Evaluation of Maximum Entropy models for assessing the restoration scenarios influence on coastal wildlife populations

Paul Leberg, University of Louisiana at Lafayette

Determination of how decisions regarding wetland restoration affect wildlife populations is an important part of any management plan and is integral to CPRA's master planning efforts (Nyman et al. 2013). Habitat suitability indexes (HSI) have been used by the CPRA to predict the response of wildlife to planned restoration projects, but have disadvantages for this purpose. First, traditional HSI models were not originally developed for predicting wildlife responses to management. Second, they were not developed for assessing processes occurring at large spatial scales. Although there have been a few applications of HSI models at the scale of the Master Plan, one of the few quantitative validations of regional models indicated that 40% of these models failed and many of the successful models were only weakly predictive of actual species use of sites. Given some of the difficulties of applying HSI models to master planning efforts, we propose an alternative approach to the problem of predicting the effects of coastal change on wildlife populations. Such an approach would benefit not only the State's efforts in coastal planning.

Maximum entropy (ME) models estimate the probability that the species is present, given the environmental conditions at a location. This approach requires two types of data tied to specific locations across a landscape. The first are records of a species' occurrence. These could come from an existing database, or they could be collected through field research. Second are measurements of the environment where the species is found. For this purpose, we propose to use variables we have measured from our field work at bird colonies across southern Louisiana. We will build a similar set of models from the water depth, salinity, wetland morphology and vegetation generated by the modeling efforts that were the foundation of the 2012 Master Plan. We will then estimate the probability that the species will occur at any spatial and temporal point for which there are the same sorts of modeled data used to understand the current distribution of the species.

This maximum entropy approach we are proposing has two advantages over the HSI approach. First, instead of trying to redefine the equations used in HSI models to provide meaningful results for the data types generated from the Master Plan's models, our approach uses the same types of environmental variables modeled in the Master Plan to develop the equations predicting species presence. Second, the approach will provide a framework for both determining if the species is likely to be affected by changes in wetland habitat and for validation model results. To date the ME approach has been used to predict changes in species distribution in changing climate and during invasions of novel environments. Our proposed project will be, to our knowledge, the first attempt to use the approach to understand the effects of large management efforts on a species regional distribution. As such, this work should not only to directly benefit CPRA's planning efforts, but also to help provide a framework for other programs attempting to manage ecosystems at the landscape level.

Funding is requested for a CSAP intern who will evaluate whether maximum entropy modeling might be more suitable for the purpose of understanding how a coastal management activity might affect a wildlife species than the currently used HIS approach. Our objective is to develop species occupancy models as a tool for wetland restoration planning and to evaluate predictions of those models. Working with the CRPA and selected partners like LDWF, we will evaluate how the approach using the roseate spoonbill and the brown pelican. These species are selected because appropriate occurrence data exist for both species in LDWF databases. We have worked with these databases in the past, and anticipate no difficulty in accessing a large number of observations for many species. To these observations, we will add our own georeferenced observations from years of field work in coastal Louisiana. Because we have also conducted field work at many of the sites occupied by breeding colonies of these species, we have access to environmental data that can be used to development the ME models. Finally, we have chosen these species because an HSI model for Roseate Spoonbills has been developed for the 2012 Master Plan and HSI model for Brown Pelicans will be developed for the 2017 Master Plan. Thus it will be possible to directly compare the results of the two models.

The intern will use the modeling software MaxEnt (Phillips et al. 2006) to predict the probability of species occurrence at a site. This software requires two sets of information: data on locations where the species has been observed (collected from the databases as discussed above), and observations of environmental variables from those same sites. Environmental variables will be obtained from our past sampling of waterbird colony sites. An alternate set of environmental variables, will be the existing vegetation, hydrology, and wetland morphology model outputs from the Master Plan. This will allow direct comparison of models developed from empirical data and estimates from the master plan models.

For validation, the intern will examine the occurrence of two test species at least 30 sites not used to develop the ME models. To minimize costs, data from these sites will be obtained during visits for other purposes (field sampling trips for other projects and courses). For the ME models, the correlation of probability of a species occurrence at a site, predicted by the model, with an estimate of abundance made during a site visit. For the HSI models, we will examine the correlations between the habitat suitability index value and the estimates of abundance. If these correlations are high for both approaches, it would suggest that either the HSI or the ME modeling approaches provide useful information for the planning process. If the correlations between predicted and observed indices of occurrence or abundance are much higher from one modeling approach than for another, we will be able to make a clear recommendation about which approach should be used going forward. If predictions from both types of models are only weakly correlated with observations from the field, it would suggest that a new alternate approach, yet to be determined, should be used in future master planning efforts.

Because maximum entropy models have proven their utility in other contexts, and because our models will be based on environmental data generated for the master plan was designed to generate, we predict this approach has the potential to be much more useful for planning that the HSI models currently in use. Therefore, in addition to producing models for two species that could be used in the next master plan, we believe this approach could lead to a shift in how future master plans attempt to understand the effects of restoration on wildlife. Thus this work has direct implications both for the mission of CPRA to improve wildlife habitat, but also provides a new framework for both the development of species models, as well as tools for model evaluation.

Relevance to CPRA and Louisiana's Master Plan – This research will provide CPRA with an evaluation of an alternate modeling approach to understand how wildlife populations will response to coastal management activities. The project addresses objectives of Coast 2050 and Comprehensive Master Plan in terms of understanding the consequences wetland loss and proposed restoration activities for two wildlife species. The proposed work will also provide an alternative framework for modeling the responses of other fish and wildlife species. The proposed approach should be more accurate and easier to integrate into CPRA's Master Planning effort than the HSI approach that is currently being used.

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