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Fisheries

EFFECTS OF SHRIMP TRAWLERS ON THE FISHERIES STATUS AND ENVIRONMENT OF THE NORTHWEST ARABIAN GULF

WPŁYW TRAWLERÓW KREWETKOWYCH NA STAN RYBOŁÓWSTWA I ŚRODOWISKA NATURALNEGO W PÓŁNOCNEJ CZĘŚCI ZATOKI PERSKIEJ

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The catch per unit effort (c.p.u.e.) estimated as kg/hr and the yield per recruitment (*Y/R*) of ten common by-catch fishes are used in the present paper to investigate the effects of shrimp trawlers on the fisheries status and its environment in the Northwest Arabian Gulf. Samples were collected on weekly basis through fishery-oceanography survey carried out by the Marine Science Centre at the University of Basrah during the period of 1995–1999, using two small shrimp trawlers. The catch per unit effort (c.p.u.e.) of total, commercial fishes, shrimps, and other invertebrates catches showed a drastical drop year by year. The results of the relative yield per recruitment (*Y'/R*) of the ten investigated species, their optimum and current lengths at first capture (L_c) and their lengths at first maturation (L_m) indicate that the stock of these species suffered a problem of recruitment overfishing. A strategy of protection for Northwest Arabian Gulf fisheries involves implementing closed season, introducing an effort limitation policy should be designed.

INTRODUCTION

Shrimp trawlers are one of the most common fishing vessel types widely used throughout the world. The by-catch by this fishing method contributed 3–5 million tons/yr, half of which was discarded at sea (Slavin 1982). Alverson et al. (1994) thoroughly discussed the global assessment of the by-catch and discards, and stated that the catch per unit of effort (c.p.u.e.) of by-catch shrimp trawlers in the Arabian Gulf was about 4.17 kg/hr.

The Iraqi marine waters at the most northern tip of the Arabian Gulf are representing the estuarine part of the Gulf. As a result of its estuarine habitat, this part plays an important role as nursery and feeding grounds for many fish species (Hussain and Ahmed 1995). This region is characterised by the river runoff as gauged from Shatt Al-Arab River which

estimated to be ~ 5 km^3/yr (Al-Manssory 1996), whereas Abdullah (1990) had pointed out that the annual discharge of Shatt Al-Arab wass gradually declining. This phenomenon had been focused in the Eighth Session of the Committee for the Development and Management of the Fishery Resources of the Gulfs held in Oman 1994 (Anonymous 1996) in which a decision to monitor the effect of this reduction on the environment of the Arabian Gulf was recommended.

The commercial fishing in the NW Arabian Gulf, was completely stopped in 1980 and intensively resumed following the cease-fire in 1988 by artisanal fishery (large wooden launches and small boats using traps, gill nets, hadra: an intertidal rounded maze trap made of reeds, and hook and line). Since 1992, an industrial fishing vessels (small shrimp trawlers, 15–17 m length and a few large trawlers) was widely used. Such fishing activities represented by not fewer than 1000 fishing vessels of different types (wooden boats of 12–17 m length, small fiberglass boats of 3 m length and back trawlers of 15–20 m length) operate in approximately 300 km^2 had made the assessment of the NW fisheries an urgent step. Thus, the Marine Science Centre at the University of Basrah has executed a long-term fishery-oceanography survey during the five last years 1995–2000 using two small trawlers covering the Iraqi marine and coastal waters including the Shatt Al-Arab estuary, Khor Al-Amaya and Khor Abdullah.

The development of underwater submersibles and underwater photography has aided assessment of trawl damage to the sea bottom (Caddy 1973; Gibbs et al. 1980). Unfortunately, no attempt has been carried out neither in Iraqi nor in the other Northwest Arabian Gulf countries to assess the trawling effects on the seabed and its living resources.

The catch per unit effort (c.p.u.e.) estimated as kg/hr and the yield per recruitment (*Y/R*) of ten common by-catch fishes are used in the present paper to investigate the effects of shrimp trawlers on the fisheries status and its environment in this region.

MATERIAL AND METHODS

Study area

The NW Arabian Gulf is representing the estuarine habitat of the Gulf (Fig. 1). This part differs from other Gulf regions due to:

1. The terrigenous and biogenic sediments transported by the Shatt Al-Arab River.
2. The freshwater discharge from the Mesopotamia rivers and Karun especially during the flood season.

Topographically, the depths are slopping gently from the coastal mud flats for 30–40 km south, then a sudden drop in depth occurs due to the formation of relatively deep valleys "Khors" of depth 10–20 m (Fig. 1). The sediments were comprised of sand (48.2%), silt (23.5%), and clay (28.3%) (Albadran 1995).

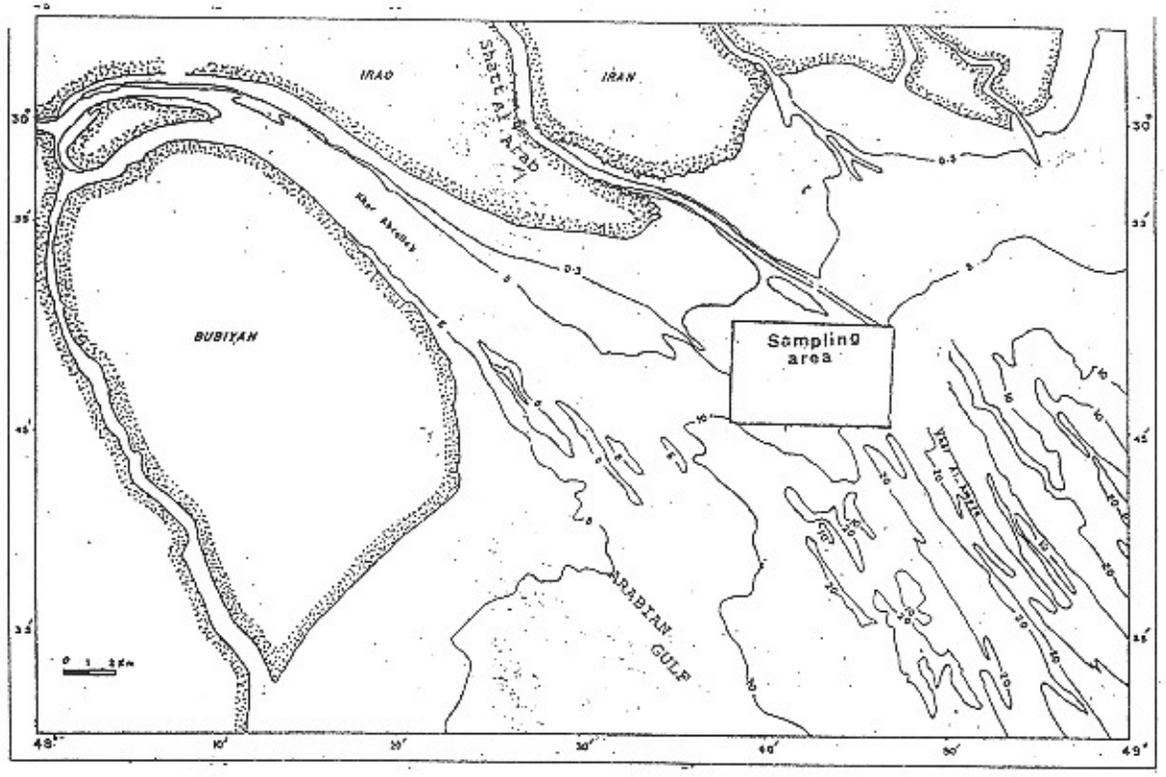

Fig. 1. Location map of Iraqi marine waters, northwest Arabian Gulf, showing the sampling area

Fish collection

Samples were collected on weekly basis through fishery-oceanography survey carried out by the Marine Science Centre at the University of Basrah since 1995. Two small shrimp trawlers "Behar" and "Mahar" were used for fishing operations. Each is 17 m long, 3 m wide, with inboard engine operating a shrimp trawl net (17-m head-rope, 18-m foot-rope and stretched mesh 2 cm in the wings and 1 cm in the cod-end) from a winch system towed by wire of 75–100 m. All shrimp trawlers operate in the Northwest Arabian Gulf use a net of similar features. The samples were collected for seven consecutive fishing days with an average of 5–6 hauls per day and 2–3 hours for each haul, i.e. ~ 35 hauls per week.

The total catch of each haul was categorised into:

1. Commercial fishes (marketable species).
2. Non-commercial fishes (inedible fish species, mainly sharks, rays, and small fishes).
3. Shrimps, mainly *Penaeus semisulcatus* and *Metapenaeus affinis*.
4. Other invertebrates, mainly crabs and molluscs in addition to sea cucumber and sea urchin, which locally considered as non-commercial catch.

The weight of each category was calculated using 3 standard baskets (18 kg for each) randomly collected from the multi species catch and sorted into the above four groups. The weight of each group, in the three baskets, was then calculated in relation to the haul and eventually to the whole trip. The c.p.u.e. of each category was expressed as (kg/hr). The total lengths of the investigated fish species were measured either from random sub-samples of each haul or using the whole catch of the haul when it was small. Then the length frequency data of each species were pooled on monthly base.

Analytical methods

Ten common fish species were chosen for the stock assessment aspect in the present study namely:

silver pomfret, *Pampus argenteus*;
sin croaker, *Johnieops sina*;
tonguesole, *Cynoglossus arel*;
giant sea catfish, *Arius thalassinus*;
anchovy, *Thryssa mystax*;
tigertooth croaker, *Otolithes ruber*;
silver croaker, *Johnius belangerii*;
greater lizardfish, *Saurida tumbil*;
goatfish, *Upeneus sulphureus*;
big-eye shad, *Ilisha megaloptera*.

The relative yields per recruitment (Y'/R) of these species were estimated by length-based method using FiSAT of Gayanilo et al. (1996). This program is the most recent software produced as a result of merging the two main programs ELEFAN developed by Pauly and David (1981) in ICLARM and LFSA developed by Sparre (1987) in FAO. This program package consisting of robust methodologies used with microcomputers, enabling users to formulate management options for fisheries in data-sparse, tropical contexts.

L_m was calculated by other authors as an average length of fishes first time taking part in spawning.

The relative yield per recruitment (Y'/R) routine provided in the program was used to estimate separately the (Y'/R) and stock predictions for each species, and hence, to recommend adequate management regimes. The selection ogive technique was adopted. Input data required for this technique is the file of probability of capture, asymptotic length (L_∞) and (M/K), where M = natural mortality coefficient and K = catabolism coefficient, which obtained by the same program for each species. The main output is the (E_{max}): the exploitation level at which the yield per recruitment could be maximised.

RESULTS

Catch per unit effort (c.p.u.e.)

A total of ~10 155 trawling hours through 5122 hauls were executed during the survey period. The total catch obtained was 224.7 tons divided into four categories; 56.2 tons (25%) commercial fish (including about 35 marketable species), 38.5 tons (17.1%) shrimps (mostly *Penaeus semisulcatus* and *Metapenaeus affinis*), 115.6 tons (51.4 %) non-commercial catch (sharks, rays, and other unmarketable fishes) and 14.4 tons (6.4%) other invertebrates (mostly crabs and molluscs).

The annual fluctuations of the c.p.u.e. of total and its four components are summarised in Table 1. The total catch rates were gradually decreased from 428.6 kg/h at the beginning of the survey to 267.2 kg/h in 1999. The catches of the commercial fishes and shrimps were drastically dropped from 84.8 kg/h in 1995 to 40.7 kg/h in 1999 for the first and from 78.8 kg/h to 24.6 kg/h for the second. A noticeable decline was observed in the catch of these two groups during 1996–1997, where the catch rates were decreased from 86.1 kg/h to 58.4 kg/h and from 83.1 kg/h to 50.2 kg/h for commercial fishes and shrimps respectively. The catches of other invertebrates were heavily decreased during 1998–1999 from 30.1 kg/h to 16.8 kg/h. Only the non-commercial catches showed a moderate decline during the investigated period.

Table 1

Annual c.p.u.e. (kg/h) of total catch and its four components of Northwest Arabian Gulf during 1995–1999

Year	Commercial fishes	Non-commercial fishes	Shrimps	Other invertebrates	Total
1995	84.8	233.6	78.8	31.4	482.6
1996	86.1	222.4	83.1	35.2	416.8
1997	58.4	180.1	50.2	28.3	317.0
1998	41.5	193.3	33.0	30.1	297.9
1999	40.7	185.1	24.6	16.8	267.2

Relative yield per recruitment (Y'/R)

The results of the (Y'/R) of the ten investigated species, their optimum and current lengths at first capture (L_c) and their lengths at first maturation (L_m) are shown in Table 2. The present (Y'/R) of all species were lower than their corresponding maximum (Y'/R) which could be attained if the effort that maximise the yield (E_{max}) is exerted and the species are collected at their optimum (L_c). With the exception of goatfish *U. sulphureus*, the current (L_c) were lower than their optimum once and also than their (L_m) especially for *P. argenteus*, *O. rober*, *S. tumbil*, and *A. thalassinus*. Such results indicate that, under the present fishing effort exerted by shrimp trawl net of stretched mesh 1 cm in the cod-end, less advantage may be given for species occupy the Northwest Arabian Gulf to spawn at least one time before capture.

Table 2

Relative yield per recruitment and the corresponding current and optimum length at first capture and length at first maturation of common fishes in the Northwest Arabian Gulf

Species	Current (Y'/R)	Max. (Y'/R)	Current L_c (cm)	Optimum L_c (cm)	L_m (cm)	Reference
Pampus argenteus	2.30	2.33	15.9	20.0	15.7	Mohammed and Ali 1993
Otolithes ruber	1.90	2.10	12.8	28.0	22.4	Mathews et al. 1989
Johnieops sina	1.80	1.90	9.8	14.0	10.2	Mahdi 1996
Johnius belangerii	1.63	2.00	7.5	13.5	10.4	Mahdi 1996
Cynoglossus arel	2.00	2.16	12.5	15.0	13.0	Mathews et al. 1989
Saurida tumbil	1.72	1.75	11.6	21.5	16.5	Mathews et al. 1989
Arius thalassinus	1.28	1.63	7.8	18.6	15.0	Naa'ma and Yousif 1988
Upeneus sulphureus	2.60	2.70	8.5	8.5	8.0	Mutlak 2000
Thryssa mystax	1.44	1.60	8.0	12.7	9.5	Hussain and Ali 1987
Ilisha megaloptera	1.20	1.87	7.6	16.1	13.5	Abdullah 2000

DISCUSSION

Knowledge of the effect of trawl gear on the bottom living resources is important as many estuarine fish species depend on these organisms as food sources. Ali et al. (1993) found that crabs, shrimps, and molluscs are the major food items for the demersal fish assemblage in the Northwest Arabian Gulf.

Heavy tickler chains on muddy or sandy bottoms are believed to expose many burrowing animals thus making them vulnerable to predators. The damage of sessile organisms by the foot-rope and otter boards is greater than that of the net. Consequently, most of the effects of trawling take place outside of the net's path.

Moreover, the trawling reduces increment of the sessile invertebrates quantity. On the other hand, this damage is beneficial for fishes because their food items become more accessible. All burrowing animals and natural structural affording shelter are affected by such activity. The clearing of debris, rocks made the shrimps vulnerable to the trawl fishing as a result of this, shrimps are obligatory move to more protected areas such as rocky bottom and/or to regions crowded by small boats used drift gill nets where trawling is difficult to be used.

Due to the continuous increase of fishing effort in the Iraqi marine waters, the catch rates of by-catch fishes in Kuwait were reduced from 200 kg/h in 1977–1980 to 100 kg/h in 1982–1983. That decrease was associated with an increase in effort from 3 300 to 12 000 days per year (Mathews et al. 1989). Similarly the c.p.u.e. of both commercial and non-commercial catches in the Iraqi marine waters during the five last years showed a clear decline. Moreover, the (Y'/R) results obtained in the present study for the common fish species elucidate that the current length at first capture (L_c) of these species are lower than their lengths at first maturation (L_m). This problem may cause a great recruitment over-fishing in future due to the continuous removal of pre-spawning fishes. Therefore, a management work should be started for selectivity aspect to design a net of an appropriate mesh size to collect the optimum lengths avoiding any over-fishing problem.

A total of 250 shrimp trawlers, not less than 100 vessels per week are operating in the studied area. The average of daily fishing time is 10 hours for each vessel, which is an equivalent to 120 fishing days/vessel/year, i.e. 30 000 fishing day/year for the whole fleet. Accordingly, it could be assumed that this ground was swept ~ 50 times per year. Such fishing activity is enough to disturb the top 10 cm of the seabed three times a month. Such repeatedly trawling and slow growth of the sessile invertebrates, may make the full recovering of these organisms take several years.

Pauly (1979) found that as effort increase, smaller and less valuable fish dominated the catch. Mathews et al. (1989) estimated the discards in Kuwaiti waters to be 8 000–12 000 tons per year. Such amount discarded which logically increased during the 1990s due to the increasing of fishing activity in the Northwest Arabian Gulf countries may caused an organic pollution in this region. A considerable attention should be directed for such case by the regional fisheries authorities of the Northwest Arabian Gulf countries.

The side effects of trawling can be summarised by:

- The damage of the vegetated substrates, the nursery habitat for both fishes and shrimps. Staples et al. (1985) found that commercial catches of *Penaeus semisulcatus* occurred only near sea-grass area. Unfortunately, no quantitative estimates of sea-grass are available in the Northwest Arabian Gulf. Basson et al. (1977) illustrated the otter boards scar the bottom removing plant roots.

- The increasing of the turbidity due to high sediment suspension and reduce the light penetration for photosynthesis and in reintroducing trapped nutrients to the water column.
- The formation of trenches, Caddy (1973) estimated that trenches, presumably resulting from otter trawl boards, covered 3–7% of the bottom area of Chaleur Bay in the Gulf of St. Lawrence.

CONCLUSIONS

1. Shrimp trawlers operations disturbed the bottom living resources. Their most obvious direct effect is on the abundance of shrimp and demersal fishes due to its effect on their (Y'/R). The other side effects include the productivity of the seabed, destruction of benthic vegetation (egg nests) and probable damage to man-made structures such as pipelines.
2. Generally, there is a lack of fundamental research required to support definite conclusions. A strategy of protection for Northwest Arabian Gulf fisheries involves implementing closed season, introducing an effort limitation policy should be designed to reduce the total amount of trawling and priority should be devoted to create a natural coastal protected area.
3. These conclusions are tentative, and further studies are essential to be carried out, especially the regulating of fishing effort. The understanding of the seabed swept during trawling and its importance as a habitat for feeding and nursery grounds and the rate of shrimps preyed by-catch fishes would allow an assessment of the possible damage caused by shrimp trawlers for shrimp and demersal fish stocks.

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