

Summary

Four seagoing vessels are used in the California Cooperative Sardine Research Program. In the past two years oceanographic conditions in the offshore area from Oregon to central Baja California have been regularly measured. As a result, a mass of detailed and accurate data has been accumulated. These data comprise a permanent contribution to scientific knowledge.

In the course of the program, new techniques for collecting and, particularly, for the processing the data have been worked out. New instruments have been designed, developed, and tested. Several of these, among them the gear for high-speed tows, are of outstanding importance.

Our studies of the sardine's environment have succeeded in further relating changing oceanographic conditions to changing weather conditions. We have found unquestionable evidence of upwelling, which provides conditions favorable for the survival of larvae, at several locations off the coast, notably off Cape Mendocino and Point Conception.

Two centers of spawning abundance have been located. One is in the vicinity of Cedros Island, off Baja California, the other is off Southern California and northern Baja California. Spawning is more intense,

though limited to a smaller area, off Cedros Island. As shown by the 1949 and 1950 data, these are the present centers of sardine spawning off the Pacific Coast.

It has been found that most spawning occurs in waters between 12.5° and 16.5° C. During the 1950 season, 98.4 percent of the spawning samples were found within a slightly narrower range—12.5° to 16° C.

Surface temperatures during the spring of 1950 were slightly lower than in 1949 in most of the area covered.

Schools containing adult sardines have been found in waters ranging from 11° to 20.4° C. Other oceanographic factors are being examined.

Under laboratory conditions, it was found possible to cause sardines to move in a desired direction by use of electric current in sea water.

Examination of the statistics for the 1948-49 and 1949-50 sardine catches indicated that the major support of the fishery came from the 1946 and 1947 year classes. There were no indications that the 1948 and 1949 year classes will appear on the fishing grounds in exceptional numbers. The 1946 and 1947 groups will presumably have to supply much of the tonnage taken in the next two or three years.

Plans for 1951

In the main, work under the California Cooperative Sardine Research Program will continue along the present lines during 1951. The seagoing work cannot as yet be curtailed or simplified without running the risk of failing to obtain information of basic importance.

The California Academy of Sciences plans to pursue further its study of the behavior of fish in an electrical field. Other behavior patterns of sardines will be investigated.

The California Division of Fish and Game will continue its collection and analysis of the daily catches of the fishermen and, in cooperation with the U. S. Fish and Wildlife Service, the age composition of the commercial catch. Collection of records of the poundage of sardines used in the California live-bait fishery will be carried on as in the past and analyzed as a supplemental measure of the abundance of the 1951 year class. The *Yellowfin* will make a survey of the 1951 year class during the months of July through October and, in the first six months of the year, will continue the collection of data to measure the conditions under which sardine schools are found.

The Scripps Institution of Oceanography hopes to make use during the coming year of a newly devel-

oped oceanographic instrument of great potentialities. The instrument, which was developed at the Woods Hole Oceanographic Institution, is the geomagnetic electrokinetograph ("jog log"). By its use, surface current direction and speed can be measured. Such information will prove extremely useful in physical oceanography, and cannot be readily obtained in any other manner. Also, intensive work will be done at the Scripps Institution on the development of electronic instruments for use in oceanography. Efforts will be made to collect hydrographic and chemical data near shore, and to determine the amount of replenishment and to study dispersion effects, nutrients, and the accompanying productivity. Further work will be done on the heat budget and evaporation study.

The U. S. Fish and Wildlife Service will continue its recruitment studies and its participation in the routine oceanographic surveys. The Service will also continue to cooperate with the Division of Fish and Game in the collection of samples and will continue analysis of vital statistics of the sardine catch.

The year promises to see the publication of several scientific papers on various phases of the program. The physical and chemical data from at least 10 more cruises will be distributed to scientific personnel.

APPENDIX I

PERSONNEL ENGAGED IN RESEARCH UNDER CALIFORNIA
COOPERATIVE SARDINE RESEARCH PROGRAM

NOTE: Not all the persons listed below are paid from sardine research funds;
all, however, are contributing to research under the program.

<i>Name</i>	<i>Position</i>	<i>Name</i>	<i>Position</i>
CALIFORNIA ACADEMY OF SCIENCES			
Grant, Norman	Electrical Engineer	Horrer, Paul L.	Associate in Oceanography
Goody, Thomas C.	Marine Biologist	Howard, Francis J.	Research Assistant
Loukashkin, Anatole S.	Assistant Biologist	Hubbs, Carl L.	Professor of Biology
CALIFORNIA DIVISION OF FISH AND GAME			
Clark, Frances N.	Senior Marine Biologist	Huffer, Robert P.	Senior Marine Technician
Clothier, Charles	Assistant Marine Biologist	Hutchins, Dorsey M.	Typist-Clerk
Conner, Geraldine	Assistant Statistician	Isaacs, John D.	Associate Oceanographer
Daugherty, Anita E.	Assistant Marine Biologist	Johnson, Carl I.	Senior Laboratory Mechanician
Eberhardt, Robert L.	Junior Aquatic Biologist	Johnson, Martin W.	Professor of Marine Biology
Herndon, Edward M., Jr.	Senior Clerk	Johnson, Norman W.	Marine Technician
Johnson, Einar M.	Watchman	Kelmers, Andrew D.	Marine Technician
Kuykendall, Vinna	Tabulating Machine Operator	Klein, Hans T.	Senior Engineering Aide
Nelson, Helen	Supervising Account Clerk	Knight, Wilbur L.	Marine Technician
Pinkas, Leo	Junior Aquatic Biologist	McHugh, John L.	Assistant Marine Biologist
Ponder, Ruth	Junior Stenographer-Clerk	Manar, Thomas A.	Editor
Powell, Patricia	Senior Librarian	Mao, Han Lee	Research Assistant
Pratt, George W.	Watchman	Marquardt, Robert L.	Senior Marine Technician
Radovich, John	Junior Aquatic Biologist	Moser, Douglas K.	Storekeeper
Rinard, Rose	Intermediate Stenographer-Clerk	Petersen, Evans E.	Guard
Wilson, Robert C.	Assistant Marine Biologist	Phillips, Howard	Maintenance Man
Young, Parke H.	Assistant Aquatic Biologist	Pruitt, Milo R.	Senior Laboratory Mechanician
<i>(Yellowfin crew)</i>			
Felando, Andrew, Jr.	Netman and Boatswain	Rakestraw, Norris W.	Professor of Chemistry
Haldane, Herbert S.	Radiotelegraph Operator and Assistant Engineman	Reid, Joseph L.	Research Assistant
Hawkins, Glen T.	Deckhand	Reid, Robert O.	Assistant Oceanographer
McLeod, Rory A.	Deckhand	Revelle, Roger R.	Professor of Oceanography and Acting Director of the Scripps Institution of Oceanography
Mills, Robert A.	Motor Vessel Engineman	Riley, Gordon A.	Visiting Associate Professor
Mitchell, Otto N.	Deckhand	Sampson, Robert K.	Senior Marine Technician
Petrich, Paul D.	Master, Fisheries Vessel	Sargent, Marston C.	Assistant Professor of Oceanography
Pruitt, Harold E.	Assistant Motor Vessel Engineman	Sibley, Slade W.	Marine Technician
Roth, Lewis	Ship's Cook	Snodgrass, James M.	Associate Marine Biologist
Thompson, Robert W.	Deckhand	Squire, Mary C.	Laboratory Technician
SCRIPPS INSTITUTION OF OCEANOGRAPHY			
Allanson, Audley A.	Marine Technician	Stockman, Arthur M.	Laboratory Assistant
Barkley, Richard A.	Laboratory Technician	Stose, Clemens W.	Marine Superintendent, Hull
Barney, Ruth M.	Typist-Clerk	Sullivan, Joe	Janitor
Barraclough, William E.	Research Assistant	Sweeney, Beatrice M.	Research Associate
Barstow, Mary C.	Laboratory Technician	Trent, Luz F.	Laboratory Technician
Beckwith, Warren W.	Senior Marine Technician	Vetter, Richard C.	Research Assistant
Berberich, Frank J., Jr.	Electronics Engineer	Waitley, Diane	Typist-Clerk
Bieri, Robert I.	Research Assistant	Walker, Theodore J.	Instructor in Marine Botany
Bowman, Thomas E.	Assistant in Marine Biology	Watters, Ardis H.	Typist-Clerk
Brinton, Edward	Research Assistant	Weaver, Maxine N.	Secretary-Stenographer
Burgeson, Willis M.	Senior Storekeeper	Whisenand, Alice A.	Laboratory Technician
Carlson, Deane R.	Marine Technician	Wilburn, Virginia A.	Statistician
Cawley, John H., Jr.	Principal Electronics Technician	Wisner, Robert L.	Senior Laboratory Technician
Clark, Peter S.	Marine Technician	Wooster, Warren S.	Associate in Oceanography
Cunningham, Leonard M., Jr.	Marine Technician	<i>(Crest crew)</i>	
Dare, Marjorie C.	Secretary-Stenographer	Brandal, G.	Captain
Dinkel, Charles C.	Assistant in Marine Chemistry	Fox, F. E.	Chief Engineer
Edinger, Richard M.	Expediter	Gonyea, L. J.	Marine Electrician
Edwards, Frank H.	Marine Technician	Kelley, G.	Second Engineer
Folsom, Theodore R.	Senior Laboratory Mechanician	Kelsay, W. C.	Seaman
Fraser, Howard S.	Guard	Kittel, R. P.	Marine Electronics Technician
Godfrey, Mary L.	Engineering Aide	Mehling, M. J.	A.B. Seaman
Gossett, David A.	Marine Technician	Miller, F.	First Officer
Handley, Ruth R.	Principal Clerk	Newbegin, R. C.	Second Officer
Hayes, Margaret A.	Laboratory Assistant	O'Brien, R. J.	Second Engineer
Herreshoff, Karl F.	Marine Technician	Powell, A. L.	Seaman
		Robinson, W. F.	Cook
		Stowe, R. D.	Seaman
		Walker, J. M.	Oiler
		<i>(Horizon crew)</i>	
		Carter, A. B.	Marine Electronics Technician
		Chapman, T. H.	Seaman
		Daniels, E. F.	Second Engineer

<i>Name</i>	<i>Position</i>
Faughn, J. L.	Captain
Fenton, G. M.	Oiler
Fleming, C. S.	Oiler
Foster, E. G.	Seaman
Keith, L. E.	Seaman
King, W. C.	Second Engineer
Lewis, C. H.	Chief Engineer
Marain, M. W.	Second Officer
Massey, J.	Chief Engineer
Miller, H. A.	Seaman
Nolan, F. J.	Second Officer
O'Callaghan, T. J.	Oiler
Proulx, E. J.	Marine Electrician
Vaughn, F.	Cook
<i>(Shop force)</i>	
Cundiff, L. A.	Second Engineer
Ringel, F.	Electrician

U. S. FISH AND WILDLIFE SERVICE

Ahlstrom, E. H.	Supervising Marine Biologist
Anas, R. E.	Biological Aid
Attebery, H. R.	Biological Aid
Ball, O. P.	Biological Aid
Calderwood, M. M.	Marine Biologist
Colter, J. C.	Chemistry Aid
Counts, R. C.	Marine Biologist
Dougherty, J. B.	Marine Biologist
Eckles, H. H.	Marine Biologist
Felin, F. E.	Marine Biologist
Giffiu, B. M.	Chief Clerk

<i>Name</i>	<i>Position</i>
Higgins, M. D.	Clerk-Typist
Jordan, C. W.	Biological Aid
Kramer, D.	Marine Biologist
Marr, J. D.	Chief, South Pacific Fishery Investigations
Mead, G. W.	Collaborator
Morris, N. L.	Clerk-Stenographer
Murray, M. B.	Statistical Clerk
Myers, G. S.	Systematic Zoologist (fish)
Permenter, D. O.	Biological Aid
Reitman, M.	Biological Aid
Russell, P. S.	Clerk-Stenographer
Squire, J. L.	Biological Aid
Takeuchi, M. S.	Clerk-Stenographer
Thraillkill, J. R.	Marine Biologist
Walker, E. T.	Marine Biologist
Walser, C. W.	Marine Biologist
Widrig, T. M.	Statistician
Wilimovsky, N. J.	Collaborator

(Black Douglas crew)

Burbridge, A.	Cook
Byers, W. A.	First Engineer
Fedishau, O. J.	Second Mate
Houston, G. O.	Messboy
Hovde, H.	First Mate
Jenkins, K. C.	A.B. Seaman
Joelson, S. M.	Captain
McGoldrick, W. E.	A.B. Seaman
Moller, A. E.	A.B. Seaman
Ryerson, J. L.	Chief Engineer
Schaefer, J.	Second Engineer

APPENDIX II

CURRENT PROJECTS UNDER CALIFORNIA COOPERATIVE
SARDINE RESEARCH PROGRAM

CALIFORNIA ACADEMY OF SCIENCES

<i>Project</i>	<i>Chief Scientist</i>
Physiology and Behavior Studies.....	Thomas C. Groody

CALIFORNIA DIVISION OF FISH AND GAME

Age-Determination and Length Frequency.....	Anita E. Daugherty Leo Pinkas
Average Monthly Catch of Fishing Vessels.....	Frances N. Clark Anita E. Daugherty
Environmental Factors Affecting Availability.....	Robert C. Wilson
Relation of Food to Availability.....	John Radovich
Young Fish Survey.....	Robert C. Wilson

SCRIPPS INSTITUTION OF OCEANOGRAPHY

Studies in Physical Oceanography.....	Robert O. Reid Paul L. Horrer
Studies in Chemical Oceanography.....	Warren S. Wooster
Marine Botany.....	Marston C. Sargent
Marine Invertebrate Plankton.....	Martin W. Johnson
Marine Vertebrates.....	J. L. McHugh
Special Developments.....	John D. Isaacs James M. Snodgrass

U. S. FISH AND WILDLIFE SERVICE

Availability Studies.....	T. M. Widrig
Racial Studies.....	F. E. Felin
Recruitment Studies.....	E. H. Ahlstrom
Vital Statistics (current).....	J. C. Marr
Vital Statistics (1931-1940).....	H. H. Eckles

ACKNOWLEDGMENTS

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