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Mobile decision-tree tool technology as a means to detect wildlife crimes and build enforcement networks

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ABSTRACT

Accurate field identification of illegally traded wildlife and wildlife products is critically important in the detection and suppression of wildlife crimes. Yet many law enforcement officers and concerned citizens lack access to resources for identifying species and products; this is particularly true for those with no formal expertise in biology, zoology or wildlife training. Emerging digital technologies such as mobile applications may provide important easy-to-use decision-tree style tools for in situ identification. With local government and civil society partners, we are piloting such tools in China and Vietnam to identify whole animals and ivory products; and in the United States developing tools that will be used at U.S. military bases in Afghanistan to identify species from wildlife products. We are coordinating these efforts to minimize redundancy and overhead; we benefit from shared backend support for a photo database and species ID keys that can be translated easily to ensure enough flexibility for targeting needs of the specific country and audience. Planned inclusion of 'ask the expert' and geolocation functions will increase accuracy in identification and aid monitoring and research of supply chains. For these emerging technologies to be successful, deployment must be accompanied with on-the-ground trainings to recruit and retain enforcement personnel. The establishment of a supporting network of experts and a user community will be critical for long-term implementation and evaluation of success. Preliminary response from users of a pilot app in China demonstrates high potential for employing these technologies as routine tools to help fight wildlife crimes.

1. Introduction

The illegal trade of animals and products made from parts of animals is a major global threat to wildlife. In the last 25 years, populations of many iconic species such as elephant, rhinoceros, tiger, and saiga antelope have decreased dramatically or become locally extinct, and much of this decline is due to illegal hunting for coveted products such as ivory, medicines, and clothing (Emslie et al., 2013; Li et al., 2007; Maisels et al., 2013; Milner-Gulland et al., 2001; Walston et al., 2010). Weak enforcement systems have enabled wildlife to be poached and traded to markets where sales of wildlife and products made from wildlife parts fuel illegal business (Bennett, 2011). Responsibility for enforcement is spread across individuals along supply chains, from rangers to transportation and border guards. Lack of awareness and interest in wildlife conservation are one of the major obstacles, along with lack of training and technical resources, for combating these crimes (Bennett, 2011; Kaaria and Muchiri, 2011). Law enforcement authorities stationed at borders, including customs, immigration, police, military, agricultural and transportation personnel (The World Bank, 2013) are at the front line of the wildlife crime trade-chain battlefield in ensuring illicitly traded products are not crossing borders or being offered for sale in local markets. The rapidly increasing international trade and flow of travelers has put considerable pressure on border authorities, who must screen a broad range of goods and decide whether or not to release a shipment in a matter of minutes or even seconds (Gerson et al., 2008). Building capacity of enforcement personnel can increase the quality of market

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surveillance for illegally traded wildlife. However, the ability for these law enforcement entities to impact illegal wildlife trade requires having access to easy-to-use tools and resources to aid in the identification of traded wildlife and products.

Knowledge, motivation, and technical resources specific to wildlife are three main factors that can improve the impact of law enforcement agencies on illegal wildlife trade (Bennett, 2011; Gerson et al., 2008; Kaaria and Muchiri, 2011). Ideally, customs agents would have extensive training as well as easy access to the latest forensic techniques and laboratories to facilitate identification of wildlife to the species level (Bell, 2011; Rosen and Smith, 2010). In reality, training is limited; and, while promising, forensic science must occur in properly equipped laboratories (Anderson, 2013), far away from the front lines of trade activity. In the past, organizations have experimented with wild species identification prototypes mimicking field guides (Tallant et al., 2010). This approach revealed significant practical limitations as it required some previous knowledge of wildlife to ultimately be successful in identifying to a species level. Capitalizing on this experience, the "decision-tree style" may be a more viable approach to allow successful operation by officers with relatively little training to make quick and reliable identification of potential crimes in the field (Rosen and Smith, 2010).

Decision-trees are a system to provide classification based on inputs and organization of information. They have wide-spread application, from determining water treatments, to diagnosing medical conditions and classifying astronomical images (Murphy, 2001; Murphy and Olson, 1996; Salzberg et al., 1995). Often, decision-trees facilitate analysis by assigning probabilities to supplied data selections, with additional weights to account for potential errors, to calculate the outcome of system manipulations (Murphy, 2001). Decision-trees can also be simple dichotomous or multichotomous keys employed to identify items of the natural world such as flowering plants, minerals, or insects (Carle, 2010; Alan Plante et al., 2003; Watts, 1998). These keys use a process of elimination to narrow the possibilities at each selection and can be effective as a tool to classify or identify based on different factors. This approach could be equally useful for identification of traded wildlife and wildlife products but until now has yet to be tested.

Emerging technologies such as interactive web pages and mobile applications provide an opportunity to make multichotomous keys available to a variety of audiences at a relatively low cost, as use of mobile technologies is booming around the globe (ADMA, 2012; Smith, 2013). For these tools to curb wildlife trade at the scale necessary to prevent decline of wildlife populations, organizations must deploy them in strategic locations and to a network of individuals engaged in using them for specific purposes. The Wildlife Conservation Society (WCS) has been involved in the enforcement of wildlife trade for over a decade supporting networks of trained park rangers and training customs, police and forestry officers in places such as Congo, Thailand, China, Indonesia, Malaysia, and Vietnam (Bennett, 2012; Lee et al., 2005; Roberton, 2013; Walston et al., 2010; WCS, 2013a) and training military police to secure on-base markets (Kretser, 2012; Kretser et al., 2012). These networks represent opportunities to test whether emerging technologies using decision-tree approaches will be a viable method for enforcement. We present three cases from WCS field programs in China, Vietnam, and the United States illustrating how to build a network of users employing decision-tree style tools to improve detection of wildlife crimes.

2. Methods

WCS is developing and pilot-testing decision-tree style technological resources to identify wildlife and products made from wildlife parts to a species level across three diverse contexts and audiences in China, Vietnam, and the United States. All authors on this paper are WCS staff and are intimately involved and leading this development process. To streamline mobile technology production efforts, we are creating a back-end database structure that can be adapted to multiple tools and includes species information as well as photographs. Front-end technology enables each program to be tailored to the specific site context including language, local legal framework, and types of wildlife available in the markets. Information particular to the database comes from existing literature on the species of interest, experts in the field, and inspection of products previously confiscated. Identifying the end-user and the context is important to the development and deployment of these tools.

We report on progress of three programs to improve identification of wildlife crimes. In all cases, we rely on initial impressions of challenges and opportunities based on our experiences developing the technology and participant observation. For China and Vietnam, we examine how frequently the tools are downloaded and user retention (i.e., those individuals who continue to use the technology) over time measured by dividing the active users in the past 3 months by the number of lifetime downloads. For China, we provide limited data from user surveys following trial runs of this technology with customs and forestry police. We trained 93 customs officers from Guangdong and Guangxi provinces and 33 forestry police from Qinghai province ($n = 126$). We also met with individuals from the academic community to provide information and expertise on the user experience." These informal discussions informed the development of a pilot survey. We administered the voluntary survey using convenience sampling of individuals who participated in app training sessions ($n = 74$). The surveys measured users' perceived benefits and usefulness of the mobile app and their opinions about future improvements to the app and the interface. The self-administered survey featured closed-ended questions with some yes/no responses and some 5-point Likert-type scale responses according to the nature and scope of each question. We summarize the app technology employed by WCS to date in a table representing a typology of uses based on location, language, and features. This will enable future comparison among apps.

3. Results and discussion

3.1. China

With a population of over 1.3 billion, China is potentially the largest demand market for several species of wildlife globally due to the traditional use of wildlife for medicine, food, and trophies and the increase of that use due to rapid economic development. In recent years, Chinese authorities have progressively acknowledged the impact illegal wildlife trade has on global biodiversity as well as the country's international reputation (Hu Jintao, 2012). The destruction of 6.15 tons of ivory artifacts and tusks in January 2014 by crushing marked China's commitment to take a resolute stance against illegal wildlife trafficking. Since 2009, WCS has supported capacity building efforts, including species identification training of Chinese law enforcement agencies on wildlife conservation and innovative investigation techniques. Written assessments carried out immediately after training programs found a twofold increase in species identification skills of law enforcement officers compared to the pre-training baseline where about 33% of participants demonstrated species identification skills (Wong, pers comm.). After six months, only 41% of participants retained knowledge gained from the workshops (Wong, pers comm.). We needed a tool to improve knowledge retention