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Spatial Methods for Understanding Human-Wildlife Interactions

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ABSTRACT

Interactions between humans and wildlife are a growing concern associated with increased human presence in wildlife habitats. Collecting reliable geographical data on human-wildlife interactions poses a significant challenge owing to the cryptic nature of wildlife and the fleeting timing of such interactions. In this presentation I will demonstrate a citizen science approach for studying human-wildlife interactions, and how it links with more traditional spatial ecology methods. GPS tracking is used to collect fine-scale spatial-temporal data on the locations of people along a hiking trail. At the same time, hikers were asked to complete a wildlife viewing survey that was linked to the GPS data based on the time attribute. Specifically, I will demonstrate new tools for mapping human-wildlife interactions and studying the environmental context within which these interactions occur.

1. Introduction

Human activity in remote and natural areas is increasing (Balmford et al. 2009). Many outdoor recreation activities are directly related to the presence of wildlife (e.g., hunting, wildlife photography) or may be a secondary motivation (e.g., hiking). However, human presence within wildlife habitat can disturb wildlife, for example, causing increased vigilance (Manor & Saltz, 2003), altering movement behaviour (Marantz et al., 2016), or shifting habitat selection patterns in both space and time (Coppes, Burghardt, Hagen, Suchant, & Braunisch, 2017). While the public health benefits of increasing participation in outdoor recreation activities are clear (Godbey, 2009), the long-term and spatial effects on local wildlife are much more difficult to quantify.

Collecting robust data on human wildlife interactions is challenging for a variety of reasons. First, these interactions are often fleeting, and may not always be realized by the human actor. Second, they may be associated with a distance decay effect, i.e., interactions are stronger the closer the two individuals involved are. Finally, human-wildlife interactions are generally rare events, occurring often in more remote areas. Thus, innovative methods are required to collect reliable data on such interactions. Citizen science offers an opportunity for studying the impacts of human outdoor activity on local wildlife (Forrester et al. 2017).

Here I demonstrate a study aimed at collecting, analyzing, and mapping human-wildlife interactions. I explore the types of data that can be generated for studying human-wildlife interaction in a citizen science context. The aim of the presentation is to demonstrate new spatial tools for studying these interactions and how these can be used to understand unique spatial events.

2. Methods and Data

The study took place in Glen Lyon in the Perthshire region of Scotland (Figure 1). The site includes a popular 17.5 km hiking trail which includes summits to four prominent munros (defined as peaks above 3000 ft; Carn Gorm, Meall Garbh, Carn Mairg, Creag Mhor). Elevation in the area ranges from

210 m at the trailhead to a maximum of 1042 m (3419 ft; Carn Mairg). The trail is situated on an estate, which also runs several outdoor recreation activities including red deer (*Cervus elaphus*) stalking, fishing excursions, and has domestic livestock (i.e., sheep) roaming free throughout.

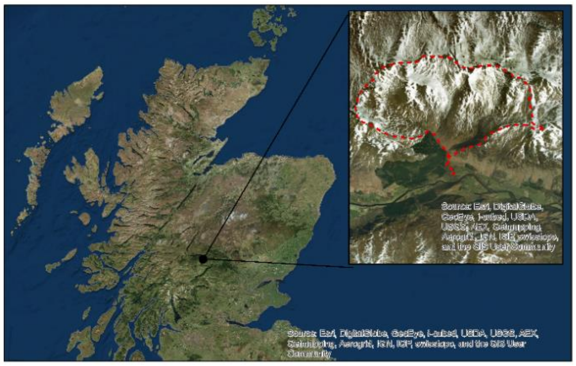
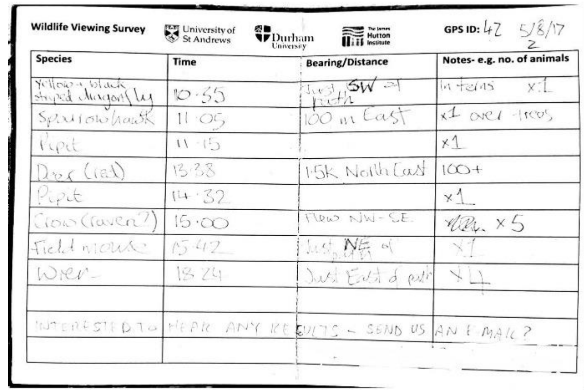


Figure 1: Location of the study area in the Glen Lyon region of Perthshire in Scotland.

We collected sample data during the summer and autumn months of 2017 and 2018 stratifying our sample days across weekends and weekdays. During sampling days, we asked all hikers entering the trail to carry a GPS device while out on the hill. For each group of hikers (groups defined as individuals from the same party walking together) that agreed to participate we gave them one small portable GPS device (GPSPro 747) to be carried by a single member of each group. The GPS devices were pre-programmed to record position continuously (i.e., one position fix every 5 seconds) prior to being given to a participant. A drop-box was located at the return point (near the car park) where GPS devices could be returned if the team member was no longer present. We did not collect any further information (e.g., age, gender) about hikers during this experiment.

At the same time, we asked participants to carry and fill-out a wildlife viewing survey, which was a piece of card which we provided (along with a pencil). The survey required participants to record the time, species of wildlife, and approximate distance and bearing at which wildlife were viewed while hill-walking (Figure 2). The survey was designed to be simple and easy to fill-out. The cards were then transferred to a digital spreadsheet by a team member.



Wildlife Viewing Survey — University of St Andrews — Durham University — The James Hutton Institute — GPS ID: 42 5/8/17 2

Species	Time	Bearing/Distance	Notes- e.g. no. of animals
Yellow + black striped dragonfly	10·55	Just SW of path	In ferns x1
Sparrowhawk	11·05	100 m East	x1 over trees
Pipit	11·15		x1
Deer (red)	13·38	1·5K North East	100+
Pipit	14·32		x1
Crow (raven?)	15·00	Flew NW-SE	[illegible] x5
Field mouse	15·42	Just NE of path	x1
Wren	18·24	Just East of path	x4
INTERESTED TO	HEAR ANY RE	SULTS – SEND US	AN EMAIL?

Figure 2: Example of wildlife viewing survey returned by participants, used to map human-wildlife interactions.

Based on the time information provided by participants in the wildlife survey the location of the walker at that point in time was cross-referenced based on their GPS tracking data. The locations where walkers viewed wildlife then served as the focal point for estimating the location of the wildlife at that point in time. Where the participant provided an estimate of the distance and bearing of the wildlife encounter, we used this information to map that location using simple geometry. Any wildlife encounter recorded by a participant with a distance estimate of > 500 m was not used in subsequent analysis. When a participant did not provide this information, we simply mapped the encounter based on the location of the participant at the time of the encounter.

Throughout both summers we deployed an array of camera traps situated along transects at various points along the hiking trail and at random locations throughout the study area. The cameras use an infrared sensor to trigger photos and capable of detecting animals in both day and night and across all weather patterns. We focused our study on red deer, but the cameras also captured other animals – mostly sheep). Camera trap photos were manually processed by a team member to codify whether deer were present (and the presence of other animals, i.e., sheep). We also identified various deer behaviors (e.g., running, head-up, head-down) from photos to study how different behavior of red deer were associated with distance to the trail, and the presence of hikers.

To explore contextual factors associated with the hill walker data, we calculated sightlines for all encounters recorded in the wildlife viewing survey and for every camera trap location using GIS-based viewshed analysis.

3. Results

We collected sample data on 35 (25 in 2017 and 10 in 2018) different days during the summers of 2017 and 2018. Of the 197 people that we approached, 185 agreed to participate, a success rate of 93.9%. From the 185 participants we collected 153 wildlife surveys with useable data. In total, we were able to successfully digitize 323 (2017: 259 and 2018: 64) wildlife encounters.

In order to map wildlife encounters, we needed useable measures of time, distance, and bearing. Where distance or bearing was missing we assumed the encounter occurred in proximity with the hiker. Of the 323 wildlife encounters collected, 143 (2017: 102, 2018: 41) contained both distance and bearing estimates. An example of a single participant's GPS data and their mapped wildlife encounters is provided in Figure 3.

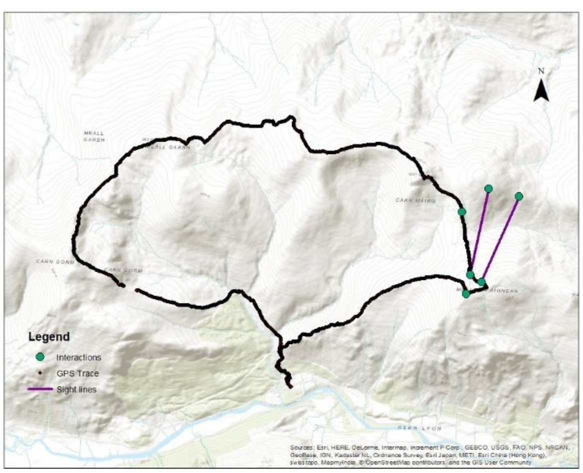


Figure 3: Example of a single participant with their GPS track and wildlife encounters mapped. Distance and bearing between the individual participant and the location of the wildlife (i.e., sight lines) were estimated by the participant and shown as a purple line on the map.

To test the quality of the participant wildlife encounter data we compare mapped encounters with the observations from the camera traps and visual observations in the field. Here we restrict the analysis to only red deer as they are the focal species for which the camera traps were deployed (e.g., the height and calibration of the cameras), and thus other species are not commonly observed.

Our preliminary results suggest issues with relying on participant generated content to identify human-wildlife interactions. Based on our in-situ visual observations we found that hikers routinely failed to see wildlife, even when they were within sight lines.

We cross-referenced all hiker GPS data with the camera trap data to identify the times when participants were near (within 100m) of the cameras. Over the course of two summers we collected over 100 000 camera trap images, of which approximately 30% contained our focal species (red deer). From this we estimated the error rates associated with the participant survey wildlife encounter data and found that there was a high-error rate of encounters with red deer that were missed by hikers.

4. Conclusion

Our study explores the feasibility of using a citizen science approach for collecting geographical data on human-wildlife interactions. Specifically, we found an extremely high level of engagement in our preliminary study (greater than 90% participation rate). This rate of participation at initial glance is high, but other studies have shown comparatively high willingness by outdoor recreationalists to participate in GPS tracking studies (e.g., Meijles, de Bakker, Groote, & Barske, 2014). Given that in many of these more remote areas there are only small numbers of people out on the landscape, such a participation rate is very encouraging. Given the challenges associated with collecting human-wildlife interaction data, maintaining such high participation rates will be advantageous to future work in this area.

While the data we have collected appears to be of relatively good quality upon initial inspection. However, in 2018 we situated a team member at a viewpoint within the site and found that hikers routinely did not identify deer that were within viewing range. Other problematic aspects of citizen science studies however need further study, for example, what might be more important is the variability between participants in their capability to observe (or report) wildlife sightings (Moyer-Horner, Smith, & Belt, 2012), rather than overall measures of error.

The approach we have taken here is highly labor intensive (i.e., it requires a study member be present to pass out GPS devices and the survey). Future work will explore how to upscale data collection of human wildlife interactions using mobile-phone based apps. Other studies have demonstrated how mobile-phone apps can be used effectively in collecting similar types data in ecological field studies (Teacher, Griffiths, Hodgson, & Inger, 2013) and we will look to draw on these studies in our developments.

It is generally unknown at what distance human presence influences different wildlife species. Previous studies have explored this in different contexts, for example previous research has found that rocky mountain elk (*Cervus elaphus* L.) respond at large distances (i.e., up to 2000 m) to all-terrain vehicles (Preisler, Ager, & Wisdom, 2006). Along the trail in our site wildlife (especially red deer) may be encountered (i.e., sighted) at similarly long distances (e.g., using binoculars, when visibility is high). For example, we had some wildlife encounters with distances measurements of greater than 1000 m. At what distance such an encounter represents a true interaction with a hiker is another question that needs to be explored further in future research.

In summary, collecting reliable and robust geographical data on human-wildlife interactions is a challenge, owing to the cryptic nature of wildlife and the fleeting timing of human-wildlife interactions. We employed a citizen science approach to collect data on wildlife encounters along a popular hill-walking route in the Glen Lyon region of the Scottish Uplands. Specifically, we used voluntary GPS tracking of hikers and a paper-based wildlife viewing survey to map the locations of wildlife encounters along a hiking trail.

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