The Development Process and Methods for the Guanabara Bay Report Card

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A general overview

Ecosystem health assessments have become more common in recent years, and report cards are being produced by a variety of groups from small, community–based organizations to large partnerships. Ecological report cards provide a numeric grade or letter that is similar to a school report card, and are considered a public friendly way to provide a timely and geographically detailed assessment of ecosystems or rivers.

As environmental monitoring has been conducted in Guanabara Bay for many years and there is a need to communicate the data collected. Synthesizing and integrating the data into a document that is accessible to the general public and specific groups throughout the Guanabara Bay and Basin informs the community of the health of their local waterways. However, not all the information that is generated by this process can fit into a public-friendly report card. The following pages describe in detail the methods and scoring procedures used to develop the Guanabara Bay report card.

A number of steps were taken in the development of the report card. The first preliminary meeting was held in early April 2016 with partners from the Sanitation Program of the Surrounding Municipalities of Guanabara Bay (PSAM), the Rio de Janeiro State Environmental Institute (INEA), and KCI Technologies Inc.

The first full stakeholder workshop was conducted April 25th, 2016 at INEA in Rio de Janeiro with participants from UMCES, INEA, KCI, PSAM, and other organizations working in the region. The main goals of the April 25th workshop were to explore the values and threats of Guanabara Bay and it's Basin, establish separation of the Bay and Basin into appropriate reporting regions, and to determine the indicators most relevant to tell the story of ecosystem health for Guanabara Bay. A newsletter was developed summarizing the results of the workshop.

On April 29th, 2016 an expanded workshop with over 200 stakeholders was held at the Museum of Tomorrow in Rio de Janeiro. This meeting brought together stakeholders from all around Guanabara Bay, and served to not only discuss the report card, but also to talk about governance, management, and restoration in the Bay. The workshop included talks by Ricardo Piquet (Director of the Museum of Tomorrow), André Corrêa (State Secretary of the Environment), Dora Hees Negreiros (Institute of Guanabara Bay), Pedro Navalón (Consórcio Águas de Barcelona – Labáqua/Aqualogy), and Nair Palhano (KCI). Additionally, Bob Summers (KCI) and Bill Dennison (UMCES) gave presentations on the state of Guanabara Bay and the Guanabara Bay report card. This workshop helped to further define the values, threats, and indicators for the report card. A survey was created to receive feedback for the report card about the report card process.

Another stakeholder workshop was held on June 23rd, 2016 in Niteroi. This meeting included stakeholders from the April workshops as well as a wider group of participants from additional universities and municipal government offices. The meeting reviewed the stakeholder-based decisions that had been made during the first workshop, went over the selected values, threats, and key indicators, and went over the workshop newsletter and the subsequent survey results that were received. The group discussed some of the indicators selected, as well as raised new ideas that hadn't been heard in the previous meetings.

After the workshop, numerous conference calls and phone meetings occurred to finalize the indicators, determine sub-regions and sampling sites, establish thresholds, review data analysis and report card scores, and design and produce content for the report card.

Another workshop on October 5th, 2016 occurred to review the indicators, data, thresholds, scoring, and draft report card and website. The presentation of the draft report card and report card website was at the INEA (State Environmental Institute) offices in Rio de Janeiro. The Secretary of the Environment for the State of Rio, Andre Correa and his cabinet as well as other groups working on Guanabara Bay Restoration were in attendance.

Meetings in April 2017 to finalize the report card and website occurred in Rio de Janeiro with partners from UMCES and PSAM. These meetings went over the final edits for the report card and plans for the release event. Next steps were also discussed to plan a science conference and arrange a series of webinars to include experts from the Chesapeake Bay area in Maryland.

The final report card integrates the environmental health of Guanabara Bay into and overall grade and the environmental health of the Guanabara Basin into an overall grade. The health for Guanabara Bay is based on five indicators: biological oxygen demand, dissolved oxygen, total phosphorus, dissolved inorganic nitrogen, and fecal coliform. The health for Guanabara Basin is based on five indicators: biological oxygen demand, dissolved oxygen, orthophosphate, dissolved inorganic nitrogen, and turbidity. Background information about key features, values, and threats in Guanabara Bay and its Basin, discussion about sanitation and trash, information about governance, monitoring, and indicators, and details about what the public can do to protect the health of the Bay and Basin were included in the report card document, in addition to the scores and grades.

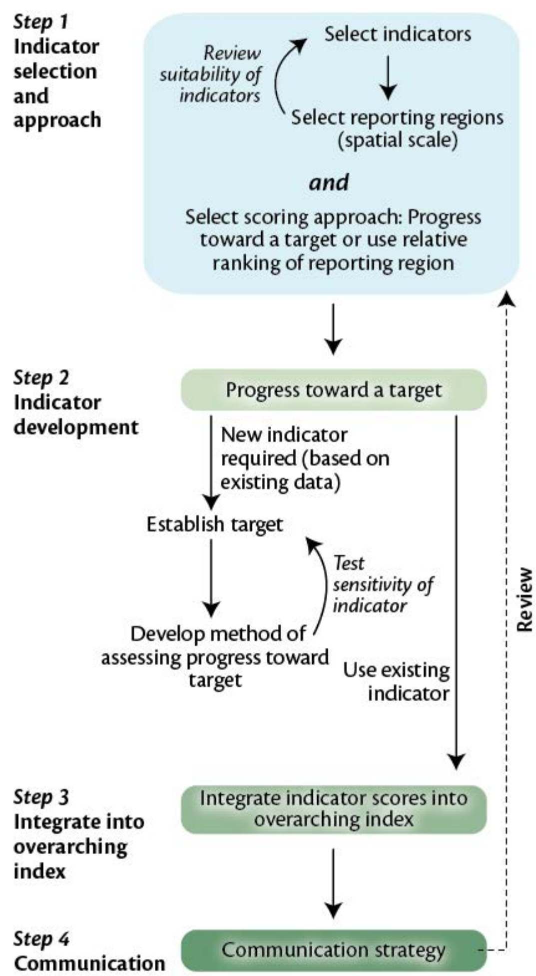
The report card provides a transparent, timely, and geographically detailed assessment of health in Guanabara's Bay and Basin using data from 2013-2015. The data was collected by INEA's monitoring program. In the years that follow, additional indicators can be added to the analysis as well as refinement of thresholds based on further research.

Table of Contents

Introduction

Ecological report cards are considered a public friendly way to provide a timely and geographically detailed assessment of ecosystems or rivers. Report cards provide a numeric grade or letter that is similar to a school report card, allowing for quick and understandable results to a broad audience. One key aspect of report cards is that they integrate and synthesize diverse data sources and types. Over the last ten years, report cards have gained popularity as a communication tool in the United States (Chesapeake Bay, Gulf of Mexico, Mississippi River, Long Island Sound, Willamette River) as well as many international areas (Great Barrier Reef, Australia; Chilika Lake, India; Orinoco River, Colombia).

Existing data collected by the government through the State Institute of the Environment (INEA) provides an excellent platform and material to develop an annual report card that acts to synthesize, interpret, and disseminate this information about the region. Ultimately, the partners of the Environmental Sanitation Program for the Municipalities Surrounding Guanabara Bay (PSAM) and INEA plan to use this iterative process of creating report cards to improve community and management awareness and understanding of the status of health of Guanabara Bay and its Basin. The primary objectives of this project are to collate and compile data, review relevant indicators, and synthesize information to effectively report the environmental status of Guanabara Bay and its Basin.



Determining indicators

The figure at right illustrates the process that occurs when producing a report card. There are four main steps: 1) Indicator selection and approach, which includes assessing currently available data as well as the "ideal" datasets, 2) Indicator development, which includes developing targets or thresholds (discussed more in the next section) for each indicator, 3) Integrating indicators into an overarching index, and 4) Communicating the results through a report card product. Fundamentally, all report cards should be based on indicators and indices that are scientifically defendable, preferably peer-reviewed, and transparent. The data and methods underlying the report card should be understandable and clear to all audiences, should they want to drill down from the overall grade to individual metrics that make up indicators or indices.

For the Guanabara Bay report card, several workshops of local experts were convened throughout the project, and one of the main goals of the workshops was to determine potential indicators for the report card (image at right). The workshop started with a full list of potential indicators including indicators of water quality, fisheries, wildlife, marine mammals, human health, toxic contaminants, and others. As the discussions continued, an ideal list of indicators that could be included was collated. From there, the spatial and temporal resolutions of the indicators were determined to ensure that there was sufficient amount, coverage, and frequency of data for use in the analysis. For example, water quality data was collected by the Rio de Janeiro State Environmental Institute (INEA), but due to limited sampling, three years of data were used to conduct the analysis. With more robust annual datasets that have consistent monthly or biweekly sampling, future report cards can include two or even one year of data to give a better picture of current health. Other indicators not currently in the report card can be incorporated in the future with broad and stable monitoring programs either established by INEA, or by other scientific groups and organizations in the region.

Data sources

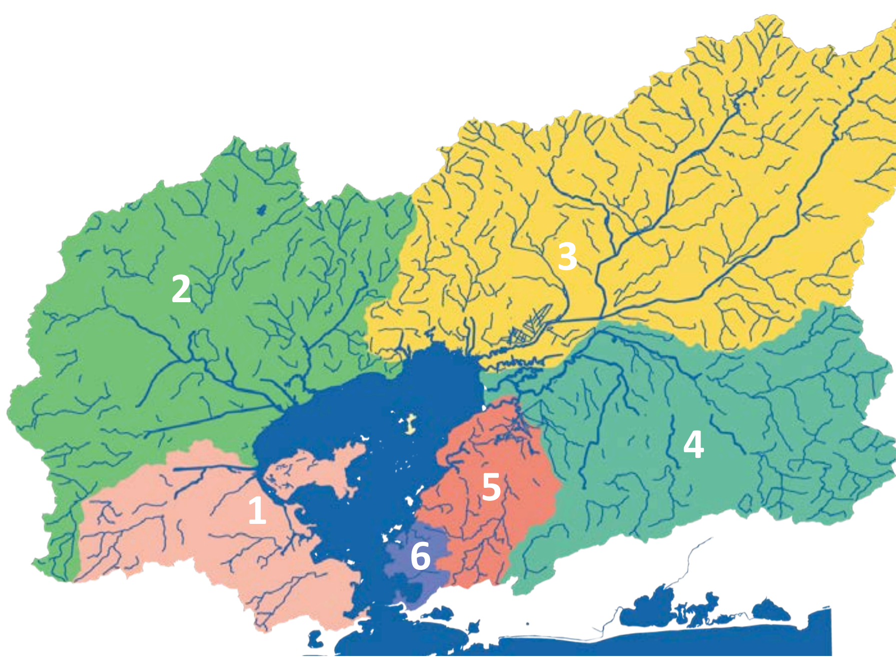
The majority of the data in the report card were collected by the Rio de Janeiro State Environmental Institute (INEA). The data about trash containment in the ecobarriers were also provided by INEA. Data on sewage treatment in each municipality in the surroundings of Guanabara Bay were obtained through the 2016 Diagnostics (reference year 2014) from the National Sanitation Information System (SNIS).

Sampling site and sub-region determination

Sampling site locations were already established by INEA's monitoring program prior to the workshops. Therefore, the pre-existence of this monitoring contributed to the development of the report card. Sub-region areas are usually determined based on geographic features (such as geology or land use) or hydrology (such as drainage basin size, water circulation patterns, water flow). For example, if there is an upstream portion, a mixing portion, and a "receiving waters" portion, those could be the three sub-regions. Remember that all sub-regions need to have enough sampling sites to be scientifically rigorous and provide consistent analysis.

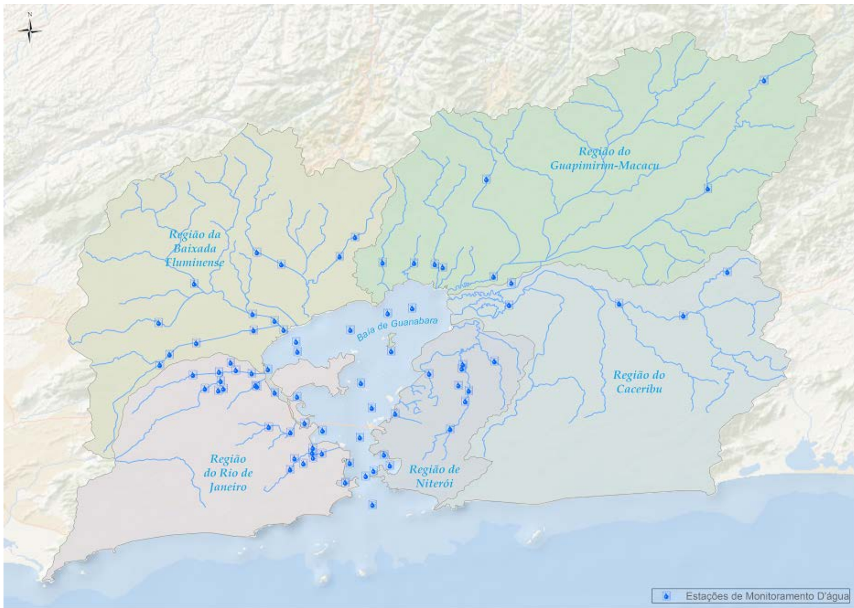
The sub-regions were determined during the workshops in April and June 2016. The Guanabara Bay sub-regions were determined based on analysis done by Mayr et al. 1989 and described by Fistarol et al. 2015. There are five sub-regions for the Bay. The first region is the Central channel which has high oceanic flushing and extends from the oceanic entrance of the Bay to Paqueta Island. The second region is the Mouth of Guanabara Bay which includes nearshore regions at the mouth of the Bay on both the west side (Rio de Janeiro) and the east side (Niteroi). The third region is the Central margins of Guanabara Bay which includes shipyards and the harbors of Rio de Janeiro and Niteroi with dredged channels. The fourth region is the Northern Guanabara Bay which includes shallow water habitats and mangrove forests from the Iguacu River mouth to Itaoca. The fifth region is the Northwest Guanabara Bay which is west of the Iguacu River mouth and includes channels separating Governador Island and Fundao Island from the mainland.

The Guanabara Basin sub-regions were determined using the pre-existing sub-watersheds that compose the entire Basin, and grouping some of the sub-watersheds in order to have sufficient sampling sites in each sub-region. Based on the consensus of the workshop participants the Basin was divided into six sub-regions. The first is the Rio de Janeiro region which is the most urbanized basin that extends from the mouth of Guanabara Bay to the Pavuna River and includes Governador Island. The second is the Baixada Fluminense region which is in the northwest, and has low lying topography with industrial development and substantial occurrence of low income communities lacking basic sanitation services. The third is the Guapimirim-Macacu region which is in the northeast, and is the least impacted. It has extensive mangroves, conservation areas, agriculture, and potable water resources. The fourth is the Caceribu region which is in the southeast and supports petrochemical industrial development, urban development and agriculture. The fifth sub-region was arbitrarily named Alcântara and extends from the Caceribu River basin to the Das Pedras River and supports the rapidly growing city of Sao Goncalo, the second most populated in the region. The sixth is the Niteroi region which is very small but largely urbanized. Even though it is highly urbanized it has the highest proportion of treated sewage in the region, and because of this key difference, it was separated from the Alcântara



region.

There was sufficient sampling site coverage within the Bay for all regions (even though some regions have more stations than others). In the Basin, there was sufficient sampling site coverage except for in the Niteroi region. The Niteroi region has no sampling sites monitored by INEA and therefore does not have a score for this report card. All of the data used in the report card was collected by INEA.



Indicator relevance

The indicators in this report card help answer the question "How healthy is Guanabara Bay and it's Basin?" Each indicator measures a different parameter of the environment that affects organisms that live in the ecosystems of the region. For Guanabara Bay there are five indicators, dissolved oxygen, biological oxygen demand, total phosphorus, dissolved inorganic nitrogen, and fecal coliform. For Guanabara Basin there are five indicators, dissolved oxygen, biological oxygen demand, orthophosphate, dissolved inorganic nitrogen, and turbidity.

Dissolved oxygen (DO) is a key indicator of ecosystem health. Nearly all aquatic animals need adequate DO in the water to survive, even aquatic plants can be harmed if the water around their roots is low in DO. Low dissolved oxygen levels can also cause changes in water chemistry that may trigger the release of nutrients from sediments into the water column. Low DO is often a result of eutrophication, excess nutrients in the water that fuel algal blooms, and when the algae die and decompose, the decomposition process depletes DO.

Biological oxygen demand (BOD) is a key indicator of ecosystem health. Nearly all aquatic organisms need oxygen to break down organic material in the water. Organic compounds are naturally found in water, but too many organic compounds indicate polluted water. Organic compounds come from biodegradable organic material such as industrial wastes, agricultural wastes, and human wastes. BOD can be used to determine the effectiveness of sewage treatment systems. Healthy waters will have low BOD levels while polluted waters will have high levels.

Nutrients such as total phosphorus, orthophosphate, and dissolved inorganic nitrogen, are essential to the health and diversity of organisms in rivers and bays. However, excessive nutrients in water systems can lead to harmful algal blooms, which may negatively affect the health of humans and other animals. The primary nutrients of concern are nitrogen and phosphorus. Both are required for plants and animals to grow; however, when in excess, they can cause serious problems. When nitrogen and phosphorus are present in excess, algae overgrowth may occur, resulting in an algal bloom that eventually dies and decays. The decomposition process depletes dissolved oxygen, which can lead to very low dissolved oxygen levels and subsequent fish kills. Lower algae levels promote cleaner, clearer water, more available habitat, and fewer harmful algal bloom effects.

Turbidity is an important water quality indicator to determine ecosystem health. Turbidity is a measure of how much light penetrates through the water column. It is dependent upon the amount of suspended particles (e.g., sediment and plankton) and colored organic matter present. Clear water is critical for the growth and survival of aquatic grasses (due to limiting photosynthesis), as well as fish, crabs, and other aquatic organisms. Poor turbidity is usually caused by a combination factors, such as erosion, excess suspended sediments from runoff from the land, and the growth of phytoplankton, which is fueled by nutrients.

Fecal coliform is a crucial indicator to determine environmental health and predict impacts on human health. Bacteria occur naturally in both fresh and salt water. Bacteria are also commonly found in the intestines of humans and other warm-blooded animals. Most are harmless to humans and animals, but some are pathogenic and can cause illness if they are present in water that humans have contact with. Pathogens can come from the feces of many animals, including wildlife and pets, or from humans, through insufficient sewage treatment, leaking septic systems, and broken sewer lines. Testing for all pathogens is difficult, so we usually test for the presence of indicator bacteria. Indicator bacteria, such as fecal coliform, are present in large numbers, so they are easy to find and relatively inexpensive to monitor. This indicator is not harmful itself, but can come from similar sources as pathogens. The presence of fecal coliform suggests that harmful pathogens may also be present. During significant rainfalls, there is an increased risk for elevated and unsafe bacteria in natural waters. Fecal coliform is used as an indicator of human health in brackish and salt water.

Indicator thresholds and scoring

The indicators that had enough spatial and temporal resolution to use in the report card were dissolved oxygen, biological oxygen demand, total phosphorus, dissolved inorganic nitrogen, and fecal coliform for the Bay. For Guanabara Basin there are five indicators, dissolved oxygen, biological oxygen demand, orthophosphate, dissolved inorganic nitrogen, and turbidity.

Once these indicators were identified, targets or thresholds for each indicator were developed. Establishing targets for each indicator can be done by using pre-existing standard thresholds from the scientific literature or determining acceptable management goals. A threshold ideally indicates a tipping point where current knowledge predicts an abrupt change in an aspect or some aspects of ecosystem condition. Thus, from the perspective of choosing meaningful, health-related thresholds, this must be the point beyond which prolonged exposure to unhealthful conditions actually elicits a negative response, for the environment or human health. For example, prolonged exposure to dissolved oxygen concentrations below criteria thresholds elicits a negative response in aquatic systems by either compromising the biotic functions of an organism (reduced reproduction) or causing death.

More generally, however, thresholds represent an agreed-upon value or range indicating that an ecosystem is moving away from a desired state and toward an undesirable endpoint. Recognizing that many managed ecosystems have multiple and broad-scale stressors, another perspective is to define a threshold as representing the level of impairment that an environment can sustain before resulting in significant (or perhaps irreversible) damage.

When selecting thresholds, it is important to recognize that there are many already available, and more than likely, there are thresholds available for the indicator that is chosen. A good place to start looking for existing thresholds and goals is in other report card methods or scientific reports and publications.

One way to develop threshold values, if none exist, is to relate them to management goals, and these goals can be used to guide the selection of appropriate indicators. Even with the definition of agreed-upon thresholds, there is still the question of how best to use these threshold values in a management and governance context. Recognizing this challenge, thresholds can still be effectively used to track ecosystem change and define achievable management goals for restoration, preservation, and conservation of an ecosystem. As long as threshold values are clearly defined and justified, they can be updated in light of new research or management goals and, therefore, can provide an important focus for the discussion and implementation of ecosystem management. Alternatively, if stressors are correctly identified and habitats appropriately classified, there should be multiple attributes (indicators) of the biological community that discriminate in predictable and significant ways between the least and most impaired habitat conditions. Reference communities can then be characterized using these data, which in turn can be used to develop threshold values.

In order to determine thresholds for Guanabara Bay and the Basin, a literature review was conducted. Within the literature review, both local and regional studies and reports were examined. Numerous meetings to review threshold determination and analysis were held with staff from State Environmental Institute (INEA), Sanitation Program for the Municipalities in the Surroundings of Guanabara Bay (PSAM), and other stakeholders in the region. State-wide standards are preferred for use as thresholds, and the State of Rio had standard thresholds for all of the indicators. The indicators had thresholds available through National Council of the Environment (CONAMA) Resolution number 357 from 2005 and CONAMA Resolution number 274 from 2000. One indicator which did not have Brazilian specific thresholds established was turbidity, thus, standards from the United States Environmental Protection Agency (USEPA) and the Mid-Atlantic Tributary Assessment Coalition (MTAC) Protocol were used.

The selection of thresholds according to the Class 2 definition from CONAMA Resolution 357 occurred during the workshops and were discussed until a consensus was reached with the participants. According to CONAMA Resolution 357, the Class is a set of water quality conditions and standards needed to fulfill requirements to allow current and future preponderant water uses. Freshwater is classified into Class 2 when it can be used for human consumption supply, after conventional treatment; protection of aquatic communities; primary contact recreational activities (diving, swimming, water-skiing); irrigation of vegetables, fruit plants and parks, gardens, sports and leisure field where the public can have primary contact; and aquaculture and fishery activities. On the other hand, salt water is classified into Class 2 when it can be used for amateur fishery activities; and secondary contact recreation. Those uses were considered consistent for environmental health protection and also human use, and, therefore, Class 2 standards were chosen.

Guanabara Bay Thresholds

Dissolved oxygen

The dissolved oxygen (DO) threshold was determined using the Class 2 Saline standard value from CONAMA Resolution 357/2005. The threshold is a minimum value of 5 mg/l. For each DO sample, the measurement was compared to the threshold on a pass/fail basis. When the DO value was >5 mg/l, it equaled a passing score (100%). When the DO value was <5 mg/l, it equaled a failing score (0%).

Biological oxygen demand

The biological oxygen demand (BOD) threshold was determined using the Class 2 Freshwater value from CONAMA Resolution 357/ 2005. The value for freshwater was used because in the Brazilian resolution there is no standard for BOD in saline waters. The threshold is a maximum value of 5 mg/l. This is consistent with the US Environmental Protection Agency standards, which consider <5 mg/l for any waterbody to be unpolluted, natural water (USEPA, 2006). For each BOD sample, the measurement was compared to the threshold on a pass/fail basis. When the BOD value was <5 mg/l, it equaled a passing score (100%). When the BOD value was >5 mg/l, it equaled a failing score (0%).

Total phosphorus

The total phosphorus (TP) threshold was determined using the Class 2 Saline value from CONAMA Resolution 357/2005. The threshold is 0.093 mg/l. For each TP sample, the measurement was compared to the threshold on a pass/fail basis. When the TP value was <0.093 mg/l, it equaled a passing score (100%). When the TP value was >0.093 mg/l, it equaled a failing score (0%).

Dissolved inorganic nitrogen

Dissolved inorganic nitrogen (DIN) is comprised of nitrate plus nitrite and ammonium. These forms of nitrogen are readily available to phytoplankton and often control the formation of blooms. In the Brazilian resolution there is no specific DIN threshold but there are individual thresholds for ammonium, nitrate, and nitrite. The thresholds for each considering Class 2 Saline water are:

- Nitrate = 0.7 mg/l
- Nitrite = 0.2 mg/l
- Ammonium = 0.7 mg/l

By summing these three values the threshold for DIN could be determined. The threshold is 1.6 mg/l. For each DIN sample, the measurement was compared to the threshold on a pass/fail basis. When the DIN value was <1.6 mg/l, it equaled a passing score (100%). When the DIN value was >1.6 mg/l, it equaled a failing score (0%).

Fecal coliform

The fecal coliform (FC) threshold was determined using the CONAMA Resolution 274/2000, which defines the bathing water criteria in recreational areas. The threshold is 250 MPN/100ml, according to the criteria of appropriate water under the excellent category. For each FC sample, the measurement was compared to the threshold on a pass/fail basis. When the FC value was <250 MPN/100ml, it equaled a passing score (100%). When the FC value was >250 MPN/100ml, it equaled a failing score (0%).

Indicator	Thresholds	Time period	Source
Biological Oxygen Demand	5 mg/l	2013-2015	Class 2 Saline – CONAMA Resolution 357/2005
Dissolved Oxygen	>5 mg/l	2013-2015	Class 2 Freshwater – CONAMA Resolution 357/2005
Total phosphorus	0.093 mg/l	2013-2015	Class 2 Saline – CONAMA Resolution 357/2005
Dissolved inorganic nitrogen	1.6 mg/l	2013-2015	Class 2 Saline – CONAMA Resolution 357/2005
Fecal coliform	250 MPN/100ml	2013-2015	Excellent Category –CONAMA Resolution 274/2000

Bay Indicators and Thresholds

Guanabara Basin Thresholds

Dissolved oxygen

The dissolved oxygen (DO) threshold was determined using the Class 2 Freshwater value from CONAMA Resolution 357/2005. The threshold is a minimum value of 5 mg/l. For each DO sample, the measurement was compared to the threshold on a pass/fail basis. When the DO value was >5 mg/l, it equaled a passing score (100%). When the DO value was <5 mg/l, it equaled a failing score (0%).

Biological oxygen demand

The biological oxygen demand (BOD) threshold was determined using the Class 2 Freshwater value from CONAMA Resolution 357/2005. The threshold is maximum value of 5 mg/l. For each BOD sample, the measurement was compared to the threshold on a pass/fail basis. When the BOD value was <5 mg/l, it equaled a passing score (100%). When the BOD value was >5 mg/l, it equaled a failing score (0%).

Orthophosphate

The orthophosphate threshold was determined using the Class 2 Freshwater value from CONAMA Resolution 357/2005 for total phosphorus. The threshold for total phosphorus was used, because while INEA monitors orthophosphate, Brazilian CONAMA Resolution only has a threshold value for total phosphorus. The Class 2 Freshwater Total Phosphorus threshold for lotic habitat was used (0.1 mg/l) because rivers are moving waters. The threshold is 0.1 mg/l. For each orthophosphate sample, the measurement was compared to the threshold on a pass/fail basis. When the orthophosphate value was <0.1 mg/l, it equaled a passing score (100%). When the orthophosphate value was >0.1 mg/l, it equaled a failing score (0%).

Dissolved inorganic nitrogen

Dissolved inorganic nitrogen (DIN) is comprised of nitrate plus nitrite and ammonium. These forms of nitrogen are readily available to phytoplankton and often control the formation of blooms. In the Brazilian resolution there is no specific DIN threshold but there are individual thresholds for ammonium, nitrate, and nitrite. The thresholds for each considering a Class 2 saline water are:

- Nitrate = 0.7 mg/l
- Nitrite = 0.2 mg/l
- Ammonium = 0.7 mg/l

By summing these three values the threshold for DIN could be determined. The threshold is 1.6 mg/l. For each DIN sample, the measurement was compared to the threshold on a pass/fail basis. When the DIN value was <1.6 mg/l, it equaled a passing score (100%). When the DIN value was >1.6 mg/l, it equaled a failing score (0%).

The Brazilian CONAMA Resolution has thresholds for Class 2 freshwater for nitrate, nitrite and ammonium. However, when we summed the values the threshold for DIN would be 11.5 mg/l. This is a very high value which is not protective of the ecosystem and would not support fish in the rivers. Thus, the Class 2 Saline waters threshold was used for the Bay and the Basin.

Turbidity

The turbidity threshold was determined using the US EPA and MTAC protocol documents. The threshold is 10 NTU (Nephelometric Turbidity Units). For each turbidity sample, the measurement was compared to the threshold on a pass/fail basis. When the turbidity value was <10 NTU, it equaled a passing score (100%). When the turbidity value was >10 NTU, it equaled a failing score (0%). More information on the standard turbidity threshold can be found in the report available at: (https://www.epa.gov/sites/production/files/2015-10/documents/sediment-report.pdf)

Indicator	Thresholds	Time period	Source
Biological Oxygen Demand	5 mg/l	2013-2015	Class 2 Freshwater – CONAMA Resolution 357/2005
Dissolved Oxygen	>5 mg/l	2013-2015	Class 2 Freshwater - CONAMA Resolution 357/2005
Orthophosphate	0.1 mg/l	2013-2015	Class 2 Freshwater CONAMA Resolution 357/2005 (for Total phosphorus)
Dissolved inorganic nitrogen	1.6 mg/l	2013-2015	Class 2 Saline – CONAMA Resolution 357/2005
Turbidity	10 NTU	2013-2015	US State thresholds and MTAC Protocol

Basin Indicators and Thresholds

Scoring

Once thresholds have been identified, data are scored using either a pass/fail or multiple threshold method. Ideally, multiple thresholds are used to provide some gradation of results from poor to excellent, rather than just pass or fail, but this may not be appropriate for all indicators.

A pass/fail scoring method is a simple method used to calculate indicator scores based on whether or not an ecologically relevant threshold was met. The process outlined below uses dissolved oxygen as an example, and results are scored on a scale of 0 to 100%, where the higher percentage values represent more healthy conditions (see figure below).

1. Sort data by station

2. Calculate the score for each data point
Ex: If DO>5.0 mg/l, the Score = Pass (or 100))

3. Calculate the score for each station
Ex: ((Total # of scores = Pass)/(Total # of scores for that station))*100 = % total

Region	Station	Date	DO Value (mg/l)	Threshold (mg/l)	Score	Station score (%)
Alcântara	00RJ10AN0740	1/30/2013	5,6	5	100	7,69
Alcântara	00RJ10AN0740	6/13/2013	4,4	5	0	
Alcântara	00RJ10AN0740	8/21/2013	1,6	5	0	
Alcântara	00RJ10AN0740	9/16/2013	1,2	5	0	
Alcântara	00RJ10AN0740	11/4/2013	1,4	5	0	
Alcântara	00RJ10AN0740	1/13/2014	1,0	5	0	
Alcântara	00RJ10AN0740	3/19/2014	0,8	5	0	
Alcântara	00RJ10AN0740	5/13/2014	2,8	5	0	
Alcântara	00RJ10AN0740	8/26/2014	2,2	5	0	
Alcântara	00RJ10AN0740	10/21/2014	1,6	5	0	
Alcântara	00RJ10AN0740	3/3/2015	1,6	5	0	
Alcântara	00RJ10AN0740	9/1/2015	0,0	5	0	
Alcântara	00RJ10AN0740	11/25/2015	0,6	5	0	
Alcântara	00RJ10AN0741	6/13/2013	0,0	5	0	0
Alcântara	00RJ10AN0741	8/21/2013	0,4	5	0	
Alcântara	00RJ10AN0741	9/16/2013	0,4	5	0	
Alcântara	00RJ10AN0741	11/4/2013	0,0	5	0	
Alcântara	00RJ10AN0741	1/13/2014	0,6	5	0	
Alcântara	00RJ10AN0741	3/19/2014	0,0	5	0	
Alcântara	00RJ10AN0741	5/13/2014	0,0	5	0	
Alcântara	00RJ10AN0741	8/26/2014	0,0	5	0	
Alcântara	00RJ10AN0741	10/21/2014	1,0	5	0	
Alcântara	00RJ10AN0741	3/3/2015	0,0	5	0	
Alcântara	00RJ10AN0741	9/1/2015	1,8	5	0	
Alcântara	00RJ10AN0741	11/25/2015	2,4	5	0	
	⋮			⋮		⋮

4. Calculate watershed score by averaging all station scores in the watershed

Region	Region score (%)	Area (km²)	Weighting factor	Weighted score	Overall DO Score (%)
Alcântara	0,85	237,82	0,06	0,05	30,29
Baixada Fluminense	8,33	1103,24	0,27	2,28	
Caceribu	44,23	811,34	0,20	8,90	
Guapimirim-Macacu	51,10	1498,37	0,37	18,98	
Rio de Janeiro	0,91	383,11	0,09	0,09	
Niterói	-	32,50	0,008	-	

For Guanabara Bay and Basin, all indicators were assessed through a pass/fail criteria. By using multiple thresholds in the future, indicators can be assessed with greater precision than using a pass/fail method, facilitating even better decision making.

Once each indicator is compared to a pass/fail or multiple threshold scale and assigned a score, it is averaged into a station score. Then, each station score within a sub-region can be averaged together to a sub-region score for that indicator. Each overall sub-region score is area-weighted into the overall Bay score, and similarly, the overall Basin score. An example of the scoring for the Basin is below.

Region	BOD Region score (%)	DO Region score (%)	PO_4^{3-} Region score (%)	DIN Region score (%)	Turbidity Region score (%)	Overall score for each Region	Overall grade for each Region
Alcântara	6	1	4	2	58	14	F
Baixada Fluminense	12	8	31	14	36	20	F
Caceribu	69	44	56	29	55	51	D
Guapimirim	64	51	81	82	61	68	C
Rio de Janeiro	1	1	3	4	12	4	F

Scores and grades for the Basin for each indicator (after weighting based on the area of each sub-region)						
Indicator	BOD	DO	PO_4^{3-}	DIN	Turbidity	FINAL
Score	41	30	50	41	48	**42**
Grade	D	F	D	D	D	**D**

For all indicators, the grading scale follows a 15-point grade scale of 0–100%, (see table at right).

Score (%)	Grade	Description
85-100	A	Very good
70-85	B	Good
55-70	C	Moderate
40-55	D	Poor
0-40	F	Very poor

Final grades are divided to provide a clearer picture of health (see figure below). This scale provides information about small improvements or declines in ecosystem health. This grading scale allows evaluation of small changes in ecosystem health, even at the very poor, and poor ranges.

A	B	C	D	F
85–100%: Water quality in these areas is very good.	70–85%: Water quality in these areas is good.	55–70%: Water quality in these areas is moderate.	40–55%: Water quality in these areas is poor.	0–40%: Water quality in these areas is very poor.

Quality Assurance/Quality Control

Data analysis QA/QC

After data were analyzed, a second person re-checks the data. All numbers are compared to original spreadsheets to make sure there are not any errors transferring data. All calculations are also checked, to make sure equations have been entered in correctly, and applied to the correct cells in the Excel spreadsheet. The current dataset is small enough to check every indicator and every calculation. Also, this was the first time the analysis was done, as it is the first report card for Guanabara Bay. As datasets become larger and more complex, a subset of data is checked. This is done by comparing the current year's indicator score to last year's indicator score. If the score is different by 33% (or a pre-determined amount) between one year and the next, those data are flagged and checked for accuracy. Having proper quality assurance and quality control methods is vital to maintaining the integrity of the data and consistency in the information reported.

Other data

Sewage treatment

Information from the Diagnostics 2016 (reference year 2014) by the Brazilian National Sanitation Information System (SNIS) was used to estimate percentage of treated sewage by each municipality in the surroundings of Guanabara Bay. The data available in the SNIS website is provided by the sewerage service providers and the specific datasets used in the analysis were: AG010 – indicator for volume of consumed water including exported water, AG019 – indicator for volume of treated water exported, ES006 – indicator for volume of treated sewage in the municipality, and ES015 – volume of exported sewage that is treated in the facilities of another municipality.

The generated sewage volume was estimated as the volume of water that is effectively used by all the users and population, assuming that all this water after used turns into sewage. Therefore, the value was obtained subtracting the volume of treated water exported (AG019) from the volume of consumed water (AG010).

$$\text{Total Generated Sewage} = \text{AG010} - \text{AG019}$$

The volume of treated sewage was estimated as the volume of treated sewage in the municipality (ES006) summed to the volume of exported sewage that is treated in facilities of another municipality (ES015).

$$\text{Total Treated Sewage} = \text{ES006} + \text{ES015}$$

So, an estimation of the generated sewage by each inhabitant was obtained by dividing the total generated sewage by the total population of the municipality.

$$\text{Generated Sewage per Capita} = \frac{\text{Total Generated Sewage}}{\text{Total population}} = \frac{\text{AG010} - \text{AG019}}{\text{Total population}}$$

An average for treated sewage by each inhabitant was similarly obtained.

$$\text{Treated Sewage per Capita} = \frac{\text{Total Treated Sewage}}{\text{Total population}} = \frac{\text{ES006} + \text{ES015}}{\text{Total population}}$$

Having the estimates (generated sewage per capita and the average for treated sewage per capita) and the population of the municipality living within the limits of the Guanabara Bay Basin (which was estimated using data from the census), it was possible to determine the amount of generated and treated sewage for the inhabitants in each municipality, just considering the territory inside the limits of the watershed that drains to the Bay. Consequently, it was possible to estimate these values for the entire Basin in order to obtain the overall percentage of generated and treated in the Basin. Table below shows this analysis.

Municipality	Population in the Watershed (hab) (Information given by PSAM and obtained through the census "Setor Censitário")	Total sewage generation (10^6 m3/yr)	Total treated sewage (10^6 m3/yr)	Sewage generation per person (1000 m3/hab.yr)	Sewage treatment per person (1000 m3/hab.yr)	Sewage generation watershed (10^6 m3/yr)	Sewage treatment watershed (10^6 m3/yr)	Treatment (%)
Belford Roxo	469332	31,4	10,8	7E-05	2E-05	30,7	10,5	34%
C. de Macacu	54273	3,3	0,0	6E-05	0E+00	3,2	0,0	0%
Duque de Caxias	855048	61,1	2,9	7E-05	3E-06	59,4	2,9	5%
Guapimirim	51483	1,1	-	2E-05	0E+00	1,0	0,0	-
Itaboraí	218008	11,9	0,2	5E-05	1E-06	11,4	0,2	2%
Magé	227322	10,8	0,0	5E-05	0E+00	10,5	0,0	0%
Mesquita	168376	9,6	0,7	6E-05	4E-06	9,5	0,7	7%
Nilópólis	157425	12,8	0,0	8E-05	0E+00	12,7	0,0	0%
Niterói	420159	45,2	42,9	9E-05	9E-05	38,3	36,4	95%
Nova Iguaçu	607893	65,6	0,0	8E-05	4E-08	49,5	0,0	0,05%
Rio Bonito	43026	3,6	0,0	6E-05	0E+00	2,7	0,0	-
Rio de Janeiro	4004786	708,9	334,6	1E-04	5E-05	439,9	207,6	47%
São Gonçalo	999728	75,8	7,9	7E-05	8E-06	73,4	7,6	10%
S. J. Meriti	458673	32,4	0,0	7E-05	0E+00	32,2	0,0	0%
Tanguá	30732	1,2	0,0	4E-05	0E+00	1,2	0,0	0%
TOTAL	8766264	1074,6	400,0			775,7	265,9	34%

The information about sewage was included in the report card to illustrate how the lack of sanitation in the municipalities surrounding Guanabara Bay is a severe problem. SNIS has additional information and indicators that can be applied in future report cards.

Trash collection

Information about trash containment by the ecobarriers implemented in the main rivers flowing to Guanabara Bay was provided by the partners from PSAM in conjunction with INEA and the State Environmental Secretariat (SEA). The table with this information follows below.

ECO	Water Body	MONTHLY MONITORING										
		Aug-15	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16
		Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton
1	Canal do Mangue	2,70	5,76	2,64	6,78	6,55	5,11	0,00	0,00	0,00	1,56	0,00
2	Canal do Cunha	73,14	183,66	301,19	166,15	103,65	148,78	148,56	70,83	53,52	124,97	46,75
3	Canal da Vila dos Pinheiros											
4	Canal da Baixa do Sapateiro											
5	Canal Nova Holanda	6,50	7,33	22,20	8,21	0,00	0,00	0,00	0,00	4,43	2,76	0,00
6	Rio Ramos											
7	Canal da Rua Darcy Vargas											
8	Rio Irajá	28,00	30,27	10,71	11,13	12,47	11,41	7,71	7,15	7,00	12,62	7,79
9	Rio Meriti	47,45	126,43	12,17	13,87	9,47	5,55	3,28	5,28	4,14	132,71	39,07
10A	Rio Iguaçu			0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
10B	Rio Sarapuí			0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
11	Rio Estrela			0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
13	Rio Imboaçu			0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
14	Rio Marimbondo			0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
15	Rio Brandoas			0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
16	Rio Bomba			0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
17	Canal da Vila Maruí			0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
TOTAL		157,79	353,45	348,91	206,14	132,14	170,85	159,55	83,26	69,09	274,62	93,61

ECO	Water Body	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	TOTAL
		Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton
1	Canal do Mangue	16,10	11,80	12,44	10,93	13,15	8,49	9,36	2,91	7,79	9,25	4,46	5,43	143,21
2	Canal do Cunha	44,88	114,83	88,00	62,83	53,92	76,00	124,01	53,04	159,94	97,96	65,47	31,44	2393,52
3	Canal da Vila dos Pinheiros													
4	Canal da Baixa do Sapateiro													
5	Canal Nova Holanda	5,25	4,24	3,64	2,27	1,43	2,63	2,01	0,87	1,51	2,38	2,91	1,80	82,37
6	Rio Ramos													
7	Canal da Rua Darcy Vargas													
8	Rio Irajá	4,71	10,74	12,41	10,56	9,89	12,84	20,54	11,44	14,45	19,15	13,14	8,46	294,59
9	Rio Meriti	49,01	76,88	117,55	60,63	172,48	99,74	148,64	49,63	118,10	91,75	89,11	43,05	1515,99
10A	Rio Iguaçu	147,67	169,75	242,26	214,81	191,63	138,50	284,48	82,01	104,32	87,81	100,30	85,07	1848,61
10B	Rio Sarapuí	12,72	40,83	139,32	165,19	141,32	88,28	116,15	112,00	129,65	216,98	85,96	133,49	1381,89
11	Rio Estrela	0,00	39,54	66,30	50,58	71,99	63,71	196,41	134,33	241,21	115,67	52,76	50,85	1083,35
13	Rio Imboaçu	0,00	1,58	3,74	2,40	5,72	11,87	10,37	15,70	12,36	18,86	15,72	3,16	101,48
14	Rio Marimbondo	0,00	0,45	0,79	0,64	0,56	0,46	1,08	0,38	0,94	1,38	0,91	0,70	8,29
15	Rio Brandoas	0,00	2,16	1,92	1,07	1,30	0,92	0,44	1,76	0,35	0,65	0,37	0,32	11,26
16	Rio Bomba	0,00	21,24	38,14	27,08	15,73	17,47	10,08	7,30	6,70	3,61	1,02	9,89	158,26
17	Canal da Vila Maruí	0,00	3,79	1,82	1,07	1,15	1,15	1,28	0,52	0,79	1,22	1,07	0,78	14,64
TOTAL		280,34	497,83	728,33	610,06	680,27	522,06	924,85	471,89	798,11	666,67	433,20	374,44	9.037,46

Currently there seventeen ecobarriers installed in the surroundings of Guanabara Bay and that all of them started fully operating together in august 2016. Over two years in operation the ecobarriers retained roughly 9000 tons of trash. The table incorporated in the report card considered only the data monitored in 2016.

Issues of concern

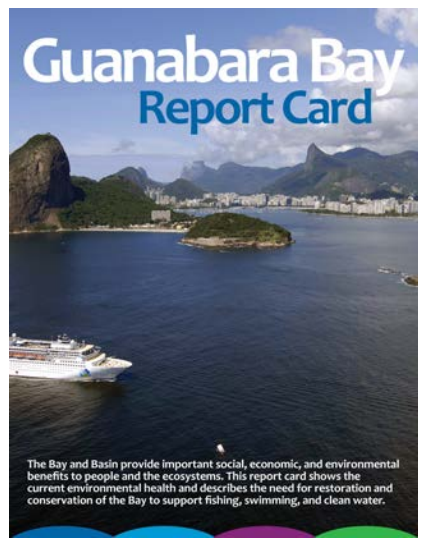
Future indicators

During workshops and meetings with partners and stakeholders, many indicators were identified as being important to telling the story of ecosystem health in Guanabara Bay and the Basin. The following indicators were identified as being important but were unable to be included in the first version of the report card are: chlorophyll, phytoplankton, marine mammals, dolphins, fish assemblage, mangroves, water clarity, contamination of crabs, sea horses, trash collection, sewage hookups, toxics, pathogens, heavy metals, hydrocarbons, PAH, PCBs, DDTs, mussels, biofouling, and organic contamination. Almost all of the indicators would have to have thresholds determined for them as there are not already existing thresholds available.

Data gaps

Within the Guanabara Basin there are 55 stations where INEA collects data. None of these stations falls into the Niteroi region, therefore, there is no score for the Niteroi region in this report card. In the future, more stations could be added, or more monitoring data from other sources could be used to fill this data gap. Additionally, more sampling sites could be added in the headwaters in the Caceribu and Alcantara regions.

Communication through a report card



Ecological report cards, much like school report cards, provide performance–driven numeric grades or letters that represent the relative ecological health of a geographic region or component of the ecosystem. They are an important tool for integrating diverse data types into simple scores that can be communicated to decision makers and the general public. In other words, large and often complex amounts of information can be made understandable to a broad audience.

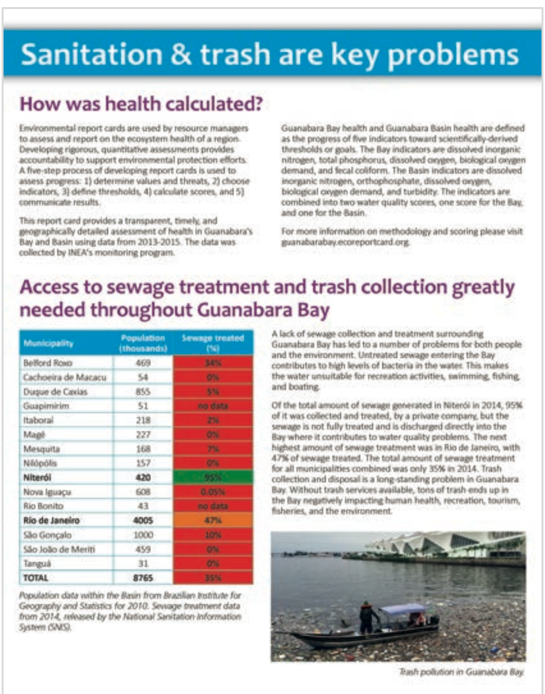
Ecological report cards enhance research, monitoring, and management in several ways. For the research community, they can lead to new insights through integration schemes that reveal patterns not immediately apparent, help to design a conceptual framework to integrate scientific understanding and environmental values, and help to develop scaling approaches that allow for comparison in time. Within monitoring realms, report cards justify continued monitoring by providing timely and relevant feedback to managers and can have the added benefit of accelerating data analyses. For management, they provide accountability by measuring the success of restoration efforts and identifying impaired regions or issues of ecological concern. This catalyzes improvements in ecosystem health through the development of peer pressure among local communities. Report cards also can guide restoration efforts by creating a targeting scheme for resource allocation.

Ecosystem health assessments have become more common in recent years, and report cards are being produced by a variety of groups from small, community–based organizations to large partnerships. Although methods, presentation, and content of report cards vary, the underlying premise is the same: to build community awareness and raise the profile of health impairment issues and restoration efforts.

Some common elements of report cards include

1. A map of the watershed or region
2. A grade stamp
3. The year(s) of the report card
4. A summary of the key features (e.g., ecosystem types, recreation activities)
5. A "What You Can Do" section

For the Guanabara Bay report card numerous meetings were conducted to plan the content, layout, and design of the documents. Many iterations of the report card occurred as the document evolved into its final state. The report card provides background information on the region, impacts to the ecosystems, information about sewage treatment and trash pollution, details about governance, monitoring, and restoration, and information about what the public can do to make a difference were included in the report card document, in addition to the methods, scores, and grades. This report card provides a much-needed synthesis of monitoring data being collected in Guanabara Bay and it's Basin in a visually appealing and engaging manner (see image above). The Guanabara Bay report card includes the five basic elements listed above. In addition, more detailed discussion of some of the pertinent issues in the region are included.



Sanitation & trash are key problems

How was health calculated?

Environmental report cards are used by resource managers to assess and report on the ecosystem health of a region. Developing rigorous, quantitative assessments provides accountability to support environmental protection efforts. A five-step process of developing report cards is used to assess progress: 1) determine values and threats, 2) choose indicators, 3) define thresholds, 4) calculate scores, and 5) communicate results.

This report card provides a transparent, timely, and geographically detailed assessment of health in Guanabara's Bay and Basin using data from 2013-2015. The data was collected by INEA's monitoring program.

Guanabara Bay health and Guanabara Basin health are defined as the progress of five indicators toward scientifically-derived thresholds or goals. The Bay indicators are dissolved inorganic nitrogen, total phosphorus, dissolved oxygen, biological oxygen demand, and fecal coliform. The Basin indicators are dissolved inorganic nitrogen, orthophosphate, dissolved oxygen, biological oxygen demand, and turbidity. The indicators are combined into two water quality scores, one score for the Bay, and one for the Basin.

For more information on methodology and scoring please visit guanabarabay.ecoreportcard.org.

Access to sewage treatment and trash collection greatly needed throughout Guanabara Bay

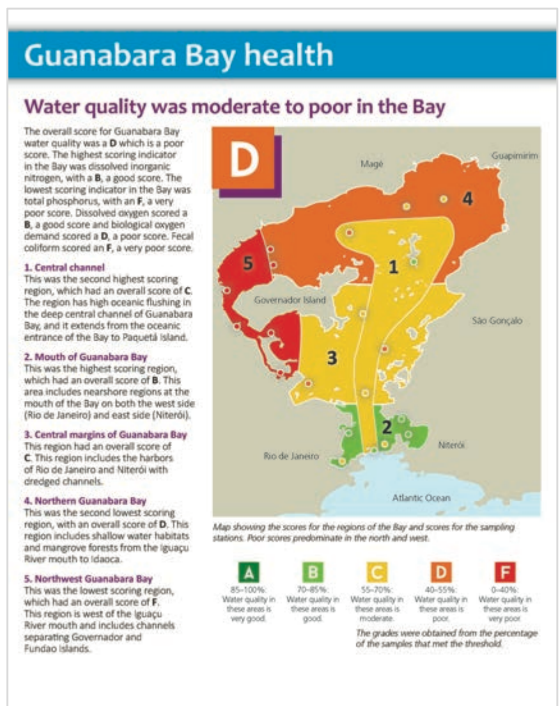
Municipality	Population (thousands)	Sewage treated (%)
Belford Roxo	469	34%
Cachoeira de Macacu	54	0%
Duque de Caxias	855	5%
Guapimirim	51	no data
Itaboraí	218	2%
Magé	227	0%
Mesquita	168	7%
Nilópolis	157	0%
Niterói	**420**	95%
Nova Iguaçu	608	0.05%
Rio Bonito	43	no data
Rio de Janeiro	**4005**	47%
São Gonçalo	1000	10%
São João de Meriti	459	0%
Tanguá	31	0%
TOTAL	**8765**	35%

Population data within the Basin from Brazilian Institute for Geography and Statistics for 2010. Sewage treatment data from 2014, released by the National Sanitation Information System (SNIS).

A lack of sewage collection and treatment surrounding Guanabara Bay has led to a number of problems for both people and the environment. Untreated sewage entering the Bay contributes to high levels of bacteria in the water. This makes the water unsuitable for recreation activities, swimming, fishing, and boating.

Of the total amount of sewage generated in Niterói in 2014, 95% of it was collected and treated, by a private company, but the sewage is not fully treated and is discharged directly into the Bay where it contributes to water quality problems. The next highest amount of sewage treatment was in Rio de Janeiro, with 47% of sewage treated. The total amount of sewage treatment for all municipalities combined was only 35% in 2014. Trash collection and disposal is a long-standing problem in Guanabara Bay. Without trash services available, tons of trash ends up in the Bay negatively impacting human health, recreation, tourism, fisheries, and the environment.

Trash pollution in Guanabara Bay



Guanabara Bay health

Water quality was moderate to poor in the Bay

The overall score for Guanabara Bay water quality was a **D** which is a poor score. The highest scoring indicator in the Bay was dissolved inorganic nitrogen, with a **B**, a good score. The lowest scoring indicator in the Bay was total phosphorus, with an **F**, a very poor score. Dissolved oxygen scored a **B**, a good score and biological oxygen demand scored a **D**, a poor score. Fecal coliform scored an **F**, a very poor score.

1. Central channel
This was the second highest scoring region, which had an overall score of **C**. The region has high oceanic flushing in the deep central channel of Guanabara Bay, and it extends from the oceanic entrance of the Bay to Paquetá Island.

2. Mouth of Guanabara Bay
This was the highest scoring region, which had an overall score of **B**. This area includes nearshore regions at the mouth of the Bay on both the west side (Rio de Janeiro) and east side (Niterói).

3. Central margins of Guanabara Bay
This region had an overall score of **C**. This region includes the harbors of Rio de Janeiro and Niterói with dredged channels.

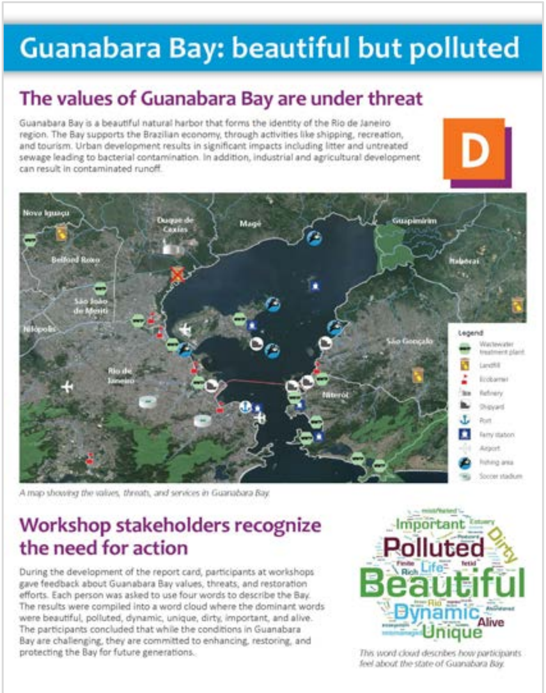
4. Northern Guanabara Bay
This was the second lowest scoring region, with an overall score of **D**. This region includes shallow water habitats and mangrove forests from the Iguaçu River mouth to Idaoca.

5. Northwest Guanabara Bay
This was the lowest scoring region, which had an overall score of **F**. This region is west of the Iguaçu River mouth and includes channels separating Governador and Fundao Islands.

Map showing the scores for the regions of the Bay and scores for the sampling stations. Poor scores predominate in the north and west.

A — 85–100%: Water quality in these areas is very good.
B — 70–85%: Water quality in these areas is good.
C — 55–70%: Water quality in these areas is moderate.
D — 40–55%: Water quality in these areas is poor.
F — 0–40%: Water quality in these areas is very poor.

The grades were obtained from the percentage of the samples that met the threshold.



Guanabara Bay: beautiful but polluted

The values of Guanabara Bay are under threat

Guanabara Bay is a beautiful natural harbor that forms the identity of the Rio de Janeiro region. The Bay supports the Brazilian economy, through activities like shipping, recreation, and tourism. Urban development results in significant impacts including litter and untreated sewage leading to bacterial contamination. In addition, industrial and agricultural development can result in contaminated runoff.

D

A map showing the values, threats, and services in Guanabara Bay

Workshop stakeholders recognize the need for action

During the development of the report card, participants at workshops gave feedback about Guanabara Bay values, threats, and restoration efforts. Each person was asked to use four words to describe the Bay. The results were compiled into a word cloud where the dominant words were beautiful, polluted, dynamic, unique, dirty, important, and alive. The participants concluded that while the conditions in Guanabara Bay are challenging, they are committed to enhancing, restoring, and protecting the Bay for future generations.

This word cloud describes how participants feel about the state of Guanabara Bay.

Guanabara Basin health

Very poor water quality in the Basin

The overall score for Guanabara Basin water quality was a **D** which is a poor score. The highest scoring indicator in the Basin was orthophosphate, with a **D**, a poor score. The lowest scoring indicator in the Basin was dissolved oxygen, with an **F**, a very poor score. Both biological oxygen demand and dissolved inorganic nitrogen scored **D**. Turbidity was the second highest scoring indicator with a **D**.

D

Map showing the scores for the regions of the Basin and scores for the sampling stations.

1. Rio de Janeiro region. This was the lowest scoring region, with an overall score of **F**, a very poor score. This is the most urbanized basin, which extends from the mouth of Guanabara Bay to the Pavuna River and includes Governador Island.

2. Baixada Fluminense region. This region had an overall score of **F**, a very poor score. This basin in the northwest has low lying topography with industrial development and agriculture.

3. Guapimirim-Macacu region. This was the highest scoring region, with an overall score of **C**, a moderate score. This basin in the northeast is the least impacted. It has extensive mangroves, conservation areas, agriculture, and drinking water sources.

4. Caceribu region. This was the second highest scoring region, with an overall score of **D**, a poor score. This basin supports petrochemical industrial development, urban development, and agriculture.

5. Alcantara region. This was the second lowest scoring region, with an overall score of **F**, a very poor score. This basin extends from the Caceribu River basin to the Das Pedras River and supports the rapidly growing city of Sao Gonçalo.

6. Niterói region. While Niteroi has data about the sewage treatment in the city, there are no INEA water quality sampling sites within this region. Therefore this region does not have a score. Although this small basin is largely urbanized, it has the highest proportion of treated sewage.

Next steps: the plan to restore the Bay

Governance, monitoring, and restoration

Strong governance is vital to support the multiple uses of the Bay

Developing a shared governance plan for the Bay allows stakeholders from local, state and federal governments, academia, and communities to lead the restoration of Guanabara Bay.

Establishing a lasting restoration plan includes key actions like implementing stormwater management, sewage treatment, solid waste management, forest and mangrove restoration and climate change adaptation.

To assess progress, monitoring should continue and expand to include data for trash, fisheries, and sediment contamination throughout the Bay and the Basin.

Your actions can make a difference!

You can and must, before everything, become an owner of Guanabara Bay. It is yours! Most of the communities surrounding the Bay do not know that they are near one of the most beautiful bays in the world. The Bay is degraded, that is true. However, by working together, we can all help improve the health of Guanabara Bay.

Properly dispose of trash – The trash from your house, if not collected, ends up in rivers which flow into the Bay. You can help by only throwing your trash in authorized places, where it will be collected by the City. Help keep your neighborhood clean!

Plant trees – Planting trees and native shrubs helps support the Bay. During storms, runoff from city streets flows into the rivers and the Bay. When there are green spaces in the city the water can be naturally filtered before it reaches the Bay. Green spaces like parks also help make our communities more beautiful and enjoyable.

Become a stakeholder – Get involved by participating in your neighborhood associations, local watershed committees, non-governmental organizations, and volunteer programs. Talk to your neighbors about the Bay and why it is important for everyone.

Protect river banks – River banks are protected areas in Brazil because they control river volume, water quality, and protect against flood events. Construction near rivers prevents natural ecosystem services the river banks provide. It is illegal to build on or near river banks.

Acknowledgements

Workshops to develop the Guanabara Bay Report Card were held in Rio de Janeiro in April 2016 and in Niterói in June 2016. Over 200 representatives from numerous organizations were engaged in developing the report card. The report card was produced by University of Maryland Center for Environmental Science, KCI, and PSAM with support by the Inter-American Development Bank. Data was provided by INEA.

Cover photo courtesy of Nilo Lima. All other photos courtesy of Alexandra Fries.

guanabarabay.ecoreportcard.org

PSAM KCI inea ian.umces.edu

Conclusions

Overall the monitoring programs and resulting data collected in Guanabara Bay and its Basin provided an excellent base from which to produce a report card. The scores and grades were synthesized into a public-friendly document that can inform and engage its readers. Furthermore, the resulting report card is a tangible output of the efforts of the PSAM and INEA, which is important for their continued support in the management of the region.

The process of producing the report card, from the initial workshop to the final stages of the report card, was made possible by the collective efforts of PSAM, INEA, KCI, and the Integration & Application Network, UMCES through funding by the Inter-american Development Bank (IDB). This effort cannot be understated in regards to finishing the product on time, so that the report card is relevant and topical when released.

It is important that the report card be updated regularly (usually yearly) with continuous participation and inclusion of stakeholders of Guanabara Bay in the development process. In future report cards, with increased sampling sites and new indicators measured, the integrity and quality of the data will increase and provide guidance for management actions towards the restoration of Guanabara Bay. Discussions have already occurred with staff from PSAM to add additional indicators to the next version of the report card.

Web Resources

Guanabara Bay Report Card
www.guanabarabay.ecoreportcard.org

INEA
www.inea.rj.gov.br/

Integration & Application Network
ww.ian.umces.edu

University of Maryland Center for Environmental Science
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