

# THE GUANABARA BAY REPORT CARD

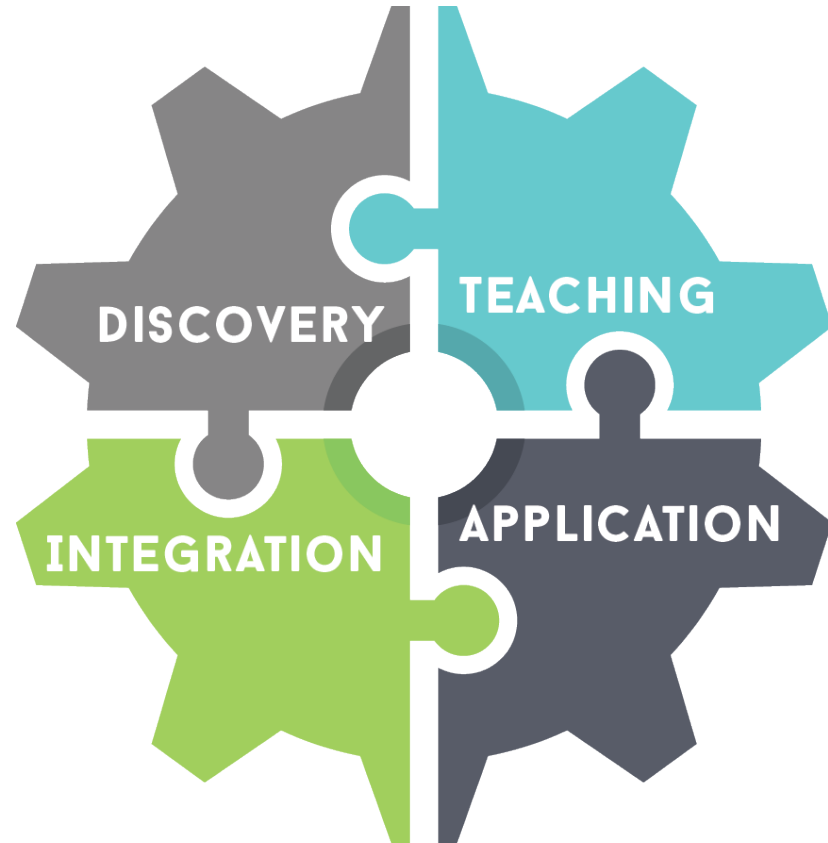


**Bill Dennison**

29 April 2016

# UNIVERSITY OF MARYLAND CENTER FOR ENVIRONMENTAL SCIENCE AND THE INTEGRATION AND APPLICATION NETWORK

- UMCES formed in 1925 to provide practical environmental advice
- UMCES defines scholarship as discovery, integration, application, and teaching
- IAN was created in 2002 to address integration and application



# WHO ARE WE?

IAN's aim is to enable better communication to empower change.



Integration & Application Network

Communicate better. Empower change.



WORK WITH US

IAN PRESS

ECOCHECK

TOOLS

PROJECTS

NEWS

LEARN

PEOPLE

CONTACT

ABOUT

SEARCH

## COMMUNICATION



## REPORT CARDS



## TRAINING



## Laguna de Bay

### 2013 Ecosystem Health Report Card



The first Report Card for Laguna de Bay in the Philippines is now available!

## NEWSLETTER

Video & Blog Highlights

A Look Inside New York Harbor poster released for classroom use

IAN kicks off collaboration with Cambodian Ministry of Environment on Mekong Flooded Forest Landscape Report Card

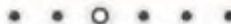
Texas coast pilot project workshop creates EcoHealth Metrics

OysterFutures project underway

On the Horizon

## JOURNAL ARTICLES

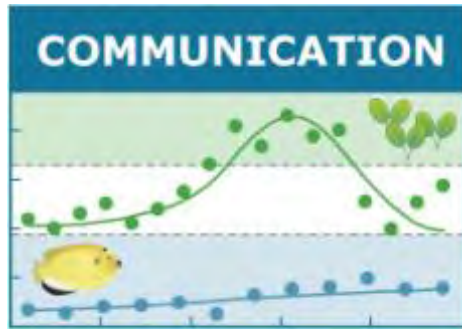
Oyster delta N-15 as a Bioindicator of Potential Wastewater and Poultry Farming Impacts and Degraded Water Quality in a Subestuary of Chesapeake Bay



Innovation for a better future



# IAN HAS THREE MAIN FOCUS AREAS



Develop Science  
Communication  
products

Environmental  
Report Cards

Science  
Communication  
Training

# SOLVING, NOT JUST STUDYING ENVIRONMENTAL PROBLEMS

## STUDY

- Dispassionate
- Embrace complexity
- Publish & funding via peer review
- Getting it right



## SOLVE

- Passionate
- Simplify
- Publish & funding via stakeholders
- Getting it done

# SYNTHESIZING INFORMATION FOR LESS TECHNICAL AUDIENCES

## Synthesis



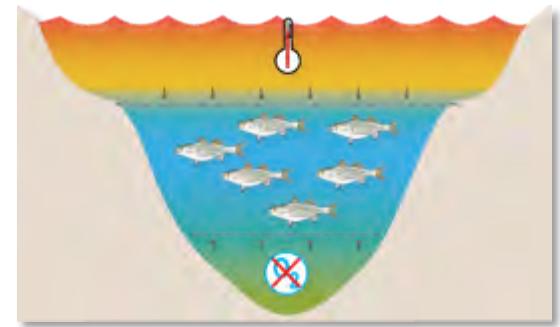
Synthesized data

## Visualization



Illustrate key points

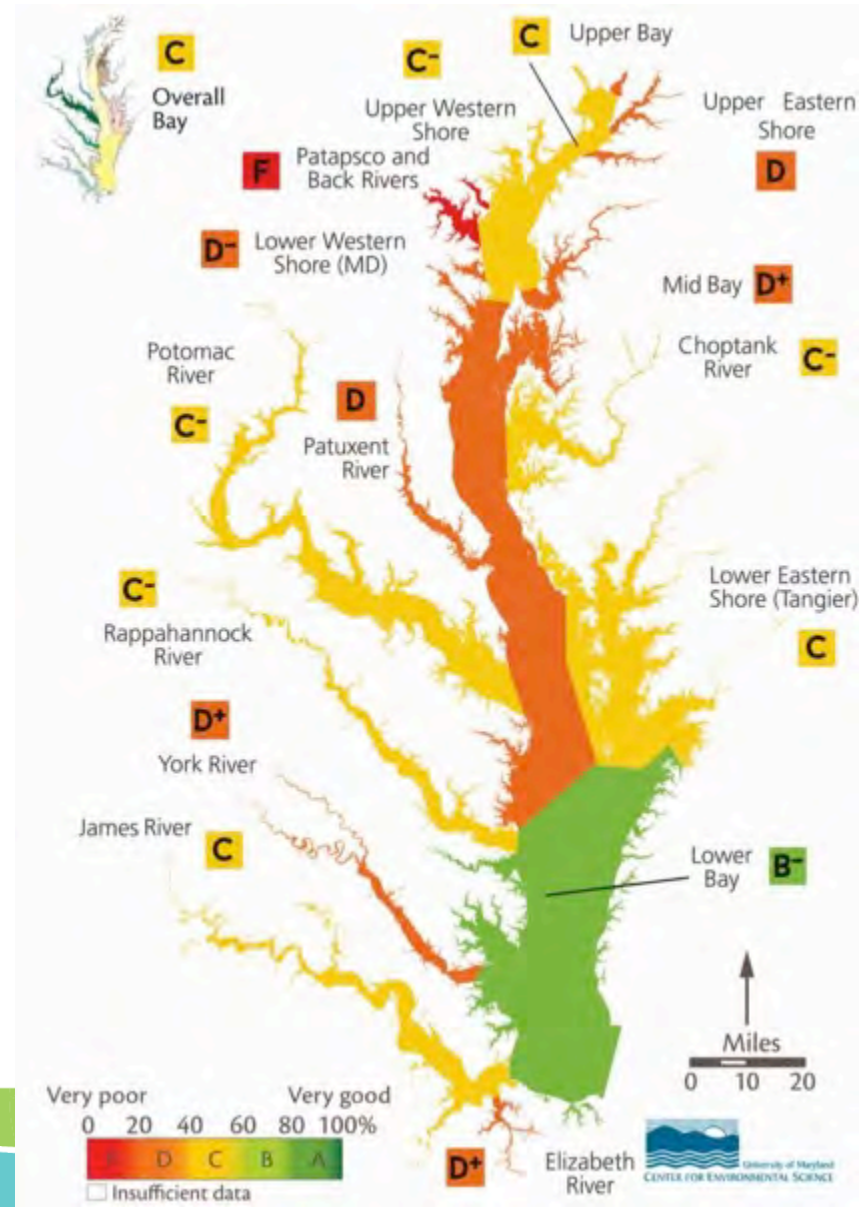
## Context



So what?

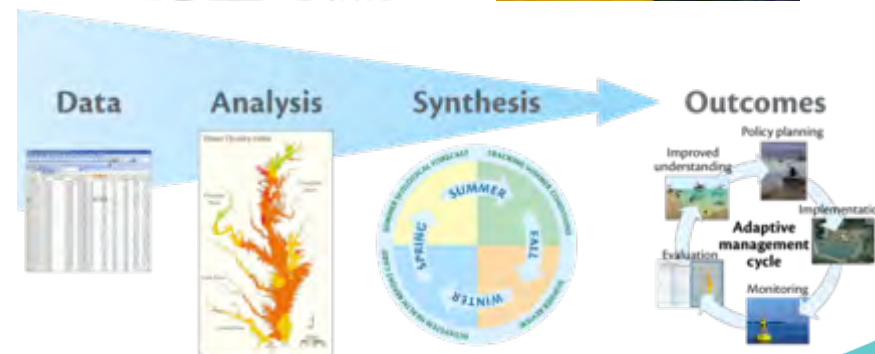
# WHAT IS AN ECOSYSTEM HEALTH REPORT CARD?

- Broad-level assessments of a region or system
- Communicate complex information
- Based on real data: transparent and defensible
- Provide accountability
- Engage communities



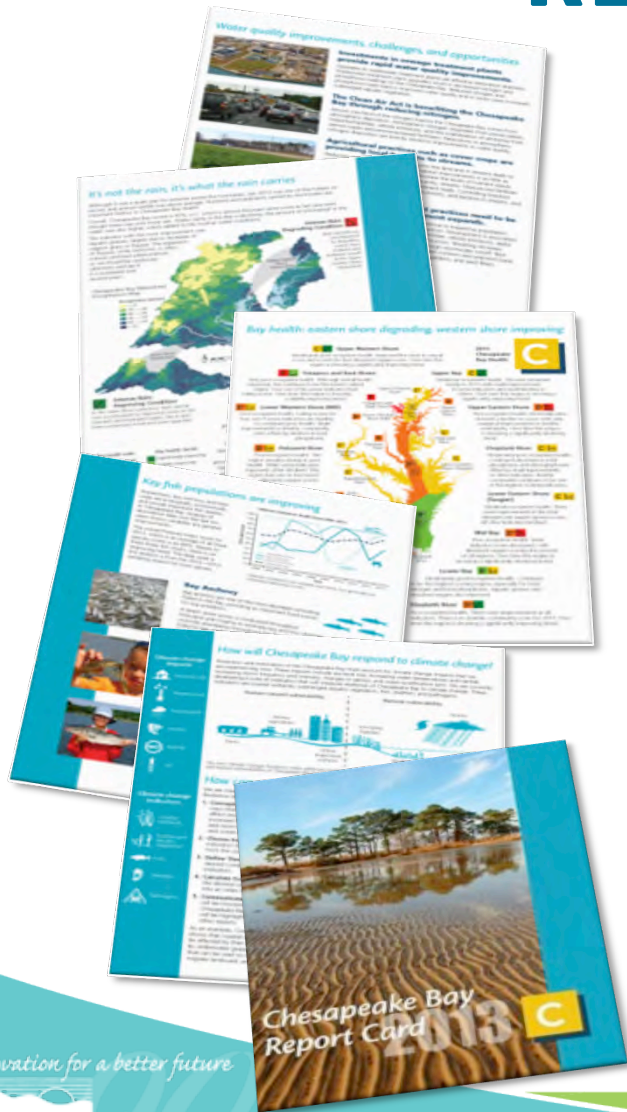
# ECOSYSTEM HEALTH REPORT CARDS ARE AN EFFECTIVE COMMUNICATION TOOL

- Peer pressure is a powerful human motivator
- Educational report cards are a common experience
- Report cards synthesize large amounts of data





# OUTCOMES OF ECOSYSTEM HEALTH REPORT CARDS



- Well received and influential
- Comprehensive package – goes beyond simple grading
- Visually appealing
- Being local – sense of ownership
- Educational

# REPORT CARDS ADDRESS MANY AUDIENCES

- Top tier = Report card
- 2<sup>nd</sup> Tier = Newsletter, website
- 3<sup>rd</sup> Tier = Technical reports, scientific literature
- Base = Data



# WE HAVE DEVELOPED REPORT CARDS IN ICONIC REGIONS AROUND THE WORLD



# REPORT CARDS ARE A FIVE STEP PROCESS

## 1 Create a conceptual framework



Create a framework defining goals and major aspects of each goal that should be evaluated over time.

## 2 Choose indicators



Select indicators that convey meaningful information and can be reliably measured.

## 3 Define thresholds



Define status categories, reporting regions, and method of measuring threshold attainment.

## 4 Calculate scores

Source	Station	Region	Date	EQ Value
DNR	CCC0003		4/29/03	9.00
DNR	CCC0003		4/29/09	9.50
DNR	CCC0009		4/29/05	9.70
DNR	CCC0003		5/28/05	8.90
DNR	CCC0009		5/28/09	9.00
DNR	CCC0008		5/28/09	9.00
NAI	Increment		6/28/00	0.00

Calculate indicator scores and combine into index grades.

## 5 Communicate results



Communicate results using visual elements, such as photos, maps, and conceptual diagrams.

# WE USE A PARTNERSHIP APPROACH AND WANT TO ENGAGE YOU IN THIS PROCESS

This workshop was led by KCI, University of Maryland Center for Environmental Science, and PSAM supported by the Inter-American Development Bank. Participants included Izidro Paes Leme Arthou, José Paulo Azevedo, Guido Gelli, Marcos Santanna Lacerda, Nair Palhano, Marco Pessoa, Stella Procópio da Rocha, Marcio Santarosa, Mariana Correa dos Santos, Klinton Senra, José Alfredo Sertã, Leonardo Daemon Doliveira Silva, Fátima de Freitas Lopes Soares, Rony Sutter, Luciana Ventura, and Victor Zveibil.



*Some workshop participants at Instituto Estadual do Ambiente (INEA) on 25 April 2016.*



Create a conceptual framework



# CONCEPTUAL MAPPING EXERCISE



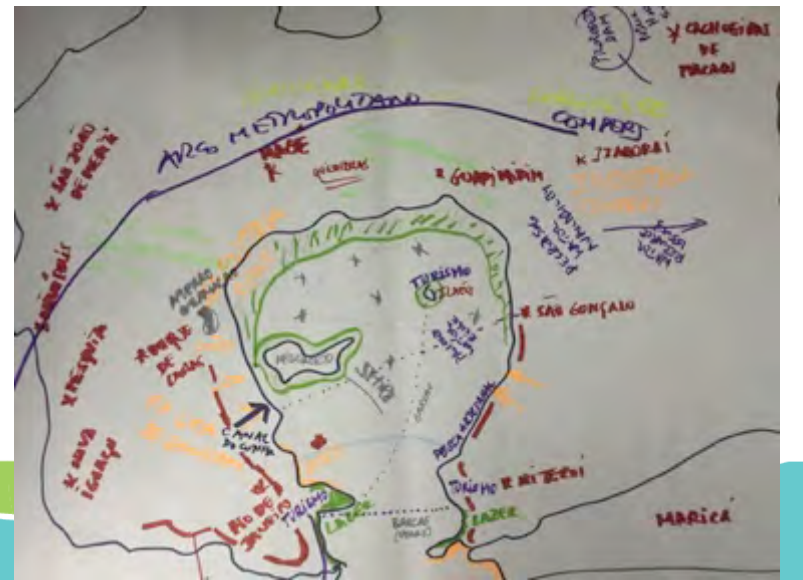
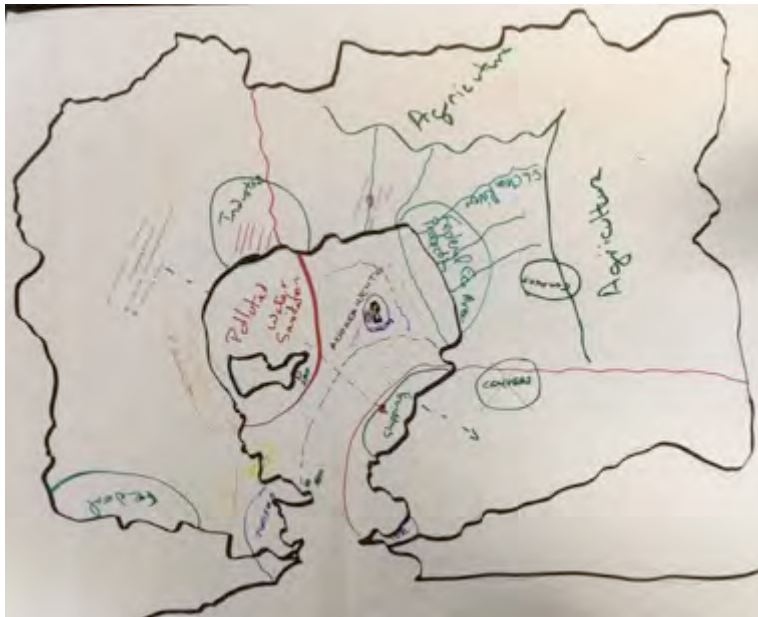
Innovation for a better future



1 Create a conceptual framework



# INITIAL CONCEPTUAL MAPS



1 Create a conceptual framework



# GUANABARA BAY

## KEY VALUES & MAJOR THREATS

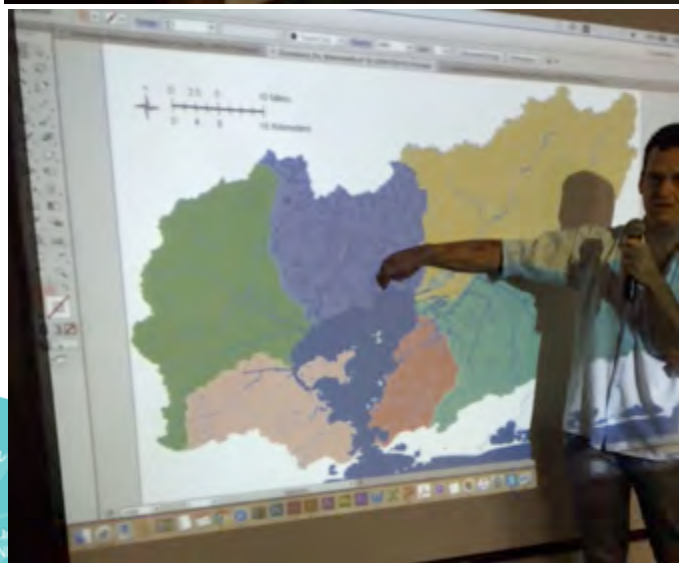
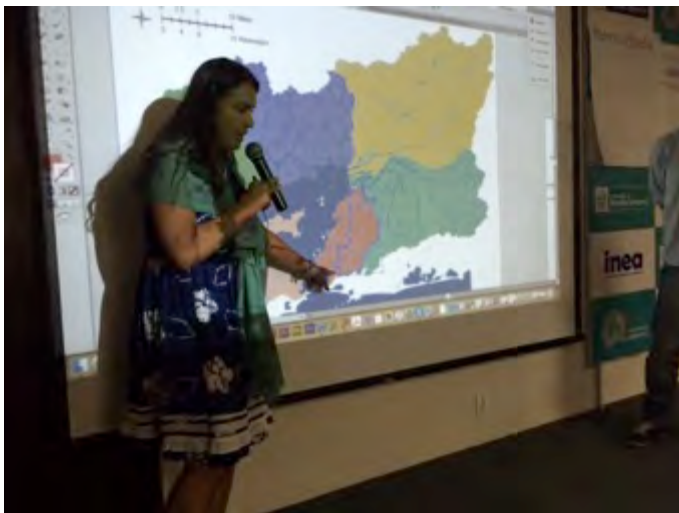




Create a conceptual framework



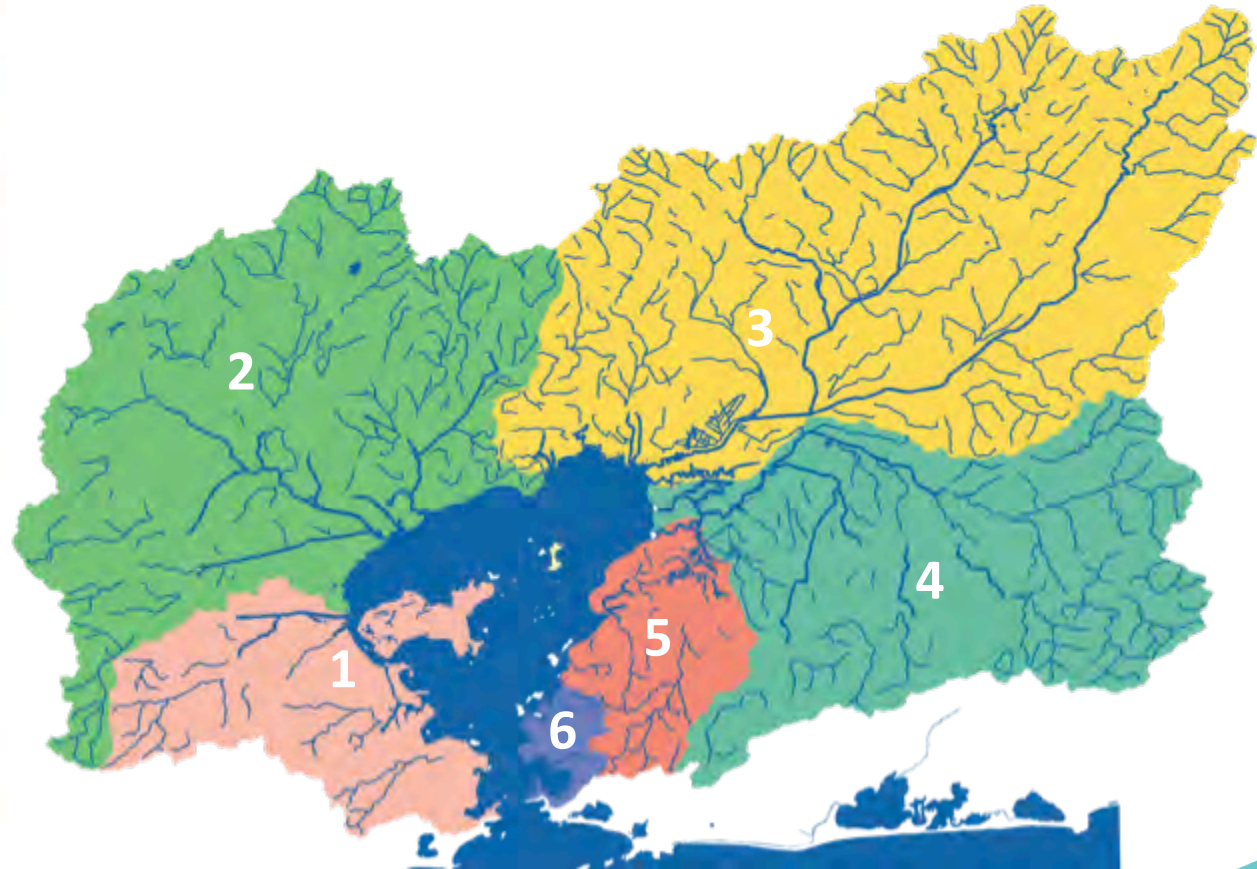
# REPORTING REGION DISCUSSION



1 Create a conceptual framework



# REPORTING REGIONS: GUANABARA BAY & RIVER BASIN



*Innovation for a better future*



2 Choose indicators

# POTENTIAL INDICATORS FOR GUANABARA BAY



Dissolved oxygen



Chlorophyll



Mangroves



Phosphorus



Phytoplankton



Water transparency



Nitrate



Marine mammals



Contamination of crabs



Ammonium



Fish assemblage



Sea horses



Coliforms

2 Choose indicators

# POTENTIAL INDICATORS FOR THE GUANABARA BAY BASIN



DO

Dissolved oxygen



Turbidity

BOD

Biological oxygen demand



TDS

Total dissolved solids

P

Total phosphorus



Air/water temperature

NO<sub>3</sub>

Nitrate



Coliforms




pH

pH

# INITIAL WORKSHOP NEWSLETTER WILL BE DISCUSSED AFTER LUNCH

## Assessing the health of Guanabara Bay and its river basins


The region around Guanabara Bay is an internationally iconic location, including metropolitan areas like Rio de Janeiro, Niterói and São Gonçalo, beaches like Copacabana and Ipanema, and sights like Sugarloaf and Corcovado. This place of incredible natural beauty has pressing environmental problems, largely due to activities of the 6.6 million people that live in the Guanabara Bay basin. We have embarked on a program to develop scientifically rigorous, transparent assessments of the health and restoration progress of Guanabara Bay and its river basins, with the ultimate goal of producing a report card for Guanabara Bay and its river basins in 2026. This newsletter summarizes the discussions with environmental and social scientists, engineers, and government officials who developed a first draft of the indicators and reporting regions for the assessment of Guanabara Bay and its river basins.



## Guanabara Bay

### Regions of the Bay

Five reporting regions for Guanabara Bay were identified in a recent assessment (Palanski et al., 2015) based on floating rates, bathymetry and natural features.



1. Central channel. The region with high oceanic flushing which follows the deep central channel of Guanabara Bay, extending from the oceanic entrance to Paqueta.
2. Mouth of Guanabara Bay. Transition regions near the mouth of Guanabara Bay on both the west side (Rio de Janeiro) and east side (Niterói).
3. Central margins of Guanabara Bay. This region includes the Harbors of Rio de Janeiro and Niterói with divided channels.
4. Inland Guanabara Bay. This region includes the shallow water habitats and mangrove forests from the Itaquá River mouth to Itaboraí.
5. Northwest Guanabara Bay. This region is west of the Itaquá River mouth. It includes channels separating Governador and Fundão islands.

### Indicators of health


Water quality indicators have been integrated into a water quality index by INEA (compliance index) for marine waters. This index includes five indicators of water quality (dissolved oxygen, total phosphorus, dissolved nitrate, dissolved ammonium and bacterial contamination). These indicators were assessed important but more are needed to characterize the health of Guanabara Bay. Additional indicators will be considered for inclusion based on data availability and quality.

DO	Dissolved oxygen	chl a	chl a biomass
P	Phosphorus	TSS	TSS abundance
NO <sub>3</sub>	Nitrate	MP	MP biomass
NH <sub>4</sub>	Ammonium	WT	Water temperature
B	Bacteria	CO	Conductivity of water
Chlorophyll		Sea level	
MP	MP biomass		

## Guanabara Bay River Basin

### Indicators & regions of the River Basin

Nine water quality indicators have been integrated into a water quality index, DO, biological oxygen demand, total phosphorus, nitrate, pH, turbidity, total dissolved solids, air/water temperature, and trace metal/cadmium sulfides.



### Six regions

1. Rio de Janeiro region. This is the most urbanized basin, which extends from the mouth of Guanabara Bay to Rio Favares and includes Guanabara Bay.
2. Bacia da Passagem region. This basin in the northwest of Guanabara Bay has low lying topography with industrial development, agriculture and low resource communities.
3. Bacia da Maracá region. This basin is the least impacted, in the northeast, with extensive mangroves along the coast. Conservation areas, irrigated agriculture, and drinking water sources are in this basin.
4. Casimiro region. This basin supports petrochemical industrial development, some urban development, and extensive agriculture.
5. Akatene region. This basin extends from the Cocimbu River basin to the Rio das Pratas. This river basin supports the second largest city, São Gonçalo, which has rapid growth.
6. Alvalade region. This small basin in the southeast is largely urbanized. Niterói has the highest proportion of treated sewage in the region with discharge into the mouth of Guanabara Bay.

## Guanabara Bay values & threats



Guanabara Bay is a beautiful natural harbor that helps form the identity of the Rio de Janeiro region. Guanabara 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. These values and threats will inform the selection of report card indicators.

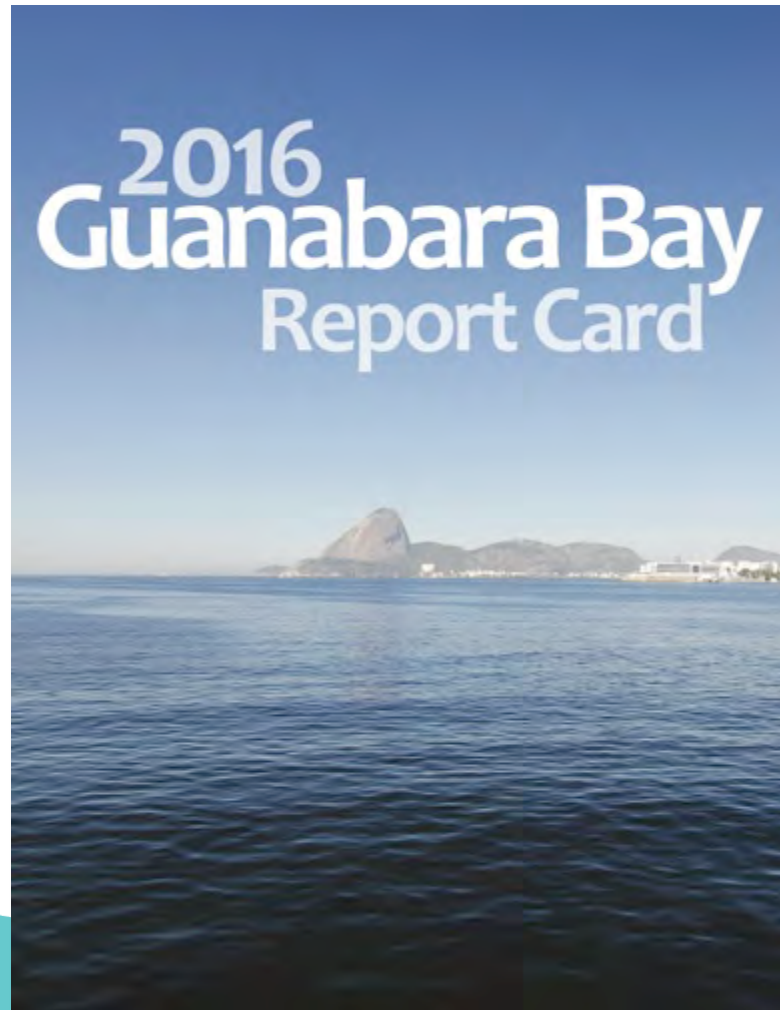
This workshop was led by KCI, University of Maryland Center for Environmental Science, and funded supported by the Inter-American Development Bank. Participants included: Carlos Lopes, André Paulo Almeida, Gabriel Bell, Marcos Laranjeira, Marc Hoffmann, Mariana Mouta, Diana Príncipe de Rocha, Natalia Sartorius, Mariana Correa dos Santos, Cláudia Lima, and André Sampaio. Guanabara Bay Basin Study, Valéria de Freitas Lopes Soares, Rosy Satter, Carolina Ventura, and Victor Zurek.

Other workshop participants at Instituto Estadual de Ambiente (IEA) on 23 April 2024.

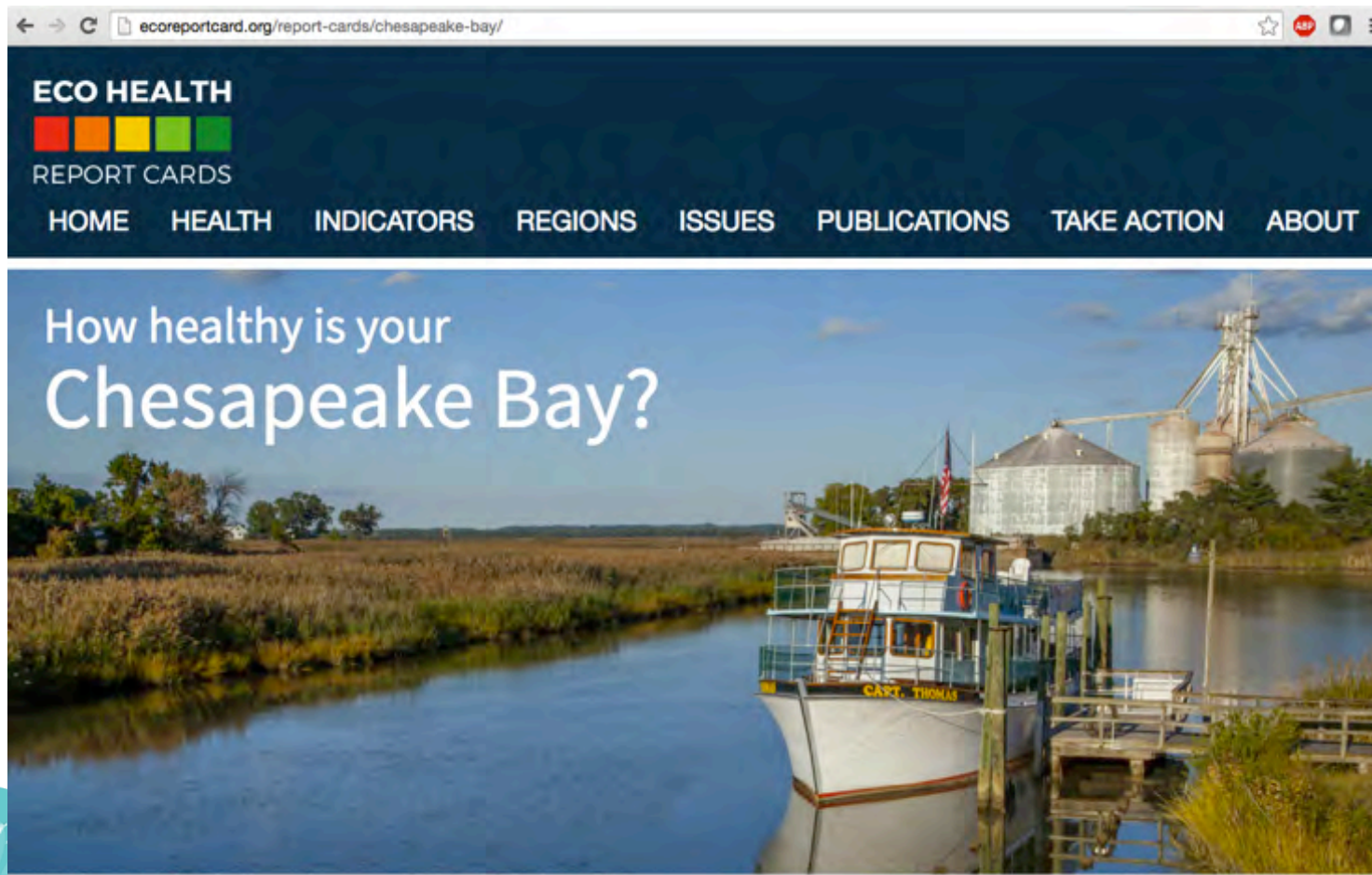



- Globally iconic location
- Pressing environmental problems
- Need for scientifically rigorous, transparent assessments to track restoration progress

# WE WILL PRODUCE A PRINTED REPORT CARD FOR GUANABARA BAY (LIKE CHESAPEAKE BAY)



# WE ALSO WILL ADD THE GUANABARA BAY REPORT CARD TO ECOREPORTCARD.ORG



# THE WEBSITE ALLOWS PEOPLE TO INVESTIGATE THE DATA

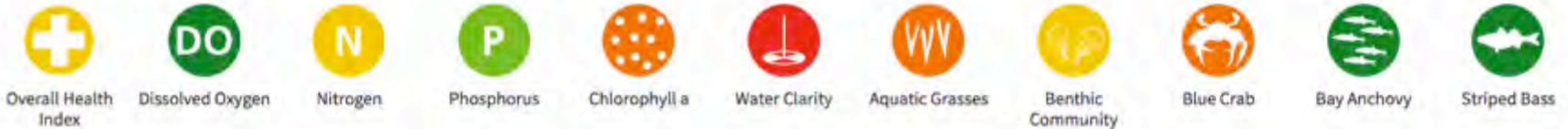
← → ↻ ecoreportcard.org/report-cards/chesapeake-bay/health/ ☆ ARP

## How healthy is your Chesapeake Bay?

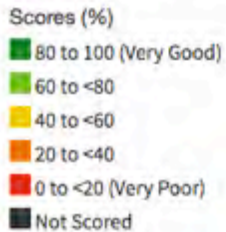
1986

2014

### BY INDICATOR |



### BY REGION | Overall



### TRENDS | Overall





# THE WEBSITE PROVIDES DETAILED EXPLANATIONS

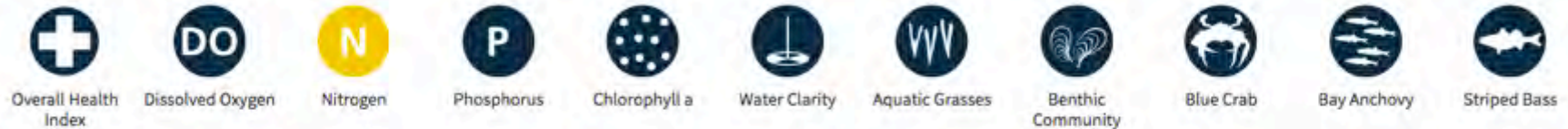
ecoreportcard.org/report-cards/chesapeake-bay/health/

## How healthy is your Chesapeake Bay?

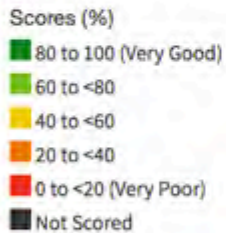
1986

2014

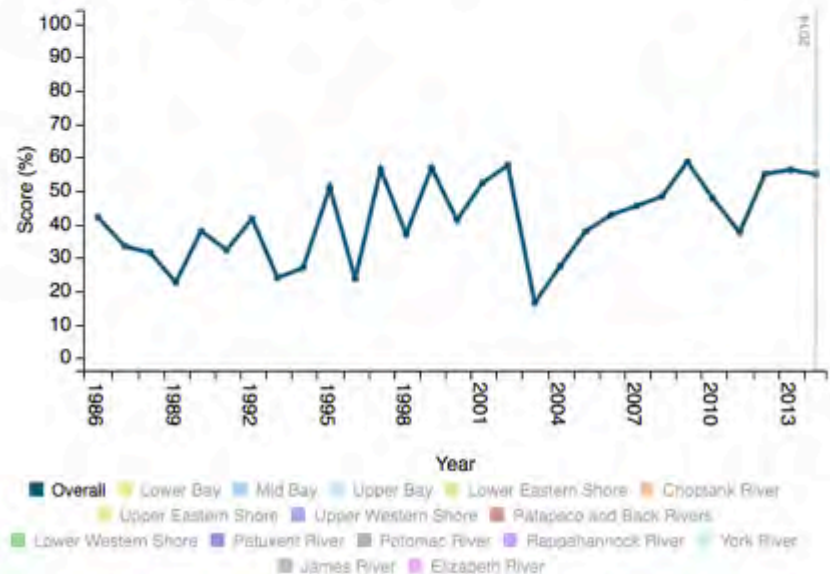
### BY INDICATOR | Nitrogen



### BY REGION |



### TRENDS | Nitrogen



# THE WEBSITE PROVIDES THE METHODOLOGY

ECO HEALTH



REPORT CARDS

HOME

HEALTH

INDICATORS

REGIONS

ISSUES

PUBLICATIONS

TAKE ACTION

ABOUT

HOME / REPORT CARDS / CHESAPEAKE BAY / INDICATORS / PHOSPHORUS



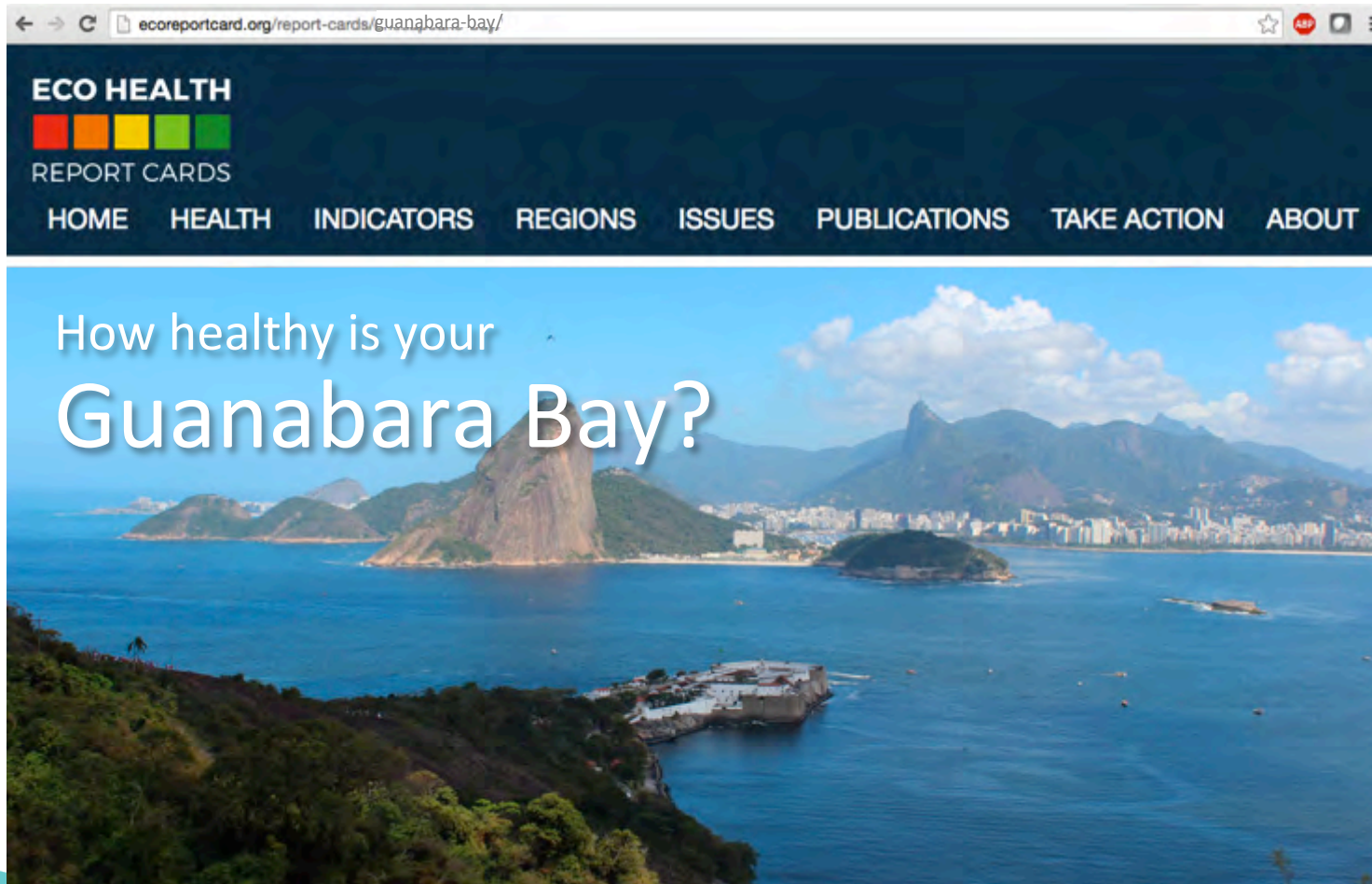
## What is the Phosphorus indicator?

Total phosphorus is an indicator of too much phosphorus in the water. Phosphorus attaches to sediment particles, so phosphorus and sediment pollution are linked. Phosphorus is an essential nutrient for all plants and animals. But too much phosphorus in the water causes algae to grow in large, dense algal blooms, which depletes oxygen for fish and other marine organisms.



When sediment runs off land, it can carry nutrients like phosphorus into the water.

# GUANABARA BAY REPORT CARD HOME PAGE EXAMPLE



# GUANABARA BAY REPORT CARD



## How healthy is your Guanabara Bay?

1966

2014

### BY INDICATOR |



Overall Health Index



Dissolved Oxygen



Nitrogen



Phosphorus



Chlorophyll a



Water clarity



Aquatic Fauna



Benthic Community



Fish Catch



Bivalves



Shrimp Catch

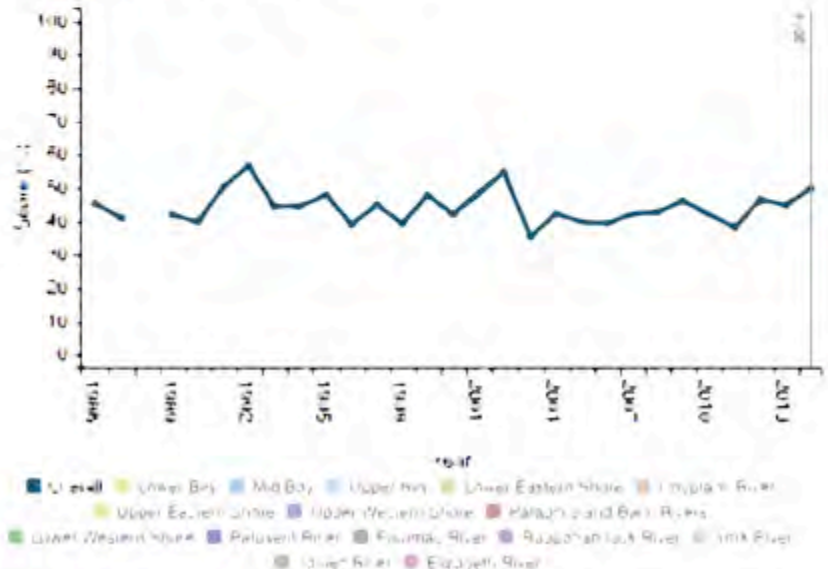
### BY REGION | Overall

Score (0-100)

- 80 to 100 (Very Good)
- 60 to 80 (Good)
- 40 to 60 (Fair)
- 20 to 40 (Poor)
- 10 to 20 (Very Poor)
- 0 (Not Scored)



### TRENDS | Overall



# GUANABARA BAY BASIN REPORT CARD

## How healthy is your Guanabara Bay Basin?

1966

2014

### BY INDICATOR |



Overall Health Index



Dissolved Oxygen



Nitrogen



Phosphorus



Coliform Bacteria



Water Clarity



Aquatic Insects



Benthic Community



Fish Catch



Benthic Macroinvertebrates



Shrimp Catch

### BY REGION | Overall

Score by region

80 to 100 (Very Good)

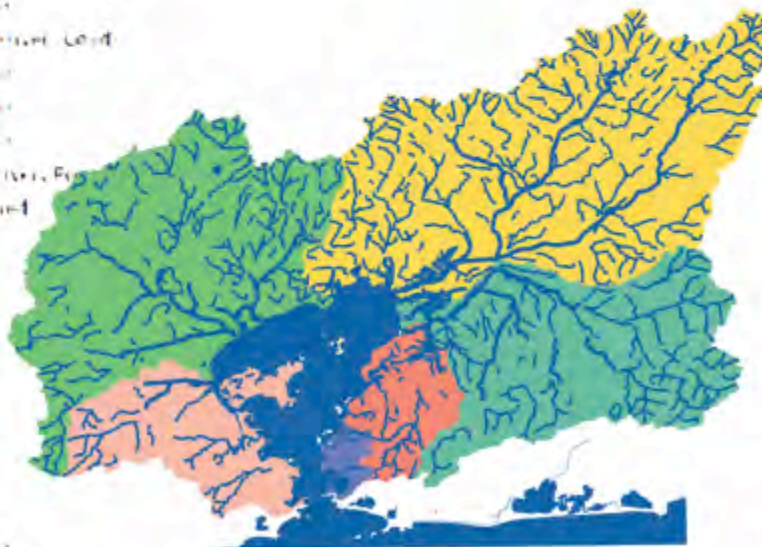
60 to 80 (Good)

40 to 60 (Fair)

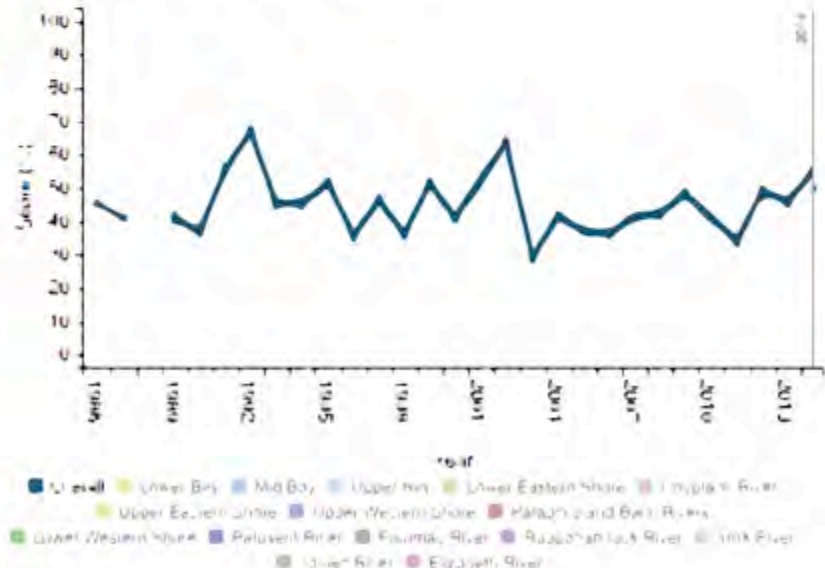
20 to 40 (Poor)

10 to 20 (Very Poor)

0 (Not Scored)



### TRENDS | Overall



# GUANABARA BAY BASIN REPORT CARD EXAMPLE

## Guapimirim-Macacu Basin

Coliform:



Dissolved oxygen:

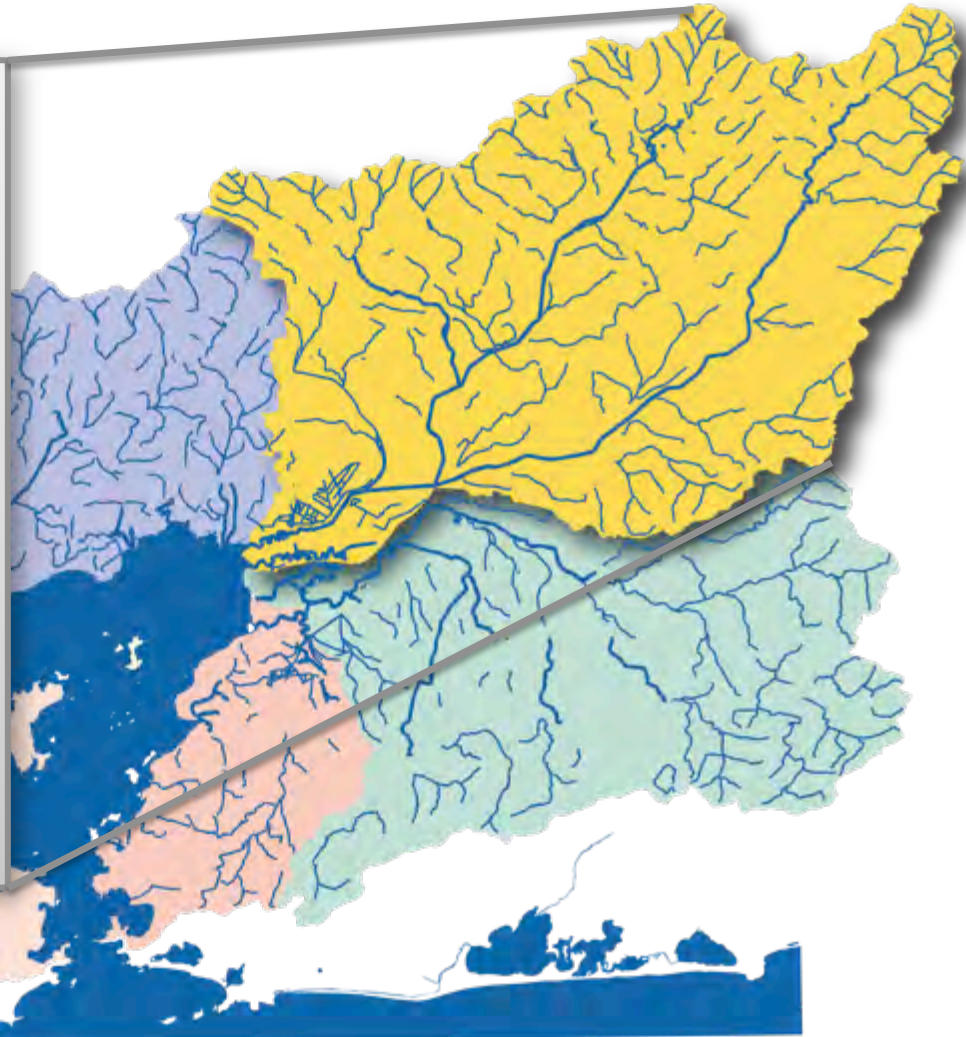
DO

Nitrate:

NO<sub>3</sub>

Overall Score:

?



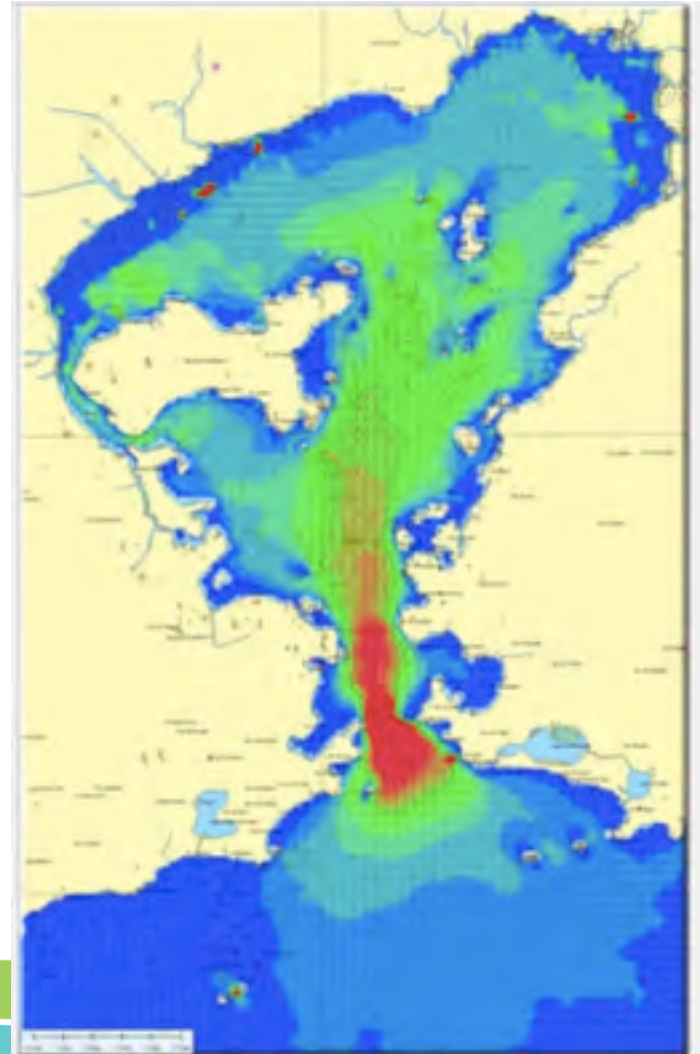
# GUANABARA BAY IS AN AMAZING PLACE

- Beautiful natural harbor
- It attracts people to live, work, and play



# GUANABARA BAY IS VULNERABLE TO HUMAN IMPACT

- Restricted exchange with ocean
- Poor flushing where it is needed most





# GUANABARA BAY HAS SOME SIGNIFICANT ENVIRONMENTAL IMPACTS



Visible (e.g. litter)

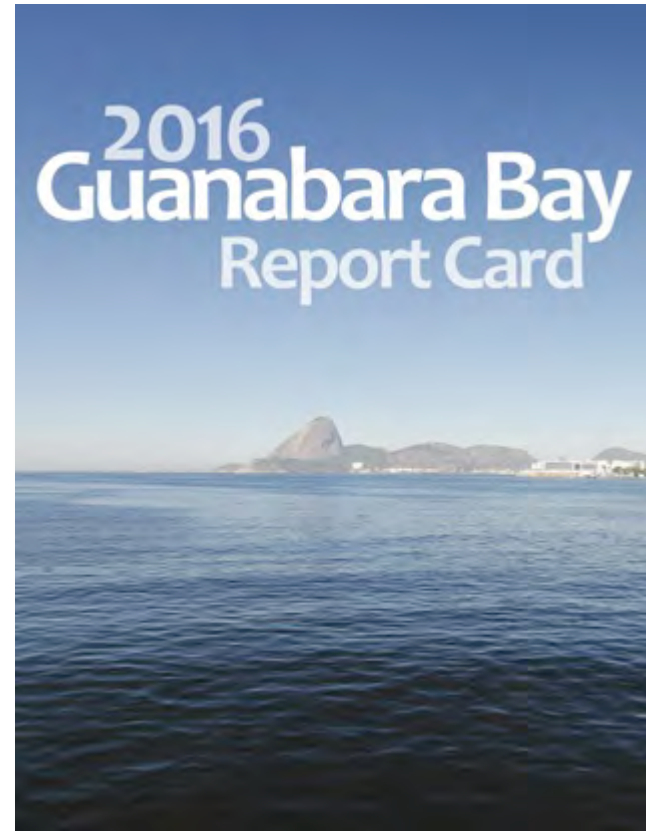
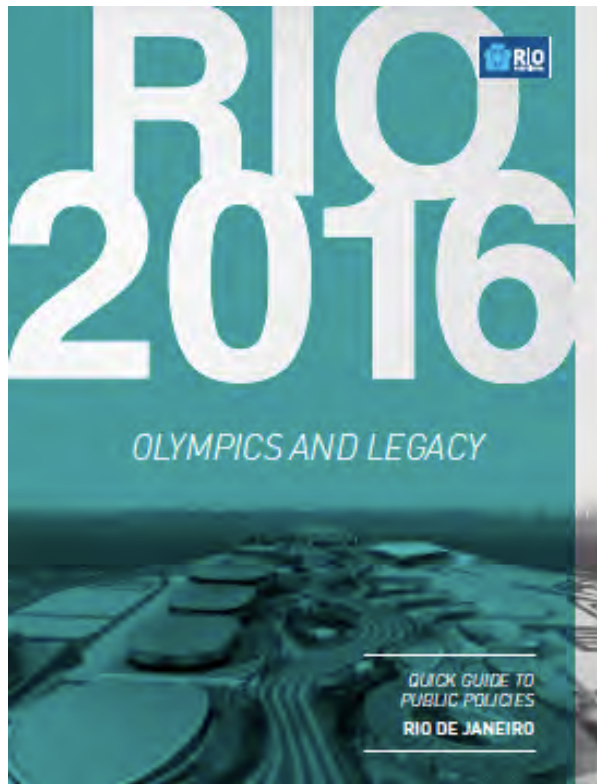


Invisible (e.g. bacterial contamination)

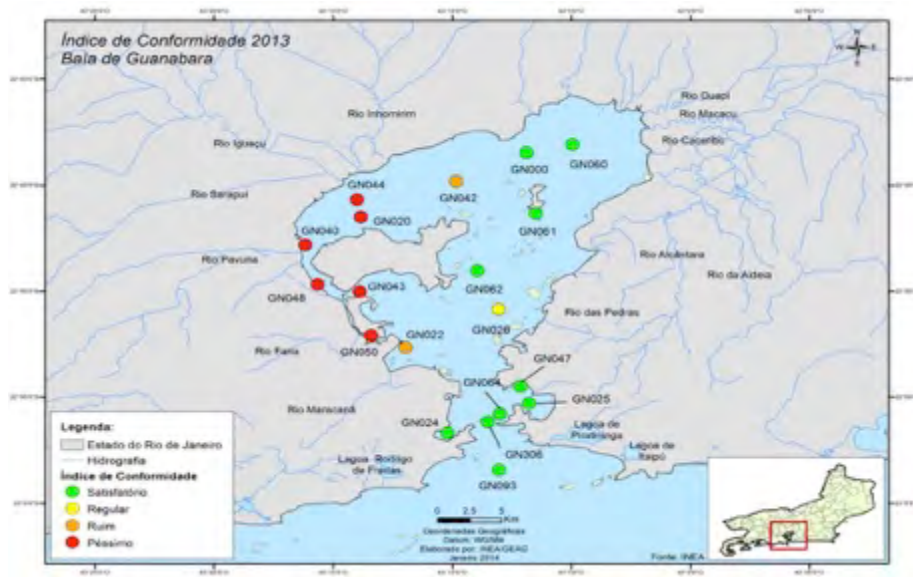
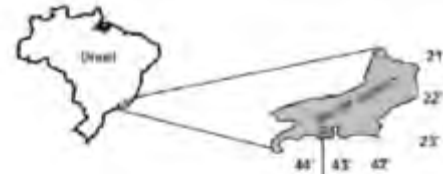
# THERE IS STRONG INTEREST IN IMPROVING GUANABARA BAY (THIS IS WHY WE ARE ALL HERE TODAY)



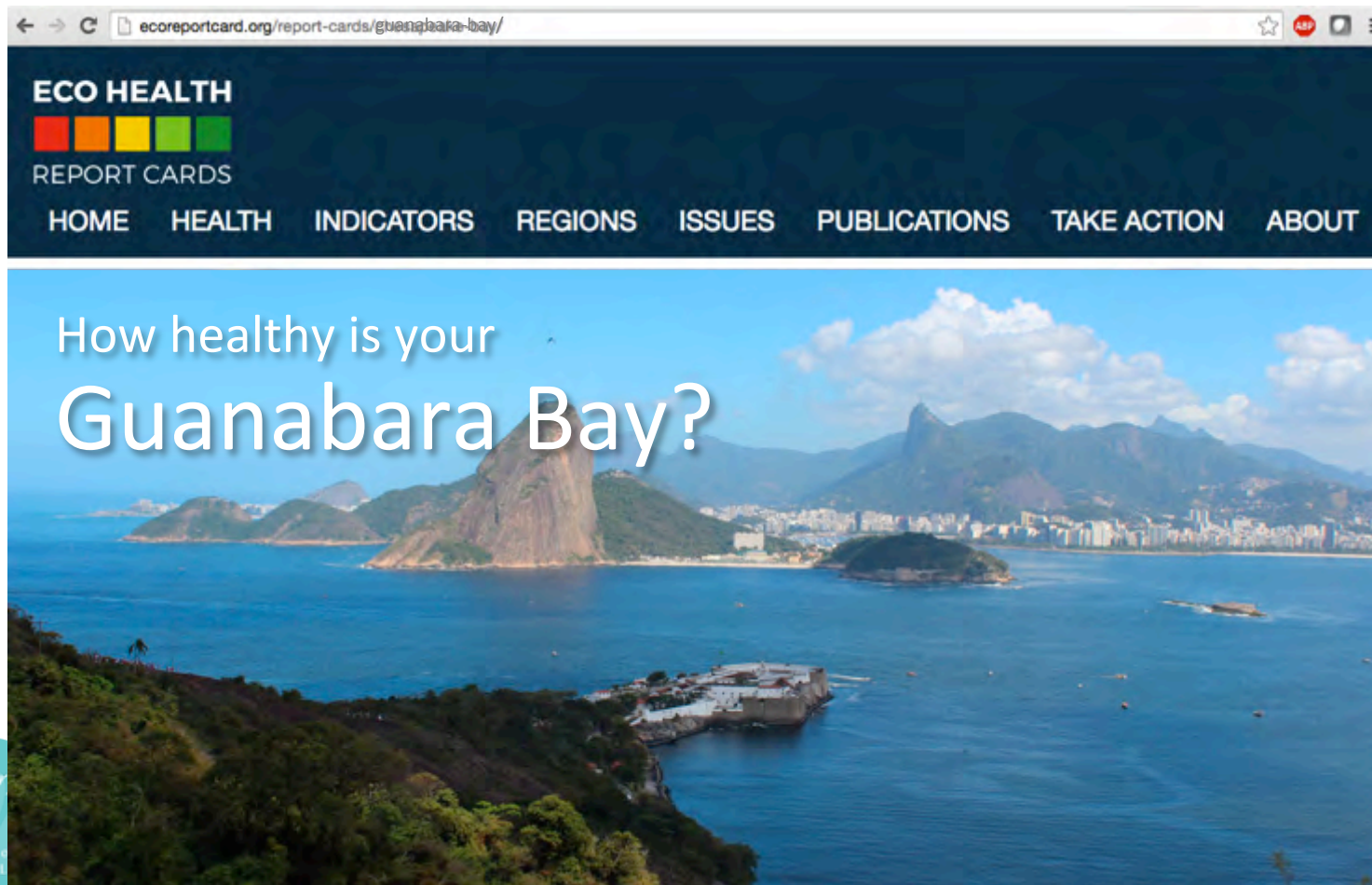
# WE HAVE A UNIQUE OPPORTUNITY TO ACCELERATE GUANABARA BAY RESTORATION



# THERE IS A STRONG SCIENTIFIC FOUNDATION FOR GUANABARA BAY RESEARCH AND MONITORING



# WE CAN BUILD ON THIS FOUNDATION TO CREATE A SCIENTIFICALLY RIGOROUS, TRANSPARENT PROCESS FOR TRACKING RESTORATION PROGRESS



The image shows a screenshot of a web browser displaying the 'EcoHealth Report Cards' website for Guanabara Bay. The browser's address bar shows the URL 'ecoreportcard.org/report-cards/guanabara-bay/'. The website has a dark blue header with the 'ECO HEALTH' logo, which consists of five colored squares (red, orange, yellow, green, dark green) and the text 'REPORT CARDS'. Below the header is a navigation menu with the following items: HOME, HEALTH, INDICATORS, REGIONS, ISSUES, PUBLICATIONS, TAKE ACTION, and ABOUT. The main content area features a large, scenic photograph of Guanabara Bay in Rio de Janeiro, Brazil, with the text 'How healthy is your Guanabara Bay?' overlaid in white. The bottom of the image contains two logos: on the left, the logo for the University of California Center for Environmental Innovation, with the tagline 'Innovation for a better' and the text 'University of California CENTER FOR ENVIRONMENTAL INNOVATION'; on the right, the logo for 'ian'.

# WE LOOK FORWARD TO ENGAGING WITH YOU IN THIS PROCESS



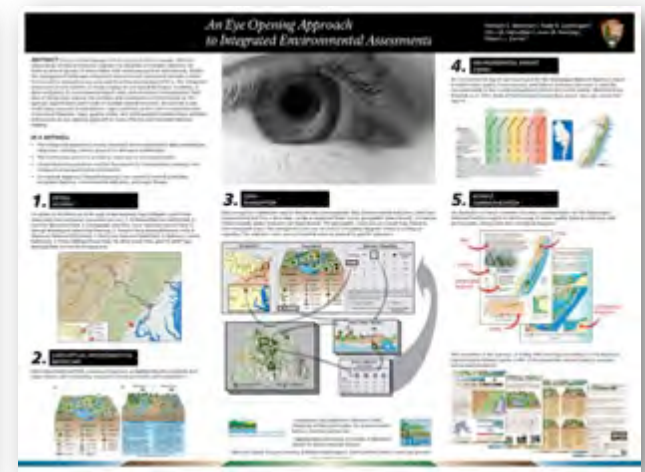
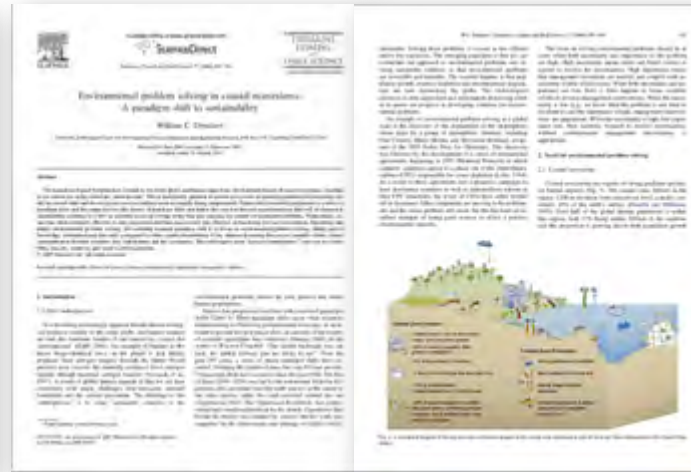
# THANK YOU

# DEVELOPING A VARIETY OF SCIENCE COMMUNICATION PRODUCTS

Newsletters

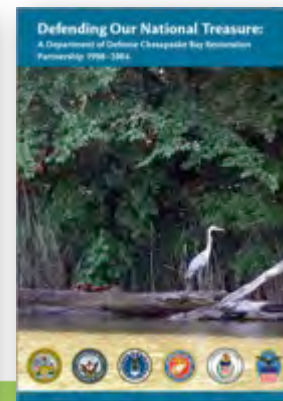
Science Journals

Posters



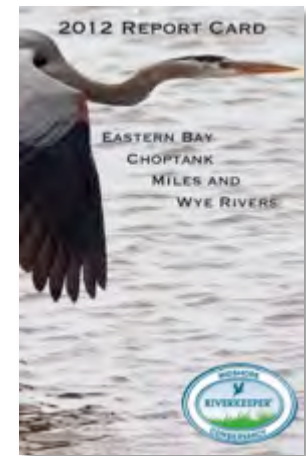
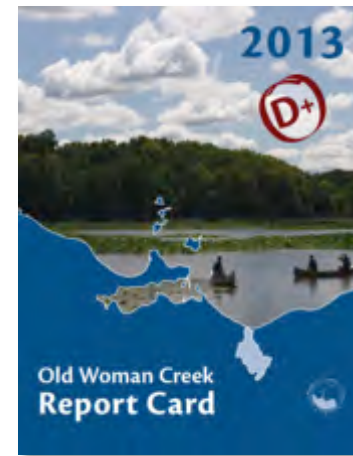
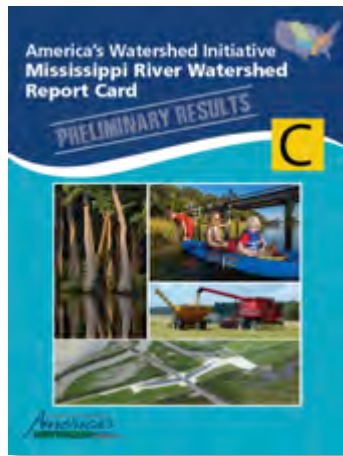
Reports

Books





# REPORT CARD EXAMPLES



# Report cards are a five step process

## 1 Create a conceptual framework



Create a framework defining goals and major aspects of each goal that should be evaluated over time.

## 2 Choose indicators



Select indicators that convey meaningful information and can be reliably measured.

## 3 Define thresholds



Define status categories, reporting regions, and method of measuring threshold attainment.

## 4 Calculate scores

Source	Station	Region	Date	DQI Value
DNR	CCC0001		4/29/09	9.00
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DNR	CCC0004		5/28/09	8.90
DNR	CCC0005		5/28/09	9.00
DNR	CCC0006		5/28/09	9.00
MSU	11700001	Upper	6/08	

Calculate indicator scores and combine into index grades.

## 5 Communicate results



Communicate results using visual elements, such as photos, maps, and conceptual diagrams.

1.  
Conceptual  
framework

2.  
Indicators

3.  
Thresholds

4.  
Calculate  
scores

5.  
Communicate  
results



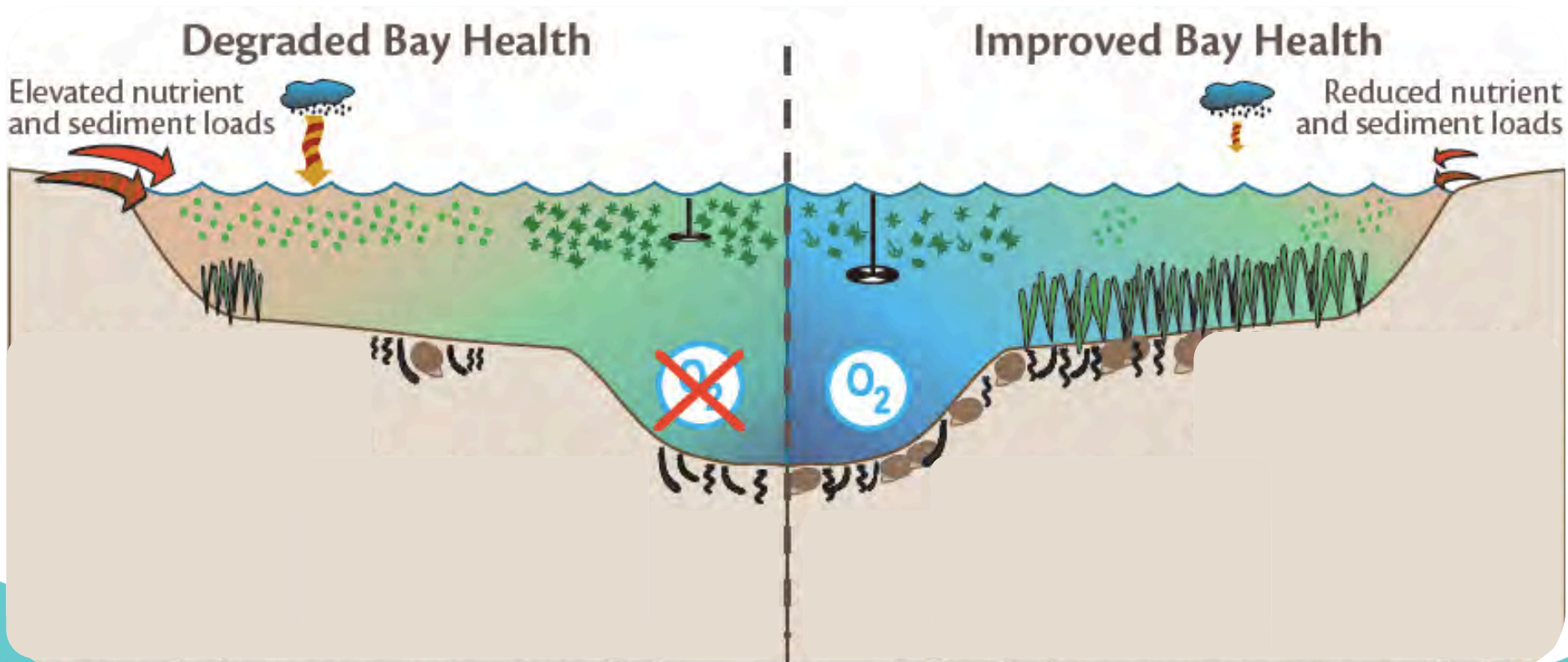
Workshop to identify values and threats

- Brings together relevant experts and stakeholders in one place at one time
- Together develop content and structure of report card
- Builds consensus amongst different parties
- Iterative – review and editing during and after workshop



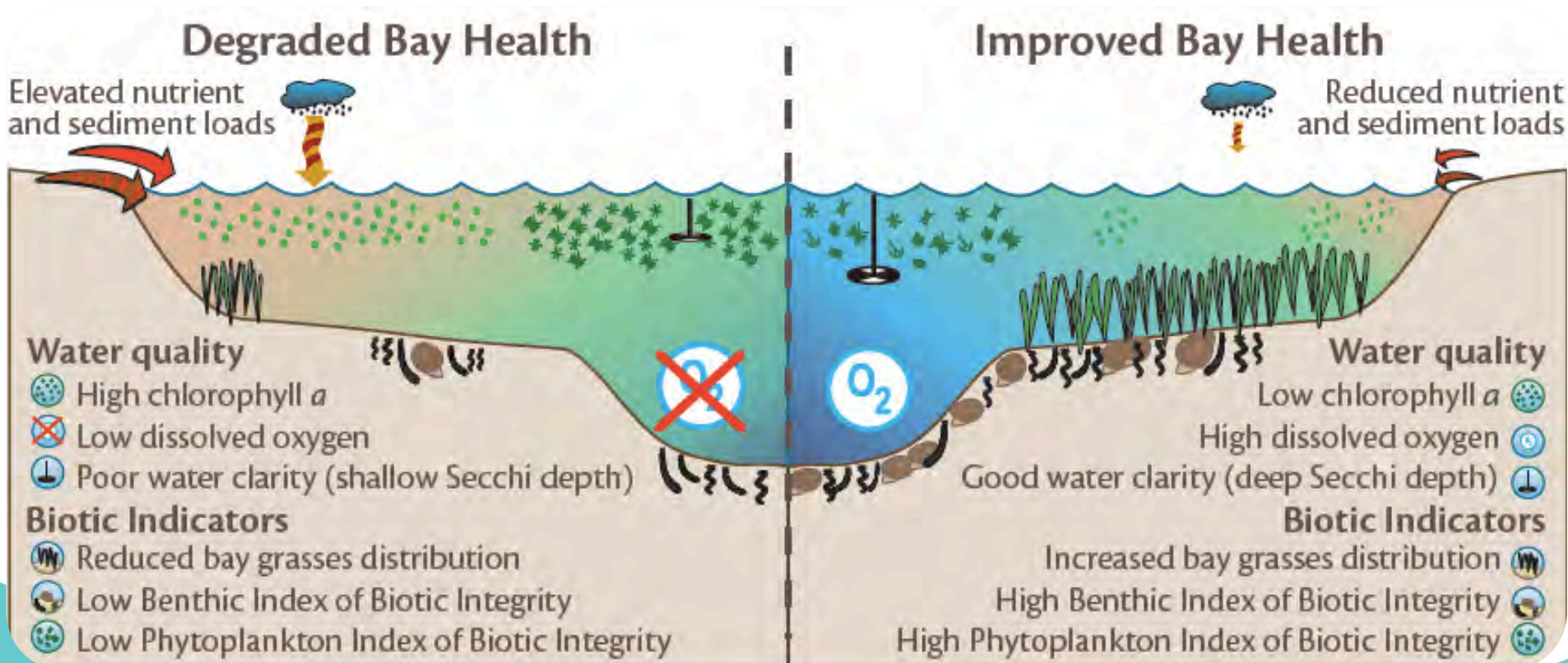
1. Conceptual framework
2. Indicators
3. Thresholds
4. Calculate scores
5. Communicate results

## Chesapeake Bay – Build conceptual diagrams



1. Conceptual framework
2. **Indicators**
3. Thresholds
4. Calculate scores
5. Communicate results

## Chesapeake Bay – Indicators measure values and threats





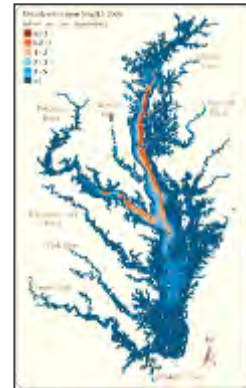
The method of assigning thresholds for each indicator can be based on either, or a combination, of the following:

- Regulatory guidelines (e.g. local or regional water quality guidelines);
- Biological limits (e.g. dissolved oxygen requirements for protection of an important species);
- Socio/economic requirements (e.g. minimal fish stocks determined to be required for sustainable fishery);
- Reference conditions (e.g. historical baseline or nearby system with conditions that would like to be matched);
- Professional judgment



## Score Calculation Methods

1. Prepare Data : Calculate annual mean, median (or multi-year rolling mean or median) for each indicator
  2. Assess data against thresholds
    - % of measured or interpolated area that meets or does not meet threshold
- OR
- % of sites that meets or does not meet threshold



1. Conceptual framework

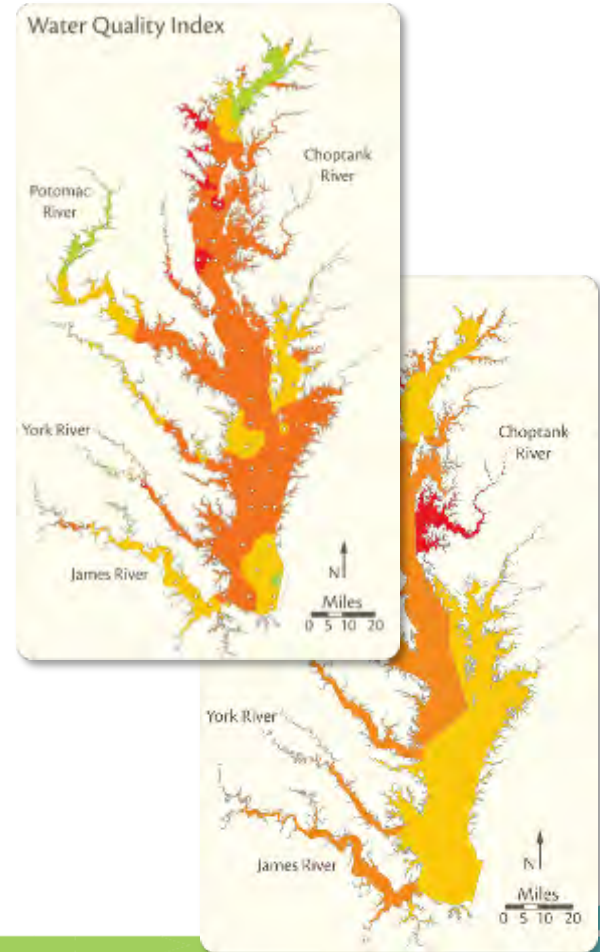
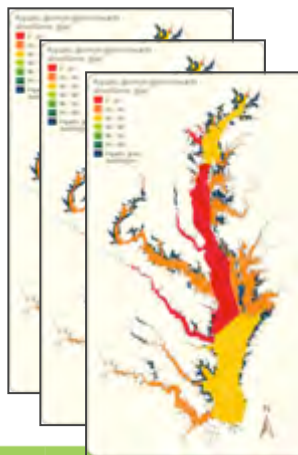
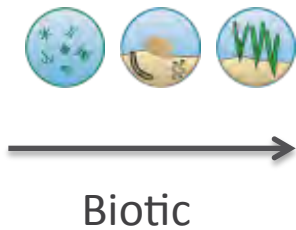
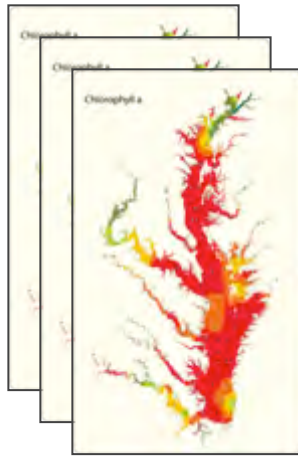
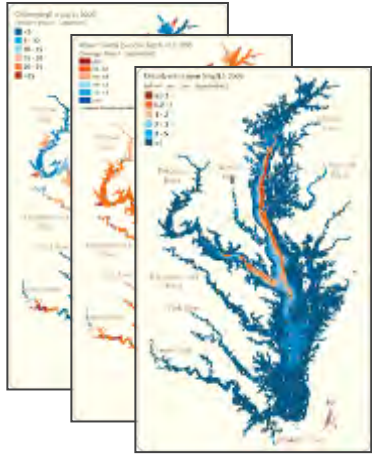
2. Indicators

3. Thresholds

4. Calculate scores

5. Communicate results

## Chesapeake Bay Methods



Data integrated

Compared to thresholds

Combined into indices







Score

Grade

Explanation

80-100 %



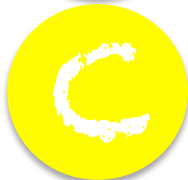
All water quality and biological health indicators meet desired levels.

60-80 %



Most water quality and biological health indicators meet desired levels.

40-60 %



There is a mix of good and poor levels of water quality and biological health indicators.

20-40 %



Some or few water quality and biological health indicators meet desired levels.

0-20 %



Very few or no water quality and biological health indicators meet desired levels.

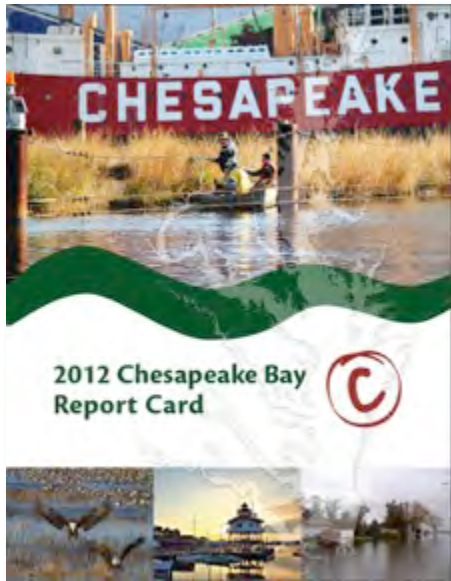
1. Conceptual framework

2. Indicators

3. Thresholds

4. Calculate scores

5. Communicate results



Cover



Values and threats



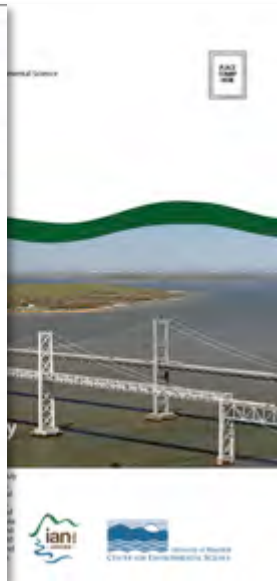
Indicators and methods



Scores/Grades



Trends



Credits

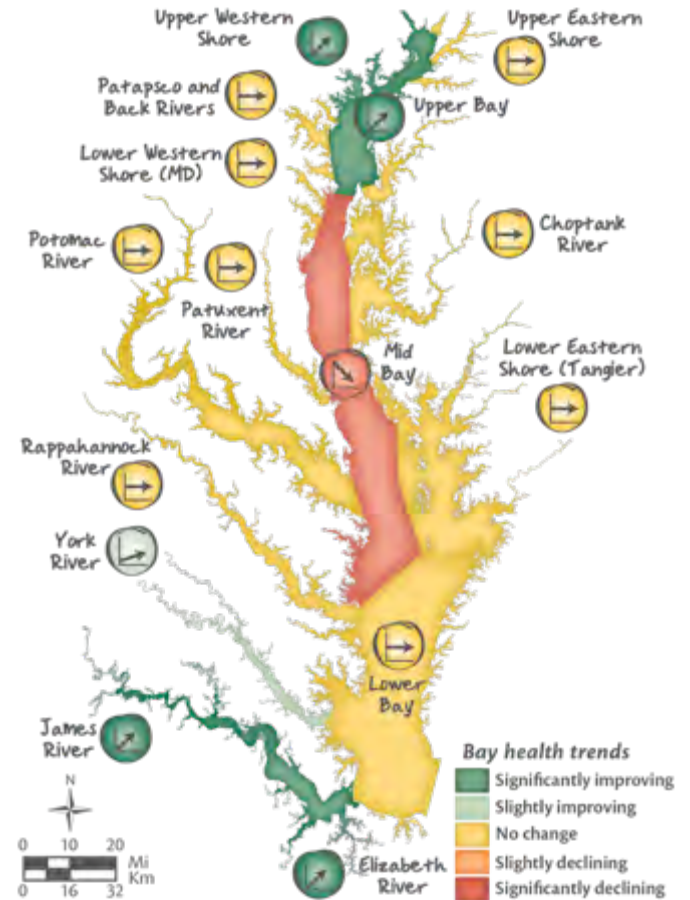
1. Conceptual framework
2. Indicators
3. Thresholds
4. Calculate scores
5. Communicate results



## Keep evolving

### Chesapeake Bay:

- has new indicators
- is now reporting trends
- Includes flow weighted scores



# Retrospective on ecosystem report cards

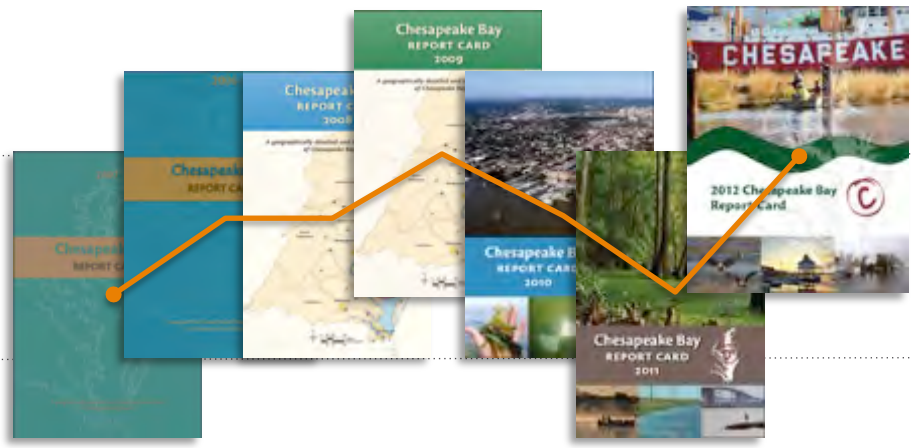
A

B

C

D

F



Chesapeake Bay, USA

2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013

# Moreton Bay report card

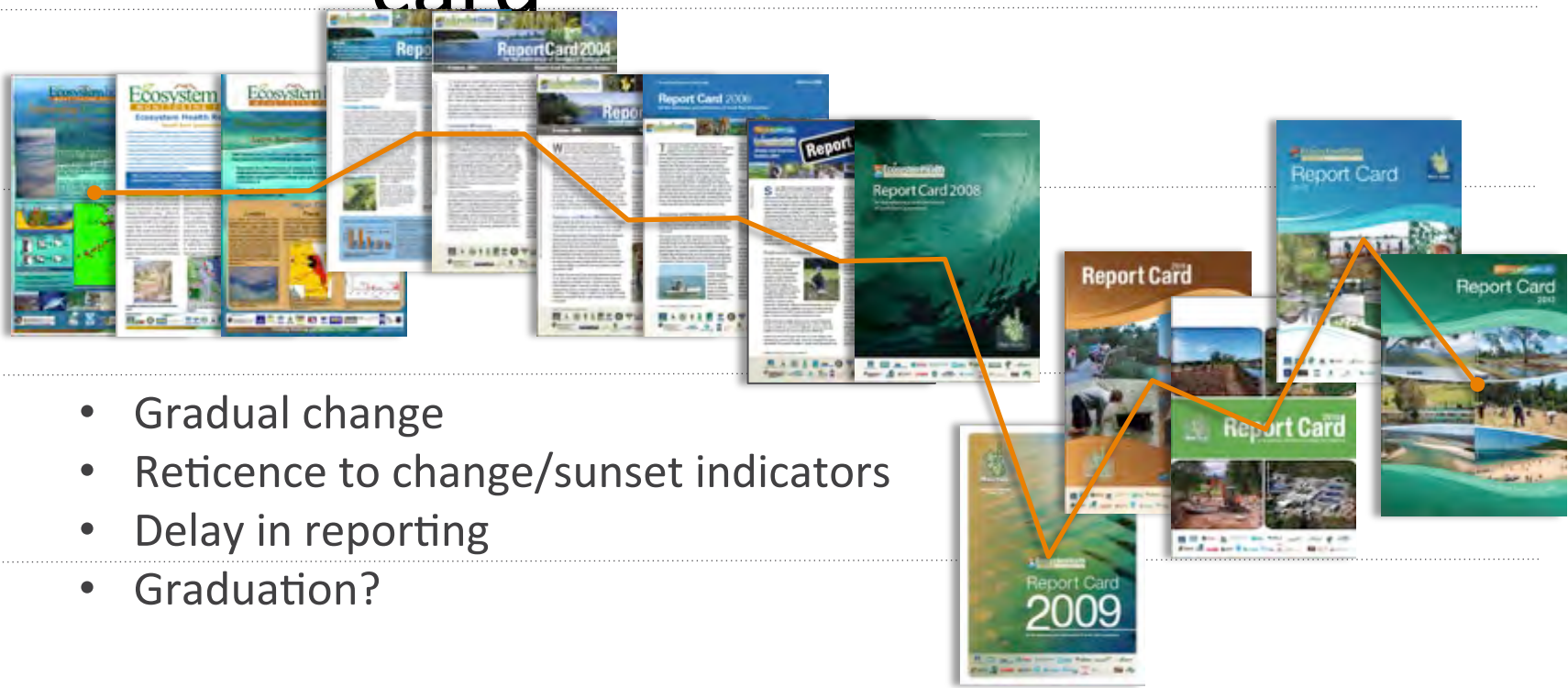
A

B

C

D

F

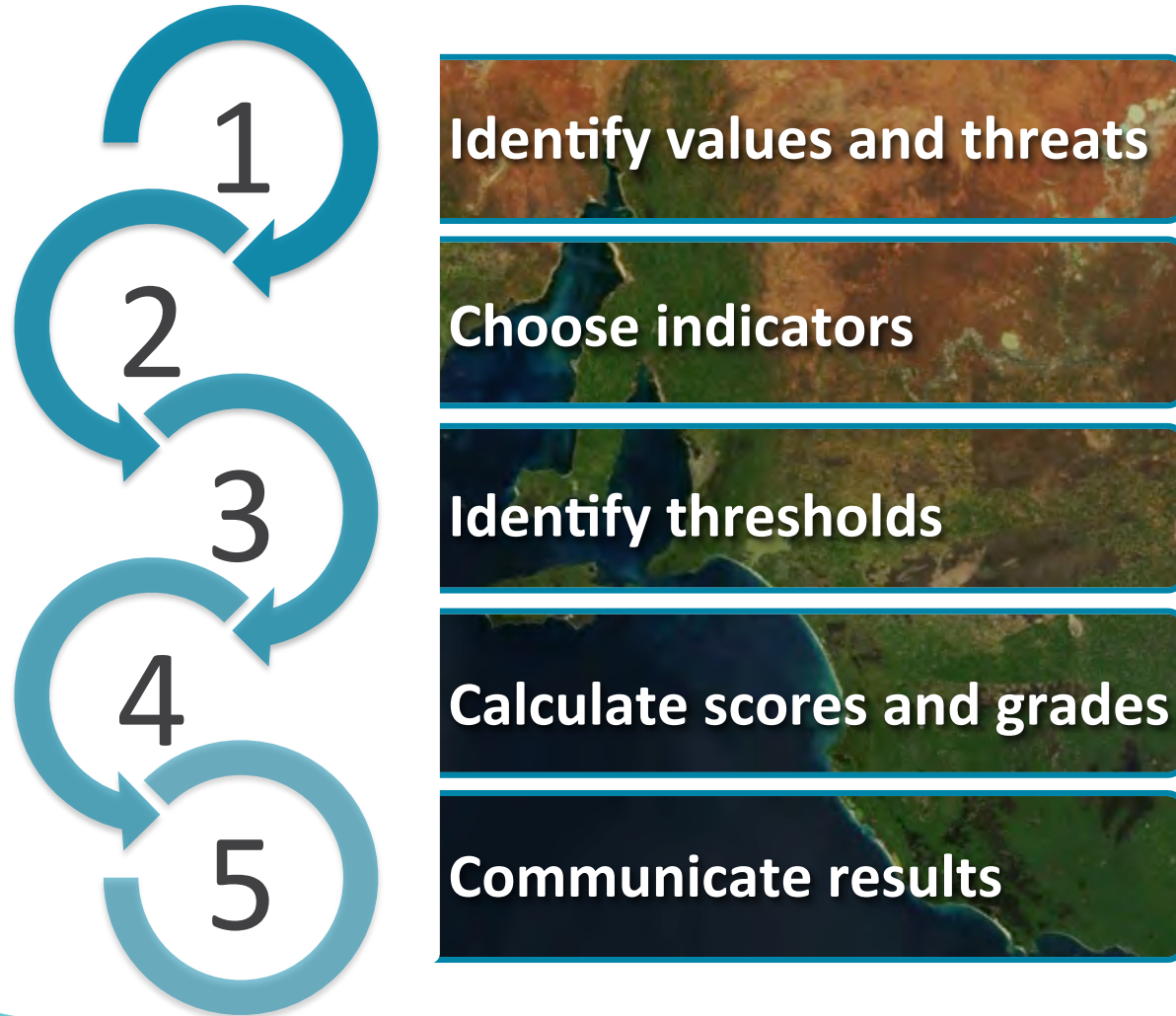


- Gradual change
- Reticence to change/sunset indicators
- Delay in reporting
- Graduation?

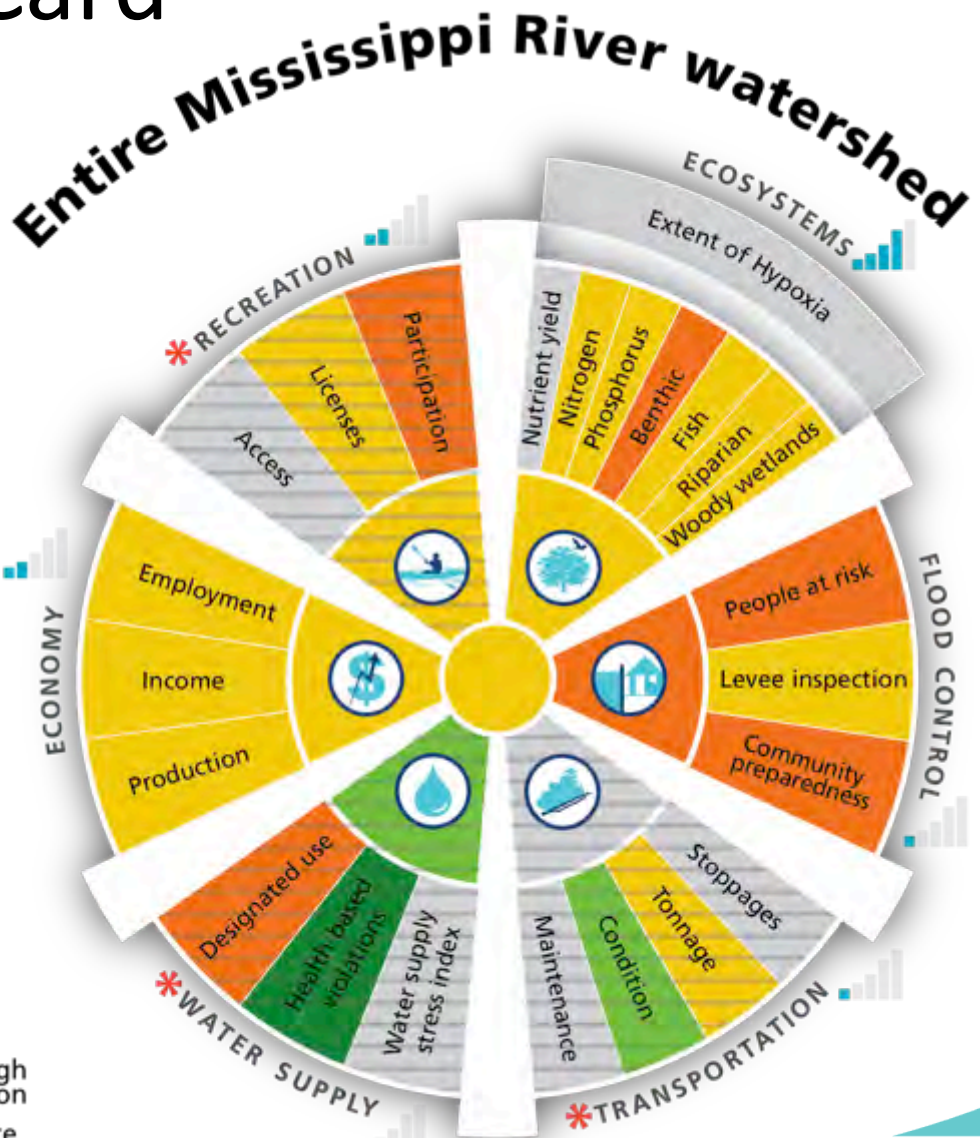
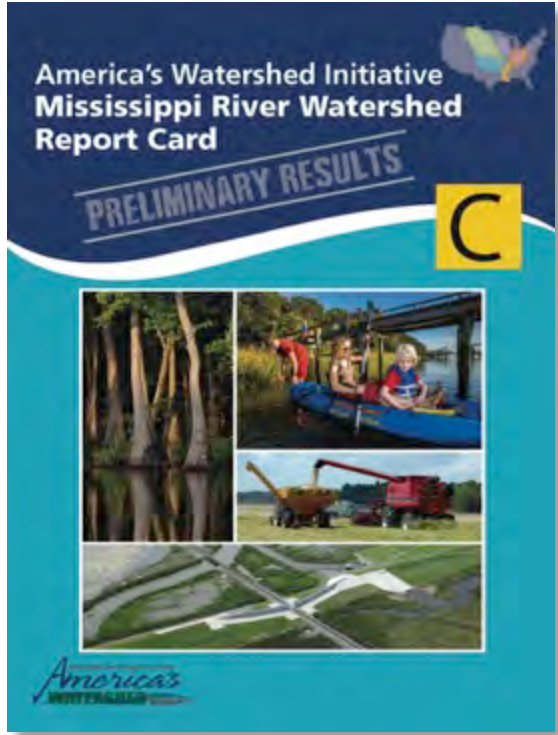
Moreton Bay, Australia

2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013

# In summary:



# Mississippi River Watershed Report Card



- Scoring system
- A
  - B
  - C
  - D
  - F
  - Not enough information
  - Incomplete analysis



# Mississippi River Report

## Card

Beautiful, productive, abundant water



The Ohio River Basin is the 200,000 square-mile eastern drainage of the Mississippi River watershed, covering an area from southwestern New York to northern Alabama, including parts of 14 states. The basin is dominated by forests, row crop agriculture, pastureland for livestock, and urban development. Due to its vast resources of coal and water, it is home to 29 million people and produces roughly 20% of the electricity in the United States. At the heart of the basin lies the Ohio River, a 981-mile resource that is one of the major industrialized rivers of the world. With the help of navigation dams, the Ohio hosts the largest inland port in the nation and moves more than 230 million tons of cargo per year. The river provides opportunities for industrial development, power production, commercial navigation, and widespread recreation. The river also serves as the source of drinking water for more than 5 million residents.

Industrialization and urbanization came at the expense of the river itself, as with most of the great rivers throughout the nation and world. Today, however, due to a conscious effort by state and federal agencies, nonprofit organizations, private businesses, and municipalities, the Ohio River combines economic and development opportunities with recreational and ecosystem goals.



Flow capacity for the Mississippi River in thousands of cubic feet per second, based on the 1956 project design flood. Graphic courtesy US Army Corps of Engineers.

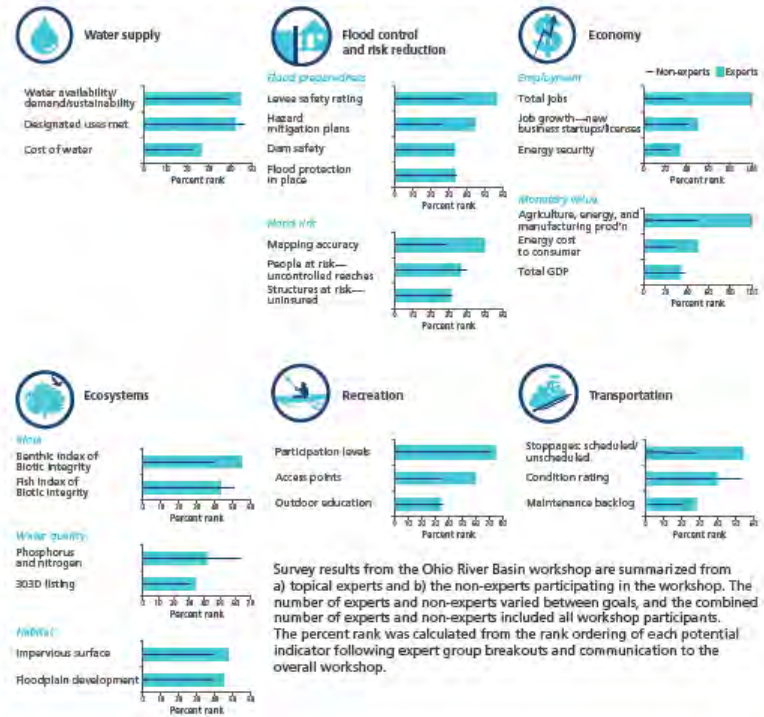
- Ohio Basin features**
  - Locks and dams
  - Shipling/navigation
  - Power plants
  - Reservoir tourism
  - Riverboat
  - Corn belt
  - Soy farming
  - Forested areas
  - Recreation
  - Water supply
  - Biodiversity
  - Animal feed lots
  - Cattle grazing
- Ohio Basin issues and threats**
  - Aging infrastructure
  - Combined sewer overflows
  - Habitat loss
  - Economic disparity
  - Stormwater
  - Flooding
  - Surface coal mining
  - Mountaintop mining
  - Hydraulic fracturing
  - Transportation corridors
  - Harmful algal blooms
  - Nutrients
- Underlying geology**
  - Karst
  - Coal
  - Uticin Mercallus shale formation



A conceptual diagram illustrates the main threats and key features of the Ohio River Basin.

### Potential indicators for the Ohio River Basin

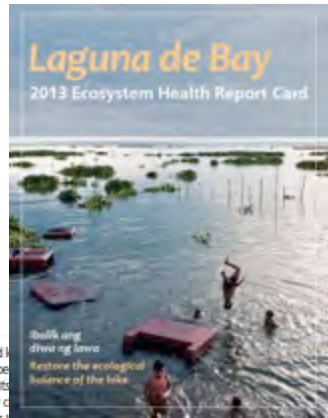
America's Watershed Report Card is designed to report on the status of achieving six broad goals developed at the America's Watershed Summit in September 2012. The goals were developed to reflect the things that people value in the watershed. Potential indicators for each goal were determined at the Ohio River Basin workshop. The final list of indicators will be determined by several factors, including data availability and how well they represent the goals.



This list of potential indicators is not intended to be comprehensive, but provides examples from what was generated at the workshop.



# Laguna De Bay Report



## 2013 Laguna de Bay ecosystem health report card

### LAGUNA DE BAY



Laguna de Bay scored a low passing mark, 76%, a C-, in water quality. The Lake consistently is within the Department of Environment and Natural Resources (DENR) guidelines for class C waters in DO, BOD, nitrate, and total coliforms. However, it scored 0% in chlorophyll a and 59% in phosphates. Water quality was affected by high population and industrialization.

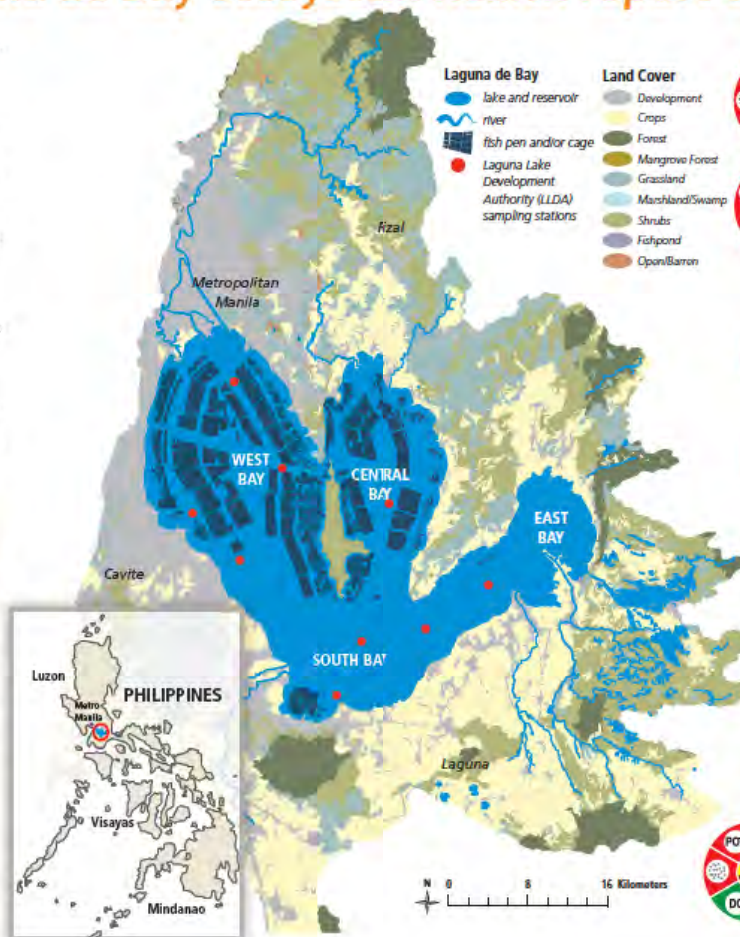
The Lake received an F in Fisheries (48%), with 53%, 68%, and 22% scores in fish native species composition, zooplankton ratio, and catch per unit effort (CPUE), respectively. Invasive fish species and competition among fisherfolk contributed to the low scores.

Even though the DENR guidelines are met in most water quality indicators, the chlorophyll a, phosphates, and zooplankton ratio scores show that the Lake is highly eutrophic. These results have a negative impact on the fisheries of Laguna de Bay. Overall, these scores are not only a cause of concern for fisheries, but the whole community and all the industries supported by the Lake.

### How are the scores calculated and what do they mean?

The 2013 Laguna de Bay report card measured indicators for water quality and fisheries for the West, Central, East, and South bays. Six water quality indicators were compared to the Department of Environment and Natural Resources (DENR) guidelines for class C waters (suitable for fisheries and recreation) which were then combined and represented as a percent score for each bay. The three fisheries indicators were calculated as ratios or percentages that are then combined as a percent score for each bay. The grading scale follows the typical scale used in Philippine universities.

- A** 91-100%: All the indicators meet desired levels. Quality of water in these locations tends to be very good, most often leading to preferred habitat conditions for aquatic life.
- B** 83-91%: Most indicators meet desired levels. Quality of water in these locations tends to be good, often leading to acceptable habitat conditions for aquatic life.
- C** 75-83%: There is a mix of good and poor levels of indicators. Quality of water in these locations tends to be fair, leading to sufficient habitat conditions for aquatic life.
- D** 70-74%: Some or few indicators meet desired levels. Quality of water in these locations tends to be poor, often leading to degraded habitat conditions for aquatic life.
- F** 0-70%: Very few or no indicators meet desired levels. Quality of water in these locations tends to be very poor, most often leading to unacceptable habitat conditions for aquatic life.



### WEST BAY



The West Bay has the second lowest water quality score. It is the most heavily developed and the most populated. For 2013, it is within DENR's guideline for class C coliforms at 98%. However, it has the lowest score in phosphates (56%) and like all the bays, received a 0% in chlorophyll a. This score reflects its high population density and the need to reduce phosphorus runoff into the Lake.

The West Bay has the second highest fisheries score of 55% (F), with a 62% score in zooplankton ratio, CPUE (35%), and the second highest score in native fish species composition at 68%. This region has the highest concentration of commercial fish pens and cages, and an estimated fishing ground allocation of 1 fisher/101 hectares (ha).

### CENTRAL BAY



The Central Bay has the lowest water quality score at 71%, however, its 65% score in Fisheries is the highest of all bays. Although it scored 100% in nitrate, DO, BOD, and total coliforms, it had the lowest score in phosphates with 25%, and a 0% in chlorophyll a.

The Central Bay has the highest in percentage of native fish in catch composition and zooplankton ratio, with scores of 68% and 100%, respectively. It has approximately 1 fisher/110 ha of fishing ground allocation.

### EAST BAY



The East Bay has the highest water quality score at 81%. It received an A in all water quality indicators except for chlorophyll a (0%, an F). However, the East Bay scored the lowest in fisheries with 28%, scoring a mere 3% for CPUE.

East Bay has a higher number of fishermen operating in a smaller fishing area with a fishing ground allocation of only 1 fisher/28 ha and the highest concentration of the invasive clown knife fish. This species was introduced in the Lake through the East Bay and most likely propagated faster because of the East Bay's water quality.

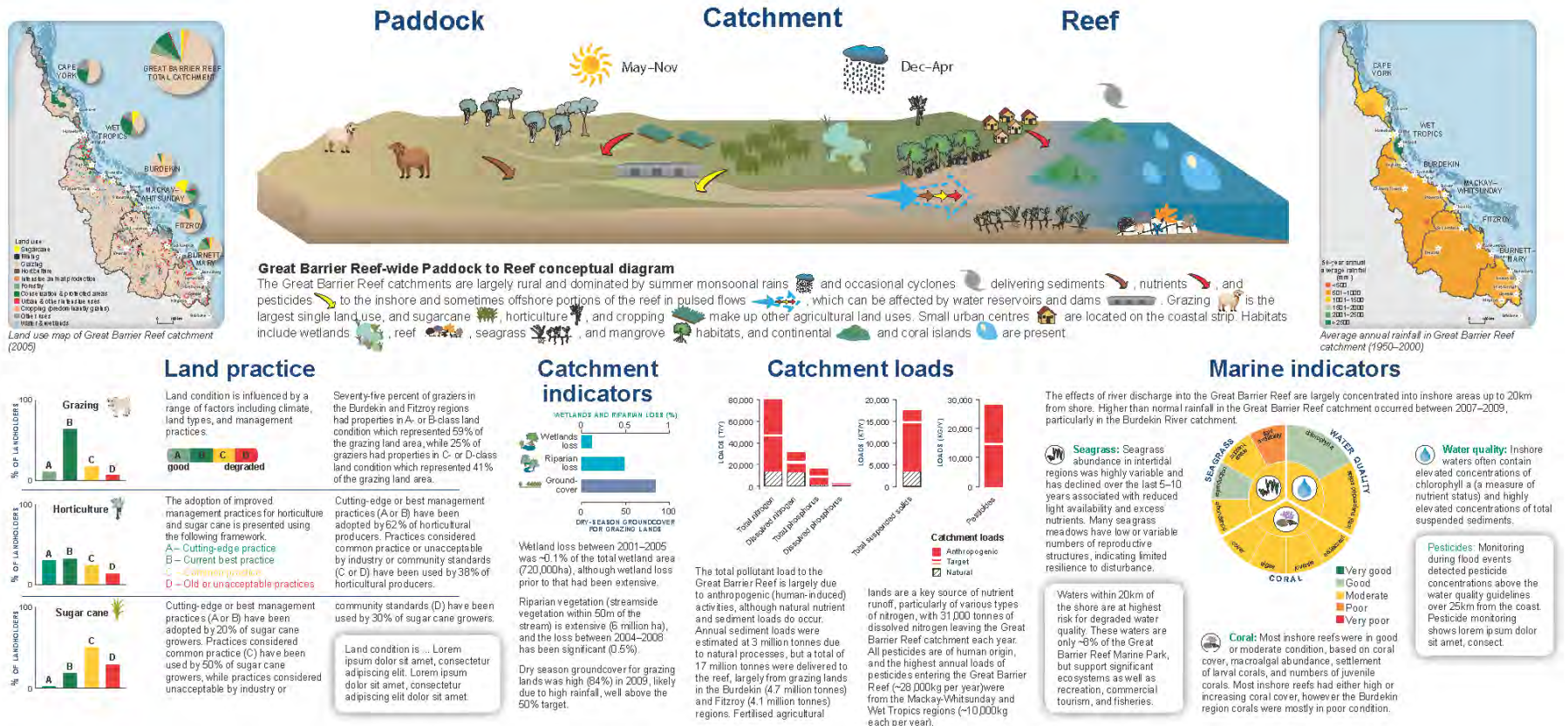
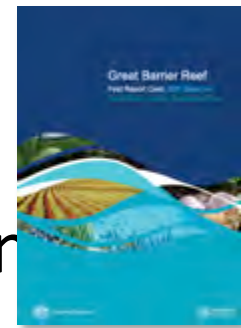
### SOUTH BAY



The South Bay has the second highest score in water quality at 77%, with 100% in nitrates, DO, BOD, and total coliforms. Like all the bays, it has a 0% in chlorophyll a and an F in phosphates at 62%. It had the second lowest score in fisheries, 43%, with the lowest score in native fish species composition at 37% even though a designated fish sanctuary is located within the South Bay.

# Great Barrier Reef

## Report Card Evolution of report cards to include pressure and response indicators



# Chilika Lake Report Card



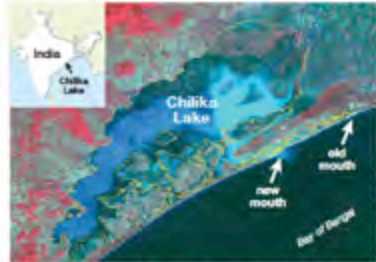
## Calculating the ecosystem grade for Chilika Lake

Chilika Lake was divided into four reporting zones, each of which received a report card grade. The grades were calculated from the average of water quality, fisheries, and biodiversity indices, comprised of data collected over the 2011-2012 period. On-going monitoring will allow grades to be updated on a periodic basis, providing a means to track change over time.

### What do the grades mean? \*

- A** 90-100%. All water quality and biological health indicators meet desired levels. Quality of water in these locations tends to be very good, most often leading to very good habitat conditions for fish and shellfish.
- B** 60-80%. Most water quality and biological health indicators meet desired levels. Quality of water in these locations tends to be good, often leading to good habitat conditions for fish and shellfish.
- C** 40-60%. There is a mix of good and poor levels of water quality and biological health indicators. Quality of water in these locations tends to be fair, leading to fair habitat conditions for fish and shellfish.
- D** 20-40%. Some or few water quality and biological health indicators meet desired levels. Quality of water in these locations tends to be poor, often leading to poor habitat conditions for fish and shellfish.
- F** 0-20%. Very few or no water quality and biological health indicators meet desired levels. Quality of water in these locations tends to be very poor, most often leading to very poor habitat conditions for fish and shellfish.

\* Grades denoted with a + or - indicate a score that is within 2% of a score's high or low boundary. For example, a B+ is indicative of 79-80%.



Until recently, Chilika Lake suffered from increasing sediment loads and reduced connectivity with the sea. In 2002, a new mouth to the Bay of Bengal was opened. This hydrological intervention helped improve salinity levels, enhance fish landings, decrease the size of invasive species, as well as improve water quality overall.

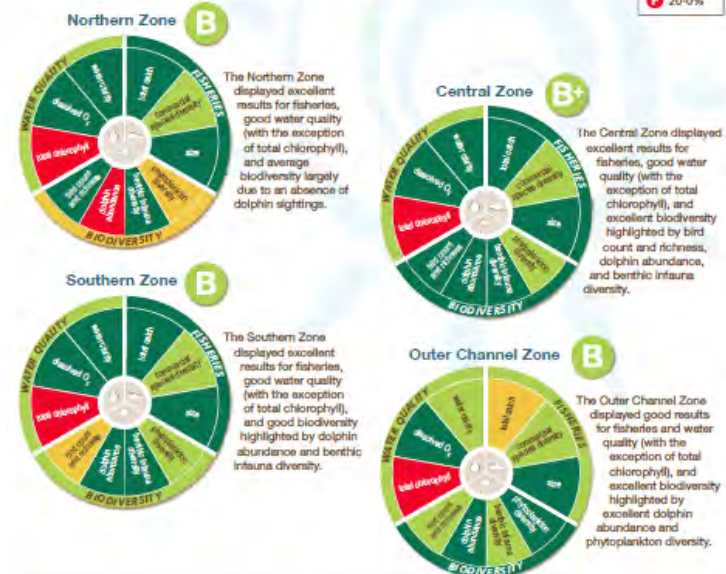


## Chilika Lake 2012 Report Card

Overall, Chilika Lake scored a **B** for ecosystem health based on performance of water quality, fisheries, and biodiversity indices.

The Lake as a whole displayed excellent (A) dissolved oxygen concentrations, water clarity, total fishery catch and size, and benthic infauna diversity. The Lake failed, however, for total chlorophyll concentrations (F), based on desired conditions. Of the ten indicators that were assessed within water quality, fisheries, and biodiversity, 79% (B+) in the Central Zone, followed by 76% (B) in the Southern Zone, 71% (B) in the Outer Channel Zone, and 69% (B) in the Northern Zone. A breakdown of these indicators by zone is provided below.

- A** 80-100%
- B** 60-80%
- C** 40-60%
- D** 20-40%
- F** 0-20%



## There's more to this story: Salinity

The four zones used in this Chilika Lake Report Card are based mostly on salinity variations that occur within the Lake. Salinity in the Lake is driven by freshwater river flow from the north and west, and tidal seawater from the east and south. This results in a variation of salinity in the Lake, from freshwater in the north, brackish waters in the center and south, and full saline waters to the east around the islands and outer channel. The boundaries between these zones shift throughout the year, driven by monsoonal rains and seasonal winds.

During the 1990s, extensive siltation in the Lake was limiting access to the sea, reducing tidal flushing and decreasing salinity to such an extent that biodiversity declined and invasive aquatic weeds proliferated. This had a highly negative impact on the Lake's habitat for wildlife and fishery resources. In 1992, it was included in the Montreux Record by Ramsar due to change in the ecological character. In 2000, CDIA opened a new mouth to restore the lake ecosystems. This new opening increased salinities throughout the Lake, vastly improving water quality, recovering lost habitat for important species, enhancing fish resources, and controlling invasive species. Lake salinity and connectivity to the sea are now closely monitored to ensure that conditions do not return to those experienced prior to 2000. The lake was removed from the Montreux Record due to restoration of the lake ecosystem in 2002.

# Gulf of Mexico Report Card

- DPSSIR framework
- Multinational effort



## Example component: Birds

## Report card prototype

## Example component: Seagrass ecosystems



Brown Pelican population over time in Florida, Louisiana, and Texas (John et al. 2002).

**Gulf of Mexico birds**  
The Gulf of Mexico is a major flyway for migratory birds that provides essential stopover habitat along three migratory pathways. The Gulf has large, undisturbed, and diverse areas of coastal habitats that provide breeding and wintering habitat for shore birds, marsh birds, frigate birds, and waterfowl. These habitats support internationally significant populations of birds including Brown Pelican, American Flamingo, Redhead, Whooping Crane, Sooty Tern, and Snowy Plover. Representative bird species associated with different habitats can be effective indicators of Gulf ecosystem health.

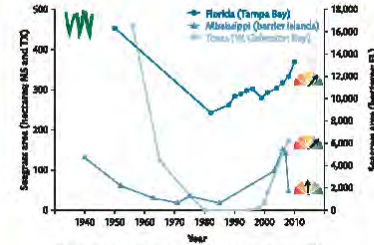
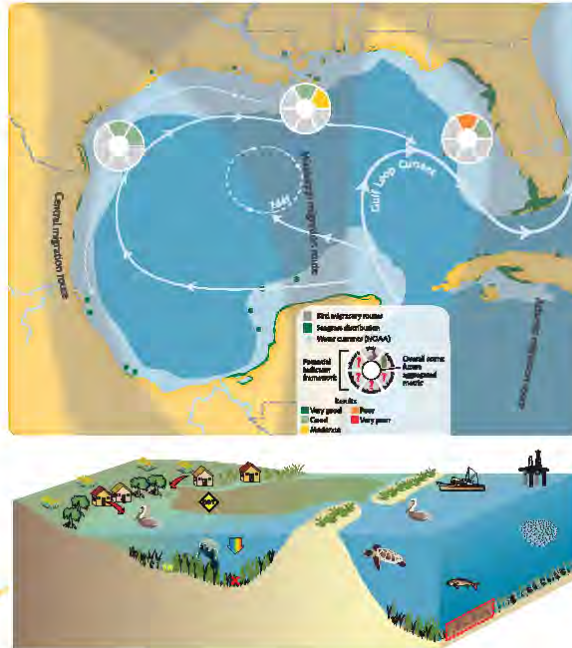
With the listing as an endangered species (1970), the ban on DDT (1972), and effective management, the number of breeding pairs in the northern Gulf increased to 20,000–25,000 by the end of the 1990s. Brown Pelicans were removed from the endangered species list in Alabama and Florida in 1985, and in Mississippi and Texas in 2009. However, Brown Pelicans continue to be adversely impacted by human activities which have resulted in the decline of the Florida population since 1989 to levels approaching those seen in the 1960s, although the specific causes are presently unknown. The fully developed Report Card will provide indicators of both the ecological health of the Brown Pelican and the human activities and stressors affecting them. This Brown Pelican example illustrates the importance of the Gulf of Mexico Report Card in characterizing the causal links between human activities and ecological health and thereby informing decisions to achieve sustainability.

**Brown Pelican trends**  
The Brown Pelican is an iconic symbol of the Gulf of Mexico and important indicator of the effects of human activities on Gulf ecosystem health. An estimated 25,000 Brown Pelicans nested along the Gulf Coast in the early 20th Century but populations began declining in the 1950s because of human disturbances. By the end of the 1960s, direct and indirect effects of DDT and dieldrin had resulted in catastrophic population declines, with Florida having the only remaining significant breeding population in the Gulf of Mexico.

**Birds as Indicators**  
Population patterns of bird species can be effective indicators of environmental

health because they utilize a wide range of habitats within the Gulf of Mexico. With input from the avian science community, we envision developing indicators for key species representing colonial water birds, waterfowl, marsh, beach, shore, wetland, and pelagic sea birds. These key species will serve as indicators for health of their particular habitats by reflecting the pressures and stressors acting upon them, such as coastal development and habitat alteration, human disturbance of nests and colonies, food availability, hunting, and contaminants. Metrics describing the health of bird populations will expand upon those described here for the Brown Pelican, and new indicators will be developed. Finally, a key element of the Gulf of Mexico Report Card framework is to develop new integrative metrics that characterize the pressures and stressors impacting on birds and their habitats.

Contaminants, in particular DDT, reduced Brown Pelican populations prior to the chemical being banned in the USA in 1972. Brown Pelican populations rebounded, but habitat alterations continue to be a threat to the population.



Seagrass area over time in Mississippi, Texas, and Florida (Hoadley et al. 2002; Carter et al. 2005; W. Pulich pers. comm.).

**Gulf of Mexico seagrass ecosystems**  
Seagrass ecosystems are a dominant habitat in shallow waters throughout the Gulf of Mexico and are essential to its health and integrity. Expansive seagrass meadows provide an important refuge, supporting recreational and commercial fisheries. Unfortunately seagrass ecosystems are often threatened by increased nutrient inputs and other stressors, e.g. dredging, coastal development. Thus the health of seagrass ecosystems provides an important indicator of the health of the Gulf of Mexico at both local and Gulf-wide scales.

**Seagrass trends**  
Progressive deterioration of seagrass beds has occurred around the Gulf but notable recoveries exist in some areas (illustrated)

Urban development and agriculture runoff lead to turbidity and nutrient inputs into shallow coastal waters. Excess nutrients reduce seagrass species diversity and subsequently spread around the Bay. Shallowly, Tampa Bay, Florida, seagrasses experienced a widespread loss in a



rapidly urbanized watershed post World War II. The critical stressor was excessive nitrogen inputs from sewage discharges into Tampa Bay but beginning in the 1990s, major improvements to sewage treatment plants reduced nitrogen inputs by 90%, leading to clearer water and ongoing recovery of seagrasses. At present, nitrogen inputs come from stormwater runoff and air pollution from power plants and automobiles. The Tampa Bay National Estuary Program was established in 1991 to further improve seagrass ecosystem health, focusing not only on nitrogen inputs but also reducing toxic pollutants, restoring and protecting seagrass habitats, and reducing dredging and other physical stressors.

**Seagrass ecosystems as indicators**  
Many features of seagrass ecosystems can serve as indicators in addition to areal coverage. Seagrass species composition can be an indicator, e.g. comparing a stressor-specific meadow like turbot grass to a mixture that includes other Gulf of Mexico species. Animals using seagrasses as a habitat (e.g. shellfish, reef fish) can be indicators. Because seagrasses are closely linked to water quality, particularly the underwater light regime, water quality metrics like chlorophyll and turbidity can be appropriate indicators. Seagrass ecosystems provide important services that also could be indicators, including primary and secondary production, carbon and nutrient sequestration, erosion protection, and recreational fishing.

1.	2.	3.	4.	5.
Conceptual framework	Indicators	Thresholds	Calculate scores	Communicate results



## Chesapeake Bay (Chesapeake 2000 Agreement)

- Values to protect
  - *Fisheries (fish, oysters and crabs)*
  - *Recreation*
  - *Tourism*
- Threats
  - *Sewage*
  - *Urban and agricultural runoff*
  - *Overfishing*
  - *Loss of habitat*

1.  
Conceptual  
framework
2.  
**Indicators**
3.  
Thresholds
4.  
Calculate  
scores
5.  
Communicate  
results

## Report card indicators elsewhere

Report Card	Indicators
Chesapeake Bay	<p><b>Pre 2012</b> = BIBI, PIBI, aquatic grasses, DO, Chlorophyll, water clarity,</p> <p><b>Current</b> = BIBI, aquatic grasses, DO, chlorophyll, water clarity, TN, TP, Blue Crabs, Bay Anchovy</p>
Chilika Lake	<p><b>Water Quality</b> = Chlorophyll, DO, water clarity,</p> <p><b>Biodiversity</b> = Bird richness and abundance, dolphin abundance, benthic infauna diversity,</p> <p><b>Fisheries</b> = total fish catch, fish diversity and fish size</p>
Moreton Bay	<p><b>Bay</b> =</p> <p><b>Rivers</b> =</p>
Laguna de Bay	????

1. Conceptual framework
2. Indicators
3. **Thresholds**
4. Calculate scores
5. Communicate results

## Chesapeake Bay Thresholds (can be seasonal and vary geographically)



Chlorophyll *a*:  $\leq 2.8$  to  $\leq 20.9 \mu\text{g L}^{-1}$  <sup>(3)</sup>



Dissolved oxygen:  $\geq 1.0$  to  $\geq 5.0 \text{ mg L}^{-1}$  <sup>(4)</sup>



Water clarity:  $\geq 0.65$  to  $\geq 2.0 \text{ m Secchi depth}$  <sup>(3)</sup>



Bay grasses: Hectares <sup>(2)</sup>



Benthic community:  $\geq 3$  Benthic IBI <sup>(5)</sup>



Phytoplankton:  $\geq 3$  Phytoplankton IBI <sup>(6)</sup>