International Council for the
Exploration of the Sea

C.M. 1963

Symposium on the Measurement
of Abundance of Fish Stocks

No. 13

Comparison between Catch per Unit Effort in the Norwegian Gill-net and Purse-seine Fishery for Herring

by

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Introduction

Any method using catch per unit effort for estimating relative fish stock abundance pre-supposes that the unit of effort expended per time unit is the same every season. If the fishing power of the boats and fishing intensity per time unit change the question then arises whether such changes can be registrated and reliable measures can be obtained. A comparison of changes in fishing power and catch per unit effort for two completely different gears from the same fishery might therefore be valuable.

Data on catch per unit effort from the Norwegian Winter Herring fishery were given in a paper to the Herring Symposium in 1961 (Østvedt, in press). The present paper is a further discussion on the reliability of these data.

In most fisheries on pelagic fishes the main catch are taken either by gill-net, purse-seine or trawl. In the Norwegian Winter Herringfishery the catch has been about equally shared by gill-net and purse-seine. This makes it possible to get two independent estimates of catch per unit effort.

The gears used during the Winter Herring season are gill-net (drift-net and set-net), purse-seine and land-seine. Table 1 gives the percentage of the total catch taken by each gear since 1946. The catch by land-seine has in most years been negligible and catch per unit effort for this gear is not considered. The catch record does not distinguish between catch taken by drift-net and set-net. The same boats may start the season with drift-net and change over to set-net, when the herring concentrates close to the bottom for spawning (Vårsild). A few boats, mainly smaller ones, use set-nets exclusively and consequently work during the second part of the season only.

In addition to general catch records more detailed information has in most years since the war, been secured from about 20-25% of the fleet during the Winter Herring season. These records, containing information about size of boats, number of nets, length of season, number of days with catch, etc. were collected for an investigation of the economical results of the herring fishery. (Vintersildfiskets lønnsomhet, Fiskets Gang).

Gill-net Fishery

Fishing power. Table 2 shows the average number of nets for the different length groups of drifters and the average number of nets (including set-nets) for all boats. In 1947 boats larger than 55 feet used twice as many nets as the smaller boats. The number of nets in boats above 55 feet have increased since 1947 with nearly 50%. Figure 1 shows the mean length of gill-net boats plotted against the mean number of nets. It appears that the increase in number of nets is related to an increase in average length of the boats. Provided the boats are using all their nets, or the same proportion of the numbers every fishing day, the fishing power as regards nets has increased with about 50% since 1947 (in this connection the introduction of nylon nets are not considered). This assumption involves that catch increases linearly with number of nets per shot.

Table 3 shows the percentage of the number of gill-net boats with echo-sounder. Until 1952 less than 5o% of the boats were equipped with echo-sounders. No data are available after 1955, but at least 9o% were equipped with echo-sounders. Adjustment on fishing power for the use of echo-sounder is not possible. It has, however, only to be taken into account when comparing catch per unit effort for periods before and after 1955.

Fishing time. Table 3 shows the average number of days in each season for all the boats and the number of days with catch. Since 1961 the arrival and spawning of the herring has been delayed, but from 1947 until 196o the time for the arrival has been nearly constant as has the length of the seasons.

The number of days with catch depends mainly on the weather. From the weather reports it is known that in 1949, 1953, and 1958 the weather was unusual stormy during the Winter Herring season, and in these years the number of days with catch was low. In 195o, with only 14 days with with, the fishing was stopped for one week during the best part of the season because of too small landing capacity. For the gill-net boats it is presumed that the number of days with catch probably nearly equals the number of days fishing (e.g. shooting the nets). In years with good catches, one day's catch (and night's) is usually from one shot only. In years with reduced catches the number of shots per day may increase.

Catch per unit effort. The number of gill-net boats is not very accurately registrated and several of them also fish during part of the season only. The number of boats are therefore, for the gill-net fishery, not a true figure of the effort expended each season. Data giving the mean catch per boat per season for approximately 2o-25% of the boats are, however, available. By taking the ratio between these figures and the numbers of days with catch, the mean catch per day per boat (number of landings) is obtained. Since the number of nets per boat (boat size) has increased and thus probably also fishing power, catch per unit effort for the gill-net fishery has been calculated as catch per boat per day per net. The information on catch, number of nets etc. has been given volontarily by the ship owners and for most of the years these records have been given from too many "good boats" compared with the whole fleet. This tendency will give too high catch per unit effort, but provided the discrepancy is the same every year the estimated catch per unit effort would show a correct trend.

Purse-seine

Fishing power. Marr (195o) has shown that for the Californian sardine fishery a highly significant correlation exists between the catch per week and total boat length. In Figure 1 boat length is plotted against catch of Norwegian Winter Herring. For the years 1954-57 boat lengths are given in 1o-feet groups while for the other years in only three groups, i.e., smaller than 1oo feet, from 1oo-119.9 feet and larger than 12o feet. The relationship between total length and catch are for these groups approximately linear, but the slope of the line tend to be lower in the last period with smaller catches. This fact, as pointed out by Marr would be expected since smaller boats tend to reach their capacity at relatively lower levels of apparent abundance than the larger boats. The data available on boat length show, however, no increase in mean length for the period 1947-6o.

More important than any changes in boat lengths are probably the individual skill of the fishing skipper. In years with reduced catches unsuccessful boats (unskilled skippers) tend to leave the fishery. In no other fishery is the individual skill of the fishing skipper of so great importance. This is clearly demonstrated by the fact that every year the same fishing skippers are among the top-catchers. Adjustment for such changes in fishing power are not possible. Fishing power may, therefore, be underestimated in periods with low catches.

Table 4 shows the number of boats fishing with purse-seine and the percentage equipped with echo-sounders. Already in 1949 more than 9o% of the boats had echo-sounders. In the last years also ASDIC has been a part of the standard equipment. It cannot be doubted that these instruments have increased the fishing power of the boats to a greater extent. In the present case it has mainly to be taken into account when comparing the seasons before and after 1949, from which time more than 9o% of the boats were equipped with echo-sounders. It must be realized, however, that acoustic fish-detection instruments are more important in years with low abundance.

Fishing time. Length of season and number of days with catch for the purse-seiners are shown in Table 3. As for the gill-net fishery the length of the season has been nearly constant. So was also the number of days with catch until 1957, at which time it fell to less than one third of the maximum numbers reached in 1951 and 1954. For the purse-seiners, weather, availability and abundance will have a combined effect on the number of days with catch. The weather plays an important role to the purse-seine fishery, but sufficient data are not available to adjust for its influence on catches. Silliman & Clark(1945) have, however, shown that for the Californian sardine fishery adjustment for weather had very little effect on weekly boat catches. Information on time spent scouting and fishing is not available. But the number of days with catch will be a minimum estimate of the time spent on fishing. In years with high abundance and high availability the deviation between days spent fishing and days with catch will be at a minimum.

Catch per unit effort. For the purse-seine fishery catch per unit effort has been calculated as catch per boat per season.

Most of the purse-seiners take part in the fishery during the whole season and the numbers are fairly correctly registrated. It cannot be doubted that during the post-war period the methods of finding and catching the herring in the purse-seine fishery have been improved, but adjustment on boat unit for increases fishing power can, however, not be made.

Results and Conclusions

Total catch and catch per unit effort of Winter Herring for the years 1947-61 for gill-net and purse-seine are shown in Figure 3. As it appears from the Figure, the catch per unit effort for both gears follow the same trend as the total catch. In the catch per unit effort the variation between years with high and low total catch is smoothed down. In order to facilitate comparison the catch per unit effort for both gears are shown in Figure 4 in relative units. It appears that catch per unit effort for both gears was on a high level in 1948, then slightly decreasing until 1954-56, when the rich year-class 1950 was recruited. Since 1957 the catch per unit effort has decreased steadily, thus in 1961 reaching about 1/5 of the top level in 1954. In 1954-56 the catch per unit effort for purse-seine showed a higher level than for gill-net, but in 1958-60 it was lower.

It is clear that a successful season for the purse-seiners to a great extent depends on the availability. The availability for the purse-seiners due to fish behaviour etc. may fluctuate widely from one season to another. It is a well-known experience of the fishing skippers that the bigger herring (e.g. olders) are more difficult to catch than the smaller ones. The bigger herring readily seek to deeper water during the fishing operation and thus escape the net more often than the smaller ones. In the years with high catch per unit effort, 1954-56, recruit spawners made up from 30-40% of the catch, while after 1958 the number of recruit spawners has been reduced, constituting less than 15% of the catches.

The exact amount of effort in the purse-seine fishery per time unit each year cannot easily be measured. Also bearing in mind the importance of availability in the purse-seine fishery one would expect the catch per unit effort for the purse-seine fishery to show greater fluctuations than the catch per unit effort for the gill-net fishery, which in fact is demonstrated in Figure 4. It seems fair to suggest, therefore, that the catch per unit effort from a gill-net fishery would give a more reliable estimate of relative abundance than would those calculated from the purse-seine fishery.

Summary

Data on the catch per unit effort in the Norwegian Winter Herring fishery were given in a paper to the Herring Symposium in 1961 (Contribution No.43). The present paper is a further discussion on the reliability of catch per unit effort from gill-net and purse-seine.

From 1947 to 1960 the fishing power as regards number of gill-nets per boat increased with more than 50%. Catch per unit effort for the gill-net fishery is therefore calculated as catch in numbers per boat per day per net (number per landing per net). It is supposed that the number of days with catch equals the number of fishing days, thus excluding unsuccessful hauls and the effect of the weather.

For the purse-seine fishery catch per unit effort is calculated as catch in numbers per boat. The relationship between catch and boat lengthfor the purse-seiners is approximately linear. The data available show no increase in mean boat length for the period 1947-6o. No corrections have been made on catch per unit effort of purse-seine for weather, scouting time or other variable factors.

A comparison of total catch with catch per unit effort for purse-seine and gill-net for the period 1947-6o reveals that both estimates follow the same trend as did the total catch for both gears. In the catch per unit effort the variation between years with high and low total catch is smoothed down.

It is shown that in the years 1954-56 the catch per unit effort for purse-seine was on a higher level than for gill-net, but in 1958-6o it was lower. The deviation may partly have been caused by difference in availability of recruit spawners and older spawners to the purse-seiners.

It is suggested that catch per unit effort from gill-net is a more reliable measure of relative stock abundance than catch per unit effort from purse-seine.

References

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Table 1. Percentage of total catch of Winter Herring taken by each gear.

Year	Gill-net	Purse-seine	Land-seine
1946	67.7	37.7	0.6
1947	52.0	46.8	1.2
1948	51.4	40.0	8.6
1949	41.4	52.1	6.5
1950	37.3	51.0	11.7
1951	40.7	57.9	1.4
1952	38.8	60.5	0.7
1953	33.9	64.3	1.8
1954	32.2	67.0	0.8
1955	34.7	64.4	0.9
1956	28.9	70.8	0.3
1957	42.1	57.3	0.6
1958	49.4	50.4	0.2
1959	50.6	49.3	0.1
1960	45.0	55.0	-

Table 2. Number of nets according to boat length and mean length of all gill-net boats.

Year	Number of nets					Boat length in feet
	Drift-net Boat length in feet				Total Gill-net	
	≤45	45.0-54.9	≥55	Total		
1947	31	49	64	56	52	48.4
1948	31	44	58	50	50	48.1
1949	30	46	78	66	60	51.0
1950	25	47	73	62	65	50.9
1951	23	51	82	72	74	53.1
1952	36	55	84	66	69	51.1
1953		47	80	71	76	56.6
1954		40	80	69	74	56.3
1955		42	81	70	77	56.6
1956		50	83	74	78	55.9
1957		47	84	74	80	56.3
1958		53	89	81	82	57.9
1959		57	91	84	85	58.7
1960		52	91	82	83	59.8

Table 3. Length of season and number of days with catch.

Year	Gill-net				Purse-seine	
	Drift-net		Total			
	Length of season	Days with catch	Length of season	Days with catch	Length of season	Days with catch
1947	48	21	45	18	63	-
1948	53	22	50	21	74	-
1949	54	13	48	13	75	-
1950	62	14	56	14	72	-
1951	59	22	57	21	75	16
1952	51	17	52	18	74	15
1953	52	12	53	13	75	11
1954	50	20	50	19	72	16
1955	53	20	55	21	75	15
1956	52	20	55	21	73	15
1957	58	23	58	22	73	12
1958	58	16	60	16	73	5
1959	57	19	56	18	65	6
1960	56	20	56	19	58	5

Table 4. Number of boats and percentage with echosounder.

Year	Gill-net		Purse-seine	
	Total numbers	% with echosounder	Total numbers	% with echosounder
1946	1866	-	273	3
1947	1876	6	261	40
1948	2032	4	312	75
1949	1955	9	350	90
1950	2045	18	385	92
1951	1975	26	434	94
1952	1885	43	474	97
1953	1587	63	482	99
1954	1460	77	492	100
1955	1435	89	549	-
1956	1321	-	561	-
1957	1408	-	599	-
1958	1413	-	593	-
1959	1297	-	564	-
1960	1162	-	439	-

Table 5. Gill-net fishery. Total catch in numbers and numbers per unit effort.

Year	Total catch in millions	Catch per boat in thousand	Catch per boat per day	Catch per boat per day per net
1947	912.5	605	34600	647
1948	1608.6	895	42600	852
1949	931.8	533	40600	679
1950	1118.6	643	44200	670
1951	1171.8	788	37400	507
1952	1014.5	577	32100	465
1953	710.8	476	36600	480
1954	1144.6	909	47500	642
1955	1235.0	880	41300	535
1956	1144.7	817	38900	498
1957	1223.5	952	42900	537
1958	564.9	431	27700	336
1959	647.0	496	27600	326
1960	414.3	390	20600	248

Table 6. Purse-seine fishery. Total catch in numbers and numbers per unit effort.

Year	Total catch in millions	Catch per boat in thousand
1947	821.2	3144
1948	1251.9	4012
1949	1172.7	3351
1950	1529.5	3973
1951	1667.4	3841
1952	1581.8	3326
1953	1347.8	2796
1954	2381.6	4839
1955	2291.8	4174
1956	2803.8	4998
1957	1665.5	2779
1958	576.9	972
1959	630.1	1116
1960	506.7	1155

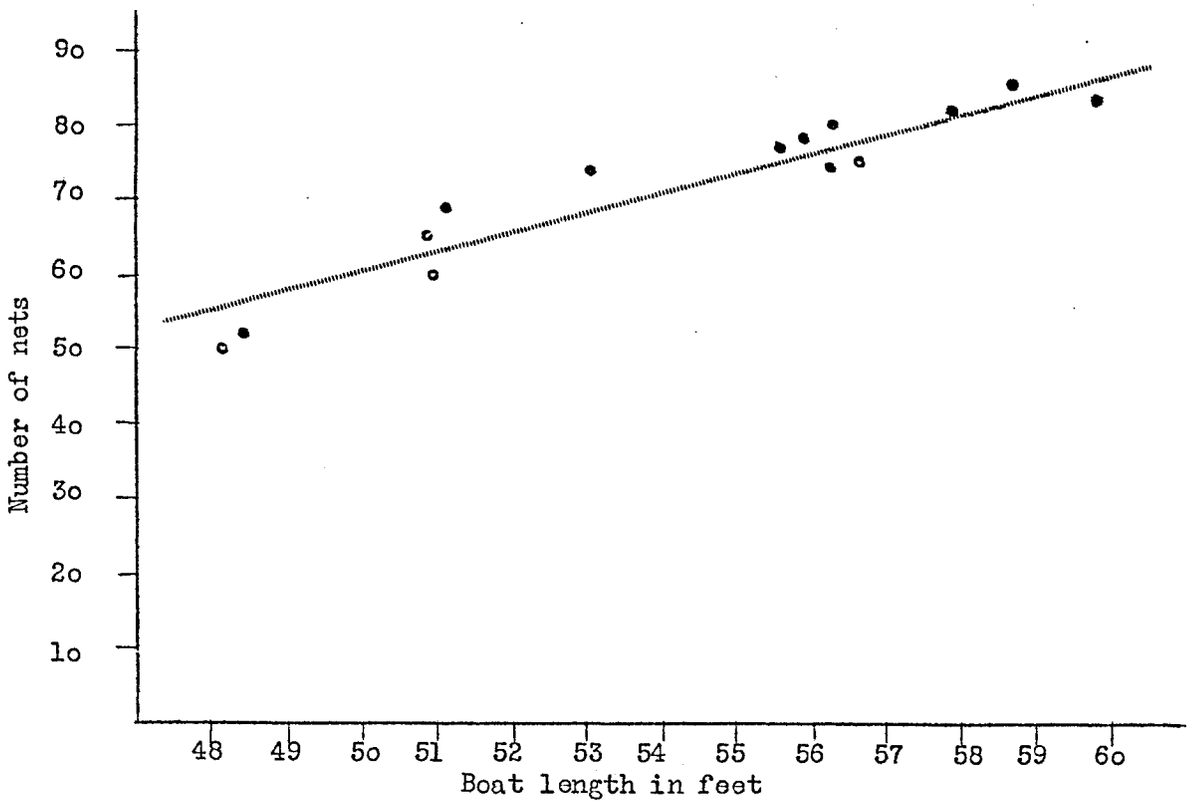


Figure 1. Gill-net fishery. Relationship between number of nets and boat length.

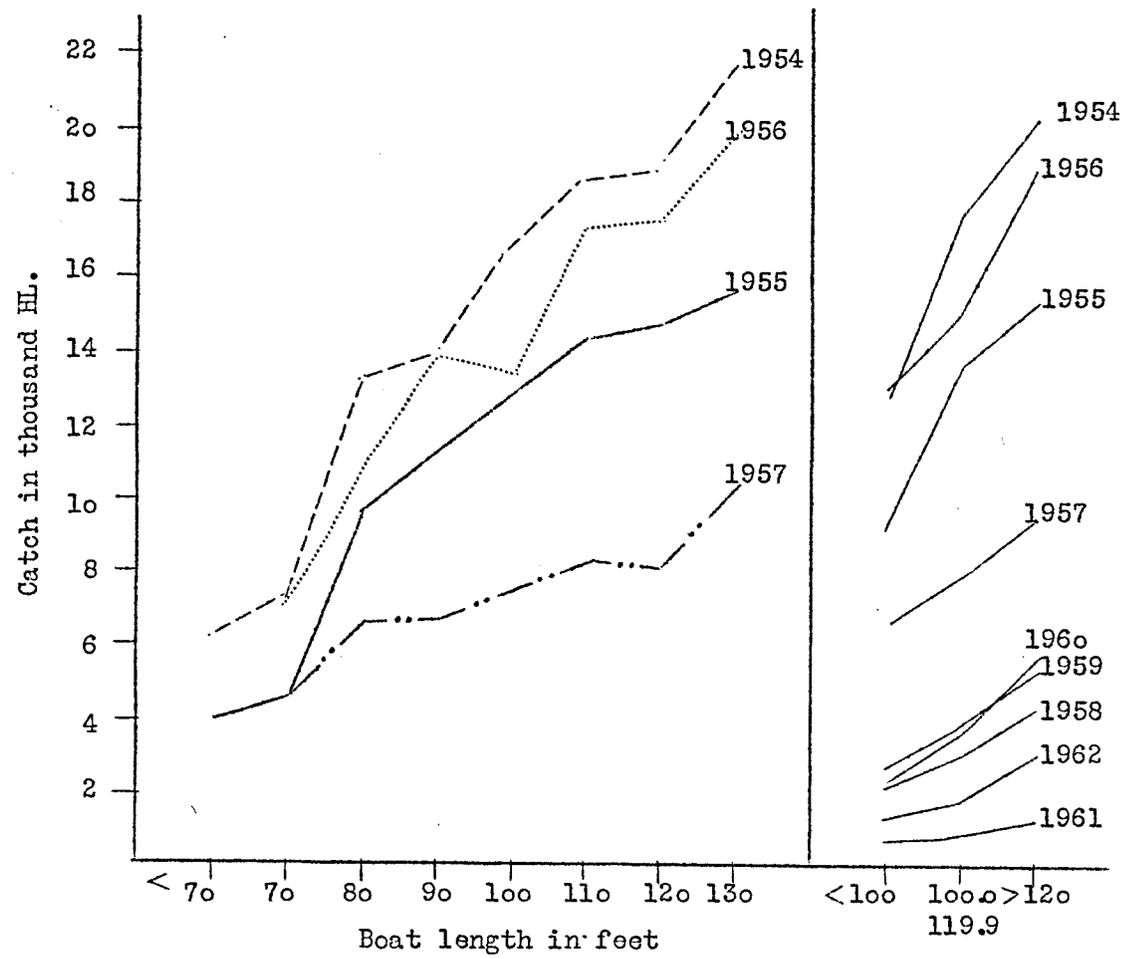
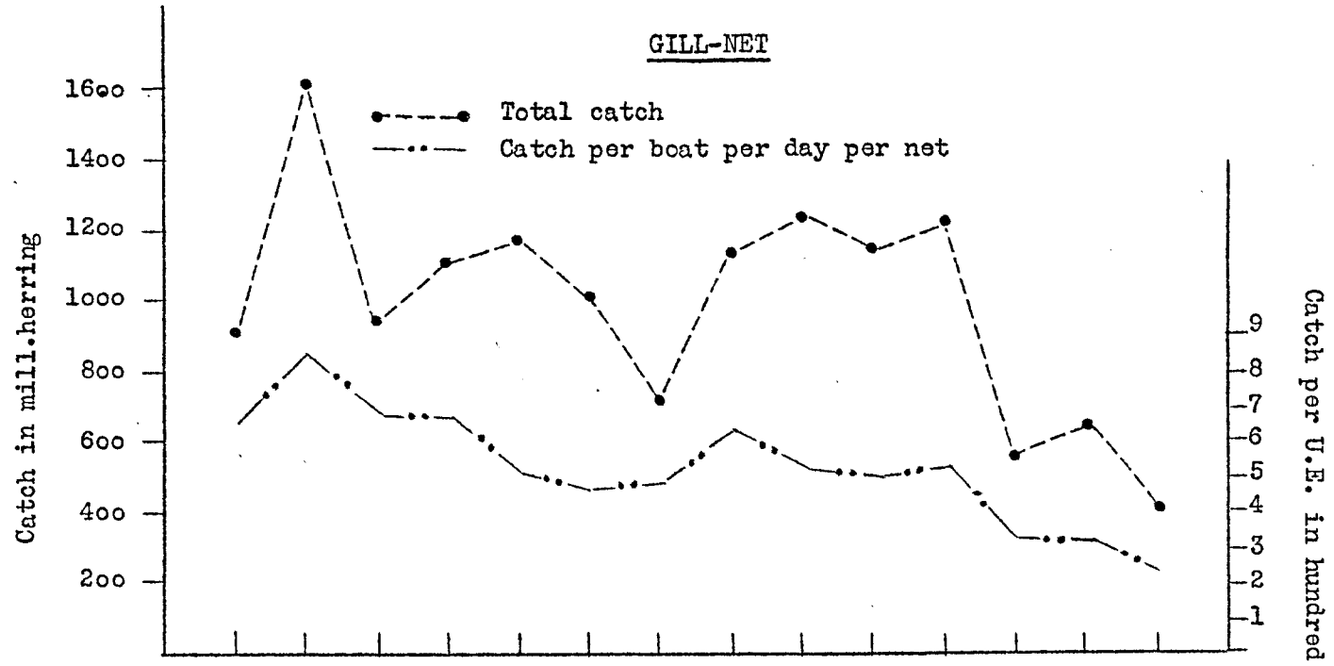


Figure 2. Purse-seine fishery. Relationship between catch and boat length.



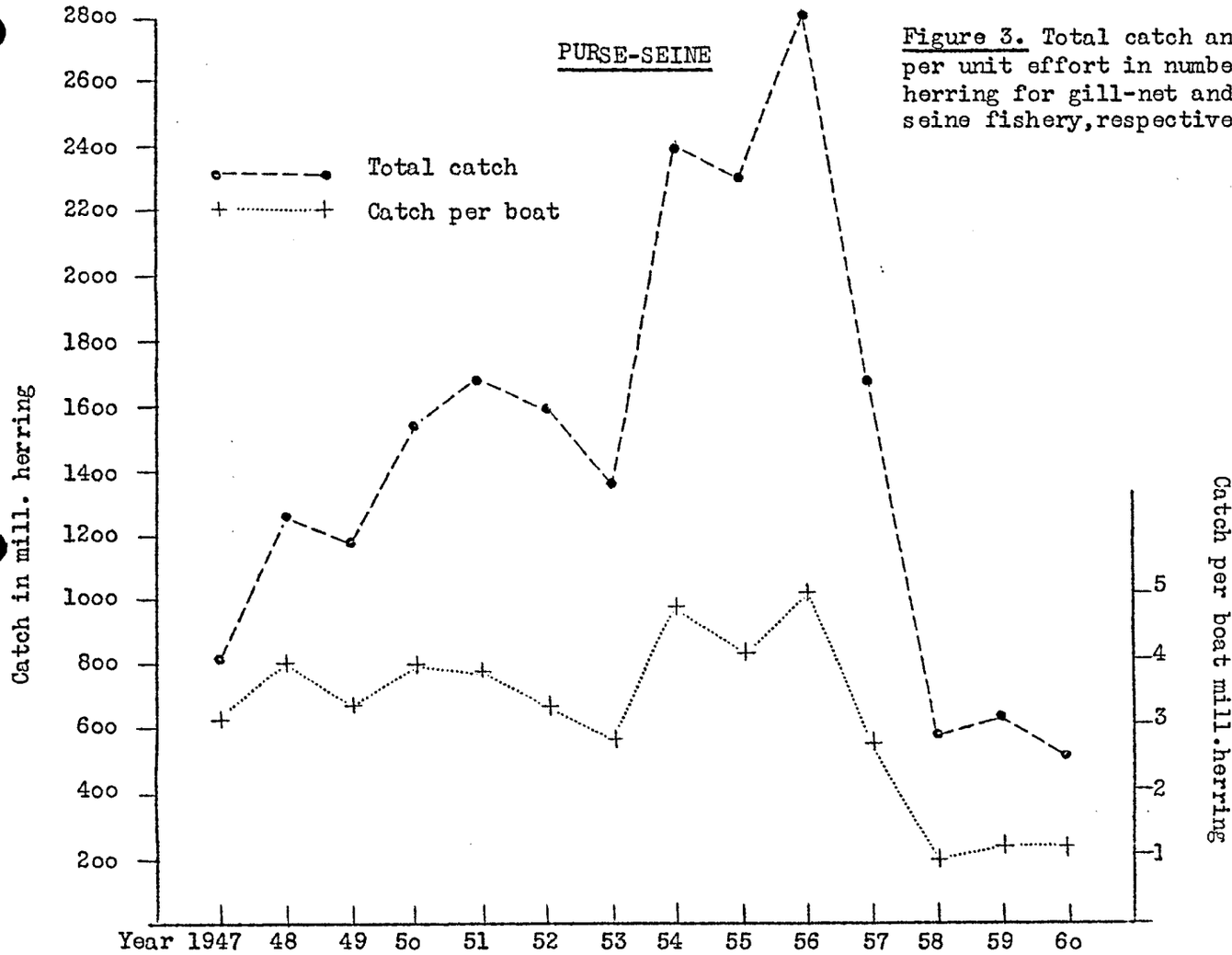


Figure 3. Total catch and catch per unit effort in numbers of herring for gill-net and purse-seine fishery, respectively.

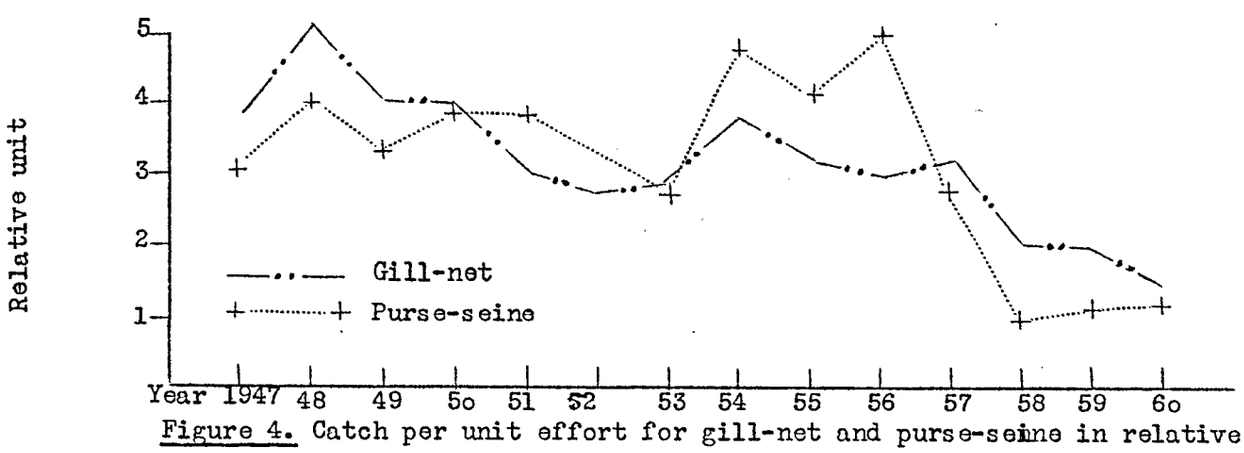


Figure 4. Catch per unit effort for gill-net and purse-seine in relative units.