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MIGRATIONS OF STURGEON TAGGED IN THE SACRAMENTO-SAN JOAQUIN ESTUARY[1]

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A total of 2,692 white sturgeon (*Acipenser transmontanus*) and 54 green sturgeon (*Acipenser medirostris*) were tagged in 1967 and 1968. Tag returns from white sturgeon indicate that the population inhabits the lower estuary during the summer, fall and winter. An apparent spawning migration occurs during late winter and spring. Two green sturgeon were recaptured at the mouth of the Columbia River, one in Washington, one at Santa Cruz and one in the estuary.

INTRODUCTION

Tagging of sturgeon in 1954 (Chadwick, 1959) revealed very little concerning white sturgeon migration. One white sturgeon tagged in San Pablo Bay was caught at the mouth of the Columbia River 294 days later. All other tag returns from white sturgeon were from San Pablo Bay to the confluence of the Sacramento-San Joaquin rivers. No upstream returns were obtained. Twenty-five green sturgeon were tagged in 1954. Three tags were returned from Oregon (Chadwick, 1959).

In 1967, we tagged 1,612 white surgeon and 26 green sturgeon. In 1968, we tagged 1,080 white sturgeon and 28 green sturgeon. Most of the tagging was done in San Pabo Bay. All sturgeon tagged were legal sized fish, 40 inches TL or larger. For a description of tagging methods, see Miller (1972).

MIGRATION OF WHITE STURGEON

A total of 341 white sturgeon tag returns have been received. This includes 3 years of 1967 tags and 2 years of returns from the 1968 tagging. Returns were tabulated according to the areas designated in Figure 1. All years of returns were combined since differences between years could not be ascertained due to the small number of returns in any year and area. Defining migrations by such tabulations has inherent drawbacks because the fishery probably does not always reflect the abundance of fish in a given area.

Over 73% of the tag returns were received from the Suisun and San Pablo areas (Areas 6 and 7), Table 1. The fishery in these areas exists throughout the year, but is concentrated in the period from November to March. Over 63% of the returns from these two areas were received during these 5 months. Sturgeon returns from the Delta (Area 9) were only 3% of the total and were concentrated in the winter and spring months.

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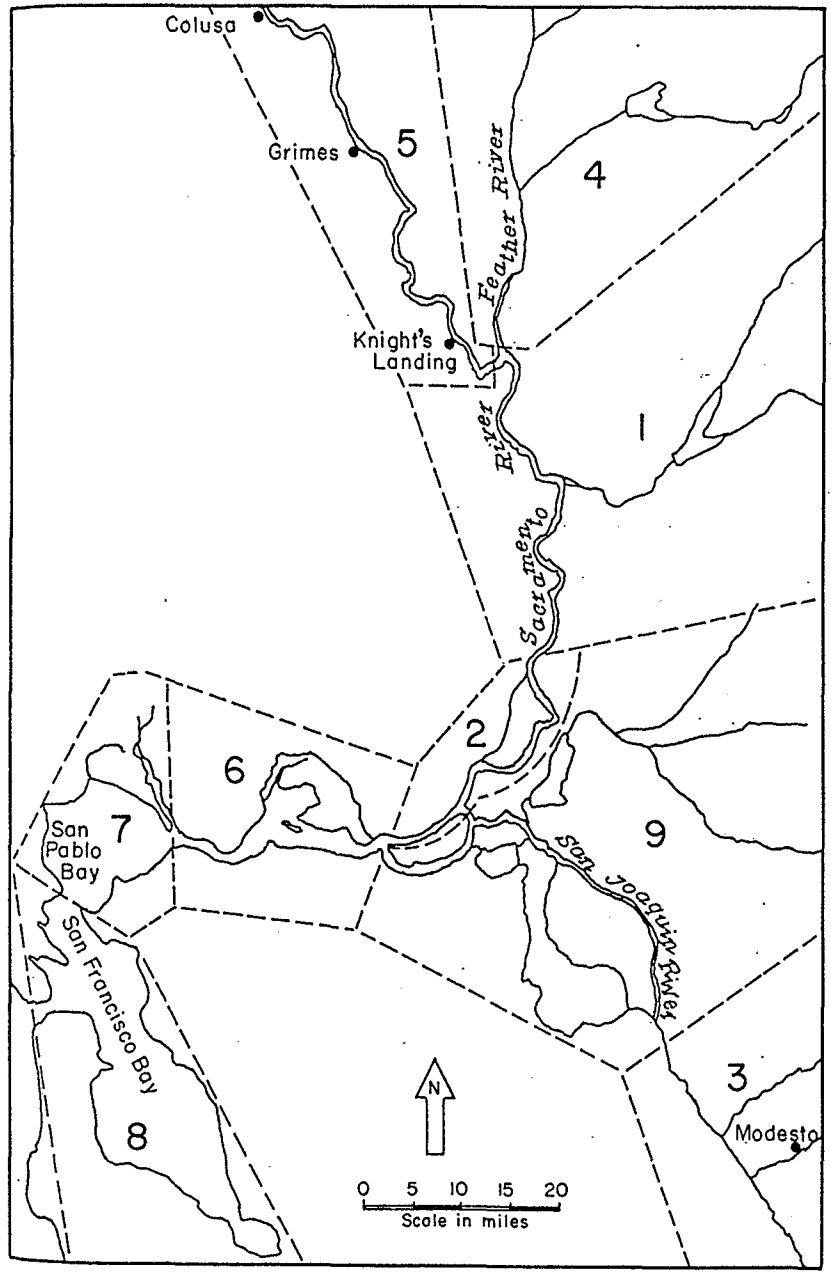

FIGURE 1. The Sacramento-San Joaquin estuary showing tag return areas.

Many sturgeon appear to migrate to the lower Sacramento River (Area 2) in the winter prior to the spawning season and move on up the Sacramento River (Areas 1 and 5) from March through June. Returns from the upper Sacramento River were scattered between the mouth of the Feather River and Colusa.

This time period agrees well with known spawning times determined by sampling larvae (Stevens and Miller, 1970). Larvae were caught in the Sacramento River system from March 28 to May 21, 1968. Tag returns from the upper Sacramento River ranged from March 26 to May 11, 1968.

The average size of fish caught in the upstream areas was nearly 52 inches TL at tagging which is about 4 inches above the average size of the tagged population. It is not known at exactly what size sturgeon become sexually mature although we have found female sturgeon mature at 45 inches. The likelihood of being mature increases with size and age so it is not surprising that the average size of fish caught in the spawning area is larger than the population mean size.

Tag returns suggest that the Sacramento River is the major spawning area for the white sturgeon. The fact that one sturgeon was caught in the Feather River in April indicates that spawning may occur there. The San Joaquin River may have been an important spawning area prior to its degradation by man. In 1968 flows were low in the San Joaquin River when the two sturgeon were caught there. One of these sturgeons was caught 7 miles north of Modesto and the other 3 miles south of San Joaquin City. No sturgeon larvae were caught in the San Joaquin River in the spring of 1968 during some exploratory sampling.

MIGRATION OF GREEN STURGEON

Of the 54 green sturgeon tagged, 5 returns were received. Four of these fish were tagged in October 1967 and were recaptured by commercial fishermen. They ranged from 45 to 50 inches TL at tagging. The dates and localities of recapture were December 28, 1967 near Santa Cruz, California; September 20, 1968 at the mouth of the Columbia River; July 25, 1969 at Gray's Harbor, Washington; and August 17, 1970 at Astoria, Oregon. The return from Gray's Harbor is the farthest north of all returns received from green sturgeon tagged in San Pablo Bay. One green sturgeon tagged in October 1967 was recaptured in San Pablo Bay on January 1, 1971.

CONCLUSIONS

White sturgeon appear to be confined principally to the estuary, spending the summer, fall and winter in the lower bays and Delta. The fish which are going to spawn migrate upstream during February, March, April and May, then return downstream. Green sturgeon returns corroborate previous findings (Chadwick, 1959) that they spend more time in the ocean than white sturgeon and move considerable distances along the coast. It is not known whether green sturgeon spawn in the Sacramento-San Joaquin system, but 10 to 20-inch juveniles are common in the Delta (Radtke, 1966).

TABLE 1. White Sturgeon Tag Returns by Area and Month

Area number	Sacramento River 1	Lower Sacramento River 2	San Joaquin River 3	Feather River 4	Upper Sacramento River 5	Suisun Bay 6	San Pablo Bay 7	San Francisco Bay 8	Delta 9	Total
November	2	3	--	--	--	24	15	--	--	44
December	--	4	--	--	--	12	14	--	1	31
January	--	5	--	--	--	14	24	1	2	46
February	1	12	--	--	1	6	24	2	2	47
March	1	4	2	1	5	3	23	6	--	40
April	8	1	--	1	2	1	12	1	1	30
May	4	--	--	--	2	1	5	--	2	14
June	2	--	--	--	1	5	6	--	1	15
July	--	--	--	--	--	7	7	--	--	14
August	--	1	--	--	--	11	3	--	1	16
September	1	2	--	--	--	13	2	--	--	18
October	--	6	--	--	--	16	4	--	--	26
Total	19	38	2	1	9	113	139	10	10	341
Percent of total	5.6	11.1	.6	.3	2.6	33.1	40.8	2.9	2.9	

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MOLTING AND GROWTH IN LABORATORY REARED PHYLLOSOMES OF THE CALIFORNIA SPINY LOBSTER, *PANULIRUS INTERRUPTUS*[1]

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Phyllosome larvae of the California spiny lobster were reared in individual, multiple, and mass cultures in laboratory closed circuit sea water systems. Laboratory-reared larvae progressed through six phyllosomal stages in a series of eight molts. Maximum length of larval life in the laboratory was 114 days; gradual mortality indicated that nutritional factors were the likely cause of death.

INTRODUCTION

The intent of this study was to rear the larvae of *Panulirus interruptus* through its 11 phyllosomal stages in the laboratory. Attempts at laboratory rearing of spiny lobster phyllosome larvae have generally been limited in their success. The only spiny lobster that has been successfully reared through its complete phyllosomal development in the laboratory is *Scyllarus americanus* (Robertson, 1968). No palinurid phyllosomes have ever been carried in the laboratory through their complete larval development. In this study sequence of larval stages, duration of stages, and number of molts within each stage were carefully followed. Particular attention was given to the effects of temperature and food on larval development and survival.

MATERIAL AND METHODS

Equipment

Closed circuit sea water systems were used in this study. Plywood tanks, coated with black fiberglass resin, measuring 1.5 m x 0.6 m x 0.2 m, were used as culture tanks for individual and multiple cultures of phyllosome larvae. Two corner filters containing glass wool and charcoal were placed in each of these 132 liter (35 gallon) tanks. An ultraviolet sterilizing unit was attached to a dynaflow filter containing calcium carbonate chips, charcoal, and glass wool, so that water was both filtered and sterilized before returning to the tank (Figure 1). Oyster shell fragments were scattered over the tank bottom to maintain a basic pH. Large scale aeration of the tank was obtained by using a 2 cm diameter PVC tube, 1.2 m long, into which a series of small holes had been drilled. A stainless steel rod, sealed in rubber surgical tubing, was placed inside the air tube to keep it on the bottom of the tank. Small 25 watt heaters were used to maintain tanks at 25 C, while other tanks were kept at ambient room temperature (20 C). Black

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