Leveraging Hydrologic Models to Compare Ecosystem Restoration Measures in a Bar-Built Estuary

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Prior and current land uses often stress marshes in complex ways, making it difficult to predict the most efficient path for restoration. This is particularly true in bar-built estuaries, where natural lagoon closures are important drivers in the hydrology of perched marshes. Lower Watsonville Slough has been subject to 1) historic clearing that removed natural side channels and microtopographic relief, 2) reduction of marsh extent by agriculture and development, 3) hydrologic constrictions including berms between the slough and marsh plain and levees on the main stem of the Pajaro River, to which Watsonville Slough is a tributary, and 4) manual breaching of the lagoon during natural closures that would otherwise inundate the marsh.

Dominance of non-native xeric species and stunted growth of native species in portions of the marsh plain indicate truncated hydrology. To ascertain which restoration measures would maximally reestablish appropriate marsh hydrology, numerous hydrologic and geographic information system (GIS) models were leveraged and combined. Representative Hydrologic Engineering Center's River Analysis System (HEC-RAS) model scenarios were run for four distinct lagoon mouth (open and closed) and hydrologic (wet and dry) states through a year. Inundation heat maps were generated for each run, and then combined into an annual inundation heatmap using weightings derived from the Lagoon Quantitative Conceptual Model (QCM), a parametric mass-balance model used to predict lagoon closures and natural openings.

Ranges of modeled inundation that support robust marsh, upland or stunted marsh, and open water were determined by comparing the existing conditions annual inundation heat map with a vegetation map. Modeling was completed for the future without project and three alternatives to determine the most effective restoration of marsh hydrology. While intensive, this robust and thoroughly reviewed analysis led to a different selected plan than a simpler marsh condition index model might have supported.

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