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Short Communication

Webcams as an untapped opportunity to conduct citizen science: Six years of the American Kestrel Partnership's KestrelCam

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ABSTRACT

Hundreds of zoo-based or wildlife webcams have become available during the past twenty years, mostly with the goal of educating the public. However, there has been virtually no peer-reviewed research that evaluates the education, conservation, or scientific impact of webcams. Here, we provide one of the few examples of a webcam used for citizen science, and the only test of efficacy for crowd-sourced data collection using webcams. The Peregrine Fund streamed six seasons of American Kestrel (*Falco sparverius*) nests using the same nest box from 2012 through 2017 and viewers input observations into an online portal. We analyze trends in participant and kestrel behavior and test for sources of bias in this citizen scientist-generated dataset by independently reviewing a subset of recordings to determine accuracy of viewer-logged data. Citizen scientists logged a maximum of approximately 5.25% of all footage, but with an accuracy of 88%. Although number of participants declined yearly, on average, participants became more engaged. Sources of bias were related to people's daily activity periods (i.e., less participation at night) and activity within the nest box (i.e., less participation when there were no birds in the box). This citizen scientist-generated dataset generally corroborated the literature regarding American Kestrel biology. Researchers may be cautiously optimistic that datasets generated by citizen scientists can provide valuable information on a given system or study species. Given the ubiquity of webcams and their potential competition for conservation dollars, more research evaluating any aspect of their impact or application is sorely needed.

1. Introduction

Technological advances have revolutionized mass communication, web-based data collection, and the ability to mobilize and engage large audiences in specific activities. These opportunities enabled a burgeoning of research projects involving citizen scientists (Bonney et al., 2014; Bonney and Dickinson, 2012; Silvertown, 2009) and, simultaneously, online wildlife webcams that aim to engage and educate public audiences in issues related to biology and conservation (Dodson and Murphy, 2012). In response, leaders in citizen science have developed a community, tools, and guides to facilitate practitioners in the development of successful citizen science projects. For example, in the past decade, the Citizen Science Association (citizensci.

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org) and its associated journal, *Citizen Science: Theory and Practice* were launched. Additionally, the publications of books (e.g., Dickinson and Bonney, 2012), user's guides (e.g., Phillips et al., 2014), and dozens of peer-reviewed articles (e.g., Bonney et al., 2009; Freitag et al., 2016; West and Pateman, 2016) help in these endeavors.

Simultaneously, a few organizations have emerged as leaders in providing wildlife webcams on multiple species for viewing by the public, including Explore.org, Cornell Lab of Ornithology's Bird Cams, and Raptor Resource Project, each receiving millions of views per year. Additionally, hundreds of individual wildlife webcams are available to the general public and many are operated by non-profits conservation organizations, zoos, aquariums, or science museums (Dodson and Murphy, 2012). However, surprisingly little research has focused on any aspect of zoo-based or wildlife webcams, be it biological discoveries or the influence of webcams on learning or human behavior. Indeed, a Web of Science search (webofknowledge.com, accessed June 6, 2018) for 'wildlife AND webcam' returned only 3 results (Cushing and Washburn, 2014; Dodson and Murphy, 2012; Hayward and Hayward, 2012) and 'bird AND webcam' returned seven results, only six of which were generally relevant to birds and webcams (e.g., Peluso et al., 2013; Verstraeten et al., 2010). Of the few studies investigating aspects of webcams, most are focused on data collected on the webcam subject (e.g., Davis et al., 2017; Hayward and Hayward, 2012; McClure et al., 2015; Peluso et al., 2013), rather than practitioner objectives and methods or viewers behaviors (but see Dodson and Murphy, 2012).

Given that the stated objective of many webcams is to educate the public in issues of wildlife and conservation (Dodson and Murphy, 2012) and that they can potentially compete with conservation dollars, studies focused on the utility, learning outcomes, or conservation impacts of such projects are warranted. Additionally, because many zoo or wildlife webcams are developed for educational outreach (Dodson and Murphy, 2012), there is a fantastic opportunity for webcams to serve as an avenue for conducting citizen science. Webcam practitioners may benefit by adopting strategies for setting goals and conducting evaluations as described by citizen science leaders (Louv et al., 2012; Phillips et al., 2014).

The American Kestrel Partnership (hereafter referred to as the AKP; online at kestrel.peregrinefund.org) is a project of The Peregrine Fund that engages the public in issues of raptor biology and conservation. The mission is to galvanize a continent-wide community of informed citizen and professional scientists that contribute high quality data to help uncover the mystery of the long-term and steady decline of American Kestrels (*Falco sparverius*; McClure et al., 2017; Smallwood et al., 2009). Toward achieving the mission, two components of the program are a box-monitoring program and a wildlife webcam focused on an American Kestrel nest box located in Boise, Idaho (hereafter referred to as the KestrelCam; accessed at kestrel.peregrinefund.org/webcams). The KestrelCam has streamed the contents of a nest box each breeding season from 2012 through 2017. Features aimed to enhance learning and engagement among viewers of the KestrelCam include Activity Logging, a shared Discussion Board, and in 2017, weekly Live Chat sessions with a staff member of AKP. The Activity Logging feature enables the public to act as citizen scientists by logging their observations of the KestrelCam into a shared database.

In this study, we analyze data collected from six years of activity logging of the KestrelCam. Our objectives were to analyze trends in citizen scientists' contributions, report trends in kestrel activities and food deliveries as recorded by citizen scientists, identify biases in a data set generated by citizen scientists, and evaluate the efficacy of harnessing the power of webcams and citizen science as a method of data collection. Our evaluation is intended to improve data quality, viewer participation, and retention for the KestrelCam and to also inform other potential practitioners on the use of webcams for citizen science endeavors.

2. Methods

2.1. Hardware & streaming

The KestrelCam nest box is located at The Peregrine Fund's headquarters at the World Center for Birds of Prey in Boise, Idaho. There are two cameras that together provide a view of the inside of the box and the outside of the box. The inside camera is focused from above looking down onto the floor of an American Kestrel nest box and the outside camera is most often focused on the exterior of the nest box so the entire nest box and some of the surrounding landscape is in view (Fig. 1A). The camera footage from the inside and outside cameras are placed beside each other on the streaming screen so that viewers can observe real-time activity both inside and outside the nest box simultaneously (Fig. 1A; see Supplemental Fig. 1 for nest box, camera, and streaming specifications). Each season, we started streaming the cameras 24 h per day for public viewing around the time that the first egg was laid. We terminated the stream a few days after the nestlings fledged, thus while the camera was streaming, the box was nearly continuously occupied. The inside camera was equipped with infrared so activity inside the box was visible at night.

2.2. Activity logging by citizen scientists

When viewing the KestrelCam on the AKP website, viewers could log what they saw by clicking a button labeled "Activity Log." They were prompted to input their screen name and select an "actor" and an "action" (Supplemental Tables 1 and 2 list all "actions" and "actors" available for selection). All submitted observations were automatically saved to a database with a time and date stamp recorded in addition to their selected screen name. Importantly, screen names were designated by the user without restrictions on names accepted, and could be different with each entry and be shared by multiple users.