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The spatial pattern of redwood burl poaching and implications for prevention

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ABSTRACT

Poaching redwood burls is a problem for Redwood National and State Parks (RNSP), in Northern California, USA. Poachers use chainsaws to remove and they sell them at local burl shops. Consequently, targeted trees are left susceptible to disease and can die. Given the limited resources RNSP have at their disposal, the study reports an empirically driven resource allocation strategy. The study first explores the spatial distribution of poaching incidents and other potentially important drivers of poaching in RNSP before employing an econometric approach informed by crime pattern theory to better understand how features of the natural and built environment within RNSP explain burl poaching. An exact logistic model suggests areas that include a greater number of targets (i.e. redwood burls) that are accessible to roads, as well as areas that are near to a greater number of burl shops are at an increased risk of burl poaching. The odds-ratios for each respective variable in the model are utilized to highlight those areas at greatest risk, and in turn to provide practical guidance for more spatially focused ranger patrols and interventions. A comprehensive intervention strategy that works on multiple levels to reduce opportunities for burl poaching in RNSP is discussed.

1. Introduction

The size and scope of the illegal trade in flora and fauna has increased during the last few decades becoming the world's fourth largest crime sector (Nellemann et al., 2016). Despite this, the poaching and trafficking of flora (Bourgon, 2017; Goettsch et al., 2015; Nellemann, 2012), has attracted little research, except for the illicit commercial exploitation of timber (van Solinge, 2010, 2014). Unfortunately, anecdotal evidence suggests that the poaching of redwood trees and their burls in the U.S., and cedar trees in Canada, is a serious crime problem with poachers exploiting these ancient trees for profit (Bourgon, 2017).

Coast redwoods (*Sequoia sempervirens*), the focus of this study, are poached, trafficked, and sold illicitly within domestic and international markets. A large proportion of this species grows within Redwood National and State Parks (RNSP) where the trees are protected by law. RNSP are a combination of old- and new-growth forests located in the Pacific coastal region of the U.S. and have been designated a UNESCO World Heritage Site. Coast redwoods are among the oldest and tallest living tree species on earth (Noss, 1999) and are considered endangered by the IUCN (Farjon and Schmid, 2013). Such trees often grow burls, which are accumulations of bud tissue on the trunk capable of sprouting

new redwoods with the same genetic code once a redwood falls (Del Tredici, 1999; Redwood National and State Parks, n.d.). Redwood burls are in high demand and can sell for thousands of dollars due to their appearance, their beautiful colors and patterns, and their remarkable durability (Shirley, 1940). They are used to create high-end furniture and decorative products, as well as wood grain dash trim kits for luxury automobiles.

Poachers have recently begun to target burls in RNSP (Redwood National and State Parks, 2014), with potentially serious consequences. According to a joint statement released by the RNSPs (n.d.) when a burl is removed, the wound increases susceptibility to disease thus jeopardizing the tree's health (Deleon, 1952). Poachers unable to reach a burl high on a trunk sometimes cut down the entire tree (Brown, 2014), which can topple surrounding trees. Without its burls, the fallen redwood is no longer able to spawn a clone.

Apprehending poachers has proved difficult. Catching them in the act is unlikely given that there are only 12 park rangers (eight federal and four state) for an area of 560km² in the RNSP to patrol. Evidence of burl poaching is often discovered days, weeks, and even months after the event (determined through personal communication with rangers). Further, prosecuting poachers requires the burl be matched to the

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source tree. This becomes increasingly difficult as time elapses and offenders find opportunities to sell and/or modify the burls. Disposing of illicitly obtained burls appears relatively easy given the abundance of burl shops ($N = 16$) in and around RNSP. Burl shops process redwood burls and turn them into furniture and crafts, and sell them locally and online. Redwood burls can be legally harvested from private land, salvaged or reclaimed. However, no proof of origin or record of ownership is requested from individuals looking to sell redwood burls, and consequently, illicit burl is routinely sold to burl shops.

1.1. Poaching of flora

Recent literature suggests poaching and trafficking of non-timber flora products is commonplace. Cacti, for example, are among the five most common threatened taxonomic groups on earth with approximately one-third of 1478 global species threatened by extinction due to anthropogenic pressures (Goetsch et al., 2015). One of the richest areas for cacti diversity and abundance in the world is the Chihuahuan Desert Ecoregion that straddles northern Mexico and southern United States. This area has become a hotbed for poaching activities by private collectors and commercial poachers (Robbins, 2003). Apart from cacti, two of the most valuable and overexploited flora species in the U.S. is American ginseng (*Panax quinquefolius*) and Venus flytraps (*Dionaea muscipula*). American ginseng desired in various parts of Asia for its medicinal properties has been harvested in the U.S. dating back to the mid-1700s (Anderson et al., 2002); while it can be commercially harvested, a considerable amount has been poached from national parks in Appalachia resulting in being categorized as “vulnerable” by the IUCN. Also endemic to eastern parts of the U.S., Venus flytraps have historically been overexploited to meet local and international demand. Like American ginseng, Venus flytraps are currently considered “vulnerable” by the IUCN and it is estimated that approximately only 73,000 to 158,000 wild plants remain (Yearsley, 2017). This problem is not endemic to North America with the illegal trade in wild ornamental plants flourishing in Southeast Asia. More specifically, recent market surveys in various countries throughout this region demonstrate a “massive, previously undocumented” trade in orchids, many of which are threatened and are being trafficked across borders (Phelps and Webb, 2015, p.296).

Despite the prevalence of this crime problem, no previous studies have explored the spatial concentration of flora poaching and whether there is any relationship to features in the built environment. The following section discusses our theoretical framework for this study.

1.2. Environmental criminology

In this paper the problem of burl poaching is considered from an ecological perspective. Ecological theories of crime focus on patterns in time and space and locate their genesis in features of the physical and social environment in which offending occurs as opposed to offender disposition (Kurland et al., 2014). For such theories, crime events, their patterns, and how to prevent them are the objective of analysis as opposed to more traditional criminological theories that focus on criminal dispositions. As such, the focus is on the analysis of burl poaching events that occur in the RNSP to understand the environmental conditions that make poaching events more, or less, likely to occur in particular places.

There are four pillars of the environmental criminological framework: (1) the routine activity approach (Cohen and Felson, 1979), (2) crime pattern theory (Brantingham and Brantingham, 1984), (3) rational choice perspective (Cornish and Clarke, 1986), and (4) situational crime prevention (Clarke, 1980). These can be broken into two distinct groups. The first three contribute to our understanding of the crime event and how crime patterns form at the macro-, meso-, and micro-levels respectively while the latter focuses on how crime can be prevented. More specifically, the routine activity approach identifies

what conditions are necessary for a crime to occur. Crime pattern theory adds a further layer by describing how these conditions emerge in time and space. Rational choice explains the decision-making process of offenders under conditions that provide opportunities for crime. While situational crime prevention—rooted in the aforementioned theories—seeks to implement opportunity-reducing measures directed at specific crime types by manipulating the immediate environment so as to make crime more difficult, risky, and less rewarding (Clarke, 1997).

These ecological theories of crime have been used to explain the occurrence of wildlife crime in different contexts. For example, the routine activity approach has been applied in South Africa to understand the abalone trade and poaching of rhinos (Warchol and Harrington, 2016; Herbig and Warchol, 2011), the poaching of trophy animals in the U.S. (Eliason, 2012) and poaching in protected areas in Uganda (Moreto and Lemieux, 2015). A component of rational choice perspective, choice structuring properties, has been applied to illegal, unregulated, and unreported (IUU) fishing to understand how illicit fish are offloaded (Marteache et al., 2015). Similarly, situational crime prevention has been utilized to understand situational factors associated with IUU fishing (Petrossian, 2015). Yet, crime pattern theory has been conspicuously neglected in its application to wildlife crime and believe it is critical for understanding the nature of the redwood burl poaching problem.

Crime pattern theory posits that offenders, like other people, are not tied exclusively to one particular area, but are mobile, repeatedly travelling to and from various locations such as work, school, home, or entertainment facilities (nodes), usually using the same routes (paths). Thus, human mobility is non-random and heavily patterned, and the regularity of these movement patterns leads people to develop “awareness spaces”. From an offender perspective these are areas where they are more likely to be aware of opportunities to offend as well as other factors associated with crime commission, such as the street network and probability of detection (Brantingham and Brantingham, 1993; Rossmo et al., 2005). Crime events occur when the awareness space of an offender intersects with that of a potential target or victim. Consequently, the crimes that these individuals commit will likely cluster in and around their activity spaces with a higher concentration occurring at or near their activity nodes and paths (Rossmo, 2000).

There are numerous environmental features of the landscape in and around RNSP that may influence why some areas of the park are more susceptible to burl poaching incidents than others. For example, a growing number of empirical studies on crime and place have demonstrated that the configuration of the street network, and more specifically greater accessibility and traffic flow are of substantial importance to where crime-levels are higher (Beavon et al., 1994; Davies and Johnson, 2015; Johnson and Bowers, 2010; Summers and Johnson, 2017). With regard to the literature on wildlife crime, several studies have found that poaching occurs in close proximity to roads as it relates to elephants (Maingi et al., 2012), rhinos (Eloff and Lemieux, 2014), and deer (Haines et al., 2012). Thus, according to crime pattern theory and prior empirical studies on fauna poaching, we expect that burl poaching incidents would be more likely to occur in those areas in RNSP that have greater road accessibility. However, accessibility alone is not sufficient to explain where burl incidents are more likely to occur. Instead, it must be considered in combination with target richness (or availability). Hence, we posit (Hypothesis 1) that areas that are both accessible and target rich will be at increased risk of having a burl poached.

Other research has shown a link between the presence of illicit markets and increases in theft in the surrounding area (Langworthy, 1989; Pires and Guerette, 2014). In the context of this problem, we expect (Hypothesis 2) that there will be an increase in the odds of an area experiencing burl poaching as propinquity to a greater number of burl shops increases for two reasons. One, offenders will be cognizant of local shops that purchase illicit burls, and the more potential

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