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DISTRIBUTION OF FISHES IN THE SAN RAFAEL RIVER SYSTEM OF THE UPPER COLORADO RIVER BASIN

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ABSTRACT. The San Rafael River and lower reaches of four major tributaries, Cottonwood, Huntington, Ferron, and Rock Canyon creeks, were sampled for fish and water quality in March-April, June, and October, 1977. Native species of fish included speckled dace *(Rhinichthys osculus)*, flannelmouth suckers *(Catostomus latipinnis)*, bluehead suckers (*C. discobolus*), and roundtail chubs (*Gila robusta*). Red shiners (*Notropis lutrensis*), fathead minnows (*Pimephales promelas*), black bullheads (*Ictalurus melas*), and channel catfish (*I. punctatus*) were recorded introduced species. A single young-of-the-year Colorado squawfish (*Ptychocheilus lucius*) was caught in the lower San Rafael River in October. This is the first documented record of Colorado squawfish in the San Rafael River. Native fish were dominant at seven stations in the tributary streams and middle section of the San Rafael River and introduced fish dominated the fauna near the mouth of the river.

The future extraction of coal in the Upper Colorado River Basin has aroused concern about impacts of this development on native fish and wildlife. The fish fauna of the basin constitutes one of the least understood groups of fishes native to a major North American river (Holden and Stalnaker 1975). The San Rafael River Basin is a major sub-basin in the system, and large coal deposits occur within its boundaries. Before the present survey, only the cold, headwater streams of the San Rafael River on the Wasatch Plateau (Manti-La Sal National Forest) had been adequately surveyed (unpublished data, Utah Division of Wildlife Resources). The fish of the lower river, where it flows through the arid Colorado Plateau, are relatively unknown. The objective of this study was to gather information on the species composition, distribution, and relative abundance of

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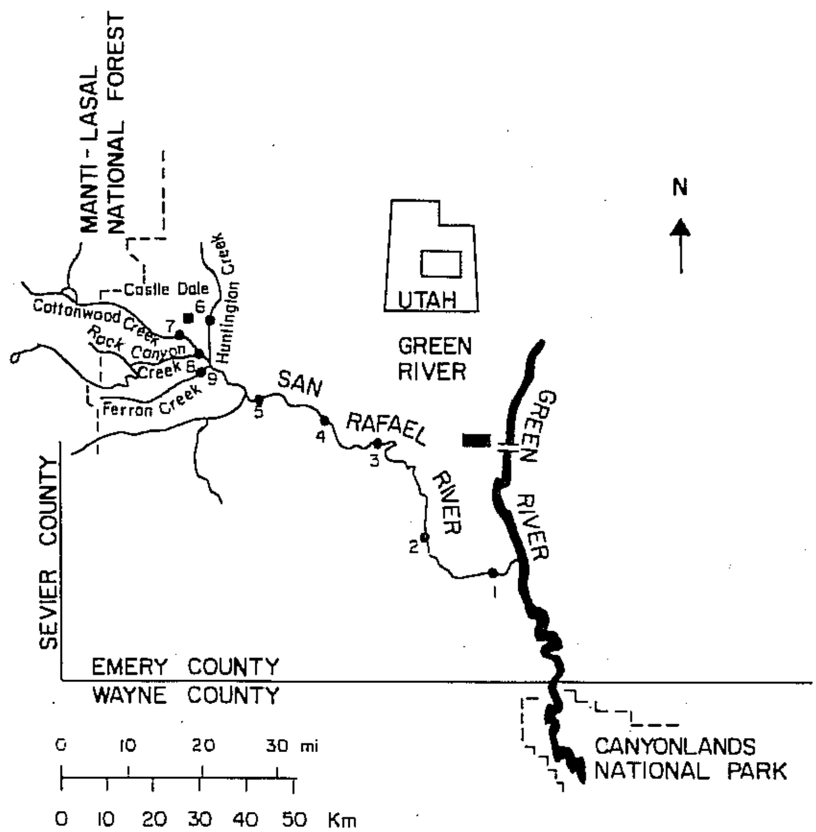

Fig. 1. Collection sites in the San Rafael River Basin: (1) San Rafael River, 3 km upstream from its mouth; (2) San Rafael River, 3.2 km upstream from Rt. 24 bridge; (3) San Rafael River at San Rafael Campground; (4) San Rafael River, 16 km upstream from 3; (5) San Rafael River, 2.7 km downstream from mouth of Ferron Creek; (6) Huntington Creek, 19.2 km upstream from its mouth; (7) Cottonwood Creek, 12.8 km upstream from its mouth; (8) Rock Canyon Creek, 1.6 km upstream from its mouth; (9) Ferron Creek, 12.8 km upstream from its mouth.

fishes in the San Rafael River, before energy development alters the fish fauna.

STUDY AREA. The San Rafael Basin encompasses about 4500 km^2 in southeastern central Utah (Fig. 1). The river is formed by the confluence of Huntington, Cottonwood, and Ferron creeks, near the town of Castle Dale (Emery Co.), Utah. The river then flows about 175 km through the San Rafael Swell of the arid Colorado Plateau and terminates at the Green River downstream from the town of Green River, Utah.

The San Rafael River is generally a wide, shallow stream. The bottom is predominately sand or silt, but the upper reaches have extensive areas of rubble and gravel. Streamside vegetation is sparse: dominant riparian plant species are tamarisk (*Tamarix pentandra*) and willows (*Salix* spp.).

The average annual precipitation at Castle Dale is near 22 cm (Utah State Engineer ND). However, it fell to 65% of average during 1977 (Nat. Oceanic and Atmos. Admin. 1977). Consequently, streamflows were reduced, especially in late summer and early fall, when the main river flow became intermittent. From 1971 to 1977 flows near the mouth of the river ranged from 0.3 to 47.5 m^3/s (U.S. Geol. Surv. 1971-75). Except for brief, high intensity storms, streamflow is dependent on runoff from the nearby mountains. As is typical of southeastern Utah streams, the river below its tributaries carries a high sediment load.

METHODS. Fish were collected from the San Rafael River and tributaries in March-April, June, and October 1977 at nine stations (Fig. 1). March-April collections were made with a 230-W backpack electrofishing apparatus. Two passes were made through each 100 m section that was sampled. However, the electrofishing gear was judged to be ineffective because of the high conductivity of the river; consequently, the June and October collections were made with a 7 m seine (3 mm mesh). Fish were seined from 50 m sections, and the catch doubled to represent a 100 m section. Stations were chosen that contained both riffle and pool habitat. Each station was seined repeatedly until relatively few fish were collected. Captured fish were held in containers until the sampling was completed, and were then identified, counted, and returned to the water. Selected samples were preserved for future reference. Water quality characteristics (temperature, dissolved oxygen, alkalinity, pH, hardness, turbidity, conductivity, phosphate, and chloride) were determined at each station with a Hach water quality kit (Model DR-EL). Water velocity was determined at each station with a March-McBirney velocity meter (Model 201).

RESULTS. *Fish distribution.*—The speckled dace (*Rhinichthys osculus*) was the most common native species in the San Rafael River and its tributaries (Table 1). It was followed, in order, by the flannelmouth sucker (*Catostomus latipinnis*), bluehead sucker (*C. discobolus*), and roundtail chub (*Gila robusta*). One young-of-the-year Colorado squawfish (*Ptychocheilus lucius*), an endangered species (U.S. Dept. Int. 1973), was found at station 1 in October (Fig. 2). The red shiner (*Notropis lutrensis*) was the most common introduced fish, followed by the fathead minnow (*Pimephales promelas*), black bullhead (*Ictalurus melas*), and channel catfish (*I. punctatus*).

In general, native and introduced fish were separated in the river system. Introduced fish were found only at the farthest downstream stations (1 and 2), and native fish only at upstream stations (3-9. At most stations, diversity and abundance was greater in the June samples than in the March-April or October samples. Of the more

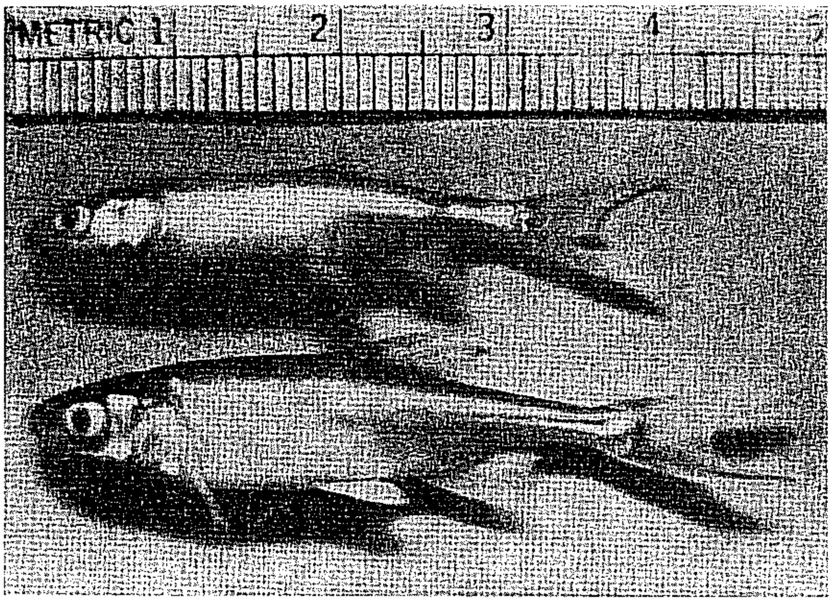

Fig. 2. Colorado squawfish (upper: 35 mm total length) and roundtail chub (44 mm total length) collected in October from station 1.

than 3,000 fish collected, 61% were taken in June. Increased sampling efficiency due to lower water probably accounted for these larger collections in June. Sampling inefficiency, differences in sampling gear, and the variable nature of irrigation water removal from the streams obscured other more specific observations on seasonal population fluctuations.

Throughout the course of the investigation, certain habitat preferences of native fish were apparent. Speckled dace and bluehead suckers were usually found in a deep riffle or shallow glide over cobble- or rubble-covered bottom. Flannelmouth suckers usually preferred the lower portions of a glide or pool, where a mud or silt bottom was present. Roundtail chubs were usually found in the deepest parts of pools.

Water quality characteristics.—Samples taken during this study corresponded with data collected by the U.S. Geological Survey (1971–75). Dissolved oxygen ranged from a high 11 mg/l in March and April to a low of 1 mg/l in isolated pools in October (Table 2). Total alkalinity ranged from 150 to 510 mg/l; hardness from 1,400 to 1,920 mg/l; conductivity from 2,250 to 7,800 μohms, and phH

TABLE 1. *Relative abundance and seasonal occurrence of fish in the San Rafael River and tributaries, 1977. Data are given as total number per 100 m. Percent of the collection is given in parentheses.*

Species	Station 1 Apr	1 June	1 Oct+	Station 2 Apr	2 June	2 Oct+	Station 3 Apr	3 June	3 Oct+	Station 4 Apr	4 June	4 Oct	Station 5 Apr	5 June	5 Oct+
Cyprinidae															
*Gila robusta**	—	—	1(01)	4(09)	6(10)	2(02)	1(50)	12(12)	5(10)	—	30(05)	7(03)	1(10)	7(01)	—
Notropis lutrensis	—	2(11)	63(90)	7(19)	28(45)	54(67)	—	—	—	—	—	—	—	—	—
Pimephales promelas	3(100)	13(74)	5(09)	25(67)	16(26)	13(16)	—	—	—	—	—	—	—	—	—
*Ptychocheilus lucius**	—	—	1(01)	—	—	—	—	—	—	—	—	—	—	—	—
*Rhinichthys osculus**	—	—	—	—	—	—	1(25)	54(54)	41(84)	4(100)	314(53)	231(91)	7(70)	448(91)	49(69)
Catostomidae															
*Catostomus latipinnis**	—	—	—	1(01)	6(10)	—	1(25)	21(21)	3(06)	—	73(12)	13(05)	1(10)	21(04)	18(25)
*C. discobolus**	—	—	—	—	2(03)	—	—	13(13)	—	—	174(29)	1(01)	1(10)	15(03)	4(06)
Ictaluridae															
Ictalurus punctatus	—	3(15)	—	—	—	—	—	—	—	—	—	—	—	—	—
I. melas	—	—	—	2(04)	4(06)	12(15)	—	—	—	—	—	—	—	—	—

Species	Station 6 Mar	6 June	6 Oct	Station 7 Mar	7 June	7 Oct	Station 8 Mar	8 June	8 Oct	Station 9 Mar	9 June	9 Oct
Cyprinidae												
*Gila robusta**	3(05)	2(01)	3(02)	13(18)	3(02)	—	—	—	—	Not sampled	—	8(06)
Notropis lutrensis	—	—	—	—	—	—	—	—	—		—	—
Pimephales promelas	—	—	—	—	—	—	—	—	—		—	—
*Ptychocheilus lucius**	—	—	—	—	—	—	—	—	—		—	—
*Rhinichthys osculus**	30(53)	233(78)	172(95)	8(11)	59(37)	74(89)	16(46)	22(100)	—		98(97)	66(46)
Catostomidae												
*Catostomus latipinnis**	23(41)	40(13)	—	50(70)	93(58)	9(11)	16(48)	—	—		—	53(37)
*C. discobolus**	1(01)	23(08)	5(03)	1(01)	2(03)	—	2(06)	—	—		3(03)	16(11)
Ictaluridae												
Ictalurus punctatus	—	—	—	—	—	—	—	—	—		—	—
I. melas	—	—	—	—	—	—	—	—	—		—	—

+ Habitat was limited to isolated pools.

* Indigenous.

TABLE 2. *Water quality of the San Rafael and tributaries*, 1977.

Station and month	Water temp (C)	Total alkalinity mg/1	Dissolved oxygen (mg/1)	Turbidity (FTU's)	Conductivity (µohms)	Hardness (mg/1)	pH	Phosphate (mg/1)
						Characteristic		
1								
Apr	4	350	10.5	500	2450	1570	9.1	—
Jun	19	230	5.8	5	—	1600	8.4	0.2
Oct	15	150	4.7	—	3700	—	—	—
2								
Jun	29	320	—	65	—	1750	8.3	0.1
Oct	20	200	6.5	—	3800	—	—	—
3								
Jun	24	230	5.0	5	—	1490	8.4	0.2
Oct	18	230	1.0	—	5500	—	—	—
4								
Apr	1	370	13	50	2250	1450	9.1	—
Jun	31	250	6.3	10	—	1590	7.8	0.4
Oct	14	200	7.5	—	6000	—	—	—
5								
Mar	10.5	335	10.5	20	6000	1920	8.8	0.1
Jun	23	230	5.3	65	—	1400	8.4	—
Oct	20	200	7.0	—	5250	—	—	—
6								
Jun	23	290	5.0	30	—	1520	8.4	0.2
Oct	16	350	5.0	—	7000	—	—	—
7								
Mar	7	390	9.8	30	5500	1785	8.6	0
Jun	27	280	6.3	2	—	1450	8.4	0.4
Oct	12	510	7.0	—	5960	—	—	—
8								
Mar	8	385	7.3	25	7800	2045	8.6	0.1
Jun	16	330	5.5	30	—	1610	8.7	0.2
9								
Jun	24	340	3.0	45	—	1590	8.4	0.2
Oct	18	300	7.4	—	—	—	7.1	—

from 7.1 to 9.1. Water temperature was 1 C in March and rose to 31 C by June.

DISCUSSION. The distribution of native and introduced fish in the San Rafael River reflects a pattern that has become common in the West. Several investigators have reported introduced species replacing native fish in lower reaches of rivers and streams (Deacon et al. 1965, Deacon and Bradley 1972, Cross 1976).

In the San Rafael River, the segregation of native and introduced species is probably due to differences in habitat between the upper and lower sections of the river. The lower San Rafael River consisted of wide, shallow stretches, with uniform sand bottoms. The few pools were small and shallow. Introduced species appear to be better able to survive in this type of environment. Habitat in the upper stations was more diverse; pools were deep and long, cover was more frequent, and substrate was more variable. Areas with more diverse habitat are apparently more suitable for native fish.

Diversion of water for irrigation probably is the major cause of habitat differences between the upper and lower sections of the river. Small reservoirs control streamflow in each of the tributaries. However, much of this water is diverted before it reaches the lower San Rafael River.

The combined effects of drought and diversion of water for irrigation played an important role in distribution of fish in the San Rafael River during 1977. In October, these two factors created extreme conditions in lower sections of the river (stations 1, 2, and 3), when fish were stranded in isolated pools along the otherwise dry stream bed. Desert fishes are often able to survive for extended periods in these small pools, even with the additional stress of disease, parasitism, and predation (Deacon and Minckley 1974). Low dissolved oxygen may also play a role in the decimation of the crowded fish, particularly when organic material creates a high biochemical oxygen demand (Larimore et al. 1959). Dissolved oxygen in pools at station 1 ranged from 1 mg/l to 4.8 mg/l. Pools which were also inhabited by beaver had low oxygen-levels due to decomposing fecal material and other organic matter, and contained few fish. More fish were found in pools where oxygen levels were higher.

Fish repopulation of decimated riverine areas after dewatering (Larimore et al. 1959) or pollution-caused fish kills (Krumholz and Minckley 1964, Gunning and Berra 1969, Olmstead and Cloutman 1974, Phinney 1975) is often swift. We observed repopulation of Ferron Creek (station 9) in October after dewatering in June. In June, streamflow was reduced such that fish were confined to a shallow pool. However, streamflow had resumed by October and the fish population was larger and more diverse (Table 1).

The collection of a young-of-the-year Colorado squawfish represents the first record of the species in the San Rafael River. Colorado squawfish are considered to be large-river fish (Minckley 1973), and have only rarely been reported in rivers other than the large rivers of the basin (e.g. the Yampa, Green, Gila, and Colorado rivers). May (1970) reported several small Colorado squawfish (100 to 200 mm total length) in the White River near the mouth of Piceance Creek. Adults have been reported at the mouths of the White, Uinta, and Duchesne rivers (Seethaler 1978). We do not know whether the small Colorado squawfish was spawned in the San Rafael River or moved upstream from the Green River.

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