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RESEARCH PAPER

The importance of the intertidal area for the Mullet *Liza klunzingeri*

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أهمية منطقة المد والجزر لسمكة الميد *Liza klunzingeri*

عادل الصفار وعبدالرحمن بن حسن وطلال دشتي وعلي تقي وعلي الموسوي وعدنان العلوي

Abstract. The mullet *Liza klunzingeri*, locally known as *maid*, is an important commercial species in Kuwait and accounts for up to 16% of the total finfish landings. To determine the seasonal and spatial distributions of juvenile mullet, a small-mesh seine net was employed monthly at seven selected coastal sites during the period from November 2013 through October 2014. Semicircular sweeps of the 30 m long, two-meters high seine covered an area of approximately 1,400 m^2. Juvenile maid were captured at most of the sampling sites during the entire investigation period, but mainly in spring and summer, indicating a wide coastal distribution of this species. The highest catches of juveniles occurred in May with an average of 30.2 kg per sweep, corresponding to a density of 22 g/m^2. Catches of juveniles from sampling sites in or just south of the Kuwait Bay, near prime maid fishing grounds, were much higher than those from more southerly sampling sites. The captured maid ranged in total length (TL) from 18 to 179 mm, with a high peak at 41 to 50 mm. By-catch included thirty species, with hasoom (*Sillago sihama*), Imchawah (*Diplodus sargus kotschyi*), and yowaff (*Nematalosa nasus*) being the most common. The by-catch consisted mostly of juveniles with lengths less than100 mm TL, showing the importance of the intertidal and coastal waters for many species.

Keywords: Juveniles; Nursery grounds; Biomass; Distribution

المستخلص: تعتبر سمكة *Liza klunzingeri* والمعروفة محليا بالميد من الأنواع التجارية المهمة في الكويت، وأعلى تقدير لها يصل إلى ١٦ ٪ لمجمل كميات الأسماك الزعنفية في الأسواق. ولتحديد التوزيع الموسمي والمكاني ليوافع الميد تم استخدام شبك طاروف ذو فتحات صغيرة، عند سبعة مواقع ساحلية مختارة، شهريا من نوفمبر ٢٠١٣ ولغاية أكتوبر ٢٠١٤. وكانت عملية المسح على شكل نصف دائرة بشبك طوله ٣٠ متر وارتفاعه مترين، وكانت المساحة المغطاة ١٤٠٠ متر مربع. وتم صيد يوافع الميد في معظم المواقع خلال فترة البحث وبالأخص في الربيع والصيف، مما يدل على التوزيع الواسع لهذا النوع من الأسماك على السواحل. وكان أعلى مصيد لليوافع في شهر مايو بمتوسط ٣٠,٢ كيلو جرام لكل عملية مسح، تعادل كثافة ٢٢ جرام لكل متر مربع. وكان مصيد اليوافع من المواقع في جون الكويت أو في جنوبه القريب، بالقرب من مناطق صيد الميد الرئيسية، أكثر بكثير من نظيره من المواقع الساحلية الأكثر جنوبا. وتراوح الطول الكلي للمصيد من الميد من ٢٣ إلى ١٤٥ مليمتر مع كون المنوال عند ٤١ و٤٥ مليمتر. وضم المصيد المرادف ثلاثين نوعا، وأكثرها شيوعا الحاسوم (*Sillago sihama*) والمجوة (*Diploddus sargus kotschyi*) واليواف (*Nematalosa nasus*). ويتكون المصيد المرادف من يوافع بطول أقل من ١٠٠ مليمتر للطول الكلي، مما يبين أهمية مناطق المد والجزر والمياه الساحلية للعديد من الأنواع البحرية.

الكلمات المفتاحية: التراكم الحيوي على الأسطح المغمورة،

Introduction

Around 243 species of bony fishes inhabit Kuwait's waters and includes the commercially important mullet species, locally known as *maid*. Mullets ranked third after that of "newaiby" *(Otolithes ruber)* and "sha'em" *(Acanthopagrus latus)* in all finfish species based on the average landings for the last ten years. Formerly, maid were identified as *Liza carinata*, but more recently, the species has been identified as *Liza klunzingeri* (Carpenter et al., 1997). Adult mullets range between 15 and 25 cm in length (Abou-Seedo and Al-Khatib, 1995; Dadzie et al., 2005) and occupy a variety of marine habitats, form schools, and are probably an important link between primary producers and secondary consumers in the marine trophic ecosystem. Mullets are caught by gillnet, intertidal stake traps (hadrah) and as a by-catch of shrimp trawlers operating in shallow waters. Current catches of mullet are mainly by gillnet, and the minimum allowable marketable size of this species is 14 cm.The Central Statistical Bureau (CSB) generates the annual data on Kuwait's fishery landings and routinely records the landings volume of 22 species of finfish, including mullet. From 2000 to 2012, landings of finfish declined to 50%, from about 4,500 tons to 2,200 tons (Fig. 1). The decline in mullet landings was 90%, from about 750 tons to only 78 tons, for the same period.

Small mullets, 8 cm or less in length, are actually juveniles and locally called zorie. Juveniles have no commercial value but are occasionally used as a fresh bait for sport fishing. Zorie are often found very close to the shores, particularly on a rising tide during spring. The shallow areas along Kuwait's coastline are reported to provide a nursery habitat for *L. klunzingeri* (Abou-Seedo and Dadzie, 2004; Dadzie et al., 2005).

A project was conducted to assess Kuwait's mullet (*Liza klunzingeri*) stock status, estimate the potential harvest volume, and formulate a management plan for a

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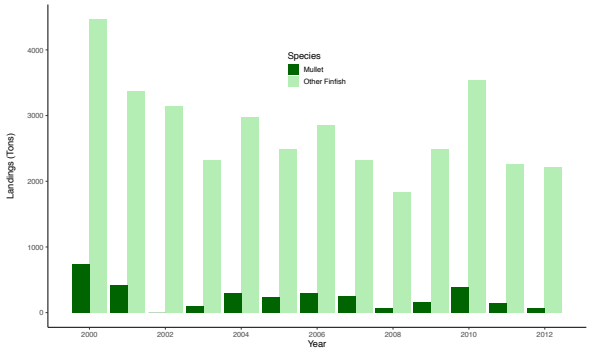

Figure 1. Landings of mullet (*Liza klunzingeri*) and other finfish in Kuwait.

long-term sustainable mullet fishery. Part of this study included a nursery ground survey for mullet juveniles along Kuwait's coastal waters. Here, we present the results of the nursery ground survey.

Materials and Methods

To conduct the nursery ground survey, most of the Kuwait's coastline was examined for suitable sampling sites and seven locations were selected (Fig. 2). These sites are characterized by gradually sloping bottom; prominent rocks and debris were removed before the start of the survey to allow smooth, uninterrupted sweeps with a seine net.

Small-mesh seine net was employed for the juvenile mullet survey. Small mesh seines were obtained from an USA-based company. The nets were received with the following measurements: length, 30 m; height, 1.8 m; and square mesh opening about 7×7 mm. At 45 and 30 cm intervals, the net was supported with floats at the top and lead weights at the bottom, respectively. A bamboo pole was tied to each end of the net to facilitate seining. The operation of the net was conducted as follows: on a rising tide, the two poles were positioned 30 m apart at the water's edge. Keeping one pole fixed, the other pole was swept into the rising tide making a 30-m radius semicircle, sweeping an area of 1,400 m^2 in the process (Fig. 3, Fig. 4A, B). This operation required from 5 to 20 min, depending on weather, water current and (or) the amount of seagrass and seaweed that interfered with the operation (Fig. 4C). Separating the catch, however, took 15 to 45 min, especially if considerable seaweed was collected in the net (Fig. 4D). The catch was returned to the laboratory and separated by species when possible. For the mullet catch, the total length to the nearest millimeter and the weight to the nearest gram of all (less than 25) or about 25 individuals were measured. For the rest of the mullet catch, the number was counted and the total weight was measured. For other species, only the total length was measured to the nearest millimeter for all (less than 25) or about 25 individuals and the total weight of the catch were recorded. For a very

Figure 2. Location of the 7 sampling sites (black stars) of the nursery ground survey of *Liza klunzingeri* in Kuwaiti waters.

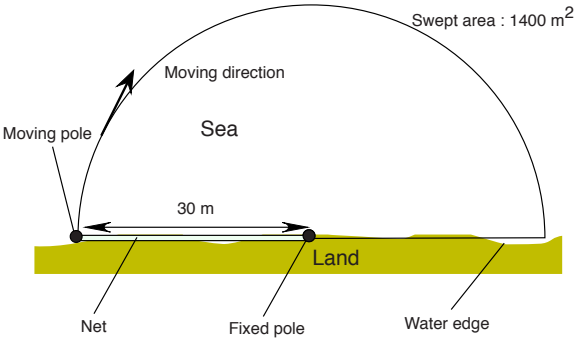

Figure 3. Schematic illustration of the operations carried out for the nursery ground survey.

large catch, a sample was taken and the number and the weight measured were calculated for the total catch.

Results and Discussion

Table 1 summarizes the monthly juvenile survey catches. No sampling was carried out in the month of July. The highest catches of juveniles occurred in May with an

Figure 4. (A) The seine net at the beginning of the operation, which required three to four persons for deployment. (B) The seine net deployment at the end of a sweep. (C) The seine net operation in the presence of abundant benthic algae and (D) Separating the catch from the macroalgae required considerable effort.

average of 30.2 kg per sweep, corresponding to a density of 22 g/m^2.

Juvenile Mullet Length-frequency

The length-frequency data for the juvenile mullet captured in the nursery ground survey showed that the mullet ranged from 1.8 to 17.9 cm with a high peak at 4.1 to 5.0 cm and a low peak at 8.6 to 9.5 cm (Fig. 5). The monthly length-frequency for juveniles showed the moving of towards right indicating its seasonal growth (Fig. 6).

Biomass and distribution

The abundances (number and weight per squared kilometer) of juvenile mullets in the surveyed nursery grounds were estimated using the catch rate and the swept area (1,400 m^2) (Table 2).

Juveniles were caught at all sampling sites especially during spring and summer seasons indicating a wide distribution of juveniles in the coastal waters of Kuwait over a prolonged period (Figs. 7 and 8). A large number of juveniles occurred from March through June particularly along the Kuwait Bay's southern coast (Sampling site 3), just south of Kuwait Bay (Sampling site 4), at Sampling site 5, and at Sampling site 6 (Fig. 2). The average number of juveniles per square kilometer in these sampling sites exceeded two million (Table 2). The paucity of juveniles caught at Sampling site 7 is an indication that Kuwait's southern coastal waters are not as important a nursery area as the northern waters.

Juveniles were most abundant in April and May, which supports the view that April and May are the major months of recruitment (Dadzie et al., 2005).According to the interviews with the fishermen, mullets were most abundant in the shallow areas in Kuwait Bay, areas around Failakah Island, and areas east and south of Bou-

Table 1. Estimated Juvenile Abundances of *L.Klunzingeri* (Number and weight per squared kilometer) based on the catch rates and swept Areas.

Month		St.1	St.2	St.3	St.4	St.5	St.6	St.7	Total	Average
Dec-13	No.(×1000)	2.9	0.0	32.9	0.0	nc	nc	nc	36	8.9
	Wt. (kg)	2.0	0.0	24.3	0.0	nc	nc	nc	26.3	6.6
Jan-14	No.(×1000)	nc	0.0	84.3	21.4	nc	0.0	nc	106	26.4
	Wt. (kg)	nc	0.0	80.9	12.4	nc	0.0	nc	93.2	23.3
Feb-14	No.(×1000)	3.6	0.0	0.0	0.0	nc	64.3	0.0	68	11.3
	Wt. (kg)	3.8	0.0	0.0	0.0	nc	54.5	0.0	58.2	9.7
Mar-14	No.(×1000)	21.4	522.9	130.0	0.0	nc	4025.1	0.0	4699	783.2
	Wt. (kg)	17.0	606.2	288.5	0.0	nc	3329.6	0.0	4241.3	706.9
Apr-14	No.(×1000)	0.0	460.0	13577.4	3786.5	8085.9	17269.6	0.0	43179	6168.5
	Wt. (kg)	0.0	291.1	20409.3	6465.5	10440.0	20944.4	0.0	58550.4	8364.3
May-14	No.(×1000)	1.4	8.6	9708.8	20144.7	8145.2	5137.2	0.7	43147	6163.8
	Wt. (kg)	80.7	84.7	45375.0	79395.4	14292.1	11590.7	0.7	150819.3	21545.6
Jun-14	No.(×1000)	2465.8	17.1	370.0	21.4	18.6	75.0	0.0	2968	424.0
	Wt. (kg)	27580.1	43.7	2890.3	102.3	56.9	410.7	0.0	31084.0	4440.6
Aug-14	No.(×1000)	nc	6.4	85.7	132.1	37.1	101.4	0.0	363	60.5
	Wt. (kg)	nc	91.0	913.3	923.6	179.0	1075.1	0.0	3182.1	530.4
Sep-14	No.(×1000)	10.0	5.0	7.9	56.4	323.6	0.0	0.0	402.9	57.6
	Wt. (kg)	178.3	50.3	147.6	678.9	5459.3	0.0	0.0	6514.4	930.6
Oct-14	No.(×1000)	5.7	0.0	0.0	8.6	0.0	2.1	0.0	16.4	2.3
	Wt. (kg)	208.0	0.0	0.0	157.0	0.0	45.9	0.0	411.0	58.7
Nov-14	No.(×1000)	0.0	0.0	78.6	5.0	3.6	45.9	0.0	133.0	19.0
	Wt. (kg)	0.0	0.0	945.0	98.6	27.1	45.9	0.0	1116.6	159.5
Total	No.(×1000)	2511	1020	24075	24176	16614	26721	1	95118	13726
	Wt. (kg)	28070.0	1167.0	71074.2	87833.7	30454.6	37496.7	0.7	256096.9	36776.2
Average	No.(×1000)	279.0	92.7	2188.7	2197.8	2373.4	2672.1	0.1	8647.1	1247.8
	Wt. (kg)	3118.9	106.1	6461.3	7984.9	4350.7	3749.7	0.1	23281.5	3343.3

nc= not carried out, St. =sampling site

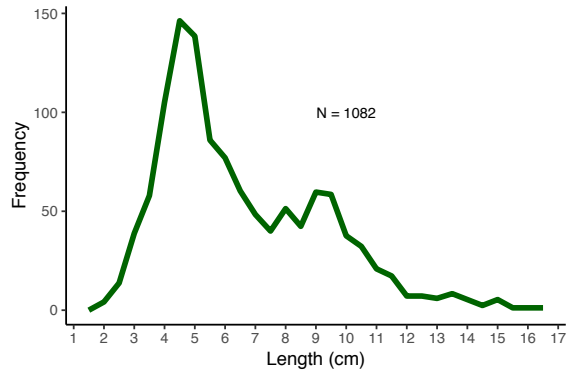

Figure 5. Length-frequency data of the juvenile mullets captured in the nursery ground survey.

byan Island (Fig. 9).

The by-catch species are listed in Table 3. The most commonly caught species numerically was *Sillago sihama* (hasoom), followed by *Diplodus sargus kotschyi* (Imchawah) and *Nematalosa nasus* (yowaff). The sizes of the by-catch were small and most were juveniles with lengths less than 100 mm and individual mass of a few grams.

The nursery ground survey found large quantities of juvenile mullet mainly in April and May along the Kuwait Bay's southern coast (Sampling site 3), just south of Kuwait Bay, at Sampling site 4, at Sampling site 5, and at Sampling site 6 (Fig. 2). For example, the highest estimated number of juveniles per square kilometer exceeded twenty million at Sampling site 4 in May (Table 2). A closed season from April through May in these areas may be necessary to protect the juveniles

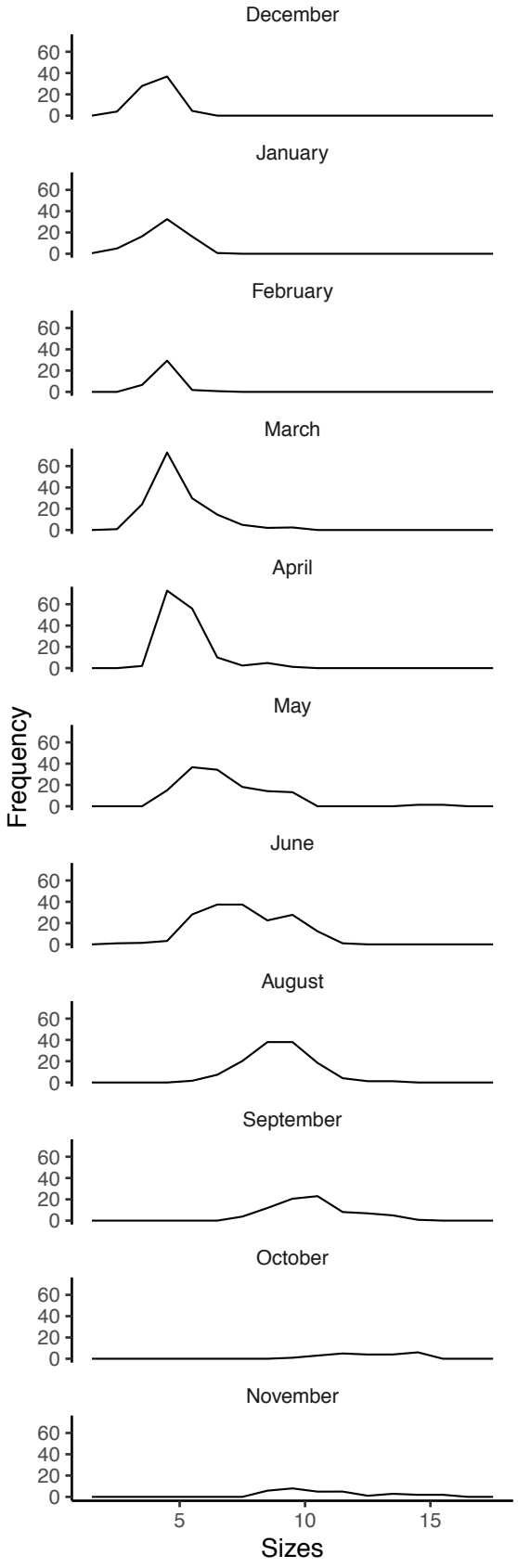

Figure 6. Monthly length-frequency data of the juvenile mullets captured in the nursery ground survey.

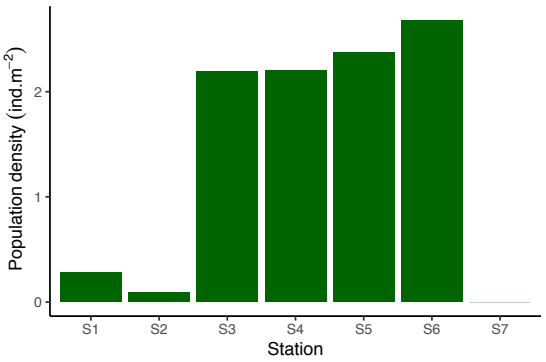

Figure 7. Spatial variation of the abundance of juvenile mullet.

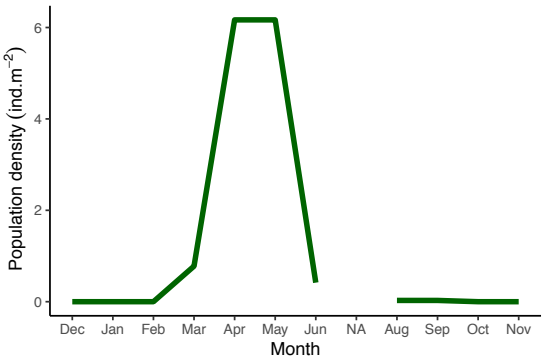

Figure 8. Temporal variation of the abundance of juvenile mullet.

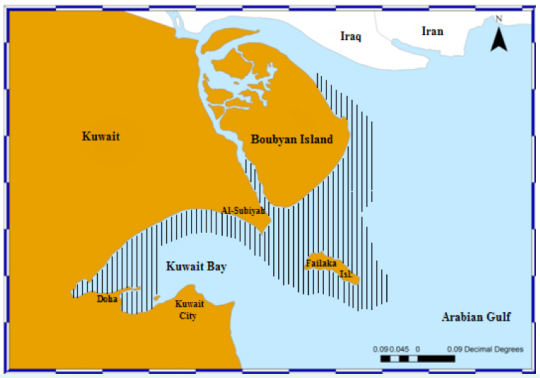

Figure 9. Mullet fishing areas (Hatched area) as indicated by fishermen during interviews.

Table 2. Juvenile mullet abundance, weight and by-catch catches (No. org/1400m^2) at 7 selected sampling sites .

Month		St.1	St.2	St.3	St.4	St.5	St.6	St.7	Total	Average
Dec-13	No.	4	0	46	0	nc	nc	nc	50	12.5
	Wt. (g)	2.8	0.0	34.0	0.0	nc	nc	nc	36.8	9.2
	By-Catch Wt.(g)	6.3	0.0	1.3	0.0	nc	nc	nc	7.7	1.9
Jan-14	No.	nc	0	118	30	nc	0	nc	148	37
	Wt. (g)	nc	0.0	113.2	17.3	nc	0.0	nc	130.5	32.6
	By-Catch Wt.(g)	nc	0.8	2.3	22.4	nc	233.7	nc	259.2	64.8
Feb-14	No.	5	0	0	0	nc	90	0	95	16
	Wt. (g)	5.3	0.0	0.0	0.0	nc	76.3	0.0	81.5	13.6
	By-Catch Wt.(g)	127.1	7.1	55.6	0.0	nc	4.9	1846.0	2040.7	340.1
Mar-14	No.	30	732	182	0	nc	5635	0	6579	1097
	Wt. (g)	23.9	848.7	403.9	0.0	nc	4661.4	0.0	5937.8	989.6
	By-Catch Wt.(g)	1055.2	218.3	481.3	187.1	nc	2.0	1372.0	3315.8	552.6
Apr-14	No.	0	644	19008	5301	11320	24177	0	60450	8636
	Wt. (g)	0.0	407.6	28572.5	9051.535	14615.7	29321.6	0.0	81968.9	11709.8
	By-Catch Wt.(g)	7855.0	8592.4	17231.5	2248.5	5384.3	19678.4	299.0	61289.1	8755.6
May-14	No.	2	12	13592	28202	11403	7192	1	60404	8629
	Wt. (g)	113.0	118.5	63523.7	111151.4	20008.5	16226.6	1.0	211142.8	30163.3
	By-Catch Wt.(g)	1161.5	2859.3	17542.2	13296.7	591.5	20784.4	1023.7	57259.2	8179.9
Jun-14	No.	3452	24	518	30	26	105	0	4155	594
	Wt. (g)	38611.4	61.1	4046.4	143.2	79.7	574.9	0.0	43516.7	6216.7
	By-Catch Wt.(g)	2536.0	2674.9	2071.9	588.3	849.9	2709.8	279.1	11709.9	1672.8
Aug-14	No.	nc	9	120	185	52	142	0	508	85
	Wt. (g)	nc	127.4	1278.6	1293.0	250.6	1505.1	0.0	4454.9	742.5
	By-Catch Wt.(g)	nc	5154.6	1083.8	1543.9	396.2	109.9	38.9	8327.4	1387.9
Sep-14	No.	14	7	11	79	453	0	0	564	81
	Wt. (g)	249.6	70.4	206.6	950.5	7642.9	0.0	0.0	9120.0	1302.9
	By-Catch Wt.(g)	248.6	2931.7	637.3	895.4	235.0	1358.0	226.7	6532.8	933.3
Oct-14	No.	8	0	0	12	0	3	0	23	3
	Wt. (g)	291.2	0.0	0.0	219.8	0.0	64.2	0.0	575.3	82.2
	By-Catch Wt.(g)	449.2	2457.3	254.7	1956.1	803.8	1077.6	1136.0	8134.7	1162.1
Nov-14	No.	0.0	0.0	110.0	7.0	5.0	0.0	0.0	122	17
	Wt. (g)	0.0	0.0	1323.0	138.0	38.0	0.0	0.0	1499.0	214.1
	By-Catch Wt.(g)	66.8	2204.3	74.5	1138.4	170.1	1049.6	311.0	5014.8	716.4
Total	No.	3515	1428	33705	33846	23259	37344	1	133098	19206
	Wt. (g)	39297.2	1633.7	99501.9	122964.8	42635.5	52430.1	1.0	358464.2	51476.5
	By-Catch Wt.(g)	13505.7	27100.7	39436.5	21876.8	8430.9	47008.3	6532.3	163891.3	23767.4
Average	No.	390.6	129.8	3064.1	3076.9	3322.7	3734.4	0.1	12099.8	1746.0
	Wt. (g)	4366.4	148.5	9045.6	11178.6	6090.8	5243.0	0.1	32587.7	4679.7
	By-Catch Wt.(g)	1500.6	2463.7	3585.1	1988.8	1204.4	4700.8	725.8	14899.2	2160.7

nc= not carried out

Table 3. Overall species composition of the by-catch (abundance and biomass) from all samples (in decreasing order)

Rank	Scientific Name	Catch in No.	Catch Wt.(g)	Total Lenght Range (mm)
1	*Sillago sihama*	10203	62060.0	21 to 242
2	*Diplodus sargus kotschyi*	9479	19483.3	26 to 174
3	*Nematalosa nasus*	5992	24130.6	62 to 132
4	*Herklotsichthys lossei*	1980	4118.2	51 to 79
5	*Acanthopagrus latus*	1408	6426.4	21 to 160
6	*Aphanius dispar*	982	3787.5	25 to 71
7	*Hypoatherina temmincki*	883	5974.5	21 to 129
8	*Herklotsichthys quadrimaculatus*	662	855.7	38 to 85
9	*Hemiramphus sp.*	622	10616.0	100 to 242
10	*Gerres filamentosus*	456	3041.7	20 to 216
11	*Strongylura leiura*	447	13072.3	230 to 443
12	*Pentaprion longimanus*	185	892.3	35 to 164
13	*Pomadasys stridens*	139	339.1	43 to 84
14	*Rhabdosargus haffara*	87	223.1	30 to 93
15	*Scomberoides commersonnianus*	83	1631.0	60 to 165
16	*Liza subviridis*	82	5046.8	90 to 247
17	*Metapenaeus stebbingi*	81	94.2	100 to 150
18	*Trachinotus mookalee*	31	76.2	41 to 60
19	*Thryssa whiteheadi*	26	743.8	165
20	*Leiognathus bindus*	17	110.3	28 to 102
21	*Solea stanalandi*	12	32.8	52 to 76
22	*Gerres oyena*	8	13.8	37 to 69
23	*Crab sp.*	7	4.6	18 to 35
24	*Ilisha compressa*	7	51.0	83 to 125
25	*Pseudotriacanthus strigilifer*	6	69.1	52 to 190
26	*Sparidentex hasta*	5	60.4	53 to 152
27	*Upeneus tragula*	5	80.4	90 to 122
28	*Gnathodon speciosus*	4	0.5	21 to 24
29	*Sepia pharaonis*	1	1011.0	235
30	*Lutjanus ehrenbergii*	1	0.3	26
31	*Terapon puta*	1	2.1	54
32	*Scatophagus argus*	1	29.5	89
33	*Sea cucumber sp.*	1	31.1	97

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