CALCULATING THE 2006 CHESAPEAKE BAY REPORT CARD SCORES

Ecosystem health report cards are an effective means of tracking and reporting the health of a waterway at both local and regional scales. A report card is being developed within the Chesapeake Bay science and management community in order to provide a transparent, timely, and geographically detailed annual assessment of Chesapeake Bay habitat health. This newsletter summarizes the methods and data used to calculate the report card scores for 2006.

MEASURING PROGRESS TOWARDS BAY HEALTH

Chesapeake Bay health has been affected by elevated nutrient and sediment loads, resulting in water quality and biotic (biological) degradation (Figure 1). For the report card, Chesapeake Bay health is defined as the progress of six indicators towards established ecological thresholds. The three water quality indicators are chlorophyll *a*, dissolved oxygen, and water clarity, and the three biotic indicators are bay grasses (submerged aquatic vegetation), Benthic Index of Biotic Integrity (soft bottom only), and Phytoplankton Index of Biotic Integrity.

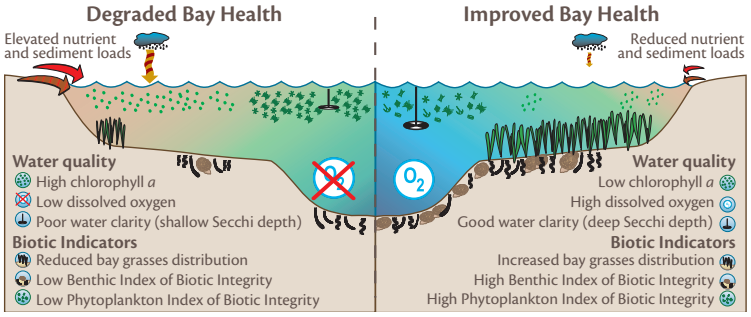


Figure 1: Comparison of water quality and biotic indicators in a degraded and improved Bay ecosystem.

Indicators for the Chesapeake Bay Habitat Health Index were chosen so that they would relate to the management objectives established in the Chesapeake 2000 Agreement, represent key ecological processes, and fulfill practical requirements such as data availability and geographic coverage. The goal of improved Bay health through nutrient and sediment reductions should result in the indicators meeting established ecological thresholds (Figure 2). Threshold values were established for each indicator based on published scientific literature and technical reports. Measuring progress towards thresholds allows for both combining diverse indicators into indices and comparison between Bay regions.

Monitoring data were assessed against the threshold values by determining the percentage of samples passing the thresholds over the period of interest.[1] Bay grasses were assessed as the proportion of the restoration goal present.[2] The Bay was divided into 15 reporting regions (Figure 3) and the average of the 3 water quality indicators was used to generate the Water Quality Index, and the average of the 3 biotic indicators used to generate the Biotic Index. The Chesapeake Bay Habitat Health Index was determined by averaging the Water Quality and Biotic Index values for each reporting region (Figure 2).

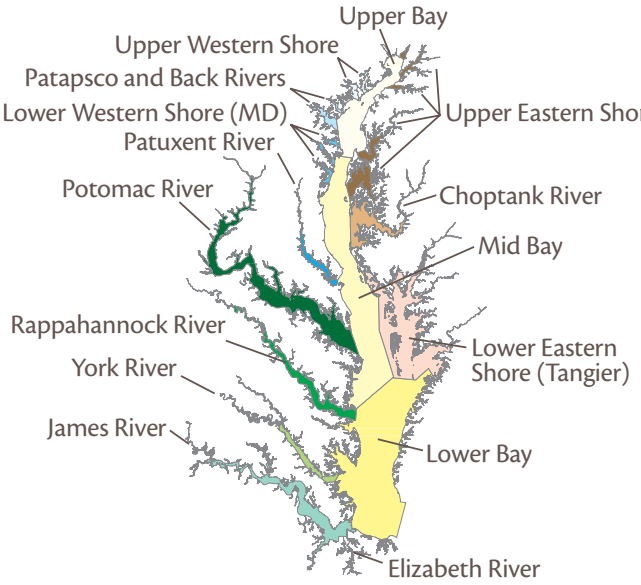
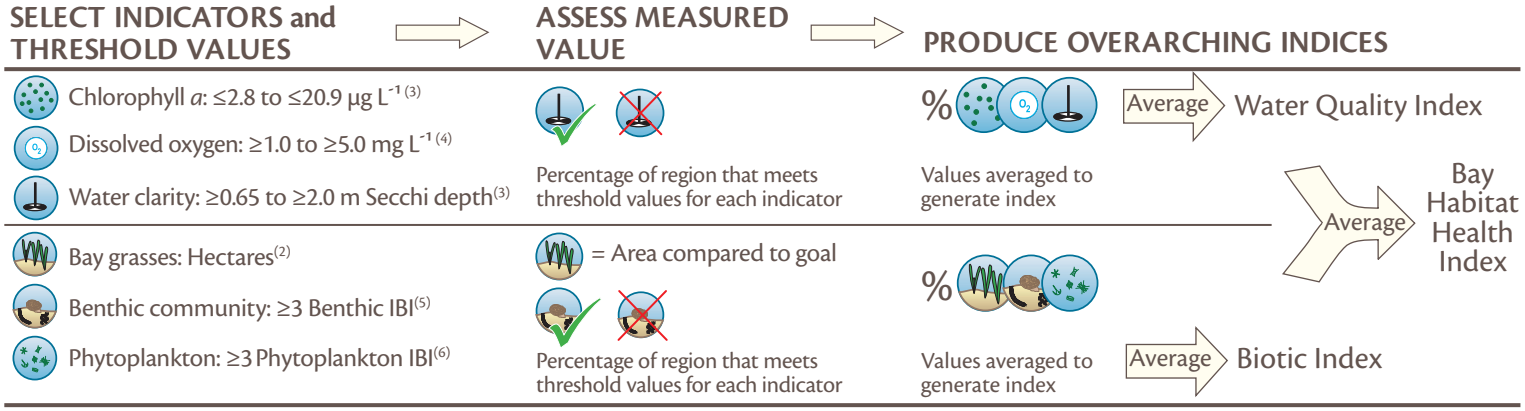


Figure 3: Chesapeake Bay reporting regions.

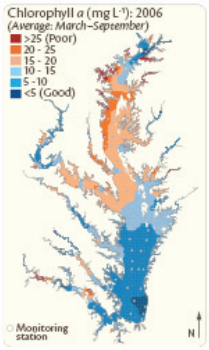


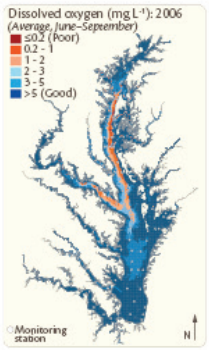
(number) = see backpage for referenced literature

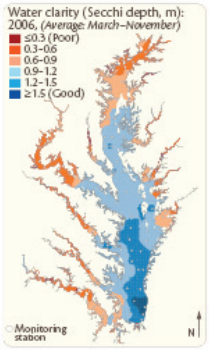
Figure 2: Approach to determining the Water Quality, Biotic, and Bay Habitat Health Indices.

WATER QUALITY INDEX ⟹ BAY HABITAT HEALTH INDEX ⟸ BIOTIC INDEX

1. Collect data

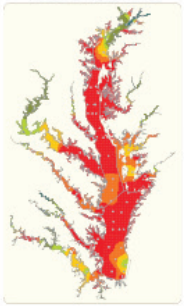




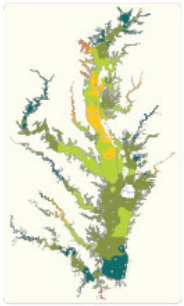


2. Compare to threshold

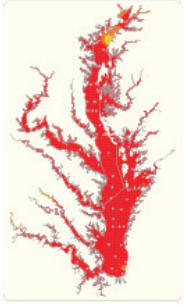
Chlorophyll a



Dissolved oxygen



Water clarity



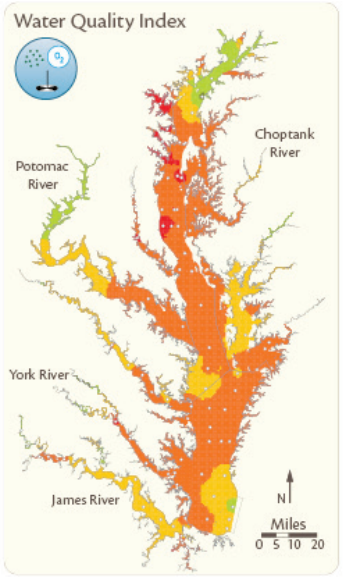
Habitat health scale

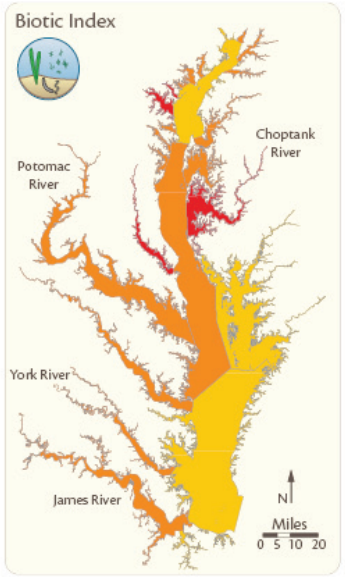
Unhealthy habitat ⟵ Healthy habitat

0 20 40 60 80 100%

Insufficient data

3. Combine into index



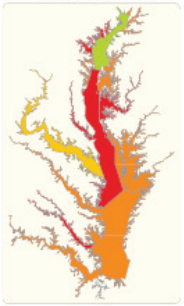


4. Average into overall index

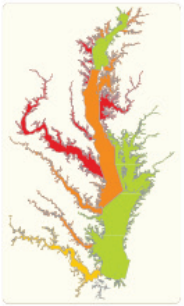
The Bay Habitat Health Index was calculated by averaging the Water Quality Index and Biotic Index scores for each reporting region (right). www.eco-check.org/reportcard/chesapeake/

2. Compare to threshold

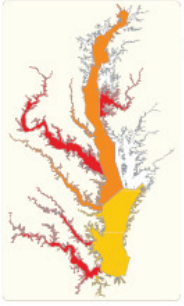
Bay grasses



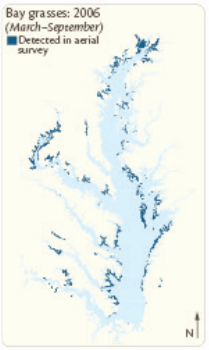
Benthic Index of Biotic Integrity

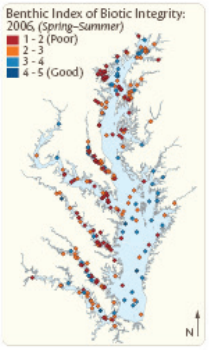


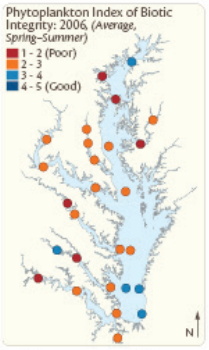
Phytoplankton Index of Biotic Integrity



1. Collect data







1. Water quality was measured at 144 sites, with a maximum of 13 times per period of interest. Spatial interpolations of average water quality conditions were produced to show spatial variability. 2. The frequency that each water quality parameter exceeded established thresholds at each station was then calculated and mapped.[1] 3. For each sampling station, the frequency that each indicator exceeded the threshold was combined into a single score, the Water Quality Index (WQI), and then mapped. The Water Quality Index was calculated by averaging the area weighted scores for water clarity, dissolved oxygen, and chlorophyll *a* for each reporting region (see Figure 2 on page 1).

1, 2. The distribution of bay grasses is estimated each year using aerial surveys. The area (hectares) of bay grasses relative to the restoration goal is calculated for each reporting region. Samples for assessing benthic community were collected at approximately 300 sites over the spring and summer.[5] The area of the reporting region exceeding the Index of Biotic Integrity (IBI) threshold was calculated. Samples for assessing the phytoplankton community were collected at approximately 25 stations, 12–13 times during spring and summer.[3,6] The frequency that the Phytoplankton Index of Biotic Integrity score exceeded the threshold was calculated for each reporting region. 3. The Biotic Index was calculated by averaging the area weighted scores for bay grass, Benthic IBI, and Phytoplankton IBI for each reporting region (see Figure 2 on page 1).

TESTING THE SENSITIVITY OF THE WATER QUALITY INDEX

The Water Quality Index (WQI) needs to be sensitive to changes in the amount of nutrients delivered to the Bay so that future changes in management actions can be detected. To do this, the Index was tested by comparing a low flow/low nutrient year (2002) with a high flow/high nutrient year (2003) (Figure 4). The year 2002 approximated the 175 and 12.8 million pound restoration goals for nitrogen and phosphorus loads, respectively, to the Bay. 2003 is approximately >2.5x and >8x these restoration goals. The methods and thresholds used to calculate WQI scores proved to be sensitive to nutrients. For example, the 2002 score was substantially higher than the 2003 score for the Choptank, James, and Mid Bay regions. However, some regions did not show distinct differences between the two years (e.g., Patapsco and Back, and York Rivers), perhaps illustrating that factors other than flow and nutrients play a larger role in the health of these systems.

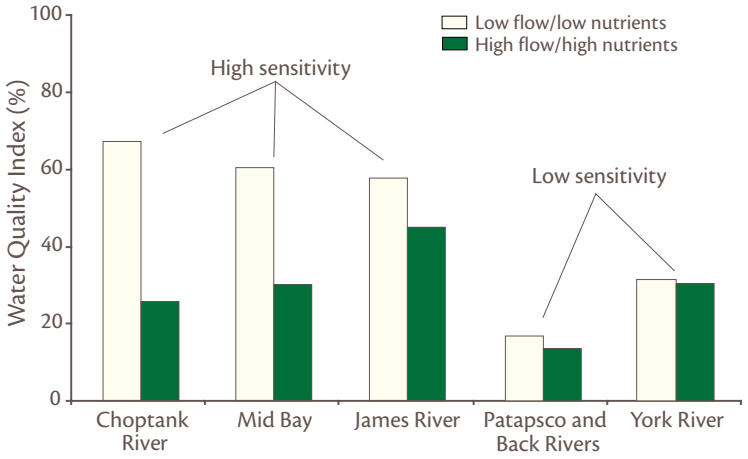
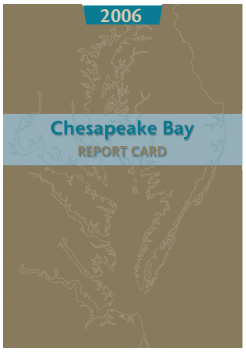


Figure 4: Comparison of WQI scores for low flow/low nutrients to high flow/high nutrients for five regions of Chesapeake Bay.

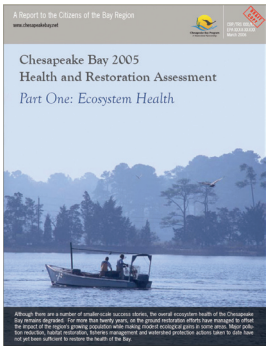
COMPARING HEALTH REPORTS

The Chesapeake Bay report card is unique in that it provides a geographically detailed and integrated approach to form numerical rankings of 15 reporting regions on an annual basis. This approach compliments those focusing on Bay-wide assessment over longer time frames. The geographic detail provided in the report card reflects the complexity of Chesapeake Bay and its tributaries, and provides information that can help guide and focus restoration efforts. The report card is a developing product, with a more complete assessment of Bay health expected in the future. Future report cards will aim to include indicators of fish and shellfish status at suitable spatial scales and time frames.



Chesapeake Bay report card

- Bay and tributary specific assessment using six indicators
- Integrated into an index
- Provides assessment for the past year only
- Numerical rankings of reporting regions
- Continued development and refinement required



Chesapeake Bay health and restoration assessment

- Bay-wide assessment using 13 indicators
- Provides assessment for the past 20 years
- Numerical ranking of Bay-wide indicators
- Continued development and refinement required

This newsletter uses data collected by various Chesapeake Bay Program partners reporting to the Monitoring and Analysis Subcommittee (MASC). Members of the Tidal Monitoring and Analysis Workgroup and Living Resources Analysis Workgroup have done the majority of the data analyses. We would like to acknowledge the following organizations for the extra effort taken in providing data in a timely fashion: Virginia Institute of Marine Science aquatic grass survey team, Versar Incorporated, Maryland Department of Natural Resources, Virginia Department of Environmental Quality, Morgan State University, and Old Dominion University.

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1. Williams *et al.* (2007) www.eco-check.org/reportcard/chesapeake/
2. U.S. Environmental Protection Agency (2003) EPA 903-R-03-004.
3. Buchanan *et al.* (2005) *Estuaries* 28:138-159.
   Lacouture *et al.* (2006) *Estuaries and Coasts*: 29(4): 598-616.
4. U.S. Environmental Protection Agency (2003) EPA 903-R-03-002.
5. Llanso (2002) www.baybenthos.versar.com/referenc.htm
6. Chesapeake Bay Program. www.chesapeakebay.net/assess/methods

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