Seasonal and Spatial Abundance and Assemblages of Ichthyoplankton, Kuwait Waters 2003~2005

Akihiro Shiroza[1], Barbara Muhling[2], John Lamkin[2], William J. Richards[2]

[1]*Cooperative Institute for Marine and Atmospheric Studies, University of Miami, Miami, Florida, United States*

[2]*Southeast Fisheries Science Center, National Oceanic and Atmospheric Administration, Miami, Florida, United States*

Introduction

This study on the ichthyoplankton typically found in Kuwaiti waters was prepared based on samples from 15 survey cruises carried out between July 2002 and June 2005 at 24 locations off the Kuwait coast. The surveys were carried out under a PAAC (Public Authority for the Assessment of Compensation for Damages Resulting from Iraqi Aggression) Marine and Coastal sampling program, implemented by CIC (Consortium of International Consultants), and under the technical supervision of KISR (Kuwait Institute for Scientific Research).

During the Iraqi occupation in 1991, the territorial waters of Kuwait were directly affected by the largest oil spill in history. During the period of the spill, approximately 1.7 million tons of oil was released into Kuwaiti coastal waters (Massoud et al., 1998). In addition, during the Iraqi withdrawal, 727 land-based oil wells were destroyed by the retreating forces. The firing of the wells led to the emission of soot and oil mist containing various toxic substances. The burning wells are estimated to have combusted more than 500,000 million barrels of crude oil over a period of 258 days (Readman et al., 1996; Al Sawari, 1998; Massoud et al., 1998). The combustion process resulted in large quantities of carbon dioxide, sulphur dioxide and nitrous oxides being sent into the atmosphere and more problematically, soot and fine ash containing heavy metals such as nickel, vanadium and lead. Additionally, large amounts of crude oil droplets were sprayed into the air. The prevailing north-westerly Shamal winds carried the emissions southeast over Kuwaiti waters and Saudi Arabia (Trux, 1992). The precipitation in the vicinity of Kuwait exceeded 500 mg·m-2 (Husain and Memon, 2002). The fate of the combustion products is unclear, though some are likely to have been trapped in sediment, and others may have entered the food chain leading to high contamination levels in top predators such as piscivorous fish.

Independent of the distinct pollution resulting from the Iraqi invasion, a number of permanent pollution sources can be identified, which may also contribute to the contamination of Kuwait's marine waters. These include: oil industry, urban and industrial waste waters and natural oil seepage; agrochemical activity and river discharge; and, construction.

All of these various factors are likely to affect zooplankton distributions, densities and diversity in the region. The results from this study will serve as a baseline for future monitoring assessment and development of ecological indicators.

Survey Area

The survey area encompasses Kuwait's territorial waters located in the north-western tip of the Arabian Gulf. The plankton sampling was carried out at 24 stations on a previously established KISR grid (Fig. 1). The northern part of the station grid lies at the entrance to the Arabian Gulf of the Khor As Subiyah and extends southwards towards the Saudi Arabian border near Al Khiran, the distance of the sampling stations from the coastline varying from less than 1 km to approximately 45 km.

Methods and Materials

Neuston samples were taken from Arabian Gulf bi-monthly from April 2004 to June 2005 on 7 cruises at selected 8 stations: 0K6, 00A, 001, 004, 005, 006, 017, and 22A (Fig. 1). Six samples were collected per station; three tows before sunset and three tows after sunset.

Neuston collections were made using a single AQUATIC RESEARCH INSTRUMENT 100 cm diameter plankton net equipped with 333µm mesh. The net was deployed at the surface and towed on the side of the vessel at a steady speed of 1-2 knots for 3 minutes.

The zooplankton samples were immediately fixed with 4% formaldehyde/ seawater solution, then transferred to 70% ethanol solution after 2-3 days.

The raw samples were first pre-processed to separate out the fish eggs and fish larvae at KISR and at the Gdynia Sea Fisheries Institute, Poland. Ichthyoplankton samples were examined at SEFEC using stereomicroscope (Leica MZ 16 with 0.71-11.5X zoom) and identified to the lowest practical taxonomic level (generally to family only) and counted.

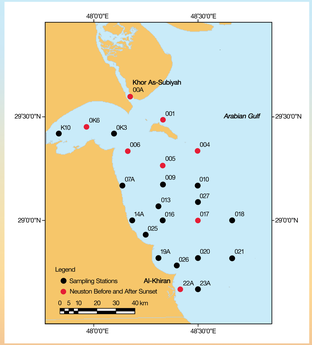
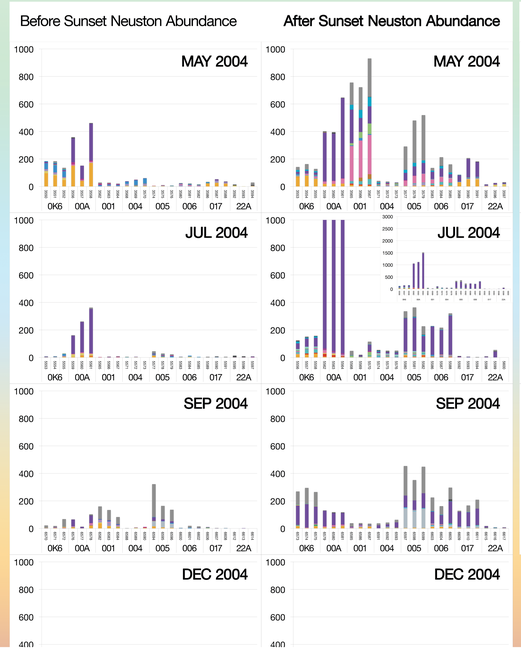
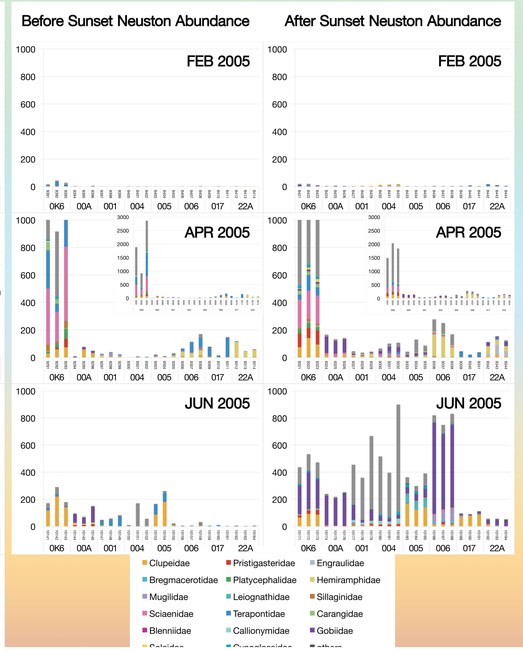


Figure 1. Map of the survey area.





Seasonal and Spatial Comparison

The station with most abundant collection was station 0K6 with 15,764 larvae, followed by station 00A, 005, 006, 001, 004, 017, and least at 22A with 9,100, 6,128, 5,763, 5,085, 3,061, 2,581, and 1,109 larvae, respectively.

Overall, larvae were abundant during the summer months, between April to October, and declined during winter months, between November and February, at all stations except station 017 (figure 2). At station 017, larvae were most abundant on the December 2004 cruise, with 749 fish accounting for 29.02% of larvae caught at that station.

Only 15 families were identified from the winter months. The dominant families in the winter were Soleidae (37.89%), Mugilidae (27.61%), and Terapontidae (13.85%). These three families accounted for 73.36% of all fish larvae collected. The summer months were dominated by Gobiidae and Clupeidae and significant numbers of sciaenids and terapontids. These four families made up 80.02% of the ichthyoplankton collected in the summer.

Kuwait Larval Fish Assemblages: Multivariate Analyses Results

The ANOSIM analysis showed significant difference in larval fish assemblages between site groups. The ANOSIM global R-statistic between site groups (across both gear types) was 0.16 ($p \leq 0.01$). The R-statistic between gear groups (across all site groups) was not significant ($R=0.05$, $p=0.20$), and so results from both gear groups were pooled for all further analyses. Pairwise comparisons between site groups showed significantly different larval fish assemblages between most sites (Table 2), with assemblages from the two estuarine sites (0K6 and 00A) the most distinctive.

The CDA ordination suggested that there was some separation between assemblages from different sites, although there was considerable overlap (Fig. 3). Samples from the two estuarine sites were located towards the top and right of the plot, while samples from site 22A were located towards the bottom left.

Correlation of the canonical axes with the original species variables suggested that larvae from the Gobiidae and Pristigasteridae were characteristic of site 00A, Exocoetidae and Atherinidae were associated with site 22A, and Terapontidae was associated with site 0K6 (Fig. 3).

The leave-one-out analysis (with 'm' chosen at random as 13) highlighted the considerable overlap between samples from different sites, with 73 out of 203 samples classified correctly. This equated to an overall mis-classification error of 64%. Out of all the sites sampled, site 00A was the most distinctive, with 73.1% of samples correctly classified, and site 005 was the least distinctive, with 4.0% correctly classified (Table 3).

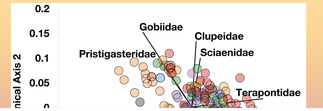
Multi-dimensional scaling ordination of the mean assemblage for each station at both day (before sunset) and night (after sunset) suggested separation between stations, and separation between day and night samples (Fig. 5). A crossed ANOSIM between day/night groups, across station groups showed a significant difference between samples collected before sunset versus after sunset ($R=0.13$, $p<0.01$).

Table 2. Pairwise R-statistics from ANOSIM test between site groups. * denotes result significant at $p \leq 0.05$, ** denotes result significant at $p \leq 0.01$.

	0K6	00A	1	4	5	6	17
00A	0.4 **						
1	0.07*	0.36**					
4	0.15**	0.41**	0.02				
5	0.05	0.29**	0.01	0.01			
6	0.07*	0.28**	-0.01	0.03	-0.01		
17	0.11**	0.39**	0.08*	0.11**	0.09*	0.04	
22A	0.39**	0.38**	0.16**	0.11**	0.16**	0.14**	0.25**

Table 3. Leave-one-out allocation of observations to groups (for 'm'=13).

Station	0K6	00A	1	4	5	6	17	22A	Total	% correct
1	5	2	6	2	0	4	2	2	23	26.10%
4	5	1	3	4	2	2	4	4	25	16.00%
5	6	4	2	6	1	2	2	2	25	4.00%
6	3	0	7	2	1	8	6	1	28	28.60%
00A	2	19	0	1	0	0	1	3	26	73.10%
17	3	1	2	1	2	2	12	2	25	48.00%
0K6	9	3	4	1	3	1	7	0	28	32.10%
22A	1	1	0	3	2	1	1	14	23	60.90%



Discussion

The ichthyoplankton collected from neuston samples in Kuwait waters were relatively diverse with 35 families identified and an unknown number of species. The three most abundant families in the neuston were Gobiidae, Clupeidae and Sciaenidae. This group accounted for over 65% of the fish larvae collected. The gobiies were distributed throughout the collection area, but peak abundances were at stations 006, 004, 0K6, and to a lesser extent 00A. The large catches occurred in the 'after sunset' neuston collections. In July 2004, 674 gobies were collected before sunset, and 3,482 after sunset at station 0K6. Clupeid larvae were generally distributed more evenly but had peak concentrations at stations 005, 00A, and 017. The sciaenids were concentrated in stations 00A, and 001. The engraulid larvae were found offshore primarily at stations 005, 017, and 22A.