

THE FISHERY FOR NORTHERN ANCHOVY, *ENGRAULIS MORDAX*, OFF CALIFORNIA AND BAJA CALIFORNIA IN 1976 AND 1977

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ABSTRACT

Anchovy landings for 1976 totaled 189,066 metric tons (208,407 tons) with 60% landed by American fishermen and 40% by Mexico. The 1977 landings amounted to 243,124 metric tons (267,995 tons) with 58% landed by Mexican boats and the remaining 42% by U.S. fishermen.

Age composition of the 1976 catch consisted largely of the 1973 year class for southern California samples, whereas the 1976 year class dominated Baja California samples. The 1976 year class dominated samples from both southern and Baja California during 1977.

Average fish sizes in 1976 were 106 mm standard length (Baja California) and 125 mm SL (California), whereas in 1977 the mean length of the Mexican fish increased to 113 mm SL although California-caught fish decreased in size to 120 mm SL. Sex ratios ranged during 1976 from 2.15 females to 1 male (Baja California) to 1.16 females per 1 male (southern California), whereas in 1977 the sex ratios were much closer to 1:1 in California and in Baja California.

RESUMEN

Las capturas de anchoveta para 1976 sumaron 189,066 toneladas métricas (208,407 toneladas), con el 60% de las capturas correspondiendo a los pescadores norteamericanos, y el 40% a México. Las capturas de 1977 llegaron a 243,124 toneladas métricas (267,995 toneladas), con el 58% pescado por barcos mexicanos y el 42% restante, por pescadores de los EE.UU.

Para las muestras del sur de California, la generación de 1973 contribuía principalmente a la composición de la edad de los peces capturados en 1976, mientras que la generación de 1976 dominaba en las muestras de Baja California. La generación de 1976 dominó las muestras del sur de California y de Baja California durante 1977.

Los promedios de las tallas de los peces capturados en 1976 fueron de 106 mm de longitud normal (Baja California) y de 125 mm de longitud normal (California), mientras que en 1977 la longitud media del pez mexicano aumentó a 113 mm de longitud normal aunque el tamaño de los peces de California disminuyó a 120 mm de longitud normal. Las proporciones entre los sexos durante 1976 variaron de 2.15 hembras por 1 macho (Baja California) a 1.16 hembras por 1 macho (sur de California), mientras que en 1977 las proporciones entre los sexos eran mucho más cercanas a 1:1 en California y en Baja California.

INTRODUCTION

The anchovy resource off the west coast of California and Baja California has developed into a major fishery in recent years. Most of the catch was made between San Quintin, Baja California, to north of San Francisco, California (Figure 1). Major ports of landings are Ensenada, located in Baja California, and Monterey, Oxnard, and Terminal Island in California.

Since the anchovy resource is common to both the United States and Mexico, the Instituto Nacional de Pesca and the California Department of Fish and Game have entered into a cooperative program of monitoring the anchovy fisheries of each country. Chavez et al. (1977) have described the life history of the anchovy and the results of the fisheries during 1975. This report is the continuation of this cooperative study and summarizes the catch data for 1976 and 1977.

THE FISHERY FOR 1976

Anchovy landings for 1976 totaled 189,066 metric tons (208,407 tons), of which 113,320 mt (124,913 tons), or nearly 60%, were caught by American fisherman and 75,746 mt (83,495 tons) were landed by Mexican fishermen (Table 1).

A total of 106 vessels, representing 66 American and 40 Mexican boats, was involved in the anchovy fishery. The average capacity of the Mexican boat was considerably greater (116.7 metric tons [128 tons]) than the American boat (76.0 metric tons [84 tons]), although its size was slightly smaller (15.5 m [51 ft]) as compared to 19.0 m [62.7 ft], respectively). The slight increase in average capacity of Mexican boats was due to the addition of several large-capacity (296-mt [326-tons]) purse seiners (Table 2).

The American fleet, although numbering as high as 66 vessels, contained 45 boats that were considered full-time anchovy boats. A majority of these vessels participated in the anchovy reduction fishery, which accounts for 99% of all anchovies landed in California. Since the reduction fishery is regulated by a season and a quota (Chavez et al. 1977), the number of active fishing boats fluctuates throughout the year. Most of the fishing activity occurs in southern California, although a minor fishery occurred in central California. This fishery was influenced by other fisheries such as the herring fishery in San Francisco Bay, which occurred January through March, and by the

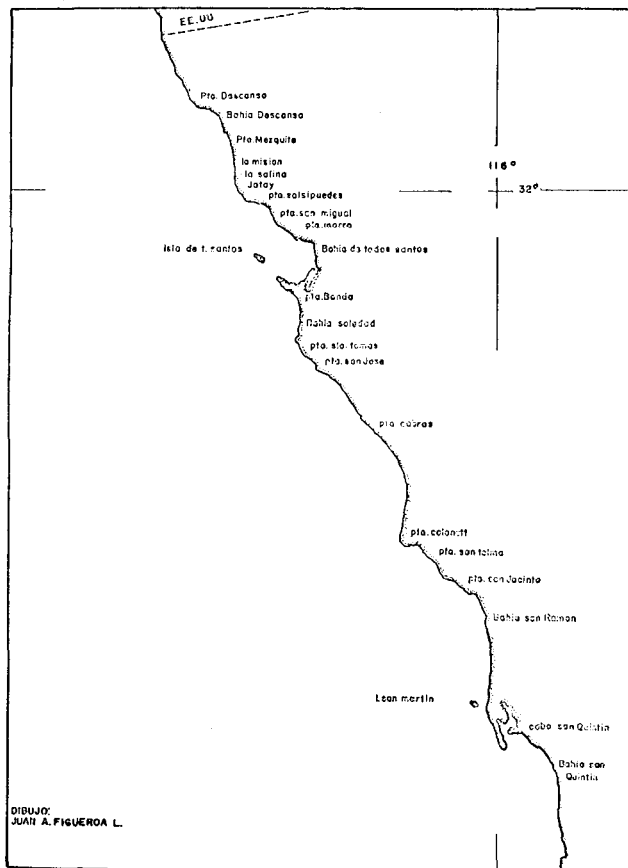
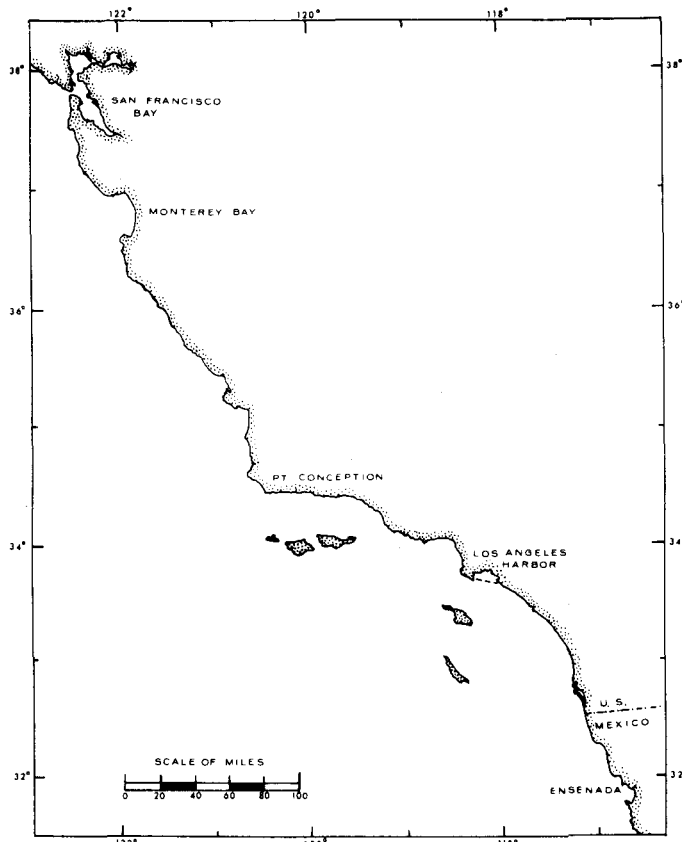


Figure 1. Top, anchovy fishing grounds of California; bottom, anchovy fishing grounds off Baja California.

TABLE 1
 Anchovy Landings for 1976.

Month	Weight (metric tons)		Total
	U.S.	Mexico	
January	18,009	85	18,094
February	1,549	119	1,668
March	10,597	49	10,646
April	16,225	1,055	17,280
May	1,648	1,437	3,085
June	115	3,753	3,868
July	174	12,836	13,010
August	425	5,097	5,522
September	6,833	15,000	21,833
October	10,037	15,943	25,980
November	27,234	14,297	41,531
December	20,474	6,075	26,549
Total	113,320	75,746	189,066
Short tons	124,913	83,495	208,407
%	59.9	40.1	100.0

mackerel and tuna fisheries in southern California, which occurred all year.

The Mexican fleet, which numbered a maximum of 40 boats, fluctuated between three boats during March and 30 boats in July, although in the fall and winter a major portion of the fleet became involved with the Gulf of California sardine fishery.

Monthly landings for the U.S. fishery were greatest during the fall and winter months with the smallest landings during the summer season (Table 1). The Mexican fishermen were most successful in summer and fall with winter months displaying the least amount, which reflects the effect of the sardine fishery (Table 1). The small amount of anchovies landed in U.S. waters during summer is due to the closure of the reduction fishery at this time. Mexico presently has no such regulation.

Major fishing grounds in southern California were the San Pedro Channel, Point Dume, Santa Monica Bank, and off Ventura. Fishing was best during the spring months in San Pedro Channel and off Huntington Beach, whereas fall catches occurred off Ventura and Santa Barbara. Central California landings occurred predominantly in Monterey Bay. A total of 2,312 boat trips were made in 1976, with as few as four trips in July to as many as 489 trips in November.

Primary Mexican fishing grounds were near Ensenada in February, May, and September, and the second most important areas were north of Ensenada: Playa del Rosarito, Punta Descanso, Las Salinas, Jatay, and Salsipuedes. Substantial catches were made south of Ensenada near Punta Cabras, Punta Colonett, Punta Piedras, Camalu, and Bahía San Ramon during July and August. The number of boat trips for 1976 totaled 1,391, ranging from five trips in January to 307 in October. Daily landings ranged from a maximum of 1,980 mt (2,182 tons) in October to 5.0 (5.5 tons) in November.

Plant facilities in the U.S. remained the same as the previous year with four plants in southern California and two plants in central California. Processing capacity remained unchanged at 1,677 mt (1,850 tons) per day in the south and 200 mt (220 tons) in the north. Nine processing plants were located in Ensenada, which processed anchovies for canning (0.68%) and for reduction (99.32%).

Prices of anchovies ranged from \$31 to \$44.50/ton for U.S. fishermen, while Mexican fishermen received \$17 to \$30/ton for reduction and \$24 to \$28/ton for canning.

THE FISHERY FOR 1977

Landings in 1977 reached a record high of 243,124 metric tons (267,995 tons), of which 142,575 mt (157,160 tons), or nearly 58.6%, were caught by Mexico and 100,549 mt (110,835 tons) were caught by the U.S. (Table 3).

A dramatic change occurred in the dimensions of the Mexican fleet. In 1977, the average length of the vessel increased from 15.5 to 22.1 m (51 to 72 feet), and the catch capacity increased from 116.2 to 128 metric tons (129 to 141 tons; Table 2). This increase was due to the presence of 12 large-capacity 296-mt (326-ton) purse seiners. The American fleet on the contrary did not increase as much, as indicated by slight increases to 21.5 m (70 feet) and 90.7 mt (100 tons). Fleet size for both U.S. and Mexican fisheries totaled 41 vessels from Mexico and 45 boats from the U.S. (Table 2). The U.S. fleet size remained nearly constant during the fall, ranging between 35 to 45 vessels, but fewer boats were active during winter and spring (Table 2). This trend was the result of fishing effort towards jack mackerel and herring. The summer months saw little activity in anchovy fishing. Mexican fleet size fluctuated between 6 and 30 vessels/month.

U.S. landings during January and February were considerably lower than the previous year as a result of the herring fishery interest in the northern zone and an excellent jack mackerel fishery in the south. Anchovy fishing did improve markedly in March, although catch success declined progressively throughout the spring. Summer monthly landings were minimal until August

TABLE 2
 U.S. and Mexican Fishing Vessel Information.

	U.S.		Mexico	
	1976	1977	1976	1977
Total number of boats	66	45	40	41
Mean vessel size				
Meters	19.0	21.5	15.5	22.1
Range	6-28	6-33	11-31	7-31
Mean catch capacity				
Metric tons	76.0	90.7	116.7	128
Range	5-181	10-208	14-296	12-296

when the reduction fishery was opened (Table 3). As it was noted the previous year, the fall months were most successful (Table 3). Total number of boat trips for the year was 2,015, ranging from five trips in July to 482 trips in October.

Mexican catches from January to May occurred south of Bahia Todos Santos (Camalu, Colonett, and Bahia San Ramon), and in the remaining months, the catch locations were in Bahia Todos Santos and nearby areas to the north (Punta Descanso, La Mision, La Salina, Salsipuedes, Punta Blanca, and Bahia Soledad). Number of boat trips totaled 2,032 with a low of 24 trips in February and a high of 407 trips in July. Daily landings ranged from 3.9 mt (4.3 tons) in February to 2,012 mt (2,218 tons) in July. Minor and occasional catches were made at Cedros Island, Bahia Tortugas, San Carlos, Isla Coronado, and Isla Margarita. Other species such as yellow-tail (jurel), *Seriola dorsalis*; jack mackerel (charrito), *Trachurus symmetricus*; bonito, *Sarda chiliensis*; and Pacific mackerel (macarela), *Scomber japonicus*, were caught.

The southern California processing facilities increased their capacity from 1,677 to 1,877 mt (1,850 to 2,070 tons) per day. Mexican reduction capacities remained the same.

U.S. anchovy prices ranged from \$34.50/ton to \$58.75/ton with an average price of \$41/ton. Mexican prices varied from \$24 to \$30/metric ton for reduction and \$28 to \$32/metric ton for canning.

FISHERY MONITORING

Methods and Materials

Sampling and aging methods utilized in both countries were described in detail by Chavez et al. (1977).

TABLE 3
 Anchovy Landings for 1977.

Month	Weight (metric tons)		Total
	U.S.	Mexico	
January	2,214	2,430	4,644
February	315	1,220	1,535
March	19,926	984	20,910
April	8,278	4,293	12,571
May	1,713	5,591	7,304
June	122	25,196	25,318
July	171	35,398	35,569
August	410	29,928	30,338
September	9,634	9,752	19,386
October	25,059	10,076	35,135
November	23,538	14,143	37,681
December	9,169	3,564	12,733
Total	100,549	142,575	243,124
Short tons	110,835	157,160	267,995
%	41.4	58.6	100.0

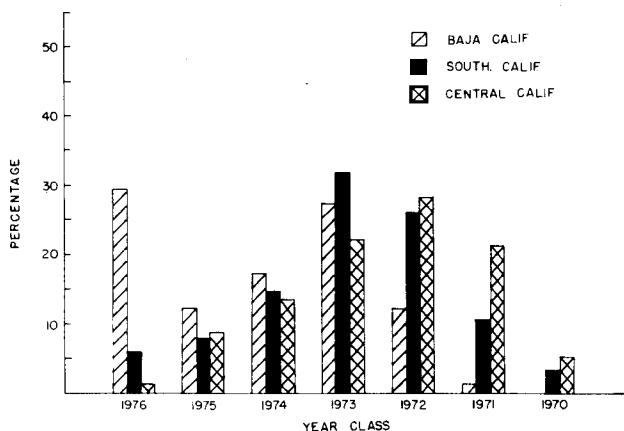


Figure 2. Age composition of anchovies caught off California and Baja California in 1976.

Results

Age Composition

Both southern California and Baja California samples during 1976 were characterized by large numbers of 1973 year class fish (32% and 27% respectively), although the Mexican catches were dominated by 1976 year class fish (Figure 2). This year class was nearly absent in California samples due to gear restrictions and a minimum size restriction. Older age groups were more prevalent in California samples than in Baja California samples.

Monthly age compositions differed between areas during the fall when Mexican samples consisted mainly of 1976 year class fish in contrast to the abundance of 1973 year class fish in U.S. samples (Figure 3).

In 1977, both California and Baja California age data indicated large percentages of young fish (Figure 4). Fish of the 1977 year class comprised over 50% of central California take, while the 1976 year class dominated the catch from southern and Baja California. Both California and Baja California age data revealed substantial numbers of the 1977 and 1976 cohorts throughout the year (Figure 5).

Length Composition

Baja California length data exhibited a bimodal distribution during 1976 with peaks near 85 and 115 mm (3.3 and 4.5 inches) standard length and an average length of 106 mm (4.2 inches) SL (Figure 6). Individuals smaller than 100 mm (4 inches) SL were present in all months and were extremely abundant in September through November (Figure 7). California anchovy lengths ranged from 80 to 160 mm (3.1 to 6.3 inches) SL with an average length of 125 mm (4.9 inches) SL (Figure 6). The total length distribution showed a pronounced mode at 130 mm (5.1 inches) SL and a minor mode at 100 mm (4 inches) SL (Figure 6). Monthly length distributions dis-

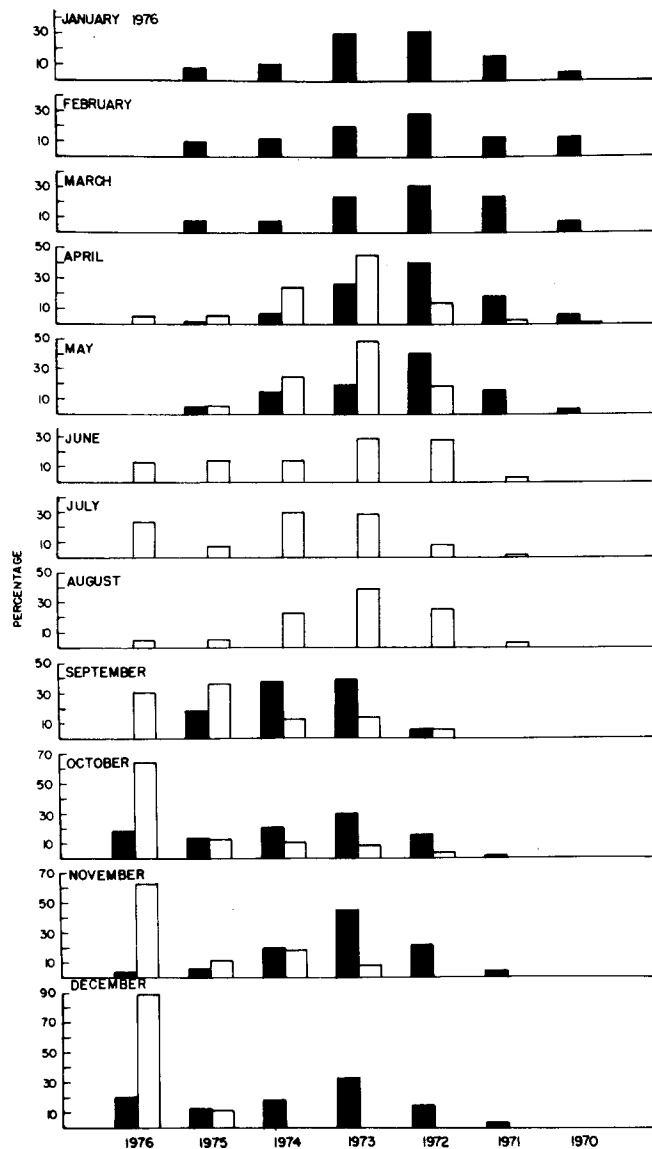


Figure 3. Monthly age composition by year class for 1976; solid bars, California; open bars, Baja California.

played a prominent mode near 125 mm (5 inches), although a small mode occurred near 95 mm (3.7 inches) SL (Figure 7).

During 1977, Mexican-caught anchovies averaged 113 mm (4.4 inches) SL with a range of 60 to 158 mm (2 to 5.3 inches) SL, whereas California data displayed unusual length distributions between central and southern California fish (Figure 6). Southern California length data were shown as a normal distribution with a mode of 120 mm (4.7 inches) SL, while central California data displayed a bimodal distribution.

Monthly length distributions for both countries were similar until August when the central California fishery was sampled (Figure 8). Normally, this region contains

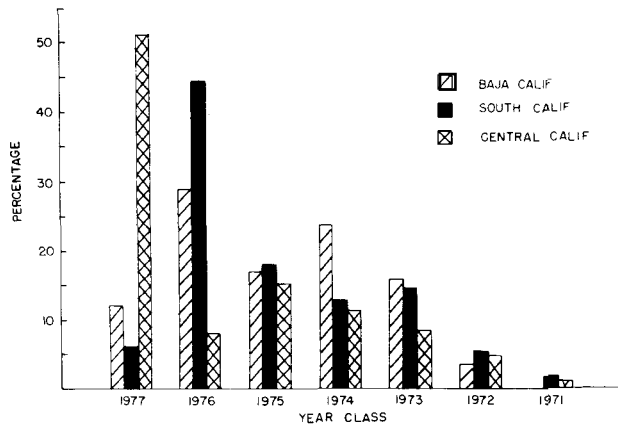


Figure 4. Age composition of anchovies caught off California and Baja California for 1977.

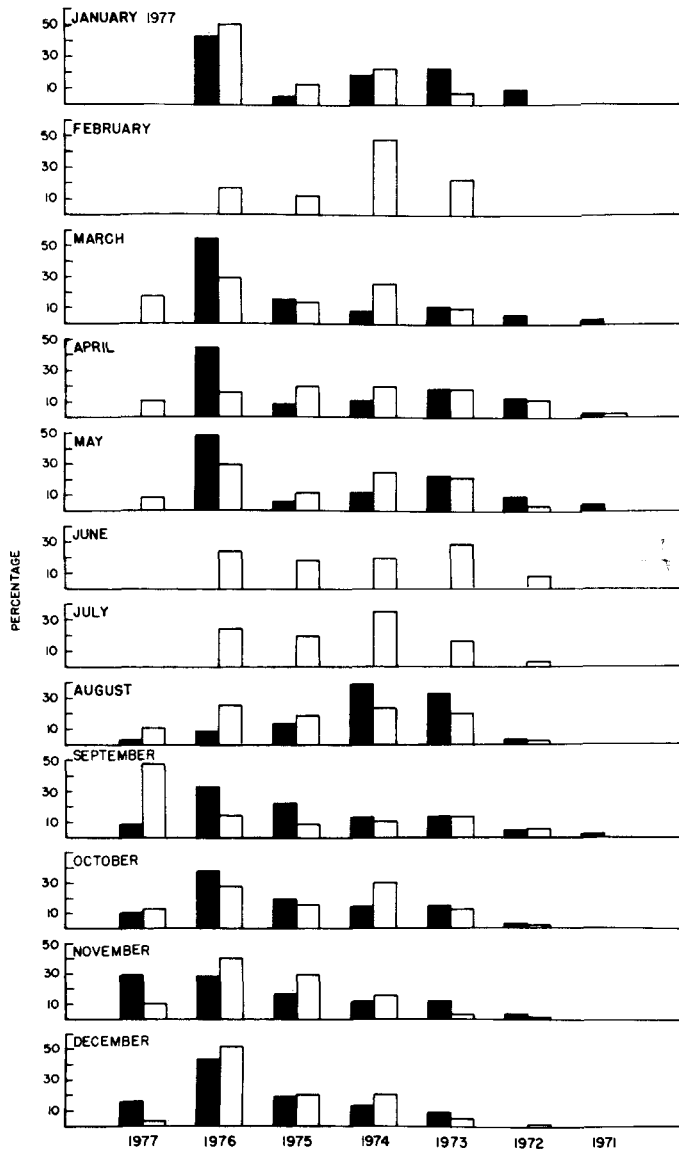


Figure 5. Monthly age composition by year class for 1977: solid bars, California; open bars, Baja California.

larger and older fish. Considerable length variations occurred between Baja California and California samples during September and December (Figure 8). An estimated 18% of the Mexican landings were fish smaller than 100 mm (3.9 inches) SL.

Sex Composition and Ratio

Sex composition of the catch during 1976 ranged from a female to male ratio of 1.16:1 in southern California to 2.15:1 in Baja California (Table 4). The Baja samples were dominated by females in all the months except December, whereas the southern California samples displayed a near 1:1 ratio in most of the months with an exception in May (Table 4). Central California samples indicated a nearly 2 to 1 female to male ratio, although only two months were sampled.

Anchovy sex ratios for California and Baja California were much closer to 1:1 during 1977 (Table 5). Baja California samples did contain slightly higher proportions of females than did the California samples (Table 5). One possible explanation for this decline in numbers of females could be the age structure of the catch, for significant numbers of young fish were caught during the year. Sunada (1976) stated that males were equal in proportion to females in younger age groups, whereas older age groups were dominated by females.

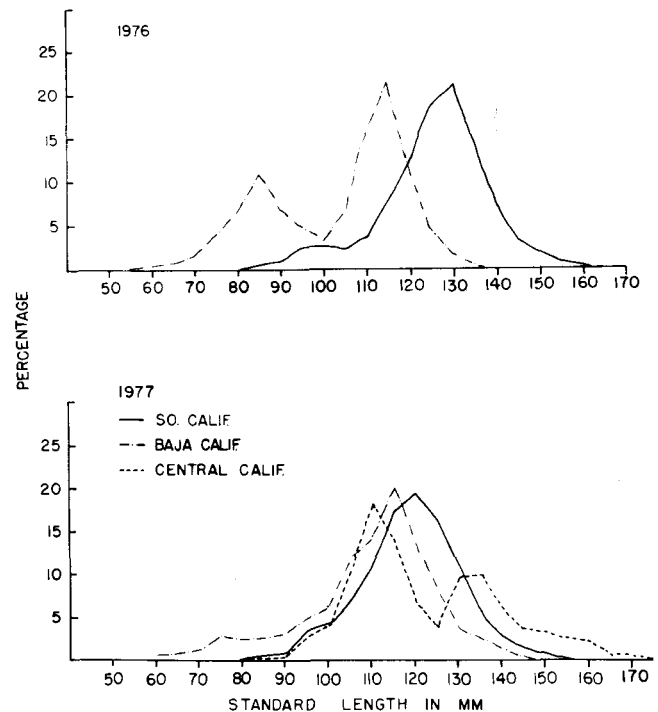


Figure 6. Annual anchovy length-frequency distribution for California and Baja California for 1976 and 1977.

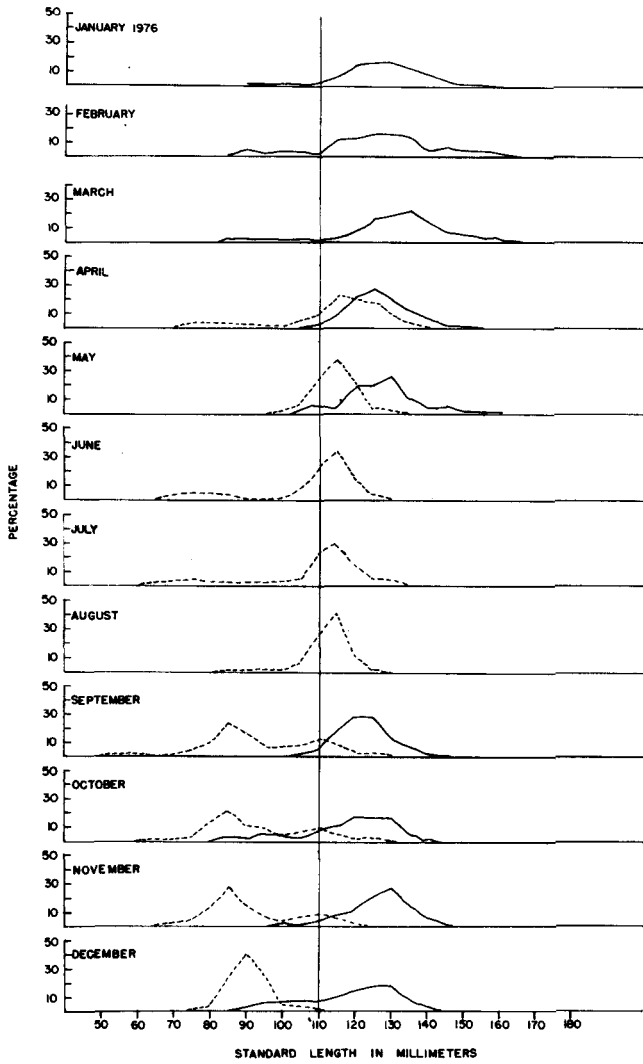


Figure 7. Length-frequency distribution of anchovies by month for 1976: dashed line, Baja California; solid line, California.

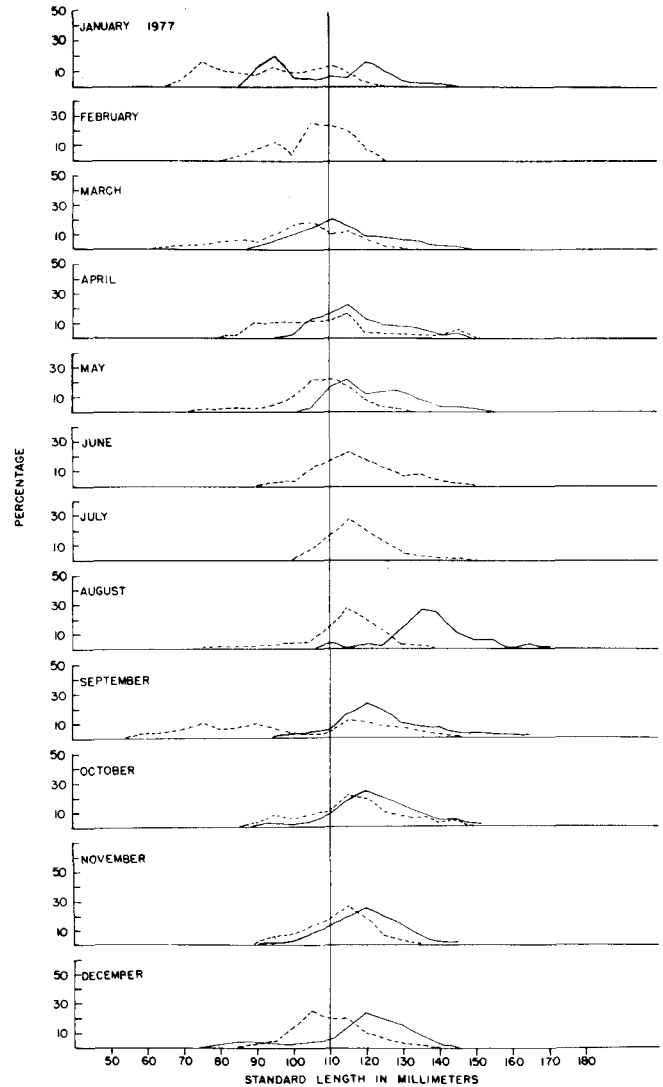


Figure 8. Length-frequency distribution of anchovies by month for 1977: dashed line, Baja California; solid line, California.

TABLE 4
 Anchovy Sex Ratios for U.S. and Mexico for 1976.¹

Month	Central California		Southern California		Mexico		
	Male	Female	Male	Female	Male	Female	Unknown
January	-	-	43.0	57.0	-	-	-
February	-	-	45.9	54.1	-	-	-
March	-	-	51.4	48.6	-	-	-
April	-	-	40.9	59.1	38.7	56.8	5.2
May	-	-	32.9	67.1	37.2	62.8	-
June	-	-	-	-	22.6	77.4	-
July	-	-	-	-	21.7	63.7	14.6
August	-	-	-	-	30.9	65.5	3.6
September	-	-	42.0	58.0	29.1	70.9	-
October	-	-	44.9	55.1	16.7	53.3	25.3
November	26.2	73.8	51.9	48.1	26.0	74.0	-
December	54.2	45.8	49.3	50.7	65.4	34.6	-
Percent	36.4	63.6	46.4	53.6	28.3	60.8	10.2
Ratio female:male	1.75:1		1.16:1		2.15:1		

¹Percentage by numbers.

TABLE 5
 Anchovy Sex Ratios for U.S. and Mexico for 1977.¹

Month	Central California		Southern California		Mexico		
	Male	Female	Male	Female	Male	Female	Unknown
January	-	-	45.8	54.2	33.6	66.4	-
February	-	-	-	-	31.4	68.6	-
March	-	-	47.2	52.8	37.7	57.3	5.0
April	-	-	50.5	49.5	29.6	70.4	-
May	-	-	44.9	55.1	38.2	60.5	1.3
June	-	-	-	-	35.4	64.5	-
July	-	-	-	-	35.4	64.5	-
August	40.0	60.0	-	-	51.7	38.1	5.2
September	44.6	55.4	42.2	57.8	22.4	39.7	37.9
October	-	-	49.8	50.2	33.3	63.3	3.4
November	45.2	54.8	44.3	55.7	19.6	68.4	2.4
December	54.4	45.6	51.9	48.1	35.7	64.3	-
Percent	45.6	54.4	47.5	52.5	38.6	55.6	5.7
Ratio female:male	1.19:1		1.10:1		1.44:1		

¹Percentage by numbers.

CONCLUSION

The anchovy fishery continued to expand in 1976 and 1977 with combined U.S. and Mexican landings of 189,066 metric tons (208,407 tons) in 1976 and 243,124 mt (267,995 tons) in 1977. Mexico increased her share of the catch from 40% in 1976 to 58% in 1977. Part of this trend can be attributed to the addition of 12 large purse seiners in the Mexican fleet. Fishing effort in both countries was influenced by the presence of more profitable species such as mackerel and herring.

Age structure of the sampled population during 1976 was dominated by the 1973 year class for California samples and by 1973 and 1976 cohorts in Baja California samples. The following year, age compositions from southern California and Baja California were quite similar, with 1976 year class dominating the catch. Central California samples contained unusually high percentages of young-of-the-year fish (1977 year class). Monthly age compositions differed between regions (U.S. and Mexico) during the fall of 1976, with Mexican landings dominated by young fish. During 1977, age structures of the two fisheries were more or less similar.

Mexican samples in 1976 exhibited a bimodal length distribution with peaks near 85 mm and 115 mm SL while California samples displayed a single mode near 130 mm SL. Length frequencies during the fall of 1976 showed distinct separation of size distribution between U.S. and

Mexican catches. The lack of any size regulations in the Mexican fishery became obvious with the increased numbers of fish smaller than 100 mm SL. It is very possible these fish were from the southern stock with its slower growth rate. Both southern California and Baja California length data in 1977 displayed one mode while central California data exhibited two modes. Monthly length frequencies between countries were similar during the fall and winter with the exception of September. The majority of the fish were larger than 100 mm SL in all areas.

Anchovy sex ratios from the two countries showed greater numbers of females in the catch for both 1976 and 1977, although in 1977 the proportion of females, while still the majority, declined slightly.

The biological data from both countries indicate the fisheries to be harvesting primarily the central stock. As for the contribution of the southern stock, this is difficult to ascertain. Presently several studies are under way to more accurately determine the proportion of southern stock fish mixed with fish from the central stock.

LITERATURE CITED

- Chavez, H., Silva, S., and J.S. Sunada. 1977. The fishery for northern anchovy, *Engraulis mordax*, off California and Baja California in 1975. Calif. Coop. Oceanic Fish. Invest. Rep. 19:147-165.
- Sunada, J.S. 1976. Age and length composition of northern anchovies, *Engraulis mordax*, in the California anchovy reduction fishery, 1973-74 season. Calif. Fish Game 62(3):213-224.