Producing the Chesapeake Bay (and Moreton Bay) ecosystem health report card

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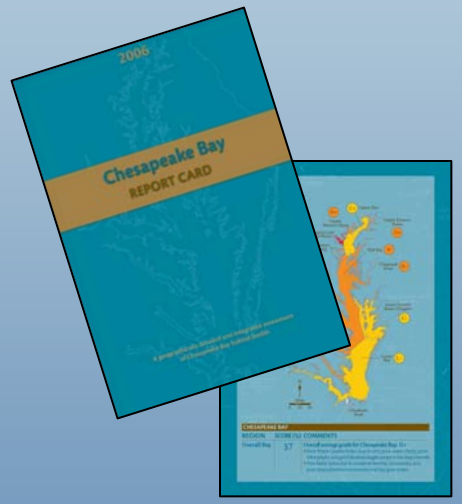


Integration & Application Network

CHESAPEAKE EcoCheck

www.eco-check.org

Chesapeake Bay Program

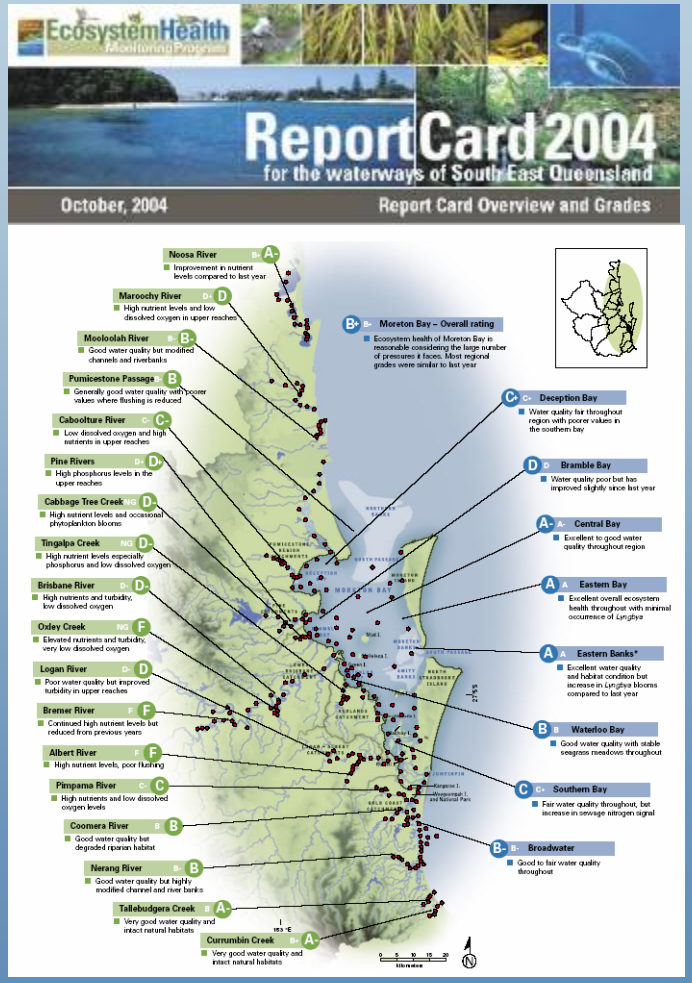
A Watershed Partnership

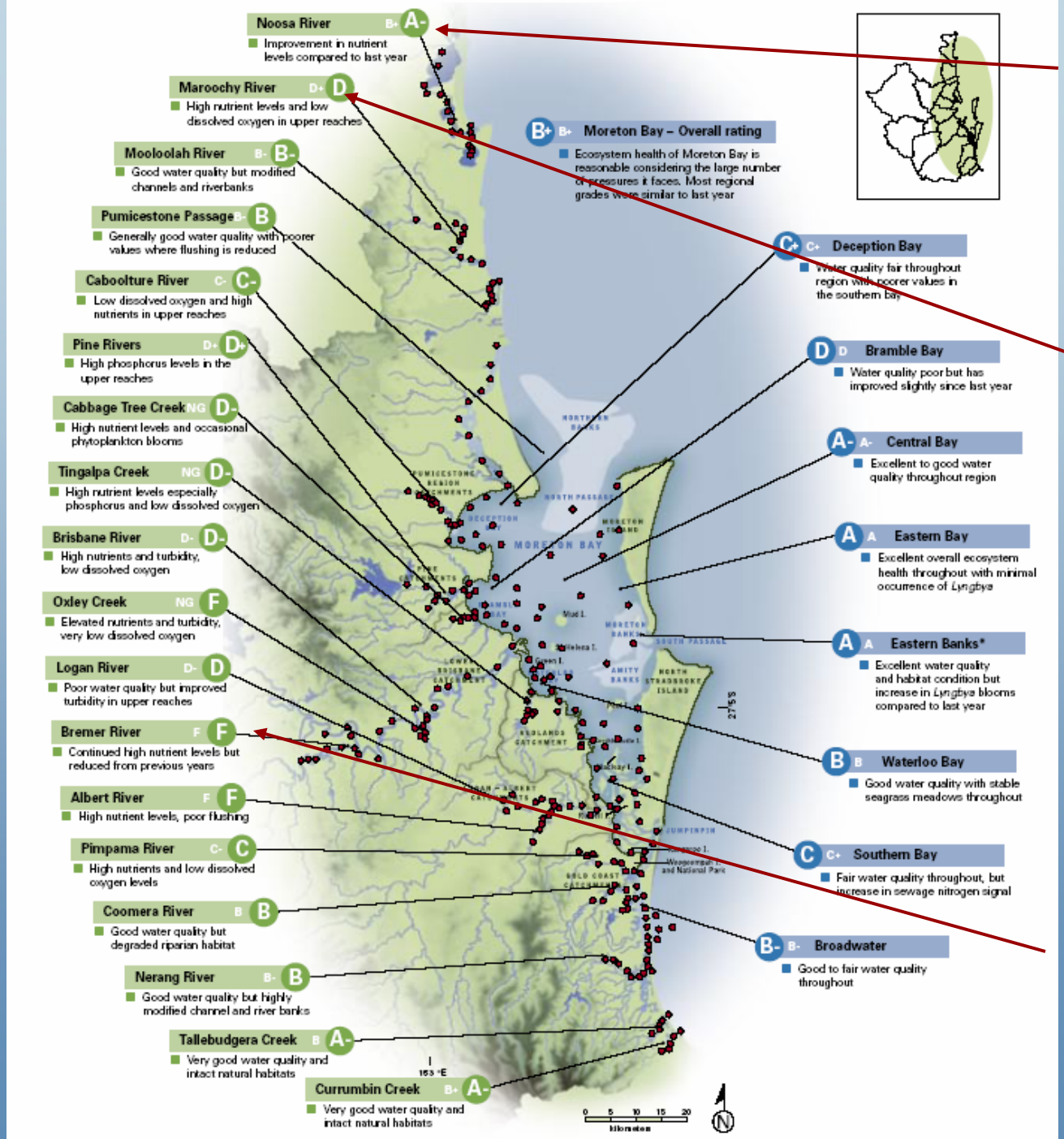
Overview

- The Moreton Bay experience (condensed!)
- Chesapeake Bay Report card
  - Background
  - Methods development
  - 2006 report card

Moreton Bay Report Card

- Grades all waterways from ‘A’ (Excellent) to ‘F’ (Fail)
- Annual release since 1999
- The most important tool for evaluating and communicating health of the regions waterways Directed / focused management action
- Impetus for some costly (but environmentally important) intervention





"A" rating used to promote the regions as a place to visit

Poorly operated treatment plant identified as cause of downgrading from a C to D. Treatment plant problems fixed and grade starts to improve in subsequent years

Report card highlights river health as worst in region. River becomes focus of major study and efforts to reduce pollution.

Ongoing program of improvement and expansion

2001

- Grades based on expert assessment of data
- Focus on Bay region
- ~7 local governments

2002

- Grading methods being developed
- Expand to northern region
- ~11 local governments

2003

- 80% of grades based on index
- Expand to south
- 11 local governments

2004

- 95 % of grades based on an index
- Expanded to watershed
- 20 local governments

SEQRWQMS water quality objectives

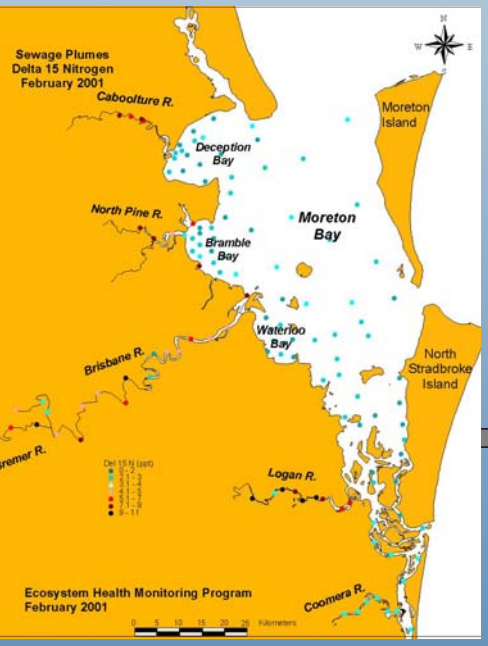
Performance Indicator	Performance measure	Bay Objective	Estuary Objective	Sample frequency
$\delta^{15}N$ (macroalgae)	Annual maximum	<4 ppt	NA	Annual
Chlorophyll-a	Annual median	<1 µg/L except Bramble, Waterloo, Deception and southern Moreton Bay <2 µg/L	<10 µg/L	Monthly
Total nitrogen	Annual median	< 0.22 mg/L or 15.7 µM	< 0.45 mg/L or 32.1 µM	Monthly
Total phosphorus	Annual median	NA	< 0.06 mg/L or 1.9 µM	Monthly
Dissolved oxygen	Annual median	NA	Between 80 to 100%	Monthly
Secchi	Annual median	> 1.7 m	NA	Monthly
Turbidity	Annual median	NA	<20 NTU	Monthly
Lyngbya	Annual maximum	<0 % cover	NA	Variable

NA = Not Applicable

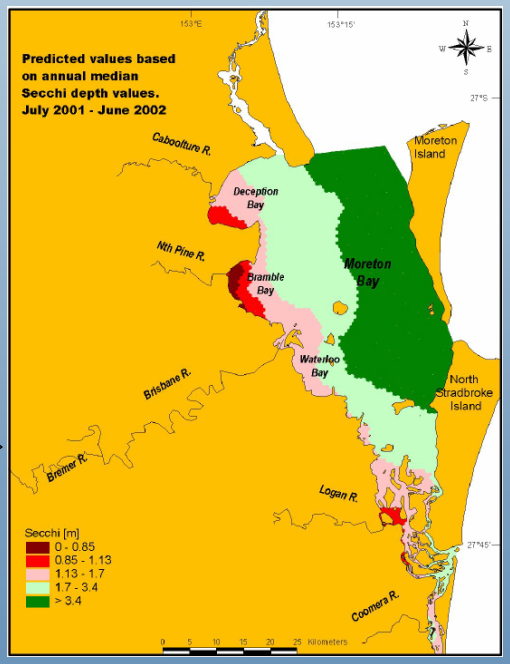
Ecosystem Health Index (80%)

Proportion of the waterways area that complies with the established objectives

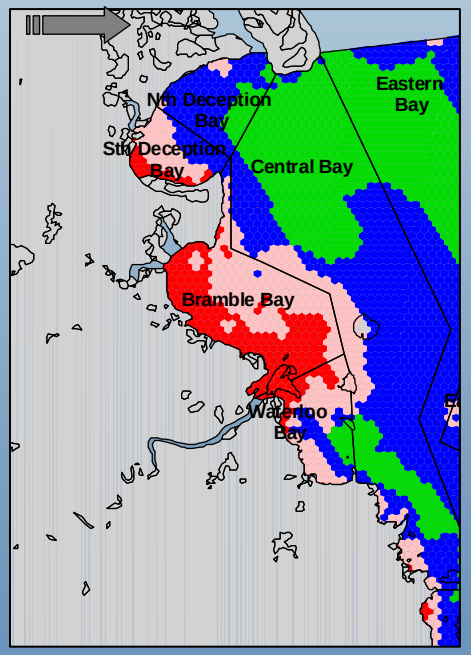
Ecosystem health indicator
(e.g. Secchi depth)



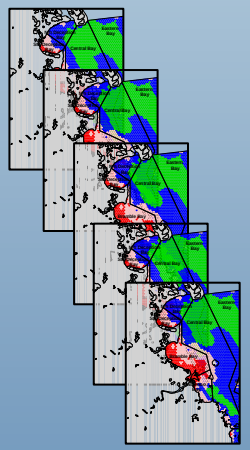
1 year of monthly monitoring data



Median values calculated and spatial prediction between sites

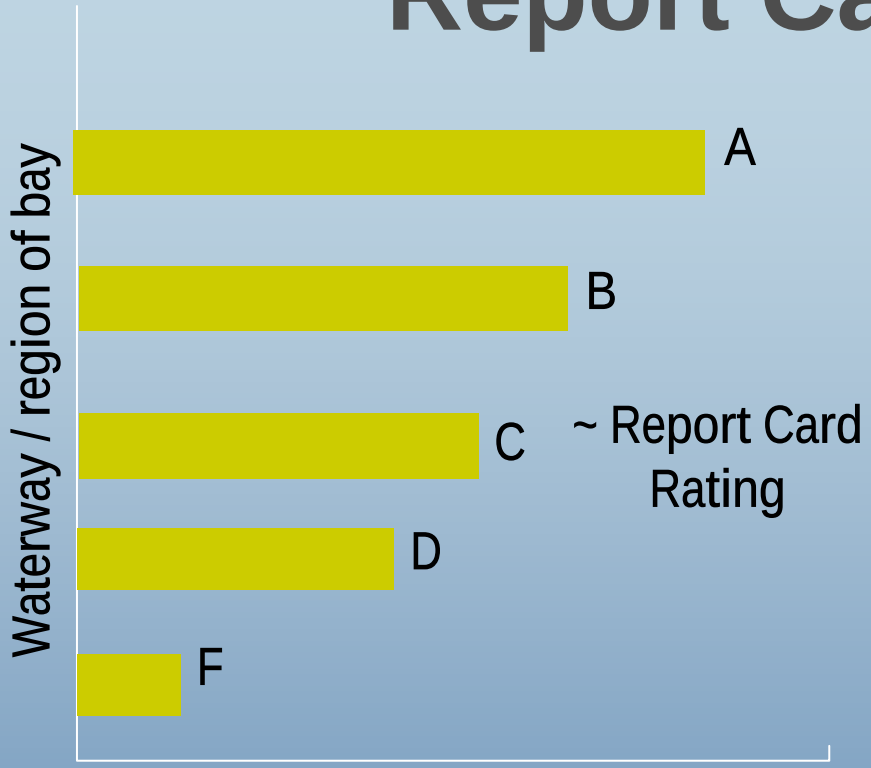


Compliance area calculated for each river or region of Moreton Bay



Process repeated for each indicator and average

Report Card grades



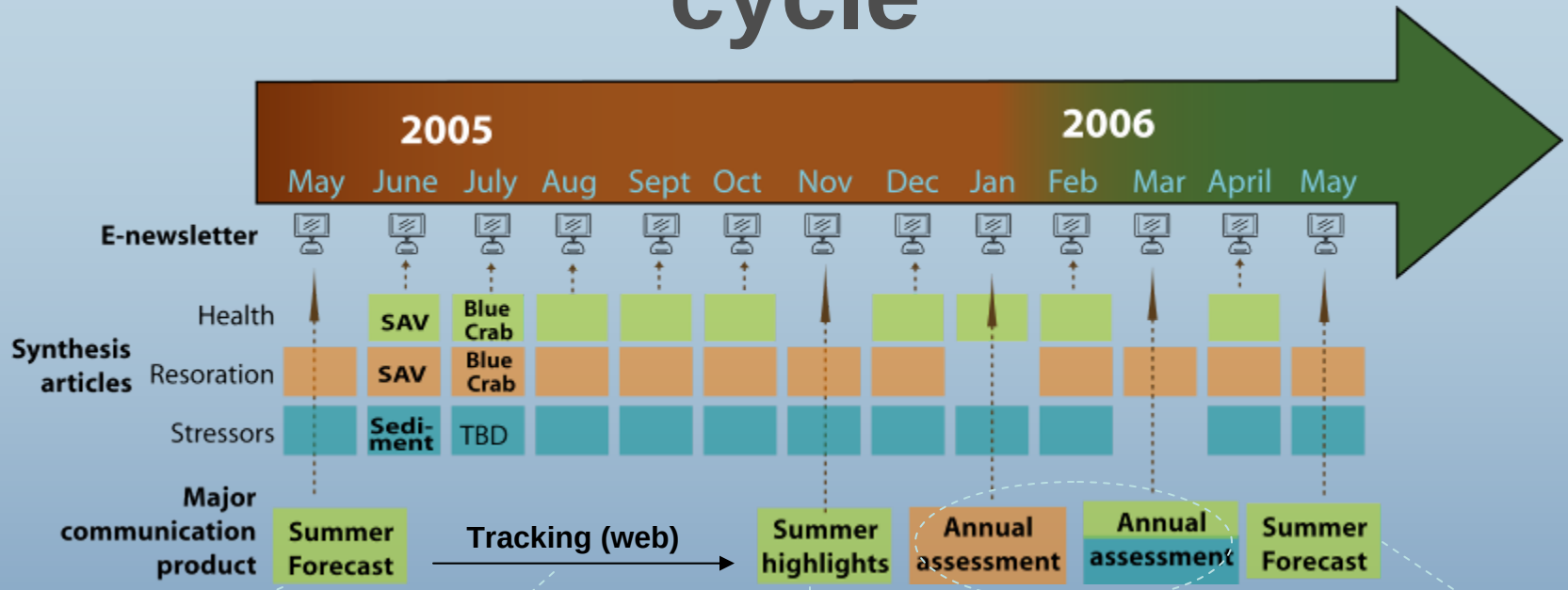
Estuary	EHI	Chl_a	TN	DO	TP	Turbidity
Logan River	**0.42**	1.00	0.25	0.36	0.15	0.40
Maroochy River	**0.54**	0.79	0.45	0.40	0.31	0.88

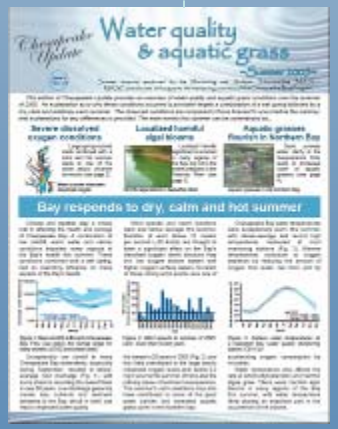
Chesapeake Bay Report Card

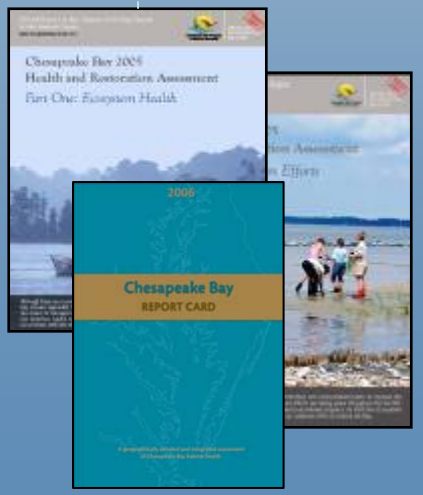
Developed a framework that:

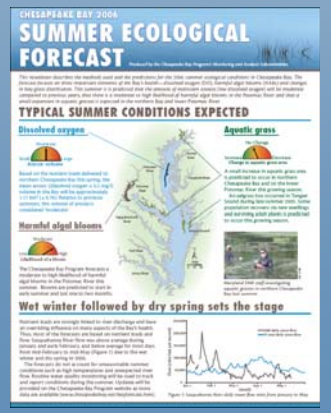
1. Separates: Bay health, Bay stressors, restoration effort
2. Provides a logical hierarchy
3. Is closely aligned with the Bay Program's overall communication strategy

Developed annual communication cycle

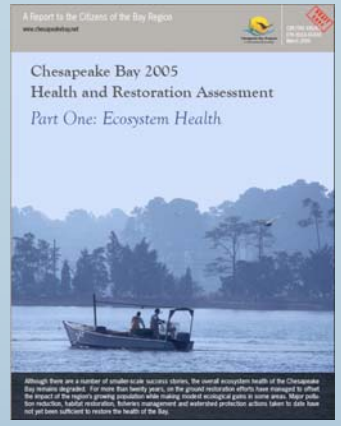






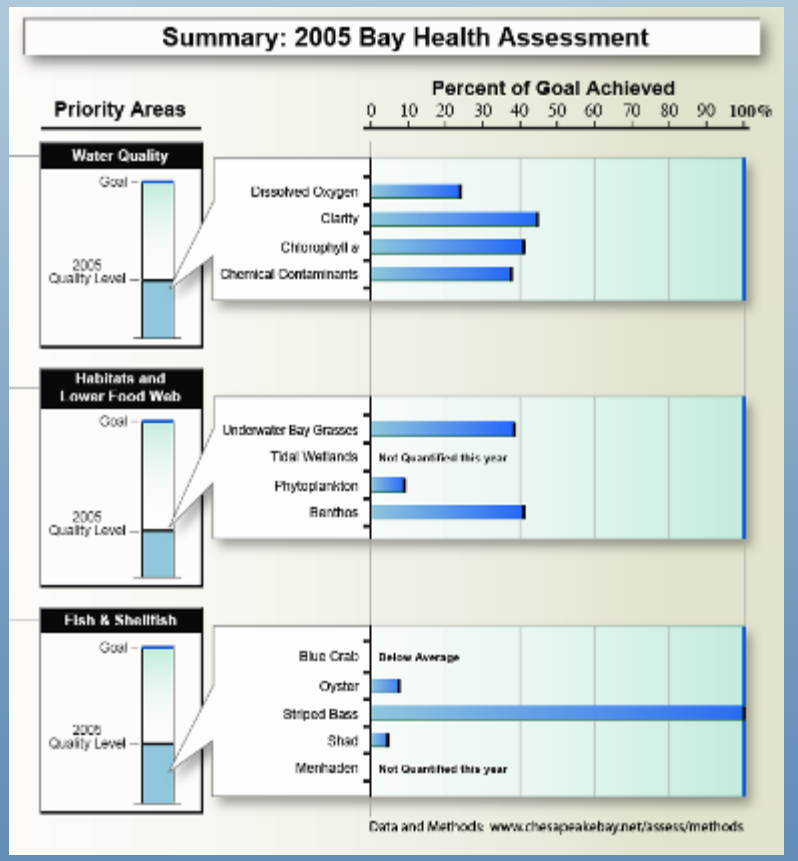


Chesapeake Bay 2005: Ecosystem Health Report



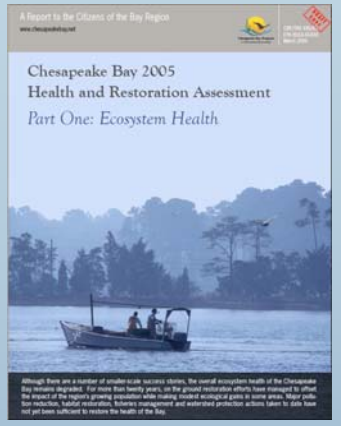
Resolves many issues:

- **Fewer indicators**
- **Improved structure**
- **Improved timeliness**
- **Simple and consistent**
- **Defines health as passing or failing guidelines**
- **Starts to provide indices**



Chesapeake Bay Health and Restoration Report:

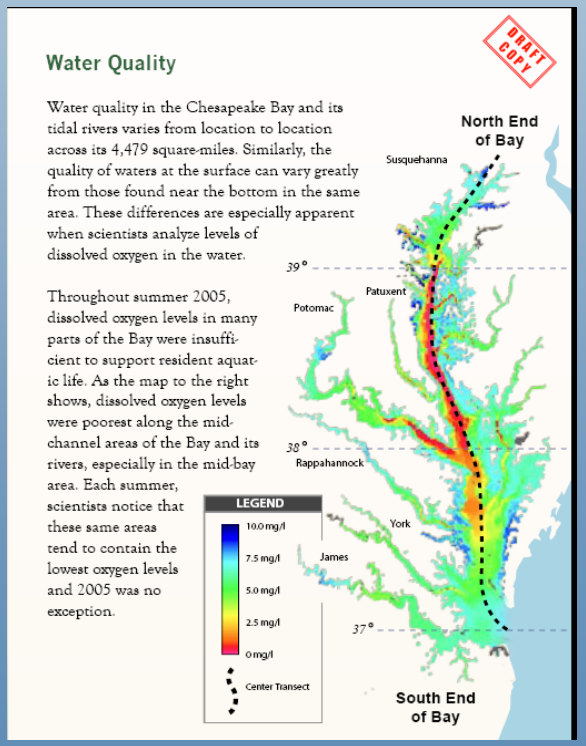
Part 1: Ecosystem Health



Some remaining challenges:

- **Some indicators not developed**
- **Some indicators still not timely**
- **Better integration:**
  - **Provide spatial detail**
  - **Provide overarching indices**

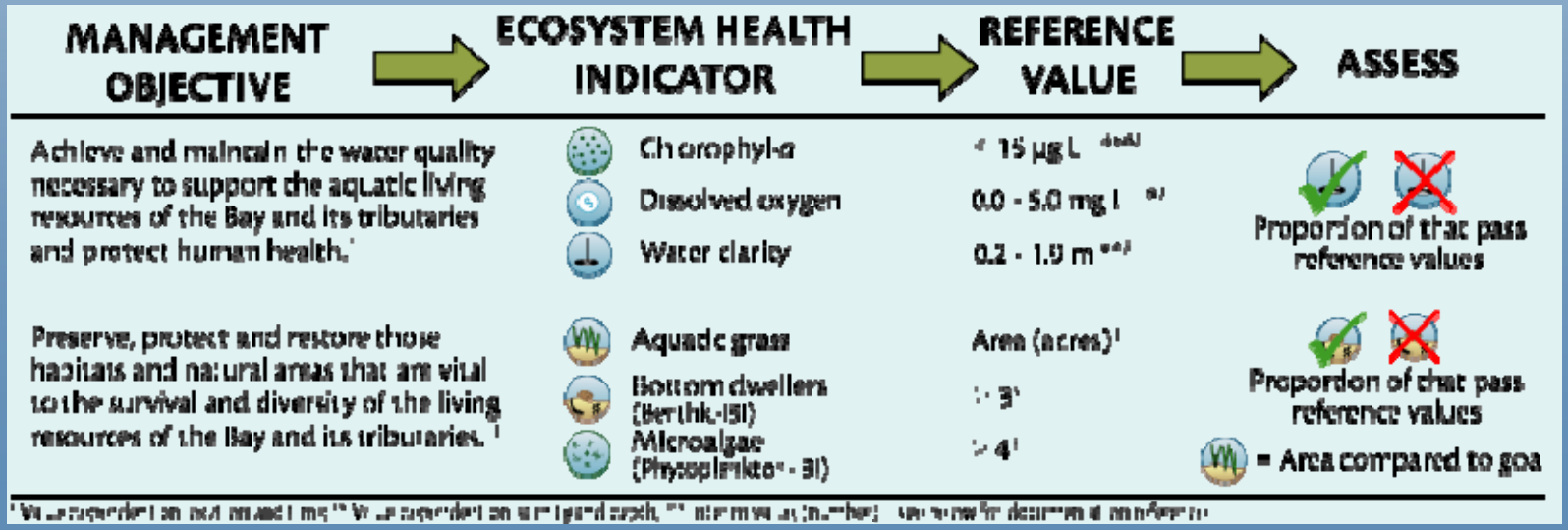
Bay Health Index / report card



Approach

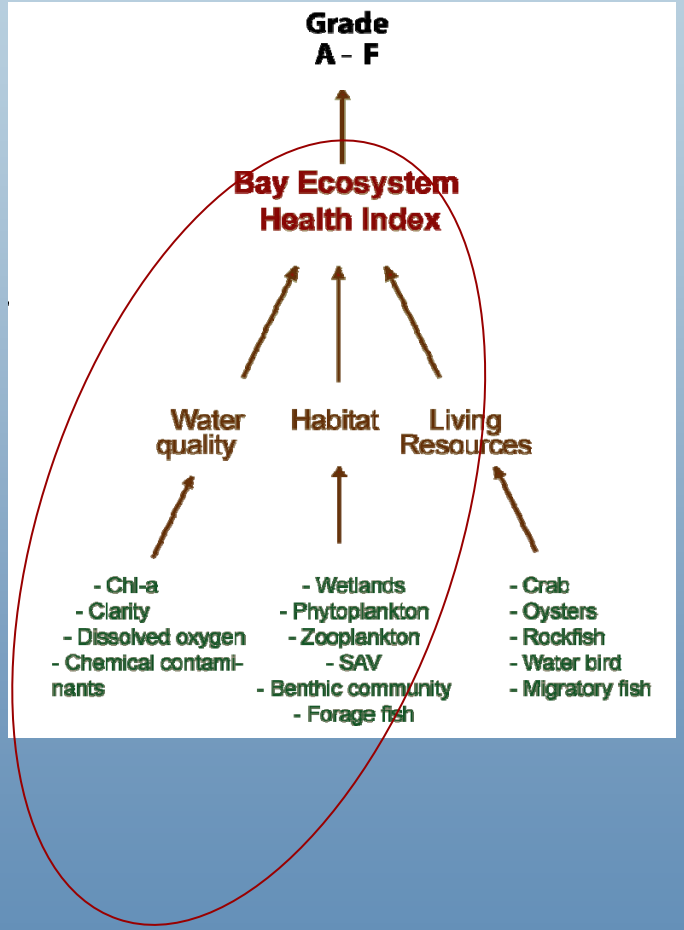
Reporting progress towards established thresholds:

- Capitalizes on effort taken to develop thresholds
- Provides consistency → defendable and simple index values
- Linked to management objectives



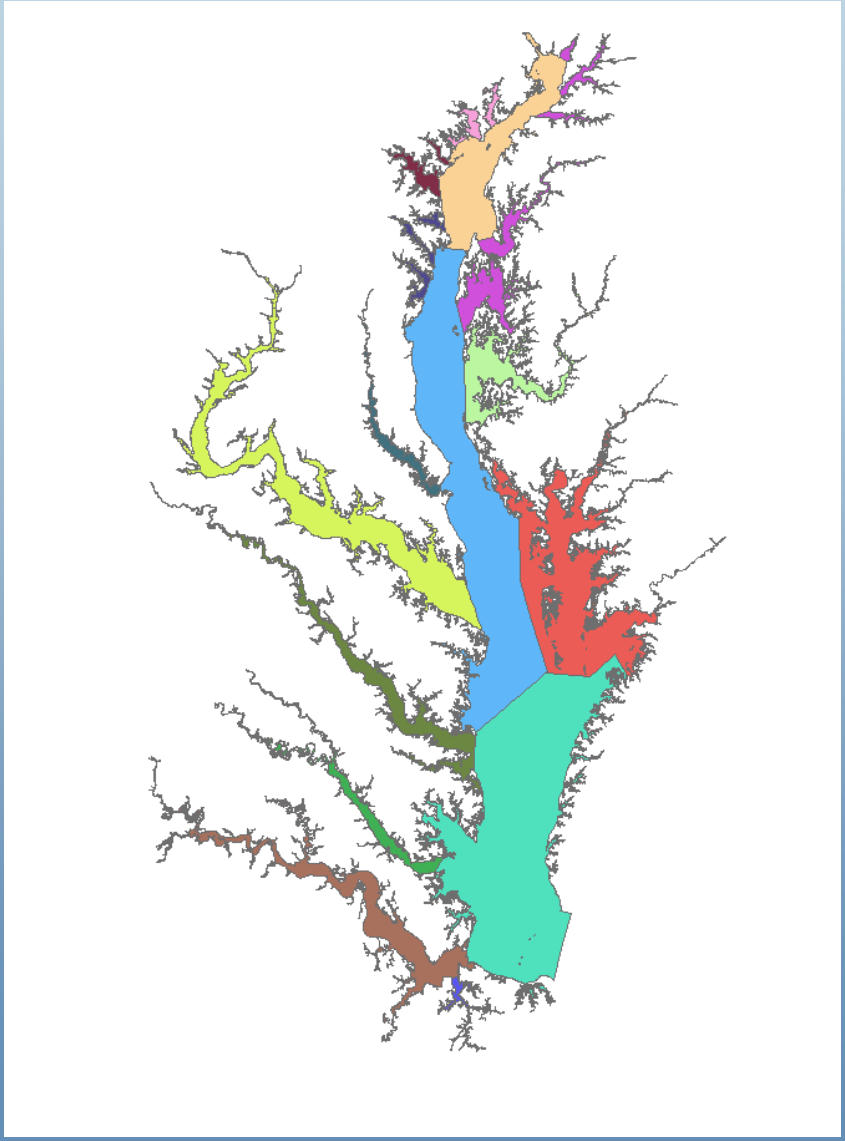
Methods - indicators

- **Indicators for 2006**
  - Water Quality Index
    - Chl-a,
    - Dissolved oxygen
    - Secchi disc depth
  - Biotic Index
    - SAV
    - Benthic index of biological integrity (BIBI)
    - Phytoplankton index of biological integrity (PIBI)
- **Other indicators will be included in the future (e.g. toxics, fish, shellfish)**



Agreed to reporting regions

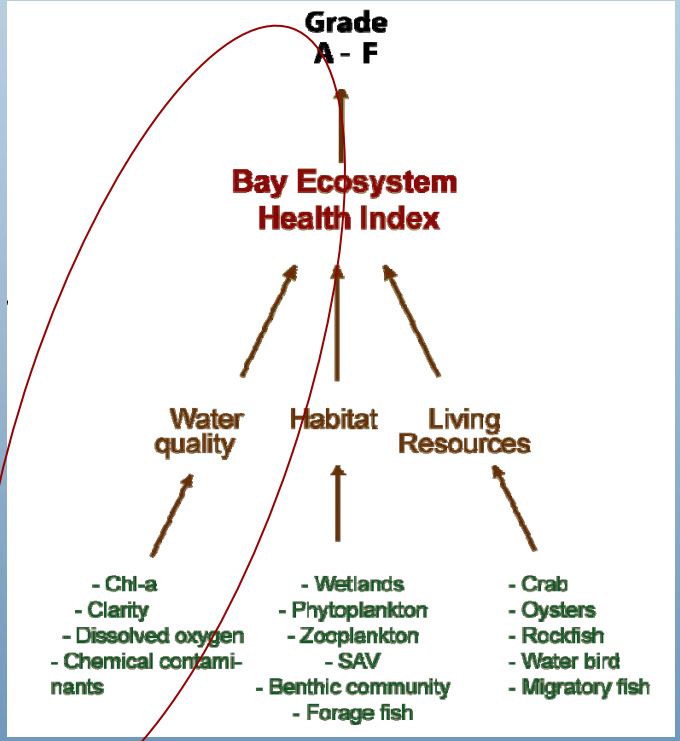
Reporting regions are aligned with Tributary Strategy regions



Calculating the WQI

Establishing water quality thresholds:

- Variety explored (esp Chl a)
- Needed to be sensitive
- Comparable (“apples to apples”)
- Used published values



WQI Thresholds

Chl-a Salinity Regime	Chl-a Season	Chl-a Reference Community Thresholds ($\mu g\ L^{-1}$)*	Secchi Depth Salinity Regime	Secchi Depth Season	Secchi Relative Status Thresholds (m)*	DO Designated Use	DO Season	DO Criteria Thresholds ($mg\ L^{-1}$)‡
Tidal Fresh	**Spring**	**≤14.0**	**Tidal Fresh**	**Apr-Oct**	**≥0.85**	**Open Water**	**Jun-Sept**	**≥5.0**
Oligohaline	**Spring**	**≤20.9**	**Oligohaline**	**Apr-Oct**	**≥0.65**	**Deep Water**	**Jun-Sept**	**≥3.0**
Mesohaline	**Spring**	**≤6.2**	**Mesohaline**	**Apr-Oct**	**≥1.63**	**Deep Channel**	**Jun-Sept**	**≥1.0**
Polyhaline	**Spring**	**≤2.8**	**Polyhaline**	**Mar-Nov**	**≥2.0**			
Tidal Fresh	**Summer**	**≤12.0**						
Oligohaline	**Summer**	**≤9.5**						
Mesohaline	**Summer**	**≤7.7**						
Polyhaline	**Summer**	**≤4.5**						

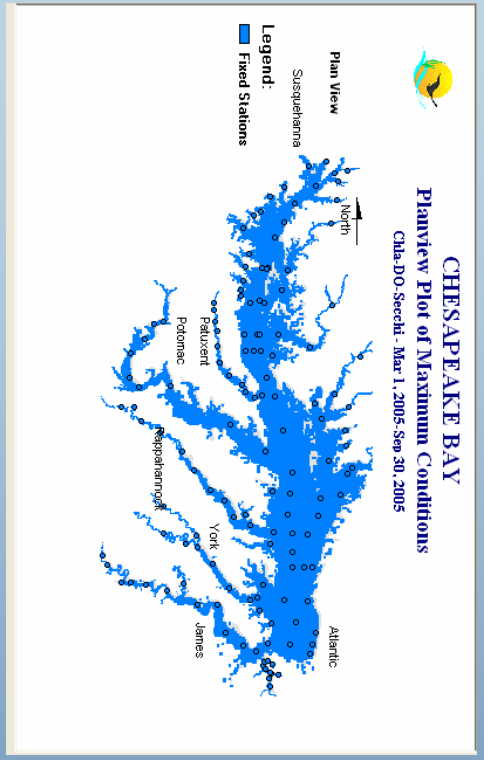
* Lacouture et al., Estuaries and Coasts (2006) & Buchanan et al., Estuaries (2005);

‡U. S. Environmental Protection Agency (2003)

Calculating the WQI

Metric score (% of threshold):

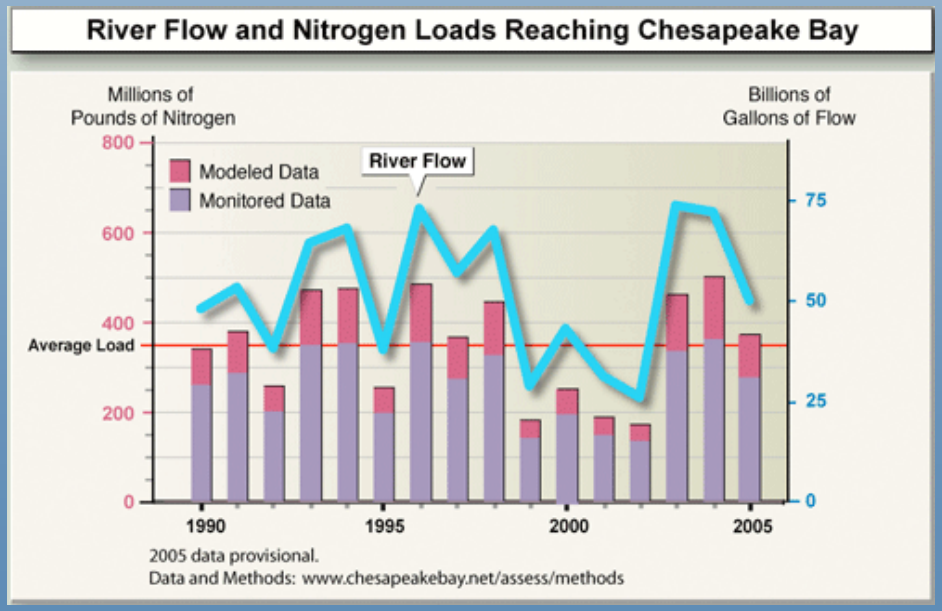
- Variety of approaches investigated:
  - Pass/fail annual average
  - Site specific and by segment
- Approach adopted:
  - % of samples passing threshold over growing season of interest
  - % of samples within each segment passing threshold value is then area-weighted by the segments which constitute each reporting region

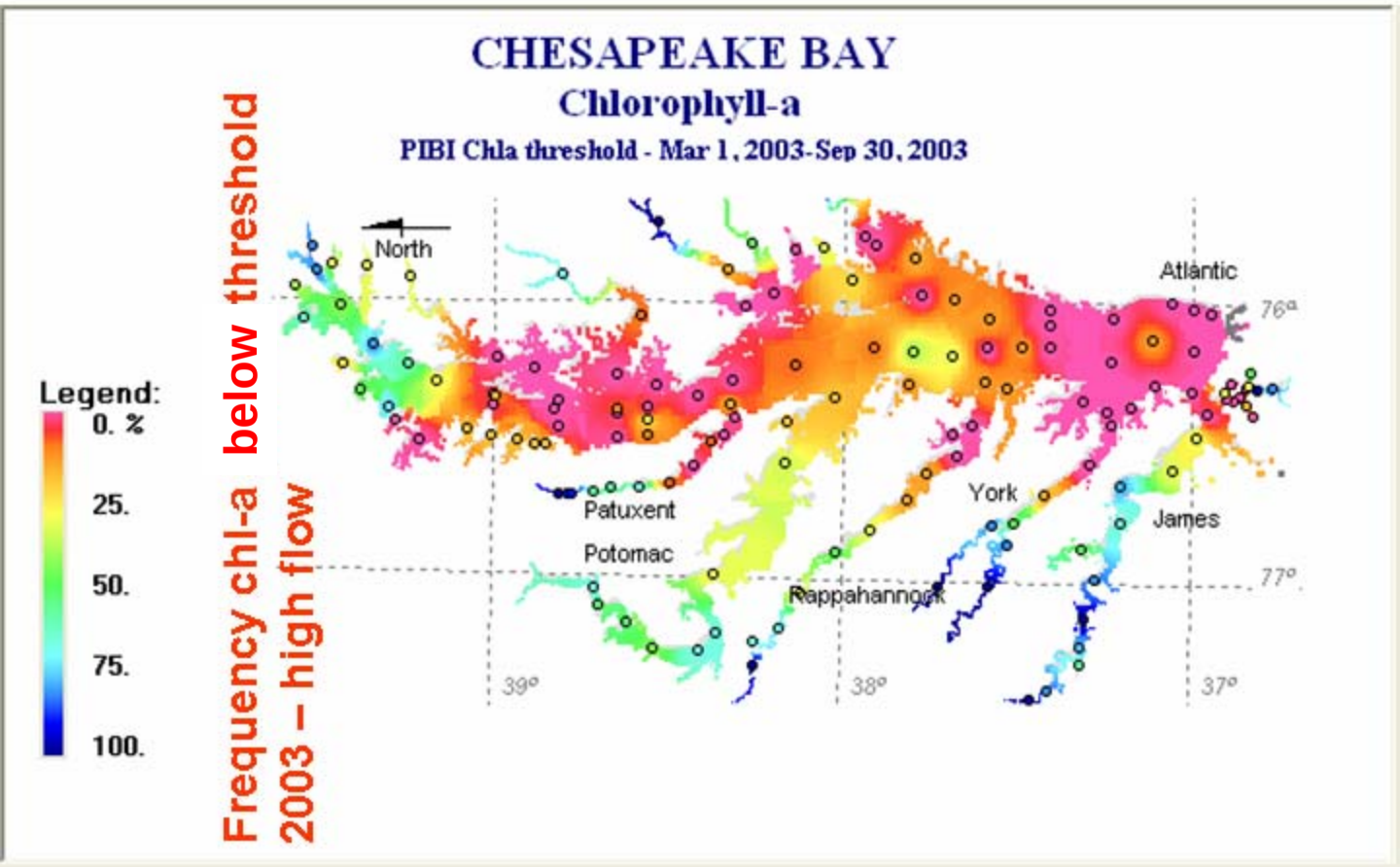


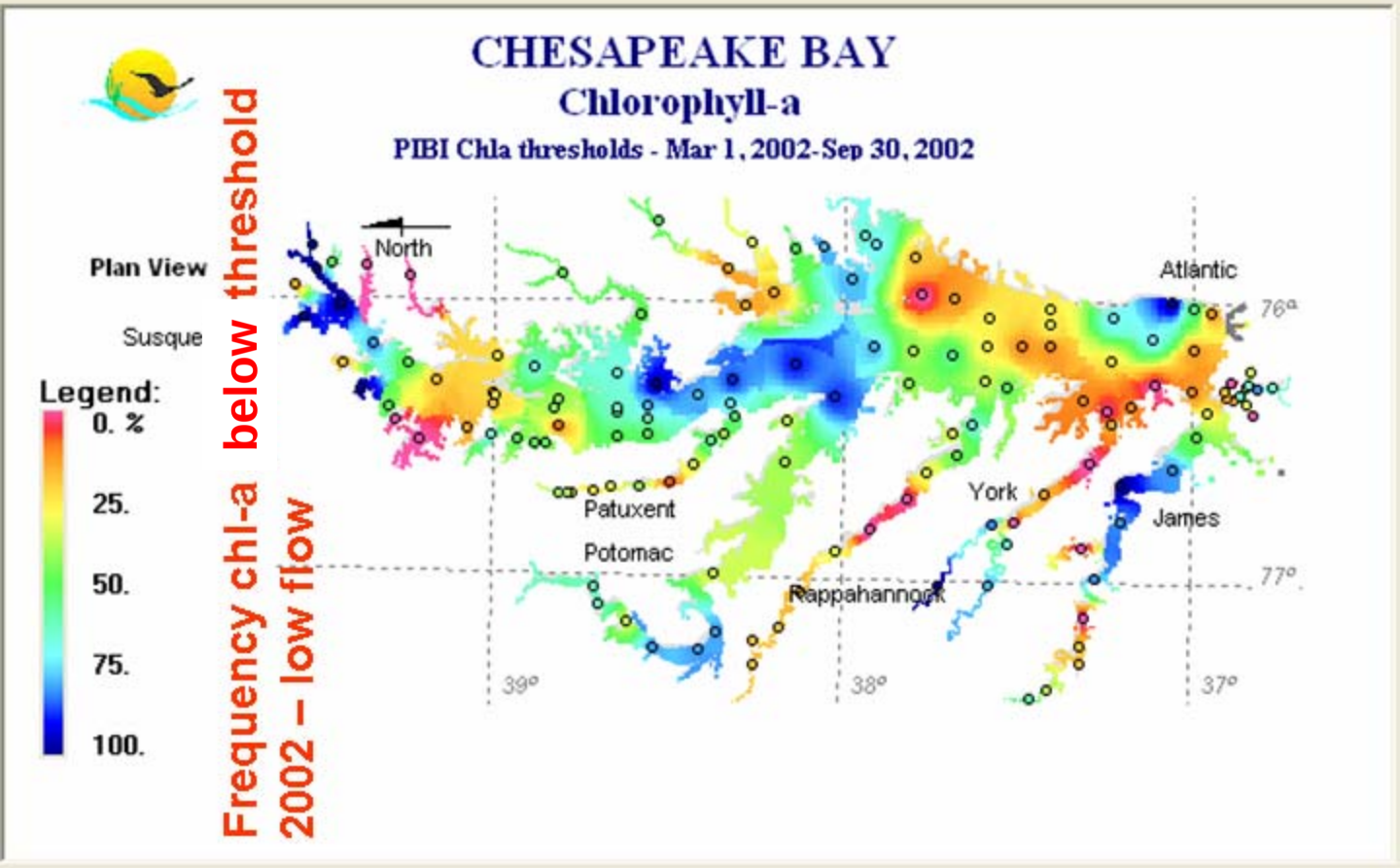
Testing the sensitivity of the WQI

Low (2002) & high (2003) flow years

- 2002 → Approximates the 175 and 12.8 million pound restoration goals of N and P loads, respectively
- 2003 → >2.5 and >8 times their goals, respectively




CHESAPEAKE BAY
Chlorophyll-a
PIBI Chla threshold - Mar 1, 2003-Sep 30, 2003
Frequency chl-a below threshold
2003 – high flow
Legend:
0. %
25.
50.
75.
100.
North
Atlantic
76°
Patuxent
Potomac
Rappahannock
York
James
77°
39°
38°
37°


CHESAPEAKE BAY
Chlorophyll-a
PIBI Chla thresholds - Mar 1, 2002-Sep 30, 2002
Frequency chl-a below threshold
2002 – low flow
Plan View
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Legend:
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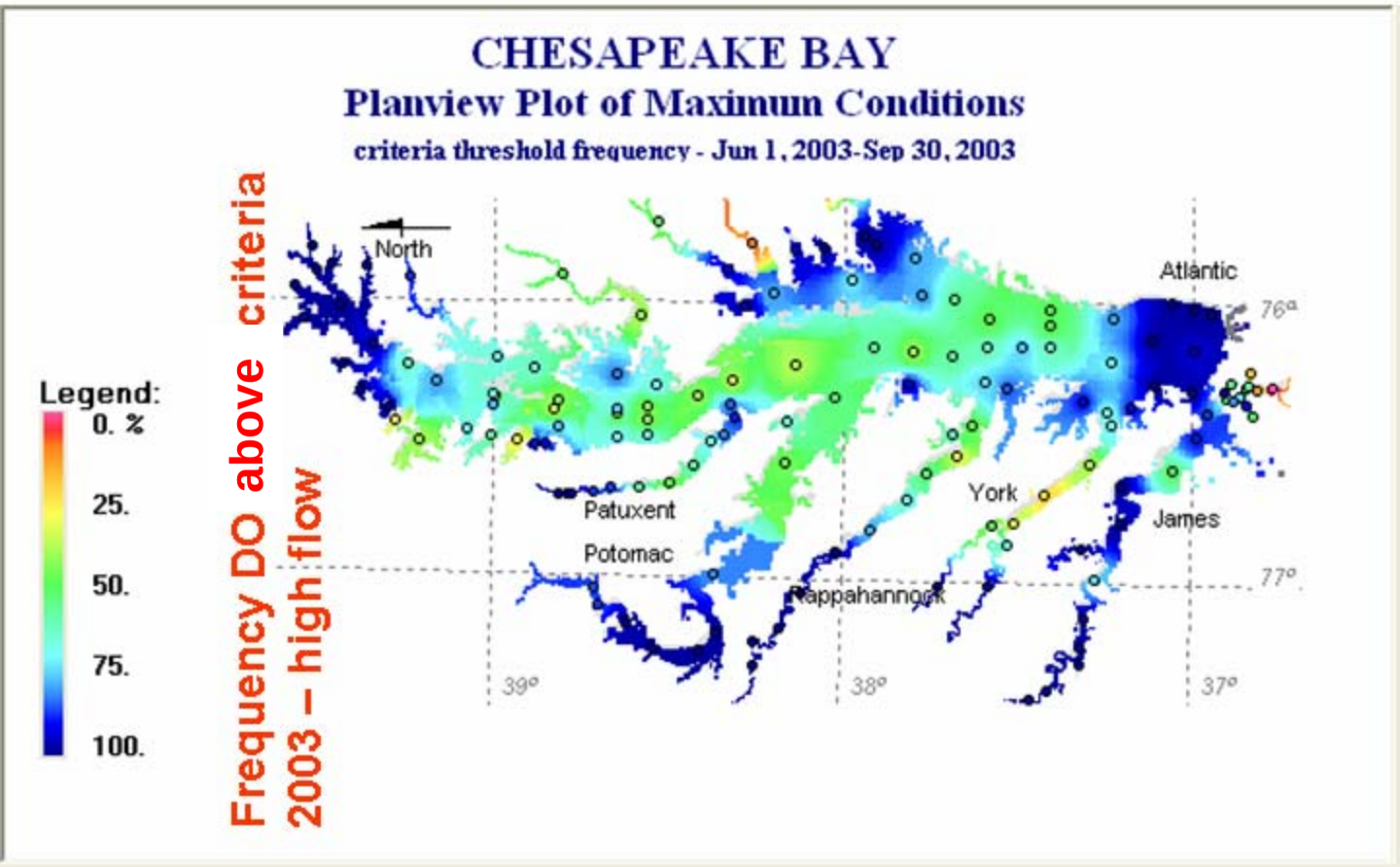
CHESAPEAKE BAY
Planview Plot of Maximum Conditions
criteria threshold frequency - Jun 1, 2003-Sep 30, 2003
Frequency DO above criteria
2003 – high flow
Legend:
0. %
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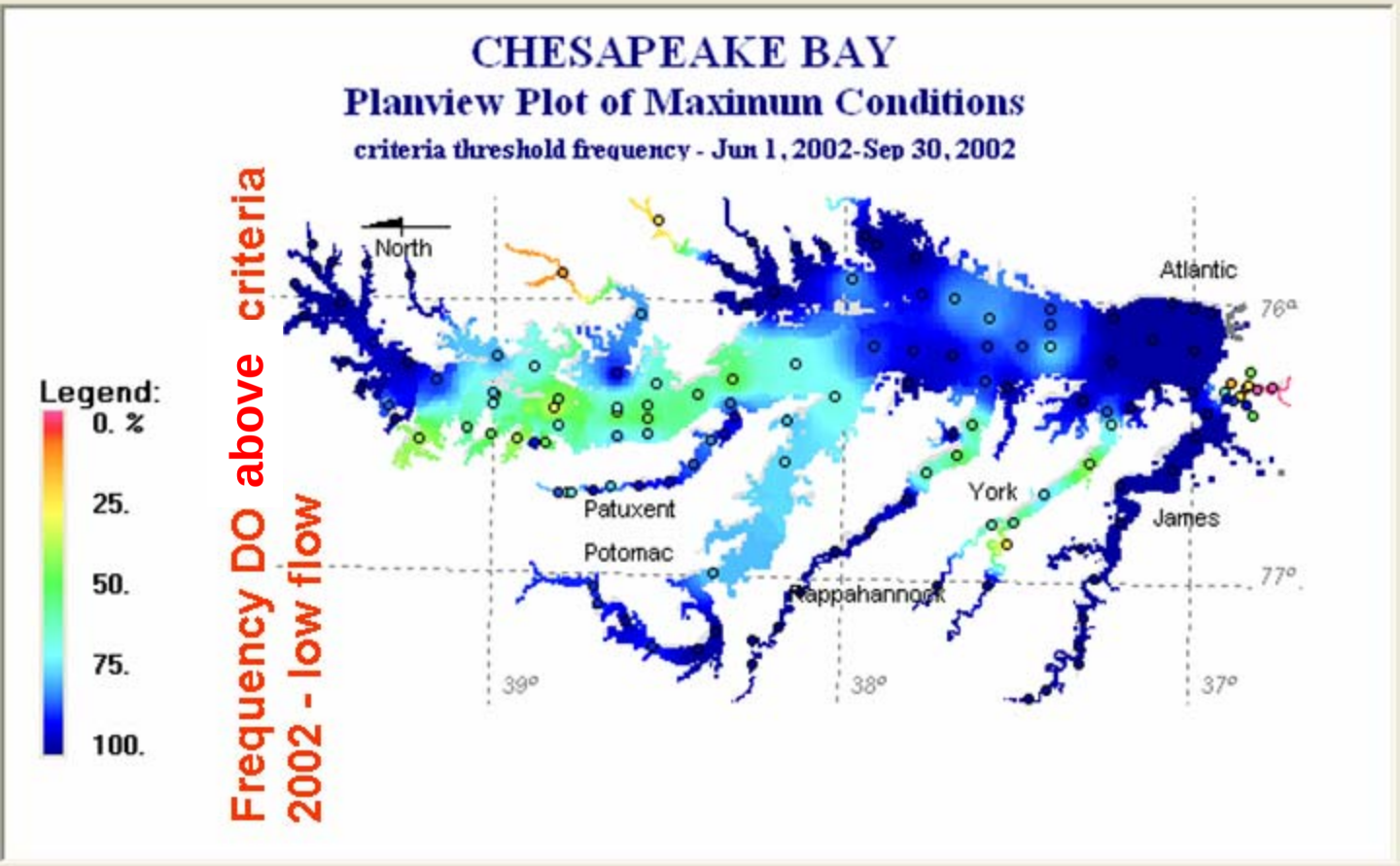
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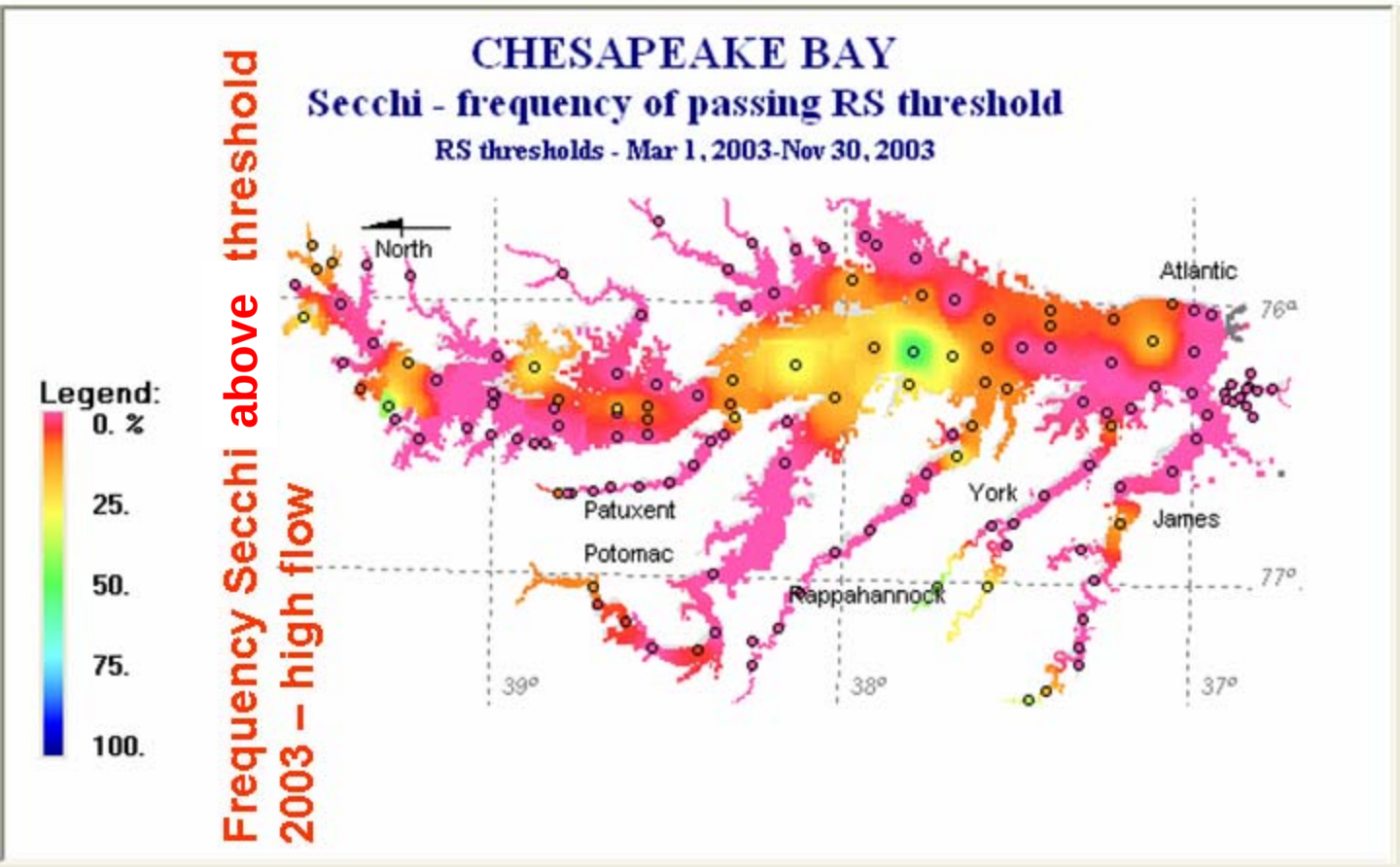
CHESAPEAKE BAY
Secchi - frequency of passing RS threshold
RS thresholds - Mar 1, 2003-Nov 30, 2003
Frequency Secchi above threshold
2003 – high flow
Legend:
0. %
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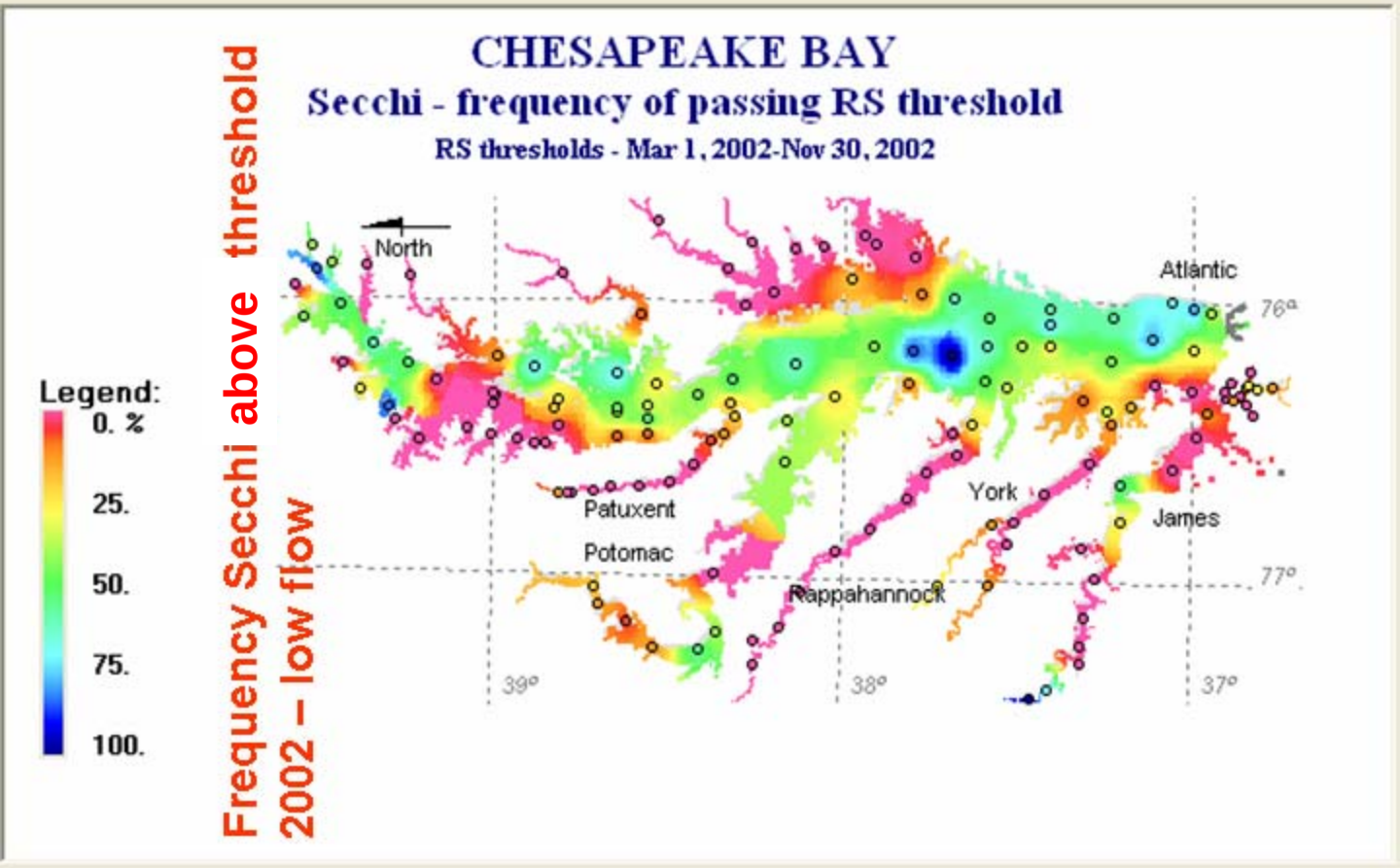
CHESAPEAKE BAY
Secchi - frequency of passing RS threshold
RS thresholds - Mar 1, 2002-Nov 30, 2002
Frequency Secchi above threshold
2002 – low flow
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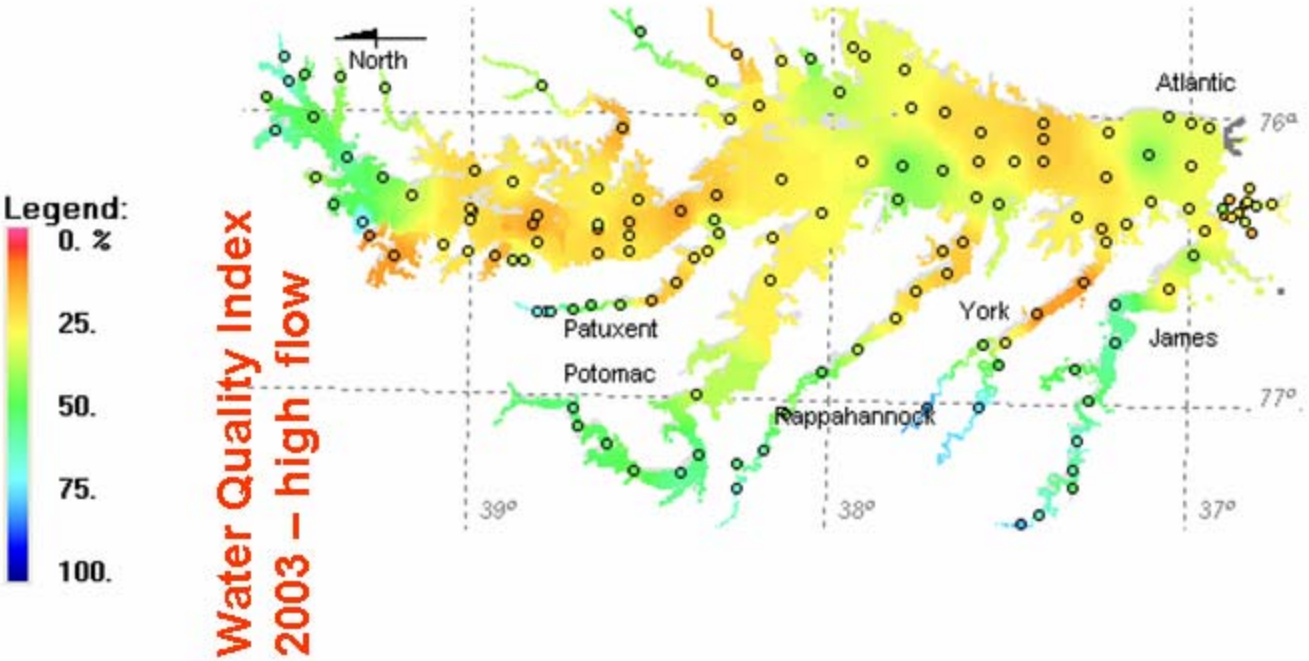
CHESAPEAKE BAY

Planview Plot of Maximum Conditions

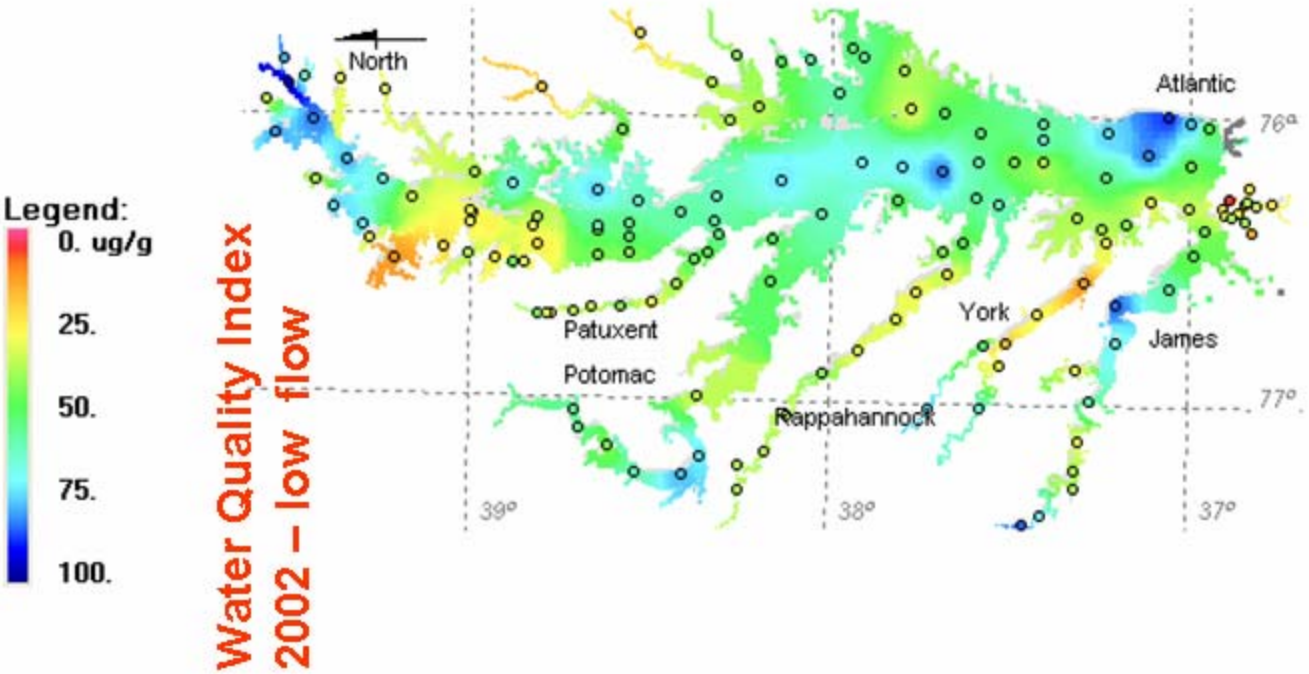
Chla-DO-Secchi frequency - Mar 1, 2003-Nov 30, 2003



CHESAPEAKE BAY

Water Quality Index

Chla-DO-Secchi frequency - Mar 1, 2002-Nov 30, 2002

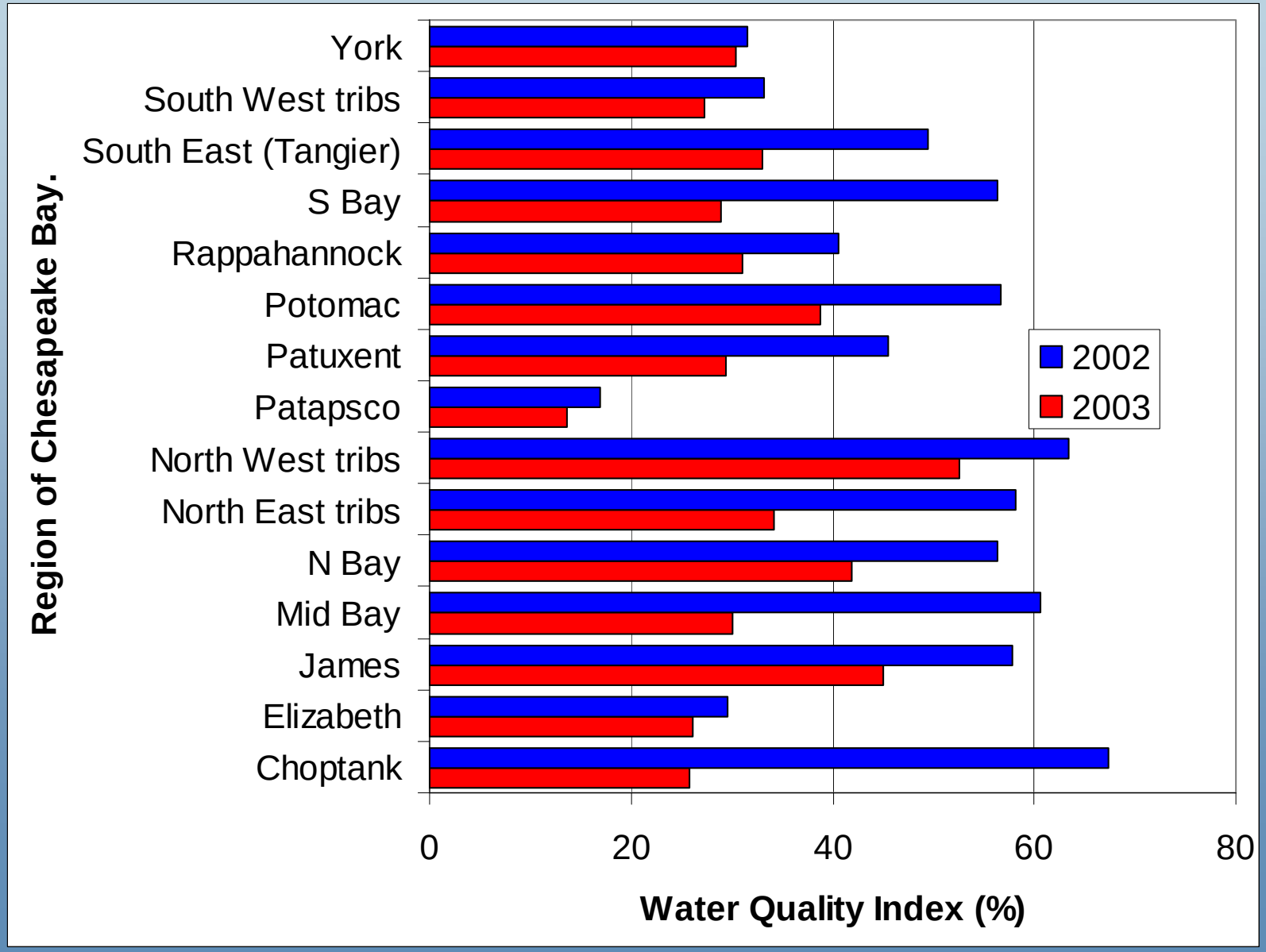


Combining chl-a, DO and Secchi = WQI

2002 data	2002	2002	2002	2002
Reporting Regions	Chl-a	DO	Clarity	WQI
Patapsco	0	51	0	16.8
Elizabeth	38	42	9	29.6
York	25	65	5	31.5
South West tribs	46	54	0	33.3
Rappahannock	30	81	11	40.6
Patuxent	39	90	7	45.5
South East (Tangier)	49	93	7	49.5
N Bay	53	86	30	56.4
S Bay	30	93	46	56.4
Potomac	58	82	30	56.6
James	59	100	14	57.8
North East tribs	50	81	44	58.2
Mid Bay	63	73	45	60.5
North West tribs	63	98	29	63.4
Choptank	70	83	49	67.3

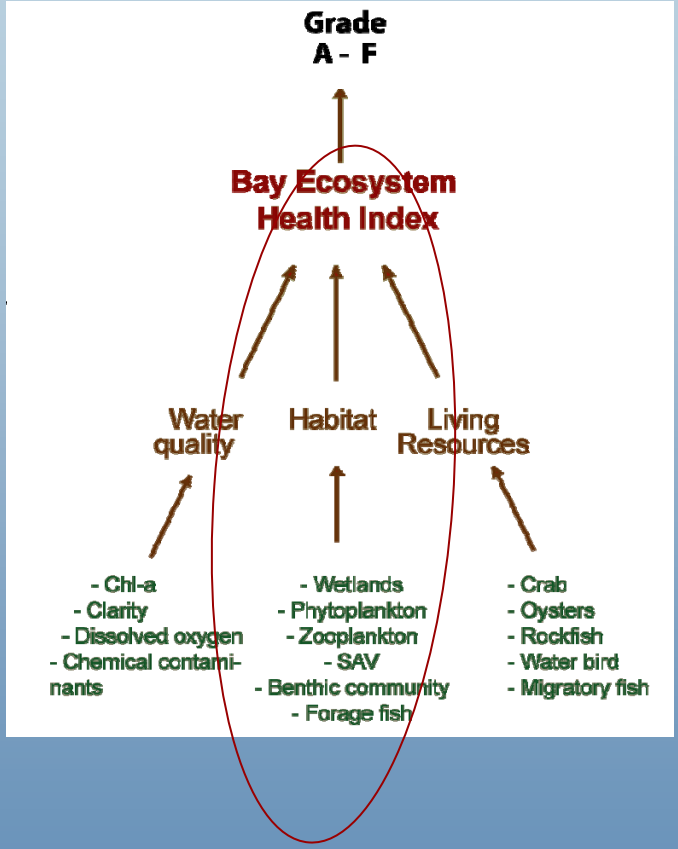
2003 data	2003	2003	2003	2003
Reporting Regions	Chl-a	DO	Clarity	WQI
Patapsco	0	41	0	13.6
Choptank	4	73	0	25.8
Elizabeth	25	54	0	26.1
South West tribs	20	62	0	27.3
S Bay	4	77	5	28.9
Patuxent	13	72	4	29.3
Mid Bay	13	59	19	30.0
York	36	50	6	30.4
Rappahannock	19	66	7	31.1
South East (Tangier)	12	82	5	33.0
North East tribs	12	74	16	34.1
Potomac	38	73	5	38.8
N Bay	41	79	6	41.9
James	47	85	3	45.1
North West tribs	46	100	12	52.6

Comparing 02 and 03 WQI



Calculating the Biotic Index (BI)

- Metrics used:
  - SAV
  - Phytoplankton IBI
  - Benthic IBI
- Thresholds:
  - SAV: segment specific restoration goals (acres)
  - PIBI and BIBI → 3.0



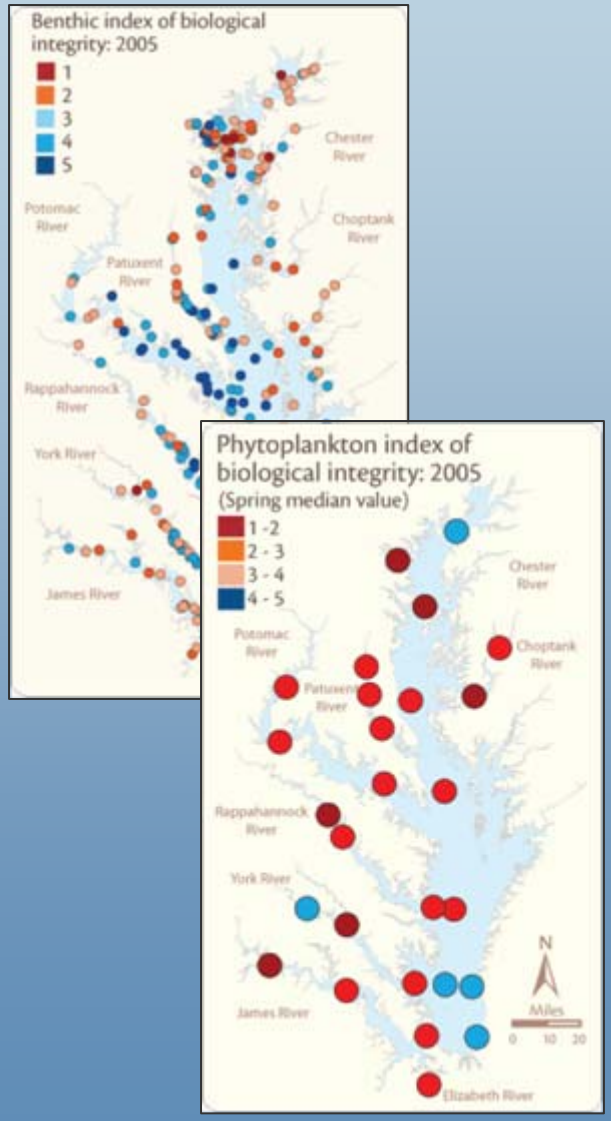
SAV

- Most recent year survey data
- Compliance of a reporting region
  - Total area present (acres) as a proportion of the total restoration goal

Reporting region	CBP segments included in region	SAV restoration goal by reporting region (acres)
Northern Bay	CB1TF, CB2OH, CB3MH	14,978
Mid Bay	CB4MH, CB5MH	18,436
Southern Bay	CB6PH, CB7PH, CB8PH, MOBPH	32,286
Patuxent River	PAXMH, PAXOH, PAXTF	1,954
Potomac River	ANATF, MATTF, PISTF, POTMH, POTOH, POTTF	21,203
Rappahannock R.	CRRMH, RPPMH, RPPOH, RPPTF	2,534
York River	MPNOH, MPNTF, PMKOH, PMKTF, YRKMH & PH	3,304
James River	APPTF, CHKOH, JMSMH, JMSOH, JMSPH, JMSTF	2,629
Elizabeth River	EBEMH, ELIPH, LAFMH, SBEMH, WBEMH	No Grow Zone
Chester River	CHSMH, CHSOH, CHSTF	3,005
Choptank River	CHOMH1, CHOMH2, CHOOH, CHOTF	9,877
Tangier Sound	TANMH	38,336
Patapsco River	PATMH	389
Nanticoke River	NANMH, NANOH, NANTF	15
TOTAL		148,946

Benthic and Phytoplankton IBI

- The BIBI and PIBI is scaled from 1 to 5, and sites with values of 3.0 or more are considered to meet the Restoration Goals.
- BIBI
  - Estimate the amount of area in a reporting region that meets the Restoration Goals
- PIBI
  - % of samples with IBI ≥ 3.0 in reporting region
  - Area weighted segment %'s → reporting region %'s

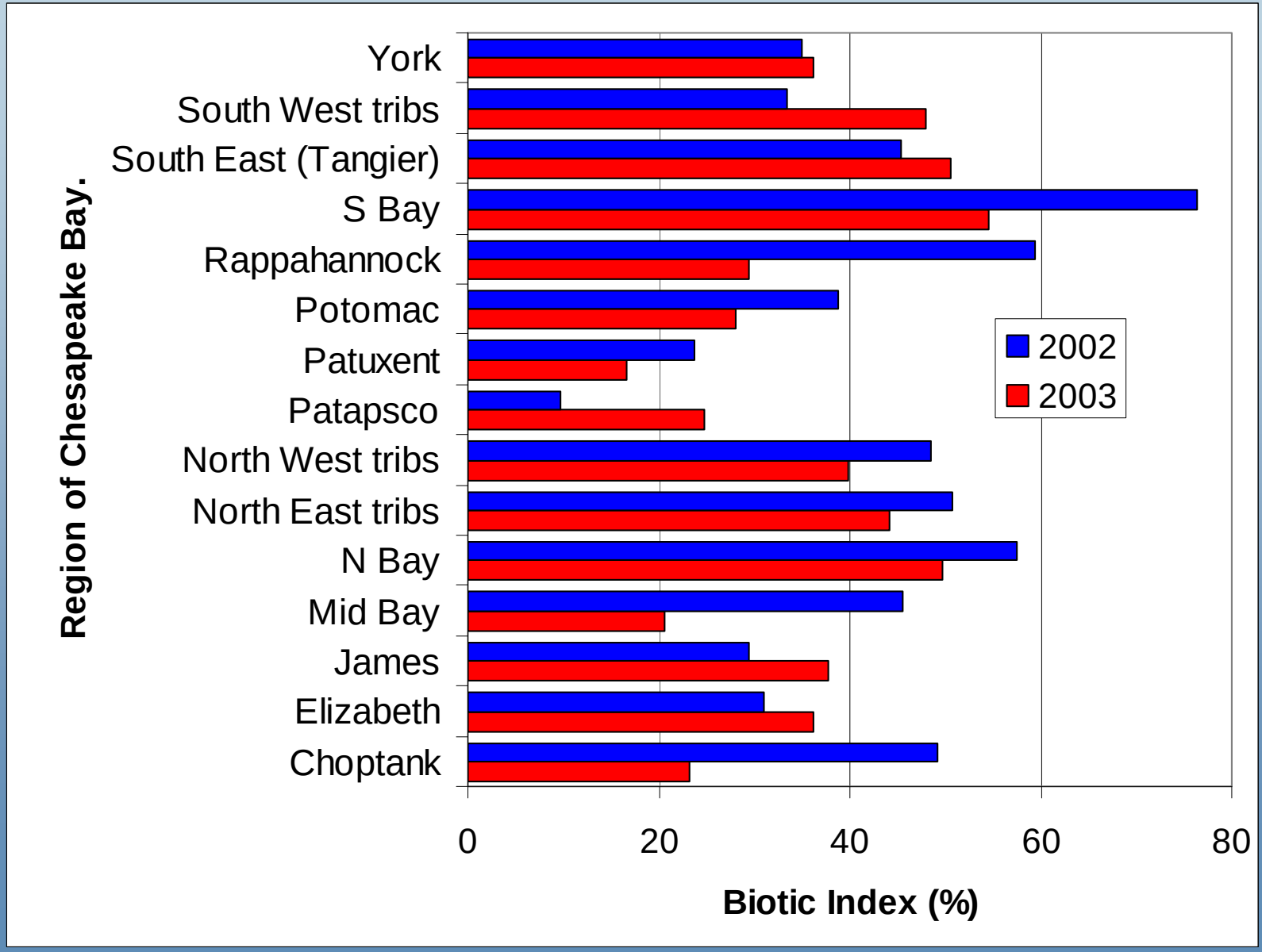


Combining PIBI, BIBI and SAV = BI

2002 data	2002	2002	2002	2002
Reporting Regions	P-IBI	B-IBI	SAV	BI
Patapsco	0	27	2	**9.8**
Patuxent	18	36	17	**23.7**
James	17	50	21	**29.5**
Elizabeth	33	29	NGZ	**31.0**
South West tribs	NA	27	39	**33.3**
York	11	60	34	**34.9**
Potomac	41	28	47	**38.7**
South East (Tangier)	NA	48	43	**45.4**
Mid Bay	86	22	28	**45.5**
North West tribs	NA	68	29	**48.5**
Choptank	18	60	69	**49.1**
North East tribs	NA	67	35	**50.7**
N Bay	39	68	66	**57.4**
Rappahannock	56	52	70	**59.4**
S Bay	94	75	60	**76.3**

2003 data	2003	2003	2003	2003
Reporting Regions	P-IBI	B-IBI	SAV	BI
Patuxent	8	24	18	**16.6**
Mid Bay	30	23	9	**20.7**
Choptank	12	31	27	**23.2**
Patapsco	10	63	2	**24.7**
Potomac	25	20	39	**28.1**
Rappahannock	38	48	3	**29.4**
Elizabeth	50	22	NGZ	**36.1**
York	57	16	35	**36.1**
James	54	35	24	**37.8**
North West tribs	NA	56	24	**39.8**
North East tribs	NA	67	22	**44.2**
South West tribs	NA	63	34	**48.1**
N Bay	41	56	52	**49.7**
South East (Tangier)	NA	76	25	**50.5**
S Bay	51	56	57	**54.6**

Comparison of 02 & 03 BI



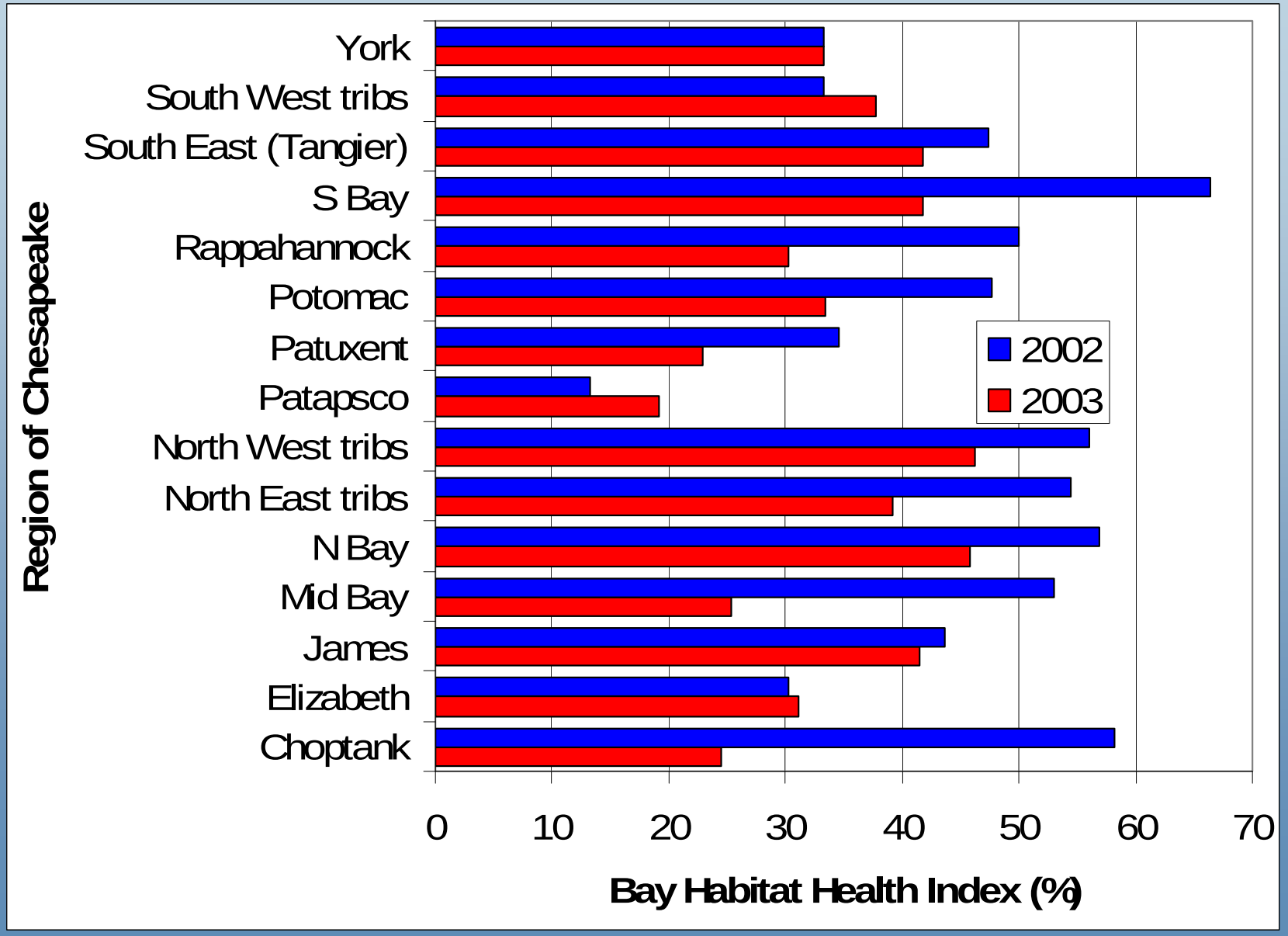
Combining WQI and BI = BHHI (2002)

2002 data	2002	2002	2002	2002	2002	2002	2002	2002	2002
Reporting Regions	Chl-a	DO	Clarity	WQI	P-IBI	B-IBI	SAV	BI	BHHI
Patapsco	0	51	0	**17**	0	27	2	**10**	**13**
Elizabeth	38	42	9	**30**	33	29	**NGZ**	**31**	**30**
York	25	65	5	**31**	11	60	34	**35**	**33**
South West tribs	46	54	0	**33**	**no data**	27	39	**33**	**33**
Patuxent	39	90	7	**45**	18	36	17	**24**	**35**
James	59	100	14	**58**	17	50	21	**29**	**44**
South East (Tangier)	49	93	7	**49**	**no data**	48	43	**45**	**47**
Potomac	58	82	30	**57**	41	28	47	**39**	**48**
Rappahannock	30	81	11	**41**	56	52	70	**59**	**50**
Mid Bay	63	73	45	**61**	86	22	28	**46**	**53**
North East tribs	50	81	44	**58**	**no data**	67	35	**51**	**54**
North West tribs	63	98	29	**63**	**no data**	68	29	**49**	**56**
N Bay	53	86	30	**56**	39	68	66	**57**	**57**
Choptank	70	83	49	**67**	18	60	69	**49**	**58**
S Bay	30	93	46	**56**	94	75	60	**76**	**66**

Combining WQI and BI = BHHI (2003)

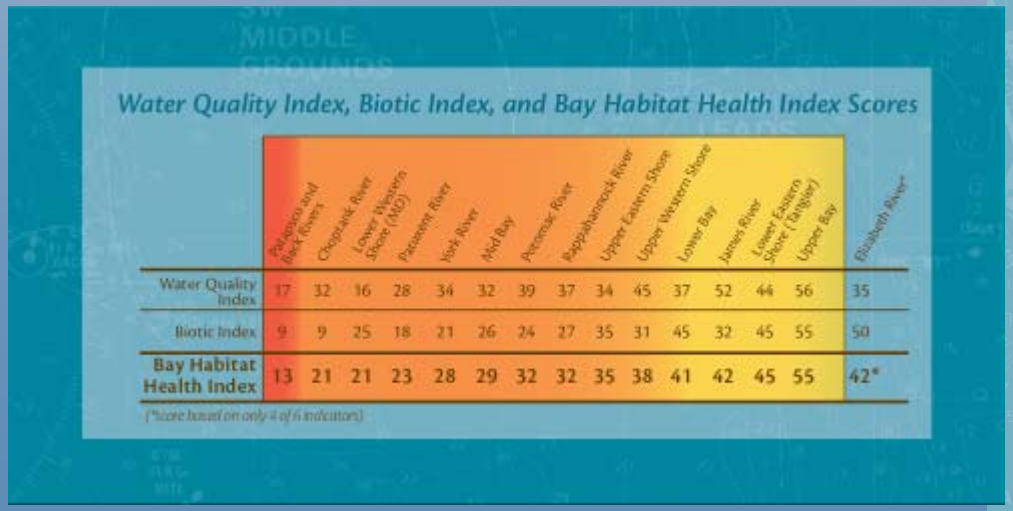
2003 data	2003	2003	2003	2003	2003	2003	2003	2003	2003
Reporting Regions	Chl-a	DO	Clarity	WQI	P-IBI	B-IBI	SAV	BI	BHHI
Patapsco	0	41	0	**14**	10	63	2	**25**	**19**
Patuxent	13	72	4	**29**	8	24	18	**17**	**23**
Choptank	4	73	0	**26**	12	31	27	**23**	**24**
Mid Bay	13	59	19	**30**	30	23	9	**21**	**25**
Rappahannock	19	66	7	**31**	38	48	3	**29**	**30**
Elizabeth	25	54	0	**26**	50	22	**NGZ**	**36**	**31**
York	36	50	6	**30**	57	16	35	**36**	**33**
Potomac	38	73	5	**39**	25	20	39	**28**	**33**
South West tribs	20	62	0	**27**	**no data**	63	34	**48**	**38**
North East tribs	12	74	16	**34**	**no data**	67	22	**44**	**39**
James	47	85	3	**45**	54	35	24	**38**	**41**
S Bay	4	77	5	**29**	51	56	57	**55**	**42**
South East (Tangier)	12	82	5	**33**	**no data**	76	25	**51**	**42**
N Bay	41	79	6	**42**	41	56	52	**50**	**46**
North West tribs	46	100	12	**53**	**no data**	56	24	**40**	**46**

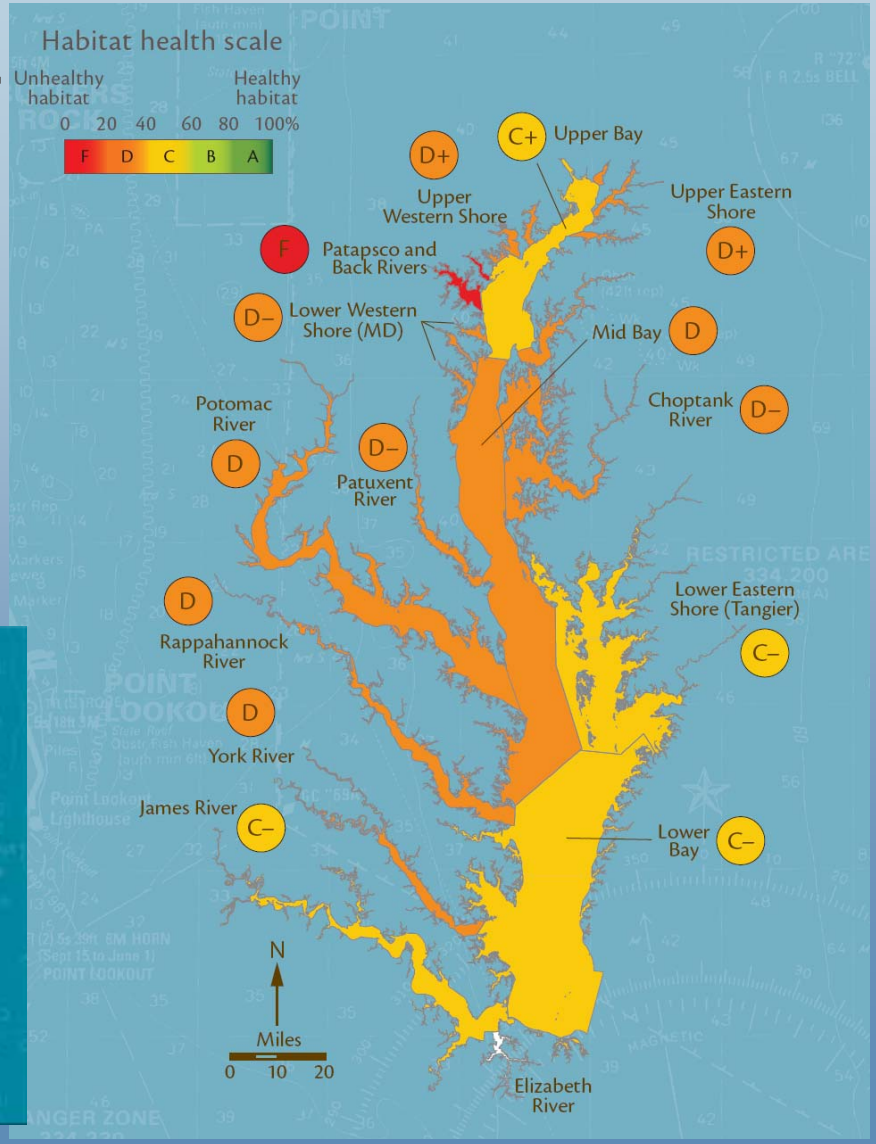
Comparison of 02 & 03 BHHI



2006 report card

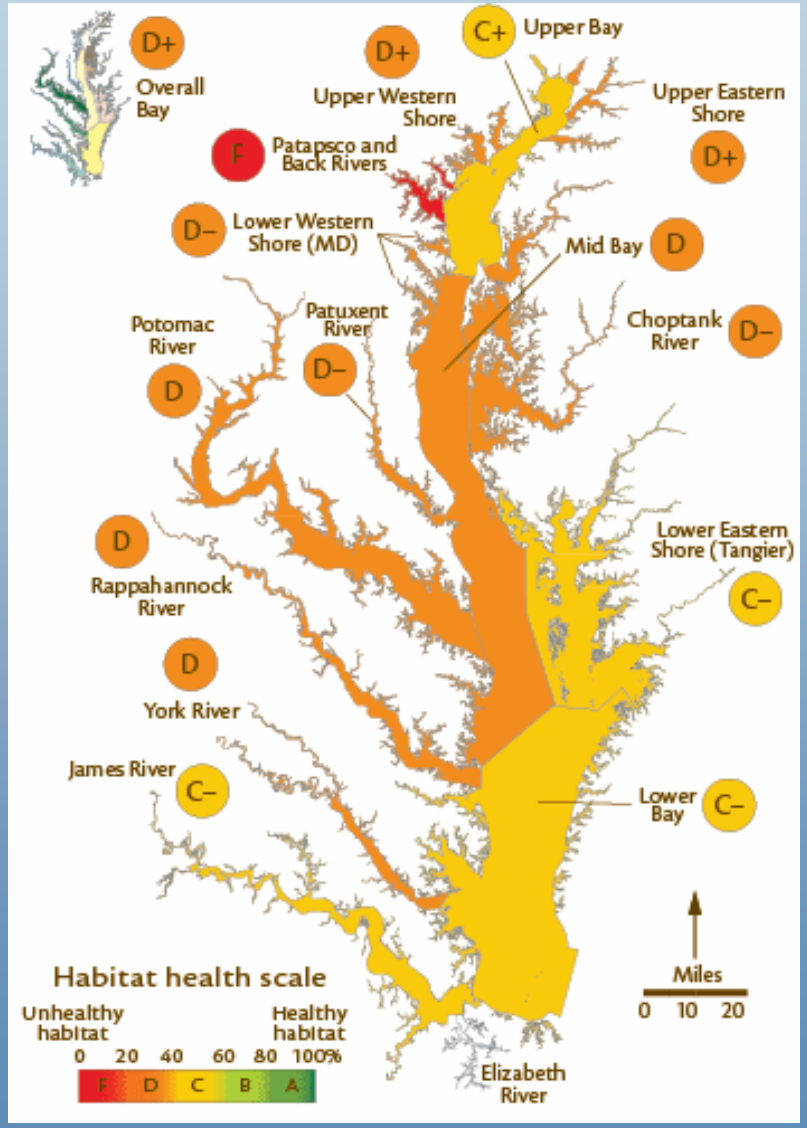
- Release in April
- Report card, newsletter & websites
- Media event at Chesapeake Bay Program





2006: not a good year for habitat health

- Health generally poor
- Health varied from region to region
- Lowest grade: Patapsco & Back rivers (F)
- Highest grade: Upper Bay (C+)
- Overall Bay grade: D+



CHESAPEAKE EcoCheck

Assessing and forecasting ecosystem status

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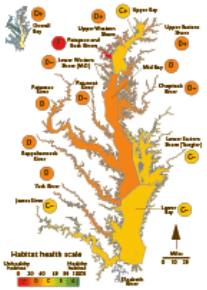
Chesapeake Bay Habitat Health Report Card: 2006

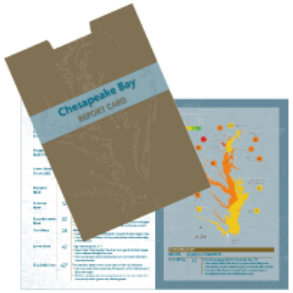
This report card provides a transparent, timely, and geographically detailed annual assessment of 2006 Chesapeake Bay habitat health. This report card complements the Bay-wide, long-term trend assessment produced by the Chesapeake Bay Program. A report card will be released each year, in early to mid April, providing an assessment of the previous year's habitat health. 2006 is the first year that the report card has been released. This report card rates 15 reporting regions of the Bay using six indicators that are combined into a single overarching index of habitat health. Habitat health is defined as progress of the six indicators towards established scientifically derived ecological thresholds or goals. A low score therefore means that the region rarely meets the ecological threshold levels. A high score means that the region often meets the threshold levels. This web site enables you to explore the report card via the 15 Bay regions, by the indicators and indices, and as an overview of 2006 Bay habitat health.

Move your mouse over the following icons to link to the information you would like to access.

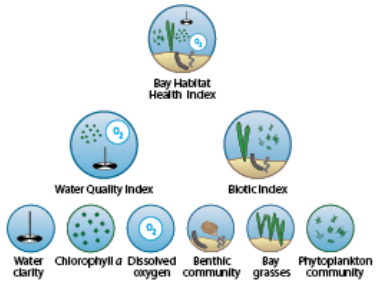
Region Summaries



2006 Report Card Overview



Indicators and Indices



Acknowledgements

The data and methods underpinning this report card represent the collective effort of many individuals and organizations working within the Chesapeake Bay scientific and management community. The following organizations are acknowledged for their significant contributions to the development of the report card: Chesapeake Bay Program, University of Maryland Center for Environmental Science, National Oceanic and Atmospheric Administration, Maryland Department of Natural Resources, Virginia Department of Environmental Quality, Virginia Institute of Marine Science, Versar Incorporated, US Environmental Protection Agency, Maryland Department of the Environment, Interstate Commission on the Potomac River Basin, Old Dominion University, and Morgan State University.

While acknowledging the critical role of these organizations in generating, analyzing, and reviewing the data, the Integration and Application Network, University of Maryland Center for Environmental Science and EcoCheck (NOAA-UMCES Partnership) are responsible for the report card release.

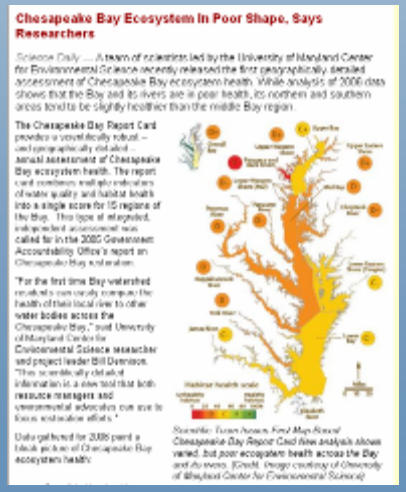
www.eco-check.org

Impact of the first year

- Broad media coverage
  - Newspapers, TV and radio
  - Local, national and international
  - Focus on what needs to be done
- Likely adoption by MD Bay Stat
- Many request from educators (grade 8 to university)
- Many meetings and workgroups

Bay is still hurting, 2 reports say

Quality of water called poor; loss of grasses noted



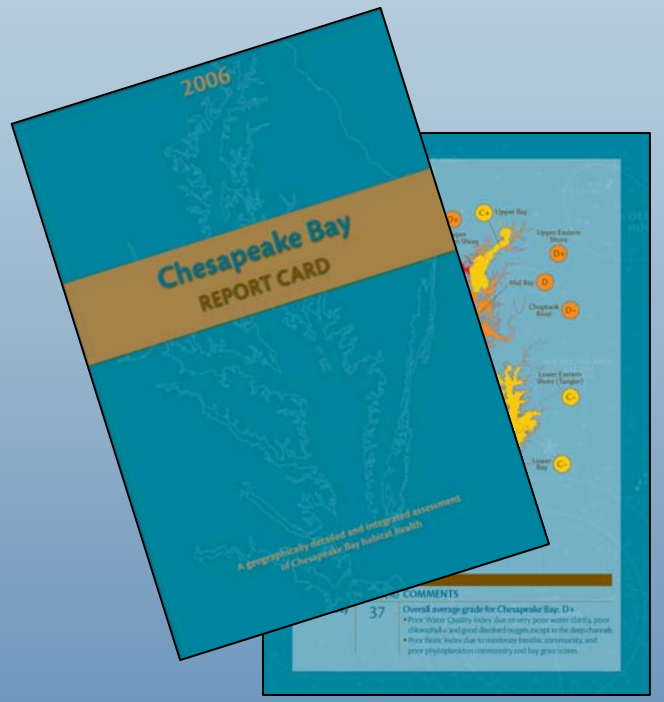
Chesapeake Bay Ecosystem In Poor Shape, Says Researchers

Acknowledgements

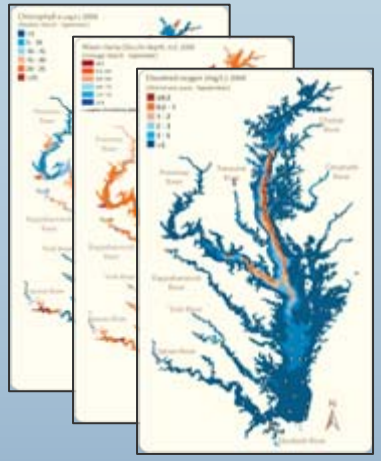
- Ad hoc work group members:
  - Claire Buchanan (ICBRB)
  - Roberto Llansó's (VERSAR)
  - Peter Bergstrom (NOAA)
  - Jackie Johnson, (ICPRB/CBP)
  - Rick Hoffman (VADEQ)
  - Bruce Michael (MDDNR)
  - Richard Lacouture (Morgan State Univ.).
- Member of the Chesapeake Bay Program workgroups
  - Tidal Monitoring and Analysis workgroup
  - Living Resources Analysis workgroup

Why produce a report card

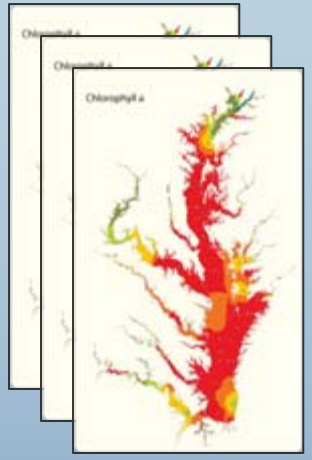
- Provide a performance derived letter or numeric grade to a component of the ecosystem or a geographic region
- Enable large and often complex amounts of information to be communicated to a broad audience
- Can provide accountability; measuring the success of a particular effort
- Identify regions or issues of concern

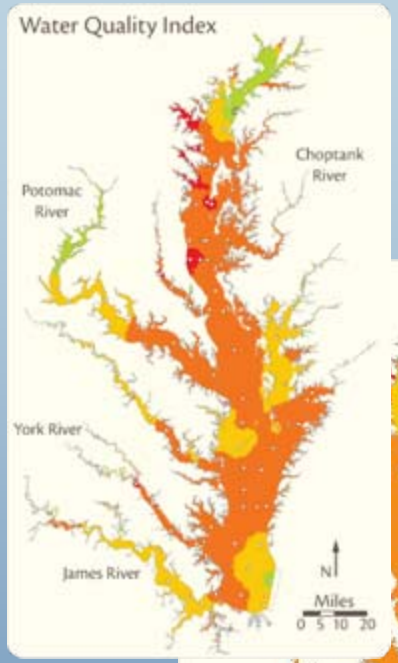


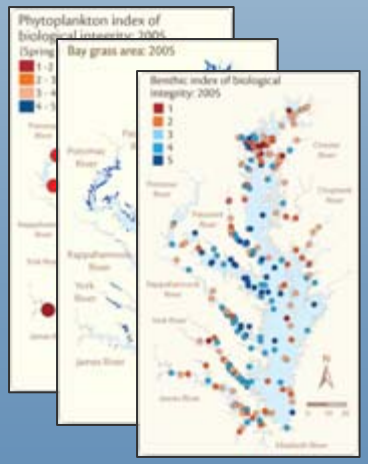
Water quality and biotic indicators combined into indices



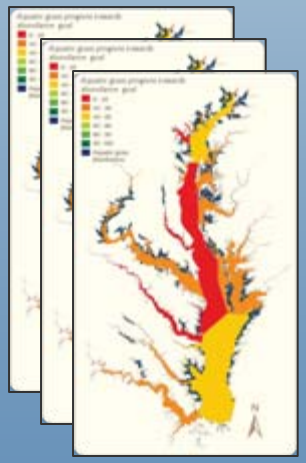
Water quality

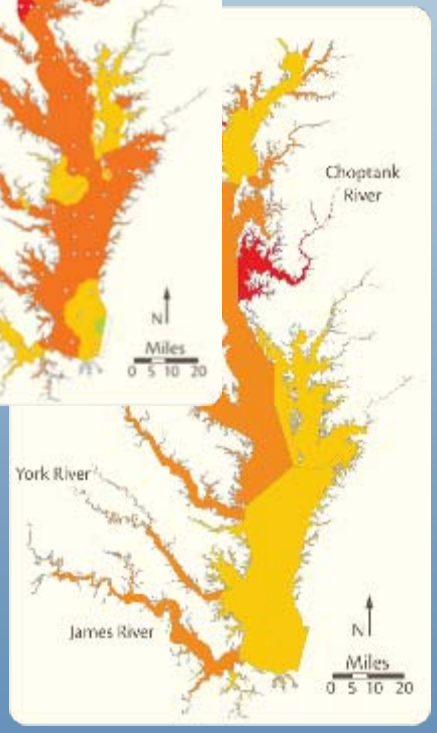






Biotic





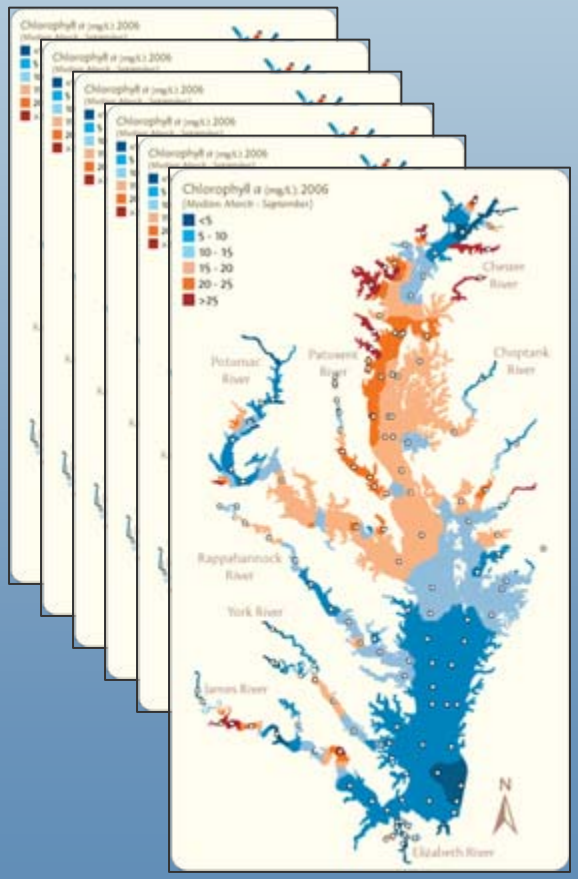
Data integrated

Compared to thresholds

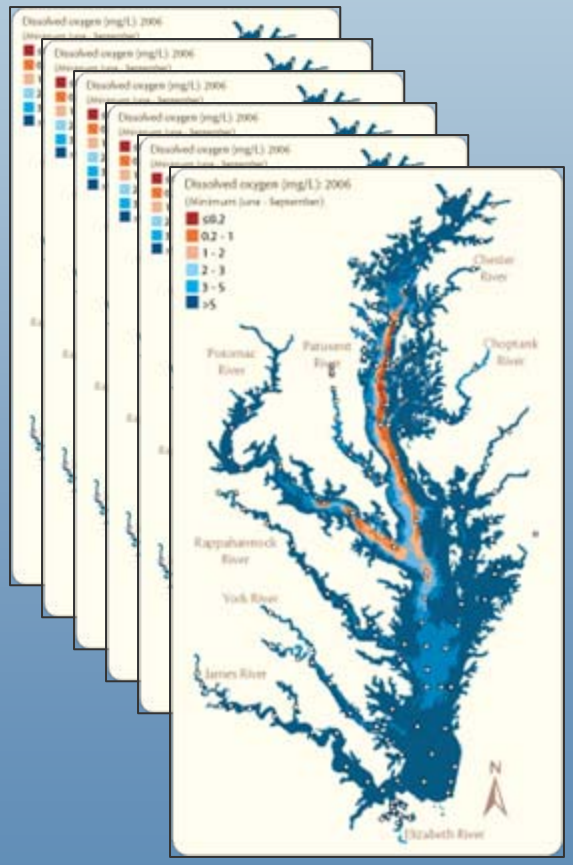
Combined into indices

Water quality indicators measured

Chlorophyll a



Dissolved oxygen



Water clarity