PRELIMINARY RESULTS OF STUDIES ON THE PRESENT STATUS OF THE PERUVIAN STOCK OF ANCHOVY (*ENGRAULIS RINGENS* JENYNS)

G. SAETERSDAL, J. VALDIVIA, I. TSUKAYAMA and B. ALEGRE

Instituto del Mar del Perú

Lima, Perú

INTRODUCTION

This report presents the results of an analysis made in September 1964 of all data then available on the Peruvian anchovy. It was presented to the Peruvian Marine Institute and written in a form intended for circulation to non-experts in stock assessment. It is a follow-up of work reported on by Saetersdal and Valdivia (1964) and by Saetersdal et al (1965).

THE FISHING EFFORT AND THE CATCH

The Fleet and Its Capacity

Table 1 shows the number of vessels that has operated during the whole years 1959–1963 and during the first part of 1964. Table 2 shows the distribution by holding capacity and the estimated total capacity of the fleet. The number of vessels increased by 60% from 1962 to 1963 and the capacity increased by nearly 80%. The data of the fleet from January to June 1964 indicate a continued, but lower increase.

TABLE 1

NUMBER OF VESSELS IN OPERATION, 1959–1963 AND JANUARY–JUNE 1964 BY MATERIAL OF CONSTRUCTION

Material of Construction	1959	1960	1961	1962	1963	Jan-Jun 1964[1]
Wood	343	578	650	763	1,009	930
Steel	11	75	100	188	377	434
Wood and Steel	--	--	--	--	4	1
Without Data	1	1	3	145	366	456
Totals	355	654	753	1,096	1,756	1,821

[1] Provisional data.

The Result of the Fishery

As can be seen from the figures giving the total catch (Table 3) an increase of catch from 1962 to

TABLE 2

DISTRIBUTION OF VESSELS BY HOLDING CAPACITY AND ESTIMATION OF TOTAL CAPACITY OF THE FLEET IN OPERATION 1959–1963 AND JANUARY–JUNE 1964

Capacity in tons	1959	1960	1961	1962	1963	Jan-Jun 1964[1]
10/19	--	1	1	--	--	--
20/29	22	16	10	3	3	2
30/39	45	47	36	23	14	8
40/49	62	68	55	54	50	13
50/59	49	50	45	41	40	26
60/69	78	122	130	118	115	89
70/79	41	82	86	86	94	73
80/89	34	116	147	146	155	147
90/99	15	99	141	182	211	339
100/109	3	25	45	128	274	186
110/119	1	5	21	52	155	168
120/129	--	8	12	68	154	154
130/139	1	1	2	12	35	43
140/149	--	2	3	13	40	49
150/159	--	3	2	5	9	10
160/169	--	2	6	9	12	16
170/179	--	--	--	1	4	7
180/189	1	3	2	1	5	12
190/199	1	1	1	--	1	2
200/209	--	--	--	--	1	1
230/239	--	1	2	1	1	1
250/259	--	--	--	--	1	--
260/269	--	--	--	--	9	8
Without data	2	2	6	153	373	467
Total	355	654	753	1,096	1,756	1,821
Total Capacity	21,015	47,620	58,945	[2]99,000	[2]176,000	--

[1] Provisional data.
[2] Include estimations for vessels without information of capacity.

TABLE 3

CATCH BY PORTS AND YEARS 1959–1963 AND CATCH IN JANUARY–JUNE 1964

Ports	1959	1960	1961	1962	1963	Jan.–June 1964[1]
Chimbote	549,904	736,301	1,259,302	1,999,795	1,767,095	1,484,437
Samanco	85,532	90,086	135,480	129,114	95,298	83,961
Casma	53,612	59,336	49,473	64,669	44,246	117,602
Huarmey	246,294	264,280	261,019	308,175	247,976	205,617
Supe	2,405	128,189	373,622	655,131	753,452	594,367
Vegueta	--	--	--	--	--	46,971
Huacho	78,511	164,036	264,414	421,609	517,054	292,655
Chancay	59,558	44,642	99,708	369,555	545,339	334,689
Callao	754,047	1,310,746	1,925,074	1,965,989	1,771,648	1,018,961
Pucusana	18,970	32,201	47,516	55,559	56,688	31,510
Tambo de Mora	--	--	--	--	143,518	300,110
Pisco	--	--	--	23,943	59,276	80,487
Atico	--	--	--	--	32,371	46,697
Mollendo	8,623	27,926	44,820	125,836	121,885	73,250
Ilo	51,242	85,859	119,281	148,352	263,418	346,968
Other ports	--	--	--	6,897	--	--
Totals	1,908,698	2,943,602	4,579,709	6,274,624	6,419,261	5,058,284

[1] Provisional data.

(88)

TABLE 4A

AVERAGE ANNUAL CATCH FOR VESSELS GROUPED BY 5 FEET OF LENGTH 1959–1963. ALL THE COUNTRY, CHIMBOTE AND CALLAO

All the Country

Length (ft.)	1959		1960		1961		1962		1963[1]	
	Catch	Vessels	Catch	Vessels	Catch	Vessels	Catch	Vessels	Catch	Vessels
25–29	1,750	1	2,250	1						
30–34	2,607	7	1,650	5	1,875	4	2,750	1		
35–39	2,598	23	2,050	10	2,000	4	1,500	2		
40–44	3,210	25	2,861	18	2,750	12	2,861	9		
45–49	4,146	53	3,375	36	3,604	24	3,120	27		
50–54	6,854	48	5,592	79	5,417	72	5,282	62	3,509	21
55–59	7,109	39	6,905	68	6,590	81	6,784	89	4,762	34
60–64	9,750	19	7,421	114	8,500	214	8,965	242	5,897	171
65–69	--	--	10,750	1	9,000	26	10,716	104	7,442	233
70–74	--	--	--	--	--	--	11,350	15	8,393	24
75–79	--	--	8,822	7	8,750	10	11,550	15	6,910	19
80–84	--	--	6,250	2	10,500	2	19,250	1	4,792	1
90–94	--	--	--	--	--	--	--	--	10,098	3
Total vessels	--	215	--	341	--	449	--	567	--	506

[1] Incomplete data.

TABLE 4B

CHIMBOTE

Length (ft.)	1959		1960		1961		1962		1963[1]	
	Catch	Vessels	Catch	Vessels	Catch	Vessels	Catch	Vessels	Catch	Vessels
35–39	--	--	2,750	2						
40–44	2,806	9	1,750	2						
45–49	4,083	9	3,583	3	2,750	1	2,750	1		
50–54	6,219	16	5,071	14	5,204	11	5,679	14	3,188	5
55–59	7,762	17	6,795	22	7,250	26	7,361	27	5,092	14
60–64	9,650	10	7,211	38	8,796	76	10,040	81	5,910	65
65–69	--	--	--	--	10,188	8	13,056	31	7,884	68
70–74	--	--	--	--	--	--	11,850	10	8,692	12
75–79	--	--	7,750	2	16,750	1	15,250	2	7,429	5
80–84	--	--	--	--	10,500	2	19,250	1	4,792	1
90–94	--	--	--	--	--	--	--	--	10,098	3
Total vessels	--	61	--	83	--	125	--	167	--	173

[1] Incomplete data.

TABLE 4C

CALLAO

| Length (ft.)	1959		1960		1961		1962		1963[1]	
	Catch	Vessels	Catch	Vessels	Catch	Vessels	Catch	Vessels	Catch	Vessels
35–39	2,306	9	--	--	--	--	1,750	1		
40–44	4,062	8	3,167	6	3,625	4	5,250	1		
45–49	4,900	20	3,750	17	4,150	10	3,361	9		
50–54	8,397	17	5,683	30	5,417	30	4,875	20	3,759	5
55–59	7,417	9	7,424	23	6,538	26	6,202	31	4,512	7
60–64	11,750	3	7,650	45	8,282	78	7,881	84	5,414	36
65–69	--	--	10,750	1	9,295	11	9,266	31	7,057	54
70–74	--	--	--	--	--	--	16,750	1	8,149	7
75–79	--	--	9,167	6	8,464	7	12,321	7	7,205	7
80–84	--	--	--	--	9,750	1	--	--	--	--
Total vessels	--	66	--	128	--	167	--	185	--	116

[1] Incomplete data.
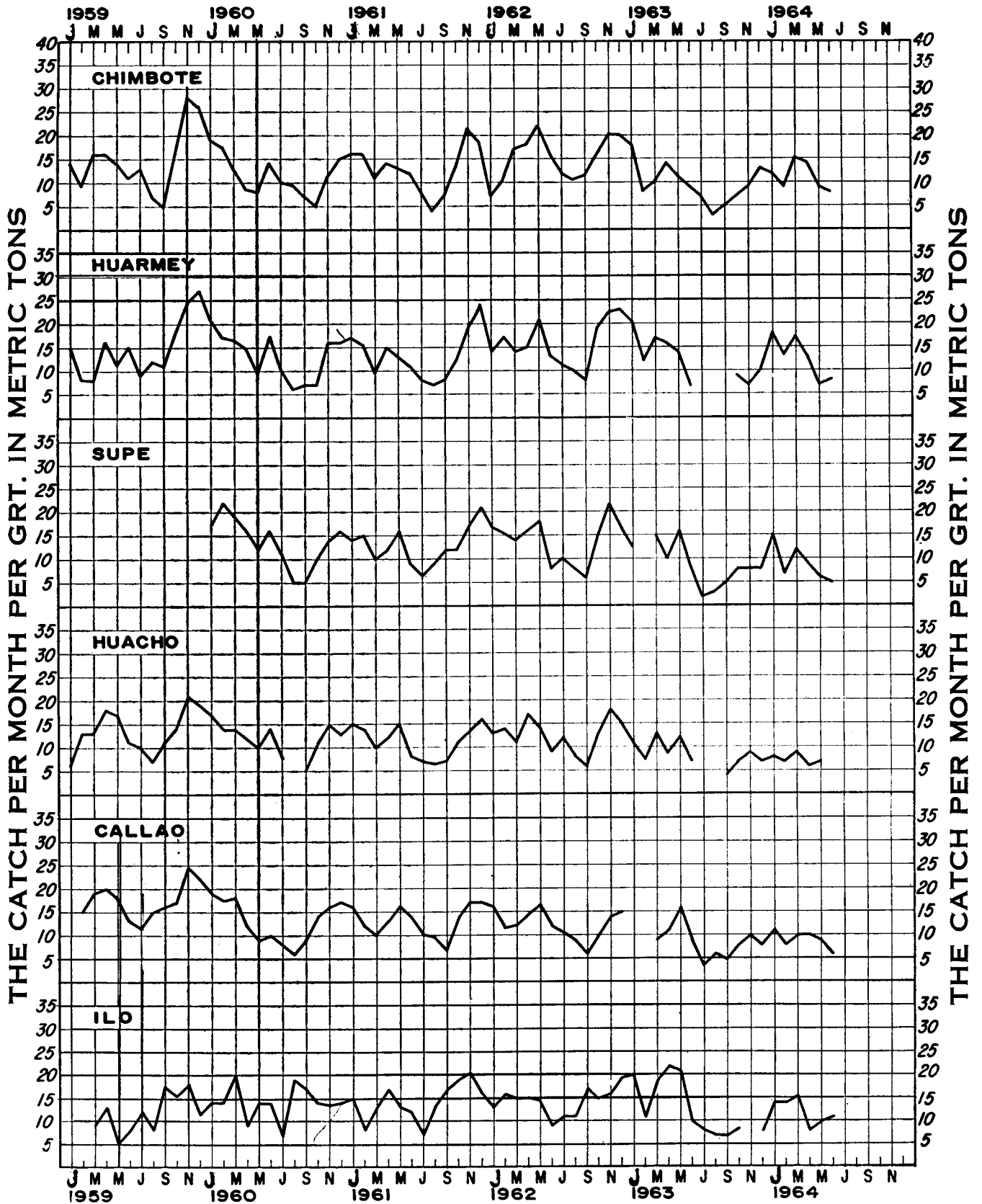
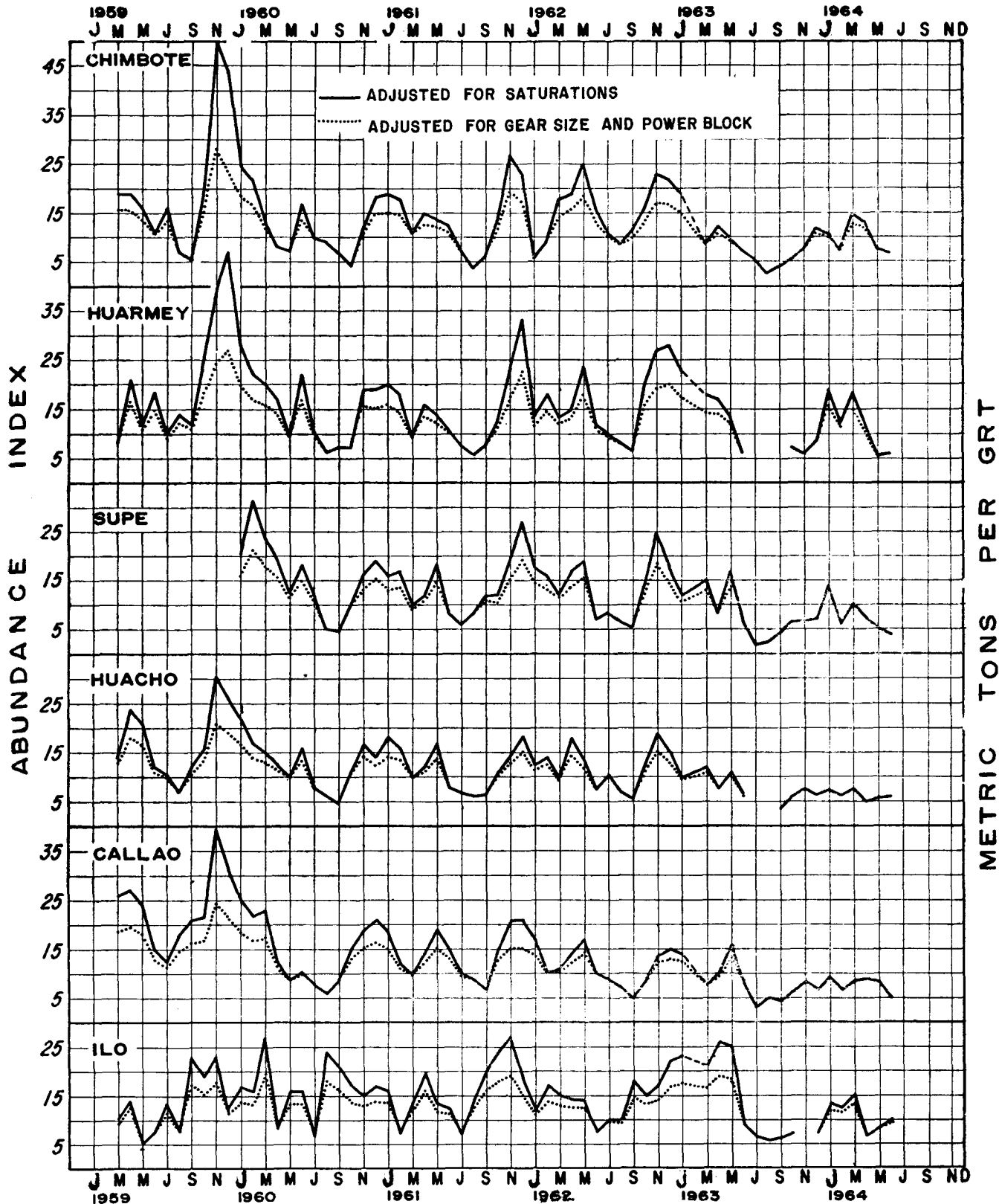FIGURE 1.   The catch per month per gross register tonnage.

FIGURE 2.   Abundance index corrected for change of fishing power A, and for effect of saturation B.

1963 corresponding to that of the effort did not take place. The total landings of 1963 was only about 2% over that of 1962.

The low fishing results of 1963 are also evident from that data of the mean catch by vessel-length-groups over the whole year (Table 4). The 1963 averages are down 30 to 40 percent as compared to 1962, and they are the lowest figures since 1959.

We may thus conclude that relatively speaking 1963 was a poor year for the anchovy fishery. Only because of the great increase of fishing effort did the total quantity landed slightly surpass that of the previous year.

ESTIMATES OF THE FLUCTUATIONS IN THE ABUNDANCE OF THE ANCHOVY POPULATION

The Catch Per Unit of Effort

In our previous report, we showed that a convenient time-unit of effort is the work of the vessels during 1 month and that the standardization of the vessels can most easily be accomplished by using the gross

registered ton as a unit of measure. We thus use catch per month per GRT as our basic measure of abundance. Figure 1 demonstrates this *uncorrected abundance index.*

The Abundance Index

Because it is thought that improved equipment and increases of size of gears has affected the fishing power of the vessels since 1959, some corrections need to be made in this measure of catch per unit of effort. The corrections made are described in our previous report, and for the period July 1963–June 1964, the same correction has been applied as for the first part of 1963. This corrected index is shown in Figure 2. It is also believed that when the fish is very abundant saturation of vessels will depress the c.p.u.e. A vessel cannot catch more than its capacity, even
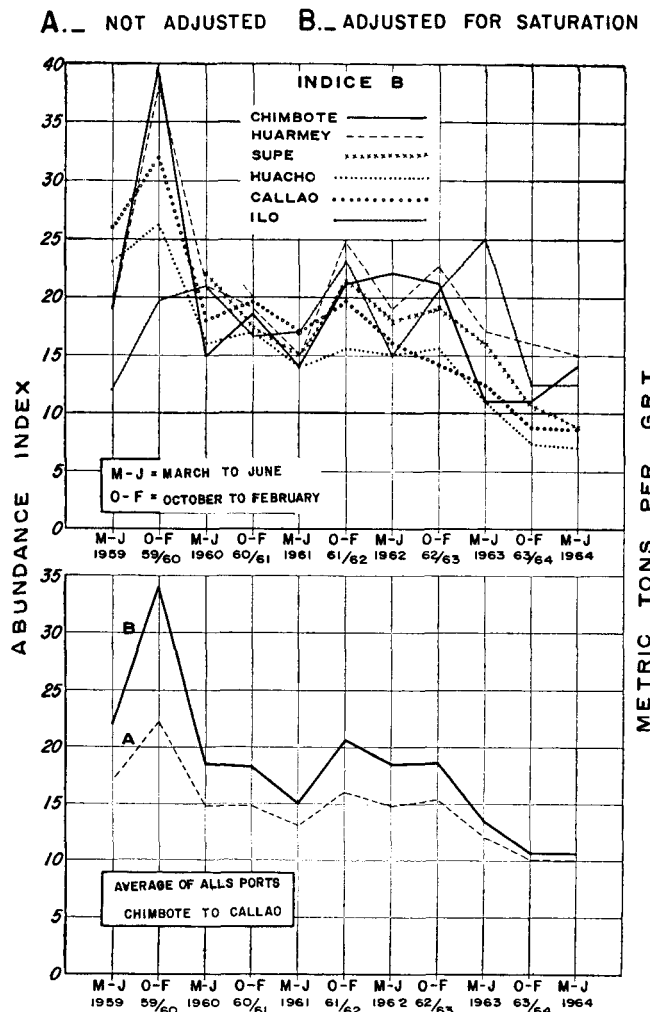

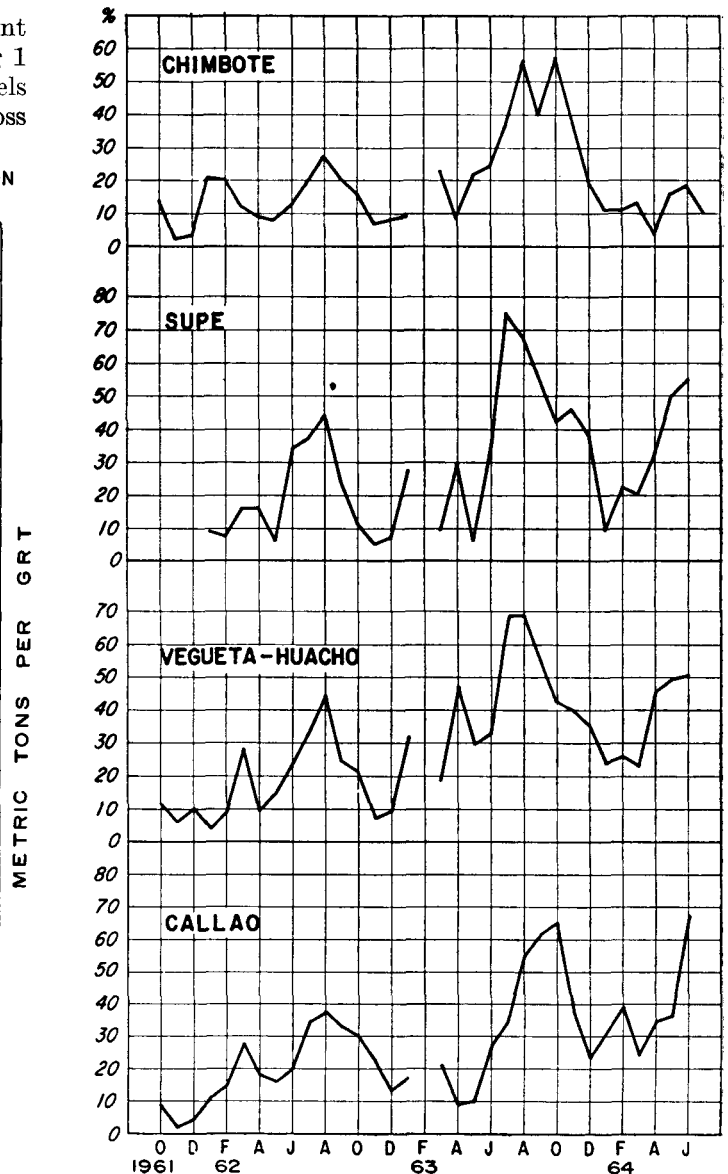FIGURE 3.   Summary of abundance by fishing season.

FIGURE 4.   Percent trips without catch.

if the sea was full of fish. When incorporating an assessment also of this saturation effect, the index B. Figure 2 is the result. It is seen from these figures that the abundance during 1963 was low in all ports. Figure 3 shows summary by fishing seasons from which the decline during 1963 and 1964 is evident. The decline is most drastic in the central ports

Callao, Huacho, Supe, but it is also clearly present in the mean value of all ports between Callao and Chimbote. The most prominent feature of these curves is the absence in 1963/64 of the usual peak abundance of the October to February fishing season. The abundance indices of the last part of 1963 and the first part of 1964 are the lowest on record since 1959.

Trips Without Catch

The records of poor fishing and the estimates of low abundance during this time are confirmed by data collected on number of unsuccessful trips of vessels. Figure 4 shows how trips without catch have increased since June 1963. The ports of Supe, Huacho and Callao show also very high figures during 1964 while Chimbote seems to be back on a normal value this year.

THE SIZE OF THE ANCHOVY

Figure 5 shows the annual size-abundance curves March through February for the three years since 1961. The striking feature of these curves is the low abundance of the big adult fish (14 cm and more) during the last year. The monthly length-curves which are available, but not shown in this report, show that this decline of abundance of adult fish started already in the last part of 1962. It became prominent during 1963. Figure 6 shows the estimated abundance of fish of sizes of 14–15 cm. or more (adult anchovy, consisting of usually several spawning groups) by month from March 1961 onwards.

FIGURE 5. Annual length-abundance curves. Chimbote, Callao and Ilo. March to February.
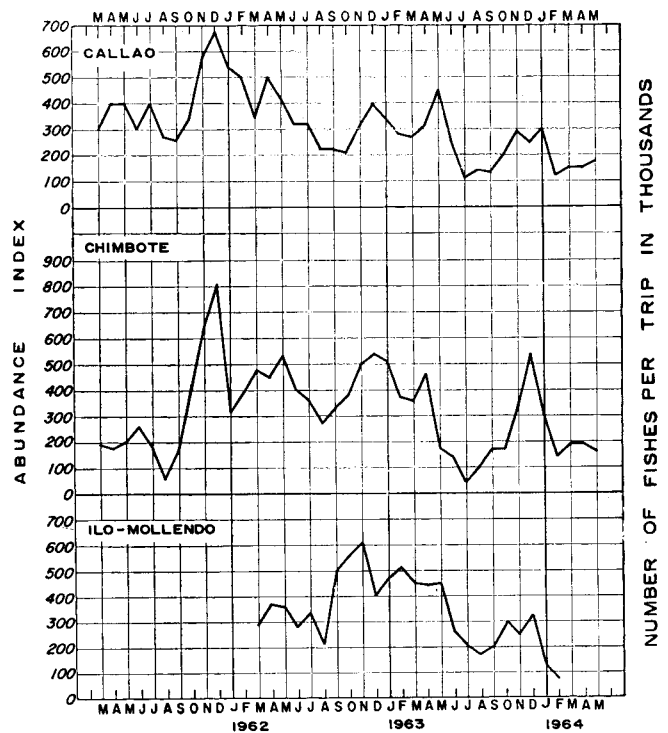

FIGURE 6. Modal abundance of adult group 14–15 cm. from length-abundance curves.

The low values since June 1963 is striking in all three ports Chimbote, Callao, and Ilo. It seems then that the reason for the poor fishing of 1963 was the low abundance or low availability of the big adult fish during this period.

CAUSES OF REDUCED ABUNDANCE OF BIG ADULT FISH

Natural Fluctuations of Recruitment

There is one phenomenon that is known to have caused great fluctuations of stock size in a number of marine fish populations, i.e., natural variations in recruitment brought about by varying success of survival of eggs and larvae from the different broods. The results of our length-measurements indicate that such types of fluctuations do occur also in the Peruvian anchovy stock. Although direct age-determina-

tions are not available, it is possible from the size compositions to determine the age of the young fish and the size abundance curves offer a possibility to assess the abundance of the year-classes. In Figure 7, we have plotted the abundance of the recruit-groups 1961 through 1964 as measured in two different ways, by their modal abundance and by the estimated total number caught per unit of effort. Figure 7 also shows the abundance of the adult fish as the mean value of the months November through May each year. The recruitment apparently dropped off from 1961 to 1962 and a further reduction took place in 1963. In 1964, however, a very strong group was recruited to the fishery. As Figure 7 demonstrates, the reduction that occurred in the abundance of the adult fish is parallel to that of the recruits up till the season November 1963 to May 1964. We expect that there will be a time lag of about one year between the stage at which we measure the abundance of the recruit-group (usually March to June) and the time when the group has reached the adult stage and thus may influence the abundance of this group of 14–15 cm fish. Figure 8 shows a comparison of recruitment and abundance of adult fish when applying such a time-lag. A straight line from zero could be fitted reasonably well to these points, and confiding in these results we could conclude that fluctuations in the recruitment give cause to similar fluctuations in the abundance of the total stock which again brings about considerable variations in the success of the fishing. Before drawing this conclusion, however, we should await the results of the fishery during the period November 1964 through May 1965. The high recruitment of 1964 should bring about a considerable increase of the abundance of adult fish during this season. If this happens we think that the above conclusion can safely be drawn. It would then be a matter of great practical importance to be able to
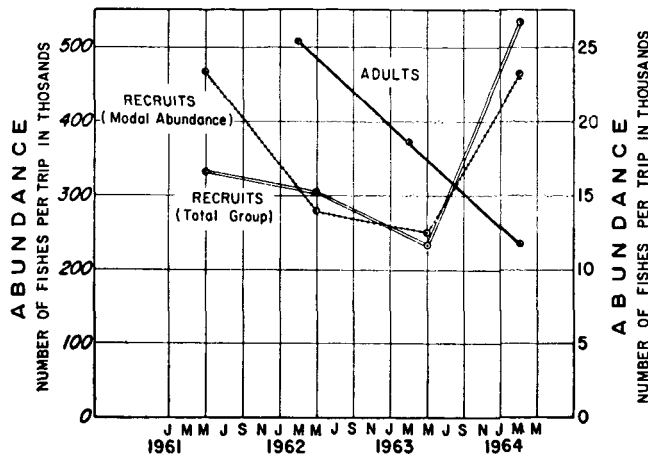

FIGURE 7. Abundance of recruit groups and the groups of adult fish. Chimbote and Callao together.

NUMBER OF FISHES PER TRIP IN THOUSANDS

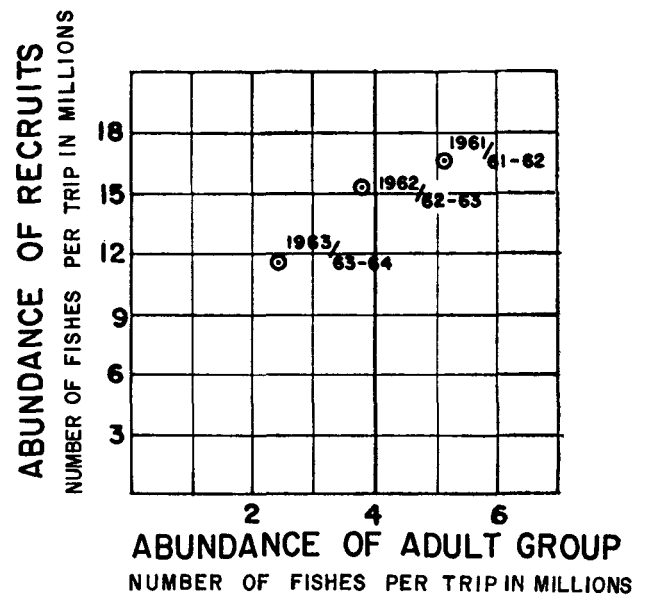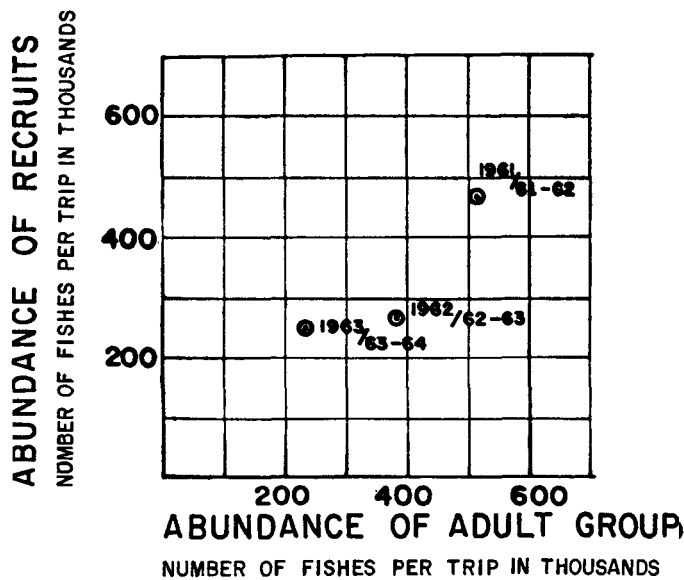
NUMBER OF FISHES PER TRIP IN MILLIONS

FIGURE 8. Relation between abundance of recruit groups and groups of adult fish. The abundance of the recruit group is measured in two different ways.

measure recruitment-strength as accurately as possible so as to get a better basis for forecasting yield fluctuations.

Effects of the Fishery on the Stock

There is little doubt that a fishery of about 6 million tons per year must have some effects on the anchovy population. The total mortality rate must have increased. By how much we do not know, but from a rough assessment of predation of birds and fish it is not unreasonable to think that the mortality has at least been doubled. We should expect that it would be possible to demonstrate the effects of this increase of mortality on the size composition of the fish. Such demonstrations are, however, complicated by the fluctuations in recruitment. A longer series of data is necessary to compensate for the natural fluctuations in the size composition, and thus provide a normal average basis for a comparison.

The comparisons of recruitment and adult fish abundance shown in Figure 8 have one feature which may indicate an increase of total mortality. The expectation of a straight-line relationship passing zero is only valid if the total mortality has been unaltered during the period of observation. If mortality increases one would expect the abundance of the adult group to fall off more than that of the recruits. A tendency of this nature can be seen in the data plotted in Figure 8.

We expect to be able to make more definite statements concerning the effects of the fishery on the stock after the season November 1964 to May 1965. If the abundance of the population of adult fish and thus the success of fishing do not rise to the expected

"normal" level during this season as a result of the high recruitment in 1964, then it must be concluded that the fishing mortality influences the stock to a marked degree.

In practice the effects of increased mortality and the resulting lower average size and age of the fish in the stock would be a corresponding decrease of the mean size of the fish caught in the fishery. The total stock abundance would also on the average be lower with a decrease of the catch per unit of effort. The yield would be more variable from year to year because it would to a greater extent depend upon the fluctuating abundance of the recruit fishes. This of course would make the operation of the industry more difficult with higher costs of raw material and less continuity of operations. It is, however, not thought that any lasting or permanent harm will be made to the stock by this form of over-exploitation. The recruitment in big oceanic fish stocks does not seem to be directly related to the size of the spawning stock: big-year-classes can result from the spawning of poor-ones. The direct economic effects on the industry will be those arising from expensive and in periods scarce raw material. These effects can, however, be serious enough as we have seen from the state of the industry during 1963–64.

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