THE DYNAMIC MARSH MANAGEMENT TOOL (DMMT) –

OPTIMIZING COASTAL-MARSH AND NATURAL-RESOURCE PRESERVATION UNDER UNCERTAIN SEA-LEVEL RISE

warren pinnacle consulting, inc.

The Dynamic Marsh Management Tool integrates current model results, uncertainty analysis, and stakeholder values to estimate cost-per-benefit ratios for alternative management strategies

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. Because of this, prioritization of marsh-management strategies can be a difficult undertaking. Ideally, a manager could evaluate the relative benefits of adaptation strategies and maximize wetland benefits while considering uncertainty both in future sea-level rise, and dynamic marsh response. A modeling framework to evaluate the costs and benefits of management strategies while accounting for these uncertainties has been developed (Figure 1, left).

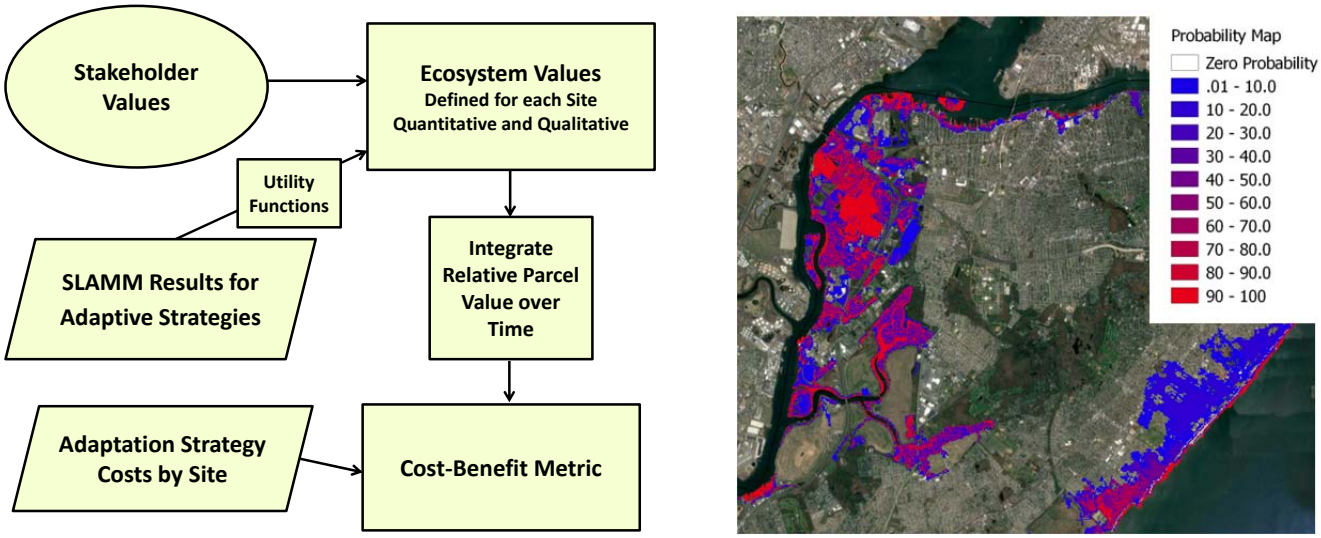

FIGURE 1. SCHEMATIC OF DMMT AND A SPATIAL UNCERTAINTY ANALYSIS MAP USED (PERCENT LIKELIHOOD OF HABITAT CHANGE BY 2085)

The base data for the tool are high-resolution uncertainty-analysis results from the SLAMM model under multiple adaptive-management strategies (Figure 1 right). Adaptation strategies that have been simulated include:

- thin-layer sediment deposition of dredge material onto existing marshes,
- upland land purchase and purchase of easements to allow marsh migration,
- marsh habitat restoration to historic footprints (or new-project footprints), and
- tidal-amplitude restoration via culvert replacement.

Model results are combined with ecosystem-valuation assessments from stakeholders that define a set of relative "wetland benefits." Stakeholders enumerate site specific wetland benefits that can include nature-centered benefits (such as nekton habitat preservation) and human-centered benefits (such as recreation and flood protection). Model results and stakeholder values are then linked together using utility functions that characterize the relationship between defined wetland benefits and geometric metrics such as "marsh type," "marsh area," marsh edge," and "marsh width." Expected-values for each site's wetland benefits can then be projected into the future and compared to the estimated costs for each adaptation strategy (Figure 2). Estimates of optimal marsh-management strategies are produced, by maximizing the "wetlands benefits per estimated costs" ratio.

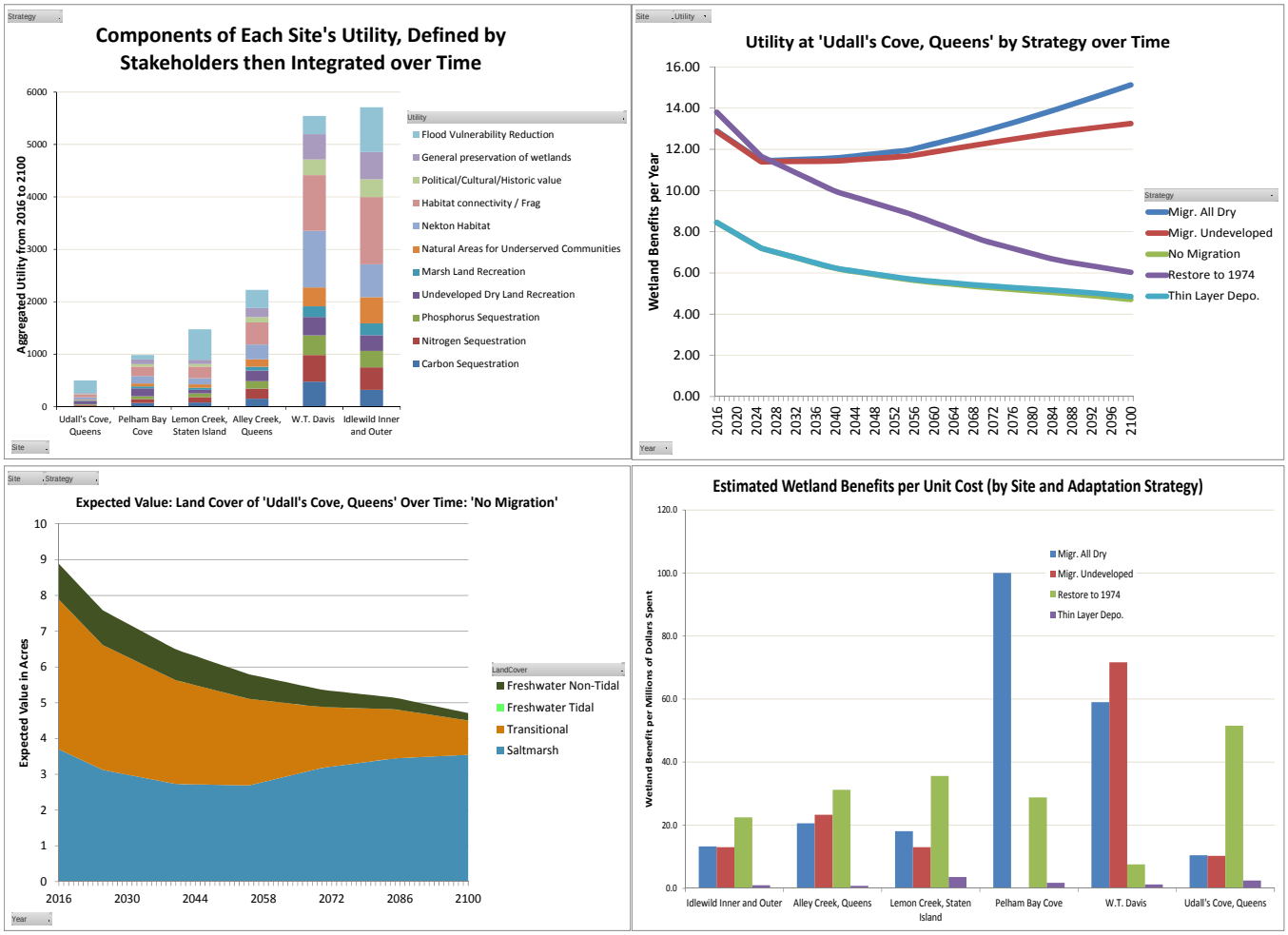

FIGURE 2. UPPER LEFT: COMPONENTS OF MARSH WETLAND BENEFITS BY DEFINED STUDY AREA. UPPER RIGHT: EFFECTS OF ALTERNATIVE MANAGEMENT STRATEGIES ON ONE DEFINED MARSH SYSTEM. LOWER LEFT: EXPECTED VALUE OF LAND COVER GIVEN UNCERTAIN SEA-LEVEL RISE. LOWER RIGHT: COMPARITIVE BENEFITS PER ESTIMATED COST OF EACH ADAPTATION STRATEGY BY SITE STUDIED

This new tool has been applied in two different New York Counties (partnering with NYSERDA and NYC Parks) and is currently being applied to a third county (partnering with NYSERDA and TNC) and Casco Bay in Maine (with Casco Bay Estuary Partnership). The current New York State project has built on previously completed high-resolution uncertainty analysis modeling (Clough, Polaczyk, and Propato, 2016 in *Ecological Modeling*).

Existing SLAMM model applications can be utilized as the base of the tool or new applications created with updated spatial data for a reasonable cost. For more information on the DMMT including model results and New York City case studies, please visit http://warrenpinnacle.com/prof/SLAMM/NYSERDA2015/DMMT.html. To learn more about applying DMMT for your study area, please contact Jonathan Clough (jclough@warrenpinnacle.com) or Marco Propato (mpropato@warrenpinnacle.com) or call Jonathan at 802-496-3476.

Other Projects Warren Pinnacle Consulting has recently been involved in include:

- Modeling Effects of Sea-Level Rise and Storm Surge on Roads and Infrastructure
- Modeling Effects of Deepwater Horizon on Nearshore Environments (Blancher et. al 2017; Clough et al, 2017 accepted)
- Creation of SLAMM version 6.7 including dynamic wave erosion (with ESA Associates and funding from TNC)
- Creation of AQUATOX 3.2 with EPA funding (EPA release expected in 2017)