



## Indirect predation management in a longleaf pine ecosystem: Hardwood removal and the spatial ecology of raccoons



R. Brian Kirby<sup>a,b</sup>, Michael J. Cherry<sup>a,1</sup>, Lisa I. Muller<sup>b</sup>, Robert J. Warren<sup>c</sup>, Michael J. Chamberlain<sup>c</sup>, L. Mike Conner<sup>a,\*</sup>

<sup>a</sup> Joseph W. Jones Ecological Research Center, 3988 Jones Center Drive, Newton, GA 39870, USA

<sup>b</sup> Department of Forestry, Wildlife and Fisheries, University of Tennessee, Knoxville, TN 37996, USA

<sup>c</sup> Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA 30602, USA

### ARTICLE INFO

#### Article history:

Received 11 August 2016

Received in revised form 27 September 2016

Accepted 28 September 2016

Available online 4 October 2016

#### Keywords:

Habitat use  
Hardwood removal  
Home range  
Longleaf pine  
Nest predation  
Raccoon

### ABSTRACT

Raccoons (*Procyon lotor*) are native and ubiquitous throughout much of the continental United States and are invasive in many countries around the world. Where they occur, raccoons are a known predator of ground-nesting birds and herpetofauna. Raccoons often are associated with hardwood trees; therefore, hardwood reduction in open pine (*Pinus* spp.) forests of the southeastern U.S. may reduce raccoon use while providing suitable habitat for upland ground-nesting species. As a result, some have suggested removal of undesirable hardwoods as a means to manage nest predation by altering raccoon behavior. However, effects of operationally removing hardwoods from an open pine matrix on raccoon home range size and habitat selection are unknown. We compared home range sizes and habitat selection of adult raccoons in a longleaf pine (*Pinus palustris*) dominated forest before and after large-scale, operational hardwood removal. Male raccoons had larger ( $P < 0.001$ ) home ranges than females, but home range sizes did not differ ( $P = 0.54$ ) by period (i.e., before or after hardwood removal). However, raccoon habitat selection at the home range scale varied ( $P = 0.02$ ) between periods as did selection of habitats within the home range ( $P = 0.01$ ). When selecting areas for home ranges, raccoons had greater ( $P = 0.01$ ) affinity for young pine stands following operational hardwood removal. Within the home range, raccoons increased ( $P = 0.01$ ) selection for wetlands and decreased ( $P = 0.02$ ) selection for primary roads following hardwood removal. Raccoon habitat selection within the home range did not vary ( $P = 0.39$ ) seasonally. Pine forests were important when establishing home ranges during both periods, but other habitats (i.e., secondary roads, young pine, hardwood, and mixed pine-hardwood) became equally as important as pine following hardwood removal. Within the home range, hardwood stands remained the most important habitat feature before and after hardwood removal. Our results suggest that raccoons alter habitat selection in response to hardwood removal, which may affect patterns of nest predation by raccoons.

© 2016 Elsevier B.V. All rights reserved.

### 1. Introduction

The global collapse of large predator populations has led to dramatic changes in food webs (Estes et al., 2011). Perhaps one of the most pervasive effects of this trophic simplification has been the release of smaller predators (i.e., mesocarnivores; Ritchie and Johnson, 2009). As mesocarnivores become more abundant, emergence of zoonotic diseases, reduction of biodiversity, and declines

in abundance of mesocarnivore prey create increasing challenges for natural resource managers (Prugh et al., 2009).

Raccoons (*Procyon lotor*) are an adaptable and abundant mesocarnivore native throughout much of North America and invasive in many countries around the world (Ikeda et al., 2004; Bartoszewicz, 2011). Historically, they have been an economically important furbearer (Kamler and Gipson, 2004), but they are also a disease vector (Atwood et al., 2009; Rosatte et al., 2010) and an important nest predator of ground-nesting birds (Miller and Leopold, 1992; Rollins and Carroll, 2001; Gehrt, 2003; Schmidt, 2003) and herpetofauna (Burke et al., 2005; Smith et al., 2013). One system in which raccoons are important nest predators is the longleaf pine (*Pinus palustris*) forest of the southeastern United States.

\* Corresponding author.

E-mail address: [mconner@jonesctr.org](mailto:mconner@jonesctr.org) (L.M. Conner).

<sup>1</sup> Current address: Department of Fish and Wildlife Conservation, Virginia Tech, Blacksburg, VA 24060, USA.

These open-canopied, fire-dependent longleaf pine forests once occupied > 36 million ha, but land use changes have resulted in this ecosystem occupying < 5% of its former range (Landers et al., 1995; Van Lear et al., 2005; Jose et al., 2006). Longleaf pine ecosystems host globally significant levels of biodiversity (Mitchell et al., 2006), and the restoration of this forest type is now a major conservation priority (Van Lear et al., 2005; Outcalt and Brockway, 2010). Within longleaf pine ecosystems, raccoons are an important nest predator of nongame species such as gopher tortoises (*Gopherus polyphemus*; Smith et al., 2013) which are considered threatened in portions of its geographical range, and game species including northern bobwhite (*Colinus virginianus*; Rollins and Carroll, 2001) and eastern wild turkeys (*Meleagris gallopavo silvestris*; Williams and Austin, 1988). Managers often lethally control raccoons in an attempt to reduce nest predation; however, predator control is a controversial technique that often does not provide the desired outcome (Salo et al., 2010; Conner and Morris, 2015).

Commonly used management practices within longleaf pine forests include prescribed fire (Landers et al., 1995), and removal of hardwoods via mechanical (Provencher et al., 2001; Kush et al., 2004) and herbicide (Brockway and Outcalt, 2000) treatments. Land management strategies focusing on removal of mesophytic oak species [e.g., water oak (*Quercus nigra*) and live oak (*Q. virginiana*)] while retaining more pyrophytic oaks such as southern red oak (*Q. falcata*) and post oak (*Q. stellata*) are considered to promote biodiversity and positively impact forest system dynamics in the longleaf pine matrix (Hiers et al., 2014). These forest management practices may have indirect effects on nest predation by altering spatial ecology of predators. Raccoons are often associated with hardwoods (Leberg and Kennedy, 1988; Gehrt and Fritzell, 1998; Gehrt, 2003) and frequent fires may be detrimental to raccoons (Chamberlain et al., 2002). Thus, hardwood removal and frequent prescribed fire may influence raccoon space use in ways that benefit upland ground-nesting species.

In an artificial nest study spanning 12 years, Morris and Conner (2016) observed increased nest loss if the area had burned during the preceding 2 months of nest placement, and suggested decreased cover and potential attraction of predators to recently burned areas might have facilitated nest detection. They also observed decreased nest loss as a long-term effect of hardwood removal from within longleaf pine uplands, but they did not identify nest predators. Jones et al. (2004) explicitly studied effects of prescribed burning on raccoon predation of artificial nests, noting that prescribed burning reduced raccoon use of mature longleaf stands by 62% during the growing season following fire. To date, no studies have evaluated effects of hardwood removal on raccoon spatial ecology.

Raccoon home ranges have been studied throughout their native geographical range in ecosystems dominated by agriculture (Beasley et al., 2007; Atwood et al., 2009), prairies (Fritzell, 1978; Henner et al., 2004), managed pine (*Pinus* spp.) forests (Chamberlain et al., 2002, 2003), and urban areas (Prange et al., 2004; Bozek et al., 2007). Environmental influences on home range size and location include landcover composition, food availability, and presence of suitable den sites (Gehrt, 2003). Raccoon home ranges also vary seasonally and between sexes; males generally maintain larger home ranges than females, particularly during the breeding season, likely to maximize mating opportunities (Gehrt and Fritzell, 1997; Chamberlain et al., 2003; Gehrt, 2003; Fisher, 2007).

As with most species, raccoon habitat selection varies with resource availability (Chamberlain et al., 2002; Byrne and Chamberlain, 2011). Within forested landscapes of the eastern United States, hardwood forests are important to raccoons, presumably because these habitats provide den sites and hard mast during winter (Gehrt, 2003). However, raccoons also thrive in pine- and

mixed pine-dominated landscapes. For example, Chamberlain et al. (2003) found mature pine stands to be equally important to raccoons as mature hardwood forests in central Mississippi because infrequent prescribed fire resulted in dense woody understory vegetation and increased soft mast availability. Raccoon preference for hardwoods and infrequently burned pine forests suggests that hardwood removal from frequently burned longleaf pine uplands may result in decreased raccoon use of this forest type.

Our intent was to advance knowledge regarding the effects of removing mesophytic hardwoods (a common open-canopy pine restoration tool) on raccoon home ranges and habitat selection. We studied raccoon spatial ecology in a longleaf pine-dominated study area before and after hardwood removal efforts spanning a 15-year time period (i.e., 1999 = pre-removal; 2015 = post-removal). We tested the hypothesis that operational hardwood removal would result in altered space use and habitat selection by raccoons.

## 2. Materials and methods

### 2.1. Study area

We conducted research at the Joseph W. Jones Ecological Research Center at Ichauway (hereafter Jones Center), approximately 45 km south of Albany, Georgia. The Jones Center was a privately owned, 11,735-ha research facility in southwestern Georgia that previously served as a hunting plantation managed for northern bobwhite and other game species for over 80 years (Jacqmain et al., 1999). The Ichawaynochaway Creek flowed for approximately 24 km through the study area, and the Flint River served as approximately 22 km of the eastern boundary (Boring, 2001). The Jones Center had flat to gently rolling karst topography with elevation ranging from 27 to 61 m above sea level. It had annual precipitation of 132 cm and temperatures ranging from 11 °C in winter to 27 °C in summer (Boring, 2001). Longleaf pine woodlands and limesink wetlands dominated the Jones Center, with an understory predominately consisting of wiregrass (*Aristida stricta*) and old-field grasses (*Andropogon* spp.; Drew et al., 1998). In addition to longleaf pine, other *Pinus* spp. included loblolly pine (*P. taeda*), pond pine (*P. serotina*), shortleaf pine (*P. echinata*), and slash pine (*P. elliottii*).

Prescribed burning was the primary land management practice on the Jones Center. Fires occurred on an approximate 2-year rotation with most burns occurring between 1 January and 31 June, encompassing both dormant and growing-season fires. Supplemental feeding, maintenance of wildlife food plots, and lethal management of predators (e.g., coyote [*Canis latrans*], bobcat [*Lynx rufus*], raccoon, gray fox [*Urocyon cinereoargenteus*], and Virginia opossum [*Didelphis virginiana*]) were used on portions of the study area to promote northern bobwhite populations (Nelson et al., 2015). Because of on-going research and because northern bobwhite were not hunted in the areas used for this study, predator removal and supplemental feeding did not occur in raccoon study sites.

### 2.2. Treatment

We consider our study quasi-experimental in nature using operational removal of mesophytic hardwoods as our treatment. Mechanical removal of mesophytic hardwood species such as water oak and live oak from within longleaf pine uplands occurred between 2000 and 2014. Dirt roads on our study area served as firebreaks. These firebreaks also served as prescribed fire ignition points resulting in low-intensity fires insufficient to top-kill mesophytic oaks. Decades of low-intensity fires in these areas led to

Download English Version:

<https://daneshyari.com/en/article/6459583>

Download Persian Version:

<https://daneshyari.com/article/6459583>

[Daneshyari.com](https://daneshyari.com)