



Vol. 08 No.1 | Global Crises and Tourism

Vol. 08 Article 4 | August 2021

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## Current Status, Implications and Challenges of Introduced and Invasive Species at Saanane Island National Park

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Received date: June 07th, 2021; Accepted date: July 30th, 2021; Published date: August 30th, 2021.

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### Abstract

*Introduced species (ITS) are organisms that are either intentionally or non-intentionally introduced to a new geographic area. The majority of introduced species usually cannot survive in their new habitats. Some turn into Invasive Species (IS) when they become more aggressive and outcompete with the native species. Introduced and Invasive species poses both positive and negative impacts to the native species and the environment. Saanane Island National Park (SINP) is among of 22 National Parks found in Tanzania. This study was conducted at SINP to determine the current status of introduced and invasive as they poses possible positive and negative impacts to the sustainability of the park. We report a total of 20 plant IS and 14 ITS of animals recorded since 1968 at SINP. Some introduced animals notably Lion (*Panthera leo*), Nile Perch (*Lates niloticus*), Wildebeest (*Connochaetes taurinus*), Zebra (*Equus quagga*) and peacock (*Pavo cristatus*) have significantly improved the attractiveness of SINP as tourist destination at Mwanza City. This study also shows that 93 per cent of tourists who visited SINP in 2020 did so because wanted to see these ITS. However, most of the ITS have struggled either to survive or to adapt to the environment at SINP. Similarly, plant IS identified included *Lantana camara*, *Leucaena leocaphala* and *Eichhornia crassipes* which are among the top 100 worst invasive species listed by International Centre for Nature Conservation (IUCN). These IS have been a scourge and are associated to many problems such as reducing attractiveness of SINP through impeding animal or vessel passage, destroying habitats, outcompeting with native plants, reducing visibility, causing disease, reducing range size and destroying phytoplankton communities that sustain a healthy aquatic ecosystems. The findings from this study will be helpful to SINP and other protected areas for effective management and control of invasive and introduced species which is key in conservation, maintenance, restoration of biodiversity and attractiveness of protected areas.*

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**Keywords:** Introduced species, invasive species, ecology, sustainable tourism development, Saanane Island National Park

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## 1.0 INTRODUCTION

Biological diversity has been in decline ever since the emergence of modern man (*Homo sapiens*) [Aguoru et al., 2015; Novacek and Cleland, 2001]. However, biodiversity loss increased speedily from the 20th century due to the increase in the human population and globalization coupled with the advance of science and technology (Boy and Witt, 2013; Witt et al., 2018). One of the most effective ways of preventing biodiversity loss is through controlling overpopulation, introducing or re-introducing organisms to habitat where there are few natural enemies or danger and establishing National Parks for the purpose of conservation and wildlife tourism (Aguoru et al., 2015).

Globally, Tanzania is one of the richest countries in terms of mega-biodiversity. It hosts six out of the 25 most famous biodiversity hotspots in the world (BIEP, 2020). Approximately 40 percent of Tanzania's surface area is designated to forest, wildlife and marine protected areas for conservation (Laher and Sing'oei, 2017; Busungu, 2020). In 2019 alone, six new National Parks were established namely Nyerere (30,893 square kilometers), Kigosi (7,460 km<sup>2</sup>), Burigi-Chato (4,707 km<sup>2</sup>), Ugalla River (3,865 km<sup>2</sup>), Ibanda-Kyerwa (298.6 km<sup>2</sup>) and Rumanyika–Karagwe (247 km<sup>2</sup>) (TANAPA, 2021). The total area of the new National Parks established in 2019 is 47,470.6 km<sup>2</sup> which is much bigger than the whole country of Denmark (43,094 km<sup>2</sup>) or Netherlands (41,850 km<sup>2</sup>).

The name Saanane represents the first name of the fisherman and farmer Mzee Saanane Chawandi who lived with his family on the island. When he died in 1964, the Government took over the island and established the first Government Zoo in Tanzania through Government Notice 567/64. It was managed by the Game Division as a Game Sanctuary (Nahonyo and Sangu, 2017, Antony, 2020; and Salumu 2020). In order to reinforce conservation for animals and improve tourist attractions, the government of the United Republic of Tanzania through TANAPA from time to time has introduced several animals like buffaloes, bushbucks, dik-diks, duikers, elands, elephants, impala, reedbucks, black rhinoceroses, topi, warthogs, wildebeest, Burchelli's and Grevy's zebras, giraffes, and velvet monkeys. In line with this, animals had been introduced into SINP from time to time according to the recommendations of ecologists. Some of these animals were left to graze freely; some were kept under enclosures. SINP has become more popular as a tourist attraction in the Mwanza region. The number of tourists has increased significantly every year (Katalihwa 1981; Antony, 2020 and Salumu 2020). This increased trend

of tourists visiting SINP have created a lot of movements within the park. It somehow contributed to the introduction of new species as well as increase of invasive species (Antony, 2020; Salumu 2020).

Invasive plant species are considered to be one of the greatest threats to the long-term conservation of biological diversity in both terrestrial and aquatic habitats worldwide (Courchamp et al., 2003). Global extinctions recorded over the past six centuries have been dominated by invasive species, and introduced mammals are recognized as the main cause (MacPhee and Flemming 1999 and Aguirre et al. 2005). According to Aguirre et al. (2005) invasive species has multiple effects on native species by: 1) alteration of plant populations and the animals which rely on them; 2) predation; 3) competition for local resources and habitat disruption; 4) dispersal of micro and macro parasites; 5) genetic transformation of native populations through hybridization; and 6) prey on native predators (changing the food chain). Over time, these impacts can hold back growth, hastened extinction of species, altered food webs and ecological processes. The study of introduced and invasive species is among one of the research priority areas in Tanzania (TAWIRI, 2017). The aim of this current research was to investigate the status, challenges and implications of introducing invasive species at Saanane Island National Park.

## 2.0 RESEARCH MATERIALS AND METHODOLOGY

### 2.1 Study Area

Saanane Island National Park is located two kilometers southwest of the city center of Mwanza at the Capri Point area in the Mwanza Gulf of Lake Victoria. It lies at latitude 2° 32' 39.71" S and longitude 32° 53' 22.99" E. Saanane Island National Park comprises three isles (Saanane, Chankende Kubwa and Chankende Ndogo). It covers an area of just 2.18 square kilometers which includes both aquatic and terrestrial areas. The Saanane Island National Park was established in 2013 and is the smallest National Park in Tanzania (TTB, 2021).

### 2.2 Research Materials

The research material that was used in the study included two published guide books (Terry, P.J and R.W. Michieka, 1987 and Dharani, 2011). They describe trees, shrubs and weeds of East Africa for identification. PlantNet Identification software (PNI, 2021) was used for identification of trees, shrubs or

weeds in cases where the plants was not covered by these books. Cameras for taking pictures of invasive plants using the Global Positioning System (GPS) gave the coordinates of the area where the invasive species were identified.

2.3 Research Methodology

The study used a survey design methodology. This design is suitable to small parks or other natural areas which may not have the resources for extensive early detection efforts (Geissler, 2014). The method was focused on invasion pathways, routes along which invasive species are likely to move and to occur, and especially on sensitive areas with important native plants. Systematic sampling was done after every 20 meters along passable trails or road within the park. Primary data was obtained at each sampling area through observation and taking photos of invasive species. This method resembles a methodology which was used to identify rare and invasive species in Burigichato National Park (Makunga and Gobolo, 2020). Interpretation of suspicious invasive species was done using PlantNet mobile software and field guide books of common tree, shrubs and weeds in Africa. In cases where the target invasive species could have been dispersed by birds, wind, or water away from trails and road, an observation was made using high resolution binoculars. A questionnaire was given to respondents with different demographic and socio-economic backgrounds. This research instrument was pertinent to determine the introduced animals' species, the influence and motive of tourists' visits as well as the implication and challenges of invasive species in the park. Secondary data was obtained from the SINP office. It has a database of introduced and invasive species which have been sighted and recorded during their normal activities within the park. Similarly, secondary data on the impacts of invasive species on wildlife, eco-system, biodiversity and native species were obtained from published and unpublished reports at SINP.

3.0 FINDINGS

3.1 Demographic and Socio-economic Characteristics of Respondents

This study used respondents with different demographic and socio-economic background in order get their impressions and different perspectives about introduced and invasive species. The study found that most of the respondents had education from secondary and tertiary education. The highest number (29.5%) had

degree education followed with (25.4%) with secondary education. Others included college education (20.5%), postgraduate education (8.1%), and primary education (16.5%). According to Conservator at Saanane most of tourists visiting at Saanane National Park are students from various universities, colleges, secondary and primary schools in Mwanza City. Since university and college students have more freedom and have more money to spend compared to other students, this is the reason why more than 50% of the respondents have college education and degree . The age group which was highly represented in respondent was 21-35 years old (39.1 per cent). This age group corresponds with the age of college and university students. Other age groups [less than 20 years, 36-60 years and over 60 years] had 27, 30.1 and 3.4 per cent respectively. Most of the respondents [66.5 per cent] were male while the females were only 33.5 per cent. This suggests that males are more adventurous than females. Due to the fact that this research was done during Covid-19 pandemic, only 9.2 per cent of the respondents were international tourists. They mostly came from neighboring countries like Kenya and Uganda. Most of the respondents visited Saanane National Park either once (29.5 per cent) or twice (42.5 per cent). This implies that SINP should do more to add attractions or design activities within the park to increase repeat visitors. This research involved respondents from different occupations such as fishermen, farmers, students, tourists, ecologists, conservators, tour guides, office workers and researchers. The involvement of different occupations of people at the park was helpful in explaining biodiversity, introduced species, invasive species, their dispersal and effects from different perspectives. Table.1 summarizes the demographic background of the respondents used in this study.

Table1: Demographic and Socio-economic Characteristics of Respondents

Occupation	Gender		Age group				Level of education					Nationality		How many times visited at SINP				Total
	M	F	<20	21-35	36-60	>60	P	S	C	D	P	Tz	N-Tz	Once	Twice	3 times	>3 times	
Fishermen	16	0	4	8	3	1	11	4	1	0	0	16	0	6	10	0	0	16
Farmers	6	4	2	5	3	0	7	1	1	1	0	10	0	8	2	0	0	10
Students	13	7	14	6	0	0	0	3	6	9	2	18	2	5	10	3	2	20
Tour guides	11	3	4	9	1	0	0	3	6	5	0	14	0	0	0	3	9	14
Conservator	1	1	0	1	1	0	0	0	0	1	1	2	0	0	0	0	2	2
Ecologist	1	1	0	0	2	0	0	0	0	1	1	2	0	0	0	0	2	2
Office workers	3	7	3	6	1	0	2	6	2	0	0	9	1	1	6	3	0	10
Researchers	7	5	3	8	1	0	0	0	0	8	4	11	1	2	6	2	2	12
Tourists	39	21	10	14	32	4	4	20	14	18	4	55	5	21	28	7	4	60
<b>Total</b>	<b>97</b>	<b>49</b>	<b>40</b>	<b>57</b>	<b>44</b>	<b>5</b>	<b>24</b>	<b>37</b>	<b>30</b>	<b>43</b>	<b>12</b>	<b>137</b>	<b>9</b>	<b>43</b>	<b>62</b>	<b>18</b>	<b>21</b>	<b>146</b>
<b>Percentage(%)</b>	<b>66.5</b>	<b>33.5</b>	<b>27.4</b>	<b>39.1</b>	<b>30.1</b>	<b>3.4</b>	<b>16.5</b>	<b>25.4</b>	<b>20.5</b>	<b>29.5</b>	<b>8.1</b>	<b>93.8</b>	<b>6.2</b>	<b>29.5</b>	<b>42.5</b>	<b>12.3</b>	<b>15.7</b>	<b>100</b>

NB: Symbols M, F, P, S, C, D, P, Tz and N-Tz represent Males, Females, Primary, Secondary, College, Degree, Postgraduate, Tanzanian and Non-Tanzanian respectively.

### *3.2 Status of Invasive Plant Species and Their Effects at SINP*

The Saanane Island National Park went through land use changes over a span of 70 years from human settlement, agriculture, zoo and finally National Park. The vegetation of the island has been modified from two types of vegetation: grassland and dwarf shrub grassland on the eastern gulf of Mwanza and to wooded and bushed grassland on the western gulf zone (Katalihwa 1981). There are open grassland, small patches of dry forest characterized by various species of *Ficus natalensis*, *Ficus ingens*, *Ficus cymosa* and *Haplocoelom mombasaensis* species. These are also said to be the native species in the National Park. Large parts of the rocky hills are covered by *Combretum* woodlands degrading to thicket, and swampy vegetation in areas touching the Lake Victoria. In some few places there are introduced plants such as *Ricinus communis*.

In this study 20 invasive species were identified and recorded at SINP. The species include trees, shrubs, grasses, climbers, waterweeds and parasitic plants. The shrubs were the most dominant species while the climbers and trees were less common. Shamba la mwanzo area of SINP, the weather station, shamba la mwisho and director's loop were the areas found to hold many species of IS while the Serengeti ndogo and campsite were found to have less species. Their country of origin have been identified as well as their effects on the Saanane Island National Park. Table 2 summarizes the invasive species identified and their effects.

**Table 2:** Status of Invasive Plant Species and Their Effects at SINP

S/N	Common name	Scientific name	Origin	Effects
01	Black-jack	<i>Biden pilosa</i>	USA, Australia	Kills natural vegetation by allelopathy, toxic to animals,
02	Candle bush	<i>Senna alata</i>	Mexico	Reduces wildlife range size, unpalatable to animals, dislodge natural vegetation
03	Common wire weed	<i>Sida cordifolia</i>	Central America	Dislodges natural vegetation, reduces pasture ranges, not palatable to animals
04	Arrow leaf sida	<i>Sida rhombifolia</i>	Central America	Dislodges natural vegetation, reduces pasture ranges, not palatable to animals
05	Castor oil	<i>Ricinus communis</i>	India	It can cause death to animals, unpalatable and reduces pasture range to animals.
06	Coolata grass	<i>Hyparrhenia hitra</i>	Eurassia	Spread quickly to colonize and dislodges native grasses
07	Heartleaf Ampelopsis	<i>Ampelopsis glandulosa</i>	Asia, America	It is a climber which strangle vegetation, hinder movement of animals and people, not palatable
08	Rattle weed	<i>Crotalaria retusa</i>	USA	Dislodges natural vegetation, reduces pasture range, toxicity to animals and habitat distortion
09	Paper reed	<i>Cyperus papyrus</i>	Madagascar	Spread quickly to colonize and dislodges native grasses
10	Physic nut	<i>Jatropha curcas</i>	America	Dislodges natural vegetation, reduces pasture ranges, not palatable to animals
11	Sodom apple	<i>Solanum incunum</i>	Africa,Asia	Toxic to grazing animals, cause specie decline , habitat distortion
12	Water hyacinth	<i>Eichhornia crassipes</i>	South America	Form thick mats which reduces aeration to fauna and flora in the lake, inhibit navigation to the park, provides habitats for vectors animal diseases
13	African Mistletoe plant	<i>Tapinanthus bangwensis</i> L	West Africa	Spread quickly to parasitize native plants causing some plant to die and hence loss of biodiversity
14	Mysore Thorn	<i>Caesalpinia decapetala</i>	Asia	Strangle vegetations, Reduces Park-carrying capacities and hinder the movement of livestock and people.
15	Common Lantana	<i>Lantana camara</i>	Central/south America	Dislodges natural vegetation, reduces pasture range, toxicity to animals and habitat distortion
16	Lion's tail	<i>Leonotis leonurus</i>	South Africa	Reduces pasture range, toxicity to animals, dislodges natural vegetation
17	White lead tree	<i>Leucaena leucocephala</i>	Central America	Dislodges native wildlife species, It alter secondary succession processes and it makes areas unusable and inaccessible.
18	Coffee weed	<i>Senna occidentalis</i>	Tropical America	Competes aggressively with native vegetation, not edible and poisonous to animals, It reduces pasture range.
19	Southern marigold	<i>Tegetes Minuta</i>	South America	Biodiversity loss, rarely eaten by wild animals ,poisonous when consumed accidentally or in large amount
20	Popcorn tree	<i>Senna spectabilis</i>	Central/south America	Reduce wild animal range size, dislodges natural vegetation

Source: SINP, 2020.



**Figure 1:** Water Hyacinth (*Eichhornia crassipes*)



**Figure 2:** Heartleaf Ampelopsis (*Ampelopsis glandulosa*)



**Figure 3:** Common Wire Weeds (*Sida cordifolia*)



**Figure 4:** Coffee weed (*Senna occidentalis*)

### 3.3 Mode of Invasion and Dispersal of Invasive Plant Species

SINP have more than 54 species of birds. Of these, most of the birds are said to be migratory birds that probably travel from different parts of the world (SINP, 2020 and Katondo et al. 2005). These birds might be carriers of the IS by their droppings when they happen to stop at any place in the parks. Their droppings may sometimes contain undigested pieces of seeds. It is mostly known that birds feed on seeds. Due to the diversity of IS they happen to germinate and grow in either condition. Also, the birds involve themselves in activities of nest making. Here they pick small pieces of woods and some grasses from different trees and places. Some might be IS and in these favorable conditions they would grow.

Animals that were introduced in the park from different parks and game reserves have been found as significant contributors to the spread of some invasive plant species seeds. Some species of seeds use animal dispersion as a natural part of their life cycle. Hence the movement of these animals to the park could also bring

the introduction of this species. Some of the seeds such as *Solanum nigrum* easily pass through the digestive tract of the birds and mammalian herbivores. This allows the seeds of the species to move to a new location through animal dung (Corlett, 2009).

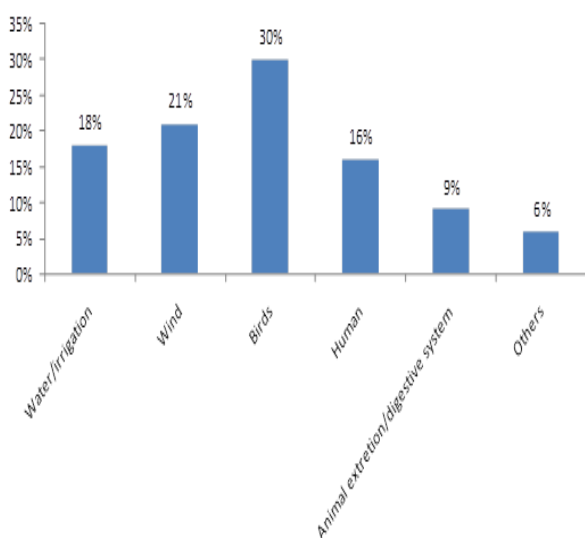
According to SINP management during dry season (June to September) irrigation is done within the park by pumping water from the lake. The purpose of irrigation is to make sure that the pasture and all vegetation in the park are readily available to the herbivores. The water from the lake might contain seeds of IS. Fiore and Schroeder (1997) observed that irrigation water spreads invasive species in agro-ecosystems. This paper agrees with postulate that seeds of IS might have brought in by rivers or water washed into lake from different areas of East Africa where the lake reaches. Moving transport vessels like boats sometimes unintentionally carry IS seeds by attaching themselves to the vessels. The fish hooks that are used for sport fishing are also likely to carry and impose the IS.

However, historically SINP had human activities which included fishing and farming before it was established as a National Park in July 2013. The farming activities that were conducted with the former settler Mzee Saanane Chawandi included farming of some grains and seeds. Because of different ways of harvesting, some seeds and grains possibly remained behind after harvest. This is likely to be one way that IS were introduced into SINP. The presence of resident and migratory birds enormously helped in spreading the movement of IS. The migratory birds (both partial and sedentary) such as Squacco Heron (*Ardeola ralloides*), Grey Heron (*Ardea cinerea*), Open Billed Stork (*Anactomus lamelligerus*), Paradise Flycatcher (*Terpsiphone viridis*), and Little Egret (*Egretta garzetta*) increase chances of introducing or spreading invasive species. Plant species such as Black Jack (*Biden pilosa*), Love Grass (*Eragrostis cilianensis*) and Hooked Bristlegrass (*Setaria verticillata*) have seeds that can easily hook on to or attach to human clothes and can be transported for a long distance.

Tourists or tour guides can unintentionally carry these species inside the park with them on their clothes. They may also have carried species on the soles of their shoes. As they moved in to the park, they keep spreading the species there. According to Pickering and Mount (2010) tourists can aid in dispersal of seeds from one area to another through various mechanism as explained above. Furthermore, the wind is also likely to be one of the modes of invasion of IS at SINP. Plants

like *Elodea Canadensis* are common and mostly moved with the direction of wind. However, the invasion of IS at SINP has been found to be mostly unintentionally rather than intentionally. In the current study it was found that Birds (30 per cent) and wind (21 per cent) were the main dispersal agents of invasive species. Other dispersal agents identified were water/irrigation (18 per cent), human activity (16 per cent), animal extraction/digestive system (9 per cent) and others (6 per cent). Figure 5 depicts the model of invasion and dispersal of the invasive species at Saanane Island National Park.

**Figure 5:** Mode of Invasion & Dispersal of Invasive Species at Saanane Island National Parks

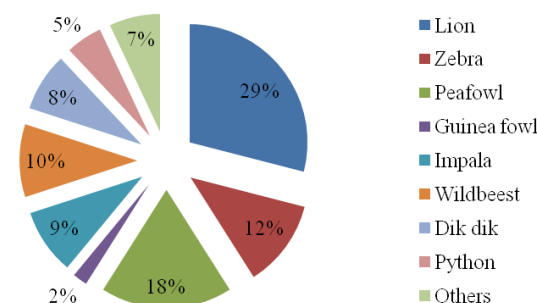


Source: SINP, 2021.

### 3.4 Status of Introduced Animal Species at Saanane Island National Park

According to Katalihwa (1981), Nahonyo and Sangu (2017), Antony (2020) Salumu (2020) as well as Saanane Island National Park information's, prior to becoming a National Park it underwent several land use changes from human settlement area, garden, a zoo and more recently a National Park. The wild animal that are native to this area includes Rock Hyrax (*Procavia capensis*), African Hedge Hog (*Atelerix albiventris*) Leopard Tortoise (*Stigmochelys pardalis*), Nile Crocodile (*Crocodylus niloticus*), Rock Monitor (*Varanus albigularis*), Flat-headed Rock Agama (*Agama mwanzae*), Red-headed Rock Agama (*Agama agama*) as well as several species of birds, snakes, amphibian and insects. Other wild animals were also introduced at Saanane Island National Park. Notable

introductions at SINP includes Hippopotamus from Guinea (at SINP are famously called Nyerere Hippo), Chimpanzee, Zebra, Lion, Python, Peafow, Wildebeest, Guinea Fowl, Impala, Dik-dik, Nile Perch and three species of Tilapia. Some of the introduced animals were transferred to another places when they failed to adopt. Some died and some survived. Many tourists are attracted to visit SINP because of the presence of these introduced species. Figure 6 illustrates in percentage terms which animals were attractive for tourists. Table 3 shows the expected versus observed offspring of introduced species. This explains whether the animal had adapted significantly after being introduced to the park. The more the number of observed versus expected offspring, the higher the adaptation of the animal to the park. The lower the observed offspring versus expected, the less adaptation of the animal to the park. These findings suggest that the Velvet Monkey and Impala have adapted very well since their introduction. Animals with average adaptation include Lions, Zebra, Wildebeest, Python, Guinea Fowl, Peafowl and Dik-dik. The animals which have failed to adopt and became extinct at the park include Hippopotamus and Chimpanzee. Some introduced animals like Nile Perch probably have over adapted and turned into an invasive species. However, in this study it was untenable to not possible to assess the Chi-square value for Nile Perch or other species of Tilapia which was introduced to the Lake Victoria in the early 20th century.



Source: SINP, 2020.

**Table 3.** Potential Reproduction Potential & Observed Reproduction of Introduced Animals

Animal type	Observed Offsprings	Expected Offsprings	X <sup>2</sup>	Significance Difference
Lion	3	15	9.6	***
Zebra	3	6	1.5	***
Wildebeest	3	6	1.5	***
Hippopotamus	2	0	0	NS
Chimpanzee	2	0	0	NS
Peafowl	12	33	13.3	NS
Guinea fowl	78	102	5.6	***
Python	4	13	6.2	***
Impala	92	98	0.36	**
Nile Perch	NA	NA	NA	NA
Velvet Monkey	66	73	0.49	**
DikDik	9	18	4.5	***

\*\* Significance difference at P= 0.5 (5%) level of significance

\*\*\* Significance difference at P=0. 1 (10%) level of significance

NS=Not significant different, NA- Not assessed

Source: SINP, 2020.



**Figure 7A:** Picture of Extinct Hippo at SINP

**Figure 7B:** Lioness at SINP

### 3.5 Control Measures of Invasive Species at Saanane Island National Park

The SINP management has been putting efforts into removing the invasive plant species in such a way that it is possible for the park to not causing trouble to the animal species there. SINP have been practicing prescribed bush burning or controlled bush burning to burn all IS plants in different seasons of the year. The burning has been taking place mostly in areas which are

dominated by a large number of IS. Although prescribed burning have been used successfully and recommended in IS control (Bukombe et al.2018 and Ditomaso et al. 2006) it has not solved the IS problem completely at SINP. In 2019 bush burning was done to the shamba la mwisho area. However, the plants have been reemerging from time to time.

Several other IS management practices have been applied including physical methods by uprooting the plants, hoeing and cutting them down for terrestrial IS. In management of aquatic weed [specifically water hyacinth (*Eichhornia crassipes*)], chemical control using herbicides such as 2,4-D (2,4-dichlorophenoxy), Diquat (6,7-dihydrodipyridol pyrazinediumon), and Glyphosate (Isopropilamine salt of N-phosphomethyl as well as the importation, mass rearing and releases of exotic biological control agents (Guerena et al. 2015) has been tried. Water weeds have been severally removed from the Lake Victoria for some time but still they keep reemerging now and then.

### 3.6 Adaptation Measures of Introduced Species at Saanane Island National Park

The adaptation of an animal to a new environment is a key element for survival and thriving in any new environment or in the case of climate change. The adaptations of wildlife to a new environment or climate change can involve behavioral, physiological or structural change. In some instances the new species may not survive if there is no niche for the new species to fill or the species cannot adapt to fill a new ecological niche that is different to its original niche. Hence, the species will likely go extinct relatively quickly at the local level (Kate, 2015).

Kate (2015) also added that if the species is a generalist or able to thrive in a variety of the environments and consume a lot of food resources, the species will do well. If the ecosystem has reached its stable state, this means that the new invasive species will replace the native species. No two species can share the same ecological niche as one will be better adapt and survive or if they reproduce quickly. Hence, if the invasive species will be a better adapter, it will be able to complete with the native species.

### 3.7 Challenges and Implications

The ecological value and potential uses of islands as conservation sites have been pointed by many researchers and governments (Hill and Hill,1987 and Wright and Beaver, 1986). Historically, ship wrecks, fishermen, settlers or governments have used islands



for farming, mining, lighthouse stations, prisons and defense emplacements. These activities resulted in the destruction of the natural ecosystems and the introduction of invasive species (Burke-Gaffney, 2020 and UNESCO,2020). SINP in its quest to restore nature and eradicate invasive species has faced a lot of challenges including its size. SINP is the smallest National Park in Tanzania. This makes it very difficult to introduce of many new animals. Secondly, the rocky features of SINP make it very difficult for grasses as well animals to adapt and survive. Thirdly, the closeness to the city of Mwanza is a factor. SINP is the only National Park which is within a city. This implies a high chance of noise pollution, environmental pollution and too much interaction with humans which can spread zoonotic diseases. This also makes the adaptation and survival difficult. Fourthly, the connection with Lake Victoria is important. The Lake Victoria basin encompasses more than six countries which implies that there is a high chance of invasive species being introduced into the lake via water. Fifthly, little research about SINP has been done. There is very little research to determine the best way of restoring, inventorying, adapting and utilizing the present resources at SINP.

## 4. DISCUSSION

### 4.1 Demographic Characteristics of Respondents

Age is one of the vital factors in predicting tourism demand and travel motivations. According to Elisa et al. (2015), an elder population is more likely to travel and spend more time on tourism activities due to its disposable income as compared to the younger generation. Mieczkowski (1990) and Ma et al (2018) also suggested that the age factor is important in influencing the desire for travel, relaxation and exploration of nature. In the current study, a large percent (66 per cent) of the tourists encountered were below 35 years of age. They were less than 20 years old (7.4 per cent), 21-35 (39.1 per cent, 36-60 (30.1 percent) and more than 60 (3.4 per cent). This implies a larger percentage of tourists at SINP are from the younger generation. This corresponds with the level of education. Most of them are students either at secondary, college or university level within Mwanza City or neighboring regions. They often visit SINP with a study tour group with their teachers or they visit independently as tourists. The level of education in (Figure 1) was an important factor in determining the awareness of respondents to invasive species, their effects and disposal mechanisms. Respondents with higher education and with an occupation related to wildlife conservation [such as ecologists, conservator,

tour guide and researcher] had more understating of the situation. They could identify some invasive species, their effects and suggest some control measures. The respondents were 66.5 per male and only 33.5 percent female. There were more male tourists, students and tour guides while most office workers were females. This agrees with findings from Doran (2016) and Lotter et al. (2014); Cave and Ryan (2007) suggested that women participates more in soft adventure than hard adventure tourism. Moreover, compared to men, women prefer indoor than outdoor activities. That is why most tour guides were male while office workers were female. This study recommends an improvement in women's participation in tourism activities like visiting SINP. Although the secondary data show that SINP tourists are mostly locals, because the study was conducted during Covid-19 pandemic this might explain why the majority of the tourists (93.8 per cent) were Tanzanians and the minority (6.2 per cent) were non Tanzanians.

### 4.2 Impact of Introduced Species on Attraveness & Conservation at Saanane Island National Park

The study shows tourism activities which are provided by the Saanane Island National Park includes walking safari, picnicking, camping, boat cruising, walking safaris, photographing and video shooting. However, 93 per cent of the tourists interviewed were attracted to visit the park due to introduced animal species such as Lions (29 per cent), Peafowl (18 per cent), Zebra (12 per cent), Wildebeest (10 per cent), Impala (9 per cent), Dik-dik (8 per cent), Python (5 per cent) and Guinea Fowl (2 per cent). About 7 per cent of the tourists were attracted by rocks sport, fishing or boat cruising. The findings of this study suggest that the introduction of animal species has greatly enhanced biodiversity in the park. Although some animals like the Lion and Peafowl are kept in cages, this policy still had an impact in terms of conservation and protection. Some studies showed that some animals do well in intensively managed areas such as zoos. When they multiply, some of their offspring can be release or reintroduced to the wild (Bauer et al., 2015). According to Suding et al. (2004), restoring or even renewing distorted habitat through reintroduction or introduction of new species forms the basis of conservation and should be encouraged. Durugbo et al. (2012) argues that protected areas like Saanane Island National Park should encourage bio-conservation in order avoid species decline and extinction as well as permanent detrimental change to the environment.

### 4.3 Assessment on the Adaptation of the Introduced Animal Species

Based on the research findings, the adaptation of introduced species was a big issue as illustrated in Table 3. When we looked on the total number of the introduced animal species, present population, expected population and the death rate of the animal species using Chi Square value, this implies either they have adopted to the new environment or not. Using Chi Squares values as a benchmark, some animals such as Hippopotamus (*Hippopotamus amphibious*) and Chimpanzee (*Pan troglodytes*) failed to survive at SINP. Hippos are semi-aquatic mammals, usually inhabiting shallow lakes, river of swamps. They like a quiet and calm environment (Clarke, 1953). A Hippo could not probably survive due to the fact that SINP is located near a city with all its noise and disturbances. There are few areas with shallow water and there is a small home range. Similarly, chimpanzees are specialist frugivores that consume other plant parts such as fibrous pith and leaves, in greater amounts during fruit shortages (McLennan, 2013). These are not readily available at SINP. Therefore, before their introduction, a number of variables should first be considered. These will help predict the likelihood of species' adaptations and long-term persistence in areas considered for protection (Cabeza et al. 2004) as well as identify locations suitable for reintroductions. (Joachim et al. 1998).

Other introduced animals such as Lion, Wildebeest and Zebra moderately adapted but failed to reach their maximum reproduction potentials at SINP. According to Stuart and Pimm (2006) for animal species to adopt to a new environment, what is required is enough home range size, access to food, water, optimum temperature, few or balanced competitors and predators. Animals caging or restricted movement as was the case for Lion, Peafowl and others at SINP increased stress which can have an impact on their adaptation or habituation. Maple and Bloomsmith (2018) and Fischer and Romero (2018) asserted that when introducing an animal to a new environment, the optimal animal welfare must be considered. More particularly, stress and disturbance from tourists should be minimized to increase the animal adaptation rate. Animals like Nile Perch which was introduced in 1950s have overadapted and turned into an invasive species. It has also caused Cichlids and native fish to decrease and become extinct (Kees et al, 2006). Nile Perch are an example that poses a big challenge to the conservators. They should try to reverse the situation before all the native species of fish and Cichlids in Lake Victoria disappear due to the prowess and competitiveness on the Nile Perch.

#### 4.4 Invasive Species Status and Effects

National Parks and Protected Areas are moderately free from the human activities compared to the surrounding landscape. As a result, the extent of plant invasions is expected to be low in the National Parks. However, the data from this paper have showed around 20 plant invasive species and one animal invasive species affected the ecosystem at SINP. It has been revealed that Nile Perch (*Lates niloticus*), Common Lantana (*Lantana camara*), Water Hyacinth (*Eichhornia crassipes*) and White Lead Tree (*Leucaena leucocephala*) are among the top 100 of the world's worst invasive alien species (GISD, 2014). Plant invasions dramatically affect the distribution, abundance and reproduction of many native species. Therefore, impacts of invasive alien species can be immense, insidious and irreversible. Invasive species are currently officially recognized as the chief drivers affecting nature, environment and the direct driver of species extinctions globally (Butchart et al., 2019 and Ichii et al. 2019). The finding from SINP revealed same effects of invasive species in protected areas. Some common effects observed included habitat loss, reduction in biodiversity, modifying food web by destroying or replacing native food sources, ecosystem distortion; pollute of the air and sometimes leading to death of some animals. The effects of invasive species can be aggravated to be even worse with the effects of climate change and global warming (Kriticos et al., 2003). Studies on the identification and impact of IS's have increased in importance faster than those dealing with management. The rapid escalation of problems that forced invasion ecology onto the agendas of conservation managers. Only recently has the scientific community realized that a better understanding of the ecological impacts of invasive species is crucial for prioritizing management efforts (Parker et al., 1999 and McNeely, 2011). The findings of the study have found that the common modes of invasion or dispersal include water, air, wind and tourists. In addition to that, a study by Makunga et al. (2020) revealed invasive species being found in areas of Burigi-Chato National Park. These include *Zantoxylum usambarense*, *Cyperus papyrus*, and *Biden pilosa*. Some of these are found at SINP which probably have the same water pattern as the Burigi-Chato National Park.

According to a report by TANAPA (2019), plant invasive species are rampant and increasing at an alarming rate in many National Parks notably Mahale, Serengeti, Rubondo and Mikumi National Parks. This broadly explains by the fact that invasive species in National Parks have been historically planted in areas before they later became National Parks. Before the

1920's, people were inhabiting these areas. The plants were mostly trees for shade and ornaments [for example, *Sena spectabilis* in Mikumi National Park]. By the time these areas became National Park, the seedlings of invasive species had become huge trees that had already spread over extensive areas. Different methods of management of the invasive species have been documented. Some of them were successful and some not successful (TANAPA, 2019; Bukombe et al. 2018 and Makunga et al., 2020). The scenario is almost the same for SINP where invasive species like *Eichhornia crassipes* have been there for a long time. SINP historically was inhabited by the settlers whose activities were both farming and fishing before it became a National Park (Katalihwa 1981 and Nahonyo and Sangu, 2017).

## 5.0 CONCLUSION

The beauty as well as biodiversity of SINP has been greatly enhanced with the introduction of animals. SINP has developed in the past few years since it was gazetted as a National Park by the United Republic of Tanzania. The animals introduced at SINP have followed three different patterns. One group completely failed to survive the new environment. Another group have moderately adapted while the other group have over adapted and turned into invasive species.

The number of plant invasive species at SINP is noteworthy. Their negative effects on the environment, native habitat, distortion of ecosystem, accessibility and the native and introduced animal species is reaching a level where if not well managed. They will have a huge effect to SINP management. Some of the invasive species are of global concern and listed by ICUN as among the top 100 most worst invasive species. Migratory birds found in SINP have played a large share in aiding the spread of plant invasive species. They travel from one region to another carrying the seed in their digestive system or feathers. Animals introduced at SINP also have helped in spread and dispersal of invasive species through their digestive system and attachments of their fur. Other factors [namely wind, irrigation and tourists] have also contributed to the spread and dispersal of invasive species at SINP. The SINP management have tried to control the invasive species by application of different methods such as prescribed bush fire, uprooting, hoeing and cutting of invasive trees which has prove successful but only for a short time.

## 5.1 RECOMMENDATIONS

SINP management should consider extensive research on its ecology, environment factors and animal behavior before introducing them into the park. This will increase the chances of adaptability of the introduced animals. Arrangement should be made for tourists, camp maker or visitors entering SINP in such a way that they have minimum effect on the animals, the scenery and the habitat. This will involve demarcating the areas to which they are allowed to access by the correct placement of roads, tracks and campsites. Since invasive species differs in nature and so is their way of being controlled, the SINP management should use appropriate chemicals to remove invasive species from the park. They should consider the type of IS rather than using the general methods like bush fire. Such methods in turn will not completely combat some of the species effectively.

The SINP management should consider an integrated management of invasive species with neighboring organizations like beaches and hotels. For example, the management of water weeds by a single organization is not effective because water weeds tend to move following the blowing of the wind. Thus, when the management of SINP combines efforts with the neighboring organizations, the control of this species will be more effective. Consideration should be given to the prediction and prevention of invasion and the management of species, which have become invasive. The latter includes such aspects as biological recording, coordinated control, different control options and the importance of monitoring.

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