

STATE OF CALIFORNIA  
DEPARTMENT OF FISH AND GAME  
MARINE RESEARCH COMMITTEE

# CALIFORNIA COOPERATIVE SARDINE RESEARCH PROGRAM



## *Progress Report*

1 January 1951 to 30 June 1952

*Cooperating Agencies*

CALIFORNIA ACADEMY OF SCIENCES  
CALIFORNIA DEPARTMENT OF FISH AND GAME  
HOPKINS MARINE STATION, STANFORD UNIVERSITY  
U.S. FISH AND WILDLIFE SERVICE  
UNIVERSITY OF CALIFORNIA, SCRIPPS  
INSTITUTION OF OCEANOGRAPHY

1 July 1952

J. G. BURNETTE  
CHAIRMAN

EARL WARREN  
GOVERNOR

WARREN T. HANNUM  
DIRECTOR OF NATURAL RESOURCES



STATE OF CALIFORNIA  
**Department of Natural Resources**  
MARINE RESEARCH COMMITTEE

Post Office Box 807  
Los Altos, California  
July 1, 1952

Honorable Earl Warren  
Governor of the State of California  
Sacramento, California

Sir:

In this paper is presented a review of eighteen months of work under the California Cooperative Sardine Research Program. The work has been undertaken by five scientific agencies under the direction of this committee. The picture that emerges from the findings of the agencies is not encouraging. The catch in the 1951-52 season fell below profitable levels and some of our research people feel that the next two seasons may be even worse. The urgency of the situation, the import of the research findings, warrant the close study and reflection of everyone interested in California's marine resources.

Respectfully,

  
J. G. Burnette, Chairman

  
D. T. Saxby, Vice-Chairman

  
Richard S. Croker, Secretary

  
W. W. Ambrose

  
J. R. Biven

  
Paul Denny

  
Seth Gordon

  
Robert C. Miller

  
John V. Morris

## THE SARDINE SITUATION, 1 JULY 1952

Today, that portion of the adult sardine population that is available to the California industry is almost totally confined to the waters off Southern California.

Unless the factor of availability should so operate as to increase the catch of older fish, the industry for the next few years will be dependent for any significant improvement in the catch on the sardines that have been spawned off Southern California and Baja California (chiefly the latter) since 1948.

The 1948 year class: This year class accounted for 65 percent of the 1951-52 catch. There is some evidence that indicates it may be a year class of major proportions, though it has so far not made an outstanding contribution (in numbers) to the catch.

The 1949 year class: This year class is about one-sixth the size of the 1948 year class.

The 1950 year class: This year class seems only slightly greater than the 1949 year class.

The 1951 year class: It is too early to say much about this year class, though it seems only slightly better than the 1949 year class at present.

The outlook for the industry in the next two seasons: Very bleak; it appears that unless the factor of availability operates so as to increase the catch of older fish, the industry, if it depends upon the sardine alone, must for the next two seasons subsist upon the smallest catches in a generation.

The long-term outlook: We are just beginning to be able to understand some of the major aspects of the fluctuations of the sardine population. More work will be needed before we can confidently predict variations in the catch at long range.



# Contents

	Page		Page
INTRODUCTION .....	7	School Patterns .....	22
PART 1: THE SARDINE AND ITS ENVIRONMENT, YESTERDAY AND TODAY .....	9	Behavior in an Electrical Field.....	22
Distribution of Sardines.....	9	Food of the Sardine.....	23
Eggs and Larvae.....	9	Food of the Larvae.....	23
Young Fish .....	9	Food of the Adult.....	23
Adult Sardines .....	9	The Environment .....	24
Subgroups .....	10	Oceanographic Conditions .....	24
Numbers of Sardines.....	12	Relation of Oceanographic Conditions to Other Factors.....	33
Adult Sardines .....	12	Population Size .....	33
The Total Population .....	12	Year-Class Size .....	33
Variations in Mortality Rates.....	13	Mortality Rates .....	33
Age Composition of the Catch.....	14	Fishing Success .....	33
Size of Older Year Classes.....	14	The Food Supply .....	37
Eggs, Larvae, and Young Fish.....	14	Predators and Competitors .....	37
Spawning Surveys .....	14	Bacteria .....	37
Young Fish .....	16	Other Fishes .....	38
Habits and Behavior.....	22	Future Studies .....	44
Olfactory Sense .....	22	PART 2: THE OUTLOOK FOR THE FISHERY.....	45
		APPENDIX: TABULAR MATERIAL .....	47

## ILLUSTRATIONS

Figure	Page	Figure	Page
1. Station plan, California Cooperative Sardine Research Program, 1951 .....	6	28. Comparison of abundance of 1948, 1949, 1950, and 1951 year classes of sardines at various ages.....	22
2. Relative abundance of young sardines, 1938-40 and 1950-51, in each of several localities.....	8	29. Diagram illustrating behavior of sardines in the absence and in the presence of an electrical field.....	23
3. Percentage of the sardine catch taken in the four major fishing areas during 11 seasons.....	8	30. Diagram illustrating behavior of sardines in an electrical field .....	23
4. Fish growth and scale growth.....	10	31. Food items in stomachs of 273 adult sardines as compared with plankton content of water samples.....	25
5. Means of averages of observed lengths of sardines taken in four areas from 1941-42 through 1951-52 seasons.....	10	32. Current patterns off the California coast, 1939, 1949, 1950 .....	26
6. Deviations of one-year-old sardines in San Pedro fishery from average growth curve, 1941-42 through 1951-52 seasons .....	11	33. Upwelling along the California coast.....	27
7. Size distribution of 1948 year-class sardines sampled at Monterey, San Pedro, and Ensenada in 1951-52 season.....	11	34. Indicators of upwelling, central California, 1938-40 and 1949-51 .....	28
8. Catch and population estimates, 1932-33 through 1951-52 seasons .....	12	35. Indicators of upwelling, off Point Conception, 1938-40 and 1949-51 .....	29
9. Total mortality rate and fishing intensity, 1932-33 through 1950-51 seasons .....	13	36. Temperature survey, Monterey Bay, 2 October 1951.....	30
10. Percentage age composition based on numbers of sardines in California fishery for three time intervals.....	14	37. Temperature survey, Monterey Bay, 13 December 1951.....	31
11. Relative year-class size of sardines as measured by number of three-year-old fish caught per boat month in California .....	14	38. Upwelling along the coast south of Monterey, late 1951 and early 1952.....	32
12. Cedros Island area, Baja California.....	15	39. Sardine catch and surface temperatures, August, 1949.....	34
13. Sardine spawning, January, 1951 .....	16	40. Sardine catch and surface temperatures, August, 1950.....	34
14. Sardine spawning, February, 1951 .....	16	41. Sardine catch and surface temperatures, September, 1949 .....	34
15. Sardine spawning, March, 1951 .....	17	42. Sardine catch and surface temperatures, September, 1950 .....	34
16. Sardine spawning, April, 1951 .....	17	43. Sardine catch and surface temperatures, October, 1949. (Inset, November, 1950).....	35
17. Sardine spawning, May, 1951 .....	18	44. Sardine catch and surface temperatures, January, 1951.....	36
18. Sardine spawning, June, 1951 .....	18	45. Sardine catch (1949-50 and 1950-51) and schools of sardines located during the surveys (1949, 1950, and 1951) as related to surface temperatures.....	37
19. Sardine spawning, July, 1951 .....	19	46. Average volumes of plankton taken in California Cooperative Sardine Research Program cruises, March, 1949, to December, 1951.....	38
20. Sardine spawning, August, 1951 .....	19	47. Sardine larvae, 1951 .....	39
21. Sardine spawning, September, 1951 .....	19	48. Anchovy larvae, 1951.....	40
22. Sardine spawning, October, 1951 .....	20	49. Hake larvae, 1951.....	41
23. Sardine spawning, November, 1951 .....	20	50. Jack mackerel larvae, 1951.....	42
24. Sardine spawning, December, 1951 .....	20	51. Rockfish larvae, 1951 .....	43
25. Sardine spawning, January, 1952 .....	20		
26. Sardine spawning, February, 1952 .....	21		
27. Sardine spawning, March, 1952 .....	21		

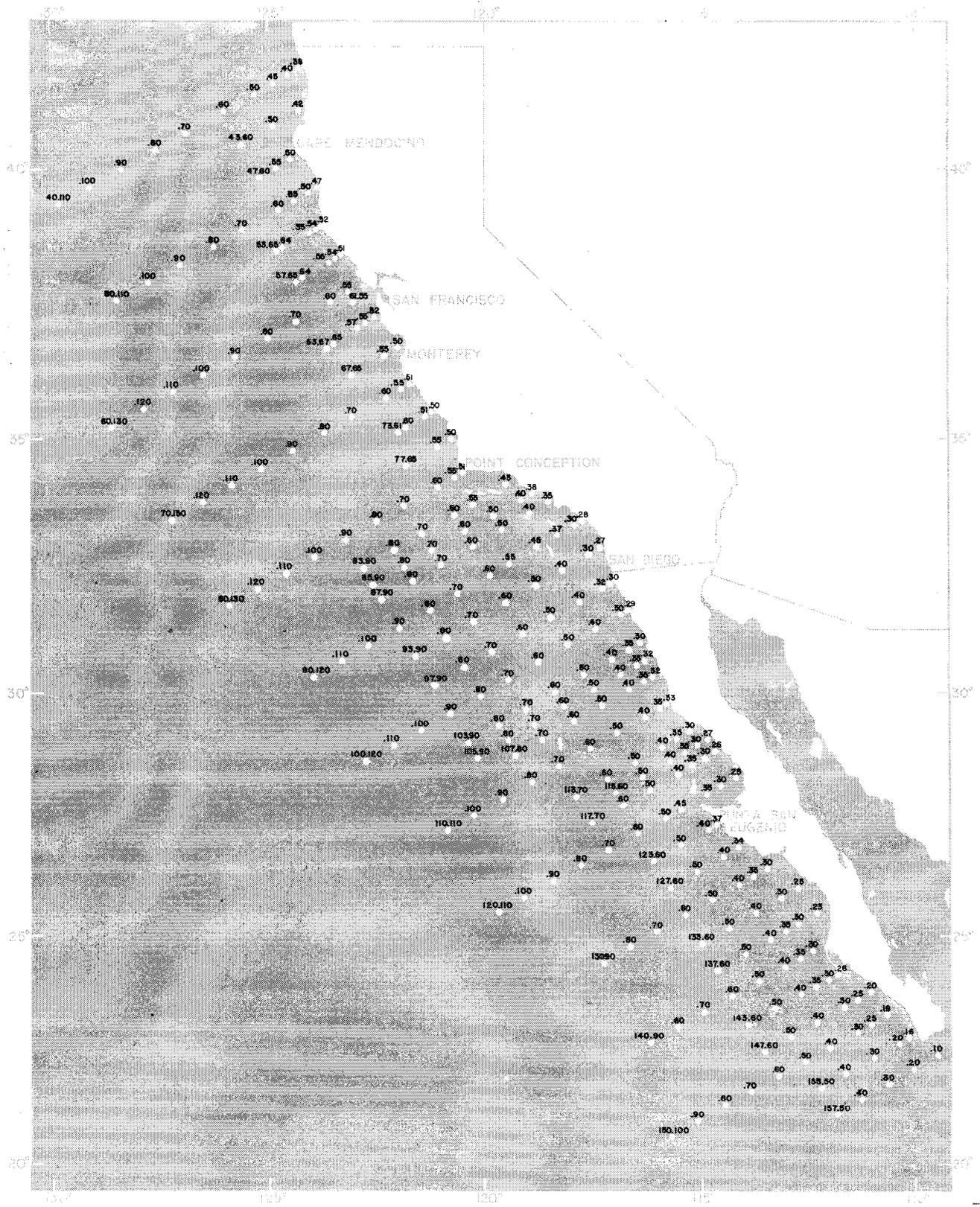


FIGURE 1. Station plan, California Cooperative Sardine Research Program, 1951. More intense coverage was made of the inshore areas and the southern Baja California region than in previous years.

## Introduction

Where are California's sardines?

How many are there?

Is it likely that enough can be caught in the next few seasons to maintain the industry?

These are the questions that this report, which reviews 18 months of work (1 January 1951 to 30 June 1952) under the California Cooperative Sardine Research Program, is designed to answer as fully as is now possible.

At its November 1951 meeting, the Marine Research Committee put into the record these objectives for the research agencies participating in the program:

- 1) to seek out all possible facts concerning and factors influencing the distribution, numbers, habits, and behavior of the sardine at each stage of its life;
- 2) on the basis of these facts to make the best possible estimates of the fluctuations in the abundance and availability of the sardine and to predict the outlook for the fishery;
- 3) to make these facts and estimates promptly known to the appropriate management agencies, to the industry, and to the public at large.

In this report, we seek to meet the first objective in Part 1: *The Sardine and Its Environment, Yesterday and Today*, in which is briefly summarized what we have learned in the past 18 months and the findings are compared with those of earlier, more prosperous

periods; the second objective is met in Part 2: *The Outlook for the Fishery*; and it is hoped that the report as a whole, will satisfy the third objective.

Five agencies are now engaged in research on the sardine—the California Academy of Sciences; the California Department of Fish and Game; Hopkins Marine Station of Stanford University; the U. S. Fish and Wildlife Service; the University of California, Scripps Institution of Oceanography. The work is supported in part by funds from the industry itself (in the form of a tax on sardine landings) and in part from the Federal Government, but the largest portion of the research funds comes from the State of California as a whole, through the Legislature. (Next year, further moneys will be available from a tax on processed mackerel and anchovies. According to present plans, these fisheries are to be subject to the special tax for one year only.)

None of the five agencies pretends to have come up with an easy answer to "the sardine problem." What they here present, through the Marine Research Committee, to the people who support their work—the industry and the public at large—is a series of comparisons of the status of the sardine population today with that of several years ago, with the feeling that from this picture of a very critical period as contrasted with a relatively prosperous one, there will emerge the best answers they can at present give to those three important practical questions—Where are the sardines? How many are there? Can they be caught?

CALIFORNIA COOPERATIVE SARDINE RESEARCH

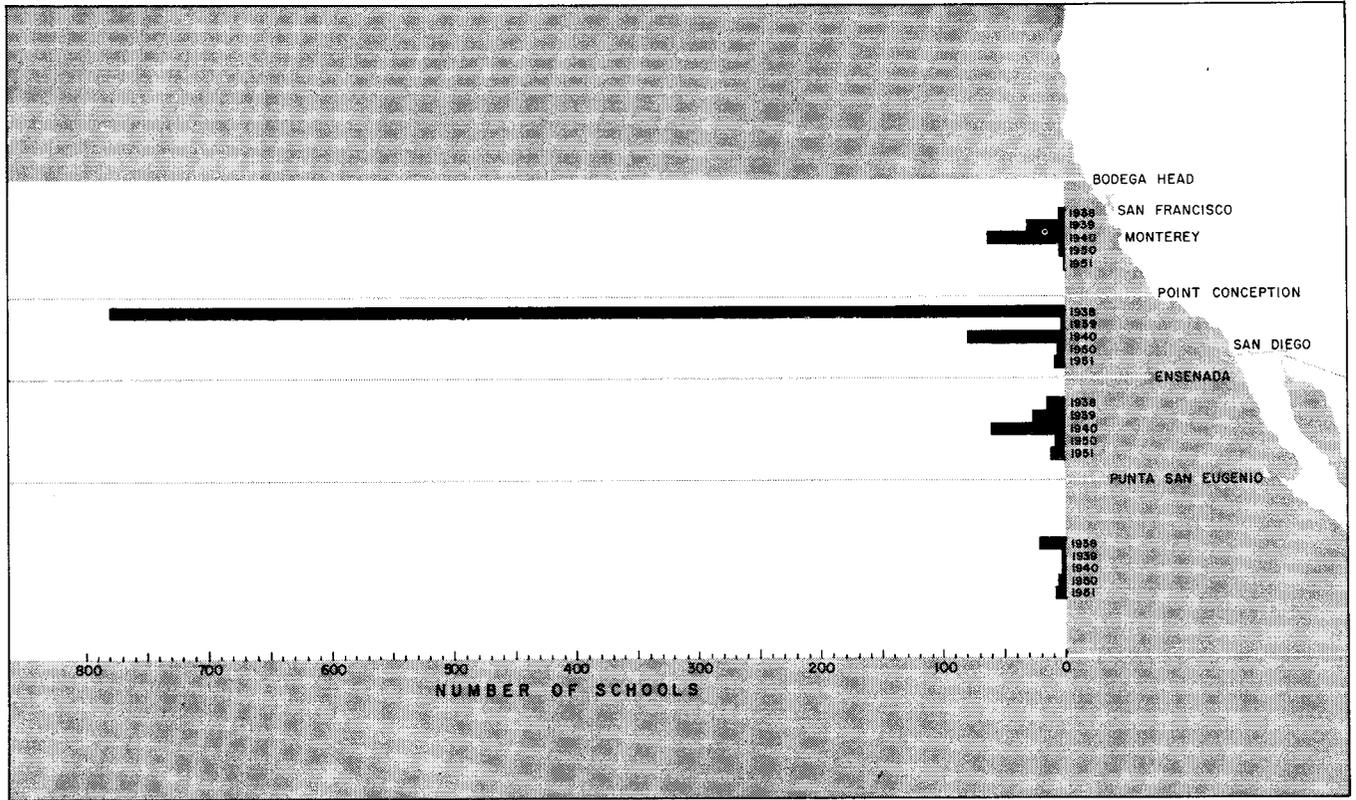


FIGURE 2. Number of schools of young sardines, 1938-40 and 1950-51, in each of several localities. Note extreme abundance of 1938 year class off Southern California. (Data, Table 2, Appendix.)

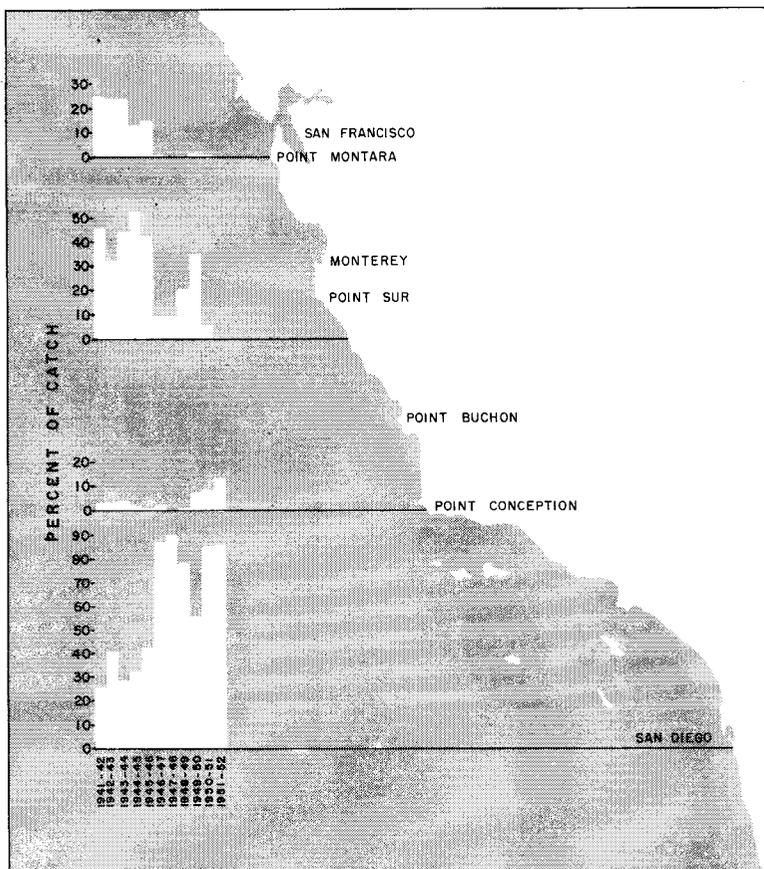


FIGURE 3. Percentage of the sardine catch taken in the four major areas during 11 seasons. (Data, Table 3, Appendix.)