Wild Animals in Daily Life

Short Paper

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Abstract

Humans have historically low engagement with the natural world. Global urbanization has led people to abandon wildlife-rich landscapes. The current lack of connectedness to nature is known as nature-deficit disorder. However, to encourage sustainable relationships between humans and other animals, technology to reconnect is urgently needed. The natural world is in a dire state; we are in the midst of a Sixth Mass Extinction. Here we propose that a novel information system, including a mobile app and privacy tools, could enable reconnection with the natural world. We propose the combination of real-time tracking data from wild animals and humans. Novel wildlife experiences, integrated into people's daily lives, may increase the connectedness to nature, which serves as a key factor for pro-environmental behavior. Further benefits are identified in education, philanthropy, health, and entertainment. Finally, we utilize an innovative privacy-preserving architecture to shield wildlife data from criminal intent.

Keywords: Wildlife, nature conservation, connectedness to nature, animal, mobile app, data tracking, experiential learning, health, gamification, privacy-preserving system

Introduction

The ecosystems that sustain life on earth are severely threatened (MacDougall et al. 2013). Anthropogenic climate change, in particular, poses serious risks to the long-term habitability of earth for most species (IPCC 2014). In short, humans face the prospect of directly triggering the Sixth Mass Extinction (Leakey and Lewin 1996).

Despite our reliance upon the natural world and its ecosystem functions, people in affluent countries have historically low engagement with the natural world (Larson et al. 2011). Most children in the United States, for example, spend less than 30 minutes outdoors, and even less time in "natural places" like forests, parks, lakesides, or beaches (Juster et al. 2004). The term "nature deficit disorder" (Louv 2008) exemplifies the broken relationship between many youth and the natural world. Meanwhile, usage of mobile devices continues to skyrocket. Surveys indicate that the average 5-16 year-old spends 6.5 hours daily on internet-connected devices (Larson et al. 2011).

Here we explore the possibility that such technology usage may ironically enable reconnection with wildlife and the natural world. Rather than separate us from nature, can technology bring us closer? Can an app inspire curiosity about and empathy with other species?

The core idea of the present work is to combine tracking data from wild animals with tracking data from humans. To our knowledge, this has not been previously proposed by other researchers or practitioners. The proposed mobile app displays both their own human activity data and corresponding wildlife movement data in real-time, helping the user feel more connected to wild animals by creating a direct parallel to their lives. He or she can be encouraged to voyage with a wild tiger in the jungle, a polar bear in the arctic, or an elephant in the savannah. Measurements from animals and humans are fused, with the ambition to give the wild animals renewed attention in our everyday life.

The paper is structured as follows: We firstly explain the fundamental concept "connectedness to nature". Then we provide an overview of existing app-based approaches to connect humans with natural world, and point out a safety problem in wild animal data and how we solve it. We formulate two relevant hypotheses and outline the test setting. At the center of the paper is the presentation of our mobile app and the privacy-preserving system architecture. In the last section, we discuss the findings and limitations and provide an outlook on future work.

Literature Review

Connectedness to Nature

Nature is desolate. Many animal species are already extinct, while countless others are highly endangered. In most cases, existing protective measures are not sufficient and biodiversity is continuously decreasing. New and innovative approaches are urgently needed to raise people's awareness of nature conservation. Therefore, researchers try to better understand pro-environmental behavior and its barriers (Kollmuss and Agyeman 2002). A positive human-nature relationship is fundamental to countering today's environmental problems ((Frantz et al. 2005; Nisbet et al. 2009). This relationship, called "connectedness to nature" (Schultz 2002), can be defined as "a self-perceived relationship of interconnection between the self and the natural world" (Mayer and Frantz 2004; Olivos et al. 2011). Some researchers argue that problems might have arisen from a disconnection between humans and their natural environment (Jordan 2009; Tacey 2000). Scientific questionnaires have been developed to measure connectedness, including the "New Environmental Paradigm" scale (NEP, Dunlap 2008), the "Inclusion of Nature of the Self" scale (INS, Schultz 2001, 2002), the "Implicit Association Test" (IAT, Greenwald et al. 1998), the "Connectedness to Nature Scale" (CNS, Mayer and Frantz 2004), the "Love and Care for Nature" scale (LCN, Perkins 2010), and the "Nature Relatedness" scale (NR, Nisbet et al. 2009).

Increased connectedness to nature leads to engagement in a range of conservation behaviors (Gosling and Williams 2010; Mayer and Frantz 2004; Schultz 2001). However, Louv (2008) describes how many children manifest a broken relationship with the natural world; indeed, many groups have been measured to have historically low engagement with local ecosystems (Larson et al. 2011). As a countermeasure, most literature identified "experiential learning in nature" as a key activity for increasing connectedness. Its effectiveness was demonstrated with pupils (Liefländer et al. 2012), students (Zhang et al. 2017) and tourists (Orams 1997). Experiential learning in nature typically requires a field trip which is time-consuming and costly. It is not scalable in terms of the number of participants and the extent of the experience. In addition, people with reduced mobility may not be able to participate. To overcome these weaknesses, we propose an app-based approach which may create similar learning experiences. The goal is to increase connectedness to nature, and to ultimately support pro-environmental behavior.

Nature Apps

Jepson and Ladle (2015) analyzed nature apps in the Google Play Store. The largest categories are "personalization", "games", and "reference". Most of them does not fully exploit the full range of capabilities inherent in the technology and simply add nature elements to generic code architecture, or display established book content together with additional features like movies, audio, and maps. Interactive nature field guides are reviewed by Shrode (2012). Because of "disappointing" simplicity, Jepson and Ladle (2015) are "waiting for the revolution" in nature apps. They see three areas with high potential: "(1) real-time 'machine learning supported' species identification apps; (2) augmented reality integrated into nature visitor attraction apps; and (3) apps that are linked to add-on sensors designed for ecological research". Gardiner (2016) supports this view with her article about wildlife attraction and zoo apps.

Sandbrook et al. (2015) propose games for biodiversity conservation, but they admit that "most conservationists know little about digital gaming". The authors note that the affordances of smartphones (e.g., multiple sensors, 3D visuals, motion controls) offer exciting and largely unrealized potential for the development of digital conservation games with the aims to support education, behavioral change, fundraising, research, management, and monitoring. Examples of today's "first-generation" nature games include: replicating hunting experiences (DeerHunter 3D, Duck Hunter), killing evil poachers (Poacher Terminator), playing wildlife photographer (Camera Birds), and saving whales (Wounded Whale Rescue).

Kretser et al. (2017) argue that mobile apps have the potential to disrupt wildlife crime activities throughout supply chains and contribute to market reduction, but these gains have yet to be seen. The software of Yang et al. (2014) has another approach: It allocates resources for protection against poachers.

Many mobile apps are designed to record or identify wildlife, for example for species in forests of Indonesia (Vatresia et al. 2016) or for bat species in Europe (Walters et al. 2012). The smartphone is connected with an ultrasonic bat detector (hardware add-on) which records bat calls and transmits the geo-referenced data. Artificial Neural Networks classify the recordings from 34 European bat species. Another field for future nature applications are warning systems. A shepherd in Switzerland may be warned about a nearby wolf (Frey, Hardjono, et al. 2017), villagers in Sumatra could learn of an approaching elephant herd, or real-time animal warning systems can designed for vehicles (Zhou 2014).

In his wonderful book "Animal Internet: Nature and the Digital Revolution" (Pschera 2016), the author describes how human beings are reconnecting with the natural environment in new ways. The book starts with a story about a little girl who has an emotional encounter with a wild wolf, enabled by technology that is already available today. The author does not advise to go back to nature in romantic style, but enter novel relationships with wild animals supported by latest technology and novel information systems. Animals become part of the Internet and people get a new picture of the animals by perceiving them with their senses. A project of Li et al. (2015) is a concrete realization of Pschera's vision. They installed a dense sensor network in a wetland area and stream thousands of data points (audio, temperature, wind, etc.) every 30 seconds to the Internet. The goal is to expand the boundaries of public perceptions of natural phenomena. A new user perception is created by visualization techniques or by real-time music compositions based on the sensor data (Lynch 2016). A company called Internet of Elephants plans to integrate real-time wildlife data in games. According to their website (http://www.internetofelephants.com in May 2017), players will guess tomorrow's location of wild animals. A monetizing workflow for wildlife data providers is outlined. In addition, the company has developed an augmented reality app which utilizes a virtual elephant to create engagement.

Data Privacy

The usage of wildlife data has a downside: data is vulnerable to crime. An incident several years ago demonstrated the importance of the safe handling of wildlife data. Criminals tried to hack the GPS collar of a tiger in the Madhya Pradesh Reserve in India with the aim to access the database with the real-time location data of all tracked tigers. In this worst case, the criminals could easily locate and kill all tracked tigers. Fortunately, the attack failed and the attackers did not access the server. The incident was published in the news and in National Geographic (Ingber 2013). The attack was called "cyber-poaching" and "feared as new threat to rare wildlife". Cooke et al. (2017) tries to solve the security issue with organizational countermeasures. Overall, literature about data protection of wildlife data is rare.

A novel privacy-preserving framework, called OPAL, was proposed by "MIT Trust::Data Consortium" (https://www.trust.mit.edu/projects) and described in the book of Hardjono, Shrier and Pentland (2016). It follows the paradigms proposed at the World Economic Forum (WEF) in 2008 for the protection of human data (Dutta 2009). By applying this framework to animal data for the first time, we are able technically guarantee the security of the raw data. The core concept of the framework is to transmit code, not data. Only non-sensitive aggregated data leaves the secure environment of wildlife monitoring centers; the sensitive raw data remains in protected databases. Technical details and uses cases are described in our previous work (Frey, Hardjono, et al. 2017).

Research Design

Hypotheses

As shown in the literature review, scholars are generally disappointed about today's nature apps and are in expectation of an upcoming revolution. The current trend of data mining in the wild (Krause et al. 2013) may bring the hoped-for turn. New tracking technologies enable gathering real-time data and giving researchers unprecedented insights into the life of wild animals at low costs. The animals can be observed in a much higher resolution than with previous methods, especially in terms of space and time. Today, only a few applications based on such wildlife data are available for end consumers.

At the same time, massive data mining of our own human activity has led to the era of the "quantified self" (Lupton 2016). Smartphones often serve as measuring devices (Daponte et al. 2013), but additional devices (like fitness tracker bracelets for permanent pulse measurement) are also popular.

Here we see the opportunity to use the newly gathered data to rebuild the shrinking connectedness to nature. Using such tracking data, humans and non-human animals can be reconnected in a radically new way. We propose to fuse wildlife tracking data with human tracking data. We hypothesize that the fusion of both has the potential to bring human and non-human species closer together. Through this approach, people may perceive animals from a new perspective and thereby change their behaviors to better align with environmental priorities. It is a new way of experiential learning. Since experiential learning in nature is able to significantly increase connectedness to nature (as previously shown in the literature review) our first hypotheses is:

> **Hypothesis 1**
> App-based experiential learning using wildlife data increases the connectedness to nature.

Braun and Dierkes (2017) showed a positive correlation between the duration of an experiential learning situation and the resulting increase of connectedness to nature . Thus, our second hypothesis is:

> **Hypothesis 2**
> The duration of the app usage positively correlates with the increase of connectedness to nature.

Previous research analyzed various factors that could influence the effect of experimental learning on connectivity (Braun and Dierkes 2017). This includes, for example, the connectedness at the beginning of the intervention. An initially high connectivity cannot be further increased by experimental learning. Age, as another example, is an influencing factor as well. In our analysis, therefore, we also investigate the question which factors play a relevant role in our results. Potential demographic factors are: age, gender, education, income, political attitude, and family life stage.

Study Design

We are developing a mobile app for experiential learning about wild animals. The user playfully attempts to reach the same walking distance as the animals did the day before. In other words, the user "follows" the animals. Once an animal has been reached, the user can observe it closely and gather insights. The details of the app are described in the next chapter.

To test our two hypotheses, we measure the connectedness to nature of the app users with a questionnaire. The proposed questionnaires from the literature show different correlations between connectedness and biospheric concerns, egotistical concerns, and ecological behavior (Olivos et al. 2011). We decided to use the "Inclusion of Nature of the Self" scale (INS) for comparability with the results from Braun and Dierkes (2017). They used INS to measure the connectedness to nature before and after an outdoor environmental education program. We are interested to create the same effect, but on a smartphone device. Another reason for using INS is its simplicity: It contains a single item. This allows us to consult the users on a regular basis without unnecessarily bothering them. The questionnaire is displayed on the screen when the users start the app for the first time. In addition, we ask demographic questions at the beginning. Then, once a week, the single-item scale questionnaire appears again in order to track user's connectedness over time.

Several other data are collected while people are using the app. It may help to better understand the provided experiential learning situation. Such data are: user's daily walking distance, daily usage time, number of spotted animals, number of invited friends, number of views on collected learning cards, and in-app purchases.

Mobile App

In this section, we present our mobile app for connecting wild animals and humans. The mobile app may inspire at least four different outcomes: education, philanthropy, health, and entertainment. These account for the variety of users who can use the app with different motivations. The app is described using these four perspectives in the following four sections. An overview of the main features of the app is given by Figure 1(a) which shows the main menu. The six menu items are: daily ranking, real-time visualization about the user's spotted animals, the user's achievements, an archive of previous learnings, user settings, and general app information.

Education

First of all, the app should be a tool to expand the sense of self to include the natural environment. Connectedness to nature is expected to increase. The app aims to place learners "in touch" with real animals in the wild. The user receives wildlife data which provides insights about how animals in the wild are currently living. It is a new way of education because it is different to classic school lessons in biology where static knowledge is taught. This is particularly important because it is known that the possession of pure environmental knowledge, as taught in the classroom, does not trigger any change in eco-friendly behavior (Kollmuss and Agyeman 2002). Instead, a "direct experience" is necessary , such as spotting an animal (Rajecki 1982).

The app lets the user be a scientist. The motto is "Follow and Learn!". The user follows animals of different species, visualized by a race in a flat landscape as shown in Figure 2. As explained in a previous chapter, the user can spot an individual animal by walking the same distance as the animal the day before. Thus, the user can reach many different animals during a single day. If an animal is reached, the user is able to observe the animal, i.e. the user receives real-time information such as altitude or landscape type (forest, grassland, farmland, rocks) in which the animal is currently in. This is computed by the combination of the current GPS position and a geo-ecological map. In addition, the user can learn interesting things (static information) about the animal. Figure 1(d) shows an example what happens when a clouded leopard is spotted. Users can collect and review the learnings in form of virtual learning cards, ordered by animal name, species or spotting date. Further implementations could even allow users to formulate hypotheses about animal movement or compute various comparative summary statistics (for example, average time moving at night versus in the day, or in winter versus summer).

The app now focuses on endangered species, but familiar animals are also included. In version 1.0, the app uses historic data collected in the wild years ago, now available online in wildlife data sharing platforms (e.g. https://www.movebank.org, https://www.zoatrack.org). In later versions, the app will integrate real-time data from wildlife monitoring centers. The usage of such real-time data is more sophisticated and described in the next chapter about the system architecture.

There are huge differences in the daily walking distance of different species. The app does not adjust the distances, i.e. there is no normalization of the data. Thus, some animals are easier to reach than others, which is perfect from a gamification perspective. Moreover, the normalization would lead to false learnings.

Philanthropy

Nowadays, a popular way for engaging people in donation are animal adoption programs (Colléony et al. 2017). Such programs are widely offered by nature conservation organizations and zoos. Adopters typically get a symbolic gift like a certificate or a toy, sometimes some additional information like life history or day of birth on paper, but meaningful, daily information exchange is lacking. There are no direct and ongoing connections between adopters and adoptees. We propose to move adoption into the digital space. Users can adopt animals with simple in-app purchases. This saves administrative costs and shipping a gift or a certificate is not needed anymore. Instead, the user receives a digital representation of the animal which is then handled like the others animals in the app. Thanks to the provided real-time wildlife data, the user may get in a very intimate relationship with the animals, much more than with today's adoption programs. We suspect that this can create an emotional bond which in turn makes an adoption more sustainable, i.e. over several years instead of a one-time payment.

This established relationship may bring joy, but what happens if the animal dies? The option to simply ignore the death, or replace the dead animal's data with another animal, is dishonest and loses an educational opportunity, according to Russel (2016): "the emotional connection children expressed with companion animals that died is a highly significant aspect of their learning about wider processes of life and death". We therefore apply recommendations from child/adult psychology related to the death of pets and honestly explain in the app what has happened, provide supporting information, and offer more ways person can donate or directly support other living animals.

Supporting a specific wildlife habitat is another common donation approach. For instance, a donator decides to support the rainforest or wildlife in the arctic in general. This approach can also be transferred to the digital world as well. In our app, user can sponsor a habitat (e.g. rainforest, ocean) by in-app purchases. In doing so, the user unlocks additional flat landscapes (water, sky, ice, desert, rainforest). Experience from the gaming industry shows that unlocking maps or receiving digital items by in-app purchases can be profitable (Hamari et al. 2017). As a conclusion, our approach can offer new ways to monetize wildlife data while simultaneously creating greater public engagement.

Health

Researchers proposed and evaluated so-called mobile health coaches (Free et al. 2013). These coaches support the user to achieve personalized health goals and can play an active role in recovery with digital interventions. In particular, pedometers are quite popular to increase physical activity (Lubans et al. 2014). Measuring the daily walking activity and providing real-time feedback on progress towards a daily goal significantly increased the average walking time (Zuckerman and Gal-Oz 2014). We pick up this idea and focus on walking distance. We introduce a new challenge: users' daily goals are no longer fixed. Rather, they are dependent on animals' walking distances from yesterday. Goals are therefore set by nature; in other words, the user is trained by wild animals. The user gets a notification if an animal is spotted. It means that the feedback is always positive here, which leads to a performance increase according to social cognitive theory (Bandura 2004). However, the role of feedback to promote physically activity is an ongoing discussion in research including contradicting theories (Kramer and Kowatsch 2017).

In order to further improve the fitness motivation, friends can be invited, which then also appear in the ranking or in the flat landscape (see "Josh" in Figure 1 and 2). The invitation of friends may lead to a network effect, in which more and more people are getting interested in using the app and improving their fitness. In addition, the user can choose a specific animal as personal trainer/buddy (marked by a heart in Figure 2), which is then waiting if the daily goal is far or is pushing if the goal is nearby.

Entertainment

Entertainment plays an important role on smartphones. 15% of apps on smartphones are games (Frey, Xu, et al. 2017). As described in the previous subsection, a trend goes towards gamification and serious games. Games are no longer just a trivial activities enjoyed by children (McCallum 2012). Serious activities like dieting or language learning are combined with game elements to engage and motivate users. Our app has such game elements as well. First, the daily ranking which displays the walking distance as a horizontal bar chart in descending order as shown in Figure 1(b). Second, the user tries to spot the animals as previously described. The number of spotted animals and the set goal per species is displayed as achievements, see Figure 1(c). In addition, a level number is shown at the bottom of the page. The level is dependent on the number of spotted animals. The number is useful for oral comparison between friends and colleagues. Moreover, additional landscapes (water, sky, ice) and corresponding animals can be unlocked by level-ups. As shown in Figure 1(c), there are also awards for categories of animals. For instance, "ice animals" includes polar bear, penguin, and polar fox, and "water animals" includes whale sharks and manatee. Collecting itself is already a play element, as successfully demonstrated by the popular location-based mobile game Pokémon GO. In addition, researchers found that Pokémon Go increased physical activity across men and women of all ages, BMI levels, and prior activity level (Althoff et al. 2016). A last element is the option to compete with the own buddy against the buddies of friends. Because a species can only be used as a buddy when previously spotted, this option provides an additional motivation to follow animals.

(a) Menu (b) Ranking (c) Achievements (d) Spot

Figure 1. Mobile App for Connecting Wild Animals with Humans.

Figure 2. Visualization of the Walking Distance in a Scrollable, Flat Landscape.

System Architecture

Since there are risks for misuse and privacy concerns related to the wildlife data, we implement a privacy-preserving system architecture. The novel approach is not the focus of this work and we refer to the references given in the literature review for conceptual and technical details. Nevertheless, this approach is used here for the first time to protect and safely share data from nature.

An overview of the system architecture is shown in Figure 3. First of all, the animals are equipped with tracking devices which transmit raw data to monitoring centers. Modern tracking devices are cheap and easy to use and thus, very popular today. A monitoring center can be a small research station in the mountains or a zoo in a big city. Monitoring centers usually collect data from several individuals and from different species. For example, the organization KORA is responsible for monitoring all carnivores in Switzerland. There are many ongoing initiatives where different centers jointly put their data in a centralized database management system (Urbano et al. 2010). The required data harmonization can be very complex, since different methods are used in the way of data collection and storage. In contrast, the present solution allows decentralized storage of the raw data without harmonization. Using the OPAL framework (Frey, Hardjono, et al. 2017; Hardjono et al. 2016), only aggregated data relevant to the app is passed on. In our case, this includes three information: the travel distance, activity level and landscape type in which the animal is currently located. Based on these three categories of information, it is not be possible to locate an animal, and therefore the protection of the animal against poachers is ensured. The app provider can then use the aggregated data for its customers. Applications with real-time data are possible without exposing the animals to danger. The sensitive GPS and accelerometer data remain secure behind the firewalls of the monitoring centers. The users can then compare their own walking distances with those of wild animals. Additional fitness tracking devices for the users are not needed because the smartphone is already able to measure the distance using GPS and accelerometer.

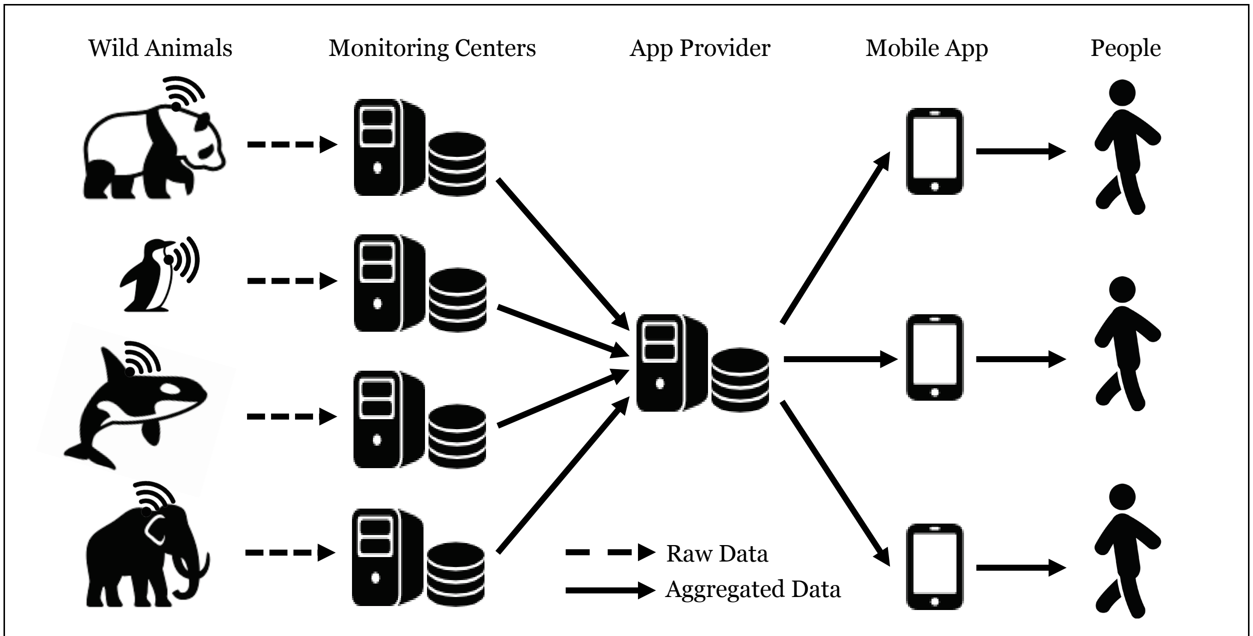

Figure 3. System Architecture and Data Flow.

Expected Results

The app will be publicly released in Fall/Winter 2017 and will be promoted with the pay-per-install feature on Facebook. Our goal is to get 2000 active users in order to test the hypotheses. The languages available in a first step are English and German. Since the app is attractive for non-profit (e.g. zoos) and commercial purposes (e.g. fitness tracker companies), a collaboration can lead to further distribution channels and brandings. However, we have to make sure that the app is not abused as a greenwashing or profit-oriented marketing tool, with the consequence of a further desensitization of environmental issues.

We expect positive results from both hypotheses: that an app-based experiential learning increases the connectedness to nature; and the longer the people use the app, the stronger this connection will be. Since researchers demonstrated a positive correlation between extent of connectedness and pro-environmental behavior in the past (Gosling and Williams 2010; Mayer and Frantz 2004; Schultz 2001), our expected results would proof the capability of our app-based approach to protect the environment and to support species conservation.

Discussion, Limitations and Future Work

Animals and plants are currently threatened by high extinction rates (MacDougall et al. 2013). There are many successful species protection programs, but to date they are not enough to significantly slow the rate of extinction. Innovative solutions with state-of-the-art technologies are required. Our intention is to strengthen understanding and respect for wild animals. This article takes the theory that increased connectivity to nature leads to a pro-environmental behavior. For this reason, we describe a new mobile app that is supposed to strengthen connectedness to nature. The main idea is to combine human and wildlife data in a daily used application. We expect similar effects as experiential learning in a nature-based outdoor excursion has.

The article serves as a starting point for a discussion of other applications based on wildlife data. Data in general can be seen as the new currency of the 21st century (Gates and Matthews 2014). This realization marked the growth of the Internet and the beginning of the so-called information age (Castells 1999). Big Data has become the fashion word of our time. Profits derived from data and its analysis are indisputable. Information systems let data flow through new channels and open new areas of application. In particular, the direct route to the final consumer is increasingly sought. In contrast, the value of data from the wilderness appears to be not yet recognized outside research activities. Researchers are now collecting wild animal data and recognize the opportunities of Big Data. But innovative information systems, which bring the data directly to the end consumer, are rare. In most cases, the data remain within the research community and the public benefits only at a later stage through collective insights. We believe that direct access to wildlife data, with open source ethics, has many potential implications. A new ecosystem of apps can emerge, driven by public developer communities that can also pursue commercial interests. New opportunities for animal welfare organizations are conceivable and should be evaluated from environmental perspectives.

We describe an information system which demonstrates how data can be securely used in favor of wild animals to simultaneously benefit human education, philanthropy, health, and entertainment. The current retention in the offered information systems on wild animals is certainly also in data security. Data which can be clearly identified by an animal are usually not in the interests of the wild animal, even if they are only photo-tourists. Therefore, in the present article, we show that the public release of sensitive wild animal data is possible without jeopardizing the safety of the animals.

Providing data — especially in real-time — can be challenge for wildlife monitoring centers. It requires technical know-how and resources usually scarce in non-profit organizations. Future work might address scalability. Can standards be established that make provisioning easier while allowing individual data types and styles? The current solution allows the use of aggregated data without having to harmonize the raw data. However, the query of the aggregated data is standardized and the monitoring centers must build at least an adapter, which executes the standardized query on the individual database schema.

We admit that it is unclear whether the presented app would have a sustainable influence on users. Some fraction of users may only remain engaged for a few months and then lose interest in using the app. One third of fitness device owners stopped using them within six months (Ledger and McCaffrey 2014) and the number of active users of Pokémon GO decreased from 25 million to 7.5 million within the same period of time (Windels 2017). However, a study has shown that real-time feedback can produce a sustainable effect on environmental protection (Tiefenbeck et al. 2016) and a second study reported a long-term effect of the experiential learning in nature (Braun and Dierkes 2017). Therefore, in addition to reexamining our two hypotheses, future work should examine long-term effects. Do users retain their increased connectedness to nature, even if the app is not used anymore?

Besides our focus on environmental connectedness in this article, future work may try to better understand the mechanism of the app itself. What core functionality is needed to make experiential learning on a mobile app in the current context successful? Which are the key elements to motivate people to use the app? Is the connection to real-time wildlife data a key motivator for wearing the fitness device longer than six months? Very promising seems to us also the presented possibility to "buy" animals within the app. Will people use this digitized variant of animal adoption programs? Moreover, the app allows for a number of novel twists on classic gamification hypotheses. For example, do competition conditions hold when people are competing against an animal as they do with a human? Do details about the animal increase this competition?

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