STATE OF UTAH
NATURAL RESOURCES
Wildlife Resources

Norman H. Bangerter, Governor
Dee C. Hansen, Executive Director
William H. Geer, Division Director

1596 West North Temple • Salt Lake City, UT 84116-3154 • 801-533-9333

October 2, 1986

Dr. Robert J. Behnke
Department of Fishery Biology
Colorado State University
Fort Collins, CO 80525

Dear Dr. Behnke:

Leo Lentsch mentioned to me your interest in our use of Colorado River cutthroat trout in the Flaming Gorge tailwater of the Green River. We have learned very little about their performance thus far, but I will fill you in on where we stand.

We would like to reach the point that Colorado cutthroat are employed in high lakes and other waters of the Colorado drainage, where opportunities for their reestablishment remain. Likewise as regards Bonneville cutthroat on the north slope of the Uintas and elsewhere.

Snake River cutthroat trout have done well in the Flaming Gorge tailwater, but our source (Jackson NFH) has altered this brood stock to a late fall spawning period. The progeny of these domesticated brood attempt to spawn in late fall in the Green River. I understand Idaho has experienced similar problems with Snake River cutthroat domesticated at Jackson, especially downstream of Palisades Reservoir, where they have attempted reintroductions. Recruitment of Snake River cutthroat in the Green River has been disappointing and we feel the reasons for their failure to reproduce well are: 1) fluctuating discharges (however brown trout are self sustaining) and 2) the altered spawning date. Perhaps, like rainbow trout, Snake River cutthroat egg survival suffers at water temperatures approaching 4 C. Consequently, we began looking for a cutthroat egg source that was from spring spawning stock.

Wyoming has offered to help us develop a Snake River cutthroat egg source from their Lake-of the-Woods stock. This would require time to implement however, and I would rather see the Jackson NFH replace their broodfish with Lake-of the-Woods stock. Should this happen it would solve problems for Idaho, Utah, and perhaps elsewhere. Alternatively, we experimented with Strawberry cutthroat in 1983 and 1984. These failed to perform as well as the Snake Rivers. Consequently, we concluded that we should thoroughly explore use of cutthroat trout native to the drainage before further tests of other strains were conducted.

APPENDIX A

FLAMING GORGE TAILWATER SPORTFISHERY STUDIES

SCOPE OF WORK

Background

Cooperative Bureau of Reclamation (Reclamation) and Division of Wildlife (DWR) studies from 1978-1982 documented that trout growth rates in the Flaming Gorge tailwater are among the highest found in North America. These outstanding growth rates are the result of penstock inlet modifications, which permit selective withdrawal of warmer surface waters from Flaming Gorge Reservoir. The cooperative studies also revealed that: 1) habitat for juvenile (less than 12 inch) trout was extremely limited in winter; 2) habitat for adult trout was relatively high year-round; 3) due to exceptionally high angler exploitation and poor recruitment, habitat for adult trout was probably underutilized; 4) for the majority of the tailwater, habitat for both rainbow and cutthroat trout adults probably declined as a function of increasing discharge (Q), but at the tailrace habitat increased with Q; 5) habitat quality and winter survival of yearling trout declined with increasing distance from the dam, and 6) hooking injury was a significant source of mortality among released fish.

In response to these findings, DWR implemented a new fishery management plan intended to establish a high quality fishery and to better utilize the production capability and habitats of the Green River. To reduce mortality among released trout, the new management plan prohibited the use of bait. Also, the possession limit was changed from 8 fish of any size to two fish under 13 inches and one over 20 inches. The number of fingerlings stocked annually was reduced by half and their size was increased from the previous 4 1/2 - 5 inches to 6 inches. By stocking 6 inch fingerlings in May, most stocked fingerlings recruit to the adult life stage prior to their first winter. Stocking of catchables was eliminated. The protection of 13-20 inch size fish will significantly increase number of trout that recruit to the adult life stage. The combined effect should be a major increase in the adult trout population.

Relation Between Discharge and Sportfishery Management

The Browns Park and Pipe Creek habitat simulation sites predicted a decrease in habitat with increasing Q. During 1983-84, Q was exceptionally high and sportfishing catch curves strongly suggested that mortality from June 1983 - June 1984 was especially high, even among adult trout. During high flow tests in February of 1982, facing velocities for both adult and juvenile trout increased with Q, suggesting that at some level of Q energy expenditures needed to maintain position may exceed energy available from ingestion of food and from fat reserves. During the 1982 test flows and shortly thereafter, juvenile trout disappeared from the tailwater but adult trout remained in seemingly undiminished numbers. The level of winter Q sustainable by adult trout is, therefore, undefined. Furthermore, habitat criteria for adult trout were measured under conditions of low adult densities. Since initiation of the 1985 management plan, the adult population has increased more than 5 fold. The interaction, if any, of adult density and habitat criteria for the adult life stage has not been defined.

Research Needs

Initially, it appears that the 1985 management plan for the tailwater is producing the desired results. The standing crop of adult trout has increased dramatically. The proposed rewind and uprate of the Flaming Gorge generators, however, is likely to alter the operational criteria, and thus tailwater conditions. Maximum Q will increase from approximately 4,200 to 4,800 cfs at reservoir elevations above approximately 6,000 feet. This will increase the magnitude of fluctuations in Q and, during years of high reservoir inflow, may also increase mean monthly Q in winter. To adequately assess the affect of the rewind on the tailwater sportfishery it is necessary to evaluate: 1) whether the increase in Q will cause a significant increase in trout facing velocity (and, therefore, an increase in winter stress) and 2) the effect of increasing fluctuations in Q on the tailwater's ecosystem. In addition, the tailwater fishery downstream of Red Creek is largely sustained by natural reproduction. There is virtually nothing known regarding spawning dynamics in the tailwater. Vulnerability of spawning and rearing sites to changes in Q should be addressed.

Similarly, effects of reservoir operations upon endangered native fishes of the Green River are being investigated through other cooperative studies involving the Bureau of Reclamation and Fish and Wildlife Service. Simultaneous study of habitat needs of both the sport and endangered fisheries of the Green River will allow for a more coordinated, broad based, approach to evaluation of the effects of various reservoir operational options upon the Green River ecosystem.

Objectives

1. Assess the response of the tailwater sportfishery to the 1985 fishery management plan -- i.e. determine if the fishery management plan is compatible with current operational criteria and habitat conditions.

2. Assess the change in operation of the Flaming Gorge hydroelectric units resulting from proposed operational criteria for endangered fish and the proposed rewind and uprating with respect to the tailwater sportfishery:

    A. Determine the relationship between Q and facing velocity for adult trout for discharges ranging from 800-4800 cfs.

    B. Determine whether facing velocities at higher discharges compromise winter survival in terms of sustainable swimming speeds and energetics.

C. Determine how trout react to change in Q and whether magnitude of change or rate of change can influence survival of larval and adult life stages.

Sub-projects

The study will be composed of six sub-projects, each of which will contribute to one or more of the overall study objectives. Sub-project number one will address whether the 1985 fishery management plan proves to be compatible with current operational conditions by estimating population responses. Sub-project number 2 will look at reponse of the fishery to possible future operational conditions, while addressing information gaps remaining from the previous study phase. Sub-project number 3 will look at instream recruitment, its importance, its vulnerability to discharge fluctuation, and whether it will be enhanced by discharge regimes requested for native fish recruitment. Sub-project number 4 will involve laboratory studies to isolate the effects of temperature and discharge in winter. Attempts to identify specific causes of stress symptoms have been seriously hampered in the past by the multitude of other uncontrollable and unexpected environmental factors encountered in the field (water quality, fish densities, food resources, unexpected changes in discharge regime, generator failures, variable weather conditions, etc). Sub-project 5 will identify energy intake of trout and will compliment sub-project 2 by supplementing the findings regarding energy outputs with information on energy availability from feeding in winter. Sub-project 5 will also address operations of the dam by evaluating food availability and invertebrate drift with respect to discharge and ramp rate. Sub-project 6 serves all other study elements by evaluating and quantifying the physical condition of fish from both the tailwater and laboratory studies and by helping to identify the causes of physiological abnormalities.

<u>Sub-project Number 1</u> - Assess response of the tailwater sportfishery to the 1985 management plan.

During 1985, technology for estimating the populations of trout in specific mile-long sites of the Green River were developed. These methods will be applied during the study period to relate population responses to discharge, stocking rate, size of fingerlings stocked, harvest, and other parameters. The results will be instrumental in evaluating effectiveness of the 1985 management plan under prevailing conditions (Objective Number 1). It may prove possible to extrapolate some of the results to conditions imposed with post-rewind operational scenarios. Electrofishing will also serve the other four jobs by providing periodic samples of trout from the tailwater for food habits and physiological analysis and for collection of fish used in laboratory studies.

Sub-project Number 2 - Fish behavior in reponse to discharge and habitat conditions.

Studies of microhabitat of trout will give a field level assessment of the relationship between mean facing velocity and Q, over the range of discharges expected after the rewind (Objective Number 2A). This work will also evaluate the ability of individual trout to accommodate changes in Q (Objective Number 2C). It is presently unclear whether trout in winter will relocate to areas of lower velocity as Q increases or, if they do, how far they are capable of moving. Trout are in a semidormant state in winter and may prove capable of only relatively small adjustments in their locations. The higher densities of adult trout made possible by the 1985 management plan may complicate fish behavior by introducing higher levels of intraspecific competition and social interactions (territoriality, aggression, effects of social hierarchy, etc.) This work will build on earlier scuba observations by also radio tracking individual fish, night and day, during winter.

Sub-project Number 3 - Spawning success and its relationship to discharge.

Since the penstock modification, instream recruitment has annually increased in its importance to the tailwater sportfishery. For instance, harvest of brown trout (which are not stocked in the tailwater) increased from 29 fish in 1977 to over 4,000 fish in 1983. The contribution of recruitment of cutthroat and rainbow trout to the fishery is not known. The 1985 management plan, by causing a reduction in harvest and stocking, will increase the proportion of instream recruitment in the catch. Larval trout orient to the shallowest shoreline areas and are thus the most susceptible life stage to discharge fluctuations. Studies of spawning success will document where recruitment occurs, when fry emerge from the substrate and, ultimately, when and where fry are most vulnerable to discharge fluctuation (objective 2C). Spawning studies will also permit assessment of whether discharge requests for native fish might also prove beneficial to recruitment of any tailwater sportfish species.

<u>Sub-project Number 4</u> - Laboratory isolation of stress inducing variables.

Field variables that are not considered germane to the problem at hand can be excluded with appropriate laboratory study design. In this case, laboratory tests can isolate the effects of Q and temperature on facing velocity (Objective Number 2A), as determined in Job 2, while avoiding the usual complications (generator failures, effects of power demand, aberrant weather conditions, water quality problems, emigration, etc.) encountered in the field. Trout of various life stages will be exposed to facing velocities and temperatures expected in the field using stamina channels. Specific physiological measures of stress will be monitored during the test that should answer questions regarding the ability of tailwater trout to cope with swimming speeds imposed by the discharge regime of the Flaming Gorge hydroelectric units (Objective Number 2B).

Sub-project Number 5 - Energetics and food availability.

Seasonal food availability will be measured with emphasis on winter. Trout will be autopsied for evaluation of energy reserves (visceral fat and proximate analysis) and food habits on a seasonal basis. The results will help to address objective 2B by determining whether there is a seasonal depletion of energy reserves for any life stage or species of trout and whether any such depletion has a bearing upon the organism's ability to cope with increased Q.

Sub-project Number 6 - Quantification of physiological stress.

In the earlier tailwater studies it was found that emigration, rather than direct mortality, was the major cause of poor winter carry-over. Similarly, in laboratory studies, inability to cope with test conditions will be expressed as changes in behavior that are difficult to quantify. Physiological changes that cause avoidance behavior and failures in test channels are, however, very likely to be quantifiable and measurable through autopsy and histological procedures. Sub-project 6 will interface with field and laboratory studies to quantify indicators of stress, correlate them with environmental conditions and determine if stress indicators observed in the tailwater can be duplicated in the laboratory. Physiological studies may identify the mechanism leading to any failure of trout to cope with their environment in either the laboratory or in the Flaming Gorge tailwater.

Summary of Costs

	1987	1988	1989	Total
Sub-project #1 Population Monitoring	25,300	25,900	31,500	82,700
Sub-project #2 Microhabitat	85,923	72,216	62,465	220,604
Sub-project #3 Spawning	50,385	49,261	14,714	114,360
Sub-project #4 Laboratory Tests	37,171	28,719	26,083	91,973
Sub-project #5 Food Habits	55,528	54,098	45,354	154,980
Sub-project #6 Physiology	32,625	41,895	42,300	116,820
Total Study	286,932	272,089	222,416	781,437
University Share*	48,656	47,344	34,573	130,573
State Share	44,425	45,195	53,300	142,920
Federal Share	193,851	179,550	134,543	507,944

*The Cooperative Fishery and Wildlife Research Unit will wave University overhead charges which are 32% of direct costs. Direct costs are all costs except those for equipment.