Develop Analyses, Modeling, and Decision Support System Training Curriculum to Support Improved Plant and Animal Conservation in the Face of Climate Change

Project Description: Spatially explicit environmental suitability and spatial allocation analyses are increasingly being employed by land managers to inform conservation decisions and climate adaptation planning. Powerful and general statistical and GIS tools to perform these analyses have arisen in the biodiversity-protection literature. For example, Maxent, a type of species distribution model which uses field observations and GIS derived environmental covariates to estimate site suitability where data aren't available, is one of the most commonly applied tools to estimate the response and vulnerability of species to climate change (http://data.prbo.org/apps/ecn/).

Despite the fact that there has been a proliferation of projects utilizing tools like Maxent to aid conservation decision making, many managers do not have the time or expertise to learn to use these new tools or to keep current with scientific developments in this field. For example, recent studies have investigated the advantages and limitations of Maxent and similar approaches. Additionally, new research has demonstrated how outputs from Maxent and related tools can feed conservation design software (Marxan, Zonation) that help managers choose low cost spatial allocations to satisfy multiple objectives and constraints (fuels treatment, nesting habitat, recreation, water retention) (Figure 1). These outputs can parameterize corridor design, critical habitat designations, land protection design, restoration priorities, , and other landscape-scale assessments..

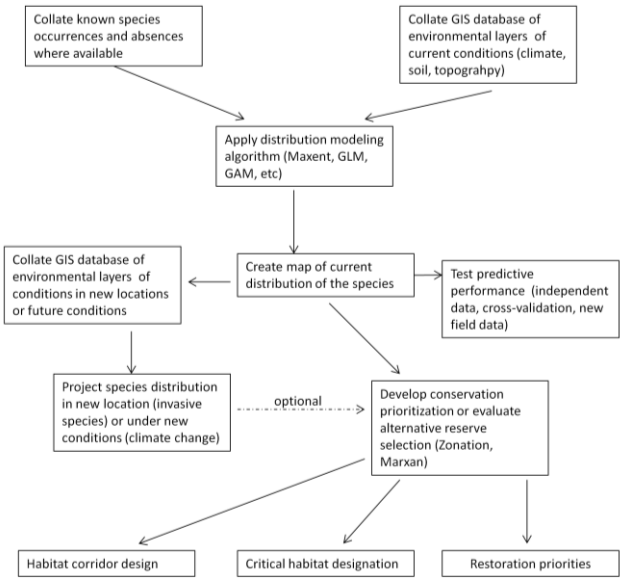

Figure 1 Workflow diagram illustrating the use of spatial environmental suitability models to aid natural resource management decision making.

However, land managers and their staff rarely have the time or the means to keep up to date with the most recent scientific literature on best practices and their applications. Further, the number of web sites and clearinghouses distributing data and information has increased and staff no longer have a complete understanding of available data and information which they could make use of. Informal surveys in the US Fish and Wildlife Service indicate an astonishing lack of knowledge and understanding of available and applicable climate change data and how to apply this new information to their local program needs. Thus, there is a danger that powerful tools are being underutilized or used inappropriately to make management or policy decisions.

The goals of our project are: 1. Educate managers and technical staff on current best practices for developing and using spatial environmental suitability models, resource allocation applications, and their use. 2. Train technical staff to complete their own analyses using appropriate tools, model outputs, and data. 3. Train both technical staff and managers to understand new data and applications, including abundant climate change data, and appropriately apply to their local decision needs. 4. Emphasize educating staffs to better understand concept of uncertainty and consider it in their decision-making framework. Our project will develop a training curriculum for teaching the best practices for the development of spatial models for conserving plants and animals in the face of climate change. We will develop two courses, one for managers and non-technical staff, and another for GIS-statistical analysts. The course for land managers will be geared towards understanding what tools and data are available, how they can be used, and identify existing data and information sources. We anticipate the course for managers will be two days long and the technical

class will be four days of "hands on" training. Both courses will be instructor led courses, but all course materials will be distributed and available. As an example, we will demonstrate the applications and limitations of commonly used tools such as Maxent, Zonation and Marxan for developing effective adaptation strategies to rapid environmental change. For the technical class, we will provide instruction on the whole modeling process; from acquiring data, to creating Maxent distribution models and applying them to derivative conservation planning applications such as Zonation. We will examine how uncertainty can be incorporated into model development or addressed in model outputs. Course content will be modularized, so that content can be independently used to build custom content outside of the curriculum. We will teach an interagency pilot of each course, and make open-source course materials, including sample data, available for more general application by LCC partners.

CA LCC Priorities addressed: Our project will provide pragmatic decision support for managers by teaching a synthesis of best practices, high quality data and tools, and how to intelligently use this new information. Our courses will help managers understand the tools that are available, including understanding and applying uncertainty associated with analytical products. Similarly, our hands on course will enable technical analysts in public agencies to complete their own analyses. By evaluating a set of existing tools in our test workshops we can provide feedback as to what is working and what is missing from available tools for climate adaptation planning. We expect that our courses will add value to existing conservation planning efforts by enabling managers to take advantage of the best available scientific tools.

Our courses and curriculum will provide a resource LCC partners can use to conduct analyses which examining ecosystem impacts and the ability to track change specific to managers needs. For example, using models we have already developed, we will demonstrate examples of how models of species distributions are being used to inform the design of renewable energy development for the Desert Renewable Conservation Plan in southern California (Howell and Veloz, 2011). After completing our courses, managers and their staff will have a better understanding of how species distribution models can be used to predict species habitat changes in response to climate change.

CA LCC Criteria addressed: 1) Our project will directly support resource managers and analysts in public agencies through development of a dynamic curriculum and delivering training to better inform understanding of the data, tools, and analyses being used to assess threats from rapid environmental change. Our curriculum will help managers and analysts to be able to use existing models for their conservation or adaptation decisions and will provide them with the training to create their own models when existing products do not meet their needs. 2) Through our courses, we will demonstrate how sources of uncertainty can be incorporated into a typical analysis workflow and we will present results from currently funded CA LCC projects which are investigating which sources of uncertainty are greatest with distribution modeling across the state of CA with birds and plants. 3) Our courses will be integrative as we will use examples of decision support tools for plants, birds, and invasive species. We will use the California Climate Commons (http://climate.calcommons.org/), Environmental Change Network (http://data.prbo.org/apps/ecn/) and the International Biological Information System (ibis.colostate.edu) as case studies for how existing tools can be used to acquire data and applied to support management decisions. 4) Our courses will be made widely accessible through the California Climate Commons or team members' websites. 5) Our team includes scientists from academic institutions, federal agencies and non-profit organizations and provides a strong connection between cutting edge science and the needs of managers. Each team member will be

leveraging a considerable expertise gained from work over the last decade in applying the spatial models we will be teaching for research and conservation applications. We also anticipate that the courses will provide opportunities for new collaborations between the instructors and participants as we explore how the needs of managers can be met through spatial modeling. 6) Our curriculum will provide training on tools and models that are currently being applied throughout the CA LCC as well as in many other LCCs across the continent. Our curriculum could be used to help ensure consistent methodologies are being applied within and across LCCs.

Scope of Work – Approach & Integration with Related Projects: We will develop a training curriculum for two training courses; one targeted at managers and non-technical staff and the other targeted at GIS analysts. By developing two courses we will be able to provide guidance at a more general level to managers that need to understand and use model outputs to guide decisions while also providing the technical details GIS analysts need to produce their own models and provide support for interpreting existing tools. Every module of these courses will follow instructional lesson plan guidelines including: module objectives, materials needed, procedures, practice, assignments, assessment checks, and evaluation.

The course for managers will be two days long and will focus on introducing tools which are currently available for spatial models to support plant and animal conservation and adaptation planning for rapid environmental change and discussing the applications and limitations of various approaches. An important outcome of this training will be to give managers a list of questions they can ask to help assess a model's output. Further, managers will be exposed to existing data and information availability, particularly climate change data. The course material will be presented as a set of modules associated with a workflow. These modules include the assembly of model input data (occurrence data, environmental data); modeling of species distributions, conservation prioritization and planning; and connectivity analyses and planning for ecosystem services (i.e. reserve design planning, restoration priorities, water footprints) (Figure 1). Upon completion, managers will be able to identify which tools are best suited for their decision-making needs and they will be able to interpret and select from existing model outputs to support their conservation and adaptation efforts.

DRAFT Management course curriculum outline (2 day course):

- Pre-workshop review: A suggested reading list and a list of related online decision support tools to explore prior to the course.
- General overview
    - What are models and how should they be used to support decision making?
    - Describe the modeling workflow using existing projects as examples
    - Managing uncertainty
- Resources available
    - Data: Species occurrences, current and future climate data, etc.
    - Existing web application and clearinghouses such as climate change, species distribution sites
    - Dealing with lack of data.
- Species distribution models
    - Background
    - Maxent: Applications, assumptions, limitations

- Conservation applications (Marxan, Zonation, corridors)

The course for GIS analysts will be focused on the same general topics as the course for managers but will go into greater depth and will be a hands-on training. The curriculum will enable participants to use provided sample data to create models that they could use for application in their agency.

DRAFT GIS analyst course curriculum (4 day course)

- Pre-workshop review: A suggested reading list and a list of related online decision support tools to explore prior to the course, tutorials to try out existing tools.

- General overview
  - What are models and how should they be used to support decision making?
  - Describe the modeling workflow using existing projects as examples
  - What to do about uncertainty
- Resources available
  - Input data:
    - Species occurrences (standardized vs. citizen science vs. museum)
    - Climate data (observed data, general circulation models)
  - Web applications
    - California Climate Commons
    - Environmental Change Network
    - International Biological Information System
  - Dealing with lack of data.
- Species distribution modeling (Maxent)
  - Introduction to distribution modeling
  - Introduction to Maxent
    - Background, assumptions, applications, limitations
    - Using Maxent
    - Model selection
    - Evaluating predictive performance
    - Practice using with tutorials and sample data
- Conservation planning prioritization (Marxan/ Zonation)
  - Introduction and background
  - Applications: what tools are best for which questions
  - Practice using tools with output models from Maxent exercises
- Modeling with rapid environmental change
  - Climate Change
    - Changes is species distribution
    - No-analog climate and model extrapolation
  - Invasive species
    - Predicting introductions and expansions
    - Response to climate change
  - Connectivity
    - Can we facilitate the movement of species across a changing landscape?

We will develop the curriculum for both courses and then run pilot workshops to test and revise the course material. At the conclusion of each pilot workshop we will have participants fill out a workshop survey to evaluate the course. Based on feedback, we will revise the curriculum and distribute widely. The US Fish and Wildlife service has agreed to try to create a regular update and delivery process for course curriculums.

Products/Data Sharing: For our project we will develop a training curriculum for both courses that will include sample data, multimedia, and module lesson plans. The courses themselves will open to anyone interested but the target audiences will be planners, managers, and technical analysts (usually GIS Specialists). We will make final course content and curriculum available through partner websites and the California Climate Commons.

Measuring results: Our project will be successful if after finishing our courses, workshop attendees are able to critically evaluate existing models and tools and conduct their own analyses using the tools we have demonstrated. We will have all attendees evaluate the courses upon completion and will incorporate lessons learned into our curriculum which we will provide online. Further, we will encourage those who do not attend the workshop to access our curriculum through the California Conservation Commons where they can rate the courses and discuss the curriculum with other users.

The final deliverables for this project will include: lesson plans, multimedia support such as powerpoints, and sample data. Our goal is that other instructors can reuse this content either wholly or as modules within their own instructional content.

Project Timeline

Task	Q1	Q2	Q3	Q4
Literature review including existing courses	x			
Develop course curriculum		x	x	
Incorporate feedback on proposed course content from potential users		x	x	
Hold test workshops			x	
Incorporate feedback from workshop participants/ revise curriculum				x
Distribute course curriculum online				x

References

C.A. Howell and S. D. Veloz. 2011. Priority Areas for Breeding Birds within the Planning Area of the Desert Renewable Energy Conservation Plan. PRBO Technical Report. PRBO contribution #1823.http://www.prbo.org/cms/docs/terre/PRBOTechnicalReport_PriorityAreasforBreedingBird%20intheDRECP_V4.0_122811.pdf