

The Role of Social Media in Enhancing Environmental Awareness through Citizen Science

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Introduction

“Citizen scientists benefit from knowing they’ve helped advance scientific research and knowledge in a field they are passionate about. Plus, they get to be part of the thrill of discovery” (Toerpe, 2013, para. 13)

The introduction of social media has changed the world. Globally, people have immediate access to information and can instantly connect with businesses, access academic information and talk with other people thousands of miles away, all in a matter of seconds and for essentially no cost. Organizations have changed the way they pursue their goals and initiatives from a ‘push strategy’ to an ‘interested in’ strategy by creating small, localized groups and organizations that draw people of interest in, rather than begging for them to join and contribute (Malta Environment and Planning Authority, n.d.). The global introduction of social media has increased environmental awareness by having online classrooms, using various social media networks as interactive and learning tools and creating an online database for people to share their thoughts, photos and videos.

Environmental agencies can take advantage of the widespread use of social media to gather and collect data from citizen scientists around the world. Citizen scientists are “public volunteers assisting scientists in their research by submitting data, sharing experiences or spreading valuable information” (National Wildlife Federation, 2009, para. 4). Having instantly-communicated information through smartphone technology can help environmental agencies gather information such as photos, gender, size, shape and coordinates of species under question that could help solve or contribute to sustainability initiatives and foster environmental awareness.

Facebook is the most popular free social networking site in the world having 900,000,000 users, with Twitter being the second most popular with 310,000,000 users (eBizMBA, 2015). Among these users are current and potential citizen scientists who

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could use these social networking sites to contribute to an online database of information which would allow environmental researchers to access this information quickly, efficiently and free of charge.

Collecting field data requires gathering information from multiple groups or communities located in different locations and geographical areas (Ontario Human Rights Commission, n.d.). Time and energy is required to produce sufficient and accurate data through citizen science, which can create problems because of tedious and difficult tasks such as counting and measuring. David, Corinne and Sperling (2007) explain “the utilization of citizen scientists could face issues concerning the endurance of citizen scientists’ patience” (p.7). A solution to these problems is using social media as a database to compile information from citizen scientists in the field which can eliminate concerns of timely data collection because social networking has become increasingly popular among all ages over the years and is widely accessible in most geographical areas (Kapow Software, n.d.). With access to cellular service in most regions of the world, social media can be accessed in remote and unique locations which are valuable for research purposes. The use of a smart phone with cellular service, built-in camera and GPS are the tools that are needed to successfully use social media networks and to communicate information instantly to an online database for public and scientific use.

The easy accessibility of social media networks can provide important collections of data, including information on invasive species. Citizen scientists can take advantage of Twitter, Facebook and other social networking sites to provide scientists with specific information about invasive alien species like the green crab. The green crab has become one of the 100 worst alien invasive species in the world (Fisheries and Oceans Canada, 2013). On the East coast of Canada, the Atlantic provinces have seen an increase in the number of green crabs since they were first recorded in 2003 (Fisheries and Oceans Canada, 2013). Social media networks can equip citizen scientists with the tools they need to easily provide information on green crab for multiple research purposes.

Green crabs feed on clams, oysters, other crabs, isopods, barnacles and algae and severely impact mussels and cockles (Holmes, 2001, para. 31). Green crabs eat almost anything and have virtually no predators, which is why there is a desperate need for intervention to save the biological ecosystem and some threatened fisheries. Fisheries are an important aspect of a community because they significantly contribute to food security, income, and economic welfare (NEPAD, 2008, para.1). This research paper will explore the positive impacts of citizen science and how citizen science can be improved by more effectively using social media to gather and display information of green crab in Canadian waters. The use of social media by citizen science can aid in increasing awareness of green crab and protection of ecosystems for future generations. Researchers can use information collected to see the abundance and distribution of the species under investigation in an effort to create a more effective management plan.

This paper will also explore two online interactive websites including The Ecological Monitoring and Assessment Network (EMAN) of Environment Canada and NLNature. EMAN provides funding on four subjects for citizen science education and observation through the NatureWatch program, but does not include monitoring of green crab (Canadian Museum of Nature, 2014). This paper will also explore the Newfoundland Nature (NLNature) website which is an interactive database that allows citizen scientists to submit information on wildlife and other environmental phenomena

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through social networking sites. One of the drawbacks of NLNature is that invasive species like the green crab have not been submitted or emphasized in importance. While these two programs have important merits, neither website is designed to realize the benefits of incorporating social media, especially in efforts to combat invasive alien species. It is recommended that NatureWatch and NLNature need to reassess their programs so that funding is provided to citizens for observation and education through citizen science to monitor invasive species through social media networks so that more accurate and in-depth data for environmental research is available. This paper will also explore strategies, which have been employed in other contexts to help improve the quality of citizen science. For instance, to provide increased knowledge and accuracy of citizen science, the National Ocean and Atmospheric Administration (NOAA) has created educational grant opportunities to enrich citizen science in various environmental fields across 30 states in the United States (NOAA, n.d.). Canada would benefit if a program like this was established and it would contribute to a better understanding and monitoring of invasive species like the green crab.

Methods

The current research will employ a case study approach to provide an in-depth look at how social media can advance citizen science. Case studies are “a form of qualitative descriptive research that is used to look at individuals, a small group, or a group as a whole” (Colostate Education, 2015, para.1). In the past, case studies have proven that using social media can provide easier and more accessible ways for citizen scientists to contribute to environmental research, focusing on invasive species.

I will present case studies on Canada’s NatureWatch Program and Memorial University’s NLNature program. I will also explain NOAA’s National Sea Grant College Program (NSGCP)’s positive and negative aspects regarding efforts to enhance environmental awareness in the United States and how Canada could benefit from a similar program. These two case studies were chosen for this study because they are regularly used by the public both provincially and nationwide, and they are both lacking in strong social networking strategies. To achieve this in-depth understanding and to help liberate these findings, an in-depth review of relevant literature has been performed.

Social media is an important tool in creating environmental awareness. Canada’s Nature Watch Program demonstrates how using mobile applications that provide instructions for identifying species and mapping can increase public participation which is applicable to all age groups in citizen science (Nature Watch, 2015). NLNature also demonstrates how using an interactive website for submitting sightings using a smartphone can be easily available to all age groups and can aid in the understanding of our natural environment. To further citizen scientists’ participation and understanding of our natural environment in Canada specifically invasive species like the green crab, a program like the NSGCP should be established in Canada and it should provide age-friendly mobile applications for citizen science participation because social media has huge potential to create environmental awareness and sustainability, which could provide environmental researchers with important information about the devastating impacts of invasive species in Canada such as the green crab.

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Social Media 1.0

1.1 The Beginnings of Social Media

Since the beginning of our species, humans have relied on communication strategies to interact with friends and family, and to strengthen relationships. The earliest forms of communication across large distances were written letters delivered by hand from one person to the other dating back to 550 B.C. (Small Business Trends, 2013). In the 1700s, the telegraph was invented which allowed messages to be delivered over a long distance faster than people delivering letters on foot (Small Business Trends, 2013). In the mid-1940s, the first super computers were invented which lead to the birth of the internet (The Peoples History, 2004). By the early 1980s, personal computers were common and social media was becoming quite popular as a form of communication from one person to another, and from one country to another (The Peoples History, 2004). Today, social media spreads information in a fast and economically feasible way that is available to the public at any time and location, and is still advancing and growing in demand around the world.

1.2 How Social Media Can Increase Environmental Awareness

Environmental issues such as deforestation, species at risk and invasive species are a huge concern in today's world. The opportunities that social media networking and social media sites offer for increasing environmental awareness are yet to be fully utilized, but they include the promotion of good environmental practices, the sharing of ideas and raising awareness about environmental campaigns and initiatives (Humanitarian Centre, 2013). Social media allows for the near-instant dissemination of information making it attainable around the world and creating increased environmental awareness on a variety of topics.

2.0 Citizen Science

2.1 What is Citizen Science?

Citizen science refers to a set of research methods which engage public volunteers who assist scientists in their research by submitting data, sharing experiences or spreading valuable information (National Wildlife Federation, 2015). Citizen science can provide a diversity of data such as species abundance, images and behaviour of species under observation. Social media can also be the stepping-stone or method for recruitment for the next generation of experts (Biological Records Centre, n.d.). Social media is available in most geographical areas around the world which allows citizen scientists to access potential databases for data collection making it easier to create environmental awareness. Scientists can benefit from citizen science because it is a cost-effective way to obtain a large amount of data from volunteers who have often-intimate local knowledge of and connection to the research area.

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2.2 The Effectiveness of Citizen Science

Effective use of citizen science as a method of data collection relies on techniques from many disciplines such as science communication, information science education and informatics (Shirk & Zuckerberg, 2014). Using these techniques, volunteers involved can be dispersed in various locations around the world because these new technologies are available globally and are universally accepted. Citizen science is also effective because it provides engagement between people and their environment, it is cost-effective, data can be trusted, and there is a high diversity of approaches which could appeal to citizen scientists' differing interests such as counting butterflies or monitoring leafing and flowering plants (Centre for Ecology and Hydrology, 2014). An example of effective use of citizen science can be found at Parks Canada. Parks Canada protects nationally significant places of Canada's cultural and natural heritage and encourages public appreciation and enjoyment of the environment for present and future generations (Parks Canada, 2011). Parks Canada encourages citizen science through interpretation programs where participants are accompanied by an interpreter and are asked to count a particular species including flowering spring plants and Christmas birds depending on the program (Parks Canada, 2014). Another example of citizen science is through the Ecological Monitoring and Assessment Network of Environment Canada which has created a citizen science group called Nature Watch which focuses on four subjects of observation including FrogWatch, PlantWatch, IceWatch and WormWatch (Canadian Museum of Nature, n.d.). These programs allow citizen scientists to report important information including the date and time of a particular sighting which is very useful feedback for environmental scientists.

2.3 Drawbacks

Citizen science is most effective when it is simple and straightforward. If data collection involves complex, tedious, or demanding tasks, participation is likely to be reduced (Centre for Ecology and Hydrology). One of the drawbacks of citizen science is that participants are often not able to provide information on complex scientific analyses because it exceeds general knowledge. To provide in-depth knowledge of data collection techniques and credibility of data collection, the National Oceanic and Atmospheric Administration (NOAA) in the United States has created a Sea Grant model which integrates research, outreach and education to make ocean and coastal literacy available to students of all ages and also the public in the United States to increase environmental education and awareness about protecting the natural environment and its ecosystems (National Oceanic and Atmospheric Administration, n.d.). The NOAA Sea Grant program provides engineers, educators and students the education they need to address issues like coastal hazards and sustainable coastal development (NOAA, n.d.). Additionally, the NOAA Sea Grant program supports citizen scientists and researchers with the funding they need to learn about complex scientific data collection that goes beyond the knowledge of local citizen scientists. The NOAA program provides citizen scientists with in-depth education on environmental issues to help further protect the natural environment at a higher level.

3.0 Benefits of Combining Social Media and Citizen Science

3.1 Combining Social Media and Citizen Science

Combining citizen science with social media can create a simple and straightforward data collection method that would be available to all ages. Using social media as a data collection tool can create a diverse and easily accessible way of entering data from a large geographical area. Over the past decade, communications technology has been able to enhance traditional citizen science efforts. With access to a smartphone, data collection is an inexpensive and virtually free feedback approach that can be accessible to scientists quickly and efficiently because information can be extracted anywhere and at anytime when connected to the Internet. Technological advances have also reduced lag time between initiation of a research project and data collection. One of the most noticeable and important benefits of combining social media and citizen science is how volunteers can participate over a large geographical area while still providing important data for scientific analysis, as long as there is cellular service in that particular area.

3.2 Case Studies

Case studies involve a form of descriptive research that is used to look at varying amounts of participants rather in a small group or a group as a whole (Colostate, 2015). First launched in 2000 as a partnership between Environment Canada, the environmental NGO Nature Canada and other organizations, NatureWatch is a website that allows people of all ages to monitor wildlife and environmental changes while also providing accessible and easy ways of contributing information for scientists such as a new smartphone application which was recently created (NatureWatch, 2015). In the year 2000 and today, the aim of NatureWatch was getting public attention in regards to helping researchers track changes in the natural environment (Nature Watch, 2015). Newfoundland Nature (NLNature) is a user-friendly interactive website which provides a platform for citizen reported sightings of plants, animals and other natural phenomena that can be valuable for scientific use (NLNature, 2013). NLNature is a program developed by Memorial University's Faculty of Business Administration and Department of Biology to help develop innovative approaches to information modeling and information management through research (NLNature, 2013). NatureWatch and NLNature are two interactive websites that allow citizen scientists to contribute valuable data for scientists using social media sites and tools such as a smartphone and access to a computer.

3.2.1 Case Studies that Combine Social Media and Citizen Science

NatureWatch is an online environmental monitoring program that encourages active learning about the environment while collecting data for scientists to monitor and protect it (NatureWatch, 2015). Submitted information is pooled together to improve scientific knowledge of changes in Canada's natural environment including habitat degradation, detrimental effects of deforestation and climate change issues such as

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freeze-thaw cycles of water bodies (NatureWatch, 2015). NatureWatch hosts four monitoring programs including FrogWatch, IceWatch, PlantWatch and WormWatch (NatureWatch, 2015). Since the launch of the new website now known as NatureWatch 2.0 in the fall of 2014, it is fully compatible with all mobile devices and provides enhanced tools for identifying species and mapping user observations (NatureWatch, 2015). Instead of taking a picture of an observed species, storing it and then remembering to submit it, having the NatureWatch application on your smartphone allows you to match what you are observing to picture on the website without any further requirements. NatureWatch also uses Twitter and Facebook for marketing purposes to promote their citizen science programs. With the ease and accessibility of NatureWatch 2.0, it can become a popular passtime for family and community members which can consequently help scientists gather information on climate change to identify positive or negative wildlife population trends and learn about species distribution while educating Canadians of all ages how our natural environment is changing and how they can help protect it.

Newfoundland Nature (NLNature) is an online atlas which provides a platform where residents can submit sightings of plants, animals and other natural phenomena such as rocks and landmarks (NLNature, 2013). Memorial University's Faculty of Business Administration and Department of Biology use the sightings that are submitted by users to monitor local wildlife, have up-to-date conservation policies and protect the natural environment (NLNature, 2013). NLNature uses the internet as its main database for citizen scientists to create a personal account, record their sightings and also include important characteristics like the time of observation, coordinates and attributes while also being able to provide photos for a more accurate description (NLNature, 2013). Once a citizen scientist submits a sighting, it is added to the interactive atlas of wildlife where the most recent sightings are visible with the citizen scientist's name and the date posted (NLNature, 2013). Using an online atlas allows citizen scientists to raise awareness and learn about local wildlife while also helping scientists protect Newfoundland's natural environment through submitting important information to scientists (NLNature, 2013).

NatureWatch and NLNature use social networking sites like Facebook and Twitter to promote their websites and provide citizen scientists with up-to-date information about upcoming programs and initiatives. NatureWatch uses Facebook to promote their website and also post upcoming seasonal events to keep residents and participating citizen scientists aware of monitoring programs (Facebook, n.d.). NatureWatch also uses twitter to promote monitoring programs and they also retweet environmentally conscious tweets such as facts about littering, getting involved in environmental programs and environmental funding opportunities (Twitter, n.d.).

Both NatureWatch and NLNature use social media for advertising purposes, but they only provide information for their websites including upcoming events, environmental statistics and environmentally friendly facts, rather than providing interactive framework opportunities through these networks. If citizen scientists could provide sightings and observations of species under observation and submit them via social networking sites while also having access to the main websites, scientists would be able to obtain more information across a broad geographical area that could contribute to scientific understanding and protection of Canada's natural environment.

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3.4 Social Media and Citizen Science in a new Context

NatureWatch and NLNature focus on native species which are easy for the majority of citizen scientists to observe safely and submit sightings for scientific use. Invasive species are one of the biggest threats to native wildlife, and approximately 42% of Threatened or Endangered species are at risk because of invasive species (National Wildlife Federation, n.d.). Invasive plant species like Cheatgrass which covers millions of acres in western North America is an example of how an invasive species can outcompete native plants in the region (United States National Plant Arboretum, 2008). Cheatgrass and other invasive species tend to rapidly spread and there are limited research and management opportunities for infestation mitigation measures. Citizen scientists currently play an active and contributing role in a wide range of ecological projects, but there seems to be few projects focusing on the observation of invasive species. Invasive marine species are rarely observed by citizen scientists because they are in a marine ecosystem and they are usually only visible when in shallow waters making them harder to observe. Exploring the potential contribution of citizen science to monitoring invasive alien species is especially important as the ecological cost of invasive marine species can threaten ecosystems locally and a global scale.

4.0 Invasive Species – Green Crab

4.1 What is the Green Crab?

The European green crab (*Carcinus Maenas*), is a native species of Europe and Northern Africa (Fisheries and Oceans Canada, 2013). Although called ‘green’ crab, individuals can range in color from green to yellow to orange (Fisheries and Oceans Canada, 2013). Green crabs have five spines on each side of their carapace, and they also have three rounded lobes between the eyes (Eat the Invaders, 2012). The size of green crabs range from two and a half inches from front to back of the carapace, up to four inches (Washington Department of Fish and Wildlife, n.d.). Green crabs can live for up to seven years and females are capable of producing up to 185,000 eggs per year (Fisheries and Oceans Canada, 2013). Green crabs are a naturally territorial and aggressive species and they primarily feed on shellfish, mussels, small worms, mollusks and crustaceans (Environmental Data Center, n.d.).

4.2 The Pervasiveness of Green Crab

In most regions it inhabits, the European Green Crab is considered to be an aggressive invasive alien species. Arriving on the eastern seaboard of North America by the 1870s, the green crab is now dispersed globally with records of occurrence in Australia, South Africa and along the Atlantic and Pacific coasts of North America (United States Geological Survey, 2011). By surfing ocean currents and hitching rides on the bottom of boats and ships and fishing gear, the green crab is found on every continent excluding Antarctica (Fisheries and Oceans Canada, 2013).

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Green Crab have a significant impact on biodiversity and habitat because they destroy eelgrass by digging for prey in sediment and making burrows by cutting the root of the eelgrass and destroying the ecological habitat (Fisheries and Oceans Canada, 2013). The ability of the Green Crab to reproduce quickly and survive in low salinity water, combined with near absence of natural predators, has allowed it to spread at a dangerous rate creating detrimental impacts on both the natural ecosystem and economy.

Non-native species can have drastic impacts on ecological communities by altering natural ecosystem functions, which then threatens the services that these ecosystems provide for people and their communities. By inhabiting a wide variety of habitats, the Green Crab has devastating social and economic impacts on commercial fisheries. Damages to the commercial shellfish fishery from Green Crab on the East Coast of the United States total \$22.6 million per year and the potential future damages are likely to increase by \$0.84 million per year if Green Crab invades certain parts of Alaska (Lovell, Besedin, Grosholz, 2007). Green Crab threaten commercial species such as juvenile Dungeness crab, flatfish and bivalves and many other types of organisms and have also been associated with the decline in soft shell clam (Aquatic Nuisance Species, n.d.). The loss of shellfish and other species due to Green Crab invasions has caused a significant impact on the amount of catch available for harvest by commercial fisheries.

Green Crab has been established on the Atlantic coast of North America for over 180 years (Kern, 2002). Managing the Green Crab invasion is important for the protection of native species, overall ecological biodiversity and to sustain local and commercial fisheries. Experimental mitigation measures that are in place today include but are not limited to the direct removal of Green Crab by trapping in the East coast of Canada (Fisheries and Oceans Canada, 2010). Trapping procedures have proven to be successful as native rock crab species numbers have increased over time and continuous trapping gradually reduces the average size of a Green Crab shifting it to a more vulnerable size for other native predators (Fisheries and Oceans Canada, 2010). A management structure that includes prevention and containment, detection and forecasting, eradication, control, mitigation and data management would form a foundation for a rapid response to help start addressing the invasive green crab problem that exists around the world today (Kern, 2002).

4.3 How Social Media Can Aid in Invasive Species Awareness

Green crab are reproducing rapidly in North American waters and are continuing to destroy ecosystems creating devastating impacts on native species and economic impacts for commercial fisheries. Green Crab reproduce up to three times in their five-year lifespan (Washington Department of Fish and Wildlife, n.d.). Citizen science programs like NatureWatch and NLNature do not promote the importance of monitoring and collecting data on green crab, even though Green Crab are quickly destroying Canada's oceanic ecosystems. Using social media to augment citizen science research to gather and collect information on Green Crab sightings in marine environments could help scientists gather data on the spread of Green Crab and population densities in different geographical regions. Nature Watch and NLNature do not promote or stress the importance of the Green Crab invasion, but if these programs were to take advantage of social media and combine it with citizen science opportunities, information on Green

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Crab could become easily accessible for scientists increasing public and scientific awareness providing up-to-data, accurate information.

5.0 NOAA National Sea Grant College Program

5.1 Canada Needs a Sea Grant Program

The NOAA created the National Sea Grant College program in 1966 in the United States which was designed to create and maintain a healthy coastal and economic environment (NOAA, n.d.). In every coastal and Great Lakes state, there are 33 Sea Grant networks currently working together to help citizens understand and conserve America's coastal environment and resources (NOAA, n.d.). This Sea Grant invests in research including shellfish farming, seafood safety and fisheries management and the results of this research are shared with the public through outreach programs (NOAA, n.d.). Throughout the nation, Sea Grant networks provide valuable leadership in marine and aquatic science education; playing a huge role in education in public schooling, undergraduate, graduation and professionals to prepare them with knowledge on how to conserve protect and sustain coastal environments (NOAA, n.d.). This Sea Grant program provides the next generation of potential citizen scientists with the knowledge they need to provide more in-depth information on invasive species, including the green crab.

Canada needs a program like the NOAA Sea Grant program to provide future citizen scientists with increased knowledge about in-depth and credible data collection regarding invasive Green Crab. For citizen science to be more effective and broadly used in relation to monitoring invasive Green crab, citizen science should be combined with social media to provide an even broader demographic of data collection, communication, and accuracy. This combination will allow environmental research to access data catalogues via social media networks easily and at any time. By having subsidized educational opportunities available to the public, and using social media tools like Twitter and Facebook for free and easy accessible data applications, citizen scientists can more effectively monitor and record sightings and observations of green crab for scientific use.

6.0 Conclusion

The continuing growth and use of social media networks around the world reflects the desire to connect and communicate with each other about common interests. Combining citizen science and social media can create free and easily accessible ways of collecting data for scientists to monitor and protect our natural environment. NatureWatch 2.0 is an example of a citizen science program that takes advantage of social networking sites for advertising purposes and uses smartphone technology to gather and collect information on sightings and observations of species over large geographical areas. NLNature uses social networking sites for marketing and advertising purposes as well, but is lacking in smartphone capabilities. Both NatureWatch 2.0 and NLNature do not stress the importance of monitoring invasive species like the Green Crab, but if citizen science was combined with social media such as Twitter or Facebook,

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information on population densities, habitat degradation and incidents of occurrence could be easily communicated for environmental research in an effort to create an eradication or management plan. The NOAA NSGCP currently funds programs to educate potential and future citizen scientists and established professionals with the knowledge they need to provide in-depth information on observing species characteristics, including invasive species like the Green Crab. To provide citizen scientists with in-depth knowledge about collecting and observing invasive species, Canada needs a program like the NSGCP because Canadians need to be educated on how to preserve and protect our coastal environments. Citizen science needs to be combined with social media data collection methods because it is free, timely and extremely informative for collection information on Green Crab which is extremely important for the future health of our biological ecosystems.

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