ESTABLISHING THE BASELINE OF MARINE RESOURCES OF THE SULTANATE OF OMAN

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ABSTRACT

The extensive coastline of the Sultanate of Oman has shaped its culture, economy, history and its people for millennia. Today, the coastal marine resources are still of great economic importance and continue to influence the lifestyle of the people of Oman. Marine living resources along the coast of Oman are an endowment of biodiversity, provide food and energy resouces and opportunities for tourism and recreation. Unfortunately, the continuous pressure of development threatens this marine environment primarily via over -fishing, global climate change, habitat modification, and coastal zone pollution. A continuous monitoring program and research are key steps that will allow us to differentiate between anthropogenic and natural variability. We have been collecting data from five monitoring sites, three in the Gulf of Oman and two in the Arabian Sea from 2004 onwards. Data collected includes phyto plankton diversity, and hydrographic parameters such as temperature, salinity, nutrients and oxygen that will not only provide us with baseline data necessary for future studies on anthropogenic impacts on this ecosystem but also a better understanding of the seasonal and interannual changes associated with monsoonal forcing. In this paper we address the seasonal monsoonal cycle and its impact on the biology of the coastal waters and use our findings to arrive at conclusions about how variability in phytoplankton and its environment could impact the food chain of this ecosystem.

METHODS

Water samples were collected at least twice a month at three stations Fahal Island (F), Bandar Khairan (BK) and Offshore (OFF) from a depth of 1m, 10m, 20, 50m and 100m in the Gulf of Oman. Two stations in the Arabian Sea (Gulf of Masira (GOM) and East of Masira (EOM)) were sampled monthly whenever possible. The temperature, salinity, oxygen, chlorophyll a and turbidity data were collected using a CTD and water samples were collected using a 5 l Niskin bottle. Aliquots of whole water were collected for chlorophyll a analyses and phytoplankton enumeration. Dissolved inorganic nutrients samples were stored frozen. Chlorophyll a concentrations were determined by standard fluorometric methods (Parsons et al. 1984), phytoplankton enumeration and identification using inverted microscopy. Nutrients were analyzed in duplicate using a 5-channels SKALAR Auto -Analyzer.

STUDY AREA

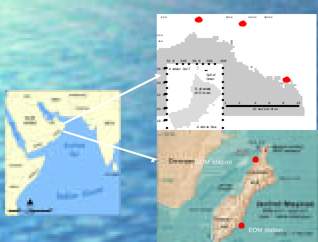
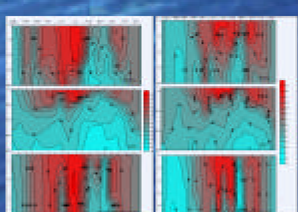


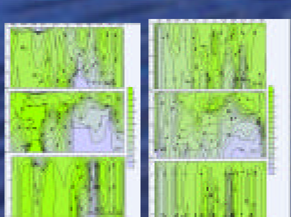
Fig. 1 Location of 3 sampling sites in Gulf of Oman. Additional sites were selected at Masirah Island since 2006. The coastal region of Oman occupies a unique position, being located between the Indian Ocean in the south and the Arabian Gulf in the north. Its coastal oceanographic conditions are poorly known. The seasonal monsoonal winds (North East (NE) and the South West (SW)) play a vital role over the physical, chemical and biological changes in the Gulf of Oman and Arabian Sea.

RESULTS AND DISCUSSION



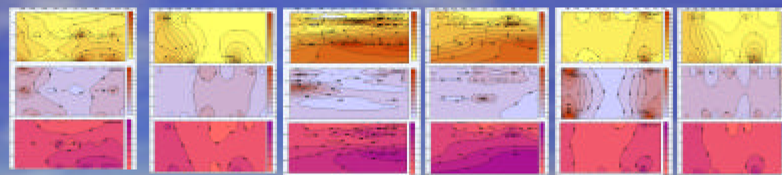
Water temp. 2004 at all stations   Water temp. 2005 at all stations

Fig 2. Water column temperatures revealed a distinct seasonal pattern in the evolution of the thermal structure. At all 3 stations the water column was warmest and highly stratified during the Spring Inter -monsoon (SIM) months of April and May. The transition into the SW monsoon saw a steep upward shoaling of isotherms and cooling of the surface waters due to wind driven upwelling. Significant drops (8°C) of water temperature were recorded at all stations during August in 2004 and 2005. Water temperature at BK and F were colder in comparison to 2004. Sea surface temperatures were however at their lowest during the NE monsoon due to winter convective mixing which led to a colder and well mixed water column.



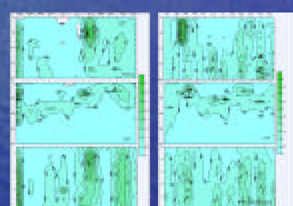
Oxygen 2004 at all stations   Oxygen 2005 at all stations

Fig.3. A striking feature of the coastal waters of Oman is the presence of a shallow oxygen minimum layer. The onset of the SW monsoon clearly contributed to the uplift of these oxygen poor waters to depths as shallow as 10m. The shoaling of the oxygen poor waters was very prominent and long-lived at station OFF extending way into the NE monsoon. At BK and FA the shoaling of oxygen poor waters took place during a narrower window of time. The NE monsoon of 2005 was also marked by a shoaling of oxygen poor waters. A number of fish kill events in the coastal water of Oman are associated with oxygen depletion.



Nutrients (u M) F station 2004   Nutrients F (uM) station 2005   Nutrients (u M) OFF 2004   Nutrients (u M) OFF 2005   Nutrients (u M) BK 2004   Nutrients (u M) BK 2005

Fig. 3. Nutrient (NO_3, PO_4 & NH_3) concentrations were always above detection limits throughout the year and followed a distinct pattern of seasonality at all 3 stations. The highest concentrations of nutrients were recorded at Station OFF during winter and autumn where except for brief periods during the year, NO_3, PO_4 were always in excess of 2 μM at the surface. The trends especially in the shallow stations (F and BK) were slightly different from Station OFF. At these stations the transition to the NE monsoon saw the largest influx of nutrients into the euphotic layer. At station BK, a in 2005, a prominent influx of nutrients was also observed during fall. Bottom water showed highest concentrations. High values of nutrient during winter followed by a decrease during spring and the minimal values during summer influenced the phytoplankton component. The yearly variation in nutrients concentrations correlated positively with water temperature and chlorophyll a.



Chlorophyll 2004 at all stations   Chlorophyll 2005 at all stations

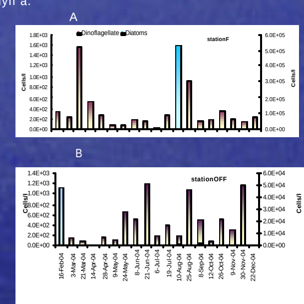


Fig. 4. Distinct winter, summer and fall- time increases in chlorophyll provide clear indication of the existence of clear seasonal cycles of phytoplankton biomass distribution in the Gulf of Oman. At all 3 locations, increases in phytoplankton biomass were clearly tied to the influx of nutrients. At the offshore station (OFF), the transition to SIM saw the establishment of a subsurface chlorophyll maximum, which shallowed as the season progressed rising to almost the surface during the SW monsoon. Chlorophyll trends at the shallower stations were identical but in 2005 the NE monsoon increase in chlorophyll was delayed until Feb. indicating interannual variability in the seasonal trends. Fig. 4B shows that Dinoflagellates were the most dominant species except for Aug. at Station F (93% *Leptocylindrus sp.*) and Feb. at Station OFF (*Nitzschia sp.) Cyanobacteria* accounted for a much lower percentage and occurred during summer at both stations when nitrate concentrations were below 1uM. Dinoflagellate were present throughout the year, but it was from March and August at station F and May, June August and November when their relative contribution in number of cells was most important . In addition, *Noctiluca scintillans* seemed to contribute significantly to total phytoplankton abundance during winter and spring at all stations.

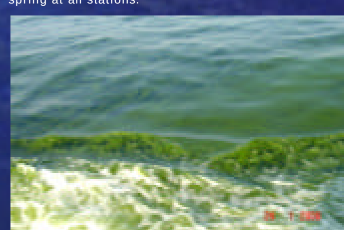


Figure 5. *Noctiluca scintillans* bloom during winter 2006 in Bandar Khairan

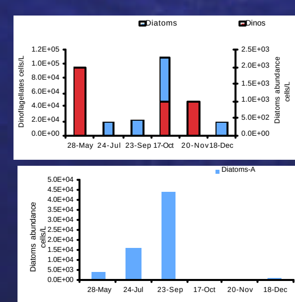


Fig. 6. Preliminary results of seasonal variation of phytoplankton communities in 2006 at A) station West of Masirah island B) East of Masirah islands along the east coast of Oman. Phytoplankton standing stocks were much larger than in the Gulf of Oman. Note that the coastal waters along the east coast of Oman coast come under the direct influence of the SW monsoon. Diatoms were by far the dominant phytoplankton east of the island, whereas the western part of the island comprised largely of dinoflagellates and diatoms.

CONCLUSIONS

Observations of phytoplankton communities in the coastal region of Oman indicate prominent temporal and spatial variability associated with changes in environmental conditions that are brought about by the reversal of the monsoonal cycle. The close relationship between environmental conditions and phytoplankton community structure, suggest that any alterations in the monsoon periodicity or its intensity could have a large influence on phytoplankton communities, with potentially large impacts on the fisheries resources of Oman in -turn. In the light of evidence by Goes et al. 2005, that coastal upwelling along the coasts of Somalia, Oman and Yemen is intensifying as a result of climate change, our observations assume tremendous significance

The role of cyclonic and anticyclonic eddies in phytoplankton communities spatial and temporal abundance and changes in dissolved oxygen in the coastal water of Oman is yet to be investigated.