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RESULTS OF JACK MACKEREL
TAGGING STUDY, 1971-75

by

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ABSTRACT

Methods and materials used to tag and recapture jack mackerel, *Trachurus symmetricus*, off the coast of southern California and Baja California, Mexico, are described. Tagging, recapture, and movement data resulting from this program are reported. Analysis of these data indicates substantial movement of jack mackerel within the range of the California fishery and suggests a seasonal inshore-offshore movement pattern.

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INTRODUCTION

The jack mackerel, *Trachurus symmetricus*, resource off the west coast of North America is known to be large and widely distributed. The spawning biomass is estimated to be 2.1 to 4.8 million tons based upon abundance of jack mackerel eggs collected at sea. Adults are distributed from Cape San Lucas to the Gulf of Alaska, and range hundreds of miles offshore (Ahlstrom 1968).

The California fishery is operating on the fringe of this large population. Landings in California since 1947 have fluctuated from a high of 73,000 tons in 1952 to 8,700 tons in 1954. Part of this fluctuation is due to varying amounts of fishing effort directed towards other species and to reduction in size of the fleet over the years; however, some variability in landings is due to differences in availability of jack mackerel from year to year.

The reasons for these differences in availability are poorly understood. An offshore spawning population appears to be relatively stable, but little is known of the relationship between this offshore population and those fish within range of the California fishery. The purse seine fleet seldom takes jack mackerel older than 6 years of age, though 20- to 30-year-old fish appear in the sport catch. Most catches in recent years consist of fish 3 years old or younger.

Because knowledge of jack mackerel migratory behavior is so meager, many questions remain unanswered. Is the jack mackerel resource made up of one large interbreeding population or is it composed of a number of discreet subpopulations? Will stocks fished heavily in one area be

replaced by fish moving in from other areas? The initiation of a comprehensive tagging program by the Department of Fish and Game, with funds supplied by the Marine Research Committee, has been the first step in gaining a better understanding of jack mackerel behavior, movements, and racial structure. This program was instituted so that the fishery may develop to its full potential under sound management.

METHODS AND MATERIALS

Tagging

The tagging program was initiated July 1, 1971. Preliminary research indicated that the Floy anchor tag (Dell 1968) had qualities that made it quite suitable for use on jack mackerel. The tag could be applied quickly and in large numbers by a cartridge fed tagging gun. Testing by Carline and Brynildson (1972) indicated tagging mortality and shedding were minimal on fish similar in size to jack mackerel. The external vinyl shaft of the tag was long enough (7.6 cm) to be seen easily by cannery personnel or fishermen handling fish individually.

Experiments were conducted at Marineland of the Pacific, Undersea Gardens in Marina del Rey, and aboard the ALASKA to estimate netting, handling, and tagging mortality rates and to find methods for reducing this mortality. Results of these experiments indicated that netting and handling mortality were more significant than tagging mortality. Jack mackerel that were netted and handled many times, resulting in heavy scale and slime loss, suffered mortality rates as high as 90% following apparent bacterial invasion. When netting operations were kept to an absolute minimum and water soaked cotton gloves were used to handle the fish, mortality rates dropped below 20%.

Another form of mortality, though not very measureable, was due to the accumulation of predators, particularly the California sea lion, *Zalophus californianus*, and the blue shark, *Prionace glauca*, around the tagging operation. It was not uncommon, when working off commercial fishing boats at night, to encounter five or six sea lions while releasing tagged fish. Limitations on operation time aboard these vessels makes such mortality unavoidable.

The small wound created by inserting the tag does not appear to cause any great harm to the fish. Examination of recaptured fish with tags still attached revealed that in the great majority of cases sufficient scar tissue had formed around the tag to prohibit tag vibration from increasing the size of the wound. No attachment of tissue to any portion of the tag was ever noted, not even on fish that had been at liberty for nearly 1 year. This observation indicates the wound remains a possible site for bacterial or parasitic invasion. A small number of tags that had been out for 3 months or more had considerable algal growth on the exposed portion of the tag; however, this additional material does not seem to adversely affect tag retention nor increase the diameter of the insertion site.

Of the 16,813 jack mackerel tagged during the program, approximately 40% were collected and released from commercial purse seiners, 20% from local bait receivers supplied by lampara boats; and 40% collected by hook and line from sportfishing vessels, Department research vessels, piers, jetties, and sport fishing barges.

Aboard commercial purse seiners, a 2-1/2 x 2-1/2 x 3 ft plywood receiver was used to retain jack mackerel during tagging operations. The

receiver was supplied with continuous water flow from the vessel's pumps and was as far removed from the fishing operation as possible. As many as 500 jack mackerel could be hand-brailed into this receiver from the vessel's net after the net had been pursed and drawn close to the boat. Fish were withdrawn from the receiver, tagged, and released during the 1 to 2 hours the fishermen required to transfer their catch from the net to the vessel's hold and restack the net.

Tagging operations from bait receivers required less preparation. The available jack mackerel were crowded in the receiver, scooped into buckets, tagged, and released. The lampara bait fishermen, who supplied these fish, and the commercial fishermen from the aforementioned purse seine vessels were financially compensated for all fish provided.

Fish procured by hook and line were either tagged immediately and released, or retained in a bait tank to tag and release at a later time. Hook and line collection avoids net abrasion but has a major disadvantage in that the soft mouth parts of the jack mackerel are easily torn during removal of the hook. Barbless hooks were used during much of the study to reduce this damage.

Returns

Through the first 2-1/2 years of the program, tag recoveries came primarily from Terminal Island cannery personnel, although a few were returned by sportfishermen. Cannery workers handle each jack mackerel that is being packed for human consumption. Consequently, nearly one-half of the jack mackerel landed by commercial fishermen since the inception of this program were handled individually. The remaining

tonnage of jack mackerel landed commercially, from which we received no tag returns, is converted into pet food. The tag return rate from the canneries dropped dramatically after January 4, 1974, when the canning facilities at Star Kist were destroyed by fire. They have not been rebuilt. The Pan Pacific Cannery continues to can a small percentage of the jack mackerel landed; however, the great percentage is now converted to pet food and tag returns have all but ceased from that area. When a tag was recovered from the cannery foreman it had to be traced through interviews to the vessel which caught the fish to determine the location of recapture. To induce cannery workers and sportfishermen to return tags or tagged jack mackerel, posters offering a \$1.00 reward were placed in the vicinity of all canneries and sportfish landings throughout southern California and Baja California, Mexico.

RESULTS

Tagging

A total of 16,813 tagged jack mackerel had been released by June 30, 1975 (Table 1). Generally, those released at Cortes Bank and San Clemente Island were tagged from commercial purse seine vessels and those tagged and released in San Diego Bay and Santa Monica Bay were supplied by lampara boat bait fishermen. At the remaining locations the most frequently used method of procurement was hook and line. Tagging operations from commercial purse seiners were all but eliminated following the Star Kist fire when virtually all of the tag returns from the canneries ceased. Scaled down tagging operations continued from sportfishing areas and in conjunction with other investigations for the remainder of the program.

TABLE 1. Areas of Jack Mackerel Tag Releases and Returns.

<u>Area</u>	<u>Number tagged</u>	<u>Number of returns</u>
<u>Southern California</u>		
Ventura	3	-
San Miguel Island	41	-
Santa Cruz Island	33	-
Santa Monica Bay	1,590	24
Dago Bank	270	3
Santa Barbara Island	5	7
Santa Catalina Island	2,164	38
San Clemente Island	2,936	31
Cortes or Tanner Bank	5,149	35
Newport Beach	228	6
Dana Point	104	-
La Jolla	684	4
San Diego	2,550	5
Questionable	-	19
<u>Baja California</u>		
Pt. Santo Tomas	2	
60-Mile Bank	25	
Guadalupe Island	633	
Blanca Bay	51	
Santo Domingo Bay	72	
Cedros Island	93	1
Magdalena Bay	80	
Hipolito Bay	100	
<hr/>		
TOTALS	16,813	173

Returns

There has been a tag return rate of approximately 1% for the entire 4 years of the program. In view of the fact that less than 50% of the fish landed by commercial boats are handled individually, we feel that this figure represents a reasonable return. The figure is inflated somewhat because, following a tagging operation aboard a purse seiner, there is usually a substantive return of tags that have been at liberty one week or less. This situation results from an accumulation of fishing boats in the same area for as long as good weather holds out and jack mackerel schools remain. Approximately 13% of the tag returns fall into this category.

The average tagged fish was at liberty about 2 months before recapture and the extremes range from 1 day (minimum) to 1,012 days (maximum). The single fish that had been at liberty 1,012 days was recovered near Oceanside, approximately 40 miles northwest of its release site in San Diego Bay.

Movement

Recaptures indicate a considerable amount of movement within the fishery (Figure 1). Those fish that have demonstrated substantial movement (Table 2) averaged 82 days at liberty. The greatest movement noted was from San Diego Bay to Santa Monica Bay over a 212 day period. The number of questionable recaptures (Table 1) results from an occasional inability to pinpoint the location of recapture. For example, if a number of commercial boats from different fishing grounds unload about the same time, the recapture location is in doubt or a sportfisherman may

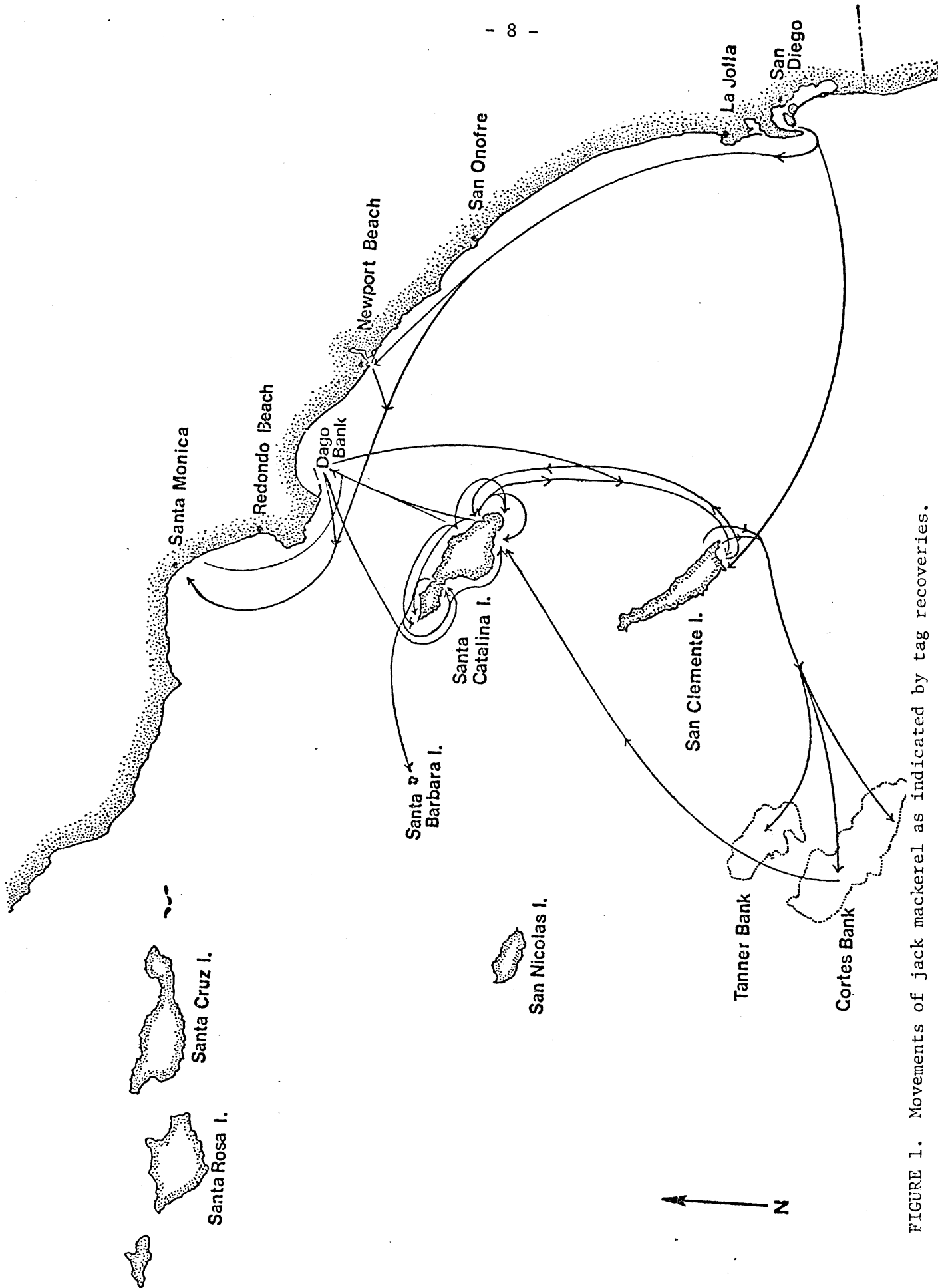


FIGURE 1. Movements of jack mackerel as indicated by tag recoveries.

TABLE 2. Substantial Movement of Tagged Jack Mackerel.

Recapture date	Number of returns	Days at liberty	Area of release	Area of recapture
Nov. 16, 1971	3	19,28,30	Catalina Island	Dago Bank
Nov. 22, 1971	1	37	Catalina Island	Dago Bank
Dec. 10, 1971	1	43	Catalina Island	Dago Bank
Dec. 16, 1971	1	63	Catalina Island	Catalina Island
Jan. 3, 1972	1	67	Catalina Island	San Clemente Island
Jan. 10, 1972	1	74	Catalina Island	San Clemente Island
Jan. 21, 1972	7	97,85,90 91,92,95,95	Catalina Island	Santa Barbara Island
Feb. 8, 1972	1	113	Catalina Island	Santa Barbara Island
July 10, 1972	2	10,11	San Clemente Island	Cortes Bank
Aug. 6, 1972	1	46	San Clemente Island	Tanner Bank
Aug. 8, 1972	1	48	San Clemente Island	Cortes Bank
Aug. 10, 1972	1	41	San Clemente Island	Cortes Bank
Aug. 20, 1972	1	51	San Clemente Island	Cortes Bank
Sept. 14, 1972	1	68	San Clemente Island	Cortes Bank
Sept. 16, 1972	2	76,76	San Clemente Island	Cortes Bank
Oct. 9, 1972	1	102	San Clemente Island	Catalina Island
Dec. 9, 1972	1	66	San Diego Bay	Newport Beach
Jan. 9, 1973	1	184	Cortes Bank	Catalina Island
May 6, 1973	1	212	San Diego Bay	Santa Monica Bay
July 27, 1973	1	13	Santa Monica Bay	Dago Bank
Sept. 22, 1973	1	92	Newport Beach	Santa Monica Bay
Nov. 5, 1973	1	93	Dago Bank	Santa Monica Bay
Mar. 26, 1974	1	236	Dago Bank	San Clemente Island
Mar. 27, 1974	1	302	San Diego Bay	San Clemente Island

occasionally delay returning a tag for many months and in the interim forget some of the collection data.

DISCUSSION

Interviews with commercial fishermen, particularly those that concentrate on jack mackerel when the northern anchovy, *Engraulis mordax*, fishery is slow or closed, reveal that the greatest concentrations of jack mackerel appear at the offshore fishing areas (Cortes Bank and San Clemente Island) from March through September. Before accepting this judgment completely, however, we take into consideration that less scouting for jack mackerel in the offshore areas is initiated in late fall, winter, and early spring because of poorer weather conditions and a tendency for the anchovy fishery to be concentrated in nearshore waters. In view of the fact that our data were derived primarily from commercial activity, there is good probability that our results would support the hypothesis that there is seasonal movement of jack mackerel stocks and that jack mackerel, in commercial concentrations, are more available in the offshore areas in late spring, summer, and early fall. Subsequently, that is what our data suggest. More conclusive or contradictory evidence for this hypothesis is no longer available since the destruction of the Starkist canning facilities.

Tag returns from sportfishermen are concentrated along the coast. These returns indicate considerable, but non-patterned, movement for jack mackerel up and down the coast from Santa Monica to San Diego.

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