Development and Launch of a Comprehensive Fish and Wildlife Reporting Mobile Application

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Abstract

This paper describes the conception, development, launch, marketing, and maintenance of the Florida Fish & Wildlife Conservation Commission Reporter (FWC Reporter), a mobile application (app) that the public can use to report fish and wildlife and environmental concerns to appropriate state agency offices. The FWC Reporter, launched in February 2018, is the first comprehensive reporting app developed by a fish and wildlife agency in the United States that we are aware of. On the basis of a consumer concept test and library research, the app's design incorporates elements of fast and frugal heuristics and inductive decision theory. The FWC developed this version of the app in-house with an open-source development package, and involves primarily email and telephone to send reports and facilitate communication with agency staff. From February 2018 through December 31, 2018, the FWC recorded over 1,000 downloads on Android and 4,308 on Apple devices, and 258 emailed reports. Since fish and wildlife reporting apps do not provide clear benefit to the user (low value proposition), it is crucial that offices receiving reports are proactive in building and maintaining their own reporting constituency. Engagement with the public is not only through active recruitment of app users, but also following up after a report is made so that the users know their efforts are appreciated. Two FWC programs demonstrated successful engagement, horseshoe crabs *Limulus polyphemus* and fish kills, as they received the most email reports. Other topics for any conservation or fish and wildlife agency to consider when developing their own reporting mobile app include download intention, adoption, continuance, habit formation, public and organizational acceptance, and marketing.

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Introduction

Fish and wildlife (F&W) agencies are essentially service organizations that provide information, deliver services, and receive information from their constituency. Citizen engagement is important, and much of this is now affected through digital technologies. The public has long acknowledged that mobile devices resolve many of the shortcomings of telephone and fixed internet-based communication because they are carried on person, usable almost anywhere, and have many features, such as cameras and applications (apps), that enhance

information exchange (Sareen et al. 2013). As such, they have become the hardware of choice for people communicating with government, commercial enterprises, and each other (Eom and Kim 2014). Some prominent disciplines where mobile has made significant inroads include education (Wu et al. 2012; Crompton et al. 2016), medicine (Boruff and Storie 2014; Ventola 2014), energy management (Aman et al. 2013), and commerce (Shankar et al. 2016). The number of mobile-device users surpassed the number of fixed internet access users in 2014 (Bosomworth 2015; Ericsson Mobility Report 2016). In the world of social networking, for example, more

than 80% of Facebook's daily users are mobile (Smith 2015) and 70% of its earnings are from mobile devices.

Mobile is altering the way governments deliver services (Sharma and Gupta 2004; Liu and Yuan 2015). Using mobile technology helps governments provide real-time information to agencies and real-time services to citizens, which improves the speed of information transmission (Ishmatova and Obi 2009). In state F&W agencies, adoption of mobile technologies has increased rapidly, especially since 2016 (Ganapati 2015). For example, as of December 2018, all but six F&W agencies now have mobile-friendly main portals and additional mobile apps and mobile web pages that meet Google's standards for mobile friendliness (Ziadeh 2015). Mobile friendliness includes legible font sizes, little need for manual screen resizing by the user, and well-configured screens (i.e., minimal text, consistent arrangements from screen to screen, pictures). Lack of attention to these details can lead to app abandonment by users.

Utilitarian in structure, F&W agency mobile apps fall into two categories. The first is information provision (information out). This includes rules and regulations such as bag limits for fish or game, locations of destinations such as parks and boat ramps, educational pages such as descriptions of life histories of wildlife, and functions such as license purchases. The second category is reporting (information in). This may be simple citizen reporting to the agency such as the calling in of a wildlife violation or more engaged reporting as with a citizen science- or ecologically themed social networking app. Typically, reporting apps are structured as a series of menus of listed organisms and environmental issues that the user works through to arrive at the correct identification or the appropriate office to contact.

As of 2013, of the more than 1 million mobile apps available on each of the Google Play and Apple App stores (as of the first quarter 2019 there are 2.1 million available on Google Play and 1.8 million on the Apple App store [Statista 2018]), a bit more than 6,300 apps were relevant to F&W agencies (Jepson and Ladle 2015). Of these, only 33 had citizen reporting capabilities. Of the 755 recreation-supporting apps, 219 can log sightings. Many citizen participation apps focus on target species (Great Koala Count, Bugs Count, Plant tracker, Leaf-watch). A few enable users to send anonymous tips to law enforcement (CalTIP of California's Department of Fish and Wildlife, Utah Hunting and Fishing of Utah's Division of Wildlife Resources, and Pocket Ranger® of several state F&W agencies). The State of Washington has individual mobile apps and mobile web pages for reporting general wildlife observations, including elk *Cervus canadensis* observations along Highway 20, moose *Alces alces*, mountain goats *Oreamnos americanus*, nonnative species, bats *Eptesicus fuscus*, *Myotis* sp, *Parastrellus hesperus*, *Lasiurus cinereus*, *Antrozous pallidus*, and wolves *Canis lupus*. Florida has a wildlife reporting app oriented toward citizen scientists interested in gopher tortoises *Gopherus polyphemus*. OzAtlas, an Atlas of Living Australia, and the Global Biodiversity Information Facility are apps via which the user's sightings are logged into biodiversity data archives.

In the Florida Fish and Wildlife Conservation Commission (FWC), citizen reports of fish- and wildlife-related issues are made by telephone to a biologist or call center, via email, or by filling out a form on an agency web page. Each method provides valuable public access to agency experts. Phone calls and, to a lesser extent, emails have the advantage of presenting a personal touch, quick action, and the ability of agency representatives to ask the callers questions and request information, such as photographs. Reaching an expert is often limited to 9-to-5 work hours, with the alternatives being to leave a message, to contact law-enforcement dispatch depending on the type of report, or to wait for an email reply. Web sites have the benefit of providing easy access to more comprehensive background information and the opportunity for the citizen to enter data that are inserted into a database automatically. However, the reporting typically occurs when the citizen is no longer at the site of the observation, which can lead to some information becoming imprecise, especially as more time passes (Mazursky 2000; Barrouillet and Camos 2012) or events can occur that can interfere with memory (Brown et al. 2007; Souza and Oberauer 2015). Finally, the intention to report may wane as the citizen becomes more temporally distant from the event (McDermott et al. 2016), particularly if reporting is inconvenient or the strength and stability of the intention to report are low (Sheeran et al. 1999; Conner and Godin 2007).

This paper describes the conceptualization, design, development, and release of the FWC Reporter, a comprehensive mobile app for general reporting for fish- and wildlife-related communications between the FWC and the public. In developing this mobile app, the goals for enhancing conservation and management were to increase the amount and quality of publicly reported information to FWC programs, shorten FWC response time to events such as fish kills while complementing the current web- and telephone-based reporting systems, and providing an additional path for engagement between the public and FWC. For those agencies considering a comprehensive reporting app, the theoretical and design considerations and properties of successful comprehensive fish and wildlife reporting apps are discussed.

Methods

The FWC divided the development and release of the FWC Reporter into three tasks. The first was development of the theoretical foundation for mobile app design and development. The FWC used literature research to compile what is known about the theory of creating, releasing, and usability of mobile apps. It explored apps that had been released by government agencies, especially those from state F&W agencies. Finally, the FWC conducted a consumer concept test, making use of brief interviews with citizens to assess their interest in mobile apps and what they liked and disliked about them.

The second step was design, programming, and testing. On the basis of the literature research and consumer concept test, the FWC applied elements of a user-centered design (Norman 1988). The app's logic, or how the menus were structured and ordered and how inputs were processed, was based on heuristics, which is a primary decision tool used by humans under conditions of uncertainty (Slovic et al. 1977). Also considered was whether the heuristic was ecologically rational (Mousavi et al. 2016). An ecologically rational heuristic is one where the decision algorithm matches the structure of information in the environment, in this case, making a fish or wildlife report while usually engaging in some activity away from the home (Todd and Gigerenzer 2012). The fast and frugal heuristic, which assumes that individuals make decisions with limited information and time, satisfied the need of ecological rationality (Gigerenzer and Goldstein 1996; Marewski and Gigerenzer 2012). Specifically, the FWC applied the fast and frugal heuristic take-the-best (Gigerenzer and Goldstein 1996; Lee et al. 2016) and ordered selections inductively, listing more specific topics at the top of the list and more general ones at the bottom. The inductive ordering allowed for items with the highest recognition signals listed near the top to be seen early in the search. With take-the-best, the user stops searching as soon as a selection discriminates sufficiently to be a valid selection. If no selection discriminates, then the user selects the umbrella option at the bottom of each list. The environmental context (Todd and Gigerenzer 2007) was minimizing intrusion upon the citizen reporter's activity space with a fast and easy reporting sequence. People rely on simple strategies to deal with situations of sparse resources; time, and interest (Simon 1956, 1990). Take-the-best seemed appropriate for this environment, but the FWC also included safeguards in case the user went down an unexpected path in the decision tree. Safeguards included tabs to return to the main menu, use of the backup feature on the device, some items included in more than one menu, and reports almost always ending with the ability to contact FWC.

The FWC engaged all staff and offices that would receive reports from the app throughout app development. Each office specified how it wanted to interact with the FWC Reporters and their staff reviewed the logic-flow diagrams relevant to them that served as the blueprints for the programmer. The app was programmed for the Android operating system first using Appcelerator Studio 4.1 and translated to Apple's iOS after sufficient debugging using Appcelerator Studio 4.4. Appcelerator is an open-source development package for iOS, Android, and Windows Phone. This package was deemed appropriate given the project budget and level of organizational commitment at the start of this project. Testing involved initial debugging by developers, internal testing by FWC staff, and external testing by members of the public. FWC incorporated consideration of usability heuristics into the testing when applicable and generally followed Inostroza et al. (2013, 2016). The FWC Reporter was launched unofficially in February 2017 on Android and iOS to monitor its performance in the mobile ecosystem.

The third step was the outreach marketing plan and official launching of the app. This plan was both in-reach, to get FWC offices and their leadership on board and expand awareness of the app in the agency, and outreach, to get the word out to the public and organizations that might be interested in having their reporting needs included in future releases of the app. This plan involved engaging fishing, hunting, and other clubs focused on outdoor activities, contacting FWC offices that engage the public directly at shows, clinics, and other events, drafting press releases and planned media advisories, designing and distributing a poster for outreach events, promoting the app on web pages, and staggered releases on social media including Facebook, Instagram, Twitter, Snapchat, and Flickr. The FWC Reporter was launched officially in February 2018 with an accompanying press release.

Results

Consumer concept test

The FWC interviewed 24 individuals at the Florida Sportsman Show in Tampa September 13 and 14, 2013. The objective was to understand people's expectations when it came to downloading and using a mobile app. Nineteen subjects were male and five were female. Nine were under 35 years of age, four between 36 and 45, five between 46 and 55, and six 56 or older. All lived in Florida, with two less than 10 y, five between 11 and 20 y, six between 21 and 30 y, and six more than 30 y. Sixteen had at least a smartphone, nine had a tablet, two had a cell phone, and eight had a computer. Only five of the subjects noted that they belonged to any recreational or conservation-based organization.

Eleven had reported fish and wildlife concerns to FWC in the past, and 24 thought that having a fish and wildlife reporting app on their phone or tablet was a good idea. The reasons given were that making a report would be faster (8), convenient (14), and that they could send pictures (2). When asked if they would take photographs if prompted to do so, 21 answered yes and 1 answered no.

Key features of a successful mobile app mentioned in the responses included easy navigation (13), fast operation (8), the ability to send images (4), and the fact that the users' phones were always present (6). Nobody had concerns with providing global positioning system (GPS) coordinates from their phone, and 20 had no concerns with providing personal information (name, email, cell phone number). One subject had concerns regarding the inconvenience of typing in GPS coordinates, one had concerns with providing personal contact information because he or she works on projects with FWC, and two may have concerns about providing personal information, but these were not specified.

Structure of the FWC Reporter and logic flow

The FWC Reporter processes 46 reporting scenarios (Figure S1, *Supplemental Material*). Making a report involves two to four steps. Step one involves two or three menus that guide the user to the proper reporting destination, either the data menu or the contact-by-telephone menu. The FWC Reporter keeps list items short, predominantly one to four words (a few had up to seven words) and writes them in layman's English. One exception is the menu item, "invertebrates." This item provides an option to display a description of the word.

Step two either presents telephone contacts for those reports that do not collect data or displays a data collection screen. Minimal data are collected: date, time, GPS location, an option to take a picture, an option to type in additional information, and an option to include personal contact information. Two data screens allow for the recording of video. Information collected on the data screen is incorporated into the body of an email message that is then sent to the appropriate electronic mailboxes. Images and video are email attachments, although the user can also embed the image into the email body. The email is then sent using the device's native email tool.

For those reports that had data collected, step three displays telephone contacts, so the user can call the appropriate office if desired. If the user contacts the office that received the report while at the location of the observation, the FWC biologist can discuss the case with the citizen reporter and request more information in real time. Final identifications are made by FWC staff on the basis of the images, video, and data sent by the user. One reporting scenario, gopher tortoise, is directed from the FWC Reporter to an external gopher tortoise citizen science mobile app to complete the report. Two other reporting scenarios, panther (*Puma concolor coryi*) and bear (*Ursus americanus floridanus*) sightings, are redirected to mobile web pages where the data entered onto the form are inserted directly into their respective sighting databases.

The last step for all reports is to exit the app. Reports falling outside normal business hours, 9-5, are handled either by emails or phone messages that are addressed the next business day, phone calls to on-call hotlines, law enforcement dispatch, after-hours phone number alternatives, or data entry via mobile web pages. Overall, application of a heuristics model led to a mobile app whose outcomes are simple, rational, and efficient (Scheibehenne et al. 2007; Neth et al. 2014; Neth and Gigerenzer 2015). Comments by FWC staff and some members of the public during testing supported this strategy.

Usage

The FWC officially launched the FWC Reporter on February 17, 2018. The app had over 1,000 downloads on Android and 4,308 first-time downloads on Apple as of December 31, 2018. The email reports received by FWC are summarized in Table 1. Four reviews, all five stars, are on the Google Play Store and four reviews that averaged four stars are on the Apple store. Most reports included images and GPS coordinates.

User comments are summarized on Table 2. The comments fell into four categories. The first includes compliments and issues that users had. The second was advice and offers to help. The third was users who used the comment tool in the mobile app to make a report instead of using the app as it was designed. The fourth was users following up on their report. The FWC followed up on all comments and in many instances email conversations and some phone calls took place. The FWC stresses that offices receiving reports engage the public and thank them for taking the time or answering questions. The FWC referred several reports' comments to law enforcement.

Maintenance plan

The FWC Reporter is maintained in house, where FWC programmers fix problems and make enhancements as needed. The staff makes edits and updates, and upload upgrades to the mobile app stores. Users of the FWC Reporter are then notified that an update is available for download. Initially, the staff made updates approximately every 6 mo to 1 y depending on need, and will likely shift to an annual update schedule.

Discussion

The FWC Reporter is a comprehensive, utilitarian, niche mobile app designed for a broad user base. The target user is a Florida resident or visitor who is familiar with mobile devices and their apps. The FWC Reporter provides value in addition to simply serving as an alternative pipeline for communicating with FWC. First, by receiving images in an email, staff scientists can work in real time with citizens to identify a plant or animal or resolve a problem. Improved efficiency, more and better reports, more certain identifications, and fewer communications from citizens reaching the wrong office should reduce costs of processing such information, improve customer satisfaction, and result in high continuance intention (Hsiao et al. 2016; Wang and Chen 2016). Second, although the FWC Reporter may not support statistically defensible sampling, it does serve a surveillance purpose, especially regarding suspected exotics not previously observed in an area (Delacour-Estrella et al. 2014; Chandler et al. 2017) or phenologies or home ranges altered by climate change (August et al. 2015). Finally, a reporting mobile app facilitates the ability of the public to engage with their fish and wildlife conservation agency. Engagement leads to improved public understanding and increased interest in issues relevant to conservation and proenvironmental behaviors (Johansson, Rahm and Gyllin 2013; Palacin-Silva et al. 2016).

The mobile ecosystem, of which the FWC Reporter is a part, is expanding rapidly as users shift from desktop and laptop computers and their associated anchored web pages to mobile devices, their affiliated apps, and mobile

Table 1. Summary of reports made in Florida by the public using the Florida Fish & Wildlife Conservation Commission (FWC) Reporter mobile application (app) since the February 17, 2018 launch. NA = reporting categories that were not available in the app during the time period.

	February 17–June 30	July 1–December 31
Total reports	165	93
Reports with images attached	63	43
Reports with images embedded	37	13
Reports with global positioning system included	84	50
Emailed reporting categories		
Fish kill	24	34
Abnormal fish (wounds, parasites, etc.)	2	3
Abnormal invertebrate (wounds, parasites, etc.)	0	1
Water discoloration/debris	3	14
Pollution/dumping	1	0
Tag on fish	NA	1
Sawfish *Pristis pectinata*	1	0
Goliath Grouper *Epinephelus itajara*	NA	0
Suspected nonnative (animal or plant)	26	10
Horseshoe crabs *Limulus polyphemus*	73	9
Coral reef (damage, algae, pollution, etc.)	NA	0
Scallop harvest *Argopecten irradians*	NA	0
Birds: dead or dying	2	1
Cranes/kestrels/burrowing owls *Grus canadensis, Grus americana, Falco sparverius paulus, Athene cunicularia*	NA	3
Bats: dead or dying *Chiroptera* sp.	0	1
Turtles or tortoises *Clemmys guttata, Pseudemys suwanniensis, Apalone ferox, Gopherus polyphemus*	NA	0
Rare snake (amphibians/reptiles)	9	4
Dead or sick deer *Odocoileus virginianus*	5	1
Regulatory sign (damaged or missing)	9	3
Other reports sent as comments[a]		
Derelict vessel	2	0
Wildlife violation (poaching, harassment, etc.)	0	1
Dead sea turtle *Caretta caretta, Chelonia mydas, Dermochelys coriacea, Lepidochelys kempi, Eretmochelys imbricata*	0	1
Dead manatee *Trichechus manatus*	0	1

[a] These reports were made by the user in the FWC Reporter's commenting function, not in the path designed for the respective reports. Each of these only had the option to telephone the agency to make the report.

web pages. Any government agency that receives reports from the public and is interested in building and launching a reporting mobile app will have to navigate this ecosystem to achieve their objective of creating a following and receiving reports. In the discussion that follows, I explore the challenges associated with building and launching a successful reporting mobile app.

Creating a following

Most mobile apps fail to develop a sustainable user base. Hence, designing and marketing a fish and wildlife reporting mobile app so that it becomes part of an individual's portfolio of apps requires a profound understanding of the mobile ecosystem. Fundamentally, a successful mobile app is about usability. Usability includes several attributes such as context, effectiveness, efficiency, satisfaction, cognitive load, learnability, and memorability (Harrison et al. 2013). The FWC considered all of these usability attributes in the design of the FWC Reporter. The mobile app had to respect the activities in which the user was engaging, as well as context and effectiveness by being minimally intrusive. Reports

needed to be completed quickly and efficiently; the app had to be easy to learn. As for learnability (Flood et al. 2013), it had to require little thought during use, have minimal cognitive load, and offer ease in recalling how to use it after a long lapse between reports; for memorability, it had to provide satisfaction upon the completion of a report, with expression of appreciation for a user's effort. These development considerations led to a simple mobile app that has a consistent look and feel throughout and, when possible, burdens the user with no more than four menus before he or she reaches the data-collection screen.

There has been a tremendous amount of theory development and study regarding intention, adoption, continuance, habit formation, and marketing and in the psychology and behavior relevant to technology and use of mobile apps. The technology acceptance model, technology acceptance model 2, the unified theory of acceptance and use of technology, expectation confirmation theory, theory of consumption values regarding perceived value, expectation confirmation theory, service science theory, and others all reflect similar processes,

Table 2. Summary of comments sent by Florida users of the Florida Fish & Wildlife Conservation Commission (FWC) Reporter mobile application (app) from the launch date of February 17, 2018 through December 31, 2018. Comments were sent by the public using a commenting tool in the FWC Reporter, not one from a Google or Apple Mobile app store. Receiving comments in this manner allowed staff to respond quickly to questions and concerns and directly engage their reporting constituency.

Date	Comments
Compliments, questions, issues	
February 19	Love the app, great idea. Will definitely use. Keep up the great work! 👍
February 27	Just saw this app and downloaded it. If it works like I hope it should help in many areas of the outdoors. Good Luck
March 9	The app was very easy to use
April 16	Pretty cool. Thank you
May 12	Hard to record consecutive reports. Option to send more than one photo for single report? Automatic quit to program after sending report with option to comment prior to quitting?
June 4	No exit on iPhone 6 Plus as well as ipad
July 7	How do I text a report?
September 8	App kicked me out when I tried to take picture of debris Don "On an iphone8 thanks for taking the time to let me know, I honestly was not expecting any feedback
September 23	You all are so asinine I could do a better job with my full time kayak tour guiding job. You allow people to keep undersized fish as well know fishing spots they frequent. How hard is it to patrol frequently fished spots. (Let me break it down more simple for y'all) bridges where all the Cubans and Hispanic families are. How hard is it to use your government funding to stop this. PUT MY TAX DOLLARS TO WORK
October 4	I took multiple photos but app only allowed one to submit.
Advice and help	
February 19	Thanks for making this app available! Your casual user would be more likely to file a report if the initial fields (name, phone, email, etc.) could be auto-filled using the information stored in the iOS system, as is the case for some other apps.
February 28	I was wanting to review the app
April 19	Take me off your contact list. I have moved up north.
August 1	I see some interesting things when I am birding and around my property and will share them with you.
August 10	Testing from husband's iPhone. Selected "no" for "are you in location where owl was seen" Would be nice to have time and date as separate entry boxes. Difficult to maintain consistent formatting in current version. Is there a way to save the observer info (name, email, and phone) within the app so they don't need to type that every time a report is submitted? The "review our app" button is still present after the review email is submitted. It would be better to have a different screen view after submitting the form. Is it possible to have a button for "submit another report" after the submission email screen? Could the second report have all the user info auto-filled? There is an awkward delay between hitting the "submit report" button and the submission email pop up screen. During this pause I see the screen with the "review our app" button. Also, after submitting it would be nice to have a "return to main menu" or "return to home" option. Otherwise I want to hit the back button. Not intuitive to close the app on the post submission screen.
Used app's comment tool to report	
March 30	I believe I saw a dead panther on I-10 about a quarter of a mile east of mile marker 217 on the west bound side. It was next to the guard rail in the median.
April 2	A local business owner and resident of Marco Island, Collier Co, posted on Facebook yesterday that he used his endoscope to scope a gopher tortoise burrow on Marco Island. He posted the statement saying this action and a photo of a tortoise inside a burrow. His business is <name>
April 10	<name> Fishing Charters with Captain <name> Just posted photos of himself and an over 40″ tarpon (appears so in photo) he has fully out of the water just for a photo opportunity on his Facebook page. Look at the measuring device in the bottom of the photo. thought this was illegal.
April 27	just downloaded to report desd 10 inch sea turtle on beach 100 yards north of service club beach venice sarasota county found impossible to do got dispatch twice pls report this for me and fix the app hard to find where to report.
May 5	Today (May 5 at 3:00pm) I saw a dolphin in lake Monroe south side west of the Monroe canal. I thought it was unusual
May 7	I have information of what I consider poaching on a regular basis in fact they disregard all laws for their own benefit personally witnessed numerous violations this is a big one you guys don't want to pass up
May 21	Whole Stone crab under the John ringling bridge in Sarasota next to hearts landing bait shop
July 16	Saw two Manatees feeding along Ponce Inlet Jetty
August 21	Hi, this dead turtle is located just north of the blue lifeguard stand on Siesta Key. It's shell is approximately 20 wide X 22 long
September 26	Two men poaching a bear with compound bow on arbutus and state road 50 in weeki wachee river estates
November 6	A facebook friend posted this on facebook tonight. I know my email is on this but I would like to report anonymously.
Agency follow-up	
May 2	Hello, Just checking if there was any FWC LE action on this report? Thank you, (from April 12 report)

but largely in the context of accepting new technologies (Oliver 1977, 1980; Davis 1989; Sheth et al. 1991; Venkatesh and Davis 2000; Bhattacherjee 2001; Legris et al. 2003; Chou et al. 2013; Lee and Chen 2014; Wang 2014; Islam et al. 2017). To compress these models and theories into a single applied context for launching a successful F&W reporting app, ensuring that the app meets users' expectations in terms of value and ease of use greatly improves chances for continuance and for habit formation in its use.

Download intention, first-time use, and adoption

Successful formation of download intention can lead a prospective user to visit the mobile app's page at the app store, browse users' comments (Huang and Korfiatis 2015), and form perceptions of usefulness and ease of use (Davis 1989). Perceptions of usefulness and ease of use are two direct determinants of a prospect's intention to use a mobile app (Venkatesh and Davis 2000). Depending on the prospective users' interest in the app, personality type, state of mind during the visit to the app store, and a little luck, the outcome is a download (Huang et al. 2013; Bhandari et al. 2016).

Developing a strategy for creating download intention among your target markets depends on what type of mobile app is being pushed. Hedonic apps tend to stress experiential attributes, whereas utilitarian apps, such as the FWC Reporter, focus on completing pragmatic and practical tasks (Ahmad 2012). Hedonic and common problem-solving apps, such as direction finders, are often searched for on app stores when desire or need are to be satisfied. Fish and wildlife reporting apps tend to represent a niche market that serves a smaller, more directed user base that is unlikely to browse an app store for such an app.

Digitally based recommender systems (Resnick and Varian 1997) will likely have little effect on downloads because they are too passive and too imprecise for a fish and wildlife reporting mobile app. Recommender systems track user behavior, such as app downloads, or properties of downloads, such as foreign language apps, for example, to make recommendations to the user for additional downloads. Push marketing, however, through direct promotion by the agency and by peer-to-peer diffusion by word of mouth (Rogers 2003), especially by trusted messengers, would more likely succeed as a fish and wildlife reporting mobile app's predominant recommender system. Some examples of direct agency promotion are: 1) a presence at outdoor events such as boat and fishing shows; 2) open houses; 3) need-based promotions that target specific users, such as hunters who are concerned about and would likely report instances of deer wasting disease; and 4) any outreach having direct contact with the public. Interest can also be spurred by inclusion of the app stores' links in press releases and on web pages for agencies and nongovernmental organizations, outdoor-oriented clubs and organizations, and neighborhood associations.

Through the push-marketing efforts described above and word of mouth, it is expected that many users will have some familiarity with the FWC Reporter before they make their first report. Any users who download the FWC Reporter because they became aware through press releases or websites will be first-time users without familiarity. In both cases, but more so with those having no familiarity, knowing what to report and then navigating the FWC Reporter to make the report will be new and will take some guesswork. Too many wrong guesses can lead the user to abandon the app. The FWC expects the heuristic strategies of induction and fast and frugal to minimize abandonment due to guesswork.

Care should be taken to avoid dead ends, in which there is no destination for what the user wants to report. They can lead to user frustration due to the inability to close the report and increase the likelihood of app abandonment. The FWC Reporter is designed to have no dead ends; unspecified reporting categories are directed to regional call centers where they are redirected to the appropriate office if necessary.

Continuance and habit formation

Achieving continuance and habit formation with a large segment of its target market is the true measure of success for any mobile app (Parthasarathy and Bhattacherjee 1998; Shih and Venkatesh 2004; Limayem et al. 2007). Continuance, the state of the app remaining on the device and in use, depends on its meeting expectations of perceived value during first-time use (Karahanna et al. 1999). Habit formation develops from frequent use and usefulness concluded from action–outcome associations (Oliver, 1980; Sheth et al. 1991; Aarts et al. 1997; Ouellette and Wood 1998; Venkatesh et al. 2003; Limayem et al. 2007; Fang and Fang 2016; Lingawi et al. 2016).

For a comprehensive F&W reporting app, meeting user expectations in terms of perceived value and ease of use is more likely if operation of the app is broadly intuitive and no user manual is needed (Prensky 2001). This means an app with plain language, brief menu items, short menu lists, minimal number of menus, and simple data entry. Ignoring these design attributes can increase the likelihood of a reporting failure and discourage future attempts at reporting (Bagozzi and Washaw 1992). Research in technology adoption found similar outcomes (Davis et al. 1989; Thompson et al. 1991, 1994; Agarwal and Prasad 1997, 1998; Venkatesh et al. 2003). If first-time use is successful, then, as users gain experience with a system, the cognitive effort needed to deal with less intuitive reporting scenarios is reduced (Thorngate 1976; Gatignon and Robertson 1985; Limayem and Cheung 2008). Finally, a key for continuance is how easy it is for the user to update the app. Any stumbles in this process can lead to abandonment and a poor rating in the users' comments section in the app stores.

Factors besides design attributes that can increase the likelihood of continuance include comprehensiveness, voluntariness, value proposition, customer engagement, and brand and trust. Comprehensiveness of usage refers to having all of an organization's citizen reporting needs encompassed by one mobile app. A single comprehensive app can increase the likelihood of continuance because one app that addresses all reporting needs is easier to recall than many apps where each handle one or a few kinds of reports. Also, the single reporting app will take up less storage space on the user's device than many similar mobile apps. Having stable context where all reports have a similar look and feel will facilitate

performing repeated behaviors with little cognitive input (Wood et al. 2002). Even if the user has not made a specific report before, there will be little uncertainty in performing the task because it will be like reports completed in the past.

Success of the FWC Reporter depends on citizens volunteering their time to complete a report. Although some app users, such as anglers, hunters, or hikers, may report because of a sense of obligation as resource users, reporting is truly a voluntary exercise that must be considered in the design and management of a reporting app (Hyman 2013; Ballard et al. 2015). Other factors that can influence voluntariness include subjective norms or social influence and self efficacy regarding fish and wildlife management (Venkatesh et al. 2003, 2012).

Value proposition (VP; Homans 1974) and, similarly, perceived value (Zeithaml 1988), are understandings of the real and perceived benefits to be received from a product relative to costs. Commercial mobile apps tend to provide users with high VP through entertainment such as games; needed information such as directions, prices, ratings, availability, purchasing, etc.; and social networking. Many state government-sponsored mobile apps also have a high VP, such as navigating government offices, finding needed information, contact information, maps, conducting business, news, etc. F&W agencies have a predominance of high VP such as those supporting hunting and fishing and the Parks & Forests Guide apps by Pocket Ranger®.

The VP for a fish and wildlife reporting app is less obvious. There is clear value to the agency or a nongovernmental organization because information is provided by the public at little cost. For the public, the value is often indirect or may not provide immediate return. Certainly, the rescue of a trapped or injured animal through use of the app or the identification of a plant or animal creates satisfaction. Satisfaction is particularly high if using the app addresses self-concordance goals related to conservation, animal welfare, and environmental protection (Sheldon and Elliot 1999; Werner et al. 2016). In other cases, users benefit intrinsically by volunteering their time because they are interested in Florida's ecology, have questions about a species or event, or have concerns about the welfare of an animal. Fortunately, F&W agencies do have a broad constituency willing to participate in their mission, so enhancing the manner in which the public interacts with the agency does have value.

Since government agencies are service providers, I suggest that agencies' engagement with their customer base be a core element of their business plan. In addition, I believe that users of a mobile app that help an agency do its job need to know that their volunteer efforts are valued. Hence, I contend that agencies must remain engaged with their constituency. The FWC Reporter accomplishes this by having an active maintenance system, some reports sent via email, final

identification conducted by a wildlife professional rather than the user of the app, providing the opportunity for users to call the appropriate experts, reducing the number of telephone call redirections or dropped calls, sending emails to agency staff that could lead to dialogue between the citizen and the scientist regarding the report, and an opportunity for users to comment as an email directly in the app. A similar, but less comprehensive, example is the Asylum Lake Preserve mobile app for Android devices (Ebenstein 2015).

According to Hinde (1995), "Relationships involve reciprocal exchange between active and interdependent relationship partners; are purposive, involving at their core the provision of meanings to the persons who engage them; are multiplex phenomena: they range across several dimensions and take many forms, providing a range of possible benefits for their participants; and are process phenomena: they evolve and change over a series of interactions and in response to fluctuations in the contextual environment." In a mobile app, relationship building, as discussed by Hinde, can be supported by incorporating tools that allow the user to include contact information and have users comment about the app directly with agency staff. Real-time commenting can take advantage of the user's attention to the app just after completing a report. By having users send comments directly to FWC, in addition to the app stores, inclusivity is encouraged in the design of this digital service. Community participation is becoming more common in the design of mobile technologies (Garbett et al. 2016).

One outcome of engaging successfully with users is developing and managing a trusted customer–brand relationship (Schmitt 1999; Peng et al. 2014). On the brand side is the relationship between the agency (FWC) and the app (FWC Reporter). Engaging this relationship inside the agency is necessary for successful engagement between the customers, the agency, and the mobile app. Trust and loyalty in the customer–brand relationship is founded partly on customer engagement (So et al. 2016) but also on perceived value and satisfaction with the product (Fornell et al. 1996; Cronin et al. 2000; Venkatesh and Davis 2000; Bardhan et al. 2010; Wang 2014). Aside from trust in the agency producing the app, trusted messengers, typically from key constituencies, via word of mouth are also key to preserving a trusted brand (Oliver 1980; Ouellette and Wood 1998; Venkatesh et al. 2003; Limayem et al. 2007; Fang and Fang 2016).

Once a degree of certainty regarding continuance has been reached or a behavior is being repeated regularly, habits may be formed. Instrumental conditioning, or the reinforcement or punishment that influences the likelihood of a behavior's occurring again, controls the action–outcome association (Lingawi et al. 2016). Key to habit formation for reporting via the FWC Reporter is linking situational stimuli (an injured animal or suspected exotic) to activating the app and completing the report.

This link is established both by the knowledge of the instrumental contingency between action and outcome and by how users value that outcome (Lingawi et al. 2016). This value may not be only a perceived value—a report was sent to the agency and it will act as expected—but also through demonstrated value—the agency engages reporters and shows appreciation for their effort or provides information on the outcome of their action (Odekerken-Schroder et al. 2003; Alender 2015; Reamon 2016).

Innovation, organizational risk, hesitation, and commitment

The in-house development, release, and maintenance of a comprehensive F&W reporting mobile app represents an innovation for a F&W agency. As with any government agency, innovations do not come without risks (Aloini et al. 2007). Risks arise from technical capacity, public acceptance, organizational staff acceptance, and organizational leadership acceptance (Vrhovec et al. 2015; Chiu et al. 2017) and are associated with the fact that people are inherently resistant to change (Bovey and Hede 2001; Dobni and Klassen 2015).

Technical capacity is simply whether an organization has the facilities and expertise to develop a mobile app. Software projects are risky because of the rapid pace of technological evolution and changes they may mean for the organization (Cule et al. 2000; Hong and Kim 2002; Aloini et al. 2007; Bannerman 2008; Kwahk and Kim 2008; Altuwaijri and Khorsheed 2012). Development of the FWC Reporter had the minimal capacity for success, which included initial grant funding to support development and release, supplemental funding to continue the project after initial funds had been exhausted, a programmer who could program a mobile app (as opposed to a trained mobile app programmer), open-source development software, both Android and development platforms, and an ample supply of Android and Apple devices for testing.

Risk of public acceptance is reduced through adoption and continuance as discussed. The remaining uncertainty lies in obtaining acceptance by staff and leadership. Organizations might find it difficult to operationalize a multiuse mobile app that services all relevant offices in an agency (Ram 1987). Introducing new technologies or new ways of engaging the public can be seen as disruptive by some (Zaltman and Duncan 1977). Change can create anxiety, and anxiety creates barriers to successful adoption in an organization (Schein 1993). Agency acceptance may have to achieve universality before the project can be broadly introduced and promoted to its target market. For example, 50% of organizations encountered employee resistance when new technology was introduced (Venkatesh et al. 2003).

Hesitation during the development and release of the FWC Reporter was clearly present. It arose largely from the misunderstanding that the FWC Reporter would replace existing pipelines connecting the public with FWC, as opposed to the app being simply an additional agency access point. Concerns were abated in several ways. First, much of the funding had come from a grant that had lessened the need to apply existing funds to the project. Salaries of the programmer and in-reach and outreach coordinator were paid almost entirely from these grant funds, which also temporarily eased the pressure to find monies for retaining other staff.

Second, all staff and offices that would receive reports from the mobile app were engaged throughout app development. In almost all cases, their preferences were incorporated into the app. Staff turnover, especially in supervisory positions, often resulted in requests for changes in the app design, and, if possible, some were made. In addition, a few reporting offices that were less engaged during development got more involved after the app was officially launched. Their requested alterations were addressed and included in a subsequent release of the app.

Third, release to the public did not take place until high-level administrators throughout the agency were comfortable with the mobile app. I believe that hesitance arose because upper management, probably due to higher-level responsibilities, was largely unaware of the project during development. Misgivings arose once the news of imminent launch traveled up the chain of command. Concerns were addressed satisfactorily over time through presentations, a webinar, personal communications, and the support by one high-level administrator who became a key point of contact in resolving concerns of other high-level administrators (Soliman and Janz 2004; Lin 2014). Targeting leadership for education about the technologies and its implications earlier in the project life cycle should reduce organizational uncertainties and enable smooth launch of the app.

In-house development vs. contract

An important decision for any mobile app project is whether to build and maintain the app in house or to outsource the work (Park et al. 2014). Advantages for outsourcing include contracting with a business where mobile app programming is a core activity, rapid development, and, for complex apps, having a team of experienced programmers available. Disadvantages include some loss of control over development, uncertainties with vendor selection, and less flexibility in making changes as the project evolves.

A single FWC staff person programmed the FWC Reporter. Since this was the first native mobile app FWC had programmed within the agency, resources and expertise were limited in terms of the number of staff with app development experience, access to different kinds of devices and operating systems, and experience with different developer-software tool kits. However, programming in house made development more flexible and responsive to the different offices that would receive reports from it and greatly enabled the app to expand its reporting capabilities without having to amend contracts

or seek additional funding (Fulcher et al. 2013). Furthermore, the reporting mobile app was conceptually simple, with few features, and with consistent menus throughout.

Developing the app in house also motivated an agency assessment of future mobile app development. The outcome was a commitment to developing the capacity to build and maintain apps, including hiring programmers, creating development standards, and enabling interactions within and outside of the agency. Several mobile apps and mobile web pages have been developed by FWC programmers and launched since the decision was made to develop apps in house (a reprogramed gopher tortoise citizen science app and a Fish|Hunt FL app, for example).

Future directions

A mobile app can enhance an organization's ability to reach its prime target market. This target market typically includes resident and visiting outdoor enthusiasts and other citizens wanting a simple method of reporting environmental concerns to the proper authorities.

The FWC Reporter provides an additional link between the public and agency staff alongside traditional telephone calls, emails, web pages, and public meetings. A reporting app will likely require an alteration to an agency's engagement strategy because 1) existing informational resources may not be mobile optimized, 2) some agency administrators may have the perception that this additional pipeline to agency staff will overburden resources dedicated to responding to the public, and 3) a commitment by the agency to maintain the app is required.

In the mobile-device world, there is significant attention to expanding the capabilities of apps. These include crowdsourcing, data integration and sharing, permissions and privacy (Baarslag et al. 2016), interapp services, data aggregators, security, and social networking. What capabilities will make sense for a fish and wildlife reporting app will depend on the state of the market and the goals of the agencies. The basic tenets still apply: fast and frugal filtering, inductive reasoning, and user–agency engagement. One can expect improvements that simplify use of the app and increase the number of images collected and sent, longer and bigger video files that can be delivered from the device to the appropriate destination, audio or transcribed audio files that simplify descriptions made by the user, and more autopopulating of data fields.

Although use of mobile apps is expanding rapidly in government, management of the technology is still maturing. For example, the awareness that an organization can build and maintain too many mobile apps is still winding its way through government agencies (van Velsen et al. 2013). This awareness has motivated increased consolidation across offices, departments, agencies, and jurisdictions for those mobile apps having a similar function, such as reporting potholes in city streets, into a single app (Costello 2011). Some development considerations have been settled, such as keeping the mobile app simple and quick to use (Venkatesh et al. 2003) and having apps include enhanced reporting capabilities such as GPS and picture taking. The FWC applied all of these considerations in the FWC Reporter: a single app, designed to be simple and fast, that handles all public reporting for the FWC.

Supplemental Materials

Please note: The *Journal of Fish and Wildlife Management* is not responsible for the content or functionality of any supplemental material. Queries should be directed to the corresponding author for the article.

Figure S1. Diagrams illustrating the logic for the 46 types of reports included in the Florida Fish and Wildlife Conservation Commission Reporter mobile application (app). (**a**) Welcome screen. This screen displays after the user launches the app on his or her device. (**b**) Main menu. This menu contains the initial selection the user will make. (**c**). Selections if the user selects "Fish or fish kill, abnormal fish" on menu (b). (**d**). Selections if the user selects "Invertebrate (fresh or salt water)" on menu (b). (**e**). Selections if the user selects "Birds and bats" on menu (b). (**f**). Selections if the user selects "Birds: Live sighting" on menu (e). (**g**). Selections if the user selects "All other animal or plant reports" on menu (b). (**h**). Selections if the user selects "Something else/non-animal or plant" on menu (b).

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