COMMONWEALTH OF AUSTRALIA

Commonwealth Scientific and Industrial Research Organization

Division of Fisheries and Oceanography

REPORT 31

AUSTRALIAN CATCHES OF HUMPBACK WHALES

1960

By R. G. Chittleborough

Marine Biological Laboratory
Cronulla, Sydney
1961

CONTENTS

SUMMARY

The statistics of recent catches of humpback whales by the Australian whaling industry are analyzed with regard to rate of catching, dispersal of catch, sex ratio, length, and percentage immature. Age distribution from collections of ovaries and ear plugs (relative and absolute ages respectively) are tabulated and discussed.

Whaling stations on the east coast of Australia filled their quotas in 1960, but at a greater expenditure of hunting time. Individuals killed were more widely dispersed, were of slightly smaller size and lower age (especially the males) than those killed in previous years. These changes are consistent with a population decreasing in size after a period of selective exploitation.

The data available from the small quotas taken at Norfolk Island do not show regular trends. Mean lengths of 1960 catches of both sexes were less than those of previous years, but catches at Norfolk Island generally consisted of individuals larger and older than those in catches at Australian coastal stations. This could be a result of the Norfolk Island company's selection of larger whales and perhaps also reflects real differences of age composition between the humpbacks migrating past Norfolk Island and those moving along the Australian coast.

Whaling stations on the west coast of Australia did not fill their quotas in 1960, and the total catch was less than in any of the previous nine years. The diminution of the catchable portion of this population is now uniform throughout most age and size groups.

In citing this report, abbreviate as follows:
C.S.I.R.O. Aust. Div. Fish. Oceanogr. Rep. No. 31.

AUSTRALIAN CATCHES OF HUMPBACK WHALES 1960

I. INTRODUCTION

During 1960, the total catch of humpback whales from the Group V population (located between 130°E. and 170°W.) exceeded 2,271 whales. The catches made in the various locations within this stock were:-

East coast of Australia	810
Norfolk Island	170
New Zealand	360
Antarctic Area V	931
Tonga: Number not known, probably less than	100

The total catch of humpback whales from the Group IV population (located between 70°E. and 130°E.) during 1960 was 611 whales distributed as follows:-

West coast of Australia	545
Antarctic Area IV	66

Catches at stations on the Australian coast and at Norfolk Island were limited by quotas allotted to individual companies. Catches in New Zealand were restricted by limitation of the season to three months. Humpback whaling in Antarctic Areas IV and V was limited to four days.

This report is concerned mainly with the catches made at Australian whaling stations during 1960 in comparison with catches of earlier years, employing the same criteria and methods used in the previous report (Chittleborough 1960a).

The analyses of catch and effort data and their use in the study of the dynamics of the whale populations require determination of (i) The proportion of the catch per unit effort to the fishing operations. (ii) The relation between the structure of the catch and the structure of the population at that time and place. (iii) The relation between the population of the particular time and area of sampling, and the total population of which the former is a part.

These important aspects will be considered further in a much more comprehensive report: in the meantime, the present report gives some indication of the condition of these stocks of humpback whales up to 1960.

II. CATCHES FROM THE EAST COAST OF AUSTRALIA

(a) Total Catch and Period of Operations

The data summarised in Figure 1 show that at both whaling stations on the east coast of Australia, the rate of catching has been higher in recent years than in the initial years of operations. This improvement has been due to increased efficiency of operations and factory capacity: the number of catching vessels has not been increased.

The northward migrating stream of humpback whales along the Australian coast dwindles during August as the southward migration gains momentum (Chittleborough 1953). During the last six years, quotas at Tangalooma have been filled by mid-August (Figure 1), so that the greater part of these catches have been of humpbacks migrating northwards. At Byron Bay the catching period has fluctuated for various technical reasons, so that in some years the catch has been wholly from the northbound stream, sometimes from the southbound migration, and in 1960, partly from both north and southward migrations.

These variations in the period of operations can influence the average catch per unit effort as well as the composition of the catch, as discussed below.

(b) Catch Effort

The unit of whaling effort at present widely used in whaling statistics, is the catcher's day's work. Table 1 shows that at both Tangalooma and Byron Bay the average catch per catcher day for the whole period of operations was less in 1960 than in any of the previous four years.

Since the density of whales passing any one point is not constant throughout either the northward or southward migration, annual comparisons of the catch per unit effort should refer to the same portion of the migrating stream each year. At Tangalooma, the 57 day period from June 10 to August 5 has been common to each year's operations (Figure 1), and although the time of migrations does fluctuate from year to year (Dawbin 1956), this 57 day period covers the greater part of the northward migration past Tangalooma each year. Figure 2A shows that the average catch per catcher day in this period of 1960 was less than that of 1959 or 1958, but was close to that of the same period in 1955, 1956, and 1957.

As will be discussed in detail in the more comprehensive report, the catcher's day's work, although having wide acceptance as a measure of whaling effort, is not a very satisfactory unit for conditions at

Australian whaling stations. When humpback whales have been plentiful in the vicinity of these whaling stations, the managers of the stations have frequently fixed the numbers to be killed each day. Hence, the catch per catcher day may be more a measure of the daily capacity of a factory than of the availability of suitable whales.

When the capacity of the factory limits the daily catch, the number of hours spent hunting on the whaling grounds should be inversely proportional to the abundance of catchable whales if all other conditions (such as weather, selection, etc.) are constant. Thus, the average catch per hunting hour may be a better measure of the availability of whales than the average catch per catcher day. Figure 2 shows that at Tangalooma in 1960, although there was only a slight decrease in the catch per catcher day, there was a very considerable fall in the catch per hunting hour, i.e. much more hunting time had to be expended for each whale killed.

In 1960 there was also a greater dispersal of the whales killed by these catchers. Each year, most of the whales have been killed close to Cape Moreton. In 1958, 12% of the catch was taken more than five miles from Cape Moreton; in 1959, 18% was more than five miles from this point when killed, while in 1960, 38% of the catch was killed at distances exceeding five miles from Cape Moreton.

At Byron Bay, the average catch per catcher day over the whole period of whaling was less in 1960 than in earlier years (Table 1). It is difficult to assess the significance of this as the period of whaling operations has varied greatly from year to year at this station (Figure 1). Hunting began in 1960 on a date only sixteen days earlier than that on which, in 1959, the quota was filled and operations ceased. In this brief period of sixteen days, common to both years, there was a higher catch per catcher day in 1960 than in 1959, but in 1959 this period contained nine days with high winds and poor catching conditions.

It may be significant that the whales killed in the vicinity of Byron Bay during 1960 were, on the average, at greater distances from the shore station than in previous years. In 1958, the average distance from the shore station of all whales killed was 4.3 miles, in 1959 it was 4.2 miles, while in 1960 it was 6.5 miles.

(c) Sex Ratio

The percentage of females in the total catch of humpback whales at both Tangalooma and Byron Bay were greater in 1960 than in previous years (Table 2). Figure 3 shows that at Tangalooma this was due to higher percentages of females being taken during June, and to some extent during August, of 1960.

The females taken in June consisted largely of adults which were in the final stages of lactation. It is known (Chittleborough 1958b) that such females, accompanied by their yearling offspring, are in the vanguard of the northward migration each year, but the gunners of whaling vessels on the east coast of Australia have generally avoided killing such whales, even though their yearling offspring were quite self-sufficient by that time. However, during June of 1960, humpback whales were not sufficiently abundant in the vicinity of Tangalooma, so that gunners were obliged to take these adult females as part of the catch.

In the case of the catch made at Byron Bay during 1960, the percentage of females was higher than in previous years (Table 2), mainly as a result of variation in the period of whaling. In 1960, repairs to the storm damaged slipway delayed the commencement of whaling until mid-July, so that much of the quota was taken during August, when females are more plentiful in that region (Chittleborough 1958a, Figure 12).

(d) Mean Lengths

The mean lengths of both males (Table 3) and females (Table 4) taken at Tangalooma in 1960 were slightly less than in any of the previous four years, while those of whales taken at Byron Bay were within the ranges of the previous four years.

(e) Size Composition of Catches

Figure 4 shows that the males caught during 1960 both on the east coast of Australia and in Antarctic Area V were generally smaller than those caught in 1959.

The modal length of the catch of females on the east coast of Australia in 1960 was below that of the 1959 catch (Figure 4). On the other hand, Figure 4 shows that the catch of females in Antarctic Area V in 1960 contained slightly more of the larger females than in 1959.

(f) Sexually Immature Whales

The percentage of sexually immature whales in a catch may be estimated from measurements of body length, or found directly by examination of samples of gonads (see Chittleborough 1960a). Using these methods, Table 5 shows that catches on the east coast of Australia in 1960 contained percentages of immature males and females similar to those in previous years' catches.

(g) Puberal Females

Chittleborough (1960b) found that while the mean length of female humpback whales reaching puberty in Australian waters was 38.5 ft., selection of large whales by gunners can result in catches of puberal females of greater mean length. Thus, the mean length of the small sample of puberal females taken on the east coast during 1960 (Table 6) could be interpreted as indicating that there was selection of large whales during 1960, but at a slightly lower intensity than in the period from 1956 to 1959.

(h) Age Distribution

(1) Ovaries: Table 7 shows that the sample of ovaries collected from females killed on the east coast of Australia during 1960 contained more females in ovulation groups 1, 2, and 3, and slightly less of older individuals, than in the sample from the catch taken in 1959. Since the samples were taken at random from the catches of females, this means that the adult females taken in 1960 were younger than those taken in 1959.

(2) Ear Plugs: Table 8 shows that samples of ear plugs obtained in 1960 from catches of both males and females were from younger individuals than in 1959. Using these samples of ear plugs, Table 9 shows that the mean ages of male and female adults (over five years of age) taken on the east coast of Australia were less in 1960 than in 1959.

From the distribution of age within samples of ear plugs, adult mortality rates have been calculated, (Table 10), as in the previous report (Chittleborough 1960a). On the east coast, the mortality rates of the adult males sampled in 1960 were higher than those of previous years. The mortality rates of the adult females sampled on the east coast in 1960 were almost the same as in 1959, and less than those of the combined samples of 1957 and 1958, but as noted in the previous report, the values from the combined 1957 and 1958 samples may not be reliable.

Figure 5 shows adult male mortality curves derived in the same manner as described in the previous report, using the age distribution from collections of ear plugs. If these samples were representative of the adult males in this population, the progressive steepening of these curves reflects the change in the age composition of mature males in the population as a result of highly selective commercial exploitation.

Annual total adult mortality calculated for females sampled on the east coast of Australia has not increased in recent years, (Table 10), presumably because the more rapid growth rate of females minimises the possible effect of selective killing upon the age distribution of adult females.

(i) Summary and Conclusions

On the east coast of Australia, humpback whale quotas were filled in 1960, but the rates of catching were less and the individuals killed were more widely dispersed, than in previous years.

Humpbacks taken from this population during 1960 tended to be of smaller size and lower age than those killed in previous years, this trend being more obvious in the case of the males than the females.

These changes are consistent with a population decreasing in size after a period of selective exploitation.

III. CATCHES AT NORFOLK ISLAND

In 1960 the slightly larger quota (170 humpbacks) was taken in a shorter period than in 1959 (quota 150). However, it is not possible to compare the catch per catcher day in each year, as two small speedy launches were introduced at Norfolk Island in the 1960 season in addition to the larger catching vessel used in previous years. Each of the two types of whaling vessel used at Norfolk Island in 1960 have their own particular advantages, but they cannot be regarded as equivalent units of hunting effort.

The percentage of females in the total catch during 1960 was within the range of previous years (Table 2), although slightly higher than in 1959, due to a few more females being taken in June and July of 1960. As in previous years, females were much more abundant in the latter part of the season (comprising 75% of the catch in September).

The mean lengths of the males (Table 3), and the females (Table 4), taken at Norfolk Island in 1960 were less than in previous years. The mean lengths of males and females taken by the two launches were similar to the mean lengths of those taken by the larger vessel.

Table 5 shows that the percentages of immature males and females in the Norfolk Island catch of 1960 were similar to those of previous years' catches at that station.

Since 1956, thirteen puberal females have been identified in the catches at Norfolk Island. The mean length of this small sample is 39.10ft., which is similar to the mean lengths of puberal females in recent catches on the east coast of Australia (Table 6) where selection of the larger whales has also been effective.

Samples of ovaries have been obtained from catches at Norfolk Island in 1956, 1959 and 1960 (Table 11). Although the percentage within ovulation group '0' (immature and puberal females) has fluctuated in the three samples, relatively old females (20 or more ovulations) continued to be common in catches at this locality in 1960. Figure 6(A) shows that in 1960 the older females were relatively more abundant in the sample from Norfolk Island than in that from the east coast of Australia. Figure 6(B) shows that in the small sample of ear plugs obtained from male humpbacks at Norfolk Island in 1960, older males occurred with higher frequency than in the sample of ear plugs collected on the east coast of Australia in the same season.

The data available from the relatively small catches of humpback whales taken in recent years in the vicinity of Norfolk Island show some irregular fluctuations, which may not reflect real changes in that part of the population which migrates past this island. Although the mean lengths of both sexes were less in 1960 than in previous years, the catches of humpbacks at Norfolk Island have generally consisted of larger and older whales than in most catches at Australian coastal stations. This could be ascribed to a higher level of selection being applied at Norfolk Island, or to real differences in the migrating streams of humpback whales.

Because of the slower growth rate of adults, and the very considerable individual variations in growth rate, selection by gunners of large whales is more likely to eliminate juveniles from the catch than to discriminate between adults of various ages. In other words, the proportion of old adults would not necessarily be increased if catches from the same population were more stringently selected.

At Norfolk Island, the higher frequency of capture of relatively old whales (20 or more years of age), than in recent catches on the east coast of Australia, might be interpreted as indicating a real difference in the composition of the humpbacks migrating along the east coast of Australia and those passing Norfolk Island.

IV. CATCHES FROM THE WEST COAST OF AUSTRALIA

(a) Total Catch and Period of Operations

The data summarised in Figure 7 show that at each whaling station on the west coast of Australia, the rates of catching increased from year to year in the initial years of operations. This was the result of improved efficiency and factory capacity. In more recent years the rates of catching have decreased, extending the periods of operations to the time when quotas could not be filled, as the whales had migrated from the regions. Earlier commencement of hunting in 1959 was of some help at Albany, but did not result in an improvement of catching at Carnarvon (Figure 7). Quotas remained unfilled again in 1960; in fact, the total humpback catch from the west coast was the lowest for ten years.

Figure 7 shows that at Albany, the hunting of humpback whales ceased earlier than at Carnarvon or Point Cloates, even in years when quotas were not filled at Albany. The explanation is that humpback whales do not pass the Albany region during the southward migration, so that whereas the stations at Point Cloates and Carnarvon can operate upon both the north and southward streams, the Albany station can hunt only during the northward migration.

(b) Catch Effort

At both whaling stations in operation on the west coast of Australia, the average catch per catcher day was again low in 1960, (Table 1).

At Carnarvon, the average catch per catcher day for the 1960 season was slightly higher than in 1959. However, the whaling effort at this station differed in these two years in three respects.

(1) Time: The periods of whaling operations were different in these two years (Figure 7), whaling commencing much earlier in 1959 (May 17) than in 1960 (June 19).

(2) Vessels: Six catching vessels were employed in 1959, but only five of these were used in 1960, the vessel having the lowest rate of catching in 1959 not being used in the following year.

(3) Aircraft: During the 1960 season an aircraft was used in an effort to speed up the location of catchable whales.

Adjustments can be made quite simply for the first two factors: when the data for the same period (June 19 to September 22) and for the same five catching vessels are used, the average catch per catcher

day in 1959 was 1.02, and in 1960 it was 1.03. Thus the same catch per catcher day was achieved in 1960 as in 1959 by the use of a spotting aircraft in 1960. From this it may be inferred that fewer whales of legal size were available in this region during 1960.

Another indication of a further decline in availability of whales during 1960 comes from the locations of whales killed. Table 12 shows that the recent trend towards increased dispersal of the catch was continued in 1960, when 76% of the catch was taken outside Shark Bay.

(c) Sex Ratio

The percentage of females in the catch at Carnarvon during 1960 (Table 2) was the same as in 1959, and higher than in the catches of any earlier years. The percentage of females in the catch made at Albany during 1960 was less than in recent years.

(d) Mean Lengths

The mean lengths of both males (Table 3) and females (Table 4) taken on the west coast of Australia during 1960 were again relatively low in comparison with earlier catches from the west coast or recent catches from the east coast of Australia.

(e) Size Composition of Catches

Figure 8 shows that the length frequency distribution of all males killed on the west coast of Australia during 1960 was almost the same as that of the catch of males in 1959. In the case of the females, Figure 8 shows that the modal length of the catch was less in 1960 than in 1959, although the length ranges were similar in the two years.

(f) Sexually Immature Whales

Table 5 shows that the percentages of sexually immature males and females in the catches from the west coast in 1960 were again relatively high. The percentage of immature males was less, and that of immature females was greater in 1960 than in 1959, reflecting the differences in the length frequency distributions for the catches of these two years (Figure 8).

(g) Puberal Females

The mean length of the puberal females taken on the west coast during 1960 (Table 6) was almost identical with that of puberal females sampled on that coast during 1959, and much lower than samples of earlier years. As suggested for the 1959 sample (Chittleborough 1960b), the mean lengths of the puberal females sampled in 1959 and 1960 were less than the true mean length of puberal females in the original untouched population, because selective killing of larger whales in earlier years had removed the larger juveniles from the population.

(h) Age Distribution

(1) Ovaries: Table 13 shows that in the samples of ovaries collected from catches on the west coast in recent years, the proportion of individuals in ovulation group '0' (immature and puberal) has increased very greatly from 1956 to 1960, with corresponding reductions in the percentages of older females.

(2) Ear Plugs: Table 14 shows that in the samples of ear plugs from both males and females killed in 1960, the percentages of six and seven year old individuals were less than in 1959, while the percentages of individuals below six years of age increased considerably in 1960.

The mean ages of adults (over five years of age) in the samples of males and females from the west coast in 1960, were slightly higher than in 1959 (Table 9). This was the result of the decrease in frequency of young adults (six and seven years of age) in 1960 samples, rather than to a real increase in the abundance of older whales.

The adult mortality rates (Table 10) calculated from the age distribution of adults sampled on the west coast in 1960, were less than the corresponding mortality rates calculated from the 1959 samples. Once again this is the result of the diminution in 1960 of the frequency of sampling young adult males and females, and not because of any increase in abundance of older whales.

The analyses discussed above are of the age distribution in the samples obtained from each year's catches on the west coast of Australia. Table 15 shows that these samples comprised very considerable proportions of each year's catches, so that, as the sampling was random, the distribution of age in the total catches of each year would be as shown in Table 16 and Figures 9 and 10.

If, (i) the samples were representative of the annual catches, (ii) the catches were fully representative of the catchable portion of the males and females in the population, (iii) a constant hunting effort was expended each year over the whole of the population migrating past the sampling points, then Table 16 and Figures 9 and 10 would afford an absolute measure of the rate at which the catchable part of this population is decreasing.

The three conditions given above were largely, but not fully, met during the period 1957 to 1960, and are being further studied.

(i) Summary and Conclusions

From the numbers killed, the dispersal of the catches, and the rates of catching on the west coast of Australia, it is concluded that the Group IV population of humpback whales diminished, in 1960, below the low level already reached in 1959.

The composition of the catches of males and females from this population in 1960 was much the same as that of the catches in 1959, although the females killed in 1960 contained larger proportions of the smaller and younger individuals than in the 1959 catch.

V. WHALE MARKS RECOVERED DURING 1960

FO 753

Details of whale marks recovered at Australian whaling stations during 1960 are listed in Table 17. These data will be examined and discussed in a later report, with the information gained from previous recoveries of marks from humpback whales.

The recovery of mark No. 21919 at Tangalooma on the east coast of Australia, twenty days after the whale had been marked in Cook Strait, New Zealand, is of considerable interest. Exchange of whale marks between these two localities had been recorded previously (Chittleborough, 1959; Dawbin, 1959), but only after at least one summer feeding season in Antarctic waters.

VI. ACKNOWLEDGMENTS

The co-operation of the whaling companies, enabling data to be collected at their respective stations, is gratefully acknowledged.

Inspectors of the Department of Primary Industry, the Western Australian Fisheries Department, and the Queensland Department of Harbours and Marine assisted in the collection of material.

VII. REFERENCES

Chittleborough, R.G. (1953): Aerial observations on the humpback whale, Megaptera nodosa (Bonnaterre), with notes on other species. Aust. J. Mar. Freshw. Res. 4 : 219-226

Chittleborough, R.G. (1958a): Australian catches of humpback whales, 1957. C.S.I.R.O. Aust. Div. Fish. Oceanogr. Rep. No. 17.

Chittleborough, R.G. (1958b): The breeding cycle of the female humpback whale, Megaptera nodosa (Bonnaterre). Aust. J. Mar. Freshw. Res. 9 : 1-18.

Chittleborough, R.G. (1959): Australian marking of humpback whales, Norsk Hvalfangsttid. 48 : 47-55

Chittleborough, R.G. (1960a): Australian catches of humpback whales, 1959. C.S.I.R.O. Aust. Div. Fish. Oceanogr. Rep. No. 29.

Chittleborough, R.G. (1960b): Apparent variations in the mean length of female humpback whales at puberty. Norsk Hvalfangsttid. 49 : 120-124.

Dawbin, W.H. (1956): The migrations of humpback whales which pass the New Zealand coast. Trans. Roy. Soc. New Zealand. 84 : 147-196.

Dawbin, W.H. (1959): New Zealand and South Pacific whale marking and recoveries to the end of 1958. Norsk Hvalfangsttid. 48 : 213-238

TABLE 1

TOTAL CATCHES OF HUMPBACK WHALES
AND AVERAGE CATCHES PER CATCHER DAY
OVER ENTIRE HUNTING PERIODS
AT AUSTRALIAN WHALING STATIONS

GROUP V POPULATION

YEAR	TANGALOOMA		BYRON BAY	
	Total Humpbacks	Av. Catch per Catcher/Day	Total Humpbacks	Av. Catch per Catcher/Day
1956	600	4.76	120	3.08
1957	600	5.00	121	3.67
1958	600	4.89	120	2.50
1959	660	5.24	150	2.73
1960	660	4.52	150	2.46

GROUP IV POPULATION

YEAR	CARNARVON		ALBANY	
	Total Humpbacks	Av. Catch per Catcher/Day	Total Humpbacks	Av. Catch per Catcher/Day
1956	1000	1.97	119	1.59
1957	1018	2.11	102	0.66
1958	885	1.20	82	0.72
1959	541	0.83	159	0.92
1960	440	0.95	105	0.8

FO 753

TABLE 2

PERCENTAGE FEMALES IN RECENT CATCHES OF HUMPBACK WHALES AT AUSTRALIAN STATIONS

GROUP V POPULATION

YEAR	TANGALOOMA		BYRON BAY		NORFOLK ISLAND	
	Total Catch	% Females	Total Catch	% Females	Total Catch	% Females
1956	600	32.2	120	35.0	150	38.7
1957	600	29.7	121	42.1	120	22.5
1958	600	29.0	120	29.2	120	47.5
1959	660	32.4	150	35.3	150	40.0
1960	660	36.7	150	48.0	170	43.5

GROUP IV POPULATION

YEAR	CARNARVON		ALBANY	
	Total Catch	% Females	Total Catch	% Females
1956	1000	38.3	119	50.4
1957	1018	48.4	101	42.6
1958	885	46.6	82	56.1
1959	541	52.7	159	52.8
1960	440	52.5	105	41.0

TABLE 3

MEAN LENGTHS OF MALE HUMPBACK WHALES IN RECENT CATCHES AT AUSTRALIAN STATIONS

GROUP V POPULATION

YEAR	TANGALOOMA		BYRON BAY		NORFOLK ISLAND	
	Number	Mean length (ft.)	Number	Mean length (ft.)	Number	Mean length (ft.)
1956	407	40.63	78	40.74	92	41.31
1957	422	40.50	70	39.67	93	41.24
1958	426	40.81	85	41.71	63	41.35
1959	446	40.80	97	41.97	90	40.75
1950	418	40.28	78	41.51	96	40.48

GROUP IV POPULATION

YEAR	CARNARVON		ALBANY	
	Number	Mean length (ft.)	Number	Mean length (ft.)
1956	617	40.52	59	38.53
1957	525	39.89	58	38.78
1958	473	39.48	36	37.57
1959	256	37.70	75	38.71
1960	209	38.04	62	37.72

FO 753

TABLE 4

MEAN LENGTHS OF FEMALE HUMPBACK WHALES IN RECENT CATCHES AT AUSTRALIAN STATIONS

GROUP V POPULATION

YEAR	TANGALOOMA		BYRON BAY		NORFOLK ISLAND	
	Number	Mean length (ft.)	Number	Mean length (ft.)	Number	Mean length (ft.)
1956	193	41.73	42	42.40	58	42.09
1957	178	41.83	51	40.23	27	42.47
1958	174	42.09	35	42.47	57	43.40
1959	214	41.94	53	43.32	60	43.47
1960	242	41.72	72	42.43	74	42.10

GROUP IV POPULATION

YEAR	CARNARVON		ALBANY	
	Number	Mean length (ft.)	Number	Mean length (ft.)
1956	383	42.38	60	41.95
1957	493	41.71	43	40.62
1958	412	41.51	46	39.65
1959	285	39.72	84	40.44
1960	231	39.75	43	39.63

FO 753

TABLE 5

PERCENTAGES OF SEXUALLY IMMATURE MALE AND FEMALE HUMPBACKS FROM RECENT AUSTRALIAN CATCHES

EAST COAST

YEAR	MALES				FEMALES			
	By Length		By Examination		By Length		By Examination	
	No. Taken	% 36'9"	No. Examined	% Testes 4kg.	No. Taken	% 38'6"	No. Examined	% not Ovulated
1956	485	4.7	60	3.3	235	14.9	146	15.8
1957	492	5.5	215	6.1	229	20.1	183	23.5
1958	511	4.1	205	8.3	209	12.4	121	24.0
1959	543	4.1	273	2.9	267	13.9	205	21.5
1960	496	6.5	293	7.5	314	13.1	214	17.8
NORFOLK ISLAND								
1956	92	6.5	44	13.6	58	22.4	48	20.8
1957	93	3.2	52	11.5	27	14.8	-	-
1958	63	3.2	-	-	57	3.5	-	-
1959	90	11.1	-	-	60	8.3	47	6.4
1960	96	4.2	26	7.7	74	9.5	68	19.1
WEST COAST								
1956	676	6.8	-	-	443	10.2	279	8.6
1957	583	9.8	488	13.5	536	16.2	521	21.5
1958	509	13.0	439	18.0	458	17.9	438	21.0
1959	331	30.2	254	34.6	369	36.6	353	30.0
1960	271	28.8	208	26.0	274	41.2	263	38.0

FO 753

TABLE 6

MEAN LENGTHS OF SAMPLES OF PUBERAL FEMALE HUMPBACK WHALES FROM AUSTRALIAN COASTS

EAST COAST

SAMPLE	NO.	RANGE (FT.)	MEAN (FT.)	S.D.	S.E.
1952-54	60	34.50-42.17	38.51	1.73	.22
1956-59	15	36.33-43.00	39.38	1.81	.47
1960	11	37.17-40.67	39.21	1.27	.38

WEST COAST

1949-54	77	35.25-43.50	38.50	1.66	.18
1956	17	35.25-45.50	40.15	3.04	.74
1957	42	35.75-44.50	39.49	2.18	.34
1958	59	35.00-43.25	39.08	1.11	.14
1959	43	35.00-40.50	37.96	1.45	.22
1960	33	35.75-40.50	38.00	1.29	.23

TABLE 7

PERCENTAGE FREQUENCY DISTRIBUTION OF NUMBERS OF OVULATIONS IN FEMALE HUMPBACKS EXAMINED ON EAST COAST OF AUSTRALIA

YEAR	1956	1957	1958	1959	1960
No. females examined	146	182	121	205	214
Previous ovlns.	%	%	%	%	%
0 (Immature & puberal)	17.8	26.9	24.0	22.0	20.6
1	3.4	5.4	6.6	6.3	9.3
2	6.2	7.7	4.1	2.9	9.3
3	6.8	9.8	11.6	8.3	11.2
4	8.2	3.9	5.8	7.8	7.5
5	8.2	4.9	7.4	3.9	2.8
6	12.4	4.4	2.5	4.4	5.6
7	6.8	4.4	6.6	5.9	4.7
8	4.8	1.6	6.6	3.9	3.3
9	5.5	2.7	2.5	2.9	3.7
10	2.7	3.2	2.5	3.9	0.9
11	2.0	3.2	5.0	4.4	2.3
12	2.0	2.2	2.5	3.9	2.3
13	4.7	1.1	-	2.0	2.8
14	-	2.7	0.8	2.4	2.3
15	0.7	1.6	2.5	0.5	0.9
16	-	1.1	0.8	1.5	0.5
17	-	1.1	1.6	1.0	2.3
18	-	1.1	2.5	1.5	1.4
19	-	0.6	0.8	0.5	-
20	1.4	-	-	2.4	-
21	0.7	1.1	2.5	0.5	1.4
22	0.7	0.6	-	1.5	0.9
23	2.0	2.2	-	1.5	0.9
24	-	0.6	-	-	-
25	0.7	-	-	-	0.5
26	-	1.1	-	0.5	0.5
27	0.7	-	-	1.0	-
28	0.7	1.1	-	1.0	-
29	-	-	0.8	0.5	0.5
30	-	-	-	-	-
30	0.7	3.2	-	1.5	1.4

FO 753

TABLE 8

FREQUENCY DISTRIBUTION OF AGE FROM SAMPLES OF EAR PLUGS COLLECTED FROM EAST COAST CATCHES

YEAR	MALES				FEMALES			
	1957	1958	1959	1960	1957	1958	1959	1960
No. in sample	181	93	236	238	90	57	125	170
Age distribution (years)	%	%	%	%	%	%	%	%
2	-	-	-	-	-	-	0.8	-
3	2.2	-	0.4	3.8	2.2	1.8	1.6	4.7
4	3.3	5.4	1.7	2.1	7.8	7.0	4.0	5.3
5	7.7	8.6	7.2	8.4	6.6	10.6	9.6	8.8
6	9.4	6.5	11.0	13.9	5.5	12.3	8.8	12.4
7	5.0	6.5	8.5	8.0	10.0	7.0	7.2	12.4
8	6.6	1.1	7.6	9.2	7.8	14.0	6.4	8.8
9	5.0	5.4	7.6	9.2	8.9	8.8	9.6	1.8
10	6.6	8.6	7.2	6.3	6.7	5.3	6.4	6.5
11	6.1	7.5	8.9	3.4	5.6	7.0	6.4	6.5
12	4.4	5.4	4.2	5.0	1.1	5.3	8.0	4.7
13	5.5	4.3	5.9	6.3	3.3	-	4.8	2.9
14	3.3	5.4	1.3	3.4	3.3	1.8	3.2	4.7
15	4.4	1.1	3.8	2.1	2.2	5.3	1.6	4.7
16	3.3	6.5	3.4	3.4	3.3	3.5	4.0	1.8
17	2.2	5.4	4.2	2.5	2.2	-	2.4	1.2
18	3.3	4.3	2.1	0.8	4.4	5.3	-	0.6
19	1.1	4.3	3.0	2.5	3.3	-	2.4	2.4
20	2.2	-	1.3	1.7	1.1	-	1.6	0.6
21	1.1	1.1	0.4	0.4	2.2	-	2.4	0.6
22	2.8	2.2	0.9	2.1	-	-	0.8	-
23	1.7	2.2	2.1	0.4	3.3	-	0.8	1.2
24	0.6	1.1	1.7	0.8	1.1	1.8	-	1.2
25	1.7	1.1	0.4	0.8	1.1	-	1.6	1.8
26	1.1	1.1	1.3	0.4	-	-	0.8	0.6
27	1.1	-	0.4	0.4	1.1	-	0.8	0.6
28	2.8	-	0.9	0.8	-	-	1.6	1.2
29	-	1.1	0.4	-	-	1.8	-	0.5
30	1.1	1.1	0.4	-	-	-	0.8	0.5
30	4.4	3.3	1.7	1.7	5.6	1.8	1.6	1.2

TABLE 9

MEAN AGE OF ADULT HUMPBACKS (OVER 5 YRS.) IN SAMPLES FROM THE EAST AND WEST COASTS OF AUSTRALIA

		ADULT MALES		ADULT FEMALES	
		No. Examined	Mean Age (yrs.)	No. Examined	Mean Age (yrs.)
EAST COAST	1957	157	14.82	75	14.07
	1958	80	14.63	46	11.28
	1959	214	12.76	105	12.85
	1960	204	11.89	138	12.06
WEST COAST	1957	111	10.47	143	10.69
	1958	136	8.80	149	10.66
	1959	91	8.02	137	10.08
	1960	52	8.81	82	10.66

FO 753

TABLE 10

ADULT MORTALITY RATES CALCULATED FROM SAMPLES OF TWO POPULATIONS OF HUMPBACK WHALES

EAST COAST AUSTRALIA (GROUP V POPULATION)

YEAR	MALES		FEMALES	
	Annual Mortality (a)	Instantaneous Mortality (i)	Annual Mortality (a)	Instantaneous Mortality (i)
1957 + 1958	.092	.097	.144	.156
1959	.121	.129	.118	.126
1960	.142	.154	.119	.127

WEST COAST AUSTRALIA (GROUP IV POPULATION)

YEAR	MALES		FEMALES	
	Annual Mortality (a)	Instantaneous Mortality (i)	Annual Mortality (a)	Instantaneous Mortality (i)
1957	.246	.283	.165	.180
1958	.290	.343	.168	.184
1959	.421	.547	.206	.230
1960	.356	.440	.179	.198

TABLE 11

FREQUENCY DISTRIBUTION OF NUMBERS OF OVULATIONS IN FEMALE HUMPBACKS SAMPLED AT NORFOLK ISLAND

PREVIOUS OVULATIONS	1956		1959		1960	
	No.	%	No.	%	No.	%
0 (Immature & puberal)	16	32.7	4	8.5	16	23.5
1	3	6.1	7	14.9	4	5.9
2	1	2.0	3	6.4	6	8.8
3	2	4.1	-	-	5	7.4
4	2	4.1	1	2.1	4	5.9
5	1	2.0	1	2.1	-	-
6	1	2.0	4	8.5	5	7.4
7	2	4.1	1	2.1	2	2.9
8	4	8.2	1	2.1	-	-
9	1	2.0	1	2.1	1	1.5
10	1	2.0	3	6.4	2	2.9
11	3	6.1	1	2.1	-	-
12	-	-	1	2.1	1	1.5
13	-	-	2	4.3	2	2.9
14	1	2.0	1	2.1	1	1.5
15	2	4.1	-	-	-	-
16	-	-	2	4.3	1	1.5
17	-	-	-	-	4	5.9
18	-	-	1	2.1	1	1.5
19	1	2.0	2	4.3	1	1.5
20	2	4.1	2	4.3	-	-
21	1	2.0	-	-	-	-
22	2	4.1	1	2.1	-	-
23	-	-	-	-	-	-
24	-	-	-	-	1	1.5
25	-	-	1	2.1	2	2.9
26	-	-	2	4.3	2	2.9
27	-	-	-	-	1	1.5
28	-	-	1	2.1	-	-
29	1	2.0	-	-	-	-
30	-	-	-	-	-	-
30	2	4.1	4	8.5	6	8.8
TOTAL EXAMINED	49	-	47	-	68	

TABLE 12

ANNUAL CATCHES OF HUMPBACK WHALES AT CARNARVON STATION SHOWING PROPORTIONS TAKEN OUTSIDE SHARK BAY

YEAR	TOTAL CATCH	CATCH OUTSIDE SHARK BAY	
		Number	%
1951	650	14	2.2
1952	600	7	1.2
1953	600	6	1.0
1954	600	4	0.7
1955	500	4	0.8
1956	1000	25	2.5
1957	1018	53	5.2
1958	885	213	24.1
1959	541	282	52.1
1960	440	336	76.4

FO 753

TABLE 13

PERCENTAGE FREQUENCY DISTRIBUTION OF NUMBERS OF OVULATIONS IN FEMALE HUMPBACKS EXAMINED ON WEST COAST OF AUSTRALIA

YEAR	1956	1957	1958	1959	1960
No. females examined	279	521	438	353	263
Previous ovlns.	%	%	%	%	%
0 (Immature & puberal)	12.6	25.6	27.0	35.7	45.6
1	9.7	8.6	14.2	14.7	11.8
2	13.6	14.6	9.6	9.9	8.4
3	6.8	8.1	10.7	7.4	5.3
4	5.7	6.7	6.8	5.4	6.8
5	5.7	4.0	6.6	4.5	1.9
6	4.3	5.0	4.1	3.1	3.8
7	4.3	3.8	2.1	4.3	4.2
8	3.2	3.1	2.3	1.4	2.7
9	3.6	3.3	2.7	2.3	0.4
10	4.3	2.7	2.5	1.1	1.1
11	2.5	1.5	2.1	1.1	0.8
12	3.9	2.5	0.5	2.0	0.8
13	4.3	1.9	1.6	1.1	0.8
14	3.9	1.3	1.8	0.6	1.1
15	1.1	1.5	0.9	0.6	-
16	1.1	1.2	0.7	0.6	0.4
17	1.1	1.0	0.7	0.6	0.8
18	0.7	0.8	0.5	0.3	0.4
19	1.4	0.6	0.7	0.3	0.4
20	0.4	0.2	0.7	0.3	0.8
21	1.1	0.2	0.2	0.3	-
22	0.7	0.6	-	-	0.8
23	0.4	0.2	0.2	0.3	-
24	0.7	0.4	-	0.9	-
25	1.1	-	-	-	0.4
26	-	-	0.2	0.3	-
27	0.7	-	-	0.3	0.4
28	0.4	-	-	0.6	-
29	-	-	-	-	-
30	-	0.2	-	-	-
30	0.8	0.4	0.6	0.3	0.4

TABLE 14

FREQUENCY DISTRIBUTION OF AGE FROM SAMPLES OF EAR PLUGS COLLECTED FROM WEST COAST CATCHES

YEAR	MALES				FEMALES			
	1957	1958	1959	1960	1957	1958	195	1960
No. in sample	182	233	179	139	187	219	221	155
Age distribution (yrs.)	%	%	%	%	%	%	%	%
2	0.5	1.3	1.7	1.4	0.5	–	–	0.6
3	4.9	5.2	5.0	16.5	5.8	3.7	6.8	12.3
4	11.5	12.4	22.4	19.4	7.5	14.1	11.8	16.8
5	22.0	22.7	20.1	25.2	9.6	14.2	19.5	17.4
6	13.7	20.6	21.8	13.7	13.4	13.2	13.1	7.7
7	12.1	9.4	10.6	7.2	12.8	10.5	14.0	9.0
8	7.7	5.6	7.8	5.0	7.0	9.6	6.3	5.8
9	6.6	9.0	1.7	2.9	7.5	3.2	2.7	8.4
10	3.8	1.3	2.8	2.2	7.5	5.9	5.9	2.6
11	3.3	3.0	2.2	0.7	4.8	5.0	5.0	3.2
12	0.5	2.6	1.1	1.4	2.7	2.7	1.8	3.2
13	2.2	3.0	0.6	–	4.3	1.8	2.3	1.3
14	2.2	0.9	–	1.4	3.2	2.7	1.4	3.2
15	1.1	–	–	–	3.2	2.7	1.4	2.6
16	1.1	1.3	–	–	1.6	1.4	1.8	0.6
17	0.5	–	–	0.7	1.1	1.4	1.4	0.6
18	–	–	–	–	0.5	2.3	1.4	–
19	0.5	–	–	–	0.5	0.9	0.9	–
20	1.1	–	0.6	–	0.5	0.9	0.5	0.6
21	–	–	–	–	1.6	–	0.5	–
22	0.5	0.4	0.6	0.7	1.6	–	0.5	0.6
23	–	–	0.6	–	–	1.8	–	0.6
24	–	–	–	0.7	0.5	0.5	–	0.6
25	1.1	0.4	–	–	0.5	0.5	–	–
26	1.1	–	–	0.7	–	0.5	–	0.6
27	–	–	–	–	–	–	0.5	0.6
28	–	–	0.6	–	1.1	–	–	–
29	–	–	–	–	–	–	–	0.6
30	–	0.4	–	–	–	–	–	–
30	1.6	0.4	–	–	0.5	0.5	0.9	–

TABLE 15

TOTAL CATCHES OF MALE AND FEMALE HUMPBACKS ON WEST COAST OF AUSTRALIA IN RECENT YEARS AND THE NUMBERS AND PERCENTAGES OF EAR PLUGS SAMPLED FOR AGE DETERMINATION

YEAR	MALES			FEMALES		
	Total Catch	Sample (ear plugs)		Total Catch	Sample (ear plugs)	
		No.	%		No.	%
1957	583	182	31.2	536	187	34.9
1958	509	233	45.8	458	219	47.8
1959	331	179	54.1	369	221	59.9
1960	271	139	51.3	274	155	56.6

TABLE 16

AGE DISTRIBUTION WITHIN TOTAL CATCHES OF HUMPBACK WHALES FROM THE WEST COAST OF AUSTRALIA, FROM 1957 TO 1960

(Using ear plug samples as an index of age distribution)

	MALES				FEMALES			
	1957	1958	1959	1960	1957	1958	1959	1960
Total killed	583	509	331	271	536	458	369	274
Age (years)	No.	No.	No.	No.	No.	No.	No.	No.
2	3	7	5	4	3	-	-	2
3	29	26	17	45	31	17	25	33
4	67	63	74	52	40	65	43	46
5	128	115	66	68	51	65	72	47
6	80	105	72	37	72	61	48	21
7	71	48	35	19	69	48	52	24
8	45	29	26	14	37	44	23	16
9	39	46	6	8	40	15	10	23
10	22	7	9	6	40	27	22	7
11	19	15	7	2	26	23	18	9
12	3	13	4	4	14	13	7	9
13	13	15	2	-	23	8	8	3
14	13	5	-	4	17	13	5	9
15	7	-	-	-	17	12	5	7
16	7	7	-	-	9	6	7	2
17	3	-	-	2	6	6	5	2
18	-	-	-	-	3	11	5	-
19	3	-	-	-	3	4	3	-
20	7	-	2	-	3	4	2	2
21	-	-	-	-	9	-	2	-
22	3	2	2	2	8	-	2	2
23	-	-	2	-	-	8	-	2
24	-	-	-	2	3	2	-	2
25	6	2	-	-	3	2	-	-
26	6	-	-	2	-	2	-	2
27	-	-	-	-	-	-	2	2
28	-	-	2	-	6	-	-	-
29	-	-	-	-	-	-	-	2
30	-	2	-	-	-	-	-	-
30	9	2	-	-	3	2	3	-

TABLE 17

WHALE MARKS RECOVERED FROM HUMPBACK WHALES AT AUSTRALIAN WHALING STATIONS, 1960

MARK NO.	RELEASE			RECOVERY		
	Date	Location	Remarks	Date	Location	Remarks
14274	25/9/58	Moreton Is. ca. 27°S.153½'E.	Adult	15/7/60	27°06'S.153°29'E.	M. 40'0"
14464	8/11/55	Foveaux St. N.Z.		Sep.'60	Moreton Is. Aus.	In cooker
14638	5/1/56	64°15'S.158°32'W.		21/6/60	27°09'S.153°30'E.	M. 41'8"
15177	30/7/60	Norfolk Is.		9/8/60	Norfolk Is.	M. 37'9" ≠
15868	7/10/59	Moreton Is.	Adult with cow, calf.*	14/6/60	27°08'S.153°30'E.	M. 41'9".
16587	28/6/56	Moreton Is.	Approx. 38'	2/9/60	28°32'S.153°44'E.	M. 40'4".
16853	9/7/56	Moreton Is.	Approx. 41'	17/7/60	27°01'S.153°29'E.	F. 43'9".
16854)	9/7/56	Moreton Is.	Approx. 42'	25/7/60	28°43'S.153°38'E.	M. 42'8".
16855)	9/7/56	Moreton Is.	Approx. 42'	25/7/60	28°43'S.153°38'E.	s.w.a.16854
16856	9/7/56	Moreton Is.	s.w.a.16853	17/7/60	27°01'S.153°29'E.	s.w.a.16853 F.40'5".
21862	2/7/59	Cook St. N.Z.		4/8/60	28°41'S.153°38'E.	Ft.13'10"
21919	15/6/60	Cook St. .Z.	Approx. 40'	5/7/60	27°03'S.153°29'E.	F. 38'0'.
22394	15/12/59	62°42'S.143°40'E.		23/7/60	27°04'S.153°29'E.	M. 40'9".
771) 776)				14/8/60	Carnarvon ca.24°50'S.113°E.	In cooker
				3/10/60	Carnarvon	In grax tank
1152)	U.S.S.R.	Marks		5/9/60	24°38'S.112°53'E.	F. 38'6"
1273)				16/8/60	24°37'S.112°53'E.	M. 36'6".
1388)				13/7/60	35°05'S.118°07'E.	M. 37'4"
1396				16/9/60	Carnarvon	In cooker

* Streamer mark.
≠ No streamer mark.
s.w.a. Same whale as.
M. Male
F. Female

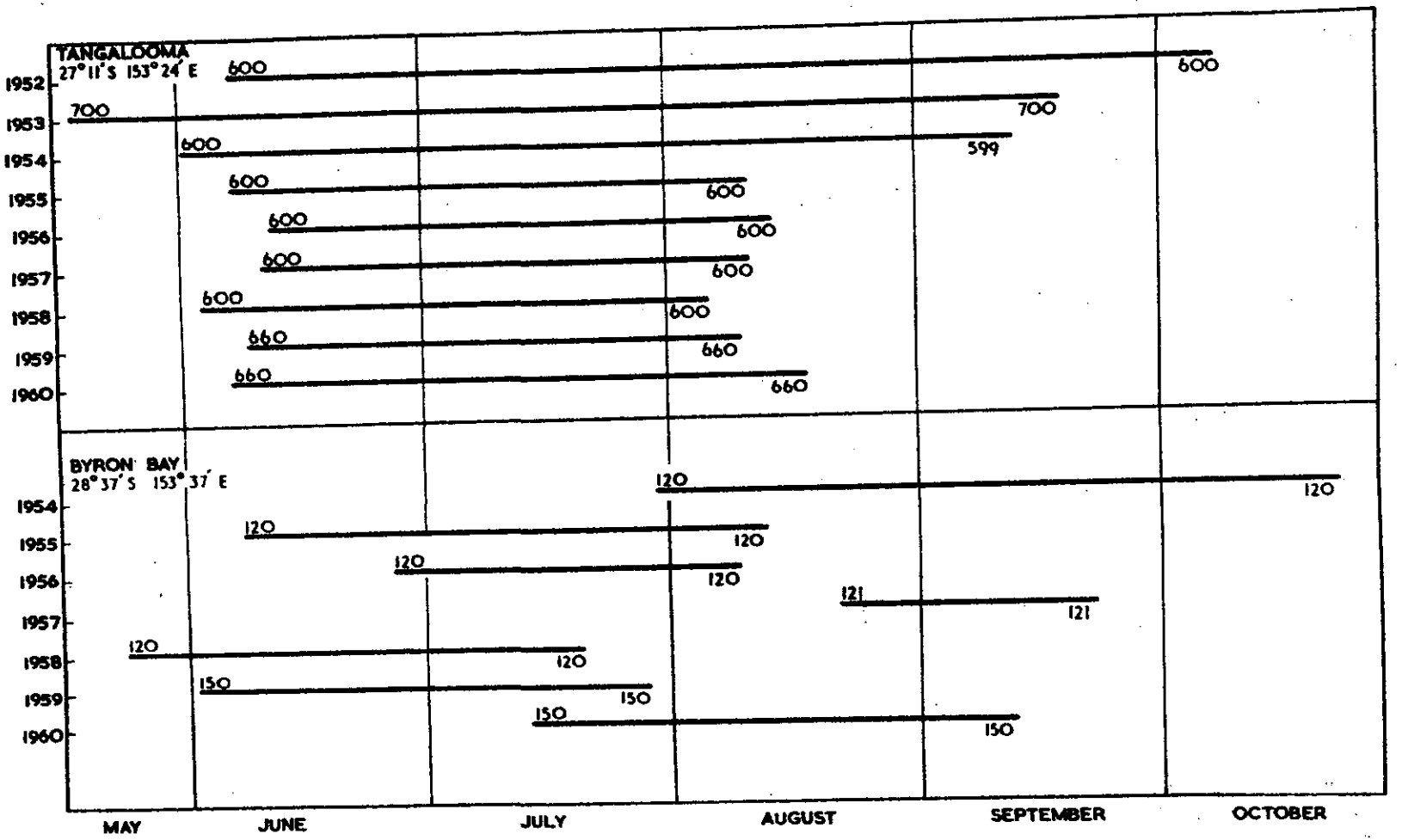

FIGURE 1: Periods of whaling for each year of operation of shore stations on the east coast of Australia. Humpback quota shown above date hunting commenced, humpback catch shown below date hunting ceased.

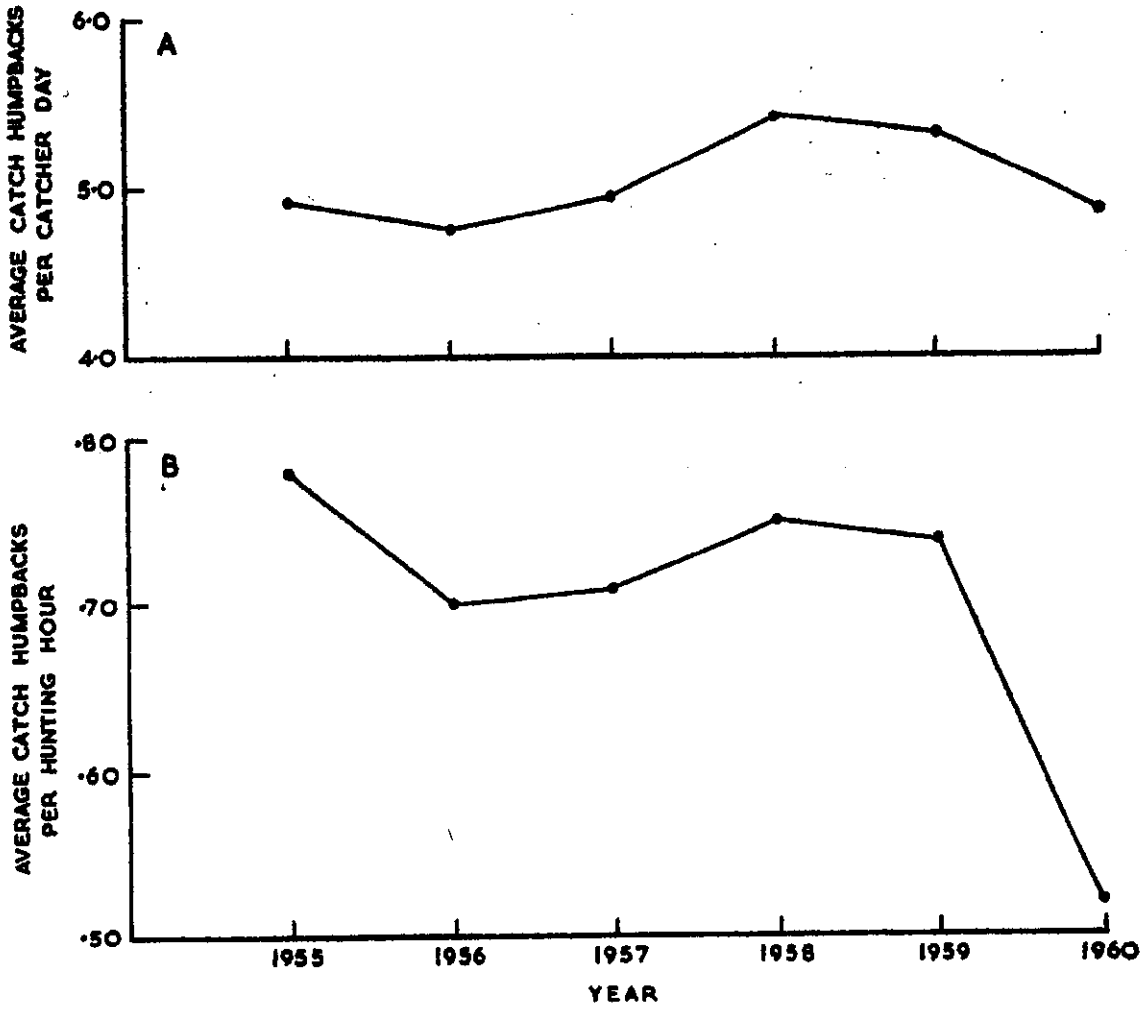

FIGURE 2: Average catches per unit effort during period June 10 to August 5 in each year (1955–1960) at Tangalooma.

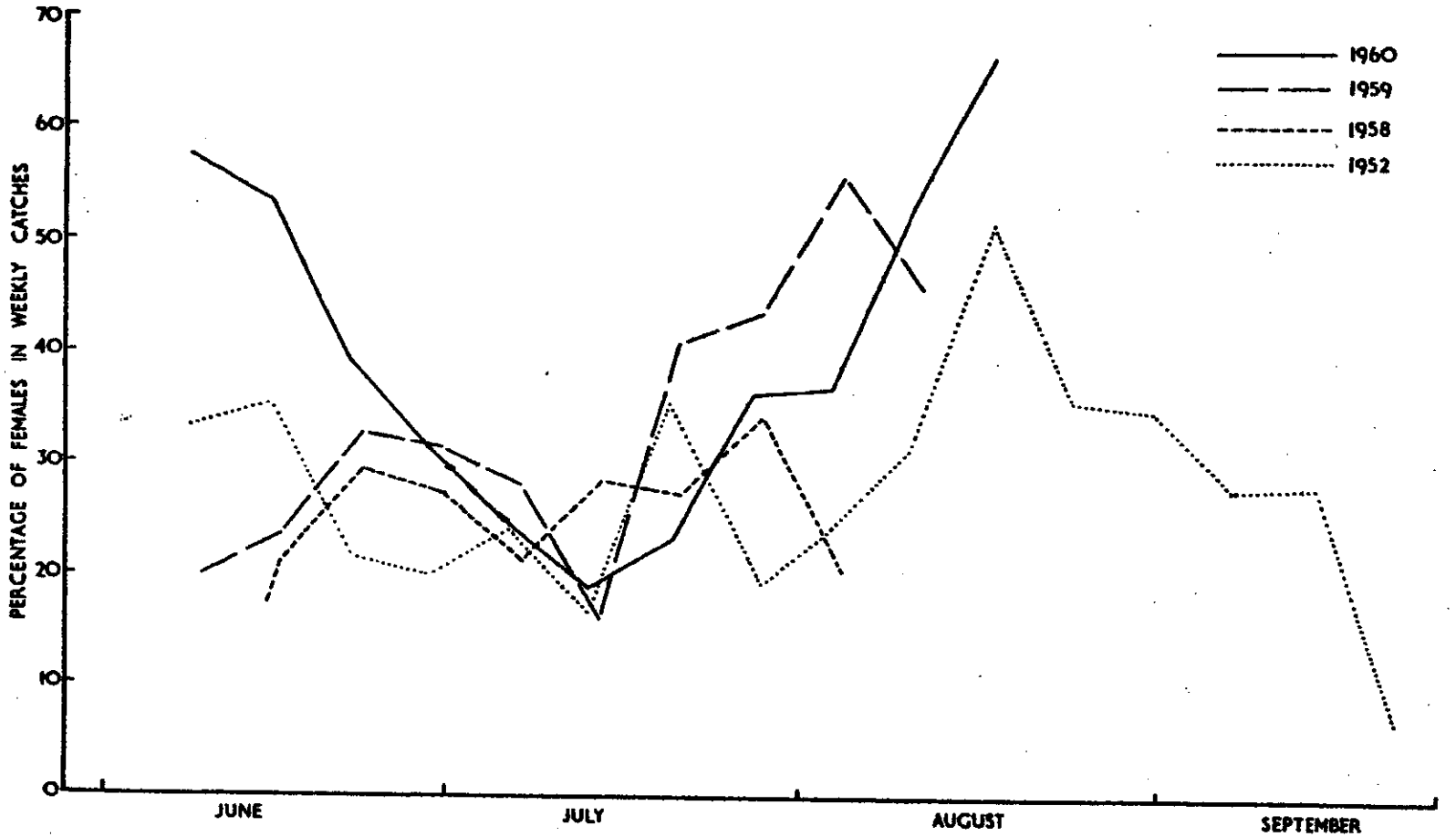

FIGURE 3: Percentages of female humpbacks in weekly catches at Tangalooma in 1952, 1958, 1959 and 1960.

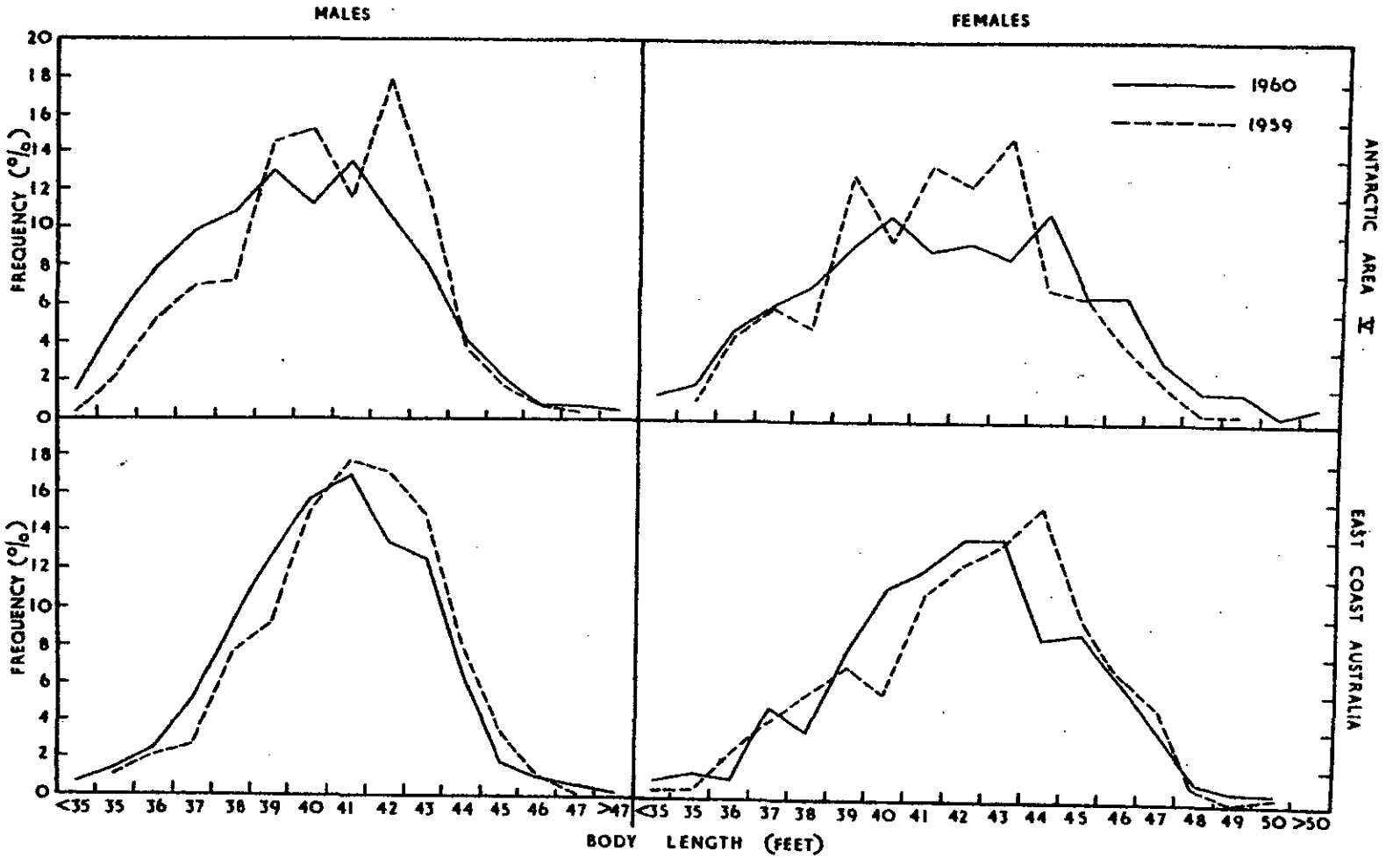

FIGURE 4: Length frequency distribution of males and females killed in Antarctic Area V and on east coast of Australia in 1959 and 1960.

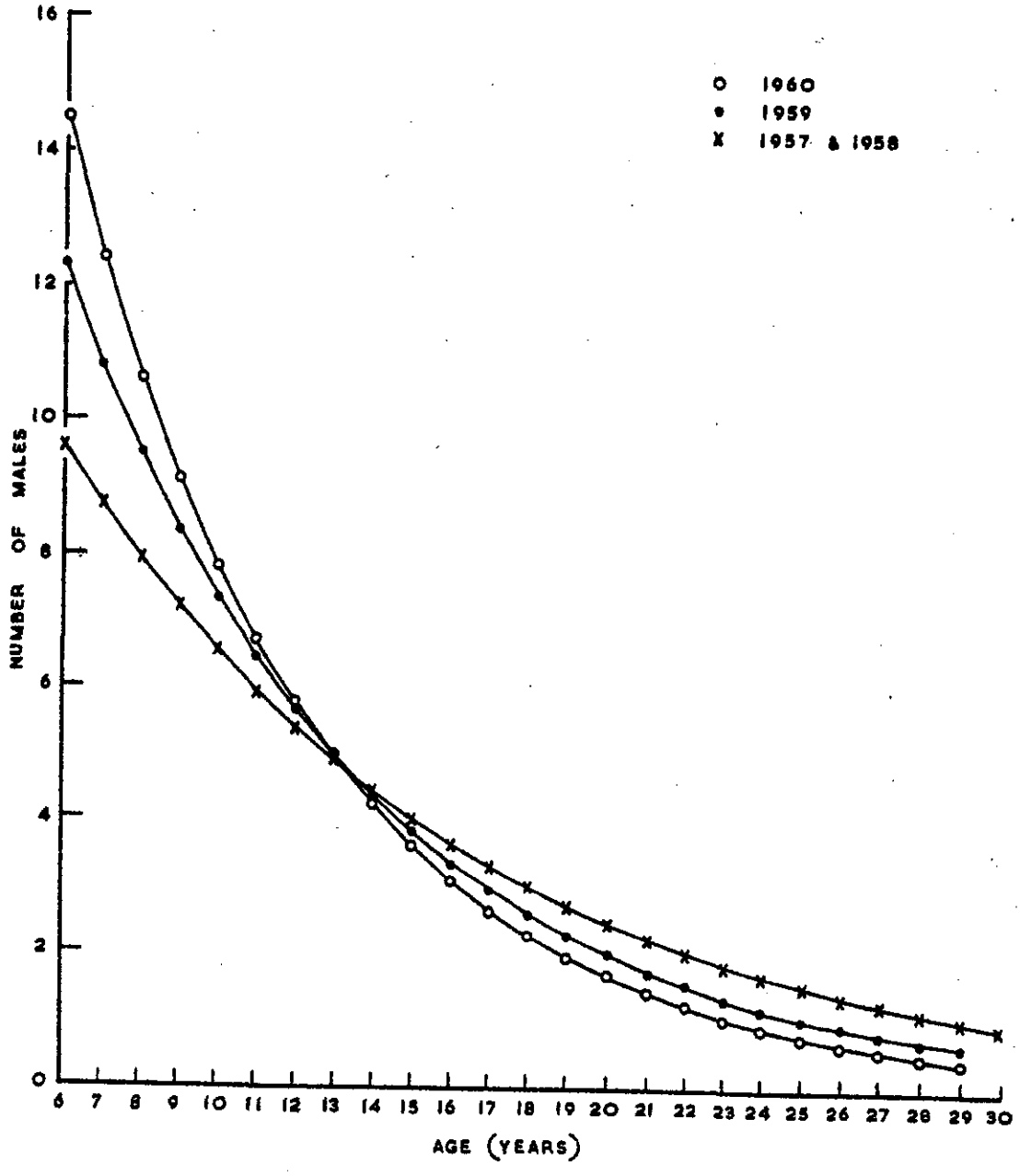

FIGURE 5: Mortality curves calculated per 100 mature males on east coast of Australia.

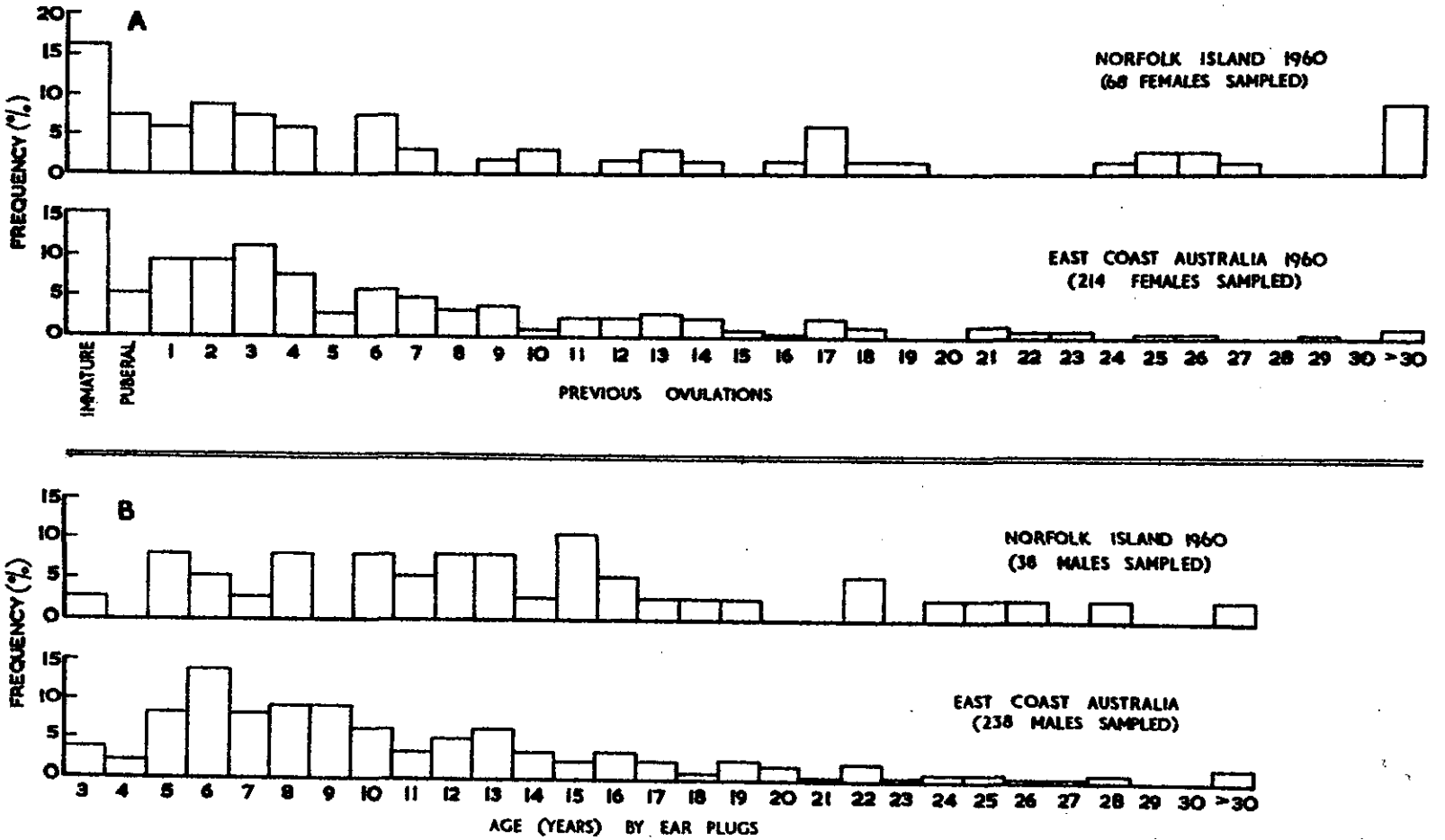

FIGURE 6: (A) Distribution of numbers of ovulations in females sampled at Norfolk Island and on east coast of Australia during 1960.

(B) Distribution of ages (by ear plugs) of males sampled at Norfolk Island and on east coast of Australia during 1960.

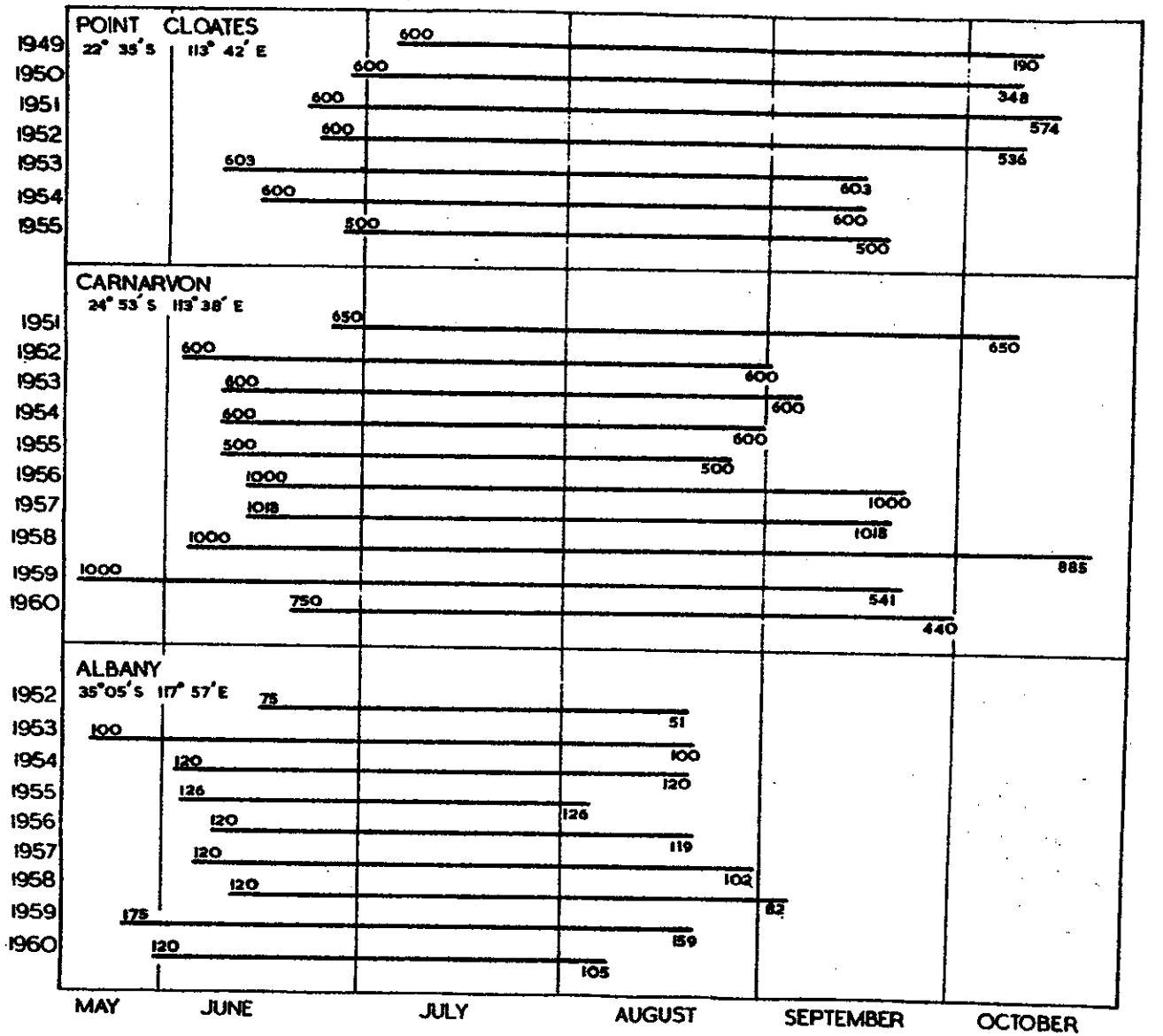

FIGURE 7: Periods of whaling for each year of operation of shore stations on the west coast of Australia. Humpback quota shown above date hunting commenced, humpback catch shown below date hunting ceased.

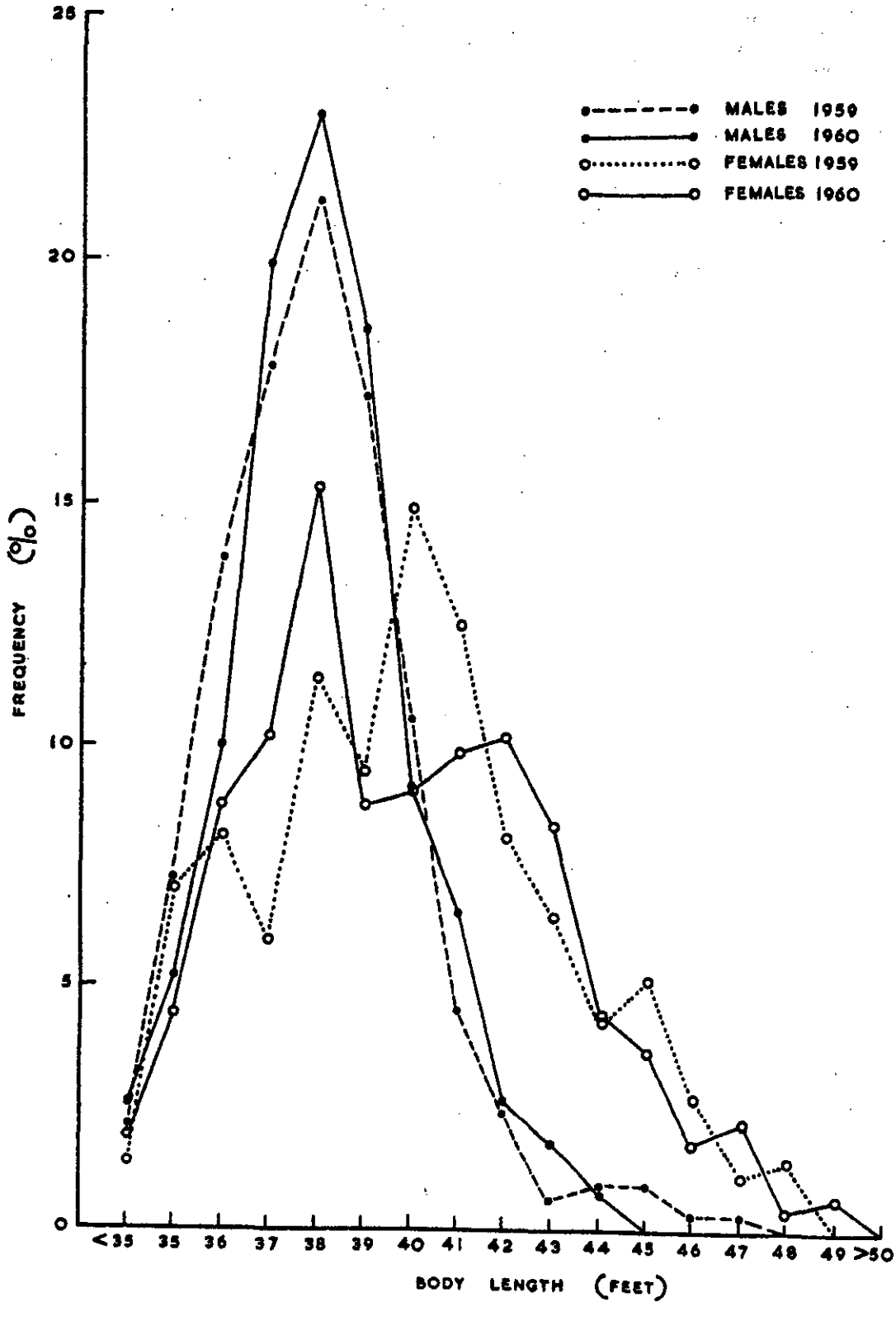

FIGURE 8: Length frequency distribution of males and females taken on west coast of Australia in 1959 and 1960.

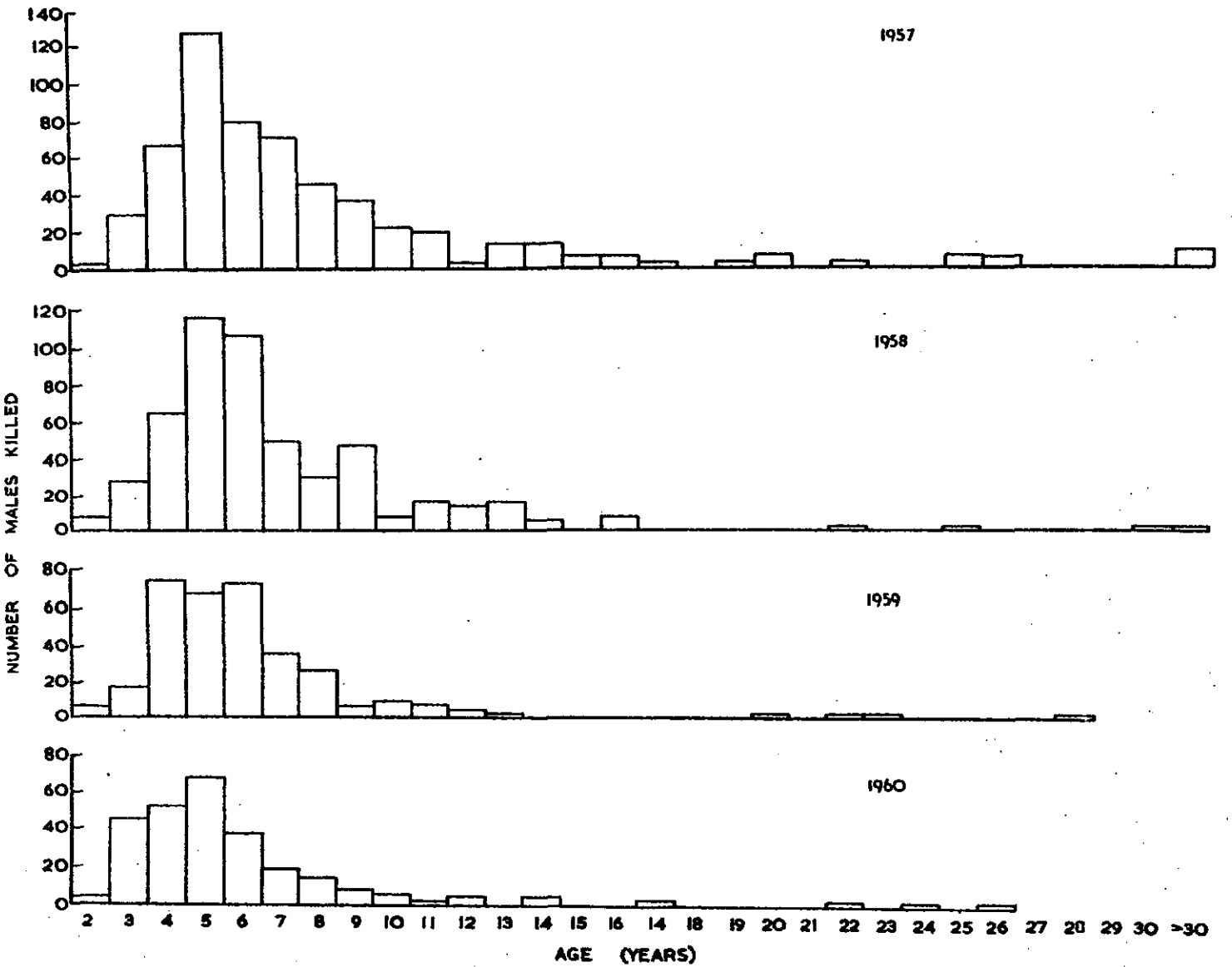

FIGURE 9: Estimated distribution of age within total annual catches of male humpbacks from the west coast of Australia.

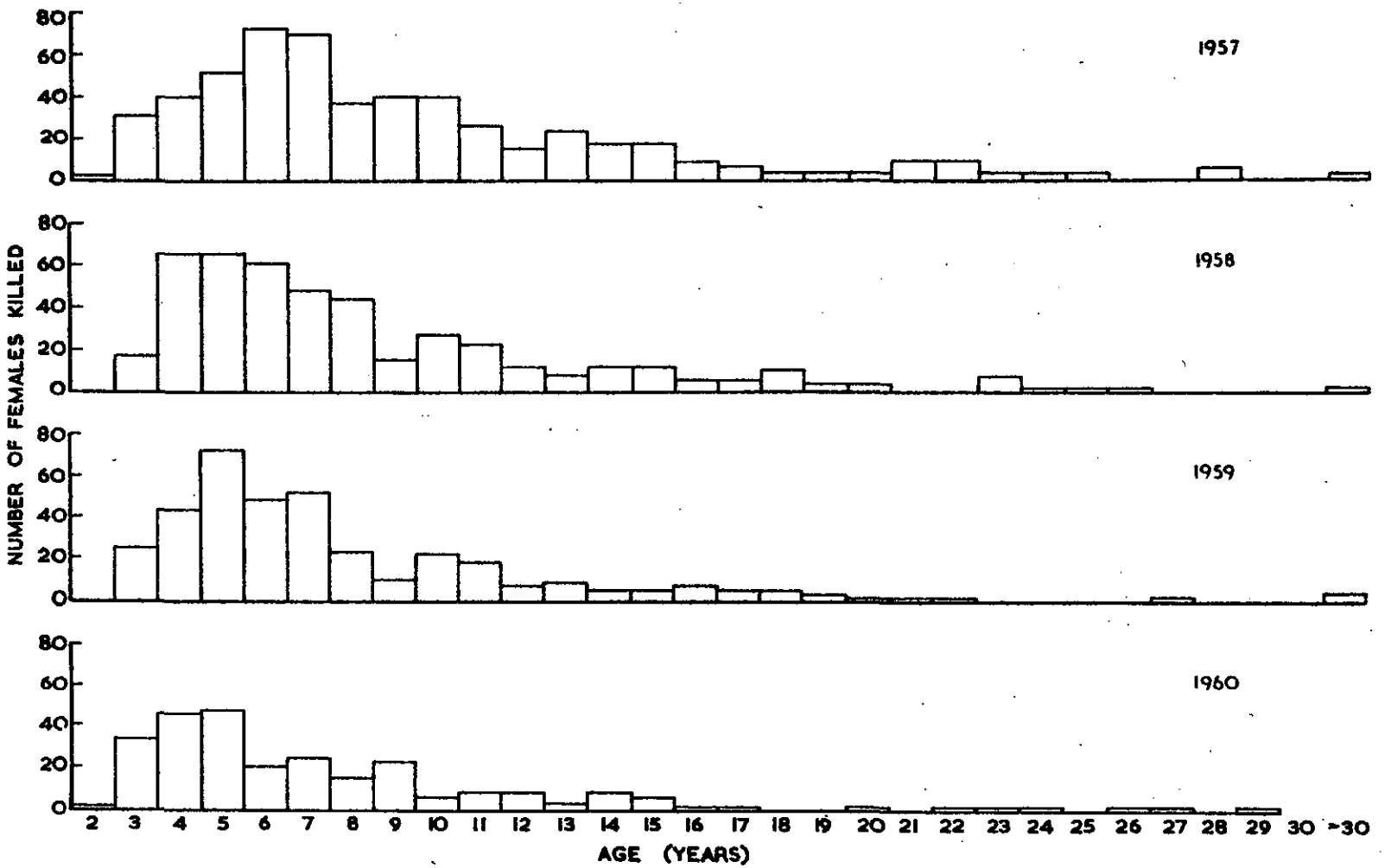

FIGURE 10: Estimated distribution of age within total annual catches of female humpbacks from the west coast of Australia.

DIVISION OF FISHERIES AND OCEANOGRAPHY

REPORTS

1. Thomson, J.M. (1956).- Fluctuations in catch of yellow-eye mullet Aldrichetta forsteri (Cuvier and Valenciennes) (Mugilidae).

2. Nicholls, A.G. (1957).- The Tasmanian trout fishery. I. Sources of information and treatment of data. (For limited circulation: not available for exchange).

3. Nicholls, A.G. (1957).- The Tasmanian trout fishery. II. The fishery of the north west rivers. (For limited circulation: not available for exchange).

4. Chittleborough, R.G. (1957).- An analysis of recent catches of humpback whales from the stocks in Groups IV and V. Prepared for the International Commission on Whaling.

5. F.R.V. "Derwent Hunter" Scientific Reports of Cruises DH3/56, DH4/56, DH5/56.

6. Cowper, T.R., and Downie, R.J. (1957).- A line fishing survey of the fishes of the south-eastern Australian continental slope.

7. Davis, P.S. (1957).- A method for the determination of chlorophyll in sea-water.

8. Jitts, H.R. (1957).- The ^{14}C method for measuring CO_2 uptake in marine productivity studies.

9. Hamon, B.V. (1957).- Mean sea level variations on the east Australian coast.

10. Nicholls, A.G. (1957).- The Tasmanian trout fishery. III. Rivers of the north and east. (For limited circulation: not available for exchange).

11. Nicholls, A.G. (1957).- The population of a trout stream and the survival of released fish. (For limited circulation: not available for exchange).

12. F.R.V. "Derwent Hunter" Scientific Report of Cruise DH6/56.

13. Chau, Y.K. (1957).- The coastal circulation of New South Wales from drift card results 1953-56.

14. Kott, Patricia (1957).- Zooplankton of east Australian waters 1945-54.

15. F.R.V. "Derwent Hunter" Scientific Reports of Cruises DH1/57 - DH4/57.

16. Rochford, D.J. (1958).- The seasonal circulation of the surface water masses of the Tasman and Coral Seas.

17. Chittleborough, R.G. (1958).- Australian catches of humpback whales 1957. Prepared for the International Commission on Whaling.

18. Australian documents prepared for the Unesco Conference on the Oceanography of the Tasman and Coral Seas, held at Cronulla, August 9-14, 1958.

19. F.R.V. "Derwent Hunter" Scientific Reports of Cruises DH5/57, DH6/57, DH7/57, DH8/57.

20. F.R.V. "Derwent Hunter" Scientific Reports of Cruises DH9/57, DH10/57, DH11/57, DH12/57.

21. F.R.V. "Derwent Hunter" Scientific Reports of Cruises DH13/57, DH14/57, DH15/57, DH16/57.

22. Robins, J.P. (1959).- F.R.V. "Marelda" Scientific Report of Cruises July 1957 - May 1958.

23. Chittleborough, R.G. (1959).- Australian catches of humpback whales, 1958. Prepared for the International Commission on Whaling.

24. H.M.A. Ships "Queenborough" and "Quickmatch". Scientific Reports of Cruises in 1958.

25. H.M.A.S. "Warrego". Scientific Reports of Cruises 1957-58.

26. Thomson, J.M. (1959).- Summary review of a scientific survey of Lake Macquarie by C.S.I.R.O. Division of Fisheries and Oceanography.

27. F.R.V. "Derwent Hunter" Scientific Reports of Cruises DH1/58 - DH9/58.

29. Chittleborough, R.G. (1960).- Australian catches of humpback whales, 1959. Prepared for the International Commission on Whaling.

30. F.R.V. "Derwent Hunter" Scientific Reports of Cruises D.H. 10/58 - D.H. 20/58.

31. Chittleborough, R.G. (1961).- Australian catches of humpback whales, 1960.