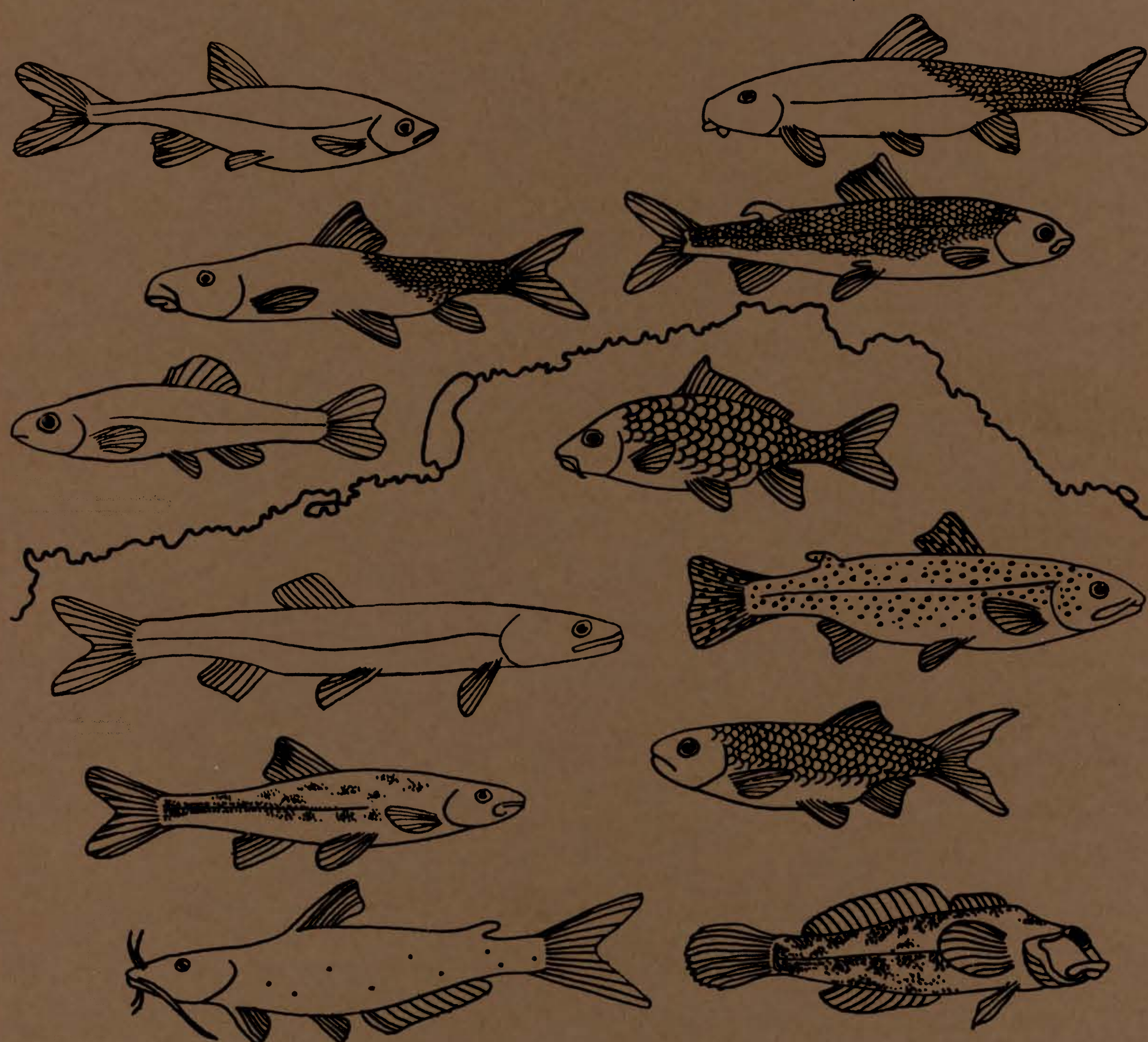
WHITE RIVER
TAYLOR DRAW PROJECT
Pre- and Postimpoundment Fish Community Investigations
FINAL REPORT



COLORADO DIVISION of WILDLIFE

Grand Junction, Colorado

June 1986

White River Taylor Draw Project

Pre- and Postimpoundment Fish Community Investigations

FINAL REPORT

Prepared for:

Water Users Association No. 1

Colorado River Water Conservation District

Rangeley, Colorado

Contract Number

5281-X

Prepared by:

Patrick J. Martinez

Colorado Division of Wildlife

Aquatic Resources Section

Grand Junction, Colorado

James B. Ruch, Director

Department of Natural Resources

David Getches, Executive Director

June 1986

TABLE OF CONTENTS

PERSONNEL CREDITS

The Northwest Region Aquatic Resources Section of the Colorado Division of Wildlife was responsible for conducting this study which was funded by Water Users Association No. 1, Colorado River Water Conservation District. Division of Wildlife personnel involved in this study were:

Walter T. Burkhard	Aquatic Program Specialist
Clee E. Sealing	Senior Wildlife Biologist
Patrick J. Martinez	Wildlife Biologist
Randy VanBuren	Wildlife Biologist
Van K. Graham	Wildlife Biologist
Gregory J. Langer	Wildlife Technician I-A
Philip Harrison	Wildlife Technician I-A
Paul Creedan	District Wildlife Manager
Scott Hoover	District Wildlife Manager
Steve Ferriole	Wildlife Technician I-A
Joe Frothingham	Pilot
Tom Lines	Area Wildlife Manager
Jack Beach	Utility Worker-II

Personnel from other agencies and organizations that provided assistance were:

Water Users Association No. 1

Greg Trainor	Consulting Engineer
Jim Geyler	Project Manager
Bill Murray	Dam Operator
John Gibson	Asst. Dam Operator
Wendy Kenny	Secretary
Anita Martinez	Contract Biologist

USFWS Colo. Cooperative Fish and Wildlife Research Unit

Eric P. Bergersen	Assistant Leader
Thomas E. Chart	Graduate Student
John G. Wullschleger	Graduate Student

USFWS Colorado River Fishery Project

Harold Tyus	Field Supervisor
Rick Jones	Field Team Leader
Marjorie Burfield	Secretary
Lynn R. Kaeding	Field Supervisor
Bob Burdick	Field Team Leader
Chuck McAda	Field Team Leader

CSU Larval Fish Laboratory

Darrel E. Snyder	Curator & Technical Director
Robert T. Muth	Assistant Administrator
Clarence A. Carlson	Administrator

Rio Blanco Oil Schale Corporation

Jack Clark	Environmental Manager
Barbara Fowler	Environmental Biologist

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Ken Kenney
Bob Bell
Joe McPhail
Leonard Plummer
Joel Hogan
Bob Wardell

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

The White River was one of the last uncontrolled major rivers in the Colorado River system. Home of eight native fish species, including endangered Colorado squawfish (*Ptychocheilus lucius*), the fish community of the White River in Colorado, in contrast to other west slope rivers, has been dominated by native fishes. In October 1984, Water User's Association Number 1 (WUA1) completed construction of Taylor Draw Dam, and Kenney Reservoir spilled by late December. A special condition of the U. S. Army Corps of Engineers 404 permit issued for the project required WUA1 to fund a three year study to investigate project impacts on Colorado squawfish. In 1983, the Colorado Division of Wildlife (CDOW) entered into contractual agreement with WUA1 to conduct the required study (Taylor Draw Project-Contract Number 5281-X). In addition to Colorado squawfish population monitoring, this study sought to infer squawfish response to habitat alterations resulting from Taylor Draw Dam construction and operation by investigating changes in selected physical parameters and the entire fish community.

The area of study was 125 km (78 mi.) of the White River between Rio Blanco Reservoir (RK 243.0, RM 151.0) and the CO/UT stateline (RK 115.5, RM 71.8). Typically, the river in the study area is a coolwater/warmwater system that is subject to extremes in discharge and frequently carries a heavy silt load. Peak discharges during this study exceeded those recorded since 1970. High flows approached but barely exceeded 4000 cfs until 1983 when discharge exceeded 6000 cfs.

Taylor Draw Dam, which is scheduled to release run-of-the-river and maintain Kenney Reservoir full the majority of the time, did not appear to influence discharge except during the filling period from October to December, 1984. Due to its low retention time, Kenney Reservoir should have minimal influence on seasonal flow or thermal regimes except during extremely low flow years. While seasonal temperature trends were not greatly affected, below the dam, diurnal thermal constancy was evident during the baseflow period (September-March) and the river remained ice-free in winter. Both conditions appeared to persist downstream approximately 16 km (10 mi.) to just below Rangley. The most obvious physical change in the river below the dam was the reduction of turbidity. Much of the river's sediment is trapped at the growing inlet delta, but depending on discharge, the entire reservoir may become turbid. Water clarity is diminished below Douglas Creek, 11 km (7 mi.) below the dam, which carries a tremendous sediment load during periods of high flow.

A total of 15 fish species representing six families was collected by seining and electrofishing. These included seven native (three endemic) and eight exotic (introduced) species. The native speckled dace (*Rhinichthys osculus*) was the most widely distributed species in seine samples while native bluehead sucker (*Catostomus discobolus*) larvae and YOY were the most common fishes except in 1985 when exotic fathead minnows (*Pimephales promelas*) became the most abundant. The overall dominance by fathead minnows in 1985 seine collections was a direct result of their explosive reproduction in Kenney Reservoir. Endemic roundtail chubs (*Gila robusta*) displayed an apparent decline in seine collections from 1983-85 while endemic flannelmouth suckers (*Catostomus latipinnis*) appeared to become slightly more abundant. Other species collected by seining, native mottled sculpins (*Cottus bairdi*), and exotic common carp (*Cyprinus carpio*), red shiners (*Notropis lutrensis*), channel catfish (*Ictalurus punctatus*), and black bullheads (*Ictalurus melas*), were rare or absent. No larval or YOY Colorado squawfish were collected.

Electrofishing collections were dominated throughout the study by flannelmouth suckers. Colorado squawfish, present in relatively small numbers, comprised only 0.1, 0.2, and 0.3% of the fish collected while electrofishing to evaluate species composition in 1983, 1984, and 1985, respectively. The only major change was the presence of rainbow trout (*Salmo gairdneri*) in 1985. First stocked in Kenney Reservoir in 1984, rainbows moved upstream out of the reservoir and over the dam where they were collected only to Rangely, 16 km (10 mi.) downstream.

A total of 41 Colorado squawfish was captured in the study area by all sampling efforts combined in 1983 (11), 1984 (12), and 1985 (18). An additional 21 specimens were momentarily stunned while electrofishing but could not be captured. Of the 62 Colorado squawfish accounted for by capture or sighting, only 13% (8) occurred above the dam axis while 87% (54) occurred between the dam site and the CO/UT stateline. Forty three (69%) of the 62 occurrences were within the 16 km (10 mi.) below the dam axis (between Taylor Draw Dam and Rangely) suggesting a preferred area for Colorado squawfish.

Of the 41 Colorado squawfish captured 15 were implanted with radio transmitters. Because all the squawfish implanted during this study exceeded 500 mm TL (517-744 mm TL), the movements observed were probably representative of adult Colorado squawfish in the White River. Based on length frequency, the majority of Colorado squawfish captured and sighted during this study were adults. Squawfish in the White River showed upstream and downstream movement, including passage through the dam axis before the dam was closed. Seven specimens entered the Green River of which two apparently participated in spawning. Fish #1642, originally implanted near Rangely in 1983, was monitored and recaptured near spawning areas in the Yampa River in 1984. This fish, recaptured in the White River in 1985 8 km (5.0 mi.) from its original capture site, had migrated over 700 km (450 mi.). Fish #04040, implanted just below Taylor Draw Dam in June, 1985 apparently spawned at the Gray Canyon spawning site in the Green River in July and returned to the White River by September. While passage of Colorado squawfish over Taylor Draw Dam was not documented by radiotelemetry, it is believed that squawfish will move over the dam and eventually disappear from the river above. This disappearance of squawfish above Taylor Draw Dam will represent the loss of 16% or one sixth of the Colorado squawfish range currently documented for Colorado.

The congregation of Colorado squawfish below Taylor Draw Dam in August 1985 probably represented a post-spawning migration of fish returning from spawning or those searching for "home ranges" for overwintering. The increased incidence of Colorado squawfish including hooking and discard of several specimens by anglers resulted in the August 15 - October 31, 1985 fishing closure in 365 m (400 yds.) of the White River immediately below Taylor Draw Dam. Electrofishing conducted within the closure indicated that the fish had dispersed downstream by mid-September.

INTRODUCTION

The White River headwaters in Colorado's Flattops Wilderness and flows westwardly into Utah before entering the Green River (Figure 1). Encompassing a watershed of 9530 square kilometers (3680 square miles), its mean annual discharge exceeds 566 cubic hectometers (459000 acre feet). Home of eight native fish species (Tyus et al. 1982), it was one of the last uncontrolled major rivers in the Colorado River system.

In 1977, Water User's Association Number 1 (WUA1) was formed as the only subdistrict of the Colorado River Water Conservation District by decree of the District Court for Rio Blanco County, Colorado. Following permitting and environmental review processes (USACE 1982b), WUA1 was granted permission to construct Taylor Draw Dam on the White River ten kilometers (six miles) east of Rangely, Colorado. Construction commenced in 1982 and Kenney Reservoir basin began filling in October 1984. The zoned, earth-filled dam is 16 m (53 ft.) high with a 305 m (1000 ft.) crest. The new 275 ha (680 surface acres) Kenney Reservoir is approximately ten kilometers (six miles) long and impounds 17 cubic hectometers (13800 acre feet) of water.

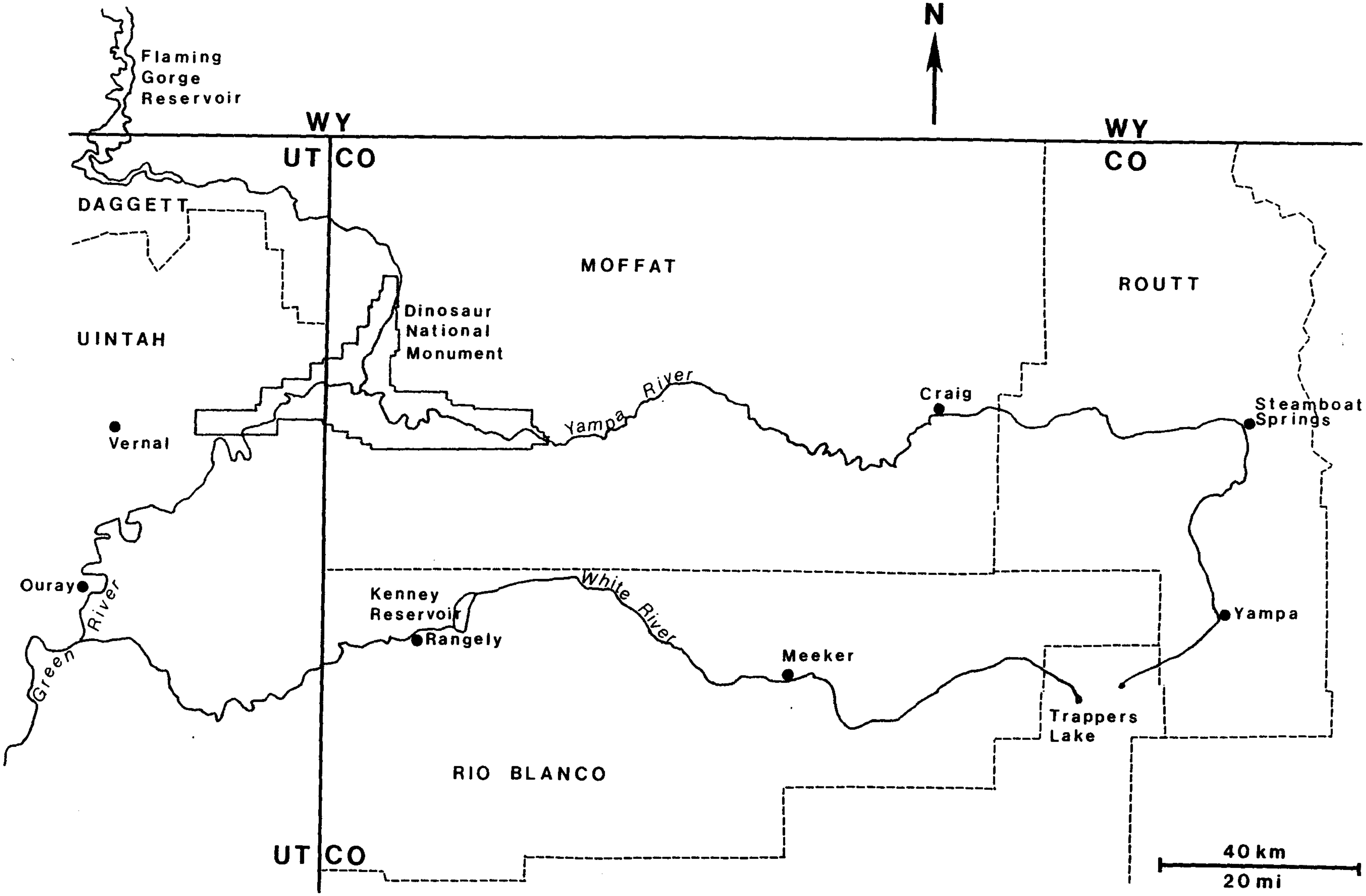


Figure 1. Major rivers flowing through the northwestern corner of Colorado.

A special condition of the U. S. Army Corps of Engineers (USACE) 404 permit, issued for the project, required WUA1 to fund a three year study to investigate project impacts on Colorado squawfish (*Ptychocheilus lucius*), a federal and state listed endangered species native to the White River. In 1983, the Colorado Division of Wildlife (CDOW) entered into contractual agreement with WUA1 to conduct the required study (Taylor Draw Project-Contract Number 5281-X).

The objectives and general outline of study procedures incorporated in the Memorandum of Agreement and appended as part of WUA1 404 permit are listed below:

(a) Monitor squawfish population from dam to stateline to:

  (1) estimate squawfish numbers

  (2) evaluate occurrence of squawfish spawning and young-of-year (YOY) rearing

  (3) study squawfish movements

  (4) identify areas with potential for development into squawfish spawning and/or YOY rearing sites

  (5) determine effects of channel morphology changes resulting from reservoir construction on squawfish

(b) Monitor squawfish populations above the dam to:

   (1) estimate squawfish numbers

   (2) evaluate occurrence of squawfish spawning and YOY rearing

   (3) study squawfish movements

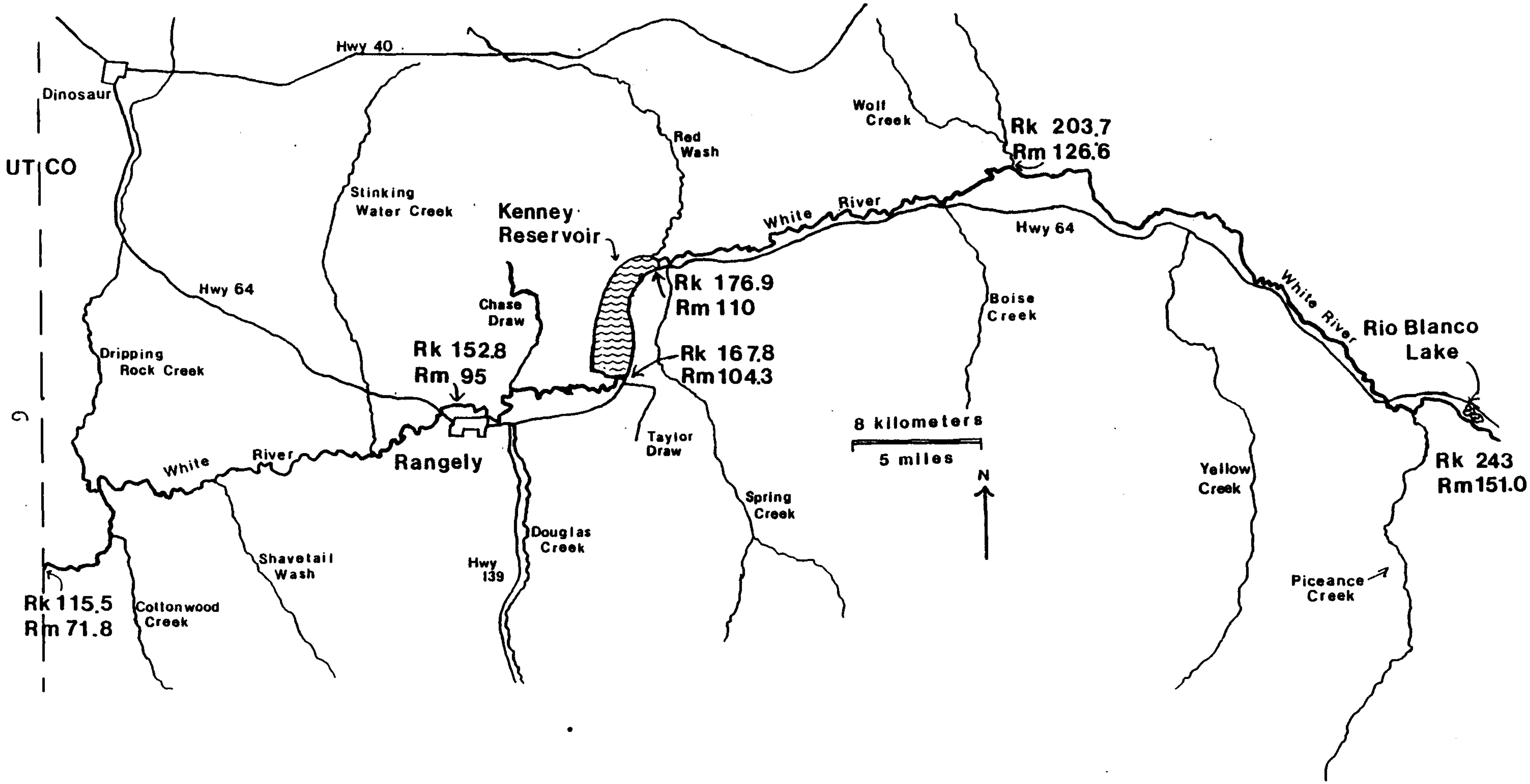
   (4) identify areas with potential for development into squawfish spawning and/or YOY rearing

To further assess project impacts on Colorado squawfish, studies in addition to squawfish population monitoring were incorporated into the Taylor Draw Reservoir Project. These studies, cooperative efforts between the CDOW and the Colorado Cooperative Fishery and Wildlife Research Unit (CCFWRU), sought to infer squawfish response to habitat alterations resulting from Taylor Draw Dam construction and operation by investigating changes in selected physical parameters and the entire fish community.

DESCRIPTION OF STUDY AREA

The area of study was 125 km (78 mi.) of the White River in Rio Blanco County, Colorado, between Rio Blanco Reservoir and the CO/UT stateline (Figure 2). The entire study reach is divided into river kilometers (RK; converted from river miles, RM) designated by past Colorado River Fisheries Project (CRFP) studies under the U.S. Fish and Wildlife Service (USFWS). The confluence of the White and Green Rivers in Utah is designated river kilometer "zero" (RK 0.0/RM 0.0). For study purposes, the river is discussed in terms of three sections: 1. from CO/UT state line (RK 115.5/RM 71.8) to Taylor Draw Dam axis (RK 167.8/RM 104.3); 2. Kenney Reservoir basin; and 3. above maximum reservoir elevation (1620.8 m/5317.5 ft.); approximately Red Wash confluence (RK 177.0/RM 110.0) to Rio Blanco Reservoir (RK 243.0/RM 151.0).

Fairly detailed physical descriptions of the White River and surrounding habitats and resources are available in previous reports (McKean and Burkhard 1978, Carlson et al. 1979, Miller et al. 1982, USACE 1982a). Typically, the river in the study area is a coolwater/warmwater system that is subject to extremes in discharge and frequently carries a heavy silt load. Channel substrate



STUDY AREA

Figure 2. Taylor Draw project study area on White River, Colorado.

is primarily cobble/rubble in flowing areas and silt/sand in slower moving sections. Water temperatures may exceed 20 C throughout this reach. Peak discharges during this study exceeded those recorded since 1970 (Figure 3). High flows approached but barely exceeded 4000 cfs until 1983 when discharge at the Below Meeker, U. S. Geological Survey (USGS) gage station exceeded 6000 cfs.

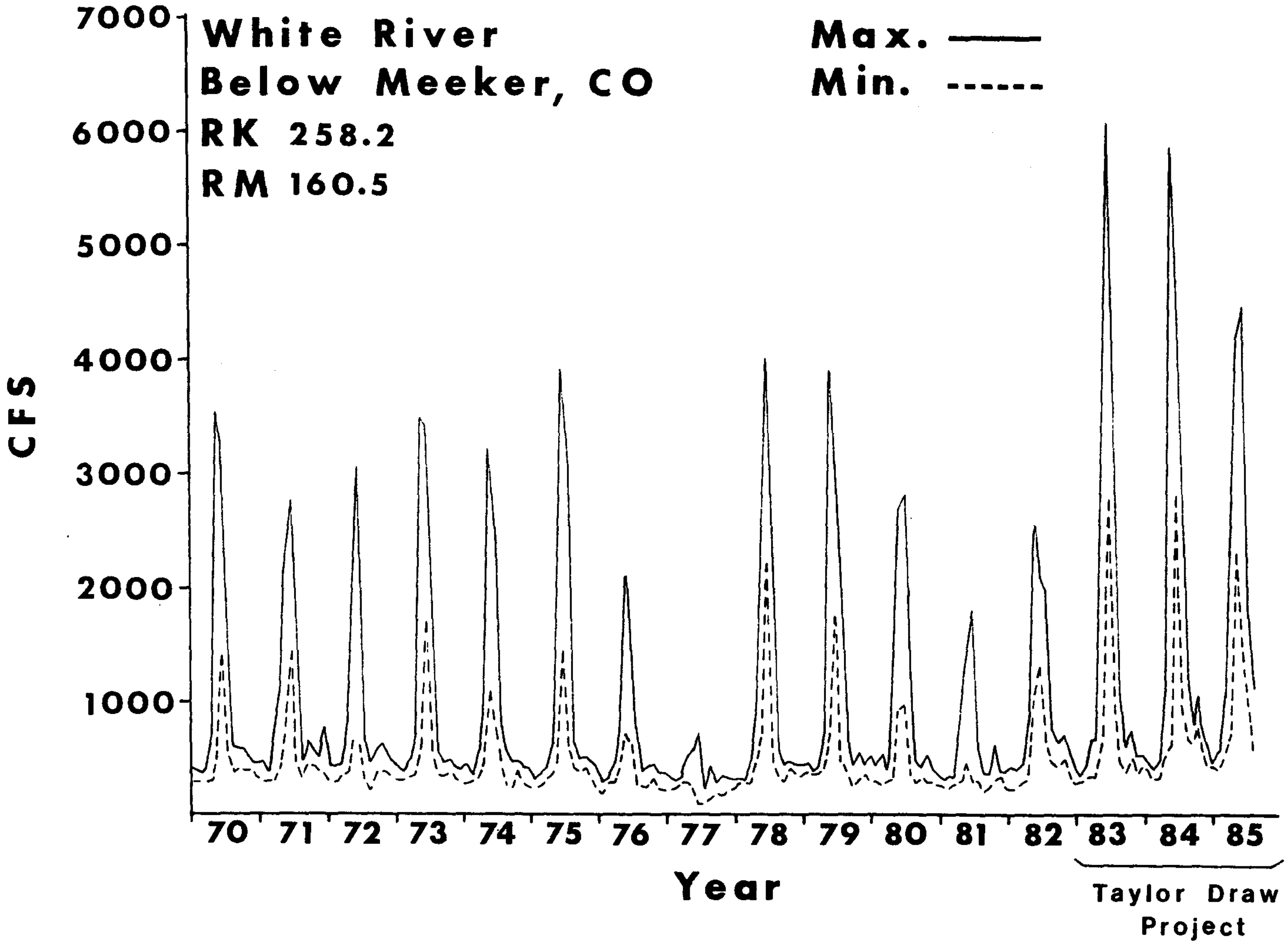


Figure 3. Mean monthly maximum and minimum discharges in the White River recorded at the Below Meeker, CO USGS gage from January 1970 to September 1985.

METHODS

Physical Parameters

Mean daily discharge measured in cubic feet per second (cfs) was obtained for 1983-85 from three U.S. Geological Survey (USGS) gage stations established on the White River: Below Meeker (RK 258.2/RM 160.5); Below Boise Creek (RK 192.6/RM 119.7); and Near CO/UT Stateline (RK 111.2/RM 69.1). Provisional data for the 1985 water year (October 1984-September 1985) was supplied by USGS and may be subject to revision.

Mean daily water temperature in the White River was recorded in 1983-85 by placing Model G Peabody Ryan thermographs at one station above and four stations below Taylor Draw Dam (Table 1). These instruments, operated from spring to fall, were checked periodically to verify operation and to ensure that the units were not buried by silt.

Turbidity was monitored in 1985 to evaluate the effects of Kenney Reservoir on water clarity below Taylor Draw Dam. Water samples were collected from the water column with a integrated depth water sampler. Turbidity expressed as American Public Health Association (APHA) turbidity units was measured with a Hellige turbidimeter.

Table 1. Thermograph stations in White River, 1983-85 (Taylor Draw Dam is at RK 167.8 / RM 104.3).

Station	RK[a]	RM[a]
	1983	
1	170.9	106.2
2	167.5	104.1
3	157.7	98.0
4	153.7	95.5
5	115.4	71.7
	1984	
1	175.9	109.3
2	167.5	104.1
3	159.4	99.1
4	152.9	95.0
5	115.5	71.8
	1985	
1	184.2	114.5
2	167.5	104.1
3	159.4	99.1
4	121.2	95.0
5	120.7	75.3

[a] distance from confluence of White and Green rivers

Fish Community

Initial timing for sampling larval and YOY fish was based on the water approaching 20 C, the temperature associated with squawfish spawning. Subsequent sampling dates were selected to assure overlapping potential squawfish spawning and larval periods. Sampling was conducted with a 3x1.2 m (10x4 ft.) two-man seine having 1.5 mm (1/16 in.) mesh aperture. All samples were labelled, preserved in a ten percent formalin solution and returned to the lab for analysis. Larger specimens which could be identified in the field were recorded and released.

Sampling in 1983 was conducted from RK 191.1 (RM 118.8) to RK 117.9 (RM 73.3), excluding the future reservoir basin. Samples were collected during three time intervals: 4-13 August; 22-26 August; and 8-12 September. Above the estimated upper limit of the reservoir basin (RK 177.0/RM 110.0) and within the eight kilometers (five miles) below the dam axis (RK 167.8/RM 104.3), sample sites were spaced approximately every 1.6 kilometers (1.0 mi.) with additional sites being selected on the basis of negligible water velocity. From eight kilometers below the dam (RK 159.3/RM 99.0) to the stateline (RK 115.5/RM 71.8), samples were collected approximately every eight kilometers in negligible velocity habitats.

Sampling in 1984 and 1985 was conducted between the Boise Creek confluence (RK 193.0/RM 120.0) and the CO/UT border (RK 115.5/RM 71.8). Samples were collected during three time segments in both years: 2-5 August, 27-30 August, and 19-22 September in 1984; and 17-20 July, 13-16 August, and 10-13 September in 1985. Samples were collected within each 1.6 kilometers (1.0 mi.) not represented by an intensive section. Sites for these samples, not randomly selected, were localities, of potential larval fish habitat. Intensive sampling sections (Table 2) were established by choosing a section midpoint by use of a randomized digit table and spacing remaining midpoints 16 kilometers (10 mi.) apart within the study area. These sections, selected prior to each sampling trip, extended 0.4 k (0.25 mi.) above and below the midpoints to create 0.8 k (0.5 mi.) intensive sampling sites. At least five samples were taken in each of these reaches from a variety of negligible velocity habitats. Intensive sites served to randomly bolster the number of fish collected throughout the study area. Sampling in these sites also ensured that collections were made in other than "ideal" larval and YOY fish habitats.

Analysis of 1983 samples was performed by the Larval Fish Laboratory at Colorado State University, Fort Collins, CO. Samples collected in 1984 and 1985 were analyzed by a private contractor with verification of questionable specimens by the Larval Fish Lab. Frequency of occurrence in samples and percent composition by species was determined for each date and totaled by year.

Table 2. Dates and randomly selected 0.8 km (0.5 mi.) "intensive" sections for sampling larval and YOY fish in the White River in 1984 and 1985.

Upper terminus			Lower terminus	
RK	RM		RK	RM
		1984		
		2-5 August		
189.8	118.0		189.0	117.5
173.8	108.0		173.0	107.5
157.7	98.0		156.9	97.5
141.6	88.0		140.8	87.5
125.5	78 0		124.7	77.5
		27-30 August		
186.6	116.0		185.8	115.5
170.5	106.0		169.7	105.5
154.5	96.0		153.7	95.5
138.4	86.0		137.6	85.5
122.3	76.0		121.5	75.5
		19-22 September		
192.3	119.5		191.5	119.0
176.2	109.5		175.4	109.0
160.1	99.5		159.3	99.0
144.0	89.5		143.2	89.0
127.9	79.5		127.1	79.0
		1985		
		17-20 July		
184.2	114.5		183.4	114.0
168.1	104.5		167.3	104.0
152.0	94.5		151.2	94.0
136.0	84.5		135.2	84.0
119.9	74.5		119.1	74.0
		13-16 August		
192.3	119.5		191.5	119.0
176.2	109.5		175.4	109.0
160.1	99.5		159.3	99.0
144.0	89.5		143.2	89.0
127.9	79.5		127.1	79.0
		10-13 September		
191.5	119.0		190.7	118.5
175.4	109.0		174.6	108.5
159.3	99.0		158.5	98.5
143.2	89.0		142.4	88.5
127.1	79.0		126.3	78.5

Comparisons were made in 12 km (7.5 mi.) segments in 1984 and 1985 to compare changes in the larval and YOY populations above, within, and below the reservoir basin.

Sub-adult and adult fishes were sampled between May and October in 1983-85 by electrofishing. Fish were collected in three areas: in the 8 km (5 mi.) above Kenney Reservoir basin; in the 8 km below Taylor Draw Dam; and in four 0.8 km (0.5 mi.) sections spaced 8 km apart below Rangely (Table 3). Sampling in 1983 was conducted using raft (14' Miwok) mounted electrofishing equipment (2500 watt qenerator and Coffelt VVP-10). In 1984 and 1985, the electrofishing equipment (2500 watt generator and Coffelt VVP-15) was mounted in a boat (14' jon) equipped with an outboard motor to facilitate mobility. All fish captured were identified to species and counted.

Colorado Squawfish

Colorado squawfish were pursued by electrofishing in conjunction with fish population sampling efforts. Additionally, two sampling trips were conducted early each year over the entire study reach exclusively for capturing squawfish. From August to October, 1985, three hours of electrofishing effort were expended in the plunge pool channels and river to 350 m (400 yds.) below Taylor Draw Dam to monitor the occurrence of Colorado squawfish in relation to an emergency fishing closure.

Table 3. Areas sampled by electrofishing for sub-adult and adult fishes in the White River, May-October 1983-85.

Upper terminus RK	Upper terminus RM		Lower terminus RK	Lower terminus RM
		Above Kenney Reservoir basin 8 km (5 mi.)		
177.0	110.0		185.0	115.0
		Below Taylor Draw Dam 8 km (5 mi.)		
167.8	104.3		159.8	99.3
		Downstream of Rangely, CO four 0.8 km (0.5 mi.) sections		
152.0	94.5		151.2	94.0
144.8	90.0		144.0	89.5
136.0	84.5		135.2	84.0
127.9	79.5		127.1	79.0

Upon capturing a Colorado squawfish, selected physical habitat parameters were measured at the specific site where a squawfish first appeared during electrotaxis (Appendix Tables 23-25). This information was collected to contribute to data used to evaluate habitat preference of the species. Water depth was measured in centimeters. Channel width, measured in meters, was estimated with a rangefinder. Water velocity, in cubic feet per second (cfs), was measured with a Model 201 Marsh McBirney Flowmeter. Water temperature (C) and conductivity (umhos) measurements were taken with a Yellow Springs YSI Model 33 S-C-T meter.

All Colorado squawfish captured were measured (total length, TL, in mm), weighed (g), and fitted with a numbered Carlin tag afixed by a monofilament suture passing through the back immediately beneath the dorsal fin. All squawfish captured in 1983 and non-telemetered specimens handled in 1984 and 1985 received white tags. Colorado squawfish implanted with radiotransmitters in 1984 and 1985 received orange tags.

Only large (>500 mm), robust Colorado squawfish were canidates for implanting. Specimens to be radiotagged were anesthetized in a 200 mg/l MS-222 (tricaine methanesulfonate)/water solution to facilitate surgical implantation of radiotransmitter modules. Following topical treatment with an antiseptic iodine solution, a 40-50 mm incision was made through the skin and musculature on the fish's lateral side slightly dorsal and anterior of the right pelvic insertion. Transmitter modules were dipped in molten beeswax which was allowed to cool and set before implanting. After inserting the module in the body cavity, the incision was closed with 8-10 separate non-absorable sutures (3-0 monofilament nylon) and the knots coated with quick drying "super glue". Radiotransmitters implanted in Colorado squawfish were 300-day AVM (1983) and 150-day Smith-Root (1984-85) fish modules operating in the 40.660 to 40.700 MHz range. Transmissions ranged from 44 to 90 pulses per minute. All squawfish receiving transmitters were detained overnight in a 120x120x120 cm holding net placed in the river to assess their recovery. Prior to releasing the fish, the radio receiver was operated to verify transmitter function, frequency, and pulse rate. None of the squawfish handled displayed ill effects upon release following tagging or surgery.

Movements of radio-telemetered squawfish were monitored by air, ground, and float searches. Radio receivers used included Custom Telemetry & Consulting standard tracking (CTC-AR-12) and remote sensing (RB-4) types, and Smith-Root search (SR-40) and scanning (RF-40) units. Custom Telemetry directional loop (L40-SM) and Larsen Kulrod (NMO-40) whip antennas were used. Radiotracking conducted in the Green and Yampa rivers by USFWS-CRFP (Vernal, UT) personnel provided additional movement information on Colorado squawfish captured and implanted during this study.

RESULTS AND DISCUSSION

Physical Parameters

Discharge

Little difference was apparent between 1983-85 hydrographs derived from two USGS gage stations above and one below Taylor Draw Dam (Figures 4-6). Discharge below Taylor Draw Dam from October to December, 1984, exhibited an erratic pattern as water was impounded and released to allow inspection of the dam as the reservoir filled. Peak discharges in 1983-85 exceeded 4000 cfs with 1983 and 1984 peak flows approaching or exceeding 6000 cfs and causing flooding in the study area. Runoff began mid-April to mid-May, peaked May to June, and receded in June or July. The baseflow period during this study was from September to March. Taylor Draw Dam is scheduled to release run of the river and maintain Kenney Reservoir full the majority of the time (USACE 1982b). Because of the limited storage capacity of Kenney Reservoir, Taylor Draw Dam should have minimal effect on seasonal flow regimes (Behnke 1981). Also, the requirement for WUA1 to release 200 cfs or natural flow, which ever is less, during drought years

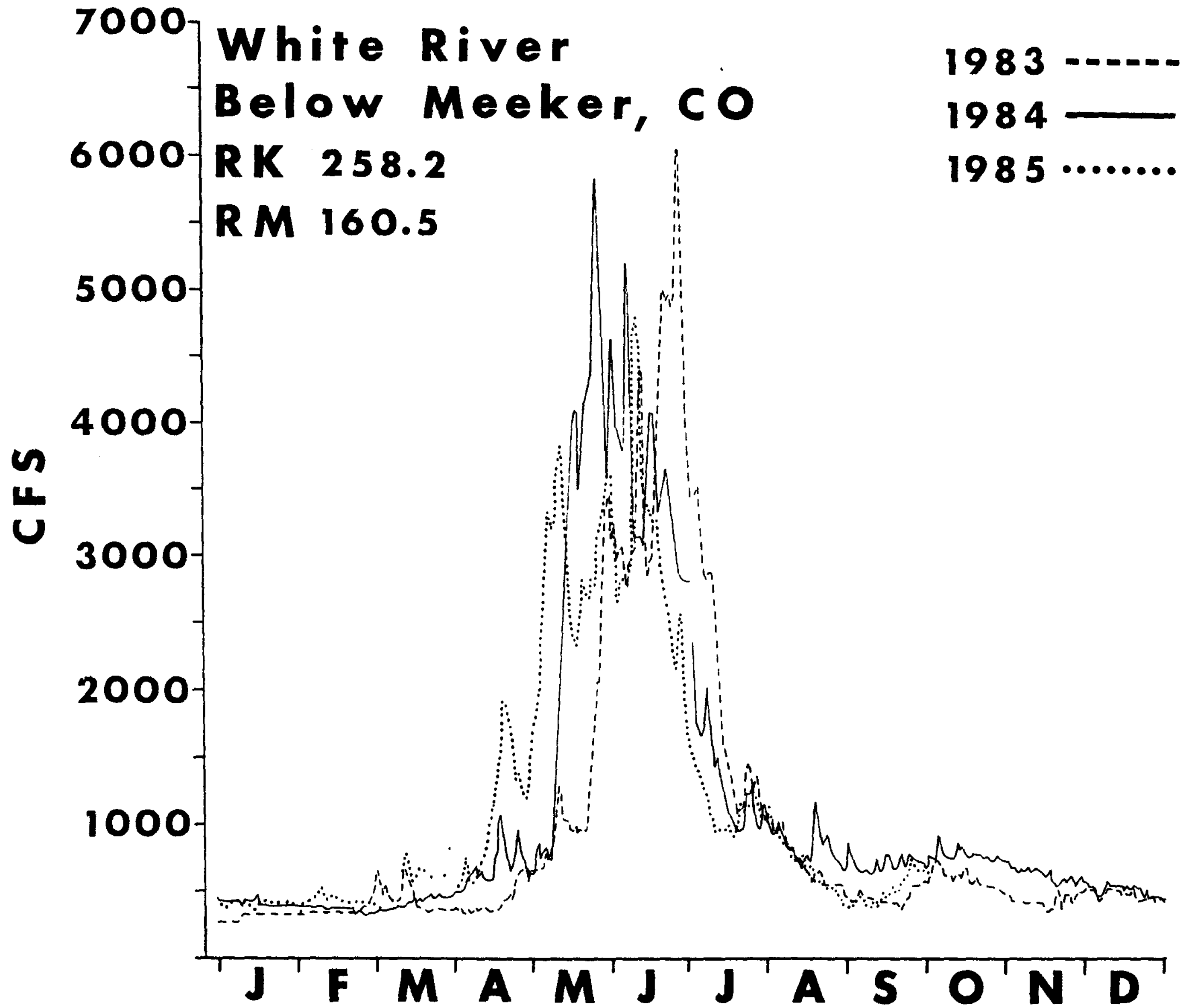


Figure 4. Mean daily discharges in the White River recorded at the Below Meeker, CO USGS gage, 1983-85.

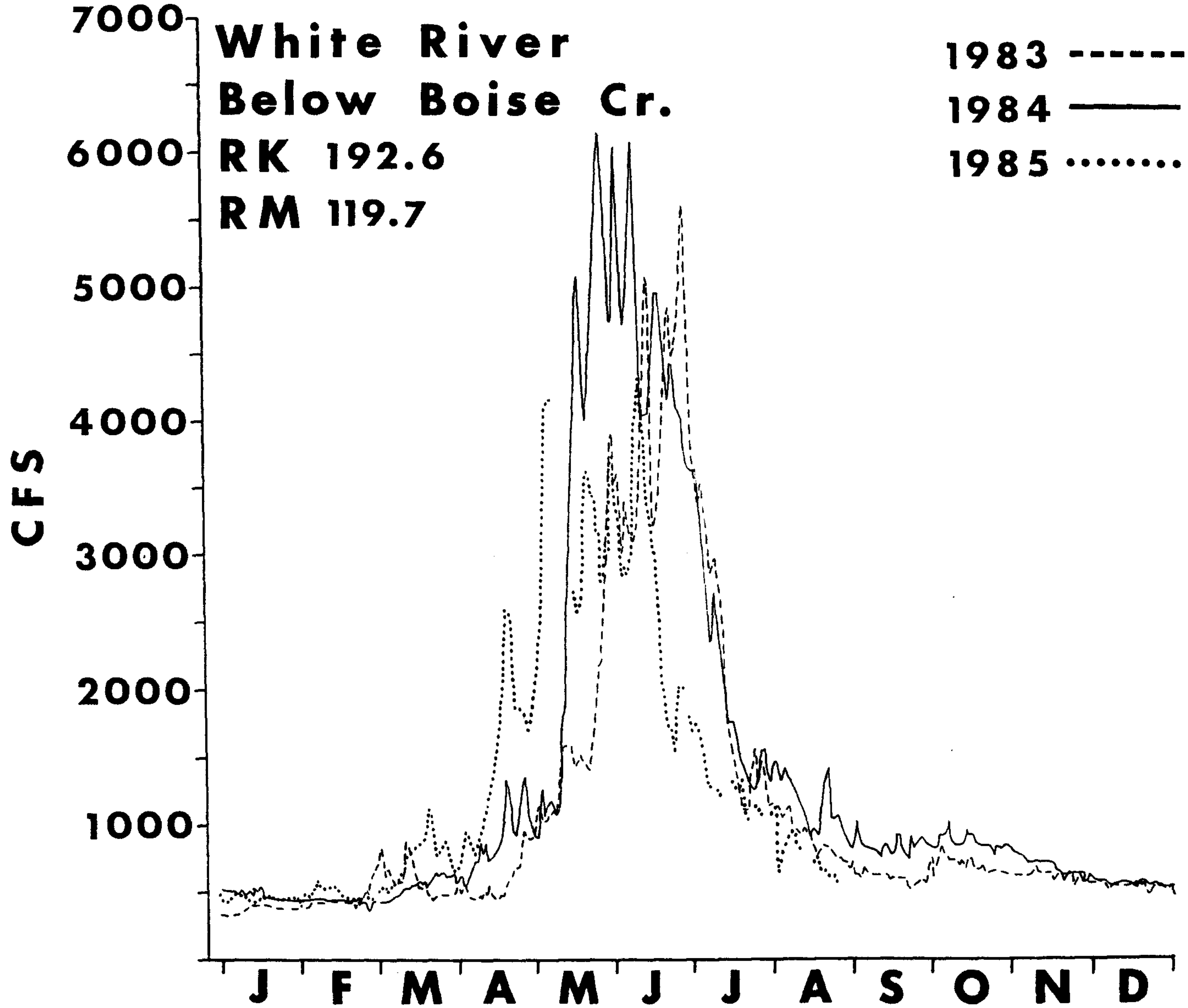


Figure 5. Mean daily discharges in the White River recorded at the Below Boise Creek USGS gage, 1983-85.

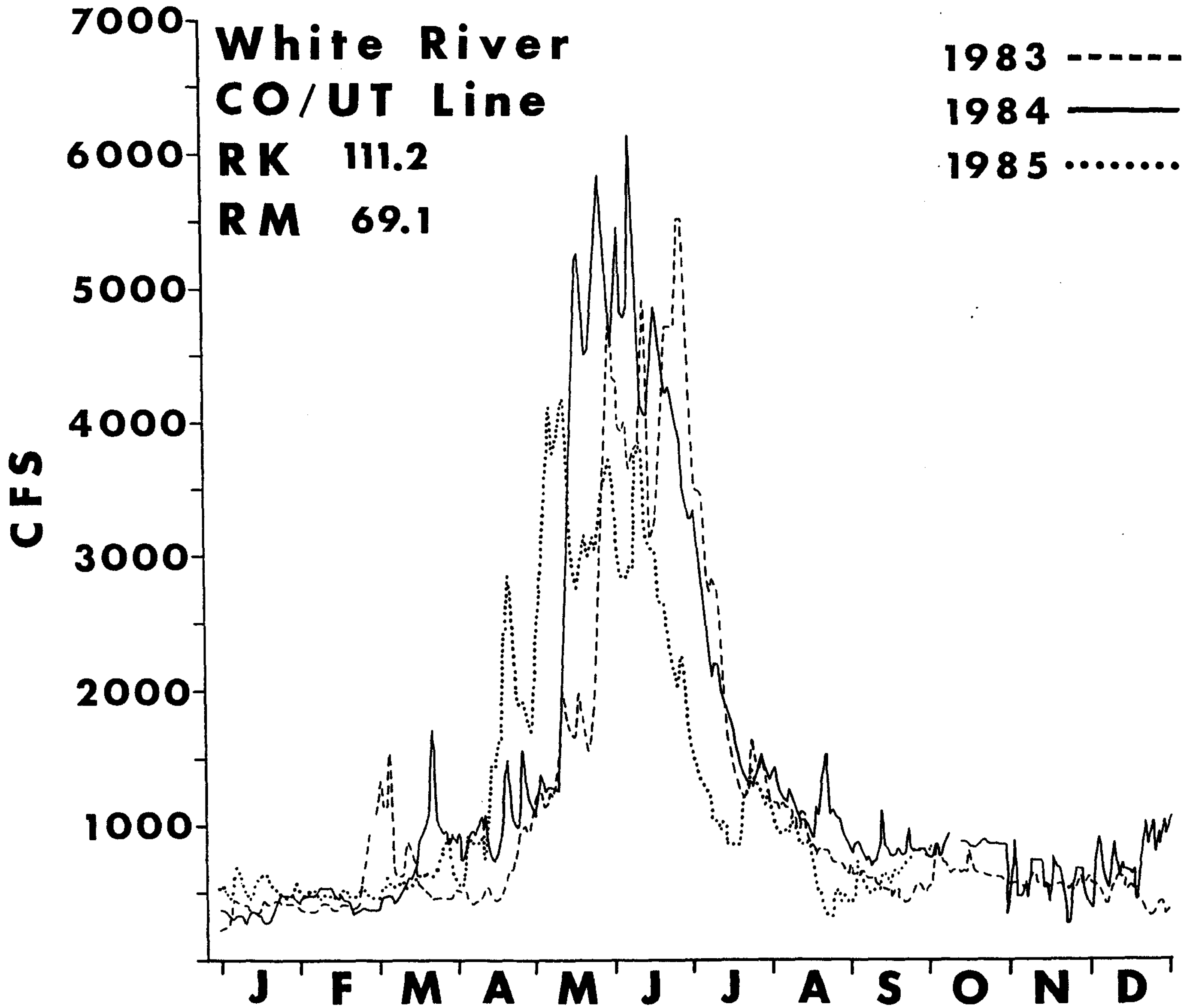


Figure 6. Mean daily discharges in the White River recorded at the Near CO/UT Stateline gage, 1983-85.

(USACE 1982b) will help preserve natural flow regimes even during very low flow years.

Installation of the proposed hydroelectric station, which is scheduled to operate at run-of-the-river, should do little more than change the point of release by a few meters. (Western Engineers, Inc. 1985). If a ponding (peaking) power generation scheme is incorporated into the operation of the hydrounit, however, the resulting daily water fluctuations below the dam may cause great changes in the habitat available to riverine fishes (Holden 1979). This may adversely affect Colorado squawfish, most seriously through potential stranding which can result following abrupt reductions in flow (Kroger 1973).

Temperature

Seasonal temperature regimes at all thermograph stations in 1985 closely resembled those in 1983 and 1984 (Figures 7-11). Retention time in Kenney Reservoir simply is not long enough to exert seasonal thermal constancy (a condition characteristic of streams below deep-release impoundments where annual temperature fluctuations are minimized or eliminated (Ward and Stanford 1979). It was predicted that temperatures downstream from the dam would not be significantly affected (USACE 1982a).

In 1985, however, thermal regimes below Taylor Draw Dam exhibited dampened daily fluctuations in September as the hydrograph entered the baseflow period (Figures

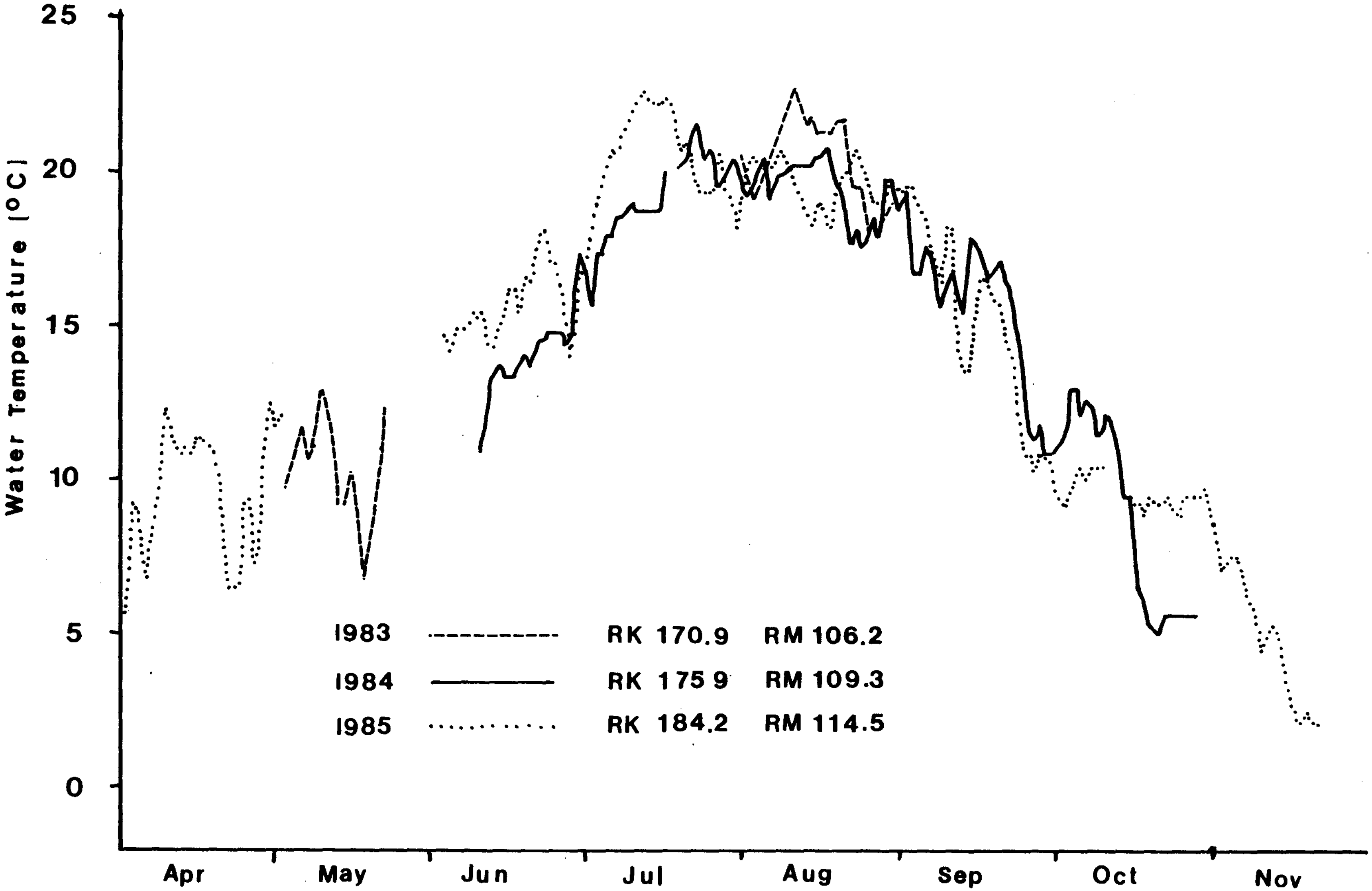


Figure 7. Mean daily water temperatures in the White River recorded by portable thermograph units at Station 1, 1983-85.

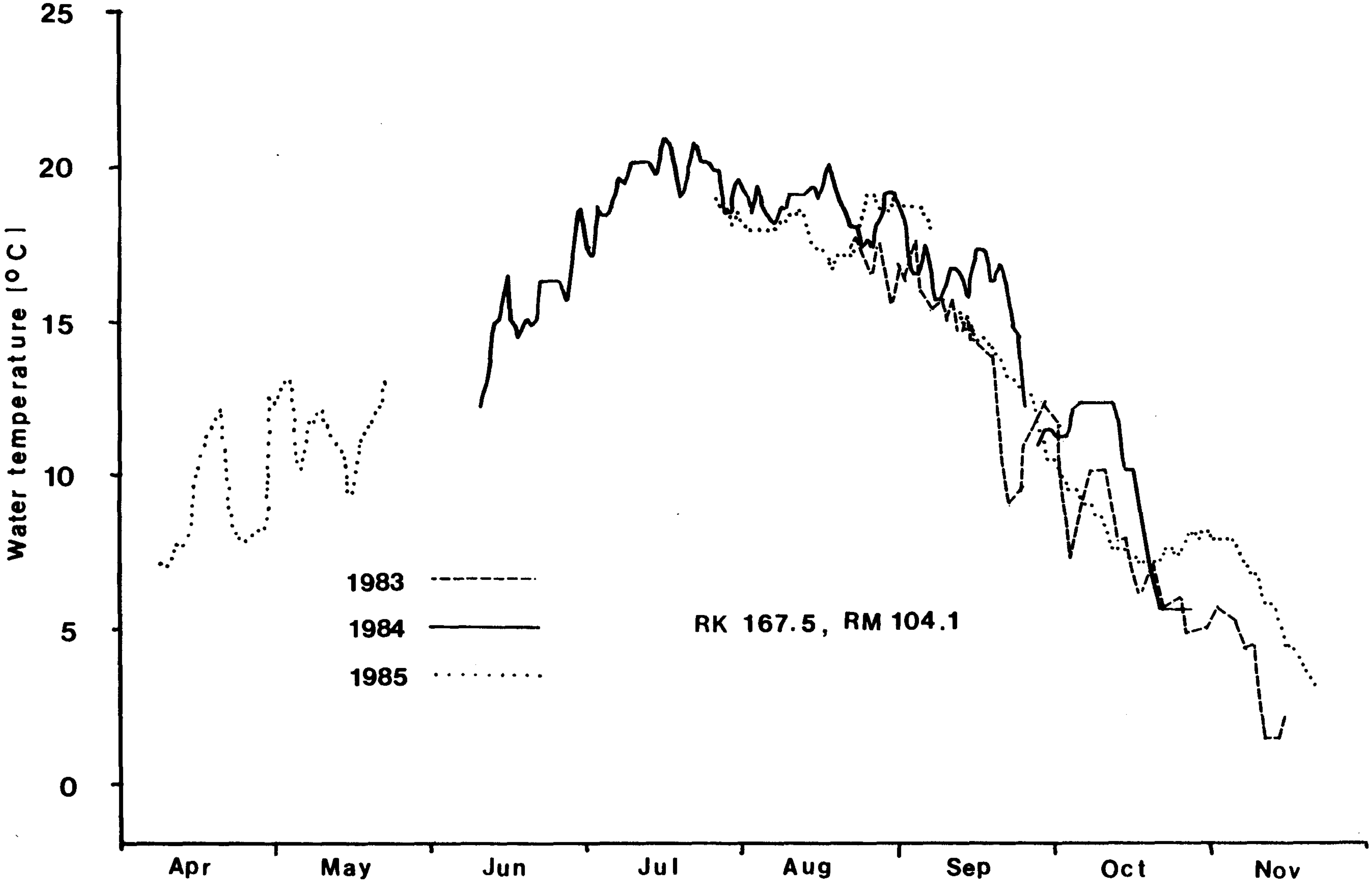


Figure 8. Mean daily water temperatures in the White River recorded by portable thermograph units at Station 2, 1983-85.

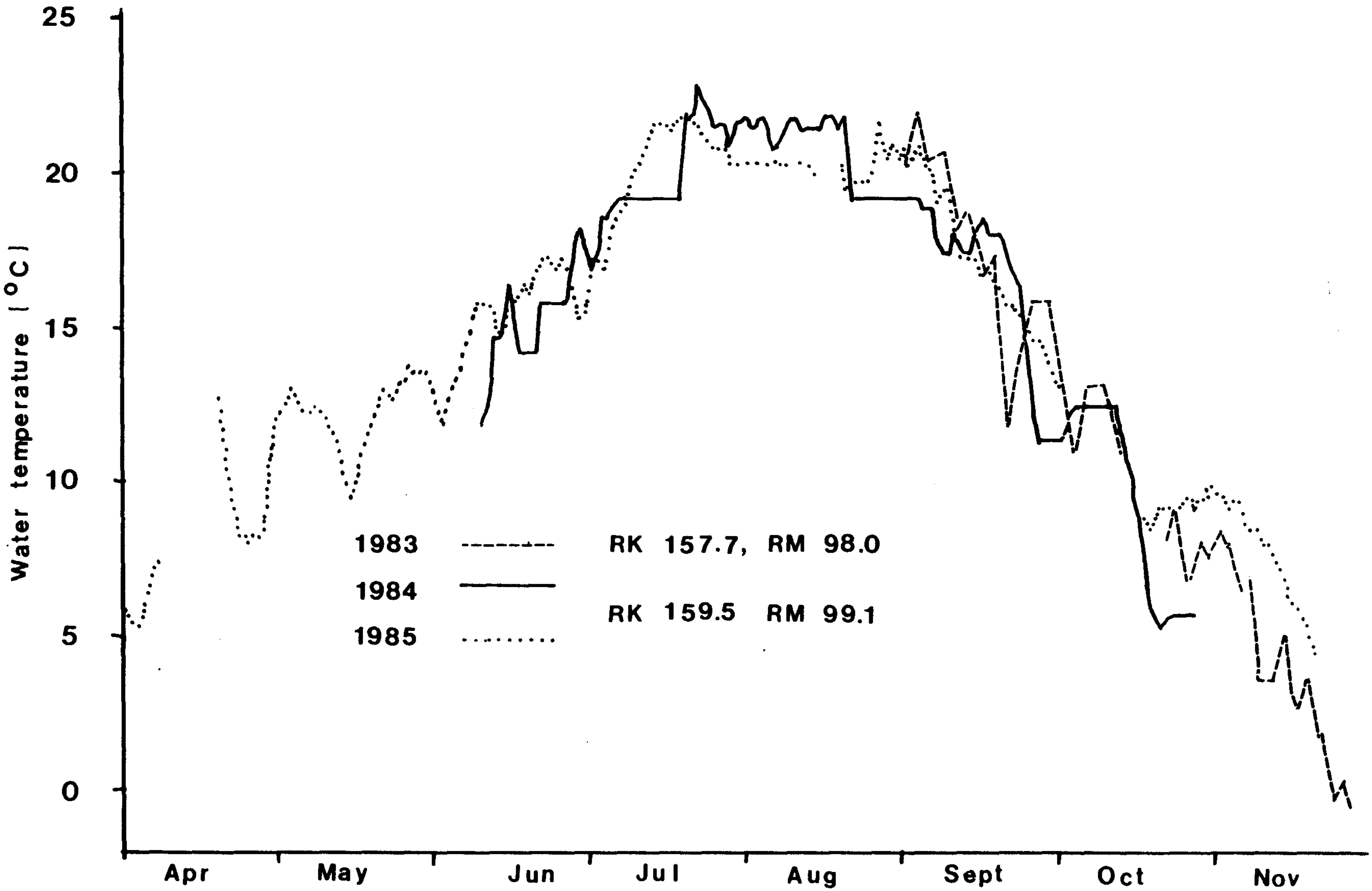


Figure 9. Mean daily water temperatures in the White River recorded by portable thermograph units at Station 3, 1983-85.

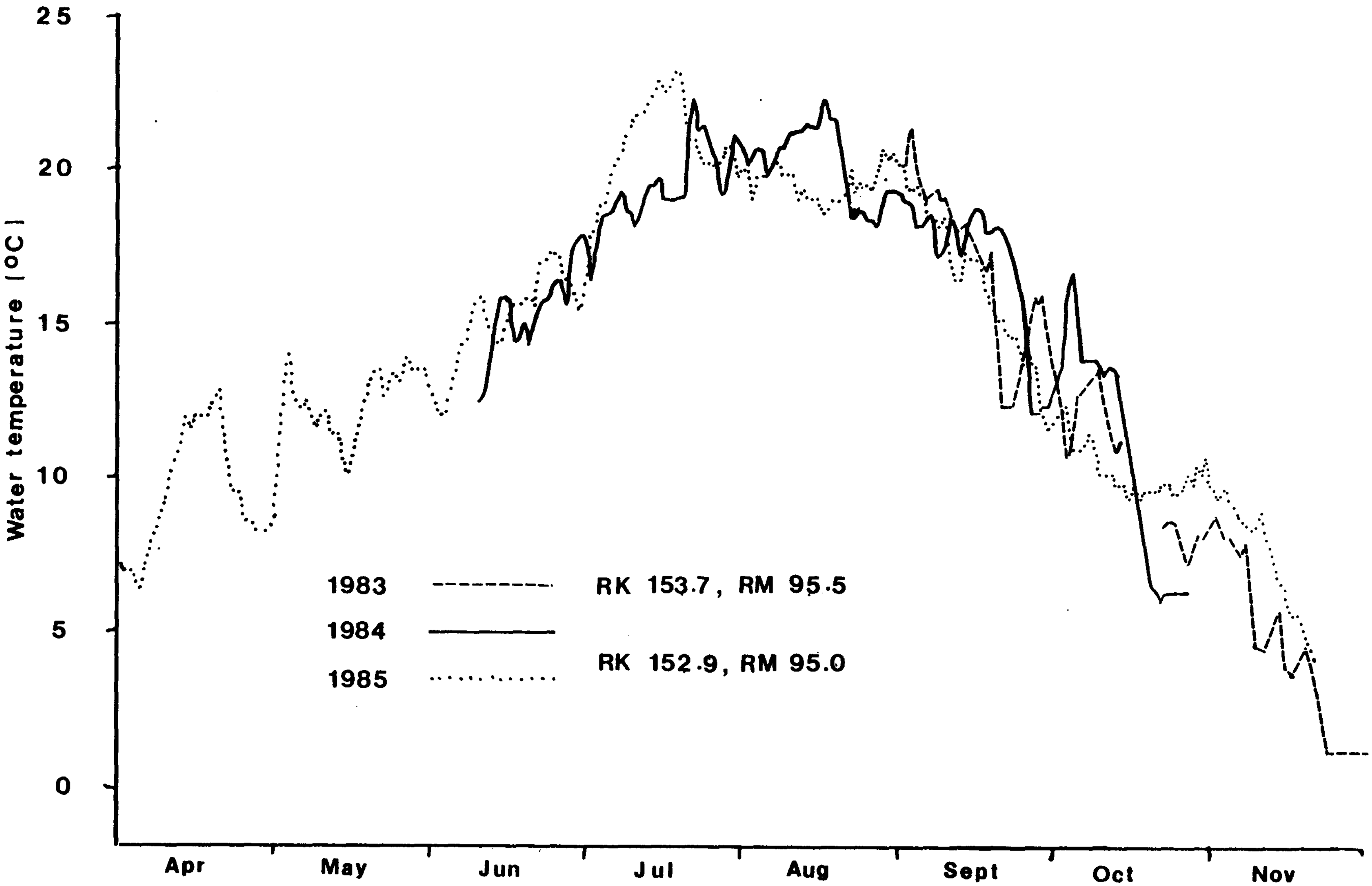


Figure 10. Mean daily water temperatures in the White River recorded by portable thermograph units at Station 4, 1983-85.

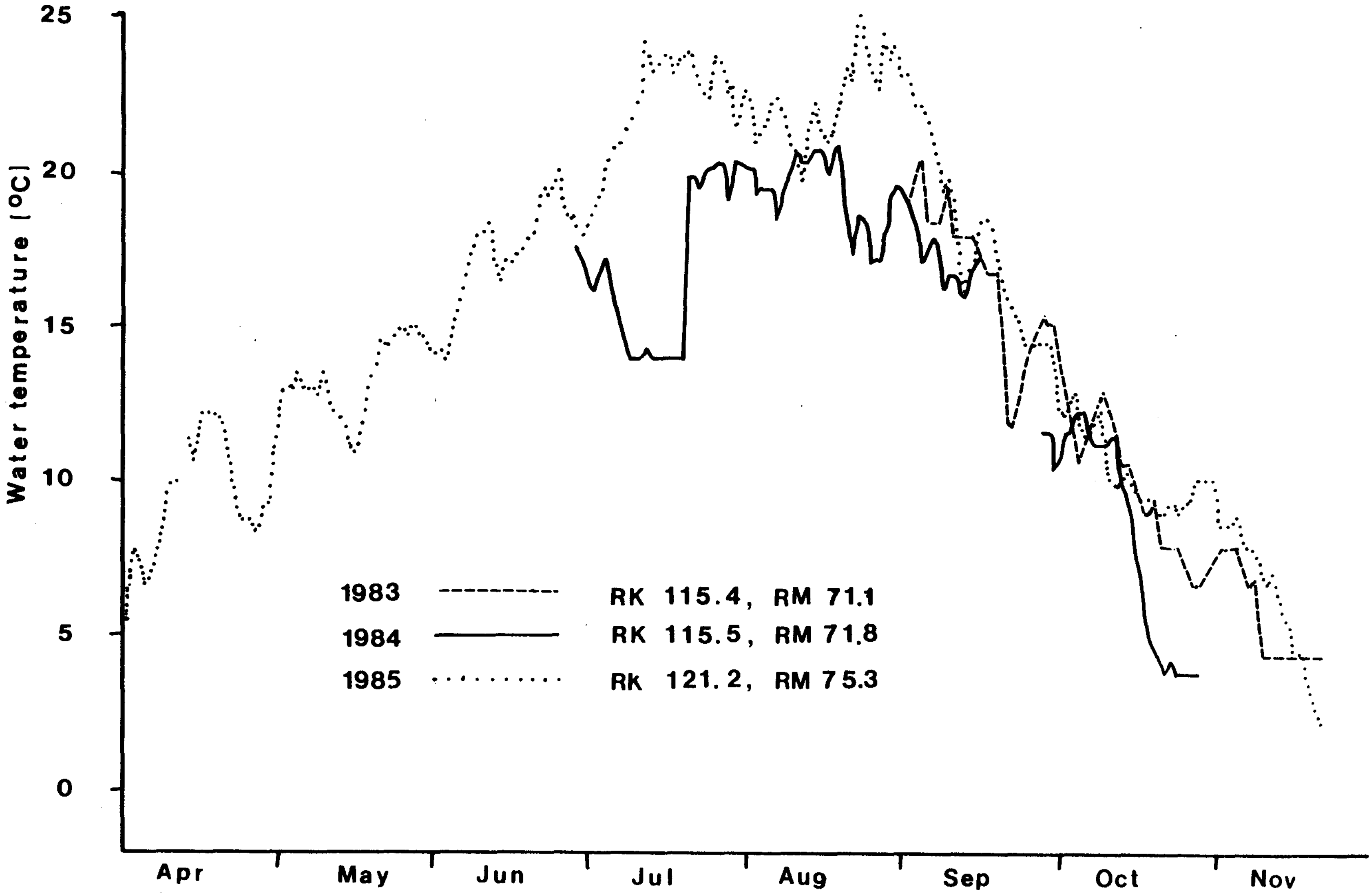


Figure 11. Mean daily water temperatures in the White River recorded by portable thermograph units at Station 5, 1983-85.

8-10). This condition, described as diurnal thermal constancy (Ward and Stanford 1979), is characteristic of streams below deep-release impoundments discharging hypolimnetic water during the entire stratification period. Kenney Reservoir did not stratify strongly in 1985 (unpublished USGS data), as predicted for low to high flow years (USACE 1982a). Therefore, Taylor Draw Dam, which cannot be considered a deep-release structure (15 m maximum depth), was not releasing water from a cold hypolimnion. Also, the diurnal thermal constancy occurred during the dams first year of operation when surface and bottom releases occurred sporadically to accomodate repairs, modifications, and inspections. The non-fluctuating thermal condition below the dam in 1985 was the result of the relatively homogenous temperature profile in the reservoir. Thermal constancy persisted at least to Station 4, 16 km (10 mi.) downstream. This effect diminished at Station 5, 48 km (30 mi.) below the dam, consistent with projections that there would be little to no change in natural temperature regimes 40 km (25 mi.) downstream even during very low to high flow years (USACE 1982a). Diurnal thermal constancy probably persists through the entire baseflow period.

Inverted stratification under the reservoir ice cover (unpublished USGS data) resulted in winter releases that were warmer than natural conditions. While this temperature elevation was not measured, it was obvious due to the ice-free condition of the river below the dam in the winters of 1984 and 1985. The influence of the reservoir in maintaining the river ice free appeared to extend to just below Rangely, approximately 19 km (12 mi.) below Taylor Draw Dam. This ice-free state of the river through the town of Rangely will accomplish one of the purposes of the project, elimination of infrequent flooding in Rangely due to ice jams (USACE 1982a).

If Kenney Reservoir stratifies strongly, as projected for very low flow years (USACE 1982a), water temperatures below the dam could be depressed by as much as 10 C. Again, this effect is predicted to diminish 40 km (25 mi.) downstream. This alteration of the natural annual temperature regime may affect the summertime distribution of native fishes (Colorado squawfish) which would probably move downstream seeking warmer water. The altered thermal conditions observed during this study should not adversely affect fish in the White River. It may, however, facilitate expansion of exotic fish species since the more stable thermal conditions below the dam, at least during baseflow, will simulate temperatures in the new lentic environment of Kenney Reservoir.

Turbidity

Probably the most obvious change resulting from the closure of Taylor Draw Dam, aside from the creation of Kenney Reservoir, was the reduced turbidity in the White

River below the dam (Simons 1979). During the high flow period, Kenney Reservoir represents a large instream pool, and the entire reservoir becomes turbid. Figure 12 illustrates the settling effect, but low retention time, of Kenney Reservoir in 1985. On 29 June, sediment laden water entering the reservoir slowed and dropped much of its load at the growing inlet delta. The river below the dam was clearer, but still relatively turbid as smaller particles remained suspended and passed through the reservoir. Turbidity gradually increased as the river flowed to the stateline. On 31 July, as flows receded, less turbid water entering the reservoir resulted in decreased turbidity below the dam, however, Douglas Creek, transporting a heavy sediment load increased turbidity significantly in the White River. Turbidity measurements on 25 August represented an entirely different situation. The inflowing river was virtually clear. The discharge, also clear, remained quite clear to the border in the absence of precipitation. On 23 September, precipitation increased the sediment load of the river upstream, however, due to greatly decreased flows compared to runoff conditions and longer retention time, the suspended load had more time to settle out resulting in very clear water below the dam. Again, the heavy sediment load contributed by Douglas Creek reappeared, turbidity increased, but was slightly reduced as sediment settled out downstream.

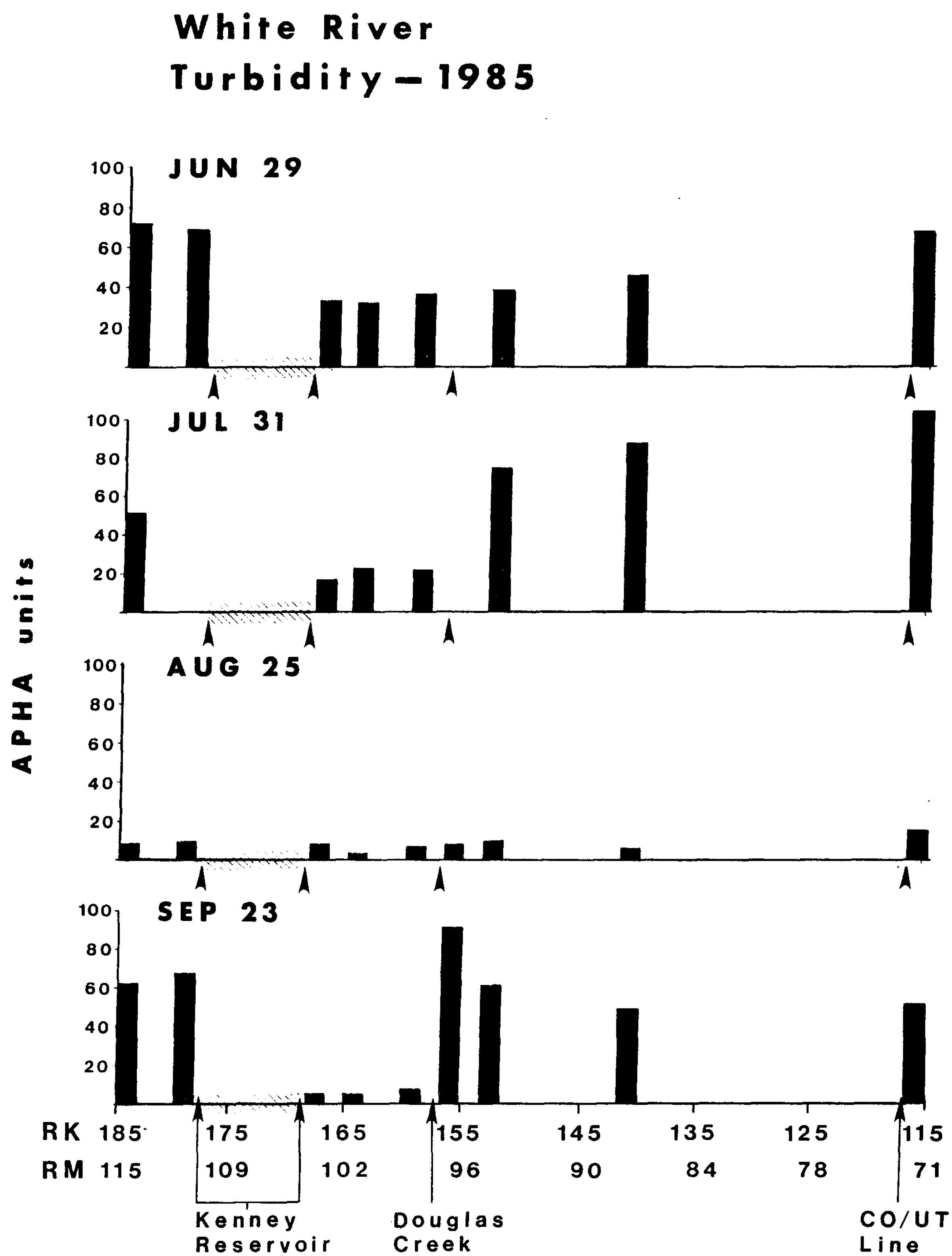


Figure 12. Turbidity of the White River above Kenney Reservoir and downstream of Taylor Draw Dam on four dates in 1985 (John Wullschleger unpublished data).

Past and present land use practices in the White River drainage have elevated the river's sediment load above natural conditions. This suspended load would settle out in reservoirs placed in the White River which can create very effective sediment traps. Kenney Reservoir is projected to have an overall trap efficiency of 72.2% after 30 years (USACE 1982a). The larger White River Dam Project proposed in Utah was projected to have an overall trap efficiency of over 90% even after 50 years of operation (Clyde 1980). Dropping of the river's sediment load in the reservoir not only reduces storage capacity but results in sediment removal and increased scour below the dam. Kenney Reservoir is projected to store less than half its original capacity in less than 30 years (USACE 1982a).

Behnke (1981) suggested that degrading (deepening) of the river channel below Taylor Draw Dam due to scour would serve to diversify and improve fish habitat. Other information indicates, however, that adverse impacts to fish habitat may result. Holden (1979) reasoned that removal of sediment deposits below dams tended to reduce habitat variability, especially slow moving, silt substrate areas utilized by young fishes. Simons (1979) indicated that removal of moisture holding silts and clays by clear "sediment-hungry" waters below dams not only erodes river banks, but eliminates deposited material necessary for vegetation growth and thus deteriorates riparian and fishery habitats. Behnke (1981) pointed out, however, that a deepened channel below the dam may facilitate Colorado squawfish movement, particularly during low flow periods.

Fish Community

A total of 15 fish species representing six families was collected in the study area. These included seven native (three endemic) and eight exotic (introduced) species (Table 4). Fourteen of these species were collected by electrofishing and ten were present in seine samples. One species, the brown trout (*Salmo trutta*), was not collected in the formal seining or electrofishing sampling areas. A single 400 mm (16 in.) specimen was collected while electrofishing for Colorado squawfish in May, 1983 at RK 192.8 (RM 119.8). Brown trout, not previously reported in the vicinity, were stocked in Kenney Reservoir in April, 1986, by WUA1. Within days, brown trout were reported below Taylor Draw Dam. A small number of hybrid tiger trout (*Salvelinus fontinalis x Salmo trutta*) also accompanied the introduction of browns.

Larval and YOY fishes

Of the native species collected in seine samples, the endemic roundtail chub (*Gila robusta*) exhibited

Table 4. Codes, and status of fish species collected by seining and electrofishing in the White River in Colorado, 1983-85.

Species			
Scientific name	Common name	Code	Status[a]
SALMONIDAE	Trout		
Prosopium williamsoni	mountain whitefish	MW	NA
Salmo gairdneri	rainbow trout	RB	EX
Salmo trutta	brown trout		EX
CYPRINIDAE	Minnows		
Cyprinus carpio	common carp	CP	EX
Gila robusta	roundtail chub	RT	NA,EN
Notropis lutrensis	red shiner	RS	EX
Pimephales promelas	fathead minnow	FH	EX
Ptychocheilus lucius	Colorado squawfish	CS	NA,EN,ED
Rhinichthys osculus	speckled dace	SD	NA
CATOSTOMIDAE	Suckers		
Catostomus discobolus	bluehead sucker	BH	NA
Catostomus latipinnis	flannelmouth sucker	FM	NA,EN
ICTALURIDAE	Catfish		
Ictalurus melas	black bullhead	BB	EX
Ictalurus punctatus	channel catfish	CC	EX
CENTRARCHIDAE	Sunfish		
Pomoxis nigromaculatus	black crappie	BC	EX
COTTIDAE	Sculpin		
Cottus bairdi	mottled sculpin	MS	NA

[a] NA = native: occurring in the Colorado River Basin before introductions by man
EN = endemic: found only in the Colorado River Basin
EX = exotic: introduced into the Colorado River Basin (non-native)
ED = endangered: in danger of extinction

the lowest frequency of occurrence except for mottled sculpin (*Cottus bairdi*) which occurred in only 2 and 4% of the samples collected in 1984 and 1985, respectively (Figures 13-15). In 1983 and 1984, roundtail chub occurred in nearly 70% of the collections; this dropped to 42% in 1985. The small speckled dace (*Rhinichthys osculus*) appeared in 99% of the collections in 1983 and 1984 and in over 90% in 1985. Both catostomids, the bluehead sucker (*Catostomus discobolus*) and flannelmouth sucker (*C. latipinnis*) were present in over 80% of the samples except in 1985 when bluehead suckers appeared in 73% of the collections.

Exotic species occurred in very few seine samples in 1983 but were prevalent in more collections in 1984 and 1985 (Figures 13-15). The low incidence of exotics in 1983 may not have been representative of their actual distribution but rather it was an artifact of less sampling effort (97 samples). Doubling the sampling effort in 1984 (198 samples) and 1985 (196 samples) resulted in the collection of more species and an increased frequency of occurrence of exotics.

Common carp (*Cyprinus carpio*) YOY, not collected in 1983, occurred in only 4% of the samples in 1984. Their occurrence in samples increased to 12% in 1985. Red shiners (*Notropis lutrensis*) appeared in 13, 42, and 28% of the collections in 1983, 1984, and 1985, respectively. The fathead minnow (*Pimephales

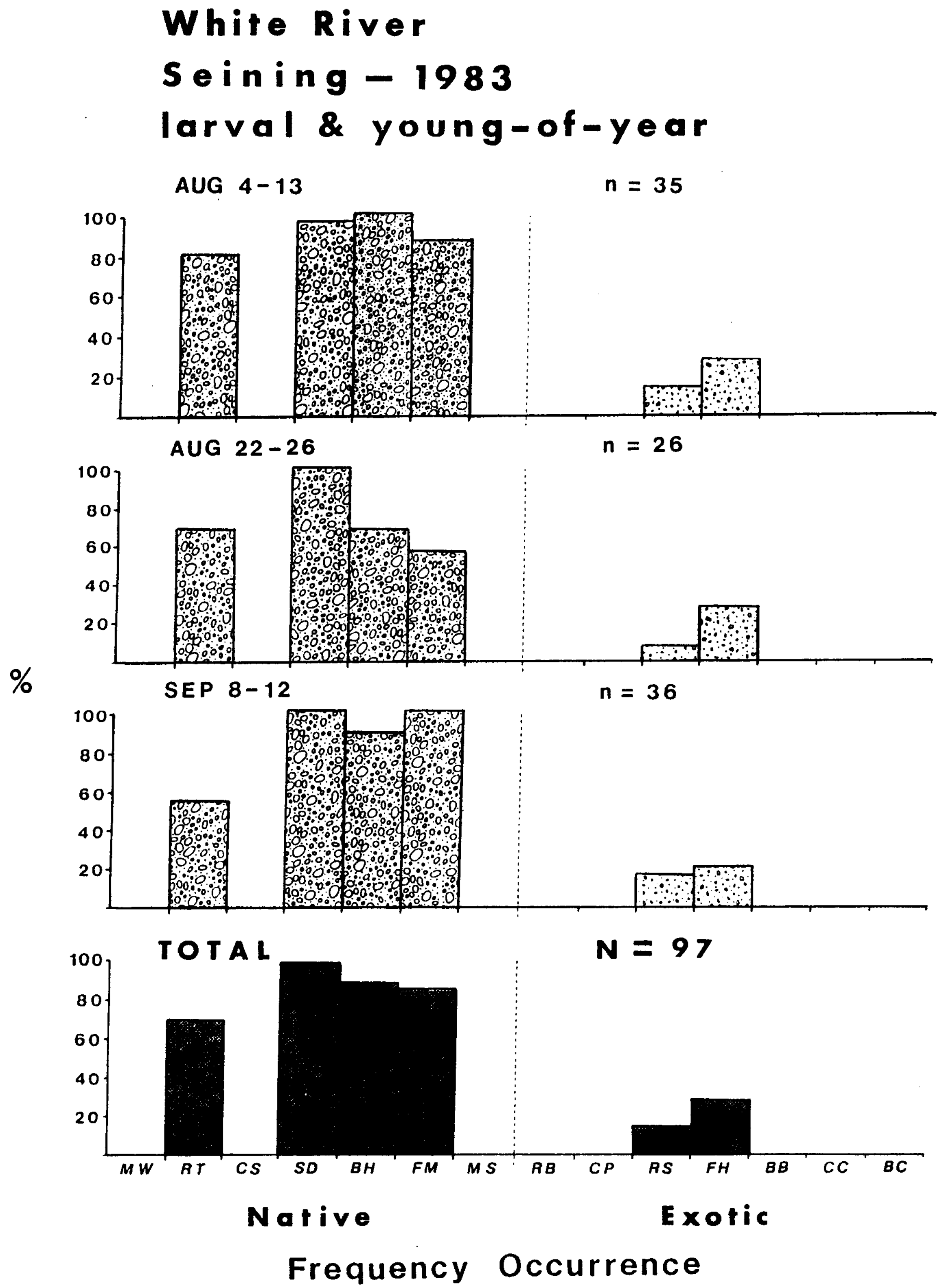


Figure 13. Frequency of occurrence of fish species in seine samples collected during three time periods from RK 193.0 (RM 120.0) to RK 115.5 (RM 71.8) in the White River in 1983.

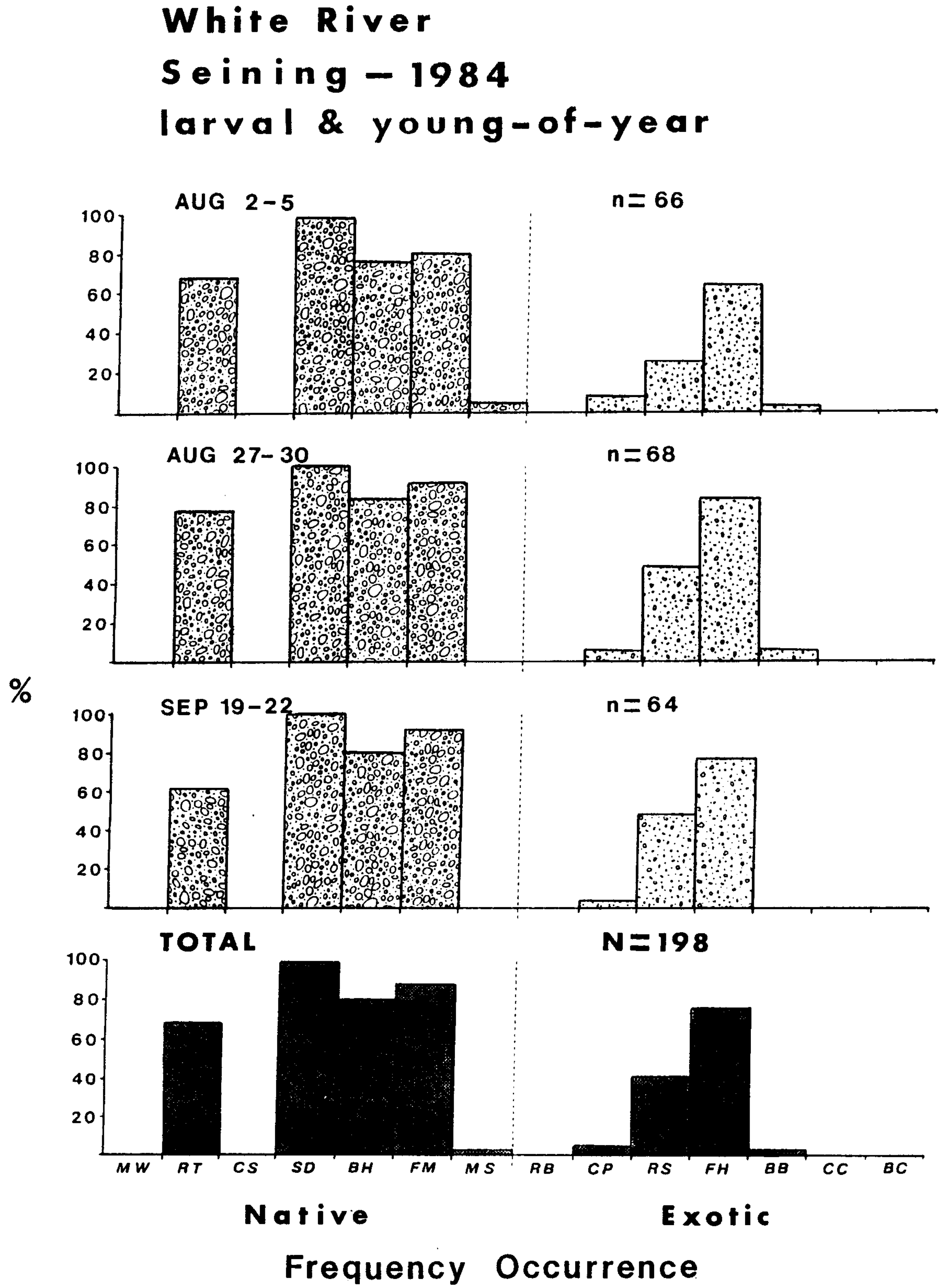


Figure 14. Frequency of occurrence of fish species in seine samples collected during three time periods from RK 193.0 (RM 120.0) to RK 115.5 (RM 71.8) in the White River in 1984.

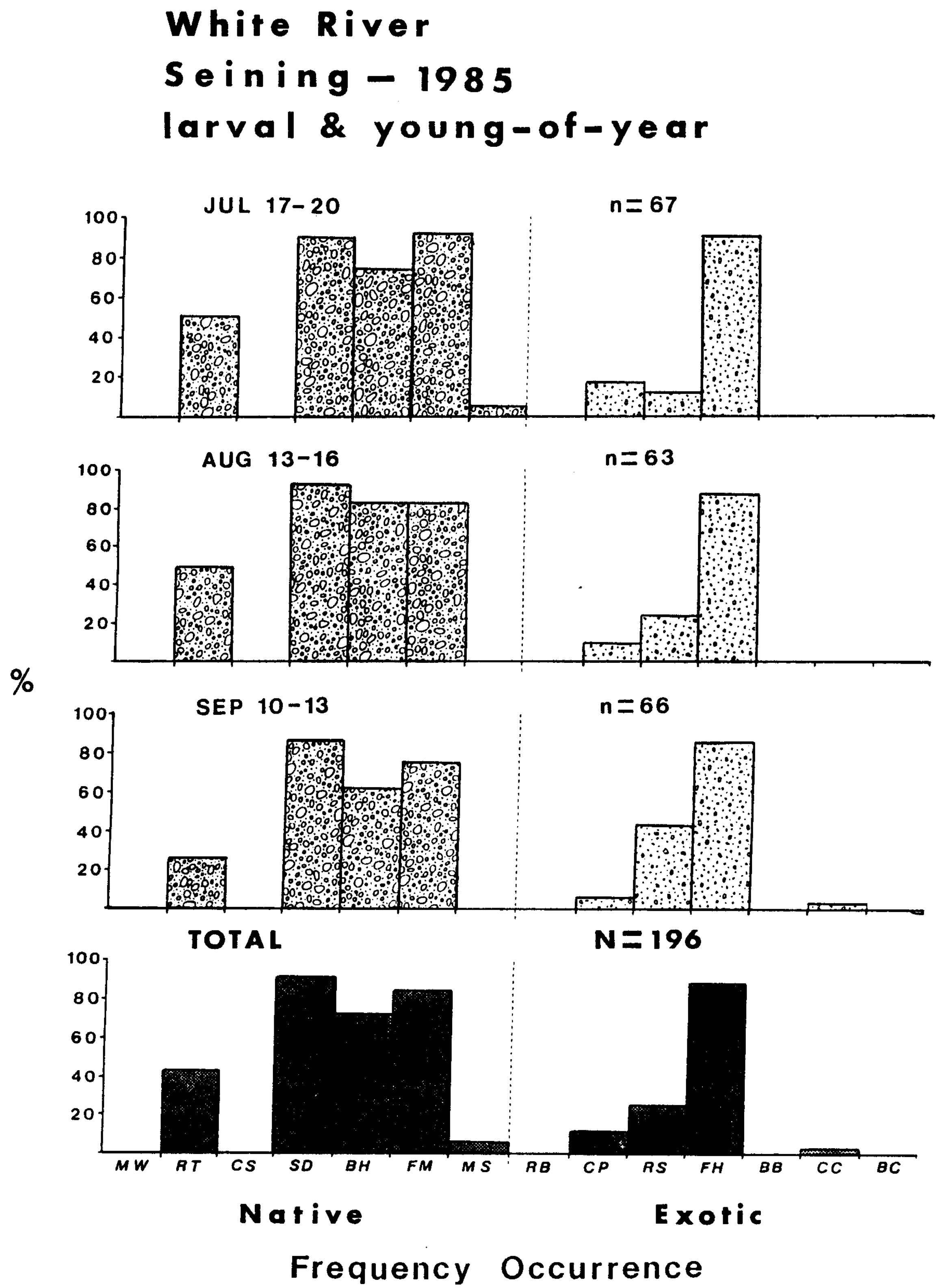


Figure 15. Frequency of occurrence of fish species in seine samples collected during three time periods from RK 193.0 (RM 120.0) to RK 115.5 (RM 71.8) in the White River in 1985.

promelas) was the most widespread exotic species in all years. Their appearance in seine samples increased from 1983 to 1985. Occurring in 27% of the collections in 1983, their incidence increased to 76% in 1984 and up to 90% in 1985. Young-of-year black bullheads (*Ictalurus melas*) and channel catfish (*I. punctatus*) were rarely encountered. Bullheads occurred in only three (2%) of the samples in 1984. Channel catfish appeared in only one sample (1%) in 1985.

Seining was always most productive during the first sampling period, shortly after or during the spawning season of most White River fishes (Carlson et al. 1979), accounting for 40 to 70% of the total catch each year. Percent composition of fish species collected in seine samples showed a dominance by native fishes in all years (Figures 16-18), however, in 1985, there was an obvious increase in the abundance of exotics, namely fathead minnows. The relative abundance of native species fell in 1985 as the fathead minnow became the most common species collected in seine samples.

Larval and YOY bluehead suckers were the most common fishes in 1983 and 1984 comprising over 37% of all fish collected in seine samples. In 1985, this number fell to 21.8% and speckled dace became the most abundant native species accounting for 22.5% of all fish collected. In 1983 (34.3%) and 1984 (24.3%), the speckled dace was the second most common of all species collected. The roundtail

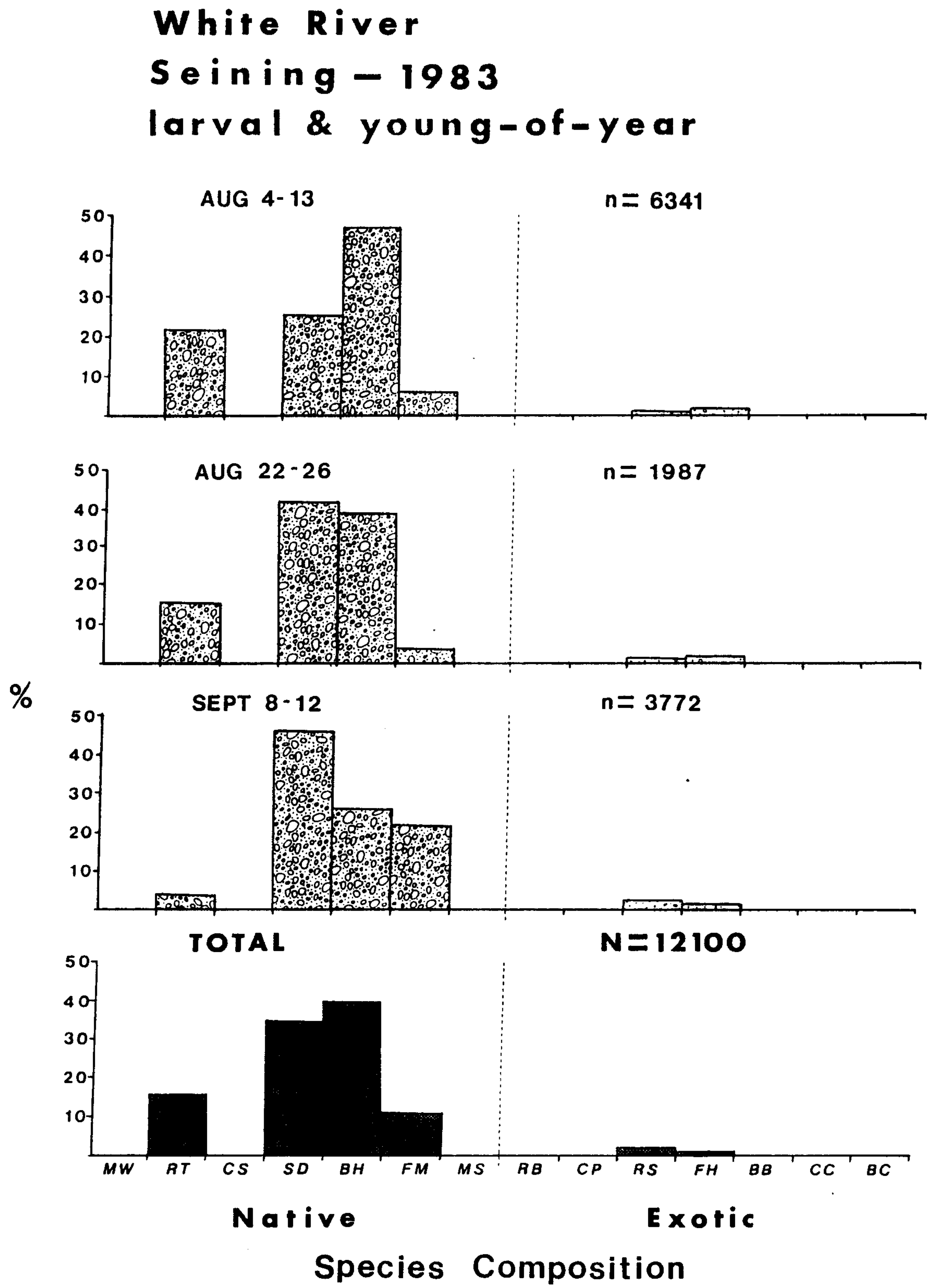


Figure 16. Percent composition of fish species in seine samples collected during three time periods from RK 193.0 (RM 120.0) to RK 115.5 (RM 71.8) in the White River in 1983.

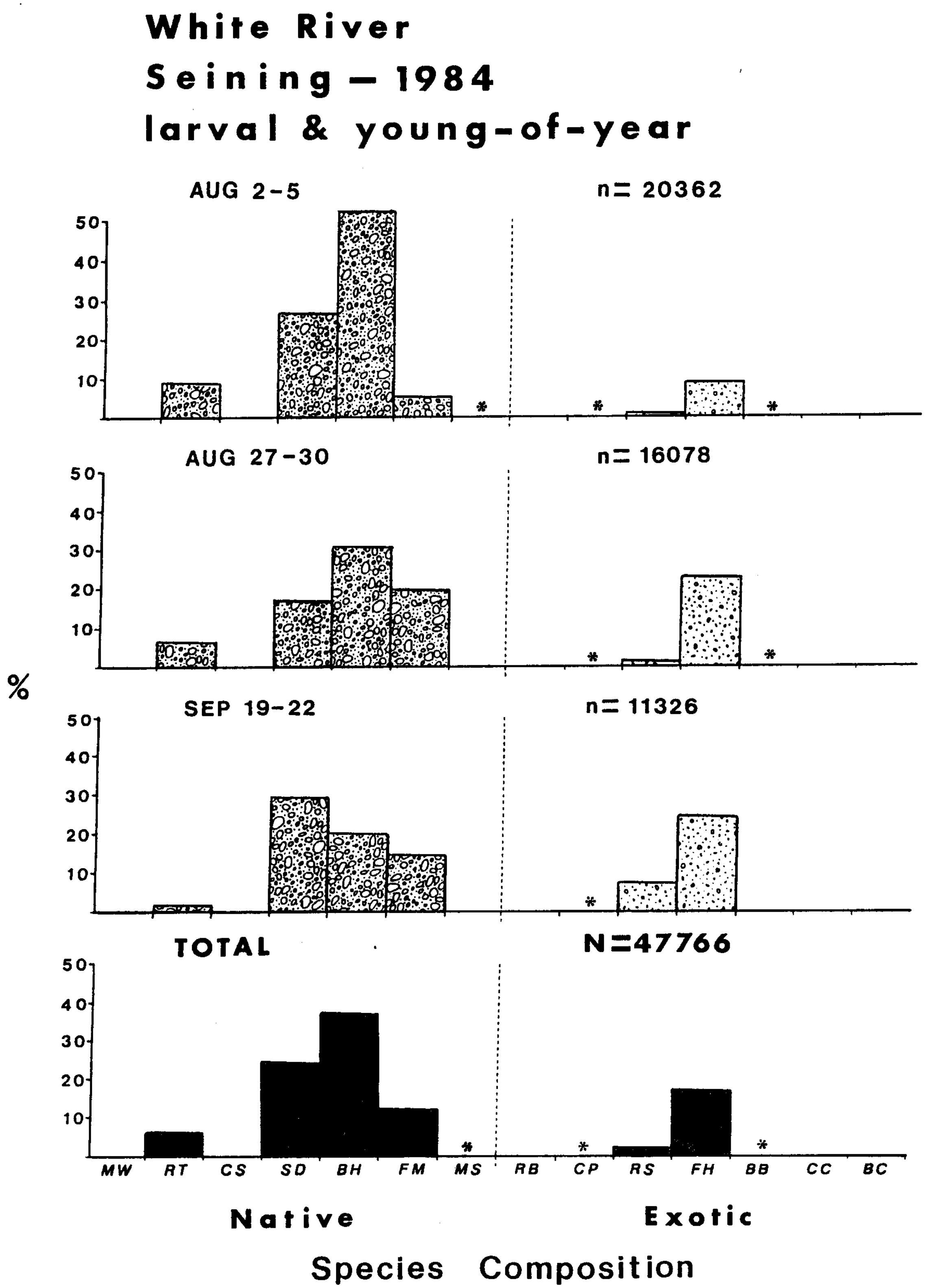


Figure 17. Percent composition of fish species in seine samples collected during three time periods from RK 193.0 (RM 120.0) to RK 115.5 (RM 71.8) in the White River in 1984 (* = <0.1%).

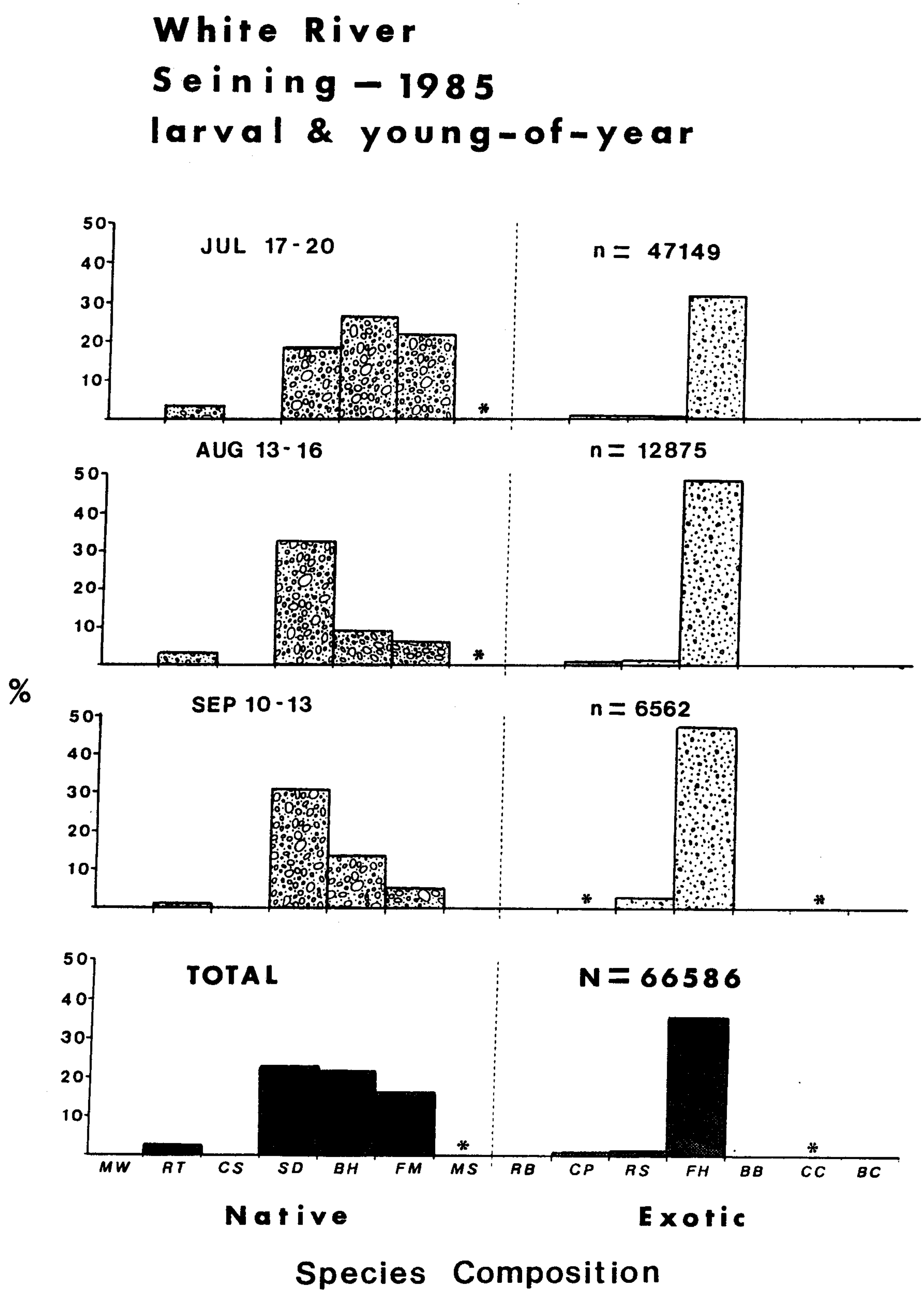


Figure 18. Percent composition of fish species in seine samples collected during three time periods from RK 193.0 (RM 120.0) to RK 115.5 (RM 71.8) in the White River in 1985 (* = <0.1%).

chub exhibited a steady decline in abundance comprising 15.1, 7.4, and 3.5% of the total number of native fish collected by seining in 1983, 1984, and 1985, respectively. Conversely, the flannelmouth sucker displayed a relative jump in abundance among the native fishes in seine samples, increasing from 10.5% in 1983 and 15.3% in 1984 to 26.3% in 1985. Compared to the total number of fish collected in seine samples, roundtails decreased from 14.9 and 6.0 to 2.2% while flannelmouths increased from 10.3 and 12.3 to 16.6% in 1983, 1984, and 1985, respectively (Figures 16-18). Carlson et al. (1979) showed that the flannelmouth sucker was the earliest spawner among White River fishes. The relative increase of flannelmouths in 1985 may be attributed to the earlier sampling in July when more larval and YOY flannelmouths were present prior to reduction through natural mortality (Appendix Table 29).

Absent in 1983 and comprising less than 0.1% of the fish collected in seine samples in 1984 and 1985, the mottled sculpin was the least abundant native species in the area sampled. Incidental seining conducted above RK 217.2 (RM 135.0) in 1984 showed YOY mottled sculpin to be very abundant.

The ictalurids were the least common of the exotic species in seine collections. Black bullheads, absent from seine collections in 1983 and 1985, were present only as sub-adults (3 specimens) in 1984 (Appendix Table 34).

This species has consistently been rare to absent in other recent investigations of the White River (Prewitt et al. 1978, Carlson et al. 1979, Lanigan and Berry 1981, Miller et al. 1982, ERI 1983, Wick et al. 1985). Always present in relatively small numbers in the aforementioned studies, the channel catfish was represented in seine collections by a single YOY specimen in 1985 (Appendix Table 35). Evidently, spawning conditions for both species are very marginal in the White River with recruitment into the population being very low.

Three minnows comprised the remainder of the exotic fish collected in seine samples. Absent from 1983 seine samples, common carp YOY were scarce accounting for less than 0.1% (16 specimens) of all fish seined in 1984 and for 0.1% (91 specimens) in 1985 (Appendix Table 31).

Lanigan and Berry (1981), Miller et al. (1982), and Radant et al. (1983) found red shiners to be the most common species in the White River in Utah. The present study, however, concurred with the results of previous studies conducted in the White River only within Colorado (Prewitt et al. 1978, Carlson et al. 1979) which showed the red shiner to be less than abundant. In 1983, red shiners were slightly more common (0.6%) than fathead minnows (0.4%), the only other exotic collected that year (Figure 16). The fathead minnow was the most abundant exotic species in 1984 and 1985 (Figures 17 and 18).

The dominance by fathead minnows in 1985 seine samples (Figure 18) was directly attributable to the explosive reproduction of this species in Kenney Reservoir. While the fathead minnow occurs widely in rivers and streams, it is not an obligate riverine species and it typically does better in lentic habitats (Holden 1979, Mahon and Ferguson 1981). This small baitfish, attaining a maximum size of only 80 mm TL (3 in.), lays its eggs on the underside of floating or submerged, usually horizontal, objects. Vegetation, rocks, and cliffs, all of which were flooded in large amounts when Kenney Reservoir filled, provide suitable spawning substrate for fatheads.

By partitioning the area sampled by seining into six segments, each approximately 12 km (7.5 mi.) long (Figure 19), seine samples collected within Kenney Reservoir basin were separated from others for comparison. Data from 1983 was not included in this comparison due to the comparatively small sample size.

Figure 20 compares data collected in the six segments in 1984, prior to closure of the dam. Native fishes outnumbered exotics in every segment. In this diagram, fatheads appear to occur in greater numbers in segments 3 (34.9%), immediately below the dam axis, and 6 (34.1%), just above the stateline. In 1985 (Figure 21), fathead minnows clearly displayed their capacity to reproduce in the new environment created by Taylor Draw

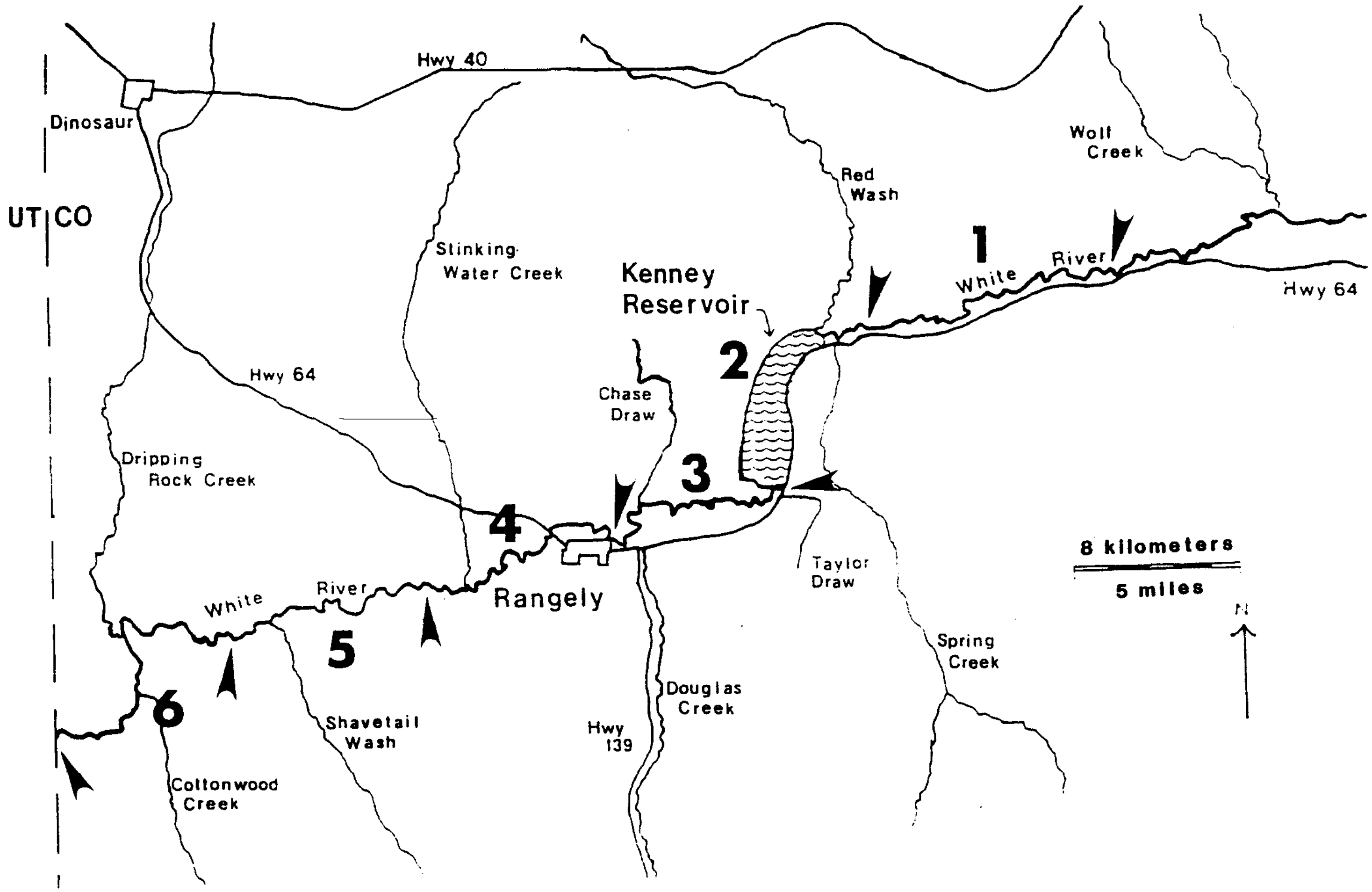


Figure 19. Six 12 km (7.5 mi.) segments for comparison of percent composition of fish species in seine samples collected from RK 193.0 (RM 120.0) to RK 115.5 (RM 71.8) in the White River in 1984 and 1985.

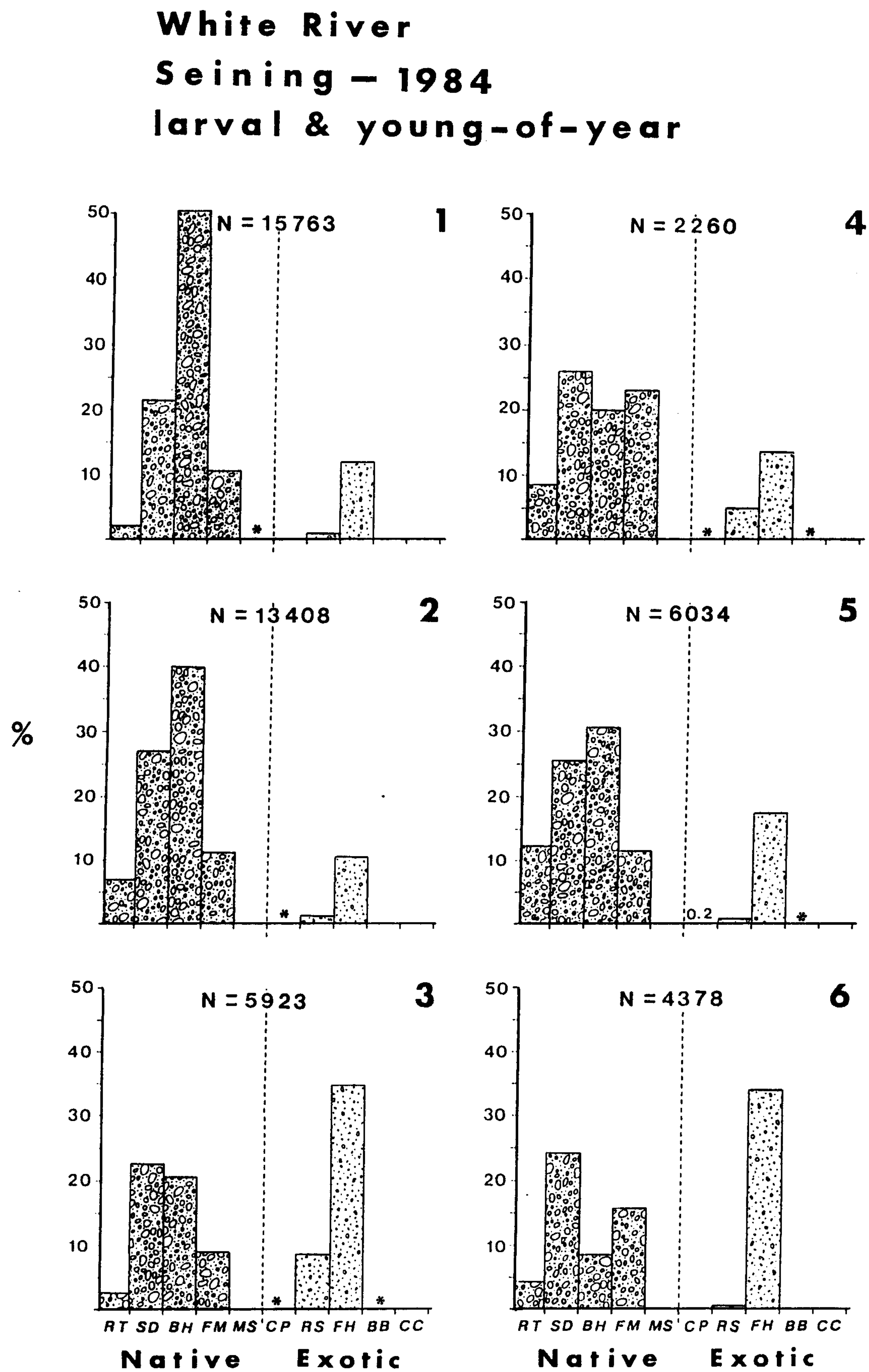


Figure 20. Comparison of percent composition of fish species collected in seine samples in six segments between RK 193.0 (RM 120.0) to RK 115.5 (RM 71.8) in the White River in 1984 (* = <0.1%).

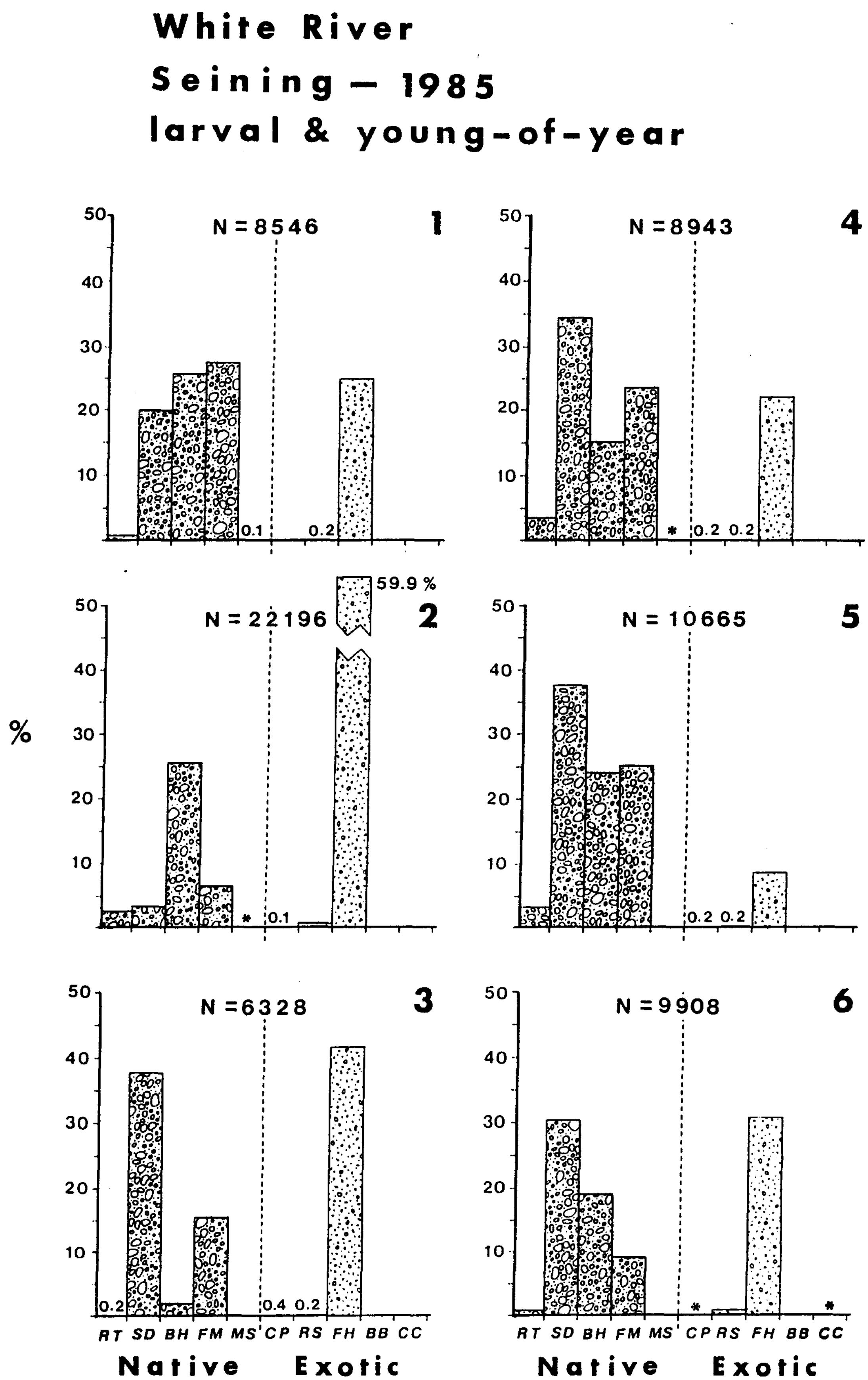


Figure 21. Comparison of percent composition of fish species collected in seine samples in six segments between RK 193.0 (RM 120.0) to RK 115.5 (RM 71.8) in the White River in 1985 (* = <0.1%).

Dam. Constituting 59.9% of the fish seined in Segment 2, fathead minnows dominated the fish community in the newly filled Kenney Reservoir. The elevated percentages of fatheads in segments 3 and 6 in 1984 were also noted in 1985 (42.8 and 31.5%, respectively). As in 1984, native fishes outnumbered exotics in all segments in 1985 except Segment 2.

Over 125,000 fish were collected and identified in 491 seine samples taken from 1983 to 1985. Of the species collected during this study YOY of mountain whitefish (*Prosopium williamsoni*), rainbow trout (*Salmo gairdneri*), brown trout (*Salmo trutta*), or black crappie (*Pomoxis nigromaculatus*) did not appear in seine collections. Most importantly, no larval or YOY Colorado squawfish were found during this study. A single 10 mm TL specimen, collected 5 August 1985 at RK 122.6 (RM 76.2), was identified as roundtail chub, possible Colorado squawfish (personal correspondence, D. E. Snyder, Larval Fish Laboratory, CSU). Certain diagnostic features of the specimen were within the ranges characteristic of Colorado squawfish (Snyder 1981) but overall, they were still more typical of roundtail chub.

While no positively identified larval or YOY Colorado squawfish were collected, their presence should not be precluded. Even though this study represents the most intensive fish sampling effort in this portion of the White River, it is still possible that Colorado squawfish reproduce in the area and that specimens that would verify this simply were not collected. The apparent lack of suitable spawning substrate and the absence of larval or YOY Colorado squawfish in collections made by previous investigators (Carlson et al. 1979, USFWS 1982, ERI 1983, Haynes et al. 1984) suggest, however, that suitable spawning conditions for Colorado squawfish probably do not occur in the White River in Colorado. There appears to be little potential of developing squawfish spawning or YOY rearing areas in the White River in Colorado due to cool water temperatures, consolidation or sedimentation of river substrates, and lack of potential shallow water nursery areas.

Sub-adult and adult fishes

Overall, the results of electrofishing showed little difference in percent species composition from 1983 to 1985, except for the appearance of rainbow trout in 1985. Native fishes clearly dominated the sub-adult and adult fraction of the fish community (Figures 22-24). Except for Colorado squawfish and rainbow trout, sub-adult and adult fishes appeared to be fairly evenly distributed among the areas sampled with no distinct patterns persisting from 1983 to 1985. Sampling effort, based on actual time spent electrofishing in individual 0.8 km (0.5 mi.) sections, was virtually equal in all areas.

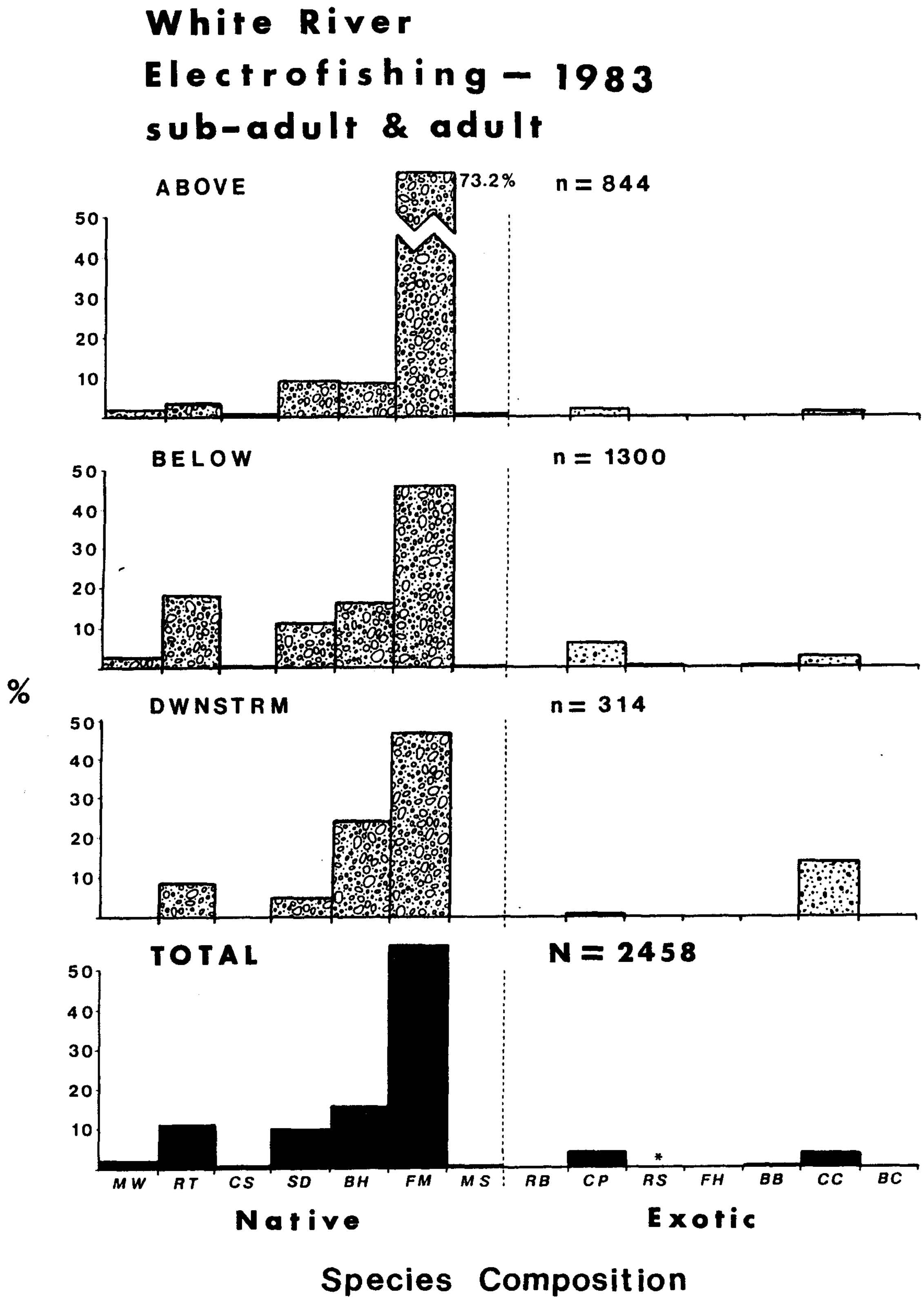


Figure 22. Comparison of percent composition of fish species collected by electrofishing in the White River 8 km (5 mi.) above Kenney Reservoir basin, 8 km below Taylor Draw Dam, and in four 0.8 km (0.5 mi.) section downstream of Rangely in 1983 (* = <0.1%) (Tom Chart unpublished data).

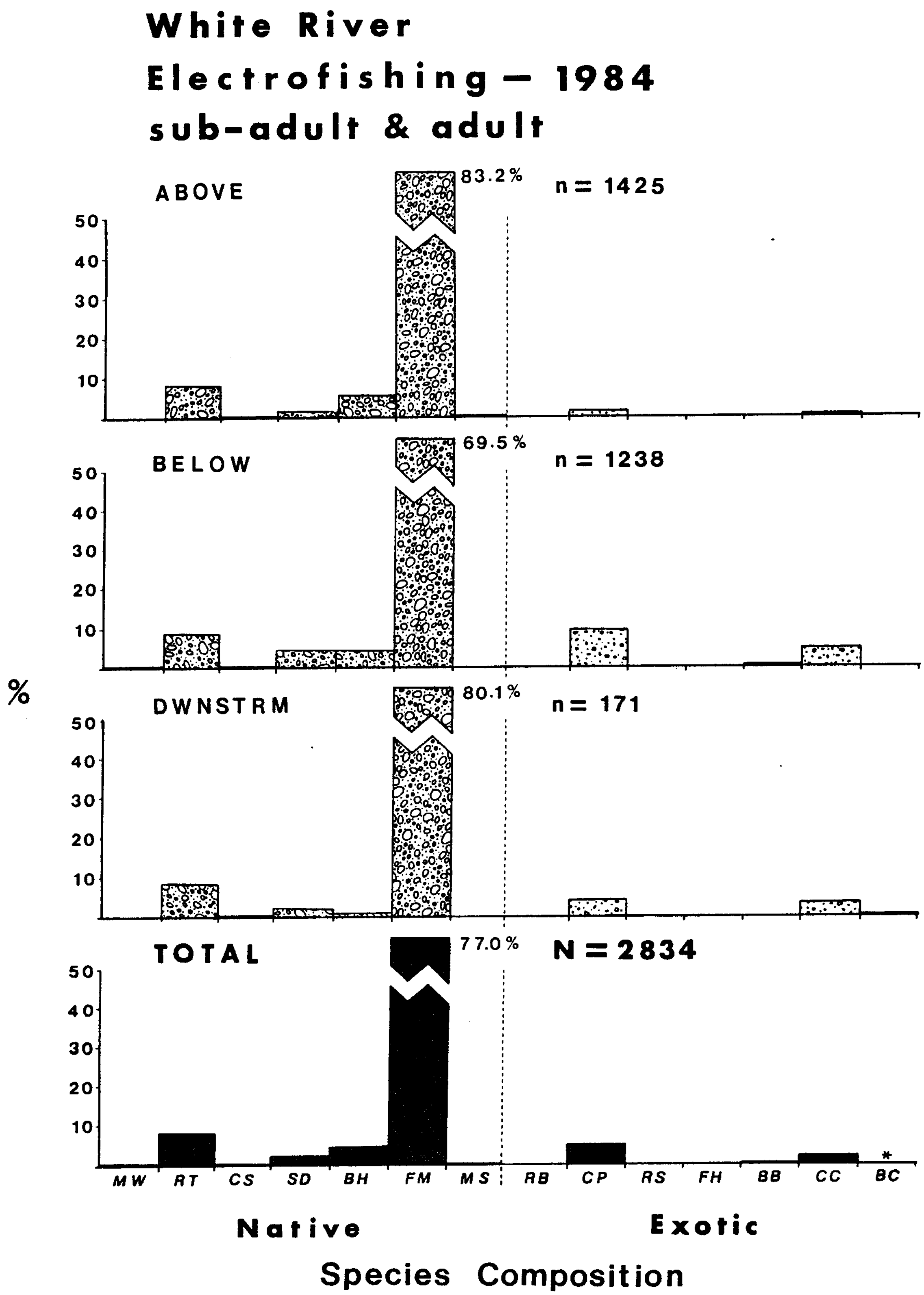


Figure 23. Comparison of percent composition of fish species collected by electrofishing in the White River 8 km (5 mi.) above Kenney Reservoir basin, 8 km below Taylor Draw Dam, and in four 0.8 km (0.5 mi.) section downstream of Rangely in 1984 (* = <0.1%) (Tom Chart unpublished data).

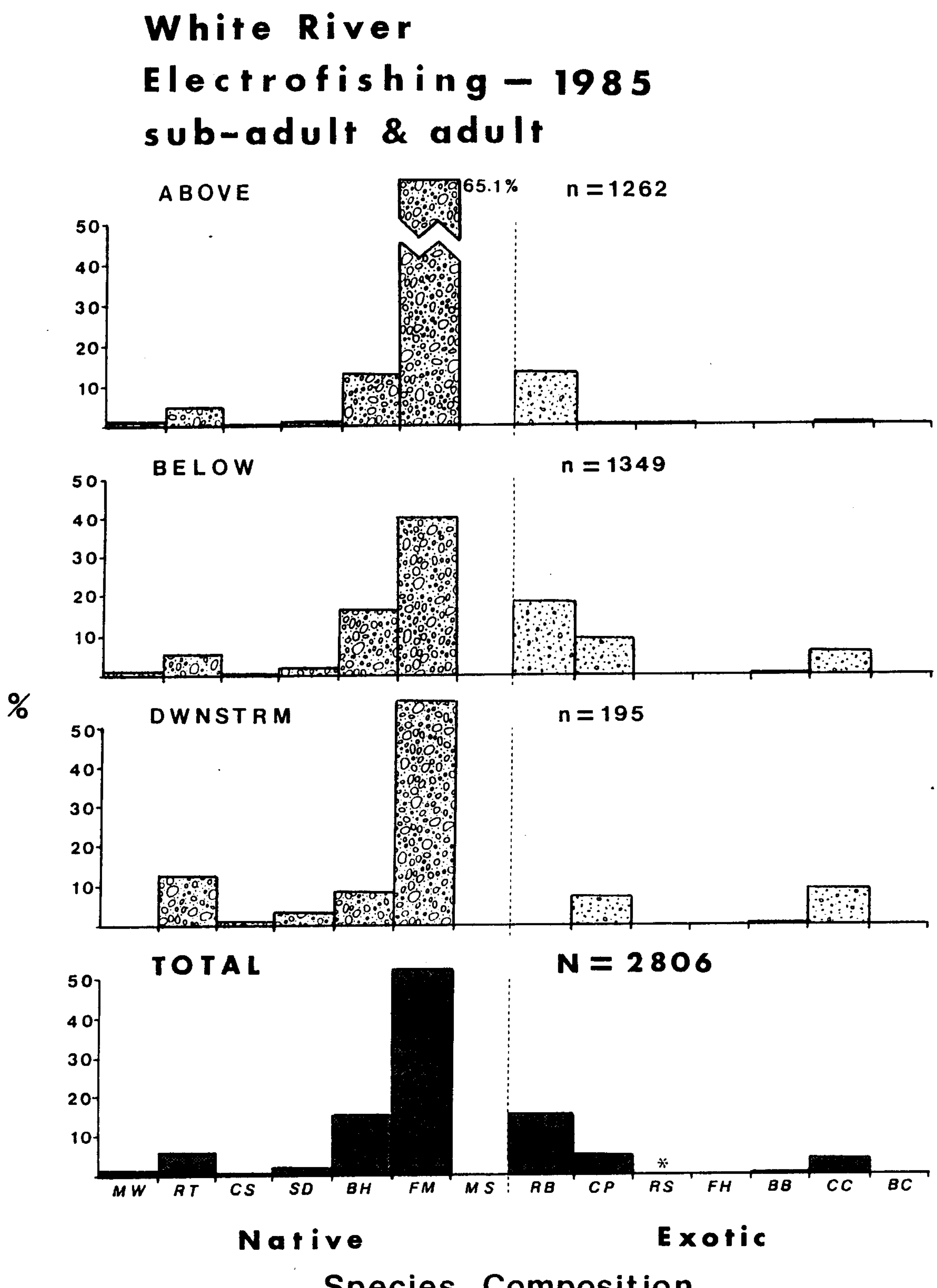


Figure 24. Comparison of percent composition of fish species collected by electrofishing in the White River 8 km (5 mi.) above Kenney Reservoir basin, 8 km below Taylor Draw Dam, and in four 0.8 km (0.5 mi.) sections downstream of Rangely in 1985 (* = <0.1%) (Tom Chart unpublished data).

Electrofishing to evaluate species composition above and below Taylor Draw Dam (axis) and downstream of Rangely resulted in the capture of 16 Colorado squawfish in 1983 (2), 1984 (6), and 1985 (8). Colorado squawfish collected by additional electrofishing efforts are not included in these comparisons. From 1983 to 1985, one specimen was captured above the dam each year. Below Taylor Draw Dam (axis), a total of 9 Colorado squawfish was captured in 1983 (1), 1984 (4), and 1985 (4). The sections downstream of Rangely accounted for four Colorado squawfish; one in 1984 and three in 1985. Eighty percent of the Colorado squawfish captures during this effort occurred below the dam axis with 60% being within the 8 km (5 mi.) below Taylor Draw Dam. Colorado squawfish comprised only 0.1, 0.2, and 0.3% of all fish electrofished during regular sampling in these areas in 1983, 1984, and 1985, respectively (Figures 22-24).

Mountain whitefish were collected only in the spring. This gamefish prefers cold, clear waters and typically occurs in the White River near and above Meeker. Winter water conditions (cold, clear) allow whitefish to range downstream to about Rangely. As runoff approaches and spring flow temperatures and turbidities increase, mountain whitefish return to upstream reaches. The small number of whitefish in 1984 (Appendix Table 13) was probably due to the later commencement date of electrofishing that year after the whitefish had returned upstream. Apparently, whitefish captured below Taylor Draw Dam in 1985 passed over the spillway in early spring thus demonstrating their ability to move through the reservoir (Figure 24).

While individuals of the smaller species, speckled dace, mottled sculpin, and red shiners, were collected by electrofishing, little can be said about their relative abundance or distribution since they are not as suceptible to electrofishing as larger species. Because of this, they are not consistently collected in proportion to their actual abundance by this sampling method. Fathead minnows, which dominated 1985 seine collections, were never collected by electrofishing primarily because they occurred in areas of the river inaccessible to the electrofishing boat. This species prefers warm, shallow waters having little or no current.

Sub-adult and adult flannelmouth suckers were by far the most common of all fish collected by electrofishing comprising 54.8, 77.0, and 52.5% in 1983, 1984, and 1985, respectively (Figures 22-24). Roundtail chubs or bluehead suckers were typically the second most common native species. Together they accounted for 10 to 20% of all fish collected by electrofishing. Interestingly, bluehead suckers, which were the most common species in seine samples in 1983 and 1984, and were very abundant in 1985, were outnumbered 4 to 1 by flannelmouth suckers in electrofishing collections. McAda (1983 and 1985) showed that blueheads and flannelmouths of similar length have similar fecundities. Apparently, suitable spawning conditions are common for bluehead suckers in this portion of the White River but recruitment of YOY into the population is very low. Conversely, adult flannelmouth suckers which are very abundant are not as successful in producing YOY (spawning or hatching), yet conditions in this portion of the river favor survival of many young flannelmouths.

Common carp comprised about 5% of all fish collected by electrofishing each year (Figures 22-24). While Behnke (1981) predicted that carp would become the dominant species in Kenney Reservoir, this was not apparent during this investigation. Also, McConnell et al. (1984) suggested that the habitat conditions in Kenney Reservoir would be highly favorable for carp. If carp do proliferate in the reservoir, they can be expected to increase in number in the adjacent White River, particularly downstream.

Black bullheads, as in seine samples, were very rare in electrofishing collections during this study. Generally, catfish are not as susceptible to electrofishing as scaled fish species, however, due to the relative shallowness of the White, they were probably sampled relative to their actual abundance. The popular gamefish, the channel catfish, accounted for only 3.5, 2.5, and 3.7% of all fish collected by electrofishing in

1983, 1984, and 1985, respectively. Behnke (1981) predicted that growth and abundance of channel catfish should increase in the reservoir, however, unless stocked, there is little reason to expect an increase of this species in the river due to the reservoir.

The single black crappie (150 mm TL) collected in 1984 was either released by a fisherman or it escaped from Rio Blanco Reservoir. This is the first record of a centrarchid collected in the White River in Colorado. Lanigan and Berry (1981), Miller et al. (1982), and ERI (1983) reported collecting small numbers of green sunfish (*Lepomis cyanellus*) from the lower White River in Utah. Miller et al. (1982) also reported very small numbers of smallmouth bass (*Micropterus dolomieui*), which probably came from the Green River, near the mouth of the White River.

Rainbow trout were first collected in the study area by electrofishing in the White River in 1985. This gamefish was first stocked in Kenney Reservoir by WUA1 and CDOW in September, 1984. Rainbows were stocked again in 1985 by CDOW and in 1986 by USFWS and WUA1. Due to the "benign" nature of salmonids (inabiliity to proliferate due to habitat requirements), CDOW and USFWS deemed it permissible to introduce this exotic species into occupied Colorado squawfish range to provide sportfishing in Kenney Reservoir.

Electrofishing in 1985 resulted in the capture of 170 rainbow trout above Kenney Reservoir and 254 below Taylor Draw Dam. None were captured in the sections downstream of Rangely. Rainbow comprised 15.1% of all fish captured by electrofishing in 1985. Spring electrofishing for Colorado squawfish showed that rainbow trout had moved 32 km (20 mi.) upstream of Kenney Reservoir by June, 1985. It is difficult to predict how far rainbows will travel upstream since ideal trout habitat in the White River occurs above Meeker. Below Taylor Draw Dam, rainbow trout appear to range only 16 km (10 mi.) downstream to Rangely. The temperature and turbidity of the White River below Rangely will probably limit downstream movement of rainbows. Even if they range further downstream during the winter, they will be eliminated by sediment laden spring flows.

Native vs exotic species

The White River in the area sampled during this study was dominated by native species. This is in stark contrast to the White River in Utah where Lanigan and Berry (1981) found the fish community to consist of 71.5% exotics and 28.5% native species in 1978 and 1979. Native fishes comprised 74.0% of all fish collected from 1983 to 1985 while exotics accounted for 26.0% (Table 5). Miller et al. (1982) also found the fish community in Colorado to be dominated by native fishes while exotics dominated in

Table 5. Total numbers of fish collected during seining and electrofishing to evaluate species composition in the White River in Colorado, 1983-85. Percentage of total number captured is given in parentheses.

Species	Year 1983	Year 1984	Year 1985	Total fish captured
NATIVE				
Mountain whitefish	49	2	31	82
Prosopium williamsoni	(0.3)	(<0.1)	(<0.1)	(<0.1)
Roundtail chub	2092	3088	1626	6806
Gila robusta	(14.4)	(6.1)	(2.3)	(5.1)
Colorado squawfish	2	6	8	16
Ptychocheilus lucius	(<0.1)	(<0.1)	(<0.1)	(<0.1)
Speckled dace	4387	11686	15017	31090
Rhinichthys osculus	(30.1)	(23.1)	(21.6)	(23.1)
Bluehead sucker	5111	18244	14957	38312
Catostomus discobolus	(35.1)	(36.1)	(21.5)	(28.5)
Flannelmouth sucker	2600	8071	12550	23221
Catostomus latipinnis	(17.9)	(16.0)	(18.0)	(17.3)
Mottled sculpin	5	12	7	24
Cottus bairdi	(<0.1)	(<0.1)	(<0.1)	(<0.1)
Total Native	14246	41109	44196	99551
	(97.9)	(81.3)	(63.7)	(74.0)
EXOTIC				
Rainbow trout	-	-	424	424
Salmo gairdneri	-	-	(0.6)	(0.3)
Common Carp	95	163	231	490
Cyprinus carpio	(0.7)	(0.3)	(0.3)	(0.4)
Red shiner	78	1044	297	1419
Notropis lutrensis	(0.5)	(2.1)	(0.4)	(1.0)
Fathead minnow	50	8203	24137	32390
Pimephales promelas	(0.3)	(16.2)	(34.8)	(24.1)
Black bullhead	2	7	2	11
Ictalurus melas	(<0.1)	(<0.1)	(<0.1)	(<0.1)
Channel catfish	87	72	105	264
Ictalurus punctatus	(0.6)	(0.1)	(0.1)	(0.2)
Black crappie	-	1	-	1
Pomoxis nigromaculatus	-	(<0.1)	-	(<0.1)
Total Exotic	312	9491	25196	34999
	(2.1)	(18.7)	(36.3)	(26.0)
TOTAL FISH	14558	50600	69392	134550
	(100)	(100)	(100)	(100)

Utah. The relative abundance of native fishes during this study would have been even higher had it not been for the explosive reproduction of non-native fathead minnows in Kenney Reservoir in 1985. Both Lanigan and Berry (1981) and Miller et al. (1982) showed that the fish community in the White River was more native closer to Colorado. Lanigan and Berry (1981) believed that exotic species were replacing native species in the lower White River.

Rio Blanco Reservoir is an off-stem impoundment (47 ha, 116 surface acres) fed by a diversion ditch from the White River at RK 243.0 (RM 151.0). This reservoir, built (1965), owned, and managed by CDOW, was stocked with non-native coolwater and warmwater gamefish in the early 1970's (Table 6). None of the species stocked in Rio Blanco, except the ictalurids, were ever reported in the White River in Colorado until the single black crappie was collected below Rangely in 1984. Vandals drained the lake in February, 1981 drawing it down to 4 ha (10 surface acres). Channel catfish were present in the White River long before Rio Blanco Reservoir was built (Lemons 1955). A rancher reported catching a northern pike (*Esox lucius*) in an oxbow pond (RK 222.0, RM 138.0) along the White River 19.3 km (12 mi.) downstream of Rio Blanco Reservoir during high water in 1983. This was the species most likely to escape Rio Blanco Reservoir and establish in the river. Regrettably, northern pike moved out of

Table 6. Recent occurrence (1980's) of fish species historically present in Rio Blanco Reservoir and those established in the White River.

Species		Exotic[a]	Recent	White
Scientific name	Common Name	species	(1980's)	River
SALMONIDAE	Trout			
Oncorhynchus nerka	kokanee salmon	X		
Salmo gairdneri	rainbow trout	X	X	
ESOCIDAE	Pike			
Esox lucius	northern pike	X	X	
CYPRINIDAE	Minnows			
Cyprinus carpio	common carp	X	X	X
Gila robusta	roundtail chub			X
CATOSTOMIDAE	Suckers			
Catostomus discobolus	bluehead sucker			X
Catostomus latipinnis	flannelmouth sucker		X	
ICTALURIDAE	Catfish			
Ictalurus melas	black bullhead	X		X
Ictalurus punctatus	channel catfish	X		X
CENTRARCHIDAE	Sunfish			
Lepomis macrochirus	bluegill	X	X	
Micropterus dolomieui	smallmouth bass	X		
Micropterus salmoides	largemouth bass	X	X	
Pomoxis nigromaculatus	black crappie	X	X	
PERCIDAE	Perch			
Perca flavescens	yellow perch	X	X	

[a] species introduced into the Colorado River Basin (non-native)

Elkhead Reservoir near Craig and became established in the Yampa River. This piscivore may pose a serious competitive threat to Colorado squawfish and may become established in Yampa Canyon thus threatening Colorado squawfish YOY production. In either case, the northern pike exemplifies the concern of establishing non-native predators in habitats occupied by threatened and endangered species.

The swift, turbid, cool water in the White River represents harsh transitional fish habitat between the coldwaters above Piceance Creek and the warmwaters below Rangely. If fish escaped Rio Blanco Reservoir, they probably encountered inhospitable habitat and did not survive. If fish now escape Rio Blanco Reservoir and survive the trip in the White River to Kenney Reservoir they will find suitable habitat. Behnke (1981) suggested that northern pike would establish and do well in Kenney Reservoir.

Behnke (1981) predicted that native roundtail chubs and flannelmouth suckers would increase in abundance and growth rate in Kenney Reservoir. Electrofishing and gillnetting in the reservoir in April 1986, prior to spring stocking of trout, showed a dominance by these two species. Flannelmouths, roundtails, and rainbows comprised approximately 40, 30, and 20% of the 338 total fish collected, respectively. The remaining 10% consisted of 13 bluehead suckers, 18 carp, two channel catfish, and one fathead minnow.

Holden (1979) reasoned that while native fish may be abundant for several years after impoundment, these obligatory riverine species tend to decline in time as they are not adapted to life in reservoirs. The outcome of this ecological relationship in Kenney Reservoir will depend largely on the biological response by fish to the new impoundment. If the reservoir ecologically represents a large instream pool, native suckers and chubs will flourish. If the reservoir functions as a true lentic habitat, opportunistic exotics such as carp will proliferate. Because of the low retention time of this mainstem reservoir, it will probably simulate, to some extent, a vast instream pool. Holden (1979) also pointed out that the initial incidence of native fishes serves as a competitive buffer against proliferation of unwanted exotic species allowing game fish to establish.

Colorado Squawfish

Distribution and abundance

A total of 41 Colorado squawfish was captured in the study area by all sampling efforts combined in 1983 (11), 1984 (12), and 1985 (18). An additional 21 specimens were momentarily stunned while electrofishing, but could not be captured (Table 7). All capture and tagging information

Table 7. Numbers of Colorado squawfish captured, sighted, and implanted in White River in Colorado, 1983-85.

	1983	1984	1985	Total
Captured	11	12	18	41
Sighted	3	5	13	21
Total	14	17	31	62
Implanted	4	5	6	15

for Colorado squawfish handled during this study are compiled in Appendix Tables 15-17. Appendix Tables 23-25 summarize available capture site notes recorded at the time and location of the collection.

Figure 25 shows that Colorado squawfish were more abundant below Taylor Draw Dam (axis) than above. Of the 62 Colorado squawfish accounted for by capture or sighting, only 13% (8) occurred above the dam axis while 87% (54) occurred between the dam site and the CO/UT stateline. May (1970), Carlson et al. (1979), Wick et al. (1981), and Miller et al. (1982) all reported Colorado squawfish captures above the Taylor Draw confluence but they were collected in very small numbers. Behnke (1981) suggested that the White River above the reservoir basin might provide habitat for 10 - 20 adult squawfish. While population estimation techniques could not be employed above or below the dam axis due to the realitively low numbers of Colorado squawfish captured and lack of recaptures, observations made during this study indicated that Behnke's estimate is probably slightly low.

Forty three (69%) of the 62 occurrences were within the 16 km (10 mi.) below the dam axis (between Taylor Draw Dam and Rangely) suggesting a preferred area for Colorado squawfish. Miller et al. (1982), while showing an increasing incidence of Colorado squawfish downstream in five segments of the White River (Strata V-Z) from Rio Blanco Reservoir (RK 150.0, RM 241.4) to the Green River

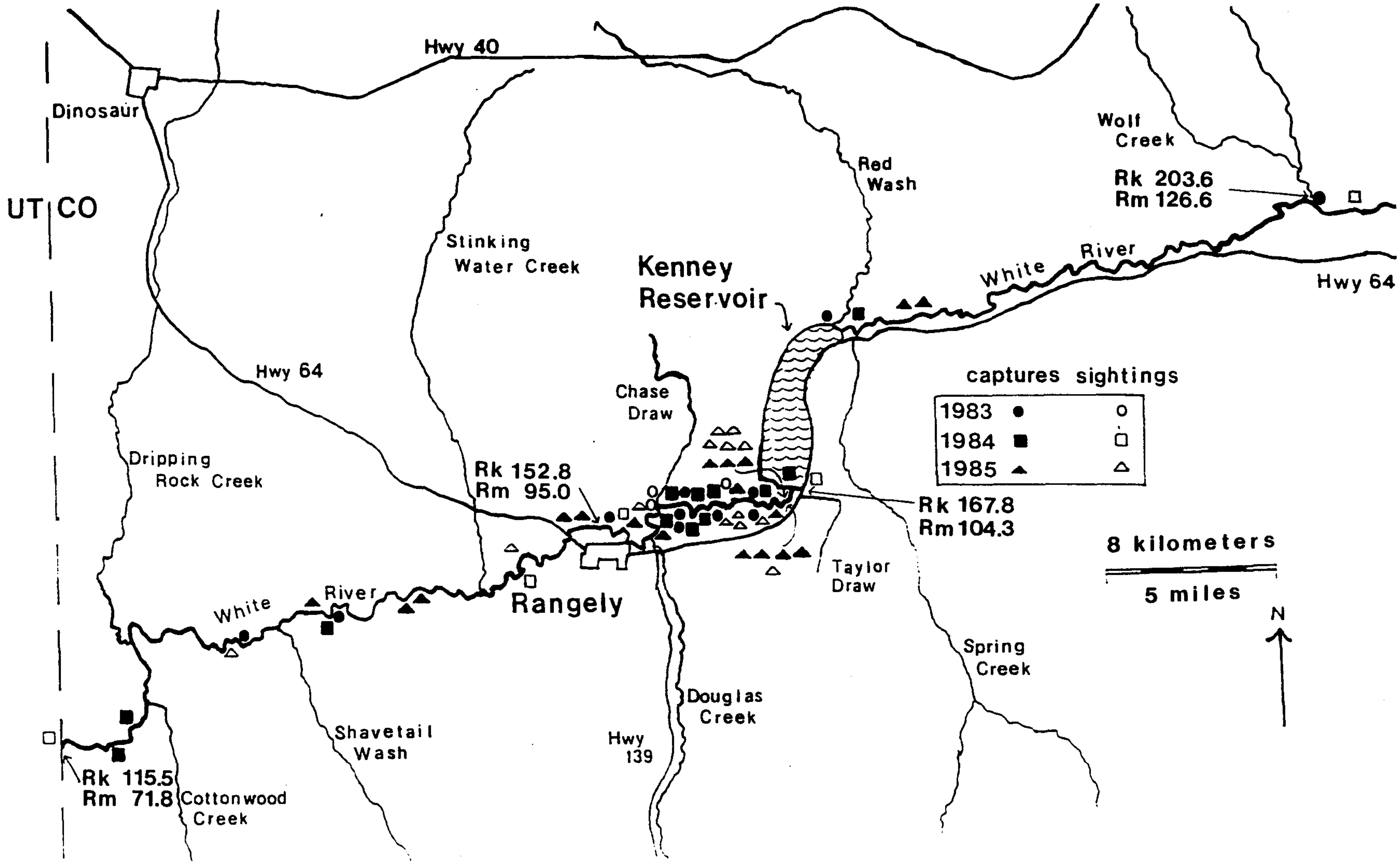


Figure 25. Distribution of Colorado squawfish captures and sightings in the White River in Colorado, 1983-85.

confluence (RK 0.0, RM 0.0), did not encounter large numbers of squawfish between the dam site and Rangely. They did, however, show a slightly elevated catch-per-unit-effort (CPUE) for Colorado squawfish in the stratum (W; 0.3/h) which included the 16 km concentration area in the present study and lower CPUE's in the adjacent upstream (V; 0.1/h) and downstream (X; 0.2/h) segments.

The maximum upstream extent of Colorado squawfish in the White River was reported by Carlson et al. (1979). Two adult specimens were collected at RK 243.0 (RM 151.0) near Rio Blanco Lake in May 1977. Use of the White River by Colorado squawfish appeared extensive, even during low-flow years (Wick et al. 1985).

Closure of Taylor Draw Dam will exclude Colorado squawfish from approximately 80 km (50 mi.) of suitable habitat in future years. Colorado squawfish remaining above the dam will gradually disappear. In Colorado, endangered Colorado squawfish presently occupy roughly 80 km (50 mi.) of the Colorado, 65 km (40 mi.) of the Gunnison, 130 km (80 mi.) of the White, and 240 km (150 mi.) of the Yampa (approximately 515 km, 320 mi.). Unless Colorado squawfish are passed or stocked above Taylor Draw Dam, their disappearance in that portion of the White River will represent the loss of approximately 16% or one sixth of the Colorado squawfish range currently documented for Colorado.

Movements and migrations

Of the 41 Colorado squawfish captured during this investigation, 15 were implanted with radiotransmitters (Table 7). All, except one specimen (#1616) implanted in 1983, provided movement information through subsequent radio contact. Appendix Tables 19-22 summarize all radio contacts for 1983, 1984, and 1985. Additional movement data were provided by recapture of Carlin-tagged Colorado squawfish that were not implanted with transmitters.

Tyus and McAda (1984) discussed three types of behavior among Colorado squawfish implanted in the Green, White, and Yampa rivers. The first, steady downstream, possibly passive, movement is indicative of a fish in poor condition (possibly due to surgery induced physiological stress). All fish handled during this study appeared vigorous upon release after implanting, however, specimen #04039 was bleeding very slightly from its surgical incision when released. This fish, captured 1 August 1985 and released just below Taylor Draw Dam, was located 36.4 km (22.6 mi.) downstream one week later (Appendix Table 22). Radio searches in October and November found this specimen at that same location. Because of the apparent lack of movement, this fish was presumed dead but attempts to recover the carcass failed.

The other two types of movements among implanted Colorado squawfish were related to the degree of sexual maturity (Tyus and McAda 1984). Colorado squawfish mature at a length of 450 to 500 mm TL (18-20 in.) at Age VI or VII (Behnke and Benson 1983). Immature Colorado squawfish are sedentary displaying relatively localized movements. Conversely, adult fish are highly mobile and may undertake extensive spawning migrations (Tyus and McAda 1984). Because all of the fish implanted during this study exceeded 500 mm TL (517-744 mm TL), the movements observed were probably representative of adult Colorado squawfish in the White River.

Based on length frequency (Figure 26), the majority of the Colorado squawfish captured and sighted during this study were adults. Several of these fish had robust body configurations indicative of advanced gonadal development. While none of the Colorado squawfish handled were ripe (no eggs or milt expressed) one specimen captured 30 June 1985 was heavily tuberculated (Appendix Table 17) suggesting readiness for or recent participation in spawning. The smallest specimen, 380 mm TL, and several other smaller individuals were obviously sub-adults having slender bodies with no gonadal development apparent externally. Two of the Colorado squawfish which were sighted while electrofishing, but could not be captured in 1985 (Appendix Table 18) were very near the maximum sizes reported for this species in recent years (Behnke and Benson 1983).

Figure 27 shows an overall pattern of downstream movement of adult Colorado squawfish captured in the White

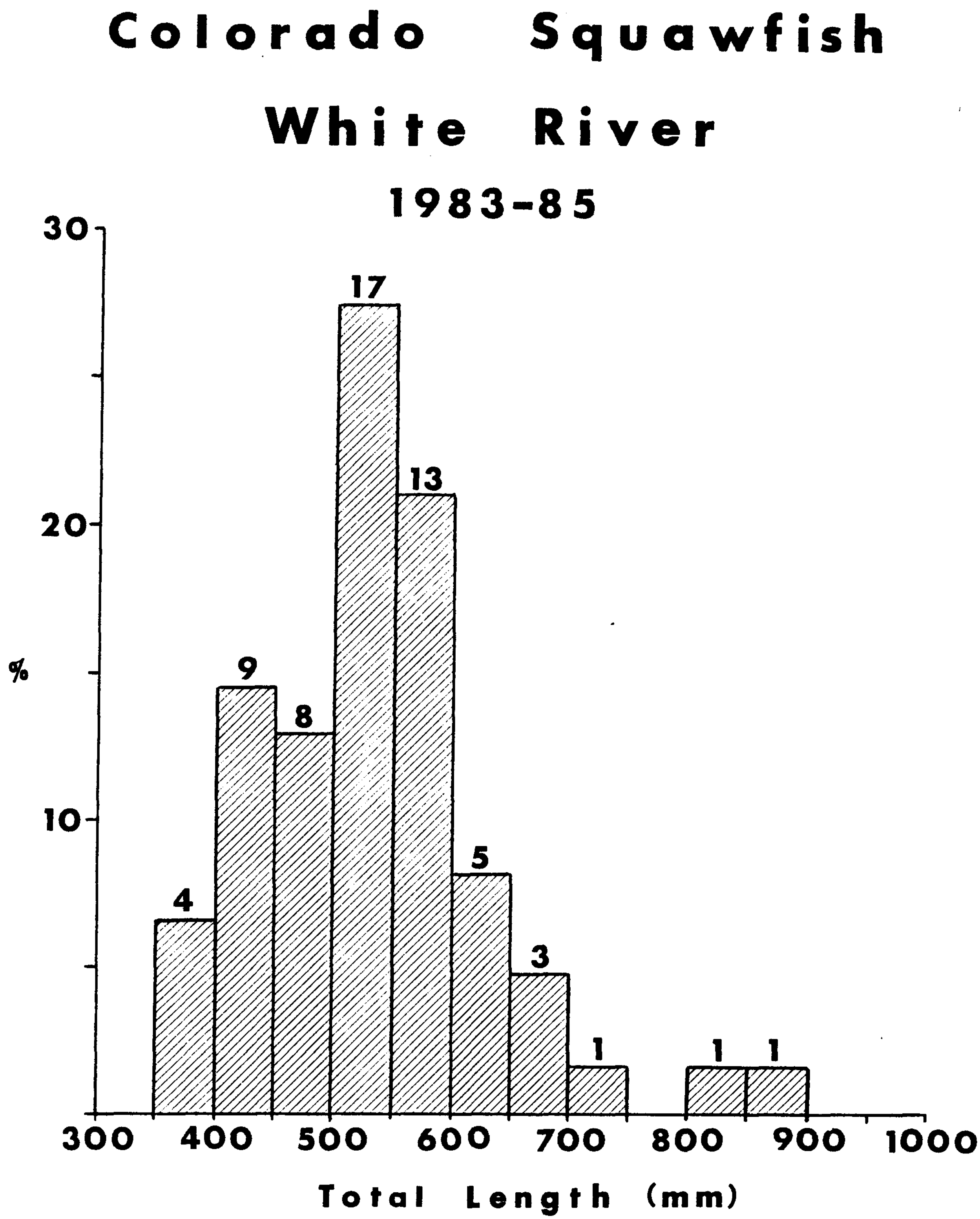


Figure 26. Length frequency of Colorado squawfish captured and sighted in the White River in Colorado, 1983-85.

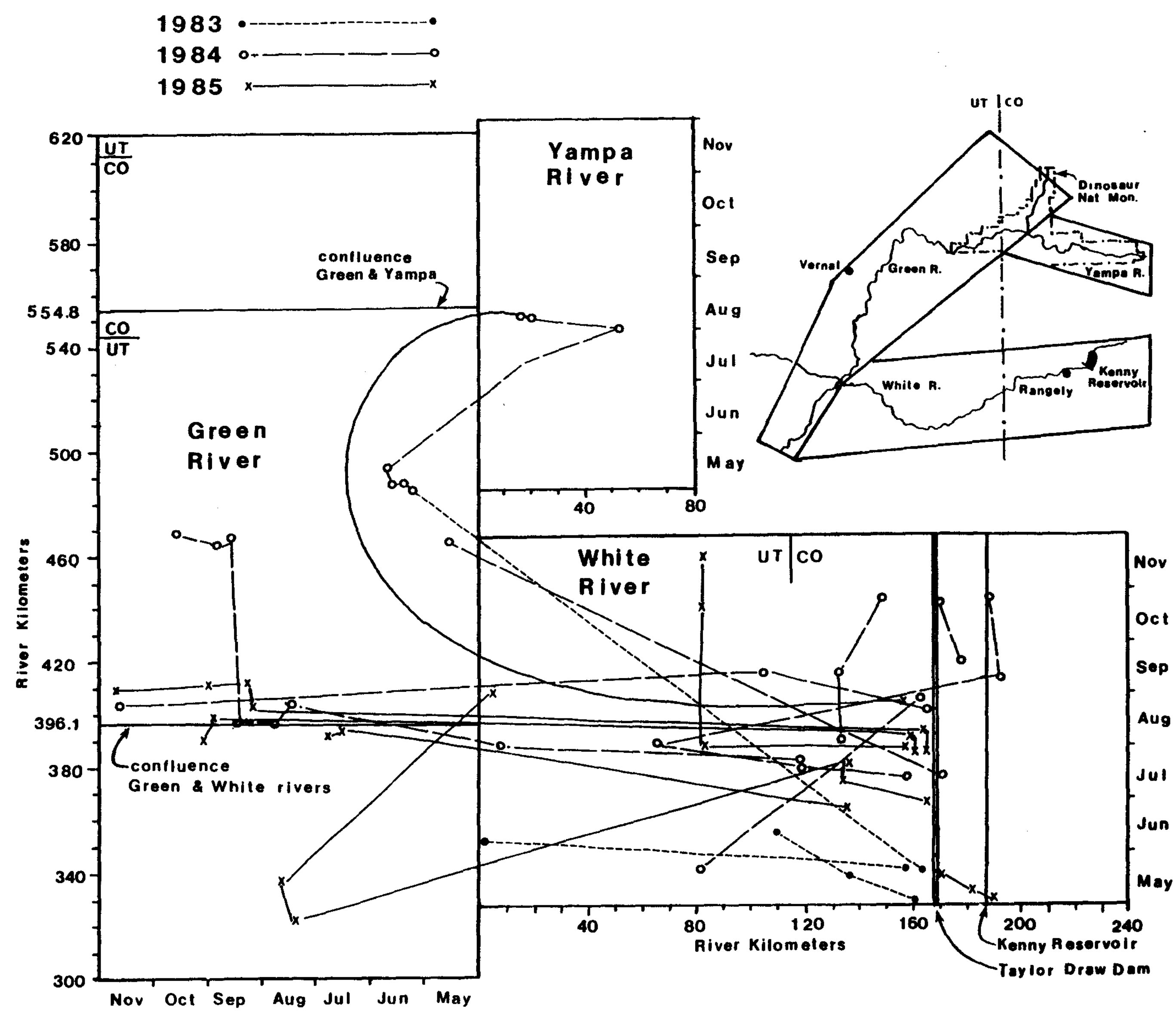


Figure 27. Movements of Colorado squawfish tagged and implanted in the White River, 1983-85, monitored by radiotelemetry and capture-recapture.

River in Colorado. Seven of the Colorado squawfish implanted during this study entered the Green River. Specimens #04033, #04036, #04037, and #04038 were last contacted in the Green River near the mouth of the White River. Fish #04031 moved more than 70 km (45 mi.) up the Green River after leaving the White River. A non-telemetered specimen, #1718, originally captured 16 July 1984 at RK 168.4 (RM 104.7) just above the Taylor Draw Dam axis, and recaptured by CRFP personnel 13 May 1985 at RK 472.7 (RM 293.8) in the Green River had also moved over 70 km (43.5 mi.) upstream from the White River confluence (RK 396.1, RM 246.2).

Two individuals entering the Green River, #1642 and #04040, provided valuable insight and support for existing data regarding the relationship of squawfish in the White River to the squawfish population in the Upper Basin. These specimens also support the homing hypothesis proposed for Colorado squawfish by Tyus (1984). He provided evidence showing Colorado squawfish migrating to two spawning sites, one in Gray Canyon of the Green River and the other in Yampa Canyon of the Yampa River. Migrations by these specimens also lend credence to the idea of Colorado squawfish returning to "home ranges" after spawning (Radant et al. 1983, Wick et al. 1983).

Fish #1642, originally captured and implanted a few kilometers below the Taylor Draw Dam axis in May 1983, was not contacted until June 1984. CRFP personnel monitored the movement of this fish by radiotelemetry as it travelled up the Green River and entered the Yampa River in July, 1984. On 17 July 1984, this fish was recaptured by a CRFP crew monitoring Colorado squawfish activity in the vicinity of documented spawning areas in Yampa Canyon, Dinosaur National Monument (Archer and Tyus 1984, Tyus and McAda 1984). This individual had migrated over 375 km (230 mi.) to reach one of the few known spawning areas available to the species in the upper basin. Remarkably, this fish was recaptured by an angler in the White River 27 August 1985 at RK 157.7 (RM 98.0), about 8 km (5.0 mi.) downstream from its original 1983 capture site. Travelling over 700 km (450 mi.) in three rivers during a three year period, this fish had apparently returned to its "home range" in the White River near Rangely (Appendix Table 20) suggesting a fidelity to a certain river reach ("home range"). Wick et al. (1983) also reported a multiple-river migration for a Colorado squawfish originally tagged in the White River above the present Taylor Draw Dam site. This fish (#1804) initially captured in the White River in September 1981 (Radant et al. 1983) at RK 218.8 (RM 136.0) travelled 405.4 km (251.9 mi.) to the Yampa River where it was recaptured 31 July 1982 at RK 27.5 (RM 17.3) in the presence of other mature Colorado squawfish exhibiting spawning behavior. Radant et al. (1983) tracked a Colorado squawfish (#3057) implanted 24 June 1982 at RK 27.7 (RM 17.2) in the White

River to the Yampa River at RK 8.2 (RM 5.1) on 21 July 1982 immediately below a confirmed spawning site. This specimen was last contacted in the Green River in September of the same year a few kilometers above the Yampa confluence.

Fish #04040, captured just below Taylor Draw Dam 30 June 1985, travelled downstream approximately 242 km (150 mi.) in two weeks to documented spawning areas at Three Fords Rapids in upper Gray Canyon of the Green River. This individual, apparently returning upstream after spawning, was last contacted in the White River at RK 6.4 (RM 4.0). Miller et al. (1982) reported similar behavior for a Colorado squawfish (#1624) captured 29 May 1981 at RK 109.4 (RM 68.0) in the White River. This specimen travelled down the White and Green rivers to Gray Canyon, supposedly spawned, and returned to RK 80.5 (RM 50.0) of the White River by 15 October 1981. This fish moved a total of 611 km (382 mi.) in five months. Another Colorado squawfish (#3051) captured and implanted in the same area of the White River (RK 103.5, RM 64.3) as the specimen monitored by Miller et al. (1982) on 16 June 1982 (Radant et al. 1983) also moved to the Gray Canyon spawning site. This specimen, located at RK 250.7 (RM 155.8) of the Green River on 13 July 1982 in the presence of other ripe Colorado squawfish, apparently spawned and was last located up the Green River at RK 347.2 (RM 215.8) on 24 November 1982.

It appears that mature Colorado squawfish in the White River can migrate to the Gray Canyon spawning site and possibly return to the White River in the same year. Only downstream movement is required to reach Three Fords Rapid. Migration from the White River to the Yampa Canyon spawning site, however, requires extensive (158.7 km, 98.6 mi.) upstream travel making it doubtful that an individual fish from the White can spawn in the Yampa and return to the White in a single year. Routes to and from both spawning sites require travel through many rapids (Evans and Belknap 1973, Evans and Belknap 1974). While Radant et al. (1983) showed a Colorado squawfish originally captured in the lower White River migrating to the lower Yampa River in approximately one month, other adult Colorado squawfish destined for the Yampa may leave the upper White and enter the Green to mature. Possibly, some of the adult Colorado squawfish entering the Green River during this study, especially those that moved upstream, were enroute to the Yampa and would have matured and spawned the following year. Wick et al. (1985) suggested that Colorado squawfish may have an erratic pattern of use of the White River, but because of the varied distances travelled, they may move in and out of the White River over a longer period of time.

Tyus (1984) noted that an individual Colorado squawfish, displaying fidelity to the Yampa River spawning site, spawned in both 1982 and 1983. Wick et al. (1983), however, suggested that adult Colorado squawfish in the upper Yampa River that apparently utilize the Yampa Canyon spawning area do not spawn every year. Presumably, Colorado squawfish which must migrate even greater distances between "home ranges" and spawning sites do not spawn every year. Further, if Colorado squawfish in the White River display fidelity to both a White River "home range" and the Yampa spawning site, it becomes even more inconceivable that these fish spawn annually. Because of the potentially infrequent spawning by Colorado squawfish, particularly among those fish migrating to the Yampa River from the White River in Colorado, protection of individual fish becomes even more important.

While fish like #1602 and #1510, last contacted in the White River, probably continued downstream or entered the Green River, several Colorado squawfish moved upstream. Fish #04030, was captured in the White River near Rangely in July 1984. After moving downstream 90 km (60 mi.), this individual returned 125 km (77.5 mi.) upstream through the dam axis and was last contacted above Kenney Reservoir after the dam closed in October, 1984. Another specimen, #04032, captured about 16 km (10 mi.) below Rangely in August 1984 was last contacted a few kilometers above Rangely four months later. Fish #1700, originally captured and tagged in the White River in Utah by Utah Wildlife Resources 22 May 1984 at RK 83.7 (RM 52.0), was recaptured 29 August 1985 in the Taylor Draw

Dam outlet chute, 84.1 km (52.3 mi.) upstream of its initial capture site.

The two Colorado squawfish implanted in the White River above Taylor Draw Dam (axis) were last contacted within Kenney Reservoir. Fish #04034, captured at RK 177.8 (RM 110.5) on 23 September 1984, entered Kenney Reservoir as it was filling in October 1984. Its constant movement along the shoreline about 0.2 km (0.1 mi.) above Taylor Draw Dam made it appear disoriented. It is doubtful that this individual continued downstream in 1984 since the reservoir was not full enough to spill until 27 December 1984. Fish #04035, captured 30 April 1985 at RK 182.6 (RM 113.5) entered Kenney Reservoir in May. After staying in shallow water near the inlet for several days this fish travelled through the reservoir and was last contacted near the spillway on 21 May. Lack of radio contact in subsequent days suggested that this individual left the reservoir via the spillway. Presumably, Colorado squawfish should be able to survive the 12 m (40 ft.) drop into the 4 m (12 ft.) deep plunge pool as did whitefish and many catchable and larger size rainbow and brown trout. Unfortunately, continued monitoring during the rest of the 1985 sampling season failed to confirm the passage of #04035 over Taylor Draw Dam.

Emergency fishing closure

The results of this study showed that the White River in Colorado is presently utilized primarily by adult Colorado squawfish, and some sub-adults, that migrate to and from distant spawning areas. Movement data for Colorado squawfish collected during this study also showed that this species regularly migrated through the Taylor Draw Dam site prior to closure and creation of Kenney Reservoir. While it was known prior to construction that Taylor Draw Dam would block Colorado squawfish movements (USACE 1982a), the congregation of Colorado squawfish that occurred below the dam from late July to early September in 1985 was not predicted. This accumulation of Colorado squawfish probably represented a post-spawning migration of fish returning from spawning or those searching for "home ranges" for overwintering. Large numbers of Colorado squawfish were observed below Flaming Gorge Dam the year following closure apparently attempting to migrate upstream (Seethaler 1978).

Four captures (Appendix Table 17), two radio contacts (Appendix Table 22), three carcasses and three confirmed catches of adult Colorado squawfish (500-600 mm TL) below Taylor Draw Dam in the first two weeks of August 1985 (Figure 28) provided impetus for pursuing a regulation to protect Colorado squawfish. Effective 15 August 1985, the Colorado Wildlife Commission enacted an emergency fishing closure in the 365 m (400 yds.) below

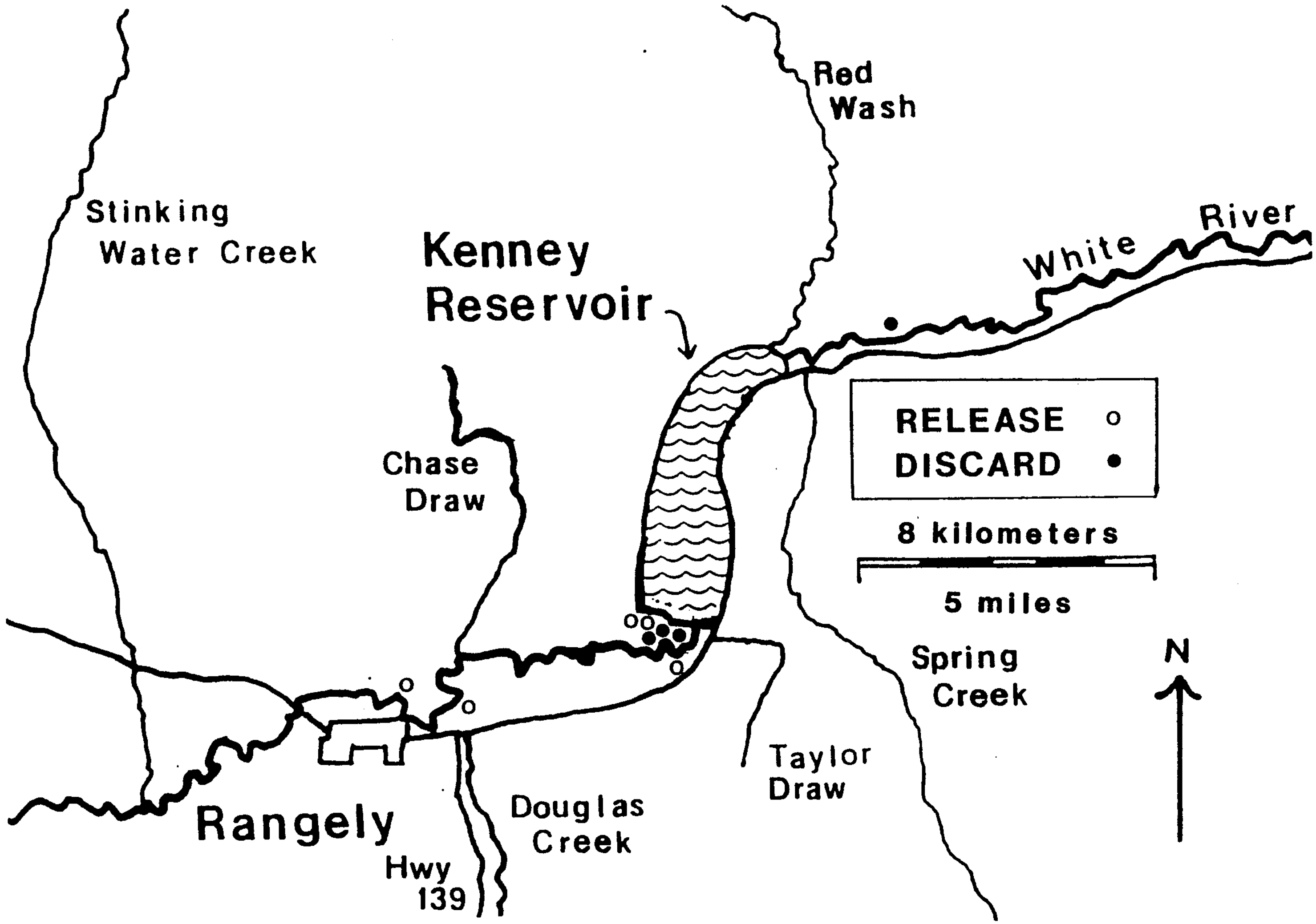


Figure 28. Locations of Colorado squawfish caught by anglers in the White River in August 1985.

the dam to address the increased incidence, hooking and discard of Colorado squawfish. Another carcass found above Kenney Reservoir and two additional confirmed catches near Rangely (Figure 28, Appendix Tables 17 and 20), plus numerous unconfirmed reports of anglers catching and releasing Colorado squawfish between the dam and Rangely in August, attested to the vulnerability of this species to angling.

Three electrofishing trips (1 hr. each) were conducted within the closure 29 August, 20 September, and 15 October 1985 to monitor the presence of Colorado squawfish. Three Colorado squawfish (#1700, #1737, and #1739) were captured during the first trip (Appendix Table 17) and three others were sighted, but could not be captured (Appendix Table 18). No Colorado squawfish were collected or sighted during the two subsequent efforts suggesting that the fish had dispersed downstream by mid-September. The temporary closure was lifted 31 October 1985 following distribution of brochures describing endangered fish and placement of informational signs at Taylor Draw Dam and Kenney Reservoir to generate public awareness of Colorado squawfish.

CONCLUSIONS

1. Taylor Draw Dam, if operated at run of the river, will have little effect on discharge and temperature regimes in the White River due to the low retention time of Kenney Reservoir. Diurnal thermal constancy will occur for about 16 km (10 mi.) below the dam during baseflow and the river will remain ice-free through the town of Rangely in winter. The greatest changes will result from the removal of sediment by the reservoir which will reduce turbidity, increase scour, and eventually create an armored channel in the river below the dam (USACE 1982a). Sediment laden flows from Douglas Creek appeared to diminish these effects below its confluence. The deepening of the channel from Taylor Draw Dam to Rangely may enhance habitat for Colorado squawfish (Behnke 1981).

2. Kenney Reservoir will provide habitat for the proliferation of exotic fish species in the White River. The dramatic increase of fathead minnows in 1985 and the projected dominance (Behnke 1981) and suitability of the reservoir for carp (McConnell et al. 1984), species which were not previously abundant in the river, illustrate the potential effect of impoundment on the fish community.

The sudden appearance of green sunfish in the White River immediately below Taylor Draw Dam in 1986, a species not formerly reported in the White River in Colorado, also supports this contention. Kenney Reservoir may also ensure survival of coolwater and warmwater predators escaping from Rio Blanco Reservoir or introduced through illicit stocking. As demonstrated by mountain whitefish, and rainbow and brown trout, these predators could leave Kenney Reservoir and survive in the White River below the dam.

3. Taylor Draw Dam will block the upstream movement of Colorado squawfish in the White River. While the White River in Colorado does not appear to contain spawning habitat for Colorado squawfish, it clearly provides suitable habitat for sub-adults and adults that spawn in the Green, Yampa or possibly the lower White rivers (Miller et al. 1982, Radant et al. 1983). Nearly 80 km (50 mi.) of recently occupied range will be lost. The dam should not preclude the downstream passage of Colorado squawfish and this species will gradually disappear above the dam through downstream migration and attrition. The disappearance of squawfish in the White River above Taylor Draw Dam will represent the loss of approximately 16% or one sixth of the Colorado squawfish range currently documented for Colorado.

RECOMMENDATIONS

1. A USGS stream gaging station should be installed in the White River between Taylor Draw Dam and the Douglas Creek confluence. All White River gaging stations in and near Colorado are plagued by icing which results in erroneous readings and requires interpolation to estimate physical measurements. The ice free nature of the river below the dam would facilitate the collection of accurate instream data year round. Further, the Taylor Draw Project MOA requires WUA1 to provide records of water release from Taylor Draw Dam to the USFWS to ensure that requirements necessary to sustain Colorado squawfish in the White River are maintained.

2. Sampling above, within and below Taylor Draw Dam should continue to study the effects of the impoundment on the fish community of the White River. Initial post-impoundment data collected during this study demonstrated that changes will occur as a result of Taylor Draw Dam. Documentation of future alteration of the fish community will provide valuable information to address the demand for future water development and its potential impacts on threatened and endangered fish species.

3. Management of Colorado squawfish as a sportfish above Taylor Draw Dam should be pursued. This alternative, presented in the Taylor Draw Project MOA, could provide a unique and attractive fishery for a historically esteemed food fish possessing sport fishing attributes. Preliminary data and observations indicate that this species may be a predator well suited to the environment which will prevail in the new impoundment.

4. Certain coolwater and warmwater predators including all esocids, percids, and smallmouth bass (*Micropterus dolomieui*) should not be introduced in Kenney Reservoir due to their potential for persistence or proliferation in the White River. The Colorado Wildlife Commission passed a regulation in March, 1986, that prohibits the stocking of any non-salmonid species in the White River drainage without the expressed written approval of the director of the Division of Wildlife. If stocked, these exotic species would undoubtedly enter the White River where they could compete with Colorado squawfish. More seriously, the White River could become an avenue for transporting these exotic predators into the middle of an area of the Green River near Ouray, UT, known to provide vital nursery habitats for much of the Colorado squawfish reproduction in the Green River basin (Archer and Tyus 1984).

5. Because Kenney Reservoir would provide a haven for coolwater (northern pike) and warmwater (smallmouth bass) predators which may escape from Rio Blanco Reservoir upstream, Rio Blanco Reservoir should be isolated from the White River or treated to remove these species. Poisoning the lake would preclude escapement or illicit stocking from this source. Blocking the inlet and pumping to maintain the water level would prevent the escape of exotic predators. This action would allow continued management of warmwater and coolwater species in this off-stem impoundment.

6. A program to provide information and education (I&E) about endangered fishes should be maintained. Informational signs, in place at Taylor Draw Dam and Kenney Reservoir, served to increase public awareness of the presence of Colorado squawfish in the White River. Distribution of brochures containing more detailed information would provide public education about these fishes. Generation of public awareness and appreciation of endangered fishes would serve to make angling a compatible activity in the presence of these species.

7. Regulations for implementing an emergency, temporary fishing closure below Taylor Draw Dam should be maintained. Future post-spawning migrations of Colorado squawfish ascending the White River will probably occur. To protect these endangered fish, the closure should be reinstated as soon as any data (angling, discard, electrofishing) indicate an increased incidence of Colorado squawfish. Electrofishing will be performed by CDOW below Taylor Draw Dam during the anticipated period of congregation, mid-July to mid-September, to verify the presence and dispersal of Colorado squawfish. Upon dispersal, the regulation would be lifted.

8. The application of fish passage at Taylor Draw Dam should be considered only after it has been designed and tested for utilization by Colorado squawfish at another location. Because of the expense of constructing such a structure over a dam the height of Taylor Draw, it should be developed on a smaller scale. Further, if it is demonstrated that Colorado squawfish will utilize a passageway, it must be resolved that the benefit to the species and its compatibility with other management activities (e.g. Colorado squawfish sportfishery in Kenney Reservoir) justify its construction at Taylor Draw Dam.

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APPENDIX

Table 8. Frequency of occurrence of fish species in larval and YOY fish samples collected in the White River, 1983-85.

Species	1983 N=97 8/4-13 (n=35)	1983 N=97 8/22-26 (n=26)	1983 N=97 9/8-12 (n=36)	Totals	1984 N=198 8/2-5 (n=66)	1984 N=198 8/27-30 (n=68)	1984 N=198 9/19-22 (n=64)	Totals	1985 N=196 7/17-20 (n=67)	1985 N=196 8/13-16 (n=63)	1985 N=196 9/10-13 (n=66)	Totals
NATIVE												
Prosopium williamsoni	---	---	---	---	---	---	---	---	---	---	---	---
Gila robusta	29	18	20	67	43	53	39	135	35	30	18	83
Ptychocheilus lucius	---	---	---	---	---	---	---	---	---	---	---	---
Rhinichthys osculus	34	26	36	96	65	68	64	197	62	60	58	180
Catostomus discobolus	35	18	33	86	50	57	51	158	51	52	40	143
Catostomus latipinnis	31	15	36	82	53	65	59	177	63	52	50	165
Cottus bairdi	---	---	---	---	2	---	---	1	4	3	---	7
NONATIVE												
Salmo gairdneri	---	---	---	---	---	---	---	---	---	---	---	---
Cyprinus carpio	---	---	---	---	7	4	2	1	23	12	8	3
Pimephales promelas	26	10	8	8	151	44	57	50	177	62	57	58
Notropis lutrensis	13	5	2	6	84	18	33	33	55	11	16	28
Ictalurus melas	---	---	---	---	3	1	2	---	---	---	---	---
Ictalurus punctatus	---	---	---	---	---	---	---	---	1	---	---	1
Pomoxis nigromaculatus	---	---	---	---	---	---	---	---	---	---	---	---

Table 9. Total number of fish in seine samples collected during three time periods from RK 193.0 (RM 120.0) to RK 115.5 (RM 71.8) in the White River in 1983.

Species	Date			Total fish
	Aug 4-13	Aug 22-26	Sept 8-12	captured
NATIVE				
Prosopium williamsoni	-	-	-	-
Gila robusta	1368	303	136	1807
Ptychocheilus lucius	-	-	-	-
Rhinichthys osculus	1595	816	1743	4154
Catostomus discobolus	2995	772	993	4760
Catostomus latipinnis	349	79	824	1252
Cottus bairdi	-	-	-	-
Total Native	6307	1970	3696	11973
EXOTIC				
Salmo gairdneri	-	-	-	-
Cyprinus carpio	-	-	-	-
Notropis lutrensis	8	5	64	77
Pimephales promelas	26	12	12	50
Ictalurus melas	-	-	-	-
Ictalurus punctatus	-	-	-	-
Pomoxis nigromaculatus	-	-	-	-
Total Exotic	34	17	76	127
TOTAL FISH	6341	1987	3772	12100

Table 10. Total number of fish in seine samples collected during three time periods from RK 193.0 (RM 120.0) to RK 115.5 (RM 71.8) in the White River in 1984.

Species	Date: Aug 2-5	Date: Aug 27-30	Date: Sept 19-22	Total fish captured
NATIVE				
Prosopium williamsoni	-	-	-	-
Gila robusta	1636	1042	189	2867
Ptychocheilus lucius	-	-	-	-
Rhinichthys osculus	5247	3000	3370	11617
Catostomus discobolus	10810	4994	2313	18117
Catostomus latipinnis	974	3176	1739	5889
Cottus bairdi	10	-	-	10
Total Native	18677	12212	7611	38500
EXOTIC				
Salmo gairdneri	-	-	-	-
Cyprinus carpio	12	3	1	16
Notropis lutrensis	65	157	822	1044
Pimephales promelas	1607	3704	2892	8203
Ictalurus melas	1	2	-	3
Ictalurus punctatus	-	-	-	-
Pomoxis nigromaculatus	-	-	-	-
Total Exotic	1685	3866	3715	9266
TOTAL FISH	20362	16078	11326	47766

Table 11. Total number of fish in seine samples collected during three time periods from RK 193.0 (RM 120.0) to RK 115.5 (RM 71.8) in the White River in 1985.

Species	Date			Total fish
	Jul 17-20	Aug 13-16	Sept 10-13	captured
NATIVE				
Prosopium williamsoni	-	-	-	-
Gila robusta	1170	258	34	1462
Ptychocheilus lucius	-	-	-	-
Rhinichthys osculus	8749	4206	2012	14967
Catostomus discobolus	12513	1165	870	14548
Catostomus latipinnis	9901	813	363	11077
Cottus bairdi	4	3	-	7
Total Native	32337	6445	3279	42061
EXOTIC				
Salmo gairdneri	-	-	-	-
Cyprinus carpio	56	32	3	91
Notropis lutrensis	33	82	181	296
Pimephales promelas	14723	6316	3098	24137
Ictalurus melas	-	-	-	-
Ictalurus punctatus	-	-	1	1
Pomoxis nigromaculatus	-	-	-	-
Total Exotic	14812	6430	3283	24525
TOTAL FISH	47149	12875	6562	66586

Table 12. Total number of fish collected by electrofishing in the White River 8 km (5 mi.) above Kenney Reservoir basin, 8 km below Taylor Draw Dam, and in four 0.8 km (0.5 mi.) sections downstream of Rangely in 1983 (Tom Chart unpublished data).

Species	River section			Total fish
	Above[a]	Below[b]	Downstream[c]	captured
NATIVE				
Prosopium williamsoni	15	34	–	49
Gila robusta	30	229	26	285
Ptychocheilus lucius	1	1	–	2
Rhinichthys osculus	75	142	16	233
Catostomus discobolus	73	202	76	351
Catostomus latipinnis	618	583	147	1348
Cottus bairdi	4	1	–	5
Total Native	816	1192	265	2273
EXOTIC				
Salmo gairdneri	–	–	–	–
Cyprinus carpio	17	73	5	95
Notropis lutrensis	–	1	–	1
Pimephales promelas	–	–	–	–
Ictalurus melas	–	2	–	2
Ictalurus punctatus	11	32	44	87
Pomoxis nigromaculatus	–	–	–	–
Total Exotic	28	108	49	185
TOTAL FISH	844	1300	314	2458

[a] 8 km (5 mi.) above Kenney Reservoir basin: RK 184.2-176.2 (RM 115.0-110.0)
[b] 8 km (5 mi.) below Kenney Reservoir basin: RK 167.8-159.8 (RM 104.3-99.3)
[c] four 0.8 km (0.5 mi.) sections below Rangely: RK 152.0-151.2 (RM 94.5-94.0), RK 144.8-144.0 (RM 90.0-89.5), RK 136.0-135.2 (RM 84.5-84.0), and RK 127.9-127.1 (RM 79.5-79.0)

Table 13. Total number of fish collected by electrofishing in the White River 8 km (5 mi.) above Kenney Reservoir basin, 8 km below Taylor Draw Dam, and in four 0.8 km (0.5 mi.) sections downstream of Rangely in 1984 (Tom Chart unpublished data).

Species	River section			Total fish
	Above[a]	Below[b]	Downstream[c]	captured
NATIVE				
Prosopium williamsoni	-	2	-	2
Gila robusta	111	96	14	221
Ptychocheilus lucius	1	4	1	6
Rhinichthys osculus	19	47	3	69
Catostomus discobolus	78	47	2	127
Catostomus latipinnis	1185	860	137	2182
Cottus bairdi	2	-	-	2
Total Native	1396	1056	157	2609
EXOTIC				
Salmo gairdneri	-	-	-	-
Cyprinus carpio	24	117	7	148
Notropis lutrensis	-	-	-	-
Pimephales promelas	-	-	-	-
Ictalurus melas	-	4	-	4
Ictalurus punctatus	5	61	6	72
Pomoxis nigromaculatus	-	-	1	1
Total Exotic	29	182	14	225
TOTAL FISH	1425	1238	171	2834

[a] 8 km (5 mi.) above Kenney Reservoir basin: RK 184.2-176.2 (RM 115.0-110.0)

[b] 8 km (5 mi.) below Kenney Reservoir basin: RK 167.8-159.8 (RM 104.3-99.3)

[c] four 0.8 km (0.5 mi.) sections below Rangely: RK 152.0-151.2 (RM 94.5-94.0), RK 144.8-144.0 (RM 90.0-89.5), RK 136.0-135.2 (RM 84.5-84.0), and RK 127.9-127.1 (RM 79.5-79.0)

Table 14. Total number of fish collected by electrofishing in the White River 8 km (5 mi.) above Kenney Reservoir basin, 8 km below Taylor Draw Dam, and in four 0.8 km (0.5 mi.) sections downstream of Rangely in 1985 (Tom Chart unpublished data).

Species	River section			Total fish
	Above[a]	Below[b]	Downstream[c]	captured
NATIVE				
Prosopium williamsoni	13	18	-	31
Gila robusta	59	80	25	164
Ptychocheilus lucius	1	4	3	8
Rhinichthys osculus	16	28	6	50
Catostomus discobolus	170	223	16	409
Catostomus latipinnis	822	539	112	1473
Cottus bairdi	-	-	-	-
Total Native	1081	892	162	2135
EXOTIC				
Salmo gairdneri	170	254	-	424
Cyprinus carpio	3	123	14	140
Notropis lutrensis	1	-	-	1
Pimephales promelas	-	-	-	-
Ictalurus melas	-	1	1	2
Ictalurus punctatus	7	79	18	104
Pomoxis nigromaculatus	-	-	-	-
Total Exotic	181	457	33	671
TOTAL FISH	1262	1349	195	2806

[a] 8 km (5 mi.) above Kenney Reservoir basin: RK 184.2-176.2 (RM 115.0-110.0)
[b] 8 km (5 mi.) below Kenney Reservoir basin: RK 167.8-159.8 (RM 104.3-99.3)
[c] four 0.8 km (0.5 mi.) sections below Rangely: RK 152.0-151.2 (RM 94.5-94.0), RK 144.8-144.0 (RM 90.0-89.5), RK 136.0-135.2 (RM 84.5-84.0), and RK 127.9-127.1 (RM 79.5-79.0)

Table 15. Summary of capture and tagging data for Colorado squawfish collected in the White River in 1983 ("---" denotes information not available) (Taylor Draw Dam is at RK 167.8, RM 104.3).

Capture			Fish		Carlin		Radiotransmitter				
date	RK[a]	RM[a]	L(mm)[b]	W(g)	color	tag#	type	tag#	frequency (Khz)	pulse (per min.)	duration (days)
05/04	161.2	100.2	539	1249	white	1602	AVM[c]	23509	40.680	66	300
05/04	161.1	100.1	529	851	white	1649	------------non-telemetered---------------				
05/04	153.3	95.3	511	936	white	1672	------------non-telemetered---------------				
05/25	165.4	102.8	744	2951	white	1642	AVM[c]	23523	40.699	64	300
05/25	165.2	102.7	519	992	white	1528	------------non-telemetered---------------				
05/25	160.6	99.8	554	1390	white	1510	AVM[c]	23498	40.662	44-45	300
08/18	176.5	109.7	632	---	white	1597	------------non-telemetered---------------				
09/01	204.3	127.0	552	---	white	1673	------------non-telemetered---------------				
10/05	136.8	85.0	529	1090	white	1616	AVM[c]	23516	40.689	84-85	300
10/05	132.4	82.3	524	1000	white	1514	------------non-telemetered---------------				
10/12	163.3	101.5	515	1100	white	1674	------------non-telemetered---------------				

[a] distance from confluence of White and Green rivers in White River
[b] total length
[c] AVM Corporation

Table 16. Summary of capture and tagging data for Colorado squawfish collected in the White River in 1984 (Taylor Draw Dam is at RK 167.8, RM 104.3).

Capture			Fish		Carlin		Radiotransmitter				
date	RK[a]	RM[a]	L(mm)[b]	W(g)	color	tag#	type	tag#	frequency (Khz)	pulse (per min.)	duration (days)
07/11	162.2	100.8	380	380	white	1717	non-telemetered				
07/15	158.3	98.4	532	1320	orange	04030	SR[c]	50134	44.666	52	150
07/16	168.5	104.7	440	625	white	1718	non-telemetered				
07/18	162.7	101.1	390	390	white	1719	non-telemetered				
07/18	161.1	100.1	418	700	white	1720	non-telemetered				
07/18	160.7	99.9	485	860	white	1721	non-telemetered				
07/23	120.7	75.0	693	2540	orange	04031	SR[c]	50734	40.686	90	150
07/24	118.6	73.7	404	540	white	1723	non-telemetered				
08/08	135.6	84.3	598	1330	orange	04032	SR[c]	50234	40.666	90	150
08/24	166.0	103.2	517	990	orange	04033	SR[c]	50634	40.686	52	150
08/24	161.5	100.4	538	1070	white	1722	non-telemetered				
09/23	177.8	110.5	596	1490	orange	04034	SR[c]	50834	40.690	90	150

[a] distance from confluence of White and Green rivers in White River
[b] total length
[c] Smith-Root Inc.

Table 17. Summary of capture and tagging data for Colorado squawfish collected in the White River in 1985 (Taylor Draw Dam is at RK 167.8, RM 104.3).

Capture			Fish		Carlin		Radiotransmitter				
date	RK[a]	RM[a]	L(mm)[b]	W(g)	color	tag#	type	tag#	frequency (Khz)	pulse (per min.)	duration (days)
04/30	182.6	113.5	548	1630	orange	04035	SR[c]	50534	40.682	52	150
05/01	158.3	98.4	443	670	white	1724	non-telemetered				
06/27	151.7	94.3	422	490	white	1725	non-telemetered				
06/27	135.3	84.1	644	2060	orange	04036	SR[c]	50434	40.670	90	150
06/30[d]	167.5	104.1	538	1210	orange	04040	SR[c]	50334	40.670	50	150
08/01	167.8	104.3	600	1450	orange	04037	SR[c]	135	40.690	90	150
08/01	167.1	104.1	676	2410	orange	04038	SR[c]	335	40.690	52	150
08/01	164.6	102.3	561	1420	orange	04039	SR[c]	235	40.690	72	150
08/12	167.0	103.8	517	950	white	1727	non-telemetered				
08/12[e]	155.3	96.5	620	1300	white	1728	non-telemetered				
08/14	151.7	94.3	447	660	white	1733	non-telemetered				
08/14	141.3	87.9	538	1150	white	1734	non-telemetered				
08/14	141.1	87.7	575	1280	white	1735	non-telemetered				
08/29	167.8	104.3	564	1200	white	1737	non-telemetered				
08/29	167.8	104.3	569	1260	white	1739	non-telemetered				
08/29[f]	167.8	104.3	510	820	white	1700	non-telemetered				
09/21	182.0	113.1	562	1560	white	1740	non-telemetered				
09/22	167.5	104.1	673	2760	white	1741	non-telemetered				

[a] distance from confluence of White and Green rivers in White River

[b] total length

[c] Smith-Root Inc.

[d] heavily tuberculated

[e] removed from fisherman's stringer

[f] recaptured; tagged by Utah Division of Wildlife Resources 22 May 1984, in the White River at RK 83.7, RM 52.0

Table 18. Summary of Colorado squawfish sighted, but not captured, while electrofishing in the White River, 1983-1985 (Taylor Draw Dam is at RK 167.8, RM 104.3).

	Location[a]		
Date	RK	RM	Length(mm)[b]
		1983	
05/04	163.0	101.3	450
05/04	159.3	99.0	650
05/04	159.0	98.8	500
		1984	
06/28	168.1	104.5	500
07/12	147.4	91.6	550
07/15	154.5	96.0	500
07/22	205.9	128.0	400
07/24	115.7	71.9	650
		1985	
05/01	158.3	98.4	500
06/27	148.3	92.2	850
06/28	130.0	80.8	450
08/01	167.8	104.3	400
08/01	167.8	104.3	500
08/01	167.0	103.8	500
08/09	165.2	102.7	600
08/09	163.1	101.4	450
08/12	167.5	104.1	500
08/12	165.1	102.6	600
08/31	167.8	104.3	900
08/31	167.8	104.3	600
08/31	167.8	104.3	550

[a] distance from confluence of White and Green rivers in White River

[b] visual estimate

Table 19. Summary of radiotelemetry data for Colorado squawfish captured in the White River in 1983.

Capture Data					Location on Date of Radiotracking Trip			
					5/19[d]		6/09[d]	
Date	L(mm)[a]	Carlin[b]	RK[c]	RM[c]	RK[c]	RM[c]	RK[c]	RM[c]
05/04	539	1602	161.2	100.2	137.9	85.7	111.8	69.5
05/25	744	1642	165.4	102.8	no other contact in 1983, see Table 20. movement summary			
05/25	554	1510	160.6	99.8	----	----	0.2	0.1
10/05	529	1616	136.8	85.0	no contact in 1983 or 1984			

[a] total length
[b] white tag
[c] distance from confluence of White and Green rivers in White River
[d] DOW flight over White River to confluence of White and Green rivers

Table 20. Summary of radiotelemetry and capture-recapture data for Colorado squawfish #1642 collected by CDOW, USFWS, and WUAl personnel, 1983-85 ("---" denotes information not available).

Date	L(mm)[a]	W(g)	River	RK[b]	RM[b]	Contact	Method	Agency
05/25/83	744	2951	White	165.4	102.8	capture	electrofish	CDOW
06/05/84	---	---	Green	488.0	303.3	radio	raft	USFWS
06/07/84	---	---	Green	488.7	303.7	radio	raft	USFWS
06/11/84	---	---	Green	488.8	303.8	radio	raft	USFWS
06/13/84	---	---	Green	488.8	303.8	radio	raft	USFWS
06/18/84	---	---	Green	488.8	303.8	radio	raft	USFWS
06/20/84	---	---	Green	492.0	305.8	radio	raft	USFWS
07/03/84	---	---	Green	544.0	338.1	radio	raft	USFWS
07/12/84	---	---	Yampa	17.5	10.9	radio	raft	USFWS
07/16/84	---	---	Yampa	51.3	31.9	radio	raft	USFWS
07/17/84	770	4100	Yampa	51.3	31.9	capture	trammel net	USFWS
08/01/84	---	---	Yampa	20.6	12.8	radio	raft	USFWS
08/07/84	---	---	Yampa	20.9	13.0	radio	raft	USFWS
08/08/84[c]	---	---	Yampa	18.3	11.4	radio	raft	USFWS
08/27/85[d]	800	4082	White	157.7	98.0	capture	angling	WUAl

[a] total length
[b] in White River, distance from confluence of White and Green rivers; in Green River, distance from confluence of Green and Colorado rivers; in Yampa River, distance from confluence of Yampa and Green rivers
[c] final radio contact; probable battery failure in AVM 300-day module
[d] approximate measurements

Table 21. Summary of radiotelemetry data for Colorado squawfish captured in the White River in 1984 ("-" denotes fish was not yet radiotagged; "X" denotes no contact with fish on that date).

Capture				Location[b] on date of radiotracking trip											
Date	L(mm)[a]	Carlin	RK[b] (RM)	07/19[c]	08/03[c]	08/17[c]	08/22[d]	08/23[d]	09/12[c]	09/18[d]	09/25[d]	10/16[d]	10/25[e]	10/26[e]	11/19[f]
07/15	532	04030	158.3	122.1	67.6	X[g]	X	X	192.3	X	X	X	X	187.9	X
			(98.4)	(75.9)	(42.0)				(119.5)					(116.8)	
07/23	693	04031	120.7	-	8.7	X[g]	405.5[h]	396.5[h]	396.5[h]	468.2[h]	466.6[h]	468.5[h]	X	X	X
			(75.0)		(5.4)		(252.0)	(246.4)	(246.4)	(291.0)	(290.0)	(291.2)			
08/08	598	04032	135.6	-	-	X[g]	X	X	133.1	X	X	X	X	149.2	X
			(84.3)						(82.7)					(97.2)	X
08/24	517	04033	166.0	-	-	-	-	-	107.8	X	X	X	X	X	401.4[h]
			(103.2)						(67.0)						(249.5)
09/23[i]	596	04034	177.8	-	-	-	-	-	-	-	-	X	168.0[j]	168.0[j]	X
			(110.5)										(104.4)	(104.4)	

[a] total length
[b] distance from confluence of White and Green rivers in White River
[c] CDOW flight over White River from Rio Blanco Reservoir to confluence of White and Green rivers
[d] USFWS float search on Green River
[e] CDOW ground search from RK 192.8 (RM 119.8) to CO/UT stateline
[f] CDOW flight over Green River from Yampa confluence to White confluence; over White River from Green confluence to Rio Blanco Reservoir; over Yampa River from Maybell to Green confluence
[g] possible radio reciever malfunction
[h] distance from confluence of Green and Colorado rivers in Green River
[i] fish released 09/25/84
[j] within Kenney Reservoir

Table 22. Summary of radiotelemetry data for Colorado squawfish captured in the White River in 1985 ("-" denotes fish was not yet radiotagged; "X" denotes no contact with fish on that date).

Capture				Location[b] on date of radiotracking trip										
Date	L(mm)[a]	Carlin	RK[b] (RM)	05/10[c]	05/12[c]	05/21[c]	06/06[d]	06/12[d]	06/21[e]	07/01[f]	07/16[f]	07/19[g]	07/20[h]	07/22[e]
04/30	548	04035	182.6	175.9	176.3	168.0	X	X	X	X	X	X	X	X
			(113.5)	(109.3)	(109.6)	(104.4)								
06/27	644	04036	135.3	-	-	-	-	-	-	X	X	396.1[i]	X	393.7[i]
			(84.1)									(246.2)		(244.7)
06/30	538	04040	167.5	-	-	-	-	-	-	X	X	X	135.2	135.3
			(104.1)										(84.0)	(84.1)
08/01	600	04037	167.8	-	-	-	-	-	-	-	-	-	-	-
			(104.3)											
08/01	676	04038	167.5	-	-	-	-	-	-	-	-	-	-	-
			(104.1)											
08/01	561	04039	164.6	-	-	-	-	-	-	-	-	-	-	-
			(102.3)											

Table 22. Continued.

Capture				Location[b] on date of radiotracking trip										
Date	L(mm)[a]	Carlin	RK[b] (RM)	08/07[h]	08/14[g]	08/20[g]	09/05[e]	09/11[g]	09/26[g]	10/01[g]	10/02[g]	10/21[e]	11/21[e]	12/15[f]
04/30	548	04035	182.6 (113.5)	X	X	X	X	X	X	X	X	X	X	X
06/27	644	04036	135.3 (84.1)	X	X	X	X	X	X	X	X	X	X	X
06/30	538	04040	167.5 (104.1)	X	321.5[i] (199.8)	336.0[i] (208.8)	6.4 (4.0)	X	X	X	X	X	X	X
08/01[j]	600	04037	167.8 (104.3)	167.8 (104.3)	X	X	403.2[i] (250.6)	412.4[i] (256.3)	412.1[i] (256.1)	X	X	X	410.3[i] (255.0)	X
08/01[j]	676	04038	167.5 (104.1)	167.8 (104.3)	X	X	X	X	398.1[i] (247.4)	391.3[i] (243.2)	392.8[i] (244.1)	X	X	X
08/01[j]	561	04039	164.6 (102.3)	131.0 (81.4)	X	X	X	X	X	X	X	131.0 (81.4)	131.0 (81.4)	X

[a] total length
[b] distance from confluence of White and Green Rivers in White River
[c] CDOW monitoring in Kenney Reservoir
[d] CDOW float search from Cox's bridge (RK 184.4, RM 114.6) to Rangely Bridge (RK 152.9, RM 95.0)
[e] CDOW flight over White River from Rio Blanco Reservoir (RK 241.3, RM 150) to confluence with Green River (RK 0), and over Green River from confluence with White River (RK 396.1, RM 246.2) to Jensen Bridge (RK 485.4, RM 301.7)
[f] CDOW ground search from County Bridge (RK 192.8, RM 119.8) to CO/UT stateline (RK 115.5, RM 71.8)
[g] USFWS float search on Green River
[h] CDOW float search from Taylor Draw Dam (RK 167.8, RM 104.3) to CO/UT stateline
[i] distance from confluence of Green and Colorado rivers in Green River
[j] released at RK 167.6 (RM 104.2) after implanting

Table 23. Summary of capture site notes for Colorado squawfish collected in the White River in 1983 ("---" denotes information not available).

Capture		Specimen		Capture Site Notes						
Date	RK[a] (RM)	L(mm)[b]	Carlin	Habitat (primary, secondary)	Substrate (primary, secondary)	Channel width (m)	Water depth (cm)	Water velocity (fps)[c]	Water temp. (°C)	Water cond. (umho)
05/04	161.1 (100.2)	539	1602	main channel; run	coarse gravel	32	94	3.8	13	600
05/04	161.1 (100.1)	529	1649	main channel; run	clay	37	143	3.6	13	700
05/04	153.3 (95.3)	511	1672	main channel; run	---	34	128	1.9	14	650
05/25	165.4 (102.8)	744	1642	main channel; run	silt	34	61	1.4	16.5	520
05/25	165.2 (102.7)	519	1528	main channel; run	clay;silt	36	46	2.0	18	600
05/25	160.5 (99.8)	554	1510	main channel; run	silt	63	37	0.3	17.5	580
08/18	176.5 (109.7)	632	1597	main channel; eddy	silt	35	70	---	24	---
09/01	204.3 (127.0)	552	1673	---	---	---	---	---	---	---
10/05	136.8 (85.0)	529	1616	main channel; run	silt	40	67	0.8	8.5	340
10/05	132.7 (82.5)	524	1514	main channel; riffle	silt	47	37	1.9	9.0	330
10/12	163.3 (101.5)	515	1674	---	---	---	---	---	---	---

[a] distance from confluence of White and Green rivers in White River
[b] total length
[c] measured at 0.6 water depth

Table 24. Summary of capture site notes for Colorado squawfish collected in the White River in 1984 ("---" denotes information not available).

Capture		Specimen		Capture site notes						
Date	RK[a] (RM)	L(mm)[b]	Carlin	Habitat (primary, secondary)	Substrate (primary, secondary)	Channel width (m)	Water depth (cm)	Water velocity (fps)[c]	Water temp. (°C)	Water cond. (umhos)
07/11	162.2 (100.8)	380	1717	main channel; shoreline	silt;sand	35	73	2.4	18	200
07/15	158.3 (98.4)	532	04030	main channel; concavity	silt	28	134	0.5	20	240
07/16	168.5 (104.7)	440	1718	main channel; run	silt	40	87	3.0	22	240
07/18	162.7 (101.1)	390	1719	main channel; run	silt;sand	45	82	2.8	18	289
07/18	161.1 (100.1)	418	1720	main channel; run	silt;sand	26	110	2.0	18	260
07/18	160.7 (99.9)	485	1721	main channel; run	fine gravel; sand	30	70	1.4	18	265
07/23	120.7 (75.0)	693	04031	main channel; run	coarse gravel	38	46	2.8	23	370
07/24	118.6 (73.7)	404	1723	main channel; eddy	silt;sand	24	67	0.7	23	420
08/08	135.6 (84.3)	598	04032	main channel; shoreline	coarse gravel; small rubble	33	70	1.6	22	430
08/24	166.0 (103.2)	517	04033	main channel; shoreline	sand	47	15	1.2	19.5	420
08/24	161.5 (100.4)	538	1722	main channel; run	armor; coarse gravel	---	30	2.0	20.5	430
09/23	177.8 (110.5)	596	04034	main channel; shoreline	fine gravel; small rubble	48	98	3.3	14.5	280

[a] distance from confluence of White and Green rivers in White River
[b] total length
[c] measured at 0.6 water depth

Table 25. Summary of capture site notes for Colorado squawfish collected in the White River in 1985 ("---" denotes information not available).

Capture		Specimen		Capture site notes						
Date	RK[a] (RM)	L(mm)[b]	Carlin	Habitat (primary, secondary)	Substrate (primary, secondary)	Channel Width (m)	Water Depth (cm)	Water Velocity (fps)[c]	Water Temp. (°C)	Water Cond. (umho)
04/30	182.6 (113.5)	548	04035	main channel; run	silt;sand	40	67	0.8	12	370
05/01	158.3 (98.4)	443	1724	main channel; run	silt;sand	32	82	1.4	13	370
06/27	151.7 (94.3)	422	1725	main channel; run	gravel;sand	35	91	2.3	16	300
06/27	135.3 (84.1)	644	04036	main channel; pool	silt;sand	38	27	0.7	18	290
06/30	167.5 (104.1)	538	04040	main channel; eddy	sand;silt	40	128	0.1	15	275
08/01	167.8 (104.3)	600	04037	side channel; run	gravel; rubble	44	64	3.6	19	460
08/01	167.5 (104.1)	676	04038	main channel; eddy	sand;silt	42	97	0.7	19	450
08/01	164.6 (102.6)	561	04039	main channel; run	gravel;sand	48	43	1.9	21	425
08/12	167.0 (103.8)	517	1727	main channel; pool	sand;silt	40	85	0.9	21	475
08/12	155.3 (96.5)	620	1728	main channel; pool	sand;gravel	39	78	0.8	21	500
08/14	151.7 (94.3)	447	1733	main channel; eddy	silt;sand	36	81	---	19	---
08/14	141.4 (87.9)	538	1734	main channel; run	gravel;sand	34	68	---	20	---
08/14	141.1 (87.7)	575	1735	main channel; run	sand;gravel	38	79	---	20	---
08/29	167.8 (104.3)	564	1737	chute;run	bedrock; (concrete)	2	73	---	17	---
08/29	167.8 (104.3)	569	1739	main channel; run	rubble; cobble	33	40	---	17	---
08/29	167.8 (104.3)	510	1700	chute;run	bedrock; (concrete)	2	73	---	17	---
09/21	182.0 (113.1)	562	1740	main channel; riffle	rubble; gravel	34	52	---	13	---
09/22	167.5 (104.1)	673	1741	main channel; run	gravel;sand	32	85	---	14	---

[a] distance from confluence of White and Green rivers
[b] total length
[c] measured at 0.6 water depth

Table 26. Length frequency of roundtail chubs (*Gila robusta*) collected during larval fish and YOY sampling in the White River, in 1983-85.

Total Length (mm)	1983 Aug 4-13	1983 Aug 22-26	1983 Sept 8-12	1984 Aug 2-5	1984 Aug 27-30	1984 Sept 19-22	1985 Jul 17-20	1985 Aug 13-16	1985 Sept 10-13
1- 10	3	-	-	5	-	-	3	-	-
11- 20	1118	15	3	1427	300	-	1149	14	1
21- 30	220	240	32	147	497	32	8	184	14
31- 40	21	48	89	2	210	80	-	58	11
41- 50	5	-	12	-	6	58	1	2	6
51- 60	-	-	-	-	-	7	-	-	2
61- 70	1	-	-	24	2	-	5	-	-
71- 80	-	-	-	13	11	3	2	-	-
81- 90	-	-	-	-	8	5	-	-	-
91-100	-	-	-	5	1	3	-	-	-
101-110	-	-	-	3	1	-	-	-	-
111-120	-	-	-	-	-	-	-	-	-
121-130	-	-	-	1	1	-	-	-	-
131-140	-	-	-	4	1	-	-	-	-
141-150	-	-	-	1	-	-	-	-	-
151+	-	-	-	4	4	1	2	-	-
Totals	1368	303	136	1636	1042	189	1170	258	34

Table 27. Length frequency of speckled dace (*Rhinichthys osculus*) collected during larval fish and YOY sampling in the White River, in 1983-85.

Total	1983			1984			1985		
Length (mm)	Aug 4-13	Aug 22-26	Sept 8-12	Aug 2-5	Aug 27-30	Sept 19-22	Jul 17-20	Aug 13-16	Sept 10-13
1- 10	432	238	46	488	107	1	148	15	3
11- 20	1007	395	1028	3700	1752	493	6162	860	378
21- 30	145	171	563	570	905	1955	2272	2436	635
31- 40	8	6	105	18	158	802	8	835	550
41- 50	3	5	1	202	17	90	36	57	369
51- 60	-	1	-	154	43	18	67	1	73
61- 70	-	-	-	48	12	8	39	2	1
71- 80	-	-	-	47	4	2	13	-	2
81- 90	-	-	-	19	1	1	3	-	1
91-100	-	-	-	1	1	-	1	-	-
101-110	-	-	-	-	-	-	-	-	-
111-120	-	-	-	-	-	-	-	-	-
121-130	-	-	-	-	-	-	-	-	-
131-140	-	-	-	-	-	-	-	-	-
141-150	-	-	-	-	-	-	-	-	-
151+	-	-	-	-	-	-	-	-	-
Totals	1595	816	1743	5247	3000	3370	8749	4206	2012

Table 28. Length frequency of bluehead suckers (*Catostomus discobolus*) collected during larval fish and YOY sampling in the White River, in 1983-85.

Total Length (mm)	1983 Aug 4-13	1983 Aug 22-26	1983 Sept 8-12	1984 Aug 2-5	1984 Aug 27-30	1984 Sept 19-22	1985 Jul 17-20	1985 Aug 13-16	1985 Sept 10-13
1- 10	1	-	-	-	-	-	-	-	-
11- 20	2933	641	439	10565	2077	67	11327	308	47
21- 30	54	127	463	205	2670	1016	1176	638	561
31- 40	7	4	87	1	219	1071	5	209	225
41- 50	-	-	4	3	3	155	-	10	32
51- 60	-	-	-	16	3	-	-	-	4
61- 70	-	-	-	14	10	-	1	-	1
71- 80	-	-	-	4	10	2	1	-	-
81- 90	-	-	-	2	2	1	1	-	-
91-100	-	-	-	-	-	1	1	-	-
101-110	-	-	-	-	-	-	-	-	-
111-120	-	-	-	-	-	-	-	-	-
121-130	-	-	-	-	-	-	-	-	-
131-140	-	-	-	-	-	-	-	-	-
141-150	-	-	-	-	-	-	-	-	-
151+	-	-	-	-	-	-	1	-	-
Totals	2995	772	993	10810	4994	2313	12513	1165	870

Table 29. Length frequency of flannelmouth suckers (*Catostomus latipinnis*) collected during larval fish and YOY sampling in the White River, in 1983-85.

Total Length (mm)	1983 Aug 4-13	1983 Aug 22-26	1983 Sept 8-12	1984 Aug 2-5	1984 Aug 27-30	1984 Sept 19-22	1985 Jul 17-20	1985 Aug 13-16	1985 Sept 10-13
1- 10	-	-	-	-	-	-	-	-	-
11- 20	267	20	146	761	104	1	3283	23	1
21- 30	65	50	542	136	2610	393	5974	415	99
31- 40	17	9	129	9	390	990	608	227	154
41- 50	-	-	7	1	22	295	25	128	60
51- 60	-	-	-	8	-	22	-	20	25
61- 70	-	-	-	18	4	4	-	-	18
71- 80	-	-	-	22	15	4	5	-	6
81- 90	-	-	-	14	23	10	4	-	-
91-100	-	-	-	1	4	11	2	-	-
101-110	-	-	-	3	2	5	-	-	-
111-120	-	-	-	-	-	2	-	-	-
121-130	-	-	-	-	-	-	-	-	-
131-140	-	-	-	-	1	-	-	-	-
141-150	-	-	-	-	1	-	-	-	-
151+	-	-	-	1	-	2	-	-	-
Totals	349	79	824	974	3176	1739	9901	813	363

Table 30. Length frequency of mottled sculpin (*Cottus bairdi*) collected during larval fish and YOY sampling in the White River, in 1983-85.

Total Length (mm)	1983 Aug 4-13	1983 Aug 22-26	1983 Sept 8-12	1984 Aug 2-5	1984 Aug 27-30	1984 Sept 19-22	1985 Jul 17-20	1985 Aug 13-16	1985 Sept 10-13
1- 10	-	-	-	-	-	-	-	-	-
11- 20	-	-	-	3	-	-	-	-	-
21- 30	-	-	-	7	-	-	4	2	-
31- 40	-	-	-	-	-	-	-	1	-
41- 50	-	-	-	-	-	-	-	-	-
51- 60	-	-	-	-	-	-	-	-	-
61- 70	-	-	-	-	-	-	-	-	-
71- 80	-	-	-	-	-	-	-	-	-
81- 90	-	-	-	-	-	-	-	-	-
91-100	-	-	-	-	-	-	-	-	-
101-110	-	-	-	-	-	-	-	-	-
111-120	-	-	-	-	-	-	-	-	-
121-130	-	-	-	-	-	-	-	-	-
131-140	-	-	-	-	-	-	-	-	-
141-150	-	-	-	-	-	-	-	-	-
151+	-	-	-	-	-	-	-	-	-
Totals	-	-	-	10	-	-	4	3	-

Table 31. Length frequency of common carp (*Cyprinus carpio*) collected during larval fish and YOY sampling in the White River, in 1983-85.

Total Length (mm)	1983 Aug 4-13	1983 Aug 22-26	1983 Sept 8-12	1984 Aug 2-5	1984 Aug 27-30	1984 Sept 19-22	1985 Jul 17-20	1985 Aug 13-16	1985 Sept 10-13
1- 10	-	-	-	-	-	-	1	-	-
11- 20	-	-	-	-	-	-	8	-	-
21- 30	-	-	-	-	-	1	1	10	-
31- 40	-	-	-	-	-	-	2	15	-
41- 50	-	-	-	4	-	-	10	1	-
51- 60	-	-	-	8	-	-	20	1	2
61- 70	-	-	-	-	-	-	9	-	1
71- 80	-	-	-	-	-	-	4	1	-
81- 90	-	-	-	-	-	-	-	-	-
91-100	-	-	-	-	2	-	-	-	-
101-110	-	-	-	-	1	-	-	-	-
111-120	-	-	-	-	-	-	-	-	-
121-130	-	-	-	-	-	-	-	-	-
131-140	-	-	-	-	-	-	-	-	-
141-150	-	-	-	-	-	-	-	-	-
151+	-	-	-	-	-	-	1	4	-
Totals	-	-	-	12	3	1	56	32	3

Table 32. Length frequency of red shiners (*Notropis lutrensis*) collected during larval fish and YOY sampling in the White River in 1983-85.

Total Length (mm)	1983 Aug 4-13	1983 Aug 22-26	1983 Sept 8-12	1984 Aug 2-5	1984 Aug 27-30	1984 Sept 19-22	1985 Jul 17-20	1985 Aug 13-16	1985 Sept 10-13
1- 10	-	5	4	3	12	4	-	1	-
11- 20	5	-	53	24	58	315	1	48	104
21- 30	-	-	7	6	68	422	1	30	63
31- 40	2	-	-	13	13	72	2	-	4
41- 50	-	-	-	12	5	4	27	1	1
51- 60	-	-	-	6	1	4	2	2	5
61- 70	1	-	-	1	-	1	-	-	4
71- 80	-	-	-	-	-	-	-	-	-
81- 90	-	-	-	-	-	-	-	-	-
91-100	-	-	-	-	-	-	-	-	-
101-110	-	-	-	-	-	-	-	-	-
111-120	-	-	-	-	-	-	-	-	-
121-130	-	-	-	-	-	-	-	-	-
131-140	-	-	-	-	-	-	-	-	-
141-150	-	-	-	-	-	-	-	-	-
151+	-	-	-	-	-	-	-	-	-
Totals	8	5	64	65	157	822	33	82	181

Table 33. Length frequency of fathead minnows (*Pimephales promelas*) collected during larval fish and YOY sampling in the White River, in 1983-85.

Total Length (mm)	1983			1984			1985		
	Aug 4-13	Aug 22-26	Sept 8-12	Aug 2-5	Aug 27-30	Sept 19-22	Jul 17-20	Aug 13-16	Sept 10-13
1- 10	-	1	-	391	14	1	1475	90	5
11- 20	12	2	4	731	1197	204	12017	4326	1521
21- 30	12	4	3	377	1248	1726	1088	1568	1038
31- 40	1	3	4	58	902	776	94	308	405
41- 50	-	2	1	20	303	163	34	22	124
51- 60	1	-	-	27	39	16	15	2	5
61- 70	-	-	-	3	1	6	-	-	-
71- 80	-	-	-	-	-	-	-	-	-
81- 90	-	-	-	-	-	-	-	-	-
91-100	-	-	-	-	-	-	-	-	-
101-110	-	-	-	-	-	-	-	-	-
111-120	-	-	-	-	-	-	-	-	-
121-130	-	-	-	-	-	-	-	-	-
131-140	-	-	-	-	-	-	-	-	-
141-150	-	-	-	-	-	-	-	-	-
151+	-	-	-	-	-	-	-	-	-
Totals	26	12	12	1607	3704	2892	14723	6316	3098

Table 34. Length frequency of black bullheads (*Ictalurus melas*) collected during larval fish and YOY sampling in the White River, in 1983-85.

Total Length (mm)	1983 Aug 4-13	1983 Aug 22-26	1983 Sept 8-12	1984 Aug 2-5	1984 Aug 27-30	1984 Sept 19-22	1985 Jul 17-20	1985 Aug 13-16	1985 Sept 10-13
1- 10	-	-	-	-	-	-	-	-	-
11- 20	-	-	-	-	-	-	-	-	-
21- 30	-	-	-	-	-	-	-	-	-
31- 40	-	-	-	-	-	-	-	-	-
41- 50	-	-	-	-	-	-	-	-	-
51- 60	-	-	-	-	-	-	-	-	-
61- 70	-	-	-	-	-	-	-	-	-
71- 80	-	-	-	-	-	-	-	-	-
81- 90	-	-	-	-	-	-	-	-	-
91-100	-	-	-	-	-	-	-	-	-
101-110	-	-	-	-	-	-	-	-	-
111-120	-	-	-	-	-	-	-	-	-
121-130	-	-	-	-	-	-	-	-	-
131-140	-	-	-	-	-	-	-	-	-
141-150	-	-	-	1	-	-	-	-	-
151+	-	-	-	-	2	-	-	-	-
Totals	-	-	-	1	2	-	-	-	-

Table 35. Length frequency of channel catfish (*Ictalurus punctatus*) collected during larval fish and YOY sampling in the White River, in 1983-85.

Total Length (mm)	1983 Aug 4-13	1983 Aug 22-26	1983 Sept 8-12	1984 Aug 2-5	1984 Aug 27-30	1984 Sept 19-22	1985 Jul 17-20	1985 Aug 13-16	1985 Sept 10-13
1- 10	-	-	-	-	-	-	-	-	-
11- 20	-	-	-	-	-	-	-	-	-
21- 30	-	-	-	-	-	-	-	-	1
31- 40	-	-	-	-	-	-	-	-	-
41- 50	-	-	-	-	-	-	-	-	-
51- 60	-	-	-	-	-	-	-	-	-
61- 70	-	-	-	-	-	-	-	-	-
71- 80	-	-	-	-	-	-	-	-	-
81- 90	-	-	-	-	-	-	-	-	-
91-100	-	-	-	-	-	-	-	-	-
101-110	-	-	-	-	-	-	-	-	-
111-120	-	-	-	-	-	-	-	-	-
121-130	-	-	-	-	-	-	-	-	-
131-140	-	-	-	-	-	-	-	-	-
141-150	-	-	-	-	-	-	-	-	-
151+	-	-	-	-	-	-	-	-	-
Totals	-	-	-	-	-	-	-	-	1