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AN ASSESSMENT OF THE STOCKS OF COMMERCIALLY IMPORTANT PENAEID PRAWN IN THE CHILAW SEA, SRI LANKA.

by

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ABSTRACT Sampling by a commercial trawler was conducted during February 1984 in the Chilaw Sea, Sri Lanka, in order to assess the stock size and to study the depth and substrata related distributions of prawn. The entire extent of the prawn distribution was divided into different depth strata and then into a number of rectangles for trawl sampling. Each trawl tow was approximately one hour long. Surface salinitiy and temperature were recorded for each haul. Mud samples were taken from each rectangle to assess qualitatively their organic content and particle size. Two - way analysis of variance on catch per unit of effort values of major species of prawn indicated a significant variation area wise in the catch rates of *Parapenaeopsis stylifera.* The same analysis on prawn length data showed a progressive increase in lengths towards the south from the Deduru river estuary and the Chilaw lagoon mouth for *Penaeus indicus.* This area appears to be the source of recruitment. There were substantial reductions in *Metapenaeus dobsoni* and *P.stylifera.* stoks. This study also indicated that the prawn resources in the Chilaw sea were confined to the 0 - 8 fathom depth range, and were abundant on sand and mud patches with organic material.

INTRODUCTION

Large scale fishing for prawn, employing 3.5 ton mechanized crafts with small mesh prawn trawl nets, commenced around 1962 in Chilaw and has spread to other areas. The commercially important large species of prawns are *Penaeus indicus, P. merguiensis, P. semisulcatus,* and *P. monodon*; small species included *Metapenaeus dobsoni* and *Parapenaeopsis stylifera.* The by-catch is generally dominated by Leiognathids, *Thrissocles setirostris* and Sciaenids. The very high price, and greater demand that the larger varieties of penaeid prawn command in the foreign market encouraged over capitalization of the trawler fleet. The prawn fishing grounds in the Chilaw sea, however, are small could not sustain this excessive fishing pressure on the resource. A natural stabilization of fishing effort therefore occurred, from the peak level of around 100 boats in late 70's to around 70 boats in recent years. The economic return from each boat, however, was not commensurate with the cost of effort, due possibly to over exploitation and high cost of fishing because of increasse in fuel prices. A study of this fishery was therefore required in order to formulate a cost effective management plan to exploit this resource more efficiently.

Towards this goal, knowledge of stock abundance is as essential as other vital population dynamics parameters. In the late 70's the standing stocks of certain species of penaeid prawn in the Chilaw sea were estimated using the De Lury method (Siddeek, 1978). The resource survey carried out during February 1984, described in this paper, gives some comparative estimates of the stocks of prawn in the area. In addition, the distribution patterns of prawns are also described.

MATERIALS AND METHODS

Craft

A commercial wooden boat "Kelum-Putha" with a crew of four was employed. Her specifications were: overall length 8.48 m, beam 3 m, gross tonnage 3.5 tons, Yanmar inboard engine 30 HP fitted with a 2 to 1 reduction gear ratio. The average speed of trawling was estimated at 1.52 knots.

Trawl Gear

Two small mesh prawn trawls of the traditional type were used for sampling; one in the shallower depth range (0-4 fm) and the other in the deeper depth range (4-12fm). The characteristics of the two trawls were: head ropes (each with three small floats) 13 m and 13.8 m, respectively; ground ropes of 13 m each (with 17 lead weights of 500 gm each per rope); lengths along belly line 14.5 m and 16.5 m respectively; condend stretched mesh size 10 mm and 12 mm respectively. The estimated average width of the trawls, when on tow, were 3.44 m and 3.12 m, respectively.

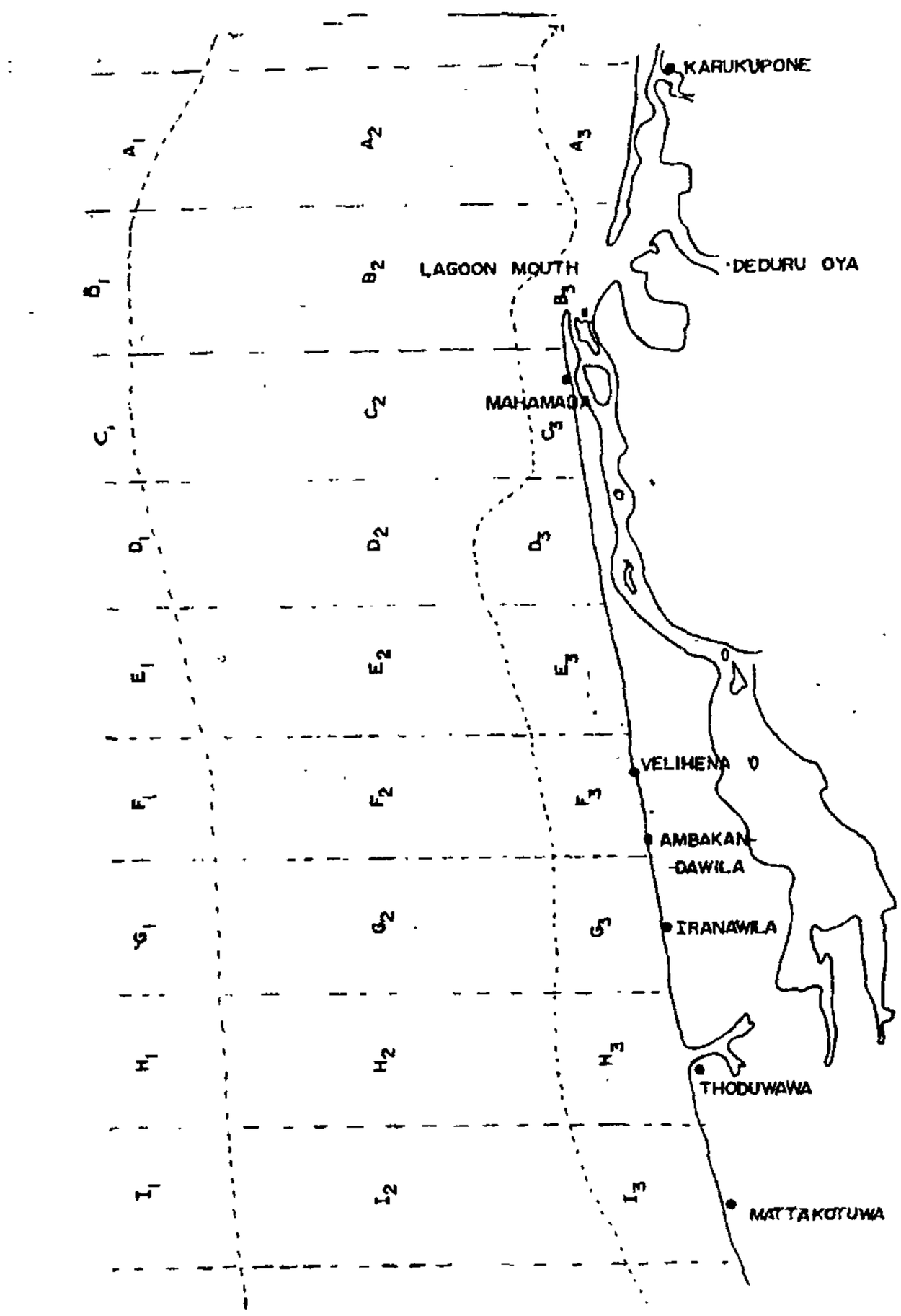

Fig. 1 Survey Area

The spread of the net was maintained by tying the towing warps to ends of outrigger booms made of bamboo. In place of the otter doors, two rectangular concrete slabs of approximately 40 kg each were used on each trawl net (see Weerasooriya, 1977 and Siddeek, 1978 for detail specifications of the nets used and the operations)

Survey Design

The length of the prawn fishing ground in the Chilaw Sea exploited by traditional trawlers and covered in this survey was approximately 14.4 km and the breadth, up to 8 fm isobath, was approximately 2.7 km (Fig. 1). The survey area was divided latitudinally into 9 transacts which in turn were divided longitudinally into three strips at depths of 4 fm, 8 fm and 12 fm, respectively; thus, making 27 rectangles. The nine transacts were labelled A to I, from north to south, and the depth ranges were coded 1 (8 - 12 fm), 2 (4 - 8 fm) ,and 3(0 - 4 fm), respectively. All trawlings were conducted during February 1984.

The correct approach to sample a population for any statistical analysis is to pre-select sampling stations in a random fashion. However, for a study of this nature, where dynamism of the population is most important, sampling had to be done within a short period of time, covering the whole area and all depths to avoid possible repetition of counts. Hence, as far as possible daily trawl operations were carried out covering very wide area and depth ranges, in a zig-zag fashion. The conditions of chartering commercial vessel restricted the trawl operations to three to four tows per day. Furthermore, the rough bottoms in some rectangles hindered even sampling per rectangle. The duration of the tow was maintained as far as possible, within 45 to 60 minutes, to ensure consistency in sampling and catch rates.

The catch was sorted out into species (according to Munro (1955) and Dall (1957) and the total catch of each species was weighed using a pan balance of 10 kg capacity. The total lengths of all large prawn and large fish were measured on board the craft and sub samples of small prawn and fish were taken for measurement in the laboratory. Two - way analyis of variance was performed on log transformed catch rate and length data separately swept area method was used to estimate stock size.

Hydrography

At the hauling position of each trawl station, total depth, secchi disc reading and surface temperature were recorded and water samples were taken for bottom temperature and salinity readings. A grab sample was taken for sediment analysis. Salinity values were read using a refractometer. Due to difficulties encountered with the samplers, these records could not be maintained continousuly in later stages of the survey. However, this shortcoming did not affect the findings presented in this paper.

RESULTS AND DISCUSSION

Hydrography

There were no appreciable temperature differences between the surface and bottom because the prawn ground was located in a fairly shallow depths, and mixing of the entire water column occurred due to wave actions. The maximum temperature difference was 0.5 C. On the other hand, across the rectangles, surface temperatures varied from 26 C to 31 C. The lower temperatures were recorded in shallow rectangles and the lowest (26 C) was recorded in rectangle B3, which is adjacent to the Deduru river estuary and the lagoon mouth. This is presumably due to an influx of cool water from the Deduru river and the lagoon. The surface salinity in this region was also observed to be relatively low (24 ppm) for the same reason. Other regions, away from the estuary and the lagoon, were outside the influence of land drainage of fresh water, and recorded consistently high values of surface and bottom salinitiy ranging from 30 to 34 ppm (Table 1).

Table 1. **Log enteries of the trawl operation (February 1984).**

Day	Operation No	Station	Depth (m)	Secchi (m)	Temperature(c) Surface	Temperature(c) Bottom	Salinity(ppm) Surface	Salinity(ppm) Bottom	Codend Mesh(mm)	Warp (m)	Time	Remarks
13	01	B3	08.5	3.0	26.0	-	24	31	10	29	06.21 - 07.13	Mostly small prawn
	02	A3	07.0	3.0	27.5	27.0	-	-	10	29	07.45 - 08.48	Mostly fish
	03	B2	10.5	1.9	28.0	27.5	-	30	12	40	09.40 - 10.23	do
	04	C2	10.5	1.8	28.0	27.5	-	34	12	40	10.50 - 11.55	do
14	05	D2	9.0	2.5	27.0	-	-	32	12	40	06.28 - 07.09	Mostly trash
	06	E2	9.5	2.4	28.0	27.5	-	33	10	40	07.25 - 08.01	Net stuck to mud,mostly trash
	07	F2	10.5	7.2	28.5	28.5	-	32	10	40	08.33 - 09.10	Net stuck to mud mostly fish
	08	G2	09.5	4.6	28.5	28.0	-	32	10	40	09.28 - 10.20	Mostly fish
	09	F2	09.0	-	-	-	-	-	10	40	10.35 - 11.15	do
15	10	H2	08.5	2.1	28.0	-	32	-	10	36	06.15 - 07.03	Mostly small prawn
	11	13	07.5	1.7	27.5	-	32	-	10	36	07.15 - 08.05	do
	12	E2	11.0	5.5	28.0	-	32	-	10	40	09.47 - 10.18	Small prawn nil
	13	12	09.5	3.0	28.0	-	32	-	10	36	08.15 - 08.55	Mostly fish
16	14	C2	11.0	3.1	28.5	-	-	-	12	47	06.32 - 07.13	do
	15	D2	10.0	2.7	28.5	-	31	-	12	40	07.34 - 08.26	Net stuck to mud, mostlyfish
	16	C2	10.5	-	29.0	-	32	-	10	47	09.10 - 19.38	Small prawn nil
	17	C3	07.5	1.8	29.6	-	-	-	10	29	10.45 - 11.20	Fair catch of large prawn
	18	C2	10.0	-	27.5	-	-	-	10	47	19.00 - 19.45	do
	19	C3	07.5	-	28.0	-	33	-	12	31	20.03 - 20.25	do
17	20	E3	09.0	4.5	28.5	-	31	-	12	29	07.45 - 08.45	Rough sea, less prawn
	21	D3	07.0	3.0	27.0	-	32	-	10	29	07.15 - 07.35	Net stucik to mud, less prawn
	22	F3	08.0	-	28.5	-	33	-	10	29	09.00 - 09.20	Net damaged, prawn nil
18	23	F3	07.5	2.2	28.0	-	29	-	10	29	07.02 - 07.45	Less prawn
	24	G3	08.0	1.7	28.0	-	32	-	10	29	08.04 - 09.05	do
	25	H3	06.8	1.6	29.0	-	-	-	10	29	09.21 - 10.24	do
	26	H2	09.0	1.6	-	-	-	-	10	35	10.04--11.42	do
20	27	B1	17.0	-	28.8	-	-	-	12	56	07.04 - 07.37	Prawn nill
	28	C1	20.5	16.4	29.0	-	-	-	12	66	08.36 - 09.36	do
	29	A2	08.0	2.2	31.0	-	-	-	12	31	10.45 - 11.22	Fair catch of prawn
	30	A2	08.0	-	30.5	-	-	-	12	31	11.30 - 12.35	Good catch of small prawn
21	31	B2	09.0	1.9	30.5	-	-	-	10	31	16.01 - 17.00	Fair catch of small prawn
	32	A3	07.3	3.1	30.5	-	-	-	10	29	17.00 - 17.40	Less prawn
	33	B3	07.3	-	-	-	-	-	10	29	17.50 - 18.30	do
22	34	D1	24.0	-	-	-	-	-	12	56	14.58 - 15.58	Prawn nil
	35	E1	20.5	16.4	-	-	-	-	12	56	16.18 - 16.43	Net stuck to mud, prawn nil
	36	E2	10.9	-	-	-	-	-	12	36	17.22 - 18.15	Less prawn
24	37	B2	10.0	-	-	-	-	-	12	29	06.29 - 06.47	Net stuck to mud, fair catch of prawn
	38	B2	08.5	-	-	-	-	-	12	29	06.58 - 08.08	Fair catch of prawn
	39	B2	10.5	-	-	-	-	-	12	40	08.20 - 09.06	Less prawn
	40	C2	10.5	-	-	-	-	-	12	36	09.50 - 09.58	Net stuck to mud, less prawn
	41	D2	10.5	-	-	-	-	-	12	36	10.10 - 10.45	Less prawn

In support of the widely accepted view of substrata specificity (Bruin, 1970), large catches of prawns were recorded in this survey from sand and mud bottom with organic material. Even though turbidity is generally regarded as a criterion for high abundance of prawn, it was observed to be a secondary factor. This observation appeared justifiable because turbidity may have occur and either from the disturbances of sand and mud bottoms beneath a water column or brought in by the currents from other regions, to an entirely different bottom, thereby, varying the abundances accordingly. There were instances of small catches of prawn with high turbidity as well as low turbidity. The latter case, for example, was observed in the rectangles within 8 to 12 fm with substrata consisting of coarse sand with shells and pebbles, had a very low turbidity and recorded zero prawn catches (Table 2).

Table 2. **Physical characteristics of the sediment on the bottom of the trawled area.**

Station	Type of sediment
A2	Brown coarse sand with pebbles and shells
A3	Yellow coarse sand with mud, shells and pebbles
B1	Yellow coarse sand with pebbles and a little organic material
B2	Brown coarse sandy mud with a little organic material
B3	Brown coarse sand with pebbles, shells and a little organic material
C1	Yellow fine sand with greenish black organic material
C2	Brown coarse sand with greenish black organic material
D1	Brown coarse sand with a very few shells
+D2	Slightly brown mud with greenish black organic material
+D2	Brown coarse sand with shells and greenish black organic material
+E2	Brown coarse sand with pebbles and shells
+E2	Brown silty mud
E3	Brown sandy mud
F2	Brownish muddy sand with greenish black organic material
+F3	Greenish brown sandy mud with greenish black organic material
+F2	Yellow sand with greenish organic material
G2	Yellow fine sand with greenish organic material
H2	Brown mud with greenish black organic material
H3	Silty grayish fine sand with black organic material

+ Different places in the same rectangle

While adult *P. indicus, P. monodon* and *M. dobsoni* were found on mud and sand bottoms with or without organic matter, *P.stylifera* was abundant on mud bottom with organic material. Bruin (1970) reported that adult *P. semisulcatus* preferred the patches of soft green mud in the Palk Bay and Mulaitivu regions in the north west and northeast coasts of Sri Lanka, where this species is more abundant. However, during this survey, a fair number of *P. semisculcatus* were caught on sand and sandy mud bottoms with organic material. This observation, however, was tentative because of the patchy and scanty distribution of *P. semisculcatus* in the Chilaw Sea which has comparatively low salinity. The overall results suggested preference to certain substrata and to certain food items.

Over fifty five fish and shellfish species were recorded during the survey and these are listed in Table 3. The weight in kg of fish and shellfish caught in each operation is tabulated in Table 4. The Leiongnathids contributed 20.8%, followed by penaeid prawn 17.97%, *Thrissocles setirostris* 13.16% and Sciaenids 10.50% to the total catch during the whole survey period. *M. dobsoni* dominated the prawn catches with 7.35%, followed by *P. indicus with* 5.29%. The higher catches of penaeid prawns, dominated by *P. indicus* and *M. dobsoni*, were observed between depths of 4 and 5 fm in the rectangles A2, B2, and B3 adjoining the Deduru river estuary and the lagoon mouth. *P. stylifera* was grouped with *P. coromandelica* and identified as *P. stylifera* because of difficulties encountered in separating these two species. *P.stylifera* was abundant in rectangles D2, H2, and I3 which are further away from the estuarine region. This appeared logical, since the entire life cycle of *P.stylifera* is confined to the marine environment (Bruin, 1970 and Garcia et al., 1981). It was interesting to observe that prawns were more abundant in

areas where mantis shrimp were less abundant (see operations 29 to 31 in Table 4). The ratio of the prawn catches to the by-catch was 1 : 4.6, and the by-catch composition was similar to that found along the southeast coast of India, dominated by Leiognathid and Sciaenid (Anon, 1981)

Table 3. **Species recorded during the prawn trawl survey**(February 1984).

Common name	Scientific name
White prawn	*Penaeus indicus*
-do-	*Penaeus merguiensis*
Green tiger prawn	*Penaeus semisulcatus*
Brown tiger prawn	*Penaeus monodon*
Small prawn	*Metapenaeus dobsoni*
-do-	*Parapeneopsis stylifera*
-do-	*Parapeneopsis uncta*
-do-	*Metapenaeus ensis*
-do-	*Metapenaeus elegans*
-do-	*Parapeneopsis cornutus*
-do-	*Caridian spp*
Pony fish	*Leiognathus splendens*
-do-	*Gazza minuta*
-do-	*Leiognathus fasciatus*
-do-	*Leiongnatus elongatus*
-do-	*Leiognathus lineolatus*
-do-	*Leiognathus daura*
-do-	*Leiognathus brevirostris*
Jew fish	*Sciaenidae*
Longed finned herring	*Opisthopterus tardoore*
Crescent perch	*Therapon jarbua*
Silver whiting	*Sillago sihama*
Long jaw anchovy	*Thrissocles setirostris*
Silver six thread tassel fish	*Polynemus xanthonemus*
Indian shad	*Euplatygaster indica*
Silver biddies	*Gerridae*
Yellow striped goat fish	*Upeneus vittatus*
Spinefeet	*Siganus spp*
Slender scaled scad	*Seleroides leptolepis*
Common spat	*Dussumieria acuta*
White fish	*Lactarius lactarius*
Cat fish	*Tachysurus spp*
Spotted batfish	*Chaetodon punctatus*
Ribbon fish	*Trichiurus savala*
White sardine	*Kowala coval*
Sardine	*Sardinella spp*
Reef cod	*Epinephelus spp*
Greater lizard fish	*Saurida tumbil*
Pigface bream	*Lethrinus spp*
Scad	*Caranx spp*
Spade fish	*Ephippus orbis*
Parrot fish	*Scarus spp*
Bluefin file fish	*Balistoides viridescens*
Tongue sole	*Cynoglossus spp*
Three spotted flounder	*Pseudorhombus triocellatus*
Puffer fish	*Tetraodontidae*
Shallow water skate	*Trygonidae*
Sea crab	*Portunus sanguinolentus*
Sea crab	*Portunus pelagicus*
Octopus	*Octopus spp*
Squid	*Loligo spp*
Mantis shrimp	*Oratosquilla nepa*
Sea cucumber	*Holothuria spp*

STATISTICAL ANALYSIS

The area and depth effects on the distributions of commercially important *P. indicus, P. semisclcatus, P. monodon, M. dobsoni* and *P.stylifera* were investigated by analysis of variance on the catch weights. The length data of *P. indicus* and *P. semisculcatus* were also subjected to analysis of variance to determine the source of recruitment to the sea fishery as well as the length related distributions. *P monodon, M. dobsoni* and *P.stylifera* were not considered for length data analysis because the data were either scanty or missing from many regions (Table 5). The rectangles within the 8 to 12 fm isobath were

Table 4. Weight of catch (kg) of the main species taken in the prawn trawl survey, February 1984

Species	Trawl operations																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Penaeus indicus	0.80	0.04	0.02	0.15	0.30	0.25	0.60	1.30	0.50	0.25	0.20	-	0.25	0.55	0.05	0.18	0.50	0.50	0.80	-	-	-
P. merguiensis	-	-	-	-	-	-	0.10	-	-	-	0.08	-	-	-	-	-	-	0.01	0.01	-	-	-
P. semisulcatus	-	0.13	0.05	0.25	0.03	0.25	0.25	0.25	0.10	-	-	0.08	0.08	0.30	0.03	-	0.56	-	-	-	-	-
P. monodon	-	0.13	-	-	-	-	0.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metapenaeus dobsoni	2.60	0.06	-	0.01	0.33	0.02	0.13	0.09	0.05	0.50	1.00	-	-	0.16	0.07	-	0.04	0.10	0.05	0.03	-	-
Parapeneopsis stylifera	0.25	-	-	-	0.50	0.06	0.33	0.26	0.13	1.00	1.00	-	-	-	0.02	-	0.01	0.10	0.05	0.03	0.05	-
Other prawns	0.50	-	-	-	0.17	0.04	0.04	0.15	0.12	0.50	0.11	-	-	0.14	0.01	-	-	0.40	0.20	0.03	-	-
Gazza minuta	-	-	-	-	0.06	0.13	-	-	-	0.38	-	-	-	-	-	-	-	-	-	-	-	-
Leiognathus daura	-	-	-	0.47	-	-	-	0.38	-	0.38	0.40	0.93	0.62	-	-	-	-	-	-	0.50	-	-
L. elongatus	-	0.15	0.35	-	0.06	0.27	0.06	0.93	1.30	-	0.20	-	0.62	5.50	3.80	0.10	1.00	-	-	0.83	0.38	0.75
L. gerroides	0.03	0.15	5.22	2.19	0.12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other leiognathids	0.03	3.18	0.52	0.78	-	-	0.12	-	-	-	-	-	-	0.15	0.20	-	0.50	2.15	0.15	0.67	0.22	-
Sciaenidae	0.40	1.14	-	-	0.43	-	1.19	0.76	0.90	-	0.30	0.07	1.75	0.30	0.40	0.15	0.35	1.00	2.50	0.75	1.50	0.20
Opisthopterus tardoore	0.78	0.90	-	-	0.12	-	-	1.50	-	-	0.06	0.42	-	0.25	1.00	0.20	0.25	-	-	1.00	2.50	-
Therapon jarbua	-	-	1.74	-	0.12	-	-	-	-	-	0.06	0.21	0.10	0.20	-	-	0.15	0.32	0.96	-	-	-
Thrissocles setirostris	0.65	7.45	-	1.56	0.62	0.10	1.25	0.38	0.20	-	0.06	0.21	0.75	0.50	0.30	0.31	0.35	0.08	0.50	0.10	1.50	-
Euplatygaster indica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gerridae	-	-	-	-	0.06	0.05	-	0.18	0.05	-	-	0.42	-	-	-	-	-	-	-	-	0.06	-
Upeneus vittatus	-	-	0.17	-	-	-	-	-	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-
Lactarius lactarius	-	0.54	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tachysurus spp	-	-	-	-	-	-	-	-	-	-	0.12	-	0.10	-	0.03	-	-	-	-	-	-	-
Chelodon punctatus	-	-	-	-	-	-	-	-	-	-	-	-	0.10	-	-	-	-	-	-	-	-	-
Trygonidae	-	1.20	0.25	0.25	-	-	0.75	0.25	-	-	0.10	-	0.10	0.60	0.03	-	0.40	-	0.40	-	0.10	-
Sillago sihama	0.06	3.46	-	-	-	-	0.60	-	-	-	-	0.15	-	0.40	-	0.13	-	0.07	0.21	-	-	-
Polynemus xanthonemus	-	-	-	-	-	-	-	0.38	-	-	-	-	-	0.05	1.00	-	-	-	-	-	-	-
Caranx spp	-	-	-	-	-	-	-	-	0.40	-	-	-	-	-	-	-	-	-	-	-	-	-
Epinephelus spp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lethrinus spp	-	-	-	-	-	0.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.10
Cynoglossus spp	0.05	0.13	-	0.40	0.45	0.10	0.15	0.30	0.05	0.30	0.60	-	0.05	0.25	-	0.01	0.25	0.25	0.40	0.16	-	-
Portunus sanguinolentus	0.30	1.00	0.20	0.30	1.50	0.60	0.70	-	1.00	0.75	0.75	-	0.25	0.75	0.15	0.60	0.50	-	-	0.25	0.25	-
P. pelagicus	-	-	-	-	-	-	-	0.04	-	-	-	-	-	-	-	-	-	0.50	1.50	-	-	-
Sepia spp	0.25	0.25	0.20	0.25	0.25	0.08	0.45	0.20	0.05	0.10	0.30	-	0.20	-	-	0.10	0.25	-	-	-	-	-
Squilla spp	0.50	0.50	-	0.05	1.25	0.10	0.48	1.10	0.80	1.10	1.10	-	0.20	0.01	-	-	0.20	0.25	-	0.01	0.05	-
Unsorted species	0.06	0.15	0.10	-	-	0.30	3.36	0.30	0.30	0.25	-	0.80	0.25	0.40	0.30	0.15	0.50	0.06	0.03	0.25	0.22	-

Table 4. Continued.

Species	Trawl operations																				
	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	Total	Percent
Penaeus indicus	0.03	0.25	0.50	0.30	-	-	1.25	1.90	0.75	0.40	0.15	-	-	0.10	0.25	0.75	0.30	0.01	0.20	14.38	5.29
P. merguiensis	-	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01	0.25	0.09
P. semisulcatus	-	-	0.02	-	-	-	-	0.01	0.06	0.15	-	-	-	0.10	-	0.01	0.30	0.20	0.10	3.31	1.22
P. monodon	-	0.25	0.10	0.15	-	-	-	0.02	-	0.20	-	-	-	-	0.03	0.20	-	-	-	1.18	0.43
Metapenaeus dobsoni	-	0.10	-	0.11	-	-	2.66	6.50	2.12	-	0.03	-	-	0.17	1.46	1.57	0.30	-	0.21	20.47	7.53
Parapeneopsis stylifera	-	0.20	-	0.54	-	-	0.08	-	0.42	-	0.01	-	-	0.03	0.29	0.39	-	0.01	0.04	5.80	2.13
Other prawns	0.05	-	-	-	-	-	-	-	0.21	-	-	-	-	-	0.03	0.79	-	-	-	3.49	1.28
Gazza minuta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.57	0.21
Leiognathus daura	0.88	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.11	4.67	1.72
L. elongatus	5.28	0.30	1.00	0.40	-	-	0.25	0.75	-	-	-	-	-	-	+	-	0.83	-	0.54	25.65	9.43
L. gerroides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.71	2.84
Other leiognathids	1.54	-	-	-	-	-	-	-	0.10	-	0.53	-	0.03	6.00	-	0.07	0.41	0.60	0.11	18.06	6.64
Sciaenidae	0.25	0.35	0.50	0.30	-	-	2.75	2.00	2.50	-	0.09	-	-	4.75	0.01	0.21	0.40	-	0.35	28.55	10.50
Opisthopterus tardoore	0.05	-	-	0.04	-	-	2.25	0.42	0.40	-	-	-	-	1.25	-	-	0.06	-	-	13.45	4.95
Therapon jarbua	-	-	-	-	-	-	-	0.17	-	-	0.03	-	-	-	-	-	-	-	-	4.06	1.49
Thrissocles setirostris	0.75	0.03	0.25	0.03	-	-	4.00	6.00	2.75	3.50	0.03	-	-	0.25	0.01	-	0.25	0.05	1.00	35.77	13.16
Euplatygaster indica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.06	-	-	0.06	0.02
Gerridae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03	0.17	1.02	0.38
Upeneus vittatus	-	-	-	-	-	-	-	-	-	-	-	0.05	0.05	-	-	-	-	0.03	-	0.35	0.13
Lactarius lactarius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.54	0.20
Tachysurus spp	-	-	-	-	-	-	0.55	0.75	0.75	-	-	-	-	-	-	-	-	-	0.01	2.31	0.85
Chelodon punctatus	-	-	-	-	-	2.00	-	-	-	-	-	-	-	-	-	-	-	-	-	2.10	0.77
Trygonidae	0.50	0.50	-	-	-	-	0.03	-	0.20	-	-	0.30	-	-	-	-	0.03	-	-	5.99	2.20
Sillago sihama	-	-	-	-	-	-	-	0.50	0.50	0.50	0.50	-	-	0.08	-	0.21	0.05	0.03	-	7.45	2.74
Polynemus xanthonemus	0.01	0.06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.06	-	-	1.56	0.57
Caranx spp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01	0.41	0.15
Epinephelus spp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.10	0.04
Lethrinus spp	-	-	-	-	-	-	0.35	-	0.75	-	-	-	-	-	-	-	-	-	-	1.30	0.48
Cynoglossus spp	0.25	0.03	-	0.03	-	-	-	-	-	-	-	0.75	-	-	+	0.03	0.03	0.25	0.01	5.28	1.94
Portunus sanguinolentus	0.30	-	0.50	0.30	-	-	0.25	-	-	-	-	-	-	-	+	0.25	0.03	0.02	0.30	11.80	4.34
P. pelagicus	-	-	1.00	0.25	-	-	-	-	0.20	1.25	1.00	-	-	0.15	+	-	-	-	-	5.89	2.17
Sepia spp	0.03	0.25	0.20	0.04	-	0.05	0.25	0.25	-	-	0.02	0.10	0.03	-	-	0.10	0.05	-	0.05	4.35	1.60
Squilla spp	0.03	0.50	2.00	1.25	-	-	-	-	-	-	0.01	-	-	-	0.01	0.20	0.01	0.10	0.03	11.84	4.35
Unsorted species	-	0.12	-	0.13	1.50	9.50	0.15	0.17	0.10	-	-	0.71	0.48	0.17	0.02	-	0.41	0.60	0.34	22.18	8.16

excluded from the analysis since few of them were trawled, and even those trawled had yielded zero catches of prawn. Furthermore, the trawl operations in certain rectangles at shallower depths were restricted to one haul each because of the rough nature of the bottoms which were unsuitable for trawling. Therefore, the rectangles were appropriately aggregated into four groups A.B,C.D,E.F, and G.H.I, respectively, to obtain a reasonable number of operations.

Table 5. **Length distributionof prawns by area and depth. (The number at each length interval refers to the count in the sample)**

Area	A. B		C.D		E.F		G.H.I	
Depth	0-4fin	4-8fin	0-4fin	4-8fin	0-4fin	4-8fin	0-4fin	4-8fin
Length group*(cm)*			*P. indicus*					
6.0- 7.9	1	5	-	1	-	-	-	-
8.0-9.9	45	80	5	8	-	2	1	2
10.0-11.9	56	87	21	29	1	7	12	2
12.0-13.9	17	61	17	52	1	35	34	53
14.0-15.9	-	3	4	10	-	28	4	36
16.0-17.9	-	1	-	2	-	2	1	4
Mean In(1)	2.34	2.36	2.46	2.50	2.48	2.68	2.53	2.61
			P. semisulcatus					
6.0-7.9	-	-	-	-	-	2	-	-
8.0-9.9	-	-	2	-	-	-	1	1
10.0-11.9	-	1	4	-	-	3	1	2
12.0-13.9	4	7	5	6	-	7	-	5
14.0-15.9	3	3	4	9	-	5	-	6
16.0-17.9	-	3	3	3	-	3	-	-
18.0-19.9	-	-	2	6	-	2	-	-
Mean In(1)	2.61	2.64	2.60	2.74	-	2.59	2.29	2.58
			P. monodon					
14.0-15.9	-	-	-	-	-	-	5	3
16.0-17.9	2	1	-	-	-	1	3	1
18.0-19.9	-	1	-	-	-	-	-	-
20.0-21.9	-	-	-	-	-	-	-	-
22.0-23.9	1	-	-	-	-	-	-	-
Mean In(1)	2.93	2.89	-	-	-	2.83	2.75	2.74
			M. dobsoni					
4.0-5.9	-	132	9	9	-	4	16	13
6.0-7.9	-	134	7	54	-	10	7	18
8.0-9.9	-	8	-	6	-	4	2	-
10.0-11.9	-	1	-	-	-	-	-	-
Mean In(1)	-	1.78	1.75	1.92	-	1.92	1.74	1.80
			Parap. stylifera					
2.0-3.9	-	-	-	-	-	-	1	-
4.0-5.9	-	4	-	1	-	5	11	22
6.0-7.9	-	4	6	5	-	25	16	40
8.0-9.9	-	1	2	2	-	9	2	8
10.0-11.9	-	-	1	2	-	-	2	2
Mean In(1)	-	1.82	2.05	2.05	-	1.95	1.84	1.88

To obtain approximately homoscedastic variables, the In (w + 1) transformation was applied to weight (kg) of catch per hour of trawl (Jones et al., 1973). The arithmetic mean of the transformed values in each aggregate of rectangles was then subjected to the analysis of variance. The same procedure was adopted in the case of length data. For *P. semisulcatus*, the length data from regions E.F and G.H.I were combined to get a sufficient number of samples at each depth range. Results of the analysis of variance of the catch rates and length data are given in Table 6 and Table 7 respectively.

Table 6. **Analysis of variance of mean In(catch rate+1) by area (A.B,C.D,E.F,G.H.I) and depth (0-4fm, 4-8fm).**

Species	Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F ratio	Significance
P.indicus	Area	3	0.0702	0.0234	0.8609	ns
	Depth	1	0.0481	0.0481	1.8609	ns
	Error	3	0.0869	0.0290		
P.semisulcatus	Area	3	0.0671	0.0224	0.9825	ns
	Depth	1	0.0001	0.0001	0.0044	ns
	Error	3	0.0684	0.0228		
P.monodon	Area	3	0.0082	0.0027	1.9286	ns
	Depth	1	0.0010	0.0010	0.7143	ns
	Error	3	0.0041	0.0014		
M.dobsoni	Area	3	0.6108	0.2036	2.7588	ns
	Depth	1	0.0741	0.0741	1.0041	ns
Parap.stylifera	Area	3	0.0908	0.0301	12.1200	*
	Depth	1	0.0171	0.0171	6.8400	ns
	Error	3	0.0074	0.0025		

Level of significance - * : 5% ; ** : 1% ; ns : non significance.
(This footnote applies to Table 7 as well).

Analysis of variance of the catch rates did not indicate any evidence for area or depth effect for *P. indicus, p. semilsculcatus, P. Monodon,* and *M. dobsoni.* Area effect, however, was observed in *P.stylifera.* This indicated that the catch rate of *P. indicus, P. semisulcatus, P. monodon* and *M. dobsoni* could be averaged without giving any weight for either area or depth variation, with the exception of *P.stylifera.* In the latter case, the catch rates had to be averaged for each area. This procedure was followed in the next section to estimate the standing stock of each species of prawn.

Table 7. **Analysis of variance of mean ln (mid length) by area and depth .**

Species	Sources of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F ratio	Significance
P. indicus	Area	3	0.0570	0.0190	19.0000	*
	Depth	1	0.0084	0.0084	8.4000	ns
	Error	3	0.0030	0.0010		
P. semisulcatus	Area	2	0.0633	0.0317	3.4835	ns
	Depth	1	0.0338	0.0338	3.7143	ns
	Error	2	0.0182	0.0091		

The analysis of variance on length data of *P. indicus* indicated significant difference between areas (Table 7). The average (In length) was observed to have increased from the lagoon mouth to the south (Table 5). This indicated that (1) there was a possible southward migration of *P. indicus* as they grew and mature, and 2) therewas a high likelihood that the recruits were coming from the Chilaw lagoon and the Deduru estuary areas. The absence of depth effects provided no evidence for offshore movement of large *P. indicus* and *P. semisculcatus* in this region during the period of study. However, trawling exercises were not undertaken in deeper areas beyond the 12 fm line, due to limitations in the operational capability of the craft; conclusions on the length related offshore movement was therefore not possible.

Estimation of average standing stocks

The average standing stock was estimated for each species using the swept area method. The calculation steps and the results are given below:

i. Average weight of catch - per - hour :

P. indicus	0.40 kg	*P. semisculatus*	- 0.14 kg,
P. monodon	0.04 kg	*M. dobsoni*	- 0.32 kg,
P.stylifera	A.B-0.15 kg	C.D-0.09 kg; G.H.I -	0.42 kg

ii. Characteristics of trawl operation:

The average width of the opening of the trawl net used in 0 to 4 fm depth - 3.44 m.
The average width of the opening of the trawl net used in 4 to 8 depth - 3.12 m.
Average speed of tow - 1.52 knots.
The estimated area of the prawn ground between 0 and 4 fm - 7.2 km^2
The estimated area of the prawn ground between 4 and 8 fm - 27.49 km^2

iii Computation steps

Area swept per hour (a) = (Average breadth of the trawl net)x(average speed of tow)

Density of fish per unit are (d) = $\frac{c/h}{a}$, where, c/h = weight of catch per hour.

Standing stock density (D) = $\frac{c/h}{aE}$, where, E = gear efficiency coefficient.

Standing stock size (B) = $\frac{c/h}{aE}$ x A, where, A = total area

iv. Results :

The stocks of prawns were estimated under two assumptions ; 1/2 and 1/3 of the stock encountered in the path of the trawl were caught (ie., E):

Species	*P. indicus*	*P. Semisculatus*	*P. monodon*	*M. dobsoni*
B(E=0.5)	3133 kg	1095 kg	313 kg	2905 kg
B(E=0.3)	5222 kg	1825 kg	522 kg	4182 kg
		Parap.stylifera		

REGION	A,B	C,D	E,F	G,H,I	Total
B (E=0.5)	187Kg	160Kg	212Kg	1205Kg	1764Kg
B (E=0.3)	312Kg	267Kg	353Kg	2008Kg	2940Kg

It was interesting to compare some of these values with earlier estimates made from the catch - per - effort data four January - March 1977 (Siddeek, 1978). The earlier estimates of standing stocks for *M. dobsoni and P.stylifera* were 9621 kg and 3264 kg, respectively. When these results were compared with the present estimates, specially with that for *M. dobosoni,* it appeared that this stock had been substantially reduced. Since there were no evidence for either major habitat degradation or adverse environmental changes which may very well have caused depletion of the stock between the two Study periods , over exploitation was the strong possibility for this effect. This may be the case for the other species of prawn as well, even though appropriate data were not available for comparison.

SUMMRY AND CONCLUSION

i. Over fifty five species of fish and shellfish were recorded during the survey. The Leiognathids contributed 20.84%, followed by penaeid prawn 17.90%, *Thrissocles setirostris* 13.16%, and Sciaenids 10.50% to the total catch. *M. dobsoni* dominated the prawn catch with 7.53%, followed by *P. indicus* with 5.29%.

ii. The prawn were abundant on sand and mud sub-strata with organic material within the depth range 4 to 8 fm.

iii. Two - way analysis of variance on the catch rates indicated that there was no significant variation in the catch rates between areas or depths for *P. indicus, P. semisculatus, P. monodon,* and *M. dobsoni,* while there was areawise variation in the catch rates for *P.stylifera.*

iv. The same analysis carried out on lengths indicated area wise variation for *P. indicus*. The mean lengths were observed to have increased southward from the estuarine region, giving an indication that *P. indicus* may have recruited to the sea fishery from this region.

v. The standing stocks were estimated using the swept area method and the values are given below separately for two different gear efficiency coefficients (E):

	E = 1/2	E = 1/3
P. indicus	3133 kg	5222 kg
P. semisculatus	1095 kg	1825 kg
P. monodon	313 kg	522 kg
M. dobsoni	2509 kg	4182 kg
P.stylifera	1764kg	2940 kg

vi. Some of these results, when compared with earlier estimates, indicated evidence of over exploitation.

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REFERENCES

ANON, 1981.
By-catch of the shrimp fishery in India, Marine Fisheries Information Service, *Technical and Extension series CMFRI,* Cochin , India No **28**, pp 1-13.

BRUIN, G.H.P. DE. 1970
The distribution of penaeid prawn in Ceylon waters. *Bull.Fish. Res. Stn. Ceylon,* Vol **21,** No. 2, pp 67 - 73.

DALL, W. 1957.
A revision for the Australian species of penaeinae (Crustacea Decapoda : penaeidae). *Aus. J. Mr. Freshwater Res.* **2** , pp 136 - 231.

GARCIA, S.L. and LE RESTE. 1981.
Life cycles, dynamics, exploitation and management of coastal penaeid shrimp stocks. *FAO Fish. Tech. Paper* No 203, 215 pages.

JONES, B.W. and J.G. POPE, 1973
A ground fish survey of Faroe Bank. *ICNAF Res. Bull* No. **18,** pp 53 - 61.

MUNRO, I.S.R. 1955.
The Marine and fresh water fishes of Ceylon. Published for department of external affairs, Canberra, 351 pages.

SIDDEEK, M.S.M. 1978
Estimating the population density of prawns by the use of catch per effort data from prawn trawlers at Chilaw. *Bull.Fish. Res. Stn. Sri Lanka.* Vol **28,** pp 1 - 26.

WEERASOORIYA K.T. 1977
Trawl nets presently used in the coastal waters of Sri Lanka. *Bull. Fish. Res. Stn. Sri Lanka* Vol. **27**, pp 19 - 27.