5.א. תקציר באנגלית, English Abstract

The Israel National Monitoring Program at the Northern Gulf of Aqaba

Funded by the Israel Ministry of Environmental Protection

Scientific report 2007

Dr. Yonathan Shaked, Program Manager
Prof. Amatzia Genin, Scientific Director
(March, 2008)

Introduction

This report describes the work and results of the Israel National Monitoring Program at the Gulf of Aqaba (NMP) in 2007. It is divided into chapters according to the various 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.

This is the fourth year in which the NMP operates regularly and data is collected using similar methods by the same 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 four years. A comparison of the present-day state of the reef with historical data can be found in the NMP report of 2004.

This report is available through the web site of the Israel Ministry of Environmental Protection: www.sviva.gov.il and that NMP web-site: www.iui-eilat.ac.il/index.aspx?page=NMP.

Key findings

The coral reefs of Eilat

1. A healthy coral reef comprises high utilization of available substrate for coral growth, high species diversity and healthy coral colonies. Additional variables are meant to provide early estimates regarding the state of the reef, and to indicate processes that may eventually impact the reef's health. Despite deep mixing of the water column that exported plenty of nutrients to the surface and resultant algal blooms in the water column and on the sea floor, most of the variables measured in 2007 indicate an improvement. As noted before, these data are insufficient to draw a long-term trend, but it is encouraging that the system fluctuates towards healthier reefs.

2. The patchy character of the reefs of Eilat, that manifests in large areas of unconsolidated substrate on which corals cannot settle, calls for coral cover data to be normalized by the area of consolidated (hard) substrate. When normalized coral cover is considered, all sites display similar values i.e. strong local inhibition of reef growth at a given site is not recognized. When data is compared across the years since 2004 a rise in the normalized coral cover is indicated this year. Values from all sites were higher in 2007 than in 2006. At the IUI-5 and IUI-15 sites this seems a continuous rise since 2004.

3. High utilization of available substrate is achieved though large coral colonies, rather than the addition of small colonies (settlement). A negative correlation between the

abundance of small colonies and utilization of available substrate provides further indication that a healthy reef in Eilat is a reef with abundant large colonies. High abundance of small colonies in Eilat indicates a stressed reef. It seems that the reefs in Eilat are not settlement-limited.

4. The data collected by the NMP in the years 2004-2006 indicate a statistically significant decline in the percent of live tissue in living coral colonies. In 2007 an increase in the percent of live tissue was found at all sites. Although the change is small, the finding is significant when the large number of colonies surveyed is considered.

5. The Shannon-Wiener species diversity index for each site (rather than for an average 10m segment of each site) was calculated using EstimateS software (Colewell 2005), freeing the estimated diversity index from dependency on the patchiness at each site. Large changes between the years, since 2004, were not detected, but the diversity index estimated in 2007 was at most sites lower than that of the previous year. The 20 most abundant coral genera comprise 95% of the coral area surveyed. Genera richness, however, is much greater than 20, exceeding 40 genera in the richest sites (KATZA-20 and IUI-5), giving additional significance to the presence of rare species in the reefs of Eilat.

6. The reef table at the southern part of the Nature Reserve was surveyed for the first time this year. A particularly low utilization of available substrate was found (compared to the other, fore-reef sites). It is worth noting that the reef table comprises almost exclusively of hard reef-rock. Along with the low utilization, a low density of coral colonies was found. In other variables, such as the diversity index or the percent of live tissue in living colonies, the reef-table is not outstanding although it has values that are generally on the low end of the site-spectrum. It seems that the reef table is inherently different than the other sites, and direct comparison is not warranted. Since this is the first year the reef-table was surveyed the collected data will be the standard to which additional data will be compared in coming years in order to evaluate trends and processes at this site.

7. Photo-survey sites provide direct year-to-year comparison of particular points and colonies. They do not provide a statistical representation of coral cover, diversity or abundance for the entire site. In difference to the rise in most indexes noted in the statistically comprehensive line-transect reef survey, at most photo-sites excess mortality over settlement was found in 2007. Nonetheless, at most photo-sites a net growth of corals was measured since 2004. An exception is the IUI where “negative growth” was measured since 2004, despite signs of recovery and development calculated from line-transect data. The over area covered by corals has also dropped at the Dekel site, and for non-branching corals at the Taba site.

8. The distribution of coral genera and the temporal changes in the photo-survey sites represent stability of the reef community and do not reflect unusual growth or a catastrophic decline.

9. Coral colony density at the Nature Reserve lagoon was lower in 2007 than in the previous year, but the changes between years are not statistically significant and it seems

that the lagoon population is stable.

10. The population of Sea Urchins during the period 2004-2007 seems stable at the surveyed sites (IUI and Nature Reserve), with values in 2006 being particularly low. The population of Sea Feathers seems to grow consistently, except at the IUI-5 site.

11. 2007 was marked by a particularly intensive algae bloom that was manifest in benthic algae mats covering sandy slopes and reefs, and in high benthic algae growth-potential measured off the IUI. The growth rate of benthic algae seems to drop along a depth gradient for maximal values at the lagoon to minimal values at 20 meters depth. At all depths grazing seems to successfully check benthic algae growth.

12. A survey of reef fish was conducted for the first time this year, at the southern part of the Nature Reserve. Lacking previous data, the data collected this year will be the measuring stick for future findings.

Coastal water

13. Most chemical variables measured in the coastal waters of Eilat are controlled by the seasonal cycle of summer stratification – winter mixing of the upper water column. Accordingly, the concentrations of most variables (nitrogen, phosphate, silicate) are higher in the surface waters during the winter. 2007 had an exceptionally deep and long mixing period, apparent in high nutrients and *Chlorophyll-a* concentrations measured February-April. Nutrient concentrations at the surface were generally higher this year than in previous years, and intense phytoplankton algal blooms – and thus high *Chl-a* concentrations – resulted.

14. In addition to the natural seasonal cycle it seems that the coastal waters of Eilat are occasional affected by contamination inputs that alter their chemical properties. These changes are measured on a local scale in close proximity to the source. Abnormal nitrogen concentrations were measured near the northern sampling stations (Fish Farms, Northern Beach and Navy/Meridien) during summer and autumn months. In particular, exceptionally high nitrogen, coupled with low salinity, measured in May at the Navy/Meridien station indicates direct input of saline nutrient-rich groundwater at this site.

High Ammonium concentrations, higher even than last year's, were measured at the Fish Farms station mostly at the beginning of the year. Ammonium is a very short-lived form of nitrogen in the sea and thus its presence indicates an input source. It seems that the area near the northern stations and the Navy/Meridien are often subject to contamination, albeit from a different source.

15. A survey of fish pathogens and diseases was carried out by the NMP for the first time this year. The survey, initiated by the NMP, was conducted by A. Diamant, G. Heinisch and A. Colorni of IOLR-NCM. Results were compared by the authors to previous data. Changes in parasite infection prevalence were relatively minor, displaying some decline. However, intensities of infection (mean number of parasites per infected host) by heteroxenous gut parasites indicate a steady decline when compared with previous years:1981-1985 and 1995-2000. A decline in the abundance of intermediate hosts that transmit these parasites (e.g. molluscs) may have such an effect on their infection

intensities in the final fish hosts. Thus, the drop in abundance of parasitofaunal elements of the rabbitfish may infer that the diversity of the reef habitat is declining.

The presence of well-known deadly bacterial pathogens in wild dead fish found by NPA personnel is worrisome. Although the number of wild fish examined was small and variability high, the percentage of infected fish is similar to that found in previous studies.

The open water column

16. The seasonal cycle of summer stratification – winter mixing of the upper water column is the dominant featured observed in the concentrations of nutrients, dissolved oxygen and the dynamics of phytoplankton population in the open waters. The multi-annual is governed by the depth and duration of annul mixing, and the amount of nutrients accumulated in the deep water. Mixing this year was especially long and deep, and its affects were felt in measured concentrations in the water column as well as in benthic algal blooms on the sea floor. Mixing of the entire water column to >700m and >800m occurred through February and March respectively. This deep mixing changed sea water composition, and many of the adverse trends measured in previous years were reversed: nutrient stores in the deep waters of the gulf were greatly depleted, and the dissolved oxygen stores were replenished.

17. Year 2007 saw a particularly intense planktonic algae bloom that contributed to the observed trend of rising spring *Chlorophyll-a* concentrations since 2004.While many of the observed nutrient trends since 2004 may now be considered multi-annual cycles coupled to the extent of winter mixing, a continuously rising spring *Chl-a* concentration may still represent a long-term trend.

18. Compared to the deep mixing event of 2000 (mixed depth of approximately 640m) nutrient stores in the deep water were slower to replenish this year. In the months following the extreme values produced by winter mixing, nutrient concentrations rose and oxygen concentrations dropped in the deep water in 2007 at half the year 2000 rate. This is an encouraging sign indicating a significant decrease in primary production between 2000 and 2007.

19. A particularly large decrease was measured in deep water silicate stores suggesting an increase in the presence of siliceous algae whose bloom may speed transport of silicate to the sea floor and its subsequent removal by burial.

20. Despite this year's deep mixing and cooling of the water column a gradual rise in deep water temperature since year 2000 is still apparent. In previous years it seemed there was a coupling of deep water temperature and nutrient/oxygen concentrations, but while the latter changed dramatically this year, reversing 'trends' observed since 2000, deep water temperature seems to continue rising following the 2007 deep mixing.

Continuous measurements

21. Following this year's deep mixing several peaks in *Chlorophyll-a* concentrations – i.e. planktonic blooms – were measured, that are beyond the range of values measured in the past two decades off the Observatory pier. Particularly high values were measured

during August when *Chl-a* concentrations vastly superseded "normal" summer values. It seems apparent that deep mixing that brought to the surface an abundance of nutrients directly influenced the frequency and intensity of planktonic algae blooms.

22. The maximal SSTs measured this year continue to rise above the maximum multi-annual average. The highest SST measured this year was the highest measured since 1988, and peaks extending beyond the recorded range were measured in July and in August.

23. This is the first complete annual cycle in which meteorological variables were measured by the NMP. Several southerly storm events were recorded, as well as intense low-tides that exposed shallow corals. During the low-tides of March 2007 (March 18-21) while shallow corals were exposed extremely high solar radiation was measured. This combination of conditions may damage exposed coral colonies and effect the population structure of the exposed reef sections. It is still early to assess the long-term impact of this series of low tides on the reefs of Eilat.