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APPLICATION OF GEOFENCING IN SAFEGUARDING SEA TURTLE BREEDING NETS ALONG THE BEACHES IN KENYA

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ABSTRACT

Sea turtle is one of the most endangered species in the world, with their population declining over time. The behavior of sea turtle in terms of breeding and foraging makes it become exposed to multiple threats. It stays in the sea, but lays and hatches its eggs on the sandy beaches. It creates a nest using flippers. Humans have exploited sea turtles, ranging from use of its shell, meat and eggs. Other threats are from animals such as crabs, dogs, coyotes, red ants and birds. Conservation efforts to save the sea turtles have been an on-going process. It includes involvement of local communities, visitors, beach boys, boat operators, hotels, and other businesses along the shore lines. Specific conservation activities include physically guarding the nets, transferring eggs to hatcheries, fencing and roping of nests as well as erecting warning signs to minimize threats to nests. As an alternative method to fencing and roping of sea turtle nets, use of geofencing technology has been proposed. Geofencing involves creation of virtual boundaries around a specified location such that any target device will be alerted when it crosses the boundary. It makes use of GPS, Wifi, RFID or Cell ID. Nesting sites will be identified and a virtual boundary will be built around it. A person with pre-installed app will be notified through an alert whenever this virtual boundary is breached. This enables people to be informed so as to avoid the beach areas with nests. It will become an additional conservation strategy of creating awareness and minimizing vulnerability of the sea turtle as an endangered species.

KEYWORDS: Sea turtle, Hatch, Nest, Geofencing

INTRODUCTION

Sea turtles live in the sea, but females come out of the water to lay eggs on dry part of the beach. The female digs a pit with its flippers, where she can lay from 50 up to 200 eggs in a single nest depending on

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the specie [1]. The distance between breeding and foraging areas of sea turtles is long, making it one of the limited numbers of reptiles with such behavior [2].

There are seven sea turtle's species, all of which are facing extinction since they are endangered. Kenya has five of those species. These include loggerhead, olive ridley, hawksbill, green and leatherback turtles. There has been a decrease in sea turtle populations over the last few decades since they turtles face many dangers. According to estimates, only 1 in 1000 sea turtle hatchlings reach adulthood [3].

In many places, sea turtles are considered as commonplace animals, of which they are not. Such a mentality results in these animals being overlooked or taken for granted as vital part of the ecosystem that is supposed to be protected. In many cases, conservation programs globally fail to sufficiently consider diversity of sea turtles, but instead focus on protected habitats for birds and mammals [4].

Conservation of sea turtles is aimed at guaranteeing lasting sustainable populations of each living species. This can only become successful if management plan of each species incorporates management of habitat, demography, genetics, data on ecology and husbandry. Other things to be considered in the management plan include climate change, increased human development and changes in land use variables. Any expectation to reach target of zero extinction of sea turtles in upcoming years require immediate and sustained conservation efforts. Urgent attention towards conservation of sea turtles and tortoises is required to reach the conservationists goal of improving likelihood of continuing survival of species in a healthy ecosystem and avoid extinction of turtles in the near future [5].

2.0 LITERATURE REVIEW

2.1 Sea Turtle Threats

Change in climate, increased exploitation and loss of habitat are some of the dangers faced by different species worldwide, leading to major declines and an increasing threat to their survival. This decline can be prevented through area-based conservation. Understanding of behaviors of such species forms part of effective protection [6]. Other threats of sea turtles include erosion of coastal beaches [7], flooding and ghost crabs [8].

In Kenya, reduction in breeding grounds of sea turtles due to beach development projects such as residential houses and hotels makes them to be severely endangered. Areas which are not protected since they are not under KWS jurisdiction make sea turtle nesting grounds become exposed to the risk of being destroyed since there is no control on human activities. Due to rise in tourists activities, there has been destruction of habitat suitable for sea nesting near hotels [9]. Population of sea turtles has been threatened by harvesting for their meat, oil, shells and eggs. Other threats include incidences in which sea turtles are

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capture during fishing activities as well as loss, degradation and alteration of habitat. Although Kenya has legislated laws against exploitation of sea turtles or products obtained from them, such vices continue unabated. Lack of adequate resources to effect such legislation worsens the problem. Places considered as nesting grounds for sea turtles do not have any existing law to protect them since they are outside legally identified areas that are under marine protection [11].

2.2 Geofencing Technology

Geofencing is a program with virtual barrier that enable setting up of triggers by an administrator any time a device goes in or out of pre-defined boundary, allowing email or text message alert to be sent [12]. Geofencing is built using hardware or software to create virtual perimeters based on locations that are physical [13]. This technology represents a key innovation at both national and international levels [14]. It is a technique that can be applied for a variety of purposes and is therefore highly flexible. It makes use of GPS to form a virtual boundary [15]. Hybrid positioning system has been developed to minimize limitations of GPS. This involves combination of Cell-ID and Wi-Fi positioning [16].

A smartphone has become a device with applications that are almost limitless due to built-in sensors, programmability and portability features [17]. Operating system of the smartphone performs geofencing. LocationManager Class libraries in Android are used by application developers to undertake geofencing. Documentation of iOS specifies smallest radius that can possibly be used as 10 meters [16]. Awareness can be created about existence of services in a given area that is underserved. Geofencing does not affect the privacy of individuals since there is no requirement for continuous tracking of locations. Identification of locations occurs when a virtual boundary is crossed by a device [18]. Geofencing accuracy is affected by several factors such as Wi-Fi access, type of OS, radius of the geofence, device being used and type of event being geofenced [16].

2.3 Application of Geofencing

Rise in popularity of mobile devices has resulted to geofencing being considered a standard practice by many entities [19][20]

2.3.1 Tracking patients

GPS and geofencing have been used together to track patients with memory problems, kids, and the elderly [15].

2.3.2 Vehicles

Geofences are created around a specified landmark on the map to help in monitoring vehicles and tracking them in real time. Each time a vehicle enters or moves out of the Geofence, an alert is triggered. This leads

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to multiple possibilities in different ways that can increase efficiency in vehicle operations, user safety levels and security. An application is developed on android platform and then downloaded by local public without any cost to monitor vehicles such as buses [21][12]. Geofencing is also applied in reduction of tailpipe emissions by vehicles when they are within an area occupied by disadvantaged communities (DAC) vulnerable to low air quality. This involves identification of sensitive locations such as schools, daycare centers, hospitals, nursing homes for the elderly, etc. and creating virtual boundaries around them. It includes imposing of fees whenever a vehicle enters geofenced areas. Charges can be based on per unit mass of emission, per unit distance travelled or per entry into the area [22].

2.3.3 Attendance register

Student class attendance can be monitored through setting up of a range in which clock-in/out process can be triggered by an application whenever the boundary is crossed by a device [23]. Lecture halls are used as the basis for creating virtual borders. In every lecture in a course, all students are enrolled when the lecture hall is activated and then embarks on recording attendance. Current student location is then stored [13]. Geofencing is also used in automation of nurses' attendance by creating virtual boundary around the hospital. This enables them to "clock in" and "clock out" when reporting or leaving the workplace [24].

2.3.4 Businesses

The technology is used by some businesses around their competition. Whenever the virtual boundary is approached by any potential customer, a push notification prompts the person to move to alternative establishment [19].

2.3.4 Archaeological sites

Geofencing can be applied in archaeological sites so that tourists can be guided when they are in the site [25].

2.3.5 Human-elephant conflict

In areas associated with human-elephant conflict, virtual boundaries are created using geofencing technology. Elephants are fitted with collars that are satellite-linked. Whenever they approach the virtual boundary, a shock is triggered on the collar after audio warnings have been issued from Aversive geofencing devices (AGD). This trains the elephants to move away from areas dominated by humans [26].

2.4 Sea turtle conservation measures

One of the methods considered cost-effective in managing and conserving sea turtles is voluntary action by local communities. However, conservation agents lack understanding of local community perception

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about sea turtles. Some of leading causes of decline in sea turtle population is overexploitation and poor marine resource harvesting. Scientific research that considers social-cultural and social-economic dimensions should form the basis for developing long-term measures in sea turtle management and conservation [27]. Change of community mindset, prolonged conservation efforts and modification of policy can improve economic livelihood of local communities and increase protection of sea turtles. Community-based programs for sensitizing residents against taking of sea turtle eggs combined with use of patrol, relocation of nests and continuation of hatchery are key measures that can help conserve sea turtles [28].

Other global measures include use of detection dogs to identify sea turtle eggs as compared to human surveyors [29]. Use of fencing has been identified as the most effective method of reducing predation of sea turtle eggs by crabs [30].

Local Ocean Conservation Kenya Limited (LOCK) in Watamu coastline (Kenya) has Marine Scouts whose mandate is to provide safety to nesting sea turtle females, eggs and hatchlings through physically patrolling beaches at night to deter poachers and predators. To safeguard against drowning during high tides, the Scouts relocates the nets [8].

Modern technology advancements has enabled acquisition and analysis of voluminous data related to sea turtles, leading to increased knowledge about ecology of sea turtles and their associated behavior [31]. Monitoring of sea turtles has been undertaken through use of technology such as radio telemetry, GPS-linked tracking devices as well as passive integrated transponder tags [5].

Various measures that have been employed as stated above are manual and therefore labor-intensive. Some have been done voluntarily, which implies that there should be continuous availability of people who are willing to carry out conservation efforts without remuneration. This can be challenging, given that many local communities are in need of income. Other measures have cost implication, and can only become effective as long as funding is made available, however, lack of continuous financial flow can hinder their impact.

Some of the modern technology applied in sea turtle conservation effort are costly, advanced and require high level of expertise to implement, operate and maintain.

Just like geofencing has been successfully applied in diverse areas, the technology is to be considered for sea turtle conservation efforts. This is because it is based on everyday technology use involving smartphones and widely available GPS and cell-based technology. As much as it is not possible to apply

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the technology in all areas of conservation related to sea turtles, it is important to use this easily available and applicable technology.

3.0 PROPOSED SYSTEM

To bolster the use of physical fencing for identifying nests and placing of physical signs to alert beach goers to move away from the nests, geofencing technology has been proposed. It will involve the following steps:

a) Development of software

An app that is based on android and iOS will be developed and uploaded at Google and App stores. Its proposed name is Sea Turtle Nests Alert System (STNAS). It will be made available to potential users with smartphones.

b) Location identification

Sea turtle nesting areas will be identified along Kenyan beaches frequented by people. Suitable radius will be identified around the located places. A virtual boundary will be determined based on GPS, Wi-Fi or Cell ID.

c) Registration and awareness creation

A voluntary registration exercise will be carried out. It will involve an elaborate process of bringing on-bond different government and non-government organizations carrying out conservation activities related to sea turtles, volunteer groups, hoteliers and other businesses along the coast lines, fishermen, boat operators, beach boys, local communities and individuals with the aim of creating awareness. Use of both print and social media will be undertaken to reach out to wider public.

d) Testing and Implementation process

Any person with a smartphone will be encouraged to download the STNAS app from the google store. They will be required to enable location and GPS in their phones The working of the app will be tested and any desired changes will be undertaken. It will then become a fully functional app aimed at supplementing other identified methods of protecting sea turtle nests.

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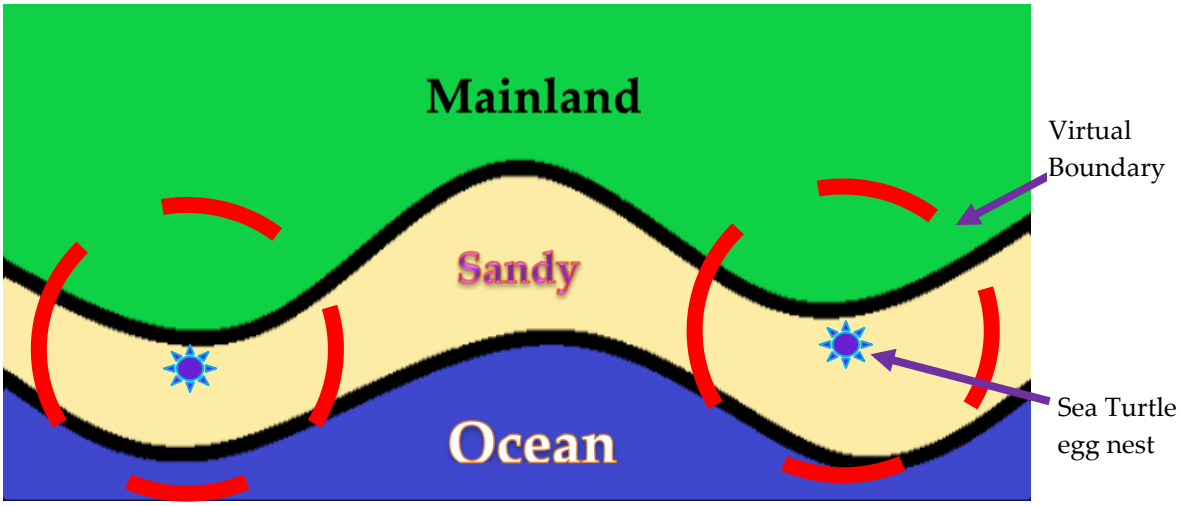

Figure 2: Proposed sea turtle nests with virtual boundaries

4.0 CONCLUSION

Application of technology towards diverse conservation measures can play a key role in minimizing threats to endangered species, reduce costs and create much needed awareness to the general public. Use of geofencing in this case propels the goals of all conservation efforts, since information is knowledge and knowledge is power. At the same time, it changes the perception of individuals in multiple ways, that is, it minimizes ignorance about conservation, raises the knowhow about additional capabilities and importance of smartphones, makes users feel part of noble effort to safeguard animals facing extinction and brings hope to conservationists.

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