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The Fishery for Perth Herring, *Nematalosa Vlaminghi* (Munro).

BY

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THE FISHERY FOR PERTH HERRING, NEMATALOSA VLAMINGHI (MUNRO)

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ABSTRACT

The Western Australian catch statistics for the Perth herring fishery over the last 30 years have been examined. While there are pockets of catches between Broome and Bunbury, those from the Swan Estuary and nearby inshore marine waters make by far the most important contribution to the fishery. In the Swan Estuary, the catches started rising in the 1950s in response to a demand by the rock lobster industry for bait and reached peak values in the late 1960s and early 1970s. Data are provided which demonstrate that catch per boat is a good index of catch per unit effort (CPUE) in the period since 1967 when market demand has tended to stabilise. The CPUE in the Swan Estuary reached a peak in August and September at the time when Perth herring start moving from the sea towards their spawning grounds in the upper estuary, except when large catches were taken in nearby marine waters. A case is made for considering the Perth herring found in the Swan Estuary and local marine waters as a unit stock. Data are presented which indicate that, if this approach is valid, recruitment declined in the early 1980s following a period of high catches in local marine waters during the late 1970s.

I. INTRODUCTION

Gizzard shads (Dorosomatinae) are important forage fish in drainages and impoundments of North and Central America (Parsons and Kimsey, 1954; Miller, 1960; Baker and Schmitz, 1971; Noble, 1981). While this group of clupeids almost certainly plays a similar role in the Southern Hemisphere, it also contributes to local fisheries in parts of the Indo-Pacific (Jones and Sujansingani, 1954; Jhingran and Gopalakrishnan, 1973; Whitehead, 1974; Ritragsa, 1976; Takita, 1978). These studies did not provide detailed information, however, on such features as historical and seasonal trends in the respective fisheries, based on total catch and catch per unit effort data, and neither was there an attempt to analyse the current state of these fisheries.

The only gizzard shad listed by Nelson and Rothman (1973) as occurring in the marine and estuarine waters of Western Australia is the Perth herring, Nematalosa vlaminghi (Munro, 1956). This species is abundant in the large Swan-Avon and Peel-Harvey estuarine systems (Chubb et al., 1979; Chubb and Potter, in press), and large commercial catches are sometimes taken from local inshore marine waters (Australian Bureau of Statistics, 1975-83). Currently, the Perth herring from these and other regions of Western Australia, such as Exmouth Gulf, forms one of the major components of the extensive fishery for bait for the commercially very important rock lobster industry (Morgan and Barker, 1979; Lenanton, 1984). Recent work has shown that in the southern part of the State, N.vlaminghi passes from the sea in the spring and early summer into the upper parts of the estuary where spawning takes place (Chubb and Potter, in press). Some of the resultant young of this semi-anadromous species apparently reach commercial size without leaving the estuary.

The current study has used catch and effort records for Perth herring in Western Australia to investigate the distribution of commercial catches in the State, and the trends shown by the fishery over the last 30 years. The catches of N.vlaminghi in the Swan Estuary and local marine waters have also been investigated to elucidate seasonal trends and the current status of the fishery for Perth herring.

II. THE FISHERY

A. FISHING TECHNIQUES AND SOURCES OF DATA

The estuarine and several inshore marine fisheries of Western Australia are multigear, multispecies and multistock fisheries (Lenanton, 1984). Thus, in the Swan Estuary, whose Perth herring fishery is by far the most important in the State (see Section II.B), gill netting, haul netting, fish trapping and hand lining would each tend to catch a number of commercially important species. While there is little alternative to considering the fishing boat and its crew and gear as one fishing unit, the work of Lenanton (1984) indicates that such an approach is valid. The Perth herring fishery in all regions is based on gill netting and haul netting, but is sometimes supplemented by purse seining in the marine waters of south-western Australia.

Data on Perth herring catches were obtained from the Western Australian Department of Fisheries files and from the catch summaries provided by the annual publications of the Australian Bureau of Statistics. These data are based on fishermen's compulsory monthly catch returns for estuaries and marine waters, the latter being divided into blocks, each equivalent to 1^{o} latitude by 1^{o} longitude (Fig.1).

B. DISTRIBUTION OF CATCHES AND THE IMPORTANCE OF THE SWAN RIVER REGION

Nematalosa vlaminghi is fished commercially at localities of human settlement between Broome and Bunbury. In more northern areas, the catches of Perth herring tend to be related to seasonal availability and the demands of the rock lobster industry. Eighty two percent of the total catch between 1975 and 1983 was taken in estuaries and marine environments between Perth and Bunbury (Fig.1). The great importance of the fishery in the Swan Estuary is illustrated by the fact that on average it contributes 35% to the State's total annual catch of approximately 192.8 tonnes per annum. Discussions with major bait suppliers to the rock lobster industry indicate that the demand for Perth herring from the Swan Estuary has tended to remain high and relatively stable since 1966.

C. LONG TERM MEASURES OF CATCH PER UNIT EFFORT IN THE SWAN ESTUARY

An analysis of the trends in the Perth herring fishery is dependent on having reliable data for catch per unit effort (CPUE) and therefore of average abundance. Since there has never been an attempt to obtain a direct measurement of the effort expended to catch particular species in the Swan Estuary, the fishermen's returns provide the only information that can be used to reflect effort. Recent work has shown that the number of days fished by boats within the whole fishery in both the Swan and Peel-Harvey estuarine systems was closely correlated with the number of boats in the respective fleets (Lenanton et al., 1984). Since the time spent fishing in a day and the techniques employed have not changed markedly during the last 20-25 years, it was therefore concluded that catch per boat was a sound index of CPUE in each of the two systems over recent times.

An examination of whether a similar approach to that described above can be adopted specifically for the Perth herring must be restricted to catch statistics after 1971 when records which note the catches of all species taken by each boat in the fleet have been retained. Records of individual catches before 1971 were destroyed. As the number of days spent fishing in recent times is closely correlated with the number of boats catching Perth herring (Fig.2a), the latter is a good index of the effort expended whilst fishing for Nematalosa vlaminghi. Since no data are available for the number of boats catching Perth herring in the four years prior to 1971 when the demand for this species had started to stabilise, these values were estimated from the close relationship that has existed over recent years between the number of boats catching Perth herring and the total number of boats in the fleet (Fig.2b). The estimates of boats catching Perth herring for the four years between 1967 and 1971 could then be used to derive estimates of the mean monthly values for the CPUE during this period.

It must be recognised that the use of CPUE, based on the catch per boat, does have limitations. These include the problems associated with apportioning the time spent fishing for particular species in a multispecies fishery and the shift from multi- to monofilament nets during the late 1960s and early 1970s. However, discussions with fishermen indicate that the use of catch per boat still provides a good indication of overall trends in relative abundance.

D. LONG TERM AND SEASONAL TRENDS IN THE SWAN ESTUARY

The catch of Perth herring rose from negligible amounts in the early to mid-fifties to approximately 20 tonnes in the early 1960s before rising precipitously to 150 tonnes in

1968/69 (Fig.3). After a subsequent marked decline to approximately 50-55 tonnes in 1969/70 and 1970/71, the catches rose sharply again before falling steadily to values of between 45 and 65 tonnes after 1978 (Fig.3). While the trends shown by the CPUE followed quite closely those exhibited by catch during the late 1960s and early 1970s, the catch, in contrast to the CPUE, has declined during more recent years. It is also important to recognise that as a result of management decisions implemented in 1969 by the W.A. Department of Fisheries to reduce fishing effort in the commercial fishery, the number of boats fishing, and hence those catching Perth herring, in the Swan Estuary has declined progressively over recent years (Fig.3).

Prior to 1976, the monthly values for CPUE showed a marked tendency to vary seasonally, with maximum values being attained in the Swan Estuary in August and September (Fig.4). These months correspond to the time when a comprehensive research programme of gill netting throughout the system started to yield large Perth herring, which belong to a group which subsequently accumulates and breeds in the upper estuary in December and early January (Chubb and Potter, in press). It is thus reasonable to assume that the greatly increased commercial catches in August/September, which were taken in the commercially open fishing waters of the middle estuary, reflect the entrance of large numbers of Perth herring on their spawning run from the marine environment. It is also worth noting that a second but smaller peak in abundance is frequently evident between February and May (Fig.4). This could represent fish that were caught on their way out of the system.

The fact that seasonal trends become less conspicuous in the late 1970s may be a reflection of the effects of the unusually large catches obtained from local marine waters in the summers of 1976/77, 1977/78 and 1978/79 (Fig.5). Moreover, a marked seasonal peak was evident again after 1980 following reduced marine catches in the summer of 1979/80 and subsequent years (Fig.4).

III. CURRENT STATUS OF THE FISHERY

A. CONCEPT OF THE SWAN ESTUARY STOCK

While emphasis has been placed on the long term and seasonal trends in the fishery for Perth herring in the Swan Estuary, large catches were also taken in nearby marine waters between 1976 and 1980 (Fig.5). The following characteristics of these catches indicate that they were based on fish that had moved in or out of the Swan Estuary.

1. The highly seasonal catches in local marine waters (Fig.6) occur in the period during which Perth herring spawn in the upper estuary (Chubb and Potter, in press).

2. Local marine fishermen report that their catches of Perth herring are drawn from schools they had observed moving out of the estuary.

3. The majority of these fish are caught by purse seine and haul net within 300 m of the shore and within 5 km of the Swan Estuary. N.B. The nearest mouth of a permanently open estuary to the Swan is that of the Peel-Harvey which is located 50 km to the south.

The view that the estuarine and local marine catches are taken from part of what might be termed a Swan Estuary stock would be consistent with the fact that at least some species of shad are known to return to their natal tributaries each year (Carscadden and Leggett, 1975).

B. CATCH AND EFFORT STATISTICS FOR THE WHOLE STOCK

The gradual decline in the catch of Perth herring from the Swan Estuary between 1975 and 1983 contrasts with the vast fluctuations in catches of this species observed in local marine waters over the same period. These marine catches were obtained opportunistically by a small number of boats, differed greatly between years and contained a very variable purse seine component (Figs 5, 6). Notwithstanding this, it was decided that catch data for the local marine waters should be combined with those from within the Swan Estuary to produce a more meaningful estimate of effort for the total fishery of the Swan Estuary stock based on the most reliable catch rate data in the Swan Estuary.

The number of boats using gill nets, which can be distinguished since 1975 when a new format for the fishermen's returns was introduced, would appear to be the best available measure of effort. For example, gill nets are a passive gear and are used frequently by all commercial fishermen in the Swan Estuary. They are also used in the same areas in this system each year. Moreover, observations of the numbers and distribution of Perth herring in the gill nets of commercial fishermen made during fishing suggest that gill nets do not become saturated. Our data also demonstrate that the same equation can be used to relate the number of days spent fishing with the number of boats in the case of both the gill netting and haul netting operations.

The total annual catch from the Swan Estuary stock was divided by the mean monthly catch rates of boats using gill nets in the Swan Estuary to give the equivalent amount of

effort required to obtain these catches if only gill nets were used (Gulland, 1969).

C. ASSESSMENT OF THE FISHERY

The total catch of Perth herring in the Swan Estuary stock, i.e. from the Swan Estuary and neighbouring coastal waters between 1975/76 and 1982/83 reached a peak of 237 tonnes in 1977/78 (Fig.7), a feature reflecting exceptionally large catches in the marine environment in this year (Fig.5). While the total catch of Perth herring from this stock declined over the next two years, it has subsequently remained between 60 and 110 tonnes. Despite marked variations in the total catch over the eight year period, the CPUE, as measured by the gill net catch of Perth herring per boat in the Swan (see Section III B), showed no obvious tendency to rise or fall (Fig.7). However, the absence of a rise in CPUE over this period when the calculated effort has fallen consistently indicates that recruitment into the fishery may have declined.

While emphasis has previously been placed on the relationship between catch and CPUE and the fishing effort, the possible role of environmental factors on Perth herring populations should not be overlooked. Thus, while the marked decline in catch and also CPUE which occurred in the Swan Estuary in 1969/70 could have been the result of the high catches taken during the previous two years (Fig.3), they could also reflect features which affected the mortality of the young or the breeding stock in earlier years. It is also possible that the very high catches in 1969/70 reflect good conditions for spawning and/or growth early in life during earlier years. Certainly, conditions in the estuary, where spawning occurs and the young subsequently spend many months, are likely to be much more variable than in local marine waters. While the unusually high catches in the coastal waters in 1976/77, 1977/78 and 1978/79 (Fig.5) may have been at least partly due to a change in the preferred target species of fishermen at the time of the year when N.vlaminghi is found in the region, it is also possible that environmental factors in these years resulted in the fish becoming more accessible. If environmental factors were important in producing higher marine catches in these three years, it may be relevant that they were taken when air temperatures were at their highest and exceeded by 2-3^{o}C the average value at that time of the year (J. Penn, pers. comm.).

IV. CONCLUSIONS

This study has shown how the catches of Perth herring in the Swan Estuary rose during the 1950s and early 1960s in response to the demands of the rock lobster bait industry. Catches in the Swan Estuary over this period were seasonal, with the major peak occurring in August and September. Since no such marked seasonal changes were observed between 1977 and 1979 at a time when catches in nearby marine environments were unusually large, heavy fishing pressure can apparently have an effect on the catches of Perth herring in the estuary. Such a view is consistent with the observation that the catch per boat using gill nets, which was considered the most reliable measure of CPUE, did not show any marked change, whereas the calculated effort to produce the total catch for the stock declined between 1977/78 and 1982/83.

While the recruitment of Perth herring to the Swan Estuary stock may have declined during the late 1970s, such changes are considered unlikely to have long lasting effects. This view is based on the fact that the estuarine and inshore marine fishery relies on many species and when the abundance of one of these declines the fishermen turn to other species. Moreover, under the current licensing policy of the Western Australian Department of Fisheries, it is unlikely that there will be a marked increase in the fishing fleet in the Swan Estuary and neighbouring inshore marine waters in the near future. However, since shad populations in the United States have suffered from man-induced degradation of estuarine environments (Rulifson et al., 1982), it is important for the fishery based on the Swan population of the semi-anadromous Perth herring, that the prevailing environmental conditions in the Swan Estuary are maintained.

Since it has been assumed that all the Perth herring caught in and near the Swan Estuary are part of a unit stock, it would be of value to test this hypothesis using a tagging programme. It would also be of interest to combine such a tagging programme with morphometric, meristic and biochemical analyses to ascertain whether there is evidence that the populations in different estuaries differ genetically. The results of such a study would provide information on whether Perth herring return to their natal streams.

Finally, it must be recognised that the conclusions in this report are based on data for the limited number of years in which boats catching Perth herring, by gill net and haul net can be distinguished in the fishermens monthly returns. It is thus recommended that catch and effort data are carefully monitored to follow their trends during future years and gain a more complete knowledge of the fishery.

ACKNOWLEDGEMENTS

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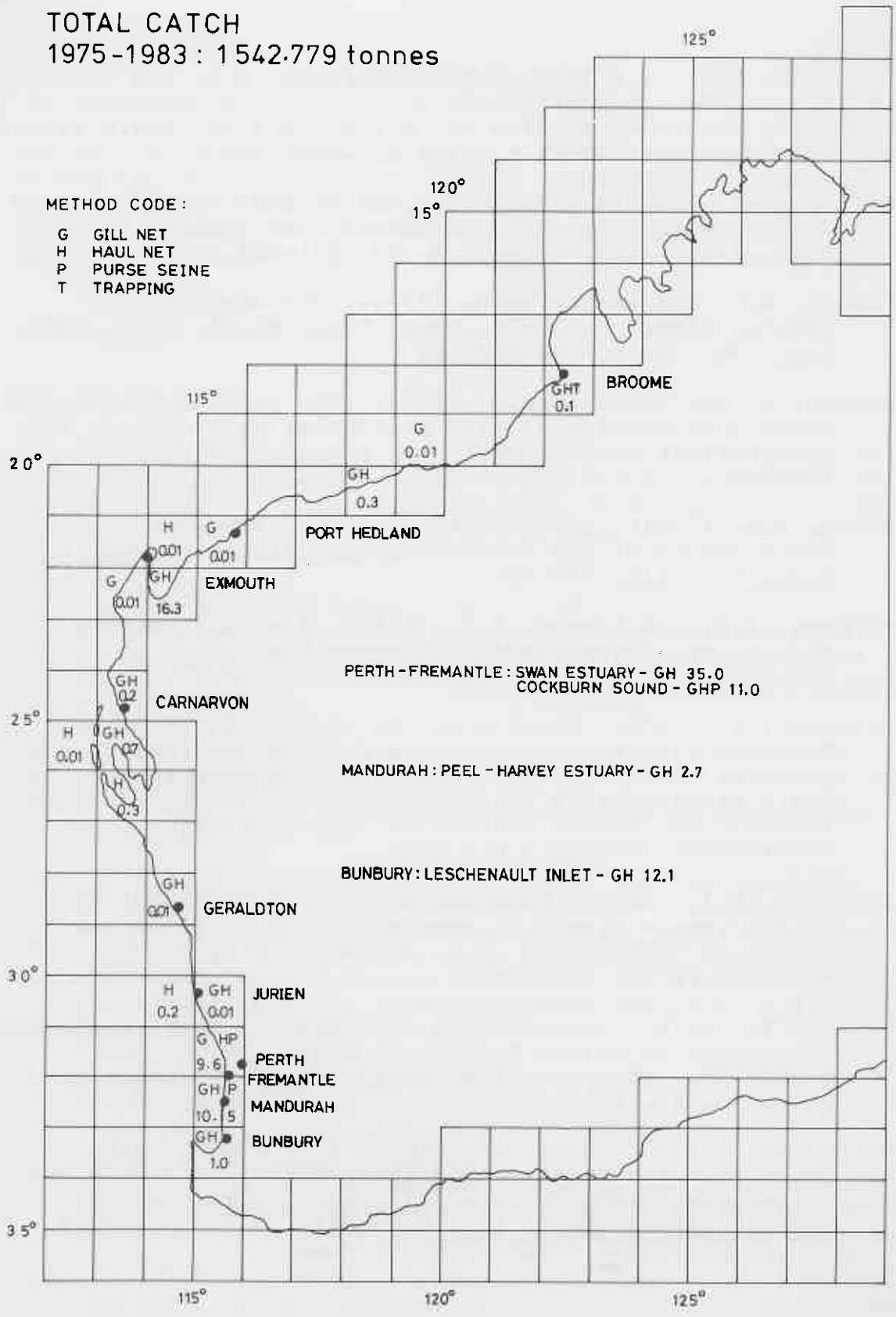

Figure 1 - Distribution of the catches of Perth herring in marine and estuarine environments, with the contribution made by each expressed as a percentage of the total catch for the period between July 1975 and June 1983.

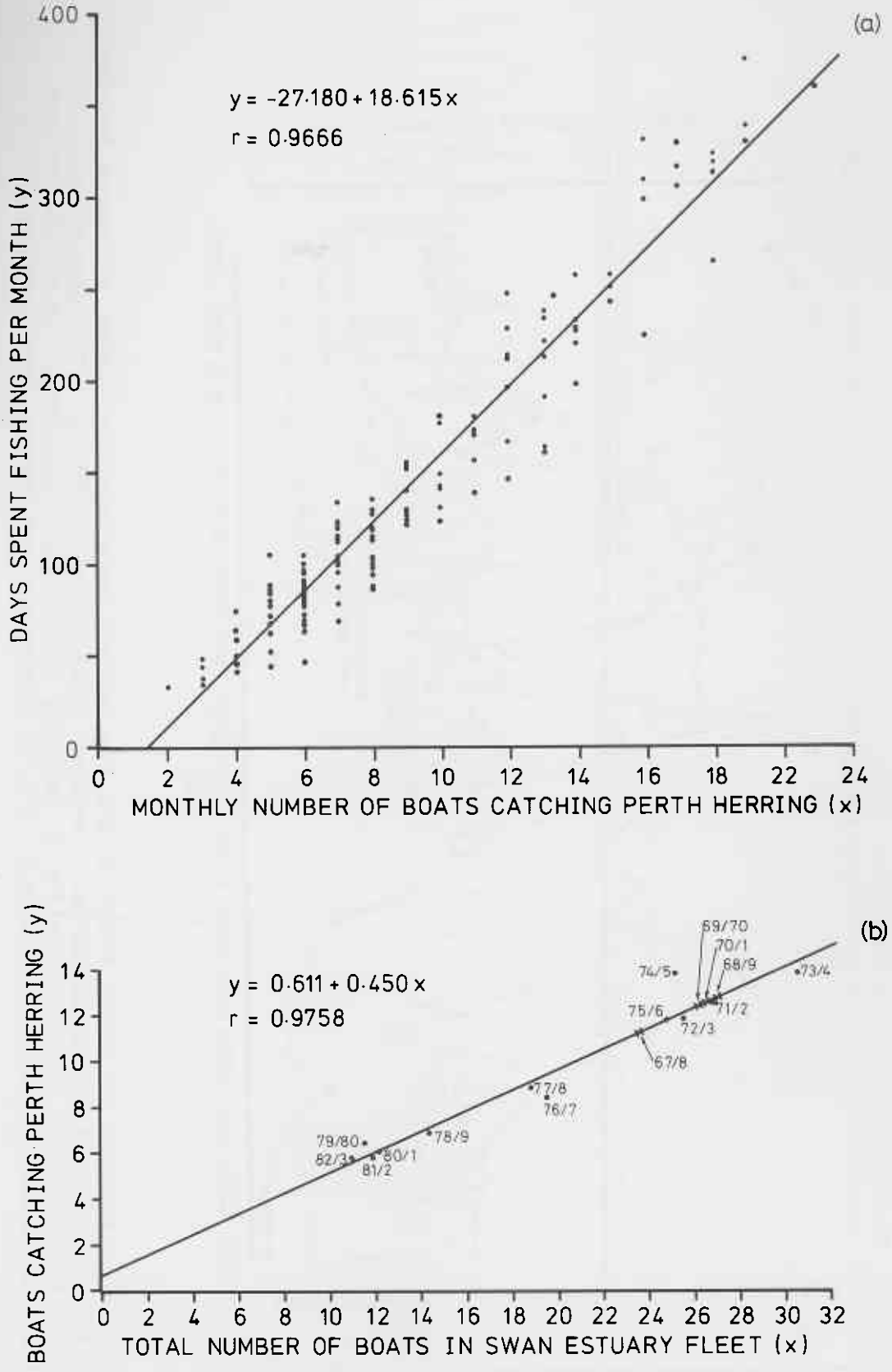

Figure 2 - The relationship between (a) the number of days spent fishing per month and the number of boats catching Perth herring per month from July 1971 to June 1983, and (b) annual values for the mean monthly number of boats catching Perth herring and the mean monthly number of boats in the total Swan Estuary fleet for the period 1971/72 and 1982/83.

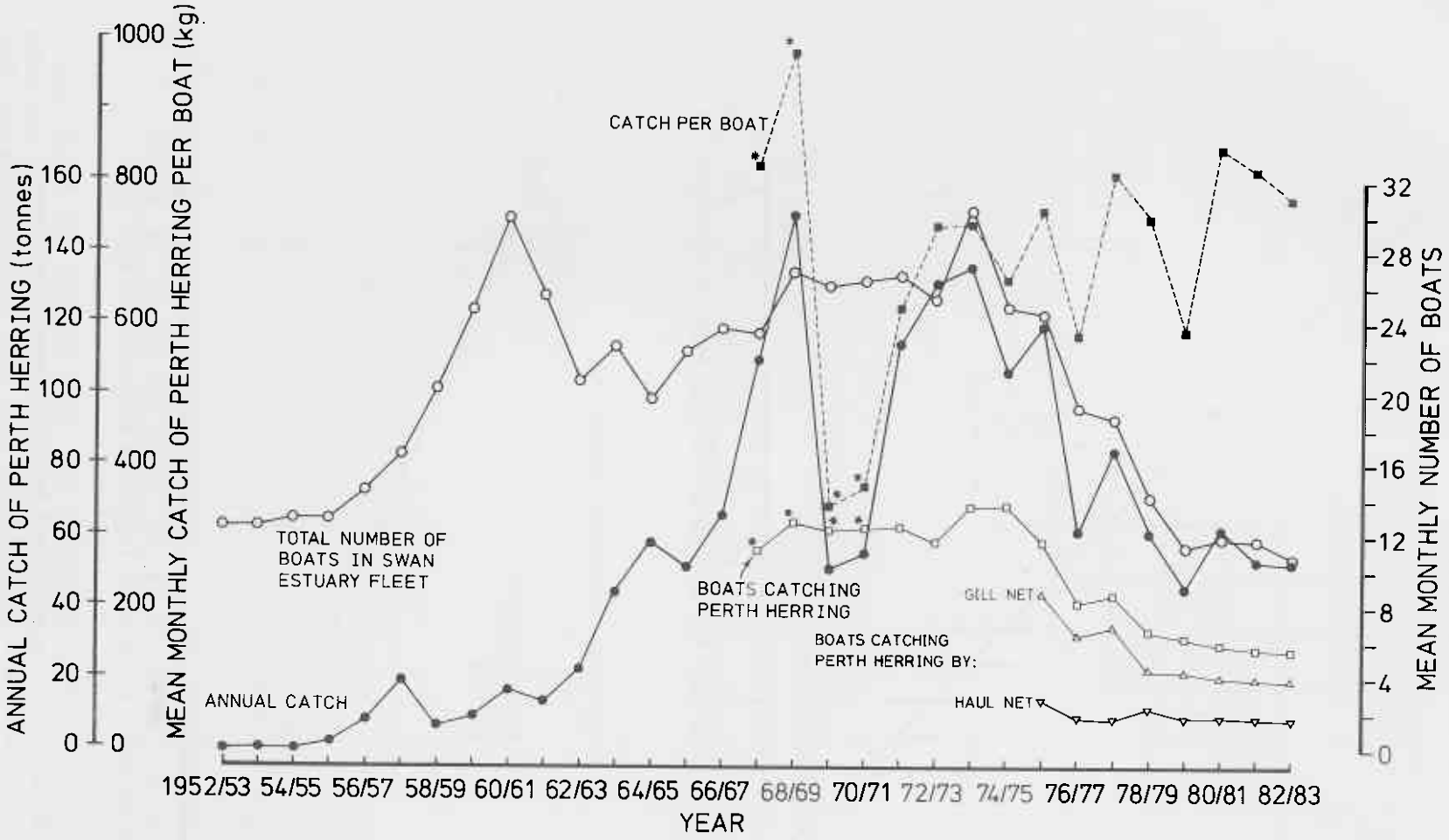

Figure 3 - The annual catch of Perth herring and the annual mean monthly number of boats in the fishing fleet of the Swan Estuary between 1952/53 and 1982/83. The annual mean monthly catch per boat taking Perth herring (CPUE) is also given. N.B. The values for the years between 1967/68 and 1970/71 represent estimates (see Section 11C).

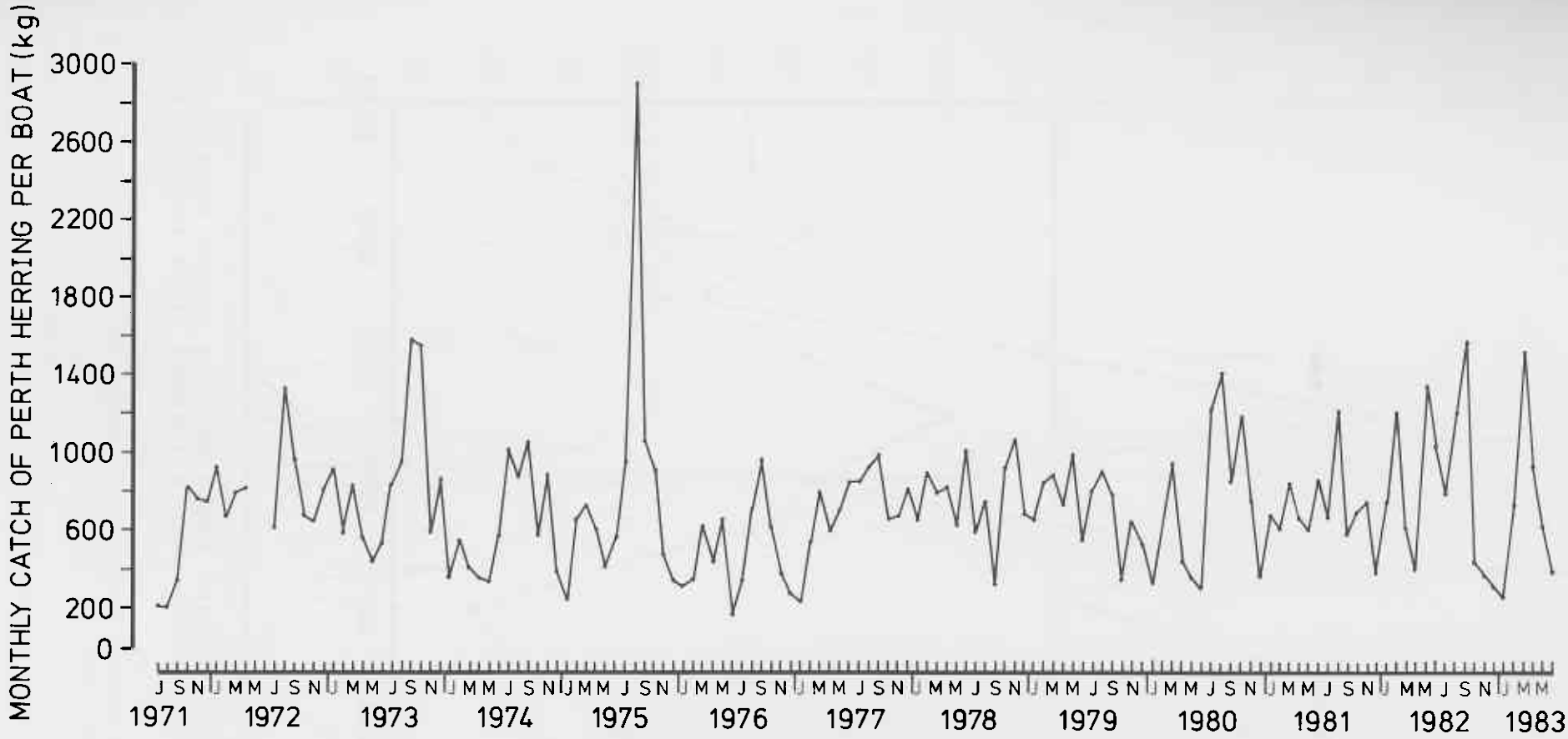

Figure 4 - The mean monthly catch of Perth herring per boat taking this species in the Swan Estuary between July 1971 and June 1983.

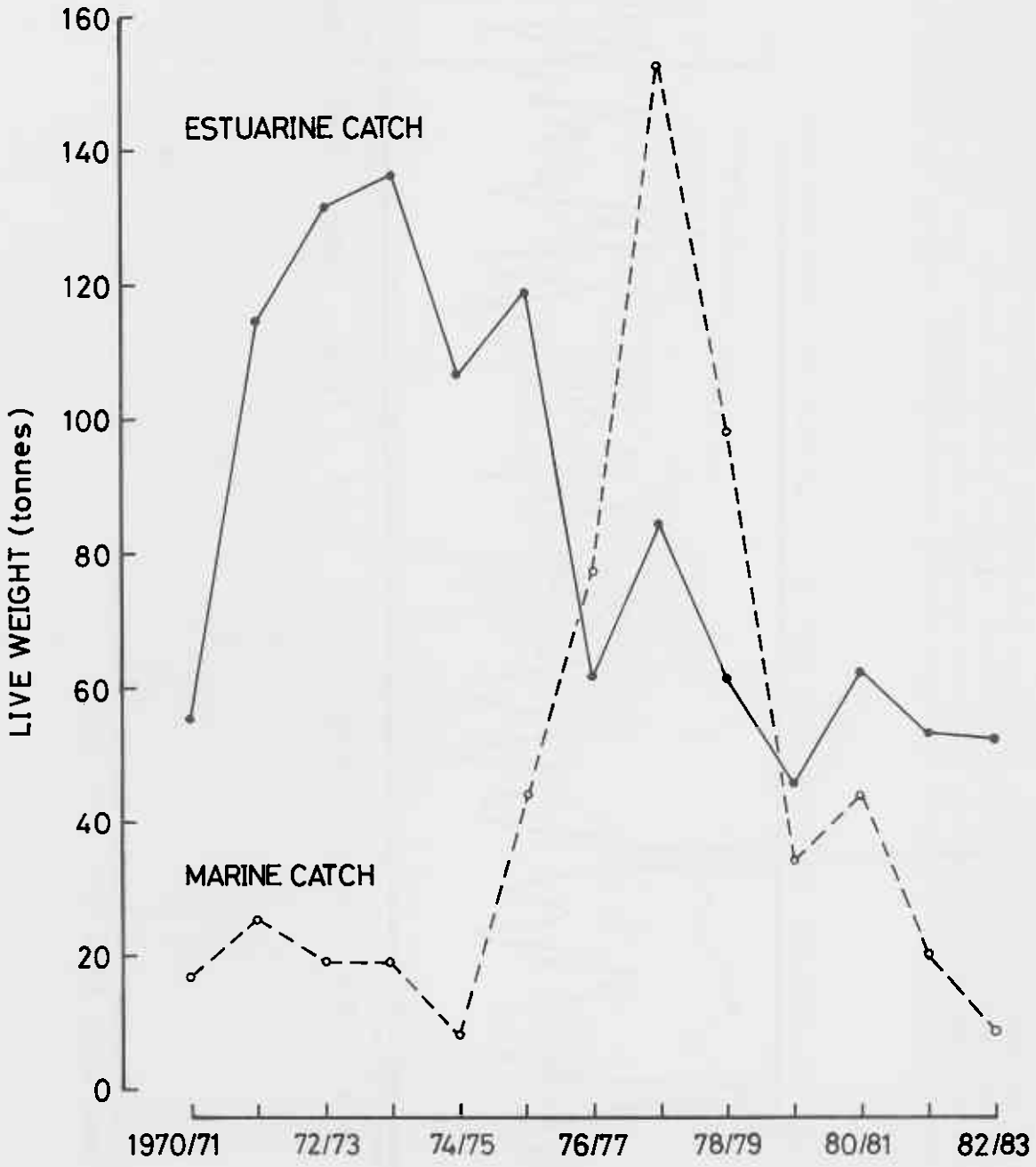

Figure 5 - The annual catch of Perth herring in the Swan Estuary (solid line) and local marine waters (dashed line) between 1970/71 and 1982/83.

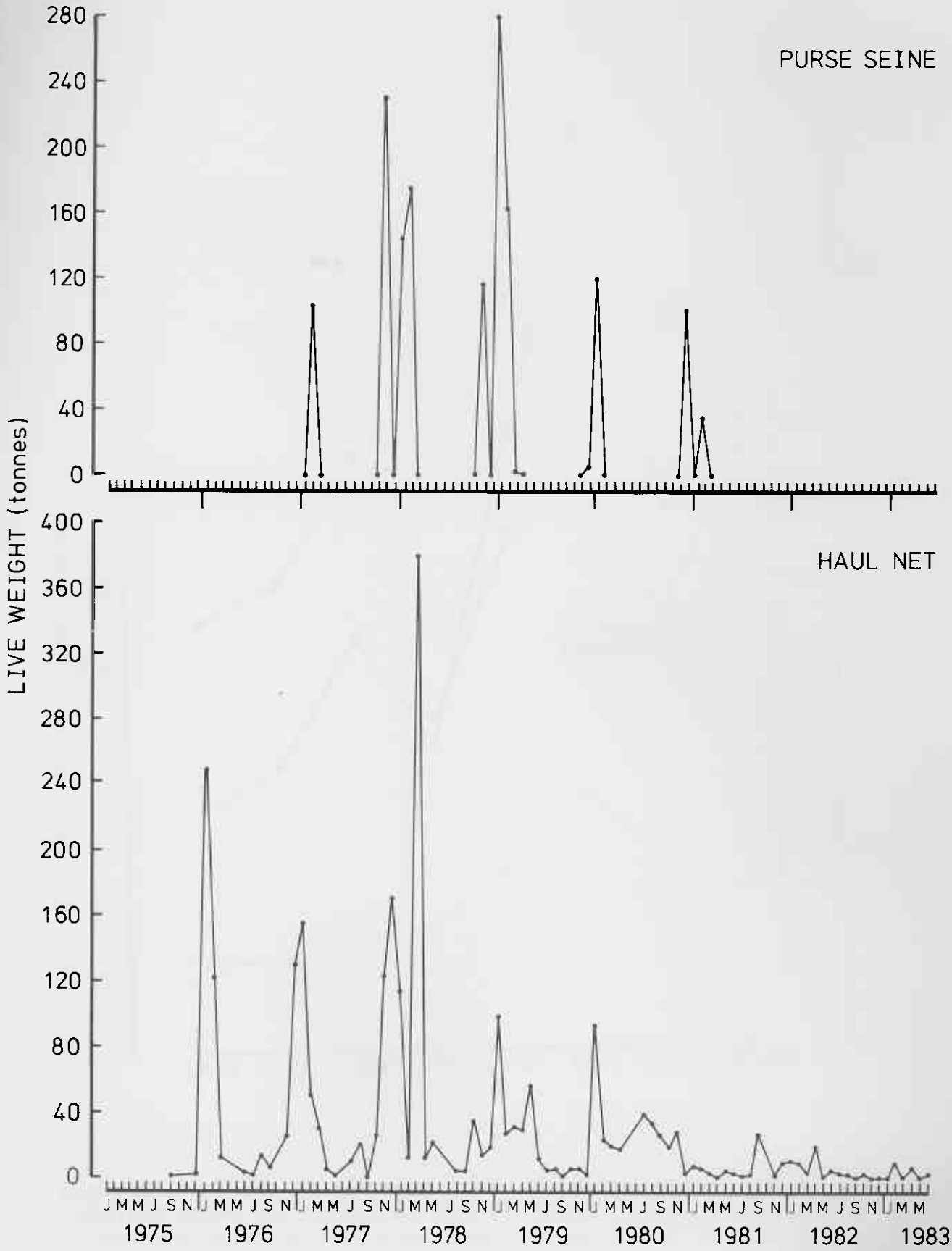

Figure 6 - The total monthly catch of Perth herring by purse seine (above) and haul net (below) in the inshore marine waters near the Swan Estuary.

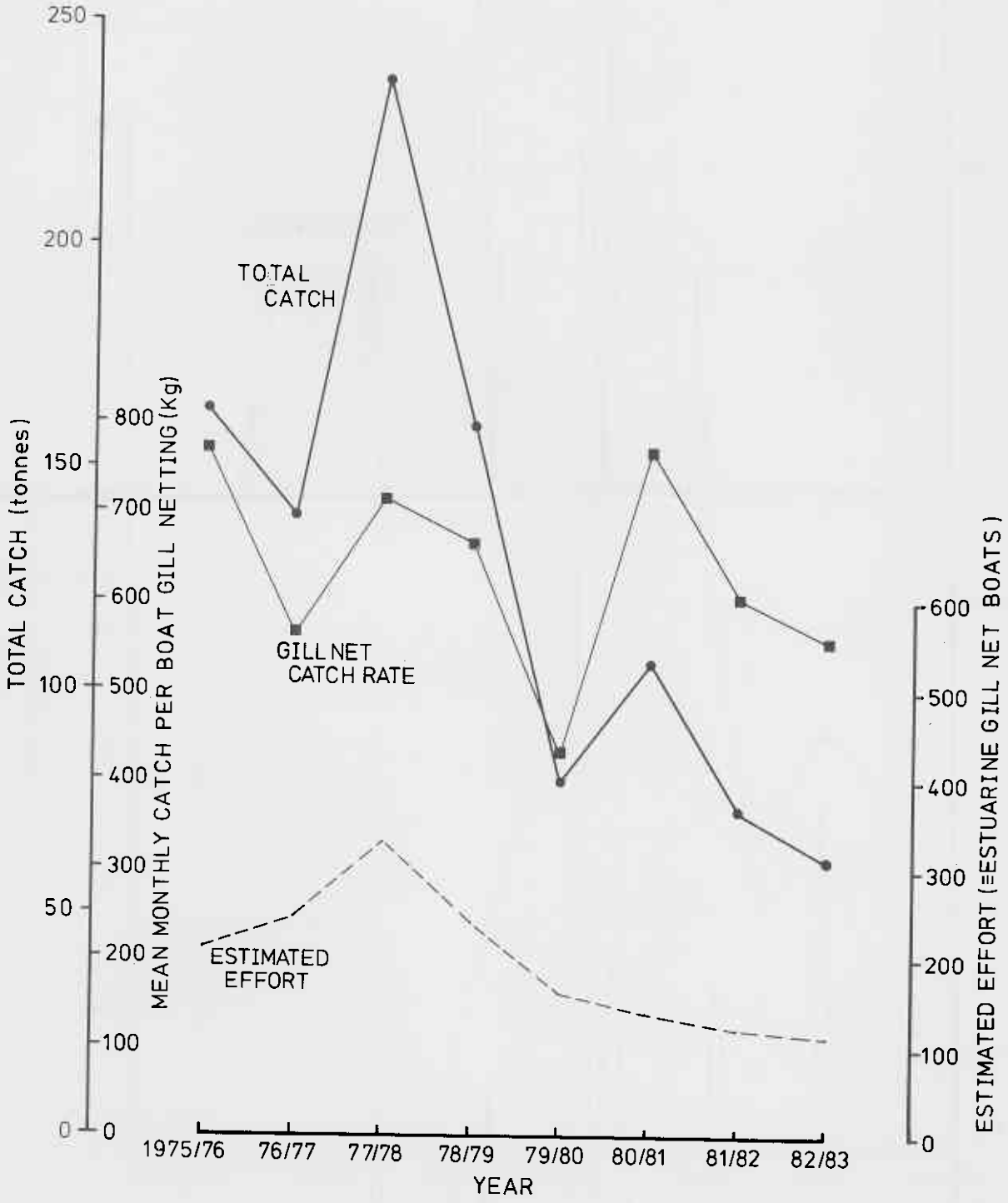

Figure 7 - The total catch of Perth herring in the Swan Estuary and local marine waters taken by all methods, the mean monthly gill net catch of Perth herring per boat taking this species (CPUE), and the estimated effort required with this CPUE to catch all the Perth herring taken in the Swan Estuary and local marine waters.

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