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Public attitudes toward the presence and management of bats roosting in buildings in Great Smoky Mountains National Park, Southeastern United States

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ABSTRACT

In the human dimensions of wildlife management, evaluating stakeholder perceptions of target species helps inform effective conservation efforts. Stakeholder perceptions are invaluable when managing taxa like bats, which may have historically negative cultural preconceptions. However, insectivorous bats provide critical ecosystem services in North America through agricultural insect pest control, and many of these species are threatened by white-nose syndrome (WNS), a disease caused by an invasive fungal pathogen. In Great Smoky Mountains National Park (GRSM), the most visited National Park in the United States (USA), bats are regularly observed roosting in historical buildings by visitors and park employees during summer. As a result, natural and cultural resource managers seek to ensure public safety and protect historical structures while minimizing impacts on bats, especially in light of declines in bat populations as a result of WNS. However, managers lacked information on visitor perceptions of bats and support for potential management action regarding the taxon. From June to August 2016, we surveyed 420 park visitors at three sites in the Cades Cove area of GRSM on their attitudes toward bats, perception of threats to and ecosystem services provided by bats, and support for management of bats. Most respondents supported management action to protect bats in buildings in Cades Cove during summer (76%). Standardized parameter estimates from a multiple linear regression developed with survey data indicated that attitudes toward bats and perception of threats to bats had the greatest effects on support for bat management. Wildlife management and conservation agencies seeking to further cultivate support for management of bats roosting in public spaces may apply these results in the design of tailored programming and outreach materials.

1. Introduction

Interactions between wildlife and humans are a persistent concern for wildlife management and conservation. In the USA, wildlife are considered natural resources owned by the public. Agencies such as the National Park Service and US Fish and Wildlife Service are charged with balancing wildlife resource conservation with human needs as a part of natural resource management. As a result, successful implementation of policy and action to manage wildlife requires an understanding of public opinions and concerns about target species (Teel et al., 2010). When target species have appealing physical features and life histories they tend to be adored and more familiar to people, and subsequently benefit from stronger support for conservation efforts (Kellert, 1985; Knight et al., 2003). Conversely, bats and other less charismatic species may be controversial or vulnerable to misunderstanding, especially if they are associated with human activities or dwellings.

In North America, bats are a conservation and management priority due to their biological importance in the control of agricultural insect pests (Boyles et al., 2011) and unprecedented population declines due to white-nose syndrome (WNS; USFWS, 2012). More than half of all bat species in North America have been documented roosting in buildings for at least part of the year (Kunz and Reynolds, 2003). Among other WNS-impacted species, this includes the little brown bat (*Myotis lucifugus*) and northern long-eared bat (*Myotis septentrionalis*), which are threatened with regional extinction in eastern North America as a result of WNS (Frick et al., 2010, 2015; Ford et al., 2011; Turner et al., 2011; USFWS, 2013). For these building-roosting species, conservation efforts are complicated by concerns for zoonotic disease transmission to people (i.e., rabies and histoplasmosis; Emmons et al., 1966, Constantine, 2009). When buildings used by bats are also historical, concerns for cultural resource preservation also arise (Howard, 2009; Hales, 2014). The perceived risks associated with human-bat interactions, and

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concerns over cultural resource protection, can result in disproportionate and unnecessary retaliatory action, including eradication and exclusion from buildings during the summer maternity season. Such responses to bat presence risk interrupting this critical period for recovery from WNS (Barclay et al., 1980; Bexell and Feng, 2013).

To benefit conservation efforts and mitigate human-bat interactions, agencies such as Bat Conservation International, the National Wildlife Federation, and the US Fish and Wildlife Service have utilized public outreach and education. These efforts often focus on dispensing information on threats to bats and ecosystem services provided by bats while dispelling traditionally negative connotations rooted in mythology and folklore (i.e., vampirism, knotting in women's hair; Daniels and Stevans, 1903, De Vries, 1974). While impacts of bat-focused education efforts on public perceptions of bats are unknown, our personal observations suggest a shift from historically negative characterizations. A positive social media presence of bats is abundant and persistent, including videos and pictures of bats that receive sympathetic and adoring emotional responses.

An understanding of current public perceptions of bats, including the factors that influence support for management, is required to enact effective conservation strategies. Cognition and behavior toward wildlife can be studied using the cognitive hierarchy model (Homer and Kahle, 1988; Vaske and Donnelly, 1999; Vaske, 2008). Within this hierarchy, a small number of general values and value orientations lead to specific, context-dependent norms and attitudes (Manfredo, 2008; Vaske, 2008; Vaske and Manfredo, 2012). Specific attitudes toward wildlife are often the focus of studies in the human dimensions of wildlife management because they are not only malleable in comparison with other cognitive traits, like values, but also well-studied as predictors of behavioral intentions (Vaske and Donnelly, 2007; Vaske, 2008). Among the most important behaviors of interest for wildlife conservation are support for or opposition to management actions (Vaske and Donnelly, 2007; Vaske and Manfredo, 2012). Communication and outreach programming can be tailored to promote support for management action if such efforts are informed by the study of stakeholder perceptions of wildlife (Ajzen, 1988; Ajzen and Fishbein, 2005; Fishbein and Ajzen, 2010).

Previous studies on perceptions of bats provide evidence of conflicting attitudes toward the taxon. While previous literature discusses social constructs regarding megabats (i.e., species of the suborder Megachiroptera, including “flying foxes”; Kingston, 2016, Vincenot et al., 2015), microbats (i.e., species of the suborder Microchiroptera) are likely perceived quite differently due to their comparatively small size and more rodent-like appearance. Addressing the lack of public awareness about microbats appears essential for bat management and conservation (Lunney and Moon, 2011; Kingston, 2016). Residents in an urban area of Colorado, USA did not perceive bats as a threat, held positive attitudes toward bats, and supported bat protection despite having low knowledge of bats (Sexton and Stewart, 2007). In a study of animal phobias in seven Western and Asian countries, bats fell into the disgust-relevant category across cultures, along with other animals like spiders and rats (Davey et al., 1998). Other studies found that undergraduate and primary school students in Slovakia who had accurate knowledge about bats, rather than belief in fear-related myths, were more likely to have positive attitudes toward them (Prokop and Tunnicliffe, 2008; Prokop et al., 2009). In the mid-western USA, children held conflicting emotional perceptions of fruit bats, yet were concerned about their welfare in a zoo exhibit (Kahn Jr et al., 2008). Other studies found that bats, relative to other species, were categorized as unlikeable (i.e., greater mouse-eared bat; Schlegel and Rupf, 2010) and ranked more negatively on scales of aesthetic value, fearful qualities, and support for protection (i.e., Ozark big-eared bat; Knight, 2008).

Informed management decisions regarding bat exclusion, restriction of human use, and timing of maintenance activities require an understanding not only of the biology of building-roosting bats, but also human perceptions of bats and bat management. To our knowledge, no study has examined perceptions of building-roosting bats or North American bats with respect to WNS. Similarly, no such research has focused on bats associated with historical buildings. Our goal was to assess visitor perceptions of building-roosting bats and related management action in Great Smoky Mountains National Park (GRSM or the Park) to provide suggestions for management and outreach strategies that may benefit bat conservation. Our first objective was to survey visitors in GRSM on their 1) attitudes toward bats, 2) perception of ecosystem services provided by bats, 3) perception of threats to bats, and 4) support for management action to protect bats. Our second objective was to model attitudes and beliefs as predictors of visitor support for bat management and conservation.

2. Methods

2.1. Study area

We conducted our study in the Cades Cove district of GRSM. Cades Cove is 18 km from the nearest town, and consists of a campground area and an 18-km one-way paved road, Cades Cove Loop Road (CCLR). This road enables visitors and park employees to navigate the area, providing scenic views, vehicle pull-offs at four trailheads, and direct access to 25 historical buildings, most of which are < 0.15 km from the road. Historical buildings are uninhabited and used as tourism sites during daytime. We selected this area of the Park after reviewing the summer 2015 results of a concurrent study of bat roosting ecology in buildings of GRSM (Fagan et al., 2017). While we observed overt bat sign (i.e., bat droppings or roosting bats) in historical buildings visited throughout the park, Cades Cove contained the most bat roosts in buildings, the greatest number of historical buildings, and the highest, most consistent visitation by tourists. A study conducted during 22–28 June 2008 found that 55% of 700 visitor groups to the Park visited CCLR, of which 47% spent 4 or more hours at the site (Papadogiannaki et al., 2009). An average of 1,257,649 people visited GRSM each month during the study period, 1 May–31 August 2016 (National Park Service [NPS], 2017). Based on estimated CCLR visitation rates from Papadogiannaki et al., 2009, we estimate an average of 691,707 people visited CCLR each month during our study period.

2.2. Sampling design

We selected three sites within Cades Cove for sampling, all of which are used for tourism: the Methodist Church, the Cable Visitor Center, and the Campground Store (Fig. 1). These sites were chosen purposively, not only to maximize the likelihood of encountering a representative sample, but to also capture visitors at three stages of their experience in Cades Cove. Based on our observations of visitor use and traffic flow during the summer 2015 field season of a related roost selection study (Fagan et al., 2017), visitors tend to pursue the one-way loop first and conclude their visit at the campground area. We assume that visitors to Cades Cove visit at least one of these sites during their visit.

The Methodist Church ($> 90\ m^2$ footprint) is an historical structure located 1.6 km into the one-way loop, and is the first historical structure directly accessible from the road. Based on personal observation prior to this study, this prominent structure invites high visitation. Our survey station was located outside the entrance to the Methodist Church to encounter visitors entering and exiting the structure.

The Cable Visitor Center ($> 175\ m^2$ footprint) is located in the Cable District, 10.6 km from the beginning of CCLR. Based on personal observations, many tourists choose to stop here to use the facilities, explore the cluster of historical buildings, or participate in activities led by NPS interpretive rangers and volunteers. Our survey station was located outside the entrance to the Visitor Center to encounter visitors entering and exiting the Cable District.