Introduction
Habitat suitability index (HSI) models can be useful components of planning and carrying out restoration efforts, but are often limited to a HSI of a single population or habitat. Here, we describe a multi-habitat HSI model approach that was developed for the US Army Corps of Engineers Los Angeles District, in support of their East San Pedro Bay Ecosystem Restoration Feasibility Study. The Southern California Coastal Bay Ecosystem Habitat model (Habitat Model) was developed to assess future restoration alternatives for the East San Pedro Bay project area, and integrates a suite of equations representing environmental response to physical and hydrodynamic changes for six different habitat types, including critically important seagrasses, oyster reefs and kelp beds.

Collaborative Modeling
The Southern California Coastal Bay Ecosystem Habitat Model development was completed through a mediated development process that involved close collaboration between ERDC, Los Angeles District and several federal, state, and local agencies including the City of Long Beach, US Fish and Wildlife Service, NOAA, CA Dept. of Fish and Wildlife, and others. Initially, a conceptual model was developed through a series of workshops and meetings.

Quantitative Modeling
The Habitat Model is designed as a spatially-explicit, grid based model that uses a series of habitat specific linear equations to calculate habitat suitability for restoration of the following habitat types: rocky reef, kelp forest, eelgrass, oyster reef, tidal salt marsh and sandy islands.

The Habitat Model is composed of six habitat types, each with a series of 2-6 variables that are assigned a dimensionless Suitability Index (SI) value representing the relationship between an environmental variable and habitat suitability for the habitat of interest. We identified critical variables and developed curves with input from our collaborators and subject matter experts from the Southern California Coastal Water Research Project, California State Water Resources Control Board, Occidental College, California Coastal Commission and California State University Long Beach.

Each SI is represented quantitatively as a series of linear suitability curves, with a minimum value of 0 for unsuitable to 1.0 for optimal habitats. Suitability curves are formulated as step-functions with linear approximations between each step. A habitat specific HSI score is calculated as the geometric mean of the individual SI values and represents the overall suitability of a particular location for restoration. Data and equations are imported into a GIS and applied to specific geo-referenced locations. The geospatial location of each habitat type is considered so that location specific data can be used to calculate SI values for each variable of interest.

Model Outputs
Eighteen different restoration scenarios incorporating the six habitat types as well as structural modifications were evaluated using the Habitat Model.

Our approach required addressing each habitat in a consistent manner to allow for an integrated evaluation of various habitat HIS values in one region. Although there are HSI models already developed for some of the habitats included in our model (e.g., eelgrass: Zhou et al 2016; oyster reef: Swannack et al 2014, Barnes et al 2007), most of the habitat types that we considered do not have existing HSI models that are useful at the habitat scale, or the region in which the model was developed is not compatible with Southern California. To our knowledge, this is the first HSI model developed within the USACE that incorporates multiple habitat types simultaneously.

Citations: