

State of California  
The Resources Agency  
Department of Fish and Game

RECEIVED  
FISH AND GAME  
DEPARTMENT  
SACRAMENTO  
JUL 15 1975

STATUS OF PACIFIC MACKEREL  
SPAWNING POPULATION, 1975

By

Eric H. Knaggs

and

John S. Sunada

THIRD ANNUAL PACIFIC MACKEREL REPORT

MARINE RESOURCES

Administrative Report No. 75-5

July 1975

STATUS OF PACIFIC MACKEREL SPAWNING POPULATION, 1975<sup>1/</sup>

by

Eric H. Knaggs<sup>2/</sup> and John S. Sunada<sup>3/</sup>

ABSTRACT

Three methods were used to determine the Pacific mackerel population. The tag and recovery method estimated the population at 620 short tons. The other two estimates were based on regression techniques of partyboat catches and these results yielded 2,921 tons and 1,385 tons, respectively. All three estimates were below the 10,000 tons prescribed for a fishery and thus no harvest could be allowed.

---

<sup>1/</sup> Marine Resources, Administrative Report No. 75-5, July, 1975.

<sup>2/</sup> Operations Research Branch, 350 Golden Shore, Long Beach, California 90802.

<sup>3/</sup> Marine Resources Region, 350 Golden Shore, Long Beach, California 90802.

## STATUS OF PACIFIC MACKEREL SPAWNING POPULATION

### SUMMARY AND RECOMMENDATIONS

This is the third annual report on the status of the spawning population of Pacific mackerel as required by Section 8388.3 of the Fish and Game Code.

For the 1975 estimates, we again used California partyboat catches in our tag and recovery and regression methods in determining spawning biomass. Though partyboat catches are influenced by many variables not related to the size of the Pacific mackerel population, it is the only fishery for which we have regularly reported data.

Using tag and recovery methods, the Pacific mackerel spawning population was estimated to be 620 short tons. Two other estimates of spawning biomass were made using regression techniques of historic partyboat catches of Pacific mackerel from Santa Catalina Island and the northern Channel Islands and previous biomass estimates. The partyboat catches in these two areas in 1974-75 result in spawning biomass estimates of less than 2,921 tons and 1,385 tons respectively.

A regression of the partyboat catch of Pacific mackerel off central California and spawning biomass, used in the 1973 and 1974 estimates, can no longer be used. A change in 1974 in the logbooks on which the partyboat catches were recorded precludes the use of this estimate.

A fishery shall be allowed once the Pacific mackerel spawning population, in waters north of Punta Eugenia, Baja California, Mexico, exceeds 10,000 tons as stated in Section 8388.5 of the Fish and Game Code. Because the three estimates are considerably below

10,000 tons and field observations do not indicate any significant changes in the population, we conclude that the spawning biomass is below 10,000 tons. Thus, there is no excess by which a harvest under Section 8388.5 of the Fish and Game Code could be allowed.

A summary of the population estimates since 1973 follows and reflects the continued low level of the spawning biomass:

Estimates of Pacific Mackerel Spawning Biomass

<u>METHODS</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>
<u>Tag and Recovery</u>	5,480 tons	2,025 tons	620 tons
<u>Correlation of Past Population</u>			
<u>Estimates w/ Partyboat Catches</u>			
Santa Catalina Island	6,970 tons	8,380 tons	Less than 2921 tons
Northern Channel Islands	4,730 tons	--	1,385 tons
Central California	6,210 tons	4,675 tons	--

INTRODUCTION

Pacific mackerel, *Scomber japonicus*, occur from the Gulf of Alaska southward into the Gulf of California. The species was never abundant north of Monterey Bay and since 1960, commercial catches have become rare north of Point Conception.

The offshore extent of Pacific mackerel spawning population, as deduced from larvae catches, is about 150 miles off southern California, 250 miles off northern Baja California, and 200 miles off central Baja California.

Ocean sport anglers take thousands of Pacific mackerel each year. They are usually among the half-dozen species taken in greatest numbers in California's coastal waters. Partyboat landings accounted for 102,619 Pacific mackerel (an estimated 50 tons) in 1974.

## POPULATION ESTIMATES

The Department of Fish and Game is required to make an annual estimate of the spawning population of Pacific mackerel to comply with Section 8388.3 of the Fish and Game Code (Addenda 1). For the 1975 estimates, we again used several methods utilizing partyboat catches to estimate the spawning population size of Pacific mackerel stocks north of Punta Eugenia, Baja California. These consisted of estimates from tagging and recapture, and correlation of past population estimates with partyboat catches of Pacific mackerel from two selected locations.

### Tagging

One estimate was made by using tag and recovery data (Addenda 2). This methods involves the release and recovery of tagged Pacific mackerel and the utilization of age composition data from the partyboat catch to convert the total population to a spawning population estimate. A total of 522 Pacific mackerel was tagged during 1974.

The catch data for Pacific mackerel were obtained from the partyboat fleet operating in California and Mexican waters. Only tagged fish recaptured by the partyboat fleet were used to estimate the spawning population of Pacific mackerel.

The estimated size of the Pacific mackerel spawning population using tagging data is 620 tons.

### Estimates Using Regression Techniques

Two other sets of data were used to calculate additional estimates of Pacific mackerel spawning biomass, independent of the tagging method.

The first set of data consisted of partyboat landings of Pacific mackerel captured in the waters around the northern Channel Islands (San Miguel, Santa Rosa, Santa Cruz, and Anacapa Island). These data were correlated with corresponding estimates of spawning population determined for each year previous to 1969 and fitted with a curved trend line called a power curve (Addenda 3). The spawning population estimate for this set of data is 1,385 tons.

The second set of data consisted of partyboat landings of Pacific mackerel captured in waters around Santa Catalina Island and correlated with previously computed spawning population estimates. This statistical trend line is a linear regression (Addenda 4). Although 6,745 Pacific mackerel were captured in waters around Santa Catalina Island, this trend line or predictive model is valid only when the number of fish caught is about 11,322, the lowest data point used in calculating the regression. If 11,322 fish were caught, the population would be estimated at 2,921 tons. Although the data do not allow an exact estimate, we can conclude that the spawning biomass is less than 2,921 tons.

A previous relationship between central California partyboat catches of Pacific mackerel and spawning population estimates is no longer valid. A change in logbooks on which the catches are reported invalidates the use of this set of data.

#### DISCUSSION

The 1975 estimates of the Pacific mackerel spawning biomass are extremely low. There is an optimistic note, however, because the ratio of the size of the 1974 year class to the spawners that

produced it was 7.5 to 1. This indicates a relatively successful spawning in 1974; unfortunately, the spawning population at that time was at a very low level.

ADDENDA 1

Sections of California Fish and Game Code  
Pertaining to Pacific Mackerel

8388. Except as provided in Section 3388.5, Pacific mackerel may not be taken or possessed at any time for any purpose except loads or lots of fish may contain 18 percent or less by weight of Pacific mackerel taken incidentally to other fishing operations. Such Pacific mackerel, incidentally taken, may be used for any purpose. (Amended by Stats. 1972, Ch. 608.)

8388.3. It is the intent of the Legislature that the Pacific mackerel resource be enhanced. During this process a fishery shall be allowed once the Pacific mackerel spawning population, in waters north of Punta Eugenia, Baja California, Mexico, has reached 10,000 tons as determined by the department. Such determination shall be made public in an annual report to the Legislature no later than July 31 of each year. It is also the intent that as the spawning population increases, in excess of 20,000 tons, the seasonal quota also be increased but at such a rate as to allow the continued increase in the Pacific mackerel population. This process should continue with the objective of maximizing the sustained harvest. (Added by Stats. 1972, Ch. 608.)

8388.5. Section 8388 shall remain in effect until the department determines that the estimated Pacific mackerel spawning population, in waters north of Punta Eugenia, Baja California, Mexico, exceeds 10,000 tons. When the department makes this determination, a season harvest quota equal to 20 percent of the amount of Pacific mackerel in excess of 10,000 tons spawning population, as determined by the



department, shall be permitted under permits issued by the department.

When the department determines that the spawning population exceeds 20,000 tons, the harvest quota shall be increased to 30 percent of the excess over 20,000 tons.

The department shall keep records of the catch of Pacific mackerel and when it appears that the season quota will be reached, it shall notify all permit holders of the date when such limit will be reached and therefore the season closed, and shall notify, by certified mail, all permit holders of such closure. (Added by Stats. 1972, Ch. 608.)

8388.7. Subject to the provisions of Sections 8388 and 8388.5, Pacific mackerel season is from October 1 through September 30. (Added by Stats. 1972, Ch. 608.)

ADDENDA 2

Estimates of Pacific Mackerel Spawning  
Biomass Using Tagging (Mark and Recapture) Methods

The total biomass was calculated using the equation:

$$P = \frac{\sum n^2(m+u)}{\sum nm}$$

where

P = biomass estimate in numbers of fish.

n = number of marked fish released into the population.

m = number of marked fish recaptured.

u = number of unmarked fish captured.

The values for the equation were calculated to be:

$$\sum n^2(m+u) = 3.870902354 \times 10^9$$

$$\sum nm = 1,966$$

with the biomass estimated in numbers being:

$$P = \frac{\sum n^2(m+u)}{\sum nm}$$

$$P = \frac{3.870902354 \times 10^9}{1,966}$$

$$P = 1,968,923 \text{ fish}$$

Conversion to pounds is accomplished by multiplying the number of fish times the average weight of fish sampled.

$$P = 1,968,923 \text{ fish} \times 0.985 \text{ pounds}$$

$$P = 1,939,389 \text{ pounds}$$

The estimated proportion of spawning biomass (determined from age samples) to total biomass is 0.636; therefore:

$$\text{Spawning biomass} = 1,939,389 \times 0.636$$

$$= 1,233,451 \text{ pounds}$$

$$= 617 \text{ tons}$$

(620)

ADDENDA 3

Estimates of Pacific Mackerel Spawning Biomass  
Using Partyboat Catch Data from the Waters  
off the Northern Channel Islands

The spawning biomass was calculated using a non-linear regression,  
least squares fit power curve. Data points were fitted to the formula:

$$y = ax^b$$

where: y = biomass estimate in thousands of pounds

X = number of Pacific mackerel caught off the northern  
Channel Islands

a = coefficient

b = coefficient

The coefficients a and b were calculated by using the following  
equations:

$$b = \frac{n \sum (\text{LOG}_{e_i} x_i \text{LOG}_{e_i} y_i) - (\sum \text{LOG}_{e_i} x_i) (\sum \text{LOG}_{e_i} y_i)}{n \sum (\text{LOG}_{e_i} x_i)^2 - (\sum \text{LOG}_{e_i} x_i)^2}$$

$$a = \exp \left[ \frac{1}{n} \left\{ \sum \text{LOG}_{e_i} y_i - (\sum \text{LOG}_{e_i} x_i) b \right\} \right]$$

A correlation coefficient was also calculated using the formula:

$$r = \frac{n \sum (\text{LOG}_{e_i} x_i \text{LOG}_{e_i} y_i) - (\sum \text{LOG}_{e_i} x_i) (\sum \text{LOG}_{e_i} y_i)}{\sqrt{\left[ n \sum (\text{LOG}_{e_i} x_i)^2 - (\sum \text{LOG}_{e_i} x_i)^2 \right] \left[ n \sum (\text{LOG}_{e_i} y_i)^2 - (\sum \text{LOG}_{e_i} y_i)^2 \right]}}$$

The values of the coefficients and the correlation coefficient are calculated to be:

$$a = .008309748$$

$$b = 2.647169714$$

$$r = .7863828270$$

with the biomass estimate for 1975 being:

$$\begin{aligned} y &= aX^b \\ &= .008309748 (122)^{2.647169714} \\ &= 2,770,361 \text{ pounds} \\ &= 1,385 \text{ tons} \end{aligned}$$

ADDENDA 4

Estimates of Pacific Mackerel Spawning Biomass  
Using Partyboat Catch from the Waters off Santa Catalina Island

The spawning biomass was calculated using a least square estimate of  $\hat{A}$  and  $\hat{B}$  fitted to the line  $y = \hat{A} + \hat{B}x$

where

$y$  = biomass estimate in thousands of pounds.

$x$  = number of Pacific mackerel caught off Santa Catalina Island.

$\hat{A}$  = coefficient

$\hat{B}$  = coefficient

The coefficients  $\hat{A}$  and  $\hat{B}$  were calculated by using the following equations:

$$\hat{B} = \frac{n\sum xy - (\sum x)(\sum y)}{n\sum x^2 - (\sum x)^2}$$

$$\hat{A} = \frac{\sum y - \hat{B} \sum x}{n}$$

A correlation coefficient was also calculated using the formula:

$$r = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$$

The values of the coefficients and the correlation coefficient are calculated to be:

$$\hat{A} = -35224.24057$$

$$\hat{B} = 3.62720696$$

$$r = .93704902$$

This formula is not valid for a sportfish catch of less than 11,322 fish (a predicted spawning biomass of 2,921 tons), because this is the lowest data point used to calculate the regression. Therefore, from

the 6,745 fish caught we cannot make an estimate from the predictive model, except to conclude that the spawning biomass is less than 2,921 tons.