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EXECUTIVE SUMMARY

The inventory of Kivu Lake Islands biodiverisity in Rutsiro, Nyamasheke and Rusizi District is a complementary work in relation with the inventory of the biodiversity in all Lake Kivu islands. The objective of the study was to collect biodiversity and socio-economic information in 9 islands: Mapfundugu Islands Complex made of four islands, Karugaruka, Nyanamo and Karinga Islands located in Rutsiro District; Ishyute Island located in Nyamasheke District and Ireba Island located in Rusizi District. The study aimed also to publishishing a status assement report for the islands by identifying the threats that they face and providing the recommendation for the conservation of biodiversity and ecosystems.

Six taxonomic groups were inventoried using different methods of rapid biodiversity assessment: plants, birds, small mammals, reptiles, amphibians and invertebrates.

Different species of particular interest were recorded, including endemic species, rare species and useful species for different purposes and internationally recognized species like water birds. The findings revealed that the study sites are home to a rich and high diversity worthy conserving, as well as different species of particular ecological interest such as endemic and rare/threatened species. The results also indicated that the islands face some threats related to human activities such as animal grazing, tree cutting, etc.

The researchers recommended that a protection network should be established for the islands located in Karongi, Rutsiro and Nyamasheke Districts, including some very small island of less than one hectare but which are still intact. For the islands located in Rusizi District, it was recommended that these be excluded in the prospective network, as these have been degraded to such extent that they cannot be recovered, except Ireba Island which, in addition to be partially degraded, is located very far away from the remaining island of the abovementioned neighboring districts.

Finally, it was concluded that Kivu Lake Islands should be considered as a biosphere reserve, and split them into a core area for biodiversity conservation where no human activity is allowed and a buffer zone where not harmful human activities to biodiversity can be authorized and reserved for tourism.

CHAPTER I. INTRODUCTION

1.1. Background

Although Rwanda is a small country, it has a considerable variety of ecosystems including island ecosystems, found mainly in Lake Kivu. Their location at the heart of the Albertine Rift makes Lake Kivu islands and the surrounding region a biodiversity hotspot. Originally, flowing northwards into Lake Albert and the Nile system, the eruption of Virunga's volcanoes created a volcanic dam in the north and after the level rose by 50 to 70 meters, the flow was reversed southwards into Lake Tanganyika through the Rusizi River (Peeters, 1957 and 1959). Despite their great number and predictable high biological diversity, their richness is not well known and their threats ignored.

Given that the biodiversity is mainly conserved in protected areas in Rwanda (the current network of National Parks covering around 10 % of the national territory) (RoR, 2009), the target of extending where possible this network and to improve the management of the existing protected areas requires an enhanced knowledge on the status of biodiversity outside protected areas (REMA, 2009).

Although few published data exist about Kivu islands, findings from biological inventory of previous similar study conducted in Karongi District revealed that those islands contain a very rich biodiversity (REMA, 2011). Kivu islands were proven to be one of key zones in Rwanda for biodiversity conservation, tourism and recreation.

In the perspective of completing data so far collected on Lake Kivu islands' biodiversity, REMA undertook a continuation of the study in islands located in Rutsiro, Nyamasheke and Rusizi Districts.

1.2. Purpose of the study

This study aims at:

- Carrying out the biodiversity and socio economic inventory of the Kivu islands located in Rutsiro, Nyamasheke and Rusizi Districts
- Publishing a status assessment report for those islands.

Biological inventory will allow assessing the fauna and flora richness contained in those particular isolated ecosystems. The study will also help to identify the threats that undermine the integrity of the islands and provide relevant information for their effective management and conservation. A socio-economic survey will supplement the study to serve as an opportunity to better understand the problems encountered by local populations living on and around islands in the three districts.

1.3. General description of Lake Kivu and the surroundings

Located on the border between Rwanda and D.R.C, between 1 °30′ and 2° 30′S and 28°50′ and 29°23′ E along the East-African Rift, Lake Kivu covers a surface area of 2,700 km2 and stands at an altitude of 1,460 meters above sea level. Lake Kivu was formed in the Pleistocene, as a consequence of the intense volcanic activity of the Virunga Mountains, which dammed the Great Rift Valley and reversed the northward flow of the rivers in the valley (Holzförster and Schmidt, 2007). The lake is 100 km long, and has a maximum width of 50 km. There are several islands in the lake, most of them are small and are found on the in Rwandan side. The biggest island, Idjwi Island, 40 km long and with an area of 69000 ha is in DRC (Hughes, R. H, Hughes, J. S., 1992)
The lake comprises two deep and steep fluvial valleys, separated by Idjwi Island. The water depth in the main basins exceeds 450 meters and has a maximum depth of 485 m (Lorke et al, 2004). It is this density structure that allows magmatic CO_2 as well as biogenetic CH_4 and CO_2 to accumulate in the lake (Hirslund, 2012). These biogenetic gases have been accumulated over the last decades; indeed the rate of accumulation has increased over the longer-term historical values (Schmid et al. 2004).

Topographically, Lake Kivu consists of a large basin (main basin) and four smaller basins (from north to south: Kabuno Bay, Kalehe, Ishungu, and Bukavu) (Degens *et al*., 1973; Tietze, 1978; Botz *et al*., 1988; Spigel and Coulter, 1996; Lahmeyer International and OSAE, 1998). Lake Kivu has a rough, jagged coast and contains numerous islands, the largest of which being Idjwi.
The lake borders five districts on the Rwandan side: from the North to the South, Rubavu, Rutsiro, Karongi, Nyamasheke and Rusizi Districts.

1.3.1. Hydrology and soil characteristics

The lake receives run-off from the surrounding mountains, with no less than 30 rivers entering it along the highly indented Rwandan shore. Rainfall in the catchments exceeds 2400 mm (Hughes, R. H, Hughes, J. S., 1992).
According to Tietze (1978), the waters of Lake Kivu are a mixture of surface water (from the catchment and rainwater) and geothermal sources (mainly located in deep areas of the lake). The chemistry of Lake Kivu is dominated by hydrothermal inputs in the bottom layer of the lake and is more saline and enriched in numerous metals compared to Lake Tanganyika water (Degens and Stoffers, 1976; Haberyan and Hecky, 1987; Barrat *et al*., 2000).
Surface water is completely isolated from deep water. Two factors contribute to the stability of the stratification: salinity gradient and the concentration of CO_2 (increasing with depth), which increase the density of water. These two stabilizing factors far outweigh the other destabilizing factors, namely, temperature and concentration of CH_4, also increasing with depth (Schmid *et al*. 2005).
Due to its relief and the nature of its bottoms, Lake Kivu is less diverse in terms of biota. The poor diversity of the lake is due to the steepness of the banks and the nature of the bottoms. The lake bottoms are rocky, made of rock of tectonic origin and the rock of organic origin. The rock of tectonic origin constitutes the entire north shore of the lake. The East and West side of the lake is formed by shores of ancient rocks that were laid bare, but they are also now covered with tuffs. Towards the shores, the bottom is quite sandy, encrusted with calcareous scales. From seismic observations, it is confirmed that the Lake Kivu basin is among the most seismically active region in the Western Rift Valley. The seismic activity has significantly contributed to accelerating the landslides in the basin, which is dominated by the mountains and steeper slopes, and an abundant rainfall up to 2000 mm (Bouwmeester, 2009). In additional to the seismic

activity prevailing, some factors such as the regressive erosion, the presence of aquifer nape, the anthropogenic action on the environment, the deforestation, the destruction or the lack of water canalization are contributing to the landslides phenomenon and inundation (Wafula, 2007).

Lake Kivu is characterized by edges which are generally composed of abrupt slopes degraded by erosion through human activities. The lake and the entire hydrological system in the Western Province are threatened by the degradation of lake shores and river banks, resulting in siltation and pollution.

1.3.2. Nutrient input and sedimentation in Lake Kivu

The study of Muvundja et al., (2009) which focused on the estimation of nutrient inputs to Lake Kivu from external sources, consisting primarily on river inflows and atmospheric deposition, revealed that phosphorus (P), nitrogen (N) and silica (Si) are the most important biogenic elements for primary productivity and carbon cycling in Lake Kivu. P and N are usually considered to be limiting factors for algae growth in aquatic systems (Hecky and Kilham, 1988), while Si is essential for diatom growth (Kilham and Kilham, 1990). Futhermore, sedimentation in Lake Kivu underwent a drastic change a few decades ago (Pasche et al., in press), which has been linked not only to the introduction of the Tanganyika sardine *Limnothrissa miodon* (Dumont, 1986) but also to land use changes and related nutrient fluxes in the catchment. Finally, the catchment of Lake Kivu is experiencing the effects of increasing anthropogenic activities.

1.4. Study sites

After the prefield prospection conducted at the Lake Kivu islands located in Rutsiro, Nyamasheke and Rusizi Districts, the islands that were retained to be investigated in each district are:

- 7 islands located in Rutsiro District (Fig.1):
  - Mapfundugu Islands complex made of a group of four islands
    - Mapfundugu I
    - Mapfundugu II
    - Mapfundugu III
    - Mapfundugu IV

- Karugaruka Island
- Nyanamo Island
- Karinga Island

➢ 1 island located in Nyamasheke District: Ishyute Island (Fig.2)

➢ 1 island located in Rusizi District: Ireba Island (Fig.3)

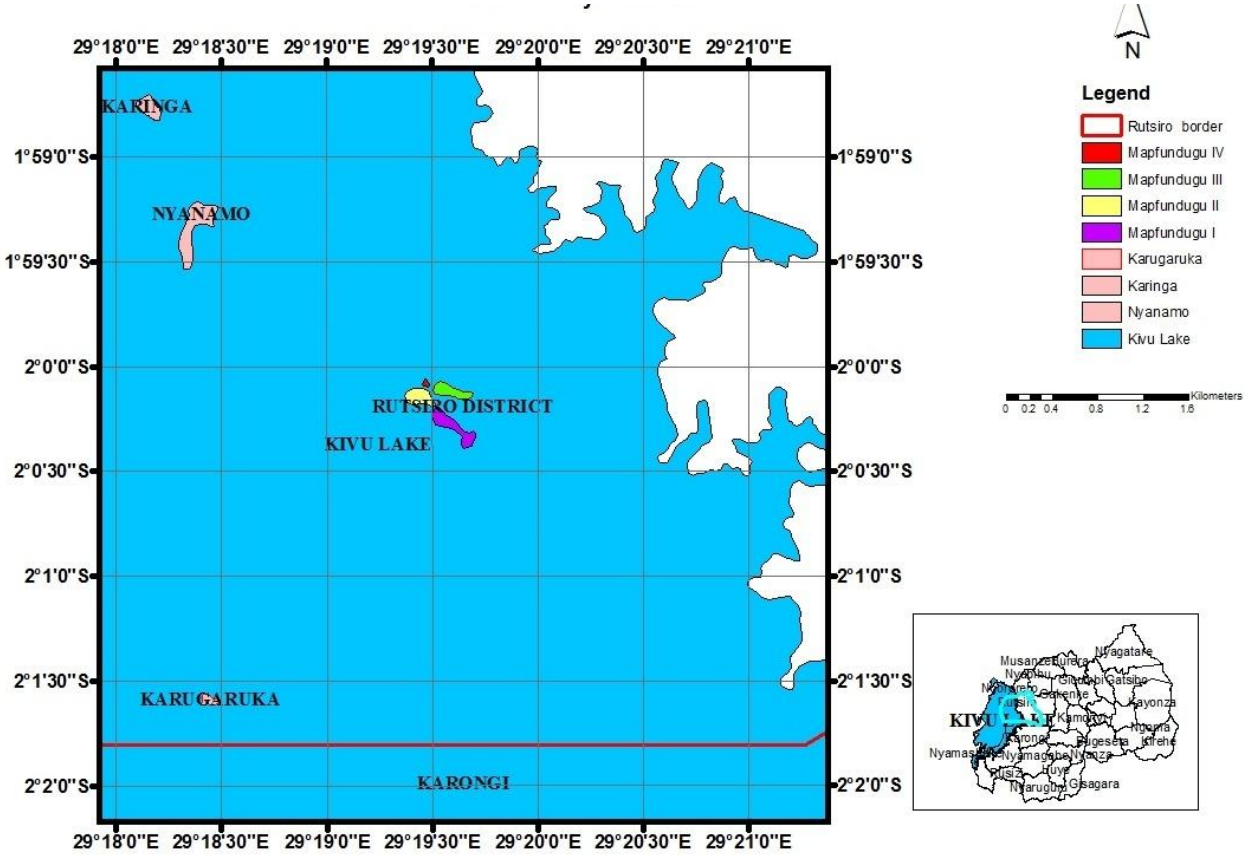


Figure 1: Location of the islands surveyed in Rutsiro District

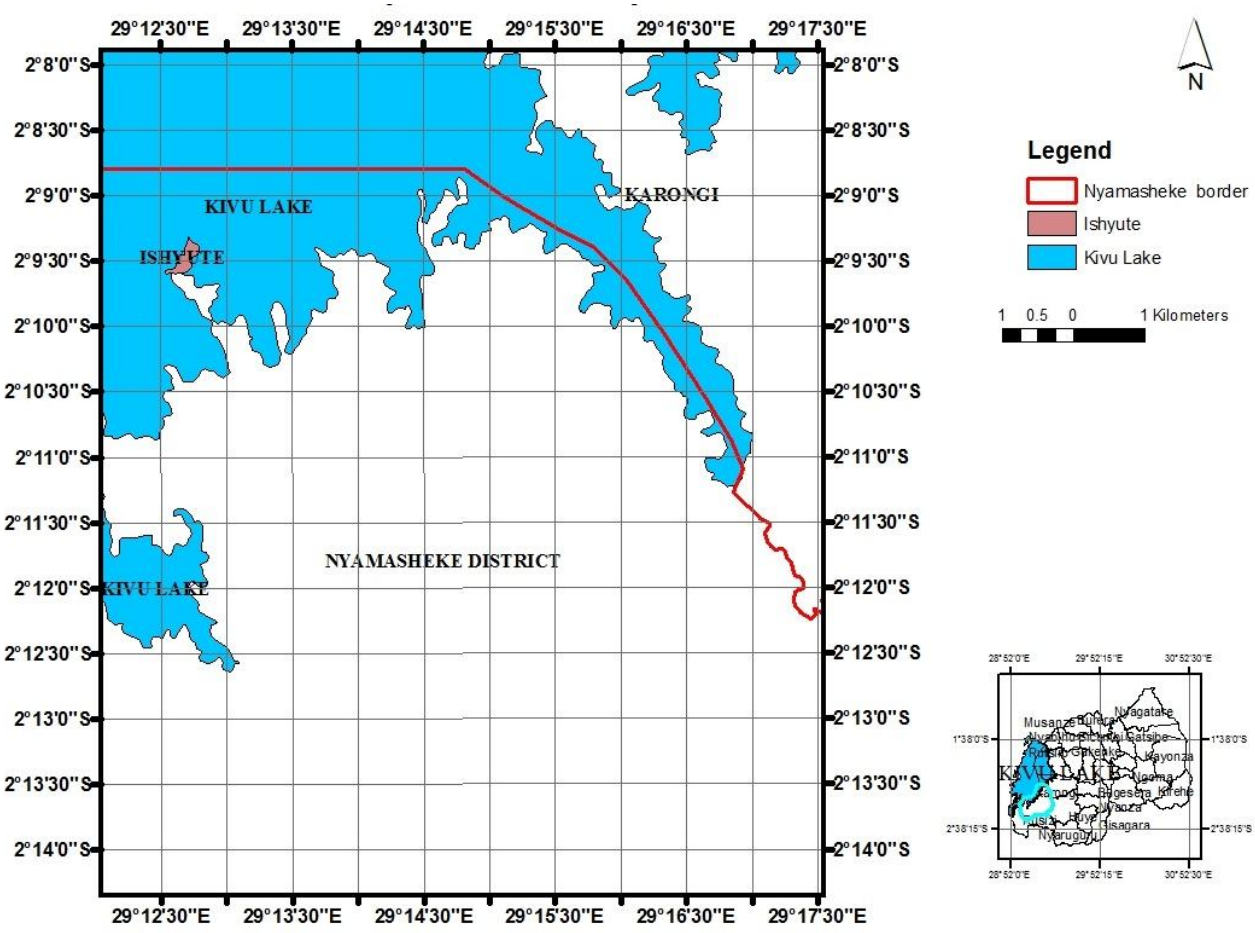


Figure 2: Location of the island surveyed in Nyamasheke District

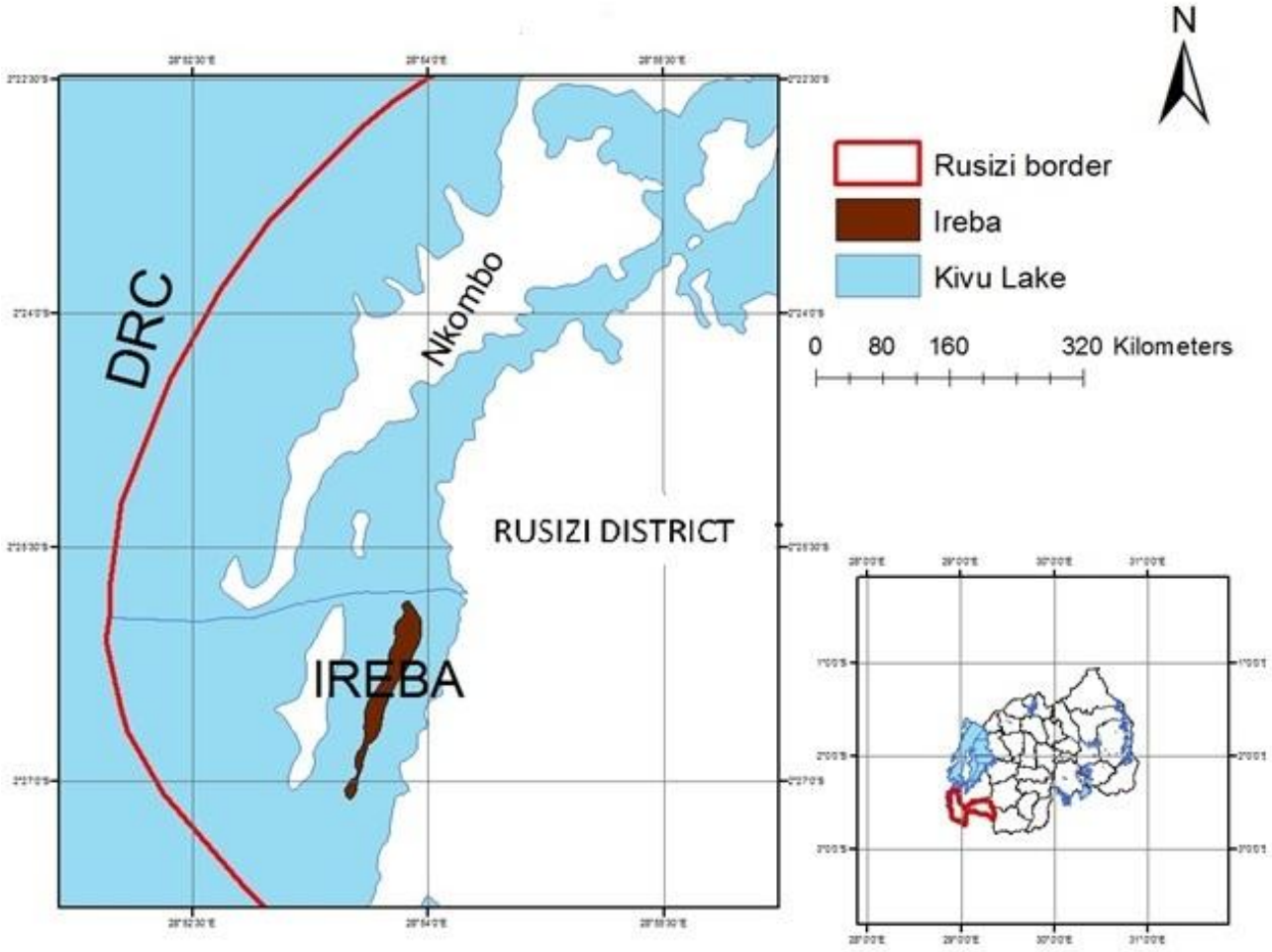


Figure 3: Location of the island surveyed in Rusizi District

CHAPTER II. METHODOLOGY

The study was conducted using Rapid Biodiversity Assessment (as a part of an ecological gap assessment, a socio-economic survey was also carried out).

In order to achieve the objectives of the study, following methodological approaches were applied:

2.1. Collection of biodiversity information

Data collection and analysis consisted in inventorying biodiversity components available in the islands under study. The inventory concerned different taxonomic groups, most typically: plants, birds, small mammals, reptiles, amphibians and invertebrates. This rapid biodiversity assessment could not result in an exhaustive inventory of all species, but useful and necessary information was recorded. In addition, socio-economic and environmental data were also collected.

2.1.1. Plants survey

Floristic and vegetation survey was conducted by investigating each island, using stratified sampling method. This allowed determining vegetation structure and floristic composition of the study area. Depending on the size of the island and floristic composition (homo/heterogeneity), the number of plots could vary. The cover-abundance value of inventoried plant species was recorded with reference to Braun-Blanquet (1932) method. Species identification were done immediately on the field, or later on with support of monographs like Troupin (1978, 1983, 1985 and 1988), Lebrun et Stork (1992-1997) and East Tropical Africa Monographs. Unknown plant species were collected and conserved at the Rwanda National Herbarium for later identification.

2.1.2. Birds survey

Three methods such as Mist-netting, Opportunistic sampling, Line transect and Opportunistic sampling methods were used for birds' survey. The abundance for each species was calculated by summing up the number of individual recorded (Tadesse et al., 2001).

2.1.2.1. Line Transect

The idea of walking around and counting all the birds detected has the appeal of simplicity and routes are selected in accordance with the aims of the study but are usually constrained by accessibility (Colin et al, 2000). One line transects was set on across the habitat types including littoral vegetation and in the savannah area. In each transect we moved slowly, sometimes stopped for a good observation and identification of hiding species, recording all sightings and calls. All the individuals in groups, when applicable, were recorded for the estimation of relative abundance.

2.1.2.2. Mist-netting technique used to capture birds

Advantages of mist-netting include variability in data when compared to procedures, which depend on extensive experience with sight and sound identification or judgment in compilation and analysis of field data (Karr, 1981a). Beside that mist-netting can provide a wealth of data in a relatively short period, mist nets are a powerful tool for detecting the presence of undergrowth bird species, particularly secretive species or those that vocalize infrequently. It should be noted, however, that the capture does not represent a strictly random sample of the avifauna since large species walking on the ground and less active species at levels above net operation are undersampled (Karr 1981b).

The birds were monitored using mist-nets of 6 meters length and 2.5 meters height within 1 days field work on each island.

The nets were placed on the ground level depending on the topography of the site, but often from 0-2.5 m (Photo 1). Those nests were placed in oriented West-East. The nests were opened at down (about 8:30) and checked at 30 minutes intervals until 12:00 when they were closed and removed for the next island. Identifications of captured birds were made with reference to Stevenson & Fanshawe (2002). All captured birds were recorded, and photographed for evidence.

Photo 1: A net with captured bird

2.1.2.3. Opportunistic observation

On one hand, nets only sampled the understory birds and transects or route of reconnaissance sampled birds that were singing and obviously moving near the route or transect line on the other hand. To complete the sampling, a quantitative sampling through general observation was also done. Binoculars were carried at all times in case of chance of sightings. Most of the time was devoted to looking for species along the trails trying to make sure that all the habitats available were covered.

2.1.3. Small mammals' survey

Surveying Small Mammals considered in this study was stratified sampling techniques. In fact, diversity of habitats was considered for trapping so to get as varied species as possible. Within

each habitat, living traps (Sherman live trap) were positioned along potential foraging or resting zones (Photo 2).

Photo 2: Living traps for small mammals

Traps were set in square grids of 15m×15m along transect at 20 meters of interval, along islands perimeters and some on top and middle altitudes. 4 trapping stations per grid had Sherman live trap hidden in tufted bush or thicket, on the base of trees. Baits used were dry *Limnotrissa* known as "indagara" with peanuts butter.

Traps were set for only one night in different stations all around an island and 4 to 6 stations were placed on each island depending on the size of the island which is not typical to standard methods. GPS was also used to record traps' positions.

Beside traps, local knowledge of biodiversity has been considered to complete the inventory. In fact, interviews with some selected local people were organized asking them small Mammals

names found on specified islands and showing them some related pictures for confirmation when necessary.

2.1.4. Reptiles and amphibians survey

Reptiles and amphibians were inventoried using direct observation. Tracking was concentrated mostly on islands' edges, in tufted grass and in areas with many rocks because they constitute the main habitat of reptiles and amphibians. Observations were done alongside transects and every time 10 minutes were spent in each position looking around and noting observed species of reptiles and amphibians. Sometimes, it was necessary to disturb some bushes with a long stick to see if any reptile or amphibian may show up as these animals are cryptic. As local population is an important source of information, a questionnaire was addressed to fishermen and other surrounding people to enrich collected information from the field.

2.1.5. Invertebrates survey

2.1.5.1. Inventory of invertebrates

Invertebrates' survey was conducted using transects and quadrat methods. Transects with 5m wide were set according to the shape, vegetation and the size of the island. Invertebrates were collected using the population estimates methods from line transects.

Two different models for this method were used: The static model that assumes that the animals are not moving and for that, animals are collected by moving stones and dead vegetation in transect and collecting all living organisms found there. The second model is the dynamic model which assumes that both the observer and the animal are moving (such as Lepidoptera where a net of 30 cm of diameter was used in the transect). The specimens were identified by using the keys of Davies (1988), Lepesme (1953); Grasse (1949); Borror and White (1970); and Picker et al. (2004).

2.1.5.2. Quantitative studies of arthropods, mollusks and flying insects

a. Quadrats method

Quadrat method was used to estimate the density of various invertebrates' taxa. A plot of 1 square meter was chosen as the minimum area (Soutwood, 1991) and different quadrats were

selected according to the vegetation and size of each investigated Island. In the quadrat, all organisms living inside were collected by moving stones and dead materials. The specimens found were kept in bottles containing formalin 10 % solution. Various taxa have been identified using the keys of Davies (1988), Lepesume (1953), Grasse (1949), Brown (1994), Needhan, (1962), Pilsbry (1919), Borror and White (1970), and Picker et al. (2004).

b. Relative methods using observation technical surface of flying insects

Flying insects were observed at a transect line of 5 m X 15 m in a specific site (Southwood, 1991). The number of transects were chosen according to the size of the Island. The specimen collected were kept in bottles containing formalin (10%) , sorted in various taxa they belong to and identified in the laboratory using the same keys as in quadrat methods.

2.1.5.3. Data analysis

a. Specific richness

The specific richness was calculated as the number of taxa in the sample. This was done for each taxa (order) in each transect.

b. Absolute density

The absolute density is the number of taxa found in 1 m^2. It is the average of specimens divided by the total number of samples collected in the quadrat divided by the quadrat area. In our case the quadrat area was 1 m^2.

c. Absolute density within transect

Absolute density that is calculated here is for flying insects and others. It represents the number of specimens of each taxa observed in the surface. It is absolute because it gives the number of individuals by area unit.

d. Statistic analysis

The statistic analysis was performed using X^2 and t-test to compare the difference between different islands.

2.2. Environmental and socio-economy survey

2.2.1. Spatial data collection

This includes the use of GPS and other appropriate tools for geographic data collection and islands mapping. Moreover, land use and land cover data were collected for all islands prospected, for a full description of the investigated ecosystems. The study site mapping was done using Arc GIS 9.

2.2.2. Socio-economy survey

To better understand the problems encountered by population living around the 9 Kivu islands investigated, the study used different approaches. This helped to assess people's conservation attitudes and development activities in the region, find out the threats from the local populations living around the main islands of Rutsiro, Nyamasheke and Rusizi Districts and assess the impact of local population on islands' biodiversity. Key data sources include: conservation stakeholders, local authorities in charge of social welfare, other relevant stakeholders, document report, records, databases, etc.

The study used both primary and secondary data. Primary data was collected using a mixture of both qualitative and quantitative techniques. Qualitative data was collected using less structured interviews and focus group discussion and non participant observation. Interviews were face to face. Quantitative data was collected using highly structured questionnaire which included both open and closed ended questions. Through document review, secondary data helped to know existing literature relevant to the study.

All those techniques would help to assess the following aspects: household structure (composition, size, basic needs {water, cooking fuel etc), property and assets, attitudes of people towards natural resources conservation methods, management and land use, policies for Kivu island conservation and management, agriculture (livestock, crops) and other income generating activities, relationship between livelihood and biodiversity, education, employment and health. Collected data were analyzed using SPSS for quantitative data and thematic analysis for qualitative data.

The target population was the local population that relies almost exclusively on islands' natural resources for their survival. The sample was selected by simple random sampling technique; sample size was 120 households from the three districts islands, that is 40 household from each district. Informed consent from subjects were obtained before participating in the study. Stakeholders including local staff in charge of population welfare and island conservation were interviewed to get information on existing policy.

CHAPTER III. RESULTS

3.1. Biodiversity inventory

Six taxonomic groups (plants, birds, invertebrates, mammals, reptiles and amphibians) were taken into consideration during the rapid biodiversity inventory conducted in studied Kivu Lake islands. Small mammals, reptiles and amphibians are generally poorly represented in the islands compared to the mainland due to their dispersal ability limitations. Most of these groups have been subject to predation mainly due to abundance of birds of prey in the region. Therefore, the islands are poor in mammal records as explained in further sections below, compared to other taxa for which table 1 gives a comparative view of species recorded in each island surveyed.

Table 1: Biodiversity inventory of the surveyed islands

ISLAND	PLANTS	BIRDS	INVERTABRATES
Mapfundugu Islands Complex	53	25	18
Karugaruka	33	10	13
Nyanamo	43	11	18
Karinga	42	12	17
Ishyute	65	23	25
Ireba	38	10	18

The findings indicate that there is a relationship between the diversity of some taxonomic groups (plants and birds specially) with the island's size, habitat variability, distance to the main land and time of vegetation recovery.

3.1.1. Mapfundugu Islands Complex

3.1.1.1. Description

Mapfundugu Islands Complex is located in Musasa Sector, Rutsiro District. It is formed of 4 grouped islands, with a total size of 103489.3 m^2 (Fig.4). The islands are respectively named:

- Mapfundugu I (43163 m^2)
- Mapfundugu II (29458 m^2)
- Mapfundugu III (3399.3 m^2)
- Mapfundugu IV (27469 m^2).

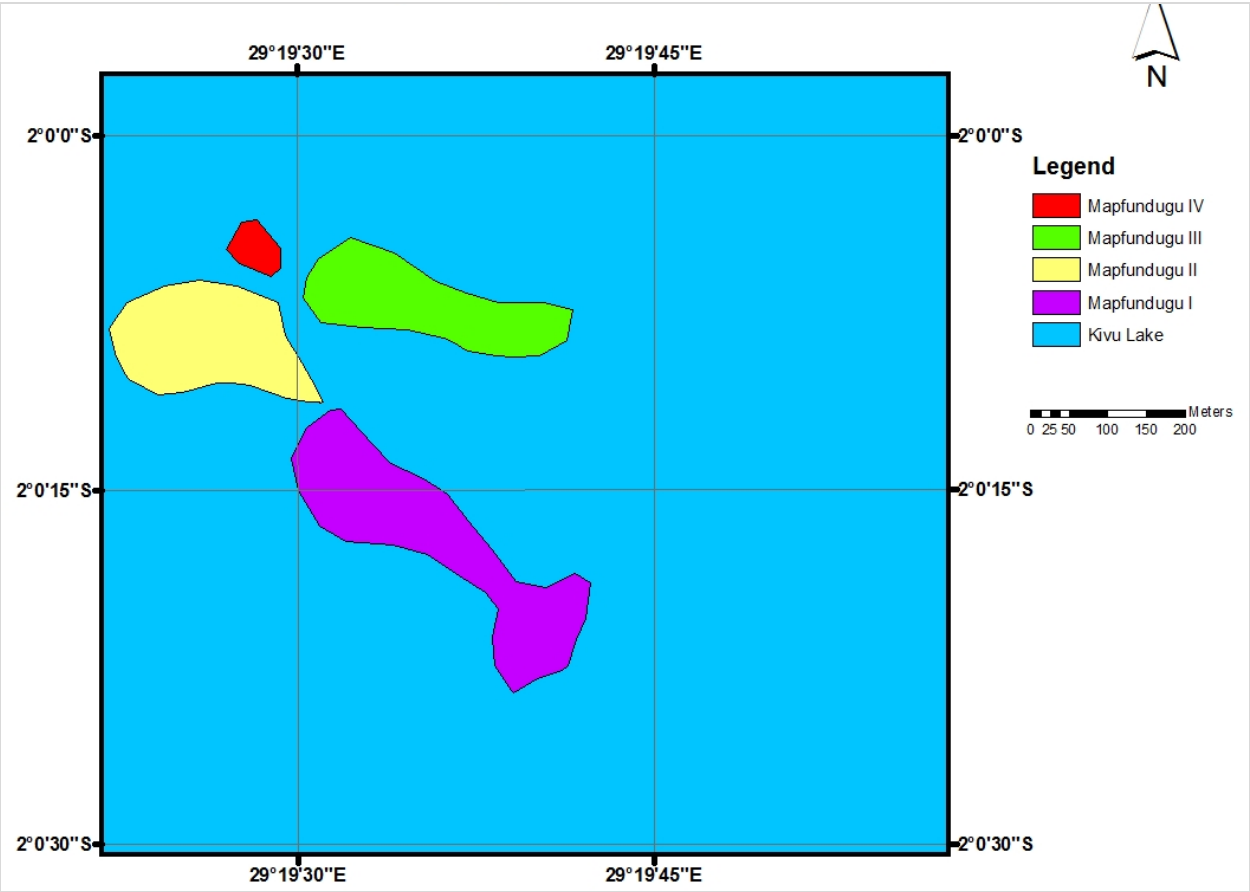


Figure 4: Map of Mapfundugu Islands Complex

The main characteristic of Mapfundugu islands is having varied ecosystems dominated by swamps, slopes on hill side and rocky zones.

3.1.1.1.1. Mapfundugu I

Located in the southern part of Mapfundugu Islands Complex, Mapfundugu I (Fig.5) is characterized by a relatively flat relief, and is almost divided in two islets at the east-southern side, with seasonal connectivity depending on the lake's water level. This island is commonly

known as Kimonyo's Islands, because it used to be owned by a certain KIMONYO and his family before they were resettled on the main land, three years ago.

Figure 5: Mapfundugu I viewed from Mapfundugu IV

Nowadays, the land still shows the signs of human presence without any natural vegetation, but rather with introduced plantations such as coffee, introduced fruit trees like avocados, guavas, ..., and different ornamental plants (*Yucca gloriosa*, *Agave sisalana*, lilies,…). There have been observed also some plants used for live fences (*Euphorbia tirucalli*), indicators of the places where buildings used to be erected. In other parts of the Island, almost all vegetation was cleared and the stark landscape started being colonized by *Clerodendrum johnstonii* (Photo 3).

Photo 3: Coffee and Euphorbia plantations (above) and colonization of *Clerodendrum* to previously cleared areas (below).

3.1.1.1.2. Mapfundugu II

Mapfundugu II is located in the East of the Complex, and is contiguous to Mapfundugu I, separated by a strip of lake water (Photo 4).

Photo 4: View of Mapfundugu II

The middle and East-Southern parts are characterized by rocky and shallow soil covered by grass savanna dominated by *Digitaria* and *Hyparrhenia* species and some species characteristic of degraded areas (Photo 5).

Photo 5: Open areas with grass on rocky land

Towards the North and West, granitic rocks are intercalated with the vegetation dominated by the species of *Acacia sieberiana* and *Ficus ingens* on the shorelines (Photo 6).

Photo 6: Dominant *Acacia* (above) and *Ficus* species (below) at Mapfundugu II.

This island is under human pressure and people continue to carry out different activities even if it is not inhabited. Indeed, the activities related to cattle keeping (with shepherds huts and fresh cow dung) have been observed but no cow was met because they move from one island to another searching for tender pasture (Photo 7).

Photo 7: Signs of cattle keeping at Mapfundugu III

In addition, some activities related to tree cutting were observed as well (Photo 8).

Photo 8: Tree cutting activities

3.1.1.1.3. Mapfundugu III

This is the smallest island of the Mapfundugu Islands Complex, made of a single steep hill dominated by dense bushes of lianas and shrubs made essentially of *Acacias* at the hill side. The island is bordered by *Phragmites*, *Ficus* and some *Euphorbia* species (Photo 9).

Photo 9: View of Mapfundugu III

At the top, the soil is rocky and holds savannah vegetation dominated by *Hyparrhenia* sp, *Panicum sp*, *Cynodon* sp, *Maytenus* sp and various Lamiaceae plant species. Some species of *Aloe* sp were also identified at the top hill (Photo 10).

Photo 10: View of the top hill of Mapfundugu III.

3.1.1.1.4. Mapfundugu IV

Mapfundugu IV is located at the eastern side of the complex, and is made of three connected hills (Photo 11). The soil is relatively deep and covered by dominant herbaceous and shrub layers at the hillsides of the island, with scattered *Euphorbia candelabrum* and *Acacia hockii* species. At the lake shores, the island is bordered with *Ficus* and *Acacia* species. At the top of the hills, the soil is rocky and is dominated by a vegetation of grass savannah.

Photo 11: View of Mapfundugu IV

In some parts of the island, there have been found many introduced species including guavas and Eucalyptus plants. In addition, other indicators of human presence consist in the existence of the sites of lime extraction at the island (Photo 12)

Photo 12: Some indicators of human influence at the island

3.1.1.2. Flora and vegetation

The vegetation types found at the four islands making Mapfundugu Islands Complex are almost similar. Ecologically, four islands making Mapfundugu Islands Complex islands share similar environmental conditions; the difference resides only at the extent and level of human activities at each of them. A list of recorded plant species at all Mapfundugu Islands is found in appendix 1, table 1.

Key plant species

***Acacia sieberiana* DC. var. *woodii* (Burtt Davy) Keay & Brenan (Family: Fabaceae)**

Local names: Umunyarugera, Umunyinya. **English name:** Paperback acacia.

Ecology and distribution: It grows in wooded grassland, bushed grassland and riverine forest. *Acacia sieberiana* is widespread in Tropical and Southern Africa. In Rwanda, this species can be found in many places near households and in the Akagera National Park.

Uses: Apart from providing shade and avenue, this species is also used as a source of firewood, charcoal, fodder (leaves and fruits), medicine (leaves, bark and gum) and bee forage.

Photo 13: ***Acacia sieberiana***

Euphorbia candelabrum **Tremaux ex. Kotschy (Family: Euphorbiaceae)**

Local names: Umuduha. **English names:** Candelabra euphorbia, Tree euphorbia.

Ecology and distribution: It grows in thickets, bushlands and wooded grasslands especially on rocky hillsides and on termite mounds. It is *a* very common tree of very dry areas of East and Central Africa to South Africa. In Rwanda, this species grows naturally in Akagera National Park and Bugesera.

Uses: Ornament, firewood, timber (roofing, doors), shade, beehives, drums, carvings, ceremonial, night torches (dry branches), insect repellent (smoke of wood) and live fence.

Remarks: The latex is very poisonous and blinding if drops into the eyes.

Photo 14: ***Euphorbia candelabrum***

Euphorbia dawei **N.E. BR. (Family: Euphorbiaceae)**

Local name: Umurara. **English name:-**

Ecology and distribution: The species of lowland savannas in the Lake Victoria Mosaic Center of endemism. It grows in wooded ravines. It is an endemic species of Albertine Rift.

Remarks: *E. dawei* is a rare species found in Rwanda only in Kivu islands. It was recorded in Rusizi plain in Burundi, but now it is completely extinct. This species is listed in appendix II of CITES.

Photo 15: *Euphorbia dawei*

***Ficus cyathistipula* Warb. (Family: Moraceae)**

Local name: Imvubuvubu. **English name:-**

Ecology and distribution: Moist soil and hillsides. Widespread from West to Central and East Africa. In Rwanda, it is found in different Lake Kivu Islands

Uses: Used for shade and for ornamental purposes because of its aerial roots.

Photo 16: *Ficus cyathistipula*

3.1.1.3. Birds

A total number of 25 bird species was recorded by sights and/or sounds during opportunistic and line transect sampling Among the recorded species *Estrilda astrild* (Common waxbill) (Photo 17) was the most abundant (12 individuals). Appendix 2 table 1 shows the preliminary bird checklist of Mapfundugu Islands Complex and their abundance.

Photo 17: *Estrilda astrild*

(source: http://rwandaonthewing.blogspot.com/ accessed on 27 June, 2012)

3.1.1.4. VERTEBRATES: Small Mammals, Reptiles and Amphibians

During our investigation, no mammals was found on all Mapfundugu Islands, although we assume that some rats could be hiding and not caught in the living traps set. This information has been confirmed by local population who stated that two kinds of rats can be observed in the area. According to the description provided, they could be shrews and rats.

On the other hand, reptiles were also difficult to encounter but only two lizards were seen exposing to sun heat (Photo18).

Amphibians are rare also but only one *Bufo gutturalis* was recorded. In fact, as it was raining much of the time, reptiles and amphibians were not showing too much.

Nevertheless, following information coming from local population, several *Naja melanoleuca* (idubi) can be found and they are very venomous. Some their cows have already been victim of bites from that serpent.

Photo 18: *Trachylepis varia* (left); *Bufo gutturalis* (right)

3.1.1.5. Invertebrates

At Mapfundugu Islands Complex, 18 species of invertebrates grouped in six classes and 14 orders were identified within plots.

Like in all habitats on earth where the insects make 2/3 of all arthropods (Campbell, 1999), the class of insects was most represented (425 individual in total out of 583) followed of Myriapoda with 82 individuals (Fig.6).

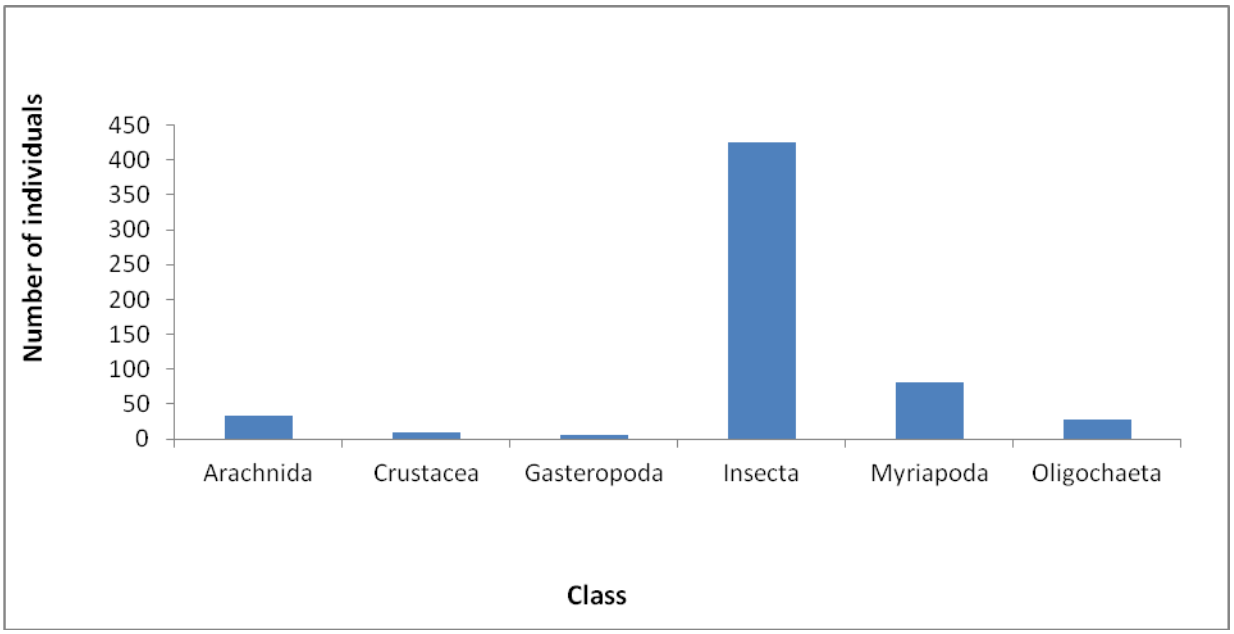


Figure 6: Invertebrates class distribution within plots at Mapfundugu Islands Complex

Considering orders, the order Hymenoptera is most represented while the orders Thysanura and Collembola are less represented (Fig.7).

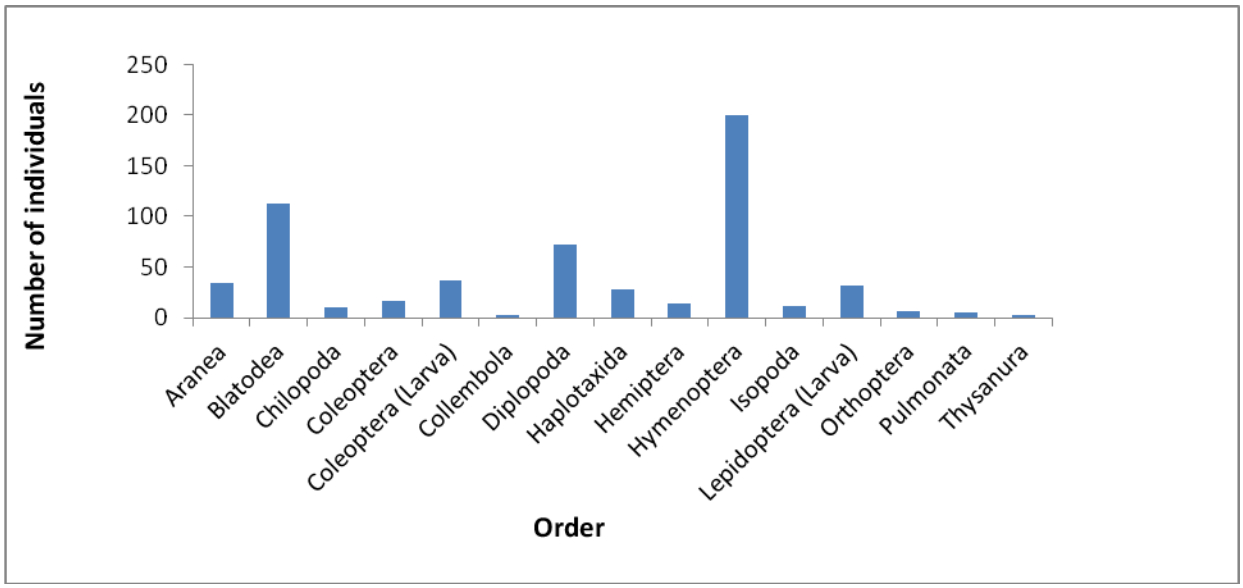
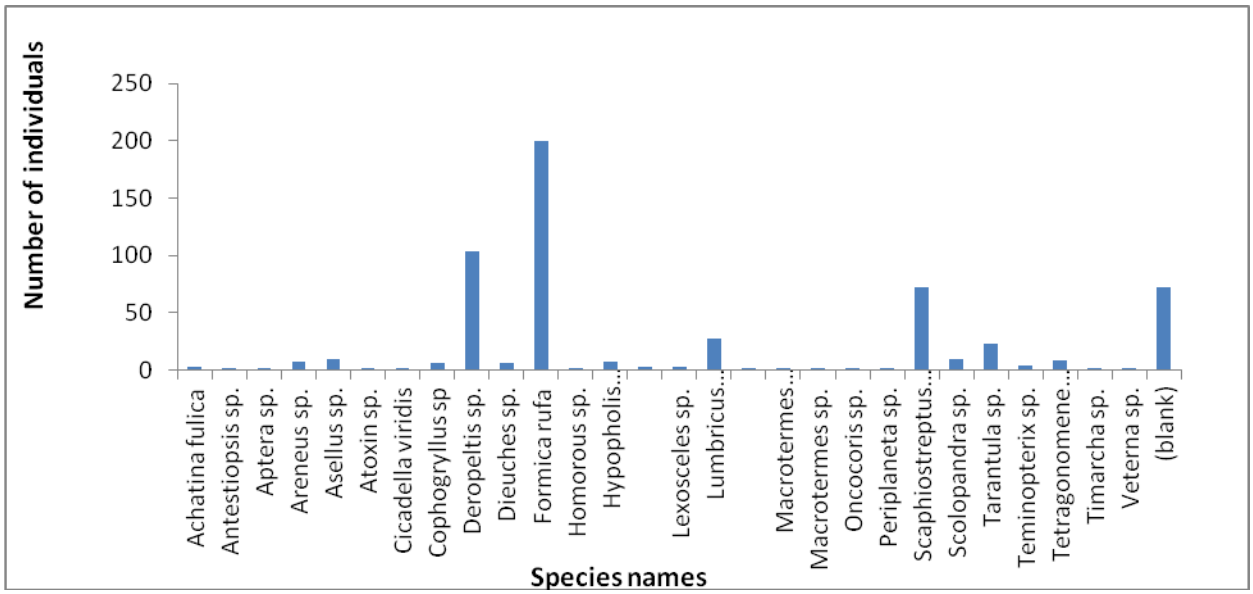


Figure 7: Order distribution within plots at Mapfundugu Islands Complex

This figure shows that the order hymenoptera came at the first place followed by Diplopoda and Blatodea which are represented by litter like species including millipedes and cockroaches. Eighteen species were identified (Fig.8).



Blank: Unidentified species

Figure 8: Invertebrates species identified at Mapfundugu Islands Complex

From this figure, we note that the species *Formuca rufa* (ants) and *Deropeltis sp (*cock roaches*)* are abundant and then follow *Scaphiostrepyus parillis (*millipedes*).* The African land snail *(Achatina sp) was* only found at this place. The blank which represents the unidentified species is mainly made of Coleoptera and Lepidoptera larva as the larva were classified in their respective order, but it was not easy to classify them till species level (Photo 19).

Photo 19: Coleoptera larva (Left); African land snail (*Achatina sp*) (Right)

Flying invertebrates mainly insects and other terrestrial invertebrates recorded along the transect are shown in figure 9

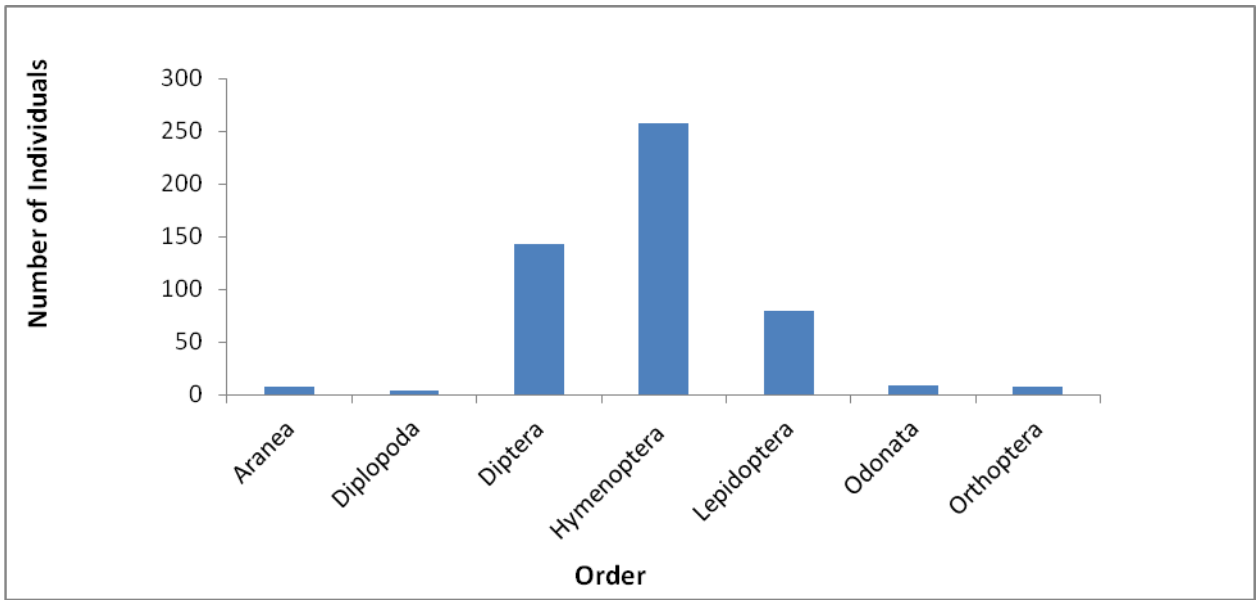


Figure 9: Orders distribution within transects at Mapfundugu Kivu Island

The most flying invertebrates were Hymenoptera (ant, wasp, honey bees); Diptera (flies, mosquitoes,) and Lepidoptera (butterflies) . Order Aranea represented by spiders and Diplopoda (millipedes) were mostly observed, where as the dragon flies (Odonata) were observed on the edge of the lake (Photo 20).

Photo 20: Millipedes (left); Dragon fly (right)

3.1.2. KARUGARUKA ISLAND

3.1.2.1. Description

Karugaruka Island occupies a surface area of 10105 m^2. It is located in Musasa Sector, Rutsiro District (Fig.10).

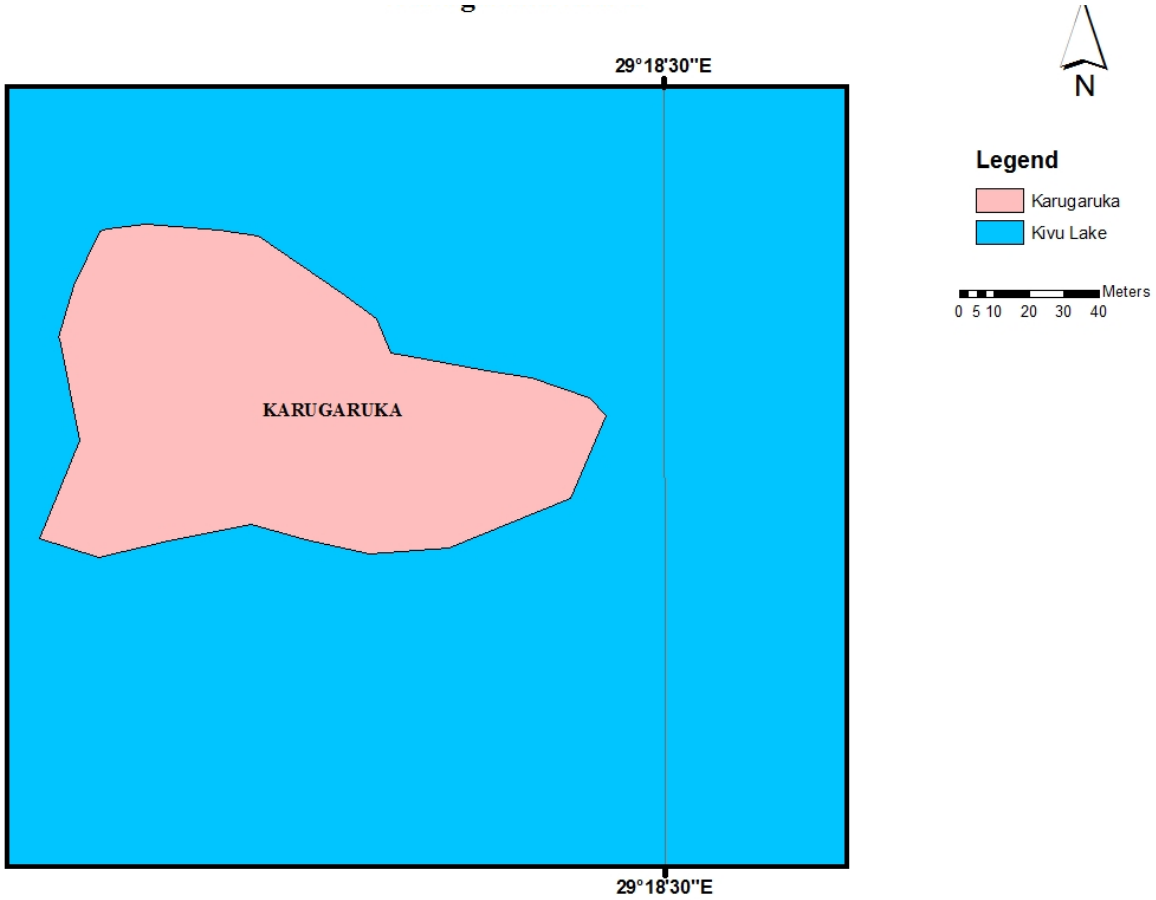


Figure 10: Map of Karugaruka Island

Karugaruka is the smallest island compared to other surveyed (Photo 21).

Photo 21: View of Karugaruka Island

The vegetation structure of the island is also different; trees are abundant on the top which cause an intermediate canopy and herbs are at the bottom around shores of the eastern part and *Ficus sp*. on the western part. The soil is covered by many rocks. This Island also shows intense human activities like grazing. A place where the cows stay for a long time was also found there (Photo 22)

Photo 22: Cows keeping at Karugaruka Island

3.1.2.2. Flora and vegetation

The species collected are found in appendix 1, table 2. The main dominant species were *Rhus natalensis*, *Indigofera erecta*, *Solanecio manii*, *Sarcostemma viminale*, *Agave sisalana*, …

Key plant species

***Rhus natalensis* Krauss (Family: Anacardiaceae)**

Local name: Umusagara. **English name:** Natal rhus

Ecology and distribution: *R. natalensis* is widespread in Tropical Asia, also found in Africa from Guinea to Somalia, Eastern and Central Africa, south to South Africa. It grows in wooded savannas, forest edges and riverine forest. In Rwanda, this species is found in low and medium altitude areas including Akagera National Park, Bugesera, …

Uses: Firewood, charcoal, timber, farm tools, food (fruit), medicine (bark, roots and leaves), fodder (leaves), ornament, shade, dye (bark of roots) and toothbrushes (stems).

Remarks: This is the most widespread and commonest *Rhus* species in Rwanda. The firewood produces a lot of sparks when it burns making it inconvenient for heating and cooking.

Photo 23: *Rhus natalensis*

***Sarcostemma viminale* (L.) R.Br. (Family: Asclepiadaceae)**

Local name: Ubuyenzi. **English name:** Sarcostemma, Caustic vine, Caustic bush.

Ecology and distribution: *S. viminale* grows in shade in closed tree/shrub community, open tree savanna and open shrub/tree savanna. It is widespread in East Africa. In Rwanda, the species is common in Akagera National Park and Bugesera.

Uses: Forages, fruits, medicinal plants (and magic), vegetables

Photo 24: *Sarcostemma viminale*

***Agave sisalana* Perrine (Family: Agavaceae)**

Local names: Umugwegwe. **English name:** Sisal

Ecology and distribution: Sisal is a hardy tropical plant needing full sunlight and moderate relative humidity. *Agave sisalana* is probably of southern Mexican origin, but it is widespread in tropical Africa.

Uses: The main sisal product is the long fibre (‘line fibre’) from the leaves, which constitute the major part of the ‘hard fibres’ of commerce. The long and straight inflorescence stalks are used for house construction, fencing and thatching.

Photo 25: ***Agave sisalana***

3.1.2.3. Birds

A total number of 10 bird species was recorded at this Karugaruka Island, by sights and/or sounds during opportunistic and line transect sampling and mistnetting methods (appendix 2, table 2). Among the recorded species *Chlorocichla flavicollis* was the most abundant (7 individuals) (Photo 26)

Photo 26: *Chlorocichla flavicollis*

3.1.2.4. VERTEBRATES: Mammals, Reptiles and Amphibians

No animal vertebrate was captured during the survey at Karugaruka Island, except some molting skins of snakes probably living in the surroundings (Photo 27). This can testify that reptiles are not too common on that island. However, interviewed population especially herdsmen confirmed abundance of Chameleons and existence of some black snakes. The latter should be Najas like *Naja nigricollis* and *Naja melanoleuca*.

Photo 27: Some reptiles molting skin at Karugaruka Island

3.1.2.5. Invertebrates

Figure 11 represents class distribution of the invertebrates collected at Karugaruka island.

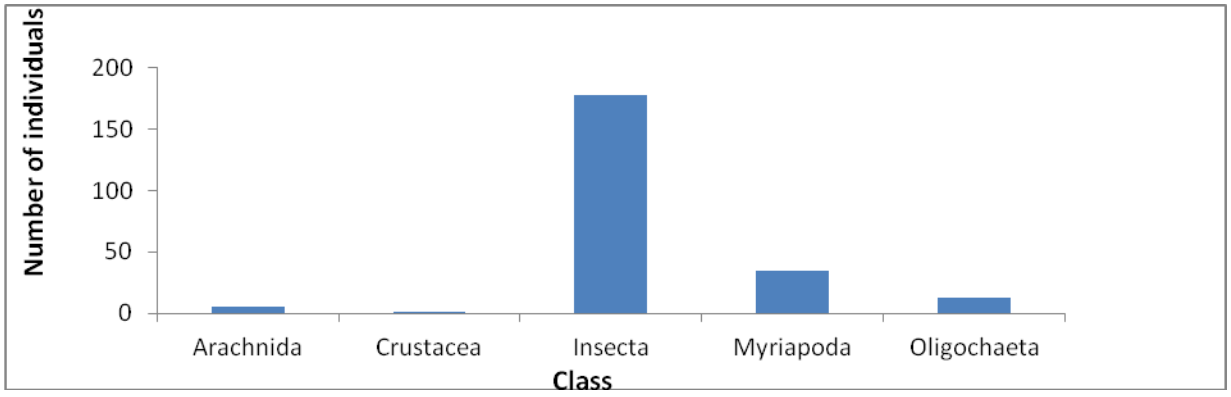


Figure 11: Class abundance within plots at Karugaruka Island

The class of Insects is most abundant while Crustacea is the least abundant.

On the other hand, the distribution of the orders is shown on figure below.

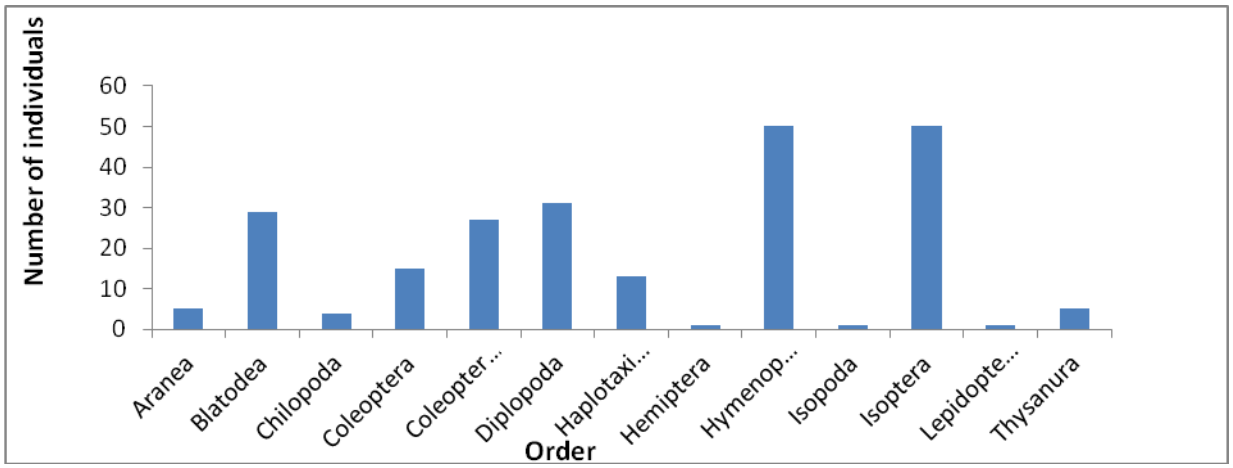


Figure 12: Order distribution within plots at Karugaruka Island

The most represented orders are Hymenoptera and Isoptera with 50 individuals for each, while Hemiptera, Isopoda and Lepidoptera larva are least abundant. This information is very interesting because abundance of Isoptera attracts birds which feed on them. They have seasonal activity variability and allow plants growth and involved in food webs in Kivu Lake especially for migrating birds which visits Kivu islands on specific periods. Hymenoptera are mainly involved in pollination and nutrients recycling while Blatodea intervene in decomposition of organic matters and therefore make available minerals for plants. They constitute also food to many birds.

The identified species are displayed in figure 13

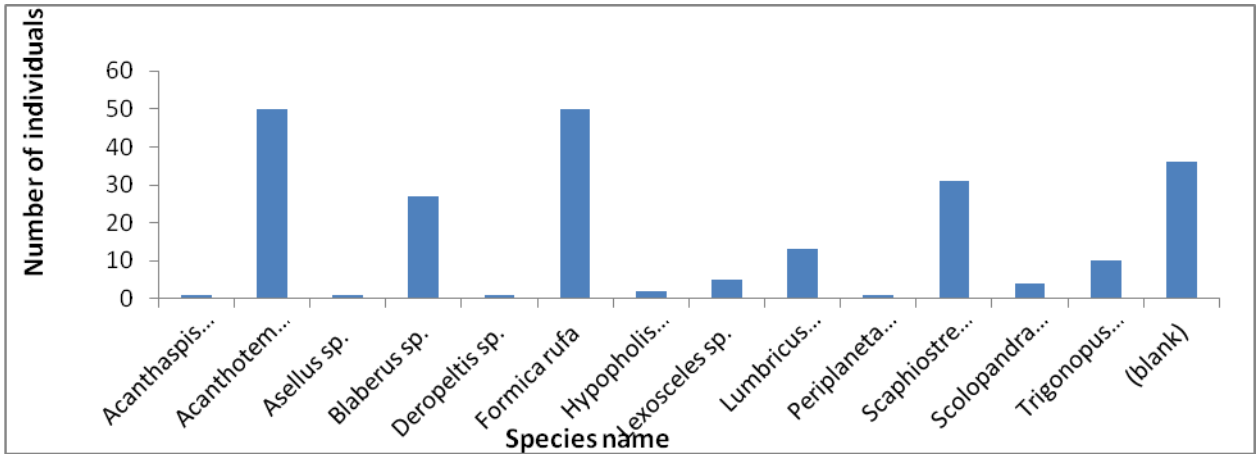


Figure 13: Species abundance within plots Karugaruka Kivu Lake Island

The most abundant to the island are *Forumica rufa* and *Acanthotermes sp*. The big number of unidentified species represented by blanks on the figure is due to the big number of Coleoptera and Lepidoptera larva as it is shown in the fig 19 on order distribution whose identification based on morphology traits is not easy. Further research especially on Coleoptera should be conducted for their deep identification.

The distribution of the species in the orders is displayed in the following figure:

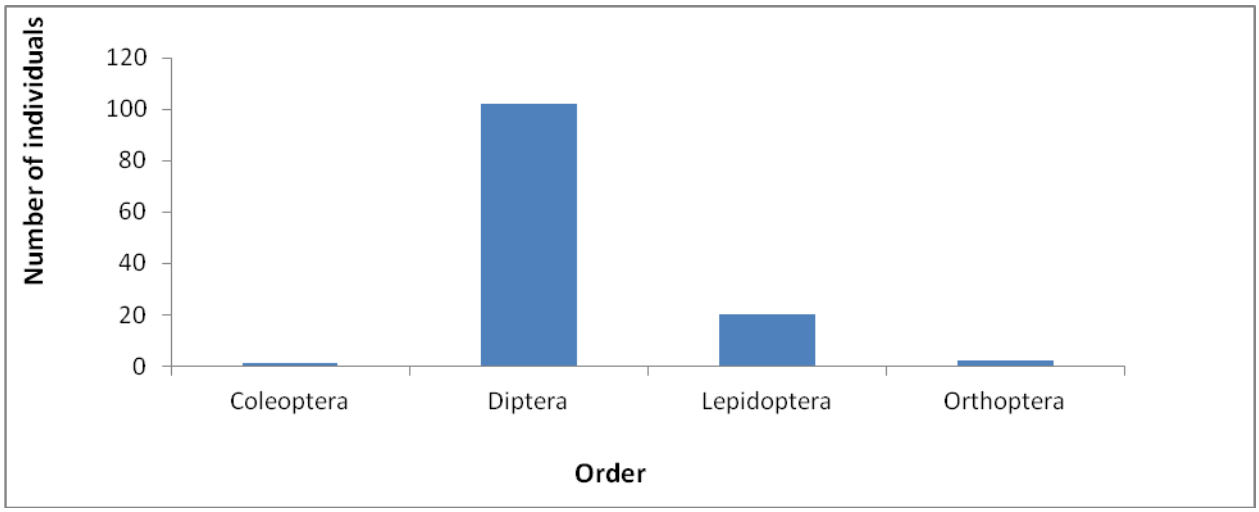


Figure 14: Order distribution within transect at Karugaruka Island

The figure shows that order Diptera is most abundant, while Coleoptera is the least.
This few number of invertebrate orders within transect is probably due to the small size of the island and isolation

3.1.3. NYANAMO ISLAND

3.1.3.1. Description

Nyanamo is an Island located in Rutsiro District, Boneza Sector. The surface area of Nyanamo is 80908 m^2 (Fig.15).

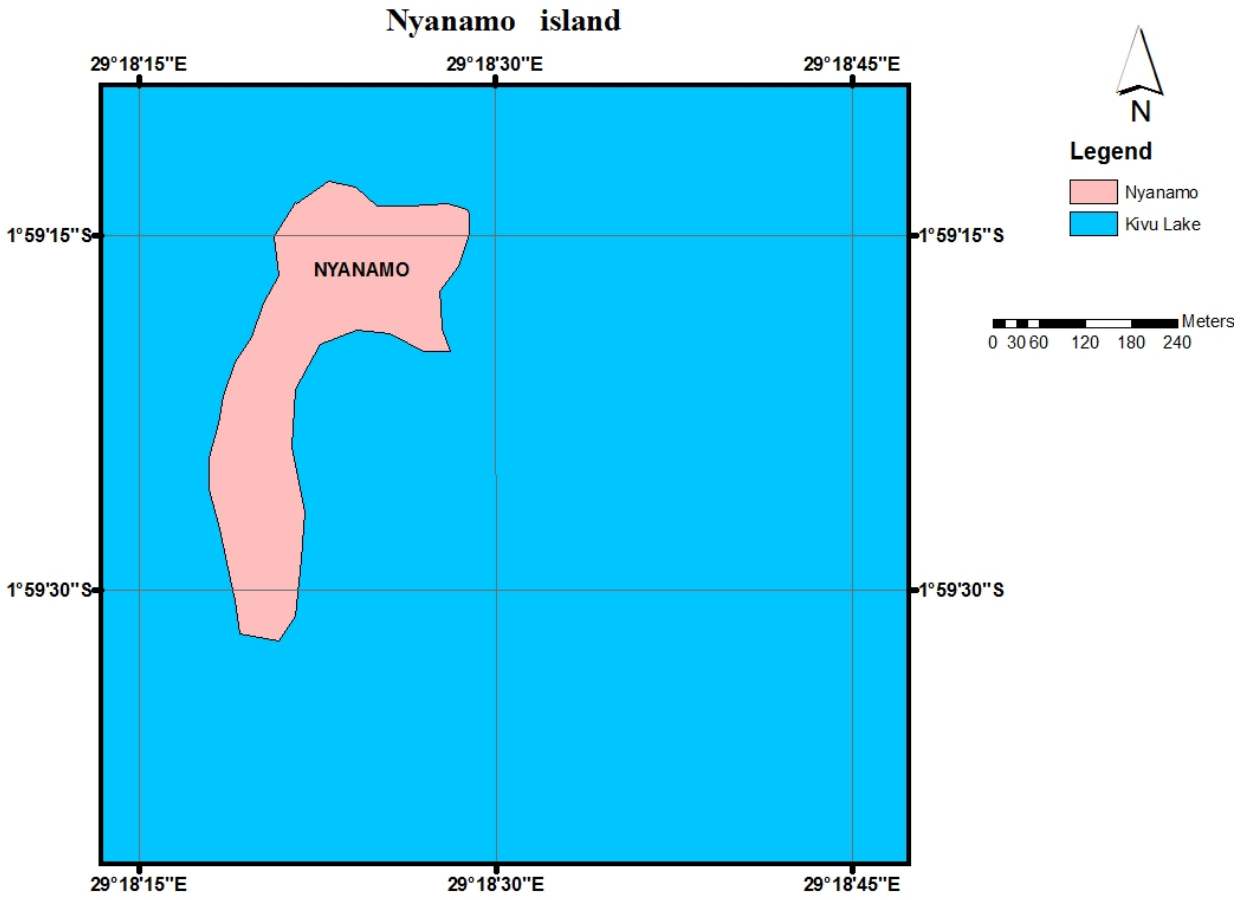


Figure 15: Map of Nyanamo Island

Nyanamo Island is composed of two hills (Photo 28). The soil is dry and rocky covered mainly by grass savannah dominated by *Hyparrhenia variabilis* toward the hilltop.

Photo 28: View of Nyanamo Island

The island is much disturbed mainly due to cattle keeping and habitat destruction by the farmers (some cows were even met grazing at the island during the field visit). Additionally, many traces indicate human settlements, such as the remains of old buildings as well as banana and coffee plantations (Photo 29)

Photo 29: Current activities and traces of human influence at Nyanamo Island.

Natural vegetation has almost disappeared, only some species of *Ficus ingens* border at the lake shores. In the southern part of the island, the soil is humid and dominant plant species include the shrubs of *Tithonia diversifolia* and diverse fruit trees (avocados, guavas…)

The northern part is characterized by dry grass savannah growing in scattered and abundant rocks (Photo 30). Some species of *Eucalyptus* have also been observed.

Photo 30: Rocks on the hill top of Nyanamo Island.

3.1.3.2. Flora and vegetation

As discussed above, Nyanamo Island does not hold much natural vegetation, but some few remaining species can be found. A complete list of some species recorded at Nyanamo is in appendix (appendix 1, table 3).

Key plant species

***Entada abyssinica* Steud. ex A. Rich. (Family: Fabaceae)**

Local names: Umusange, Umusangasange. **English name:** Tree entada.

Ecology and distribution: It grows in wooded grassland, riverine forests and wet forest edges. Widespread in Sudanian and Guinean savannas to the South border of the Sahel, to East and South Africa. In Rwanda, this species can be found in many places, particularly in the Eastern Province.

Uses: Many medicinal and fetish uses: leaves; tonic tea, wound healing, contains rotenone and tannins, bark abortive, roots have antidotal effects against various toxic agents and fish poison (ichtyotoxic), nitrogen fixation, shade and live fence.

Photo 31: ***Entada abyssinica***

Bambusa vulgaris **Wendl. ex Nees (Family: Poaceae)**

Local name: Umugano. **English names:** Yellow bamboo, Golden bamboo, Feather bamboo.

Ecology and distribution: *B. vulgaris* is an exotic species which is commonly found in humid areas especially in riverbanks, along streams and ground water vegetation. In Rwanda, is has also been introduced as an ornamental plant in Arboreta and gardens in many towns.

Uses: Soil conservation and erosion control, agroforestry, vegetable (young shoots), ornament and raw material for building and making paper, arts and crafts.

Photo 32: *Bambusa vulgaris*

***Synadenium grantii* Hook.f. (Family: Euphorbiacceae)**

Local name: Umukoni. **English name:** African milkbush

Ecology and distribution: *Synadenium grantii* is xerophytic and thrives on rocky hills with dry open woodland in the east African uplands.

Uses: In Rwanda and Burundi the latex is applied to cure syphilis. Tthe latex is also an ingredient of arrow poison.

Remarks: *S.grantii* has long been recognized as being very toxic and irritant. Contact of the latex with the skin or mucous membranes will cause a burning sensation, dermatitis and blisters. Symptoms may not be developed immediately and can be delayed for hours.

Photo 33: *Synadenium grantii*

3.1.3.3. Birds

A total number of 11 bird species was recorded by sights and/or sounds during opportunistic and line transect sampling and mistnetting methods (appendix 2, table 3). Some of the species recorded include *Phyloscopus trochilus* and *Nectarinia erythrocerca* (Photo 34).

Photo 34: *Phyloscopus trochilus* (left); *Euplectes orix* (right)

3.1.3.4. VERTEBRATES: Mammals, Reptiles and Amphibians

The animal biodiversity is represented by some lizards and no amphibians. All live traps have not captured any small mammal. This confirmed the information from local population saying that no mice were living in the Island.

3.1.3.5. Invertebrates

Like in the previous islands, the class Insecta is the most represented followed by Oligochaeta. The class of Gasteropoda is least represented on the Island. Class distribution is presented in figure 16.

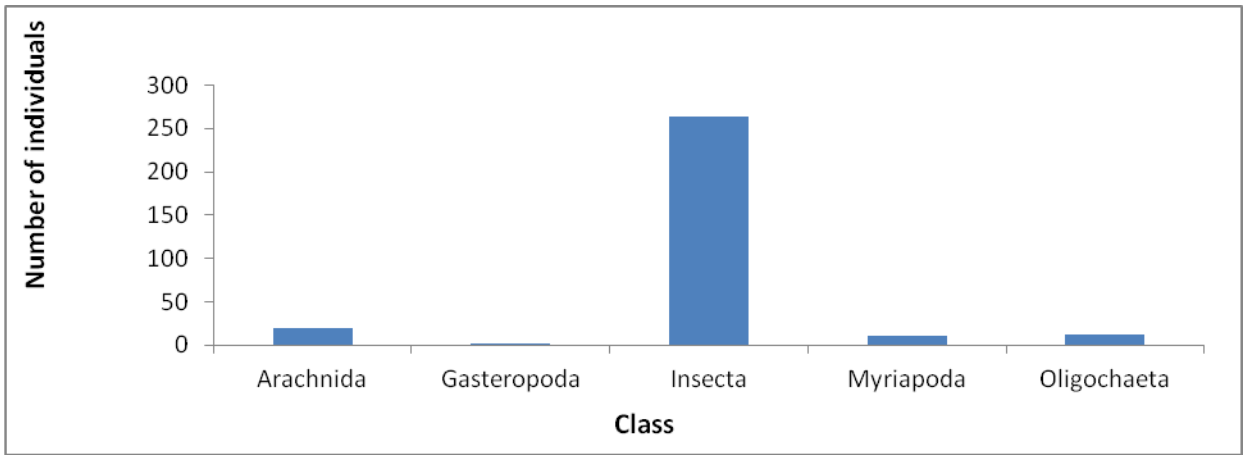


Figure 16: Class distribution within plots at Nyanamo Island

The presence of oligochaeta and gastropoda is due to the soft soil and vegetation cover where plots were set.

The distribution of orders is given in figure 17.

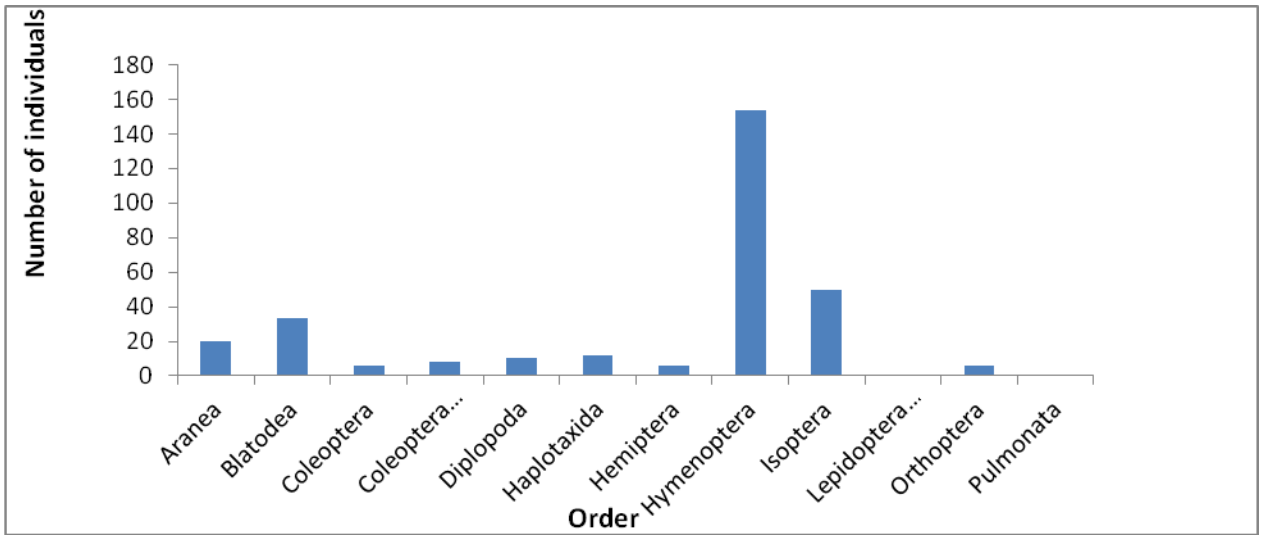
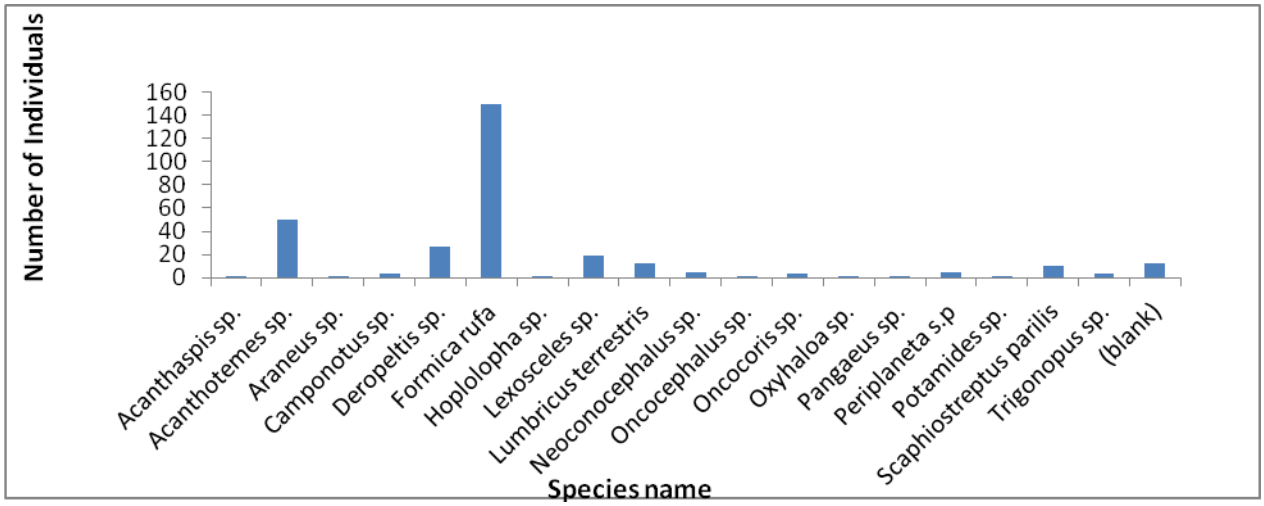


Figure 17: Order distribution within plots at Nyanamo Island

Among 11 orders recorded on Nyanamo Island, Hymenoptera, Isoptera, Blatodea are the most abundant respectively while Pulmonata and Lepidoptera larva are least abundant. The order haplotaxida on the island should be due to the soft soil which makes its favorite habitat.

The species diversity and their abundance are presented in the figure 18.



Blank : Unidentified

Figure 18: Species abundance within plots Nyanamo Kivu Lake Island

It is shown that most abundant species are *Forumica rufa*, *Acanthotermes sp*. The unidentified species (blanks) include the larva of Coleoptera and Lepidoptera.

Recorded invertebrates along transect are represented in the following figure.

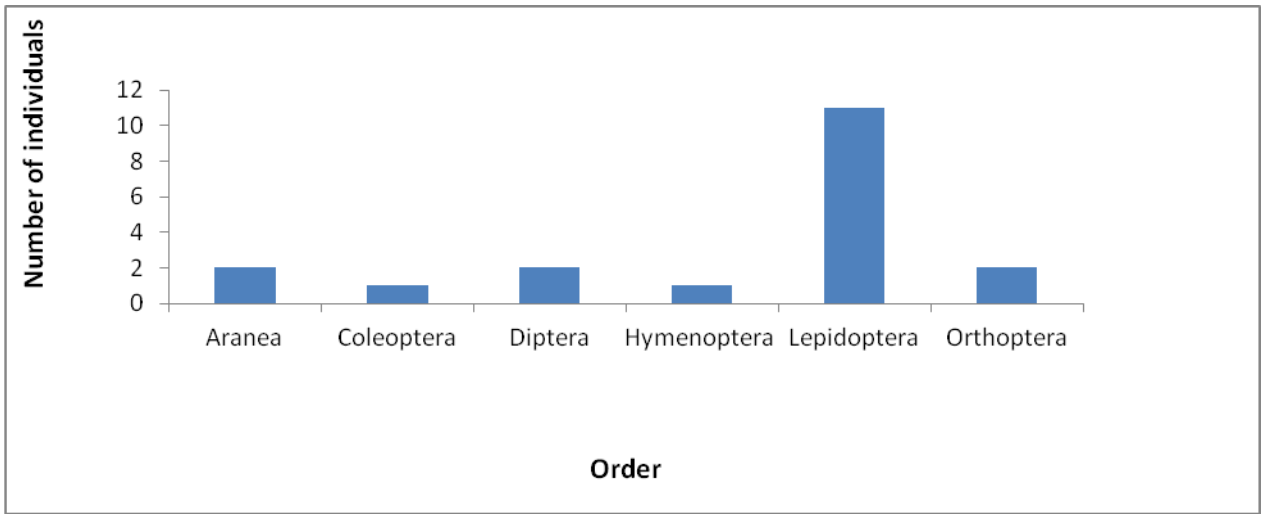


Figure 19: Order distribution within Transect at Nyanamo Island

Figure 19 shows that most abundant order within transect is Lepidoptera, while Coleoptera and Hymenoptera are least abundant.

3.1.4. KARINGA ISLAND

3.1.4.1. Description

Karinga is an island of 27177 m^2 located in Musasa Sector, Rutsiro District (Fig 20).

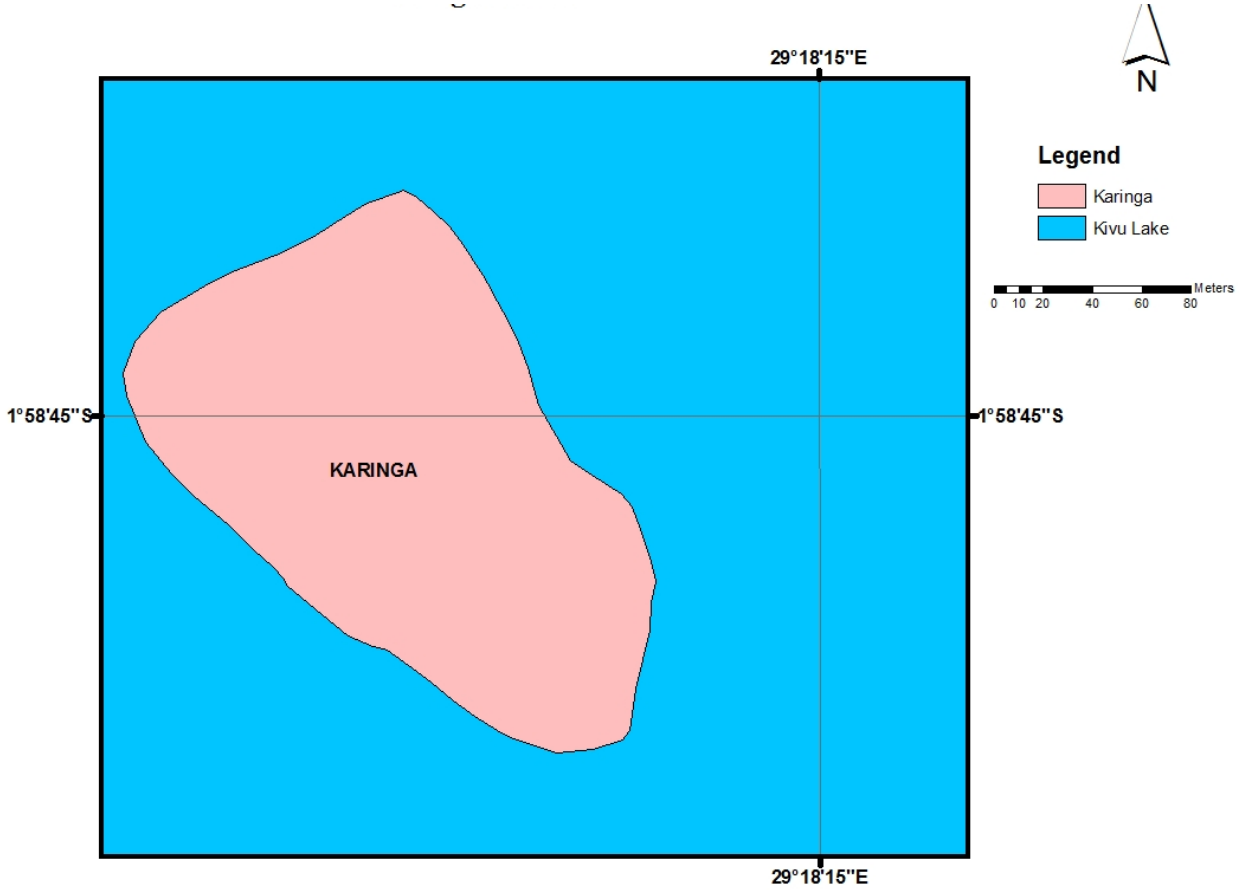


Figure 20: Map of Karinga Island

The soil of Karinga Island is shallow and dominantly rocky. The eastern part is covered by humid and rocky land and the top is mainly covered by herbs and different exotic species like: Cypress, Pines, Eucalyptus and fruit trees like Guava and Mangoes. The soil becomes rocky towards the top hill with scattered herbaceous layer dominated by *Digitaria abyssinica* (Photo 35).

Photo 35: View of Karinga Island (above); top hill of the island (below)

3.1.4.2. Flora and vegetation

Ssome species recorded at \Karinga Island are describe below. A full list is attached in appendix 1, table 4

Key plant species

***Dodonaea viscosa* Jacq. (Family: Sapindaceae)**

Local name: Umusasa, Umusamanzuki. **English names:** Hopbush, switch sorrel, sand olive

Ecology and distribution: It occurs in coastal bushland, on the landward side of mangrove forest, on sand dunes and coral rock mostly just above the high water mark. It is found in West Africa, East Africa and Madagascar. In Rwanda, it was recorded in Kivu islands and in Nyungwe National Park

Uses: It is a traditional medicine worldwide, administered orally or as poultice to treat a great variety of ailments: sore throats, colds, fever, rheumatis, itching, digestive system disorders, stimulate milk production after giving birth and to treat dysmenorrhoea and irregular menstruation.

Photo 36: *Dodonaea viscosa*

***Anthocleista schweinfurthii* Gilg (Family: Loganiaceae)**

Local name: - **English name**: -

Ecology and distribution: It occurs in secondary forest, gallery forest, in thickets and sometimes in savanna or rainforest, usually not in moist localities. *Anthocleista schweinfurthii* occurs from Nigeria east to Ethiopia and south to Tanzania, Zambia and Angola. In Rwanda, the species is also found in Mashyuza, Bugarama.

Uses: The species is locally used to cure madness. In Congo a stem bark decoction is taken to treat hernia and female sterility. A root decoction is taken to treat stomach-ache in women, ovarian problems, venereal diseases, hernia, bronchitis and fever, and also as a purgative and to induce labour. In Tanzania a root decoction is taken to treat malaria, hard abscesses and as an anthelminthic. A bath is taken in a leaf decoction to treat vaginal prolapse. The plant is also used to prepare arrow poison.

Photo 37: *Anthocleista schweinfurthii*

***Solanecio mannii* (Hook.f.) C.Jeffrey (Family: Asteraceae)**

Local name: Umutagara. **English name:** -

Ecology and distribution: Montane rainforests, usually at edges or on clearings, also in grassland and on cultivated ground. Endemic to Central and East Africa. In Rwanda, it is widespread in Nyungwe National Park and abundant in Western and Southern Province.

Uses: Fence-posts, poles, sticks, used in traditional medicine against poisoning, splenic fever, leprosy and to treat snake bites. The roots are used against rheumatism.

Photo 38: *Solanecio mannii*

3.1.4.3. Birds

A total number of 12 bird species were recorded by sights and/or sounds during opportunistic and line transects sampling (appendix 2, table 4). Among the recorded species *Nectarinia erythrocerca* was the most abundant (14 individuals) (Photo 39).

Photo 39: ***Nectarinia erythrocerca***

3.1.4.4. VERTEBRATES: Mammals, Reptiles and Amphibians

Animal biodiversity is made of lizards, many bird species feeding of fruits and in the lake. On hill tops, herbs are a bit higher but still no vertebrate was encountered.

3.1.4.5. Invertebrates

The class of insects is the most represented in this island followed with the isoptera
Main identified classes are represented in the figure 21

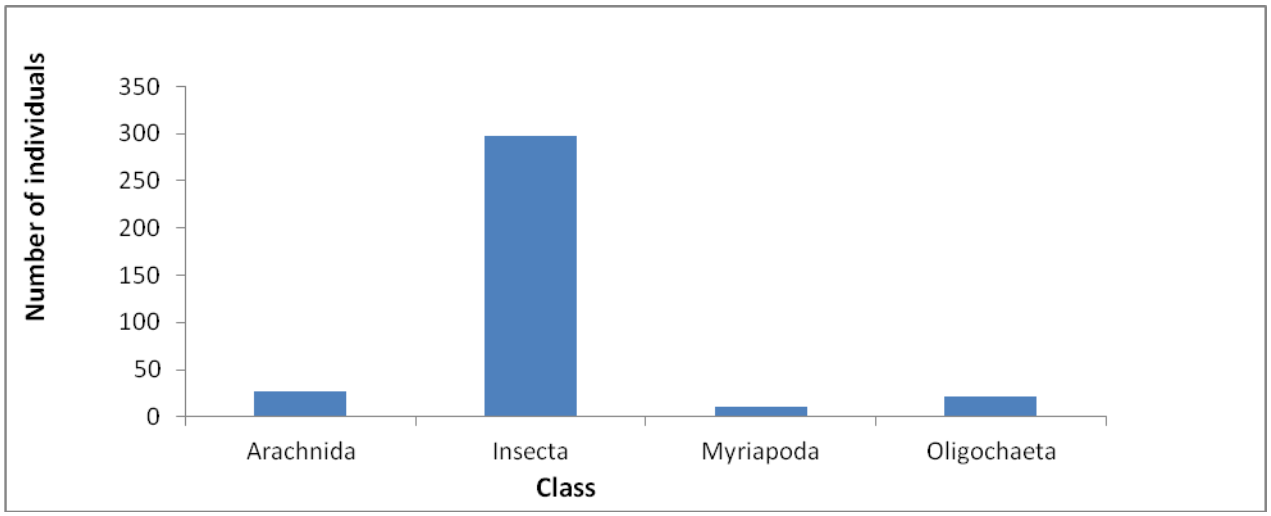


Figure 21: Class distribution within plots at Karinga Island

After the class Insecta and Aranea, Oligochaeta came to the third place. By considering the orders representation, *Hymenoptera* was found to be the most represented (Fig 22)

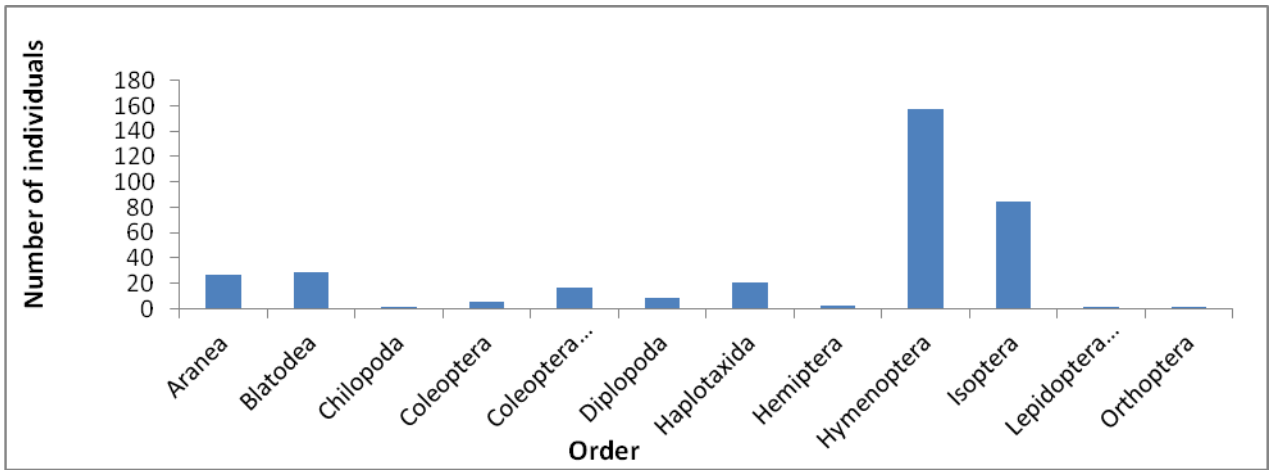
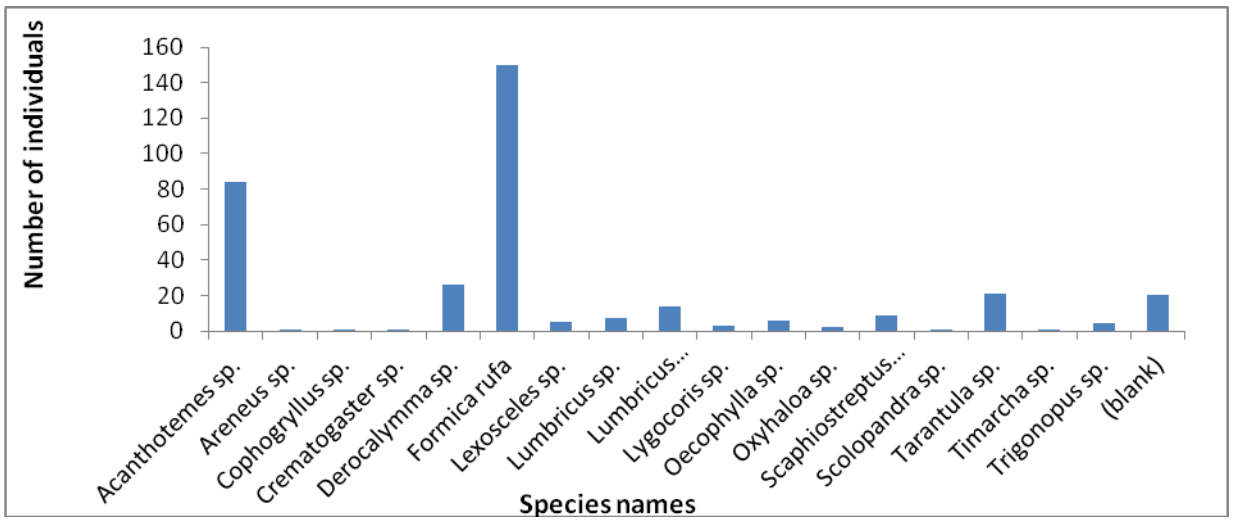


Figure 22: Order distribution within plots at Karinga Island

The coleopterans are split into two in order to show how many Coleoptera larva were abundant during the sampling period. This larva abundance should explain how much this island is very important for Coleoptera reproduction.

Species abundance recorded at Karinga Island are represented in the figure 23



Blank : unidentified

Figure 23: Species abundance within plots Karinga Kivu Lake Island

The figure above shows that among 17 species identified, the species *Formica rufa* and *Acanthotermes sp* are most representative. The blanks on the figure represent the unidentified species but also some larva stages of Coleoptera and Lepidoptera. The species *Lumbricus sp* is due mainly to wet soil at the sampling sites, where it intervenes in soil aeration and nutrient recycling; and this should justify the species diversity of the island despite its small size.

The figure 24 presents recorded invertebrates along the transect

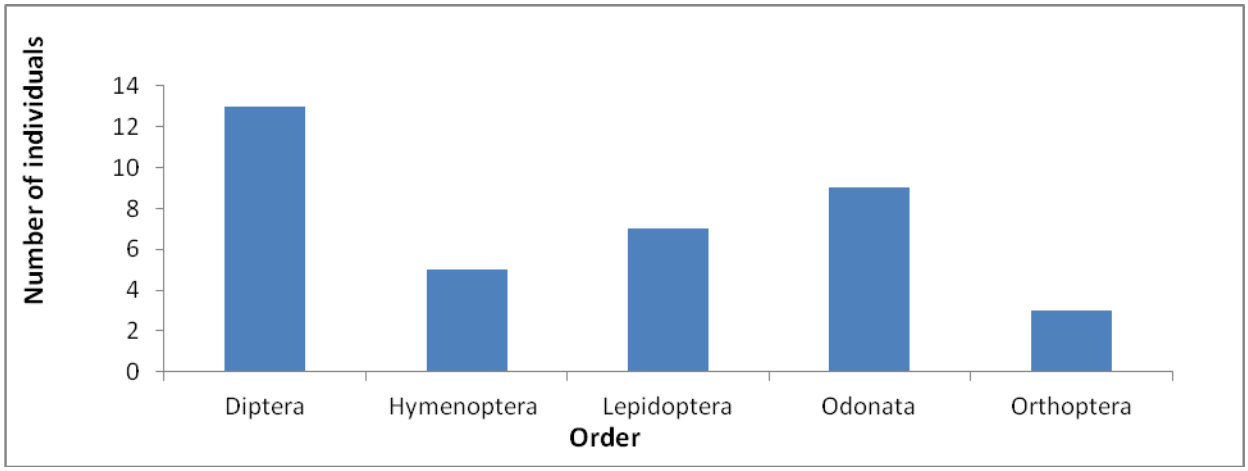


Figure 24: Order distribution within Transect at Karinga Island

Among 5 orders recorded along the transect, the orders diptera and odonata were most represented. This abundance should be due to the vegetation of the island which makes the favorable habitat for dragonflies, butterflies and other flying insects.

3.1.5. ISHYUTE ISLAND

3.1.5.1. Description

Ishyute Island is located in Nyamasheke District, Gihombo sector. It is a big island covering the surface area of 96533 m^2 (Fig.25).

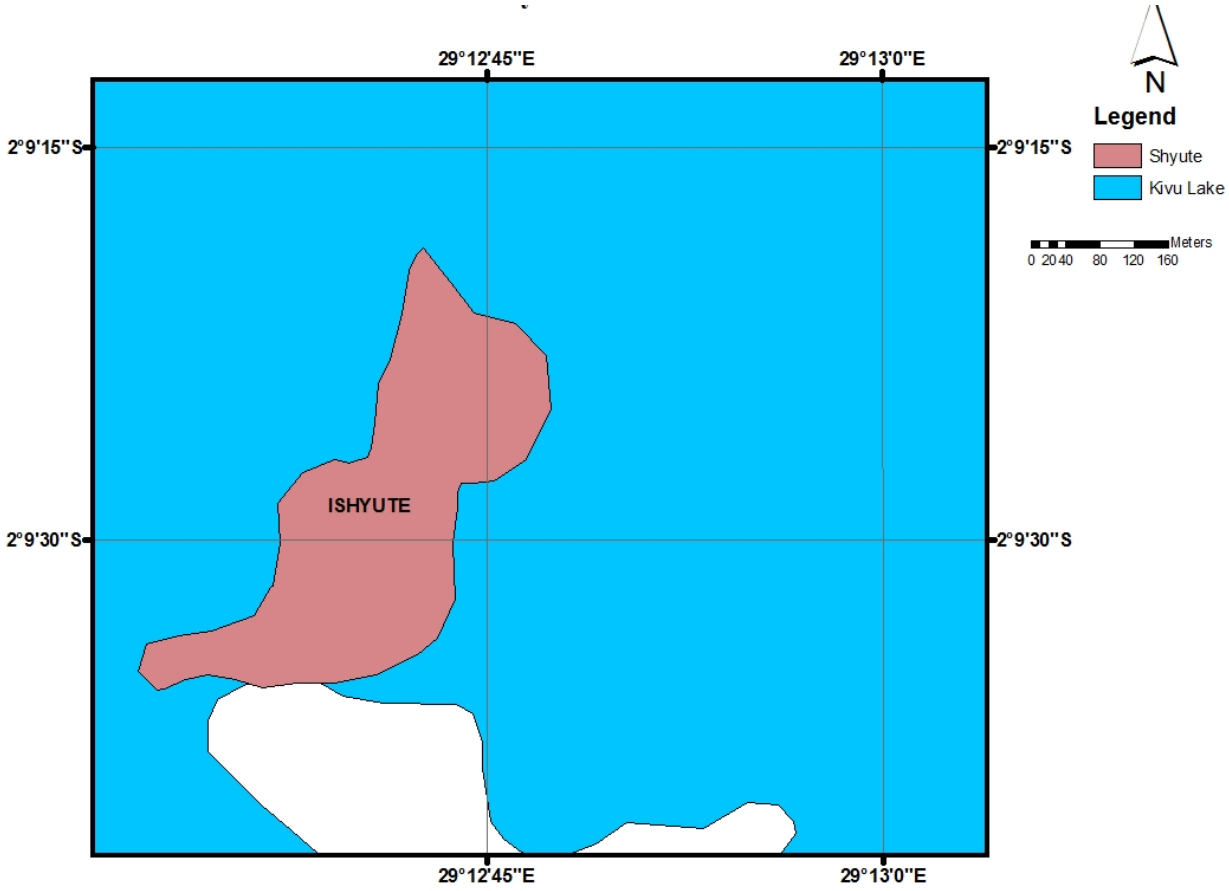


Figure 25: Map of Ishyute Island

Ishyute Island is rich in natural vegetation at a large part of its area, characterized mostly by montane forest vegetation towards the North-Eastern side (Photo 40).

Photo 40: View of the intact natural vegetation in the north-eastern sides of Ishyute Island

The South and Eastern parts hold regeneration vegetation dominated by *Desmodium uncinatum, Clerodendrum johnstonii*, *Acanthhus pubescens* and *Clematis hirsuta* characteristic of degraded species, and comprising some introduced plant species dominated by *Grevillea* and *Guava* species (Photo 41).

Photo 41: Some indicators of human presence and disturbance of natural habitat

3.1.5.2. Flora and vegetation

As stated above, Ishyute Island comprises great plant diversity, and the onsite investigation revealed that many high mountain species exist there. Given the high density of the vegetation and the difficulty to penetrate many inaccessible areas, plant inventory did not cover the whole

island (appendix 1, table 5). However, some remarkable indigenous plant species recorded at Ishyute are discussed below.

Key plant species

***Euclea racemosa* subsp. *Schimperi* (Family: Ebenaceae)**

Local name: Umushikiri. **English name:** Sea guarri, Guarri-bush

Ecology and distribution: *E. racemosa* is found in wooded grasslands, thickets, dry montane and dry lowland forests of East, Central and South Africa. In Rwanda, the species occurs in forest galleries and dry thickets in Mayaga, Bugesera, Umutara and Akagera National Park, from 1300-1500 m where rainfall ranges between 214-1519 mm.

Uses: Firewood, tool handles, shade, medicine (roots), antidote for poison, food (fruit), soil conservation, boundary marking, black dye (roots).

Remarks: Recently, many arrests occurred in Rwanda involving people illegally trafficking E.racemosa to Uganda. The police informed that trees were smuggled through Uganda to India, Philippines, Singapore and Malaysia where it is used as a raw material for manufacturing of perfumes and other cosmetics.

Photo 42: *Euclea racemosa* susps. *schimperi*

***Ficus ovata* Vahl. (Syn: *F. brachypoda* Hutch) (Family: Moraceae)**

Local names: Umurehe, Umukobe. **English name:** Wild fig

Ecology and distribution: *Ficus ovata* is found in deciduous woodlands, riverine forests, wooded grasslands and lakesides from Senegal to Ethiopia through Eastern and Central Africa south to Mozambique and Angola.

Uses: *Ficus ovata* is used for shade, boundary marking, live fence, soil conservation and improvement, stools, backcloth, medicine (latex), poles and firewood.

Photo 43: *Ficus ovata*

***Blighia unijugata* Baker (Family: Sapindaceae)**

Local name: Umuturamugina. **English name:** Triangle tops

Ecology and distribution: Blighia unijugata occurs mostly in moist evergreen forest, but also in semi-deciduous forest, in more dry areas in riverine forest, and in wooded grassland and then

often associated with termite mounds. Blighia unijugata is widespread in tropical Africa, extending from Guinea Bissau eastwards to Ethiopia and Kenya, and through DR Congo southwards to Angola, Zimbabwe and Mozambique. It is also found in South Africa. In Rwanda, it is mostly found in Bugesera.

Uses: *Blighia unijugata* is a useful local source of wood and traditional medicine. It is used for the treatment of rheumatism, kidney pain and stiffness, and they are reputed to have oxytocic action in childbirth.

Photo 44: *Blighia unijugata*

***Galiniera saxifraga* (Hochst.) Bridson (Syn : *G. coffeoides* Del.) (Family: Rubiaceae)**

Local names: Umugaja, Ikiryoheramuhoro, Umubonobono. **English name:** False wild coffee

Ecology and distribution: *G. saxifraga* is common in Eastern, Central and Southern Tropical Africa. This species is found in a wide range of habitats, including montane and moist forests,

wooded marchlands especially near water. In Rwanda, this species is found in montane forest from 1700-2750 m.

Uses: Firewood, timber (construction), tool handles, walking sticks, liquid stirring sticks and mulch.

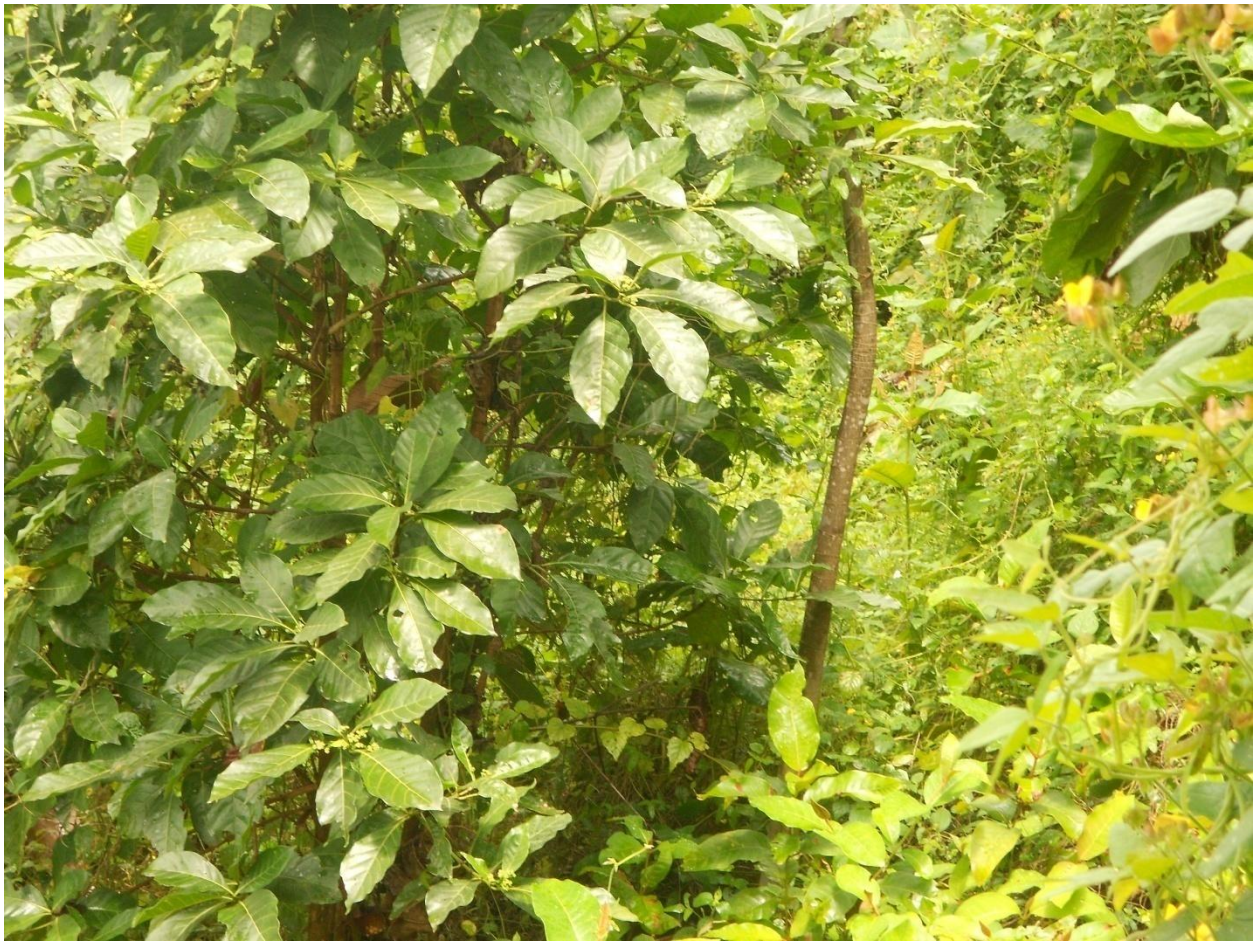


Photo 45: ***Galiniera saxifraga***

***Erythrina abyssinica* Lam. ex DC (Family: Fabaceae)**

Local names: Umuko, Umurinzi. **English names:** Red-hot-poker coral tree, Flame tree, Lucky-bean tree.

Ecology and distribution: It grows in grassland, open woodland, Zambezian miombo woodland, bushland and forest edges especially on rocky places. It is endemic to Eastern-South Africa. In Rwanda, the species is common in many places around the country.

Uses: *Erythrina abyssinica* has interesting applications in traditional medicine: the bark is most commonly used in traditional medicine, to treat snakebites, malaria, sexually transmittable

diseases such as syphilis and gonorrhoea, amoebiasis, cough, liver inflammation, stomach-ache, colic and measles. Roasted and powdered bark is applied to burns, ulcers and swellings. Pounded flowers serve to treat dysentery. Leaves are applied externally to wounds and painful joints. *Erythrina Abyssinica* produces also firewood, carvings, utensils, mortars, drums, beehives, (bark, flower and roots), fodder (leaves), mulch, soil conservation, nitrogen fixation, ornament, shade, live fence, necklaces (seeds), curios (seeds). Traditionally, this species was used in cultural rituals known as Kubandwa.

Photo 46: *Erythrina abyssinica*

***Ficus ingens* (Miq.) Miq. (Family: Moraceae)**

Local names: Umuvumu, umurehe, umurengarutare. **English names**: red-leaved fig, red-leaved rock fig, rock-breaker fig.

Ecology and distribution: *Ficus ingens* grows in various habitats but usually outside forest and prefers rocky outcrops and cliff faces throughout the bushveld, wooded grassland and coastal regions. It occurs in South Africa and further northwards into tropical Africa as far north as Ethiopia across into West Africa.

Uses: fence-posts, poles, sticks, hedges, markers, shade-trees, fibre, religion, superstitions, veterinary medicine, miscellaneously poisonous or repellent. People living in the surroundings of Lake Kivu reported that this species is also used in making canoes.

Photo 47: *Ficus ingens*

3.1.5.3. Birds

At Ishyute Island a total number of 23 bird species were recorded by sights and/or sounds during opportunistic, line transect sampling and mist netting methods (appendix 2, table 5). Among the recorded species *Estrilda astrild* was the most abundant, and other species including *Euplectes capensis*, *Cisticola erythrops* and *Cossypha natalensis* were captured (Photo 47).

Photo 48: *Euplectes capensis* (above left); *Cisticola erythrops* (above right); *juvenile Cossypha natalensis* (below).

3.1.5.4. VERTEBRATES: Mammals, Reptiles and Amphibians

Vertebrate species are snakes “Amadubi”; mice have never been seen but “Urutoni”; a small carnivore looking like a cat is more common. Local population indicated the presence of

"inzibyi" living on water edges and feeding on fishes. Some species of Lizards and a "blue headed tree Agama" (*Acanthocercus atricollis*) are the most common reptiles (Photo 48). It was also reported that *Dendroaspis Jamsoni* and *Boulengerina annulata* which are good swimmers can be seen occasionally. Amphibians are frogs and toads and *Hyperolius Kivuensis* living mainly in *Phragmites mauritianus* was recorded to exist in the area.

Photo 49: *Acanthocercus atricollis* (left); *Hyperolius Kivuensis* (right)

3.1.5.5. Invertebrates

25 species were identified, distributed in 6 classes, with the class Insecta and Myriapoda being the most represented (Fig.26).

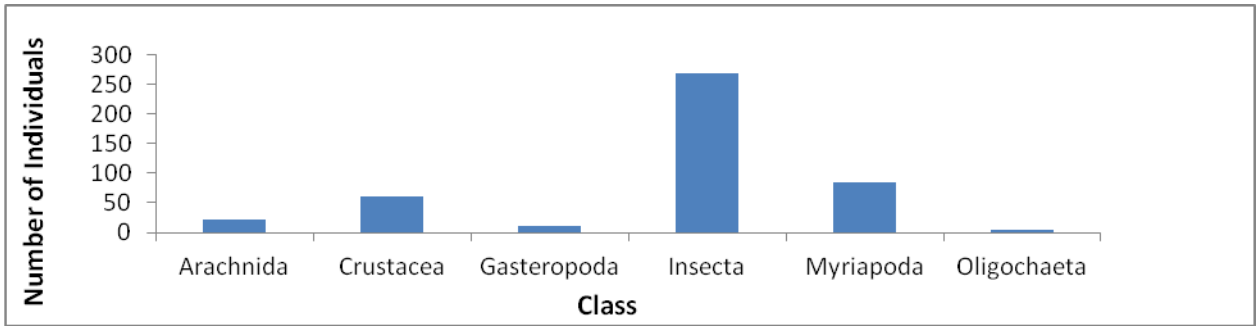


Figure 26: Class distribution within plots at Ishyute Island

In addition to rich vegetation cover, the soil of this island is rich in nutrient (much litter), the reason why the class Oligochaeta represented by earth worms is also represented.

The distribution of orders within plots is indicated in the following figure.

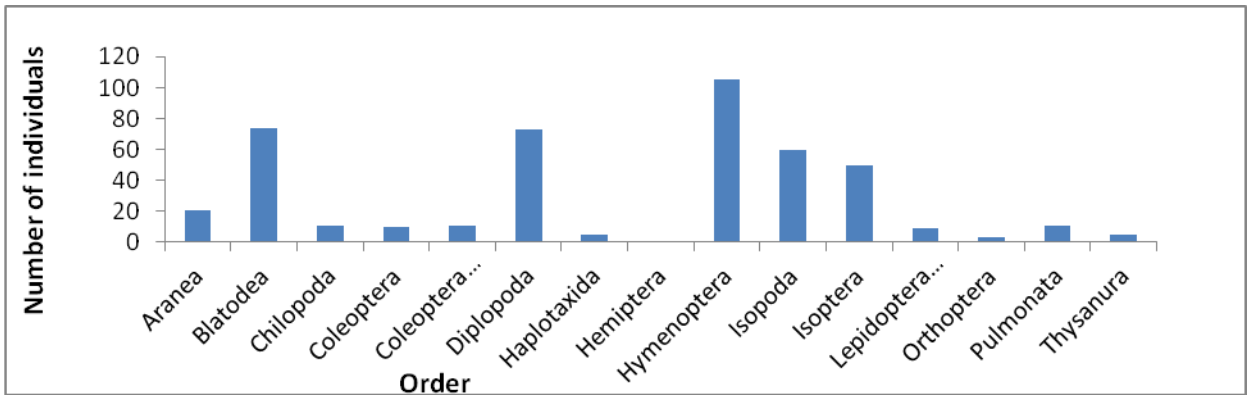
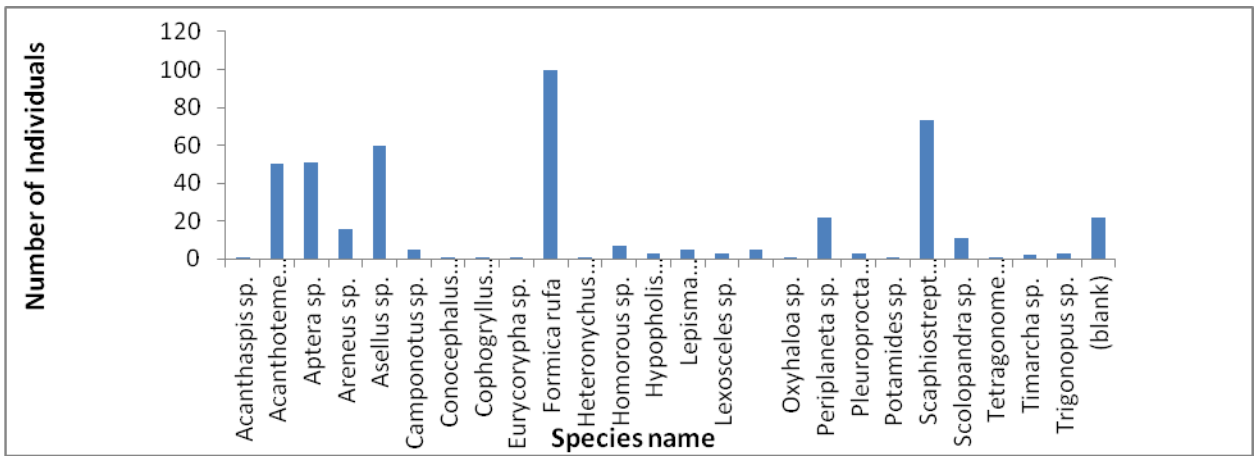


Figure 27: Order distribution within plots at Ishyute Island

For 14 invertebrate orders represented on this figure, we can notice that orders Hymenoptera, Blatodea, Diplopoda are most represented while Hemiptera is the least represented. This situation should be due to the soil characteristics (much litter) and vegetation cover of the island. The order Coleoptera is split into two which means there were adult coleopterans and some larva represented in Coleoptera (larva).

Figure 28 indicates the species distribution at Ishyute Island.



Blank: unidentified

Figure 28: Species abundance within plots at Ishyute Island.

It is shown that most abundant species to the island are *Forumica rufa*, *Scaphiostreptus parilis* and *Asellus sp* respectively. This big number in term of species diversity should be due to the fact that first the island is big in size and secondary no disturbances (anthropogenic activities)

were conducted there for 18 years and that period allowed species recolonization. The species *Pleuroprocta silvatica walekalensis* which was discovered for first time by Plisbry (1919) in DRC and recently identified in Mukondwe Island was found on the island.

Figure 29 presents flying invertebrates recorded along the transect at Ishyute Island

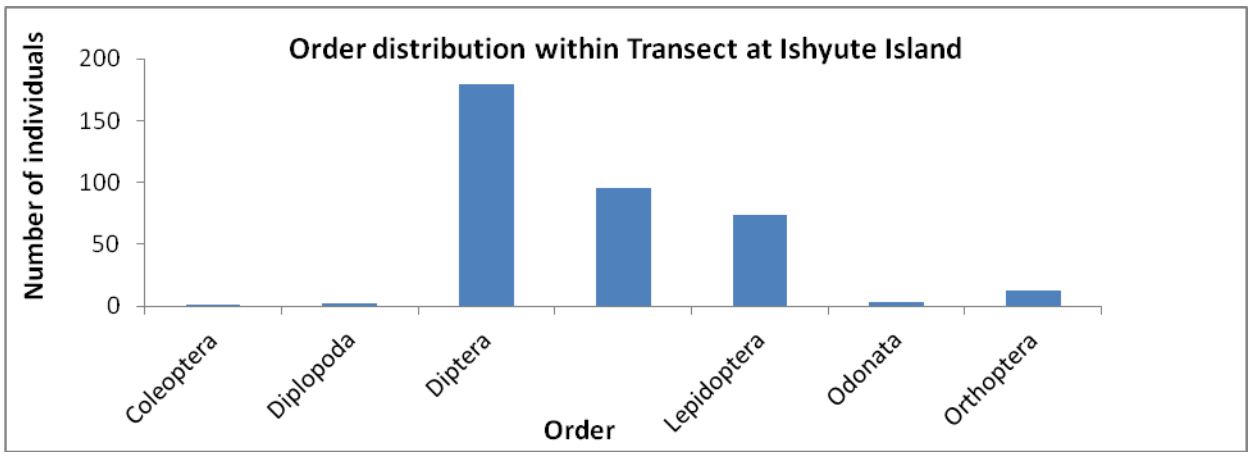


Figure 29: Invertebrates orders within transect at Ishyute Island

For the orders, the most represented orders are Diptera, Hymenoptara and Lepidoptera respectively. The least is Coleoptera with one individual. This situation of Coleoptera should may be due to the fact that transect passed through highly vegetation cover and it was not easy to see them flying or sucking on flowers.

3.1.6. IREBA ISLAND

3.1.6.1. Description

Ireba Island is located in Rusizi District, in Gihundwe Sector. It covers approximately 8000 m^2 (Fig.30). This island is owned by PHARMAKINA, a company which produces medicine against Malaria

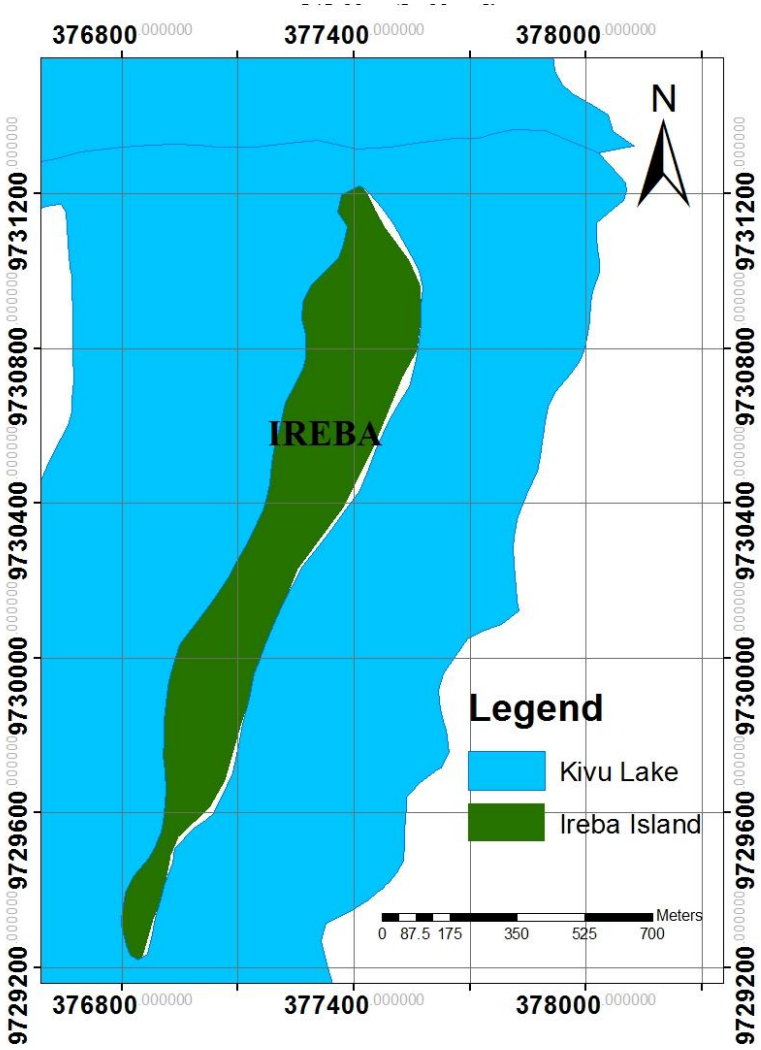


Figure 30: Map of Ireba Island

Ireba Island has a humid, not sandy nor stony, slightly black soil. The Island is well exposed to sunlight but the natural vegetation (which is shorter than Eucalyptus) is more or less shaded by *Eucalyptus* scattered approximately on ¾ of the whole Island (Photo)

Photo 50: View of Ireba Island

3.1.6.2. Flora and vegetation

Ireba Island displays two main vegetation types: natural forest and exotic vegetation:
The first is dominated by *Albizia gummifera, Psydrax parviflora* and *Bridelia brideliifolia.* The second is dominated by scattered *Eucalyptus* trees which are prominent in a matrix of shorter natural vegetation. Eucalyptus trees dominate the southern and western sides of the Island. On the East, *Grevillea* are most abundant. Considering the way natural vegetation has strived to cohabit with harsh exotic species, Ireba Island exhibits a great potential of resilience. (see appendix 1, table 6)

Key plant species

***Albizia gummifera* (J. F. Gmel.) C. A. Sm. (Family: Fabaceae)**

Local name: Umusebeya. **English names:** Smooth-bark flat crown albizia, Peacock flower.

Ecology and distribution: *A.gummifera* grows in riverine, dry lowland, montane and dry montane forests, It is widespread in Africa, from West and Central Africa, East to Ethiopia and south to Mozambique, Zimbabwe and Madagascar.

Uses: Timber, firewood, building poles, grain mortars, beehives, medicine (pods, roots and bark), nitrogen fixation, soil conservation, shade, fodder, tool handles and bee forage.

Photo 51: ***Albizia gummifera***

***Psydrax parviflora* (Afzel.) Bridson (Family: Rubiaceae)**

Local names: Umugaja, Umubaruka, Umugomera, Umuyebe. **English names:** Giant canthium.

Ecology and distribution: It grows in lowland, submontane and montane forests, also found in thickets. It is widespread in East and Central Africa, also found in Malawi. In Rwanda, *P. parviflora* was recorded in Nyungwe and Volcano National Parks.

Uses: The fruits are used as medicine for coughs and influenza. Roots are cooked with animal soup (meat and bones) and taken for intestinal worms and generalized body pains. The wood is used for timber, firewood, charcoal, and tool handles. The tree is used for shade, amenity and bee forage.

Photo 52 : ***Psydrax parviflora***

Bridelia brideliifolia **(Pax.) Fedde (Family: Euphorbiaceae)**

Local name: Umugimbu. **English name:** Bridelia

Ecology and distribution: Bridelia brideliifolia grows in montane and upper montane forests, It is widespread in East and Central Africa, and in Rwanda, it is found in Nyungwe National Park and Gishwati natural forest reserve.

Uses: Medicine (bark and roots), edible fruits, fodder (leaves), timber, building poles, firewood, charcoal, tool handles, shade, bee forage and agroforestry.

Photo 53: *Bridelia brideliifolia*

3.1.6.3. Birds

Ireba Island is a very important birding site because it is home to a big number of birds.

In total, 15 species of birds were recorded by sights and/or sounds during an opportunistic sampling (appendix 2, table 6). Most interesting birds are *Phalacrocorax carbo* (Great Cormorant) and *Musophaga rossae* (Ross's Turaco) (Photo 53).

Photo 54: *Musophaga rossae*

(source: http://rwandaonthewing.blogspot.com/ accessed on 27 June, 2012)

3.1.6.4. VERTEBRATES (Small mammals, reptiles and amphibians)

During the investigation, there was no direct observation of any small mammal, reptile or amphibians. However, it was reported by local people that many and aggressive snakes exist in the place as well as many frogs.

3.1.6.5. Invertebrates

The invertebrates of Ireba Island are dominated by the class of insects (Fig. 31)

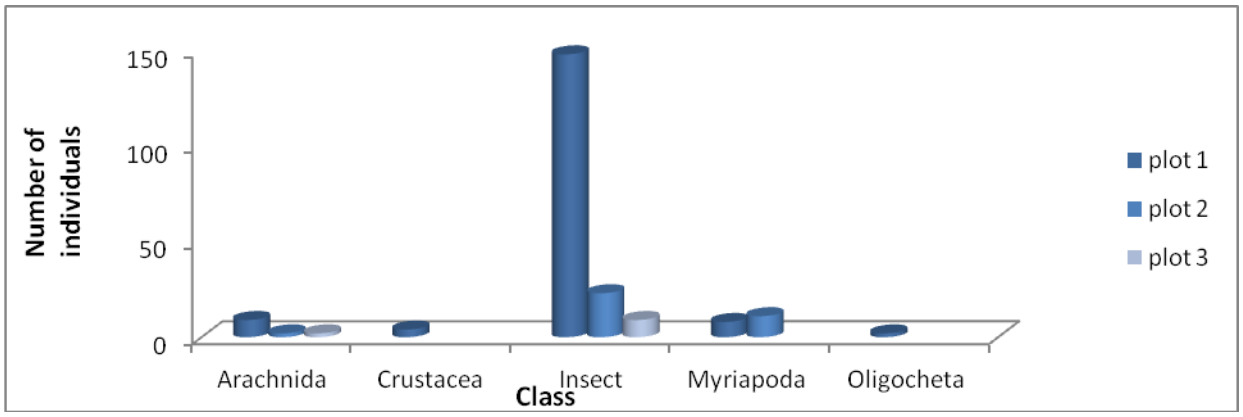


Figure 31: Class distribution within plots at Ireba Island

The distribution of orders at Ireba shows also that plot 3 is more diversified than others (Fig. 31).

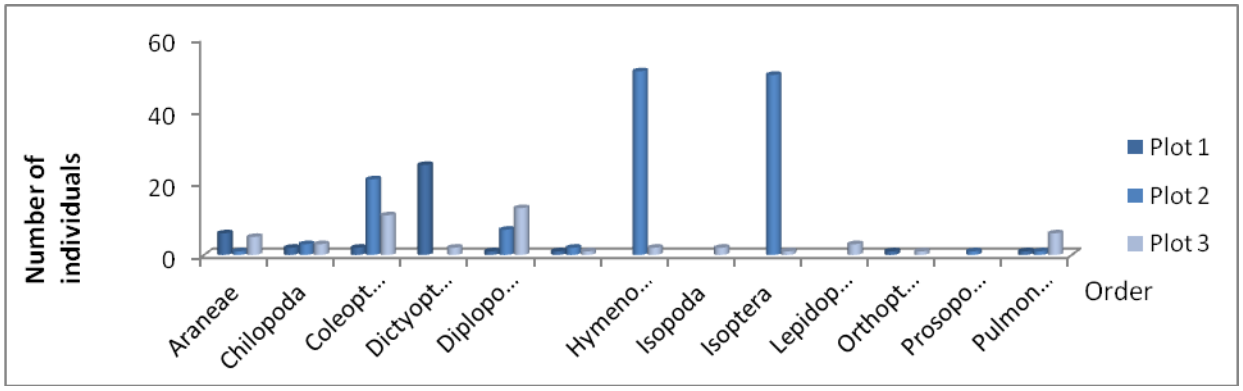


Figure 32: Orders distribution within plots at Ireba Island

The species diversity in is presented in figure 33. Figure 33 show the species diversity of invertebrates.

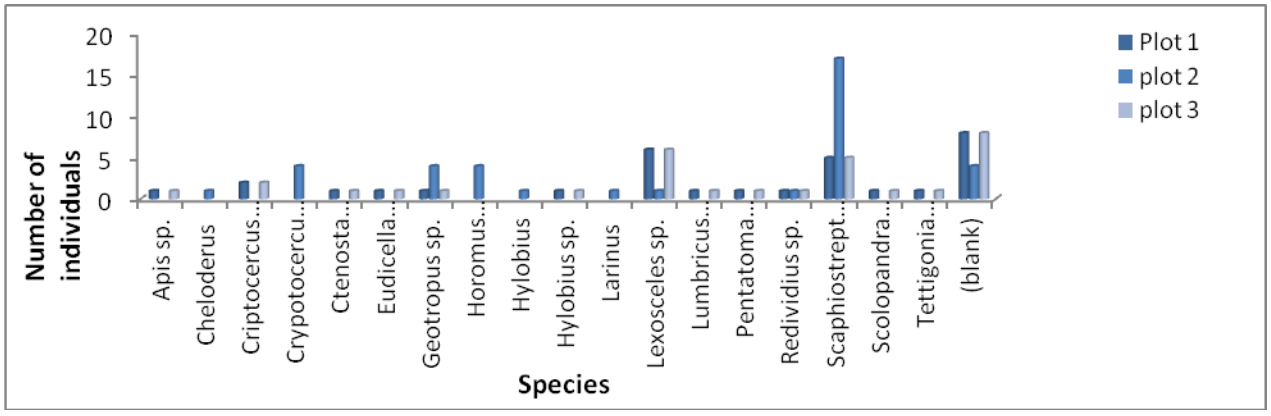


Figure 33: Species abundance within plots at Ireba Island.

3.2. Socio-economic analysis and interpretation

The survey was conducted in two districts namely Nyamasheke and Rutsiro. In every distict, the focus was put on one sector closer to islands. In Rutsiro, data were collected in Musasa sector, Gabiro cell, Rwagatoki and Nyagahinga villages. In Nyamasheke, the survey was carried out in Gihombo sector, Gitwa cell, Doga and Bwerankore villages. In Rusizi, the study dealt with Gihundwe sector Kamatati cell and Ngoma village. The main objective of the survey was to assess the socio-economic status of households in the study sites. It also identified local population attitudes towards island conservation; threats and opportunities of neighbouring the islands. In each cell, the focus was on villages closer to islands.

The results are summarized in two main sections: socio-economic status of households neighbouring the islands and assessment of the relationship between the local community and kivu islands.

3.2.1. Socio-economic status of households neighboring Lake Kivu islands

3.2.1.1. Human demography

A total of 80 households, representing 324 people were sampled in five villages: Doga, and Bwerankore, Gitwa cell, Nyagahinga and Rwagatoki, Gabiro cell, and Ngoma village in Kamatati cell. The average size is 4 people per household. Data analysis showed the following (table 2):

Table 2: Population by gender

Gender	Frequency	Percentage
Male	38	47.5%
Female	42	52.5%
Total	80	100.0

Similarly to general structure of Rwandan population which is composed by a great number of women compared to men. Data analysis showed that 47% of respondents were male while the majority of them representing 52.5% were female.

The majority of women resulted from different reasons including the 1994 genocide against the Tutsi which caused death of majority of men and another significant number to be jailed.

Besides, the gender, the survey looked at local community age. The results are summarized in the table below:

Table 3: Population age

Age	Frequency	Percentage
15-25	30	37.5%
26-35	25	31.2%
36-45	13	16.2%
46-55	6	7.5%
Total	80	100.0

The table above shows that the majority of the population living around Lake Kivu Islands is young. The age bracket of 15-25 constitute 37.5%; and 31.2% of informants are between 26 and 35 years old. This is similar to the findings of NISR (2008) that the majority population of Western Province is young aged between 15 and 35.

As far as the status of our informants is concerned, 47.5% were head of households, 26.25 % were spouse while 26.25 % were children. Data were collected during working hours, many people were found in fields working; this might be the reason behind getting the majority of head households as informants. The bar chart below summarizes the data:

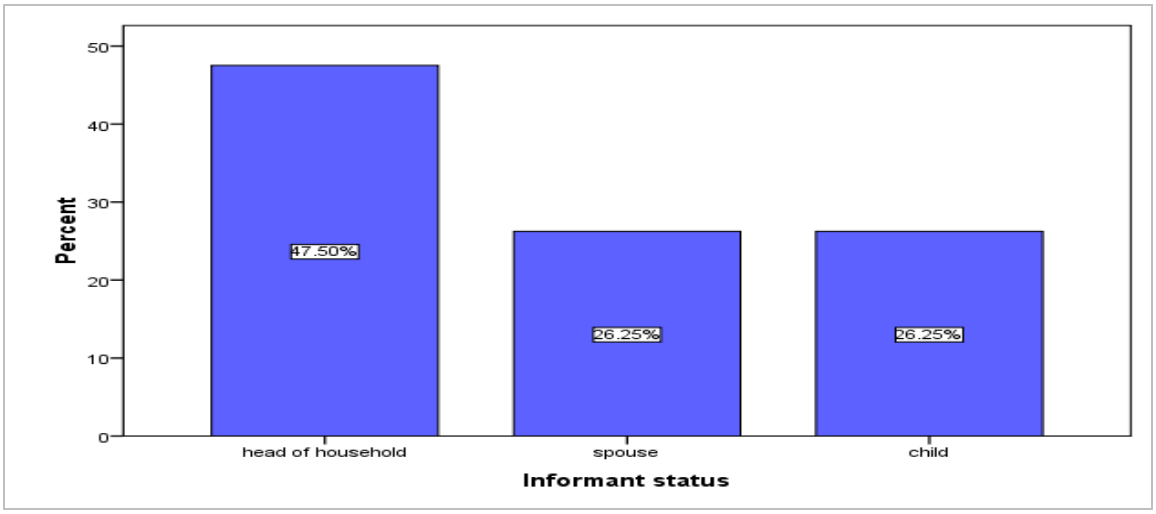


Figure 34: Status of respondents:

Table 4: Education level

Answer	Frequency	Percentage
Did not attend school	26	32.5%
Did not complete primary	36	45.0%
Complete primary	13	16.25%
Did not complete secondary	4	5.0%
Tertiary	1	1.2%

The analysis showed that 32.5% of respondents did not attend school; 45.0% did not complete primary school; 16.2% completed primary school; 5.0% did not complete secondary school; and only 1.2% went to university but did not complete it. Like the rest of rural areas, illiteracy is one of major challenges facing people living around Kivu islands.

Table 5: Education Level by gender

		Did not attend school	Did not complete primary school	Complete primary school	Did not complete secondary	Tertiary
Gender	Male	15%	22.5%	7.5%	1.25%	1.25%
	Female	17.5%	22.5%	8.75%	3.75%	0%
Total		32.5%	45%	16.25%	5%	1.25%

Table 5 showed that women comprise the majority of people who did not attend school, thus they constitute the majority of illiterate. 17.5% of women did not attend school compared to 15% of male. There is no difference between male who did not complete primary school and female. According to NISR, (2008), Gihombo sector counts 50.7% of illiterate. Among them 41.7% are men while 57.3% are women. In Musasa sector, 80.7% are illiterate; and women constitute the majority of them over 70%.

Table 6: Household head occupation

	Frequency	Percentage
On-farm employee	37	46.2
Farmer	42	52.5
Other	1	1.2
Total	80	100.0

Like the rest of the country, the economy of Nyamasheke and Rutsiro districts is primarily dependent on agriculture. Over 97% of households surveyed depend on subsistence agriculture for their livelihood. As it is shown in the table 1.5, 52.5 % of head households reported that their major occupation is farming. 46.2% of head households stated that they work as on-farm full-time employees.

It is known that the level of education has a significant impact on somebody's occupation. Due to the fact that education levels of local population are still low; the majority of heads of households neighboring Kivu islands work in agriculture. The completion of primary education (6 years of primary education), is the point at which workers leave the agricultural sector to move into non-agricultural occupations (NISR, 2008). The likelihood of a person being employed in agriculture is related to the level of education attained. People who attained primary school level are likely to work as full time agricultural employees.

Table 7: Type of households

	Child-headed	Female-headed	Male-headed	Total
Frequency	19	25	36	80
Percentage	23.8%	31.2%	45.0%	100.0

Concerning the household type, 23.8% of households around Kivu islands are child-headed, 31.2% are female-headed households while 45.0% are male-headed. It is clear that men are still heading a majority of the households. Female headed households constitute a significant proportion in the area. Occurrence of a significant number of households headed by women and children derived from different causes including genocide, HIV/AIDS, etc. Studies have shown that female and child-headed households are likely to live in poverty. They face a number of problems related to basic needs satisfaction.

Table 8: Household size

Household size	1-3	4-6	7-9	total
Frequency	27	37	16	80
Percentage	33.8%	46.2%	20.0%	100.0

As far as the household size in the region is concerned, data analysis showed that the average number is 4 people per household. (46.2%) of households represents households whose people range from 4 to 6. 33.8% are households with 1 to 3 people while 20% of households have between 7 and 9 people. It is clear that the majority of households (66.2%) around Kivu islands are made up of people between 4 and 9. This is a big threat to islands because it was shown that rising population density in rural areas has placed the physical environment under increasing stress (NISR, 2008).

Involvement of people in income generating activities is summarized in the following table:

Table 9: Number of people involved in income generating activities

	1-3	4-6	+6	Total
Frequency	66	11	3	80
Percentage	82.5%	13.8%	3.8%	100.0

Data analysis showed that 82.5 % of households have at least one person involved in income generating activities. 13.8% have from 4 to 6 people participating in income generating activities; whereas only 3.8% have more than 6 people.

Table 10: Average monthly income

Average income	Frequency	Percentage %
Less than 10000	47	58.8%
11000-30000	28	35.0%
40000-60000	5	6.2%

The analysis of average monthly income of households neighbouring Kivu islands showed that the majority that is 58.8% earn an average revenue of less than 10,000Rfw. 35% have an average monthly income between 11000 -30000 frw; whereas only 6.2% earn between 40000 and 60000Rfw. It is clear that most of the people live below poverty line because most of these households consume less than one dollar per day (MINECOFIN, 2008).

3.2.1.2. Household income

3.2.1.2.1. Land ownership and size

All the people reported that they were born in the region. The analysis of ownership of the land showed that 58.8% stated that they do not have a piece land while only 41.2% reported to have a piece of land (table 11).

Table 11: Land ownership

Land size	¼ ha	½ ha	1ha	+ ha
Frequency	28	10	9	2
Percentage	35.0%	12.5%	11.2%	2.5%

Table 11 shows that 35% own land size of ¼ ha, 12.5% own ½ ha; 11.2% own 1 ha; and only 2.5% owned land size of more than 1 ha. The majority of them revealed that their land is used primarily for agricultural activities. Land of this size is generally insufficient to support a household at a reasonable level, especially where the land is not fertile, and yet few agricultural households have the opportunity to raise their incomes by being engaged in off-farm activities. There is a high vulnerability for households owning small land sizes and given that the majority of the households in Rwanda survive on subsistence.

Agriculture is the backbone of the national economy and the majority of households are engaged in some sort of crop or livestock production activity. The agriculture sector is therefore regarded as the major catalyst for growth and poverty reduction in the region. As elsewhere in the country, a great number of households (97%) surveyed are involved in agriculture. They rely on agriculture not only for the survival but also for raising income. The food crops commonly grown in the region include beans, sojabean, banana, cassava, sweet potatoes, maize, sorghum, *Cajanus cajan*, different fruits (passion, avocado, pineapple, orange, mango etc), different types of vegetables such as cabbage, tomatoes, carrot etc. Coffee is a cash crop likely to be found in the region.

In addition, these people also rear livestock such as cows, goats, sheep, poultry etc. Many people practice agriculture and livestock in order to improve their livelihood and increase household income.

Apart from agriculture and livestock, other opportunities to generate income likely to be found in the region are fishing in the lake, transporting people and goods in the lake, and on-farm employment. Business is not common in the region. Moreover, most of informants stated that apart from their main occupation, they do not have any other source of income; and that they do not access on bank credit easily.

The results agree with the findings of NISR (2010) about causes of poverty in Rwanda which are: lack of land, poor soils, lack of livestock, ignorance, inadequate infrastructure, lack of access to water and population pressure .

To assess whether the people can find some productivity to sell after consumption, the data showed the following: 41.2 % revealed that they sell some of the crops including cassava, banana, fruit and vegetables whereas 21.2% stated that they only grow for consumption. Crops like sweet potatoes, beans etc are only grown for consumption. No extra productivity to take to market. Most of the people interviewed agreed that they practise subsistence agriculture because agricultural income is too little to satisfy household basic needs.

Data about average from productivity crops showed that 28.8% revealed that income from their productivity is less than 5000Rfw.18.8% get between 6000 and 10000Rfw; 3.8% receive between 11000-15000Rfw; and 2.5% earn more than 15000Rfw from their agricultural products.

Coffee is the only cash crops grown in the region. A majority (65%) of respondents reported that they earn between 11000 Rfw-20000 Rfw; 30% earn between 5000-10000 Rfw from coffee productivity. As far as market access is concerned, 45% stated that the nearest market is located in 500 meters while 55% revealed that the nearest market is located in 1000 meters.

Table 12: Monthly income by gender`

		Less than 10,000	10,000-20,000	40,000-60,000
Gender	Male (head)	20%	22.5%	5%
	Female (head)	38.75%	12.5%	1.25%
Total		58.75%	35%	6.25%

It is shown that the majority 38.75 % of female household-head earn less than 10000Rfw per month. 12.5% earn a monthly income of 12.5% of 10000-30000Rfw while male headed household 22.5% earn between 10000 and 30000 Rfw. 5% of male headed household receive between 40000 and 60000 Rfw compared to their counterparts who counts only 1.25% in the 3rd category.

Table 13: Livestock ownership

	Frequency	percentage
Yes	29	36.2%
No	43	53.8 %
Missing	8	10%

As far as livestock is concerned, households neighboring islands revealed that 36.2% own livestock; 53.8% stated that they do not keep any livestock; and 10% did not precise whether they have it or not. 44.8% reported that they rear cows; 44.2% raise goats while 11% keep poultry. 89.6% stated that they have between 1 and 10 animals whereas 10.4% rear more than 10 animals. Concerning how they keep the livestock, 20.7% revealed that they still use traditional method while 69% agreed that they use modern one. Only 10.2% reported that they use both traditional and modern methods. Reasons that made them keep livestock include income generating (55.1%), manure production (30.9%) and both generating income and producing manures (14%).

The majority of respondents stated that they have had the livestock between 1 and 3 years. Data showed that most of farmers sell young animals because most of cows reared do not produce enough milk for sale. They only provide milk for household consumption. The majority of them failed to estimate income from their livestock since most of them they have not sold anything

yet. They added that they are not happy with the productivity because the only role of a lot of livestock in the region is to provide manure not income.

A small portion of respondents revealed that they practice fishing in the lake; and that they do it to generate income and improve the household diet. Hunting is not common in the region.

3.2.1.3. Satisfaction of household needs

To assess the wealth of households in the region questions about ownership of improved assets were asked, data collected showed that people neighbouring Kivu islands are poor because a great number of people interviewed showed that ownership of assets like a bicycle, RV, radio is very low. A small number of people own a mobile phone and wooden canoes used for transport. No special furniture was found.

In addition, data showed that the housing situation for many households is bad. Poor housing is attributed to poverty, and also because of genocide and insecurity, which caused demolition of a considerable number of houses (Rwanyiziri and Kayijamahe, 2004). Many people live in mud-brick houses with roofs in either iron sheet or tiles; tiles are more likely to be found in Rutsiro. In Nyamasheke most of roofs are made up of iron sheets because they were provided by the government. Many people were poorly dressed, without shoes especially in Nyamasheke district.

3.2.1.4. Cooking fuel and its source

Table 14: Source of firewood

Source of fuel	Frequency	Percentage
Islands	60	75.0%
Crop residues/remains	13	16.2%
Missing	7	8.8%
Total	80	100.0%

As far as fuel used for cooking is concerned, most households (100%) used firewood. The fuel wood was found as the major cooking energy in all households. Some households use remains of agricultural crops (maize stems, grass, banana leaves, sorghum stems and leaves etc).

The analysis of the source of firewood indicated that 75% of households collect firewood from islands. 16.2% stated that they use remains of crops harvested from their fields. This collection of firewood from islands constitutes illegal exploitation of islands. Besides, firewood collection is one of the major threats Kivu islands face. 8.8% said nothing. It is likely that exploitation of islands is higher but that people were reluctant to admit to using it. 78.2 % of households stated that they do not have forests whereas 21. 8 % said that they have them; and they bought their forests.

A significant number of respondents from Gihombo revealed that they did not have access to clean water because they fetch water in Kivu Lake; they do not have modern tap. In Musasa, all the surveyed households had access to clean water. They said it took about 20 minutes to arrive where they fetch clean water. The data showed that all the people interviewed live in their own houses. They used agricultural income to build them.

3.2.1.5. Population settlement Patterns

As far as local community settlement is concerned, there are three main settlement patterns observable in both sectors. These are scattered rural agricultural settlements, which are the most widespread, then family groups, and agricultural group settlements known as "*Imidugudu*". The first type is the most widespread in all sectors, with a house or houses surrounded by an enclosure called "*urugo*", while the second type is also found there where people live along the road in agglomerations called "*Insisiro*". The third one is a result of a new national settlement policy, which recommends re-grouping households into villages so that land for cultivation can be available and services can be easily provided. Many group settlements have been constructed in the region recently and many people have not joined them yet.

3.2.1.6. Land use management

Dependence on natural resources is still high in the region. A great number (87%) rely on subsistence agriculture for their socio-economic welfare whereas over 94% of the population uses fuel wood as the primary source of energy for domestic use. This is a big challenge to biodiversity conservation.

For knowledge about land use and management policies, the informants stated that they know some policies related to land management. The policies commonly known in the region include land consolidation; the national policy of evacuating people from 50 m to the lake and that all the people have to move and live in villages near infrastructure; and regionalisation culture. As far as erosion fighting is concerned, they stated that they are increasingly involved in soil erosion control, some of measures used include building radical terraces, improving watershed management, reeds planting, digging water canals and engaging in reforestation work. In the region, food crops are grown twice a year; this also placed a threat to land because it results in land degradation. Suggestions about what can be done to improve land use include use of fertilizers and manure and fallowing the land.

3.2.1.7. Membership in cooperative

A great number of people interviewed said they are members of cooperatives and other small mutual support groups. They added that those groups aim at mutual support. *" For example, before joining the cooperative, it was so difficult to pay medical insurance, but now I don't have any problems because when I do not have money, they lend me some which helps me to solve my problems".* They stated that there are a lot of benefits of being a cooperative member because through mutual support people manage to reduce poverty by helping one another to buy livestock and other household equipment. "*Before setting up our cooperatives, no single member kept livestock; but now every member owns at least one goat due to mutual support."* One of the biggest cooperative is "***Cooperative Jya mbere Murobyi w'i Musasa*"** located in Musasa sector, its occupational activity is fishing in the lake. The benefits from this cooperative are improving household income, diet and having access to Kivu Lake fishing.

3.2.1.8. Access to education and health facilities

People from all villages agreed that every child has access to education from nursery to secondary; every child can pursue studies up to secondary school 3rd form, that is nine -year - basic education. Still, schools are located far away from their home in both sectors; the average time to arrive at school is 1hour. They revealed that they receive quality education and that they are satisfied with the current educational policies and programmes. As far as medical insurance

is concerned, they all have access to medical insurance but the average time to arrive at the health center is 2 hours.

3.2.2. Relationship between islands and neighboring community

3.2.2.1. Background and attitudes towards Kivu islands

All the islands visited were not inhabited. Only two islands Mapfundugu and Ishyute used to be inhabited. Mapfundugu island is located in Rutsiro district, Musasa sector, Gabiro cell. As far as its historical background is concerned, a man called Kimonyo used to live there with his three wives and a lot of children. He lived there for about 30 years. He died three years ago and all his relatives were sent to live on the mainland near the island. The land was not fertile enough for the family because all Kimonyo's relatives suffered from illness related to malnutrition.

Ishyute Island is located in Nyamasheke District, Gihombo sector, Gitwa cell. Two villages namely Doga and Bwerankore neighbour the island. As far as its historical background is concerned, there used to live people before 1950s. Since then, no people were allowed to live there. It was used only for consumption crops culture. After 1994 genocide, the island was no longer used for culture. The island is mainly found as a source of energy used for cooking (firewood collection) and animal grazing. "*In the past, we used to grow different crops there, but today no one is allowed to do anything in the island"*, Kivu islands were used for agricultural activities before. Today, no one is allowed to do anything there.

Only REMA is known in the region as institution involved in islands conservation. Many people stated that they only hear about the Director of REMA, no one else from organisation in charge of environment is known in the region. They agreed that they know that Kivu islands are ones of natural resources which need to be protected because tourists can come to visit them. This is seen as a big opportunity of income of local opportunities.

Concerning the advantages and disadvantages of living near the islands, the informants agreed that Kivu islands have positive impact on their socio-economic welfare. Some of advantages include collection of firewood, collection of medicinal plants and animal grazing (Photo 55).

Photo 55: Cows crossing the Lake to graze on the islands

Respondents stated all the animals in the region graze in the neighbouring islands. They leave their animals on island and go back home because no one can steal them. There is full security.

They also say that they would be happy if the islands were conserved because they could get jobs and have access to infrastructure. They believe that islands conservation could have a positive impact on their lives because some of them can get jobs, and tourism can improve their socio economic status.

The only disadvantages mentioned is that they lost some of their land which was used for agriculture and that they can have accident in water when coming from or to the mainland. Some informants revealed that they are not happy with the existing policy of island conservation because they lost their land. Others believe that the conservation of islands can improve their livelihood because it can help them to have access to improved infrastructure (some roads and

hotels for tourists will be built); and some believe that island conservation can be seen as job creation for the local community.

3.2.2.2. Opportunities and threats of Kivu islands

To identify opportunities and threats of living around the islands, people replied as follows**:**

"I think there are many opportunities here because we collect firewood there and we graze cows and goats there."

People interviewed think that they benefit a lot from living near the islands because they find firewood easily and they graze their animals there.

"A*nother opportunity I find here is getting a variety of medicinal plants that are not found on the mainland".* Respondents mentioned that they get different types of plants used as medicine for different illness on the islands.

Concerning Kivu islands threats, they stated that there is no diversification of income generating activities in the region. Another issue is that there are too many people while there is no more new farm land. There is a need to find ways to assist people benefit from activities which do not depend on land only as a natural resource.

Besides, they added that if the neighbouring islands are included in protected areas, they may find a lot of opportunities there. Some of the opportunities include getting jobs, improved infrastructure, etc. They stated that they do not find any threats about living near islands.

Concerning the existing policy on Kivu islands conservation, the informants stated that they are not allowed to do any agricultural activities there. Even animal grazing and firewood collection are practised illegally. "*you know, some years ago we were told REMA does not want anyone to cultivate or live in 50 m from the lake; also they told us that we are not allowed to graze and collect firewood there."*

CHAPTER IV: CONCLUSION AND RECOMMENDATIONS FOR THE CONSERVATION OF LAKE KIVU ISLANDS BIODIVERSITY

The ecosystems of the islands surveyed in Rutsiro, Nyamasheke and Rusizi face some challenges related to human influence. In fact, the human modified environment resulted in the introduction of many exotic plants, the habitat degradation, etc (REMA, 2011).

However, some islands still comprise a very rich diversity, particularly plant and bird's diversity, even though the limited surface area could not host as many species as big ecosystems. Indeed, the results obtained from the rapid biodiversity assessment show that a good number of plants, birds and numerous invertebrates have been recorded. Few vertebrates were collected during the survey due to their dispersal abilities limitations from the mainland and predation by birds of prey.

The biodiversity of some islands have been impacted by human activities, but others are still have their ecosystems intact (Ishyute Island specially).

For all recorded species, besides some few plant species restricted in Kivu area such as *Euphorbia dawei* and *Ficus ingens*, many bird species find their refuge in Kivu islands as well. Even though there is no deep study undertook, it could be surprising to find endemic subspecies due to isolation especially for taxa with less capacity of dispersal. Briefly, Kivu islands are not only refugia area for biodiversity but also they can be considered as center of speciation for many taxa including small Mammals, Reptiles, Amphibians, terrestrial invertebrates and some plants. Moreover, it has been stated by fishermen that less disturbed islands are the most endowed with high diversity and abundance of fishes.

Birds diversity is particularly interesting at the islands surveyed. In the former report (REMA, 2011), Sturnidae family represented by *Cinnyricinclus leucogaster*, an intraafrican migrant was also found at Nyamunini Island with *Cossypha natalensis* species. In this current work another migrants species, a paleartic migrant (*Phyloscopus trochilus*) was recorded. As the netted *Cossypha natalensis* was a juvenile, this may means that these islands are not only used as stopover of migrants birds but also sites for reproduction of some migrant species. Moreover, all these Islands seem to be a good area for other birds breeding, as various bird nests were found

in different sites for the birds like *Euplectes fransciscanus*, *Cinnyris cuprea* and *Estrilda astrild*, etc.

The presence of a high number of bird species, according to its area, and the presence of both adult and juvenile of migratory at the islands surveyed, and the presence of many waterbirds indicate the importance of the islands in the conservation of biodiversity. The protection should be not only a benefit for birds but also for other components of the biodiversity.

The conservation of the Lake Kivu Islands should therefore focus on keeping the habitat intact, specially for big islands like Mapfundugu Complex and Ishyute Islands. Other degraded islands like Nyanamo and Ireba should be subject to particular attention. In these cases and others, local population should be much involved in the conservation programs for the success of the objectives. Some activities related to cattle keeping and tree cutting should be the first to be forbidden as they constitute the important threats to investigated ecosytems.

With reference to the previous studies commissioned by REMA and UNESCO in Lake Kivu Islands, it is important to notice that all islands are not viable for inclusion into the PA network. Some are inhabited while others are severely degraded and deserve restoration before any initiative of protection.

Nevertheless, there still very interesting islands for biodiversity conservation especially in Karongi and Rutsiro District. Islands which could be relevant for protection are Mukondwe, Mbabara, Shegesha, Amahoro, Nyenyeri, Mpangara , Nyarugaba and the small surrounding islands both located in Karongi District. That area could be extended towards the south in Nyamasheke District up to Ishyute Island which very forested and less degraded compared to the majority of islands found in that District. However, some very small islands of less than 1 ha should also be included in the network because they have not been degraded for they are attractive neither for agriculture nor for grazing due to their rocky soils. Rusizi District should be completely excluded from the network for all its islands are cultivated or belong to PHARMAKINA. Moreover, the only less disturbed island in that District, namely Ireba island, is located very far away from the remaining islands selected to enter the network. Its biodiversity cannot be sustained by the Northern islands due to its geographical isolation and disturbance.

Towards the North, very interesting islands could be included in the network and they are namely Nyumunini, Rwanuma and their surrounding small islands, Mapfundugu islands complex, Karinga and Nyanamo in Rutsiro District.

However, due to some socio-economical imperatives such sites for tourism and recreation, it is important to set up within Kivu Lake islands, a biosphere reserve because this one takes into account population needs and conservation priorities. Therefore Lake Kivu Islands should be split into two parts: a core area for biodiversity conservation where no human activity is allowed; a buffer zone where not harmful human activities to biodiversity can be authorized and reserved for tourism (Fig.35).

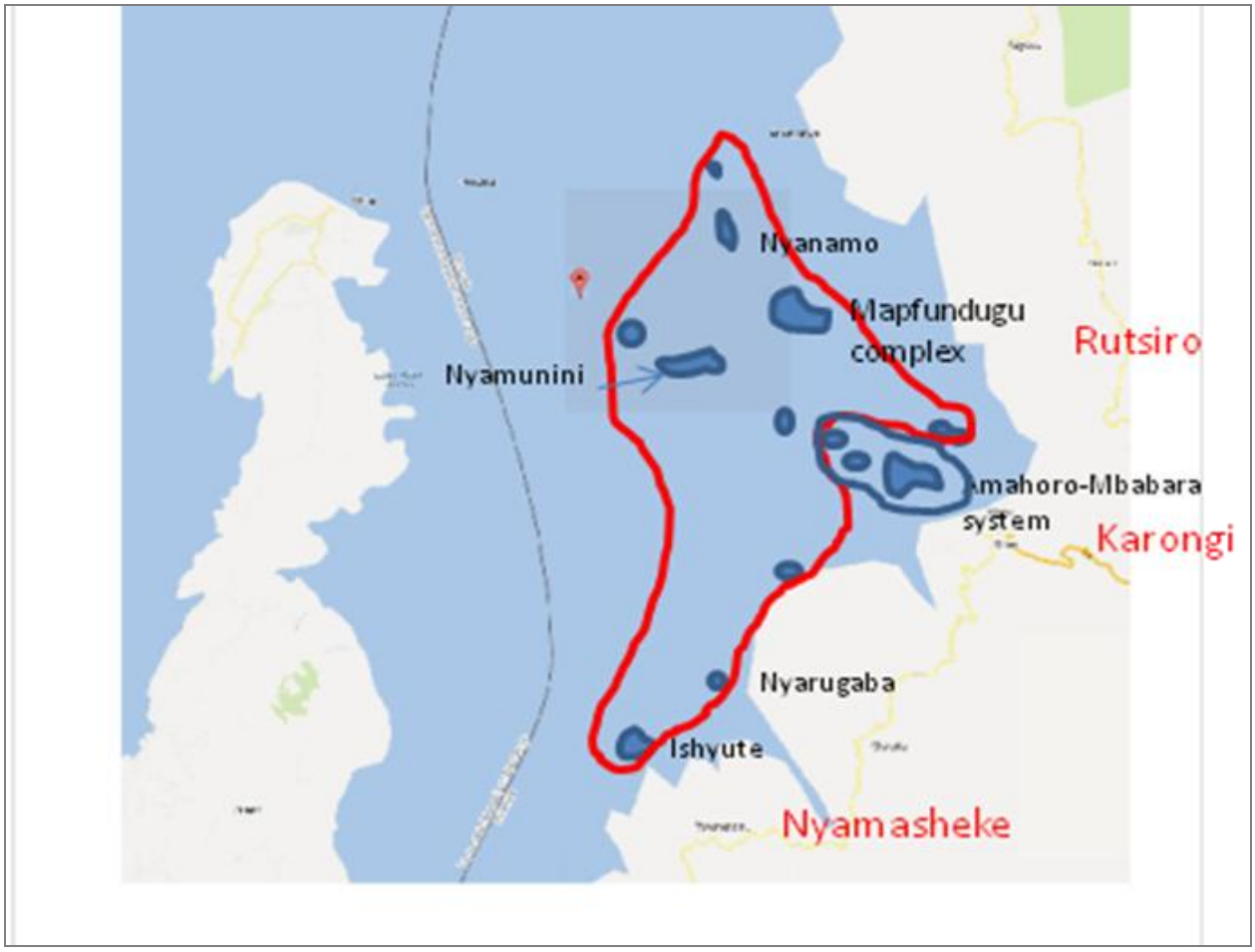


Figure 35: Suggested zoning for Lake Kivu Islands biodiversity conservation

Legend: Core area for biodiversity conservation; Touristic zone

The core zone for biodiversity conservation should include all investigated Rutsiro Islands including Nyamunini and Rwanuma, Nyenyeri, Mukondwe, Shegesha, Mpangara, Nyarugaba in Karongi District and the mosaic of small islands towards Ishyute Island within Nyamasheke District. The buffer zone should be delimited to Amahoro and Mbabara islands which constitute the continuation of peninsulas on which many hotels are erected. They could also be used for birds watching, fishing and doing nautical sports.

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APPENDIX

Appendix I: Plants' diversity

Table 1. Plant species distribution at Mapfundugu Islands Complex

Species name	Vernacular name	Mapfundugu II				Mapfundugu III	Mapfundugu IV		
		R 1	R 2	R 3	R 4	R5	R6	R7	R8
Abutilon angulatum	Umuhatura			*4*	+	+			
Abutilon mauritiannum									
Acacia hockii	Umugenge							*3*	
Acacia sieberiana	Umunyinya					*2*	+		*2*
Ageratum conyzoides	Nkuruba	+							
Aloe lateritia	Igikakarubamba					+			+
Asparagus africana	Umushabishabi								+
Asistasia gangetica	Urusogo		+						
Bidens pilosa	Inyabarasanya						+	+	
Capparis tomentosa	Umukorokombe					+			
Carissa edulis	Umunyonza	+							
Citrus lemon	Indimu							*1*	+
Clerodendrum rotundifolium	Ikiziranyenzi	*3*	*2*	*2*	*4*	*3*		*2*	*4*
Crotalaria laburnifolia	Umuyogera	+	+						
Commelina africana	Uruteja							+	+
Commelina benghalensis	Uruteja	+	+	*3*	+	+	+		
Conyza sumatrensis	Urububa	+	+						
Crassocephalum montuosum	Igifuraninda		+					+	
Crassocephalum vitellinum	Isununu	+	+	+				+	+
Cyphostemma adenocaule	Umubombwe					+			+
Desmodium uncinatum	Ituza			*1*	+				
Digitaria abyssinica	Urwiri	+	*2*	*2*	+		+		
Entada abyssinica	Umusange						+	*1*	*1*
Eragrostis racemosa	Ishinge				+		+		*1*

Eucalyptus sp	Inturusu			+			*2*	*3*	*2*
Euphorbia candelabrum	Umuduha					+	*1*	*1*	
Euphorbia dawei	Umurara					1		2	1
Ficus cyathistipula	Imvubuvubu						*1*		*2*
Ficus ingens	Umurehe	*4*		*2*			*1*		
Hyparrhenia filipendula	Umukenke	*2*	+	*1*		*3*	*1*		*2*
Indigofera circinella	Mbatama				+				
Justicia flava	Urufa								+
Killinga bulbosa	Indasigariza			+					+
Lantana camara					+				
Lantana trifolia	Umuhengeri	+	+				+		+
Leonotis nepetaefolia	Igicumucumu			+					
Leucas deflexa	Akanyamapfundo		+						
Ocimum basilicum	Umwenya	*2*	*1*	*2*	*2*	*1*	*2*	*1*	*1*
Panicum maximum	Igikaranka				+		+		+
Pennisetum purpureum	Urubingo				+		+		
Phragmites mauritianus	Umuseke			+	*2*		+		
Plectranthus barbatus	Igicuncu						+		
Psidium guajava	Ipera	+	+			+	*3*	*2*	*1*
Rhus natalensis	Umusagara					*1*			+
Ricinus communis	Ikibonobono			*1*			+	+	+
Rubus apetalus	Umukeri						+		
Rumex abyssinicus	Umufumba	+							*1*
Senna occidentalis	Umukubayoka	+	+	+	+			+	+
Sida acuta		+	+	+					
Solanecio manii	Umutagara	+	+	*1*					
Triumfetta cordifolia	Umunaba	*3*	+	*1*					
Vernonia brachyaria			+				+		+
Viola eminii								+	+

Table 2. Plant species distribution at Karugaruka Island

Species name	**Vernacular name**	**R1**	**R2**
Agave sisalana	Umugwegwe	*3*	*1*
Asparagus africana			+
Kalanchoe sp	Igitenetene	+	
Citrus lemon	Indimu	*1*	
Clerodendrum rotundifolium	Ikiziranyenzi		*1*
Commelina africana	Uruteja	+	
Commelina benghalensis	Uruteja	+	
Cyphostemma adenocaule	Umubombwe	+	
Ficus cyathistipula	Imvubuvubu	*2*	
Ficus ingens	Umurehe	*3*	
Grevillea robusta	Gereveriya		*1*
Gynura scandens	Ikizimyamuriro		+
Indigofera arrecta	Umusororo	*2*	
Lantana camara			*1*
Leonotis nepetaefolia	Igicumucumu		+
Maytenus senegalensis	Umweza		+
Ocimum basilicum	Umwenya	+	
Panicum maximum	Igikaranka		*1*
Phytolacca dodecandra	Umuhoko		+
Plectranthus barbatus	Igicuncu		+
Psidium guajava	Ipera	*2*	
Psychotria mahoni	Umugaja	*1*	
Rhus natalensis	Umusagara		*3*
Rhus vulgaris	Umusagara	+	*4*
Ricinus communis	Ikibonobono	+	
Rumex abyssinicus	Umufumba		+
Sarcostemma viminale	Ubuyenzi		*4*
Senna spectabilis	Kasiya	+	
Solanecio manii	Umutagara	*2*	
Tetradenia riparia	Umuravumba		

Thunbergia alata	Nkurimwonga		+
Triumfetta cordifolia	Umunaba	*1*	
Triumfetta rhomboidea	Umushyigura	+	

Table 3. Plant species distribution at Nyanamo Island

Species name	**Vernacular name**	**R1**	**R2**	**R3**	**R4**
Acacia sieberiana	Umunyinya	*2*	*2*	*2*	*3*
Bambusa vulgaris	Umugano			*1*	
Bidens pilosa	Inyabarasanya		+		
Capparis tomentosa	Umukorokombe			+	
Casuarina equisetifolia	Filaho				*1*
Citrus lemon	Indimu		*1*	*1*	
Clematis hirsuta	Umunkamba		+		
Coffea arabica	Ikawa		*3*	*2*	*2*
Colocasia esculenta	Amateke			+	
Commelina africana	Uruteja		*1*		
Conyza sumatrensis	Urububa		+		
Crassocephalum vitellinum	Isununu	*1*			
Crotalaria spinosa	Nyagashekenyuka	+		+	
Digitaria abyssinica	Urwiri		*3*		
Dodonaea viscosa	Umusasa	*2*			
Dracaena afromontana	Umuhati			*1*	
Entada abyssinica	Umusange	*2*	*1*	+	*4*
Eucalyptus globulus	Inturusu		*2*	*2*	*3*
Euphorbia tirucalli	Umuyenzi	*2*			*1*
Ficus ingens	Umurehe	*3*		*2*	
Ficus ovate	Umukobe		*2*	*2*	*1*
Galinsoga parviflora	Kimali		+		
Gynura scandens	Ikizimyamuriro	+			
Hyparrhenia variabilis	Umubaribari	*2*			*2*
Lantana camara		*1*	*1*		
Mangifera indica	Umwembe	*1*		*3*	
Manihot glaziovii	Isombe			*3*	

Markhamia lutea	Umusave			*1*	
Mikania cordata	Urugozi	*2*	*2*		
Musa sp	Insina			*2*	
Ocimum basilicum	Umwenya	*2*		*2*	
Panicum maximum	Igikaranka	*3*			
Persea americana	Avoka			*3*	*2*
Phragmites mauritianus	Umuseke	*3*			*2*
Psidium guajava	Ipera	*3*	*3*	*3*	*1*
Rumex abyssiniccus	Umufumba	+			
Solanecio manii	Umutagara				*1*
Synadenium grantii	Umukoni		*2*		+
Tetradenia riparia	Umuravumba				*1*
Tithonia diversifolia	Icyicamahirwe	*1*		*3*	*4*
Triumfetta cordifolia	Umunaba		+	*2*	
Triumfetta rhomboidea	Umushyigura	+	+		
Euclea racemosa subsp. *schimperi*	Umushikiri		+		

Table 4. Plant species distribution at Karinga Island

Species name	**Vernacular name**	**R1**	**R2**	**R3**
Agave sisalana	Umugwegwe	*2*		
Aloe lateritia	Igikakarubamba	+	+	
Anthocleista schwenfurthii			*3*	
Bidens pilosa	Inyabarasanya		*2*	
Carissa edulis	Umunyonza	+		
Capparis tomentosa	Umukorokombe			+
Clematis hirsuta	Umunkamba		+	
Clotaralia aculeata	Ubuyogera			+
Commelina benghalensis	Uruteja	+	+	
Conyza sumatrensis	Urububa			+
Crassocephalum montuosum	Igifuraninda		+	
Crassocephalum vitellinum	Isununu		+	
Crotalaria spinosa	Nyagashekenyuka	+		+

Cupresus lusitanica	Isipure		*2*	
Desmodium uncinatum	Ituza	+		
Digitaria abyssinica	Urwiri		*3*	+
Dodonaea viscosa	Umusasa	*3*		+
Entada abyssinica	Umusange	+		
Eragrostis racemosa	Ishinge	+		+
Eucalyptus sp	Inturusu		+	
Euclea racemosa	Umushikiri		+	
Ficus ingens	Umurehe	*2*		
Galinsoga parviflora	Kimali	+	+	+
Gallium sp		+		+
Grevillea robusta	Gereveriya			
Kalanchoe integra	Ikinetenete	+		
Leonotis nepetaefolia	Igicumucumu		+	*1*
Mangifera indica	Umwembe		*2*	
Mikania cordata	Urugozi	+	*2*	*2*
Ocimum basilicum	Umwenya	+	+	+
Panicum maximum	Igikaranka	*3*	*3*	
Phytolacca decandra	Umuhoko			*2*
Pinus patula	Pinusi	*3*	*3*	
Plectranthus barbatus	Igicuncu		*1*	
Psidium guajava	Ipera	*3*	*2*	+
Senna spectabilis	Kasiya			*3*
Sida acuta		+		+
Synadenium grantii	Umukoni	+		
Tagetes minuta	Nyiramunukanabi		+	
Tetradenia riparia	Umuravumba	+		
Triumfetta cordifolia	Umunaba		+	+
Triumfetta rhomboidea	Umushyigura	+	+	

Table 5. Plant species distribution at Ishyute Island

Species name	**Vernacular name**	**R1**	**R2**	**R3**	**R4**
Acacia kirkii	Umunyaryera				*1*

Acacia polyacantha	Umugu				*2*
Acacia sieberiana	Umunyinya	*1*		+	
Acanthus pubescens	Igitovu	*1*		*2*	
Achyranthes aspera	Umuhurura				*1*
Ageratum conyzoides	Nkuruba				+
Aloe lateritia	Igikakarubamba				
Anthocleista grandiflora	Umwarangabo				*1*
Bidens pilosa	Inyabarasanya	+	+	+	+
Blighia unijugata	Umuturamugina				*1*
Carissa edulis	Umunyonza		+		
Clerodendrum rotundifolium	Ikiziranyenzi	*1*	+		*2*
Crotalaria laburnifolia	Umuyogera		+		+
Commelina africana	Uruteja	+	+	+	
Commelina benghalensis	Uruteja				
Conyza sumatrensis	Urububa	+	+		
Crassocephalum montuosum	Igifuraninda				+
Crassocephalum vitellinum	Isununu	+	+	+	
Cussonia arborea	Igitegamajanja				+
Cyphostemma adenocaule	Umubombwe		+		
Desmodium uncinatum	Ituza	*4*			
Digitaria abyssinica	Urwiri	+			
Eragrostis racemosa	Ishinge		*3*	*1*	
Erythrina abyssinica	Umuko		+		
Euclea racemosa subsp. *schimperi*	Umushikiri		*1*	+	*2*
Ficus cyathistipula	Imvubuvubu	+	+		
Ficus ingens	Umurehe	+	+		
Ficus ovata	Umukobe	*1*	+		*2*
Flueggea virosa	Umubwirwa			*1*	
Galinsoga parviflora	Kimali	*1*		+	
Galliniera saxifraga	Umugaja	*1*		*2*	
Grevillea robusta	Gereveriya	*2*		*2*	*3*
Grewia bicolor	Umukomagabo		+		
Harungana madascariensis	Umushayishayi			*1*	
Hibiscus sp	Umucundura	+			

Hyparrhenia filipendula	Umukenke	+	+		
Indigofera circinella	Mbatama	+		+	
Justicia flava	Urufa	*1*			
Killinga bulbosa	Indasigariza	*1*			
Lantana trifolia	Umuhengeri	+	*1*	*1*	
Leonotis nepetaefolia	Igicumucumu	+		+	+
Leucas martinicensis	Kanyamapfundo	+		+	
Mangifera indica	Umwembe				*1*
Mikania cordata	Urugozi	*2*	*1*	*1*	
Ocimum basilicum	Umwenya	+	+		+
Panicum maximum	Igikaranka	*1*	*4*		
Pavetta ternifolia	Umunyamabuye				+
Persea Americana	Avoka	+			
Phaseolus vulgalis	Ibishyimbo	+			
Phragmites mauritianus	Umuseke	+			
Psidium guajava	Amapera	+	*1*	*3*	
Psydrax parviflora	Umubaruka	*1*			
Pycnostachys goetzenii	Umutsinduka		*1*	+	
Rubus apetalus	Umukeri	+			
Senna spectabilis	Kasiya	+		+	
Sesbania sesban	Umunyegenyege	+		+	
Sida acuta		+			
Solanecio manii	Umutagara				
Stephania abyssinica	Ubuhanda		+		
Tagetes minuta	Nyiramunukanabi				+
Thunbergia alata	Nkurimwonga	+			
Tithonia diversifolia	Icyicamahirwe				*3*
Triumfetta cordifolia	Umunaba		+	*1*	
Triumfetta rhomboidea	Umushyigura	+	+		
Vernonia brachyaria		*2*		+	

Table 6. Plant species distribution at Ireba Island

Species name	Vernacular name	R1	R2	R3	R4	R5	R6
Afromomum angustifolium	Igitugunguru	2	1	1	3	2	1
Albizia gummifera	Umusebeya	2	1	4	4	3	5
Allophylus africanus	Umutete	1	2	1			1
Anthocleista schweinfurthii		1	1		2	1	2
Asistasia gagjetica	Urusogo	1		1	+	1	+
Bothriocline longipes	Uruhehe	+	1	1			
Bridelia brideliifolia	Umugimbu		2	1	+		1
Cassia floribunda	Umukubayoka	5	1		+		
Cinchona officinalis				1			+
Clerodendrum johstonii	Igikumbuguru	1	3	1		1	1
Crassocephalum vitellinum	Isununu	1	1				1
Dodoneaa viscosa	Umusasa		1	+			
Dracaena afromontana	Umuhati			+	1		
Drymaria cordata	Urwungo		1	1	3	1	2
Eriosema montanum	Umupfunyantoki	1	+	+	+	+	
Erythrina abyssinica	Umuko	+		+			
Eucalyptus globulus	Inturusu	1		+	2	5	
Ficus sp	Umuvumu		1	2			1
Grevillea robusta	Gereveriya			1			
Harungana madagascariensis	Umushayishayi		3	+	+	2	
Hibiscus ludwigii		2	1	3	4	2	5
Ipomoea cairica	Umuzenga	4					
Ipomoea ochracea		2	1	3	2	3	1
Lantana camara		1	4	1	1	5	2
Maesopsis eminii	Umuhumuro	3		1		1	
Melanthera scandens	Icyumwa		+	3	+	+	+
Microglossa pyrifolia	Umunyuragisaka	1	1		+		
Pennisetum purpureum	Urubingo	1	1				+
Pentas longiflora		1		1	+		+
Phoenix reclinata	Umukindo				2		1

Psydrax longiflora	Umubaruka	*1*	*1*	*1*	+	*1*	*2*
Pteridium aquilinum		*1*	+	*3*	*1*	*1*	
Rhus natalensis	Umusagara		*1*		*1*	+	
Sinarundinaria alpina	Umugano				+		+
Tabernaemontana stapfiana	Umuronzi	*1*	+	*2*	*1*	+	*2*
Triumfetta cordifolia	Umunaba	*1*	*1*	*1*	+	*1*	+
Typha dominguensis	Umuberanya	+				*1*	
Uvaria angolensis				+			+

Appendix II: Birds' diversity

Table 1. Recorded bird species at Mapfundugu Islands Complex

Common names	**Scientific Names**	**Order**	**Families**	**Relative abundance**
Black cracke	*Amaurornis flavirostris*	Gruiformes	Rallidae	1
Hadada Ibis	*Bostrychia hagedash*	Pelecaniformes	Threskiornithidae	2
Cattle Egret	*Bulbucus ibis*	Ciconiiformes	Ardeidae	1
Pied Kingfisher	*Ceryle rudis*	Passeriformes	Alcedinidae	8
Yellow-throated Greenbul	*Chlorocichla flavicollis*	Passeriformes	Pycnonotidae	6
Red-faced Cisticola	*Cisticola erythrops*	Passeriformes	Sylviidae	1
White-browed Robin-chat	*Cossypha heuglini*	Passeriformes	Turdidae	1
Common Waxbill	*Estrilda astrild*	Passeriformes	Estrildidae	12
Fawn-breasted Waxbill	*Estrilda nonnula*	Passeriformes	Estrildidae	5
Red-collared Widowbird	*Euplectes fransiscanus*	Passeriformes	Ploceidae	1
Black-winged Widowbird	*Euplectes hordaceus*	Passeriformes	Ploceidae	2
Tropical Boubou	*Laniarius aethiopicus*	Passeriformes	Laniidae	2
Copper sunbird	*Nectarinia cuprea*	Passeriformes	Nectarinidae	1
Red-chested Sunbird	*Nectarinia erythrocerca*	Passeriformes	Nectarinidae	5
Great Cormorant	*Phalacrocorax carbo*	Galliformes	Phalacrocoracidae	3
Baglafecht Weaver	*Ploceus baglafecht*	Passeriformes	Ploceidae	1
Spectacled Weaver	*Ploceus ocularis*	Passeriformes	Ploceidae	2
Holub's Golden-weaver	*Ploceus xanthops*	Passeriformes	Ploceidae	1
Common Bulbul	*Pycnonotus barbatus*	Passeriformes	Pycnonotidae	2
Brimstome Canary	*Serinus sulphuratus*	Passeriformes	Fringillidae	1
Red eyed Dove	*Streptopelia semitorquata*	Columbiformes	Columbidae	2
Ring-necked Dove	*Streptopelia capicola*	Columbiformes	Columbidae	2
African Thrush	*Turdus pelios*	Passeriformes	Turdidae	1
Spur winged Lapwing	*Vanellus spinosus*	Charadriformes	Charadridae	2
Pin tailed whydah	*Vidua macrura*	Passeriformes	Viduidae	6

Table 2. Recorded bird species at Karugaruka Island

Common names	**Scientific Names**	**Order**	**Families**	**Relative abundance**
Hadada Ibis	*Bostrychia hagedash*	Pelecaniformes	Threskiornithidae	2
Pied Kingfisher	*Ceryle rudis*	Passeriformes	Alcedinidae	2
Yellow-throated Greenbul	*Chlorocichla flavicollis*	Passeriformes	Pycnonotidae	7
Common Waxbill	*Estrilda astrild*	Passeriformes	Estrildidae	13
Copper Sunbird	*Nectarinia cuprea*	Passeriformes	Nectarinidae	2
Red-chested Sunbird	*Nectarinia erythrocerca*	Passeriformes	Nectarinidae	6
Great Cormorant	*Phalacrocorax carbo*	Pelecaniformes	Phalacrocoracidae	1
Brimstome Canary	*Serinus sulphuratus*	Passeriformes	Fringillidae	2
Red eyed Dpve	*Streptopelia semitorquata*	Columbiformes	Columbidae	3
Ring-necked Dove	*Streptopelia capicola*	Columbiformes	Columbidae	3

Table 3. Recorded bird species at Nyanamo Island

Common names	**Scientific Names**	**Order**	**Families**	**Relative abundance**
Hadada Ibis	*Bostrychia hagedash*	Pelecaniformes	Threskiornithidae	3
Pied Kingfisher	*Ceryle rudis*	Passeriformes	Alcedinidae	3
Yellow-throated Greenbul	*Chlorocichla flavicollis*	Passeriformes	Pycnonotidae	7
Red-faced Cisticola	*Cisticola erythrops*	Passeriformes	Sylviidae	5
Southern Red Bishop	*Euplectes orix*	Passeriformes	Ploceidae	1
Red-chested Sunbird	*Nectarinia erythrocerca*	Passeriformes	Nectarinidae	3
Great Cormorant	*Phalacrocorax carbo*	Galliformes	Phalacrocoracidae	2
Willow Warbler	*Phylloscopus trochilus*	Passeriformes	Sylviidae	
Common Bulbul	*Pycnonotus barbatus*	Passeriformes	Pycnonotidae	3
Ring-necked Dove	*Streptopelia capicola*	Columbiformes	Columbidae	4
Village Indigobird	*Vidua chalybatea*	Passeriformes	Viduidae	2

Table 4: Recorded bird species at Karinga Island

Common names	Scientific Names	Order	Families	Relative abundances
Hadada Ibis	*Bostrychia hagedash*	Pelecaniformes	Threskiornithidae	2
Pied Kingfisher	*Ceryle rudis*	Passeriformes	Alcedinidae	2
Yellow-throated Greenbul	*Chlorocichla flavicollis*	Passeriformes	Pycnonotidae	7
Copper Sunbird	*Cinnyris cuprea*	Passeriformes	Nectarinidae	1
Red-faced Cisticola	*Cisticola erythrops*	Passeriformes	Sylviidae	6
Pied Crow	*Corvus albus*	Passeriformes	Corvidae	2
Common Waxbill	*Estrilda astrild*	Passeriformes	Estrildidae	13
Little Bittern	*Ixobyrchus minutus*		Anatidae	1
Red-chested Sunbird	*Nectarinia erythrocerca*	Passeriformes	Nectarinidae	16
Great Cormorant	*Phalacrocorax carbo*	Galliformes	Phalacrocoracidae	3
Common Bulbul	*Pycnonotus barbatus*	Passeriformes	Pycnonotidae	6
Ring-necked Dove	*Streptopelia capicola*	Columbiformes	Columbidae	4

Table 5: Recorded bird species at Ishyute Island

Common names	Scientific Names	Order	Families	Relative abundance
Egyptian Goose	*Alopochen aegyptiaca*	Anseriformes	Anatidae	2
Hadada Ibis	*Bostrychia hagedash*	Pelecaniformes	Threskiornithidae	4
Blue headed Coucal	*Centropus monachus*	Cuculiformes	Cuculidae	1
Pied Kingfisher	*Ceryle rudis*	Passeriformes	Alcedinidae	2
Red-faced Cisticola	*Cisticola erythrops*	Passeriformes	Sylviidae	5
Speckled Mouserbird	*Colius striatus*	Coliformes	Coliidae	2
Pied Crow	*Corvus albus*	Passeriformes	Corvidae	3
Red-capped Robin-chat	*Cossypha natalensis*	Passeriformes	Turdidae	1
Grey-capped Warbler	*Eminia lepida*	Passeriformes	Sylviidae	2
Common Waxbill	*Estrilda astrild*	Passeriformes	Estrildidae	16
Yellow Bishop	*Euplectes capensis*	Passeriformes	Ploceidae	3
Northern Red-Bishop	*Euplectes*	Passeriformes	Ploceidae	2

	fransciscanius			
Grey Kestrel	*Falco ardosiaceus*	Falconiformes	Falconidae	1
Tropical Boubou	*Laniarius aethiopicus*	Passeriformes	Laniidae	4
Double-toothed Barbet	*Lybius bidentatus*	Buceroformes	Capitonidae	2
Bronze Sunbird	*Nectarinia kilimensis*	Passeriformes	Nectarinidae	4
Long tailed Cormorant	*Phalacrocorax africanus*	Pelecaniformes	Phalacrocoracidae	1
Great Cormorant	*Phalacrocorax carbo*	Pelecaniformes	Phalacrocoracidae	3
Holub's Golden-weaver	*Ploceus xanthops*	Passeriformes	Ploceidae	2
Common Bulbul	*Pycnonotus barbatus*	Passeriformes	Pycnonotidae	5
Brimstome Canary	*Serinus sulphuratus*	Passeriformes	Fringillidae	2
Ring-necked Dove	*Streptopelia capicola*	Columbiformes	Columbidae	3
Blue-spotted Wood-dove	*Turtur afer*	Columbiformes	Columbidae	2

Table 6: Recorded bird species at Ireba Island

Common names	**Scientific names**	**Order**	**Family**	**Relative abundance**
Pied King fisher	*Ceryle rudis*	Passeriformes	Alcedinidae	2
Speckled mousebird	*Colius striatus*	Coliformes	Coliidae	8
Black-winged red bishop	*Euplectes hordeaceus*	Passeriformes	Ploceidae	2
Ross's Turaco	*Musophaga rossae*	Musophagiformes	Musophagidae	5
Great Cormorant	*Phalacrocorax carbo*	Galliformes	Phalacrocoracidae	2
Baglafecht weaver	*Ploceus baglafecht*	Passeriformes	Nectarinidae	2
Common bulbul	*Pycnonotus barbatus*	Passeriformes	Pycnonotidae	7
Ring-necked dove	*Streptopelia capicola*	Columbiformes	Columbidae	5
African paradise flycatcher	*Terpsiphone viridis*	Passeriformes	Monarchidae	2
Sacred ibis	*Threskiornis aethiopicus*	Pelecaniformes	Threskiornithidae	1

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Common names	**Scientific names**	**Relative abundance**
Pied King fisher	*Ceryle rudis*	2

Speckled mousebird	*Colius striatus*	8
black-winged red bishop	*Euplectes hordeaceus*	2
Handsome francolin	*Francolinus nobilis*	3
Common fiscal	*Lanius collaris*	3
Ross's Turaco	*Musophaga rossae*	5
Long-tailed cormorant	*Phalacrocorax africanus*	2
Great Cormorant	*Phalacrocorax carbo*	2
Baglafecht weaver	*Ploceus baglafecht*	2
Black billed weaver	*Ploceus melanogaster*	3
Allen's gallinule	*Porphyrio alleni*	1
Common bulbul	*Pycnonotus barbatus*	7
Ring-necked dove	*Streptopelia capicola*	5
African paradise flycatcher	*Terpsiphone viridis*	2
Sacred ibis	*Threskiornis aethiopicus*	1

Appendix III: Invertebrates' diversity

Table 1: Presence and absence of species on surveyed islands

Species names	Mapfundugu	Karugaruka	Nyanamo	Karinga	Ishyute	Ireba
Acanthaspis sp.		+	+		+	+
Acanthotemes sp.		+	+	+	+	
Achatina fulica	+					+
Antestiopsis sp.	+					
Aptera sp.	+				+	
Araneus sp.	+		+	+	+	
Asellus sp.	+	+			+	+
Atoxin sp.	+					
Blaberus sp.		+				
Camponotus sp.			+		+	
Cicadella viridis	+					
Conocephalus sp.					+	
Cophogryllus sp	+			+	+	
Crematogaster sp.				+		
Derocalymma sp.				+		+
Deropeltis sp.	+	+	+			
Dieuches sp.	+					
Eurycorypha sp.					+	
Formica rufa	+	+	+	+	+	+
Heteronychus sp.					+	+
Homorous sp.	+				+	
Hoplolopha sp.			+			
Hypopholis sommeri	+	+			+	+
Lepisma saccharina	+				+	
Lexosceles sp.	+	+	+	+	+	
Lombricus terrestris	+	+	+	+	+	
Lumbricus sp.				+		
Lygocoris pabulumis	+					+
Lygocoris sp.				+		

Macrotermes natalensis	+					+
Macrotermes sp.	+					+
Neoconocephalus sp.			+			
Oecophylla sp.				+		+
Oncocephalus sp.			+			+
Oncocoris sp.	+		+			+
Oxyhaloa sp.			+	+	+	
Pangaeus sp.			+			
Periplaneta s.p	+	+	+		+	+
Pleuroprocta silvatica walikalensis					+	
Potamides sp.			+		+	+
Scaphiostreptus parilis	+	+	+	+	+	
Scolopandra sp.	+	+		+	+	+
Tarantula sp.	+			+		+
Teminopterix sp.	+					
Tetragonomenes sp.	+				+	
Timarcha sp.	+			+	+	+
Trigonopus sp.		+	+	+	+	+
Veterna sp.	+					
(blank)	+	+	+	+	+	+
Total	**28**	**13**	**18**	**17**	**25**	**19**

Blank : unidentified species

Table 2: Main invertebrate taxa within plots at Mapfundugu complex Island

Taxa	Number of individuals
Arachnida	**34**
Aranea	**34**
Lexocelidae	3
Lexosceles sp.	3
Theraphosidae	23
Tarantula sp.	23
(blank)	8
Areneus sp.	7
(blank)	1
Crustacea	**9**

Isopoda	**9**
Aselludae	9
Asellus sp.	9
Gasteropoda	**5**
Pulmonata	**5**
Stenogyrinae	1
Homorous sp.	1
Urocyclidae	4
Achatina fulica	3
Atoxin sp.	1
Insecta	**425**
Blatodea	**74**
Blaberidae	4
Aptera sp.	2
Teminopterix sp.	2
Blatidae	70
Deropeltis sp.	68
Periplaneta sp.	2
Blatoidea	**38**
Blaberidae	2
Teminopterix sp.	2
Blatidae	36
Deropeltis sp.	36
Coleoptera	**17**
Crysomelidae	2
Timarcha sp.	2
Scarabaeidae	7
Hypopholis sommeri	7
Tenebrionidae	8
Tetragonomenes sp.	8
Coleoptera (Larva)	**37**
(blank)	37
(blank)	37
Collembola	**2**
(blank)	2
(blank)	2
Hemiptera	**14**
Cicaderidae	1

Cicadella viridis	1
Lygaeidae	6
Dieuches sp.	6
Miridae	2
Lygocoris pabulumis	2
Pentatomidae	5
Antestiopsis sp.	1
Oncocoris sp.	2
Veterna sp.	2
Hymenoptera	**200**
Formicidae	200
Formica rufa	200
Isopoda	**2**
Termitidae	2
Macrotermes natalensis	1
Macrotermes sp.	1
Lepidoptera (Larva)	**32**
(blank)	32
(blank)	32
Orthoptera	**6**
Gryllidae	6
Cophogryllus sp	6
Thysanura	**3**
Lepismatidae	3
Lepisma saccharina	3
Myriapoda	**80**
Chilopoda	**8**
Scolopandridae	8
Scolopandra sp.	8
Diplopoda	**72**
Spirostreptidae	72
Scaphiostreptus parilis	72
Myriapoda	**2**
Chilopoda	**2**
Scolopandridae	2
Scolopandra sp.	2
Oligochaeta	**28**
Haplotaxida	**28**

Lombricidae	28
Lumbricus terrestris	28
Total	**583**

Blank: unidentified taxa.

Table 3. Invertebrates inventory at Karugaruka Island

Taxa	Number of Individuals
Arachnida	**5**
Aranea	**5**
Lexocelidae	5
Lexosceles sp.	5
Crustacea	**1**
Isopoda	**1**
Asilludea	1
Asellus sp.	1
Insecta	**178**
Blatodea	**29**
Blaberidae	27
Blaberus sp.	27
Blatidae	2
Deropeltis sp.	1
Periplaneta sp.	1
Coleoptera	**15**
Scarabaeidae	2
Hypopholis sommeri	2
Tenebrionidae	13
Trigonopus sp.	10
(blank)	3
Coleoptera (Larva)	**27**
(blank)	27
(blank)	27
Hemiptera	**1**
Reduviidae	1
Acanthaspis sp.	1
Hymenoptera	**50**
Formicidae	50
Formica rufa	50

Isoptera	**50**
Termitidae	50
Acanthotemes sp.	50
Lepidoptera (Larva)	**1**
(blank)	1
(blank)	1
Thysanura	**5**
(blank)	5
(blank)	5
Myriapoda	**35**
Chilopoda	**4**
Scolopandridae	4
Scolopandra sp.	4
Diplopoda	**31**
Spirostreptidae	31
Scaphiostreptus parilis	31
Oligochaeta	**13**
Haplotaxida	**13**
Lombricidae	13
Lumbricus terrestris	13
Total	**232**

Blank: unidentified

Table 4: Main invertebrate taxa within plots at Nyanamo Island

Taxa	Number of Individuals
Arachnida	**20**
Aranea	**20**
Lexocelidae	19
Lexosceles sp.	19
(blank)	1
Araneus sp.	1
Gasteropoda	**1**
Pulmonata	**1**
Urocyclidae	1
Potamides sp.	1
Insecta	**264**
Blatodea	**33**

Blaberidae	1
Oxyhaloa sp.	1
Blatidae	32
Deropeltis sp.	27
Periplaneta s.p	5
Coleoptera	**6**
Cerambicidae	3
(blank)	3
Tenebrionidae	3
Trigonopus sp.	3
Coleoptera (Larva)	**8**
(blank)	8
(blank)	8
Hemiptera	**6**
Cydnidae	1
Pangaeus sp.	1
Pentatomidae	3
Oncocoris sp.	3
Reduviidae	2
Acanthaspis sp.	1
Oncocephalus sp.	1
Hymenoptera	**154**
Formicidae	154
Camponotus sp.	4
Formica rufa	150
Isoptera	**50**
Termitidae	50
Acanthotemes sp.	50
Lepidoptera (Larva)	**1**
(blank)	1
(blank)	1
Orthoptera	**6**
Pamphagidae	1
Hoplolopha sp.	1
Tettigoniidae	5
Neoconocephalus sp.	5
Myriapoda	**10**
Diplopoda	**10**

Spirostreptidae	10
Scaphiostreptus parilis	10
Oligochaeta	**12**
Haplotaxida	**12**
Lombricidae	12
Lumbricus terrestris	12
Grand Total	**307**

Blank: unidentified

Table 5: Invertebrate inventory at Karinga Island

Taxa	Number of Individuals
Arachnida	**27**
Aranea	**27**
Lexocelidae	5
Lexosceles sp.	5
Theraphosidae	21
Tarantula sp.	21
(blank)	1
Areneus sp.	1
Insecta	**298**
Blatodea	**29**
Blaberidae	28
Derocalymma sp.	26
Oxyhaloa sp.	2
(blank)	1
(blank)	1
Coleoptera	**6**
Chrysomelidae	1
Timarcha sp.	1
Scarabaeidae	1
(blank)	1
Tenebrionidae	4
Trigonopus sp.	4
Coleoptera (Larva)	**17**
(blank)	17
(blank)	17
Hemiptera	**3**

Miridae	3
Lygocoris sp.	3
Hymenoptera	**157**
Formicidae	157
Crematogaster sp.	1
Formica rufa	150
Oecophylla sp.	6
Isoptera	**84**
Termitidae	84
Acanthotemes sp.	84
Lepidoptera (Larva)	**1**
(blank)	1
(blank)	1
Orthoptera	**1**
Gryllidae	1
Cophogryllus sp.	1
Myriapoda	**10**
Chilopoda	**1**
Scolopandridae	1
Scolopandra sp.	1
Diplopoda	**9**
Spirostreptidae	9
Scaphiostreptus parilis	9
Oligochaeta	**21**
Haplotaxida	**21**
Lombricidae	21
Lumbricus terrestris	21
Total	**356**

Blank : unidentified

Table 6: Main invertebrate taxa within plots at Ishyute Island

Taxa	Number of individuals
Arachnida	**21**
Aranea	**21**
Lexocelidae	3
Lexosceles sp.	3
(blank)	18

Areneus sp.	16
(blank)	2
Crustacea	**60**
Isopoda	**60**
Aselludae	60
Asellus sp.	60
Gasteropoda	**11**
Pulmonata	**11**
Stenogyrinae	10
Homorous sp.	7
Pleuroprocta silvatica walikalensis	3
Urocyclidae	1
Potamides sp.	1
Insecta	**268**
Blatodea	**74**
Blaberidae	52
Aptera sp.	51
Oxyhaloa sp.	1
Blatidae	22
Periplaneta sp.	22
Coleoptera	**10**
Chrysomeridae	2
Timarcha sp.	2
Scarabaeidae	4
Heteronychus sp.	1
Hypopholis sommeri	3
Tenebrionidae	4
Tetragonomenes sp.	1
Trigonopus sp.	3
Coleoptera (Larva)	**11**
(blank)	11
(blank)	11
Hemiptera	**1**
Reduviidae	1
Acanthaspis sp.	1
Hymenoptera	**105**
Formicidae	105
Camponotus sp.	5

Formica rufa	100
Isoptera	**50**
Termitidae	50
Acanthotemes sp.	50
Lepidoptera (Larva)	**9**
(blank)	9
(blank)	9
Orthoptera	**3**
Gryllidae	1
Cophogryllus sp.	1
Tettigoniidae	2
Conocephalus sp.	1
Eurycorypha sp.	1
Thysanura	**5**
Lepismatidae	5
Lepisma saccharina	5
Myriapoda	**84**
Chilopoda	**11**
Scolopandridae	11
Scolopandra sp.	11
Diplopoda	**73**
Spirostreptidae	73
Scaphiostreptus parilis	73
Oligochaeta	**5**
Haplotaxida	**5**
Lombricoidae	5
Lombricus terrestris	5
Total	**449**

Blank : unidentified

Table 7: Main invertebrate taxa within plots at Ireba Island

Taxa	Number of Individuals
Arachnida	**5**
Aranea	**5**
Lexocelidae	5
Lexosceles sp.	5

Crustacea	**2**
Isopoda	**2**
Asilludea	2
Asellus sp.	2
Insecta	**150**
Blatodea	**25**
Blaberidae	25
Blaberus sp.	25
Blatidae	2
Deropeltis sp.	1
Periplaneta sp.	1
Coleoptera	**21**
Scarabaeidae	8
Hypopholis sommeri	8
Tenebrionidae	13
Trigonopus sp.	13
(blank)	**26**
Coleoptera (Larva)	19
(blank)	**1**
(blank)	1
Hemiptera	1
Reduviidae	**37**
Acanthaspis sp.	37
Hymenoptera	37
Formicidae	**34**
Formica rufa	34
Isoptera	34
Termitidae	**1**
Acanthotemes sp.	1

Lepidoptera (Larva)	1
(blank)	**5**
(blank)	5
Thysanura	5
(blank)	**21**
(blank)	**6**
Myriapoda	6
Chilopoda	6
Scolopandridae	**15**
Scolopandra sp.	15
Diplopoda	15
Spirostreptidae	**3**
Scaphiostreptus parilis	**3**
Oligochaeta	3
Haplotaxida	3
Lombricidae	**5**
Lumbricus terrestris	**5**
Total	178

Blank: unidentified