

ULTRASONIC TRACKING OF STRIPED BASS,
MORONE SAXATILIS, AND SACRAMENTO SQUAWFISH,
PTYCHOCHEILUS GRANDIS, NEAR FISH FACILITIES^{1/}

by

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ABSTRACT

Residency patterns and movements of six striped bass and two Sacramento squawfish were monitored for up to 31 days at two Central Valley fish facilities. Ultrasonic transmitters were used to determine locations of individual fish. The transmitters were either inserted into the stomach or attached externally. Tagged individuals of the two species behaved differently. Striped bass were occasionally present and Sacramento squawfish were continually present near the fish screens. However, capture, handling, and tagging had an unknown effect on subsequent behavior of the two predators.

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INTRODUCTION

Predation by fish near the intake to the Peripheral Canal may be a significant problem for small fish screened from the diversion. Downstream migrants of anadromous species such as chinook salmon, Oncorhynchus tshawytscha, striped bass, American shad, Alosa sapidissima, steelhead rainbow trout, Salmo gairdneri, and many resident species will be exposed to the fish screen. Observations at existing facilities in the Sacramento-San Joaquin River system have indicated that adult striped bass and Sacramento squawfish are the two most important predators (Hall 1979a, b).

This report describes limited experiments with ultrasonic tagged striped bass and Sacramento squawfish to determine: (1) residency and movements of these two species near fish screens and related facilities such as trashracks and fish bypasses and (2) differences between behavior of squawfish and striped bass near fish facilities. These experiments were performed in 1977 and 1978 at the State Fish Protective Facility located 4.6 km (3 miles) southeast of Byron (Figure 1) and in 1978 at the Glenn-Colusa Fish Screen, 3 km (2 miles) north of Hamilton City, California (Figure 2).

METHODS

State Fish Protective Facility

Striped bass were captured, tagged, and released immediately upstream from the trashracks preceding the louver fish screens at the State Fish Protective Facility. Three striped bass were captured by angling with artificial lures during May, 1977. These fish were tagged with Model T3 Bayshore Systems ultrasonic transmitters inserted into the fish's stomach through the mouth with a 40.6 cm (16 in.) piece of 1.3 cm (0.5 in.) ID PVC tubing.

A Bayshore Systems Model LF-24 receiver Model H-D 16 directional hydrophone were used to monitor tagged fish. We monitored daily to determine the presence or absence of tagged fish near the trashrack and floating trashboom (Table 1). Surface water temperature, pumping rate, fish salvage totals, and time of day were recorded for each day's monitoring.

Two additional striped bass were captured, tagged, and released in June and July, 1978. One of the striped bass was captured by angling and the other by a gill net. To reduce the effect of internal stomach tags on the behavior of the fish, tags were fitted externally in a similar fashion to that used for disc-dangler type tags (Chadwick 1963).

Glenn-Colusa Fish Screen

The off-river channel at the Glenn-Colusa screen contains riparian habitat and stream flow characteristics similar to the main river.

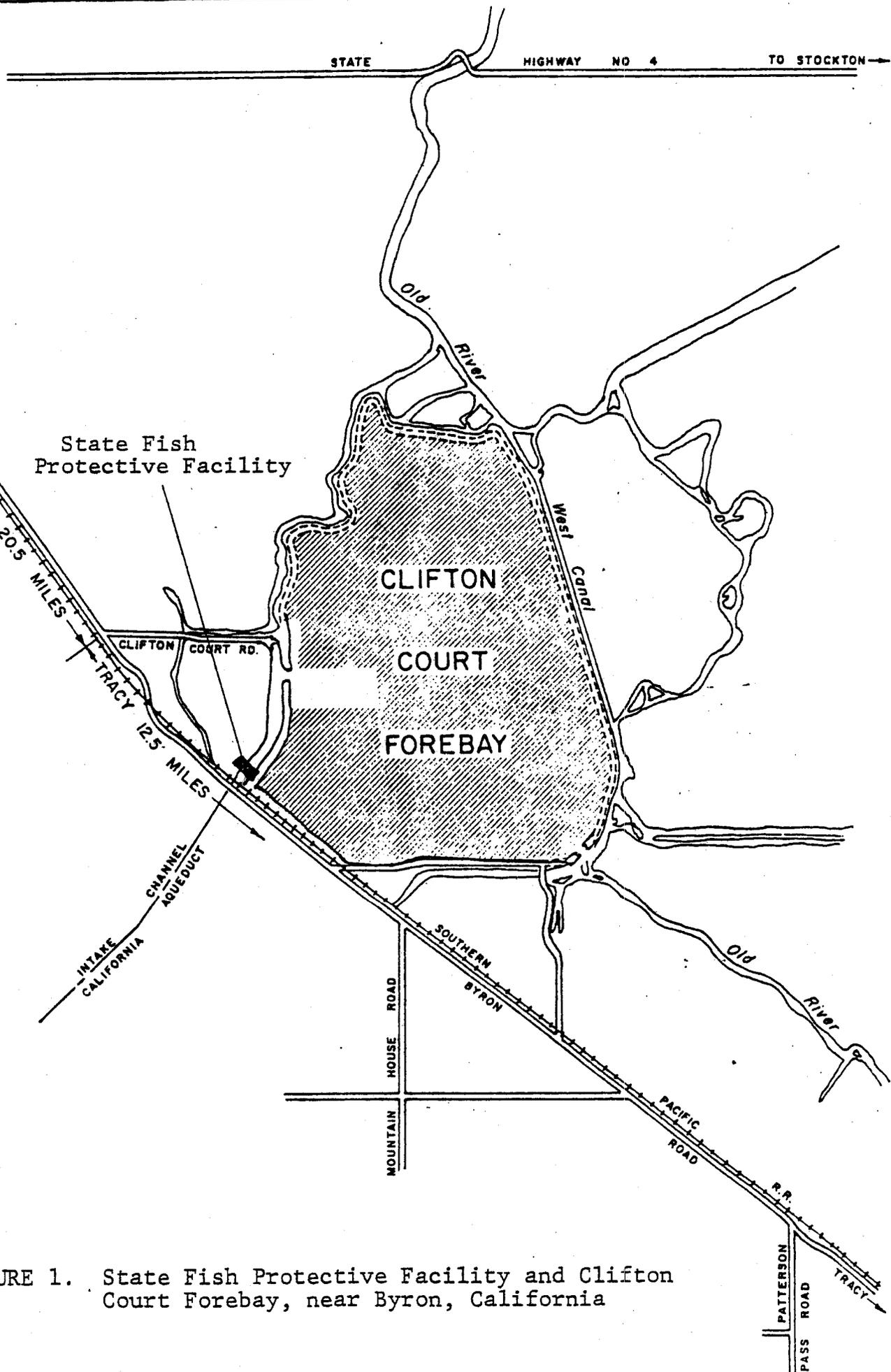


FIGURE 1. State Fish Protective Facility and Clifton Court Forebay, near Byron, California

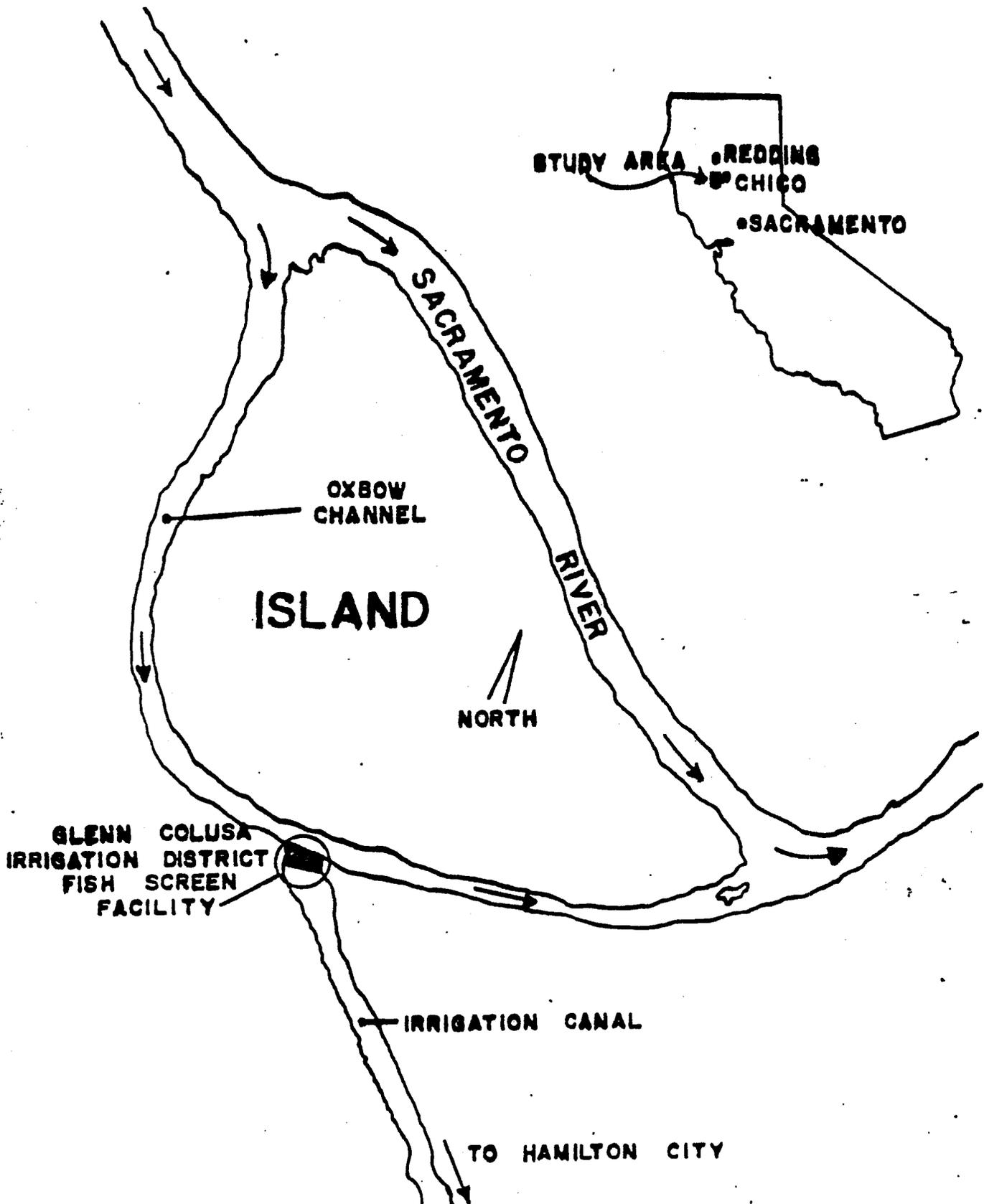


FIGURE 2. Glenn-Colusa Irrigation District Fish Screen near Hamilton City, California.

TABLE 1. Summary of individual tracking data for 6 striped bass and 2 Sacramento squawfish - May, 1977 and June-August, 1978.

Fish species and number ^{1/}	Fork length (cm)	Transmitter frequency (kHz) ^{2/}	Released		Location of release	Observations	
			Date	Time		Duration	Number
Byron Fish Protective Facility	SB-1	70 - S	5/5/77	1130 h	trashracks	31 days	37
	SB-2	55 - S	5/5/77	1320 h	trashracks	31 days	34
	SB-3	65 - S	5/12/77	1115 h	trashracks	24 days	21
	SB-4	55 - E	6/27/78	0905 h	trashracks	23 days	23
	SB-5	70 - E	7/11/78	1945 h	trashracks	3 days	9
Glenn-Colusa Fish Screen	SB-1	50 - E	8/1/78	1045 h	N end of screen	45 hours	40
	SQ-1	60 - E	8/1/78	1500 h	N end of screen	7 days	25
	SQ-2	65 - E	8/1/78	1610 h	S end of screen	7 days	20

^{1/} SB = striped bass; SQ = Sacramento squawfish

^{2/} S = transmitter inserted into stomach; E = transmitter attached externally

Immediately above and below the fish screen the channel contains downed and overhanging trees, steeply cut banks, and numerous deep pools.

One striped bass and two Sacramento squawfish were captured by angling, externally tagged, and released near the fish screen in August, 1978. The striped bass and one squawfish were tagged and released at the upstream end of the fish screen; the second squawfish was tagged and released at the downstream end of the fish screen. The tagging method was the same (external) as that previously described for the Byron Fish Protective Facility experiments in 1978. Transmitters, receiver, and hydrophone were the same as those used at the Byron Fish Protective Facility in 1977 and 1978.

Tracking at Glenn-Colusa Fish Screen was conducted almost continuously for the first 45 hours after tagging. Position fixes were obtained at least every few hours for each of the three fish tagged. Positions were determined in the channel near the fish screen and in the river upstream from the channel by drifting downstream in a skiff. Each drift covered approximately 100 m (328 ft) of river or channel. The use of the directional hydrophone enabled us to determine the location of a tagged fish along the river bank, channel, and screen face.

RESULTS

Byron Fish Protective Facility

The effects of handling and tagging, or the change in location of the transmitter, on the behavior of tagged fish could not be determined. However, observations made on striped bass at Steinhart Aquarium have shown that removal of fish from the tank to insert a stomach tag altered the fish's behavior after it was released (Mark Smith, pers. comm.). Individual fish with non-functional transmitters inserted into the stomach did not rejoin the school and failed to eat for up to 10 days after release.

Rejection (regurgitation) of transmitter inserted into the stomach was a possibility but was not observed in the Steinhart experiments. In 1977 at the Fish Protective Facility no signal constantly came from any single location indicating this was also unlikely during our investigation.

The presence at the facility of the three striped bass tagged in May, 1977 appeared to be related to high export rates, high fish salvage numbers, and lower water temperatures (Table 2). However, water exports and fish salvage numbers decreased while water temperatures increased slightly during monitoring between May 5 and June 5, 1977.

The two striped bass tagged (external) in 1978 at the Fish Protective Facility behaved differently after tagging with ultrasonic transmitters. The fish tagged on June 27, 1978 proceeded rapidly up the channel towards Clifton Court Forebay. Within 2 hours after tagging

TABLE 2. Mean daily water export, numbers of fish salvaged, and water temperatures relative to the presence or absence of the three striped bass ultrasonically tagged at the State Fish Protective Facility near Byron, California, May 5 - June 5, 1977.

Fish species, number, and transmitter frequency (kHz)		Daily Means (0000-2400 h)		
		Water export (acre-feet)	Numbers of fish salvaged	Water temperature (degrees C)
Fish Present	SB-1 70 kHz	3413	2692	17.4
	SB-2 55 kHz	2447	1477	17.5
	SB-3 65 kHz	3725	3775	16.9
Fish Absent	SB-1 70 kHz	1873	950	18.1
	SB-2 55 kHz	1869	697	18.8
	SB-3 65 kHz	733	254	19.0

the fish apparently entered Clifton Court Forebay as it could not be relocated in the channel leading to the Fish Protective Facility. This fish was not detected again during the next 23 days of monitoring.

The striped bass tagged at the Fish Protective Facility on July 11, 1978 was present near the trashracks from the time it was tagged (1945 hours) until it was recovered impinged (dead) on the trashracks at 0700 hours July 14, 1978. The water temperature at time of release was 25°C (77°F) and a blue-green algae bloom was observed. These conditions probably contributed additional stress and may have been partly responsible for the mortality.

Glenn-Colusa Fish Screen

The striped bass tagged at Glenn-Colusa Fish Screen at 1045 hours August 1, 1978 proceeded upstream in a "rest and go" pattern after release. After 45 hours of nearly continuous monitoring the fish was last detected approximately 6 km (3 miles) upstream from the fish screen in the main channel of the Sacramento River.

The two Sacramento squawfish tagged at Glenn-Colusa Fish Screen remained within 100 m (328 ft) of the fish screen throughout the seven days their locations were monitored. Their movements were more typical of resident predators, alternately present at the screen face and at resting areas above and below the fish screen (Figures 3 and 4). These two fish were originally tagged approximately 64 m (210 ft) apart at opposite ends of the fish screen. Four of the 55 position fixes for these two fish showed that they were at the same location approximately 45 m (150 ft) upstream from the screen on the west bank of the channel. Monitoring was terminated August 8, 1978 when it appeared that no locations were being utilized other than those recorded during the first 45 hours of observation.

Position fixes of the two squawfish at Glenn-Colusa Fish Screen indicated that they utilized a wide range of water velocities. Estimated velocities of between 0.03 and 0.9 cm (0.1 and 3.0 ft) per s were available and utilized near the upper and lower ends of the fish screen. This range in water velocities occurred over a distance of 6 m (20 ft) in some locations, especially near the steel bulkhead and dredge gate at the upstream end of the screen.

DISCUSSION

The "rest and go" upstream movement by the striped bass at Glenn-Colusa Fish Screen was similar to that found for ultrasonically tagged migrating striped bass in the Sacramento-San Joaquin Estuary (Finlayson 1976) and in the Chesapeake and Delaware Canal (Koo and Wilson 1972). It is possible that the striped bass tagged at Glenn-Colusa Fish Screen

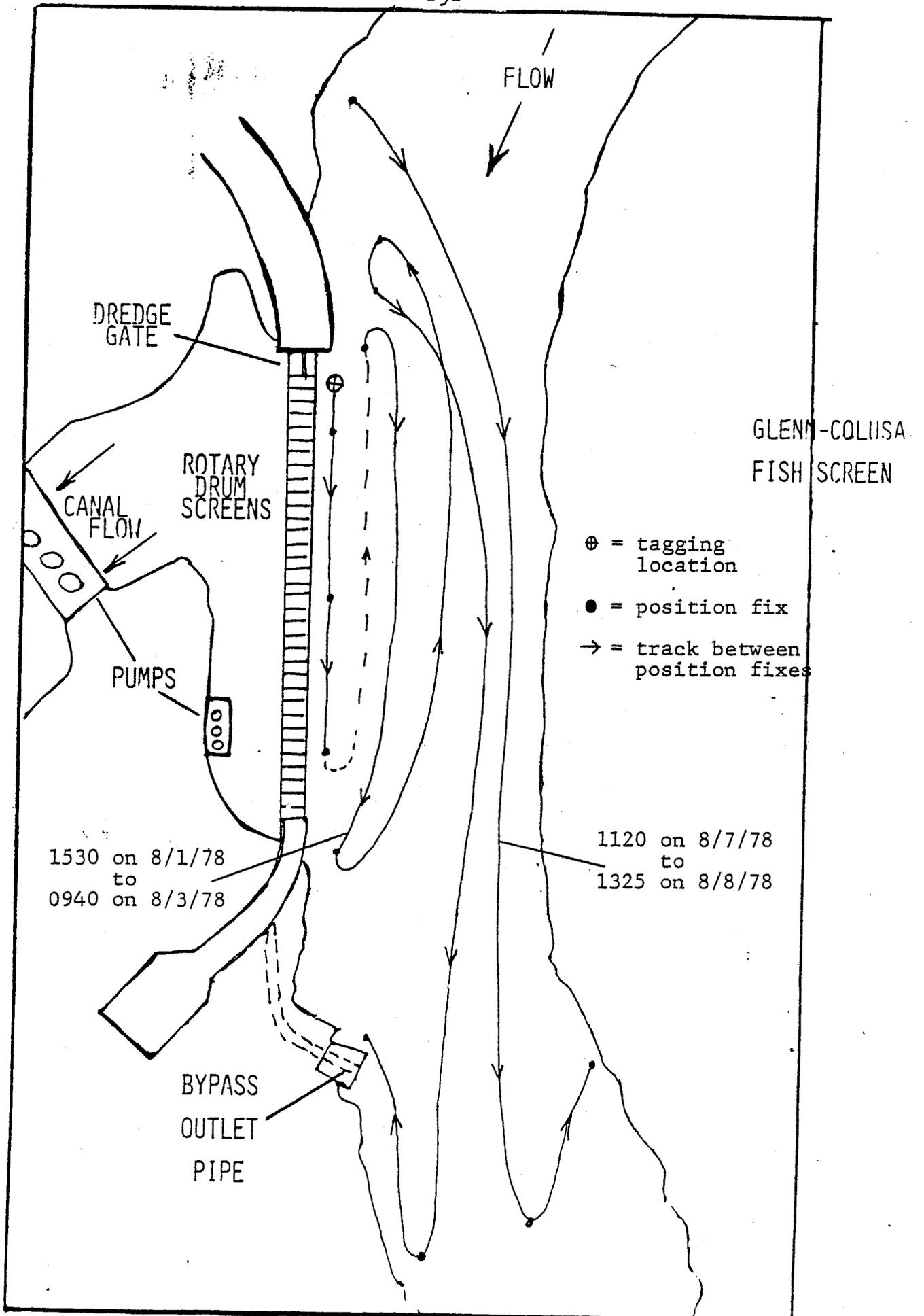


FIGURE 3. Tagging location, position fixes, and track between position fixes for a 49 cm (FL) Sacramento squawfish (SO-1) 1530 hrs on 8/1/75 to 1325 hrs on 8/8/78.

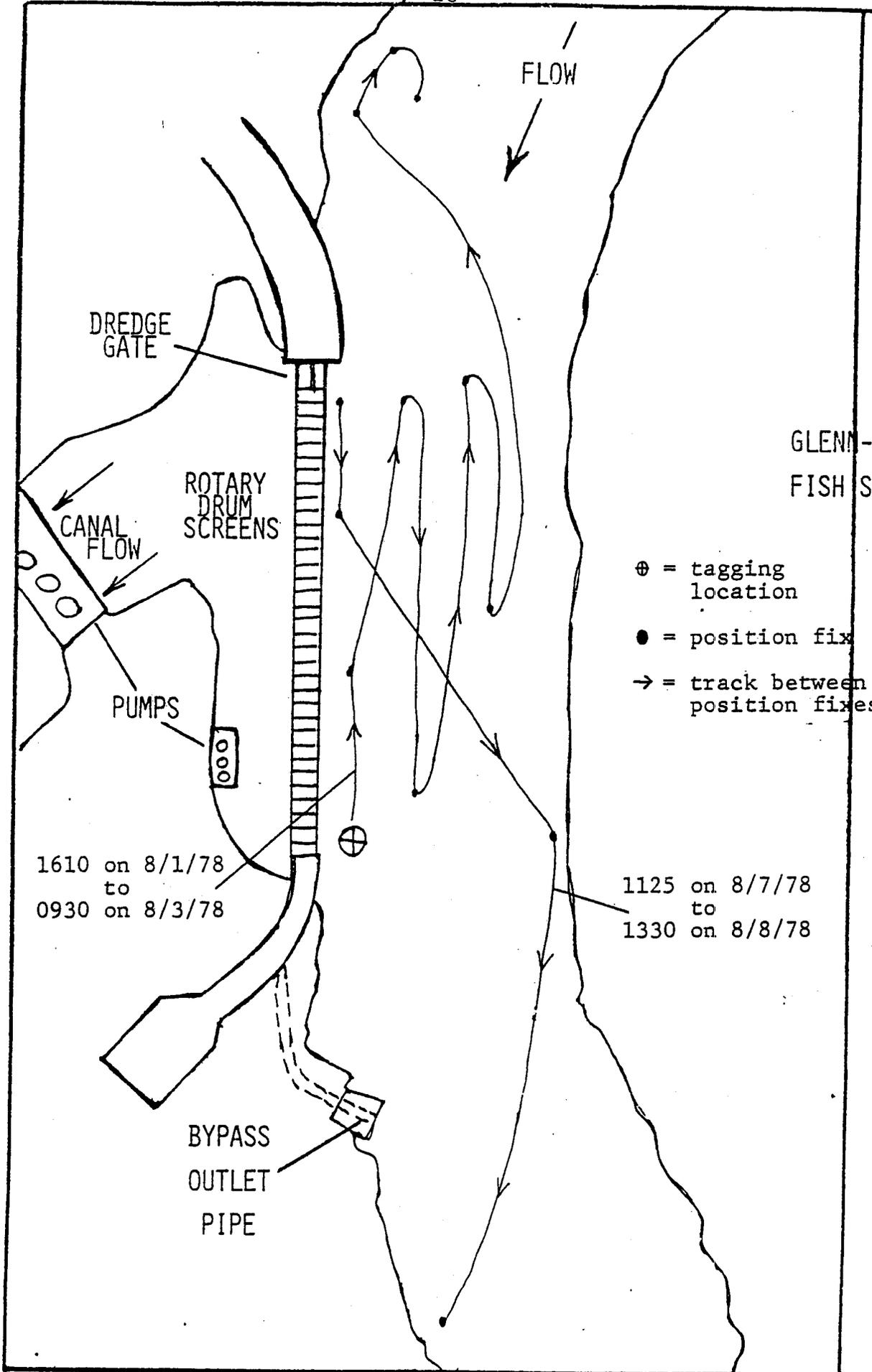


FIGURE 4. Tagging location, position fixes, and track between position fixes for a 49 cm (FL) Sacramento squawfish

was migrating upstream near the screen when captured and continued its upstream migration after tagging. It is also possible that the fish was "residing" near the screen but was disturbed by handling and tagging and moved out into the main river. Other striped bass were collected by angling in the vicinity of the tagged fish while it was being monitored in the main river.

The behavior of the two Sacramento squawfish monitored at Glenn-Colusa Fish Screen in August, 1978 was distinctly different from that of the striped bass. They were either significantly less traumatized by tagging and handling and continued a pattern of residence near the screen or they were interrupted by tagging while moving upstream. It is unlikely however that these two fish were migrating immediately prior to tagging. Sacramento squawfish movement past Red Bluff Diversion Dam (with nearly identical water temperatures, flows, and turbidities) averages fewer than five fish per day during July and August and averages about 100 per day during the period from March through May, the peak migration period.

Inserting transmitters in stomachs in 1977, and adverse environmental conditions in 1978 probably prevented an accurate determination of residency patterns of ultrasonically tagged striped bass at the State Fish Protective Facility. Monitoring at Glenn-Colusa Fish Screen in 1978 with external tags resulted in more likely behavior patterns for a very small sample of striped bass and Sacramento squawfish. Based on these limited experiments, either striped bass responded to tagging and handling differently than Sacramento squawfish or striped bass are only intermittently present at the screening facilities studied.

The two Sacramento squawfish monitored at Glenn-Colusa Fish Screen appeared to utilize the wide variety of water velocities available to them. If there is a relationship between variations in velocity and the presence of Sacramento squawfish, then future designs for fish facilities should eliminate velocity variations in the immediate vicinity of the screen face. In the future attempts should be made to more adequately define the attraction of predators feeding near fish screens.

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