PACIFIC OCEAN PERCH & HAKE STUDIED OFF WEST COAST

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From January through March 1969, BCF's 'Miller Freeman' conducted fishery research off Washington, Oregon, and California (Cruise No. F69-01). Her major objectives were to obtain data on: (1) distribution, age, size, sex composition, and relative abundance of Pacific ocean perch (Sebastodes alutus) off Washington and Oregon; (2) distribution and relative abundance of eggs and larvae of commercially important fish, particularly Pacific hake (Merluccius productus), off California; and (3) distribution and relative abundance of juvenile Pacific hake off southern California.

RESEARCH ON PACIFIC OCEAN PERCH

Historically, the Pacific ocean perch has been one of the most important rockfishes in the Pacific Northwest trawl fishery. Perch grounds off Washington and Oregon are not as extensive as those off Alaska; nevertheless, until recently, the former supported a fishery important to the economies of both states. During the past several years, increased local demand and foreign exploitation of Pacific Northwest groundfish resources have reduced perch stocks to where few U.S. fishermen find it profitable to continue fishing these grounds.

BCF Seattle, Wash., responded to this serious problem by initiating a field program in 1968 to study facets of the Pacific ocean perch: its distribution and abundance, growth and mortality, relation to the environment, size of its standing stock, and the response of the stocks to various rates of fishing. Ultimately, such information will allow estimates of the level of fishing that will maximize the harvest on a sustained basis. These estimates are required before a sound management program can be implemented.

This research cruise was the first in a series to assess Pacific ocean perch stocks off Washington and Oregon and to monitor changes in response to varying fishing rates.

Sampling for Pacific ocean perch began Jan. 8, 1969, and ended on the 24th. Weather was poor at times--but never severe enough to restrict operations. Fishing was conducted in statistical areas designated by the Pacific Marine Fisheries Commission and the U.S.-USSR fishery agreement of 1967 (fig. 1). In areas 12 to 15, drags were started at about 125, 150, 175, and 200 fathoms; in areas 10, 11, this sampling scheme had to be modified because suitable trawling grounds were limited.

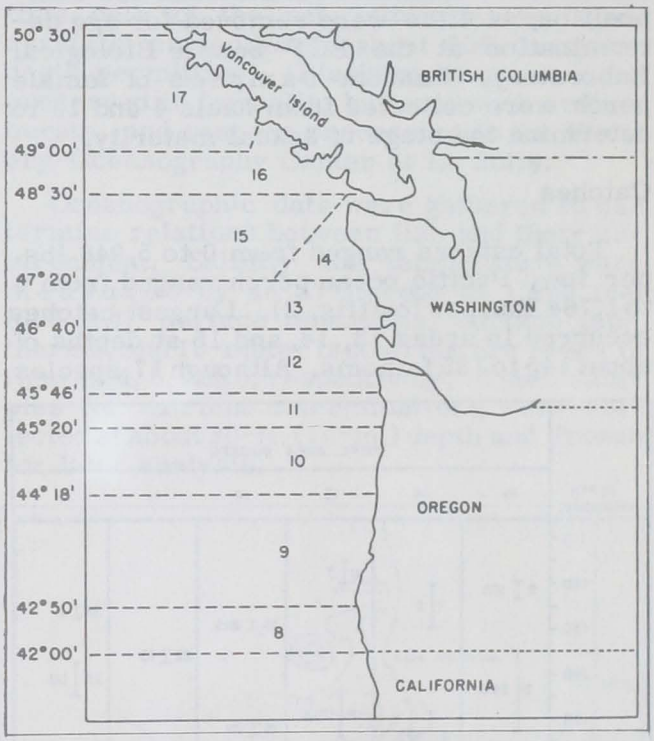

Fig. 1 - Locations of statistical areas based on Pacific Marine Fisheries Commission areas and areas designated in the U.S.-USSR fishery agreement of 1967. The Miller Freeman trawled in areas 10 to 15 on cruise F69-01.

Fishing Gear and Sampling Procedures

The vessel fished with a BCF Mark I Universal Trawl of $2\frac{1}{2}$-inch mesh (stretched

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measure included one knot) in the body and 3-inch mesh in the cod end; the cod end was lined with $1\frac{1}{8}$-inch mesh. The trawl was fitted with 7 by 12-ft. V-doors; during fishing, the nominal dimensions of the trawl mouth were 45 ft. wide by 23 ft. high. Rollers (bobbins) attached to the groundline permitted fishing on rough bottom; a depth-sensing system measured the depth the net was fished. The relative abundance of fish, as well as bottom depth, was determined with a newly installed 800-fathom depth sounder. Tows were made at $1\frac{1}{2}$ to $2\frac{1}{2}$ knots for 30 minutes.

Catches were sorted by species, and total weight of each type of fish determined. Samples of Pacific ocean perch were taken from the catch and examined for size and sex composition; otoliths were removed for age determination at the BCF Seattle Biological Laboratory. Random samples of female perch were collected from hauls 4 and 13 to determine the stage of sexual maturity.

Catches

Total catches ranged from 0 to 5,946 lbs. per tow; Pacific ocean perch ranged from 0 to 1,764 lbs. per tow (fig. 2). Largest catches occurred in areas 13, 14, and 15 at depths of about 145 to 185 fathoms. Although 17 species

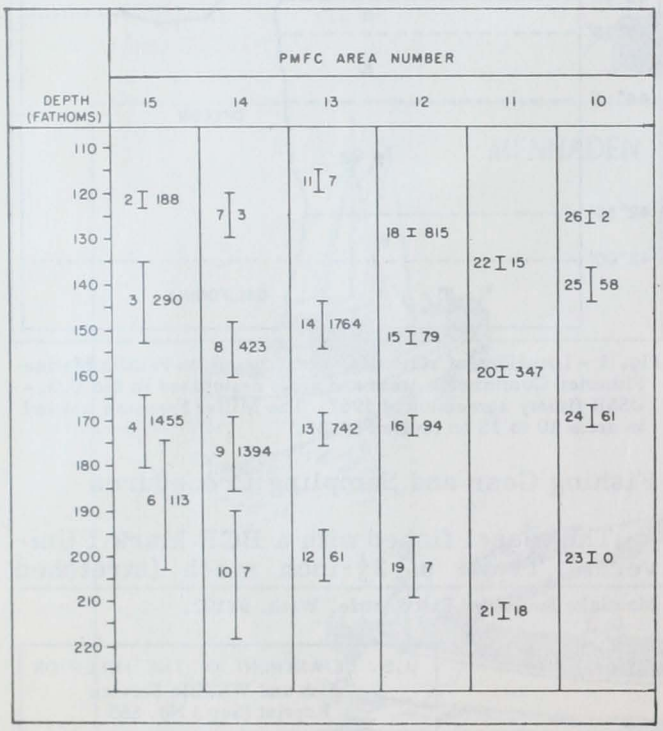

Fig. 2 - Catches of Pacific ocean perch in January 1969, by depth of trawl and statistical area. Number to left of depth range designates haul number; number to right is weight (lbs.) of catch.

of rockfish were caught, only Pacific ocean perch were taken in large numbers. Other large catches included: (1) 5,300 lbs. of Dover sole (Microstomus pacificus) taken at 200 fathoms in area 15, (2) about 2,000 lbs. of spiny dogfish (Squalus acanthias) at 125 fathoms in area 14, and (3) 2,500 lbs. of spiny dogfish at 160 fathoms in area 11.

An estimated 68 percent of the female Pacific ocean perch were sexually mature; most had eggs in advanced stages of development, but evidently none had spawned in 1969. Some fish were preserved for racial studies.

Fulfillment of objectives must await comparison of present data with similar information that will be gathered on future cruises.

PACIFIC HAKE--EGGS AND LARVAE

Only recently has the Pacific hake become the object of an important fishery. Since 1966 it has been caught by U.S. and Soviet vessels fishing along the Pacific Northwest coast. Hake catches have been processed for fish meal, but they will be used as a primary source of fish protein concentrate (FPC) when an FPC pilot plant at Aberdeen, Washington, becomes operational in the near future. Foreseeing the need for management of this fast-growing fishery, BCF began an intensive research program. One phase is collection of information concerning the hake's early life history, the eggs and larvae, particularly their distribution and abundance.

Knowledge of the distribution and abundance of hake eggs and larvae is important in three ways: (1) it enables determination of the distributional characteristics of the spawning population; (2) it allows for estimates of the size of the spawning population; and (3) it provides a basis for prediction of the contribution of present broods to the fishery several years hence.

The first benefit: Information on distribution and schooling habits might allow exploitation of the spawning population. All current evidence indicates that hake spawn at considerable depths and are dispersed over a large area; therefore, commercial exploitation during the winter spawning season does not appear feasible. Also, by gathering information on spawning, we may gain insight into the racial composition of the fishable population, which is important in establishing a management program.

Second benefit: An estimate of the spawning population size would provide a preliminary measure of the size of the fishable population because most fish available to the present fishery are adults. Stock size is another type of information important in computing the maximum sustainable harvest.

Third benefit: The adult Pacific hake population is composed of relatively few age groups. So a particularly large or small age group entering the fishable population has great significance in terms of the abundance of hake available to fishermen. There is considerable evidence that age groups vary greatly in size. Therefore, it would be valuable to fishermen, processors, and fishery managers to have advance information on expected stock size. Sampling the early life stages (eggs, larvae, and juveniles) may provide reliable forecasts of age group strength.

From Jan. 25 to Feb. 17, a cooperative U.S.-USSR survey of Pacific hake eggs and larvae was conducted off California, at plankton stations of CalCOFI (California Cooperative Oceanic Fisheries Investigations). Other organizations participating were the BCF Fishery-Oceanography Center and the Scripps Institution of Oceanography at La Jolla, Calif., and TINRO (Pacific Scientific Research Institute of Marine Fisheries and Oceanography) at Vladivostok, USSR. Sampling was begun off Pt. St. George. It was interrupted by a 2-day port call to San Francisco (Feb. 10-11) for supplies and change of scientific personnel. It was completed just north of Pt. Conception (fig. 3).

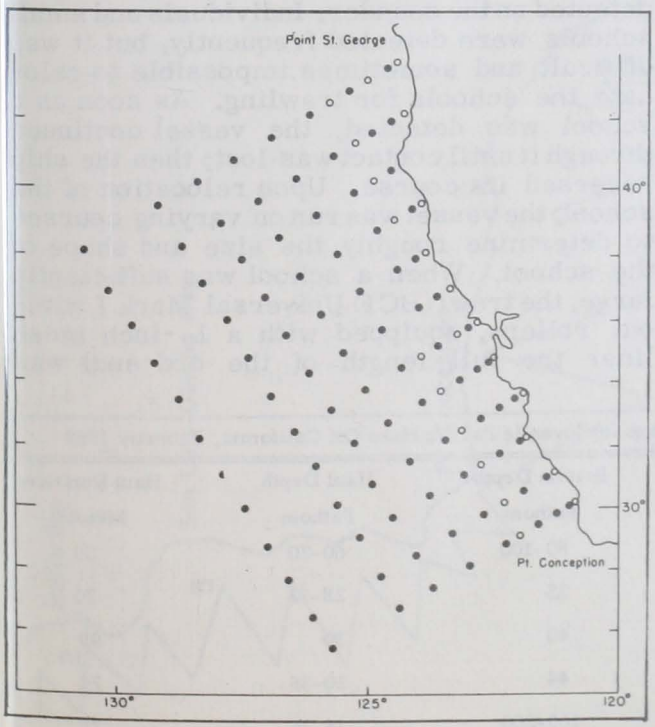

Fig. 3 - Stations fished off California in January and February 1969 to study the distribution and abundance of eggs and larvae of fish. Open circles - plankton tow stations, solid circles plankton tow and STD stations.

The plankton sampling gear used off California, of CalCOFI design, consisted of two nets mounted on a single frame. One net of 505-micron mesh had a mouth diameter of 3.3 ft. (1 m.); the other, of 333-micron mesh, had a mouth diameter of 1.6 ft. ($\frac{1}{2}$ m.). Each net was equipped with a flow meter; on most tows, a bathykymograph recorded the depth-time path of the net. Oblique tows were carefully controlled to about 656 ft. (water depth permitting). Plankton samples were preserved in formalin, buffered with sodium borate, and sent for processing to the Fishery-Oceanography Center at La Jolla.

Oceanographic data were gathered to determine relations between fish and their environment. Salinity and temperature were measured by an STD probe to 1,986 feet (600 m.). Surface isohalines, surface isotherms, and 10-meter isotherms are given in figures 4, 5, and 6, respectively. Water samples for nutrient determinations were collected at about 30-ft. (10-m.) depth and frozen for later analysis.

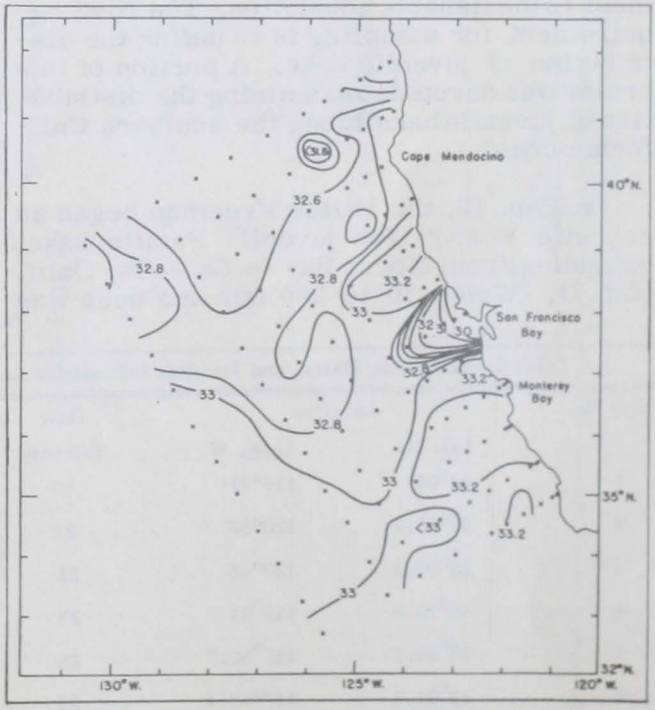

Fig. 4 - Surface salinity (‰) of water off California during the study of fish eggs and larvae in January and February 1969.

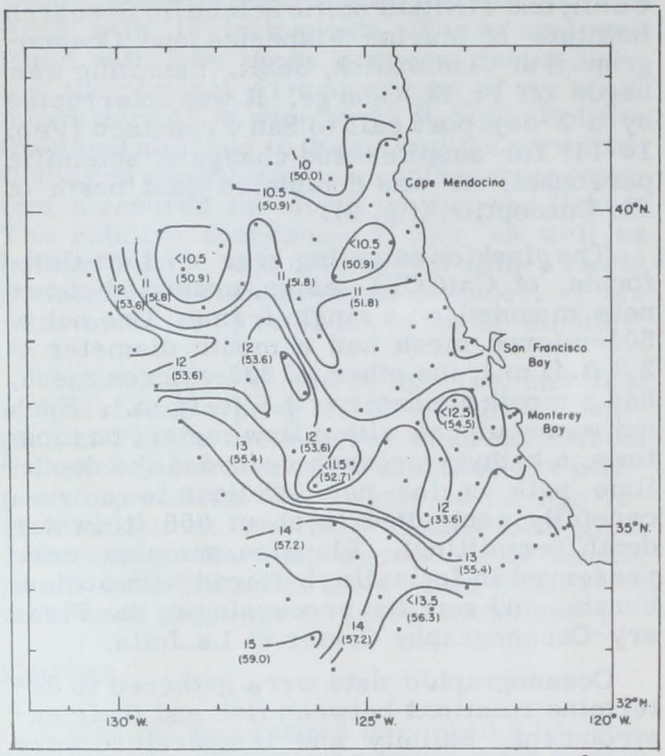

Fig. 5 - Surface temperature (°C. and, in parentheses, °F.) of water off California during the study of fish eggs and larvae in January and February 1969.

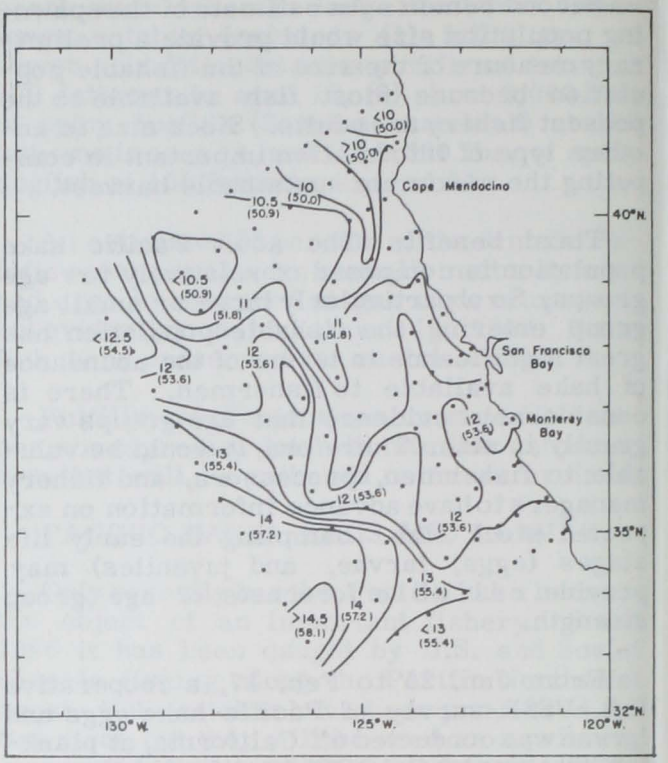

Fig. 6 - Water temperature (°C. and, in parentheses, °F.) at a depth of 33 feet off California during the study of fish eggs and larvae in January and February 1969.

PACIFIC HAKE--JUVENILES

The abundance of juvenile hake (post-larva stages) might also be used to forecast recruitment to the fishable population. The first requirement for sampling is to define the distribution of juvenile hake. A portion of this cruise was devoted to examining the distribution of juvenile hake along the southern California coast.

On Feb. 19, the Miller Freeman began an acoustic search for juvenile Pacific hake, extending from Morro Bay to La Jolla, Calif. (fig. 7). Water 30 to 200 fathoms deep was examined at vessel speeds of 6 to 10 knots. Large concentrations of fish were seldom detected on the sounder. Individuals and small schools were detected frequently, but it was difficult and sometimes impossible to relocate the schools for trawling. As soon as a school was detected, the vessel continued through it until contact was lost; then the ship reversed its course. Upon relocation of the school, the vessel was run on varying courses to determine roughly the size and shape of the school. When a school was sufficiently large, the trawl (BCF Universal Mark I without rollers, equipped with a 1 -inch mesh liner the full length of the cod end) was

Table 1 - Locations, Dates, and Trawling Information for Drags for Juvenile Pacific Hake Off California, February 1969

Haul No.	Location		Date	Bottom Depth	Haul Depth	Haul Duration
	Lat. N.	Long. W.	February	Fathom	Fathom	Minute
1	34°05'	119°37'	19	80-100	60-70	59
2	35°15.7	120°57	21	35	28-32	70
3	35°00.2	120°46	22	40	30	99
4	34°10.8	119°21.2	23	44	20-36	71
5	33°33.5	117°52.7	25	160-200	16-34	78
6	33°31.5	117°58.4	25	120-180	4-30	106

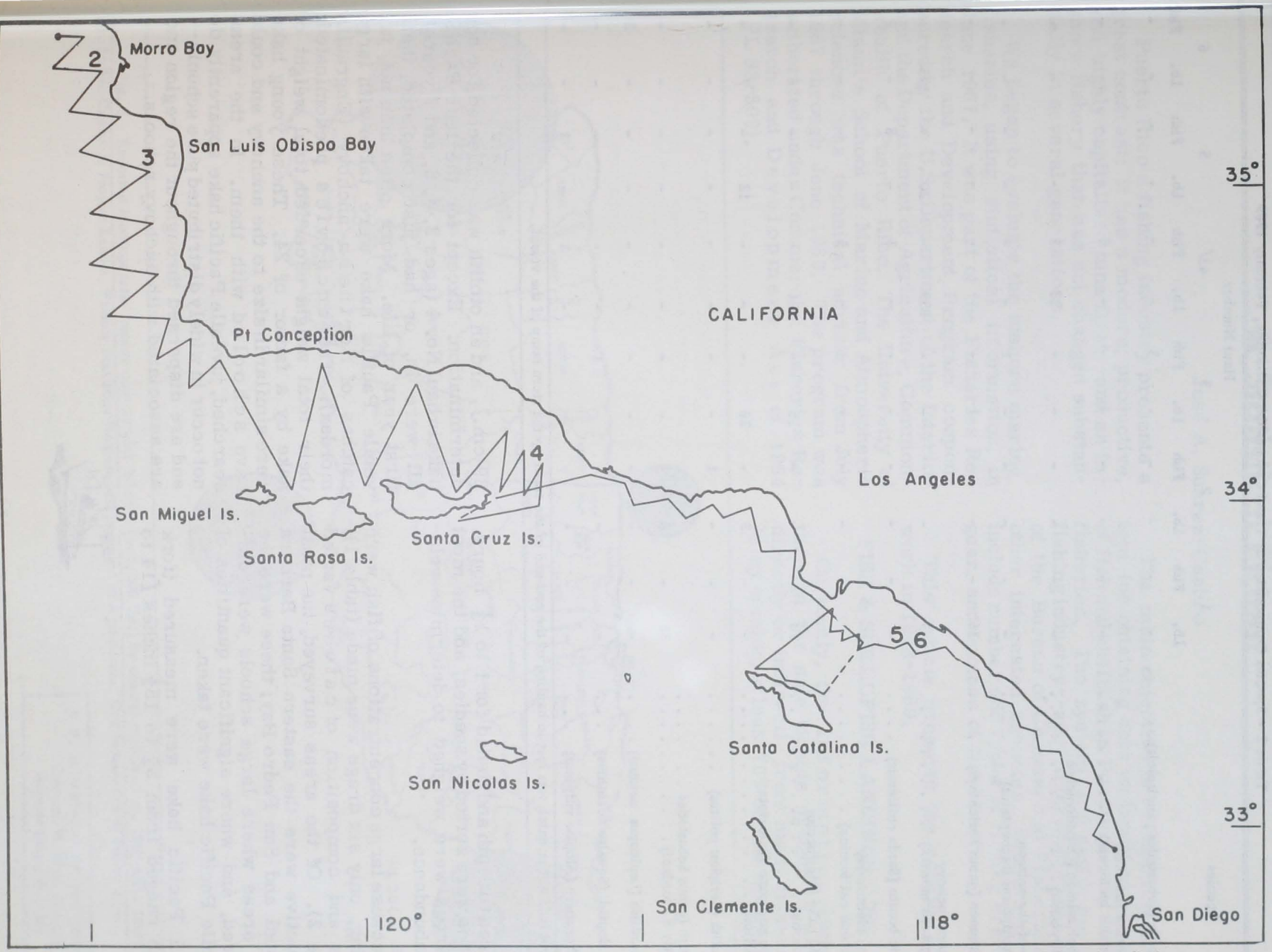

Fig. 7 - Search pattern used for juvenile Pacific hake off California in February. Numbers along the cruise tract designate fishing (trawl) sites.

Table 2 - Species Composition of Trawl Catches Off California, February 1969

Species	Haul Number 1		2		3		4 1/		5		6	
	Lb.	Fish	Lb.	Fish	Lb.	Fish	Lb.	Fish	Lb.	Fish	Lb.	Fish
Bocaccio (Sebastodes paucispinis)	-	-	-	-	-	3	-	-	-	-	-	-
California lizardfish (Synodus lucioceps)	-	-	-	-	-	-	-	6	-	-	-	-
Chinook salmon (Oncorhynchus tshawytscha)	-	-	-	-	-	-	23	1	-	-	-	-
King-of-the-salmon (Trachipterus trachypterus)	-	-	-	-	-	1	-	-	-	-	-	-
Midshipmen (genus Porichthys)	36	-	-	-	1	-	-	-	-	-	-	-
Northern anchovy (Engraulis mordax)	469	-	-	-	-	-	659	-	20	-	195	-
Pacific bonito (Sarda chiliensis)	-	-	-	-	-	-	-	3	-	8	-	9
Pacific electric ray (Torpedo californica)	-	-	-	-	-	1	-	3	-	-	-	-
Pacific hake (Merluccius productus)	28	-	-	-	.5	-	21	-	-	-	6	-
Pacific pompano (Palometa simillima)	-	-	9	-	26	-	-	-	12	-	7	-
Queenfish (Seriphus politus)	-	-	-	1	-	-	-	-	-	-	-	-
Rockfish (genus Sebastodes mostly S. jordani)	38	-	2	-	-	-	-	-	-	-	-	-
Scabbardfish (Lepidopus xantusi)	-	-	-	-	-	-	-	-	-	-	-	3
Spiny dogfish (Squalus acanthias)	-	-	-	-	-	1	-	-	-	-	-	-
Thresher shark (Alopias vulpinus)	-	-	-	-	-	-	-	1	-	1	-	-

1/About half of the catch was lost in hauling of the cod end of the trawl up the stern ramp of the vessel.

lowered to depth and fished for 1 to 1½ hours. Catches were sorted by species, and the most numerous were weighed to determine relative abundance.

Because large concentrations of fish were lacking, only six drags were made (table 1); sizes and composition of catches varied (table 2). Of the areas surveyed, the most productive were the eastern Santa Barbara Channel and San Pedro Bay; these were the only areas where large schools were discovered, and where significant quantities of juvenile Pacific hake were taken.

All Pacific hake were measured (fork length ranged from 5½ to 15½ inches [14 to 39 cm.], and an otolith was collected for age determination. Except for the four Pacific hake in haul No. 4 (ages 2, 4, 6, and 7 years), all were in, or had just completed, their first year of life. More often than not, juvenile Pacific hake were taken with large catches of northern anchovy (Engraulis mordax). The anchovies predominated: their total weight exceeded total weight of hake by a factor of 24. These young hake were similar in size to the anchovy and could have schooled with them. In the areas searched, juvenile Pacific hake apparently do not occur in widely distributed pure schools--and are dispersed throughout the region and are associated with anchovy schools.