Advancing Regulatory Processes and Conservation Outcomes with Improved Distribution Data for At-Risk Species

A lack of precise information on where at-risk species are likely to be found inhibits effective species conservation, and, for listed species, creates regulatory burdens that threaten the ESA. The use of broad range maps (Fig 1) to define habitat results in data that are inconsistent across taxa, not transparent for the regulated community, and ill-suited for directing conservation efforts. Without consistent, predictable, up-to-date, and scale-appropriate information to guide species conservation decisions, significant funding is spent analyzing T & E species impacts that may never occur on the ground, decisions on whether species warrant listing must be made with incomplete information, and resources for recovery and other conservation efforts cannot be easily targeted where they will confer the greatest benefit.

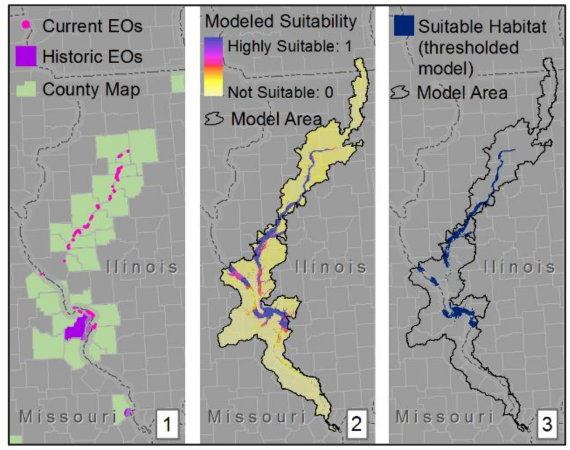

Fig 1, 2, & 3. Maps of T&E species can be overly inclusive when broad range maps (e.g. counties) are used to delimit habitat, or not comprehensive enough when observed presence data, such as element occurrence (EO) records, are used (Fig 1). SDMs provide a means to identify areas least (yellow) and most (blue) likely to provide suitable habitat (Fig 2) and can be translated into refined maps of potential habitat (Fig 3). This example is for the threatened decurrent false aster (*Boltonia decurrens*); the model area (black outline) is defined by the floodplain in which the species is found.

Fortunately, advances in ecological modeling make this a tractable problem to solve. A nationally consistent, verifiable, multi-jurisdictional library of modeled distributions for listed, candidate, petitioned, and other at-risk species can now be achieved by applying scientifically robust species distribution modeling (SDM) techniques. SDM combines species observation data with environmental predictors to map areas of likely occurrence. Today, input data are readily available and comprehensive, and modeling procedures are standardized. It is now entirely feasible to generate refined maps of the distribution of suitable habitat for almost all T & E and other at-risk species through a vetted, dynamic, and transparent scientific process.

<u>**Outcomes of an SDM Initiative for At-Risk Species:**</u>

1. **Maps of habitat suitability (from low to high) across the landscape** (Fig 2). In areas of low suitability, confidence that the species is not present is high, while areas of high suitability can guide priorities for survey, protective measures, and restoration.
2. **Habitat maps** (Fig 3). Created from modeled probabilities based on scientific standards and user-defined risk tolerance, habitat maps can be tailored to regulatory needs.
3. **A dynamic information architecture.** The system would support transparency and data sharing while (1) facilitating model revisions that exploit newly available data and (2) enabling model projections into new environmental conditions (e.g. changing climates).

<u>**Cost-Savings and Other Benefits for Government, Industry, and Biodiversity:**</u>

1. **More efficient ESA consultations by avoiding unnecessary "may affect" and "likely to adversely affect" determinations**; refined maps exclude areas of unlikely occurrence while still being protective.
2. **Reduced uncertainty in ESA implementation**, increasing trust from the regulated community and reducing litigation.

3. **Prevention of unnecessary species listings** via increased understanding of habitat availability, direction of field surveys to locate new populations, and guidance for siting of management activities.
4. **Greater efficiency in recovery efforts** through better knowledge of species habitat needs and better identification of project areas given current and anticipated future (e.g. climate-driven) suitability.
5. **Better targeting of conservation initiatives** including net conservation benefit projects, land acquisitions, and species management activities.
6. **A sound scientific basis for inventory and monitoring**, enabling scientists to find new populations and providing the foundation for development of defensible and efficient monitoring protocols.
7. **A sound scientific basis for adaptation planning;** because SDMs can be modified to represent habitat suitability under changed conditions or into previously unoccupied areas, they allow scientists and managers to anticipate species response to natural or anthropogenic environmental change.

Species distribution modeling is already being applied in diverse contexts, with demonstrated benefits, as outlined in the case studies below. **NatureServe has identified an additional 337 listed or petitioned species in the lower 48 states that are ideally suited for SDM given current data availability, and over 500 more that are good candidates for modeling provided some additional investment in data development**. Many additional species identified in State Wildlife Action Plans would also benefit from this approach.

Case Studies

SDMs Inform Listing Decisions

Better information on where species are likely to be found can streamline the listing process or prevent listings altogether. The Wyoming Natural Diversity Database developed and refined SDMs for the Wyoming pocket gopher, starting with just nine observed occurrences in 2006. That model was used to direct field surveys which identified new populations, which is turn were used to refine the model. By 2008, 34 new occurrences and substantially more habitat were identified, contributing to a 2010 decision not to list. Since then, new populations have continued to be found and the model further refined (Fig 4).

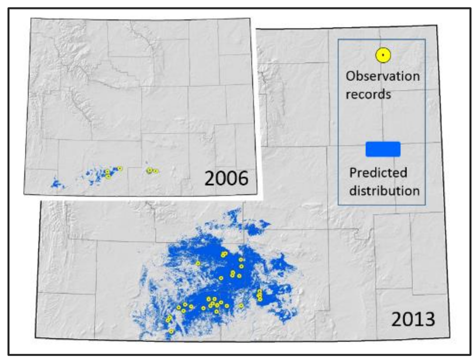

Fig 4. Known occurrences (yellow) and distribution modeling results (blue) for the Wyoming pocket gopher (*Thomomys clusius*).

SDM in the ESA Consultation Process

The status quo of using broad range maps to identify impacts to listed species results in many "may affect" or "likely to adversely affect" determinations, provoking unnecessary conflict and misdirecting limited resources. A project assessing the potential of SDM to improve the contentious pesticide consultation process found that for the decurrent false aster (Fig 1), the distribution model resulted in 10,000,000 fewer acres of mapped habitat, representing a 95% reduction in the area used to determine potential pesticide impacts. Where models exist, FWS field offices have accepted them as the best available science, but elsewhere, even across the range of a single species, data remains coarse, contributing to criticism that the current system is inconsistent and lacks transparency (Fig 5).

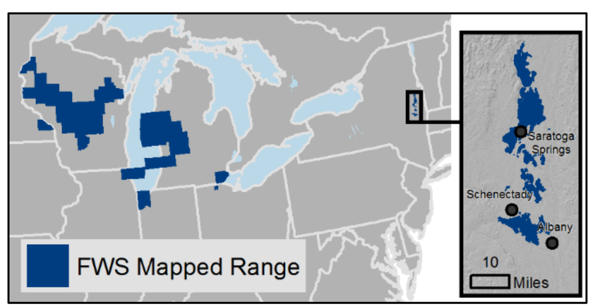

Fig 5. The current mapped range for Karner's blue butterfly (*Plebejus melissa samuelis*) as maintained by FWS. Where the New York Natural Heritage Program has modeled the species (inset at right), information is significantly more precise, enabling more realistic evaluation of impacts.

SDM to Guide Recovery Efforts
The same models demonstrated to ease regulatory burdens are simultaneously being used to advance conservation efforts. The Partners for Fish and Wildlife in Illinois plan to use the model for the decurrent false aster to prioritize outreach and financial assistance to landowners in an initiative focused on food for native waterfowl but which also stands to increase habitat for this threatened plant. Without the model, directing those resources to areas likely to have the highest impact would be a significant challenge.

SDMs Support Regional Planning
The need for precise, regional maps of species habitat is acknowledged as an essential need by Landscape Conservation Cooperatives and FWS regional offices. The Gulf Coastal Plain and Ozarks Conservation Blueprint Development Team identified development of species-habitat models as a top priority for 2017. The South Atlantic LCC has already partnered with state natural heritage programs to produce distribution models to help incorporate ten rare species into their Conservation Blueprint. FWS Region 5 is engaged in a similar project applying SDM to create species-specific screening layers for its 13-state area.

SDMs Guide Avoidance and Mitigation Strategies

A multi-state study of use of SDMs for strategic conservation prioritization on Department of Defense land identified several ways SDMs can reduce conflict between conservation needs and military activities. In Arizona, an SDM used to refine areas mapped as habitat for the state-protected Arizona ridge-nosed rattlesnake (*Crotalus willardi*) resulted in ~70km of military land newly identified as *not suitable*, reducing conflicts for military training. In Florida, a model for the state-endangered panhandle lily narrowed the land worthy of considering for off-site mitigation near Eglin Air Force Base by greater than 98%, allowing mitigation opportunities to be identified with much greater efficiency.

SDMs Focus State Conservation Initiatives
The ability of SDMs to pinpoint where state species of concern are most likely to occur has helped jurisdictions prioritize lands for protection. In Tennessee, a model indicated the federally endangered Morefield's leather flower (*Clematis morefieldii*) was likely to be found on land also known to support a rare endemic snail. Surveys confirmed the presence of the endangered plant, and The Conservation and Land Trust for Tennessee, working in partnership with the state of Tennessee, is now protecting the area, which has also been identified as important for seven other rare species and as a hotspot for ecological resiliency.

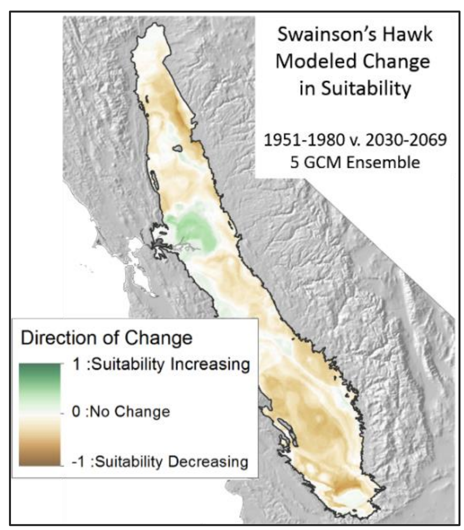

Figure 6. Map of anticipated changes in habitat suitability for Swainson's hawk *(Buteo swainsoni)* in the Central Valley of California by mid-century, given anticipated climate change as quantified using a*n* ensemble of five global climate models (GCMs).

SDMs Support Adaptation Planning
A powerful characteristic of SDMs is that once the species-environment model is constructed, a future distribution can be predicted using projected climate data. This allows modelers to estimate how the area of suitable climate for a species might shift and thus infer vulnerability to climate change, providing managers with guidance for developing adaptation strategies.