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CALIFORNIA STURGEON TAGGING STUDIES<sup>1</sup>

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## INTRODUCTION

Heavy commercial fishing in the late 1800's depleted the populations of sturgeon in California so much that the commercial fishery was closed in 1901. In 1910 it was reopened to limited fishing, but in 1917 it was closed again. From then until 1954 no sturgeon could be taken legally.

By the early 1950's, sturgeon had again become fairly abundant. Therefore, the Fish and Game Commission opened an all-year sport fishing season on April 1, 1954. The regulations provided for a one-fish daily bag limit and a 40-inch minimum size limit.

Relatively little was known about sturgeon in California, so in July of 1954 a study to gather facts pertinent to their management was begun. Some of the facts gathered on this investigation have already been reported (Pycha, 1956), but the results of a tagging study carried out in the fall of 1954 have not. It was initiated to measure the fishing mortality rate and to gather more knowledge of migrations. Since there have been few recent tag returns from these sturgeon, little additional information may be expected, and this is the final report.

The planning and field operations of this study were carried out by Richard Pycha (op. cit.), and the author's part in the study was restricted to analyzing the tag returns.

## METHODS

Totals of 994 white sturgeon (*Acipenser transmontanus*) and 25 green sturgeon (*A. medirostris*) were tagged in San Pablo Bay between early August and mid-November of 1954. These fish were caught in trammel nets. Handling and tagging methods are described by Pycha (op. cit.).

Most of the sturgeon were double-tagged, and three types of tags were used in the study. The first type was a Petersen disk tag made with cellulose nitrate disks and Type 302 soft stainless steel wire. These tags were placed on the base of the upper lobe of the caudal fin.

The second type of tag was a "spaghetti" tag similar to the Type G tags used on tuna (Wilson, 1953). It differed from the tag described by Wilson in that the sheath was red transparent Transflex tubing, and a monofilament nylon leader was threaded through the inner tubing.

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These tags were inserted between two dorsal scutes about half way back on the body.

The third kind of tag employed was the disk-dangler tag, which is a modification of the Atkins tag (Calhoun, 1953). Cellulose nitrate disks and tantalum wire 0.032 inch in diameter were used in these tags. On some fish the tags were placed below the dorsal fin, while on other fish they were placed on the upper lobe of the caudal fin.

## RESULTS

### White Sturgeon

#### Mortality Estimates

In the 4½ years since the 994 white sturgeon were tagged, 27 tags have been returned by anglers and 35 by commercial fishermen (Table 1). The commercial returns are from sturgeon caught incidentally in a gill net fishery for king salmon (*Oncorhynchus tshawytscha*) and American shad (*Alosa sapidissima*). Since the law required that these

TABLE 1  
White Sturgeon Tag Returns

Elapsed days to recapture	Angling returns	Commercial returns	Totals
0-365 .....	19	33	52
366-730 .....	6	2	8
more than 730 .....	2	0	2
Totals .....	27	35	62

sturgeon be returned to the water unharmed, it is not possible to assess the significance of these returns.

In calculating the rate of exploitation during the year after tagging, the sturgeon less than 40 inches long have to be omitted because the minimum size limit was 40 inches. This reduces the number of tagged fish to 888 and the first year angling returns to 18 tags. Therefore, 2 percent of the tags from legal-sized white sturgeon were returned by anglers in the year following tagging.

In order for this to be an unbiased estimate of the rate of exploitation, the tagging study must fulfill several basic conditions (Ricker, 1958), as follows: the tags must not be shed, they must not affect the vulnerability or mortality of the tagged fish, all recaptures must be reported, and the tagged fish must be a random sample of the population.

In this study the only direct measure of how well these conditions were met comes from a comparison of the returns from the various combinations of tags used (Table 2). The differences among the proportions of tag returns from the six groups are not statistically significant. This means that the combined rate of shedding, nonreturn, and tagging mortalities is approximately the same for each kind of tag. Furthermore, the rate of shedding during the first year would have to be low

TABLE 2  
Comparison of White Sturgeon Tag Groups and Tag Returns

Tag group	Number tagged	Number returned	Expected return*
Petersen disk (single tag)-----	142	8	8.9
Spaghetti (single tag)-----	83	5	5.2
Petersen disk and spaghetti-----	536	33	33.4
Petersen disk and disk-dangler-----	169	12	10.5
Disk-dangler and disk-dangler-----	39	2	2.4
Disk-dangler and spaghetti-----	25	2	1.6
Totals-----	994	62	62

\* Assuming a proportionate return from each tag group.

because it is the only factor likely to affect single- and double-tagged fish differently, and a high rate of shedding would result in greater returns from double-tagged fish than from single-tagged fish.

While there are no measures to indicate the magnitude of the deviations from the other basic conditions, these deviations would have to be of great magnitude to have a significant effect on the conclusions about angling harvest. For example, if half of the tags on fish caught by anglers were not returned, the true rate of exploitation would still only be 4 percent. Most factors that could be affecting the tag returns would result in an underestimate of the rate of exploitation, but it seems unlikely that any factor or combination of factors would make the true rate of exploitation more than four or five times that indicated by the tag returns. Therefore, the actual percentage of the white sturgeon present in San Pablo Bay during the fall of 1954 that was caught by anglers in the year following tagging probably falls between 2 and 10 percent.

The tag returns were not used to estimate the natural mortality rate because the rate of tag return decreased so sharply after the first year. It is unlikely that the actual survival in a long-lived fish like sturgeon would be as low as the sharp decrease in tag returns indicate. Therefore, the rapid decrease in tag returns probably reflects some other factor, such as emigration out of the San Francisco Bay area (see section on migrations) or a decrease in the harvest rate resulting from new angling regulations adopted in the spring of 1956. At that time the minimum size limit was increased to 50 inches, and the highly effective snagging of sturgeon by trolling was outlawed.

### *Migrations*

Most of the tag returns from locations in the San Francisco Bay-Delta area fall into two main groups (Table 3). One group was recovered in May and September between Carquinez Strait and the confluence of the Sacramento and San Joaquin Rivers; the other, in the fall in San Pablo Bay. They represent, respectively, the returns from the commercial salmon gill net fishery and those from the most important sport fishery. Most commercial fishing was done in these months and was

TABLE 3

## White Sturgeon Tag Returns By Month and Area of San Francisco Bay Region

Month of recapture	Area of recapture		
	San Pablo Bay	Carquinez Strait to confluence of Sacramento-San Joaquin Rivers	Delta above confluence of Sacramento-San Joaquin Rivers
January.....			
February.....			
March.....	1		1
April.....			
May.....	2	7	
June.....	1	1	
July.....		1	
August.....			
September.....	3	25	1
October.....	6		
November.....	5		1
December.....	1		
Totals.....	19	34	3

restricted to this area, and most sturgeon caught elsewhere by angling were taken accidentally by anglers fishing for striped bass (*Morone saxatilis*). Therefore, these returns reflect the locality and season of the major fisheries rather than the true migratory pattern of white sturgeon.

While the returns did not reveal a migratory pattern in the San Francisco area, they demonstrated that sturgeon sometimes migrate considerable distances along the Pacific Coast; e.g., a white sturgeon was recaptured on August 26, 1955, at the mouth of the Columbia River, 294 days after it was tagged in San Pablo Bay. This represents a minimum distance traveled of about 660 miles.

### Green Sturgeon

Three tags have been returned from the 25 green sturgeon tagged in San Pablo Bay. They are unusually interesting because they are all from Oregon. Two of the fish were taken near the mouth of the Columbia River—one on December 4, 1955, and the other on August 20, 1958. The third was recovered in Winchester Bay on September 1, 1957. These returns indicate that there is a considerable interchange among the green sturgeon populations along the Pacific Coast.

### CONCLUSIONS

Two important conclusions may be drawn from the tagging results. The first is that anglers harvested only a small portion of the white sturgeon during the year after they were tagged, even though the angling regulations then were more liberal than they are now. The other conclusion is that there is an interchange among both the white and green sturgeon populations along the Pacific Coast.

## SUMMARY

In 1954 a sturgeon sport fishing season was opened in California for the first time in 37 years. The Department of Fish and Game needed more facts about sturgeon to develop a sound management program. A research project was set up to get these facts, and one phase of this project was a sturgeon tagging study designed to determine the mortality rates and the migration patterns occurring in the populations.

During the fall of 1954, 994 white sturgeon and 25 green sturgeon were tagged in San Pablo Bay. Petersen disk, disk dangler, and spaghetti tags were used. Only 62 of the white sturgeon and three of the green sturgeon tags have been returned by anglers and commercial fishermen.

The angler return of white sturgeon tags indicates that between 2 and 10 percent of the white sturgeon present in San Pablo Bay during the fall of 1954 was harvested in the year following tagging.

The tag returns from localities in the San Francisco Bay and Delta area do not reveal any migratory pattern for white sturgeon. This does not mean that there is no migratory pattern, since the fishery was mostly restricted to two periods and the tag returns reflect only this.

One of the white sturgeon and all three of the green sturgeon returns were from Oregon waters, showing that there is some interchange among the sturgeon populations along the Pacific Coast.

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