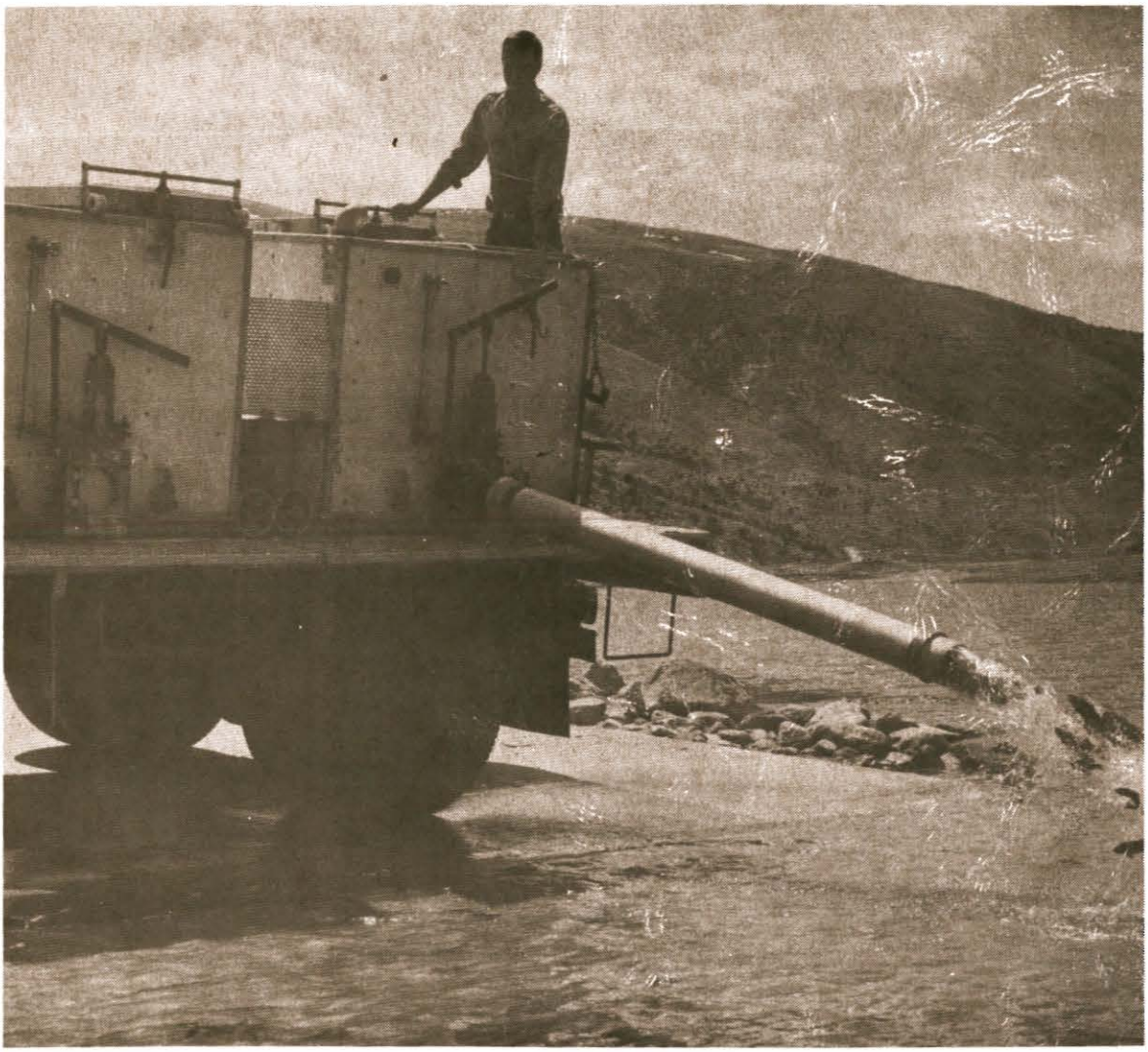
Flaming Gorge Reservoir Fisheries Investigations



1981 (Segment 10) Annual Report

Dingell-Johnson Project F-28-R-10

Publication Number 82-11

UTAH
NATURAL RESOURCES & ENERGY
Wildlife Resources

FLAMING GORGE RESERVOIR FISHERIES INVESTIGATIONS

1981 Annual Report

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ABSTRACT

Fisheries research and management activities carried out at Flaming Gorge Reservoir during 1981 included an abbreviated creel survey, trout marking and stocking, fish population trend netting, study of lake trout and smallmouth bass life histories, evaluation of wild strains of rainbow trout for introduction, and introduction of two species of coldwater forage fish.

Fishing success increased in 1981, the result of an increased catch of rainbow trout. The mean 6-month creel rate rose to 0.27 fish/man-hour from 0.17 fish/man-hour in 1980. Total estimated annual harvest was 171,370 fish. Rainbow trout were the dominant component of the harvest (91%), followed by lake trout (5%) and brown trout (2%). Harvest of kokanee was the highest ever recorded, 2,148 fish, or 1% of the harvest. Total yield was 55,621 kg, or 3.9 kg/ha. Rainbow trout were the major component of the yield (59%), followed by lake trout (36%) and brown trout (2%).

The total stocking in 1981 was 3,318,188 rainbow trout, 751,678 brown trout and 4,000 channel catfish. An experimental group of 571,000 rainbow trout was separated into two groups, each dye-marked with a different fluorescent color. One group was planted by barge and the other from shore to determine if barge stocking results in greater return to the creel than shore planting.

A new gill-netting program was started in 1981 to monitor changes in fish populations. Since this was the first year of the program, no trend comparisons were possible. The new program was intended to reduce net overloading by rough fish while providing good catches of sport fish. Several problems with the new program were found, and further modification may be needed to provide valid measurements of population trends.

Comparisons of stomach contents among the primary sport fish revealed that lake trout fed primarily on chironomids at small sizes and then switched to a fish diet, brown trout fed on a variety of foods including zooplankton and chironomids at small sizes and then switched to a fish diet, while rainbow trout were primarily dependent on zooplankton at most sizes. Attempts to age lake trout proved futile and may not prove possible using conventional techniques. Collection of life history data from smallmouth bass was hampered by manpower shortages during the summer.

Eggs of McConaughy strain rainbow trout were secured from Nebraska for stocking in 1982. Efforts to secure adequate numbers of eggs for Eagle Lake and Kamloops strain rainbow trout will continue. Direct comparisons of return of these strains will be made when sufficient numbers of each strain become available.

The first large scale attempt to establish coldwater forage fishes in the reservoir was conducted in 1981. An estimated 2,959,000 Bonneville cisco fry were stocked, along with 6,903 gravid Bear Lake sculpins. Experimental incubation of Bear Lake sculpin eggs was unsuccessful, but will be attempted again in 1982. Plans to introduce two species of shiner have been deferred.

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INTRODUCTION

Flaming Gorge Reservoir was created by impoundment of the Green River behind Flaming Gorge Dam in November, 1962. The reservoir is located in southwest Wyoming and northeast Utah (Figure 1) and at full pool (elevation 1,841 m) is 134 m deep near the dam, has a surface area of 17,000 ha and is 145 km long.

Since impoundment the reservoir fishery has constantly been under study through the joint efforts of the Utah Division of Wildlife Resources and the Wyoming Game and Fish Department. The reservoir has been divided into three areas for study purposes. The Canyon area extends approximately 48 km upriver from the dam to the Flaming Gorge, the point where the river first enters Red Canyon, and is characterized by steep rock walls, deep waters and limited littoral area. The Open Hills area extends northward from the Flaming Gorge approximately 48 km and is characterized by gently sloping shores in open, rolling terrain, moderate depth and more extensive littoral area. The Inflow area consists of the upper reaches of the reservoir and is more river-like in character. The Inflow occasionally becomes turbid and frequently has high surface temperatures and low dissolved oxygen concentrations during the summer.

This report covers work done during calendar year 1981. Work was slowed this year by the resignation of the project biologist and a

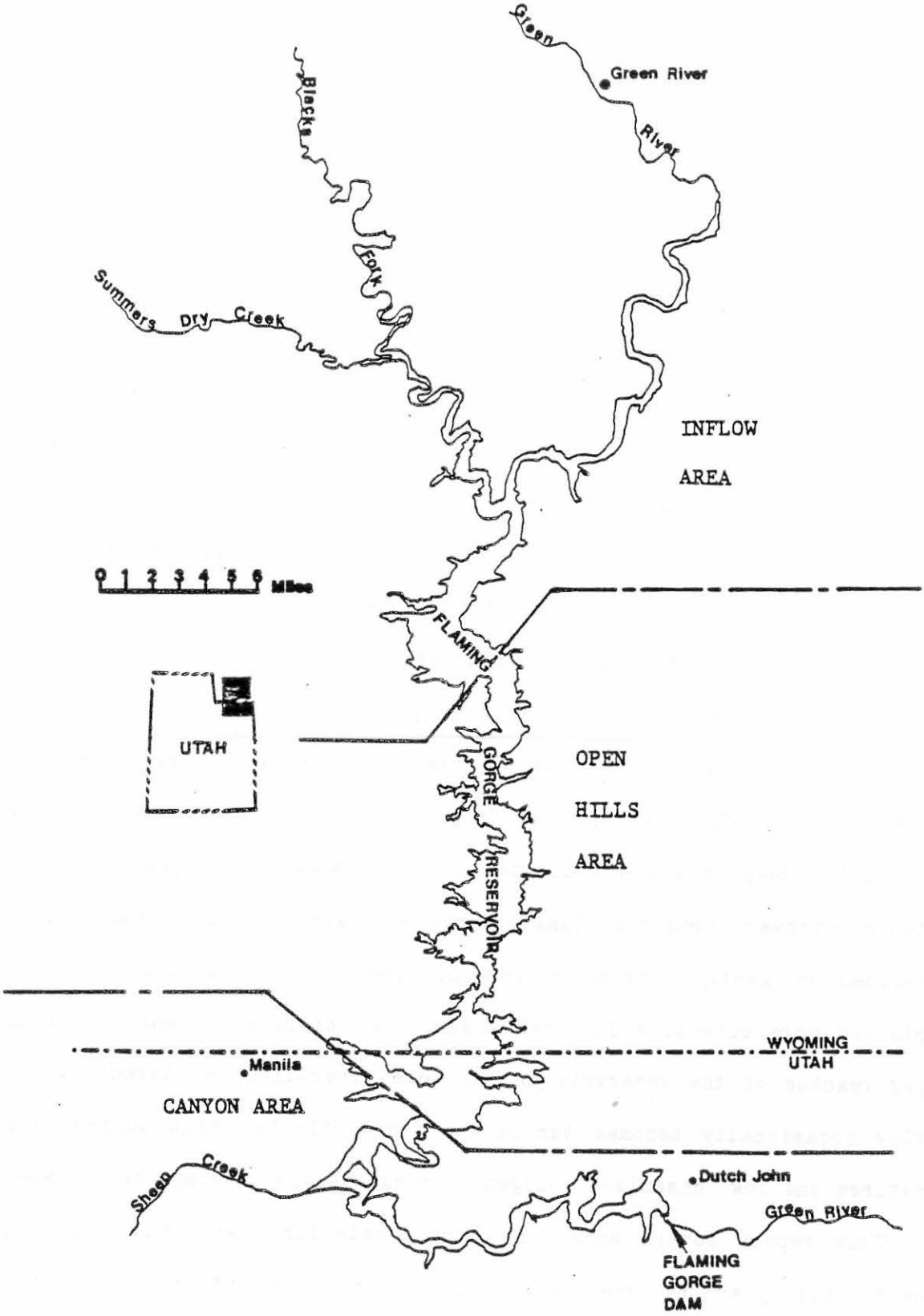

Figure 1. Map of Flaming Gorge Reservoir, Utah-Wyoming.

subsequent delay of nearly six months before a replacement was hired. As a result, several field tasks were not accomplished and preparation of the 1980 annual report was delayed.

MEASUREMENT OF RESERVOIR FISHERY
HARVEST, PRESSURE AND SUCCESS

JOB F-I

Background

Since the fishery first opened in 1964, an annual creel survey has been conducted to analyze trends in fishing pressure, harvest and success rate. The survey has proven instrumental in following the decline of the rainbow trout (*Salmo gairdneri*) fishery, in following the increases in lake trout (*Salvelinus namaycush*), smallmouth bass (*Micropterus dolomieui*) and kokanee (*Oncorhynchus nerka*) populations and in assessing the effects of management and research activities.

Objectives for this job in 1981 were to estimate the angler success rate, determine the species composition of the creel, determine the relative return to the creel of two strains of cutthroat trout (*Salmo clarki*), determine the relative return to the creel of barge planted vs. shore planted rainbow trout fingerlings, gather biological data from creeled fish for use in other jobs, and to prepare for the full-intensity aerial creel survey scheduled for 1982.

Methods

The 1981 creel survey was conducted from April through September as in 1979 and 1980 (Schmidt et al 1980b, Schmidt and Brayton 1982). Angler

interviews were scheduled randomly at all access points each month. Interviews were conducted only on weekends and holidays to gather the greatest amount of data with a minimum of effort. No estimates of fishing pressure were made. For purposes of estimating harvest, the angler counts obtained during the 1978 full-intensity survey were used. Harvest estimates obtained for the 6-month survey in 1981 were expanded to annual estimates based on the ratio of 6-month to annual harvest for each species in 1978. Because the annual expansions were based on three year old data and weekend-holiday interviews, the annual estimates obtained in 1981 should be viewed with caution.

During the angler interview surveys the creel clerk recorded party size, hours fished, number of each species caught, and what species the party was fishing for. Fish were examined for marks and, in Utah, length, weight, scales and stomachs were taken from a subsample of rainbow trout and from all other sportfish.

Plans were made to begin the full aerial survey on 1 January 1982. In addition, electronic loop car counters were installed near the top of each boat ramp to provide an index of total boat use, which will be used to estimate fishing pressure in the years between aerial creel surveys.

Results and Discussion

Fishing success increased substantially in 1981, with a mean 6-month creel rate of 0.27 fish per man-hour, compared with 0.17 fish per man-hour in 1980 (Table 1). As in 1980, the highest creel rates were recorded in the Canyon. Creel rates were nearly equal in the Open Hills

Table 1. Estimated 6-month creel rates from Flaming Gorge Reservoir, April through September, 1980 and 1981.

	Boat Fishing		Shore Fishing		Combined	
	1981	1980	1981	1980	1981	1980
Canyon	0.35	0.25	0.36	0.28	0.35	0.25
Open Hills	0.19	0.08	0.23	0.13	0.20	0.10
Inflow	0.20	0.08	0.26	0.10	0.23	0.09
Mean	0.27	0.17	0.27	0.16	0.27	0.17

and Inflow. The upper areas of the reservoir clearly had much better fishing than in previous years.

The majority of fishing effort was directed toward small trout, primarily rainbow trout (Table 2). Nearly all shore fishing was directed toward small trout (99.6%), while boat fishing pressure was directed toward several species. The percentage of effort directed toward lake trout declined from 1980 but remained above 1979 levels (Table 3). Whether this indicates an actual decrease in fishing pressure for lake trout is uncertain. General observations indicate that fishing pressure for lake trout, at least in the Open Hills, has increased since 1978. Implementation of the planned aerial creel survey in 1982 will determine the change in fishing pressure since 1978 and the amount of fishing effort directed at lake trout.

The total creel rate is seldom an accurate measure of fishing quality in a multi-species fishery (Lambou 1966). Fishing quality is

Table 2. Percentage of fishing pressure (man-hours) directed at particular species at Flaming Gorge Reservoir, 1981.

	Brown Trout	Lake Trout	S.M. Bass	Small Trout	Lake & Others	Brown & Others	Bass & Others	Small Trout and Others	Kokanee
				BOAT FISHING					
Canyon	0.73	14.05	0.07	81.27	17.57	1.12	0.48	84.59	0.00
Open Hills	0.13	34.53	1.35	59.09	38.80	1.37	1.56	62.02	0.41
Inflow	10.86	1.68	0.00	81.86	6.85	16.46	0.00	82.29	0.00
Mean	1.73	21.60	0.63	71.50	25.68	3.15	0.90	74.31	0.18
				SHORE FISHING					
Canyon	0.00	0.49	0.00	99.48	0.00	0.00	0.25	99.51	0.00
Open Hills	0.21	0.00	0.28	99.51	0.00	0.00	0.00	0.00	0.00
Inflow	0.00	0.00	0.00	100.0	0.00	0.00	0.00	0.00	0.00
Mean	0.07	0.20	0.10	99.62	0.00	0.00	0.11	99.63	0.00

Table 3. Percentage of boat fishing pressure directed specifically toward lake trout at Flaming Gorge Reservoir, 1979-1981.

Area	Lake Trout Only			Lake Trout & Other Species		
	1979	1980	1981	1979	1980	1981
Canyon	11	15	14	15	21	18
Open Hills	27	41	35	32	50	39
Inflow	17	27	22	21	34	26

better represented by species specific creel rates determined from anglers fishing only for that species. Species specific creel rates from Flaming Gorge in 1981 are presented in Table 4. Anglers pursuing small trout from shore had creel rates very similar to the overall shore fishing creel rates presented in Table 1, since nearly all shore fishing was directed toward small trout. Success of fishing for small trout from boats was much higher than indicated in Table 1, however, since more boat fishing was directed toward other species which were caught at lower rates. Boat fishing for small trout in the Canyon, in particular, was much better than indicated by the overall rate.

The increased success of fishing for small trout in 1981 may be the result of greater survival of stocked fingerlings planted last year. Reservoir levels have been generally rising over the past two years which could increase survival. Small rainbow trout increased in the gill-net catch during trend netting in 1980, indicating an increase in survival. Fishing for brown trout (*Salmo trutta*), lake trout and smallmouth bass

Table 4. Estimated creel rates (fish per fisherman-hour) for parties fishing for a particular targeted species at Flaming Gorge Reservoir, 1981.

Area	Type of Creel Rate	Species Sought: Boat Fishing: Brown	Boat Fishing: Lake	Boat Fishing: Bass	Boat Fishing: S.T.[a]	Shore Fishing: Brown	Shore Fishing: Lake	Shore Fishing: Bass	Shore Fishing: S.T.[a]
Canyon	Total catch	0.07	0.05	0.00[b]	0.45	--	0.25[b]	--	0.35
	Target species	0.00	0.02	0.00[b]	0.44	--	0.00[b]	--	0.35
	Lake trout	0.00	0.02	0.00[b]	0.00	--	0.00[b]	--	0.00
Open Hills	Total catch	0.67[b]	0.04	0.17	0.27	0.00	--	2.50[b]	0.28
	Target species	0.00[b]	0.04	0.15	0.26	0.00	--	2.00[b]	0.28
	Lake trout	0.00[b]	0.04	0.00	0.01	0.00	--	0.00	0.00
Inflow	Total catch	0.28	0.11	--	0.20	--	--	--	0.18
	Target species	0.08	0.07	--	0.18	--	--	--	0.18
	Lake trout	0.05	0.07	--	0.02	--	--	--	0.00
All Areas Combined	Total catch	0.26	0.05	0.16	0.35	0.00	0.25[b]	2.50[b]	0.28
	Target species	0.06	0.03	0.15	0.34	0.00	0.00[b]	2.00[b]	0.28
	Lake trout	0.04	0.03	0.00	0.01	0.00	0.00[b]	0.00[b]	0.00

[a]Small Trout category
[b]Sample size less than 3

was relatively slow. Brown trout fishermen were able to capture other species, but the catch rate of their target species was quite low. Few other species were caught to increase the overall rate of lake trout fishermen. Creel rates for lake trout were greater up-reservoir, although many of the lake trout caught in the Inflow were juveniles. Relatively few bass fishermen were interviewed this year, and fishing for bass appeared to be slow. Most of the fish caught by bass fishermen were bass, as indicated by the similarity of the total and target creel rates.

Lake trout were captured most effectively by anglers fishing specifically for them, although anglers fishing for brown trout in the Inflow reported lake trout creel rates nearly as high as fishermen fishing for lake trout in that area (Table 4).

The reservoir-wide creel rates for lake trout in 1980 and 1981 were substantially below those of 1979 (Table 5). Whether the reduction of creel rate is the result of heavy harvests and their effect upon the lake trout population is presently unknown. Publicity about the lake trout fishery appears to have resulted in increased fishing pressure being directed toward lake trout, and an influx of inexperienced fishermen could be responsible for decreased creel rates. In spite of apparently increased pressure over the past several years, the creel rate of lake trout increased over last year's rate in the Open Hills.

Even though overfishing of lake trout is not readily evident, the increasing popularity of this fish should be a cause for concern. Future trends in the fishery must be watched carefully, since the lake trout is a long lived, late maturing fish and currently relies completely on

natural reproduction to maintain its population. It is quite possible that if overfishing is occurring, the new length limit (only one fish over 20 inches may be taken) imposed on the reservoir in 1982 may not be restrictive enough.

Estimated 6-month harvest of all species increased to 153,131 fish (Table 6) from 94,951 in 1980. Boat fishing accounted for the largest

Table 5. Creel rate (fish per fisherman-hour) of lake trout for anglers fishing specifically for lake trout at Flaming Gorge Reservoir, 1979 through 1981.

Area	1979	1980	1981
Canyon	0.047	0.024	0.018
Open Hills	0.048	0.025	0.038
Inflow	0.188	0.130	0.073
Mean	0.049	0.028	0.033

Table 6. Estimated 6-month harvest of all species from Flaming Gorge Reservoir, April through September, 1981.

Area	Boat Fishing	Shore Fishing	Combined
Canyon	76,598	11,687	88,285
Open Hills	32,678	17,501	50,180
Inflow	6,548	8,118	14,666
Total	115,824	37,307	153,131

portion of that harvest. More fish were harvested from the Canyon than from both other areas combined.

Expanded annual harvest estimates and percent composition of the harvest for each species are presented in Table 7. Rainbow trout dominated the harvest, (91.4%), followed by lake trout (4.6%), brown trout (1.6%) and kokanee (1.2%).

Because of the reduced survey effort employed in 1981, insufficient length and weight information was collected from creeled fish. As a result, the reliability of the length and weight data presented in Table 8 has been reduced from previous years. The length-weight data were used only to calculate yield from the estimates of harvest. No attempts were made to compare average sizes of fish with those of

Table 7. Six-month and projected annual harvest estimates and percent composition of the harvest, by species, from Flaming Gorge Reservoir, 1981.

Species	Six-month		Annual	
	Harvest	%	Harvest	%
Rainbow trout	140,625	91.83	156,601	91.38
Brown trout	2,113	1.38	2,696	1.57
Lake trout	6,259	4.09	7,831	4.57
Strawberry cutthroat	306	0.20	378	0.22
Snake river cutthroat	153	0.10	190	0.11
Kokanee	2,148	1.40	2,148	1.25
Brook trout	77	0.05	77	0.04
Smallmouth bass	1,449	0.95	1,449	0.85
Total	153,131	100.00	171,370	100.00

Table 8. Mean length (mm) and weight (g) of fish harvested from Flaming Gorge Reservoir, April through September, 1981.

Species	Canyon		Open Hills		Inflow		Combined	
	L.	Wt.	L.	Wt.	L.	Wt.	L.	Wt.
Rainbow trout	276	202	309	273	--	--	286	223
Brown trout	--	--	428	1,012	358	511	374	602
Lake trout	552	2,649	600	3,254	--	--	568	2,869
Cutthroat trout	320	332	317	278	197	152	289	273
Kokanee	337	432	382	588	365	458	366	528
Smallmouth bass	304	396	240	207	--	--	251	239
Brook trout	297	295	--	--	--	--	297	295

previous years. Where no data was available from one reservoir area, the average weight from the adjacent areas was used to calculate yield.

Total estimated yield in 1981 was 55,621 kg (Table 9), or 3.87 kg/ha, based on the mean area of 14,201 ha at 1,834.7 m, the mean water surface elevation for 1981. Rainbow trout contributed the largest portion of the total yield (59%), followed by lake trout (36%). Lake trout contributed the largest portion of the yield in the Open Hills, however. These estimates must be viewed with caution, since they are the result of questionable fishing pressure estimates and small samples of mean weight.

The long term trend of the fishery has been downward, led by declining harvests of rainbow trout (Figure 2). Whether the increased harvest of rainbow trout in 1981 represents a significant change in that trend is uncertain. Reservoir elevation has been increasing since 1979. A temporary upturn of harvest occurred in 1972 following a similar increase in water levels.

Brown trout harvests have been declining steadily since 1977, while lake trout harvests had been increasing steadily until 1980. The 1981 estimate of lake trout harvest may be misleading, since a change appears to have taken place in the distribution of fishing effort for lake trout since 1978. If fishing pressure for lake trout has actually increased in the Open Hills, where the 1981 lake trout creel rate was highest, the actual harvest in 1981 could be higher than indicated.

Not shown in Figure 2 are kokanee and smallmouth bass, which have been increasing in the creel over the past few years, but which are still

Table 9. Estimated yield (kg) by species from Flaming Gorge Reservoir, 1981.

Species	Area			Total	%
	Canyon	Open Hills	Inflow		
Rainbow trout	17,196	11,902	3,249	32,347	58.79
Lake trout	3,174	13,852	2,616	19,642	35.70
Brown trout	50	509	797	1,357	2.47
Kokanee	365	572	151	1,088	1.98
Smallmouth bass	270	159	0	429	0.78
Cutthroat trout	102	23	11	135	0.25
Brook trout	23	0	0	23	0.04
Total	21,180	27.017	6,824	55,021	100.01

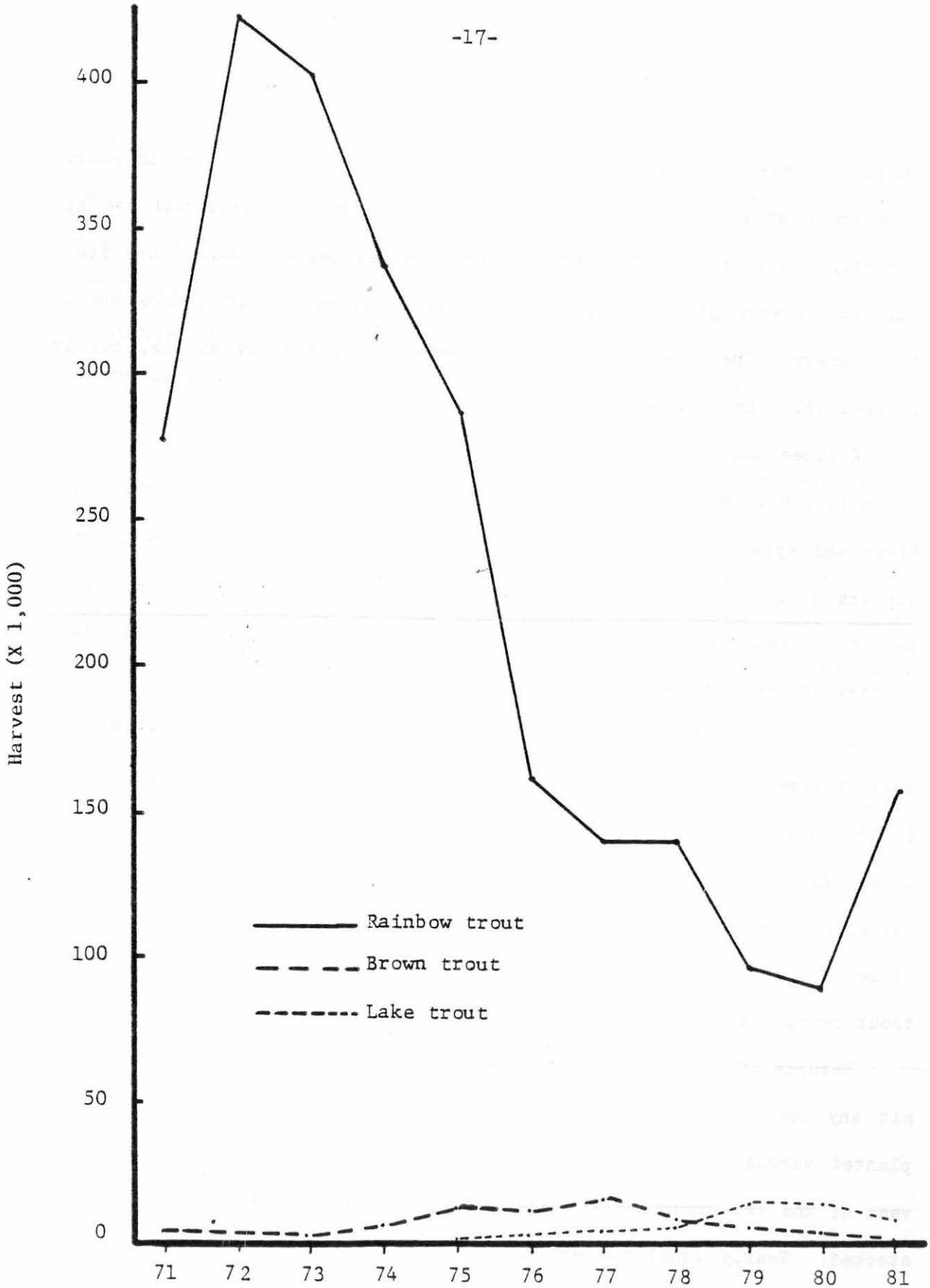

Figure 2. Annual estimated harvest of selected species from Flaming Gorge Reservoir, 1971 through 1981.

caught in relatively small numbers. Small bass are easily seen in shoreline areas around the entire southern half of the reservoir and are apparently abundant, yet the harvest has remained below 2,000. Bass fishing can be very good on occasion, but few anglers appear interested in the fishery. The potential for an increased bass fishery exists, but it is presently unexploited.

Kokanee harvests have increased dramatically, from 27 in 1978 to 2,148 in 1981. With increased spawning runs in Sheep Creek and the Green River and apparent shoreline spawning, the future of the kokanee fishery appears bright. Efforts to expand the kokanee run in the Green River should continue, and an increased effort should be made to study the life history of the kokanee in the reservoir.

The experimental stocking of two strains of cutthroat trout at the present time appears to be a failure for both strains. Estimated harvest in 1981 was 378 Strawberry strain and 190 Snake River strain. The combined harvest of both strains is about the same level as the harvest of cutthroat trout in years when none were stocked. This study will be continued for at least one more year, however, to determine if the cutthroat trout recruit to the fishery at an older age than rainbow trout.

Returns of dyed rainbow trout were too low in the first year to permit any conclusions to be drawn about the survival and return of raft planted versus shore planted rainbow trout fingerlings. Estimated harvest of the two experimental lots was 1,162 shore stocked and 1,010 raft stocked. Nearly equal numbers of each group were stocked. Even though no conclusions can be reached, there so far does not appear to be a

noticeable advantage to barge stocking, so until this study is completed, barge stocking will be discontinued to save time and manpower. Barge stocking will be reinstated only if the study demonstrates a noticeable increase in return of barge stocked trout.

During 1981, plans to implement a full-intensity aerial creel survey in 1982 were finalized. The 1982 survey will be the first full survey made since 1978 and will be instrumental in assessing current trends in the fishery. All flight and angler interview schedules were made out in preparation for the start of the survey on 1 January 1982.

One addition was made to the survey for 1982. Electronic loop car counters were installed at the top of the eight major boat ramps. Changes in boat use from year to year, as reflected by counter readings, will be used as an index to adjust the 1982 fishing pressure estimate for the years between aerial creel surveys. While changes in boat use may not be perfectly correlated with fishing pressure, the method should still provide better interim pressure estimates than using unadjusted 1982 counts for the next three or four years.

FISH STOCKING AND MARKING

JOB F-II

Background

Trout stocking programs at Flaming Gorge Reservoir were initiated in 1963. Maintenance stocking has sustained the fishery, since suitable spawning habitat for rainbow trout is lacking in the reservoir. Since 1963, Utah, Wyoming, and Federal hatcheries have supplied 56.3 million rainbow trout, 2.8 million cutthroat trout, 5.9 million brown trout, 1.2 million kokanee salmon, and 13,500 lake trout. In addition to salmonid stocking, 61,000 smallmouth bass, 773,000 largemouth bass (*Micropterus salmoides*), 4,000 channel catfish (*Ictalurus punctatus*), and 11,000 adult threadfin shad (*Dorosoma petenense*) and 30.6 million shad eggs have been stocked (Schmidt et al 1980b).

Most trout have been stocked using a planting barge. Use of the planting barge is costly, both in capital and manpower. As a result, a study was initiated in 1981 to evaluate differences in harvest of barged and single-point stocked trout.

Since 1964, several lots of fish have been marked to aid in movement, growth, and creel return studies (Table 10). In 1981, two strains of rainbow trout and all brown trout were marked.

Table 10. Marked fish stocked in Flaming Gorge Reservoir, 1964 through 1981.

Year Stocked	Species	Mark
1964	Rainbow trout	Adipose clip
1965	Rainbow trout	Left pelvic clip
1966	Rainbow trout	Double pelvic clip
1967	Brown trout	Adipose clip
1968	Rainbow trout	Blue and yellow dart tag
1969	Rainbow trout	Right pectoral clip
1970	Rainbow trout	Double pelvic clip
1970	Rainbow trout[a]	Adipose clip
1971	Rainbow trout	Adipose - right pelvic clip
1971	Rainbow trout	Adipose - left pelvic clip
1972	Rainbow trout	Red filament tags
1975	Rainbow trout	Yellow, red and green dye
1976	Rainbow trout[b]	Red dye
1976	Brown trout	Red dye
1977	Rainbow trout[b]	Adipose clip
1979	Lake trout	Adipose clip
1980	Rainbow trout[b]	Adipose clip
1980	Brown trout	Adipose clip
1980	Cutthroat trout[c]	Adipose clip
1981	Rainbow trout	Yellow and green dye
1981	Rainbow trout[d]	Adipose clip
1981	Rainbow trout[e]	Left pelvic
1981	Brown trout	Adipose clip
1981	Brown trout	Left pelvic clip

[a]Kamloops strain rainbow trout.
[b]Eagle Lake strain rainbow trout.
[c]Snake River strain cutthroat trout
[d]Eagle Lake strain rainbow trout stocked in Bone Draw and Flume Creek.
[e]McConaughy strain rainbow trout stocked in Bone Draw and Flume Creek.

The objectives of the 1981 stocking and marking program were to maintain the fish harvest by supplementing inadequate natural reproduction and to establish and evaluate species and strains capable of more effectively utilizing the productive capacity of the reservoir.

Methods

Trout stocking was accomplished by single-point planting at boat ramps and by barging. An experimental lot of rainbow trout was segregated into two groups and differentially dye marked to evaluate the return of single-point planted and barged trout. Differences in return rates will be evaluated through creel interviews during 1981 and 1982.

Brown trout were stocked in the Inflow by Wyoming biologists. Brown trout stocked in the spring were marked with a left pelvic fin clip, and those stocked in the fall were marked with an adipose clip.

On 1 September Wyoming personnel installed a fish weir approximately 0.8 km from the mouth of Sheep creek. Kokanee were collected and spawned between 2 and 15 September, and eggs were transported to a hatching facility at Flume Creek below Fontenelle Reservoir. The majority of resulting swim-up fry were released into the Green River to augment the Flaming Gorge population.

Late-running kokanee were captured by Wyoming crews in the Green River on 30 and 31 October 1980. These fish were spawned and artificially reared, and the resultant fry were released into the Green River in January 1981. Late-running kokanee were also captured and spawned on 2 and 3 November 1981 for stocking in 1982.

Results and Discussion

A total of 4,069,866 advanced fingerling trout were released into Flaming Gorge Reservoir during 1981 (Table 11). Rainbow trout comprised 81.5 percent of the total, and 18.5 percent were brown trout. Distribution of trout was roughly commensurate with surface acreage of the three reservoir areas, with 24.4 %, 53.7 %, and 21.9 % of the trout stocked in the Inflow, Open Hills, and Canyon, respectively. Wyoming biologists planted an additional 7,000 McConaughy strain rainbow trout fingerlings and 4,556 Eagle Lake strain rainbow trout fingerlings in Flume Creek and Bone Draw (Table 12). These two Green River tributaries were chosen due to their excellent spawning and nursery habitat. These introductions could potentially develop into a self-sustaining stock of reservoir-run rainbow trout.

Channel catfish advanced fingerling were stocked in the Inflow area for the first time in 1981. This species should adapt well to the higher turbidity and temperature and lower dissolved oxygen characteristic of the Inflow during the summer and fall.

An experimental lot of rainbow trout from Jones Hole was divided into two groups and marked prior to stocking to evaluate creel rates of single-point planted and barged fish. Fluorescent yellow dye was used to mark 278,909 (49%) barged trout, and an additional 292,356 (51%) trout were marked with fluorescent green dye and released from access ramps. These dye-marked fish were stocked in the lower Open Hills and upper Canyon.

The 1981 kokanee spawning operation at Sheep Creek produced 195,000 eggs from 185 females. Ninety-three percent (180,581) of the eggs eyed,

Table 11. Summary of fish stocking by species and agency for Flaming Gorge Reservoir, 1981.

Agency	Species	Area	Number	kg	No/kg	No/ha[a]
F & WS[b]	RBT[c]	Inflow	239,400	5,715	41.89	68
F & WS	RBT	Open Hills	1,501,731	32,538	46.16	230
Wyoming	RBT	Open Hills	585,610	7,548	77.58	90
Utah	RBT	Open Hills	101,340	3,391	29.89	15
Subtotal			2,188,681	43,477	53.81	335
F & WS	RBT	Canyon	241,450	4,978	48.50	24
Utah	RBT	Canyon	648,657	18,036	35.96	64
Subtotal			890,107	23,014	39.36	88
Total	RBT	All Areas	3,318,188	72,206	49.07	234
Wyoming	BT[d]	Inflow	751,678	17,569	42.79	213
Grand Total	All Trout	All Areas	4,069,866	89,775	47.91	287
Wyoming[e]	CC[f]	Inflow	4,000	242	16.53	1
Grand Total	All Fish	All Areas	4,073,866	90,017	47.88	288

[a]Based on size of management area in which stocked.
[b]U.S. Fish and Wildlife Service, Jones Hole National Fish Hatchery.
[c]Rainbow trout advanced fingerling.
[d]Brown trout advanced fingerling.
[e]Fish furnished through cooperative agreement with Nebraska.
[f]Channel catfish advanced fingerling.

and 87.5 percent (170,887) reached the swim-up fry stage. A total of 155,375 fry were released into Flume Creek from 30 November through 7 December 1981. This compares with 47,969 kokanee fry released in 1980. The Sheep Creek kokanee spawning operation is scheduled to continue through 1983.

A total of 33,440 eggs were spawned from the 30 late-running kokanee females in October 1980. This resulted in a release of 123,295 fry on 25 January 1981. Wyoming personnel collected 176,880 kokanee eggs from the Green River on 2 and 3 November 1981. A total of 157,780 survived to eye up (89%) and 150,980 fry (85% of egg take) were released in the Green River in early 1982.

Table 12. Rainbow trout stocking by Wyoming in Flaming Gorge tributaries, 1981.

Tributary	Strain	Mark	Number	No. kg.
Bone Draw	McConaughy	Left Pelvic Clip	2,000	400.92
Bone Draw	Eagle Lake	Adipose Clip	2,040	149.91
Flume Creek	McConaughy	Left Pelvic Clip	5,000	440.92
Flume Creek	Eagle Lake	Adipose Clip	2,516	149.91

FISH POPULATION TREND ASSESSMENT

JOB F-III

Background

A standardized gill-netting program has been conducted on Flaming Gorge Reservoir since 1964. Changes in the annual catch indices generally corroborated the decline of rainbow trout and the increase of Utah chub (Gila atraria) and white sucker (Catostomus commersoni) populations in the reservoir.

A variety of questions concerning the validity of the trend indices have been raised over the years. Sample size has been small: two overnight net sets in each area of the reservoir, conducted in spring, summer and fall. Catches have frequently been highly variable, and it is unlikely that annual changes correlate with actual population changes. Variability has been too great to allow statistical comparisons between years. Furthermore, catches of chubs and suckers are frequently so great that the nets may not fish effectively after only a portion of the netting period has passed. It was also clear that the netting program was inefficient at measuring changes in bass, kokanee and lake trout populations.

As a result of these concerns, Wyoming biologists conducted several netting experiments and concluded that four-hour sets beginning one hour

before sunrise were effective at catching trout but caught few chubs or suckers. A new netting program using this approach was devised and put into use in 1981.

Objectives for 1981 were to assist the Wyoming biologists in conducting the new trend netting program and to investigate new methods for obtaining annual abundance indices for bass.

Methods

The new trend-netting program was set up to utilize four-hour sets beginning one hour before sunrise. A total of six netting stations were established, two in each of the three areas of the reservoir. Each station was netted with three gill nets for two mornings during each netting period. Netting periods were established in spring and fall when the surface water temperatures approached 10 C. Each state was responsible for three of the six netting sites.

The old netting program utilized 38.1 m experimental sinking gill nets, 1.9 m deep, each with equal sized panels of the following five mesh sizes: 19 mm, 25 mm, 32 mm, 38 mm, and 51 mm bar mesh. The new nets used in 1981 were 61.0 m sinking monofilament gill nets, 1.9 m deep, with eight single mesh panels. Mesh sizes were the same five as in the old nets, plus 64 mm, 76 mm and 89 mm.

The three net locations at each netting station were selected before netting began in spring and were marked with fence posts at the high water line, such that the nets were located within a few hundred meters of each other and could be set and pulled in a short period of time.

The nets were pulled in sequence four hours after they were set. The nets were then taken to shore where the fish were picked, sorted and counted by species. Length and weight were recorded for up to twenty of each species in each net. Stomach contents were recorded for all sport fish.

During the fall netting period, at the three netting stations in Utah, lake trout captured alive were weighed, measured, tagged and released for the lake trout exploitation study (Job F-IV).

Because the trend-netting program used in 1981 was new, several additional procedures were added to further evaluate the program's effectiveness. During the spring netting period in the Canyon, two additional nets were set overnight in the same general vicinity as the three standard sets to check the relative effectiveness of short and long duration sets. Also during the spring period, Wyoming personnel netted an additional station in the Wyoming portion of the lower Open Hills to compare with the lower Open Hills station established by Utah personnel in Utah.

Results and Discussion

Results of the 1981 trend-netting effort are presented in Table 13. Since the data represent the first year of a new program, annual trends can not be assessed until several more years' data are gathered.

The rainbow trout catch rate increased from spring to fall, most likely as a result of stocking after the spring netting period. The brown trout catch rate also increased slightly in fall, but since the fall-stocked brown trout were not vulnerable to the gill nets, the

Table 13. Catch per net-hour from the new trend-netting program, utilizing four-hour sets, beginning one hour before sunrise at Flaming Gorge Reservoir, 1981.

	SPRING					FALL			COMBINED INDEX		
	Canyon		Open Hills								
Species	4-hr[a]	O.N.[b]	Wyo.[c]	W/Ut[d]	Inflow	Canyon	Open Hills	Inflow	Canyon	Open Hills	Inflow
Rainbow trout	0.42	0.71	0.19	0.15	0.41	0.80	0.75	0.25	0.60	0.47	0.33
Brown trout	--	--	0.12	0.10	0.51	0.05	0.19	0.83	0.02	0.16	0.67
Strawberry cutthroat	0.02	0.02	0.06	0.04	--	--	0.02	--	0.01	0.04	--
Snake River cutthroat	--	--	--	--	0.12	--	--	0.02	--	--	0.07
Whitefish	--	--	--	--	0.06	--	0.02	0.02	--	0.01	0.04
Utah chub	0.33	0.59	3.38	1.52	9.88	0.09	0.02	3.11	0.22	1.70	6.50
Carp	--	--	0.12	0.10	0.14	--	0.06	0.02	--	0.09	0.08
Flannelmouth sucker	0.02	0.04	0.17	0.15	0.41	--	--	0.46	--	0.08	0.43
White sucker	1.29	2.64	6.80	5.22	7.85	0.70	3.38	5.99	1.01	5.09	6.91
Bluehead sucker	--	--	0.02	0.02	--	--	--	--	--	0.01	--
Smallmouth bass	--	--	--	--	--	0.05	--	--	0.02	--	--
Kokanee	--	--	--	--	--	--	0.41	0.04	--	0.21	0.02
Lake trout	0.13	0.02	0.17	0.15	0.27	0.30	0.56	0.35	0.21	0.36	0.31
Total trout	0.57	0.75	0.54	0.44	1.32	1.14	1.93	1.51	0.84	1.123	1.41

[a]Standard 4-hour set.
[b]Overnight sets intended to compare catch efficiency with the new standard 4-hour sets.
[c]Both Open Hills netting stations netted in Wyoming by Wyoming personnel.
[d]One set in Wyoming and one set in Utah as originally planned.

increase is more likely the result of random changes in the catch or greater activity of brown trout during the fall spawning period. The lake trout catch rate clearly increased in all areas in fall, most likely a result of spawning activity. Chubs were caught much less often in the fall in all areas, but whether the change was a result of lower numbers, lessened activity or a change in preferred habitat in the fall is unknown.

Comparison of the catch per net-hour of 4-hour and overnight sets during the spring period in the Canyon revealed that rainbow trout, Utah chubs and white suckers were captured at much higher rates in the overnight sets. This indicates that sets made in the early morning period are less effective at capturing these species. This was the desired effect when considering the chubs and suckers, but the parallel loss of effectiveness for rainbow trout, the most important species, may diminish the usefulness of the program for providing a sensitive index to trout abundance.

Comparison of catch rates between the two lower netting stations in the Open Hills in the spring indicates that location of sets can play a large role in the catch rate. Catches for all species were lower from the Utah station than the Wyoming station. The difference was minor for all species except Utah chub and white sucker, which had much lower catch rates. One reason for this could simply be the high variability inherent in gill-net catches, but one interesting difference between the two areas was that the Utah station was on a much steeper shore and the nets were thus set out to a deeper depth. Steep areas may be less desirable for the rough species, yet appear to be suitable for trout. If that is the case, thought should be given to moving all netting stations to steep

shorelines to decrease the catch of unwanted species, while providing good catches of the species of most importance to the fishery. This approach might reduce catches of rough fish sufficiently to allow use of a larger sample size. The smaller catch of rough fish would still provide a usable index to their abundance, and catch efficiency would be maintained for trout.

Questions concerning the adequacy of the present netting program exist. Sample size is still low and variability is high. Total netting effort was nominally increased from 216 net-hours for the old program to 288 net-hours for the new program. Efficiency in catching rainbow trout may have been decreased, and the new approach presents many more logistical problems because it requires working and navigating on the reservoir before light. Further consideration should be given to modifying the present procedures to increase sample size. Sampling at one time of the year should be considered. Returning to overnight sets could increase the catch rate of rainbow trout, and setting on steeper slopes could reduce the net loading problems associated with large catches of Utah chubs and white suckers. Further testing of these ideas will be necessary before a final program can be established.

LIFE HISTORY STUDIES

JOB F-IV

Background

This job was established to provide life history information for the reservoir's self-sustaining sport species which appear to have potential to add to the fishery; primarily lake trout and smallmouth bass, and in recent years, kokanee.

Much of the age, growth and food habits information for this job has been obtained during creel survey and trend netting activities. Gill-netting results over the past few years indicated that lake trout spawning occurs on steep, rocky slopes in late October and November.

Objectives for this job were: continue gathering food habits data for all sport species; investigate new methods of capturing smallmouth bass; collect and analyze age and growth data; and perfect an aging technique for lake trout.

This job was hampered by the absense of the project biologist throughout the late spring and summer. Efforts to develop more effective capture techniques for bass were postponed until 1982, and no time was available to process scales collections from 1980 to 1981.

Methods

Utah personnel collected stomachs, lengths, weights and scales from all sport fish during the creel survey. Similar data were also collected during the trend netting by both states.

A new lake trout exploitation study was initiated in response to concerns about possible overfishing. The study will use voluntary angler returns of reward tags to estimate annual exploitation and mortality. The tags used were Floy FD68B plastic anchor tags inserted under the dorsal fin of adult lake trout. Each tag bears the legend "$5 REWARD UTAH FISH&GAME,SLC" and a serial number. The reward is intended to ensure that nearly all harvest of tagged fish is reported, since it is unlikely that enough adult lake trout could be captured and tagged to use the creel survey as the means of estimating tag returns.

Adult lake trout were captured in October, November and December with large-mesh gill nets. Lively fish were weighed, measured, tagged and released. Moribund fish were used to provide food habits data. The reservoir was divided into thirteen areas of approximately equal surface area and netting effort was designed to be approximately equal in each area. This was done to capture and tag lake trout throughout the reservoir roughly in proportion to their abundance, since concentrating tagged fish in a few good fishing areas could bias results. Tagging will continue through the spring of 1982.

Concern has been voiced over the survival rate of lake trout hooked at depths over 80 ft, brought to the warm surface and then released. General observations of netted and hooked fish seems to indicate that

lake trout are usually very active upon release and are able to return to the depths quickly. An actual measure of survival, however, is not available. Survival rates must be high if restrictive harvest regulations are to have the desired effect of limiting mortality.

A short study of hooking mortality was conducted during 14-17 July, 1981. Normal deep trolling techniques were employed in the lower Canyon near the dam to capture lake trout. Captured fish were to be tagged with a light weight styrofoam float with a long line which the fish could pull out to any desired depth. Tagged fish were to be followed all day in an attempt to detect any immediate mortality. The float was attached to the rear portion of the dorsal fin with a large snap swivel so that a sharp pull on the float line would pull the snap out of the fin to release the fish.

A large collection of lake trout scales, otoliths and fin rays was sent to a professional fish aging service in Northern Saskatchewan in 1980. Results of their analysis were received in 1981.

Results and Discussion

Small lake trout fed primarily on chironomids and then gradually switched to a fish diet at larger sizes (Table 14). Zooplankton and amphipods were also eaten, but were less important. Trout eggs were an important food item for small lake trout during the fall. Lake trout seem to be the only sport fish in Flaming Gorge Reservoir which rely primarily on chironomids for food as juveniles rather than on zooplankton. This could be a factor in the success of lake trout in the reservoir while rainbow trout and brown trout survival appears to be poor.

Table 14. Percent occurrence of food items in lake trout stomachs containing food, Flaming Gorge Reservoir, 1977 through 1981.

Food Item	Size Class (mm) 101-200 (n=8)	201-400 (n=61)	401-600 (n=108)	600 (n=80)
Fish, all species	0.0	34.4	69.4	100.0
Trout	0.0	1.6	11.1	18.8
Utah chub	0.0	8.2	20.4	36.2
M. sculpin	0.0	3.3	1.8	0.0
White sucker	0.0	3.3	1.8	0.0
Unidentified	0.0	24.6	43.5	65.0
Debris	0.0	16.4	13.9	3.8
Zooplankton	12.5	23.0	7.4	1.2
Crayfish	0.0	0.0	3.7	0.0
Chironomids	87.5	32.8	21.3	0.0
Spider	0.0	1.6	0.0	0.0
Snails	0.0	0.0	0.9	0.0
Trout eggs	25.0	3.3	0.9	0.0
Worms	0.0	3.3	0.0	0.0
Bait	0.0	3.3	0.9	0.0

Brown trout also switched to a fish diet at larger sizes, but they fed on a wider variety of foods than lake trout at smaller and intermediate sizes (Table 15). Zooplankton, aquatic insects (primarily chironomids) and crayfish were all important food items.

Rainbow trout fed primarily on zooplankton until they exceeded 400 mm (Table 16). Aquatic insects (primarily chironomids) were the only other major food item, with terrestrial insects, amphipods and crayfish occasionally ingested. A surprising amount of algae, vascular plants and other organic debris was found in rainbow trout stomachs. It is doubtful whether these items provide much nutrition.

Almost no rainbow trout stomachs examined were full. Most stomachs were nearly empty, with only a few individual food items. This was true even for fish which had been feeding on plankton. The high percent occurrence of zooplankton in rainbow trout stomachs indicates that plankton is a preferred food, but the small numbers of plankters found in many stomachs could indicate that they are relatively inefficient at capturing plankton. Competition for plankton with Utah chubs and white suckers could be one explanation for the observed slowing of growth rate and reduced condition factor of rainbow trout older than age I noted in earlier investigations (Schmidt et al 1980b).

The plankton found in rainbow trout stomachs was composed exclusively of small-sized individuals, primarily Bosmina and Cyclops. Some of the largest individuals were only 1.3 mm in length, as measured using an ocular micrometer. Apparently only small-sized plankton is available in the reservoir, and the rainbow trout may not be as effective in capturing it as their competitors, the Utah chubs and white suckers.

Table 15. Percent occurrence of food items in brown trout stomachs containing food, Flaming Gorge Reservoir, 1981.

	Size Class (mm)					
Food Item	101-200 (n=9)	201-300 (n=20)	301-400 (n=9)	401-500 (n=2)	501-600 (n=7)	600 (n=2)
Fish, all species	22.2	35.0	22.2	0.0	42.9	100.0
Trout	0.0	0.0	0.0	0.0	14.3	0.0
Utah chub	0.0	25.0	11.1	0.0	0.0	100.0
Redside shiner	11.1	0.0	0.0	0.0	0.0	0.0
White sucker	11.1	0.0	0.0	0.0	0.0	0.0
Unidentified	0.0	10.0	11.1	0.0	28.6	0.0
Zooplankton	44.4	35.0	55.6	0.0	14.3	0.0
Aquatic insects	44.4	40.0	11.1	50.0	0.0	0.0
Terrestrial insects	0.0	5.0	0.0	0.0	0.0	0.0
Crayfish	0.0	0.0	0.0	50.0	42.9	0.0
Debris	11.1	30.0	44.4	0.0	14.3	0.0

Table 16. Percent occurrence of food items in rainbow trout stomachs containing food, Flaming Gorge Reservoir, 1981.

	Size Class (mm)					
Food Item	151-200 (n=19)	201-250 (n=59)	251-300 (n=67)	301-350 (n=64)	351-400 (n=13)	401-450 (n=2)
Zooplankton	79.0	76.3	80.6	75.0	61.5	0.0
Aquatic insects	26.3	20.3	35.8	34.4	23.1	0.0
Terrestrial insects	5.3	13.6	7.5	12.5	7.7	50.0
Amphipods	0.0	0.0	1.5	1.6	0.0	0.0
Crayfish	0.0	1.7	1.5	1.6	0.0	50.0
Snails	0.0	0.0	0.0	1.6	0.0	0.0
Fish	0.0	0.3	3.0	4.7	15.4	0.0
Bait	5.3	6.8	10.4	3.1	7.7	0.0
Algae	0.0	22.0	4.5	10.9	7.7	0.0
Vascular plants	0.0	11.9	7.5	12.5	0.0	0.0
Debris	10.5	15.2	32.8	43.8	61.5	0.0
Cigarette butts	0.0	0.0	1.5	1.6	0.0	0.0
Stones	5.3	3.4	3.0	4.7	7.7	0.0

Smallmouth bass less than 200 mm in length fed primarily on insects, both aquatic and terrestrial (Table 17). Crayfish and fish became the major food items of larger bass, although a larger sample of stomachs from large bass is needed before an accurate assessment of food habits can be made. An increased effort to collect adult bass stomachs should be made in 1982.

Table 17. Percent occurrence of food items in smallmouth bass trout stomachs containing food, Flaming Gorge Reservoir, 1981.

	Size Class (mm)					
Food Item	51-100 (n=6)	101-150 (n=47)	151-200 (n=17)	201-250 (n=3)	252-300 (n=2)	300 (n=1)
Insects	66.7	70.2	58.8	33.3	0.0	0.0
Amphipods	0.0	10.6	5.9	0.0	0.0	0.0
Crayfish	0.0	2.1	11.8	0.0	100.0	0.0
Zooplankton	0.0	6.4	0.0	0.0	0.0	0.0
Fish, all app.	16.7	21.4	17.7	33.3	0.0	0.0
Utah chub	0.0	8.5	0.0	33.3	0.0	0.0
Smallmouth	16.7	6.4	0.0	0.0	0.0	0.0
Unidentified	0.0	12.8	17.7	0.0	0.0	0.0
Debris	16.7	12.8	17.7	33.3	0.0	100.0

Insufficient numbers of stomachs were collected from the other sport fish species to allow an accurate assessment of food habits. The few stomachs examined from kokanee and both strains of cutthroat trout contained plankton and chironomids. A concerted effort should be made in 1982 to collect kokanee stomachs.

No age and growth analyses were completed in 1981 due to the absence of the project biologist. Aging of scales collected in 1980 and 1981 will be scheduled for 1982.

Pectoral fin ray sections, along with some scales and otoliths, from 347 lake trout were sent to a professional fish aging service in Northern Saskatchewan. Of these, nearly half showed no annuli and were impossible to age. The remainder showed some marks which appeared to be annuli, but the service indicated that there was still some question as to the accuracy of their aging.

If the aging is assumed to be accurate, there is wide variation in growth of lake trout in Flaming Gorge Reservoir (Table 18). Age at maturity, based on a mean length of 700 mm as the size at maturity for females, was approximately six years.

Some questions about the accuracy of the aging do exist, however. The mean length at age II of 245.6 mm is approximately in the middle of the size range for age II lake trout reported by Carlander (1969). By age III, however, mean lengths at Flaming Gorge Reservoir were 460 mm and 554 mm, while the largest length of age III lake trout reported by Carlander is only 432 mm. It is unlikely that third year lake trout growth at Flaming Gorge Reservoir is this great and, more likely, the

Table 18. Age and length of lake trout from Flaming Gorge Reservoir, as aged by a professional fish aging service, captured in 1979 and 1980.

	Number		Mean Length (mm)		Range of Lengths (mm)	
Age	1979	1980	1979	1980	1979	1980
I	0	0	-	-	-	-
II	0	2	-	245.6	-	236.0-255.0
III	6	9	553.7	460.5	370.1-701.0	329.9-599.9
IV	6	41	586.2	477.8	430.0-671.1	391.9-657.1
V	5	49	686.0	606.6	505.0-802.9	325.1-872.0
VI	2	33	754.9	694.2	719.1-791.0	420.1-912.9
VII	4	11	705.6	761.7	556.0-845.1	542.0-913.9
VIII	0	3	-	784.6	-	693.9-896.1
IX	0	4	-	874.3	-	721.1-951.0

aging is at fault. Furthermore, according to the range of sizes at each age, some fish first reached or exceeded the size of maturity, 700 mm, as early as age III and as late as age IX. Variability in growth of that magnitude seems improbable.

The probability of aging error in the lake trout data appears high. As a result, lake trout growth can be assumed to be near or above average, but no precise assessment can be made. Further efforts to age lake trout using scales, fin ray sections or otoliths appear fruitless and should be terminated. Growth determinations should be attempted only from the fin-clipped individuals stocked in 1979.

No conclusions regarding immediate hooking mortality of lake trout were reached, since only one lake trout was captured for the study. This fish was caught by a volunteer a half hour before the biologist arrived on the reservoir and had been kept in shallow, warm water and appeared severely stressed. When fitted with the float line and released over deep water, the line went out steadily as if the fish was simply sinking to the bottom. No lateral movement was noted at release or for the first hour. An hour after release, the float was observed moving briskly across the surface for several hundred meters. The float then remained stationary for several hours. The float was then lifted gently to determine if the fish was alive or dead. Unfortunately, the fish was wedged in rocks and could not be felt on the line. Several tugs on the line to free or stimulate the fish succeeded only in pulling the float line out of the fish's fin.

The failure of this experiment in 1981 was unfortunate. An additional attempt will be made in 1982, and at least a dozen fish will have

to be tagged and monitored. This study will be able to measure hooking mortality for only the first few hours following release, however.

Tagging of lake trout for the exploitation study began in conjunction with the fall gill-net population trend study (Job F-III). A total of 71 lake trout were tagged by the end of the year. Further tagging will be done during spring of 1982.

Relatively little life history information for kokanee in Flaming Gorge Reservoir has been collected to date. General observations in 1981 indicated that shoreline spawning of kokanee has been occurring in several areas around the reservoir, with primary concentrations along the Boar's Tusk near the Flaming Gorge and across the reservoir from Squaw Hollow. All shoreline spawning was observed in November.

The kokanee spawning run in Sheep Creek in September was the largest ever seen, with over 2,000 individuals actually counted. These fish were most likely four years old and the progeny of the 1977 spawning run. The 1977 run was the first large kokanee run ever seen in Sheep creek, with an estimated run of 500.

Wyoming personnel collected kokanee eggs in Sheep Creek again in 1981. The large run facilitated the egg take and a full quota of 195,000 eggs was obtained easily. The eggs were taken to the egg rearing facility on Flume Creek below Fontenelle Dam for incubation, and the fry were released directly into the Green River upon hatching.

RAINBOW TROUT STRAIN EVALUATION

JOB F-V

Background

Based upon a review of literature it was concluded that several wild strains of rainbow trout offer potential to contribute substantially to the fishery at Flaming Gorge, under present reservoir conditions (Schmidt et al 1980a). As a result, the decision was made to introduce and evaluate the return to the creel of three wild lacustrine rainbow trout strains: Kamloops, Eagle Lake and McConaughy. Consideration of other species was deferred until a coldwater forage fish becomes established in the reservoir.

Objectives for this job in 1981 were to locate sources of eggs or brood stock of the selected strains and to arrange to acquire eggs as soon as they become available.

Methods

Sources and availability of the selected strains of rainbow trout were assessed through direct communications with fisheries personnel in other states and agencies.

Results and Discussion

During 1981, eggs of the McConaughy strain were secured from the Nebraska Game and Parks Commission and Ennis National Fish Hatchery. Plans call for Wyoming hatcheries to raise and stock approximately 75,000 and Jones Hole National Fish Hatchery to raise and stock approximately 50,000 in 1982. These fish will be fin-clipped so they can be identified in the creel, although no study of returns will be conducted until large numbers of at least two of the strains can be stocked and evaluated together. Efforts were initiated to secure a sufficient number of eggs of the McConaughy strain to provide for the majority of rainbow stocking scheduled for 1983. The egg supply at Ennis National Fish Hatchery appears sufficient to provide for all McConaughy egg needs in 1983.

Wyoming is expanding its brood stock of Eagle Lake rainbow trout, but will be able to stock only approximately 20,000 in 1982. Efforts to increase the number of eggs will continue.

No source of pure strain, disease free Kamloops rainbow trout has been found which could be used for immediate stocking. Ennis National Fish Hatchery, however, has begun to develop a brood stock of the Gerrard strain of Kamloops rainbow trout, and eggs from that brood stock might become available in several years.

FORAGE FISH INTRODUCTIONS

JOB F-VI

Background

A literature review completed in 1978 recommended four species of forage fish for introduction to Flaming Gorge Reservoir as a means of improving the food base, as a buffer against predation on stocked trout fingerlings and as a means of reducing Utah chub growth and survival through competition (Schmidt et al 1980a). Selected for immediate introduction were Bonneville cisco (*Prosopium gemmiferum*) and Bear Lake sculpin (*Cottus extensus*). Selected for further review were lake emerald shiner (*Notropis atherinoides*) and spottail shiner (*Notropis hudsonius*).

Approval to stock the cisco and sculpin was obtained from the Colorado River Wildlife Council, but the U.S. Fish and Wildlife Service was unable to clear introduction of these species under the Dingell-Johnson program without a full review under Section 7 of the Endangered Species Act. As a result, subsequent collection, rearing and stocking of these species was removed from D-J Project F-28-R and all such activity was conducted strictly at state expense. Results of those efforts will be included here to provide a record of all activities at Flaming Gorge, even though the cisco and sculpin introductions were not part of the Project.

Objectives for this job were to continue reviewing the lake emerald shiner and spottail shiner as possible forage introductions. Objectives of the Division of Wildlife Resources project to introduce sculpin and cisco were to collect, rear and stock as many cisco as practical, to further investigate collection, rearing and stocking methods for sculpins, and to stock as many sculpins as practical.

Methods

Review of the shiners was carried out by continued literature searches and through personal contact with biologists currently working with these species. Research projects are currently underway in Utah, Wyoming and other western states to evaluate these species as forage in reservoirs, and the outcomes of these studies will be watched closely.

Following the successful experimental effort in 1980, a large-scale collection of cisco eggs was carried out in 1981. An egg rearing battery consisting of 16 4.7-liter walleye hatching jars was set up in Flaming Gorge Dam. Water was taken from a cooling water supply line which came directly from the penstocks, and water temperature was 4.4 C throughout incubation.

Gravid cisco were captured at Cisco Beach, Bear Lake, on 20-24 January, 1981. Fish were captured with two sinking gill nets with 19 mm bar mesh. Each net was set and retrieved from shore using a pulley fixed to a float anchored off shore, enabling use of the nets even in rough water. Cisco eggs were stripped and fertilized by the dry method. Sperm was collected using suction catheters, and a sperm dilutent was used to facilitate fertilization after the eggs and sperm were mixed. The

fertilized eggs were water hardened at Cisco Beach and then transferred to the Bear Lake Lab in coolers. Eggs were held overnight with spring water circulating through the coolers. The eggs were then transported to Flaming Gorge Dam where they were tempered and added to the hatching jars. The eggs were treated for fungus approximately every other day after the first week.

Gravid Bear Lake sculpins were collected at Bear Lake on 22-24 April and 3 and 4 May. A 110 V alternator with variable voltage pulsator mounted in a small flat-bottomed boat with two hand-held anodes was used to capture the sculpins. Shocking was done in shallow water, up to 1 m deep, over rocky bottoms. Small nets, 165 mm diameter, proved most effective at capturing stunned sculpins from between the rocks. Fish were held overnight in small cages inside a large tank mounted in the back of a pickup truck and then hauled to Flaming Gorge Reservoir.

Sculpin egg masses were collected using SCUBA gear on 26 and 27 May. Divers worked in shallow water up to 3 m deep. The egg masses were scraped from the bottom of rocks, held overnight in circulating spring water and then transported to Flaming Gorge Dam. Half of the eggs were placed in the bottom of two hatching jars while the other half were layered on a vertical series of screens in two jars. On 26 June all eggs were transferred to a trough where water was allowed to flow over them.

Results and Discussion

Discussions with Wyoming fisheries personnel indicated that they prefer to delay the decision whether to stock the two species of shiners until completion of their research projects with those species. As a

result, further action other than continued review of literature will be deferred.

A total of 75 liters of cisco eggs were collected at Bear Lake this year, nearly filling the 75.7 liter capacity at Flaming Gorge Dam. Mean egg size was 0.2458 mm, estimated number of eggs per liter was 78,852, and the estimated total number of eggs was 5,913,159.

Incubation proceeded smoothly, and on 20 April 1981 the bulk of the eggs had hatched and were stocked out along the Boar's Tusk at the southern end of the Open Hills area. Egg volume immediately before hatching was 37.4 liters, or 50 percent of the original volume. Two jars of eggs died when water supply to those jars was interrupted, so actual survival in the remaining 14 jars was 57 percent. The total number of fry stocked was approximately 2,959,000.

Approximately 1,000 fry were held in buckets inside the dam after the others were stocked out. These fry survived without food for several weeks. All were dead by 15 May 1981. No physical deformities of the fry were seen.

A total of 6,903 gravid sculpins was stocked into Flaming Gorge Reservoir in 1981. They were stocked in rocky areas in Spring Creek Bay, near the Boar's Tusk and at Dutch John Draw. An additional 3,000 sculpins were captured, but these were lost when insufficient water circulation was provided in the holding tank.

The capture technique used this year proved effective, and capture of several thousand fish per day appears feasible on days with little wind. A five man crew was most effective, allowing one person to tend

the boat and control a safety switch for four netters. If collections were to be made over more than one or two days, an additional person would be needed to ferry the sculpins to Flaming Gorge.

A total of 2,034 g of sculpin egg masses was collected. At the time of collection, 26-27 May, eggs were found in all stages of development, from recently spawned to eyed and ready to hatch. Many fry were observed in the holding containers immediately after collection.

In spite of the maturity of some of the egg masses, little hatching occurred in the hatching jars at Flaming Gorge Dam. By 26 June no fry had been collected from the jars, even though a few fry could be seen in the bottoms of the jars. On the chance that fry could not swim up and out of the jars, all eggs were transferred to a shallow trough. The movement of the eggs to the trough apparently triggered hatching, since within an hour of the move large numbers of fry emerged and flowed out of the trough and into a collecting bucket. All of these fry, estimated visually at from 500 to 1,000, were stocked at the Dutch John Draw boat ramp. No subsequent hatching occurred. The hatching experiment was terminated two weeks later.

Hatching was observed only after the egg masses were handled, both at Cisco Beach and at the dam, suggesting that a physical stimulus may be required to trigger hatching. Future rearing efforts should be carried out in the trough and periodic agitation should be used to stimulate hatching.

Water temperature fluctuations were a problem while incubating the sculpin eggs. Throughout incubation the selective withdrawal gates over

the penstock openings were in the raised position, drawing water from near the surface. Water was taken from only one penstock, and when that generator was operating the water temperature was above 10 C. Whenever that unit was not operating, however, the water in the mixing structure and penstock cooled to 4.4 C. The cooling process was probably gradual, but warming undoubtedly occurred rapidly whenever the generator was started. Temperature fluctuations could have been detrimental to sculpin egg development. Several available options for eliminating the temperature fluctuations will be discussed with the operators at the dam before rearing of sculpin eggs is attempted again.

The cisco and sculpin introductions attempted in 1981 can be considered successful, although further refinements of sculpin rearing techniques are still needed. Further attempts to introduce these species should be carried out at least for the next three years. By that time, the fish stocked in 1981 should be reaching maturity and, hopefully, natural reproduction will be able to sustain the populations.

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