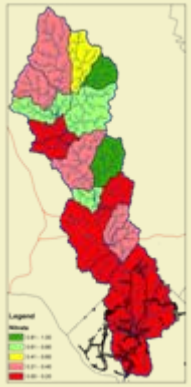
Watershed Condition Assessment for Rock Creek Park in the National Capital Region Network

(WCA for ROCR in NCRN)



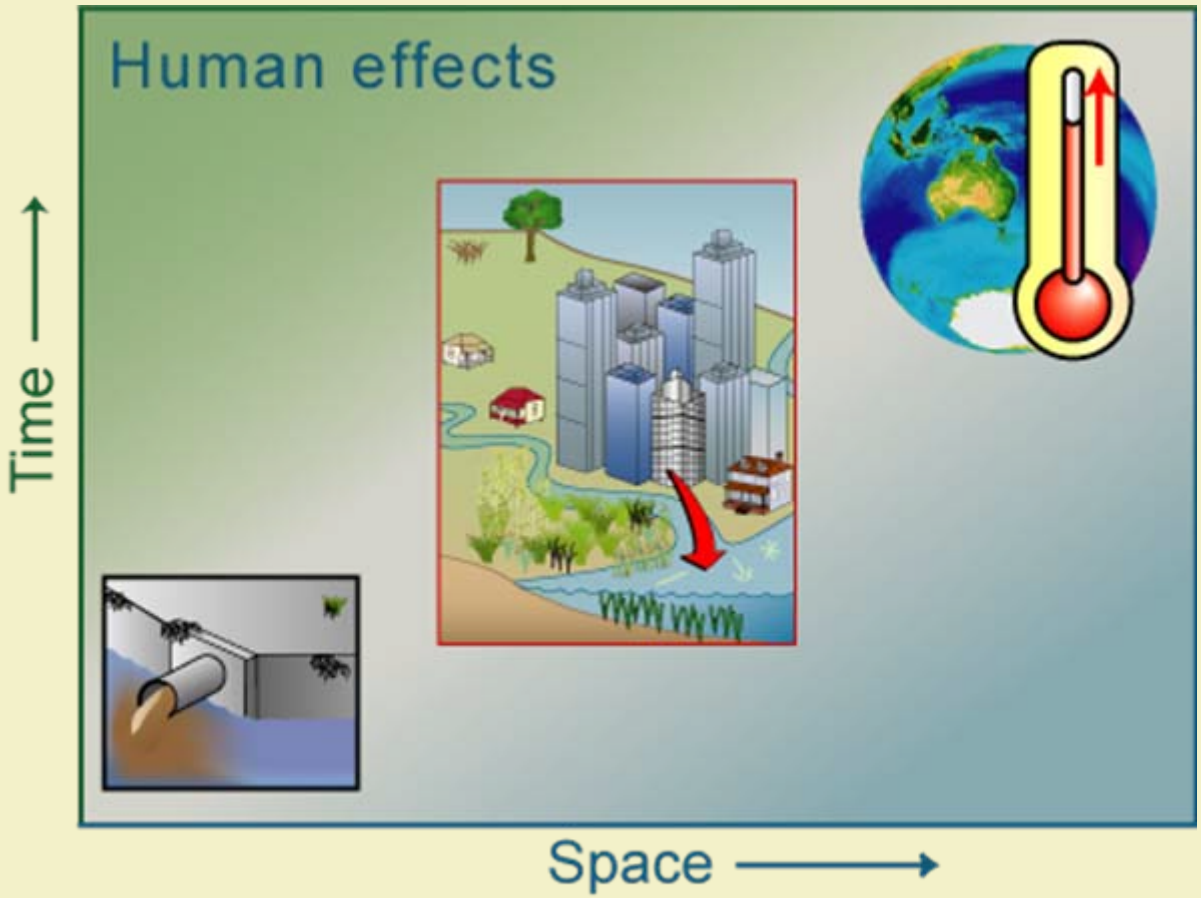
Shawn Carter (NCRN)
Jeff Runde (NCR-CUE)
Marian Norris (NCRN)
Giselle Mora (NCR-RLC)
Geoff Sanders (NCRN)
Pat Campbell
John Paul Schmit

Tim Carruthers
Lisa Florkowski
Bill Dennison
Jane Hawkey
Adrian Jones
Tracey Saxby

University of Maryland
Center for Environmental Science
Todd Lookingbill

Human impacts are at different scales, monitoring is at different scales – what are the implications for watershed condition assessments?

- Human impacts occur over a wide range of both space and time
- Point sources (small:small)
- City development (medium:medium)
- Climate change (large:large)



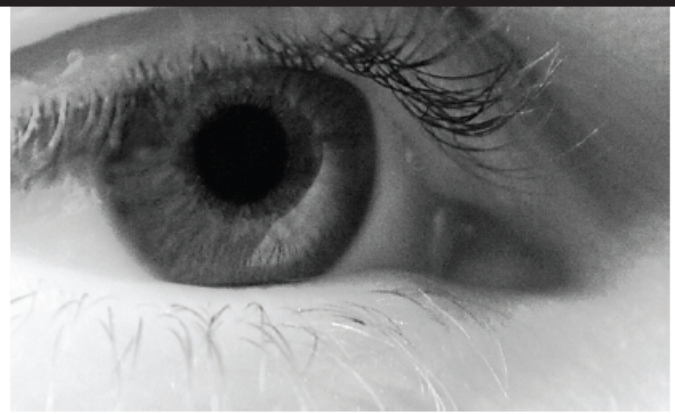
An Eye Opening Approach to Integrated Environmental Assessments

William C. Dennison[1], Todd R. Lookingbill[2], Tim J.B. Carruthers[1], Jane M. Hawkey[1], Shawn L. Carter[3]

ABSTRACT Environmental management is not practiced in a vacuum. Effective stewardship of natural resources requires the adoption of multiple objectives set forth by diverse groups of stakeholders with varied perspectives and interests. Within this management landscape, integrated environmental assessments provide a useful framework for evaluating resources and directing management efforts. The integrated assessment process involves a) initial scoping, b) conceptual ecological modeling, c) data navigation, d) environmental report cards, and e) science communication. Each step of this process requires the synthesis and visualization of information on the spatially explicit status and trends of multiple natural resources. We provide a case study using examples in mid-Atlantic region national parks in which visual elements (conceptual diagrams, maps, graphs, tables, and photographs) facilitate these activities and provide an eye opening approach to more effective environmental decision-making.

IN A NUTSHELL

- The integrated assessment process iteratively distills multivariate data and multiple objectives creating common ground for divergent stakeholders
- The multi-phase process is at least as important as the final products
- Visual elements provide an intuitive framework for summarizing, accessing, and communicating quantitative information
- Conceptual diagrams ('thought drawings') are powerful tools that link key ecosystem features, environmental indicators, and major threats

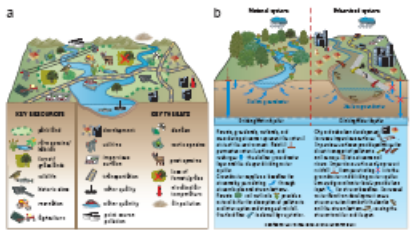


1. INITIAL SCOPING

Locations of the National Parks (red) in the National Capital Region used in the integrated environmental assessment process: 1. Antietam National Battlefield, 2. Catoctin Mountain Park, 3. Chesapeake and Ohio Canal National Historic Park, 4. George Washington Memorial Parkway, 5. Harpers Ferry National Historic Park, 6. Manassas National Battlefield, 7. Monocacy National Battlefield, 8. National Capital Parks-East, 9. Prince William Forest Park, 10. Rock Creek Park, and 11. Wolf Trap National Park for the Performing Arts.

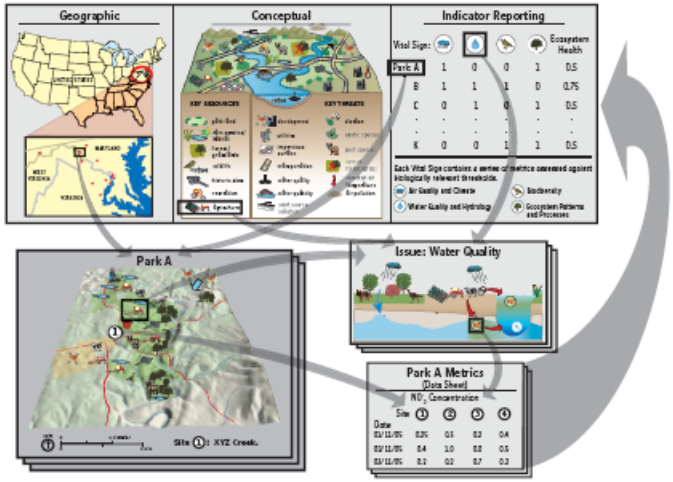
2. CONCEPTUAL ENVIRONMENTAL MODELING

Generalized National Park conceptual diagrams: a) highlighting key resources and major threats and b) detailing changes in stream processes with urbanization.



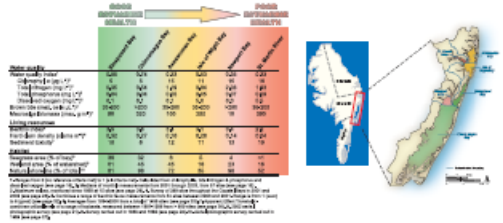
3. DATA NAVIGATION

Data navigation framework used to disseminate environmental data. Environmental indicators, which are measured and put into a data base, can be accessed via three routes: geographic (place-based), conceptual (theme-based), and/or indicator (attribute-based). The geographic route uses an overall map linked to individual park maps. The conceptual route uses an overall conceptual diagram linked to ecological vignettes. The indicator route uses a hierarchal series of general to specific indicators.



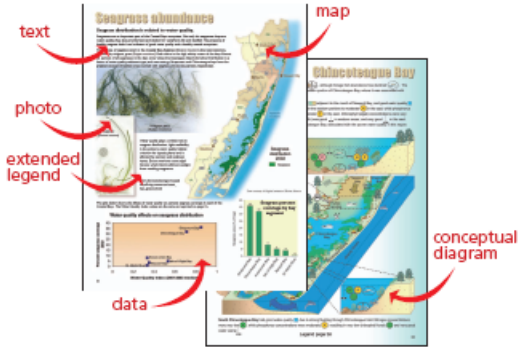
4. ENVIRONMENTAL REPORT CARDS

An environmental report card developed for the Assateague National Seashore region in which water quality, living resource, and habitat indicators are used to rank the sub-watersheds of the coastal embayments behind the barrier islands. Modified from Wazniak *et al.* 2004, *State of the Maryland Coastal Bays* report, www.ian.umces.edu/reports/.

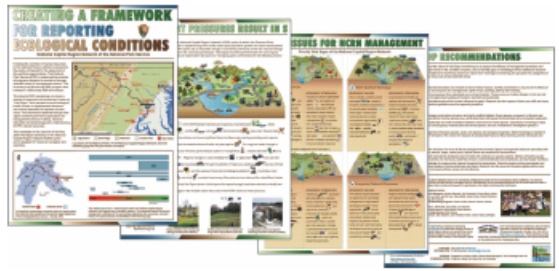


5. SCIENCE COMMUNICATION

An illustration of visual elements of science communication for the Assateague National Seashore region in which a map of water quality index is combined with photographs, data graphs and conceptual diagrams.



This newsletter is the outcome of a May 2005 Vital Signs workshop on the National Capital Region Network parks. A PDF of this newsletter can be found at www.ian.umces.edu/newsletters/.



[1] Integration and Application Network (IAN), University of Maryland Center for Environmental Science, www.ian.umces.edu

[2] Appalachian Laboratory, University of Maryland Center for Environmental Science

[3] National Capital Region Inventory & Monitoring Program, National Park Service, www.nps.gov/cue

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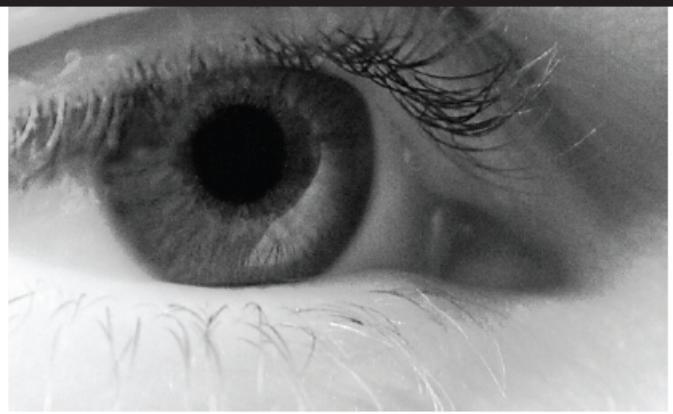

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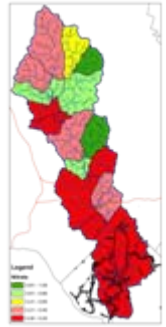
2. *CONCEPTUAL ENVIRONMENTAL MODELING*

3. *DATA NAVIGATION*

4. *ENVIRONMENTAL REPORT CARDS*



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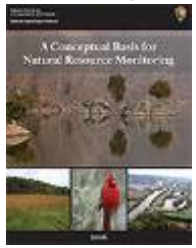

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Values and stressors common to parks of the National Capital Region Network (NCRN)

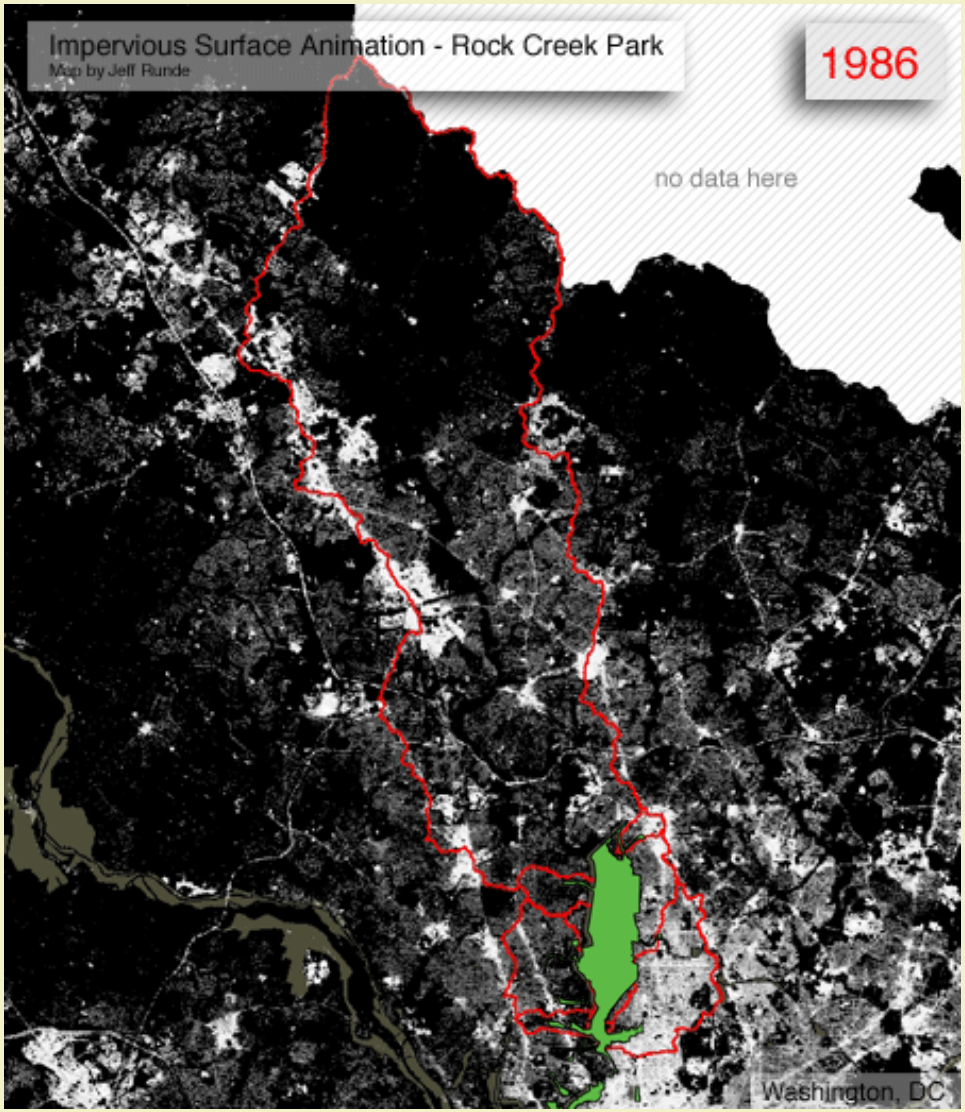
Ecosystem values:

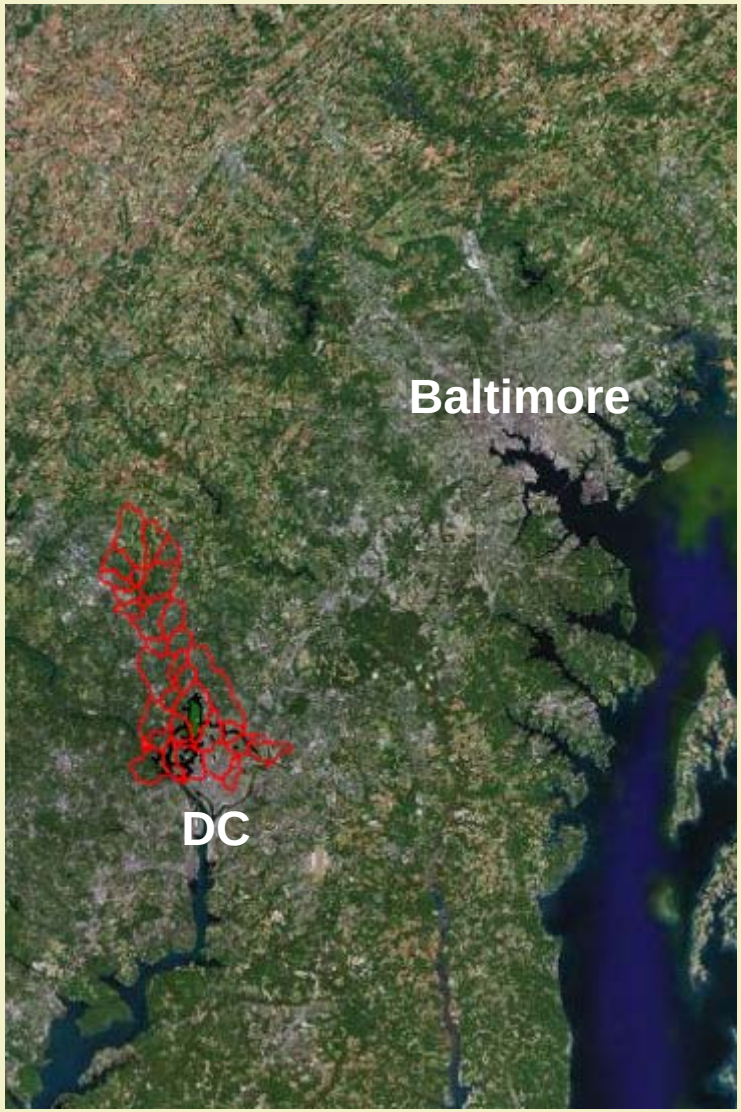
- Water
- Forest
- Grassland
- Wildlife
- Historic
- Recreation

Ecosystem stressors:

- Development
- Exotic species
- Deer overpopulation
- Impervious surface
- Increasing roads
- Pollution (O_3, Hg)

Stressor: Impervious surface around Rock Creek Park is increasing rapidly





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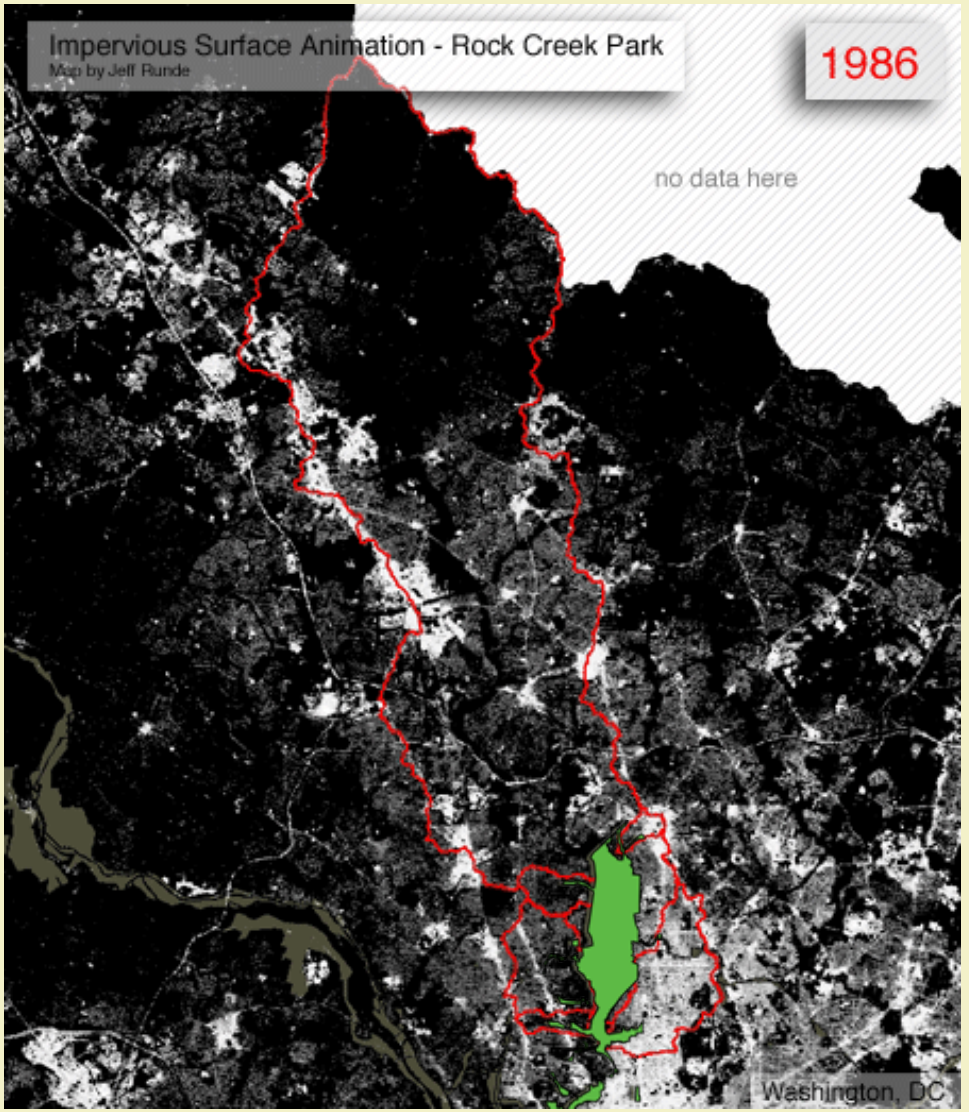
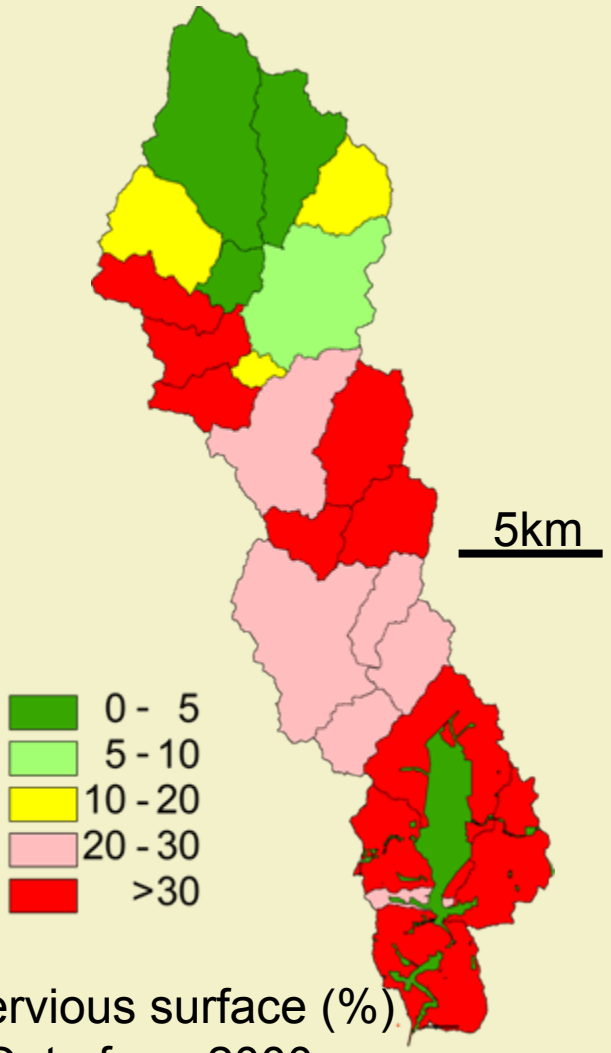
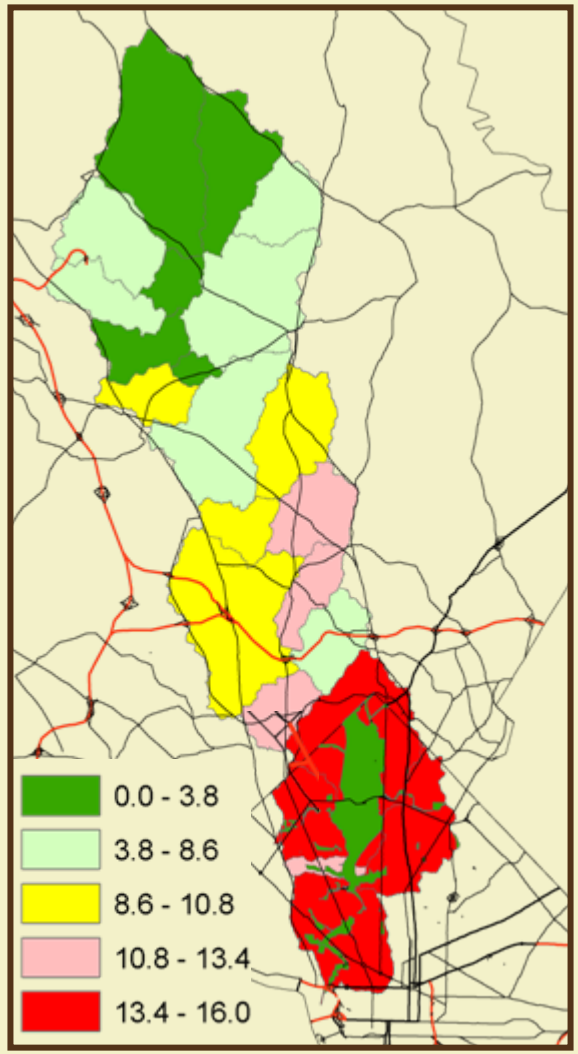




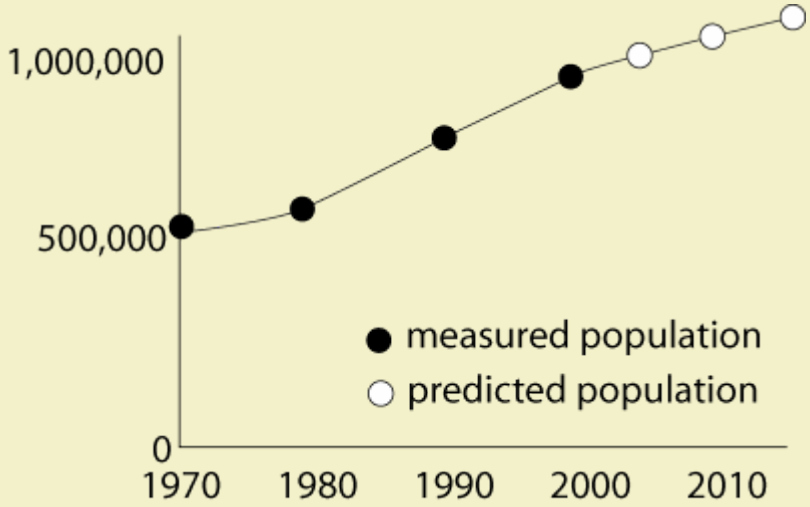
Impervious surface (%)
Data from 2000

Stressor: High road density can introduce exotic species and toxicants

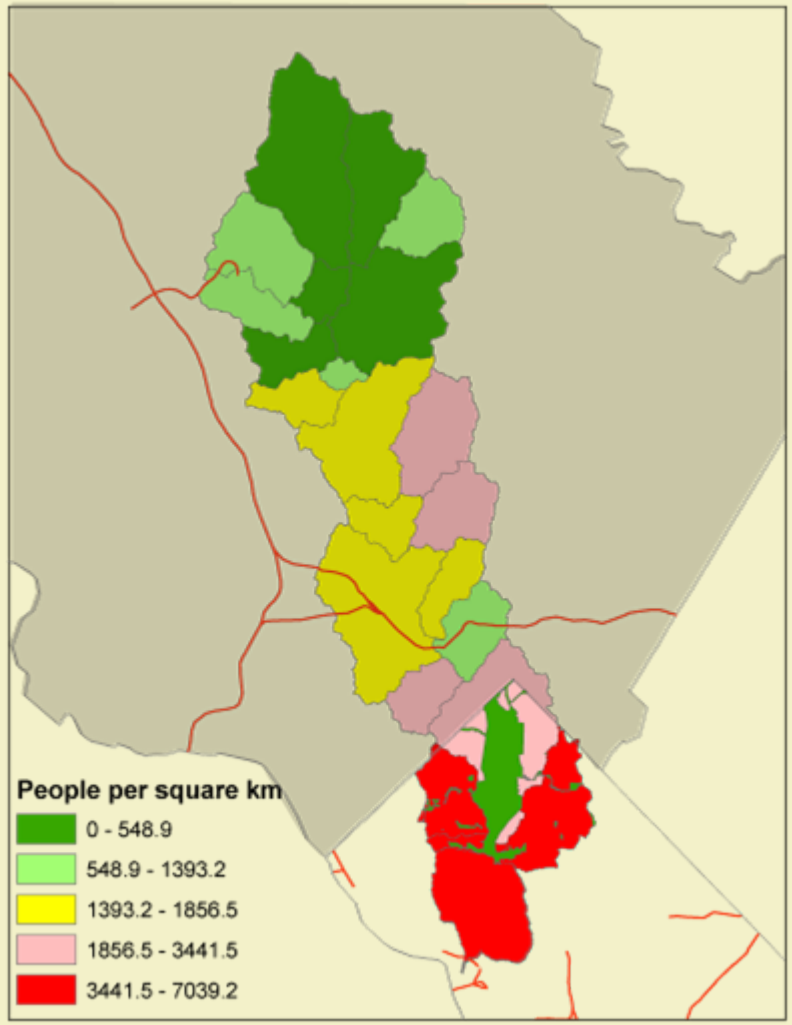


Km road per km^2 watershed

Stressor: human population in surrounding counties continues to increase rapidly



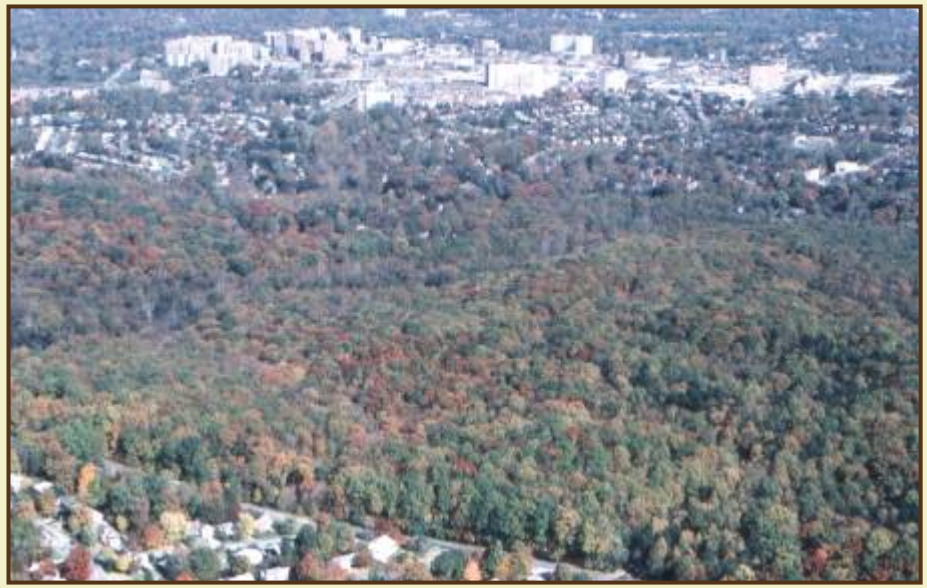
Human population of Montgomery County



Montgomery County

Stressor summary…

Rock creek park is an ecosystem oasis in a continually developing urban watershed

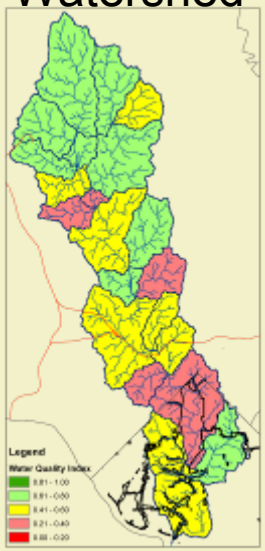


Different data synthesis approaches help to inform management at different scales

Increasing Temporal Scale

Within park

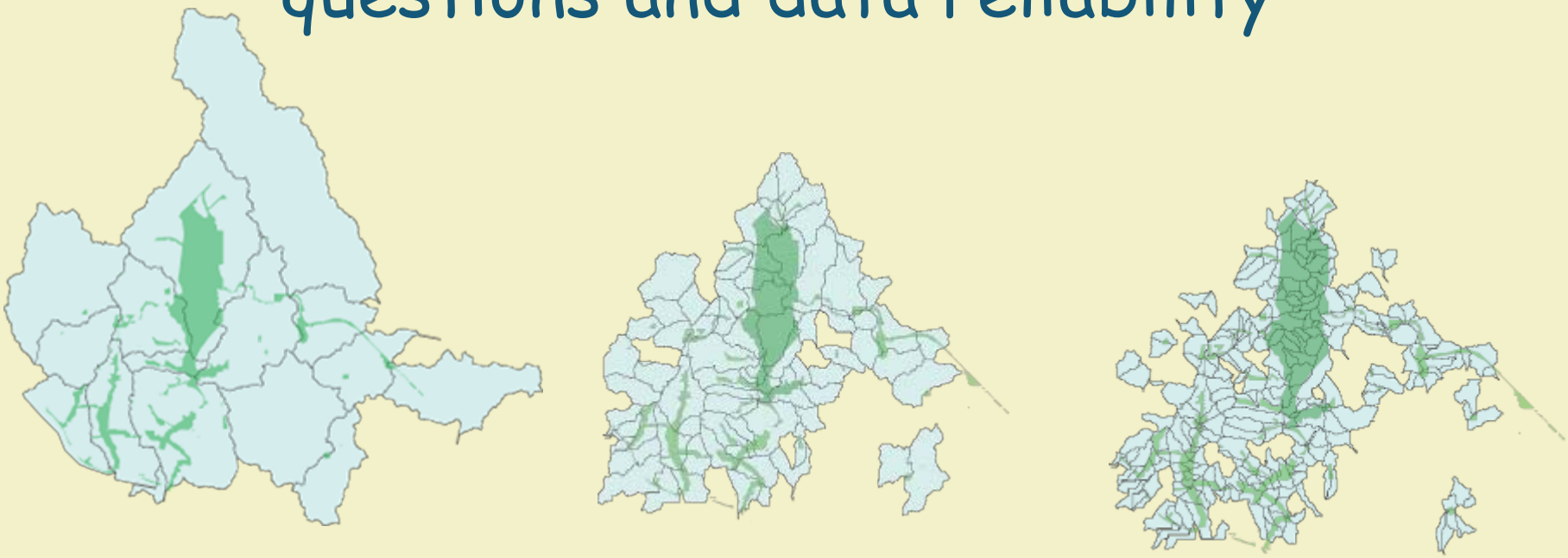
Watershed



Whole Park

Increasing Spatial Scale

Subdividing a park: balancing management questions and data reliability



Increasing detail

Increasing confidence

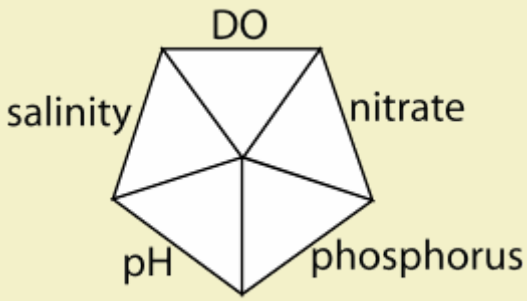
- GIS data layers can be summarized at any subwatershed scale
- Due to classifications, we are more confident in larger divisions

Park preference to use roads and Rock Creek to define regions for ROCR

- 10 regions within ROCR
- Major challenge is inconsistency between scale of data collection and within park comparisons (mainly lack of data density)

Within park assessment of water quality shows generally high phosphorus and salinity

Site	Dissolved O_2	NO_3	PO_4	pH	Salinity	Site Condition
1	0.67	0.78	0.22	1.00	0.67	0.67
2	0.67	0.67	0.00	1.00	0.17	0.50
3	0.88	0.50	0.00	1.00	0.50	0.58
4	0.75	0.25	0.00	1.00	0.17	0.43
5	0.86	0.57	0.00	0.71	0.17	0.46
6	0.89	0.67	0.00	0.78	0.17	0.50
7	0.75	0.75	0.00	1.00	0.00	0.50
8	0.75	0.25	0.00	1.00	0.33	0.47
9	0.78	0.78	0.11	0.78	0.67	0.62

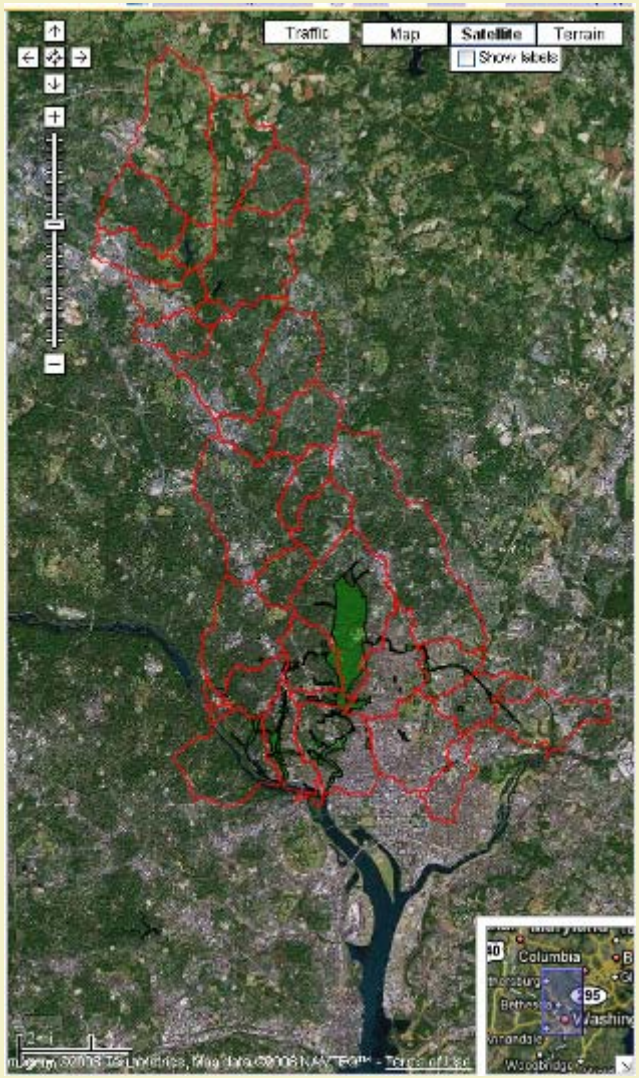


Within park status summary…

Data was often not available at a scale to assess within park patterns (often collected at the ‘park’ scale)

Water quality showed no clear within park patterns – but showed signs of degradation throughout

Watershed perspective: data from a number of sources (Grad student collected WQ data)

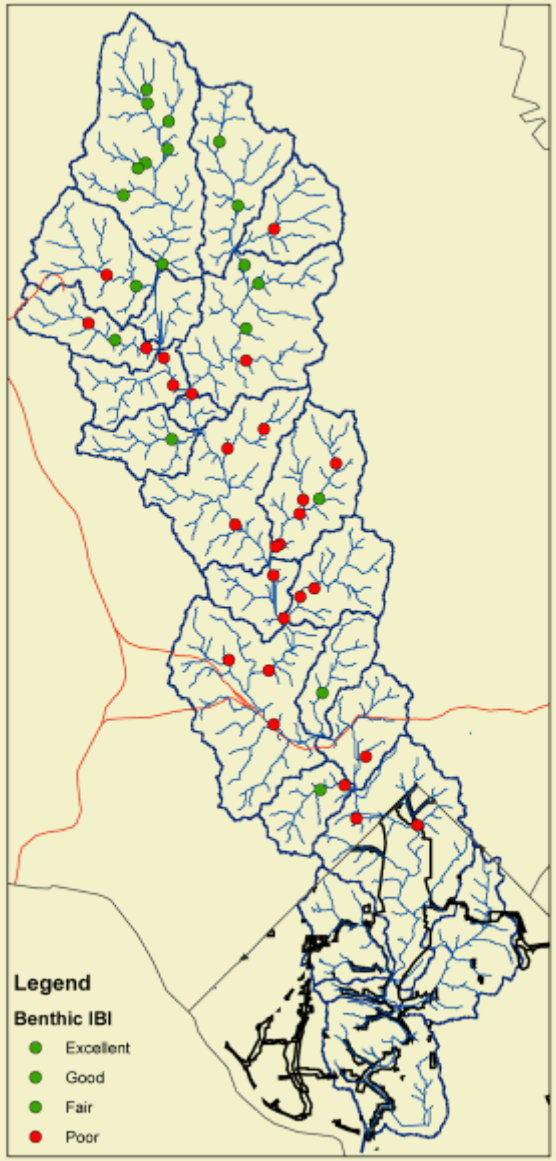


- MDDNR MBSS – 8 sites within the watershed
- Montgomery County – 96 sites within the watershed
- DDOE – 9 sites within the watershed
- FoRCE – 0 sampling sites
- NCRN I&M – 9 sites within the watershed

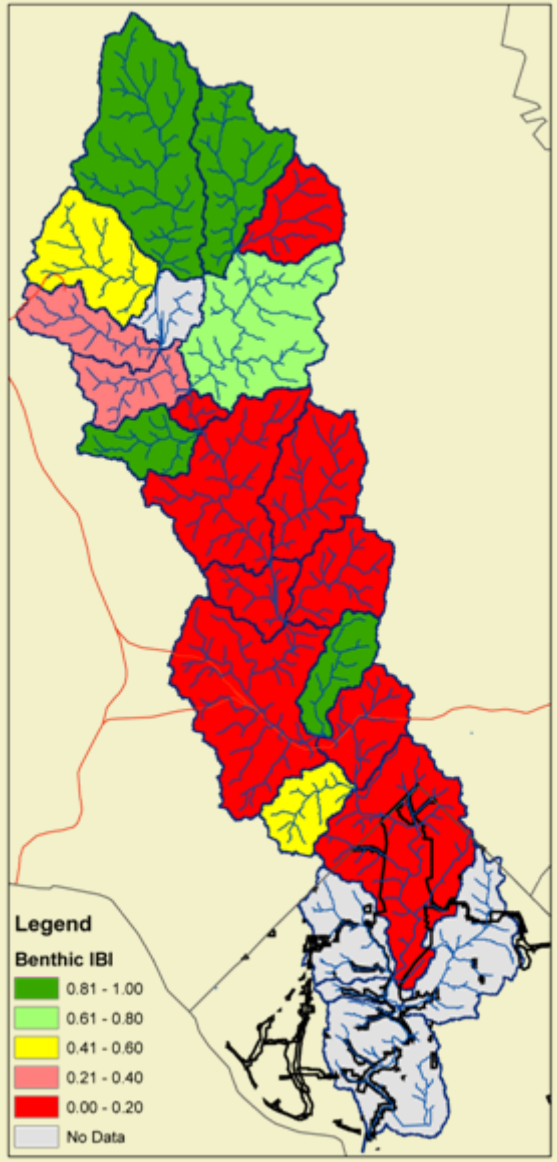
Benthic IBI degrades downstream

Site	IBI	Category
LRCR101A	18.00	Fair
LRCR101B	12.00	Poor
LRJB203A	12.00	Poor
LRJB203B	8.00	Poor
LRJB204	8.00	Poor
LRLB202	8.00	Poor
LRLR201	18.00	Fair
LRLR205	22.00	Fair
LRLR407	8.00	Poor
LRLR410	8.00	Poor
LRLR413	8.00	Poor
LRLR418	12.00	Poor
LRLR422B	8.00	Poor
LRLR425	8.00	Poor
LRLR426	8.00	Poor
LRSB101A	12.00	Poor
LRSB101C	8.00	Poor
LRTB101	12.00	Poor
LRTB202	18.00	Fair
LRTB202A	8.00	Poor
LRTB203A	12.00	Poor

Assessed against threshold value



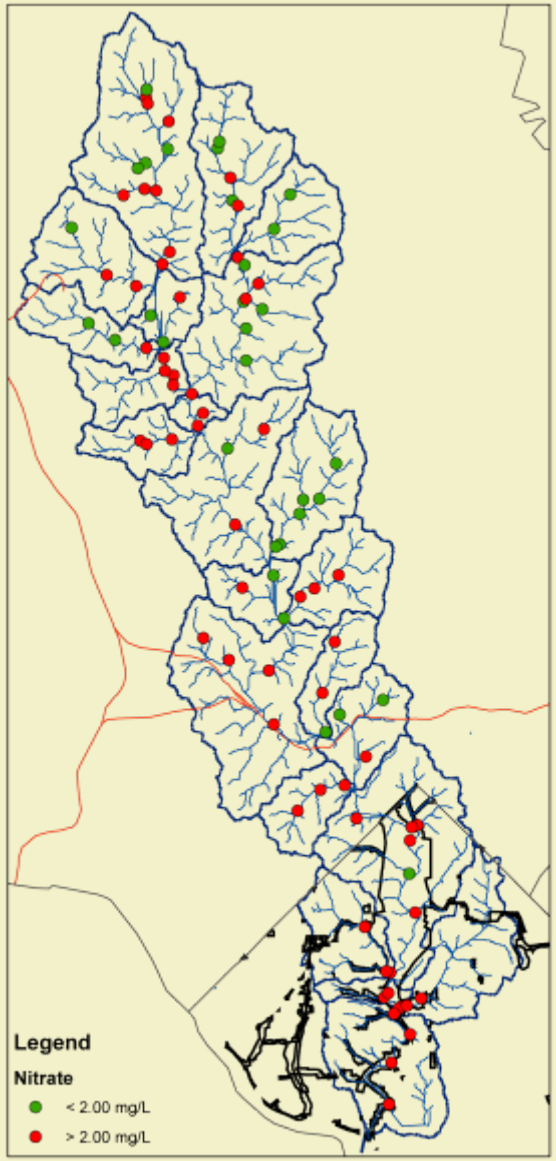
Mean value per subwatershed



Nitrate increases downstream

Site	Nitrate
BRBR	7.25
EGWA	3.50
FEBR	5.13
HACR	9.24
LRCR101A	4.84
LRCR101B	4.15
LRJB203A	6.20
LRJB203B	4.48
LRJB204	1.80
LRLB202	2.11
LRLR201	12.65
LRLR205	7.44
LRLR407	3.73
LRLR410	1.64
LRLR413	2.23
LRLR418	3.56
LRLR422B	3.66
LRLR425	3.74
LRLR426	6.32
LRSB101A	3.84
LRSB101C	0.12

Assessed against threshold value



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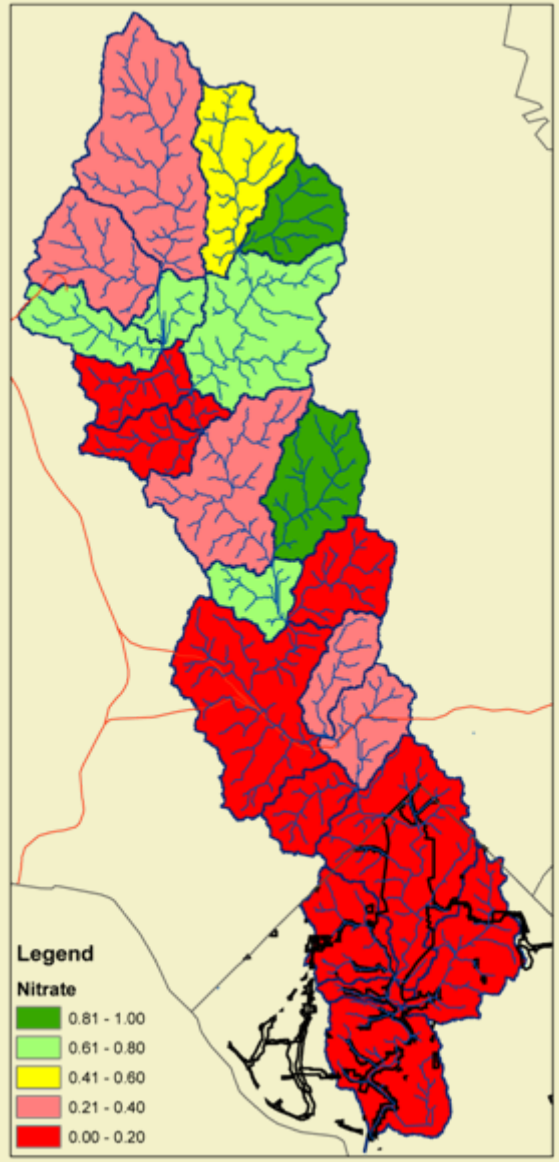
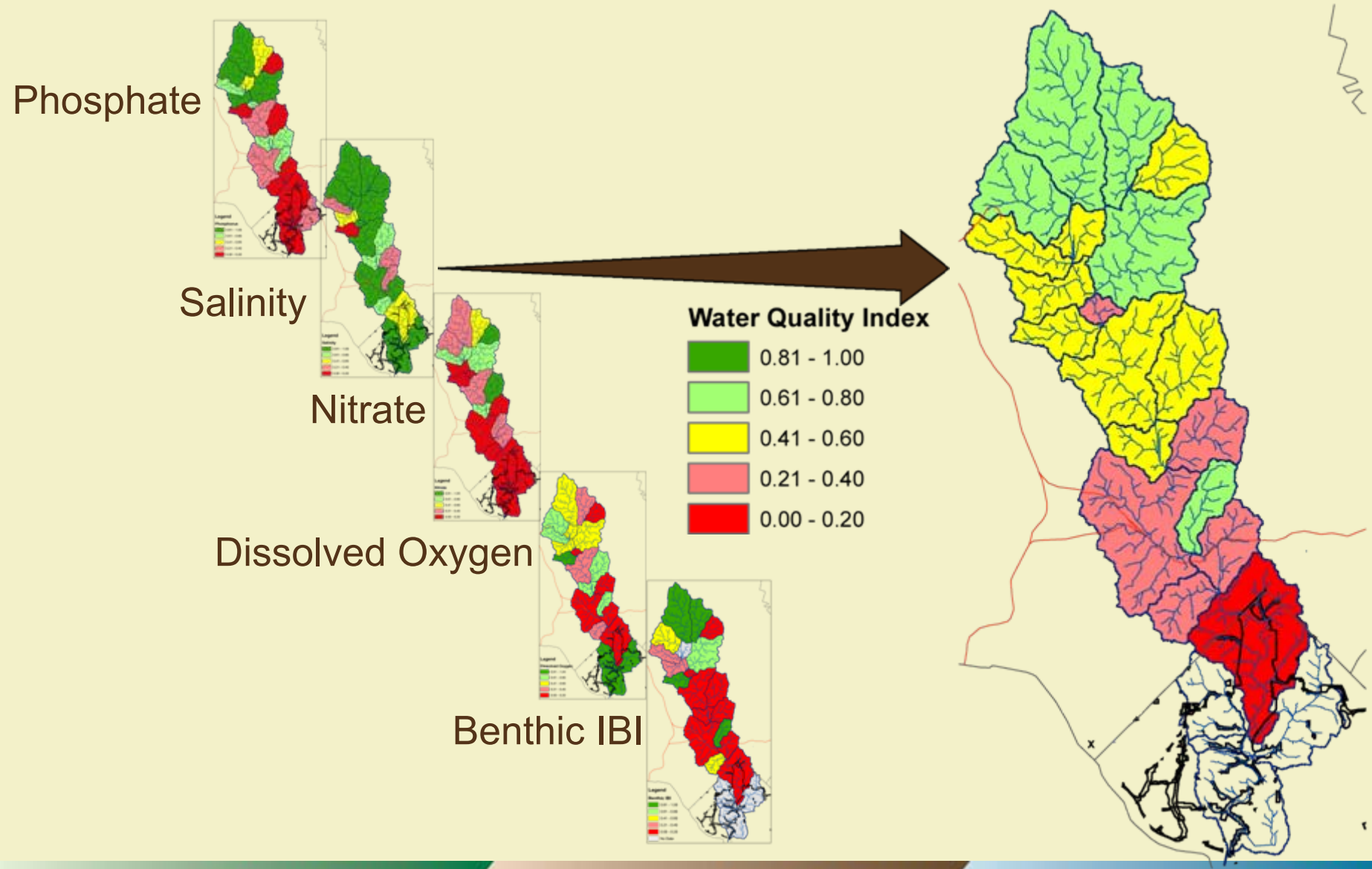


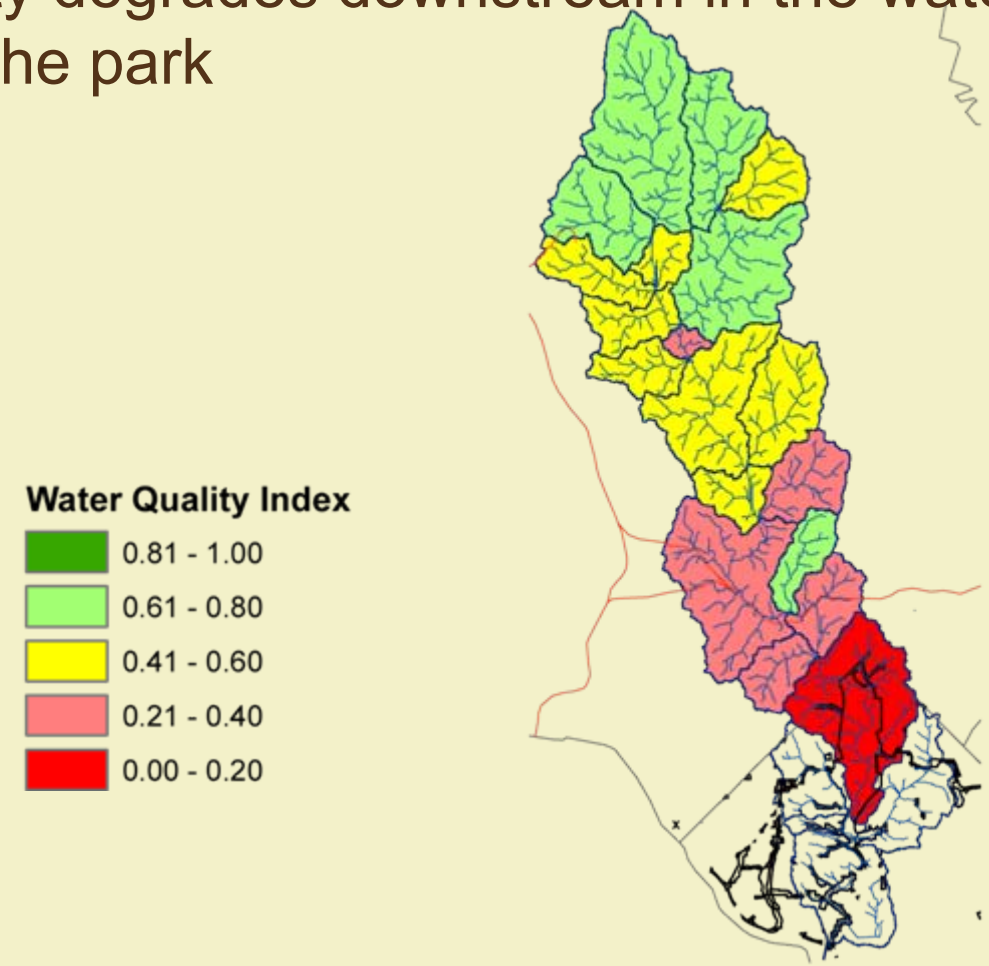
A combined index of water quality shows degradation downstream – towards ROCR



Watershed status summary…

Rock Creek Park is downstream of a highly urban watershed

Water quality degrades downstream in the watershed before entering the park



Current assessment for ROCR

Category	Vital Sign	Data	Threshold (eg EPA)	Attainment (% of time)	Category Score	Park Score
Air quality and climate	O_3	Yes	8 ppm/8 h	0.28	0.28	ROCR 0.43
		Yes	15 µg m^{-3}	0.33		
Water quality and hydrology	O_2	Yes	6.0 ≥ X ≤ 8.5	0.67	0.63	
	P	Yes	36.56 µg L^{-1}	0.49		
		Yes	IBI > 3	0.00		
Biodiversity		Yes	IBI > 3	1.00	0.56	
		Yes	< 10 deer km^{-2}	0.00		
Ecosystem pattern and process		Yes	>10% impervious	0.00	0.25	

Whole park summary assessment

Rock Creek Park has degraded air quality and ecosystem process, poor diversity but good water quality – resulting in an overall poor ecosystem condition within the park.

Air quality and climate	0.28	degraded
Water quality and hydrology	0.63	good
Biodiversity	0.56	poor
Ecosystem pattern and process	0.25	degraded

degraded

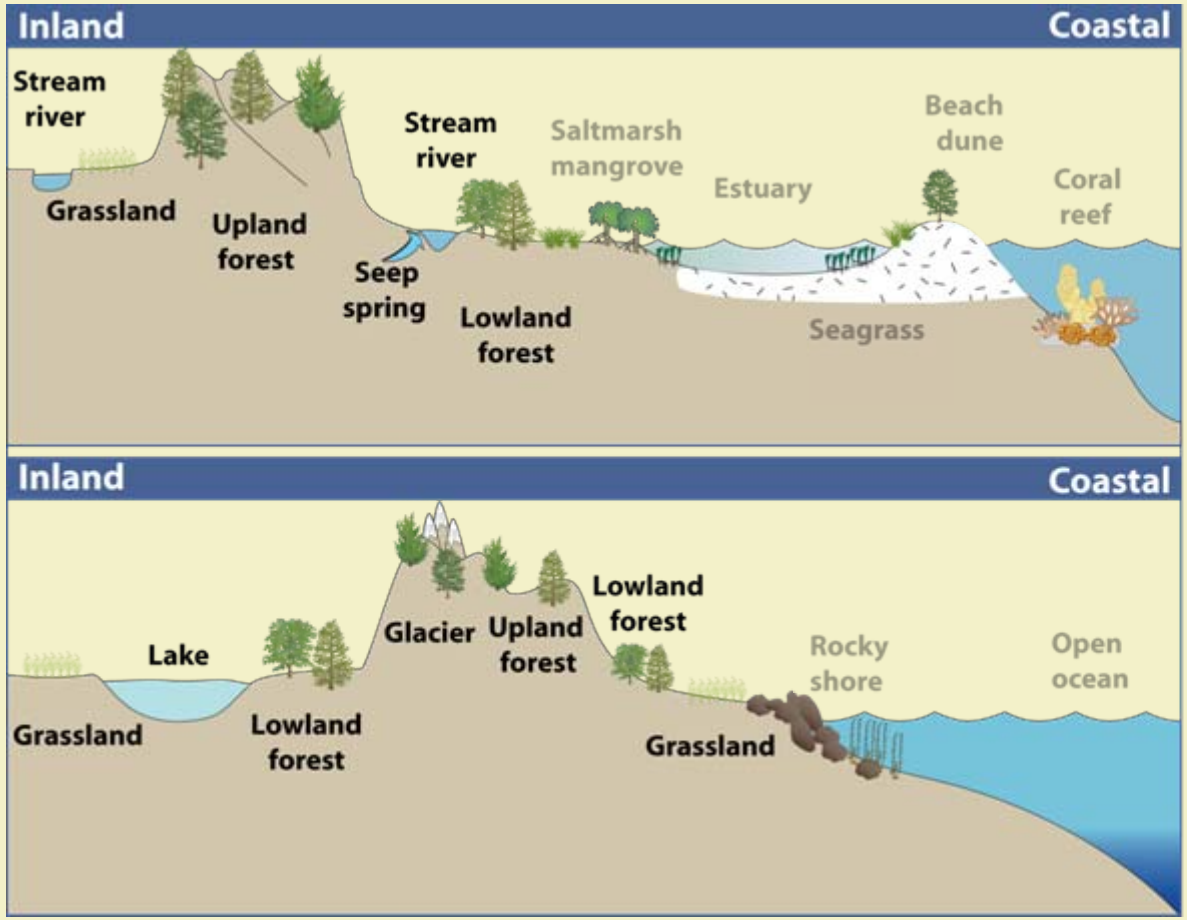
Summary of scales of information and utility..

- Within park – valuable where data is available at appropriate scale
- Watershed assessment – useful for assessing stressors
- Whole park vital signs assessment – useful between parks

But… is there a better way to compare parks while providing detailed information within each park?

- habitat based framework …?

Inland habitats for USA



Habitat types

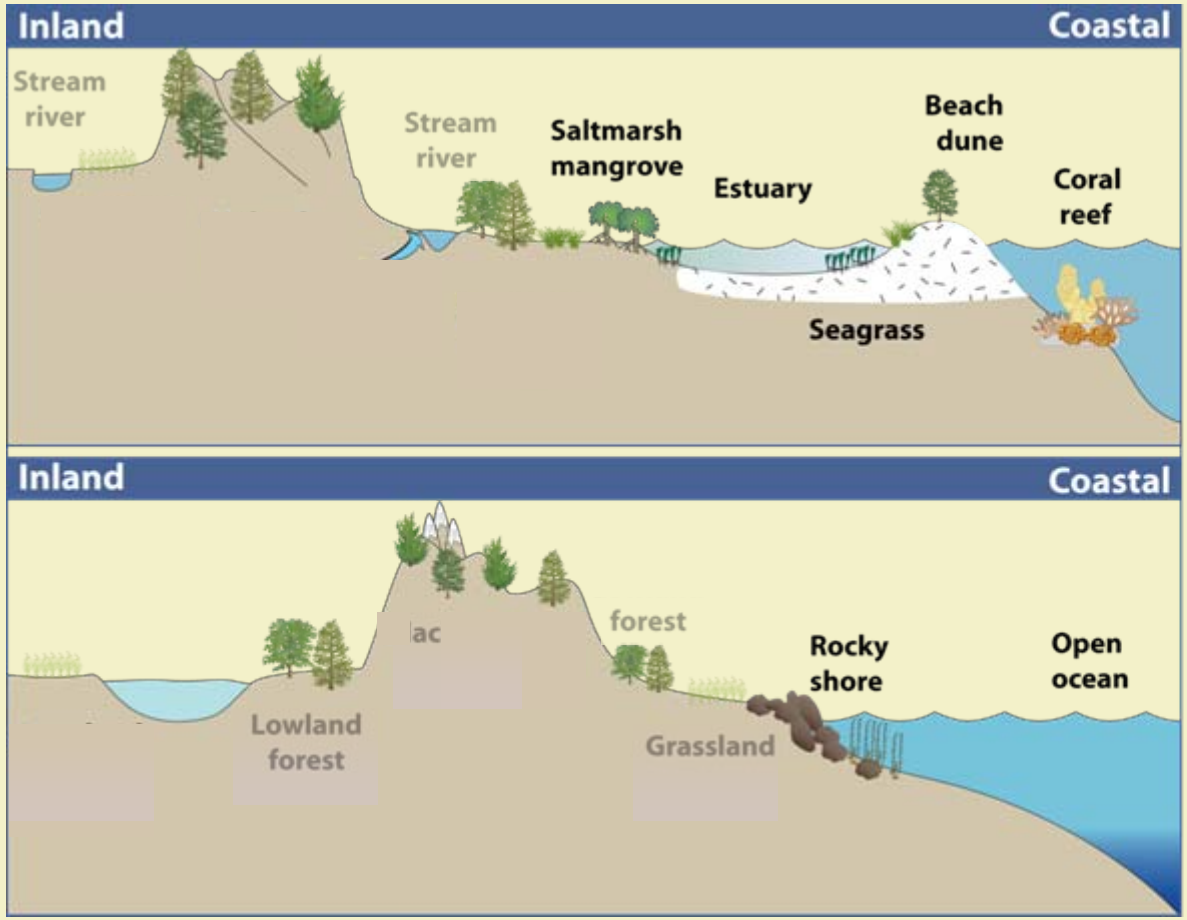
Inland habitats

1. Upland (dry) forest
2. Lowland (wet) forest
3. Grassland
4. Stream/river
5. Seeps/spring
6. Lake
7. Glacier

Coastal habitats

1. Estuarine
2. Saltmarsh/mangrove
3. Seagrass
4. Beach/dune
5. Rocky shore
6. Coral
7. Open ocean

Coastal habitats for USA



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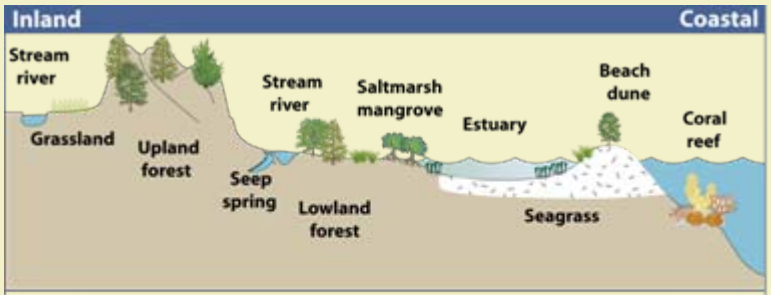
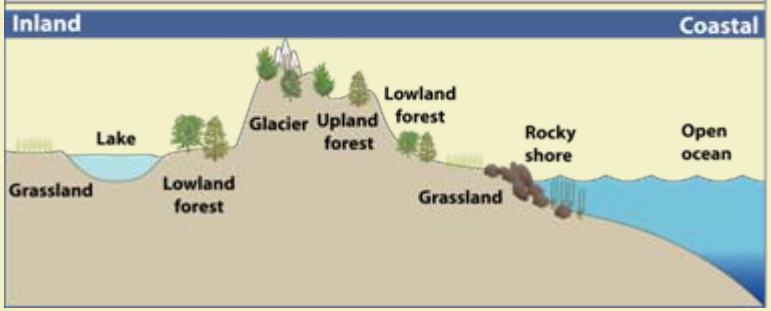
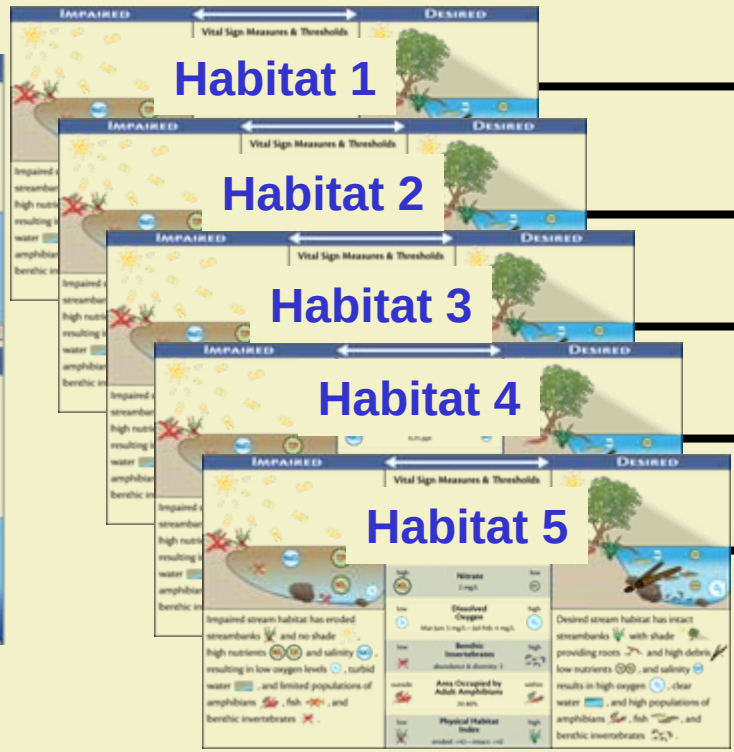
Process of Park habitat assessment

Identify park habitats → assess park habitats → assess park







X

X

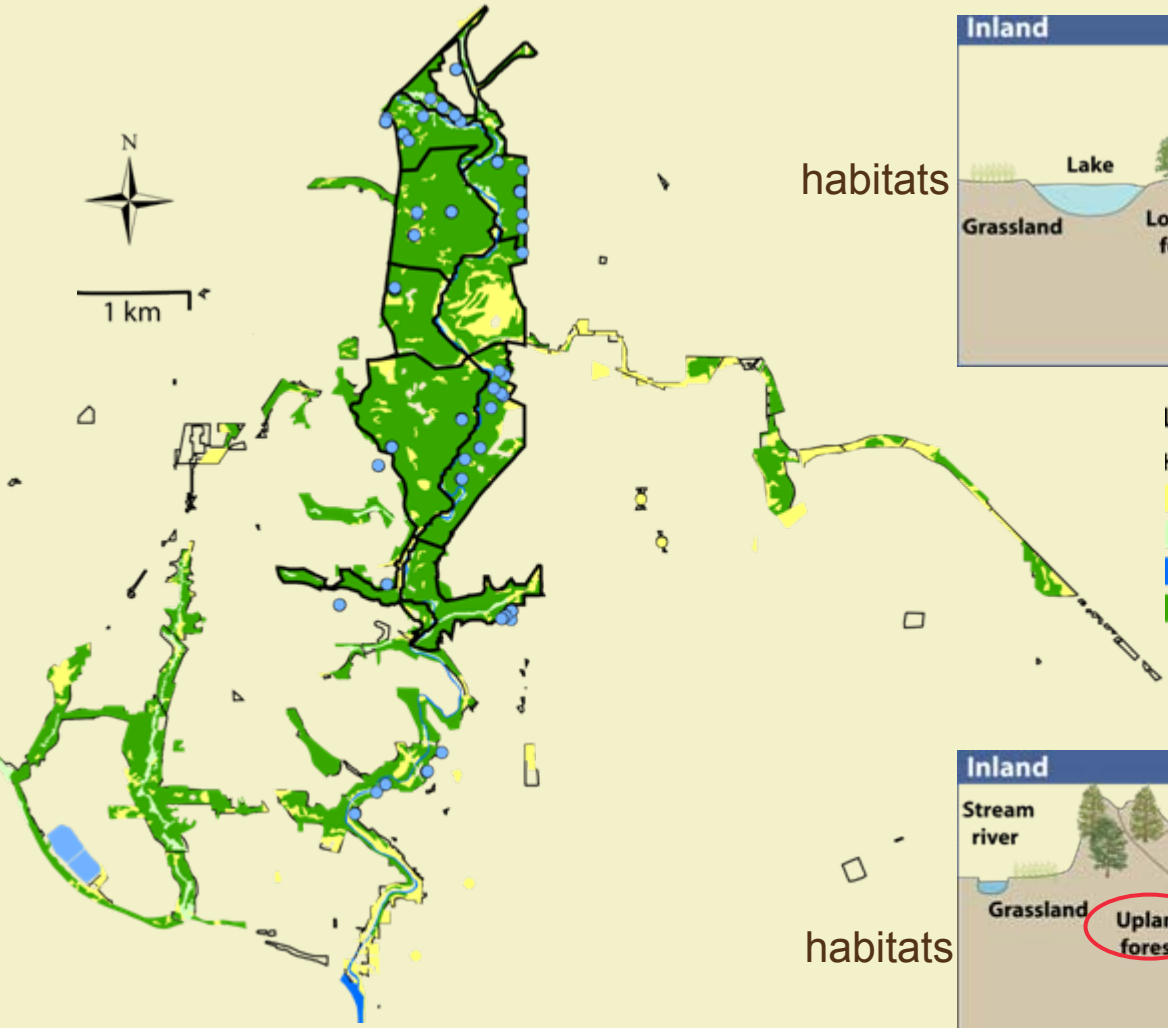
X

X

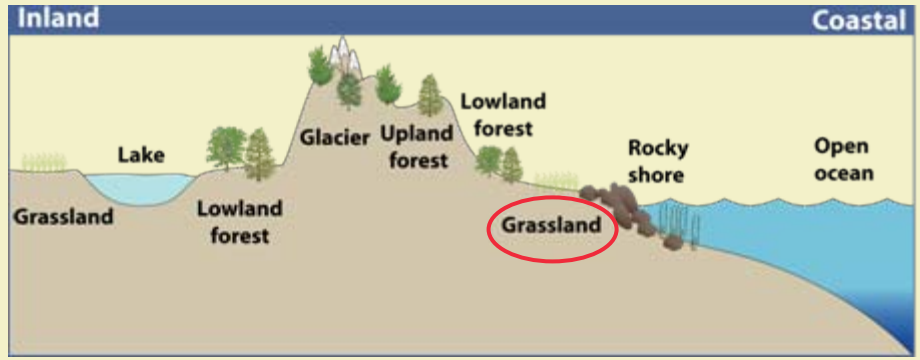
X

Park score

Of the five habitats in Rock Creek Park, upland forest dominates



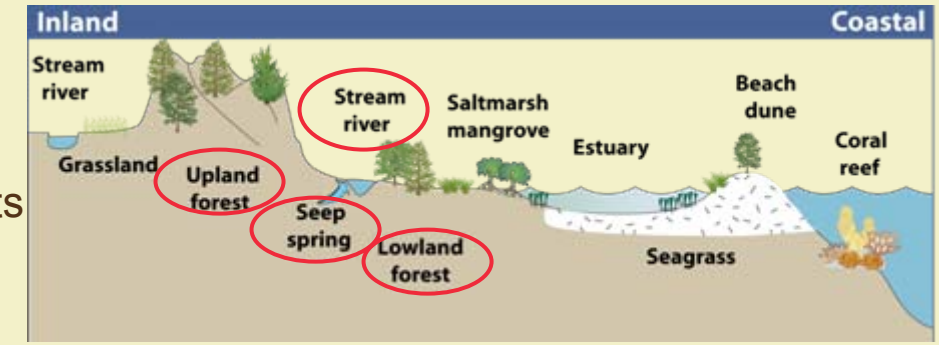
habitats



% area

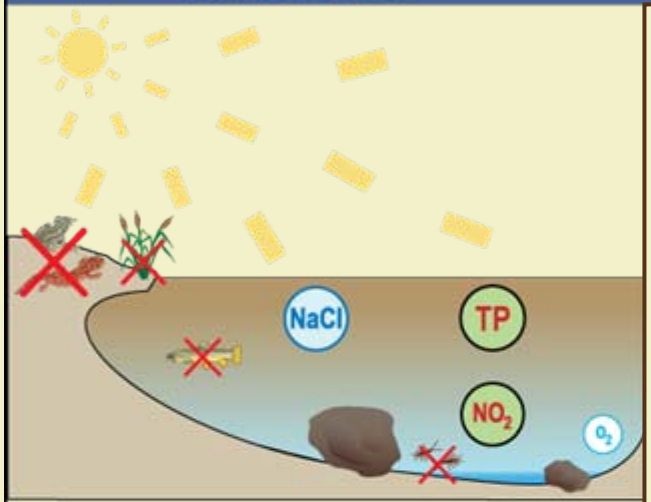
Total area: 1754 acres

habitats



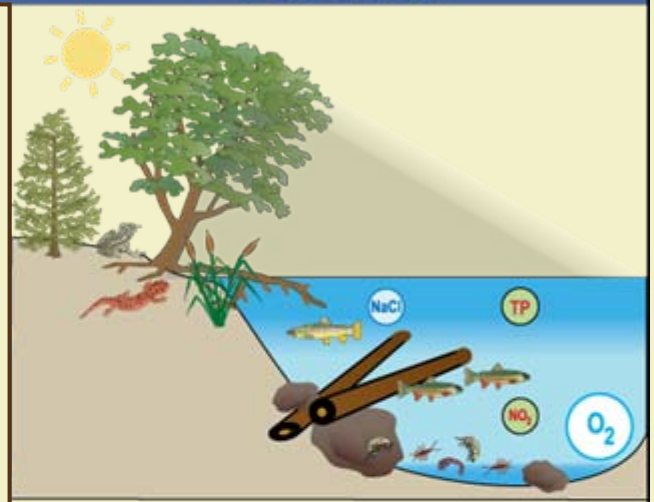
Assessment of stream habitat status

Impaired



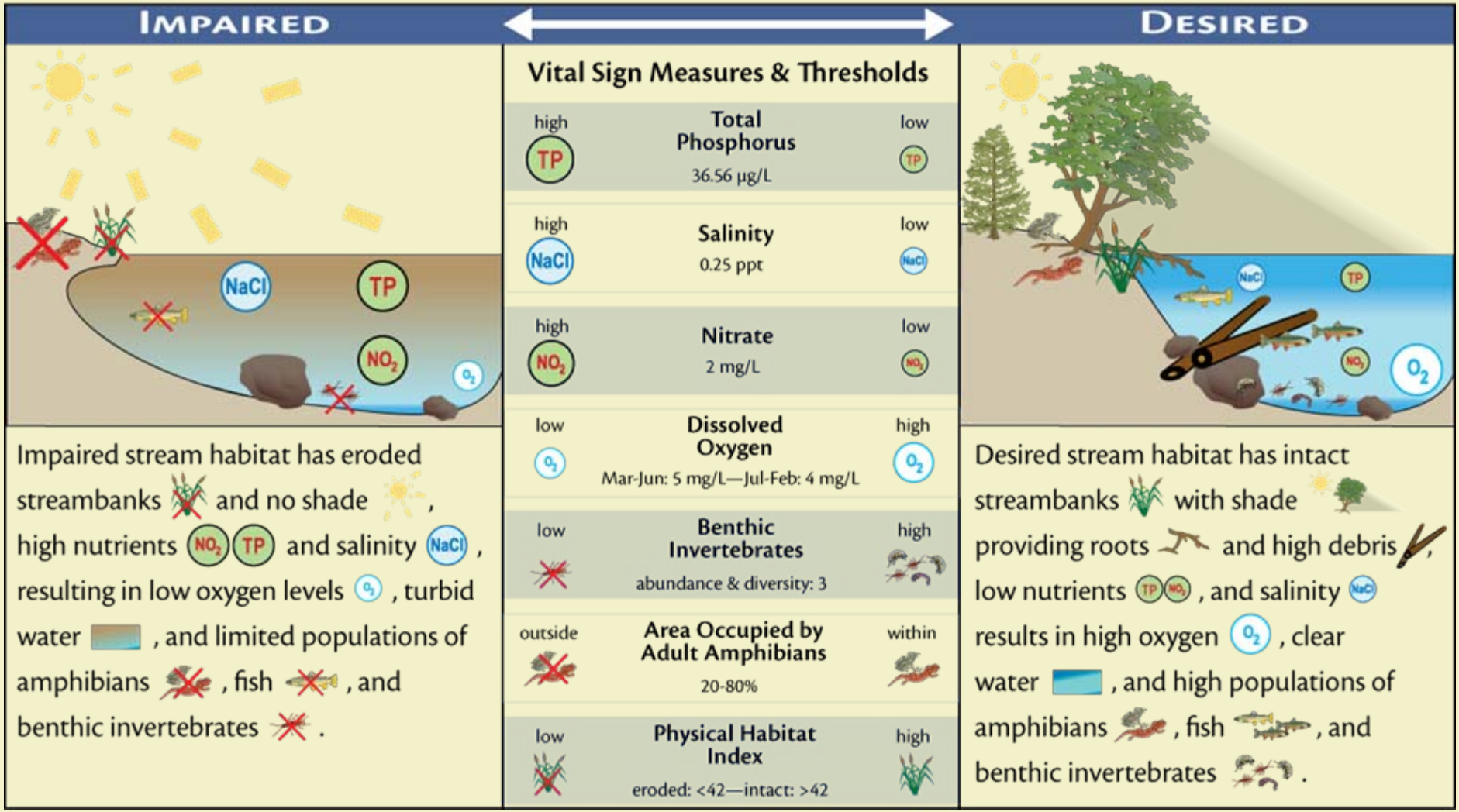
Impaired stream habitat has eroded streambanks and no shade, high nutrients NO_2 TP and salinity NaCl, resulting in low oxygen levels O_2, turbid water, and limited populations of amphibians, fish, and benthic invertebrates.

Desired

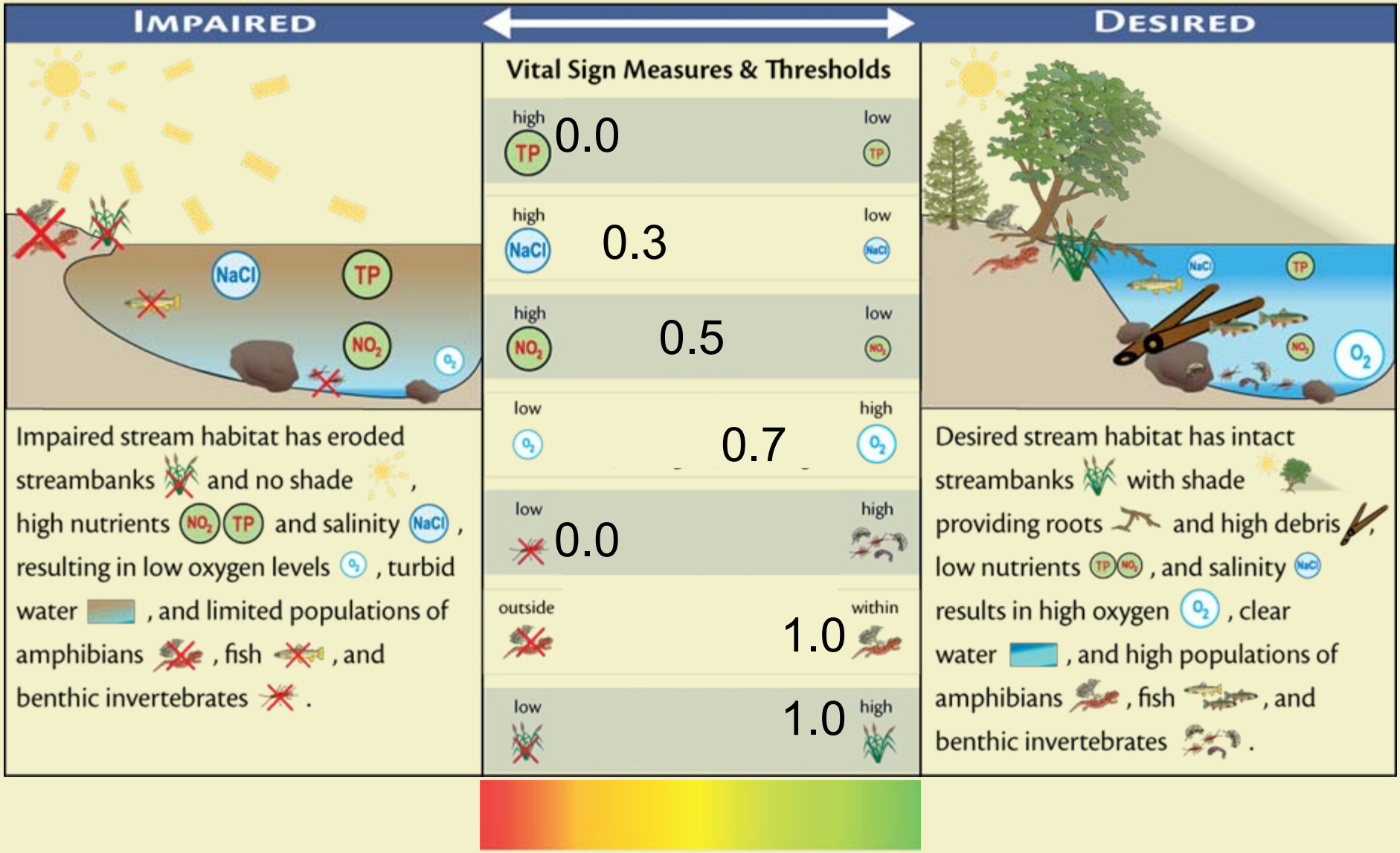


Desired stream habitat has intact streambanks with shade providing roots and high debris, low nutrients TP NO_2, and salinity NaCl results in high oxygen O_2, clear water, and high populations of amphibians, fish, and benthic invertebrates.

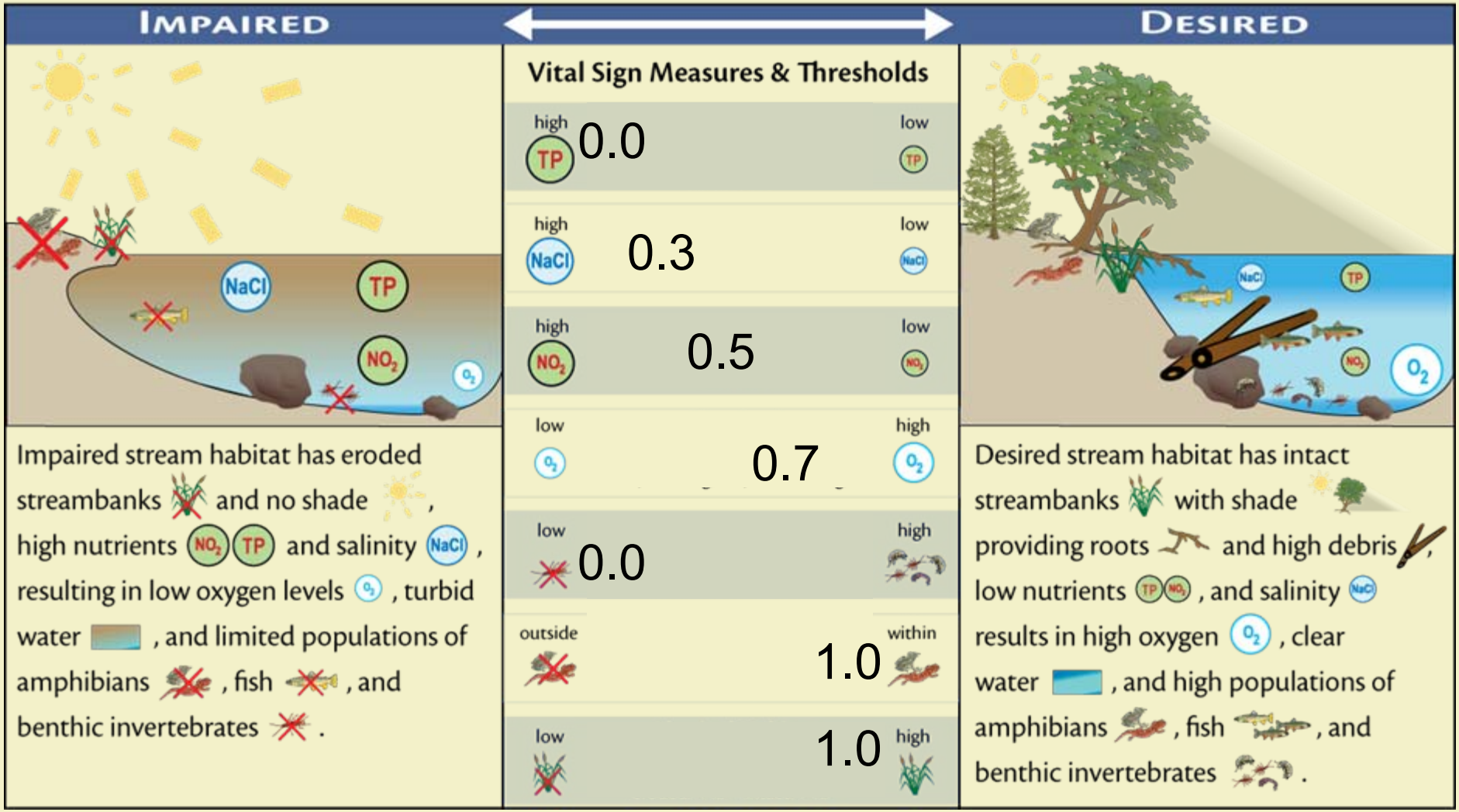
Assessment of stream habitat status



Status of stream habitats in ROCR



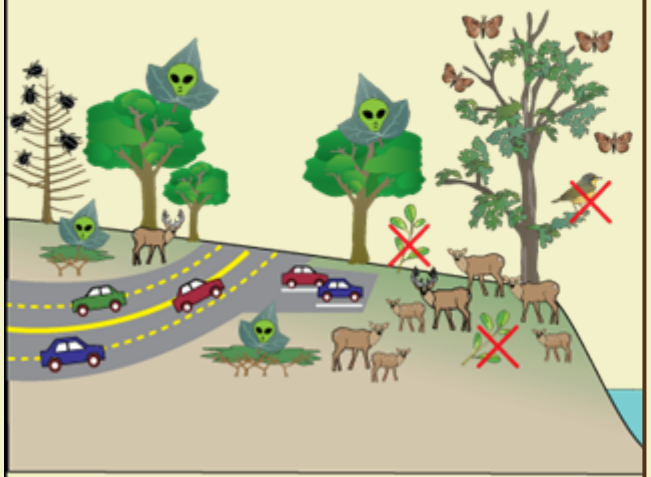
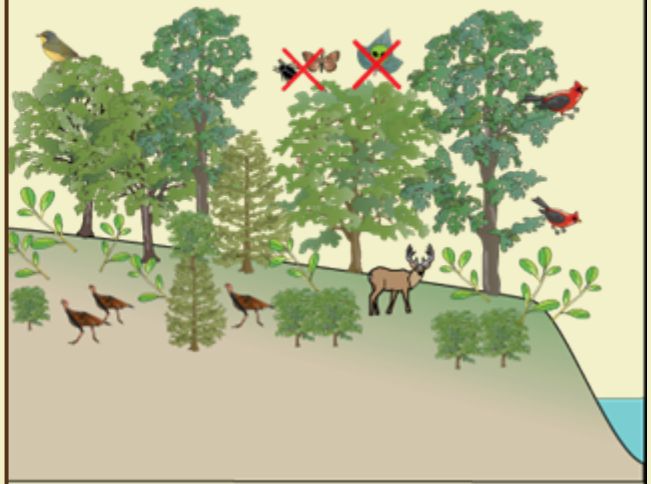
Status of stream habitats in ROCR



Stream habitat status 0.58

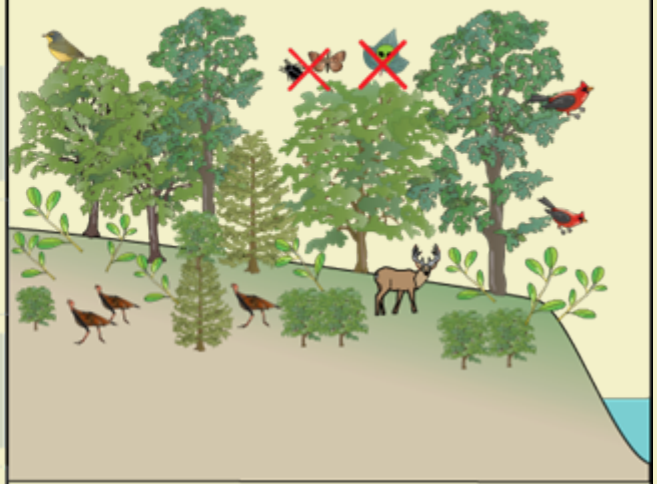
Assessment of upland forest habitat status

Upland (dry) Forest

IMPAIRED	DESIRED
	
Impaired upland forest has high numbers of alien shrubs and trees , high percentage of impervious surface , and large deer populations . Native seedling regeneration and diversity of forest-dwelling bird species are low in patch forest with high occurance of insect pests .	Desired upland forest has low numbers of exotic shrubs and trees , low percentage of impervious surface , and small deer populations . Native seedling regeneration and diversity of forest-dwelling bird species are high in continuous forest with low occurance of insect pests .

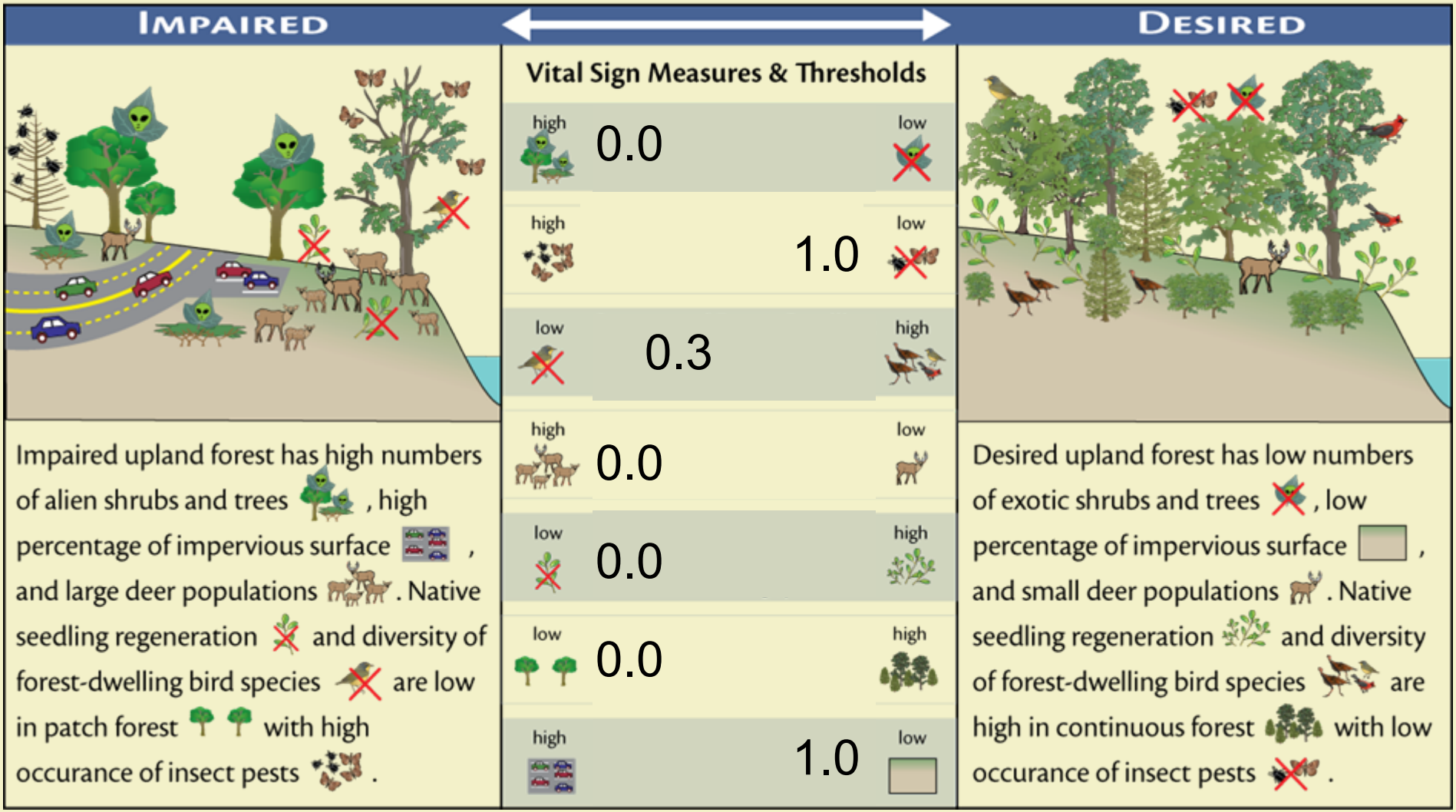
Assessment of upland forest habitat status

Upland (dry) Forest

IMPAIRED	Vital Sign Measures & Thresholds	DESIRED
	high — **Density of Exotic Shrubs & Trees** — low high: >5%—low: <5%	
	high — **Presence of Insect Pests** — low abundant:	
	low — **Presence of Forest-Dwelling Bird Species** — high low: 1 species—high: 5 species	
	high — **Deer Population** — low high: >8/km²—low: <8/km²	
	low — **Native Seedling Regeneration** — high # native seedlings/plot	
	low — **Forest Connectivity** — high low: <360m—high: >360m	
	high — **Percentage of Impervious Surface** — low high: >10%—low: <10%	
Impaired upland forest has high numbers of alien shrubs and trees, high percentage of impervious surface, and large deer populations. Native seedling regeneration and diversity of forest-dwelling bird species are low in patch forest with high occurance of insect pests.		Desired upland forest has low numbers of exotic shrubs and trees, low percentage of impervious surface, and small deer populations. Native seedling regeneration and diversity of forest-dwelling bird species are high in continuous forest with low occurance of insect pests.

Status of upland forest in ROCR

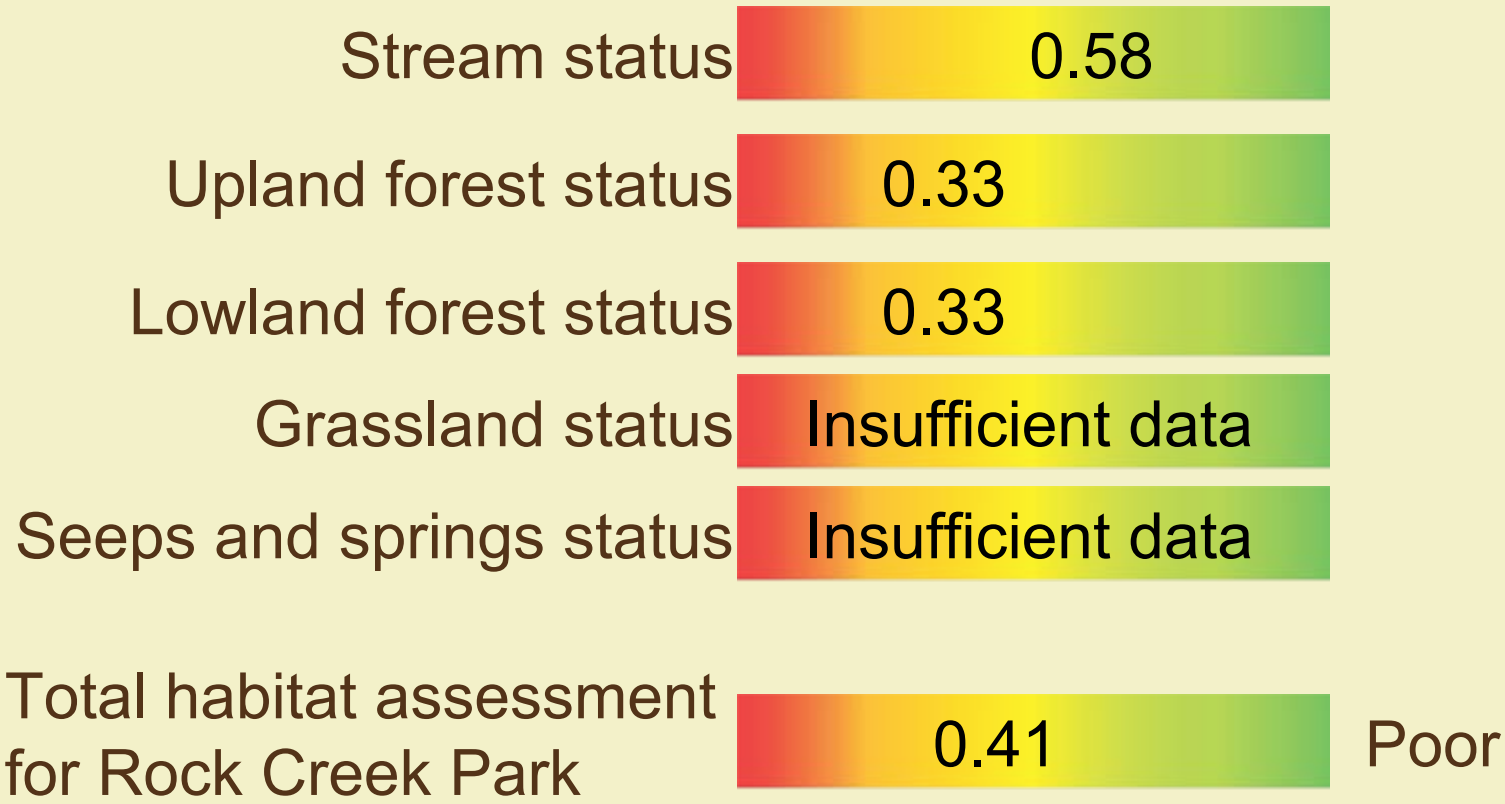
Upland (dry) Forest



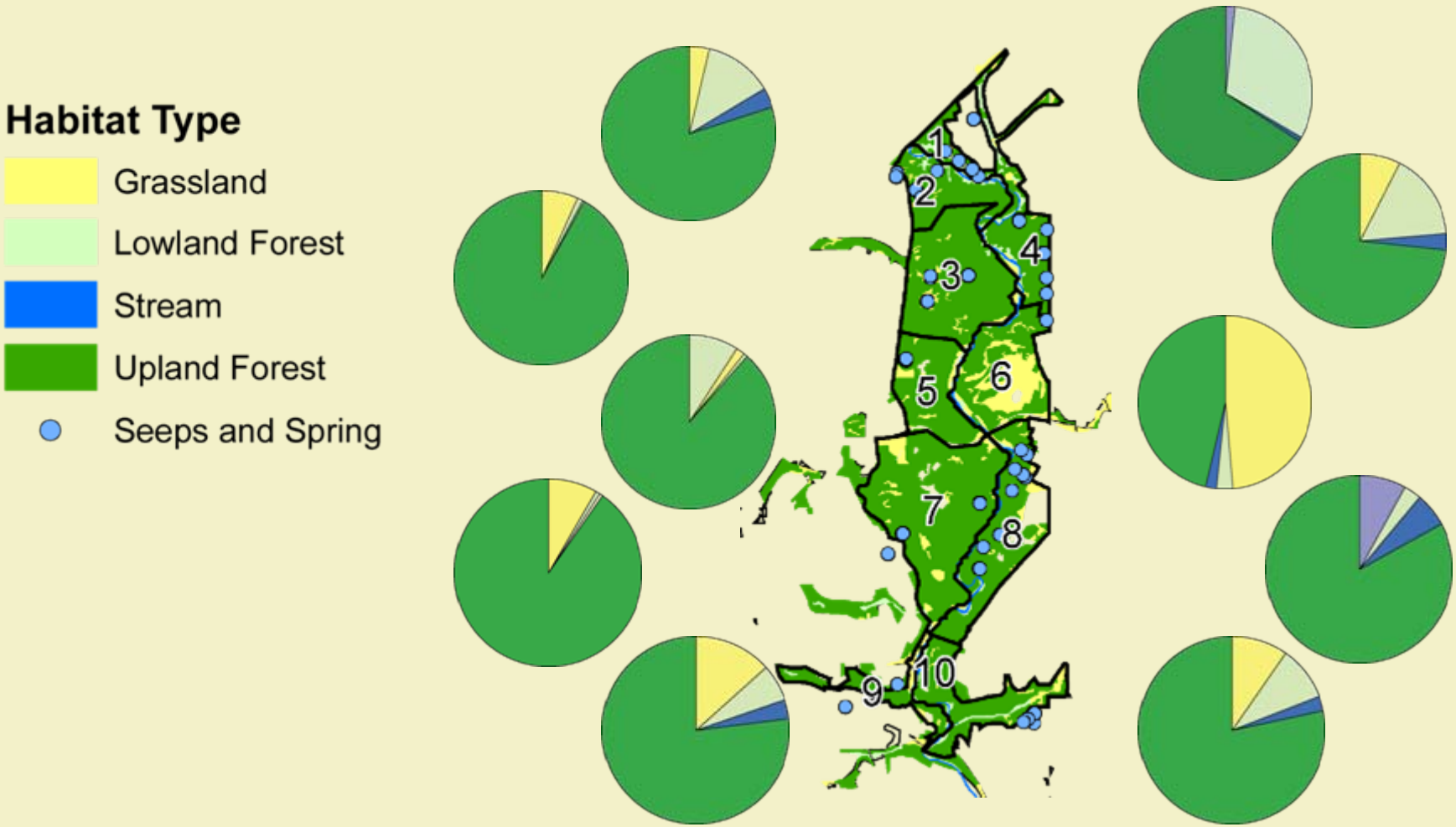
Upland forest status 0.33

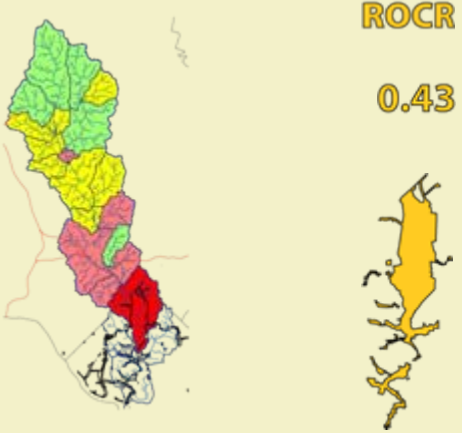
For a between park comparison…

Assessment of ecosystem status of the habitats of ROCR

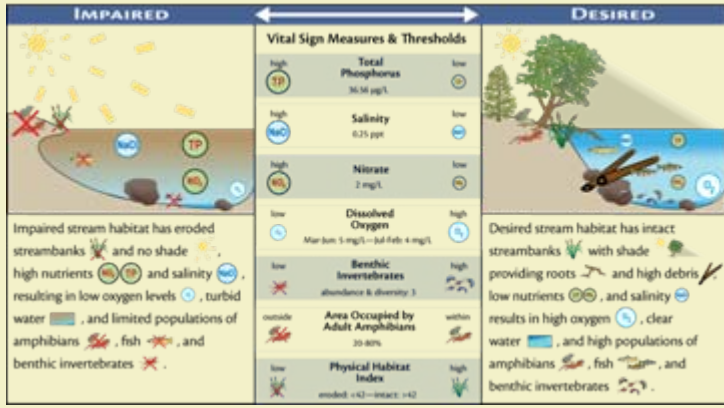


The Perennial challenge… within park comparison, Assessment of relative abundance of habitats within ROCR





Conclusions

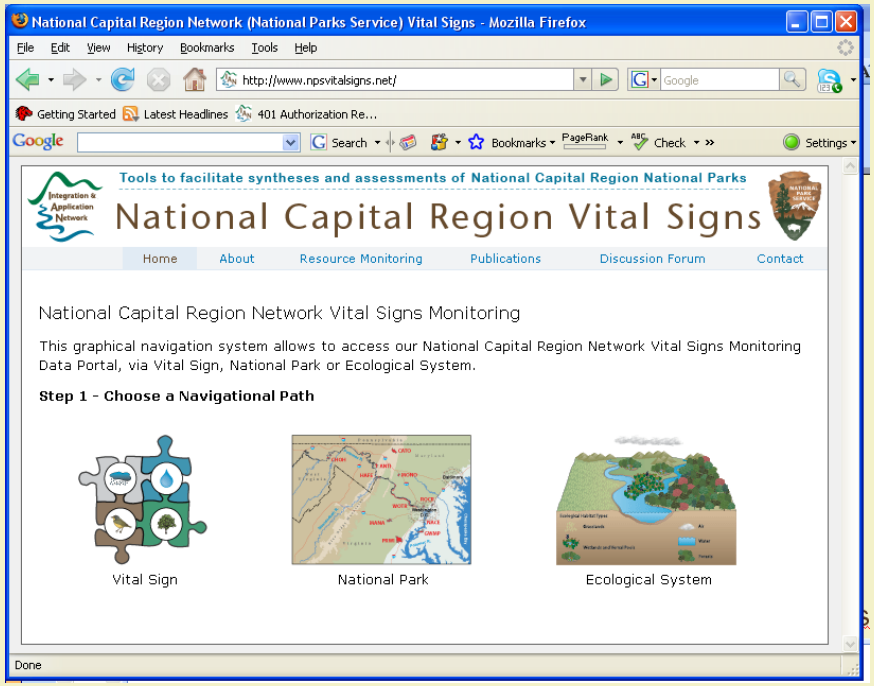


- Rock Creek Park is located downstream of a highly urban watershed, resulting in poor overall condition
- Assessment of spatial patterns within the park is limited to water quality, due to data availability
- Watershed assessments were valuable, highlighting the relatively high ecosystem status of the park compared to the surrounding watershed
- Whole park assessment based on vital signs monitoring provides potential park comparisons
- A habitat based assessment based on thresholds of responsive variables holds high potential for between park comparisons and a basis for within park inferences, highlighting important data gaps

β-test of website (this month)

Soon to be live – NCRN I&M database

If interested, please sign up to help us β-test



Integration & Application Network

ian.umces.edu

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http://www.npsvitalsigns.net/

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National Capital Region Vital Signs

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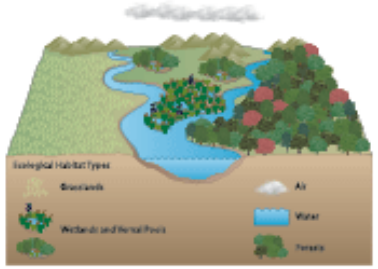
National Capital Region Network Vital Signs Monitoring

This graphical navigation system allows to access our National Capital Region Network Vital Signs Monitoring Data Portal, via Vital Sign, National Park or Ecological System.

Step 1 - Choose a Navigational Path

Vital Sign

National Park



Ecological System

Done

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http://www.npsvitalsigns.net/#step2:park_step2:step3:blank

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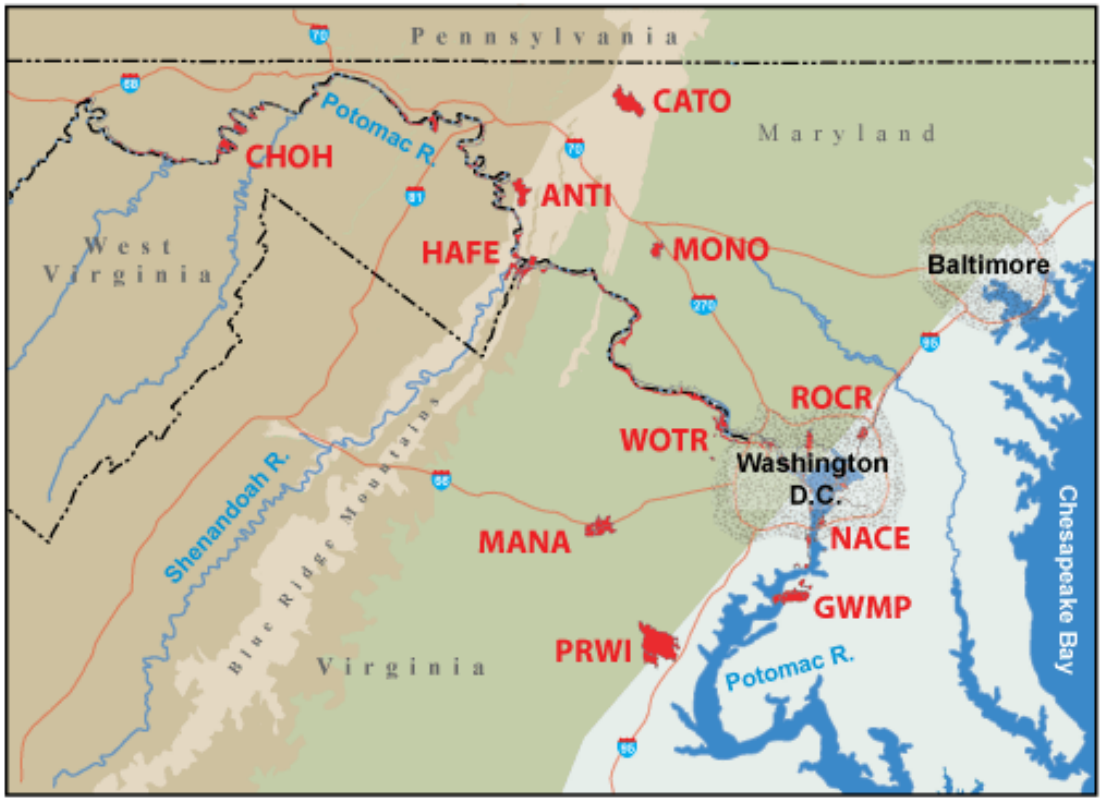
Step 2 - Choose National Park

Choose one of the 11 National Parks



- Antietam National Battlefield
- Catoctin Mountain Park
- Chesapeake and Ohio Canal National Historic Park
- George Washington Memorial Parkway
- Harpers Ferry National Historic Park
- Manassas National Battlefield
- Monocacy National Battlefield
- National Capital Parks-East
- Prince William Forest Park
- Rock Creek Park
- Wolf Trap National Park for the Performing Arts

Done

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http://www.npsvitalsigns.net/#step2:park_step2:step3:park_step3:s

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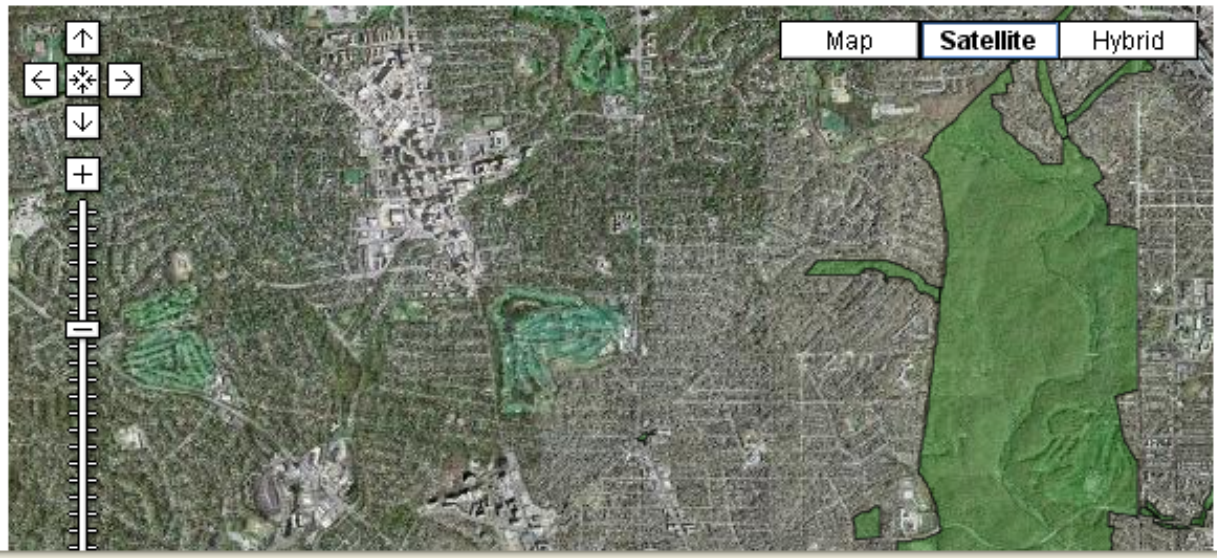
Step 3 - Choose Vital Sign and Sampling Site

Choose a vital sign from the dropdown menu and then click on a monitoring location from the map of Rock Creek Park.

- Pan by grabbing the map with your mouse and moving.
- Zoom to a location by double-clicking on the spot of interest - the map will re-center on that location and zoom in one level.
- Click the reset icon on the map to return to the original position/zoom level.

Choose Vital Sign



Done

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File Edit View History Bookmarks Tools Help

http://www.npsvitalsigns.net/#step2:park_step2:step3:park_step3:s

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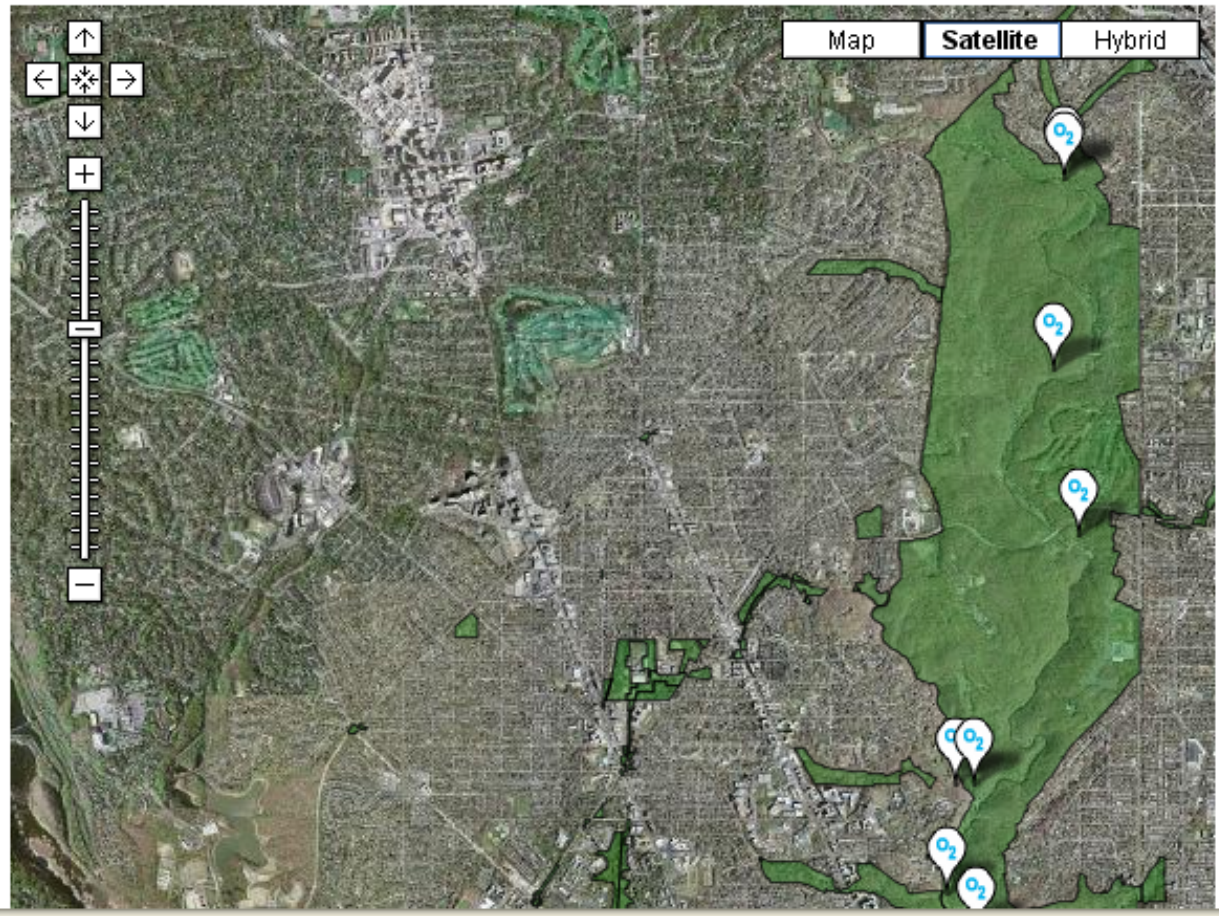
Water Chemistry



All Locations (ROCR)

Fenwick Branch (ROCR-Water-46)

Rock Creek above confluence with Fenwich Branch (ROCR-Water-33)

Pinehurst Branch (ROCR-Water-38)

Luzon Branch (ROCR-Water-39)

Soapstone Valley Stream (ROCR-Water-41)

Broad Branch (ROCR-Water-32)

Hazen Creek (ROCR-Water-37)

Piney Branch

Done

Data Portal - National Capital Region Network (National Parks Service) - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.npsvitalsigns.net/data/?vsid=water_chemistry&location_cod

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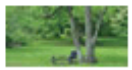
 ->  -> 

Water Chemistry Information
Google Map Overlay
Google Earth Overlay

Refine Search (National Park -> Rock Creek Park -> Water Chemistry)

Navigational Path: National Park

National Park: Rock Creek Park

Vital Sign: Water Chemistry

Monitoring Location: Luzon Branch (ROCR-Water-39)

Watershed Maps - Rock Creek Park

Information & Maps - Rock Creek Park

Done

Data Portal - National Capital Region Network (National Parks Service) - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.npsvitalsigns.net/data/?vsid=water_chemistry&location_cod

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Watershed Map of water quality data for Rock Creek Park

Choose a parameter from the dropdown menu to view data on the map of Rock Creek Park.

threshold met threshold not met no threshold for parameter no data for parameter

Extra information, including sample size(n), mean ($\bar{x}$), median ($\tilde{x}$), min, max, range, standard deviation (σ), standard error (S_E) and links are available by mousing over a site icon or label.

Click on a site icon for further options, including direct access to a graph showing the detailed data (all sampling points, not just means) for that site, and to return to the detailed data table.

- Pan by grabbing the map with your mouse and moving.
- Zoom to a location by double-clicking on the spot of interest - the map will re-center on that location and zoom in one level.
- Click the reset icon on the map to return to the original position/zoom level.

Choose Parameter

Done

Data Portal - National Capital Region Network (National Parks Service) - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.npsvitalsigns.net/data/?vsid=water_chemistry&location_cod

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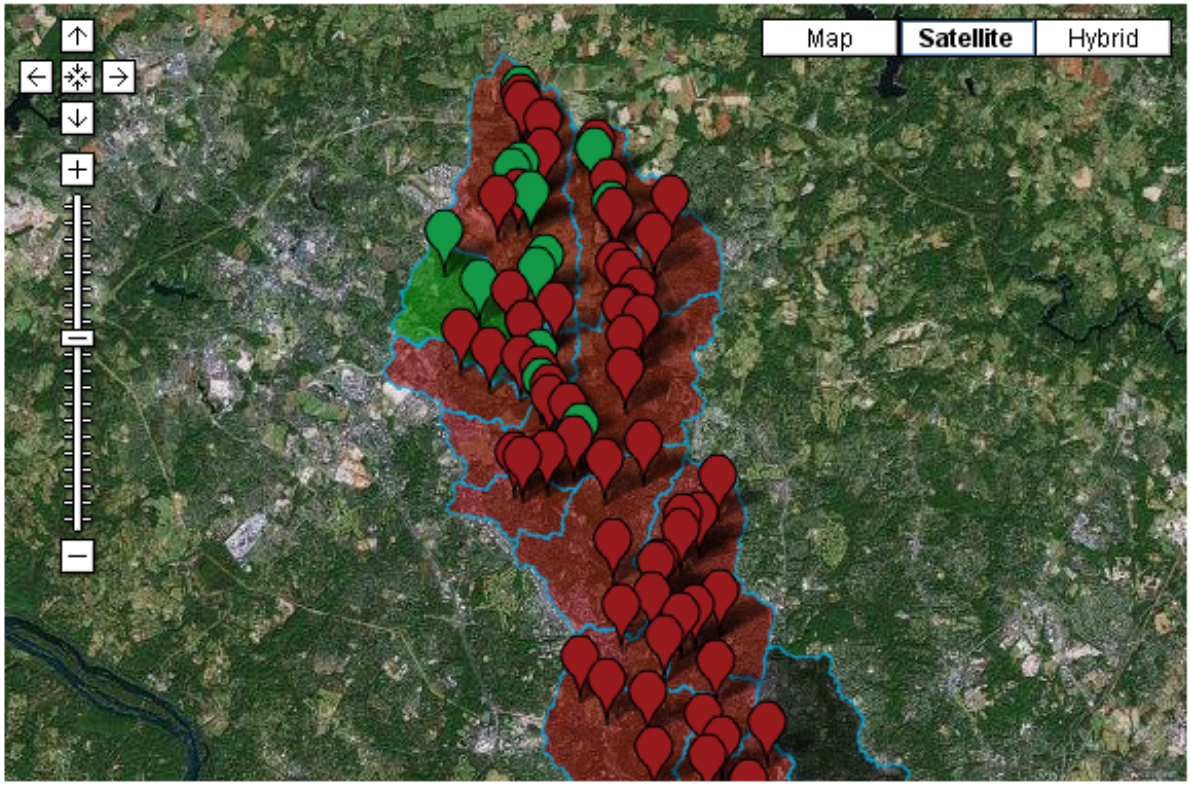
Watershed Map of water quality data for Rock Creek Park

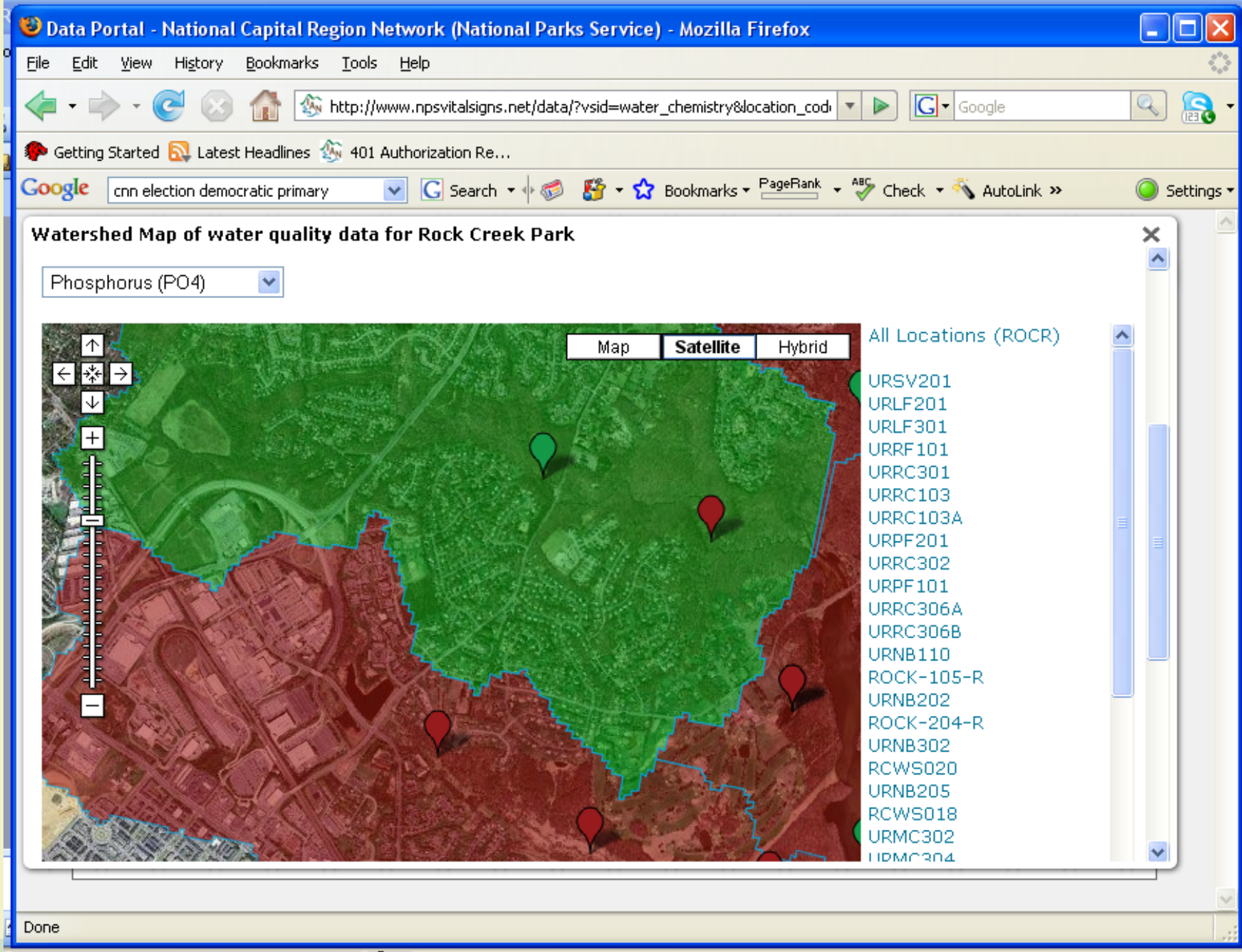
Phosphorus (PO4)



All Locations (ROCR)

URSV201
URLF201
URLF301
URRF101
URRC301
URRC103
URRC103A
URPF201
URRC302
URPF101
URRC306A
URRC306B
URNB110
ROCK-105-R
URNB202
ROCK-204-R
URNB302
RCWS020
URNB205
RCWS018
URMC302
URMC304

Done


Data Portal - National Capital Region Network (National Parks Service) - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://www.npsvitalsigns.net/data/?vsid=water_chemistry&location_cod
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Bookmarks
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Check
AutoLink
Settings
Watershed Map of water quality data for Rock Creek Park
Phosphorus (PO4)
Map
Satellite
Hybrid
All Locations (ROCR)
URSV201
URLF201
URLF301
URRF101
URRC301
URRC103
URRC103A
URPF201
URRC302
URPF101
URRC306A
URRC306B
URNB110
ROCK-105-R
URNB202
ROCK-204-R
URNB302
RCWS020
URNB205
RCWS018
URMC302
Done

Data Portal - National Capital Region Network (National Parks Service) - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.npsvitalsigns.net/data/?vsid=surf_water_dynamics&location

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Watershed Map of water quality data for Rock Creek Park

- Zoom to a location by double-clicking on the spot of interest - the map will re-center on that location and zoom in one level.
- Click the reset icon on the map to return to the original position/zoom level.

Phosphorus (PO4)

All Locations (ROCR)

URSV201
URLF201
URLF301
URRF101
URRC301
URRC103
URRC103A
URPF201
URRC302
URPF101
URRC306A
URRC306B
URNB110
ROCK-105-R
URNB202
ROCK-204-R
URNB302

Done

Data Portal - National Capital Region Network (National Parks Service) - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.npsvitalsigns.net/data/?vsid=nutrient_dynamics&location_co

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Watershed Map of water quality data for Rock Creek Park

Phosphorus (PO4)

URMC304

Hybrid

All Locations (ROCR)

URSV201
URLF201
URLF301
URRF101
URRC301
URRC103
URRC103A
URPF201
URRC302
URPF101
URRC306A
URRC306B
URNB110
ROCK-105-R
URNB202
ROCK-204-R
URNB302
RCWS020
URNB205
RCWS018
URMC302
URMC304
ROCK-211-R

Done

Data Portal - National Capital Region Network (National Parks Service) - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.npsvitalsigns.net/data/?vsid=water_chemistry&location_code=ROCR-

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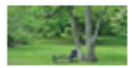
 ->  -> O_2

Water Chemistry Information
Google Map Overlay
Google Earth Overlay

Refine Search (National Park -> Rock Creek Park -> Water Chemistry)

Data - Luzon Branch (ROCR-Water-39) - Tue 4 Oct, 2005 to Wed 11 Oct, 2006

Date / Time ▲	Acid Neutralizing Capacity (ANC) ($mg \cdot L^{-1}$ $CaCO_3$)	Dissolved oxygen (DO) ($mg \cdot L^{-1}$)	pH	Salinity (ppt)	Specific Conductance ($\mu S \cdot cm^{-1}$)	Temperature, air (°C)	Temperature, water (°C)	WQI
2005-10-04 11:10	1184	7.16	7.5	*	678.67	25	19.95	0.67

Watershed Maps - Rock Creek Park

Information & Maps - Rock Creek Park

Done

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Whole park vital sign assessment

Category	Vital Sign	Data	Threshold (eg EPA)	Attainment (% of time)	Category Score	Park Score
Air quality and climate		Ozone				
		Wet Deposition				
		Visibility and Particulate Matter				
		Mercury Deposition				
		Weather				
Water quality and hydrology		Surface Water Dynamics				
		Water Chemistry				
		Nutrient Dynamics				
		Aquatic Macroinvertebrates				
		Shoreline Features				
		Physical Habitat Index				
Biodiversity		Invasive/Exotic Plants				
		Forest Insect Pests				
		Forest Vegetation				
		Fishes				
		Amphibians				
		Landbirds				
		White-Tailed Deer				
		R/T/E Species and Communities				
Ecosystem pattern and process		Land Cover/Land Use				
		Landscape Condition				

Data availability and thresholds

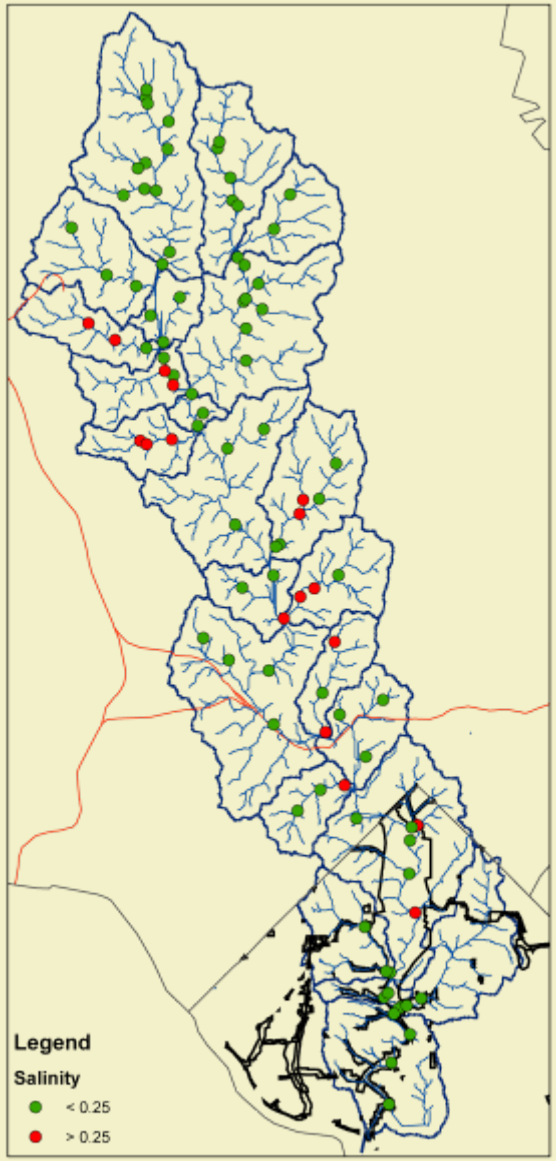
ROCR

Park	Category	Vital Sign	Data	Threshold (eg EPA)	Attainment (% of time)	Category Score	Park Score
			Yes	< 8 ppm $(8\ h)^{-1}$			
			Yes	< 10 kg $ha^{-1}\ y^{-1}$			
			Yes	<15 µg m^{-3}			
			Yes	< 2 ng L^{-1}			
			No	--			
			Yes	0.6 cfs ≤ x ≤ 6.0 cfs			
			Yes	6.0 ≤ X ≤ 8.5			
			Yes	< 36.56 µg L^{-1}			
			Yes	IBI > 3			
			--	--			
			Yes	PHI > 42			
			No	< 5% cover			
			No	< 1% of park			
			Yes	4000 m^{-2}			
			Yes	IBI > 3			
			Yes	≥ 7 locations			
			Yes	Sensitive FIDS			
			Yes	< 10 deer km^{-2}			
			No	--			
			Yes	> 60% forest			
			Yes	< 10% impervious			

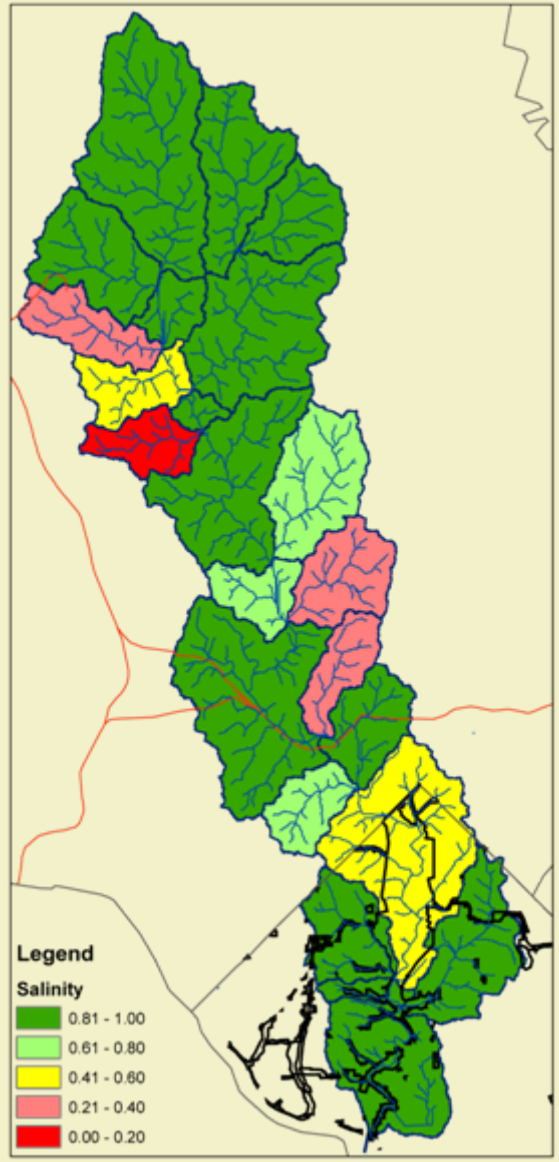
Salinity shows localized increases (Rockville)

Site	Salinity
BRBR	0.0
EGWA	0.0
FEBR	0.3
HACR	0.0
LRCR101A	0.0
LRCR101B	0.3
LRJB203A	0.3
LRJB203B	0.3
LRJB204	0.3
LRLB202	0.2
LRLR201	0.3
LRLR205	0.0
LRLR407	0.2
LRLR410	0.2
LRLR413	0.0
LRLR418	0.0
LRLR422B	0.1
LRLR425	0.1
LRLR426	0.3
LRSB101A	0.0
LRSB101C	0.2

Assessed against threshold value



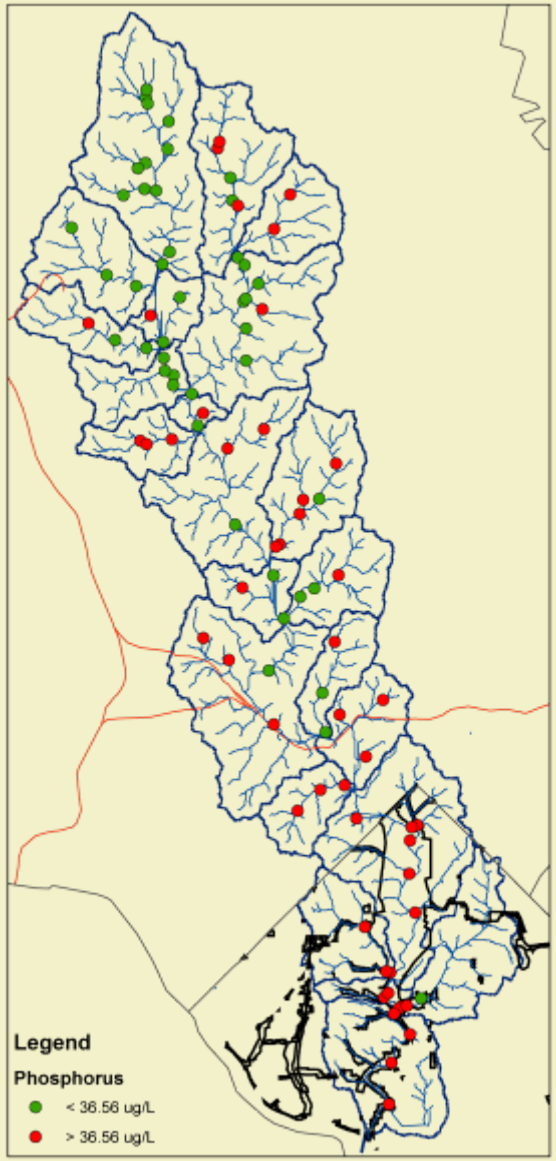
Mean value per subwatershed



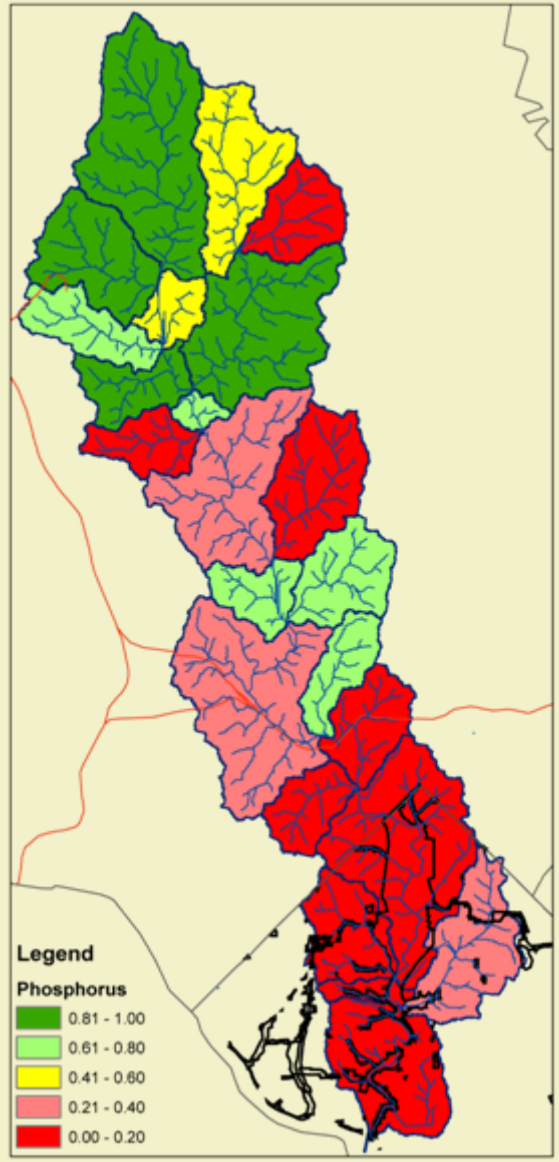
Phosphorus concentration related to population

Site	Phosphorus
BRBR	0.2375
EGWA	0.0778
FEBR	0.1169
HACR	0.3032
LRCR101A	0.1953
LRCR101B	0.0846
LRJB203A	0.0304
LRJB203B	0.0319
LRJB204	0.0276
LRLB202	0.0437
LRLR201	0.0760
LRLR205	0.0357
LRLR407	0.0220
LRLR410	0.0189
LRLR413	0.0260
LRLR418	0.1457
LRLR422B	0.1457
LRLR425	0.1308
LRLR426	0.1339
LRSB101A	0.1349
LRSB101C	0.0750

Assessed against threshold value



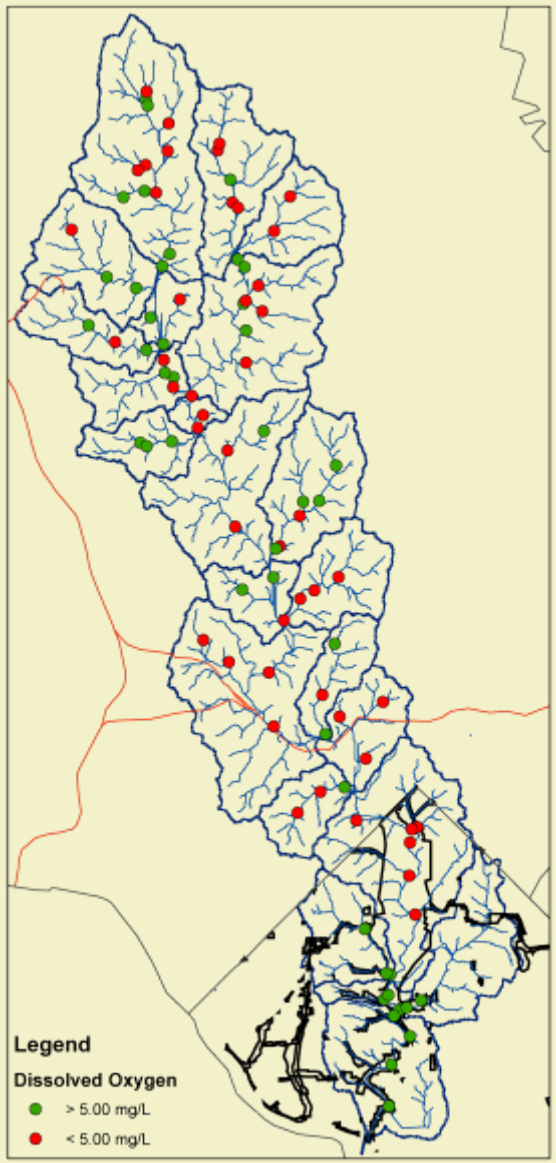
Mean value per subwatershed



Dissolved Oxygen variable through watershed

Site	Dissolved Oxygen
BRBR	7.56
EGWA	6.42
FEBR	3.07
HACR	7.40
LRCR101A	1.43
LRCR101B	5.27
LRJB203A	4.65
LRJB203B	4.24
LRJB204	4.29
LRLB202	3.94
LRLR201	6.41
LRLR205	4.03
LRLR407	4.79
LRLR410	5.03
LRLR413	3.41
LRLR418	3.75
LRLR422B	3.25
LRLR425	3.87
LRLR426	4.29
LRSB101A	5.33
LRSB101C	1.16

Assessed against threshold value



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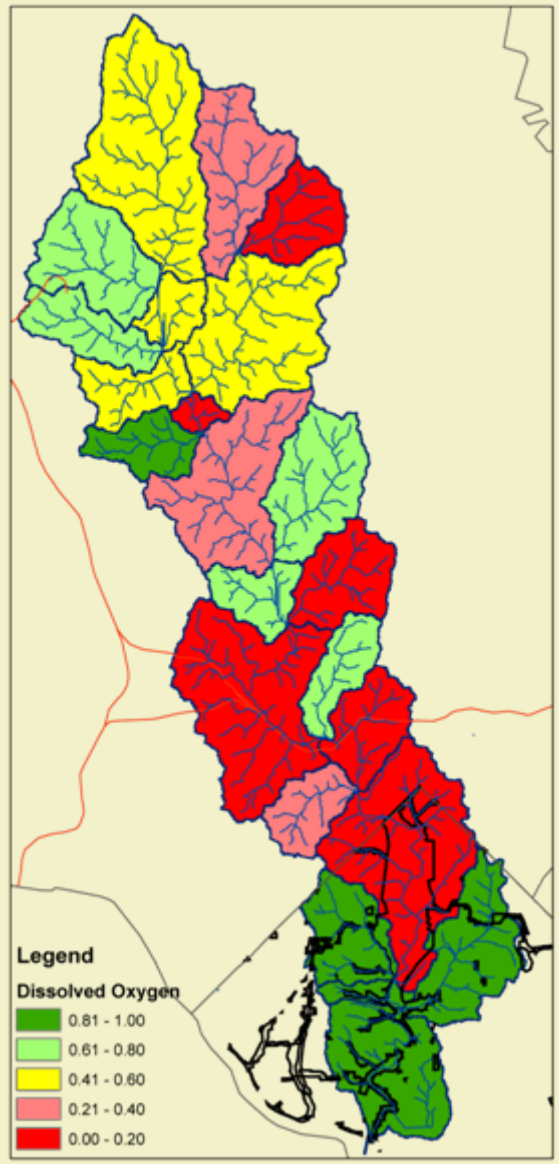
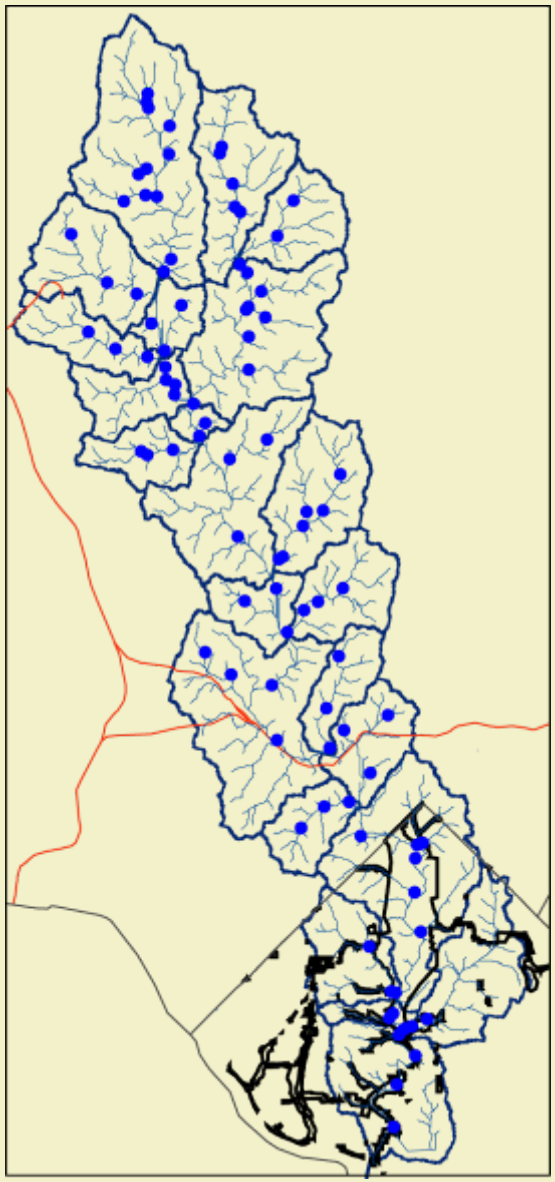


What kind of data is collected?



Collected by	IBI Data	Nutrient Data
Maryland Department of Natural Resources	All sites	None
	Some sites	None
District Department of the Environment	None	All Sites
FORCE	None	None
National Park Service	One site	All Sites
Integration & Application Network	None	All Sites

Current assessment for ROCR

Park	Category	Vital Sign	Data	Threshold (eg EPA)	Attainment (% of time)	Category Score	Park Score
ROCR		O_3	Yes	8 ppm/8 h	0.28		
			Yes	15 µg m^{-3}	0.33		
		O_2	Yes	6.0 ≥ X ≤ 8.5	0.92		
		P	Yes	36.56 µg L^{-1}	0.04		
			Yes	IBI > 3	0.52		
			Yes	IBI > 3	0.62		
			Yes	< 10 deer km^{-2}	0		
			Yes	> 10% impervious	0		

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ROCR		O_3	Yes	8 ppm $(8\ h)^{-1}$	0.28		
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			Yes	IBI > 3	0.00		
			Yes	IBI > 3	1.00		
			Yes	< 10 deer km^{-2}	0.00		
			Yes	<10% impervious	0.00		

Summary of scales of information and utility..

- Stressors – watershed scale informative and useful
- Within park – valuable where data is available at appropriate scale
- Watershed assessment – very valuable for communicating to park neighbors and placing the park in context
- Whole park vital signs assessment – useful between parks

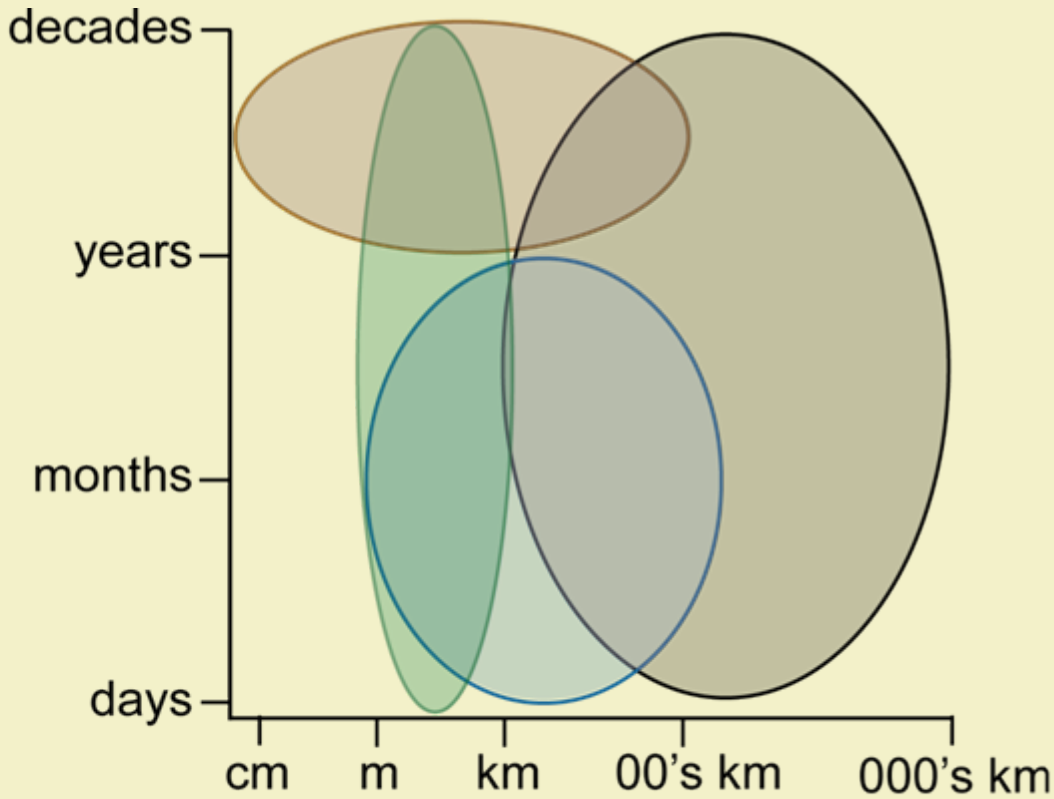
Monitored data also provides information at different ranges of space and time


Air Quality and Climate


Water Quality and Hydrology


Biodiversity


Ecosystem Pattern and Process



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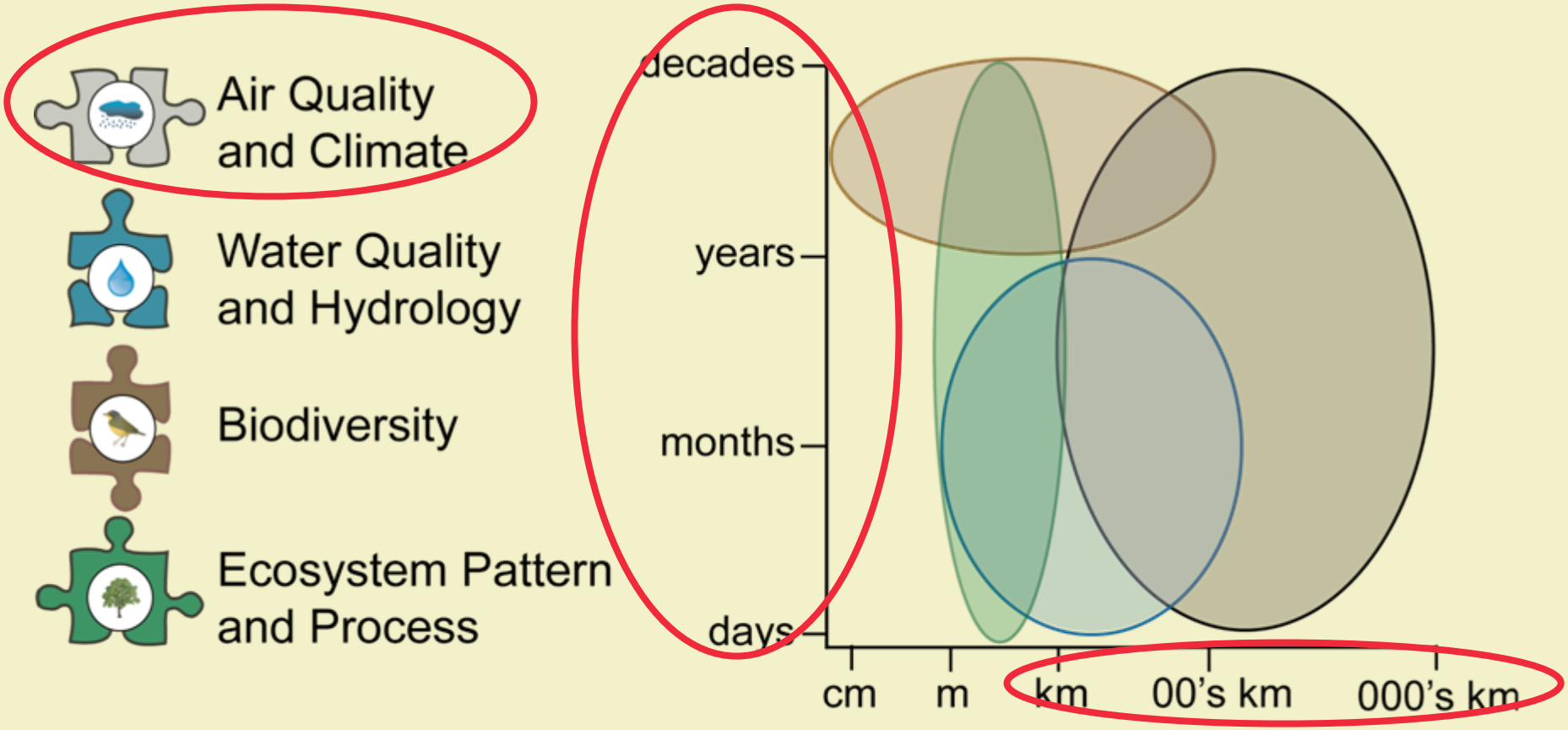

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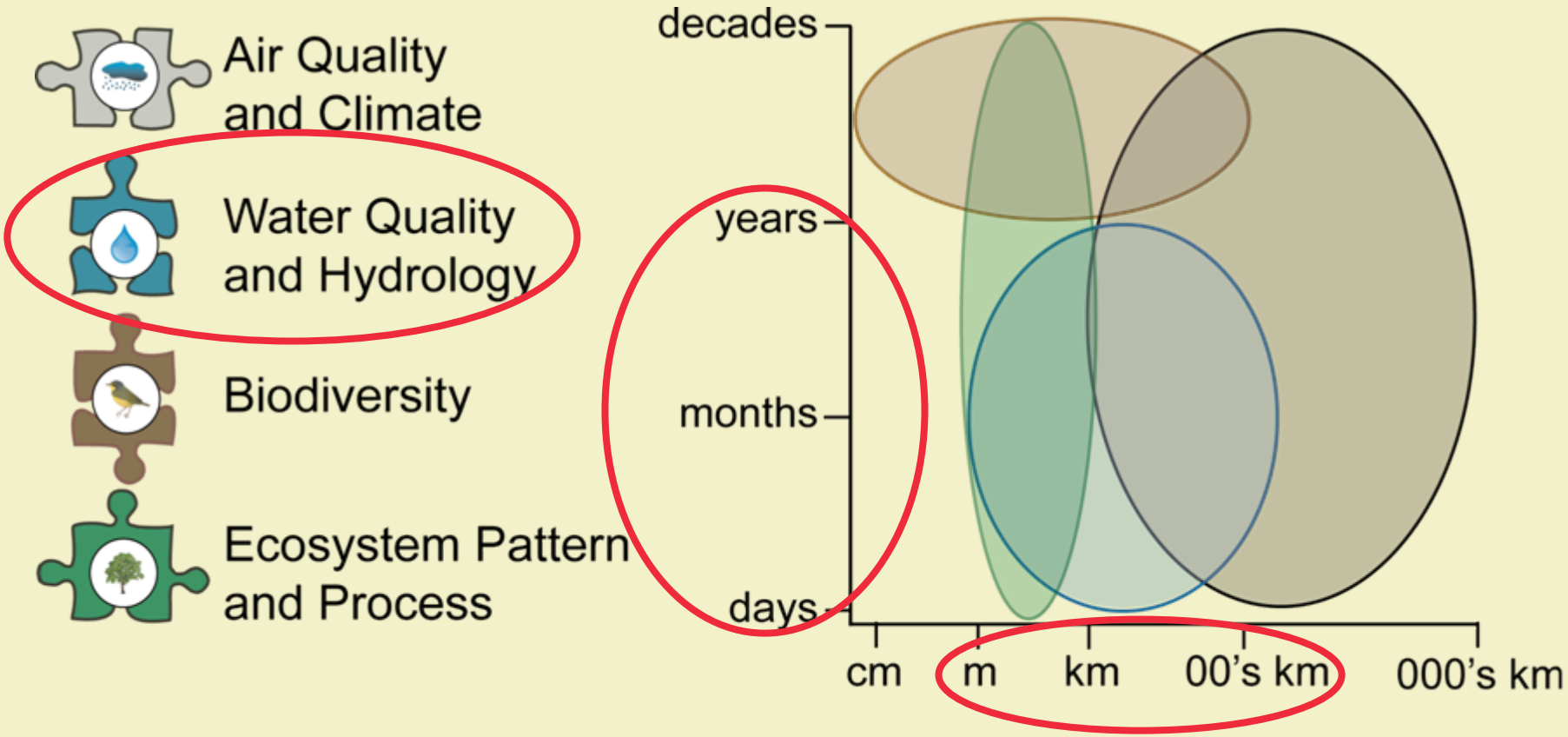

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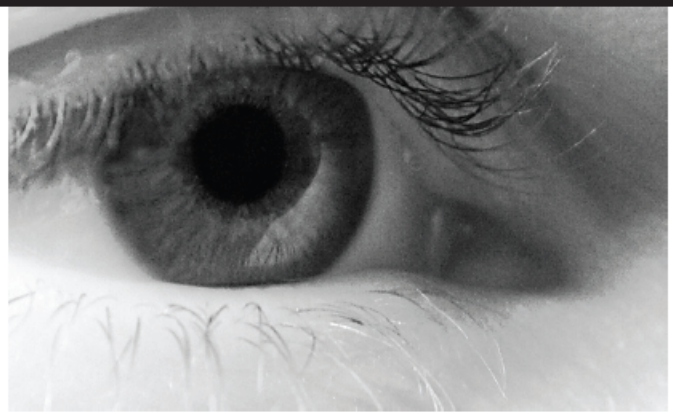

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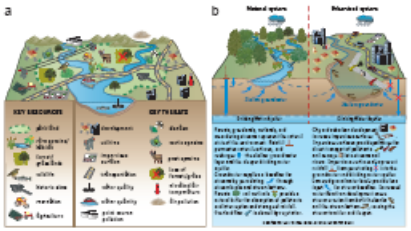
2. CONCEPTUAL ENVIRONMENTAL MODELING

Generalized National Park conceptual diagrams: a) highlighting key resources and major threats and b) detailing changes in stream processes with urbanization.



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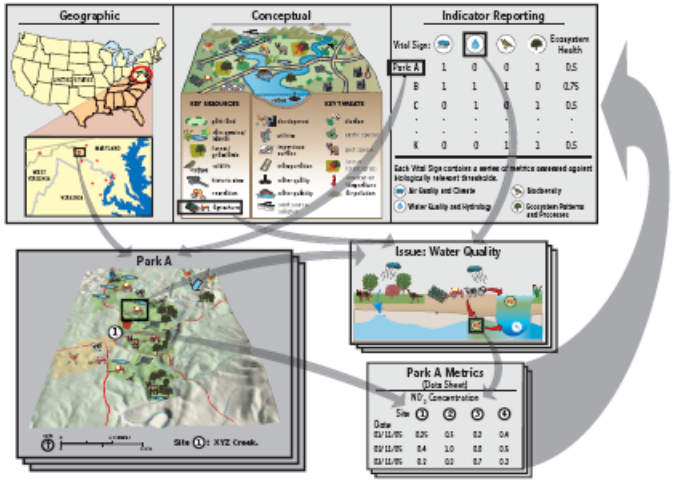

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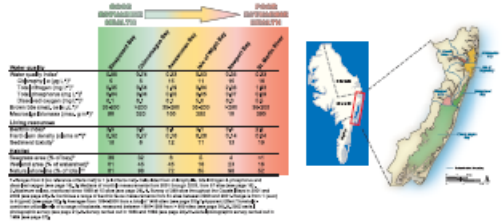

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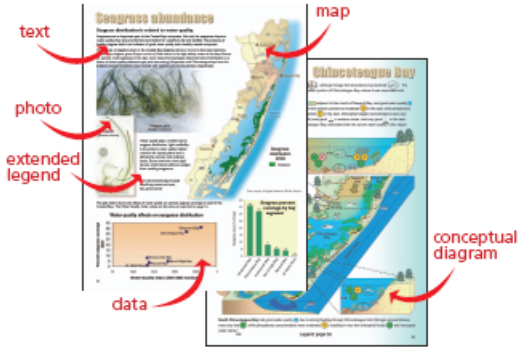

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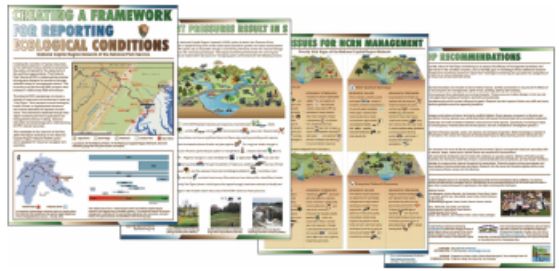

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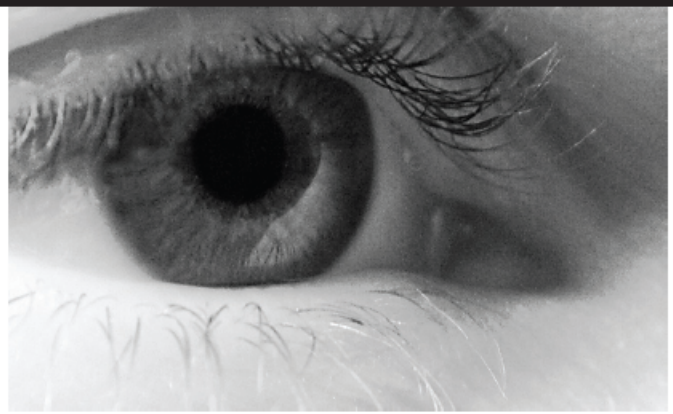

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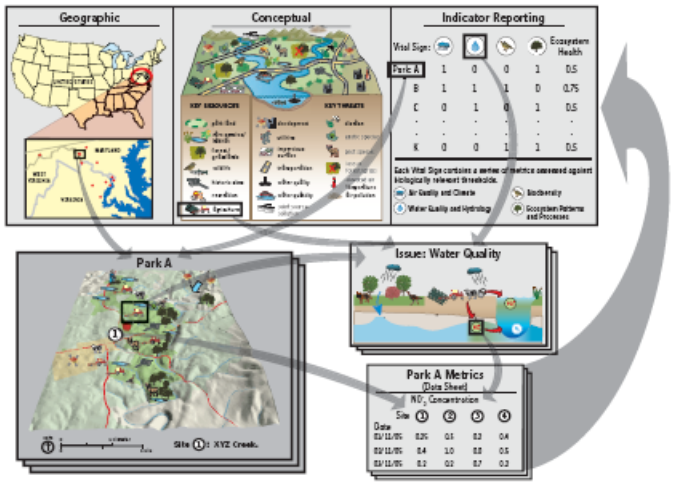

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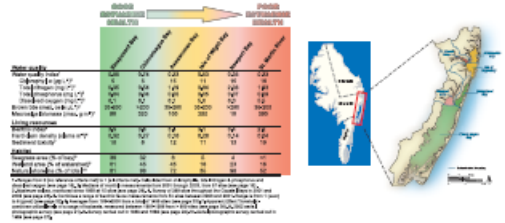

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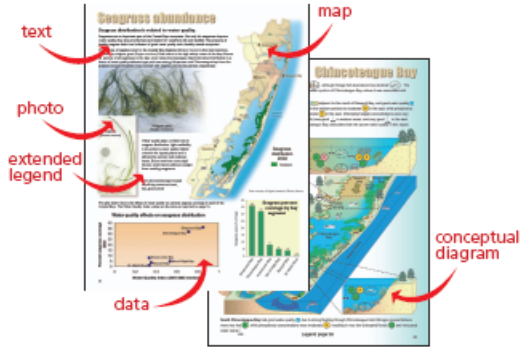

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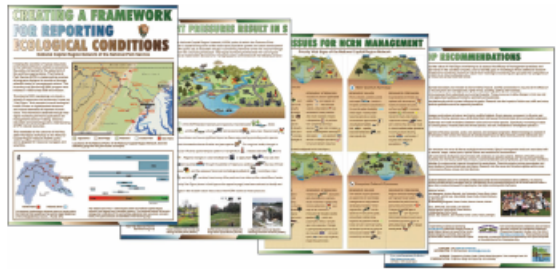

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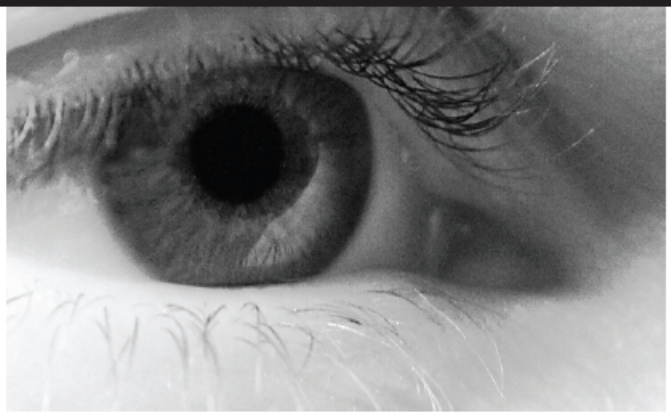

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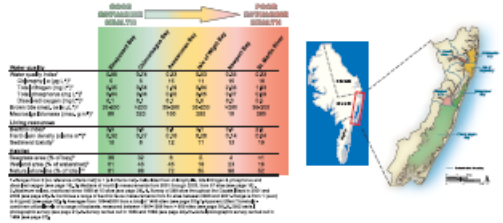

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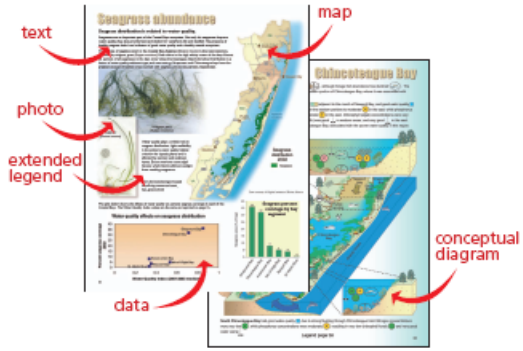

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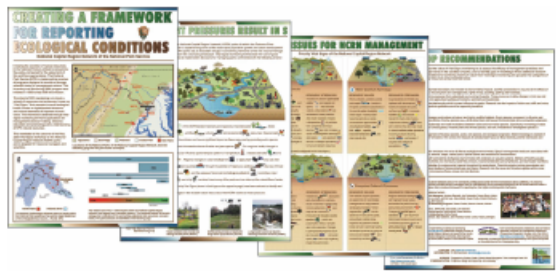

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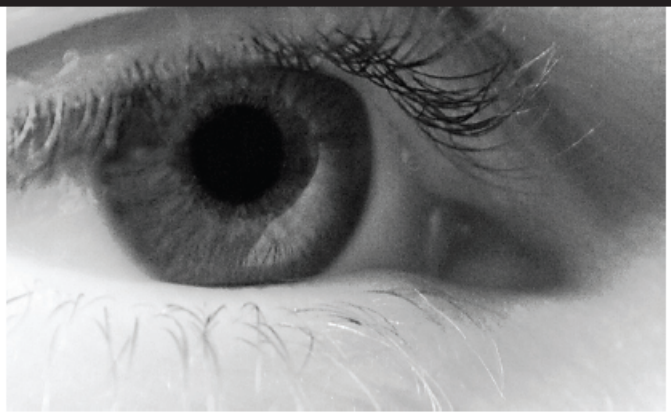

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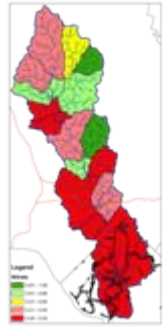

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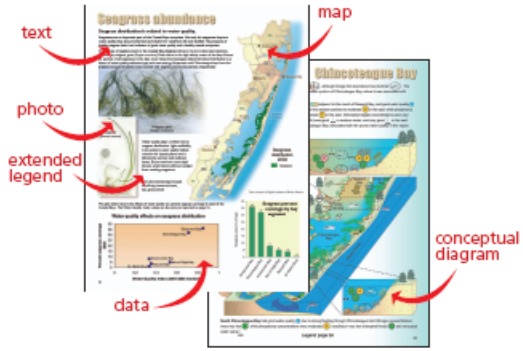

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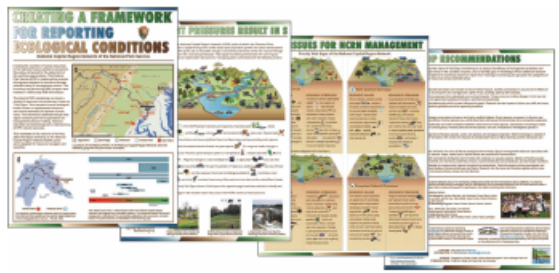

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