

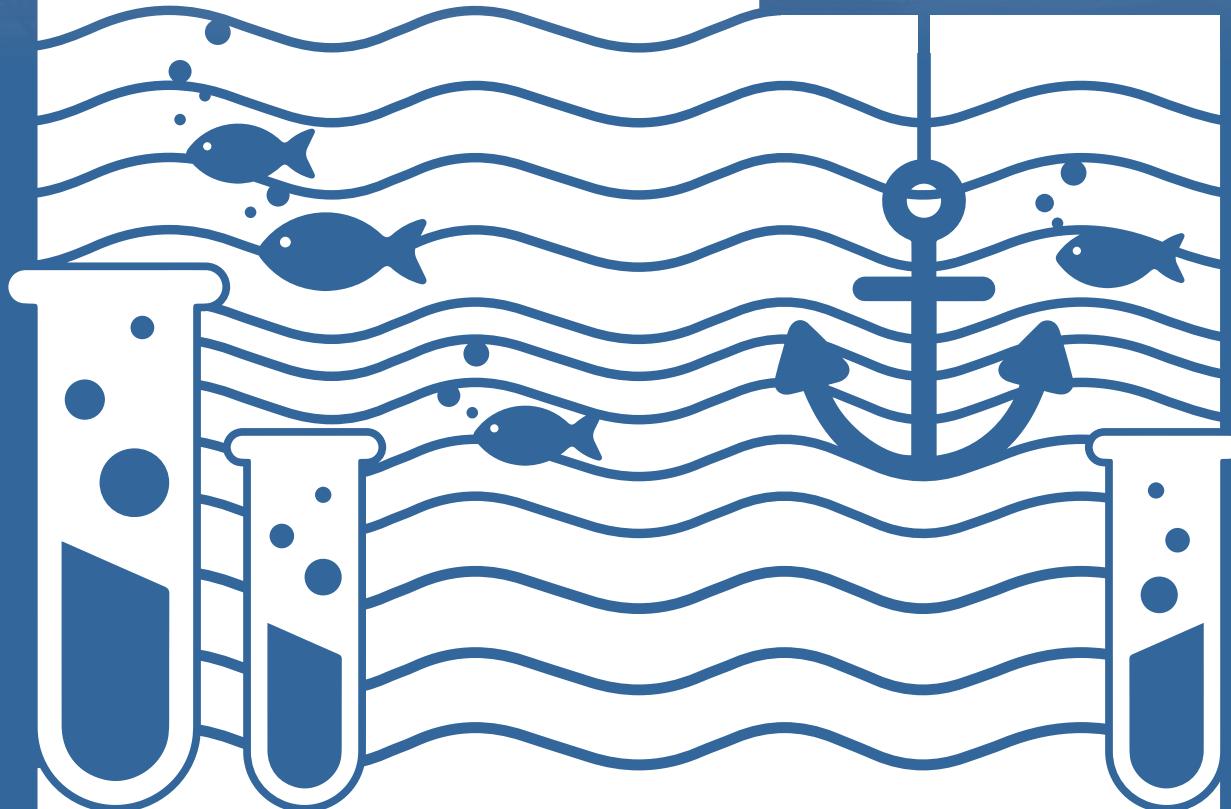


هيئة البيئة - أبوظبي
Environment Agency - ABU DHABI

MARINE WATER QUALITY

ANNUAL SUMMARY REPORT 2017

ABU DHABI







//INTRODUCTION



//BACKGROUND

The Marine Water Quality Monitoring Programme (MWQMP) of the Environmental Agency – Abu Dhabi (EAD) monitors ambient water quality conditions in Abu Dhabi Emirate waters to detect effects of human activities on habitat degradation and water-dependent resources. Abu Dhabi's marine waters face potential environmental challenges due to urbanization, industrialization, tourism, and factors associated with these. Waters in the Gulf have been exposed to pollutants, including nutrients, organic matter, heavy metals, and microorganisms.

EAD's MWQMP has collected ambient marine water quality data to monitor levels of these pollutants since 2006. In 2017, 22 sites in Abu Dhabi waters were covered under the MWQMP. Continuous monitoring is important for assessing the quality of Abu Dhabi's waters, and allows for implementing strategies to protect marine resources. The monitoring data have provided a valuable record on the state and trends of marine water quality. The data is analysed and evaluated monthly and findings are shared periodically, including annually, through water quality reports. The purpose of this summary report is to provide insight into the status of the marine environment by highlighting key findings from the 2017 MWQMP.



//DRIVING FORCES, PRESSURES, & IMPACTS TO ABU DHABI WATERS

EAD employs the drivers, pressures, states, impacts, and responses (DPSIR) model to assess how human activities may affect the environment. Figure 1 illustrates the causal chain that links human activities and environmental pressures to environmental impacts and policy responses.

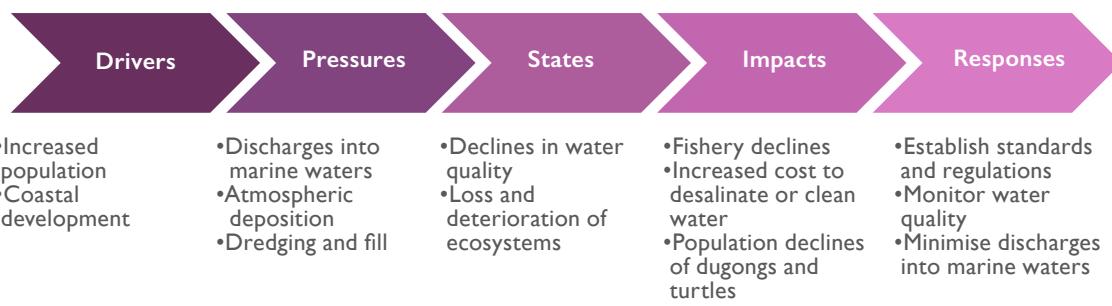


Figure 1. DPSIR model with examples relevant to Abu Dhabi.

The two major driving forces that apply pressures on Abu Dhabi's marine environment are human population growth and the associated rapid economic development. These drivers create pressures such as discharges into marine waters, atmospheric deposition of pollutants, and sediment dredge and fill operations. These pressures can introduce excess nutrients, sediments, and chemical contaminants into marine waters, leading to declines in water quality and to loss and deterioration of habitats.

Development and population growth also spur demands for more fresh water from desalination plants and an increased need for wastewater treatment facilities. Responses to these changes in the state of the environment could

involve promulgating rules and regulations for activities that cause environmental pressure, expanding the marine monitoring Programme, and taking steps to minimise discharges into marine waters.

Impacts in Abu Dhabi that have been or could be of concern in the future are presented in Figure 2. They include a decline in biotic communities and increases in eutrophication, harmful algal blooms (HABs), bacterial contamination, and contaminated sediments as well as increased costs to desalinate or clean water. EAD and other agencies respond by monitoring and enacting regulations to protect water quality.



//EUTROPHICATION

- Caused by an excessive amount of nutrients (nitrogen and phosphorus) in water bodies, which come from point and non-point sources.
- Leads to enhanced growth of algae, especially phytoplankton, resulting in diminished water clarity and depleted oxygen when blooms decompose.
- Dissolved oxygen depletion can kill aquatic life.

//HARMFUL ALgal BLOOMS

- Occur when populations of phytoplankton species increase rapidly.
- Some HAB species also produce toxins.
- HABs are responsible for mass mortalities of fish and have caused fish kills and the closure of desalination plants in U.A.E.

Figure 2. Potential Impacts from Drivers and Pressures to Abu Dhabi's waters.



//BACTERIAL CONTAMINATION

- Results from the discharge of inadequately treated municipal wastewater into the environment.
- Contaminated water or seafood can cause gastrointestinal illnesses, respiratory illnesses, and skin infections in people.

//CONTAMINATED SEDIMENTS

- Harms marine organisms, including reproductive problems and tumors.
- Contaminants get stored in organisms and become concentrated over time (bioaccumulate).
- Human health is threatened when contaminants bioaccumulate in fish eaten by humans.





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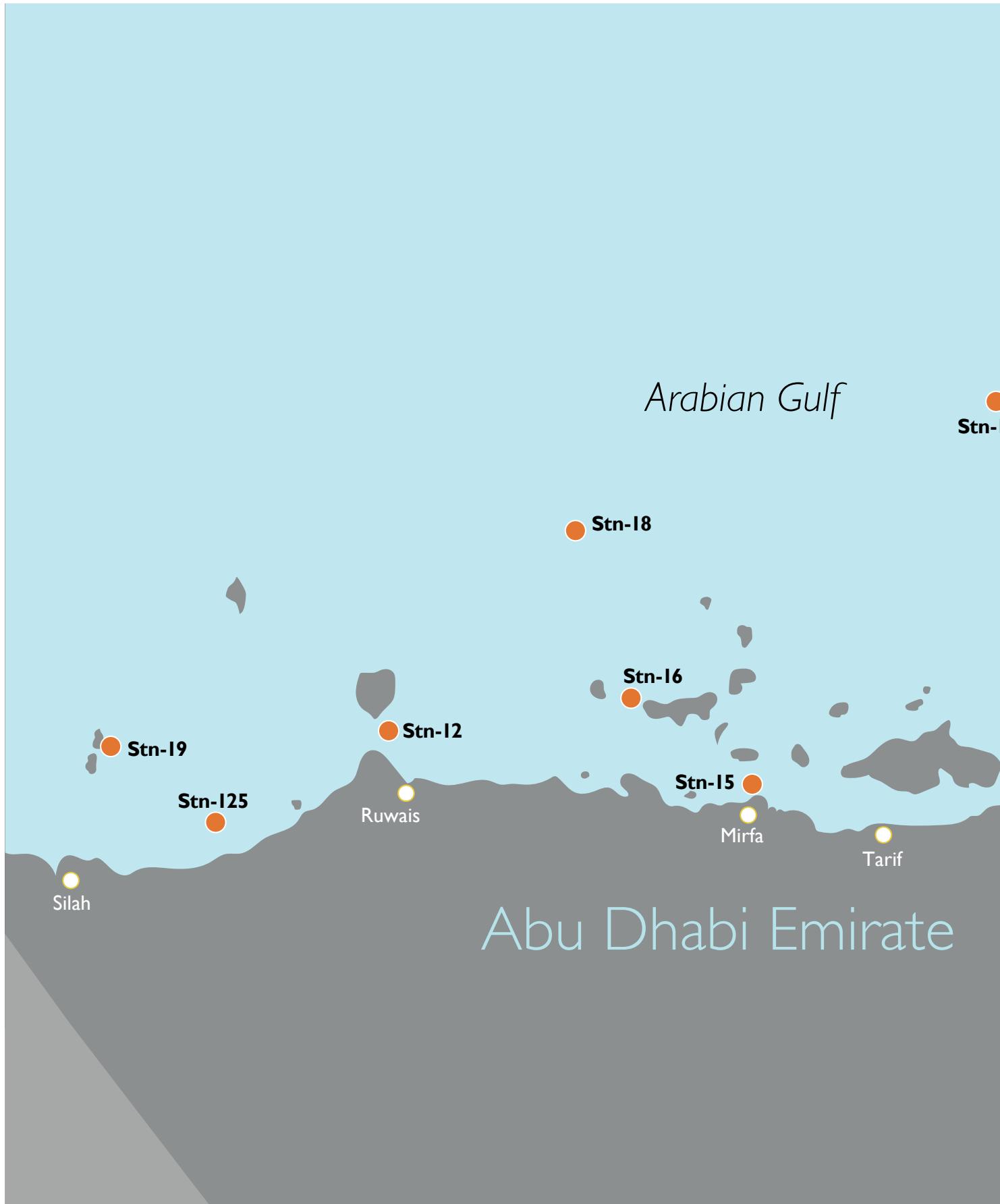
//METHODS

2.1 //SAMPLING STATIONS

Marine water quality sampling stations span the Emirate, from ecologically important areas to more heavily used areas, and from Abu Dhabi City to Al Dhafra Region of Abu Dhabi Emirate (Figure 3)

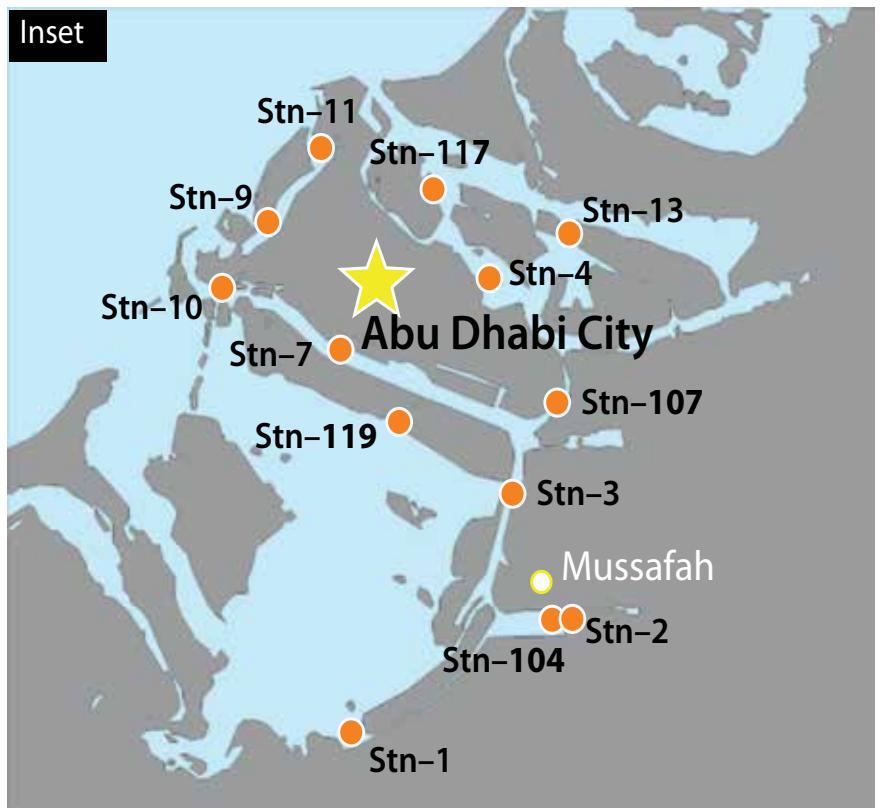
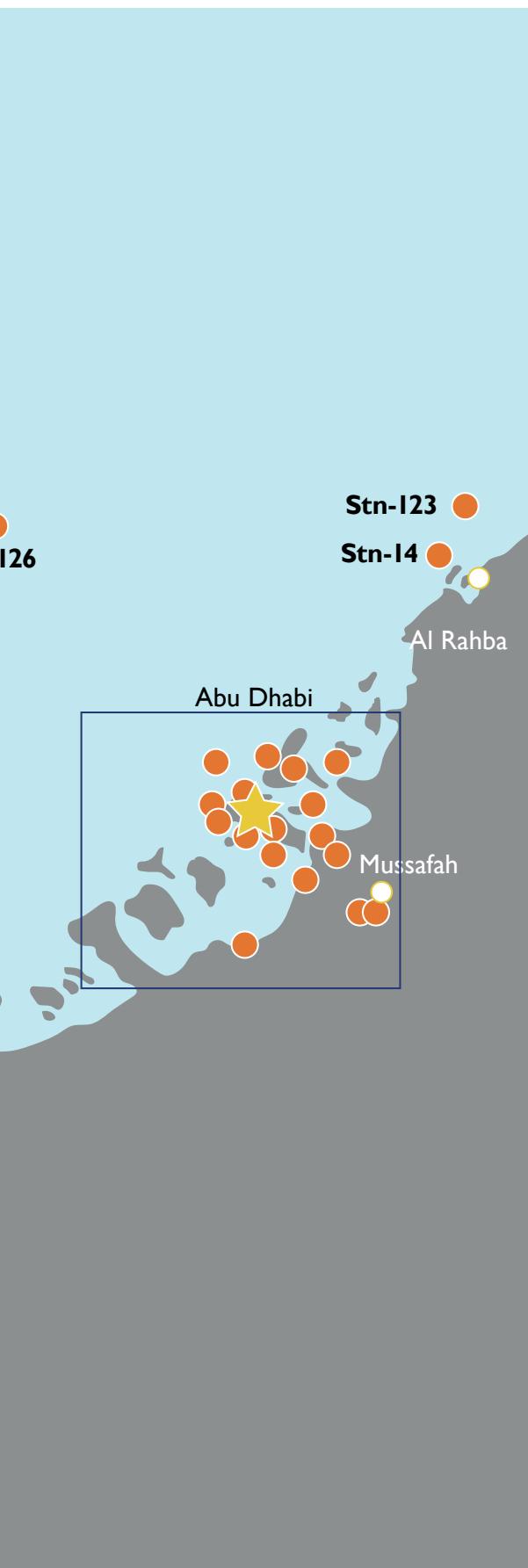
The ecological importance and nearby activities or uses, categorise the sampling stations as follows:

- Confined Areas
- Public Beaches
- Ports and Marinas
- Point Source
- Desalination Plants
- Marine Protected Areas (MPAs) and Natural Habitats
- Newly Developed and Developing Areas
- Nuclear Power Plant
- Reference Station



Note: Mussafa South Channel (Station 104) is a point source and is not included in the indices that capture ambient water quality.

Figure 3. Marine water and sediment quality monitoring stations.



Stations

Confined Areas

Stn-1 Al Salamiyah Channel
 Stn-2 Mussafah South Channel
 Stn-3 Mussafah Industrial Area
 Stn-4 Eastern Corniche

Point Source

Stn-104 Mussafah South
 Channel-Outfall

Public Beaches

Stn-7 Bateen Beach
 Stn-9 Corniche Beach
 Stn-107 Fairmont Beach

Ports & Marinas

Stn-10 Intercontinental Jetty
 Stn-11 Port Mina Zayed
 Stn-12 Ruwais

Desalination Plants

Stn-13 Um Al Nar
 Stn-14 Taweelah
 Stn-15 Mirfa

MPAs

Stn-16 Marawah
 Stn-18 Butinah
 Stn-21 Al Yasat
 Stn-19 Al Yasat
 Stn-123 Ras Ghanada

Newly Developed and Developing Areas

Stn-117 Al Reem Island
 Stn-119 Al Hudayriat Island

Nuclear Power Plant

Stn-125 Barakah

Reference

Stn-126 Reference



2.2 // SAMPLING FREQUENCY

The sampling strategy incorporates two types of sampling frequencies. The stations around Abu Dhabi City (i.e., Stations 1–11, 13–14, 107, 117, 119, 123, and 126) were monitored monthly. The stations outside of the city and in Al Dhafra Region (i.e., Stations 12, 15–19, and 125) were monitored less frequently.



2.3 //

//LABORATORY AND FIELD METHODS

Water samples were collected and analysed in an external laboratory for nutrients, organic compounds, biochemical oxygen demand (BOD), total suspended solids (TSS), heavy metals, and faecal indicator bacteria (enterococci and faecal coliforms). Sediment samples were collected at the same time as water samples and then were analysed for heavy metals. Along with the MWQ samples, observations of weather, wind, and water appearance (e.g., colour, odour, tide) were recorded.



// DATA ANALYSIS

Continuous monitoring of **Abu Dhabi** waters over the past several years has provided critical data that were used to characterise the physical, chemical, and microbial conditions in the marine environment. The 2017 data that are the focus of this summary report illustrate the nature and range of these dynamic ecosystems.

The results of the descriptive statistical analyses of the comprehensive monitoring data are presented in EAD's **2017 Marine Water Quality Technical Report**.

Water Quality Indices

To provide summary analytics, three water quality indices were calculated by applying a generic Water Quality Index (WQI) method (developed by the Canadian Council of Ministers of the Environment in 2001) to the following three separate groupings of parameters representing different aspects of MWQ:

Eutrophication Index

Indicates the level of nutrient over-enrichment of the coastal waters and is based on parameters associated with eutrophication, including nutrients (i.e., nitrate, phosphate, and ammonia), DO, and chlorophyll-a.

Microbial Index

Indicates the level of bacterial contamination in marine waters that can pose a threat to public health and is based on the faecal indicator bacteria enterococci and faecal coliforms.

Heavy Metals Index

Indicates the extent of metal contamination in marine sediments and is based on parameters that are heavy metal contaminants (i.e., cadmium, copper, lead, nickel, mercury, and zinc) in sediments.

A yearly value for the 3 indices is calculated for each station and a yearly average (presented in this report) is calculated for each of the indices for all of Abu Dhabi coastal waters.

The WQI produces a score between 0 and 100 for each monitoring station for the year. Scores are grouped into three condition rating categories of "Good" (a score of 75 and higher), "Fair" (a score of 50 to 74), and "Poor" (a score of 0 to 49).





// RESULTS

EAD monitored 22 stations for 29 water quality parameters and 10 sediment parameters. Results from the 2017 sampling programme indicate that the mean concentrations of heavy metals in water and sediment appear to be relatively stable across years. Confined areas had elevated concentrations of metals (copper, zinc, and nickel) in sediments.

Microbial parameters were not detected in the majority of samples collected in 2017, particularly at the stations outside of Abu Dhabi city. The stations in the confined areas and the ports and marinas had elevated bacterial values, with a peak reading of enterococci in the summer at the Mussafah South channel station.

Water clarity was highest at the Reference and Nuclear Power Plant stations, while it was comparatively poor in the Mussafah South Channel. Little variation was seen in dissolved oxygen levels except for two outlier readings at the Mussafah South Channel in the summer and fall. Chlorophyll-a, nitrate, ammonia, and phosphate observations were consistent across stations except for the Mussafah South Channel. These results suggest that the mitigation actions taken by Abu Dhabi Government including EAD resulted in positive effects that preserve the ecosystem and public health.

In 2017, guideline values used in the index calculator were changed for chlorophyll-a, enterococci, cadmium, copper, lead, nickel, zinc, and mercury to reflect the new Quality and Conformity Council (QCC) ambient water and sediment quality specifications. Increasing the chlorophyll-a guideline from 0.7 to 1 improved the scores at some stations. More stringent guidelines for the metals in sediment and Enterococci resulted in declines in some station scores for the Heavy Metals and Microbial indexes. Figure 4 presents the indices scores over the past seven years.

Eutrophication Index

- A significant improvement in the average annual Eutrophication Index score was observed, increasing 18 points from 51 in 2016 to 69 in 2017.
- For the first time since 2011, three stations (Mirfa, Butinah, and Al Yasat) achieved perfect Eutrophication scores of 100.
- The annual average Eutrophication score for two station categories (Desalination Plants and MPAs) went from Fair to Good.
- For the seventh consecutive year, the Mussafa South Channel had the lowest score.
- All the MPA stations achieved Good eutrophication scores for the first time since 2011.

Microbial Index

- During 2017, 62% of the stations scored 100 in the Microbial Index.
- Scores improved from 2016 to 2017 for most of the stations in the Confined Areas, Public Beaches, and the Ports and Marinas.
- Station categories farther away from the city (Desalination Plants, Marine Protected Areas, Newly Developed and Developing Areas, Nuclear Power Plant, and Reference) achieved perfect Microbial Index scores.

Heavy Metals Index

- The Heavy Metals scores for the Reference and Nuclear Power Plant stations decreased by 10 points. The EAD monitoring team will continue to monitor these sites to see if a trend develops.
- Only four stations achieved Heavy Metals scores of 100, compared with eight last year.
- The Mussafa Area stations had the lowest annual mean scores for heavy metals for the seventh year in a row.





Summary of Marine Water Quality Indices Findings

Eutrophication Index

The increase of the chlorophyll-*a* guideline from 0.7 to 1 resulted in an improvement at all stations and in all station categories. The overall annual mean Eutrophication Index score increased 18 points.

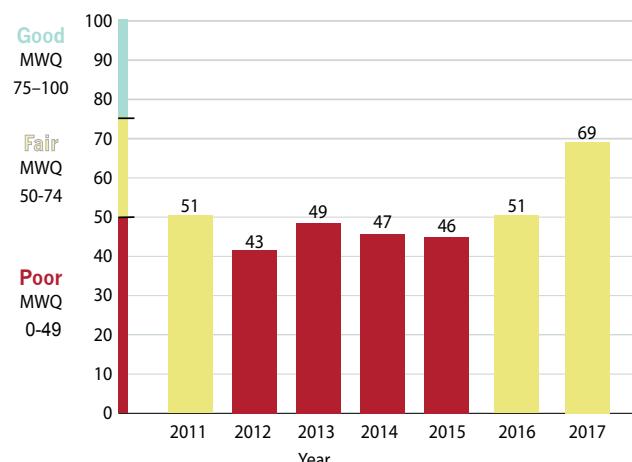
Microbial Index

Although all stations achieved Good ratings in 2017, there was a reduction in the scores for the Confined Areas, Public Beaches, and Ports and Marinas, which factored into the slightly lower annual mean Microbial Index score.

Heavy Metal Index

A small decline in the annual mean Heavy Metal Index score occurred in 2017. However, there were no changes in the station category ratings all stations that were rated Good and Fair in 2016 achieved those same ratings in 2017.

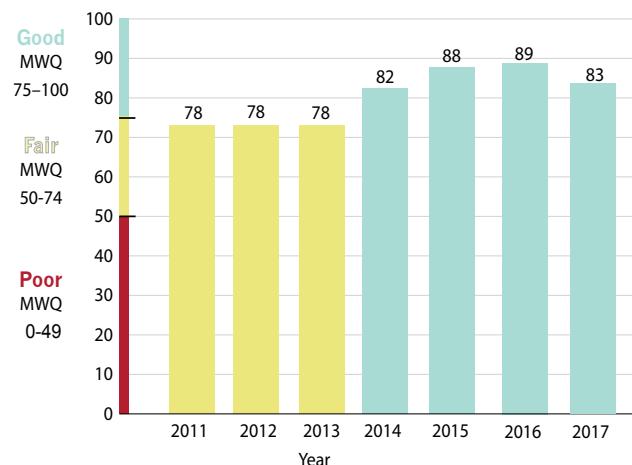
Eutrophication Index



Microbial Index



Heavy Metal Index



Note: The 2017 guideline value used in the Eutrophication Index for chlorophyll-*a* is different from previous years.

■ Poor score of 0-49 ■ Fair score of 50-74 ■ Good score of 75-100

Figure 4. Bar graphs of the indices scores from 2011 to 2017.





05

//SPECIAL PROGRAMMES

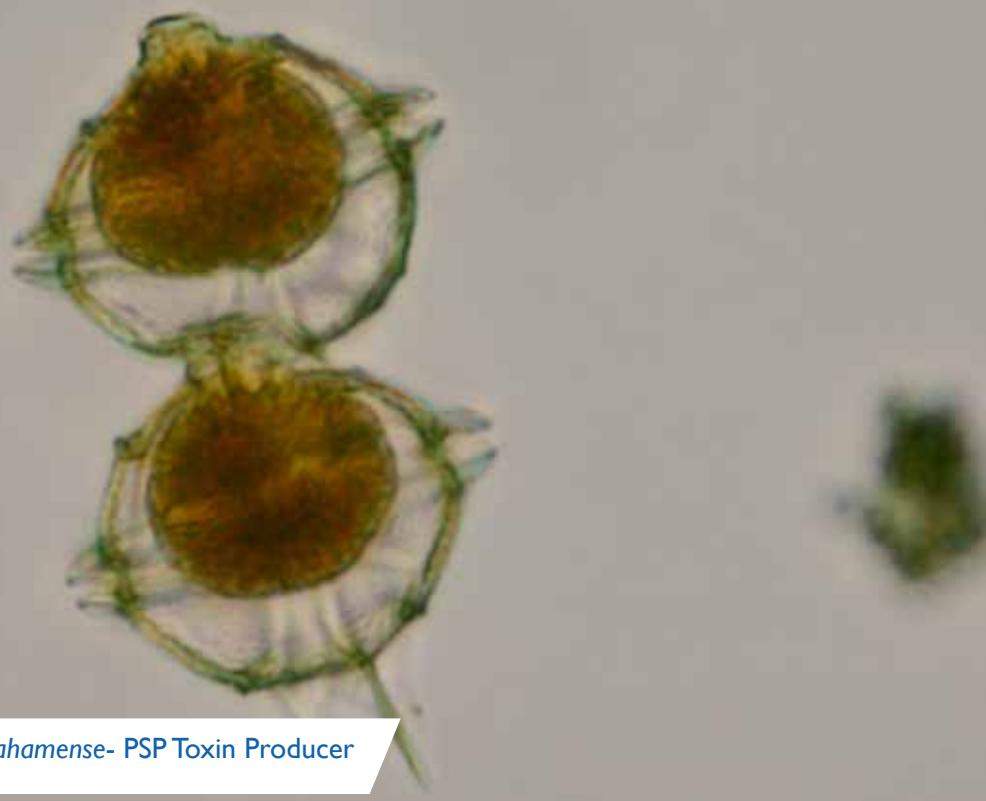


Figure 5// *Pyrodinium bahamense*- PSP Toxin Producer

//HARMFUL ALGAE DISTRIBUTION NEAR DESALINATION PLANTS

Desalination plants are the primary source of potable water in the UAE. EAD's HAB programme aims to monitor and track the distribution of bloom-forming and toxin-producing species near major desalination plants and the Barakah nuclear power plant in Abu Dhabi Emirate to better understand the potential for impact as well as support the development of mitigative engineering approaches.

Toxin-producing algae were detected near all the desalination plants (Figure 5 and Figure 6). This information is currently being reviewed as part of an early warning procedure for mitigation and management of HABs.

//MARINE WATER QUALITY AUTOMATION

Since 2006, EAD has conducted a monitoring programme in coastal and marine waters. The programme aids in meeting EAD's goals for protecting public health and the environment. In 2014 the programme incorporated an automated component with the use of buoy-mounted data loggers. These data buoys serve as an early warning system for HABs and provide data for marine water quality modeling. In 2016 the programme was enhanced with eight new automated data buoys that monitor critical marine habitats and sensitive areas. These buoys measure seven key marine water quality parameters every 15 minutes and transmit the data to EAD every hour. EAD's data buoy network now consists of 11 stations that continuously monitor marine water quality at sensitive sites along the Abu Dhabi coast.

//INVESTIGATION OF DUST AND SANDSTORM IMPACTS ON MARINE WATER QUALITY

In 2017, EAD initiated a study to investigate the impact of the frequent dust/sand storms on marine water quality. The study involved cross-cutting issues including marine productivity, coastal marine resources, and marine biodiversity. Meetings were held to solicit input into the design of the dust/sand storm investigation.

//FISH EGGS AND LARVAE STUDY

EAD initiated a study in 2007 to better understand how marine water quality affects the distribution of fish eggs and larvae in Abu Dhabi waters. The study focuses on important fish spawning and nursery grounds in Abu Dhabi waters. During 2017, the survey covered 10 important fishing areas and found that fish eggs and larvae distribution varied spatially and temporally. The data reveal



Figure 6// *Dinophysis caudata*- DSP Toxin Producer

that the peak spawning period of fish stocks in Abu Dhabi waters is pre-summer (March, April, and May) and that a key controlling factor is water temperature.

//AMBIENT MWQ AND SEDIMENT SPECIFICATIONS AND REGULATIONS

Ambient marine water and sediment quality specifications based on international best practices for long-term protection of marine life and human health were promulgated. The specifications establish quality standards for marine waters and sediment to ensure the protection of the marine environment. EAD also developed marine water quality regulations that include an anti-degradation policy and designate a "Protected Area" use that aims to protect pristine waters in Abu Dhabi's MPAs as well as a "General Use" to maintain water quality conditions that support current uses of waters outside of the protected areas. In addition, EAD conducted its first Regulatory Impact Assessment to evaluate potential social, economic, and environmental impacts of the regulations and to determine whether they achieve EAD's objective to improve marine quality.

//GUIDELINES FOR TREATED LIQUID DISCHARGES TO MARINE

In close consultation and cooperation with all local stakeholders and the Abu Dhabi Quality and Conformity Council, EAD developed draft science-based specifications for liquid discharges from land-based activities to the marine environment. Before developing guidelines for treated sewage

effluent (TSE), EAD investigated its reuse since a considerable proportion of TSE is currently discharged into the marine environment. This initiative stemmed from directions from the Higher Committee for Enhancing Marine Water Quality.

//DEVELOP AN INTEGRATED SYSTEM FOR THE MWQMP MONITORING PROJECT

EAD is working with Abu Dhabi Systems and Information Center to develop an integrated system for marine water quality monitoring in Abu Dhabi Emirate by leveraging an agreement between the Government of Abu Dhabi and ESRI to develop a unified geospatial system with mapping services and a database for MWQ monitoring. An intra-agency working group was established for coordination between the stakeholders in the Emirate to facilitate acquisition of high resolution spatial data and visualization on an executive dashboard.

06

// WAY FORWARD

EAD's MWQMP is a long-term monitoring programme that allows the Agency to track changes over time. Based on the assessment of EAD's long-term monitoring, Abu Dhabi marine waters remain generally healthy. In addition, EAD implements other short-term programmes that target emerging issues and issues requiring immediate investigation.

- In 2018, EAD will review its earlier study of 2001-2005 on the distribution of harmful algae and undertake surveys in order to assess the occurrence of invasive newly introduced species through human interference including ballast water.
- EAD will also investigate the distribution of toxic heavy metal mercury in the marine environment (seawater and sediment) and flora and fauna including both finfishes and shellfishes with special reference to public health.
- EAD will continue to conduct both short- and long-term monitoring plans to monitor the health of Abu Dhabi's waters and recommend management as needed.







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