

MIGRATORY BEHAVIOR OF LAHONTAN CUTTHROAT TROUT

(Salmo clarki henshawi) UTILIZING RADIO TELEMETRY

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Abstract.

A significant difference in total upstream versus total downstream movement was found in 1976. No significant difference in total upstream versus total downstream movement was found in 1977. Water temperature is postulated as a key triggering mechanism in upstream spawning behavior.

INTRODUCTION

Historically, the Truckee River system supported large runs of Lahontan cutthroat trout (Salmo clarki henshawi). Fish were plentiful throughout the entire basin and a large commercial fishery existed. Juday (1907) reported a total of 96,087 pounds of trout shipped from towns along the Truckee in 1900. With the construction of Derby Dam and its inadequate fish passage facilities in 1906, the large runs began to diminish due to the formation of a large delta at the mouth of the river and lack of access to traditional spawning grounds. The last spawning run passing over Derby Dam occurred in the late 1930's. Since the early 1940's, Lahontan cutthroat trout were virtually nonexistent in the Truckee. The original strain in Pyramid Lake became extinct but other strains were reintroduced in the mid 1950's.

Fishery restoration efforts initiated then are continuing today and are centered on reestablishing the Pyramid Lake Fishery to some semblance of its former significance. Management programs are directed at using both hatchery stocking and natural reproduction to rebuild the fishery. The objectives of this study were to determine the migratory behavior of adult Lahontan cutthroat trout released into the Truckee, to determine if the fish would utilize tributary streams for spawning and whether existing diversion dams were barriers to upstream migration.

Observing fish behavior during flow and turbidity conditions normal to spring runoff is impossible. In order to monitor daily movements over large distances and a number of fish simultaneously, an individual identification system that is highly mobile is necessary. In order to meet these objectives, we developed a radio telemetry system utilizing a light aircraft to monitor daily movement. Wildlife biotelemetry has been used for many years to track big game and birds (Craighead, et al., 1963; Linderman, 1974; Schumacher, et al., 1977; Lancia and Dodge, 1977). Monitoring of fish movement has been largely confined to ultrasonic tracking of salmon migrations and to a lesser extent freshwater species (McCleave and LaBar, 1972; Koo and Wilson, 1972; Stasko et al., 1976; Stasko, et al., 1973). More recently, radio telemetry has been used to track movements of Pacific salmon (Oncorhynchus sp.), Atlantic salmon (Salmo salar), American shad (Alosa sapidissima) and rainbow trout (Salmo gairdneri) in freshwater (Knight and Maranick, 1977; Liscom, et al., 1977).

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STUDY AREA

The Truckee River drains the Lake Tahoe basin, flows down the eastern slope of the Sierra Nevada into Pyramid Lake (Figure 1). The river is 192 km in length and has a total drainage area of 8,029 km². Lake Tahoe has a surface area of 549 km² and is world famous for its scenic beauty and exceptional water quality. Pyramid Lake is at the terminus of the river and is a remnant of glacial age Lake Lahontan. It has a surface area of 445 km² with a total dissolved solids level of 5,000 mg/l.

The river has 10 major tributary streams with the majority in California. Many areas of the drainage have poor vehicle access. In addition, the river is boulder strewn and has 36 major water diversion dams. Flows in the lower river, below Derby Dam at river kilometer 59.0, may range from less than 0.57 m³/sec to over 566 m³/sec. Normal spring runoff flows exceed 28.3 m³/sec.

In 1976, the study was conducted downstream from the Washoe Power Diversion (river km 122.6) to Pyramid Lake. This section was further divided at Derby Dam (river km 59.1) as Derby is an impassable barrier to upstream movement. During 1977, fish were introduced into the river above the Washoe Power Diversion.

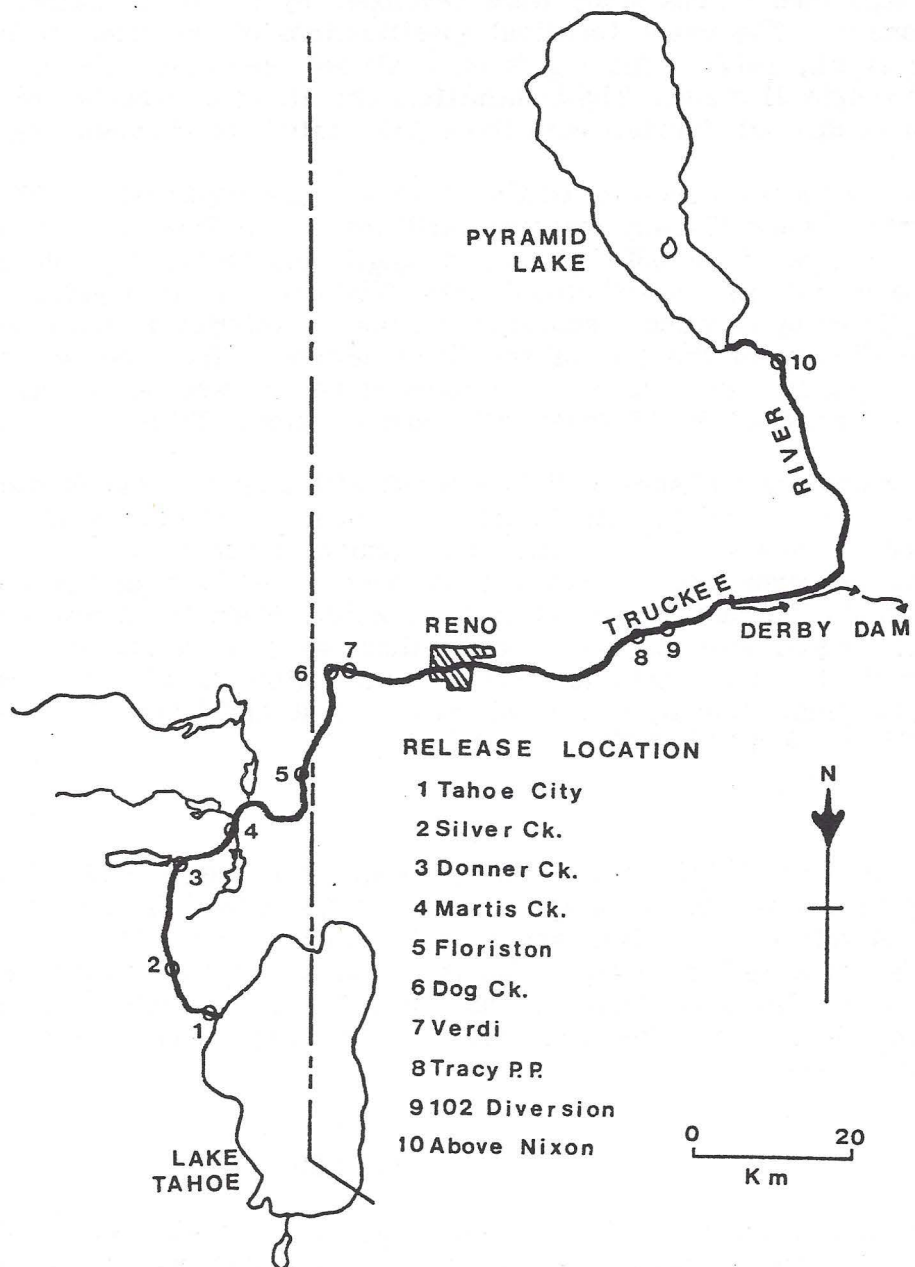


Fig. 1.- Release locations for radio tagged Lahontan cutthroat trout in the Truckee River system, California-Nevada 1976-77

MATERIALS AND METHODS

1976

Radio tags used in this study were developed by the junior authors at the University of Wyoming. The exact technical specifications of the tags are published elsewhere (Weeks et al., 1977). The tag is cigar shaped, measures 1.27 cm X 1.58 cm X 10.8 cm and weighs 31 grams. The transmitters operate at a frequency of 164.4375 -164.7125 Mhz on 12 distinct channels with three pulse rates per channel. Tag life is 45-60 days.

Twenty five adult Lahontan cutthroat trout were captured at the Marble Bluff Dam and Pyramid Lake Fishway trapping facilities on the Pyramid Lake Indian Reservation. The fish ranged from 558-818 mm in length and from 2.21-5.50 kg in weight (Table 1). Each fish was anesthetized with MS-222 prior to tagging. Tag insertion was accomplished by creating a subcutaneous pocket anterior to the insertion of the dorsal fin and slightly to the left of the fish's midline. The incision was closed with two sutures. All fish were detained 24 hours at the fishway before release into the river. Fish were released on different dates and locations (Table 1).

Tracking was accomplished by light aircraft with a simple quarter wave Marconi antenna mounted on the fuselage. An A.V.M. Instrument Co. Model LA-12 receiver was slightly modified to increase signal sensitivity. Individual fish were located by flying 152-305 m above the river. As the aircraft approached the fish's position, the signal strength meter would increase in deflection from zero. When the aircraft was directly above the fish, signal strength meter deflections were at a maximum. Ground tracking confirmed that this technique was accurate within a 50 meter radius of the fish's actual location. Fish were tracked daily at 0600 hours and 1800 hours between March 26, 1976 and June 11, 1976.

1977

Twenty five adult Lahontan cutthroat trout were tagged and released in 1977. The tagging procedure and tracking techniques were essentially the same as described for 1976. A different receiver and slightly smaller transmitter was utilized this year. Daily flights were less frequent due to inclement weather conditions along the eastern slope of the Sierra's. Data on individual fish is presented in Table 2. Fish were released the same day they were tagged. Tracking began on April 27, 1977 and ended on June 1, 1977.

RESULTS

Movement patterns in 1976 were much more pronounced than in 1977. An analysis of 1976 total upstream versus total downstream movement indicated a significant difference (P 0.001). Differences in movement for 1977 were insignificant (P 0.90). A summary of movement data for 1976 and 1977 is presented in Tables 3 and 4.

TABLE 1.--Radio tagging data for Lahontan cutthroat trout released into the Truckee River, California-Nevada in 1976

Fish No.	Date Tagged	Fork Length(mm)	Weight (kg)	Sex	Release location	
					River Km.	Name
7601	3/25/76	693	-	M	16.1	Above Nixon
7602	"	703	-	M	"	" "
7603	"	750	-	F	"	" "
7604	"	558	-	F	"	" "
7605	"	566	-	F	"	" "
7606	4/08/76	670	3.35	M	75.6	102 Diversion
7607	"	573	-	F	"	" "
7608	"	665	3.12	M	"	" "
7609	"	672	3.20	M	"	" "
7610	4/22/76	680	3.92	M	"	" "
7611	"	680	3.32	M	"	" "
7612	"	669	3.23	M	"	" "
7613	"	638	3.01	F	"	" "
7614	"	623	2.64	F	"	" "
7615	"	629	2.67	F	"	" "
7616	"	710	3.88	M	74.0	Tracy Power Plant
7617	"	680	3.46	M	"	" " "
7618	"	729	3.83	M	"	" " "
7619	"	588	2.61	F	"	" " "
7620	"	608	2.21	F	"	" " "
7621	"	689	3.66	F	"	" " "
7622	4/29/76	818	5.50	M	16.1	Above Nixon
7623	"	780	4.88	M	"	" "
7624	"	696	3.46	M	"	" "
7625	"	590	2.27	F	"	" "

TABLE 2.--Radio tagging data for Lahontan cutthroat trout released into the Truckee River, California-Nevada in 1977

Fish No.	Date Tagged	Fork Length(mm)	Weight (Kg)	Sex	Release location	
					River Km.	Name
7701	4/27/77	575	2.00	F	143.5	Floriston
7702	"	630	2.50	M	"	"
7703	"	523	1.80	F	"	"
7704	"	650	3.00	M	"	"
7705	"	570	1.80	M	"	"
7706	"	700	3.40	M	"	"
7707	"	660	2.99	F	"	"
7708	"	730	4.10	M	"	"
7709	"	729	4.90	M	"	"
7710	"	610	2.30	F	"	"
7711	"	630	2.40	M	"	"
7712	"	625	2.60	F	"	"
7713	"	630	2.50	F	"	"
7714	"	565	1.70	F	"	"
7715	5/05/77	568	1.72	F	161.1	Below Martis Creek
7716	"	475	1.04	M	"	" " "
7717	"	510	1.48	F	170.1	Donner Creek
7718	"	590	2.04	M	"	" "
7719	"	680	3.10	F	180.9	Below Silver Creek
7720	"	550	1.62	F	"	" " "
7721	"	660	3.40	F	192.3	Tahoe City
7722	"	505	1.28	F	"	" "
7723	5/20/77	642	2.84	F	126.1	Dog Creek
7724	"	623	2.48	M	124.2	Verdi Bridge
7725	"	741	3.84	F	124.2	" "

TABLE 3.—Summary of movement data for Lahontan cutthroat trout released into the Truckee River, California-Nevada in 1977.

Fish No.	Total days in river ^a	Time and rate during movement ^b				Total distance traveled (km) ^c	
		Upstream		Downstream		Upstream	Downstream
		Days	Km/Day	Days	Km/Day		
7601		Transmitter failure					
7602		Transmitter failure					
7603	3.13	1.15	1.22	0	0	1.41	0
7604	11.13	0	0	2.63	4.14	0	10.86
7605	11.25	0	0	3.29	3.30	0	10.86
7606		Transmitter failure					
7607		Transmitter failure					
7608		Transmitter failure					
7609	6.60	6.05	7.63	0	0	46.18	0
7610	34.90	6.03	6.40	4.69	5.00	38.62	23.49
7611	34.00	11.65	1.80	3.53	3.23	20.92	11.42
7612	15.00	7.55	6.13	0.46	3.15	47.63	1.45
7613	34.00	4.22	5.29	6.00	4.86	22.37	29.12
7614	34.20	7.22	6.47	6.00	4.22	46.66	25.26
7615	10.75	1.21	12.23	3.05	4.59	14.80	14.00
7616	34.00	7.26	7.32	5.21	8.09	53.10	42.16
7617	33.90	3.05	13.77	6.52	4.20	42.00	27.35
7618	7.75	3.94	10.38	0.48	2.01	40.87	0.97
7619	8.25	1.83	18.81	0	0	34.43	0
7620		Transmitter failure					
7621	8.00	7.06	4.70	0	0	33.15	0
7622	5.27	0.33	11.22	0	0	3.70	0
7623	19.29	4.83	10.70	3.00	4.14	51.81	12.39
7624	18.00	3.81	12.58	2.03	9.35	47.95	18.99
7625	28.00	4.30	5.54	3.00	6.11	23.81	18.34
Total	367.42					569.41	246.66

^a Total days tracked

^b Time and rate during active movement

^c Significant difference in upstream and downstream totals at P=.001

TABLE 4.--Summary of movement data for Lahontan cutthroat trout released into the Truckee River, California-Nevada in 1977

Fish No.	Total days in river ^a	Time and rate during movement ^b				Total distance traveled (km) ^c	
		Upstream		Downstream		Upstream	Downstream
		Days	Km/Day	Days	Km/Day		
7701	2.90	0.88	0.55	1.21	10.64	0.48	12.87
7702	6.92	5.00	0.90	1.92	3.94	4.51	7.56
7703	5.75	4.75	2.45	0	0	11.59	0
7704	6.92	1.69	10.86	3.04	7.05	18.34	21.40
7705	7.92	2.08	1.40	1.52	1.90	2.90	2.90
7706	4.23	0	0	1.52	0.21	0	0.32
7707	3.98	1.71	3.20	0.63	0.52	5.47	0.32
7708	2.71	2.33	3.80	0	0	8.85	0
7709	7.92	0.81	2.59	2.44	0.85	2.09	2.09
7710	12.92	1.50	5.15	2.29	1.13	7.72	2.57
7711	5.88	2.15	0.31	3.17	1.18	0.64	3.70
7712	2.71	0.83	0.19	0.63	0.52	0.16	0.32
7713	2.08	1.52	0.21	0	0	0.32	0
7714	6.92	2.15	1.13	4.21	1.30	2.41	5.47
7715	7.92	4.75	4.31	2.15	2.88	20.52	6.20
7716	12.83	6.94	2.67	4.21	6.13	18.58	25.83
7717	12.75	4.69	1.13	2.19	2.49	5.31	5.47
7718	8.92	0.15	4.83	0.81	1.38	0.72	1.13
7719	12.73	4.73	0.79	3.83	2.25	3.70	8.61
7720	12.75	0.08	2.01	2.79	4.33	0.16	12.07
7721 ^d	10.83	7.00	1.19	0	0	8.37	0
7722	0.73	0	0	0	0	0	0
7723	4.71	1.58	0.61	2.46	2.16	0.97	5.31
7724				Transmitter failure			
7725	7.65	3.04	1.90	2.42	4.33	5.79	10.46
Total	171.58					129.60	134.60

^a Total days tracked

^b Time and rate during active movement

^c No significant difference in upstream and downstream totals

^d Includes movement in Lake Tahoe

Females from both years did attempt to spawn in the mainstem of the river. Two ripe females released above Nixon 1976 immediately began redd excavation. Both fish deposited eggs and then moved downstream towards Pyramid Lake. One fish was captured in the impoundment behind Marble Bluff Dam. This fish had spawned and resumed feeding. A spawning pair released above Derby Day migrated upstream and began redd excavation near Idlewild Park in Reno. Fish number 7723 was observed excavating a redd near Verdi on May 25, 1977.

Fish placed in the river in 1977 tended to move less and much more sporadically than in 1976. For example, a fish might move upstream for two or three days then stop or move downstream for several days. There were no consistent trends to move upstream as exhibited the previous year. We feel that this inconsistent behavior may be attributed to changes in water temperature. For example, three fish that moved very little for seven days, immediately began moving upstream at a much greater rate when a warm rain raised the water temperature from 6°C to 11.5°C in six hours. Temperatures prior to the rain had ranged from 5.5°C to 8.5°C.

DISCUSSION

This study clearly indicated the desire of Lahontan cutthroat trout from Pyramid Lake to migrate up the Truckee River to spawn. Although the data for 1977 were not significant when comparing total upstream and downstream movement, we feel the difference is due to changes in water temperature patterns between 1976 and 1977. A more detailed analysis of this relationship is in progress.

Results also indicate that adults have no noticeable desire to enter a tributary stream to spawn. Between the 1976 and 1977 fish, they had access to every major tributary to the Truckee downstream from Lake Tahoe. Several pairs of fish were placed right at the mouths of various tributaries but none attempted to ascend.

The only fact which casts doubt on this hypothesis is the behavior of fish number 7725. This fish was released in the Fanny Bridge pool just below the outlet of Lake Tahoe. Due to low flow conditions, it was able to pass through the dam and a barrier we had erected just above the dam and enter Lake Tahoe. This fish was tracked in the lake for several days before entering Blackwood Creek on the west side. It was found dead approximately 400 m upstream from the mouth. This is the only fish that attempted to utilize a tributary.

The project demonstrated that many of the 36 diversion dams on the river are not barriers to fish migration. However, this statement must be qualified to include the size of fish used, the flows in the river during the study and the structure of the dams at that time. Since the completion of the project, most of the dams have been changed either in height and/or configuration to increase the available water diversion during the 1977 drought. The changes may have invalidated the results obtained. Many of the dams may in fact now be barriers to upstream migrating adults.

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