## Decision-support tool for coastal area management based on results of the Sea Level Affecting Marshes Model (SLAMM)

Conservation planning and management under changing climate conditions, particularly sea level rise, can be complicated by the wealth of divergent data sets available and multiple policymaking goals. Warren Pinnacle Consulting, Inc. (WPC) with funding by the New York State Energy Research and Development Authority (NYSERDA) is creating a decision-support tool to assist policymakers in planning and prioritizing coastal marsh areas for adaptation and conservation. This tool accounts for environmental and socio-economic factors, protection of developed areas, and projections generated using the Sea-level Affecting Marshes Model (SLAMM) along with their inherent uncertainty.

A key feature of the tool is that stakeholders set the values that guide it. By using a Delphi survey method and a "Wetland Benefit Unit"<sup>1</sup> approach, stakeholders define the ranking/values of various wetland ecosystem services (qualitative and quantitative) that can vary by agency or by evaluative task. These values are integrated with SLAMM predictions and applied to the parcels of currently existing and predicted future marsh lands (Figure 1). When combined with time-varying SLAMM results, this tool provides methods to aggregate information in a meaningful and simple way while explicitly including model uncertainty as part of the decision process (Table 1, Figures 2 - 4). A great benefit of this approach is that end users are in control of the tool rather than simply having it provided by scientists, which may improve overall acceptance and use. In addition it is built with flexibility in mind and an unlimited number of sites, scenarios, and ecosystem services can be incorporated depending on user needs.

This tool is unique in its approach and possibility for wide-scale application. There are few landscapescale models or modeling products that provide data to assess potential wetland response to long-term sea-level rise as SLAMM does. Wu and coworkers recently stated "there are no other landscape models we are aware of readily available for resource managers" that are similar to SLAMM<sup>2</sup>. In addition, to our knowledge there are no other groups tackling the critical issue of creating regionalscale, science-backed decision-support tools to assist planners and policymakers in their goal of creating resilient coastal communities.

Please visit <u>www.warrenpinnacle.com</u> for more information about our work. Questions can be directed to <u>jclough@warrenpinnacle.com</u>

<sup>&</sup>lt;sup>1</sup> Wetland Benefit Units are used in lieu of dollars to facilitate ecosystem service valuation in a way that avoids the pitfalls of an economic valuation. This approach was introduced by Sam Merrill and Charlie Colgan (Merrill, Samuel B. (2015) "Using Future Benefits to Set Conservation Priorities for Wetlands," Journal of Ocean and Coastal Economics: Vol. 2, Article 3. <u>http://dx.doi.org/10.15351/2373-8456.1013</u>)

<sup>&</sup>lt;sup>2</sup> Wu, W., Yeager, K. M., Peterson, M. S., and Fulford, R. S. (2015). "Neutral models as a way to evaluate the Sea Level Affecting Marshes Model (SLAMM)." *Ecological Modelling*, 303, 55–69.



Figure 1. General marsh adaptation strategy identification approach

 Table 1. Example of Marsh Management Tool tabular output. In addition to the ecosystem services shown here, the tool can also determine habitat, flood protection, and political/cultural/historical value metrics. The tool is expandable to include multiple sites (and multiple management scenarios for each site) and additional ecosystem services can be included based on client needs.

	Site Details				Nutrient Sequestration			Recreation		
relative rank					15	10	5	10	10	10
Site number	Site Name	Desc.	Acquisition Cost (in millions)	Overall benefit	C Seq.	N Seq.	P Seq.	Dry Land Recreation	Marsh Recreation	Natural Areas for Underserved Communities
Site 1	first	first one	1.5	49.95	0.61	0.40	0.20	25.50	23.24	0.41
Site 2	second	second	1.2	77.96	0.73	0.48	0.24	25.50	51.00	0.48
Site 3	third	the third	0.75	83.82	3.72	2.41	1.18	25.50	51.00	2.48
Site 4	four	the fourth	4	90.70	7.24	4.76	2.21	25.50	51.00	4.83
Site 5	five	the fifth	0.5	25.50	0.00	0.00	0.00	25.50	0.00	0.00
Site 6	six	the sixth	2	187.63	56.01	36.92	18.20	25.50	51.00	37.34



Figure 2. Flexible charts allow for comparisons of ecosystem services between sites. Here the ability to sequester nutrients is compared between sites 1-4. This can be edited using dropdown menus to show a specific time period, and sites and ecosystem services of interest.



Figure 3. Individual ecosystem services can be examined over time for selected sites. Again dropdown boxes allow for flexibility to change the sites and services plotted.



Figure 4. Users can review how landcover changes over time. Dropdown boxes allow for flexibility to change the site(s) plotted.