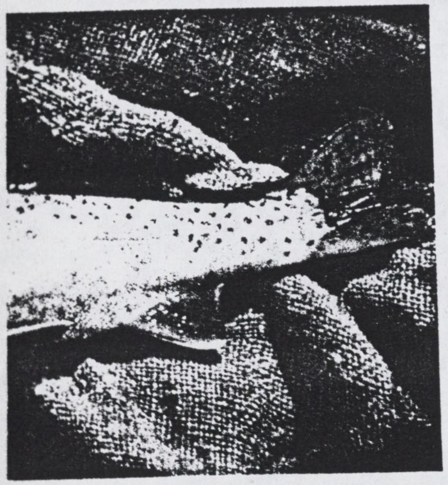


PHOTO BY MIKE JAPHET

…ws are growing to a large size in McPhee.

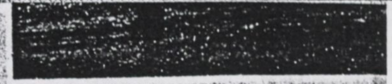
By MIKE JAPHET

MANY CHANGES have shaped the landscape of Colorado's four corners country since the Anasazi Indians lived here over 700 years ago. A recent development in the area which holds great promise for fishermen is the construction of McPhee Dam and Reservoir. McPhee is an on-channel reservoir filled by the Dolores River. It is the major feature of the U.S. Bureau of Reclamation's Dolores Water Project, designed to supply irrigation, municipal and industrial water for present-day inhabitants of southwest Colorado. Ironically, some historians believe it was a prolonged drought which ultimately caused the Anasazis to depart this region — land that will now be served by a U.S. Bureau of Reclamation water project.

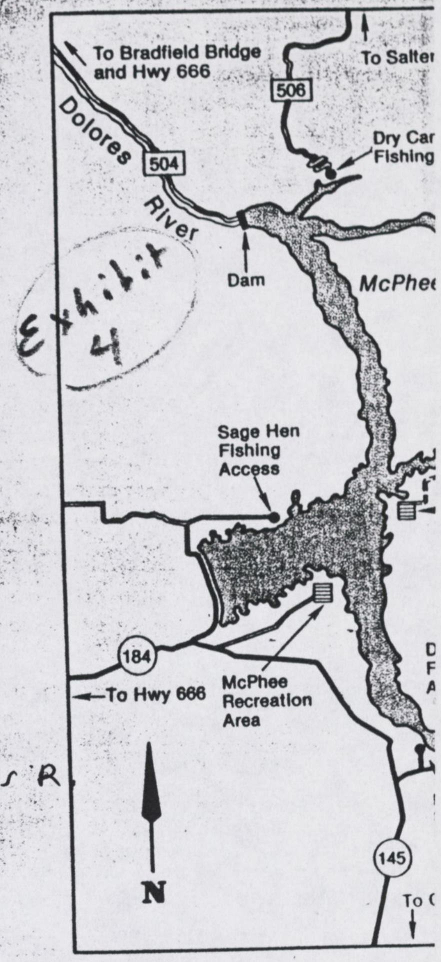
What makes McPhee special? There are several points which may stand out in the minds of fishermen. When it fills completely in 1987, McPhee will cover 4,470 surface acres, making it one of the largest bodies of water in Colorado. The maximum water depth at the dam will be 270 feet. McPhee will have more than 50 miles of shoreline with several long, narrow tree-lined canyons. Underwater structures in the form of flooded trees, brush, and rockpiles will be abundant.

McPhee has been filling gradually for

*Mike Japhet is an area fisheries biologist with the Colorado Division of Wildlife. He is stationed at Durango.*



A special attraction: the Delores River




**May 2, 1986 marks the ope… boating and fishing recreation. … four fishermen parking areas a… areas. Boat ramps and sanitary … reation Area and the House Cr… open May 2. The adjacent Fore… McPhee Recreation Area will o… ground at the House Creek R… construction and only the boat … open in 1986. One should also e… construction along the House Cr… Lone Dome road between Bradfi… Recreational use is administere…**

*nevadensis.* The Heritage Program referred them to Ann Pinzl, Curator of the Herbarium at the Nevada State Museum in Carson City.

By 1:30 pm that same afternoon, Ann verified the plant identification, and the specimen was deposited in the museum (a

action and sensitivity to the preservation of a threatened Nevada plant species. This story is a good example of how data gathered by the Nevada Heritage Program on a given species can contribute to its protection.

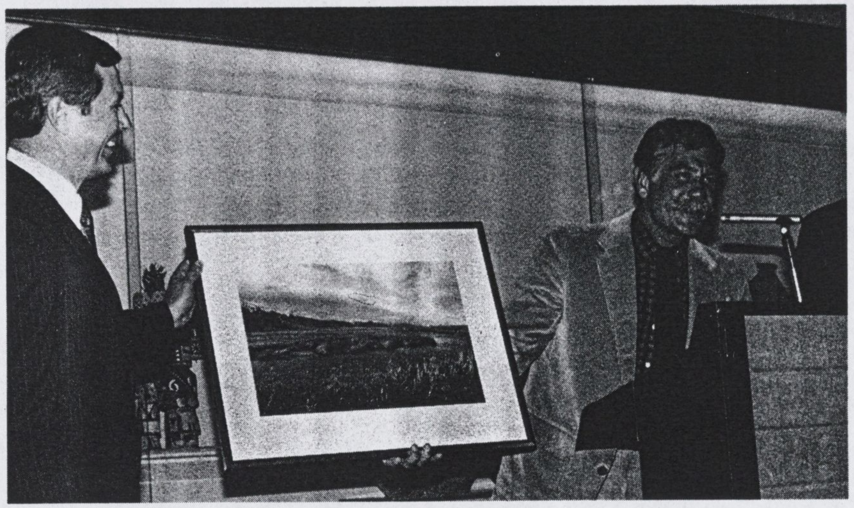
Newmont hailed by Nature Conservancy.

## Exciting News for the Ruby Valley

Newmont Gold Company chose a special evening in March to announce the largest cash contribution ever made to a Nature Conservancy project in the Great Basin: $125,000 allocated to The Nature Conservancy's Ruby Valley project in Elko County. This especially generous commitment was made at a gala event held at the University of Nevada, Las Vegas, Museum of Natural History celebrating *Tracks in the Sky*, a special photographic exhibit of the works of Tupper Ansel Blake featuring wetlands of the Pacific Flyway. Over 200 Conservancy supporters and friends were on hand to see the exhibit and honor Newmont in Las Vegas (ed. note: *Tracks in the Sky*, a travelling Smithsonian exhibit, co-sponsored by The Nature Conservancy, will be coming to the University of Utah Museum of Natural History in May of 1989. Watch for our announcement.)

In other Ruby Valley news, The Nature Conservancy successfully transferred the management of 3,000 acres of critical wetland habitat on the 7-H Ranch bordering the southern portion of Franklin Lake to the Nevada Department of Wildlife in late April. This action will insure permanent protection of this key natural area and guarantee public access.

The Great Basin Field Office would also like to thank Coeur-Rochester, Inc for its generous $10,000 contribution to the Ruby Valley Conservation Project. Other major contributors to the effort to date have included the Richard King Mellon Foundation, the Searle Family Foundation, the Wedum Foundation, First Interstate Bank of Nevada, Ducks Unlimited, and several others.



***Tupper Ansel Blake (right) honors Newmont Gold with a signed photograph of the Ruby Valley, presented to Vice President Carmen Fimiani.***

Solution to metal pollution?

# Colo. cultivating plants, bacteria as weapons against mine wastes

**By Penelope Purdy**
Denver Post Business Writer

Cattails and common bacteria may someday become powerful weapons in Colorado's effort to clean up hazardous wastes.

Researchers from the Colorado School of Mines are experimenting with plants and tiny organisms usually found in swamps to absorb waste water from an abandoned gold mine just west of Idaho Springs.

The small, man-made bog of rushes, cattails, peat moss and manure is a miniature eco-system that absorbs dangerous mine waste before it pollutes nearby streams. And it can do so at a fraction of the cost of more traditional, mechanical treatment methods.

"When you're driving down I-70, you can see the place if you look real fast," said Tom Wildeman, the School of Mines chemistry professor who heads up the project.

## May clean up mines

If the technology works in Idaho Springs, it might be used to clean up the hundreds of abandoned mines scarring hillsides throughout Colorado and leaching acids and heavy metals into mountain streams.

Most of these troublesome, abandoned pits were dug more than a century ago by gold-hungry miners. The pits' owners can't be traced so taxpayers will eventually have to foot the clean-up bill.

Usually, a complete water treatment plant is required to handle such messes, but even then byproducts must still be buried in secured landfills.

With traditional methods, it will cost $2.3 million in equipment and $550,000 in annual operating expenses to clean up five abandoned mines in the Clear Creek-Central City area.

But if the experimental wetlands method is used, the same cleanup might only be $1.6 million in equipment and at most $115,000 a year in operating expenses.

"We're hoping that if the process works here, it could be used elsewhere as well," said Holly Fliniau, project manager for the U.S. Environmental Protection Agency in Denver.

Special to The Denver Post/John McMillin

**WETLAND PROJECT:** Researchers from the Colorado School of Mines inspect the man-made bog that absorbs dangerous mine waste before it pollutes nearby streams.

The EPA has invested $168,000 in the Idaho Springs project and committed another $300,000 for research in the next two years.

At the Idaho Springs site, a simple pumping system takes waste water from the mine mouth to a concrete structure lined with a leak-proof material. The pit is filled with organic material to create a small swamp.

## Waste water absorbed

Plants and bacteria in the bog absorb waste water and its heavy metals and acids. Strangely, the bacteria don't hold onto the waste, but convert it to other chemicals. The tiny organisms put the minerals — sulfides, copper, iron, lead and zinc — back into the earth in their original form.

"What they're doing is making another ore deposit," Wildeman said. "We're not sure why that happens."

Scientists don't know if the process will work on other types of waste or very large hazardous-waste dumps. They also don't yet know what will happen to the site in the long term.

That's why the government isn't likely to use similar bogs to handle sensitive waste problems, such as the Rocky Mountain Arsenal near Denver.

"It's very difficult to direct a natural process and make it do exactly what you want it to do," Wildeman said.

pollution Bibliography



(1970), however, more than blind, rigorous application of standards and numbers is necessary to achieve success.

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