Date: October 1, 2015

To: Great Lakes Riparian Opportunity Assessment Steering Committee

From: Project Team: Amy Conley, Erin White, Tim Howard

Re: Task 2, October 1 deliverables: Critical Zones

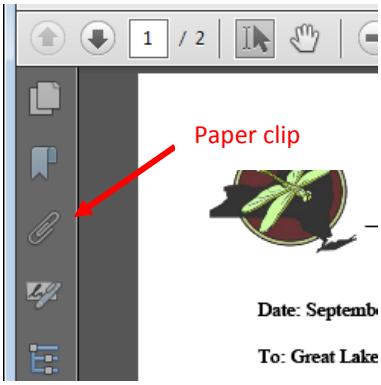
Dear Committee,

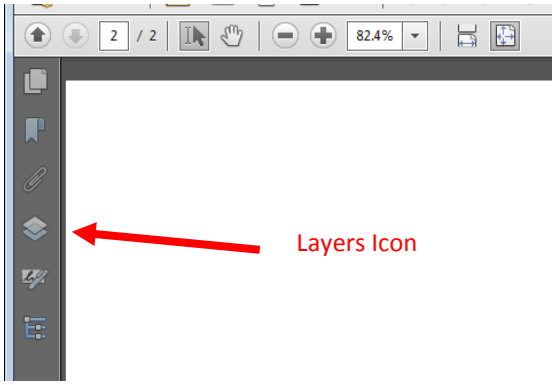
In the following pages and attached documents we provide descriptions and maps created from following the steps outlined in the methodology discussed with you earlier this summer and circulated again last week. We hope this document can provide enough information, along with the methodology document, to give you a first evaluation of the products for Task 2 as they currently stand. In our next conference call, we will go through these data in detail. We look forward to improving these products to make them even more useful to you and your partners.

The maps, and the data used to produce the maps, are intended to support Task 2: Identify critical zones for water quality and habitat quality management. Our unit of comparison for this task is the sub-watershed, or 12-digit HUC.

IMPORTANT NOTES ABOUT THE MAPS: In order to make the maps behave as expected, we have kept them as separate pdf files. Each map is 'attached' to this document. To open a map, go to the attachments panel, by clicking on the paper clip on the left-hand side of this document (see image below). This panel should be open when you first open this document.

Even better, all maps have layers enabled. You can turn on and off layers in the pdf! Each map should open with the layers panel showing on the left-hand side of the document. If it does not, you can turn on the layers panel (in the map pdf, not here) by clicking the "Layers" icon as identified in the image below.





.

Map 1. Comprehensive Results Map.
This map provides a first draft of the overall ranking of each sub-watershed within the Great Lakes Basin in New York. This interactive map provides the following information; each bullet below describes layers, nested within folder in the layers dialog:

- Region-Wide Scores/Comprehensive_Score.
  - This is the initial view you should see when opening the map
  - Sub-watershed scores for the entire basin, from predicted poorest condition (brown) to predicted highest condition (blue). This is a representation of the final score that summarizes all sub-scores, or "comprehensive score," which is also printed on the map over each basin (zoom in to read the text). The comprehensive score ranges from approximately -0.7 to 0.9. The comprehensive score was obtained by subtracting the Ecological Stress score from the Ecological Health score.
- Additional Overview layers that are self-explanatory:
  - Administrative_Boundaries/County_Boundaries.
  - Labels/NY_Counties. Labels for each county.
  - Administrative_Boundaries/HUC6 Sub Region Boundaries
  - Administrative_Boundaries/HUC6 Sub Region Names
- Region-Wide Scores/Ecological_Stress
  - This is the summary score for the ecological stress indicators used in the model. Values range from about 0-1. Darker shades of red and higher values represent higher degrees of stress.
- Region-Wide Scores/Ecological_Health
  - This is the summary score for the ecological health indicators used in the model. Values range from about 0-1. Darker shades of blue and higher values represent higher condition.
- Sub-Watersheds Ranked by Comprehensive Score:
  - For aid comparisons, we divided the entire basin into the six 6-digit HUCs.
  - For each six-digit HUC, we provide a ranking of the comprehensive score within the six-digit HUC. Each sub-basin has its own separate color-scheme and ranking label, where low numbers (and darker color tones) represent sub-watersheds of higher condition, as based on their comprehensive scores, and high numbers (and lighter color tones) represent sub-watershed with lower condition scores.

Sub-Region scoring.
In Appendix 1, we provide the ten highest and lowest scoring sub-watersheds for each basin, in tabular format. These data mimic the Sub-Region Views and rankings described above.

Map 2. Component Scores:
This map provides a visualization of the subscores used in the analysis. Each layer is displayed with a color ramp with the actual scores printed within the sub-watershed (as a separate layer that can be turned on and off). Each indicator is noted below, described from the lowermost layer grouping to the top. All calculated scores were normalized to range from 0-1 as the final calculation step.

Biological Indicators

- Brook Trout.

    - Brook Trout patches from the DEC were summed within each sub-watershed to get a total area.
    - This is the layer that is displayed by default when the map opens
    - This is an Ecological Health indicator
- BAP (Biological Assessment Profile)
    - The predicted BAP score from the NYS Freshwater Blueprint Project for each stream segment was weighted by the length of the segment, and the sum of the weighted scores divided by the total length of evaluated streams in the watershed, to produce an average score per kilometer of stream.
    - This is an Ecological Health indicator
- EPT (Ephemera, Plecoptera, Tricoptera)
    - The predicted stream invertebrate richness score from the NYS Freshwater Blueprint Project Project for each stream segment was weighted by the length of the segment, and the sum of the weighted scores divided by the total length of streams evaluated in the watershed, to produce an average score per kilometer of stream.
    - This is an Ecological Health indicator
- Rare Taxa.
    - This layer represents the sum of known rare species and significant natural communities within the riparian zone throughout the sub-basin. This score is simply a sum of total known occurrences (standardized to range from 0-1).
    - This is an Ecological Health indicator

Dams

- The number of dams were summed by sub-watershed and then standardized to range from 0-1.
- This is an Ecological Stress indicator

Erosion Index

- The erosion index was calculated for each raster cell based on predicted surface flow, derived from a 10 meter digital elevation model, and weighed by soil erosion potential from the SSURGO2 Soil database. Watershed scores reflect the average erosion index value within the riparian zone of each watershed.
- This is an Ecological Stress indicator

Topographic Wetness Index

- The topographic wetness index was calculated for each raster cell based on predicted surface flow patterns, derived from a 10 meter digital elevation model. It is treated as a coarse estimate of the likelihood and amount of landscape with high runoff. Topographic wetness index scores reflect the average topographic wetness index value with the riparian zone of each watershed.
- This is an Ecological Stress indicator

Landcover

- Floodplain Complexes
    - Floodplain complexes are the largest natural areas adjacent to streams throughout the state. We calculated the proportion of the total sub-watershed area composed of floodplain complexes.

    - This is an Ecological Health indicator
- Matrix Forest Blocks
    - Matrix forest blocks are large forested areas targeted as conservation priorities by The Nature Conservancy. We estimated both the contribution of these forested areas to the sub-watershed and to the riparian areas within the sub-watershed.
    - Matrix Forest Blocks Riparian represents the proportion of the total riparian area (within the sub-watershed) contained within a matrix forest block polygon.
    - Matrix Forest Blocks Watershed represents the proportion of the sub-watershed contained within a matrix forest block polygon.
    - Both of these are Ecological Health indicators.
- Natural Landcover
    - We extracted all the natural class types from the National Land Cover Dataset (NLCD 2011) and calculated the percent natural cover within both the riparian areas and the sub-watershed.
    - Natural Landcover Riparian displays the proportion of land cover classified as natural within the total riparian area of the sub-watershed.
    - Natural Landcover Watershed displays the proportion of land cover classified as natural within the entire sub-watershed.
    - Both of these layers are Ecological Health indicators.
- Canopy Cover
    - We used the tree canopy cover data set from the National Land Cover Database (NLCD 2011) and calculated the average percent cover within both the riparian areas and the sub-watershed.
    - Canopy Cover Riparian displays the average canopy cover for the riparian areas within each sub-watershed.
    - Canopy Cover Watershed displays the average canopy cover for the entire sub-watershed.
    - Both of these layers are Ecological Health indicators.
- LCA (Landscape Condition Assessment)
    - We calculated the average LCA score within both the riparian areas and the sub-watershed.
    - LCA Riparian displays the average LCA score within just the riparian area of the sub-watershed.
    - LCA Watershed displays the average LCA score for the entire sub-watershed.
    - Both of these layers are Ecological Stress indicators.

Functional River Networks

- Functional river networks are larger stream systems containing no barriers. This score was calculated as the total stream length in the sub-watershed classified as belonging to a functional river network.
- This is an Ecological Health indicator

Priority Waterbody List Water Quality Assessment

- Water quality impairment scores were based on streams classified as “Impaired Waters”, “Waters with Minor Impacts,” or “Threatened Waterbodies” as a part of the NY DEC’s regular monitoring program. Classification in any of these 3 categories qualifies a stream for inclusion in the Priority Waterbodies List.

- To combine these data into a single score, we calculated the proportion of stream length falling into each category and then calculated a cumulative watershed water quality score by weighting the scores for each category by the severity of the implied level of stream impairment: “Impaired” scores were multiplied by 4, “Minor Impacts” scores were multiplied by 2, and “Threatened” scores multiplied by 1. (This assumption implies that “Impaired” waters should contribute twice as much to the impairment score as waters with “Minor Impacts,” and waters with Minor Impacts should contribute twice as much as Threatened Waters.) These weighted scores were summed to create the final score.
- This is an Ecological Stress indicator

Map 3. Example Riparian zone and analysis details
This map provides a visualization of the streams, riparian buffers, and one of the land cover parameters used in the analysis for a single HUC 6 Sub-Region, Eastern Lake Erie.

Streams
- The Streams layer visualizes the river segments from the NHD Hi Resolution data set used in the creation of the riparian buffer layer.

Riparian Buffer
- The riparian buffer layer was derived using the Riparian Buffer Delineation Tool, with inputs from the NHD Hi Resolution streams layer, the National Wetland Inventory, a 10 meter digital elevation model, and an estimated 50 year flood height for each watershed.
- This buffer was used to define the riparian zone in analysis of land cover and land use variables.

Canopy Cover
- The Canopy Cover layer represents the percent of canopy cover, derived from the 2011 NLCD.

Conclusions
We are excited about these outputs and look forward to discussing them in more detail.

In the calculation of the comprehensive score as presented here, all components contribute equally, and your feedback on more specific or appropriate weighting schemes for specific questions is welcome.

Appendix 1. The ten top and bottom scoring sub-watersheds (HUC 12) within each sub-basin (HUC 6). The highest ranked sub-watershed for each sub-basin is ranked a '1' in the table, while the lowest ranked sub-watershed will have the largest rank number. "HUC 12" is an identifying number for each sub-watershed with other identifiers such "Name" and the county(ies) in which it falls. "Health" refers to the Ecological Health Score, "Stress" is the Ecological Stress Score, and "Comp." is the Comprehensive Score.

Eastern Lake Erie

Rank	HUC 12	Name	County	Health	Stress	Comp.
Top 10						
1	041201020206	Waterman Brook-Cattaraugus Creek	Erie	0.789	0.220	0.570
2	041201040302	Black Creek-Tonawanda Creek	Erie, Genesee, Niagara	0.726	0.248	0.478
3	041201020210	Big Indian Creek-Cattaraugus Creek	Cattaraugus, Chautauqua, Erie	0.600	0.238	0.361
4	041201020209	Thatcher Brook-Cattaraugus Creek	Cattaraugus, Erie	0.679	0.346	0.333
5	041201020203	Mansfield Creek	Cattaraugus	0.551	0.235	0.316
6	041201030203	Hunter Creek	Erie	0.551	0.268	0.282
7	041201040306	Saint Stephens Church-Tonawanda Creek	Erie, Niagara	0.580	0.306	0.275
8	041201020202	Spooner Creek-Cattaraugus Creek	Cattaraugus, Erie	0.540	0.274	0.266
9	041201020108	Buttermilk Creek	Cattaraugus	0.578	0.324	0.255
10	041201020205	South Branch Cattaraugus Creek	Cattaraugus	0.675	0.443	0.232
Bottom 10						
84	041201030402	Rush Creek-Frontal Lake Erie	Erie	0.322	0.601	-0.279
85	041201030401	Smoke Creek	Erie	0.413	0.699	-0.286
86	041201040504	Bull Creek	Niagara	0.231	0.530	-0.298
87	041201040603	Cayuga Creek	Niagara	0.261	0.591	-0.330
88	041201040501	Got Creek	Erie	0.313	0.644	-0.331
89	041201040406	Ellicott Creek	Erie	0.320	0.705	-0.385
90	041201040604	City of North Tonawanda-Niagara River	Niagara	0.197	0.611	-0.414
91	041201040405	Town of Amherst-Ellicott Creek	Erie	0.299	0.736	-0.436
92	041201030306	Buffalo River	Erie	0.215	0.847	-0.631
93	041201040601	Twomile Creek-Niagara River	Erie	0.140	0.778	-0.638

South Western Lake Ontario

Rank	HUC 12	Name	County	Health	Stress	Comp.
Top 10						
1	041300030201	Honeoye Inlet	Livingston, Ontario	0.811	0.245	0.566
2	041300020402	Baker Creek	Allegany	0.760	0.232	0.529
3	041300020401	Black Creek-Angelica Creek	Allegany	0.749	0.237	0.512
4	041300020303	Marsh Creek-Genesee River	Allegany	0.681	0.267	0.413
5	041300020305	Ford Brook-Genesee River	Allegany	0.686	0.273	0.413
6	041300020902	Sugar Creek	Livingston	0.673	0.279	0.394
7	041300021003	Eastover Brook-Genesee River	Livingston, Wyoming	0.606	0.220	0.386
8	041300020605	Crawford Creek-Genesee River	Allegany	0.638	0.255	0.383
9	041300020903	Bennett Creek-Canaseraga Creek	Allegany, Livingston	0.706	0.343	0.363
10	041300020901	Headwaters Canaseraga Creek	Allegany, Livingston	0.697	0.350	0.348
Bottom 10						
110	041300030703	Town of Gates-Genesee River	Monroe	0.355	0.548	-0.194
111	041300030601	Spring Creek	Genesee	0.289	0.507	-0.219
112	041300010102	Larkin Creek	Monroe	0.379	0.606	-0.227
113	041300030602	Headwaters Black Creek	Genesee, Wyoming	0.348	0.586	-0.239
114	041300010703	Headwaters Eighteenmile Creek	Niagara	0.283	0.528	-0.244
115	041300010101	Round Pond Creek	Monroe	0.299	0.593	-0.295
116	041300030701	Little Black Creek	Monroe	0.294	0.627	-0.333
117	041300030702	Red Creek	Monroe	0.327	0.673	-0.345
118	041300010104	Slater Creek-Frontal Lake Ontario	Monroe	0.212	0.752	-0.540
119	041300030704	Genesee River	Monroe	0.239	1.000	-0.761

South Eastern Lake Ontario

Rank	HUC 12	Name	County	Health	Stress	Comp.
Top 10						
1	041401020502	Mad River	Jefferson, Lewis, Oswego	0.961	0.085	0.876
2	041401020501	Headwaters Mad River	Lewis	0.861	0.061	0.800
3	041401020503	Mill Stream	Lewis, Oswego	0.895	0.095	0.800
4	041401020504	North Branch Salmon River	Oswego	0.802	0.085	0.717
5	041401020602	Prince Brook-Salmon River	Lewis, Oswego	0.799	0.098	0.700
6	041401020601	Headwaters Salmon River	Lewi	0.788	0.121	0.667
7	041401020201	Raystone Creek	Jefferson, Oswego	0.753	0.155	0.599
8	041401020202	Headwaters South Sandy Creek	Jefferson, Lewis	0.746	0.149	0.597
9	041401010101	Rice Creek	Oswego	0.755	0.187	0.567
10	041401020704	Orwell Creek-Salmon River	Oswego	0.658	0.214	0.443
Bottom 10						
57	041401010503	Mink Creek-Frontal Lake Ontario	Wayne	0.344	0.348	-0.004
58	041401010701	Headwaters Irondequoit Creek	Monroe, Ontario	0.362	0.383	-0.021
59	041401020705	Salmon River	Oswego	0.515	0.611	-0.096
60	041401010604	Fourmile Creek	Monroe, Wayne	0.359	0.488	-0.129
61	041401010702	Railroad Mills-Frontal Lake Ontario	Monroe, Ontario	0.402	0.585	-0.184
62	041401010705	Irondequoit Creek	Monroe	0.386	0.578	-0.191
63	041401010704	Thomas Creek-Irondequoit Creek	Monroe, Ontario, Wayne	0.371	0.587	-0.216
64	041401010707	West Creek-Frontal Lake Ontario	Monroe	0.349	0.578	-0.229
65	041401010703	Allen Creek	Monroe	0.304	0.666	-0.362
66	041401010706	Irondequoit Bay	Monroe	0.237	0.717	-0.481

Oswego

Rank	HUC 12	Name	County	Health	Stress	Comp.
Top 10						
1	041402020102	Headwaters East Branch Fish Creek	Lewis	0.922	0.103	0.819
2	041402020101	Alder Creek	Lewis	0.810	0.097	0.713
3	041402020804	Threemile Creek-Frontal Oneida Lake	Oswego	0.783	0.139	0.645
4	041402020104	Mud Brook-East Branch Fish Creek	Lewis, Oneida	0.814	0.171	0.643
5	041402020803	Scriba Creek	Oswego	0.823	0.191	0.631
6	041402020205	Little River	Oneida, Oswego	0.766	0.172	0.594
7	041402020802	Black Creek-Frontal Oneida Lake	Oneida, Oswego	0.763	0.182	0.581
8	041402020305	Wood Creek	Oneida	0.783	0.267	0.515
9	041402020301	Canada Creek	Oneida	0.684	0.174	0.510
10	041402020801	Hall Brook-Frontal Oneida Lake	Oneida	0.679	0.170	0.508
Bottom 10						
146	041402030103	Waterhouse Creek-Oswego River	Oswego	0.379	0.533	-0.154
147	041402030204	Oswego River	Oswego	0.426	0.593	-0.167
148	041402020606	Lower Limestone Creek	Onondaga	0.472	0.642	-0.170
149	041402011306	Owasco Outlet	Cayuga	0.510	0.704	-0.194
150	041402010401	Upper Canadaigua Outlet	Ontario	0.301	0.502	-0.200
151	041402011503	Geddes Brook-Ninemile Creek	Ondoga	0.455	0.678	-0.223
152	041402011606	Skaneateles Creek	Cayuga, Onondaga	0.467	0.782	-0.315
153	041402011508	Ley Creek Branches	Onondaga	0.346	0.698	-0.352
154	041402011509	Onondaga Lake	Onondaga	0.203	0.600	-0.397
155	041402011507	Furnace Brook-Onondaga Creek	Onondaga	0.298	0.903	-0.605

North Eastern Lake Ontario

Rank	HUC 12	Name	County	Health	Stress	Comp.
Top 10						
1	041501010702	Middle Independence River	Herkimer, Lewis	0.966	0.108	0.857
2	041501010804	Otter Creek	Herkimer, Lewis	0.985	0.130	0.855
3	041501010103	Little Black Creek	Herkimer, Oneida	0.944	0.109	0.834
4	041501010102	Twin Lakes Stream-Black River	Herkimer, Oneida	0.961	0.130	0.831
5	041501010601	Twin Sister Creek-Moose River	Herkimer, Lewis	0.926	0.109	0.817
6	041501010701	Upper Independence River	Herkimer, Lewis	0.911	0.117	0.794
7	041501011001	Shingle Shanty Brook-Beaver River	Hamilton	0.886	0.095	0.792
8	041501010405	Red River-South Branch Moose River	Hamilton, Herkimer	0.917	0.128	0.790
9	041501010803	Big Otter Lake-Otter Creek	Herkimer	0.870	0.090	0.780
10	041501010202	Little Woodhull Creek	Herkimer, Oneida	0.900	0.130	0.770
Bottom 10						
60	041501020402	Muskellunge Creek-Frontal Lake Ontario	Jefferson	0.351	0.215	0.136
61	041501020303	Lower Perch River	Jefferson	0.334	0.223	0.111
62	041501020101	Kents Creek	Jefferson	0.266	0.157	0.108
63	041501020401	Mill Creek	Jefferson	0.357	0.253	0.104
64	041501020202	Horse Creek-Frontal Lake Ontario	Jefferson	0.278	0.174	0.103
65	041501020201	Chaumont River	Jefferson	0.353	0.260	0.093
66	041501020102	Fox Creek-Frontal Lake Ontario	Jefferson	0.248	0.161	0.087
67	041501011403	Philomel Creek	Jefferson	0.238	0.324	-0.086
68	041501010901	Mill Creek	Lewis	0.359	0.492	-0.132
69	041501011404	Kelsey Creek-Black River	Jefferson	0.429	0.805	-0.376

St. Lawrence

Rank	HUC 12	Name	County	Health	Stress	Comp.
Top 10						
1	041503060203	Black Brook-West Branch Saint Regis River	Franklin, St Lawrence	1	0.098	0.902
2	041503050504	Potter Brook-Jordan River	Franklin, St Lawrence	0.944	0.064	0.880
3	041503020102	Buck Brook-Oswegatchie River	Herkimer, St Lawrence	0.969	0.094	0.876
4	041503040203	North Branch Grass River	St Lawrence	0.976	0.101	0.875
5	041503020101	Robinson River-Oswegatchie River	Hamilton, Herkimer, St Lawrence	0.966	0.101	0.865
6	041503060202	Long Pond Outlet	Franklin, St Lawrence	0.924	0.101	0.823
7	041503050505	Ellis Brook-Raquettte River	St Lawrence	0.913	0.094	0.818
8	041503020302	Wolf Creek-Middle Branch Oswegatchie River	Herkimer, Lewis, St Lawrence	0.995	0.181	0.814
9	041503080401	Crystal Creek	Clinton	0.868	0.056	0.812
10	041503060101	Hays Brook	Franklin	0.894	0.083	0.811
Bottom 10						
171	041503100202	Raquette Creek-Frontal Saint Lawrence River	Franklin	0.449	0.325	0.124
172	041503020802	Malterna Creek-Oswegatchie River	Jefferson, St Lawrence	0.408	0.298	0.110
173	041503070306	Town of Fort Covington-Salmon River	Franklin	0.384	0.289	0.095
174	041503030301	West Creek	Jefferson	0.436	0.359	0.077
175	041503100201	Dodge Creek-Frontal Saint Lawrence River	St Lawrence	0.503	0.443	0.059
176	041503090102	Wheeler Creek-Frontal Saint Lawrence River	Jefferson	0.245	0.194	0.051
177	041503080406	Ruisseau Norton	Clinton	0.000	0.000	0.000
178	041503050703	Village of Potsdam-Raquette River	St Lawrence	0.535	0.538	-0.003
179	041503030303	Trout Brook-Indian River	Jefferson	0.412	0.428	-0.017
180	041503030504	Fish Creek	St Lawrence	0.381	0.408	-0.027