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# Fluctuation of Trash Fish Catch by Thai Trawlers*

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## Abstract

Historical change of trash fish catch in Thailand was examined with reference to different types of craft statistics as well as research data basis.. The amount of trash catch by all Thai trawlers was 711,256 metric tons in 1978 and 608,245 metric tons in 1981, which consisted 66.4 % and 67.4 % of total demersal landings, respectively. The catch rate (CPUE) of trash fish as well as of all demersal resources showed a decreasing trend throughout 5-year period during 1978–1983 with a minor exception. The deterioration of the demersal resources with almost no change of trash fish composition seems to be due mainly to the high fishing intensity by gears with a small mesh size used in the region.


With the increase in trawl fishing in the Gulf of Thailand, there has been a considerable increase in the landings of small low-value fish species which are regarded as trash fish in commercial fisheries.

Although the concept of trash fish (see Table 1) is not clearly defined, trash fish are used mainly for fish meal products or as feed for cultured fish or for ducks. It should be noted that an increase in fishing intensity for trash catch in shallow waters may result in a reduction of age, at first capture, of useful demersal fishes, because trash fishes comprise a considerable number of juveniles and young of several economically important fish species.

Therefore there was an urgent need for a study on trash fish landing statistics, especially on the fluctuation of trash catch by Thai commercial trawlers. This study was made on trash fish catch from local trawlers as well as from research vessels. The need to control and manage trash fish exploitation is emphasized in the present paper.

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## Materials and Methods

### 1. Research data

The Demersal Fish Unit of the Marine Fisheries Division, Department of Fisheries, Thailand, conducted long-term experimental trawl surveys between 1966 and 1982 (SHINDO and CHARNPRASERTPORN, 1984, MEEMESKUL and SINGTOTONG, 1985). The vessels used for those surveys were PRAMONG 2 and PRAMONG 9*[1].

Although these two research vessels were 23 and 25 m in length and therefore larger than Thai commercial trawlers which are in general 14 to 25 m long, the length of the trawl nets (47.7 m) used in the surveys was not very different from commercial trawl nets.

Therefore, some of the information obtained by long-term monitoring surveys in the Gulf may provide an indication of the pattern of trash fish fisheries in Thailand.

The catch data by research vessels were classified into three groups *i.e.* Economic group (A), Favourable group (B) and Unfavourable group (C) according to the definition presented in Table 1. In the present study, however, the analyses of trash fish caught by trawlers cover only the groups above the dotted line in Table 1 (code Nos. (1) to (5)) because the factors involved in code Nos. (6) and (7) are highly variable and

*[1] PRAMONG 2 and PRAMONG 9 are equipped for bottom trawl nets with a 4 cm mesh cod-end, while commercial trawlers generally use nets with a 2.5 cm mesh cod-end.

Table 1. Schematic presentation for defining trash fish caught by trawlers in the Gulf of Thailand.

| Grouping by commercial value | Unfavourable /Favourable groups | Cause of lack of commodity value | Family/species |
|---|---|---|---|
| Trawl catch (D) — Trash fish | (C) Unfavourable group (for human consumption) | (1) Bad taste or inedible | Apogonidae, Balistidae, Lagocephalidae, Labridae, Tetraodontidae, etc. |
| | | (2) Too small (adult size) (or under-recruitment size of common group) | Leiognathidae. Apogonidae. Bothidae. Pleuronectidae. Balistidae. Fistulariidae. *Pentaprion* spp., etc. |
| | | (3) Too small(juvenile/young size) (or under-recruit ment size of economic group) | Synodontidae, Nemipteridae, Mullidae, Priacanthidae, Lutjanidae, Scolopsidae, Trichiuridae, other demersal fishes, some pelagic fishes. |
| | | (4) Too small a catch (by catch) | Almost all pelagic fishes and occasional groups. |
| | | (5) Law price (by-catch) (or lack of freshness, others) | Clupeidae (especially, *Sardinella* spp.). Small-sized Carangidae, Engraulidae, etc. |
| | (B) Favourable group | | |
| | (Economic group from view point of market value) | | |
| Economic group (A) | | (6) Unsold fish group* | Many kinds of fishes (especially pelagic fishes). |
| | | (7) Local/private consumption** | *Pentaprion* spp., Siganidae, etc. |

* Owing to special circumstances such as a fishing boat missing the fish market auction.

** Not included in official statistics.

would make the records of trash catch unreliable.

The annual changes in catch rates (CPUE) have been tabulated and presented graphically. Assuming that the catch rate (CPUE) for each component is representative of the total abundance of demersal populations, the decrement of coefficient of CPUE per year ($Z'$)*2 can be calculated from the relation:

$$N_t = N_0 e^{-Z't} \text{ or } \ln N_t = \ln N_0 - Z't$$

where $N_0$ and $N_t$ are the catch rate indices at starting year and $t$ years later.

## 2. Commercial catch data

Catch data by various types of craft at different landing sites were collected and processed by the Fisheries Statistics Unit of the Department of Fisheries, Thailand. These craft range from the smaller sized push netter (PN) to the larger sized otter board trawler (OBT) as follows:

PN : Push netter. The push net is one of the dominant artisanal fishing gears in Thailand, and is operated by a motorized boat, generally for one night only in very shallow waters.

ST : Shrimp trawler or small sized baby trawler less than 14 m in length, aiming at shrimp and usually operating for one night in coastal waters.

OBT: Otter board trawler of more than 14 m in length. Some are using 2 types of net alternately depending on the size of the craft and spending more or less 10–14 fishing days in fishing grounds around 30 m deep.

PT : Pair trawler of more than 14 m in length, aiming at Indian mackerel and squid, usually spending 4–7 fishing days in fishing grounds and operating only in the daytime.

Annual trash fish production by these craft have been tabulated and presented graphically.

*2 Generally for the estimate of the total mortality coefficient ($Z$), the abundance index in numbers of each single population is used in a closed system in which effects of both immigrant and emigrant can be ignored.

The CPUEs (catch per boat) were examined on the OBT basis, and estimate of $Z'$ was done by plotting ln (CPUE) against time ($t$).

## Results

### 1. Research Data

(1) Annual fluctuation of trash catch by Thai research vessels

Fig. 1 gives annual changes of catch rate (kg/hr) for each group observed during trawl monitoring surveys.

From Fig. 1, we can infer the following:

During the period between 1966-1973, the catch rate of total demersal animals (D) dropped rapidly year by year, in correlation with the sharp decrease in the catch rate of the favourable fish group (B). During 1974 to 1978, the catch rate of the unfavourable group (C) showed an

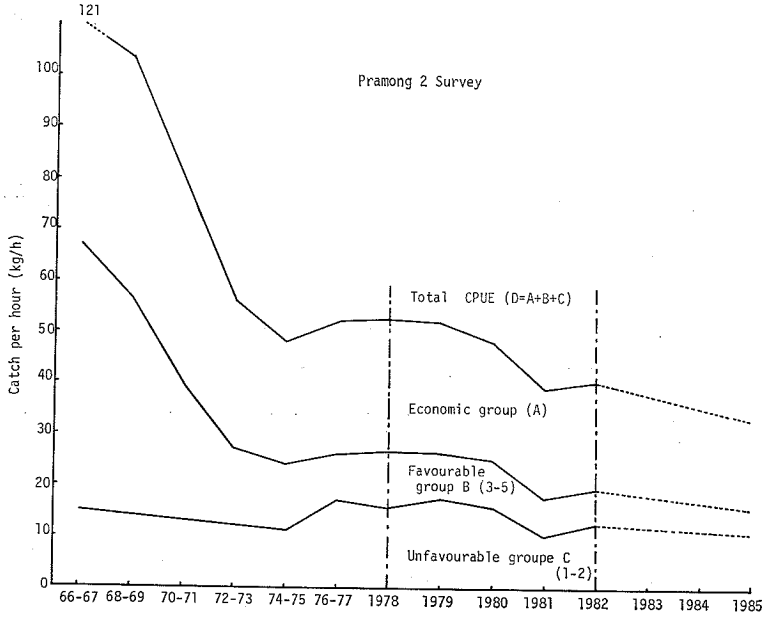
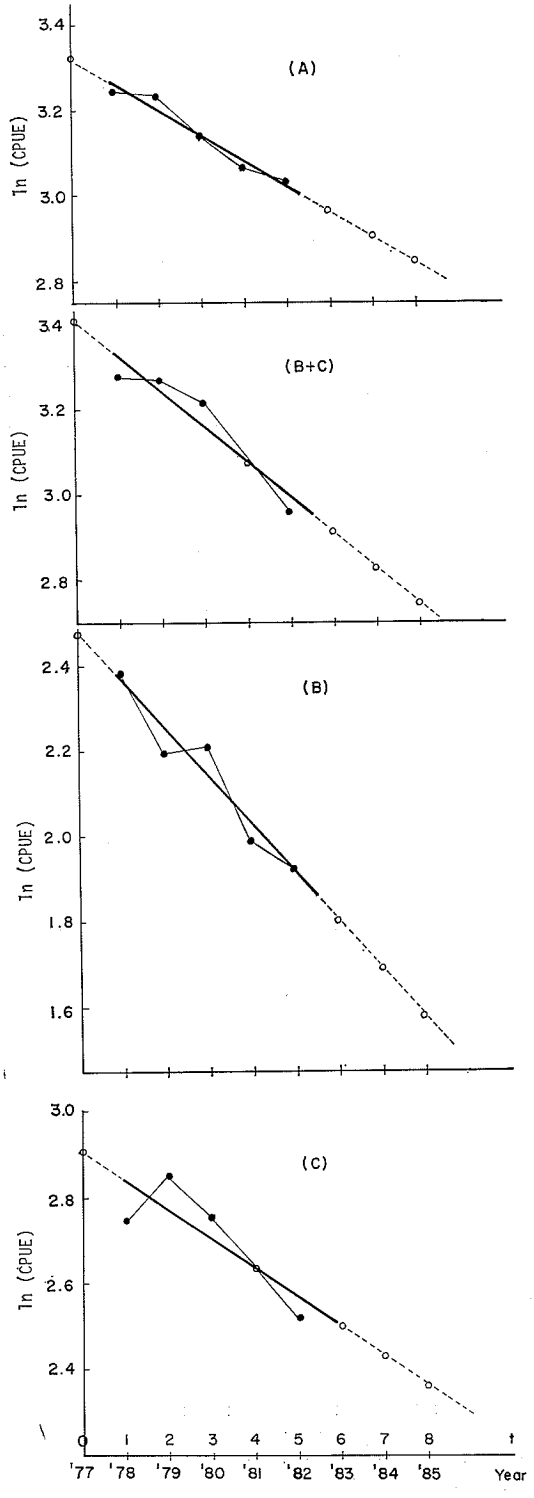



Fig. 1. Annual changes in catch rate (kg/hr) for each group observed during trawl monitoring surveys by PRAMONG 2 in the Gulf of Thailand, 1966-1982.
Data after 1983 are adapted from the estimation of three values during 1978 to 1982.
Symbols (A)-(D) and numbers (1)-(5) are adapted from Table 1.

Table 2. Estimated values of the decrement coefficient of CPUE per year ($Z'$), initial abundance index ($\ln N_0$) in 1977 and the correlation coefficient (r) between $\ln N_t$ and $t$. $t_{max}$ indicates the number of years, starting from the year 1977, after which $\ln N_t = 0$ can be expected.

| Component | $t_0$ | Applied $t$ | $Z'$ | $\ln N_0$ | r | CPUE (kg/hr) in 1985 | $t_{max}$ |
|---|---|---|---|---|---|---|---|
| A | 1977 | 1978-1982 | 0.0587 | 3.3184 | −0.9769 | 17.27 | 56.5 |
| B+C | | 1978-1980, 1982 | 0.0828 | 3.4081 | −0.9442 | 15.57 | 41.2 |
| B | | 1978-1982 | 0.1120 | 2.4759 | −0.9626 | 4.85 | 22.1 |
| C | | 1978-1980, 1982 | 0.0679 | 2.9080 | −0.8215 | 10.64 | 42.8 |

Calculations were made at one-year intervals during the period between 1978 and 1982, and the starting year ($t=0$) set in 1977.



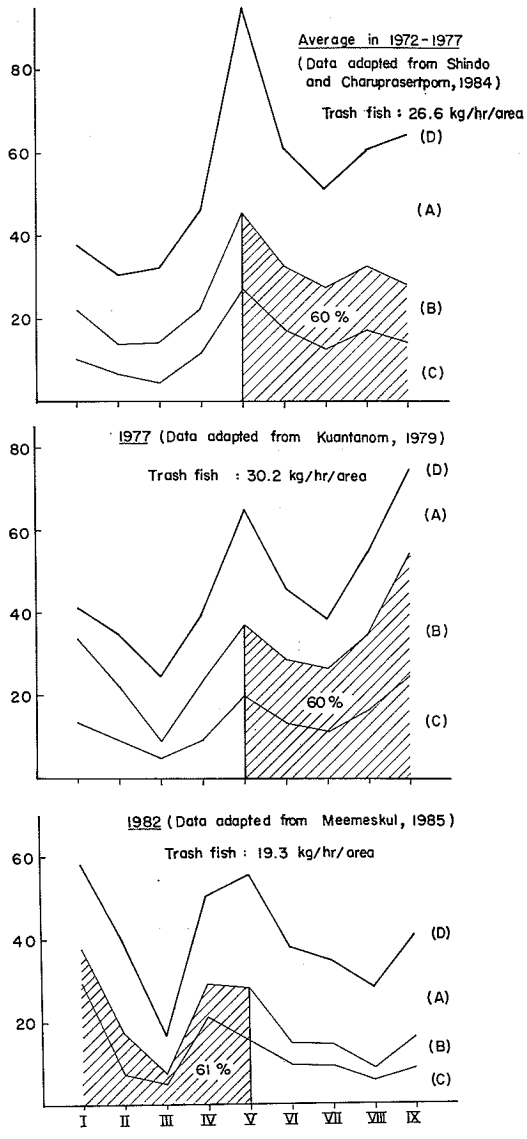




Fig. 3. Catch rates (kg/hr) for each group observed from nine statistical areas by PRAMONG 2 surveys in the Gulf. Symbols (A), (B), (C) and (D) are adapted from Fig. 1.

←Fig. 2. Plot of ln $N_t$ vs. $t$ for each component. Regression lines are calculated from black points in the period between 1978 and 1982.

increasing trend, although the catch rates of both economic (A) and favourable (B) groups maintained a rather stable state, with only a small variation. After 1978, however, all catch rates decreased again at different decreasing rates. The proportion of trash fish CPUE (B+C) in the total CPUE (D) was more than 50 per cent throughout the period under consideration.

Table 2 and Fig. 2 give the estimation of the decrement coefficient of CPUE per year ($Z'$) and other parameters.

The calculated value of $Z'$ is highest for the favourable (B) group (11–12 % per year) and lower for the economic (A) and unfavourable (C) groups (6–7 % per year). This would suggest that the fishing intensity of trash fish catch was greater for the favourable group (B) than that for the unfavourable group (C).

The estimate of $Z'$ for each group during 1978–1982 can provide an estimate of the catch rate (CPUE) of each group during the period 1983–1985 (see the estimated values shown as dotted lines in Fig. 1). Furthermore, the estimate of $Z'$ for each group's CPUE suggests that the catch rate of each group in the Gulf of Thailand will decrease year by year and is expected to reach 1 kg/hr within the number of years indicated in the last colum of Table 2, in as far as the same fishing intensity continues in the future. As regards catch of trash fish, the catch rate for unfavourable (C) group can be expected to reach 1 kg/hr by the early 21st

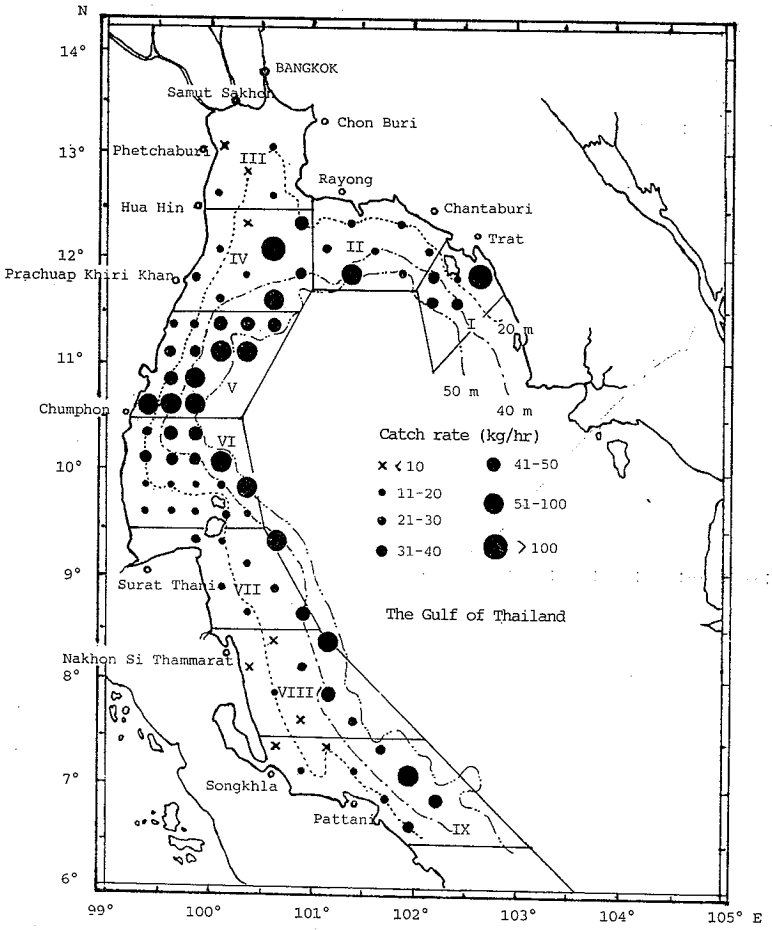



Fig. 4. Catch rate (kg/hr) for trash fish (Code Nos. 1~5) in different fishing grounds of the Gulf, 1983. The data are adapted from the trawl monitoring surveys. (After MEEMESKUL and SINGTOTONG, 1985)

century.

(2) Catch of trash fish in different fishing areas

Fig. 3 gives the average catch rate for each group observed from nine statistical areas in the Gulf of Thailand (for areas see Fig. 4).

Both the figures for 1977 and the average for 1972–1977 showed a similar tendency. The average CPUE for trash fish (B+C) in the period 1972–1977 (26.6 kg/hr) was nearly the same as that in 1977 (30.2 kg/hr), in spite of the total average CPUE in 1972–1977 (53.5 kg/hr) being a little higher than that in 1977 (46.6 kg/hr). About 60 per cent of trash fish in both periods was produced from the southern waters south from Area V.

According to the data for 1982, however, the average CPUE for trash fish decreased to 19.3 kg/hr. About 61 per cent of trash fish was produced from the northern waters north from Area V.

These results suggest that the catch rate of trash fish by research vessels in the Gulf of Thailand decreased after 1977 and that the productive areas shifted from the southern waters to the northern waters of the Gulf of Thailand. The trawling survey in 1983 revealed that the areas for high trash fish CPUE were concentrated in the waters around a 40–50 m depth, especially those in Area V (Fig. 4).

## 2. Commercial Data

(1) Periodic fluctuation of trash fish production by trawlers

Periodic fluctuations of both demersal and trash fish productions by trawlers in the Gulf of Thailand are illustrated in Fig. 5 and Table 3.

As regards the catch of trash fish, otter-board trawls seem to be the most important gear because their production was more than 62 per cent of all-trawl-gear production throughout the period under consideration, and the annual fluctuation of trash fish catch by otter-board trawlers (B+C)

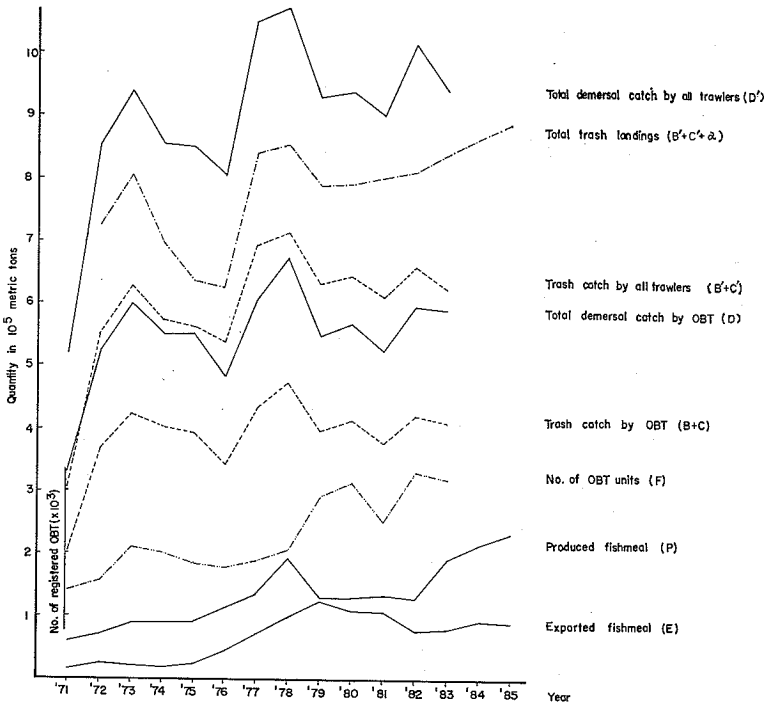



Fig. 5. Periodic fluctuations of trash fish production in the Gulf of Thailand, 1971–1985. OBT indicates regular size (more than 14 m length) otter board trawlers. Symbols B, C and D are adapted from Fig. 1, and each dash mark indicates the catch by all trawlers. $\alpha$ indicates the catch by other fishing craft. Symbols F, P and E are introduced newly.

Table 3. Trash fish production (in metric tons) from the Gulf of Thailand by all trawlers (B′+C′), by otter board trawlers (OBT), by shrimp trawlers (ST), by pair trawlers (PT), and by push netters (PN), 1971–1983 (percentages of total marine production for B′+C′, and those of total trash fish production for OBT to PN are given in parentheses).

| | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B′+C′ | 313,479 | 552,558 | 625,771 | 572,787 | 561,288 | 537,148 | 691,630 | 711,256 | 633,802 | 642,733 | 608,245 | 658,248 | 623,676 |
| (%) | (60.1) | (64.7) | (66.9) | (67.1) | (66.0) | (66.6) | (65.9) | (66.4) | (68.2) | (68.5) | (67.4) | (65.0) | (66.3) |
| OBT | 205,990 | 367,429 | 423,914 | 403,335 | 393,345 | 343,467 | 432,485 | 473,717 | 397,700 | 412,550 | 375,767 | 420,828 | 409,045 |
| (%) | (65.7) | (66.5) | (67.8) | (70.4) | (70.1) | (63.9) | (62.5) | (66.6) | (62.7) | (64.2) | (61.8) | (63.9) | (65.6) |
| ST | 22,453 | 64,582 | 85,292 | 66,336 | 48,138 | 71,423 | 107,788 | 102,367 | 111,344 | 122,447 | 125,274 | 104,744 | 101,812 |
| (%) | (7.2) | (11.7) | (13.6) | (11.6) | (8.6) | (13.3) | (15.6) | (14.4) | (17.6) | (19.0) | (20.6) | (15.9) | (16.3) |
| PT | 79,936 | 114,486 | 109,543 | 94,733 | 111,757 | 114,348 | 135,621 | 123,631 | 111,715 | 91,704 | 91,786 | 100,275 | 103,370 |
| (%) | (25.5) | (20.7) | (17.5) | (16.5) | (19.9) | (21.3) | (19.6) | (17.4) | (17.6) | (14.3) | (15.1) | (15.3) | (16.6) |
| PN | 5,100* | 6,061* | 7,022 | 8,383 | 8,048 | 7,910 | 15,736 | 11,541 | 13,043 | 16,032 | 15,418 | 32,401 | 9,449 |
| (%) | (1.6) | (1.1) | (1.1) | (1.5) | (1.4) | (1.5) | (2.3) | (1.6) | (2.1) | (2.5) | (2.5) | (4.9) | (1.5) |

* Estimated value

showed a pattern similar to that by all trawlers (B′+C′).

Generally, during the period between 1971 and 1978, trash fish catch by otter board trawlers showed a upward trend with a periodic fluctuation, reaching the peak of 474,000 metric tons in 1978. After that the trash fish catch showed a downward trend with slight annual fluctuations, although the total landings (B′+C′+$\alpha$) have reflected an increasing trend since 1979.

This increasing trend of total trash landings (B′+C′+$\alpha$) may be due to the increasing demand by fish meal products*3, as shown by the fact that most of trash fish was used for fish meal production (P), which yielded 131,000 to 232,000 metric tons during 1979–1985. The majority of fish meal produced was exported but, after 1982, the volume of fish meal exported (E) showed a decreasing trend owing to shrinking market outlets abroad in spite of an increase in fish meal production.

According to Thai scientists, the potential yield of the demersal fish stock in the Gulf of Tailand during 1961–1977 was estimated at the level of about 655,000–687,000 metric tons (CHULLASORN, 1982). However the estimated potential yield of the demersal fish stock in 1961–1977 was, ironically, nearly equal to the average commercial production of trash fish by trawlers during 1977–1983 (see Table 3).

If we assume that estimated potential yield (MSY) of demersal fish stock is a reasonable one, it is likely that the MSY was only equivalent to the trash fish exploitation by trawlers in 1977–1983, and no increase of trash fish catch as well as economic fish production by trawlers can be expected in the future.

(2) The relation between the trash catch and the number of OBT

The general situation as regards trash fish catch by commercial otter board trawlers, however, differs in several aspects if we consider the figures of catch and effort data for 1977–1983 as illustrated in Table 4.

During the two years 1977 and 1978, the number of OBT units remained almost at the same level of 1,900 to 2,000 units, with a corresponding catch of 430,000 to 470,000 metric tons of trash fish. This represents an annual catch of 230 metric tons produced per boat during these two years. In 1979, the number of OBT units increased sharply to about 3,000 units, and during 1980–1983, with the exception of 1981, the number fluctuated around 3,200–3,300 units. During that period, the value in terms of catch per unit of boats (CPUE) was found to decline to about 130–150 ton/boat. The low number of OBT units in 1981 was due to a regulation*4 issued by the Department of Fisheries (DOF), Thailand. Thus, owing to the decrease in trash

*3 According to BOONYUBOL and PRAMOKECHUTIMA (1984) about 71 per cent of trash fish was utilized as fish meal in 1973. This percentage increased to 85 per cent in 1976.

*4 In 1981 each craft owner was allowed to engaged only in a single-craft fishery.

Table 4. Number of OBT units (F), trash fish catch (B+C) in metric tons and CPUE (ton/boat) in the Gulf of Thailand, 1977-1983.

| | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | Average** in 1979-1983 |
|---|---|---|---|---|---|---|---|---|
| F | 1,899 | 2,058 | 2,927 | 3,152 | 2,523 | 3,310 | 3,212 | 3,150 |
| B+C | 432,485 | 473,717 | 397,700 | 412,550 | 375,767 | 420,828 | 409,045* | 410,030 |
| CPUE | 227.74 | 230.18 | 135.87 | 130.89 | 148.94 | 127.14 | 127.35 | 130.17 |

* estimated value
** except for 1981

Table 5. Estimated values of the decrement coefficient of CPUE per year ($Z'$), initial abundance index (ln $N_0$) in 1976 and in 1978, and the correlation coefficient (r) between ln $N_t$ and $t$. $t_{max}$ indicates the number of years, starting from the year $t_0$, after which ln $N_t=0$ can be expected.

| No. | $t_0$ | Applied $t$ | $Z'$ | in $N_0$ | r | CPUE (ton/boat in 1985 | $t_{max}$ |
|---|---|---|---|---|---|---|---|
| ① | 1976 | 1977-1983 | 0.1014 | 5.4554 | −0.8187 | 93.96 | 53.8 |
| ② | 1976 | 1979-1983 | 0.0159 | 4.9757 | −0.3817 | 125.58 | 313.7 |

fish catch due to a drastic increase in OBT units, an abrupt CPUE reduction (about 59 %) was found in 1979, and resulted in a small subsequent reduction during 1980 to 1983.

By plotting ln (CPUE) against time ($t$), we can estimate $Z'$ as well as the $t_{max}$ value (Fig. 6), and the results are given in Table 5.

The two calculations show a significant difference in the value of $Z'$, and in the estimated values of CPUE in 1985 which are 93.96 ton/boat and 125.58 ton/boat respectively. The values of $Z'$ as well as $t_{max}$, which were obtained from regression line ①, are not very different from that of (B+C), which appears in Table 2, although the CPUEs were calculated on different bases.

At the moment, we do not feel justified to extrapolate on the basis of such limited data. However, as far as a rough guess is permitted, regression line ② seems to be more suitable for forecasting trash fish fisheries, taking into account the almost stable figure of trash catch by OBT (B+C) during 1979-1983, which appears in Fig. 5.

Each obtained prameter as shown in ② of Table 5 suggests that, for example, OBT fishery for trash fish will continue for a long time —maybe for another 310 years—provided the number of OBT is regulated to a maximum of 3,000 units.

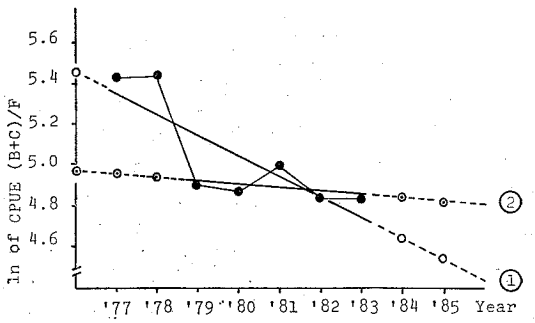



Fig. 6. Plot of ln (CPUE) vs. $t$ during the two periods of 1977-1983 (①), and 1979-1983 (②). Regression lines are calculated from 7 (①) and 5 (②) black points only.

## Discussion and Conclusion

The rapid expansion of trawl fisheries after 1979, as indicated in the number of otter board trawl units in Table 4, has put great pressure on the available demersal resources in the Gulf of Thailand. Hence the overall stock size of demersal fish has decreased drastically as shown in the reduction of total demersal catch from approximately 1,100,000 metric tons in 1978 to 900,000 metric tons in 1981.

In the tropical waters of low latitudes, trawl catches are made up of many fish groups (multi-species) without dominant species. The rapid expansion of fishing intensity may result in the

deterioration of every useful demersal resource with a reduction of age, at first capture, and fisheries are obliged to depend more upon less useful fishes. Thus trawl fishing pressures in tropical waters tend to affect uniformaly on every kind of demersal fish species.

As far as otter board trawl fishing is concerned, demersal catch was composed mainly of trash fish (more than 70 %) and this proportion has been kept for a long period (Fig. 5). And trash fishes comprise a considerable number of juveniles and young of several economically important fish species (SHINODA *et al*, 1978).

Trash fish is usually treated as economically low-value fish and mostly utilized for fish meal products or as food for cultured fish and for ducks. Hence the auction price of trash fish at landing sites is significantly low when compared with other high-value economic groups. Thus a higher benefit could not be expected from the increase of trash fish catch by trawl fishing (HAYASE and ANAPONGSUK, 1986).

In the Gulf of Thailand, it should be noted that the large proportion of trash catch by Thai commercial trawlers is mainly due to the use of nets with a small cod-end mesh size of less than 26 mm (VIBHASIR *et al*, 1985). The development of trawl fisheries should therefore be carefully controlled and managed especially if juveneiles and young are subjected to intense fishing pressure. The Government is obligated to give serious consideration to finding suitable measures to regulate the trawl fisheries in order to reduce westage in exploiting trash fish resources.

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# タイ国トロール漁船によるトラッシュ・フィッシュ（屑魚）漁獲量の変動

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**要旨**：タイ国の水産局漁業統計課に保存されている漁獲資料および海面漁業部で実施した漁獲試験結果を利用して，トラッシュ・フィッシュ漁獲量の年変化を分析し考察を加えた。トロール漁船による漁獲物の内，一般に小型で商品価値の低いトラッシュ・フィッシュ（主としてフィッシュミール用に利用される）は，底魚総漁獲量（80～110万トン）の内60～70％と安定した高い割合を占めている。1979年に漁船登録数が以前の二千隻から三千隻に急増し以降も増加傾向をたどるにもかかわらず，底魚総漁獲量およびトラッシュ・フィッシュ漁獲量は1978年をピークに急減少後横ばい状態が続いており，漁船当たり漁獲量（CPUE）に減少傾向がみられた。また，トロール網の目合も年々小型化する傾向にある。これらのことからトロール漁業の強化，発展に伴い底魚資源の獲りすぎによる資源の枯渇現象が進んでいることが示唆された。

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