ARC-83-9

Observations on the Rainbow Trout Fishery Associated With the Delay in Attaining the Recreational Pool Level at Mystic Lake, 1983

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November 30, 1983

ABSTRACT

In 1926, the Montana Power Company (MPC) built a dam at Mystic Lake in south central Montana to generate electricity. MPC must fill Mystic Lake to the recreation level of 7,663.5 by July 1 to meet conditions established by the Federal Energy Regulatory Commission (FERC). In 1982, MPC filed an amendment to their FERC license to delay fill to the recreation level from July 1 to July 10, enabling the facility to generate additional power during the month of June. In 1983, MPC's amendment was granted and a study of the impact in the delay in attaining the recreational pool level on rainbow trout spawning activity and large zooplankton development is presented. A comparative study will be conducted in 1984 when MPC must comply with the July 1 refill date.

In 1983, the rainbow trout spawning period was from mid-June to mid-July. Fry emerged in mid-August. Twenty percent of the total number of spawning fish may have been affected by the delay of fill. Zooplankton development into adult forms roughly corresponded to the end of the rainbow spawning period in mid-July.

INTRODUCTION

Prior to 1926, Mystic Lake was a natural body of water covering 342.5 acres. In 1926, MPC built a dam which added approximately 104.15 surface acres of additional water. Under conditions established by FERC, MPC must fill the reservoir to recreation level (7,663.5 feet) by July 1. In 1982, MPC filed an amendment to their FERC license (FPC No. 2301) to delay fill to the recreation level from July 1 to July 10. Under the existing FERC licensed refill date, power generation was lost in some years because reduced generation in June was necessary to refill the reservoir by July 1. Extending the refill date to no later than July 10 approximately 3,900 megawatt hours of additional generation was expected during the refill period in 1983.

This study was initiated in response to Montana Department of Fish, Wildlife and Parks (DFWP) concern that the delay of fill could seriously affect rainbow trout *(Salmo gairdneri)* spawning movement into tributaries and interfere with the life cycle of two large zooplankton species *(Diaptomous shoshoni* and *Holapedium gibberum)* thought to be an important food source to rainbow trout (Marcuson 1982).

Due to the particular hydrological conditions in 1983, DFWP, MPC and FERC agreed to delay filling the reservoir from July 1 to July 10 and monitor the effects, if any, on the rainbow trout fishery. In 1984, MPC must comply with the July 1 refill date and a comparative study between the 2 years will be conducted. The MPC provided funding for this 2-year study.

OBJECTIVES

1. Locate major rainbow trout spawning areas and determine accessibility into those areas at various lake elevations.

2. Determine the duration of the spawning period.

3. Monitor the effects of increasing lake levels on low-pool spawning areas.

4. Document the development sequence of the two large zooplankton species.

STUDY AREA

Mystic Lake is located on West Rosebud Creek in Stillwater County approximately 90 miles southwest of Billings, Montana and is surrounded by the Absaroka-Beartooth

Wilderness on three sides (Fig. 1). A 3-mile hiking trail through non-wilderness U. S. Forest Service (USFS) lands provides access to the lake. Mystic is one of the most heavily used recreation areas in the Absaroka-Beartooth Mountains. A recreational study conducted by PMC in 1983 from July 1 to July 10 estimated 32 people per day visited Mystic Lake. Their main objective was to fish (Montana Power Company 1983).

Mystic Lake is also the largest lake in the A-B Mountains. Full-pool occupied 446.65 acres when the lake elevation was 7,673.5 feet (Fig. 2 and 3). The surface area of the lake can be reduced approximately one-third and by 63.5 feet of depth (pers. comm., Mystic dame operator). Low pool normally occurs in April at 297.85 surface acres (elevation 7,610 feet) and remains at this level until spring runoff begins filling the lake in May. Recreational pool elevation occurs at 7,663.5 feet and is the minimum lake elevation required by MPC's FERC license between July 1 and September 15. Lake elevation during this time period may fluctuate 10 feet between recreational pool and full pool. Full pool generally occurs in late July. For purposes of this study, low pool referes to lake elevation prior to attainment of the recreational pool.

Tributaries draining into Mystic Lake include West Rosebud, Fish, Huckleberry and three other unnamed creeks. The Beartooth Face Stream Inventory (Marcuson 1976) assigned identification numbers (7, 8 and 10) to the three unnamed creeks in the Study Area. The Study Area includes Mystic Lake and its tributaries between low- and full-pool elevations.

METHODS

The study period was from June 15, 1983 to August 31, 1983. To meet the objectives of this study, the same methods will be used in 1983 and 1984 to compare and evaluate any impacts on the rainbow trout fishery resulting from the attainment of the recreational pool. Daily lake elevations, supplied by Mystic dam operators, along with extensive photographs of the lake and tributary inlets, were used to document lake elevations during the spawning period in 1983 and also to determine when the recreational pool was attained.

Rainbow trout spawning

For purposes of this study, spawning sites refer to the individual redd or nest sites. Spawning areas refer to one or more spawning sites.

In most streams, spawning sites are easy to observe and count due to their cleaned appearance. In the Study Area the relatively sediment-free substrate of the tributaries prohibited actual redd counts. To assess the use of a spawning area, fish numbers were counted once a week in tributaries, and their inlets, throughout the spawning period by visual observation. This method was successful in determining access into spawning areas. However, fish numbers observed (once a week) represents the minimum number of spawners using a spawning area. Kick-sampling in the gravel with a net during the incubation period produced "eyed eggs" which were helpful in back-calculating when eggs were deposited and the initiation of the spawning period. The end of the spawning period was determined by noting a decrease in fish numbers observed in spawning areas.

Fish were sampled either by hook and line or gill nets. All fish sampled were weighed and measured, and sex ratio between males and females determined. Scale samples were obtained to determine the age structure of the population.

Spawning area micro-habitat

Staff gauges, marked at 1-foot intervals, were placed in major spawning areas

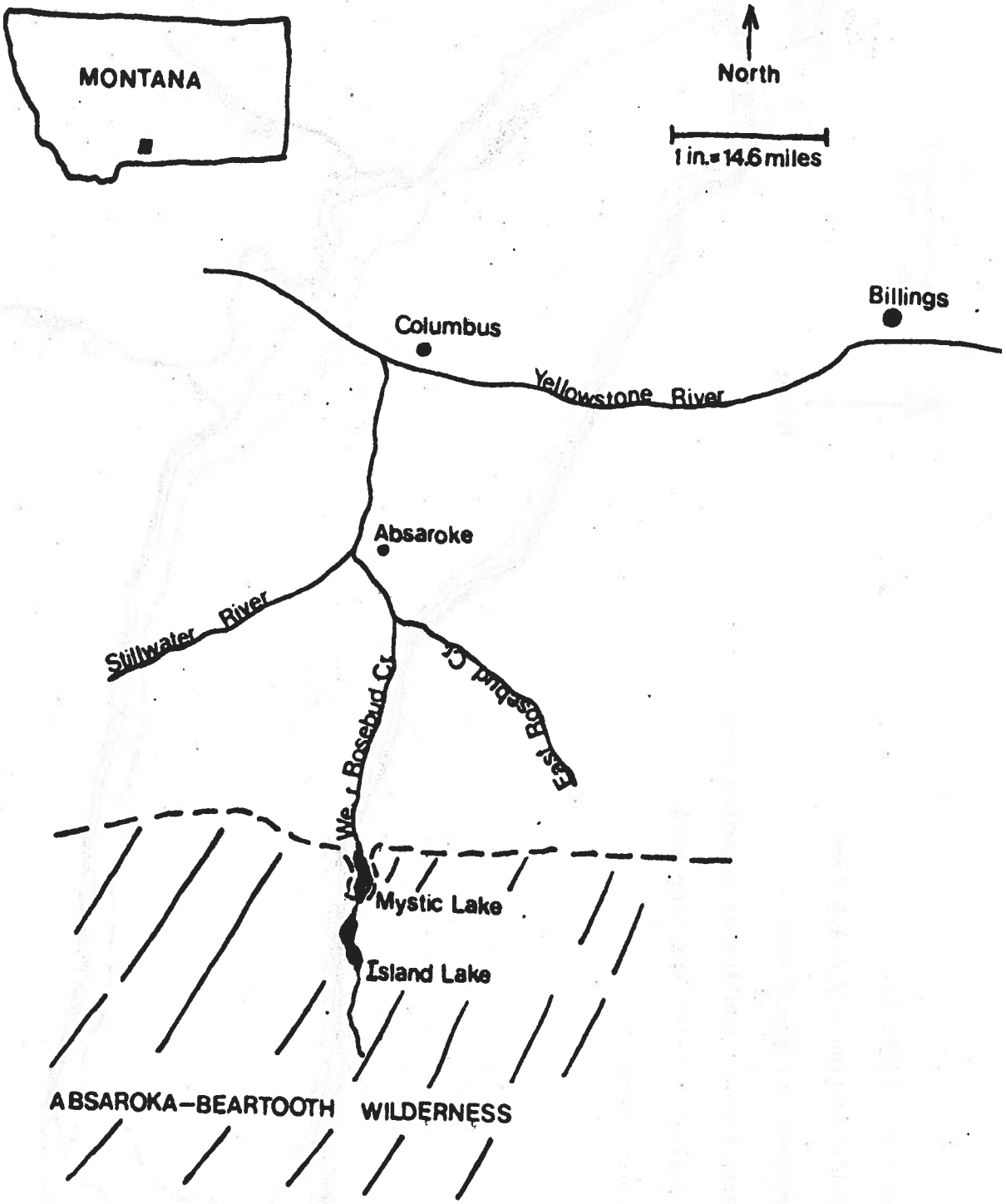

Fig. 1. Map of West Rosebud drainage.

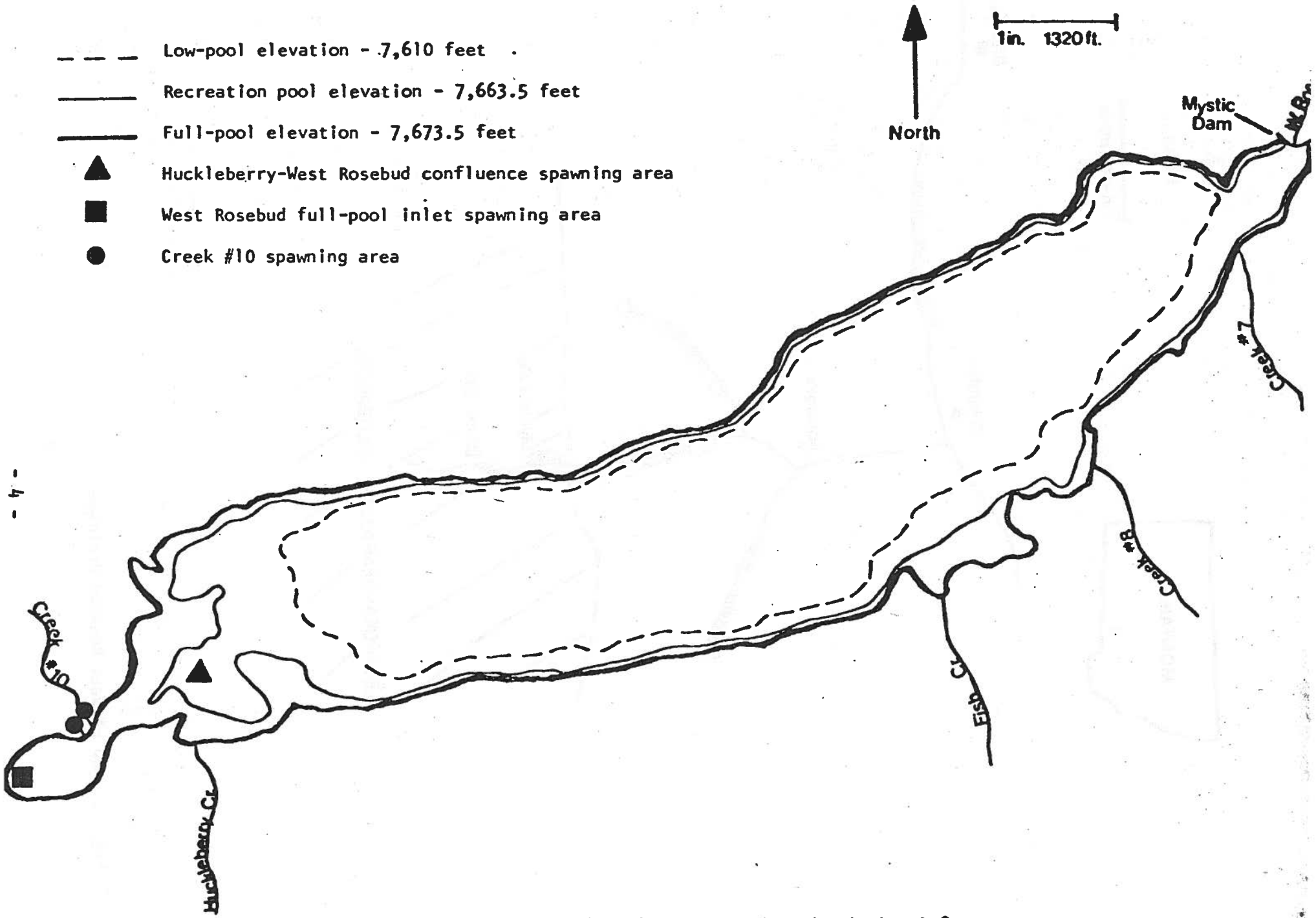

Fig. 2. Location of rainbow trout spawning areas identified in Mystic Lake during 1983.

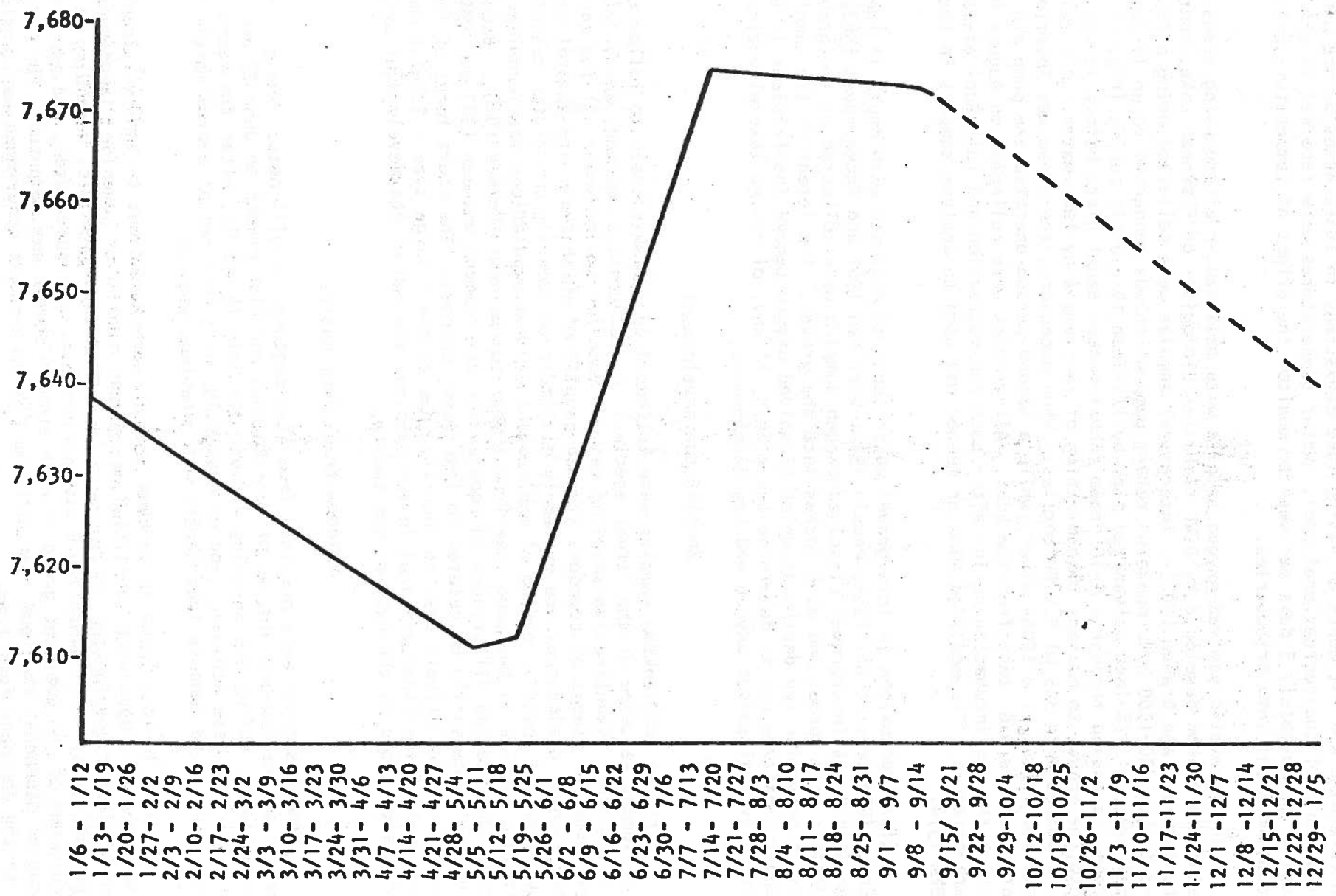

Fig. 3. Maximum weekly lake elevations in Mystic Lake from January 1983 to September 1983. Dashed line represents unavailable data at this time and is an estimate based on decreasing lake elevations observed in the past.

to determine the influence of rising lake elevations in these areas before and after attainment of the recreational pool. Water temperatures were recorded in all tributaries approximately 3 days per week to monitor the effect of temperature on rainbow trout movement into tributaries.

Intergravel dissolved oxygen samples were obtained in all spawning areas, using the method developed by DFWP fisheries biologists on Flathead Lake, Montana (Decker-Hess and Graham 1982). Intergravel samples were collected using a Black and Decker J50-1500 hand-operated rotary pump which was connected to an 18-inch-long probe of 1/8-inch galvanized pipe by 1/4-inch ID plastic tubing (Fig. 4). The probe was passed through a 5-in^2 foam rubber-backed steel plate before it was driven into the gravel to prevent contamination of the sample by lake water. All samples were pumped into 325 ml B.O.D. bottles. When necessary, the probe was inserted into the gravel by a SCUBA diver, while a second person operated the pump and performed the D.O. test from the boat. All samples were collected on August 4 during the egg incubation period after both the recreation and full-pool elevations were attained. The modified Winkler method was used to analyze samples in the field (EPA 1974).

Dissolved oxygen in intergravel water tends to decrease with depth in the substrate (Chambers et al. 1955, Meekin 1967, Sheridan 1962 and Decker-Hess 1982). In the Study Area intergravel dissolved oxygen samples were collected at the gravel surface, at 6 inches and at 8 inches into the gravel. The intent of the sampling was to determine the depths at which dissolved oxygen became insufficient in the egg depositional area and to determine the effect, if any, of rising lake elevations on intergravel dissolved oxygen and egg development.

Zooplankton development

Vertical zooplankton samples were collected on a weekly basis to follow the development sequence of the larger species: *D. shoshoni*, a copepod, and *H. gibberum* a cladoceran. Quantitative sampling was not done for two reasons: 1) the early developmental stages of copepods (termed nauplii of which there are several stages) and juvenile cladocerans are extremely difficult to identify and 2) the relative abundance and specific timing of maximum and minimum populations vary considerably within a species in the same lake from 1 year to the next (Pennak 1978). Because of this, quantitative differences in zooplankton development between 1983 and 1984 could not necessarily be related to lake level changes. The adult forms of the two species were relatively easy to identify, due to their large size - 2.0-2.6 mm. When adult forms first appeared in the samples, the end of the development cycle was calculated based on the date of the sample.

Rainbow trout food habits

Stomach samples were obtained from fish captured in gill nets. One gill net was set at the low-pool inlets of West Rosebud and Fish creeks on June 27 and 28, respectively, during the spawning period. On July 14 and 15, after the recreational and full pool were achieved, and on August 29, nets were set at approximately the same location to compare food habits with previous samples.

Aquatic insects found in rainbow stomachs were keyed out to family. Zooplankton developmental stages were identified as copepod nauplii or juvenile cladocerans. The two larger zooplankton species were identified when possible, depending on their digested state. All identifiable stomach contents were enumerated, and percent occurrence of the dominant group in each stomach sample was computed. For each group of stomachs, the food item with the highest percent occurrence was considered to be the dominant food item.

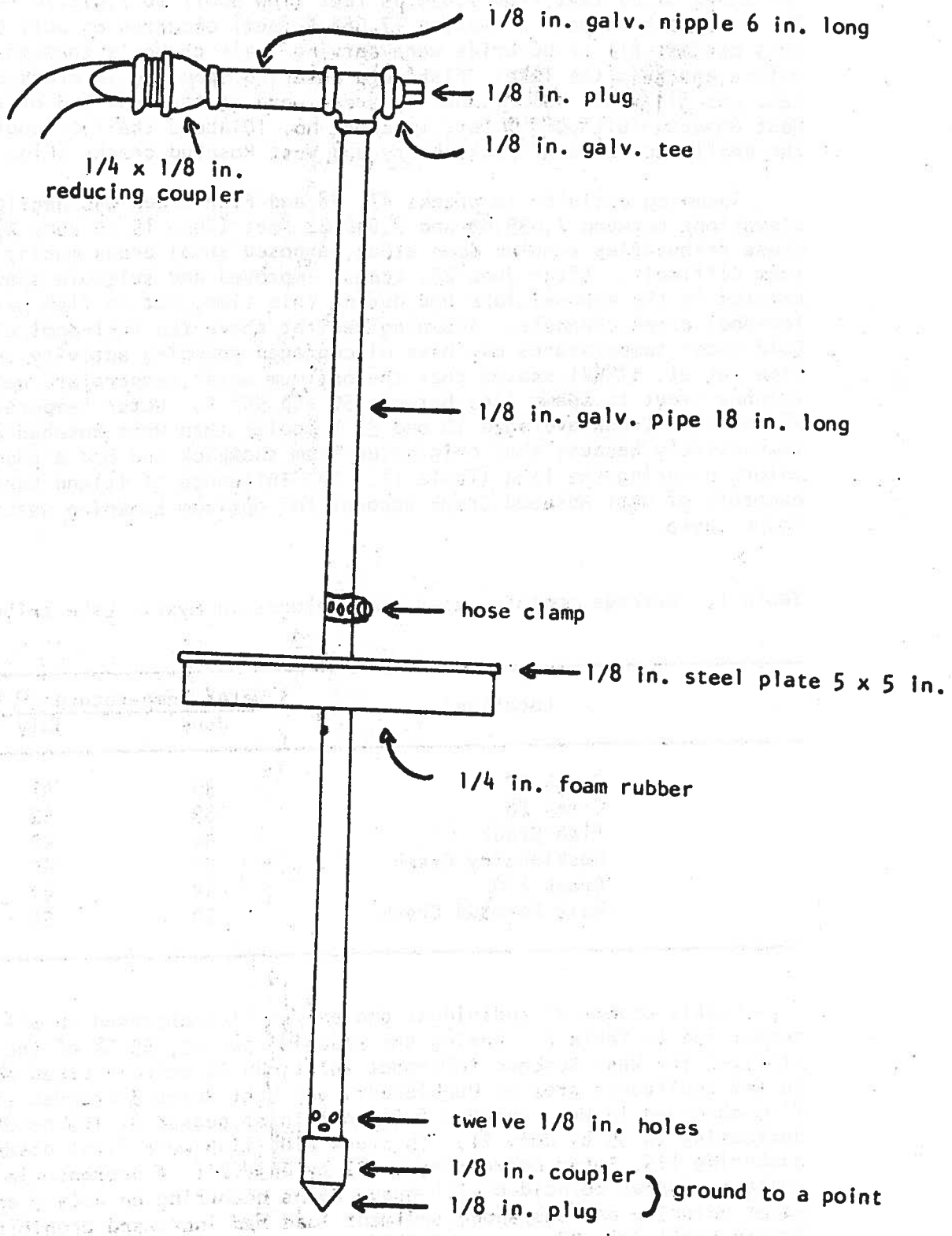

Fig. 4. Dimentions of probe used for collecting intergravel water samples in rainbow trout spawning areas (from Dicker-Hess and Graham 1982).

RESULTS

From June 15, when monitoring began, to July 9, Mystic Lake pool elevation increased 32.87 feet from 7,639.89 feet (low pool) to 7,672.76 feet (full pool). The recreational pool elevation (7,663.5 feet) occurred on July 3 (Fig. 3). During this period, all tributaries were carving their channels through exposed lake bed before entering the lake. Fish were observed spawning in creek channels while the lake was filling. Major spawning areas were at the west end of the lake in the West Rosebud full-pool inlet, in creek No. 10 above the full-pool elevation and in the confluence area of Huckleberry and West Rosebud creeks (Fig. 2).

Spawning activity in creeks #7, #8 and Fish Creek was negligible. At low-pool elevations between 7,639.89 and 7,648.22 feet (June 15 to June 23), the inlets of these tributaries tumbled down steep, exposed shoal areas making fish movement into them difficult. After June 23, access improved and suitable spawning habitat existed in the exposed lake bed during this time, but no fish were observed in these low-pool creek channels. Spawning habitat above the full-pool elevation was scarce. Cold water temperatures may have discouraged spawning activity in these tributaries. Piper et al. (1982) states that the optimum water temperature needed to induce rainbow trout to spawn lies between 50 and 55° F. Water temperatures in creeks #7, #8 and Fish Creek averaged 10 and 5° F cooler than West Rosebud and creek #10, respectively because they originated from snowpack and had a shaded north exposure before entering the lake (Table 1). The influence of Island Lake and the eastern exposure of West Rosebud Creek account for optimum spawning water temperatures found there.

Table 1. Average monthly water temperatures in Mystic Lake tributaries, 1983

Location	Water Temperature (° F)	
	June	July
Creek #7	39	41
Creek #8	39	42
Fish Creek	40	42
Huckleberry Creek	44	49
Creek #10	44	47
West Rosebud Creek	50	52

Weekly counts of individual and paired fish observed in all spawning areas are summarized in Table 2. During the spawning period, 55.5% of the observed spawners utilized the West Rosebud full-pool inlet, 24.0% were in creek #10 and 20.5% were in the confluence area of Huckleberry and West Rosebud creeks. The total number of fish observed in West Rosebud full-pool inlet peaked at 185 on June 15, eventually decreasing to 35 by July 21. In creek #10, fish were first observed on June 24 numbering 115, later decreasing to 27 by July 21. A decrease in fish numbers in these two areas coincided with heavy rains occurring on July 9 and 10. Increased water velocity and suspended sediment load had increased prohibiting visual fish counts until July 27 when visibility improved.

Fish numbers in the Huckleberry-West Rosebud confluence area on June 15 were 47 and increased to 158 on June 23 (Table 2). By June 28, the lake elevation increased to 7,565.12 feet inundating the area with approximately 7.9 feet of lake water. It was assumed that spawning had ended when the rising lake elevations flooded the area.

Table 2. Visual observation of fish during weekly fish counts in three rainbow trout spawning areas at Mystic Lake during 1983

Date	Pairs of Fish	No. of Unpaired Fish	Total No. of Fish
	West Rosebud Creek Full-pool Fish		
6/15	66	53	185
6/24	62	56	180
7/1	71	48	190
7/7	59	42	160
7/14[1]	-	-	-
7/21	7	21	35
Total	265	220	750
	Creek #10		
6/16[2]	-	-	-
6/24	35	45	115
7/1	41	39	105
7/7	11	24	46
7/14[1]	4	19	27
7/21	3	21	27
Total	94	148	320
	Huckleberry-West Rosebud Creek Confluence		
6/16	13	21	47
6/23	61	16	158
6/24	31	13	75
6/28[3]	-	-	-
Total	105	50	280

[1]Turbid water made it difficult to accurately count fish.

[2]Fish were not counted until June 24.

[3]Spawning area inundated with lake water.

Rainbow trout eggs were found by kick-sampling in the gravel at all spawning areas. Eyed eggs (the state between the time the eyes are visible and hatching occurs) were observed in West Rosebud full-pool inlet and in creek #10 on July 8. Eyed eggs were not found in the Huckleberry-West Rosebud confluence area due to the difficult sampling conditions caused by rising lake elevations. Generally, rainbow trout reach the eyed-egg state 10 to 14 days after fertilization when water temperatures are 52° F (Piper et al. 1982). Hatching occurs in 80 days when the water temperature is 40° F, 48 days at 45° F, 31 days at 50° F and 24 days at 55° F (Piper et al. 1982). At Mystic Lake, water temperatures averaged 51° F in the West Rosebud full-pool inlet and 46° F in creek #10. During 1983 the spawning period at Mystic began in mid-June and ended in early to mid-July. The incubation period lasted approximately 31 days with fry emerging in mid to late August.

A total of 170 fish were sampled by gill nets and hook and line during the study period; 95.2% were rainbow trout and 4.8% appeared to be rainbow-cuttroat hybrids. The average size of all fish sampled was 9.9 inches. There were 1.7 females to every male.

Age structure of all fish sampled is summarized in Table 3. Sample size ranged from 6.2 inches (Age II) to 14.2 inches (Age IV+). Gill nets were inefficient at capturing smaller Age I fish. Age II fish ranged from 6.2 to 8.3 inches, averaging 69 inches. Age III fish ranged from 7.9 to 9.4 inches and averaged 8.9 inches. Age IV and IV+ fish sizes ranged from 9.0 to 10.9 inches and 10.6 inches, averaging 10.3 and 12.2 inches, respectively.

Table 3. Rainbow trout age structure in Mystic Lake, 1983

Age Class	Size Range (In.)	Average Length (In.)	Average Weight (Lb.)
I	-	-	-
II	6.2-8.3	6.9	.14
III	7.9-9.4	8.9	.21
IV	9.0-10.9	9.8	.33
IV+	10.6-14.2	12.2	.53

Spawning site macrohabitat

Staff gauges located in West Rosebud and creek #10 inlets show these areas were not affected by rising lake levels until July 7, 4 days after the recreation pool was attained (Table 4). Lake elevation in these areas increased approximately 1.5 feet from mid-June, when spawners were first observed, to mid-July when eggs were still incubating.

The Huckleberry-West Rosebud confluence area was affected by rising lake water on June 28 when the area was flooded with 7.9 feet of lake water. At full pool (July 9) there was 25 feet of water over this spawning area.

Table 4. Water depths (in feet) at spawning areas in Mystic Lake during 1983

Date	West Rosebud Full-Pool Inlet	West Rosebud Above Creek #10 Inlet	Inlet Stream #10	Confluence Huckleberry-West Rosebud Creeks
6/15[1]	1.0	2.5	.5	1.25
6/24	1.0	2.5	.5	1.25
6/28	-	-	-	7.9
7/1	1.0	2.5	.5	12.25
7/7	1.5	2.75	.75	20.03
7/13	2.5	4.0	2.0	24.5
7/21	3.5	5.0	3.0	25.24
8/4	3.0	4.6	2.5	25.0
8/29	1.8	3.0	1.0	23.76

[1]Based on photographs the water depths did not change until 7/7/83, except at the confluence of Huckleberry and West Rosebud creeks.

Results of intergravel dissolved oxygen samples are summarized in Table 5. Rainbow trout eggs require a minimum of 5 mg/l of dissolved oxygen or greater to develop. With sufficient oxygen, eggs develop abnormalities and their hatching may be delayed or premature (Piper et al. 1982).

Table 5. Intergravel dissolved oxygen concentrations (mg/l) from samples obtained at four sites on August 4, 1983

Location	Probe Depth (In.)	Dissolved Oxygen Concentrations (mg/l)
West Rosebud full-pool inlet	0	8.6
	6	6.6
	8	6.0
Creek #10 inlet	0	8.6
	6	3.8
	8	1.2
Creek #10	0	9.0
	6	7.6
	8	7.0
Huckleberry-West Rosebud confluence	0	8.6
	6	8.4
	8	6.6

Intergravel samples satisfied the 5 mg/l minimum required for healthy egg development in West Rosebud full-pool inlet, creek #10 and the confluence of Huckleberry and West Rosebud creeks. Trout eggs would probably not survive in gravel located at the inlet of creek #10. Dissolved oxygen at 6 and 8 inches beneath the gravel was 3.8 and 1.2 mg/l, respectively. Some of the highest intergravel measurements occurred at the Huckleberry-West Rosebud confluence which, at the time of sampling, was under 25 feet of lake water.

Zooplankton development

Nauplii and juvenile stages of copepods and cladocerans were observed from late June to mid-July. By mid-to-late July, adult forms of *D. shoshoni* and *H. gibberum* appeared in vertical plankton tows. This year the development cycle from nauplii and juvenile stages to adult stages was from mid-June to late July.

Rainbow trout food habits

A total of 90 stomach samples were examined and their contents are summarized in Table 6. From mid-June to mid-July, rainbow trout were in tributaries or their inlets spawning and feeding primarily on aquatic insects. Chironomid larvae were found in 38% of the stomachs sampled, while copepod nauplii and juvenile cladocerans were in only 6.9% of the stomachs. Adult zooplankton forms of *D. shoshoni* and *H. gibberum* were first observed in mid-July when fish were moving out of tributaries back into the lake. Six percent of the stomachs sampled in mid-July contained adult zooplankton species. Fish sampled in late August revealed 64.3% of the stomachs contained adult zooplankton species, 28.5% contained chironomid larvae and 7.1 contained adult perlids.

Table 6. Number of stomach samples containing rainbow trout food items at Mystic Lake in 1983

No. of Stomach Samples	June 27 and 28 43	July 14 and 15 33	August 29 14
No. of stomachs containing:			
Simulid larvae	15	9	0
Chironomid larvae	16	13	4
Copepod nauplii and Juvenile cladocerans	2	3	0
Adult zooplankton	0	2	9
Perlid larvae	5	3	0
(Adults)	0	0	1
Limnephilid larvae	5	3	0

DISCUSSION

At Mystic Lake in 1983, attainment of the recreational pool elevation (7,663.5 feet) occurred on July 3, 7 days before the July 10 deadline. The delay of fill did not appear to seriously affect rainbow trout spawning movement into the West Rosebud full-pool inlet where 55.5% of the spawners were observed and in creek #10 where 24% of the spawners were found. The spawning period was from mid-June to mid-July. Fry emerged in mid-to-late August. Intergravel dissolved oxygen

concentrations in these areas at the gravel surface, 6 inches and 8 inches beneath the surface were 8.6, 6.6 and 6.0 mg/l in the West Rosebud full-pool inlet and 9.0, 7.6 and 7.0 mg/l in creek #10, respectively, on August 4. These concentrations satisfied the 5.0 mg/l minimum required forhealthy trout egg development.

The area where the delay of fill appeared to have an impact on rainbow trout spawners was in the Huckleberry-West Rosebud confluence. Twenty percent of the observed spawners used this area in mid-June before it was inundated with lake water on June 28. Viable eggs were discovered in this area before being flooded with rising lake water indicating spawning had occurred there and fish were not merely passing through to upstream spawning areas.

Intergravel samples revealed high concentrations of dissolved oxygen at all three sampling depths when the area was under 25 feet of lake water during the egg incubation period. However, it is unknown whether or not eggs deposited in the gravel successfully hatched. Circulation of water around the eggs is vital for the transportation of oxygen to the surface of the egg and removing waste products from the vicinity of the developing egg (Piper et al. 1982). Lake elevations from previous years show similar rising water conditions occur over this spawning area every year. Ground water seep or subsurface flow could occur, providing good water circulation around the eggs, but it is difficult to measure. The best way to determine the impact of rising lake water on egg development would be to install fry traps over redd sites in this area next year to monitor hatching success and fry emergence.

Weekly zooplankton samples along with rainbow trout stomach analysis revealed the zooplankton life cycle was completed in late July after attainment of the recreational pool. Appearance of adult zooplankton roughly coincided with the end of the rainbow spawning period. During the spawning period, rainbow trout were in tributaries or their inlets feeding primarily on aquatic insects while zooplankton were developing in the lake. By mid-July, when spawning rainbow had moved back into the lake, adult zooplankton appeared in zooplankton samples and in 6% of the stomach samples. In late August, adult zooplankton were observed in 64.3 of the rainbow stomach samples.

RECOMMENDATIONS

During this field season, major rainbow trout spawning areas were located and movement into and out of these areas was documented. The development cycle of zooplankton species and their importance as a rainbow food source was also investigated. The methods used during this field season provides a framework for next year's study, enabling a valid comparison between the 2 years. The following specific recommendations should be followed in 1984.

1. Monitor the rainbow spawning period during 1984 using the methods described in this report. One addition would be to install fry traps in the Huckleberry-West Rosebud confluence spawning area to determine whether or not egg development continues when this area is inundated with lake water. Fry traps could also be placed in other spawning areas to identify the timing of fry emergence in these areas.

2. Intergravel dissolved oxygen samples should be conducted prior to and during the incubation period to monitor changes in the dissolved oxygen, if any, as lake elevations increase.

3. Lake records show delay in attaining the recreation pool elevation during 1983 occurred approximately 1 week later than in previous years. The 1984 study

should begin by June 1 to accurately monitor and compare lake elevations and its effect on rainbow awning activity and zooplankton development.

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