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# Herring Catch per Unit Effort in the Magdalens Trap Fishery and Implications for Gulf Herring Stock Assessment

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Introduction. It has been suggested, based on a consideration of schooling behaviour and on data from North Sea herring fisheries, that catchability in mobile gear fisheries on schooling pelagic fish stocks increases with decreasing stock size, and therefore that fishing mortality is not proportional to fishing effort in such fisheries (Pope, 1978 MS, most recently). Under this hypothesis, CPUE in mobile gear fisheries would vary little with stock size above a critical lower limit of stock size (Fig. 1). Although not stated by Pope (1978, MS), it appears intuitively reasonable that below a critical stock size both catchability and catch per unit effort would fall off rapidly (Fig. 1). In inshore fixed-gear fisheries, on the other hand, CPUE should change in proportion to stock size (Pope, MS, 1978) (Fig. 1). If Pope's hypothesis is correct, $F_T$ (terminal fishing mortality) values for cohort analyses calculated from mobile gear effort and fishing mortality may be too low and biomass estimates from the analyses too high.

Measurement of effort in fixed gear fisheries is logistically difficult, since the fisheries are dispersed and individual units account for low proportions of the total catch. However, a recent study of the Magdalen Islands trap fishery (Spénard, 1979) has provided preliminary effort data which can be used to calculate CPUE for the period 1970-1978.

Methods. Quantifying trap fishery effort is difficult. Effort will vary with size of traps, period of time fished, and frequency of fishing.

A. Size of traps. Two sizes of floating anchored traps are used in the Magdalens - large traps extending to the sea bottom ("barrages"), mainly in use on the west coast, and smaller traps with net bottoms ("trappes à fond"), in use in other areas (Spénard, 1979). For preliminary analysis we have assumed that the two types exert equal effort. Catch data separately for the two types are unavailable. Data on numbers of "barrages" and of "trappes à fond" are available since 1971 (when "barrages" were introduced) (Table 3).

B. Period fished. The period fished in the Magdalens is the same as the period of availability of herring. Traps are set (the process takes 1 day or less) when herring first appear in gillnets, and are either taken out when catches have dropped near zero or left in the water after the herring season to fish for other species.

C. Frequency of emptying the trap. This depends on catch levels. When catches are high, traps may be emptied several times per day. When catches are low, traps may be visited every day or every several days. Thus effort may be proportional to stock levels, confounding CPUE calculations. However, at high stock levels, traps probably saturate more quickly than at low stock levels (assuming that there is a limiting density of fish within the trap above which no more fish enter). This process would tend to cause a negative relation between effective effort and stock level. Since no detailed data are available on either factor, and since the two have opposite effects on effort, we have excluded frequency of visits to traps in this preliminary analysis.

Assuming no effect of trap size on effort, constant period fished each year, and no effect of frequency of trap emptying, we chose the simple measure of the number of traps fished per year as the unit of effort.

Number of permits issued for herring traps in the Magdalens is available, with some gaps, yearly since 1900 (Spénard, 1979). Permit holders for the period 1970-1978 were interviewed to determine whether they utilized their permits to fish traps (Table 1). The percent utilization of permits in the sample interviewed was applied to the number of permits issued to obtain an estimate of number of traps fished each year (Table 1). The estimate for each year represents the maximum number of traps that could have been fished that year; thus due to uncertainty in the estimates effort could have been somewhat lower (and CPUE somewhat higher) in each year for which data are available.

Herring catches from traps 1970-1978 were available from the Bureau de la Statistique du Québec. CPUE (catch per trap year) was calculated by dividing the total herring trap catch by the estimated number of traps fished for each year (Table 1).

Results. Herring CPUE from the Magdalens trap fishery 1970-1978 is compared with CPUE from three components of the purse seine fishery for the same period (data from Winters, 1978, MS) in Figure 2.

CPUE in the trap fishery declined from high 1970 and 1971 levels to a minimum in 1976 (22% of the 1970 value) and rose between 1976 and 1978. CPUE in the Southern Gulf purse seine fishery has followed a similar pattern, declining to a minimum in 1975 and rising slightly since. On the Edge, CPUE was stable and increasing until 1975, and declined thereafter. CPUE in the southwest Newfoundland purse seine fishery declined to very low levels in 1972-73 and zero in 1974. The assessment of Lett et al. (MS, 1978), using different effort data, indicated CPUE's for the southern Gulf complex as a whole declining gradually, by about 35%, between 1970 and 1976; considering the decline of the southwest Newfoundland fishery, this would suggest fairly stable CPUE's in the other components over the same period.

An attempt was made to account for difference in fishing power of the "trappes à fond" and the "barrages" (Table 3, Fig. 4). Since the "barrages" are considerably larger than the "trappes à fond" (Spénard, 1979), their fishing power may be greater. In 1978, the Inspection Office of Fisheries and Oceans at Cap-aux-Meules estimated total "barrage" catches at 416 mt, "trappe" catches at 214 mt, for a catch per trap ratio of 5: 1 (since 5 "barrages" and 13 "trappes à fond" were in use). Taking 1 "barrage" as equivalent to 5 "trappes à fond", equivalent numbers of "trappes à fond" were calculated for 1970-1978 (Table 3) and the resulting CPUE's plotted (Fig. 4). The decline in CPUE was more pronounced using this method than in assuming equal fishing power. However, at stock levels below those sufficient to cause daily trap saturation, trap size probably does not affect fishing power greatly. Thus, the CPUE curve resulting from the assumption that fishing power of the two trap types is equal is probably the more dependable of the two.

Fishing effort has declined in the purse seine fishery since 1970-71 (Fig. 3, data from Winters, 1978, MS). Equivalent trap fishery effort (trap-years needed to account for annual total Gulf landings) was calculated by year (Table 2) and compared with purse seine effort (Fig. 3). Equivalent trap effort has remained fairly stable since 1971.

Discussion. Although the decline in CPUE in the Magdalens trap fishery between 1970 and 1976 was greater than that in the Southern Gulf purse seine fishery between 1970 and 1975 (77% vs 62%), and the 1976-1978 increase in CPUE was less pronounced in the trap fishery than in the purse seine fishery, CPUE trends in the two components are rather similar over the period investigated. Thus, from this preliminary analysis at least, there appears to be little support for the hypothesis of a difference in the catchability-stock size relationship between fixed-gear and mobile gear fisheries on pelagic stocks, at least over the range of stock sizes subjected to the Southern Gulf fisheries over the period examined. This conclusion lends support to stock assessments based on catch, effort and fishing mortalities in the purse seine fisheries (eg. Winters and Moores, MS, 1979).

Further information on catch and effort in coastal fixed-gear fisheries in the Southern Gulf (and elsewhere) is needed to complement the mobile fishery information. Monitoring of trap effort (traps fished annually and frequency of visits to traps) at the Magdalens will be continued, through annual interviews with permit holders. A study in progress of the coastal herring fishery of the Gaspe peninsula (Greendale and Powles, MS) should provide the information base necessary prior to institution of catch and effort monitoring in this area.

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Table 1. Estimated effort (trap-years), Catch and CPUE, Magdalen Islands Herring trap fishery, 1970-1978

| Year | Permits issued | Number (%) permit-holders interviewed | Number (%) permits utilized | Estimated Traps Fishing | Trap catches (mt) | CPUE (mt/trap/year) |
|---|---|---|---|---|---|---|
| 1970 | 23 | 11 (48) | 11 (100) | 23 | 4702 | 204 |
| 1971 | 23 | 11 (48) | 10 (91) | 22 | 7217 | 336 |
| 1972 | 31 | 13 (42) | 13 (100) | 31 | 3477 | 112 |
| 1973 | 33 | 15 (45) | 15 (100) | 33 | 2994 | 91 |
| 1974 | 33 | 15 (45) | 15 (100) | 33 | 2646 | 80 |
| 1975 | 28 | 15 (54) | 15 (100) | 28 | 1651 | 59 |
| 1976 | 30 | 21 (70) | 20 (95) | 29 | 1333 | 46 |
| 1977 | 31 | 25 (81) | 20 (80) | 25 | 1621 | 65 |
| 1978 | 29 | 28 (97) | 17 (61) | 18 | 1599 | 89 |

Table 2. "Equivalent effort" (trap-years) for southern Gulf herring Catches 1970-76

| Year | Southern Gulf Catch (Lett et al., MS, 1978) | CPUE Traps (mt/trap-year) | Equivalent effort (trap-year) | Purse seine effort (sets) (Winters, MS, 1978) |
|---|---|---|---|---|
| 1970 | 274735 | 204 | 1347 | 3263 |
| 1971 | 215354 | 336 | 641 | 4365 |
| 1972 | 84766 | 112 | 757 | 1951 |
| 1973 | 67747 | 91 | 744 | 1422 |
| 1974 | 41869 | 80 | 523 | 982 |
| 1975 | 44589 | 59 | 756 | 1273 |
| 1976 | 39468 | 46 | 858 | 966 |
| 1977 | 46000* | 65 | 708 | |
| 1978 | 52479** | 89 | 590 | |

* Atlantic Herring Management Committee, April 6, 1978

** Winters and Moores, MS, 1979

| | DISTRICT 28 | | | | | ARCHIPELAGO | | |
|---|---|---|---|---|---|---|---|---|
| YEAR | TOTAL TRAPS | BARRAGES | TRAPPES A FOND | PROPORTION BARRAGES | EQUIVALENT TRAPPES A FOND* | EQUIVALENT TRAPPES A FOND* | TRAP CATCHES (mt) | CPUE ADJUSTED* (mt/trap-year) |
| 1970 | 13 | 0 | 13 | 0 | 13 | 23 | 4702 | 204 |
| 1971 | 13 | 1 | 12 | 8 | 17 | 26 | 7217 | 277 |
| 1972 | 19 | 3 | 16 | 16 | 31 | 43 | 3477 | 81 |
| 1973 | 22 | 4 | 18 | 18 | 38 | 49 | 2994 | 61 |
| 1974 | 23 | 5 | 18 | 22 | 43 | 53 | 2646 | 50 |
| 1975 | 18 | 5 | 13 | 28 | 38 | 48 | 1651 | 34 |
| 1976 | 17 | 5 | 12 | 29 | 37 | 49 | 1333 | 27 |
| 1977 | 15 | 5 | 10 | 33 | 35 | 45 | 1621 | 36 |
| 1978 | 11 | 5 | 6 | 45 | 31 | 38 | 1599 | 42 |



* Taking 1 barrage = 5 trappes à fond

Table 3. Numbers of "trappes à fond", "barrages" and equivalent total "trappes à fond", Magdalen Islands. District 28 = Grindstone Island.

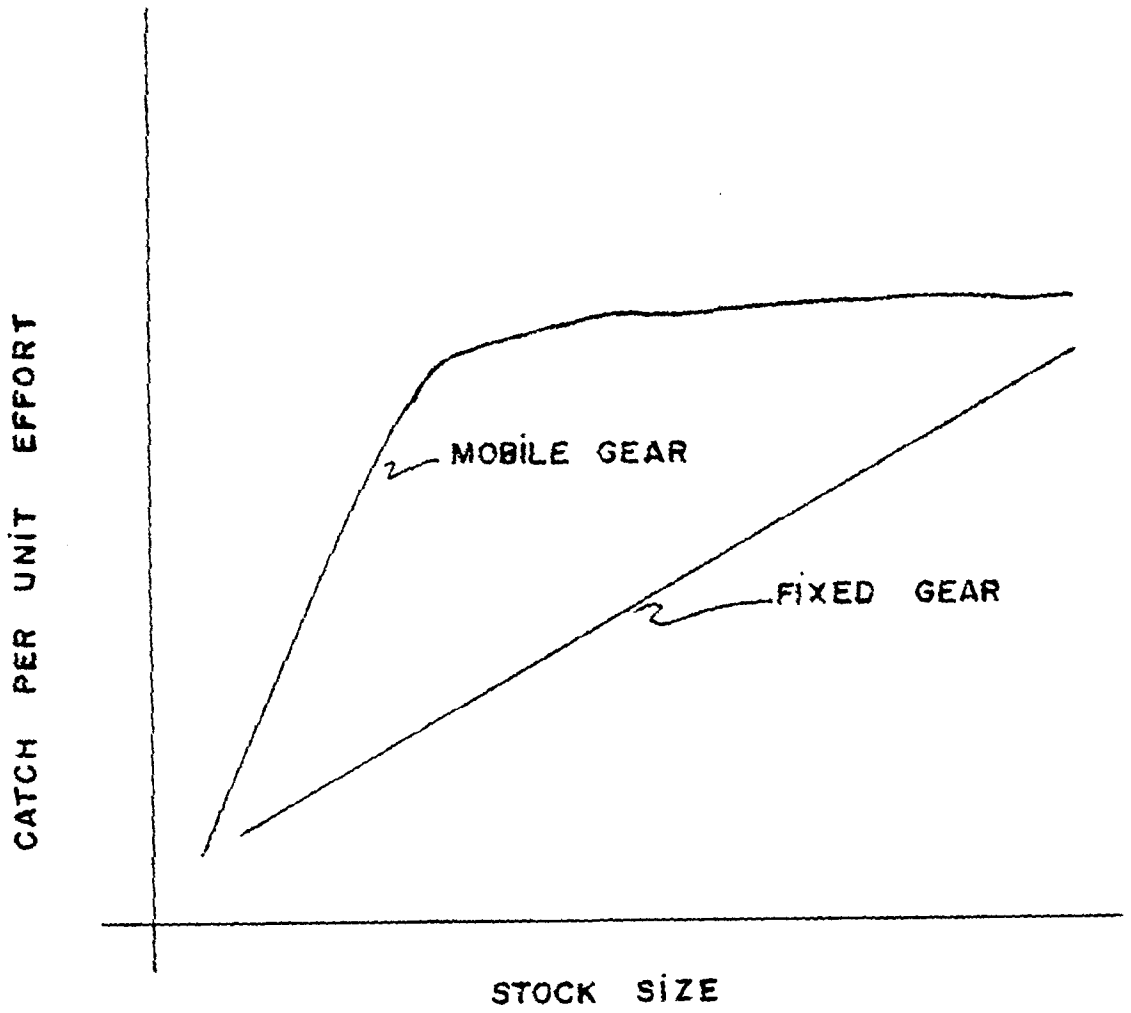


Figure 1. Hypothetical relationships between stock size and CPUE in mobile gear and fixed gear fisheries on schooling pelagic fishes.

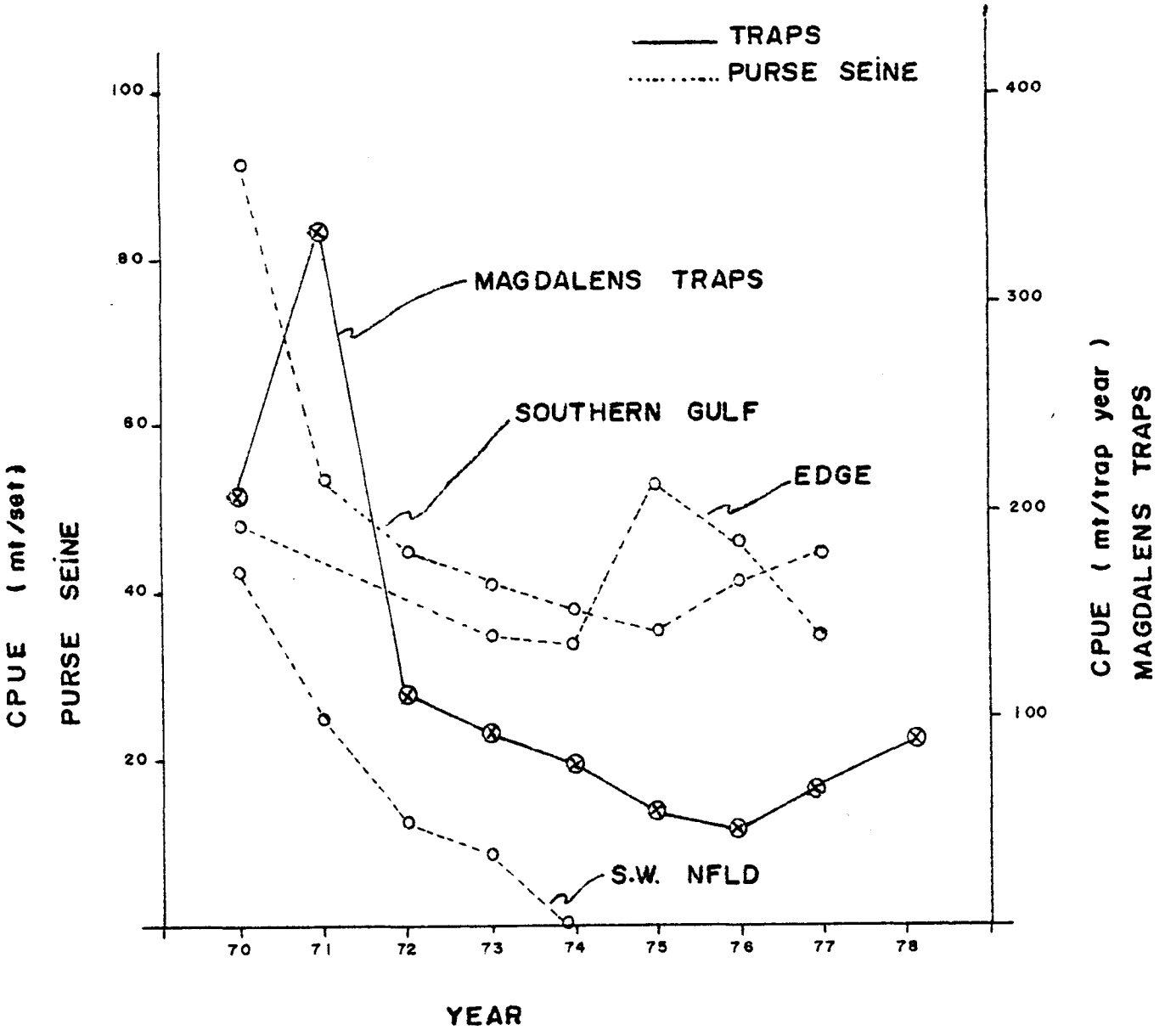


Figure 2. Catch per unit effort trends in purse seine (data from winters, MS, 1978) and trap fisheries for herring, Gulf of St. Lawrence, 1970-78.

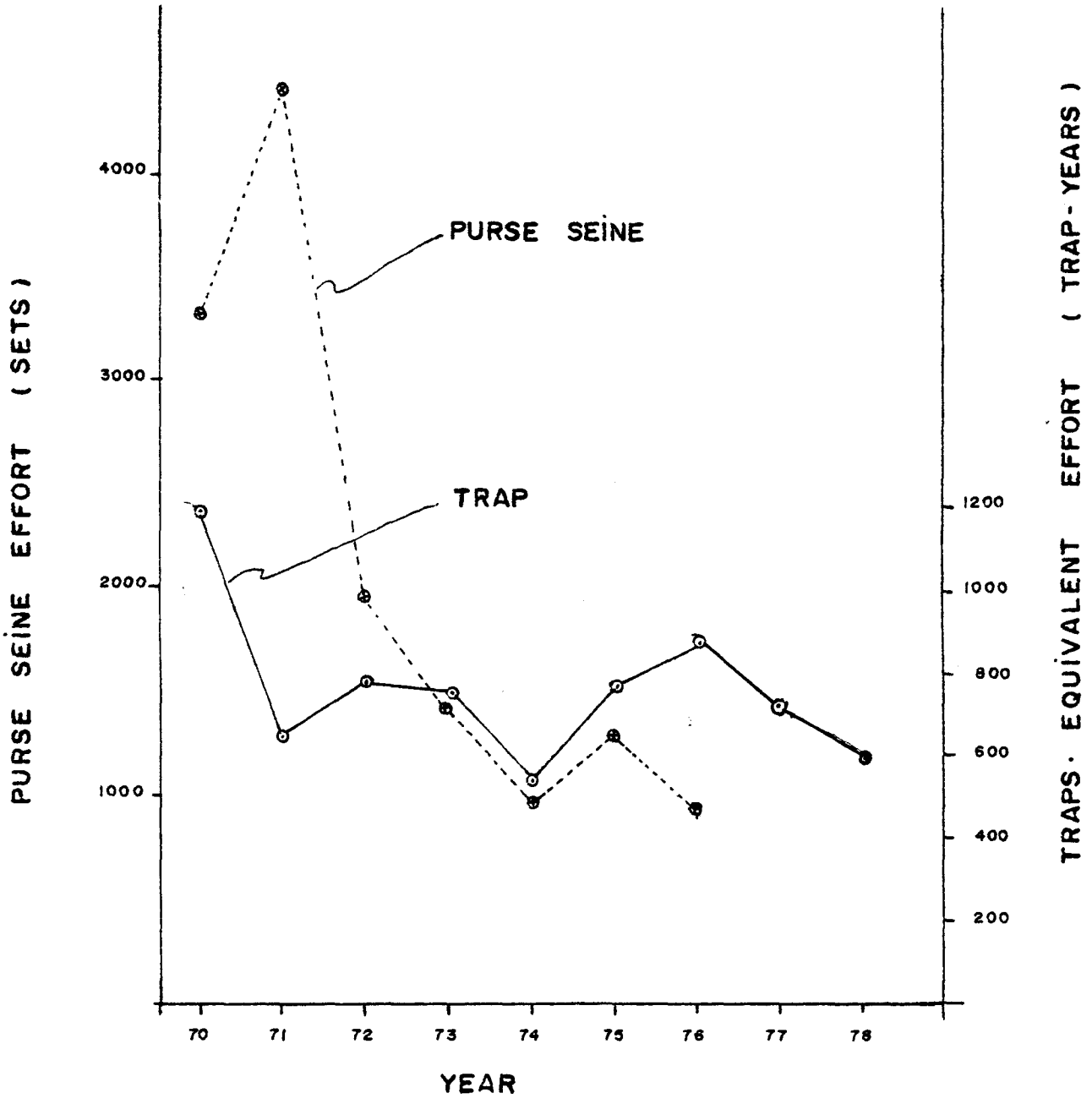


Figure 3. Purse seine effort (winters, MS, 1978) and trap "equivalent effort", 1970-78.

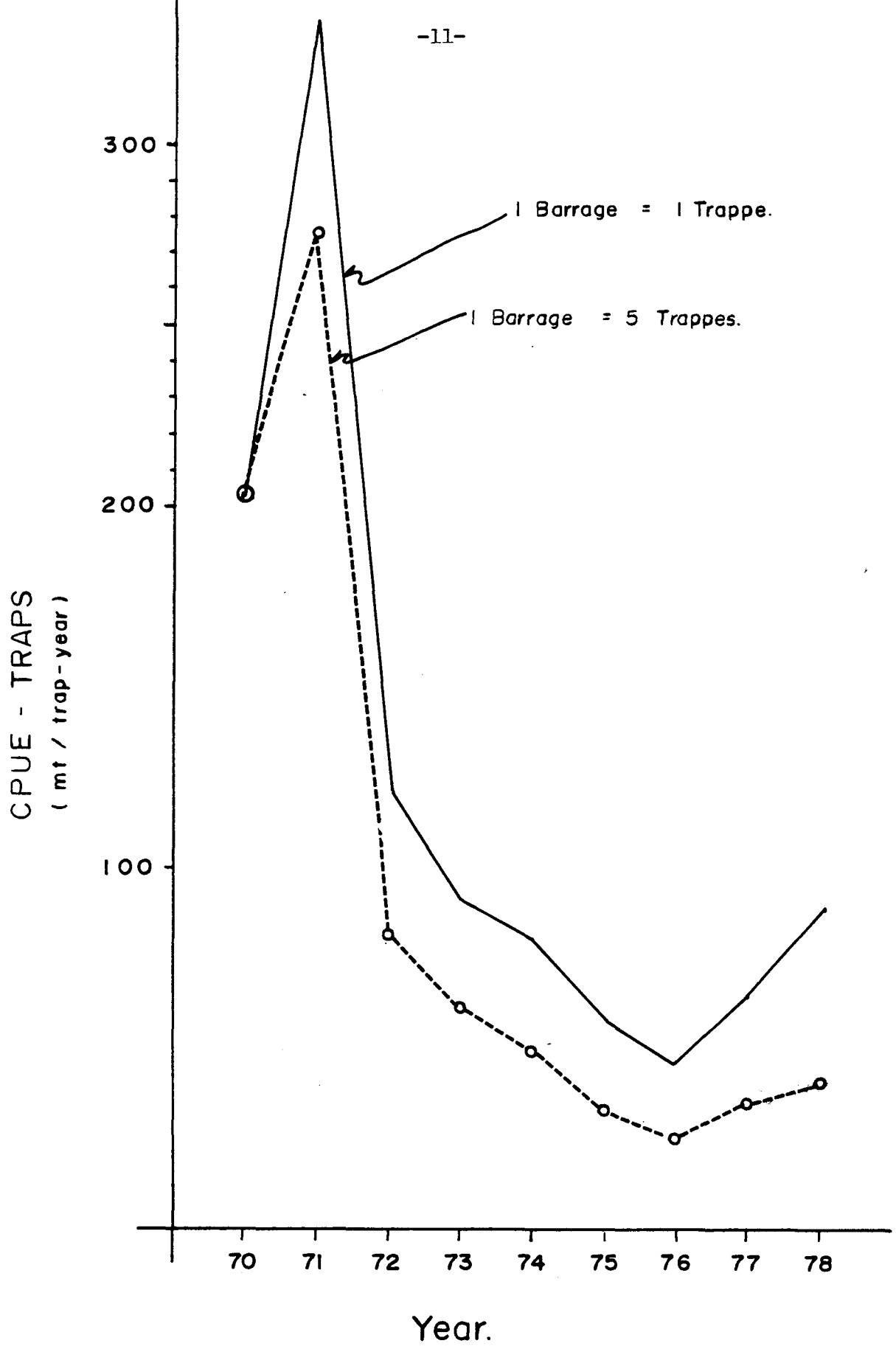


Figure 4. CPUE trends in Magdalen Island trap fishery under two assumptions on relative fishing power of "trappes à fond" and "barrages".