Journal for Nature Conservation 21 (2013) 114–121

Contents lists available at SciVerse ScienceDirect

Journal for Nature Conservation

journal homepage: www.elsevier.de/jnc

Using species distribution and occupancy modeling to guide survey efforts and assess species status

William E. Peterman[a,*], John A. Crawford[b], Andrew R. Kuhns[c]

[a] University of Missouri-Columbia, 110 Tucker Hall, Division of Biological Sciences, Columbia, MO 65211, USA
[b] Lindenwood University, Department of Biology, Saint Charles, MO 63301, USA
[c] University of Illinois at Urbana-Champaign, Prairie Research Institute, Illinois Natural History Survey, Champaign, IL 61820, USA

ARTICLE INFO

Article history:
Received 2 July 2012
Received in revised form
15 November 2012
Accepted 16 November 2012

Keywords:
Ambystoma jeffersonianum
Amphibian
Conservation
Detection probability
Habitat use
Maximum entropy
Salamander

ABSTRACT

Habitat loss and fragmentation continue to be major issues affecting the persistence and conservation of species, but identification of critical habitat remains a challenge. Species distribution modeling and occupancy modeling are both approaches that have been used to predict species distributions and can identify critical habitat characteristics associated with species occurrence. Additionally, occupancy sampling can provide measures of detectability, increasing the confidence that a species is truly absent when not detected. While increasingly popular, these methods are infrequently used in synergy, and rarely at fine spatial scales. We provide a case study of using distribution and occupancy modeling in unison to direct survey efforts, provide estimates of species presence/absence, and to identify local and landscape features important for species occurrence. The focal species for our study was *Ambystoma jeffersonianum*, a threatened salamander in the state of Illinois, U.S.A. We found that fine-scale distribution models accurately discriminated occupied from unoccupied breeding ponds (78–91% accuracy), and surveys could be effectively guided using a well-fit model. We achieved a high detection rate (0.774) through occupancy sampling, and determined that *A. jeffersonianum* never used ponds inhabited by fish, and the probability of a pond being used for breeding increased as canopy cover increased. When faced with limited resources, combining fine-scale distribution modeling with a robust occupancy sampling design can expedite survey efforts, confidently designate species occupancy status, prioritise habitat for future surveys and/or restoration, and identify critical habitat features. This approach is broadly applicable to other taxa that have specific habitat requirements.

© 2012 Elsevier GmbH. All rights reserved.

Introduction

Habitat loss and fragmentation have come to the forefront of conservation and species management, and pose significant threats to biodiversity and species persistence (Brooks et al. 2002; Stuart et al. 2004; Vitousek, Mooney, Lubchenco, & Melillo 1997). Populations of species at the edge of their natural range limit may be particularly susceptible due to limited opportunities for recolonisation following local extinction (Brown & Kodric-Brown 1977). With increased land use continuing to fragment habitats and isolate populations, critical habitat and biodiversity are in jeopardy. In order to dampen the effects of these losses, quick and accurate habitat assessments are needed to prioritise the preservation of remaining habitat, but a major impediment to the assessment of biodiversity is identification of suitable habitat. To this end, modeling of species' distribution and occupancy have become critical conservation tools (e.g. De Wan et al. 2009; Raxworthy et al. 2003). These approaches can direct survey efforts (Guisan et al. 2006; Raxworthy et al. 2003; Rebelo & Jones 2010; Williams et al. 2009), give a high degree of confidence concerning species detection/non-detection (Andelt, White, Schnurr, & Navo 2009; Bailey, Simons, & Pollock 2004b), and identify vital environmental covariates for species persistence (Hamer & Mahony 2010; Kroll et al. 2008; Schmidt & Pellet 2005). While both distribution and occupancy modeling approaches are receiving increased attention as tools to facilitate surveys, they are not readily utilised together (but see Gormley et al. 2011; Newbold et al. 2010). The focus of our study is to test the ability of distribution models to provide fine-scale discrimination between suitable and unsuitable habitat and to conduct robust sampling of sites to provide estimates of species detectability, rates of occupancy, and covariates critical to occupancy.

Numerous modeling approaches exist for predicting species distributions (see Elith et al. 2006 for a comparison of several methods). Generally, these models predict a species realised niche (Elith & Leathwick 2009), and describe the range of biological and/or

* Corresponding author. Tel.: +1 573 882 1421; fax: +1 573 882 0123.
E-mail address: Bill.Peterman@gmail.com (W.E. Peterman).

1617-1381/$ – see front matter © 2012 Elsevier GmbH. All rights reserved.
http://dx.doi.org/10.1016/j.jnc.2012.11.005

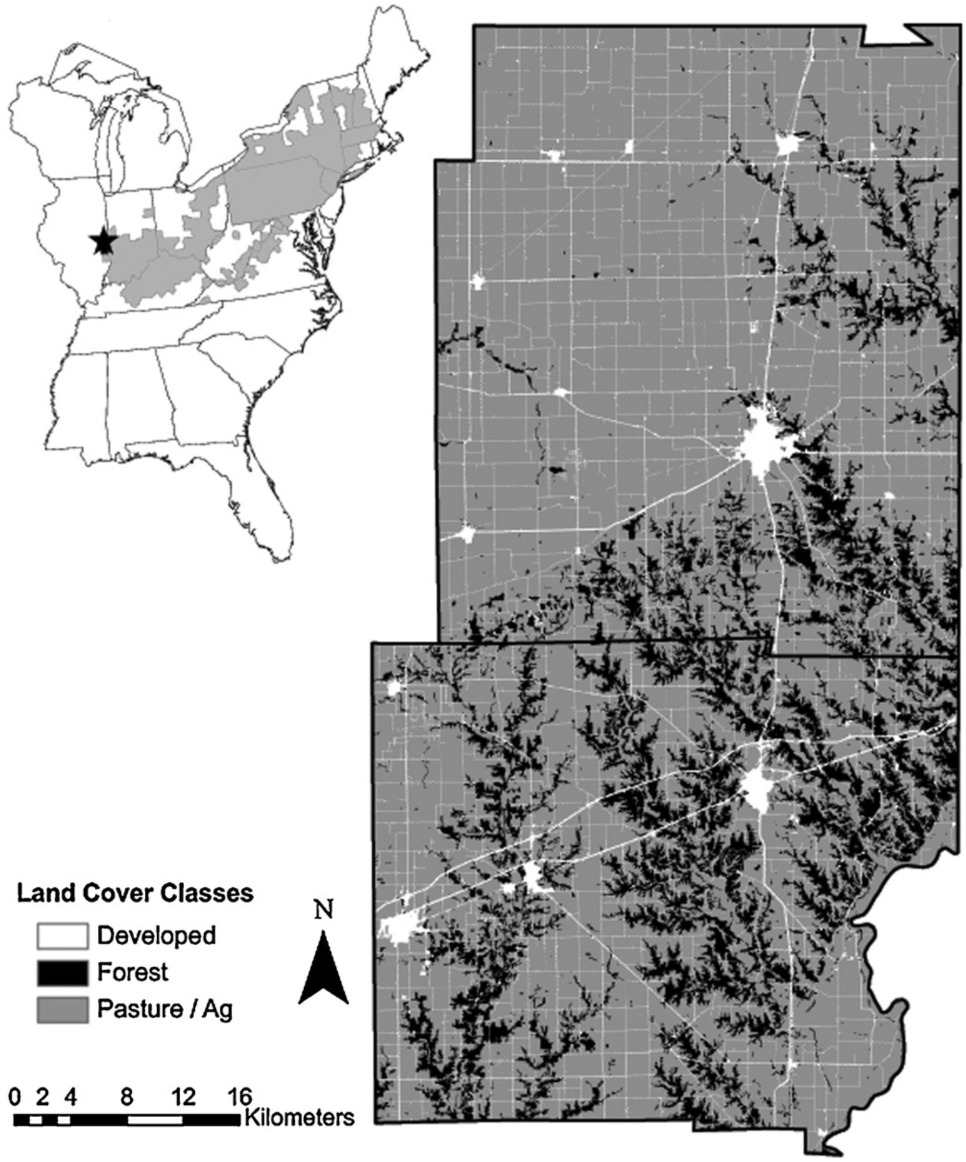

Fig. 1. Map of study area showing range of *Ambystoma jeffersonianum* in the eastern U.S.A. in light gray shading. The star in the regional map indicates the 2-county study area. Edgar County is to the north and Clark County is to the south. Approximately 50% of these two counties are forested, with the remainder being equally divided into pasture/agriculture or developed land. Developed land consists of roadways and urban areas.

physical conditions that an organism has been found to exist in. Such models are being used to direct surveys for the discovery of new populations (Guisan et al. 2006; Williams et al. 2009) and species (Raxworthy et al. 2003), conservation prioritisation (Urbina-Cardona & Flores-Villela 2010), and to predict impacts of global climate change (Milanovich, Peterman, Nibbelink, & Maerz 2010). In addition to advances in distribution modeling, the field of occupancy modeling has grown rapidly over the last decade (MacKenzie et al. 2006), with estimates of occupancy now corrected for the imperfect detection of species (Bailey, Hines, Nichols, & MacKenzie 2007; MacKenzie 2006). Using detection/non-detection data, this approach models species detection and occupancy as a function of covariates, and through model selection provides information about critical aspects of sampling efficacy and necessary habitat associations (MacKenzie et al. 2006).

With the strengths and versatility of these two different fields apparent, it is of relevance to determine how they interplay, and in particular, if there are advantages to using them in combination. To this end, we designed a study to utilise fine-scale distribution models to predict species occurrence, and then carry out robust sampling of sites in an occupancy framework. Specifically, we conducted surveys for *Ambystoma jeffersonianum* at breeding ponds in east-central Illinois, U.S.A. where it is listed as a threatened species. Illinois is the western-most extent of *A. jeffersonianum*, where they were first discovered in 1990 (Fig. 1; Phillips, Brandon, & Moll 1999), and prior to 2008 were known to breed in only six ponds. Our objectives in conducting this study were to: (1) develop a spatial model of suitable habitat for a threatened species to direct surveys and prioritise management and restoration efforts; (2) validate a robust sampling protocol for determining species presence; (3) determine the local and landscape-scale characteristics associated with occurrence; and (4) assess the generality of our approach to other taxa.

Methods

Study species

Ambystoma jeffersonianum are pond breeding salamanders that range from eastern Illinois, USA to New Hampshire, USA (Lannoo

Download English Version:

https://daneshyari.com/en/article/4399943

Download Persian Version:

https://daneshyari.com/article/4399943

Daneshyari.com