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BRIDGING THE GAP BETWEEN HABITAT-MODELING RESEARCH AND BIRD CONSERVATION WITH DYNAMIC LANDSCAPE AND POPULATION MODELS

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Habitat models are widely used in bird conservation planning to assess current habitat or populations and to evaluate management alternatives. These models include species-habitat matrix or database models, habitat suitability models, and statistical models that predict abundance. While extremely useful, these approaches have some limitations. They are generally static and don't easily address succession, land management, or disturbance. They generally address the amount of habitat or habitat suitability and, if linked to bird numbers, they assume available habitat is occupied. The assumption that all available habitat is occupied, or that breeding habitat is limiting, can be tenuous in modeling Neotropical migratory birds.

The use of dynamic landscape modeling can be very valuable to wildlife conservation planning (Akçakaya et al. 2004, Wintle et al. 2005, Shifley et al. 2006, Millspaugh and Thompson 2008). A failure to account for succession, natural disturbances, changes in land use, or planned management activities can result in inaccurate or biased estimates of habitat suitability, abundance, or viability. Dynamic landscape models simulate vegetation and landscape processes and project landscapes forward in time in a spatially explicit way. One simple way to use these landscape models is reapply the types of wildlife models mentioned above to forecasted future landscapes (i.e., Shifley et al. 2006). However this approach doesn't really model population processes but instead applies a static wildlife model to future conditions. A more desirable approach is to integrate a dynamic population model with a dynamic landscape model (i.e., Akçakaya et al. 2004, Wintle et al. 2005). Dynamic population models typically project populations forward in time using a population stage matrix that is parameterized with productivity and survival information.

Population vital rates can be linked to habitat or patch characteristics. For example, productivity can be a function of the amount of edge or patch size. These models can also incorporate uncertainty resulting from variation in our estimates of vital rates or from true process (biological) variation in the rate of interest. The end product can be a projection of population size over time or statistics such as the probability of persistence.

As the objectives for conservation become more oriented toward population or viability goals, the appeal of dynamic modeling should be obvious. For example, Wintle et al. (2005) used a dynamic landscape metapopulation model to evaluate the effects alternative forest management scenarios on some focal species and found that predicted population trajectories could differ substantially from predicted habitat availability. Sensitivity analyses also provided valuable insight into critical assumptions linking animal numbers and demography to habitat.

So, what's required to implement these approaches? Similar to habitat based modeling, a GIS environment is needed to model habitat suitability and identify patches of suitable habitat across a landscape. However, there is also a requirement for knowledge of population vital rates and assumptions about dispersal and density dependence, which is generally more difficult information to acquire than knowledge of habitat suitability. While precise estimates of demographic rates are lacking for many species, I believe for most North American landbirds we can at least hypothesize a realistic range of values for demographic parameters and investigate population sensitivity to these. A potential criticism of dynamic landscape metapopulation models is that adding the potential uncertainty in demographic parameters and a population model to the uncertainty of habitat

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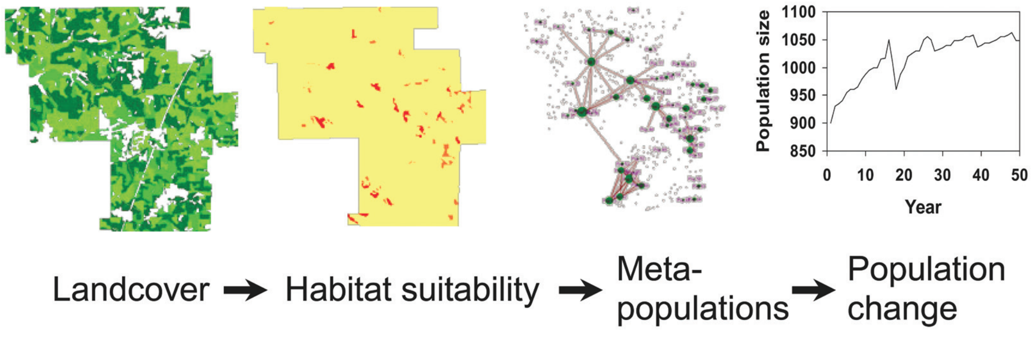

Figure 1. Landscape change can be simulated over time by dynamic landscape models and used to predict bird habitat suitability. Bird habitat suitability can be used to identify habitat patches that define meta-populations. A meta-population model links population vital rates to habitat and projects population size over time.

suitability model will only result in even more uncertainty in model outputs. However, this concern directly points to one of the benefits of this approach--it allows us to assess our level of uncertainty directly in terms of the measures we most care about, species abundance and persistence. We can also directly assess the effects of assumptions or uncertainty in model parameters on model outputs and evaluate what parameters have the greatest effect on species abundance, which can inform more productive and efficient research and conservation actions.

I believe, as others have suggested (Akçakaya et al. 2004, Wintle et al. 2005), that dynamic landscape metapopulation models have great utility for conservation planning. The widespread adoption of these approaches may be hindered, however, by stricter requirements for new data and skills compared to earlier approaches. Spatially explicit information on habitat composition and structure is required to map habitat suitability, to simulate habitat and landscape change, and to dynamically link landscape or habitat change models to avian population models. This spatial data will likely come from existing and new remote-sensing products or from spatial modeling of existing stand or point-based inventories.

The implementation of dynamic modeling and adoption into conservation planning can be facilitated in several ways. Conservation teams should not be afraid to try models with existing knowledge; but document assumptions and try to examine sensitivity of results to assumptions. The models will require continued and new studies of population vital rates rather than just habitat and abundance. New monitoring programs should address assumptions concerning population processes as part of an adaptive management process, in addition to the traditional surveillance monitoring of trends in abundance. Also, the effort and knowledge needed to implement dynamic landscape metapopulation models will likely limit their use to a limited number of priority species while simpler approaches can be applied in coarser-grained planning. Within this context its good to remember that comparisons of alternative modeling approaches is good science, and that comparison of results from dynamic landscape metapopulation models with more broadly applied habitat or abundance based approaches can serve as a form of validation. And finally, as the complexity of planning tools and approaches increases, I believe effective conservation will increasingly demand partnerships among scientists, managers, and planners and regional partnerships to share products—and this is essentially the Partners in Flight model!

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