

א.5. תקציר באנגלית, English Abstract

The Israel National Monitoring Program at the Northern Gulf of Aqaba
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Scientific report 2009

Dr. Yonathan Shaked, Program Manager
Prof. Amatzia Genin, Scientific Director
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Introduction

This report describes the work and results of the Israel National Monitoring Program at the Gulf of Aqaba (NMP) in 2009. It is divided into chapters according to the habitats and methods covered by the monitoring program. Each chapter includes a short description of the methods used, a detailed description of the results including data and figures, and a discussion of the findings. A comprehensive description of the methods used is given in the NMP annual scientific report of 2003. Figures and figure captions are given in English.

This is the sixth year of routine monitoring operations by the NMP in which data is collected using similar methods by a regular dedicated team. The ability to review such consistently collected data provides increased analytical power and confidence in our findings. Thus we begin to seek patterns and trends over the past six years. A comparison of the present-day state of the reef with historical data can be found in the 2004 annual scientific report of the NMP.

This report is available through the web site of the Israel Ministry of Environmental Protection: www.sviva.gov.il and on the NMP web-site: www.iui-eilat.ac.il/NMP/.

A data base that includes the NMP data since 2004 is available for public download through the NMP website.

Key findings

The coral reefs of Eilat

1. Over the period in which data is collected by the NMP the reefs of Eilat seem stable, with some of the proxies showing a slight increase since 2004.
2. Most of the proxies used to evaluate the state of the coral reef were lower this year than the high values measured in 2007, but are still higher than those of the years 2004-2006.
3. We document a gradual increase in substrate utility by stony corals the IUI reef sites. At the NR sites too there is a net increase, and at the Katza sites there are yearly fluctuations that amount to an insignificant change. The shallow reef site at the nature reserve (NR) has the best coral cover while the best substrate utility is found at the deeper NR site (20m depth).
4. The year 2007 saw a rise in the Live Tissue Index, which is used as a proxy for

coral health. Since then values of the LTI have dropped and are now similar to the low values measured in 2006.

5. Reef sites at the IUI have the largest fraction of small colonies, but even excluding these sites there is a reverse correlation between the fraction of small colonies and substrate utility and coral cover per site.
6. Species diversity and community structure of corals at the monitoring sites has remained stable throughout the past 6 years of monitoring.
7. This was the third year of reef surveys at the reef table (reef flat) of the Nature Reserve Reef. Throughout this interval (2007-9) a gradual rise in coral cover and substrate utility has been documented. This may be due in part to recovery of the reef table following an extreme low tide that saw many table-corals exposed in March 2007 (see the NMP annual scientific report 2007). On the other hand, the year 2007 was particularly good (high proxy values) at all reef-front sites, and with the absence of data from the reef table prior to 2007 it is impossible to determine the long term trend at this site.
8. We document a small rise in colony density at the permanent photo-sites compared to the previous year. Although changes are small the density at the photo-sites is still lower in most cases than the 2007 values.
9. At most permanent photo-sites a net growth of stony corals was documented, but at most sites this was not accompanied by an increase in coral cover.
10. Changes in the coral cover include coral growth, colony death and recruitment of new colonies. At the NR and north beach sites there have been more colony deaths than new recruitment and at the rest of the sites the number of recruited colonies is larger than colonies that died. Despite the larger numbers of recruited colonies the live coral cover lost through colony death is larger than that gained by recruitment.
11. Size distribution of coral colonies at the photo-sites remains stable. Small colonies remain the largest size group (app. 60% of all stony coral colonies). The community structure remains stable as well.
12. At the NR lagoon the coral community seems stable. A small (not statistically significant) decline in coral density is measured. Species diversity on the other hand rose since 2007 and is similar to 2006 values. It seems that fluctuations in the abundance of Stylophora, by far the most abundant coral in the lagoon, drive the fluctuations observed at the lagoon as a whole.
13. The density of sea-urchins increased in the past two years, but this year saw a return to the low values of 2006. During the monitoring years 2004-5 and 2007-8 had high sea-urchin density while the years 2006 and 2009 a decline in the urchin density was documented. Available sporadic data from past studies at the IUI show that the population size of sea-urchins in the Gulf of Eilat is prone to strong fluctuations.
14. Sea-feather density continue to increase at the NR sites but a decrease was documented this year at the IUI.
15. The growth potential of benthic algae, as indicated by settlement over plates protected from the effects of grazing, was lower this year compared to the past two years – probably due to the shallow mixing of the water column.
16. The rate of benthic algae growth decreases rapidly with depth, with maximal

values found on plates in the lagoon and minimal values at a depth of 20m. At all depths grazing seems to efficiently regulate benthic algae growth, but during the winter months, when growth potential reaches its peak, the chlorophyll-a concentrations also rises somewhat on plates that are exposed to grazing.

17. The community structure of reef fishes begins to be apparent after three years of fish surveys by the monitoring program. The largest group is the zooplanktivores that comprise some 82% of the fishes counted this year. This group has an essential part in the reef function by concentrating foods from the lower trophic levels. Carnivorous fish comprise 9% of the fishes counted, and are responsible for checking the population of reef dwellers such as invertebrates and other fish. The third-largest group is the herbivorous fish (4% this year) that make reef surfaces available for settlement by curbing algae growth. Other groups have a significantly smaller representation in our reef-fish surveys.

Coastal water

18. The seasonal cycle of mixing of the upper water column is the dominant process dictating concentrations of chemical variables measured in the coastal waters of Eilat. Accordingly, the concentrations of most variables (nitrogen, phosphate, silicate) are higher in the surface waters during the winter. Mixing of the water column this year was exceptionally shallow, less than 300 meters, and accordingly - most variables had relatively low winter concentration.
19. Few abnormal values were measured in Eilat's coastal water this year, compared to the period 2004-7, and abnormal amplitudes were significantly lower as well.
20. Lethal bacterium pathogens that were common in pre-2007 years were not found in this year's survey of wild reef fish.
21. A pathogenic gram-positive bacterium, *Streptococcus parauberis*, was isolated in an adult specimen of broomtail wrasse *Cheilinus lunulatus* found freshly dead at the NR. *S. parauberis* has been reported in fish only once before, in turbot (*Scophthalmus maximus*) farmed in Spain where it caused severe mortalities. This is the first report of such a pathogen in a Red Sea fish. *S. parauberis* is commonly found in cattle raised in the southern Arava, as well as in cattle held at the Quarantine Enclosure near Kibbutz Eilat, where livestock imported from Australia are kept prior to transfer northwards in Israel. These cattle enclosures are located only several km from Eilat's coast. We suggest that closer attention also be focused on the manner and location that livestock ships dispose of dead animals, their bedding and their excrements.
22. This is the first time the NMP surveys metal concentrations in water and sediments of Eilat's marina. Copper is the only element whose concentration was found to be higher than the permitted value for sea water in the Mediterranean, according to the guidelines of the Ministry of Environmental Protection (MEP). There are currently no guidelines in effect for the Gulf of Eilat.
23. The survey for metal concentrations in Eilat's marina was initiated by MEP's

marine pollution control unit in Eilat, and was conducted by them in the years 2004 and 2006. This year's survey conducted by the NMP aimed at achieving higher analytical resolution and accuracy, and therefore targeted a smaller subset of key elements. Samples were sent for analyses at the analytical laboratory of the Institute of Earth Sciences at the Hebrew University. Indeed analytical resolution was higher than previous years, by orders of magnitude, and in most cases a comparison could not be made with previous results due to their low resolution and seeming inaccuracy. In general, values measured this year were lower than those obtained in 2004 and 2006, but this may be an analytical artifact.

The open water column

24. The seasonal mixing cycle dictates much of the observed variability in concentrations of nutrients, dissolved oxygen and the dynamics of phytoplankton population in the open waters. This year vertical mixing of the water column was exceptionally shallow, some 300 meters, in contrast to the past two years in which mixing reached the sea floor at the northern end of the gulf (some 700m deep).
25. This year's shallow mixing signals a quick return to the "normal" situation in which nutrient accumulate in deeper water. In this year's samples a concentration gradient is apparent at depths greater than 250 meters. It seems that in the years of deep mixing a larger portion of the nutrients was kept in particulate form and the dissolved inventories were particularly low, especially during 2007. This year saw a return of dissolved inventories similar to those of the years before deep mixing in 2007.
26. The concentration of most nutrients in the water column is still lower than it was in the years 2004-6. In deep water nutrient concentrations are rising since 2007 in which values were lowest, but are still significantly lower than all measurements measured in the decade prior to that.
27. It seems that the return to high nutrient concentrations in the deep water occurs at a lower rate than it did in the period 2000-6. Two years after the last deep mixing and deep-water (deeper than 500 meters) nutrient concentrations are still lower than pre-mixing values. During 2000-6 nutrient concentrations bounced back up following a mixing event within a single summer.
28. In 2007-8 *chlorophyll-a* concentrations were exceptionally high, and *chl-a* this year was lower. Nevertheless, and despite the shallow mixing *chl-a* peaks were higher this year than in the years 2000-6. We find a slight rising trend (regression analysis: $N=110$, $P<0.04$) in *chl-a* concentrations at the deep chlorophyll maximum.
29. Deep water temperatures stopped rising during 2007-8 in which deep mixing occurred, but are still higher than their 2000-6 values. At 600 meters depth temperature rose by $\sim 0.1^{\circ}\text{C}$, and at 700 meters by $\sim 0.25^{\circ}\text{C}$.
30. For the first time this year the NMP measured particulate organic carbon (POC) and primary productivity in the water column. These measurements are a big step forward towards gaining a better grip of the ecological state of the gulf and changes that may be happening to it.

31. Profiles of POC reveal two regions of elevated concentrations (sources): a) the upper water body where phytoplankton is abundant and particulates are formed, and b) close to the sea floor where it seems that particles are resuspended from the sediment.
32. Primary productivity values measured by the NMP this year are within the range of values reported from the past few years but are higher than values measured in “true” oligotrophic seas such as Hawaii and Bermuda. Our productivity values suggest that the Gulf of Eilat is a meso-oligotrophic ecosystem.

Continuous measurements

33. This year's *chlorophyll-a* concentrations near the NR coral reef reached their peak earlier than predicted by multi-seasonal data accumulated since 1988. Three high-Chl events are particularly conspicuous: in January, February and July. In these months Chl-a concentrations are usually low, but this year short periods in which Chl-a was higher than 90% of the values measured in the past 20 years were observed.
34. In November and December sea surface temperature (SST) measured from the Observatory's pier was higher than average and at times higher than all measurements from the past 20 years. This will probably impact the dynamics of water column mixing, and is likely to result in shallow mixing in 2010. Despite high winter temperatures, the maximum SST measured this year was lower than that of the past two years.
35. SST measured from the Observatory pier seems to be still rising from a long-term perspective, although maximal values this year were lower than those measured in 2005-8. It is likely that high winter temperatures dictate this long-term rise.
36. A strong southern storm on December 16 had noticeable impact on the shoreline, particularly reshaping the unprotected southern beaches. The storm, with wind gusts in excess of 20 meters per second also damaged corals and transported sediments along the sea floor to a depth of some 5 meters. This storm occurred after our 2009 reef surveys were completed and so its effects – if any – will only show in the 2010 reef census.
37. Continuous meteorological observations from the IUI pier show that the highest air temperature this year was lower than in the past two years, and that the lowest temperature this year was almost 3°C higher than the minimum temperature in 2007-8. At the beginning of the year (Jan-March) temperatures were higher compared to the past. This high winter temperature probably effected water cooling and forced a shallow mixing this year.
38. Towards the end of summer, in October, SST rose sharply from 25°C in mid October to more than 27°C by the beginning of November. There is a small rise in air temperature during this interval, but it seems that a greater factor are the winds: during this interval winds were weak and fluctuated between northerly and southerly.