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A socio-economic assessment of the impacts of invasive alien plant species on forestry production: the case of *Senna spectabilis* in Budongo forest reserve, Uganda

BY

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DECLARATION

I, Ahimbisibwe Beine Peter hereby declare that the work presented in this dissertation is my own and has never been submitted for any award in any other institution. Proper citation and referencing has been done where information from other sources has been used.

Signature----------

Ahimbisibwe Beine Peter

Date----------

APPROVAL

This thesis has been approved by me as the University Supervisor.

Signed……

Dr. Eric Dada Mungatana

Date…….

DEDICATION

This thesis is dedicated to the memory of my departed father and grandparents.

Fare thee well.

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Foremost, I thank the Lord God who listens and grants the prayers of man.

I would like to convey my heartfelt gratitude to the management of the UNEP/GEF-IAS Project for funding my Msc. Study at the University of Pretoria.

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With a gratified heart, I say thank you to my study colleagues at both University of Pretoria in South Africa and Makerere University, Kampala Uganda for having the spirit of comradeship in the struggle that was justified by its cause.

To my lovely family and friends who played and continue to play special roles in my earthly life, I say be blessed always.

With heavy heart, I would like to pay tribute to my late father who chose to define his life purpose in the successful education of all that were willing. With this thesis, I partly honour his soul.

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All contracting parties should 'prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species' Article 8(h) of the 1992 Rio De Janeiro Convention on Biological Diversity.

LIST OF ACRONYMNS

ANOVA	Analysis of Variance
BFR	Budongo Forest Reserve
CABI	CAB International, (see www.cabi.org)
CBD	Convention on Biological Diversity (see www.biodiv.org)
CFRs	Central Forest Reserves
CEEPA	Center for Environmental Economics and Policy in Africa
ENR SIP	Environment and Natural Resources Sector Investment
ENR	Environment and Natural Resources
FAO	Food and Agriculture Organization
FORRI	Forestry Resources Research Institute
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GISP	Global Invasive Species Programme
GMA	Gross Margin Analysis
GR	Gross Revenue
IAS	Invasive Alien Species
IUCN	The World Conservation Union, see www.iucn.org
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MEMD	Ministry of Energy and Mineral Development
MES	Ministry of Education and sports
MTTI	Ministry of Tourism, Trade and Industry
MUK	Makerere University, Kampala
MWLE	Ministry of Water, Lands and Environment
NARO	National Agricultural Research Organisation
NBS	National Biomass Studies
NEMA	National Environment Management Authority
NEPAD	New Partnership for Africa's Development, (see www.nepad.org)
NFA	National Forestry Authority
NGO	Non Governmental Organisation
NPFs	National Park Forests
OER	Operating expenses ratio
PEAP	Poverty Eradication Action Plan
PMA	Plan for Modernization of Agriculture
SPSS	Statistical Package for Social Scientists
TVC	Total Variable Costs
UBOS	Uganda Bureau of Statistics
UDHS	Uganda Demographic Household Survey
UIA	Uganda Investment Authority
UShs	Ugandan Shillings (Currency)
UNEP	United Nations Environment Programme
UNEP/GEF-IAS	Project titled "Removing Barriers to Invasive Plant Management in Africa". It's a project mandated to remove barriers to management of IAS through: Influencing policy, awareness creation, prevention and control through research and capacity building.
UNHS	Uganda National Household Survey
UWA	Uganda Wildlife Authority
WTTC	World Travel and Tourism Council

Executive summary

In 2006, a baseline survey for the UNEP/GEF-IAS Project was conducted in BFR to assess the status of IAS in the area. Findings indicated that extensive forest parts had severe *S. spectabilis* encroachment which appeared to interfere with the normal functioning and productivity of the forest. This study was motivated by the magnitude of *S. spectabilis* invasion in BFR, the level of public and government concern about the invasion, and the magnitude of the IAS problem across East Africa. This study was thus undertaken to address a specific need of the research and capacity building components of the UNEP/GEF-IAS Project. The study[1] was carried out to assess the impacts of *S. spectabilis* invasion on the productivity of BFR and the socio-economic implications on the livelihoods of the dependent stakeholders (local resident population, timber suppliers and the tourism sector).

The study used descriptive statistics to assess the levels of awareness of *S. spectabilis* invasion, perceptions and knowledge of the conservation values of BFR, knowledge on the benefits and costs of living with *S. spectabilis* and impacts of *S. spectabilis* on the flow of quantities and revenues from the benefits it generates. The impact on financial profitability and efficiency of timber firms was assessed using Gross margin analysis (GMA) and financial efficiency ratio analysis respectively. The impact on the population structure of chimpanzees was studied using mean differentials and focused group discussions. Results indicate that the level of awareness about *S. spectabilis* invasion and the knowledge of the conservation values of BFR were high among all the three stakeholder groups. GMA revealed that *S. spectabilis* invasion increases variable costs in timber production thus reducing profit margins and financial efficiency of timber firms. Alteration of habitat environment occasioned by *S. spectabilis* invasion was advanced, though with uncertainty, as a possible reason for the difference in chimpanzee numbers between the infested and non infested forest conditions. Like other IAS, *S. spectabilis* was found to have both benefits and costs though the distribution of the same differs. *S. spectabilis* can be considered a net benefit to the local dependent communities whereas it may be a net loss to both the timber and tourism sectors. Conflict of interest in *S. spectabilis* management is discussed and possible solutions suggested. It was recommended that the threat of invasive species should be tackled through a multisectoral approach.

[1] This dissertation follows the style and format of the Journal of Range Management

CHAPTER ONE

1.1 Introduction and background to the study

Invasive alien species (IAS) by definition are species that are non-native (or alien) to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health (CBD, 2002, 2004, www.biodiv.org). Invasive species can be plants, animals, and other organisms. Specifically, invasive tree species are species that are able to survive, reproduce and spread, unaided, and sometimes at alarming rates across an ecosystem causing a detrimental effect on the growth of commercial tree species and giving rise to particular management problems (Van Wilgen & Van Wyk, 1999). Invasions by alien species are considered to be one of the largest threats to the ecosystems of the earth, and the services that they provide to humanity (Kaiser, 1999). Some alien tree species used in commercial forestry and agro-forestry cause significant problems as invaders of natural and semi-natural ecosystems. The magnitude of the problem has increased significantly over the past few decades, with a rapid increase in afforestation and changes in land use (Richardson, 1997).

Perrings et al (2002) suggests that most cases of invasiveness can be linked to the intended or unintended consequences of economic activities and therefore economic applications are essential to understand the problem and provide more accurate and comprehensive assessments of the benefits and costs of control alternatives to increase the effectiveness and efficiency of public funding. Invasive species are increasingly recognized as having important impacts on landscapes, ecosystems and levels of biodiversity (Baskin, 2002). These impacts are not all negative and invasive plant species bring both costs and benefits to local people. Costs are incurred if the exotic species inhibit the effective functioning of the local social and ecological systems, such as when invasive species become weeds within agricultural or forestry systems, inhibit vital ecosystem functions or affect animal or human health (Pimental et al, 2001). Ecosystem level change can also deplete peoples' sense of the value of place. Consequently, exotic species can form the base of many economically important resource management systems such as agriculture, horticulture and forestry. Invasive tree species tend to be multisectoral in their impact, and thus need to be addressed with a multisectoral approach. In some cases invasive trees provide useful products or services and, when eradication is not possible, management options should be identified in order to balance the positive and negative aspects (Cock,

2003). For instance, In Uganda, over 90% of the population uses firewood (NEMA, 1996). Normally, firewood consumption ranges between 15 and 20 kg of air-dry firewood per household per day and yet it is known that if left uncut, *S. spectabilis* produces high quality fuel wood because of its fast growth, low cleavage resistance, good calorific value and its ability to coppice. Alien invasive species are known to generate substantial costs to the forest sector in lost revenues, in expenses for their control and in lost conservation values and ecosystem services. Richardson (1998) asserts that the most direct economic impact of alien invasive species on the forest sector is related to the loss or reduced efficiency of production.

S. spectabilis is an invasive species in BFR which covers parts of Masindi, Hoima and Bulisa districts. BFR (situated between 1^{o} 37' and 2^{o} 00' N and 31^{o} 22' and 31^{o} 46' E) was chosen as the pilot site for the management of an ecosystem affected by *S. spectabilis* (spectacular cassia), a medium to large tree from tropical America. *S. spectabilis* is considered to be exerting severe socio-economic impacts as regards forestry productivity. *S. spectabilis* is extremely fast-growing, flowers and sets seed profusely. It also re-sprouts readily when cut. Out of the 82,530 ha of BFR, *S. spectabilis* had covered more than 1000 ha of the reserve as of 2004 (NARO, 2004). The species is considered a major problem requiring immediate attention. The species is thought to have been introduced by the Indian sawmill operators or by Europeans for firewood as well as live boundary marking in an attempt to preserve the forest. It is also common mainly along logging trails in the forest, where it forms pure stands at the expense of other species. It is not favoured by loggers for timber. In Hoima District, the species has been used for roofing. It is also largely unpalatable to forest animals including chimpanzees who are the subject of high profile conservation and tourism efforts (NARO, 2004). These factors partly explain its rapid spread and undesirable impacts.

The BFR was designated an important bird area (BirdLife International, 2003) and is regarded as Uganda's second most important bird area after Semiliki National Park, for species of the Guinea–Congo Forests biome. The vegetation of the forest is well known because of the pioneering work of Eggeling (1947) and forest ecology studies have continued since (e.g. Plumptre, 1996). Today, the forest is the richest for timber production in Uganda. The challenge is to balance conservation of forest biodiversity and ecological processes, production of timber on a sustainable basis and the needs of

local communities. Management of the impacts of IAS, notably *S. spectabilis* forms part of this challenge (NARO, 2004).

A quantification of the impacts of IAS is required to substantiate an argument to control invasive plant species. Previous studies in this field include Zavaleta (2000) who estimated the economic impacts of *tamarisk* species on the USA, Van Wilgen *et al.,* (1996) who examined the costs and benefits of invasive plant species at a regional scale in South African fynbos vegetation, and Le Maitre, Versfeld & Chapman (2002), who concluded that control programmes were justified after a cost-benefit analysis of management of invasive plants in four catchment areas across South Africa. Furthermore, Pimental et al (2001) estimated the total costs of invasive exotic species in the US, the UK, Australia, South Africa, India and Brazil to be more than US$336 billion per year. Hulme (2005) reports that inspite of the economic importance of many invasive species; most research work has concentrated on the biological aspects of invasions. This is unfortunate as the process of invasion by exotic species is both a social and natural one.

1.2 Research problem statement

In the study by Cock, (2003), it was asserted that while there is a growing national and international awareness of the possible risks of invasiveness of forestry trees, it is likely that some stakeholders in forestry remain ignorant of the risks, particularly since there is a general lack of quantitative information on the ecological and economic impacts of invasive forestry trees. It was therefore recommended that a number of case studies be conducted in countries that have a high dependence on forestry. Such case studies should cover a range of forestry situations (e.g. commercial and environmental) and include the development and promotion of tools for making ecological and economic assessments. Particular attention should be paid to those regions of the world where there is little information on the invasiveness of exotic forestry trees (e.g. tropical and temperate regions).The general lack of relevant information and methodologies was noted to prevent many countries from implementing risk assessments, control and management schemes.

It is reported in NARO (2004) that there exists a very weak policy and institutional environment in Uganda as explained by the gaps, overlaps and inconsistencies in existing policies, regulations, strategies and institutional arrangements concerning

IAS. Also, there is no institutional co-ordination mechanism for ensuring that IAS issues are addressed with the necessary broad, multisectoral ecosystem approaches that it deserves. The weak policy and institutional environment results in critical information for informed decision making being unavailable.

The lack of information on the socio-economic impacts of IAS has been singled out as a major barrier to the implementation of comprehensive national IAS management programmes and as one of the main reasons for the failure of IAS issues to feature prominently in the mainstream agenda of most countries (NARO, 2004). There is a shortage of information regarding the biodiversity, the status and socio-economic impact of alien species presently found in Uganda. Even in well studied areas such as Budongo, the severity of the impact of invasive plants is poorly understood. Studies have been carried out on other plant species in Budongo but not a single one on *S. spectabilis*, which following reconnaissance work undertaken during the UNEP/GEF-IAS Project[2] development phase is believed to be exerting relatively greater biodiversity and socio-economic impacts (NARO,2004).

Uganda being a very poor country with meager income sources heavily relies on tourism and timber production from forest reserves and other natural resources which forms the core reason for BFR conservation. In light of this, *S. spectabilis* is heavily impacting on the productivity of BFR and on the livelihoods of the dependent stakeholders. As alluded to earlier, there is a big challenge to balance conservation of forest biodiversity and ecological processes, production of timber on a sustainable basis and the needs of local communities and other stakeholders.

As highlighted earlier on, to substantiate an argument to control or manage invasive plant species and specifically *S. spectabilis* in this case, quantification, stakeholder perception evaluation and the distribution of the impacts of these species is required. Whereas an improvement in the ecological knowledge of invasive species is necessary to understand anthropogenic impacts on landscapes and ecosystems, an enhanced knowledge of the social processes is also required in order to inform both

[2] UNEP/GEF-IAS Project is a project mandated to remove barriers to invasive plant management in Africa. It is running in Ethiopia, Uganda, Zambia and Ghana. The four categories of identified barriers which form the basis for the intervention are: weak policies and institutional environment, unavailability of critical information and particularly information on socio-economic impacts of IAS, inadequate implementation of prevention and control as well as lack of capacity to manage IAS. This study tries to contribute to the alleviation of all the four identified barriers.

species management and conservation policy. Thus the need to carry out a comprehensive study to assess the socio-economic impacts of *S. spectabilis* on the productivity of the BFR in relation to the livelihoods of the dependant stakeholders and the Ugandan economy as a whole.

1.3 Objectives of the study

1.3.1 General objective

To assess the socio-economic impacts of *S. spectabilis* invasion on the productivity of BFR in Uganda and the socio-economic implications on the livelihoods of the dependent stakeholders (the local dependent community, timber enterprises and the tourism sector).

1.3.2 Specific objectives

1. To establish the level of awareness of *S. spectabilis* invasion among the local dependent communities.
2. To assess the impacts of *S. spectabilis* on the livelihoods of the local dependent communities.
3. To assess the impacts of *S. spectabilis* invasion on the performance of the timber enterprises operating in BFR.
4. To assess the impacts of *S. spectabilis* invasion on the tourism sector.

1.4 Research hypotheses

This study was designed to explore the validity of the assumption among policy makers and practitioners in environmental conservation that a proper understanding of the socio-economic impacts of IAS would lead to a better management of the environment hence poverty alleviation and environmental sustainability. In the attempt to understand and answer the research objectives, this study was thus informed by the following hypotheses;

1. *S. spectabilis* invasion affects the benefits (fuel wood, charcoal, construction poles, timber, and chimpanzee numbers) that the stakeholders (local communities, timber producers and the tourism sector) derive from BFR.
2. *S. spectabilis* invasion affects the timber production variable costs and hence reduces gross margins, financial profitability and efficiency.

3. There is a difference in the productivity parameters of the two forest conditions (the *S. spectabilis* infested forest and the non infested forest).

1.5 Significance of the study

This study will provide a basis for an enabling policy and institutional environment that provides a coherent framework for the sustainable prevention and management of IAS in Uganda. It is hoped that this type of analysis will inform conservation policy in Uganda and other places invaded by IAS. Possible specific policy decisions include; protection of the areas not currently invaded, controlling *S. spectabilis* populations, total elimination of *S. spectabilis*, providing an alternative source of the specific benefits provided by *S. spectabilis* through establishment of a forest plantation, or remitting a greater percentage of the tourism and timber revenue to the local government which would enable it to manage the invasive species. Also, the study responses will be used to advise both the local and central government about the level of awareness among the forest stakeholders on the invasion of *S. spectabilis* as well as conservation values of BFR.

1.6 The study area

1.6.1 Name, location and situation

The study was conducted in Budongo forest reserve (BFR) (Figure 1) which was established over time (1932 – 1968). BFR covers an area of 825 Km2 which is equal to 82,530 ha (NFA, 2008). It is situated in Bunyoro Kitara kingdom in the western part of the country, in the districts of Masindi, Hoima and Bulisa with the largest part falling in the former (Forestry department inventory, 1992). Local inhabitants are privileged to obtain free of charge and into reasonable quantities fuel wood, poles and sand for domestic use only in accordance with section 33 (1) of the Forestry Act 2003. Domestic animals are allowed to visit water and salt lick points in the reserve.

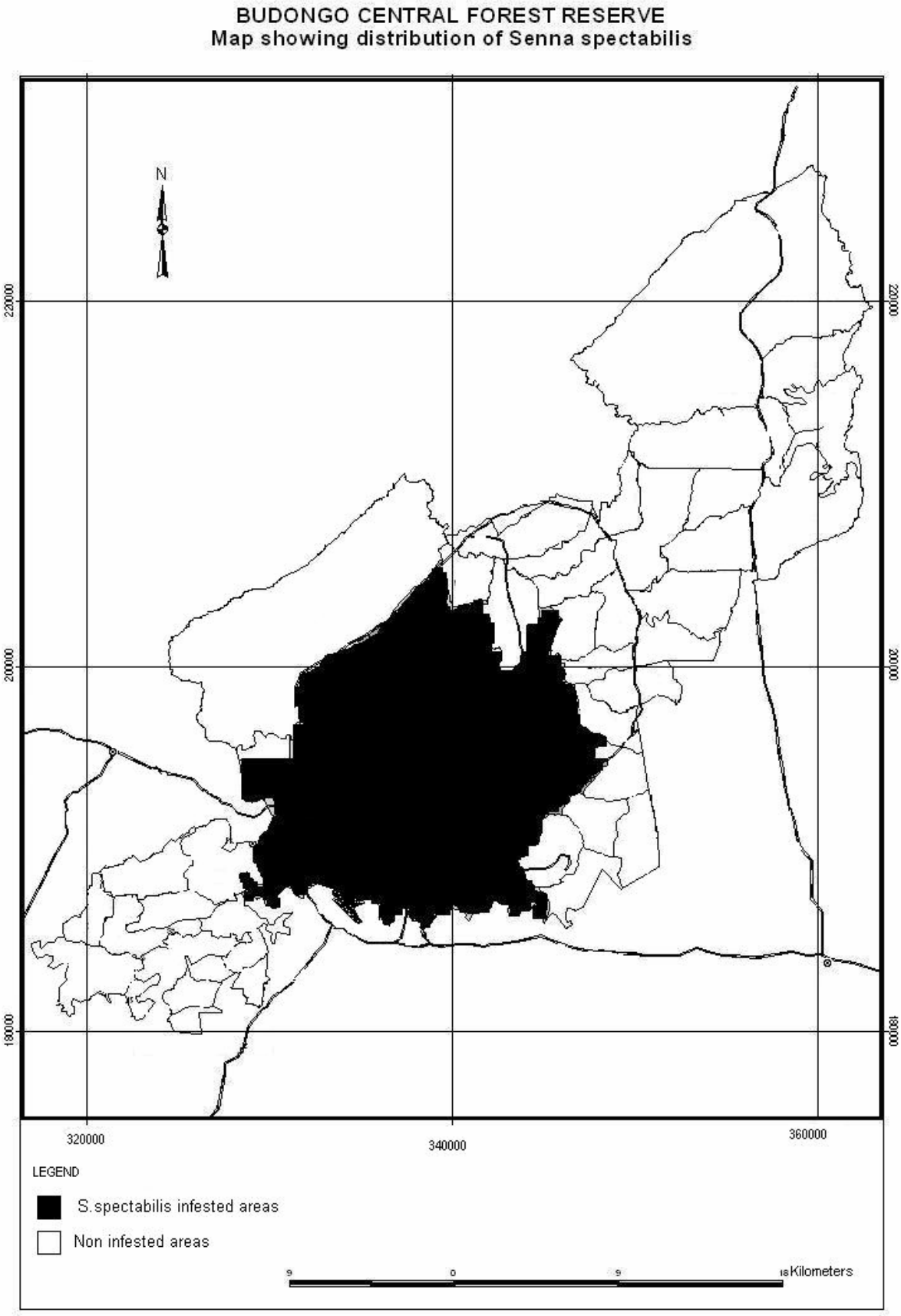


Figure 1: Spread and distribution of *S. spectabilis* in BFR

However, livestock production is not a major economic activity in this region and very few households keep livestock animals. Livestock keeping provides a minimal percentage of GDP in this area. Figure 1 above shows the spread and distribution of *S. spectabilis* in BFR. The shaded areas are the *S. spectabilis* infested forest areas while the unshaded areas are the non-infested forest areas.

1.6.2 Local conditions

1.6.2.1 Climatic conditions

The minimum temperature varies 23-29^0 C while maximum ranges 29-32^{0}C. Low temperatures occur May – July and high temperatures December – February during the months of the southern summer. BFR receives rainfall varying between 1,397 and 1,524 mm annually on 100 to 150 rain days (NFA, 2008). BFR experiences two rain seasons which are separated by two dry ones of December to mid March and June to July, the first being quite severe (NFA, 2008).

1.6.2.2 Vegetation

The original forest structure has been replaced by mixed forest type which was estimated at 65% of the whole forest area (Eggeling 1947) and stood at 85% of the whole forest (Plumptre, 1996). However the original ecological characteristics are still recognizable and the forest can be divided into wooded grassland, colonising or woodland mixed forest, *Cynometra* dominated and swamp forest types.

1.6.2.3 Description of the forest resource

Budongo Forest Management Plan (NFA, 2008) identifies several forest resources which include the following; ecological resource, biodiversity (research), tourism potential, timber and charcoal supply, non-timber resources, cultural resources, support services, climate regulatory services, stones and land resource.

1.7 Materials, methods and procedures

A comprehensive pilot study and a rapid rural appraisal were conducted in BFR in 2006 under the UNEP/GEF-IAS project development phase to study the status of the forest reserve in relation to invasive alien species. This research is therefore, a follow up of the pilot study. Findings of the pilot study confirmed that the spread of *S. spectabilis* in BFR had exceeded alarming levels and thus was recommended that a study be carried out to assess the present and potential impacts of *S. spectabilis* on the

three stakeholder groups with a view of explicating possible management options.

1.7.1 Population studied

The local resident population was sampled while timber suppliers and tourism operators were all interviewed in a census. Supplementary information was sought from forest research officers and forestry management officers.

1.7.2 Types of data

Both primary and secondary data were used in this study. Primary data covered the different dependent stakeholders and their characteristics, the impacts of *S. spectabilis* on the benefits and costs derived from the forest e.g. quantities of firewood, charcoal and timber production. Secondary data was obtained on quantities of timber produced, revenues from timber and number of chimpanzees inhabiting the different forest strata (*S. spectabilis* infested and non infested forest parts).

1.7.3 Methods of data collection

Primary data were collected using structured questionnaires administered through face to face interviews by the researcher with assistance of enumerators. The study also did structured interviews in gathering data to assess the impact of *S. spectabilis* on the tourism sector. Field observations were also done to supplement the interviews. Secondary data was collected through reviews of timber harvesters and tourism records as well as through comprehensive literature search from various secondary data sources such as the district forestry department, UWA and NFA libraries.

1.7.4 Sample design and sample selection

Stratified sampling can be used whenever the population can be partitioned into smaller sub-populations, each of which is homogeneous according to the particular characteristic of interest. The study used a combination of stratified purposive sampling and simple random sampling procedure to select respondents from the study area (BFR). To understand the impact of *S. spectabilis* on the three different stakeholders, the forest was stratified into infested and non-infested parts. A map (See Figure 1) showing high infestation and none or low infestation of *S. spectabilis* was obtained from the UNEP/GEF-IAS project. Depending on the spatial distribution of the mapped zones, a decision was made as to whether to select one or more than one area to represent each zone (*S. spectabilis* infested and non-infested). The decision put

into consideration the cost of conducting interviews in remote and far apart regions in light of the available budget and time.

The forest offers a wide range of services to the different categories of stakeholders: local resident population, timber harvesters and the tourism operators. The local resident population comprises of the in-forest and surrounding communities that rely on the forest for fuel wood, charcoal and construction poles. Given their large numbers, random sampling was used to select respondents for the study within the identified forest strata. A list of all villages in the local resident community was obtained from the local government officials and forestry management and households to interview were selected randomly from the villages depending on their proximity to each kind of forest condition.

For timber, firewood and charcoal variables, respondents were interviewed from each forest condition to assess the mean differentials in quantities of timber, firewood and charcoal harvested. Timber harvesters are licensed and regulated by the forest authorities and are usually few in number so the study considered all accessible timber producers operating within the study area. A list of all timber producers were obtained from the forest management authorities. The tourism operators are responsible for management of ecotourism and thus key informants from this category were identified to guide the researcher. Secondary time series data on various aspects of timber and tourism records were obtained from the timber suppliers and forest management officers.

1.7.5 Measures used to minimize errors

Random non systematic errors: This was achieved through careful design as described above with appropriate purposive stratification of the population, random selection procedures, sufficient sample and suitable sampling frames. Purposive stratification of the population to represent the two (infested and non infested forest conditions) distinct groups proportionally (variable sampling fractions) in the sample was done following the *S. spectabilis* spread map (Figure 1).

***Systemic errors*:** The following measures were used:

i. Enumerators were trained in pilot surveys and the questionnaires were pre-tested for suitability and identification of common measurement problems. This

was supplemented with vigilant field supervision of enumerators, daily checks for consistency of recorded information, clear and efficiently designed recording forms, well-defined measurement units and procedures.

ii. Careful timing of the visits to interviewees, rapport building through local authorities, use of adequate and up-to-date sampling frames, use of reserve lists to replace non-respondents and use of recalls were all employed among other measures to reduce non-response errors.

iii. Cross checking with secondary data and group interviews where possible and use of appropriate participatory rural appraisal tools to enable capture of refined responses.

1.7.6 Data analysis and empirical methods

1.7.6.1 Descriptive statistics

To answer the objectives that sought to identify and describe the different stakeholders, levels of awareness on *S. spectabilis* invasion and their perceptions and knowledge on the costs and benefits derived from *S. spectabilis*, data was analyzed through descriptive statistics to generate Tables, charts and graphs. The Statistical Package for Social Scientists (SPSS) was used to analyze the data. Chi-square statistics and ANOVA were utilized to get levels of significance between the two forest conditions.

To address the objectives that sought to determine the effect of *S. spectabilis* invasion on the quantity flows of timber, fuel wood, charcoal and construction poles, and the data was summarized in Tables showing means of these variables. The difference in means across the two categories of the respondents in the forest strata of *S. spectabilis* infested and non-infested was tested using student's t-test and chi-square.

1.7.6.2 Analysis of timber enterprises profitability

The level of timber enterprise profitability was determined using gross margin analysis. Timber as a benefit was chosen because it had data records unlike other benefits. Gross margin analysis is the return above variable costs. It shows the relative financial profitability of various enterprises using the enterprise budgeting approach.

Gross margins were worked out for both types of forest condition by finding the difference between gross income and the variable costs incurred. The major sources of income as already observed were timber sales. Expenditure was assessed on labour,

saw maintenance costs, transportation costs and *S. spectabilis* management. Timber producers in the two types of forest condition spent differently on the three areas of expenditure mentioned above.

In this study, to calculate the gross profits of timber harvesters, the procedure of enterprise budgeting was adopted. An enterprise budget is a listing of all estimated income and expenses associated with a specific enterprise to provide an estimate of its profitability. Gitman, (2009) defines gross profit margin as a measure of the percentage of each sales dollar that remains after the farm has paid for its goods. Still, Gitman, (2009) defines operating profit margin as a measure of the percentage of each sales dollar remaining after all costs and expenses other than interest, taxes, and preferred stock dividends are deducted. Emery *et al*. (1987) defined gross margins as the difference between the revenue and the operating expenses (variable costs) of a firm. The aim of gross margin analysis was to compare the level of profitability of the timber enterprises in the two types of forests and thus determine the effect of *S. spectabilis* encroachment on timber profitability.

For purposes of comparative analysis, gross margins were calculated on per timber tree basis. This was done with the aim of standardizing the margins given that different timber producing enterprises work on different timber tree numbers and different forest area sizes. Gross margin was therefore calculated as:

Gross margin firm j = Gross income firm j - total variable cost firm j.

$$(2) \qquad G_j = P_j Y_j - \sum_{j=1}^{n} P_j X_j$$

Where:

G_j= Gross margin (profit) in shillings/ timber tree of the i^{th} activity for timber

Y_j = Quantity of timber output per timber tree sawn for a given timber enterprise

P_j = Unit price of timber product for a given timber enterprise

P_j = Unit cost of variable inputs for a given timber enterprise

X_j = Quantity of variable inputs per timber tree used in a given timber enterprise

X= Indices for variable inputs like sawing labour, saw maintenance costs etc.

The TVC/GR (Total variable cost/ Gross revenue) ratio was calculated to determine

the financial efficiency of timber enterprises in the two types of forest condition.

Finally, it is important to acknowledge that there are several methodologies applicable to the problem at hand. For example, the use of multiple regression analysis can also isolate the effects of IAS incidence while controlling for other factors which may matter. In this study, we employ mean comparisons on the simplifying the assumption that all agents are the same in every respect except being located either in the infested or non-infested forest parts.

1.8 Organisation of the study

This research report is structured along chapters. Chapter one covered the introduction and background, study objectives, study hypothesis, study significance, research design, and general methodology while chapter two presents literature review. In Chapters three, four and five, we present the results of the study on the local dependent communities, the timber supply sector and the tourism sector respectively. Chapter six presents the summary of the general premise of the study, key conclusions and a set of policy recommendations.

CHAPTER TWO

2.0 Literature review

2.1 The threat of invasive alien species

Invasive species are a current focus of interest of ecologists, biological conservationists and natural resources managers due to their rapid spread, threat to biodiversity and damage to ecosystems. Invasion of ecological systems by non-indigenous species (Olson and Roy, 2002) has gained recognition as a growing global problem and therefore the control of such species is indeed an international and frequently global public good (Perrings *et al* 2002). The spread of invasive species is the second greatest threat to biodiversity, after habitat transformation (Vitousek et al., 1997, Bright, 1998 and Waage, 2000). Invasive plants present severe consequences in both semi and natural habitats. They are a threat in 93 of 993 Important Bird Areas (IBA's) of Tropical Africa and 7 of 27 centers of plant diversity (Binggeli et al., (1998). It is further reported that in the tropical regions, half of the invasive species occur in forested habitats which are the most diverse and where the impact of such species is enormous. The WTO Agreement embraces the need for national governments to protect its citizens and environment against invasive pests and diseases, (Evans, 2003). Invasive species have a major economic impact on agriculture, human health and the value of natural environment (Mamford, 2002; Olson and Roy, 2002). Introductions of invasive species in new areas are increasing sharply due to the liberalization of and increase in international travel, tourism and trade, (Evans et al, 2002; Perrings *et al.,* 2002).

Invasive species may alter hydrology, nutrient accumulation and cycling, and carbon sequestration on grasslands (Polley et al., 1997). The global extent and rapid increase in invasive species is homogenising the world's flora and fauna (Mooney & Hobbs, 2000) and is recognized as a primary cause of global biodiversity loss (Czech & Krausman, 1997). Bio-invasions are considered as a significant component on global change and one of the major causes of species extinction (Drake et al., 1989). Mark (1996) asserts that the plants that are likely to invade are species with attributes that allow them to take advantage of recently disturbed habitats. Some of the most important characteristics suggested by Given (1994) and Meffe (1994) include: high reproductive rates, production of large quantities of seeds, wide dispersal ability and the ability to germinate under a wide range of physical conditions. Invasive species also have early reproductive maturity, as well as high growth rates and capability of

vegetative reproduction as expressed by Denslow, (2002). These characteristics give invasive species an edge in competing against the native species.

Invasive species are a major environmental and ecological problem (Mumford, 2003) and a serious threat to trade. Quarantine against introduction of such invasive species is necessary to protect plant, environmental, human and animal health. However, enforcement of quarantine and control of such invasive species are very expensive to both country of introduction and country of origin. UNEP (2005) reports that the Millennium Assessment confirms that IAS have been one of the main drivers of biodiversity loss over the last 50 to 100 years, and assesses that the trend in the impact (at global level) will continue or increase in all biomes. The cost includes the loss of native species, biodiversity and ecosystem functioning, ecosystem services and livelihoods. Mooney & Hobbs (2000) present that the actual impacts of invasion are also being compounded by global climate change and land use changes worldwide. This is in line with the UNEP (2005) report that the current spread of invasive alien species is inextricably linked to key global changes especially land use change, human induced disturbance of natural systems, habitat destruction, overexploitation of resources, chemical pollution, and climate change.

2.2 The archetype pattern of invasion

It was noted by Hobbs & Humphries (1995) that even without any complicating factors in the usual pattern of invasion, IAS have a lag phase during which they are low in abundance and their impacts are not noticeable. This is sometimes called a "sleeper" stage. However, eventually the population reaches a phase where it increases rapidly (explosion phase) and the impacts usually become very apparent. The lag phase can be short or last over a century. Following the explosion phase, the population levels out as the ecosystem reaches the carrying capacity. The populations of introduced species often remain small and localized for long periods of time before they exhibit very rapid expansion. Until very recently, little evidence was available to support a number of hypothetical explanations for these observed time-lags or lag phases. The reasons for these time-lags are threefold. Hobbs & Humphries (1995) explain them as genotypic adaptations, cyclical disturbance or a combination of environmental conditions, species, with exponential growth, not observed until the population reaches a critical size.

The time between the introduction of a species and its first record of spread and pest status in tropical invasive woody species varies, respectively, from 3 years to around 50 years and from 4 years to around 90 years. Most woody plant species were introduced between 1838 and 1937 with a peak in the late 19th century (Hobbs & Humphries, 1995). No obvious differences are observed when the degree of invasiveness is taken into account. Figure 2 shows the archetype phases of alien plant invasion and priorities for action at each phase. Ease of treatment of invasion problem declines from left to right.

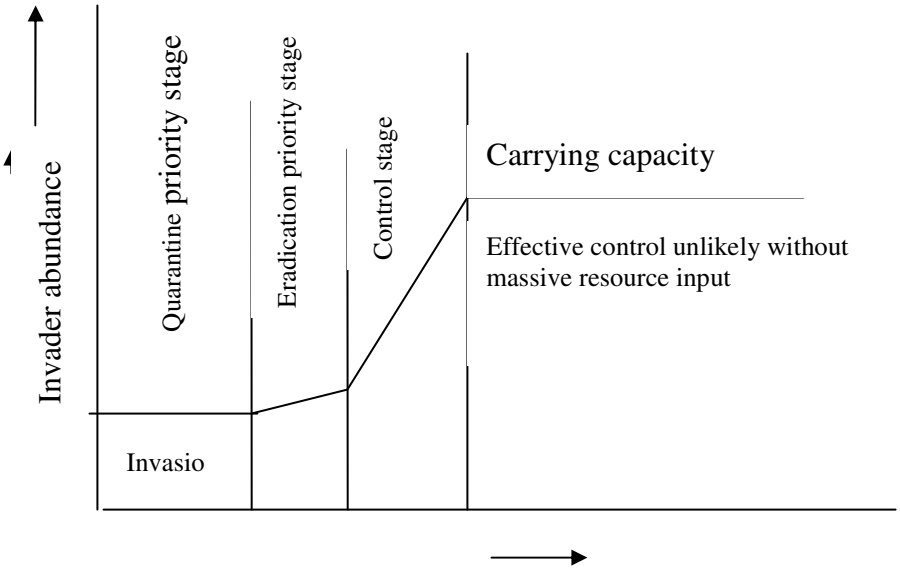


Figure 2: The archetype phases of alien plant invasion and priorities for action at each phase.

Source: Hobbs (1995)

As a consequence of these complexities, if managers are aware of the threats posed by an invasive species at an early stage, when the population is not very large yet, and the species is not well established and/or not widely spread yet, they can usually still eradicate it relatively easy. However, if the problem is only noticed much further down the line, when the invasion is much further advanced, it will be much more difficult and costly if not impossible to address it through eradication or control.

2.3 Invasion vectors and pathways

In the wake of widespread human movement, humans have aided the process of species dispersal, by, amongst other things, carrying organisms or propagules with them around the world. Humans have also created many new and very effective vectors such as grain and wood shipments, or ballast water tanks in ships; as well as many new pathways such as long-distance trucking, aeroplanes and ship voyages. As a result, many species have been able to establish new populations outside of their native range. These incursions have shown a dramatic increase in frequency, extent and damage over the last half a century or so and there is every indication of this trend continuing. There is little doubt that this is due largely to the increase in "the three Ts": Trade, Tourism and Transport (Hobbs & Humphries, 1995).

2.4. Plant invasions in forested habitats

Tropical forests that are undisturbed seem to be fairly resistant to invasions (Cronk and Fuller, 1995) but the fact that there are no forests free from disturbances, implies that such forests are susceptible to plant invasions. The level of susceptibility may depend on stability of the forest ecosystem. Invasive species in large areas of the tropics are under studied. Hence the magnitude of the problem is not known. It is however well known that the proportion of introduced plants that have become invasive is far higher in the tropics than in temperate regions (Cronk and Fuller, 1995). This is occasioned by the favorable growth conditions present in the tropics.

The plants that are likely to invade are commonly species with attributes that allow them to take advantage of recently disturbed habitats (Mark, 1996). Some of the most important characteristics suggested by Given (1994) and Meffe and Carroll (1994) include: high reproductive rates, production of large quantities of seeds, wide dispersal ability; and ability to germinate under a wide range of physical and environmental conditions. Invasive species also have early reproductive maturity, as well as high growth rates and capability of vegetative reproduction (Denslow, 2002). These characteristics ensure that invasive plants are very successful.

2.5. *S. spectabilis* as an invasive species

Senna is the genus to which *Senna spectabilis* belongs. It has about 250-350 species of flowering plants in the family *Fabaceae*, subfamily *Caesalpinioideae.* It is composed of trees, shrubs and herbs which are mostly found in the tropics and sub

tropics (Llamas, 2003). The synonym of *S. spectabilis* is *Cassia spectabilis* (Brenan, 1967). The *S. spectabilis* species that have become invasive in different parts of the world include *S. obstusifolia, S. cassiodes, S. septemtrionalis, S. occidentalis, S. hepecarpa, S. didymobotrya, S. bicarpsularis, S. Pendula, S. spectabilis, S. crymbosa, S. Alexandria and S. alata.* The last three of these are invasive in South Africa. However, the list is not exhaustive. The *S. spectabilis* species found in Uganda include *S. didymobotrya, S. siamea and S. spectabilis* (Katende et al., 1995).

S. spectabilis is native to tropical America and was introduced to Africa as an ornamental. In Africa, it occurs in Eritrea, Ethiopia, Kenya, Malaysia, Tanzania, Zambia and Uganda. In Uganda, it is widely cultivated as a boundary maker in woodlots especially in central and western regions (Katende et al., 1995). It grows up to an elevation of 2000 m above sea level. The favorable temperature and rainfall ranges between 15-25^{o}C and 800-1000mm respectively. It grows in deep, moist, sandy or loamy soils but flourishes even in poor, black cotton soils. Pollination of *S. spectabilis* is by insects (carpenter bees *Xylocopa spp. and euglossines).* It is auto compatible, but xenogamy is the predominant system of reproduction (Manente et al., 1999). Flowering is at different periods in different places e.g. in Zambia, flowering occurs in January to February, and fruits ripen in September or October while in the US, flowering occurs throughout the year. Dispersal is by explosive mechanism which makes it spread over large areas. *S. spectabilis* regenerates directly from seed and also through coppicing. Coppices can develop from cut stumps or roots. Coppicing ability is good, in some cases 50 year old trees are reported to coppice (ICRAF, 2002). The seeds are orthodox and under cool temperatures can be stored up to two years. Wakabira (1998), reports that the seeds can stay in the soil seed bank for a period of up to three years.

2.6. Negative ecological impacts of invasive species on indigenous species

Geesing et al., (2004) noted that invasive species have damaged a number of natural or agricultural ecosystems. They have caused considerable loss of biological diversity. They are particularly damaging during forest regeneration but can also negatively affect mature forests as *S. spectabilis* has done in BFR in Uganda. The invasive species reduce regeneration through competition. This is most obvious in thicket forming species such as *Lantana camara, S. spectabilis, Psidium cattlelana, Chrysobalanus icaca, Clidemia hirta* and others (Cronk and Fuller, 1995). It is noted

that the presence of invasive species such as *black whattle (Acacia mearnsili); Lantana spp, S. spectabilis, Mauritius thorn (Caesalphinia decapetala) in* many forest reserves in Uganda is preventing regeneration of native forest tree species (Plumptre et al., 2003). Other negative impacts of invasive species include alteration of ecosystem services, and hybridization (Fielder and Karieva, 1998).

FAO (2005) reported few studies and instances of ecological impacts of IAS such as hybridization and loss of biodiversity. Problems could potentially arise if introduced species hybridized to produce new invasive species. Only a few such cases i.e. hybrids of *Leucaena* and *prosopis juriflora* (Cock, 2003) have been reported in forest species. Haysom and Murphy (2003) note that in most cases, reported impacts are qualitative assessments, including, for example, the replacement of native flora and the disturbance of feeding and breeding grounds for invertebrates and vertebrates, however, there is little attention accorded to the likely impact of invasive forest trees on nutrient cycle and soil biodiversity.

2.7. General impact assessment of invasive species

Impact assessment of IAS is often challenging and imprecise. This is because the full range of economic costs of IAS goes beyond the immediate impacts on the affected agricultural systems. The measures usually included are secondary and tertiary effects such as shifts in consumer demands, changes in the relative prices of inputs, loss of important biodiversity, and other natural resource and environmental amenities (Evans, 2003). The range of economic impacts can be broadly classified in two direct and indirect impacts.

Evans (2003) identifies six types of impacts of invasive species as listed by FAO, (2001). These are: production impacts; price and market effects; trade impacts; food security and nutrition; human health; environment impact and financial costs impacts. Costs of biological invasions can also be estimated through damages, e.g., agricultural production loss (Pimentel *et al*., 2001 & Van Wilgen *et al.*, 1999). Pimentel *et al* (2001) quantified the extra-costs for control of alien weed species as the proportion of alien to non-alien weeds multiplied with the financial costs for weed control. Cronk & Fuller (1995) have used a different approach to produce their account focusing more on the control and management of the species, botanical description as well as reported cases of introductions and invasions.

The development of an understanding of environmental impacts of invasive alien plants, and their consequences, would be extremely useful for the quantification of economic impacts. Unfortunately, no standard system exists for the objective quantification of the many and varied environmental and economic impacts of invasive alien plants worldwide (Parker *et al*., 1999). Many descriptions of impacts are anecdotal or correlative (comparing invaded sites with uninvaded sites, or comparing one site at different times), or are based on the performance of the invader in other parts of the world. The types of impacts include effects mainly related to the productivity of the invaded habitat and effects on ecosystem processes and functioning.

2.8. Studies on socio-economic impact assessment of invasive species

Various studies on invasive species have appeared in recent years (e.g. Drake *et al*. 1989, Cronk & Fuller 1995, Pysek *et al*. 1995, Carey *et al*. 1996, Sandlund *et al*. 1996, and Williamson 1996). Nonetheless, there is a need for assessments focusing on socio-economic impacts of invasive behaviour and integration into the invaded vegetation. Using cost benefit analysis approach, Pimentel *et al* 2000 and Evans *et al* 2002 estimated damage and control costs of invasive species in the U.S. alone which amounted to more than $137 billion annually. United Kingdom spent over US$111million on animal and plant quarantine in 2000 and in the year 2000-2001 New Zealand had a biosafety budget of US$44 million (Mumford, 2003).

The economic consequences of invasive species include damage costs such as biodiversity loss or habitat change and the costs of prevention, control or eradication. Though damage costs are difficult to compute, measure of the effort committed to the eradication or reduction of an invasive species can be a good indicator of adaptation costs. Furthermore, some socioeconomic impact studies have included aspects of the value of biodiversity in their analyses (for example Turpie and Heydendrych, 2000; Higgins *et al*., 1997); these show that invasions have significant economic costs as a result of the impacts on biodiversity. Turpie and Heydendrych (2000) estimated the values of harvesting of wildflowers, and for recreational use in protected areas, and showed that harvest values reduced from US$ 9.7 to $ 2.3/ha, and recreational use values in protected areas reduced from $ 8.3 to $ 1/ha, when pristine areas became densely invaded by alien plants.

2.9 Empirical methods of IAS socioeconomic impact assessment

Monetary positive (benefits) and negative (costs) effects of impacts can be assessed with different methods, and can be based on both business and economic data. The following methods can be used:

Opportunity cost approach: Calculation of the monetary value of an affected good or service by foregone alternative uses. For example, Wit *et al*. (2001) measured the value of fresh water loss (indirect-use value) caused by invasive species via the value of alternatively produced crops. Production loss (direct-use value) is measured via forgone benefits in the agricultural or forestry sector.

The production costs approach: This is a method to measure the effect of an environmental externality on production possibilities, often by measuring the expenditures which individuals are willing to undertake to avert damage (Bertram, 1999). Production costs can also simply add up the direct cost e.g. cost of labour, machinery) and indirect (e.g., medical treatment) costs of measures.

The contingent valuation method **(CVM):** This is the other method employed to assess relevant values of nature conservation aspects.

Gross Margin analysis: This is another method which assesses the effect of the invasions on the profitability of the enterprises operating in infested habitats. Gross-margin analysis assesses the return above variable costs. Mugasi (2004) used gross margin analysis in his economic assessment of shrub encroachment on pastoral rangeland productivity in Mbarara district in Uganda.

The economic losses caused by invasive alien species can be divided as direct and indirect losses. Direct losses are referred to direct goods damage and practical revenue decrease to agriculture, forestry, stockbreeding, fishery, road and water transportation. Indirect losses are referred to the losses of service function of ecosystems. Methods for estimation of direct economic losses are developed for related industries, based on market price, opportunity cost, human resources cost, prevention and restoration cost (Xu *et al*. 2004). Methods for the assessment of indirect economic losses caused by invasive alien species to the service function of forest ecosystems are established, based on the review of evaluation of service function of forest ecosystem and extent of damages of alien invasive species to the service function (Xu *et al*. 2004).

2.10. Dynamics of prevention, control and management of IAS

Case studies reported by Waterhouse (1994) on *Chromolaena odorata* in Northern Australia, Wester & Wood (1977) on *Miconia calvescens* in Hawaii and on *Clidemia hirta* in Fiji and Hawaii clearly show that in the case of highly invasive species, eradication is possible if the invader is controlled at a very early stage of the invasion. Once a plant has become a weed it is usually impossible to eradicate it (Carter, 1994).

Invasive species pose a particularly difficult issue for conservation agencies as there are clear examples of exotic invasive species causing a loss of biodiversity (Bright, 1999 & Pimentel *et al*., 2001) but the economic costs of species management are potentially huge Le Maitre *et al*. (2002). Thus any decisions to eradicate or control invasive species in a country of origin would have huge financial implications for the budget of the conservation agencies involved. These issues are becoming more complex as global transport increases species transfer and climate change increases the probability of many species surviving across an expanded geographical range. While in some countries the balance of the arguments may favour a policy of strict import controls and eradication of potential invasive species, in others the advantages of such a policy may be reduced, and the feasibility of achieving such policy aims will be very slim. It is therefore reasonable to expect the optimal policy to vary with geographical location, and given that conservation is a socially and politically defined process (Brechin *et al*., 2002) the attitudes of the citizenry to these issues will be important in informing policy development.

The lack of access to documented information on IAS issues in protected areas, at international or regional scale perpetuates the problem of lack of knowledge, lack of awareness and consequently, lack of supportive action against invasives at national or international level. One of the factors that make the control of invasive so costly is that infestations are rarely caught in early stages, when the population numbers are low. Invasions are targeted for control when the plants of concern have spread widely and fully entrenched in the ecosystems (Roslyn *et al,* 2000). Where eradication is not feasible, long-term control or containment should be considered. Several strategies for control exist, including the use of biological control agents and integrated pest management. For weeds (IAS that are plants) manual eradication, mechanised removal, use of fire and herbicides are deemed appropriate. No single method is perfect and each case needs careful planning. All methods have limitations and thus all can be essential. The desired outcome of control should be to achieve gains for

native biodiversity and stakeholders livelihoods. As for eradication, there needs to be both management and political commitment to spend the resources required over the long term (Roslyn *et al,* 2000).

World over, the development and implementation of prevention and management tools for invasive plants is limited because of the basic economic and developmental benefits of the concerned plants (Cock, 2003). Some countries have made extensive investments in exotic plants and are therefore reluctant to take action against those species that have become invasive. The general lack of information and methodologies prevents many countries from implementing risk assessment, control and management of schemes.

2.11 Control of *S. spectabilis*

In Tanzania, control of *S. spectabilis* has been tried out in Mahale National park where cutting and girdling was used. These methods were combined with the gathering of seed from the ground. It was observed that there was suppressed regeneration of *S. spectabilis* while regeneration of the native species increased (Wakabira, 2002). Mutonyi (2007) assessed the effectiveness of control methods on *S. spectabilis* in Kibale National Park in Western Uganda and found out that both ring barking and cutting reduce the abundance of *S. spectabilis* but cannot completely remove the species. However, ring barking was found out to be more effective than cutting. There is need to re-enforce the two methods by uprooting seedling from the ring barked sites for a period of four years after ring barking to ensure that all seeds from the soil seed bank are eliminated. The ring barking operation should be carefully done such that no cambium and bark are left behind.

In their assessment of the effectiveness of two control options for *S. spectabilis* in Budongo forest reserve, Gumisiriza et al (2008 a) found out that the plots in which 1m and 2m of the bark was removed, 100% of the treated trees had completely died while plots where 0.5m of the bark was removed only 70% of the treated trees had died after one year. The implication of this is that the longer the height length of debarking, the higher the chances of the ring barked tree to die and dry off. All the coppices on the 1m and 2m debarked trees gradually died while a few on the 0.5m debarked trees continued to survive. The chemical treatment method of hark and squirt yielded

promising results with 80% of the treated trees totally dead and having no coppices at all. The foliar spraying method of chemical treatment yielded unimpressive results with branches and leaves on the treated trees mutated but not dead. In all the plots, there were no *S. Spectabilis* seedlings as undergrowth.

2.12. Conflict of interest in management of IAS

A significant proportion of invaders, even some quite noxious ones, benefit or please someone, and this makes regulation politically and socially complicated (Baskin 2002). Because of this, restrictions on cultivation of invasive species may impose costs to local people who may have previously been able to exploit their production. As a result, there may be substantial political opposition to strict controls on the introduction and use of certain exotic species. For effective control of invasive species, management approaches need to be perceived by local people as aiming for socio-economic, as well as ecological sustainability. People make choices that augment or diminish the chances of species becoming invasive, largely via intentional introductions to support economic activities including agriculture, forestry, gardening, and international trade (Bright, 1999).

Conflicts of interest arise from time to time in cases where important tree species become invasive and spread beyond the areas where they are cultivated such as *S. spectabilis* did in Uganda. Others include plantation forestry (*Pinus* species and *acacia* species where alien plants provide firewood (Higgins *et al*., 1997). It is thus clear that forestry has been one of the major targets of alien infestation (Richardson, 1998)**.** These conflicts have to be dealt with in a sensitive manner if progress is to be made in reducing the significant negative impacts of invading alien plants in Uganda and elsewhere in the world.

CHAPTER THREE

3.0 IMPACT OF *S. SPECTABILIS* ON THE LOCAL DEPENDENT COMMUNITIES

3.1 Introduction

One of the basic requirements for good forest rangeland management is the knowledge of the plant communities in the forest relative to the ecological sites they occupy and how they impact on the livelihoods of the dependent stakeholders. Plant communities reflect on the productive potential of the ecosystem in terms of both quantity and quality of desirable species. Monitoring of plant communities and their impacts on the functionality of their habitats supports the determination of range condition and trend (Byenkya, 2004). To the best of our knowledge, there are no studies in literature that have provided a broad scale characterization of the impacts of *S. spectabilis* invasion on the livelihoods of the dependent local communities anywhere in the world. The few studies reported on *S. spectabilis* have been on its timber and charcoal properties in comparison to those of the native desirable species while other studies centered on its control and management options.

In their study on the physical and mechanical properties of *S. spectabilis* in BFR, Ahamada et al (2007) found that *S. spectabilis* could be a suitable and relatively cheap construction material in Uganda. Based on its low cleavage[3] resistance, the species could also be suitable for fuel wood. However, it is recommended that harvesting, processing and jointing methods should consider its low cleavage. Gumisiriza et al (2008 a), Mutonyi (2007) and Wakabira (2002), have all studied control and management options for *S. spectabilis* in forest ecosystems.

This study was motivated by the magnitude of *S. spectabilis* invasion in the area, the level of public and government concern about the invasion, and the magnitude of the IAS problem across East Africa. The study was informed by a review of experiences in India, where poor women in arid and semi-arid areas benefit disproportionately from woody invasive species such as *Prosopis juliflora* in terms of fuel wood and charcoal (Saxena 1997; Tewari et al. 2000). Based on that experience, the research

[3] Cleavage refers to the splitting or parting of wood or timber. It also refers to the state of being split or cleft; a fissure or division in wood. Cleavage test provides an indication of the resistance of wood or timber to splitting. Cleavage is good for fuel wood in a sense that it facilitates easy oxygen flow in spaces created by the splitting of wood and hence allowing quick and full combustion. Cleavage is however an undesirable property for timber.

began with two presuppositions: first, that the invasion resulted in clear winners and losers among stakeholders and second that the invasion could be turned into a significant resource for the local population. This section of the study was thus undertaken to assess how *S. spectabilis* invasion in BFR has impacted on the livelihoods of the dependent local communities (hereinafter referred to as "respondents") in terms of the services they acquire from the forest reserve. In addition, the study also assessed the local peoples' perceptions of the impacts of *S. spectabilis* invasion as well as their perceptions of the conservation values of BFR. This section of the study addresses the following questions:

1. What are the demographic characteristics of respondents?
2. What are the levels of knowledge and perceptions of the local people on conservation values of BFR in the two forest conditions?
3. What are the costs and benefits to local communities of living with *S. spectabilis* in the two forest conditions? How are these costs and benefits distributed across society?
4. What is the effect of *S. spectabilis* on the flows of fuel wood, charcoal and construction poles to the local communities?
5. Is *S. spectabilis* invasion a net benefit or a net cost among the local communities?

3.2 Objectives

1. To assess respondents' level of awareness of *S. spectabilis* invasion and invasiveness by forest condition

2. To assess the level of knowledge and perceptions of respondents on the conservation values of BFR by forest condition.

3. To assess the knowledge of respondents on the benefits and costs occasioned by *S. spectabilis* invasion by forest condition.

4. To assess the effect of *S. spectabilis* on the quantity flows and revenues of fuel wood, charcoal and construction poles to respondents by forest condition.

3.3 Methodology

To achieve the objectives of this study, the questionnaire method of investigation was employed. The questionnaire was initially developed at the University of Pretoria in consultation with my academic supervisor (appendix 1). In the initial design of the questionnaire, effort was taken to ensure that the questions asked specifically

addressed the objectives stated in section 3.2. In addition, questions that sought to collect information on the socio-economic characteristics of respondents were also asked. The questionnaire was tested for internal consistency through a peer review process at the University of Pretoria before proceeding to the field.

Before the official data collection exercise began, the questionnaire was pre-tested in Nyabyeya and Nyatonzi parishes, representing infested and non infested forest parts respectively. The objective of the pre-test was to ensure that respondents understood the questions the way they were designed to be understood. An examination of the pre-test responses confirmed that the questionnaire was a suitable tool for this study.

The survey sample was selected so as to have representation from forest areas infested by *S. spectabilis* and those that were not infested by *S. spectabilis*. Basing on the *S. spectabilis* spread map (Figure 1), three counties of Buruli, Bujenje and Bulisa were purposively selected. From these three counties, three sub-counties that had a fair distribution of both infested and non infested parishes were purposively selected. The selected sub-counties were Pakanyi, Budongo and Biiso. Finally, six parishes were purposively selected from the three sub-counties. Out of the six parishes selected, three parishes i.e. Kihaguzi, Nyatonzi, and Kasenene were non-infested while the other three parishes (Nyabyeya, Biiso, and Kabongo) were infested. From each parish, a total of 42 respondents were randomly selected for interviews using random numbers such that each forest strata or condition had 126 households randomly selected for the interviews. However, the study used a sample of 124 households per forest condition after data cleaning that resulted in the dropping of some respondents due to improper responses given. The study used six enumerators who were thoroughly trained on the translation of the questions in the survey instrument from English to the local languages for effective communication between the non-English speaking respondents and the questionnaire administrator.

During the data collection exercise, the household head was the targeted respondent and incases where the household head was absent, the interviewer administered the questionnaire to the spouse. In situations where both the household head and the spouse were absent, the respondent would be the most sound-minded family member present who was in most cases the oldest person present at the moment.

Finally the collected data was cleaned, coded, entered and analysed using the SPSS statistical software package (Bryman and Cramer, 1997). Demographics, perceptions of respondents on *S. spectabilis* invasion and the knowledge of the importance of BFR were assessed by use of descriptive statistics. The effect of *S. spectabilis* on the flow of quantities of fuel wood, construction poles, and charcoal harvested was assessed through computation of mean differentials by forest condition. The Pearson Chi-square coefficients were utilised to obtain levels of significance for the non-parametric data.

3.4 Results and discussions

Results and discussions are presented as follows: the general characteristics of the sample are presented in section 3.4.1, then follows findings and discussions on objective one in section 3.4.2, objective two in section 3.4.3, objective three in section 3.4.4, objective four in section 3.4.5 and finally the synthesis of the results in section 3.4.6. The results and discussion sections focus on the peoples' responses to the objectives of the study and the possible implications of the findings on the development of programmes and policies to manage invasive plant species with particular emphasis on *S. spectabilis* in BFR.

3.4.1 General characteristics of the sample

The sample consisted of 248 respondents of which 124 were from the infested forest area and the other 124 were from the non infested forest area. The background demographic characteristics studied included gender, marital status, occupation, age, education level, household size and annual household income.

3.4.1.1 Gender of the respondents

Within Uganda's Poverty Eradication and Action Plan (PEAP) (UNHS, 2005/06), gender[4] has been identified as a cross cutting issue and it is for this reason that we included it in the study and this section highlights the gender differences emerging from the survey. In this study, the analysis is by sex because the way gender is operationalised in this context is through the respondents' sex. The distribution of gender in the sample is as presented in Table 1. Results reveal that in both forest conditions, males were more than females and resultantly constitute 64.1 % of the entire sample.

Table 1: Gender categories of respondents

Gender	Forest condition		Total
	Non infested	Infested	
Female	42 (33.9 %)	47 (37.9%)	89 (35.9%)
Male	82 (66.1 %)	77 (62.1%)	159 (64.1%)
Total	124 (100 %)	124 (100%)	248 (100%)

Considering that this study was targeting household heads as the desired respondents, the results are in fair agreement with the Uganda National Household Survey (UNHS) 2002/03 and UNHS 2005/06 Figures of 72 percent and 73.6 percent male headed households respectively. Further still, in respect of the western region where the study was conducted, male headed households are reported to be more than female headed ones (UNHS 2005/06). This suggests that the distribution of gender in the sample reflects that of the population.

3.4.1.2 Marital status of the respondents

The study explored the marital status of respondents and the results are as presented in the Table 2.

Table 2: Marital status of the respondents

Marital status	Forest condition		Total
	Non infested	Infested	
Never married	16 (12.9 %)	11 (8.9%)	27 (10.9%)
Married	98 (79.0 %)	105 (84.7%)	203 (81.9%)
Widowed	4 (3.2 %)	2 (1.6%)	6 (2.4%)
Separated	6 (4.8 %)	6 (4.8%)	12 (4.8%)
Total	124 (100)	124 (100)	248 (100)

[4] Gender refers to culturally defined aspects of being male or female (Resources for publication, Nutrition and Health 1997)

These findings indicate that the majority of respondents were married, which is in fair agreement with the findings of the UNHS 2005/06 in which it is reported that the majority of Ugandans (73.2 %) were married.

3.4.1.3 Occupation of the respondents

In this study, occupation was broadly categorized into four groups: subsistence farming, employment by public service, self-employment and others. The distribution of the respondents in different occupations is presented in Table 3. The self employed include commercial farmers, traders, drivers and mechanics. The public service employment sector constituted the more skilled occupations such as teachers, social workers, forestry officers and security guards.

Table 3: Occupation of the respondents

Occupation	Forest condition		Total
	Non infested	Infested	
Subsistence farmer	94 (75.8 %)	111 (89.5%)	205 (82.7 %)
Public service	18 (14.5 %)	3 (2.4 %)	21 (8.4%)
Self employed	8 (6.4 %)	6 (5.4 %)	14 (5.6%)
Others	4 (3.2 %)	4 (3.2%)	8 (3.2%)
Total	124 (100 %)	124 (100%)	248 (100%)

The sectoral distribution of the actively employed can provide insights into a number of issues related to the labour market in the study area. As expected, results presented in Table 3 indicate that subsistence farming was the major sector of employment with 82.7 % of the entire sample. This is fairly consistent with the UNHS 2005/06 reporting that the majority of Ugandans (73%) were employed in the agricultural sector and specifically in subsistence farming. It is imperative to note that a situation where a large proportion of the employed is constituted by unpaid family workers engaged in subsistence farming is a probable indicator of poor development, limited job creation, widespread poverty and often a large rural economy which directly impacts on the way the people treat the environment.

3.4.1.4 Age structure of the respondents

Table 4 shows the age structure for the sample, where the age-group categorisation follows that of the UNHS 2005/06. The results show that the productive age group of 15-64 years had a percentage response of 95.2 %.

Table 4: Age structure of the respondents

Age group	Forest condition		Total
	Non infested	Infested	
15-64	120 (96.8%)	116 (93.5%)	236 (95.2%)
65+	4 (3.2%)	8 (6.5%)	12 (4.8%)
Total	124 (100%)	124 (100%)	248 (100%)
Mean age	36.80	36.65	36.72

The results further indicate that the age group of 65+ is fairly consistent with the findings of the UNHS 2005/06 in which it is reported that the age group of 65+ was 3.2 % of the population. In respect of the entire sample, the mean age (age taken as a continuous variable) was 36.72 years.

3.4.1.5 Education level of the respondents

One of the outcomes of basic education is literacy[5]. The study explored literacy levels of the respondents. Those who had completed primary seven and above were considered literate. Results presented in Table 5 indicate that 69.8 % of the entire sample was literate while 30 % had no formal education and therefore illiterate. These results are in agreement with the UNHS 2005/06 figures of 69 % and 20% for literate and illiterate proportions in Uganda.

Table 5: Education level of the respondents

Education level	Forest condition		Total
	Non infested	Infested	
None	24 (19.4%)	51 (41.1%)	75 (30.2%)
Primary	54 (43.5%)	57 (46.0%)	111 (44.8%)
Secondary	37 (29.8%)	15 (12.1%)	52 (21.0%)
Post secondary	9 (7.3%)	1 (0.8%)	10 (4.0%)
Total	124 (100%)	124 (100%)	248 (100%)

These results are also in agreement with the findings of the UNHS 2005/06 in which it is reported that about 55 % and 17 % of Ugandans had completed primary and

[5] Literacy is defined as the ability to read with understanding and write meaningfully in any language (UNHS 05/06). Respondents who had completed primary seven and above were considered to be literate.

secondary school education respectively. It appears that the distribution of education in the sample approximates the distribution of the same in the population.

3.4.1.6 Household size

Findings indicated that the size of the household was, on average, six persons in both the non-infested and infested communities with the latter slightly higher than the former, which is in fair accordance with the figures 5.7, 5.2 and 5.3 reported in the UNHS of 1999/00, 2002/03, and 2005/06 respectively.

3.4.1.7 Household income

Gross household income was measured as an aggregate of incomes from agricultural activities, non-agricultural activities, remuneration and salaries as well as transfer earnings per annum. The nominal value of income is reported signifying that it was not adjusted for inflation or decreasing purchasing power. Results are presented in Table 6.

Table 6: Average annual household income ('000 Ushs per annum)

Income class	Forest condition		Total
	Non infested	Infested	
Below 600	45 (36.3%)	49 (39.5%)	94 (37.9%)
Between 600-1,200	20 (16.1%)	26 (21.0%)	46 (18.5%)
Between 1,200-1,800	10 (8.1%)	12 (9.7%)	22 (8.9%)
Between 1,800-2,400	9 (7.3%)	8 (6.5%)	17 (6.9%)
Over 2,400	11 (8.9%)	15 (12.1%)	26 (10.5%)
Non-response	29 (23.4%)	14 (11.3%)	43 (17.3%)
Total	124 (100%)	124 (100%)	248 (100%)

Overall, the proportion of households in the lowest income group was thrice (37.9 %) that of households in the highest income group (10.5%). The highest percentages (37.9% and 18.5%) of the households fell in the lowest and second lowest income classes in close agreement with the UNHS 2005/06 Figures of 40.8 % and 21.5 % respectively. On average, the study interviewed a relatively poor community. The considerable percentage (17.3 %) of non response for the entire sample can be

explained by the negative tendencies of people to conceal their incomes for fear of taxation as well as for security reasons. By and large, the distribution of household income in the sample can be considered similar to that in the population.

3.4.2 Level of awareness of *S. spectabilis* invasion and invasiveness

Knowledge of the present and potential invasiveness of IAS (in the present case *S. spectabilis*) is critical information for use in risk assessments underpinning prevention, early detection, and prioritization (De Poorter and Browne 2005). The development of a consolidated information source about *S. spectabilis* in Uganda will make it easier to understand the national scale of the invasive species threat to the country. As a result, it will provide information, which will form a basis to convince those in control of financial and other resources, to make them available for the invasive alien species management in the forestry ecosystems of Uganda and other countries. Consolidated information would also make it possible to assess trends over time, and to evaluate whether efforts to address them are paying off. Lack of consolidated information as occasioned by lack of awareness forms an insidious vicious circle, which ought to be broken. This study aims to investigate the impact of *S. spectabilis* on the livelihoods of the local dependent communities and thus it was essential that the respondents know what they are talking about. Based on this motivation, this study thus sought to establish the level of awareness of *S. spectabilis* invasion and invasiveness among members of the local dependent communities.

To achieve the objective, respondents were first tasked to identify *S. spectabilis*, an invasive tree species in BFR and other forestry ecosystems. This was done with the aim of ascertaining whether people could distinguish the invasive *S. spectabilis* from other non invasive *Senna* species that very much resemble *S. spectabilis* such as *Senna didymobotrye* and *Senna siamea.* However some studies have reported *Senna siamea* as invasive too (Katende et al., 1995). Considering that identifying *S. spectabilis* is one thing and knowing whether it is invasive is another, respondents were also asked whether they knew that *S. spectabilis* was invasive.

Results are presented in Table 7, where we report on the number (and percentage) of respondents answering in the affirmative in columns 2 and 3 (by forest condition). The total number (and percentage) of respondents answering in the affirmative is

given in column 4. Finally, the chi-square tests for equality of distribution of responses by forest condition are given in columns 5 and 6.

Table 7: Level of awareness of *S. spectabilis* invasion and invasiveness

Knowledge aspect	Forest condition		Total	Chi-square test	
	Non infested	Infested	Yes response	χ^2	p-value
Ability to identify *S.spectabilis*	116 (93.5%)	118 (95.2%)	234 (94.4%)	0.303	0.582
Awareness of *S.spectabilis* invasiveness	78 (62.9%)	82 (66.1%)	160 (64.5)	4.301	0.596

The findings reveal that the majority of the respondents in both forest conditions (>90 %) were able to identify *S. spectabilis*. In almost all scenarios, the criteria used in the identification was the long pods and narrow long leaves that make the distinctive features of *S. spectabilis* as contrasted against other *Senna* species. Results further revealed that the respondents had awareness levels of about 65 % which is in agreement with the study by Gumisiriza et al, (2008 b) on the national awareness of invasive species. The chi-square statistics suggest that members of the local dependent community are able to identify *S. spectabilis* and are generally aware of the fact that it is invasive regardless of the forest condition. In closing, one can thus confidently proceed with the rest of the analysis with the knowledge that respondents understand the key issues of contest to this study.

3.4.3 Level of knowledge and perceptions of the respondents on the conservation values of BFR

Sustainable forest management[6] must include members of the local community for purposes of policy ownership and efficiency in the daily monitoring operations of the forest. Local community members can have enhanced ownership of forest

[6] Forest management is usefully defined in terms of production, utilization and distribution of products, and the institutional or organizational arrangements by which they are carried out. Both technical and social aspects of forest management are treated as parts of a single system, (Fisher, 1989).

management policies only if they understand the conservation values of BFR. To assess whether respondents knew and appreciated the importance of BFR and therefore its conservation values, respondents were asked to state their knowledge of the purposes for which it was established (Table 8). In addition, their perceptions on whether the mentioned conservation value could potentially be compromised by IAS infestation were also sought. Perceptions and knowledge regarding invasive species have been studied using different approaches, including a random account of the general public (Jetter and Paine, 2004), only those stakeholders involved in IAS management (Bardsley and Edward-Jones, 2006), characterizing stakeholders by reviewing institutional context (Binimelis et al., 2007) or a mixture of stakeholders with a view of getting implications for management (Marina et al, 2008).

In Table 8, we report on the number (and percentage) of respondents answering in the affirmative in columns 2 and 3 by forest condition. The total number (and percentage) of respondents answering in the affirmative is given in column 4 while column 5 (non-response) reports on the number (and percentage) of respondents who neither stated yes or no in response to the different questions. Finally, the chi-square tests for equality of distribution of responses by forest condition are given in columns 6 and 7.

Table 8: Perceptions and levels of knowledge of the conservation values of BFR

Conservation value	Forest condition		Total		Chi-square tests	
	Non infested	Infested	Yes response	Non response	χ^2	p-value
Conservation of flora and fauna	120 (96.8%)	118 (95.2%)	238 (96.0%)	1 (0.4%)	2.017	0.365
Tourism attraction	120 (96.8%)	122 (98.4%)	248 (97.6%)	3 (1.2%)	0.683	0.711
Timber supply	118 (95.2%)	123 (99.2%)	241 (97.2%)	1 (0.4%)	3.770	0.152
Fuel wood supply	116 (93.5%)	123 (99.2%)	239 (96.4%)	1 (0.4%)	5.705	0.058
Building materials supply	118 (95.2%)	122 (98.4%)	240 (96.8%)	1 (0.4%)	2.352	0.308
Climate regulation	112 (90.3%)	99 (79.8%)	211 (85.1%)	11 (4.4%)	5.535	0.063
Carbon sequestration	69 (55.6%)	64 (51.6%)	133 (53.6%)	19 (7.7%)	1.504	0.471
S. spectablilis is a danger to BFR conservation	82 (66.1%)	86 (69.4%)	168 (67.7%)	6 (2.4%)	0.816	0.665
Loss felt if *S. spectabilis* killed BFR	85 (68.5%)	93 (75.0%)	178 (71.8%)	7 (2.8%)	1.280	0.527
Willingness to control *S. spectabilis*	103 (83.1%)	109 (87.9%)	212 (85.5%)	5 (2.0%)	1.176	0.555

It is clear from Table 8 that majority of respondents in both forest conditions know the importance and conservation values of BFR. The relatively low positive percentage response (53.6 %) for the entire sample reported for carbon sequestration can be attributed to the scientific nature of the purpose which probably could not be furnished by the kind of education levels of the respondents as earlier reported. The non response proportions were very low and thus can be regarded as having no influence on the general observations made. Table 8 also shows that on average, respondents know that IAS could potentially compromise the conservation values of BFR.

The χ^2 statistics suggest that the forest condition does not seem to influence the level of knowledge and perceptions that respondents have on the importance and conservation values of BFR. It is only in the case of fuel wood supply and climate regulation where forest condition appears to have an influence, and even then, the statistical significance is rather weak (at the 10% level). Statements can thus be made that irrespective of the forest condition, the local people know that BFR serves the functions of conserving flora and fauna for future generations to see, attracting tourists, supplying fuel wood, timber and construction poles, performs a carbon sequestration service as well as regulating climate. Further still, one can conclude that local communities inhabiting both infested and non infested forest parts know and appreciate that *S. spectabilis* invasion can destroy BFR conservation values, would feel at a loss if *S. spectabilis* would spread to such an extent that BFR would lose its conservation values and are thus generally willing to be part of a campaign meant to save the flora and fauna of BFR from being destroyed by *S. spectabilis* invasion. The local people's general awareness of the dangers posed by *S. spectabilis* to the conservation of BFR is consistent with the findings of Gumisiriza et al (2008 b) who found that general awareness levels of IAS were about 70 percent in Uganda.

This rather impressive perception and knowledge of the conservation values and functions of BFR can be attributed to the sensitization[7] works of the various government agencies, non governmental organisations and projects that have promoted sustainable forestry management in the country for many years. Examples of government agencies involved in promotion of sustainable forestry management in Uganda include the National Forestry Authority (NFA), the National Forestry Research Institute (NAFORI) and the National Agricultural Research Organisation (NARO). These findings can again be attributed to the anti-*S. spectabilis* campaigns fronted by the UNEP/GEF-IAS project which has been on the ground for close to four years. Ordinarily, one would expect the respondents not to perceive *S. spectabilis* as a danger to the conservation of BFR considering that they benefit a lot from it. But on the contrary, they reported in the opposite implying that the sensitization and anti-*S. spectabilis* campaigns could have had the desired impact of changing people's perception towards *S. spectabilis* invasion even though they find it useful in their

[7] Sensitization is a process of educating the people by feeding them with adequate information and knowledge. Its effect lies in the fact that after sensitization, a person can take decisions based on realistic, dependable and complete information.

daily lives. The non significance in the levels of knowledge and perceptions of respondents by forest condition can be attributed to the sensitization works of the UNEP/GEF-IAS Project and other government agencies that target all people irrespective of whether they come from infested or non infested areas. Environmental conservation campaigns are targeted to all people in the area regardless of the forest conditions they stay in.

This was probably augmented by the fairly high literacy levels of the respondents in both forest conditions as earlier reported and in agreement with the findings of Marina et al (2008) who observes that a higher level of education promoted an interest in supporting IAS management programmes, with corresponding higher donations for IAS eradication in the Donana socio-ecological systems of Southwestern Spain. Okurut et al (2002) asserts that education is very vital for boosting the productivity of the human factor making people more aware of opportunities for better living and thus the relatively high literacy levels suggested that the majority of the respondents had the necessary education to process information on improved welfare livelihoods instrumental for sustainable exploitation and management of BFR natural resource.

Futherstill, results collate with the findings of Roy (1992), who observed that after sensitization of the forest dependent communities in Midnapore district of West Bengal, India, their perception of the conservation values of the forest had changed to a realisation that protection of the forest was their own duty and that it was not money alone that could solve the problems and work as the incentive for involvement of the people in forest protection and management but rather a sense of belonging, their empowerment and institutionalisation of their power.

Consequently, the findings of this study have important implications on environmental policies regarding IAS management. People are much more aware of species that have been the subject of information campaigns like *S. spectabilis*, suggesting that such efforts can be effective and should be supported in policy decisions. Developing public awareness and sensitization campaigns to support IAS management, including sharing information about IAS impacts, is a useful and interesting tool for engaging the general public. Furthermore, several studies have demonstrated the importance of public participation in environmental conservation initiatives (Fischer and Young, 2007), and stakeholder engagement in IAS

management (Stokes et al., 2006), and the necessity of relying on stakeholder support as the means to success or failure of projects undertaken by conservation managers (Bremner and Park, 2007). It should be noted that any antagonism from different elements of society (Bertolino and Genovesi, 2003), or the lack of awareness about IAS impacts by the general public and administrations (Bonesi and Palazon, 2007) could result in the failure of an eradication project.

3.4.4 Knowledge of the respondents on the benefits and costs occasioned by *S. spectabilis* invasion

Invasive species have significant negative and positive impacts on socio-ecological systems and socioeconomic livelihoods of people (McNeely et al., 2001 and Pimentel et al., 2001). A need exists to understand more fully the implications of human knowledge, perceptions and choices regarding the use and management of invasive species. The focus of the discussion here is an assessment of the knowledge and whether there are differences in the same on the benefits and costs occasioned by *S. spectabilis* invasion between the two forest conditions.

To achieve the above, the study asked questions assessing respondents' knowledge first on costs resulting from *S. spectabilis* invasion in section 3.4.4.1 and then benefits resulting from *S. spectabilis* invasion in section 3.4.4.2.

3.4.4.1 Costs resulting from *S. spectabilis* invasion

To assess respondents' knowledge on costs resulting from *S. spectabilis* invasion, respondents were asked to state whether they knew that *S. spectabilis* was unpalatable to livestock and whether it harbours dangerous animal species. The results of this assessment are presented in Table 9 following the same procedure used in Table 8.

Table 9: Negative effects of *S. spectabilis* invasion among local communities

Perception	Forest condition		Total		Chi-square test	
	Non infested	Infested	Yes response	Non response	χ^2	p-value
Unpalatability to livestock	71 (57.3%)	86 (69.4%)	157 (63.3%)	23 (9.3%)	11.216	0.004
Harbors dangerous animal species	74 (59.7%)	81 (65.3%)	155 (62.5%)	15 (6.0%)	5.767	0.056

It is clear from this assessment that *S. spectabilis* is unpalatable. This suggests that *S. spectabilis* infestation does not enhance livestock production in the area. However, livestock in the study area makes a very small contribution to agriculture GDP (see chapter one). In both the infested and non-infested forest parts, above average proportions of respondents knew *S. spectabilis* to be harboring dangerous animal species. In particular, most households know *S. spectabilis* trees to be good habitats for mosquitoes which transmit malaria, the number one killer disease in Africa. This is because *S. spectabilis* trees establish big canopies with massive vegetation conducive for breeding mosquitoes.

Overall, the negative effects of *S. spectabilis* were reported more by the respondents in the infested areas than those inhabiting non infested areas. This can be explained by the fact that people living in the infested forest conditions have experienced more life with *S. spectabilis* and thus can tell its effects to their livelihoods with more confidence than their counterparts living in the non infested forest parts. In relation to our findings furthermore, Evans, Spreen, and Knapp, (2002) found out that invasive species can adversely affect important environmental service flows such as cropping systems, livestock grazing, and recreational uses. In addition, invasive species can have negative impacts on ecological services provided by one resource for other resources or an entire ecological system. Swallow et al (2008) reported that in Liboi

Kenya, the incidence of malaria associated with the expansion of *Prosopis juliflora*[8] *(P. juriflora)* thickets was the most frequently mentioned problem among the local communities.

Perrings et al (2002) reported that the full economic costs of biological invasions include more than the direct damage or control costs of invasive species. They also include the effects of invasives on host ecosystems, and on the human populations dependent on them. That is, they reflect the nature of interspecific interactions, and the way that different species support economic activities. No estimates currently exist concerning the value of the more widespread effects of invasions (Perrings, 2002). Invasive species are, for example, assumed in the CBD to be one of the main proximate causes of extinctions world wide (Glowka et al. 1994). They have also disrupted key ecological functions in many systems, with far-reaching implications for economic activities supported by those systems (Heywood, 1995). Indeed, most ecosystem types (terrestrial, freshwater and marine) have been impacted to a greater or lesser extent by invasions (Williamson 1998, Parker et al. 1999). But the economic implications of these indirect impacts have yet to be identified.

Habitually, evaluation of more intangible non-market costs associated with IAS impacts has been limited, largely due to the difficulties and controversies (Philip and MacMillan, 2005). Valuing non-market impacts can be challenging and thus economists are employing such tools as dynamic optimization and ex-ante simulation analyses to assist decision makers (Evans, Spreen, and Knapp, 2002). Use is also being made of methods such as "contingent valuation" and "willingness to pay to obtain or avoid similar benefits or losses." Nonetheless, the contingent valuation (CV) method has been considered inappropriate to quantify the service of control and impacts of IAS (Bardsley and Edward-Jones, 2006).

Non-market values are useful to generate a comprehensive account of social benefits or damages related to IAS, and also help to generate more accurate information on the social consequences of IAS (Leung et al., 2002). Currently, a need to confront the challenge of considering non-market costs is of great importance (Colautti et al., 2006

[8] *P. juriflora* is an invasive woody tree species in East Africa and other parts of the world and has many characteristics in common with *S. spectabilis*. It was introduced for the same reasons as *S. spectabilis* to provide live boundary markers, alternative fuel wood, charcoal, poles and low value timber sources to save the forest reserves from overexploitation and deforestation.

and Gutrich et al., 2007). It should thus be clear that the assessment of the costs of *S. spectabilis* infestation in BFR as reported above is not necessarily exhaustive.

3.4.4.2 Positive attributes or benefits of *S. spectabilis* invasion to local communities

Hettinger (2001) and Baskin (2002) assert that while exotic species may have numerous negative impacts, it is important to remember that there are substantial advantages of utilising these species in different contexts. Many of the traits that lead to a species becoming invasive, including hardiness and high fecundity, are also likely to increase a species' usefulness within different contexts. It is important; therefore, to examine local people's knowledge of, and response to, invasive species to develop effective environmental policy, especially as changing climatic conditions heighten future ecological risk.

Apart from the main benefits that the local dependent households obtain from *S. spectabilis* such as fuel wood, construction poles and charcoal which are covered in objective 3, respondents were asked in an open question for other positive attributes that they derive from the existence of *S. spectabilis* in their environs. Responses were tallied to get the total number of respondents who associated *S. spectabilis* with each of the stated benefits. Respondents were also asked to state whether they were willing to accept compensation from the government for the foregone benefits from *S. spectabilis* in the event that it was removed under a new management regime. The answers to these questions are considered to give insights on the respondents' knowledge of these other benefits of *S. spectabilis* invasion. The results of this analysis are presented in Table 10.

Table 10: Positive attributes of *S. spectabilis* to local communities

Positive attribute of *S. spectabilis*	Forest condition		Total
	Non infested	Infested	
Medicine	24 (19.4%)	20 (16.1%)	44 (17.7%)
Shade	58 (46.8%)	59 (47.6%)	117 (47.2%)
Flowers	14 (11.3%)	8 (6.5%)	22 (8.9%)
Wind brakes	10 (8.1%)	15 (12.1%)	25 (10.1%)
Income	6 (4.8%)	1 (0.8%)	7 (2.8%)
Fence	12 (9.7%)	21 (16.9%)	33 (13.3%)
Willingness to accept compensation	105 (84.7%)	107 (86.3%)	212 (85.5%)

It is clear from these results that most respondents do not consider the benefits of *S. spectabilis* listed in Table 10 as being important from their point of view. For instance people have other trees superior to *S. spectabilis* in their compounds that serve the purposes of shade and fence provision as well as acting as wind brakes. These trees include mangoes, oranges, and other fruit trees which on top of providing fruits for direct consumption, also provide the other benefits as presented above. Besides this, *S. spectabilis* was reported to litter compounds with its numerous leaves and flower petals which partly explains its undesirability as a compound tree among some homesteads. Flowers are better provided by the various flower varieties that people grow on their compounds. Further still, with the increase in extension of health services nearer to the local people, access to modern medicines and drugs has been enhanced such that few people in actual sense still use local herbs to cure their ailments.

Much more important however is the overwhelming majority of respondents from both forest conditions who confirmed they would be WTAC from government for the foregone benefits from *S. spectabilis* incase it is eradicated. It appears that respondents associate *S. spectabilis* with benefits beyond those covered in Table 10 as we show in objective 3 (see section 3.4.5). It also appears from Table 10 that residents consider *S. spectabilis* as an input in their subsistence mode of production and not a source of wealth accumulation or asset expansion.

3.4.5 The impact of *S. spectabilis* invasion on the flows of quantities and revenues from fuel wood, charcoal and construction poles

The major benefits derived by households from BFR are fuel wood, charcoal and construction poles. To understand the impacts of *S. spectabilis* invasion on these flows, respondents were asked to state the mean quantities of the above benefits they harvest from *S. spectabilis* in the forest on weekly basis. The difference in mean quantities by forest conditions gives the effect of *S. spectabilis* invasion on the flows of the same. Results are presented in Table 11 and 12 below. Table 11 shows the average amounts of products derived from *S. spectabilis* per household per week by forest condition. The entries in columns 2 and 3 of Table 11 are means and number of respondents, while the 6th and 7th columns contain results of the ANOVA test for equality of means.

Table 11: Average amount of products derived from *S. spectabilis* per household per week by forest condition

Product	Infested		Non infested		ANOVA test	
	Mean	S.E	Mean	S.E	F-value	p-value
Firewood bundles[9]	2.12 (n=123)	0.119	0.73 (n=120)	0.063	106.953	0.000
Charcoal sacks[10]	0.70 (n=123)	0.083	0.13 (n=120)	0.035	40.272	0.000
Number of poles	5.41 (n=123)	0.478	1.38 (n=120)	0.185	60.790	0.000

Table 12 below shows the average revenues from the exploitation of *S. spectabilis* products per week per household by forest condition. Average revenues were obtained by multiplying the mean quantities of the products harvested by the prevailing market average prices of the study area which were as follows: one bundle of fuel wood of *S. spectabilis* costs 3000 UShs, one *S. spectabilis* charcoal sack costs 15,000 UShs while one *S. spectabilis* construction pole costs 2000 UShs.

[9] A fuel wood bundle was defined as a bundle of air dry pieces of wood weighing approximately 20-25 kgs.
[10] A charcoal sack was defined as a sack of burnt charcoal weighing approximately 45-50 kgs.

Table 12: Revenues obtained from *S. spectabilis* products per week per household by forest condition in UShs

Product	Forest condition		Total
	Infested	Non infested	
Fuel wood	6,360 (n=123)	2,190 (n=120)	8,550 (n=143)
Charcoal	10,500 (n=123)	1,950 (n=120)	12,450 (n=143)
Construction poles	10,820 (n=123)	2,760 (n=120)	13,580 (n=143)
Total	27,680 (n=123)	6,900 (n=120)	34,580 (n=143)

Results indicate that there were variations in the mean quantities of the above said benefits obtained by the households in the two different forest conditions. In addition, the variation in the amount harvested within a given forest condition was higher in the infested than non-infested as indicated by the higher standard errors in the former. Generally, households living in the infested forest parts obtained higher quantities of the benefits than their counterparts in the non-infested forest parts. All respondents indicated some use of *S. spectabilis* products. Most users reported that they harvested *S. spectabilis* products only for subsistence functions than for sale.

The one way analysis of variance revealed that the means of fuel wood bundles, charcoal bags, and construction poles harvested were significantly different for the two forest conditions with $p< 0.05$. This implies that the availability of these products obtained from *S. spectabilis* significantly differs between the two forest conditions. It thus appears that *S. spectabilis* increases the quantity flows of fuel wood, charcoal and construction poles as well as the revenues from the same products, which is consistent with *a priori* expectations i.e. the mean quantities harvested by the people living in the infested forest parts ought to be higher that their counterparts living in the non infested forest parts for reasons of proximity and availability (Ahamada et al, 2007).

Furthermore, results in Table 12 provide revenue estimates of the benefits that households derive for each stated use by forest type. Households in the infested forest

areas generated average benefits of UShs 27,680 or 13.8 US$ weekly from the use of fuel wood, charcoal and construction poles (average exchange rate is 2000 UShs=1US$). Construction poles were the most important benefit with 10,820 UShs per week per household. In the non infested areas, the average annual value of *S. spectabilis* products was UShs 6,900 or 3.45 US$ per household per week which was 20,780 UShs (10.39 US$) less than their counterparts in the infested forest parts. Stated otherwise, respondents living next to the infested areas earn an income which is almost 300% higher than their counterparts in the non-infested areas from the exploitation of products from *S. spectabilis*. This was because of proximity and availability reasons. Construction poles and fuel wood were the most important benefits in the non infested forest area, with a mean weekly value of UShs 2,760 and 2,190 respectively per household. These results concur with the findings of Swallow et al, (2008) who found out that a woody invasive species (*P. juriflora*) provided the main economic benefits to the local people in form of construction and fencing poles as well as fuel wood. Kareiva (1994) also concluded that some IAS have economic uses.

In general, for every case of invasion, some sector of society makes a profit (Baskin, 2002). Studies done by Pasiecznik (1999) and Pasiecznik et al., (2001) on the benefits and costs of *P. juriflora*, one of the major woody invasive species in the same category as *S. spectabilis*, found out that in some circumstances, *P. juliflora* can provide a variety of valuable goods and services, namely: fuel wood, charcoal, animal feed, construction materials, soil conservation and rehabilitation of degraded and saline soils. In the drylands of India, *P. juliflora* is considered one of the most valuable tree species (Pasiecznik et al. 2001) and yet *P. juliflora* has been rated as one of the world's 100 least wanted species (Lowe et al, 2000). FAO, (2003) reported that in general, there are few studies on the positive and negative impacts of invasive forest trees. Positive impacts include the provision of fuel and other resources for resource-poor communities, and soil stabilization in over-exploited natural forest areas such as in India. According to FAO (1988), Eucalyptus which is an invasive tree species has helped to raise people's living standards by providing building materials, fuel wood, poles and farm timber.

3.4.6 Synthesis of the results

It transpires from a careful scrutiny of all the reported results that *S. spectabilis* is more of a blessing to the local communities than a curse. Weighing the benefits against the costs occasioned by *S. spectabilis*, one would earnestly conclude that *S. spectabilis* is a net benefit to members of the local dependent community. According to FAO (1988), eucalyptus which is an invasive tree species and which was introduced in Tanzania for the same purpose of live boundary marking like *S. spectabilis* has become a subject for argument in some countries because the needs of the local people and the forestry objectives likely to be achieved from eucalypts have not been well matched. It is further reported that in many places, eucalyptus plantations are making a very good contribution to the needs of the community because the advantages obtained outweigh the disadvantages. Given the multitude of benefits from *S. spectabilis*, it would be unacceptable to abandon or critique *S. spectabilis* on socio-economic grounds.

Like eucalyptus, *S. spectabilis* species grow very fast, has high cleavage value and dries up fast. That aside, *S. spectabilis* establishes several stems and falls down easily by itself. The comparative advantages of the *S. spectabilis* species has made it part of the life of the rural people in the Budongo area. Although some indigenous species may also have such advantages as they are adaptive to the local conditions and could be used for various purposes, little is known about their growth, yield, soil nutrient/plant interaction, water consumption, silviculture and management. The challenge is to fill this knowledge gap and come up with more indigenous species pool for reforestation and afforestation purposes before critiquing the role of *S. spectabilis* in light of its eradication. It therefore remains in the hands of the authorities to clearly know that *S. spectabilis* is beneficial on the overall analysis to the local communities and therefore any management options must consider this finding.

It is important to mention that the analysis only considered a partial listing of costs and benefits. However the costs and benefits that were considered were deemed paramount from the point of view of respondents. Also for reasons of lack of data and methodological complexities, the monetary values of costs such as costs of increased malaria incidence were not obtained. However the analysis confidently relied on the perceptions and revelations of the respondents to weigh the benefits against the costs

since individuals' overall perceptions of *S. spectabilis* are influenced by their assessment of the present and future costs and benefits.

CHAPTER 4

4.0 IMPACT OF *S. SPECTABILIS* ON THE PERFORMANCE OF TIMBER SUPPLY FIRMS

4.1 Introduction

Uganda's forest resources provide energy; forest and tree products, employment, livelihood support, government revenues, business opportunities, environmental functions and services, and they maintain ecological integrity (Odokonyero, 2005). The beginning of pitsawing in the country can be traced back to the introduction of commercial timber exploitation at the beginning of the last century in BFR. It originally provided employment and timber to local communities. The World Bank, (2004) reported that Uganda's natural forests contribution to GDP in 2002 was 5.8 billion Uganda shillings. The GDP figure was later adjusted by Plumptre et al (2006) by adding the value of informal and non marketable goods and services to get a new adjusted GDP figure of 11,432.24 billion Uganda shillings. Of this new GDP figure, the forest sector constituted 5.2%. Further still, Plumptre et al (2006) reported that the total contribution of forests to local people's livelihoods at the national level was calculated to be 332.3 billion Uganda shillings or 190 million US$ in 2006. The national statistical abstract (2007) reports the value of forestry in terms of its contribution to the national welfare or gross domestic product (GDP) at 6% which is expected of a developing economy. Falkenberg and Sepp (1999) reported that timber was contributing about 6.1 % of GDP in 1999.

Table 13: Total production of round-wood timber, 2001-2006 ('000 tonnes)

Wood type	2001	2002	2003	2004	2005	2006
Sawn timber	696	742	791	845	902	962
For poles	688	717	747	777	808	847
Fuel Household	16,500	17,100	17,722	18,360	19,021	19,731
Fuel Commercial	2,640	2,700	2,762	2,827	2,895	2,993
Fuel Industrial	1750	1,788	1,827	1867	1,908	1,949
For charcoal	4,635	4,960	5,308	5681	6,080	6,506
Total wood production	26,909	28,007	29,157	30,357	31,614	32,988

Source: Statistical Abstract (2007, Uganda Bureau of Statistics)

Table 13 above shows the total production of timber for the period of 2001-2006. The forestry sector offers significant employment to Ugandans at various nodes of the industry chain. It is roughly estimated that the current annual turnover of business in forestry is close to UShs.297 billion with the non-monetary value accounting for about 60%. Thus a lot of people are accordingly employed at this informal level of the sector (UBOS, 2007). In Uganda and particularly BFR, the various species that provide all the desired categories of timber include; *Chlorophora excelsa* Muvule (Luganda), *Khaya anthotheca* African mahogany, *Entandroprhagma cylindricum* Muyovu (Luganda), *Entandrophragma utile* Feather sepele, *E. angolense* Budongo mahogany, *Maesopsis eminii* Musizi (Luganda), *Olea welwitschii* Elgon teak/Elgon olive, *Lovoa brownii* Uganda walnut, *Cynometra alexandri* Uganda ironwood, *Newtonia buchanani* Newtonia.

Falkenberg and Sepp (1999) suggested that, based on wood consumption in the formal sector, potential revenue could be estimated at US$4.5 million from sawlogs. The most recent study by Bush et al (2004) indicates that sawn timber accounts for 7 percent of the total economic value (TEV[11]) of Uganda's forests and that the 6, 515 m3 of sawn timber exported was valued at US$ 2,040,690. Bush et al (2004) further reports that the size of the local timber market is estimated at 240 000 m3 from current harvesting of round wood. The domestic market remains the major market for Uganda's timber since 50 years ago. It is reported in Bush et al (2004) that on average, 126 000 m3 of pitsawn timber is traded in the local market and consumed in the household, and 52 000 m3 reaches the central markets.

It has been recognized that the forest resource is too small to sustain a large export trade in timber and other primary wood products. Nonetheless, there are possibilities for a lucrative trade in secondary wood products, such as furniture and parquet flooring for export. In 2003, the GDP growth was estimated at 5.8 percent. Uganda's population of 24.7 million people was growing at a rate of 3.4 percent/year. This made it one of the fastest-growing populations in the world (MFPED, 2003). Therefore, it was suggested that timber demand would and still will continue to rise through both a population and income effect.

[11] The TEV is the summation of values from all of the direct, indirect and non-use values associated with a resource.

Table 14: Value of round wood timber at current prices, 2002-2006 ('mill. UShs)

Wood type	2002	2003	2004	2005	2006
Sawn timber	31,104	33,062	35,280	37,648	40,174
For poles	13,505	14,032	14,593	15,177	15,784
Fuel Household	100,220	103,557	107,256	111,117	115,117
Fuel Commercial	19,574	19,959	20,439	20,926	21,424
Fuel Industrial	12,962	13,205	13,494	13,789	14,091
For charcoal	25,852	31,908	34,148	36,545	39,111
Total wood production	203, 217	215,723	225,210	235,202	245,701

Source: Statistical Abstract (2007, Uganda Bureau of Statistics)

Table 14 shows that in value terms, over 246 billion UShs per annum is the projected revenue currently realized from round wood timber but the total value is highest for fuel wood used at household level, followed by sawn timber which have all been increasing over the period.

The 1997 PEAP provides a comprehensive development framework for Uganda and guides the formulation of government policy. The goals of the PEAP are intended to address major concerns of the poor, and reduce the number of Ugandans living below the poverty line to fewer than 10 percent by 2015. The poverty-reduction targets specify that GDP should grow at 7 percent/year in real terms over the next 17 years and that growth should be equally distributed (MFPED, 2004). The World Bank projections indicate that such growth is feasible but will only be achieved if policy reforms are put in place to encourage and increase private investment and to reduce the cost of public utilities. To ensure even spread of economic growth, it will be essential to promote agriculture and off-farm activities such as pitsawing in rural areas where more than 85% of Ugandans live. Thus, despite being very wasteful and very selective in species harvested, pitsawing is seen as a viable ecofriendly alternative and pro-poor (Osmaston, 2000).

The essence of sustainable management of forest resources in Uganda is underpinned by the importance of this resource to the national economy. Uganda's economy is natural resource based with over 81% of the citizens employed in the agricultural

sector, which is purely dependent on natural resources. In effect, the Poverty Eradication Action Plan (PEAP), which is the country's main planning framework (MFPED, 2004), emphasizes that environment and natural resources are key in achieving sustained economic growth and poverty eradication. During the last decade of PEAP implementation, increases in the monetary value of environment and natural resource products such as timber, honey, bush meat, and environmental and natural resource based enterprises have become a common phenomenon.

Nevertheless, in spite of almost a decade of implementation of PEAP guided policy, widespread evidence of significant degradation of forests and other macro-ecosystems upon which the poor people derive their livelihoods is common knowledge. The current PEAP (2004/05-2007/08) estimates the cost of degradation of the natural resource in Uganda to be at 17% of annual national income (MFPED, 2004). Further still, Odokonyero (2005) reported that the supply of timber from natural forests is declining and forests continue to be lost at an alarming rate.

In terms of economic value, BFR provides a great potential and is currently the richest in terms of timber production with rare species such as mahogany. The stock of merchantable timber (trees whose diameter at breast height exceeds 50 cm) from 15 different species in BFR is estimated to be 1,366,280 m3 (MWLE, 1997). The 825^2 Km BFR is the largest mahogany forest in East Africa. (Zeppe, 2006). Timber production in BFR is mainly done by pitsawyers who provide about 90 percent of sawn timber on the local market, and employment to several categories of people, e.g. supervisors, sawyers, carriers, sellers and buyers (Odokonyero, 2003). Trees for logging are acquired through licensed allocation by the National Forestry Authority (NFA) and now recently through auctioning too.

According to Food and Agricultural Organisation, Uganda lost 50 percent of its forests, and this continues to date at a rate of 2.2 percent per year, mostly due to subsistence farming, cutting for fuel wood, and encroachment by the burgeoning population. The combined effects of deforestation and high consumption, and now IAS infestation, result in an accelerating imbalance between national demand and supply of forest products (UBOS, 2007). An assessment by MWLE, (2003) conducted during the national biomass study from 1995 to 2002 revealed that out of the 1.17 million ha of forest reserves, 58,000 ha have been degraded or depleted.

S. spectabilis invasion in BFR has caused a public outcry from timber harvesters who observe that blockage of the forest roads and paths by the falling mature *S. spectabilis* trees, consistent and fast colonization of logging grounds and other forest parts as well as the competition with the native species that are desirable for timber production continue to take a toll on their timber production enterprises. *S. spectabilis* is unsuitable for timber production because of its low cleavage resistance (Ahamada et al, 2007). This therefore makes it an obstacle in the smooth running of timber production enterprises. Just like studies conducted by Mugasi (2007), Condon (1968), and Booth and Parker (1988) on impact of shrub encroachment on gross margins in sheep industry in Australia revealed that shrub encroachment led to reduction in livestock production and increase in variable costs particularly on shrub control which occasioned the reduction in gross margins; *S. spectabilis* is expected to reduce timber firms profitability through increase in variable costs. To the best of our knowledge, no single study has ever been done to assess the impact of *S. spectabilis* invasion on the timber production sector and hence the need to bridge the knowledge gap. Basing on the above motivation, this section of the study sought to isolate and assess the impact of *S. spectabilis* invasion on the performance of the timber supply firms using Gross margin analysis and financial efficiency ratio analysis. The following questions are hereby addressed:

1. How has *S. spectabilis* invasion affected the flow of timber production by forest condition?
2. What is the effect of *S. spectabilis* on the financial profitability and financial efficiency of timber businesses?

4.1 Objectives

1. To assess the effect of *S. spectabilis* on the flow of quantities of timber.
2. To assess the effect of *S. spectabilis* on the financial profitability and financial efficiency of timber businesses.

4.2 Methodology

Following the same methodological procedures as earlier reported in chapter three, the questionnaire method of investigation was employed. The Questionnaire (appendix 2) was developed, tested for internal consistency at the University of Pretoria and then prior to data collection, pretested in Nyabyeya and Nyatonzi parishes, representing the infested and non infested forest parts respectively. Basing on the *S. spectabilis* spread map (Figure 1) the survey population was partitioned so as to have representation from forest areas infested by *S. spectabilis* and those that were not infested by *S. spectabilis*. From each forest strata or condition, 57 timber harvesters were interviewed. Lists of names of timber harvesters were obtained from the National Forestry Authority office at Nyabyeya in BFR reserve. The timber harvesters whose names had been acquired were used to identify and locate other timber harvesters by process of snow balling whereby one timber harvester would connect the researcher to another timber harvester.

The six enumerators used in the study were thoroughly trained on the translation of the questions in the survey instrument from English to the local languages for effective communication between the non-English speaking respondents and the questionnaire administrator. During the data collection exercise, the timber firm owner was the targeted respondent and incases where the firm owner was absent, the interviewer would administer the questionnaire to the second in command of the firm and so on.

Data to assess the effect of *S. spectabilis* on the flow of quantities of timber was obtained by asking respondents in both forest conditions to state the amount of timber trees they sawed in the previous harvesting period (quarter[12]) and the timber quantities obtained and sold. To enhance the chances of getting the correct response, the question above had two data points which give the same information following the procedure of convergent validity. The enumerators worked with the respondents in cross checking the information from the timber firm records and where records were not properly kept, memorizing and calculating with the aid of hand calculators were done.

[12] Timber is harvested on quarterly basis in BFR. The previous harvesting period constituted a duration of 3-4 months. Data was corrected basing on the previous harvesting period (quarter) so as to minimize errors of recall for timber firms that had poor or no records.

To assess the effect of *S. spectabilis* on the financial profitability and financial efficiency of timber businesses, data was obtained by first asking respondents in both forest conditions the unit prices for the various timber categories sold and then the revenues obtained from the timber categories sold which were obtained as a product of the timber quantities sold and the unit prices. Secondary, respondents were also asked information on the variable costs incurred in the production of timber which included sawing labour; saw maintenance costs, *S. spectabilis* removal, and then the costs of transporting the finished product to the points of sale.

As earlier presented in chapters two and three, consistency of the data collection methods was achieved through vigilant field supervision of enumerators, daily checks for consistency of recorded information, checks with secondary information, clear and efficiently designed recording forms, well-defined measurement units and procedures. Also, careful timing of the visits to interviewees, rapport building through local authorities, and use of recalls were all employed among other measures to reduce non-response errors. Finally data was cleaned, coded, entered and analyzed using the SPSS statistical software package (Bryman and Cramer, 1997).

The effect of *S. spectabilis* invasion on the level of timber enterprise financial profitability was determined using gross margin analysis. Gross margins were worked out for both types of forest condition by finding the difference between gross income and the variable costs incurred. Effect of *S. spectabilis* invasion on the financial efficiency of timber firms was assessed using ratio analysis. The effect of *S. spectabilis* on the flow of quantities of timber was assessed by using excel computational program to arrive at the totals.

4.3 Results and discussions

The results and discussions are presented as follows: the findings and discussions of objective one in section 4.4, objective two in section 4.5 and finally the summary of the findings in section 4.6. These results and discussion sections focus on the timber harvesters' responses to the objectives of the study and the possible implications of the findings on the management options for invasive plant species with particular emphasis on *S. spectabilis* in BFR region.

4.4 The effect of *S. spectabilis* on the flow of quantities of timber

To assess the effect of *S. spectabilis* on the flow of quantities of timber, the study first asked about the average number of timber trees sawn in the previous harvesting quarter and then the quantities of timber produced from the same timber trees sawn in the same period. This was done to enhance the chances of getting a reliable response through convergent validity as earlier stated.

4.4.1 Average number of timber trees sawn per enterprise in the previous quarter by forest condition

The study interviewed 57 timber firms in each forest condition and the results of the number of timber trees sawn by forest condition are presented in Table 15. The number of timber trees reported for each forest condition was averaged in excel to arrive at the average number of timber trees sawn per enterprise in the previous harvesting quarter.

Table 15: Number of timber trees sawn per timber firm by forest condition in the previous harvesting quarter.

No of timber trees	Forest condition		Total
	Infested (n=57)	Non infested (n=57)	
40	3	0	3
41	1	0	1
42	3	0	3
43	5	0	5
45	12	5	17
46	1	2	3
47	6	4	10
49	2	2	4
50	14	17	31
51	0	1	1
52	1	2	3
53	0	2	2
54	0	2	2
55	4	2	6
56	0	1	1
57	1	3	4
60	1	10	11
62	0	2	2
63	0	1	1
Total	**54**	**56**	**110**

The average number of timber trees sawn per enterprise per harvesting period gives an indication of how productive the forest is. More so, if this is done basing on the forest condition, then the productivity of the forest can be assessed in light of the infestations by invasive species such as *S. spectabilis*. In agreement with *appriori* expectations, the average number of timber trees sawn per timber enterprise per quarter was found to be higher in non infested (52 trees) forest parts than infested forest parts (47 trees). This observation could be attributed to the fact that *S. spectabilis* invasion increases costs of doing business through extra expenses incurred on unblocking *S. spectabilis* blocked roads, clearing logging grounds on top of decreasing the available number of desirable timber tree species. In respect of the entire sample, the average number of timber trees sawn was found to be 50 trees.

4.4.2 Average quantities of timber production per enterprise in the previous harvesting quarter by forest condition

To assess the effect of *S. spectabilis* on the flow of quantities of timber, respondents in both forest conditions were asked to state the average number of timber pieces by category[13] they produced in the previous harvesting quarter. The difference in the number of timber pieces produced is attributed to the invasion of *S. spectabilis* as confirmed by the timber harvesters themselves in various aspects of this study. The results of the mean quantities of the timber pieces produced in the previous harvesting quarter are as presented in Table 16.

Table 16: Average timber quantities (pieces) produced in the previous harvesting quarter by timber enterprises in BFR reserve by timber category and by forest condition

Timber category	Non infested (N=57)			Infested (N=57)		
	n	Mean	S.E	n	Mean	S.E
6X2	37	4234.27	165.010	41	3781.07	175.26
3X2	2	5240.00	460.000	4	4560.00	151.493
4X2	36	3773.33	169.310	37	3229.57	135.142
12X1	13	3173.85	712.326	14	3185.00	118.367
9X1	14	3756.14	194.983	15	3713.80	189.761
8X2	25	2670.40	75.999	21	2106.43	122.197

[13] Timber category refers to the size class of the finished or sawn timber piece. The timber categories above are the main piece sizes that are produced and marketed in BFR.

Generally, results revealed the timber quantities produced to be higher in enterprises operating in non infested forest parts as compared to those that operated in infested forest parts. This could be attributed to the fact that non infested forest parts have higher populations of the desired timber tree species than infested forest parts.

Plate 1: Road blocked by fallen S. spectabilis trees

Plate 2: A typical timber enterprise in BFR

Moreover, costs of production are higher in infested forest parts due to the extra costs incurred in clearing *S. spectabilis* and unblocking *S. spectabilis* blocked roads. This corroborates with findings by Mugasi, (2004) who observed that invasive species increase costs of firm production. In addition to variations in timber quantities produced between the two forest conditions, glaring variations were also noted in quantities produced within a given forest condition as indicated by the high standard errors.

4.5 Effect of *S. spectabilis* on the financial profitability and financial efficiency of timber enterprises

4.5.1 Analysis of timber firms' profitability

The effect of *S. spectabilis* invasion on timber firm profitability was determined using gross margin analysis (Gitman, 2009). Gross margins were worked out for both types of forest condition by finding the difference between gross income and the variable costs incurred. The major source of income as already observed was timber sales. This is the revenue generated from sale of all timber categories and it is obtained as a product of quantity per timber category and the unit price (see appendix six and seven).

4.5.2 Timber firm expenditure

Timber firm expenditure was mainly on unblocking *S. spectabilis* blocked roads, saw maintenance, sawing labor and transportation costs of sawn timber to points of sale. The timber suppliers in the two types of forest condition spent differently on the four areas mentioned above and the percentage expenditure is presented in Table 17.

4.5.3. Clearing *S. spectabilis*

Clearing *S. spectabilis* involved unblocking *S. spectabilis* blocked roads and removal of *S. spectabilis* from logging sites with the former as the main area of expenditure. Unblocking roads was a major challenge facing timber harvesters. All timber harvesters surveyed were using casual labor as the major form of labor. The method used in unblocking roads was manual chopping and removal of fallen *S. spectabilis* trees using hand saws, axes and pangas. Depending on the level of *S. spectabilis* coverage, the cost of clearing *S. spectabilis* in the previous harvesting quarter was estimated to be 3,519,286 and 2,066,667 Uganda shillings for *S. spectabilis* infested and non-infested forest areas respectively.

In *S. spectabilis* invaded forest parts, costs for unblocking *S. spectabilis* blocked roads constituted 5.56 % of total firm expenditure while it constituted only 3.43 % in timber firms operating in non-infested forest parts. The difference in expenditure in unblocking roads in the two forest categories can be attributed to variation in levels of *S. spectabilis* invasion, timber harvesters' incomes, *S. spectabilis* falling incidences, weather conditions in the forest and awareness (preparedness). As earlier on pointed out, the chances of road blockage are higher in *S. spectabilis* invaded than non invaded forest areas. Expenditure on unblocking roads in non *S. spectabilis* infested areas can be explained by the fact that all timber harvesters traverse the entire forest in their movements and transportations regardless of where they harvest from and thus are bound to come into contact with *S. spectabilis* blocked roads.

Table 17: Quarterly average expenditure of timber firms under the two types of forest condition in BFR in UShs

Area of expenditure	Forest condition	
	Non infested	Infested
Sawing labour	11,326,165.25	11,643,836.75
Transport	2,472,240.00	2,526,073.00
Saw maintenance costs	758,217.00	791,541.00
Road unblocking costs	516,666.75	879,821.50
Total	**15,073,289.00**	**15,841,272.25**

4.5.4. Saw maintenance costs

These are the costs incurred in sharpening, repairing, fueling and oiling saws that are used in sawing timber. And the fact that the same saws are used in sawing all the timber categories, there is no specific cost of saw maintenance that can be attached to a particular timber category but the cost is reported as a general quarterly cost incurred in saw maintenance. The quarterly average saw maintenance cost is 758,217 and 791,541 UShs for timber harvests operating in non *S. spectabilis* infested and *S. spectabilis* infested forest areas respectively. As expected, the costs are higher for timber firms operating in the *S. spectabilis* infested areas as much has to be done with regard to unblocking roads and clearing *S. spectabilis* in the forests. In *S. spectabilis* invaded forest parts, costs for maintaining saws constituted 4.99 % of total firm expenditure while it constituted 5 % in timber firms operating in non-infested forest parts.

4.5.5 Sawing labor costs

This is the cost incurred in paying for labor used to cut and saw the timber and it was reported per timber category. In respect of all the timber categories produced, the quarterly average cost of sawing labour is 11,326,165.25 and 11,643,836.75 UShs for timber firms operating in non *S. spectabilis* infested and *S. spectabilis* infested forest areas respectively. The difference in expenditure is due to amounts and availability of desired tree species, levels of *S. spectabilis* invasion and availability of labour. Thus the sawing labour expenditure is higher in *S. spectabilis* infested areas where part of

the labour is required for clearing *S. spectabilis* to unblock roads, establish pathways and sawing grounds as well as the scarcity of labour as many casual laborers shun infested areas due to the extra work involved. In *S. spectabilis* invaded forest parts, cost of sawing labour constituted 73.50 % of total firm expenditure while it constituted 75.40 % in timber firms operating in non-infested forest parts.

4.5.6 Transportation costs

These are the costs incurred in transporting the sawn timber products to the points of sale usually to Masindi town and with in the vicinity of the forest. Since the quarterly average cost of transport is 2,472,240 and 2,526,073 UShs for timber firms operating in non infested and *S. spectabilis* infested forest areas respectively, the transport costs can be reported as being 53,833 Ugandan shillings higher in infested forest parts. This cost depends on the distance from the sawing points to the points of sale as well as level of *S. spectabilis* invasion. The time spent on the road unblocking forest pathways and roads increases the cost of vehicle hire charges.

4.5.7 Gross margin analysis

For purposes of comparative analysis, gross margins were calculated on per sawn timber tree basis. This was done by dividing all the individual costs and revenues by the average number of timber trees sawn (50 trees) in respect of the entire population of timber firms. This was done with the aim of standardizing the margins given that different firms worked on different numbers of timber trees and forest area sizes. Table 18 shows the gross margins of firms under the two types of forest condition. Results in Table 18 indicated that the average gross income per timber tree per quarter for non infested forest parts was higher compared to that for infested parts by 35,717.31 UShs. Contrastingly, results further revealed that the average total variable costs per timber tree were higher in infested parts than non infested ones by 15,359.66 UShs. The average gross margin per timber tree sawn per quarter in non infested forest parts was 195,664.05 UShs much higher than 144,587.08 UShs in timber enterprises operating from infested forest parts. This was attributed to the higher incomes of enterprises operating in non infested parts resulting from higher numbers of timber trees sawn and low costs of doing business as already reported. Relatedly, a socioeconomic assessment of the impacts of *M. micrantha* in Kerala, Malaysia by Ellison and Murphy (2000) found that invasive species had resulted in an escalation of production costs and subsequent loss of income (KFRI, unpublished report). They

further reported that the cost of controlling the weed had significantly increased overall production costs.

Table 18: Average quarterly gross margins per timber tree sawn under the two types of forest condition in BFR in UShs

Income	**Non infested**	**Infested**
Timber sales	497,129.84	461,412.53
Total gross income	**497,129.84**	**461,412.53**
Variable costs		
Sawing labour	226,523.31	232,876.74
Transport	49,444.80	50,521.46
Saw maintenance costs	15,164.34	15,830.82
Unblocking Roads	10,333.34	17,596.43
Total variable costs	**301,465.79**	**316,825.45**
Gross margins	195,664.05	144,587.08
TVC/GR Ratio	**60.6 %**	**68.7%**

4.5.8 Effect of *S. spectabilis* on the financial efficiency of timber businesses

Gross margins per se may not reflect the real economic performance of the firms under the two types of forest condition. It was important to consider Gross revenue (GR) in relation to Total Variable Operating Expenses or Total Variable Costs (TVC) in order to establish the financial efficiency of the firms under the two types of forest condition by use of financial efficiency ratio analysis. The use of financial ratios and margins in assessing, benchmarking and monitoring firm performance as explained by Gitman, (2009) has become more common in the recent past. This has enhanced the producers' efforts to define the economics of producing firm commodities, tying economic performance at the enterprise level to financial performance at the firm level. This study adopts comparative ratio analysis in which it compares the financial efficiency ratios of timber firms operating in the two forest conditions. One ought to

note that the appropriateness of a ratio will depend upon the circumstances of the operation and the overall strategy of the firm. Financial efficiency was estimated using the Operating Expense Ratio (excluding depreciation and interest) (OER) given by TVC/GR. Efficiency represents an input/output relationship.

The TVC/GR ratio or rather Operating Expenses Ratio measures a firm's ability to generate revenues and control costs. This ratio represents the percentage of operating expenses that will consume every 1 shilling of revenue. A useful way to view the ratio is that the residual represents the amount of money left on a shilling of revenue that remains to: service debt (both interest and principal), provide for re-investment in capital assets such as machinery, equipment and infrastructure such as roads, and provide for family living withdrawals. For instance, a 75% ratio would indicate that there is 25 cents from every shilling of revenue generated left to cover debt servicing, reinvestment, and withdrawals. In general, the lower the OER, the better. This will result in more cash from every shilling of revenue generated left to cover debt servicing, reinvestment, and withdrawals.

Results presented in Table 18 indicate that the Operating Expense Ratio for timber enterprises operating in non infested forest parts was 60.6% while it was 68.7 % for firms operating in infested forest parts. This meant that for timber firms operating in non infested forest parts, there is 39.4 cents from every shilling of revenue generated left to cover debt servicing, re-investment and withdrawals while for timber enterprises operating in infested forest parts, there was only 31.3 cents from every shilling of revenue generated to cover debt servicing, re-investment and withdrawals. Thus one can assert that timber firms operating in non infested forest conditions were more financially efficient than their counterparts operating in infested forest conditions and this difference in financial efficiency can be attributed to the extra and more frequent costs incurred by timber firms in infested conditions on clearing *S. spectabilis* as well as unblocking *S. spectabilis* blocked roads.

The closeness of the ratios on the two types of firms despite differences in gross margins could be attributed to several factors. The cost of labour for clearing *S. spectabilis* and unblocking *S. spectabilis* blocked roads was very high. This was mainly because of the nature of the work involved in cutting and lifting mature *S. spectabilis* trees which are most of the times huge and heavy. Further still, due to the

demographic set up of the area, there is severe labour shortage and as a result, labourers come from distant areas and are expensive to hire. This coupled with the fact that *S. spectabilis* trees fall so frequently makes the cost of *S. spectabilis* control very high.

Timber prices were also reported as very low by the majority of the respondents interviewed. Each timber category was close to 2000 Ugandan shillings less than the price given in Kampala. This sharp difference in firm gate prices and prices on the market is essentially a result of poor marketing systems. Firms have no ability to market their products themselves, mainly because the nature of the products requires high inputs such as trucks to transport timber. As a result, timber producers rely on traders who act as middlemen between them and the consumers. More of the marketing margins, therefore, go to the traders. Furthermore, the remoteness of the area and the poor roads make it less accessible to traders, such that the few who go there dictate prices.

In conclusion, it was divulged that timber firms operating in non infested forest conditions had higher incomes and gross margins than their counterparts operating in infested conditions. More often, output or gross margins are considered as profits without respect to all inputs. This is the reason why firms remain in business even if they are not making profits. Net profit can no longer be used as a gauge of whether resources are used efficiently. However, there is strong indication that in consideration of risk and opportunity, a management strategy of low levels of investment, average levels of production, low levels of total costs, and above average marketing will help timber producers achieve profitability and financial efficiency. Financial ratios can be useful in managing the firm business by providing a check on the performance of assets and a warning as to potential areas or risk such as spread of an invasive species. Combining these ratios with an economic analysis of production costs and returns should provide firm managers with an excellent basis for decision making. As with many other tools, however, these ratios and margins do not guarantee success, but use of them will certainly improve the probability of success.

4.6 Summary of the findings

In agreement with *appriori* expectations, the average number of timber trees sawn per timber enterprise per quarter was found to be higher in non infested (52%) forest parts

than infested forest parts (47%). This observation could be attributed to the fact that *S. spectabilis* invasion increases costs of doing business through extra expenses incurred on unblocking *S. spectabilis* blocked roads, clearing logging grounds on top of decreasing the available number of desirable timber tree species.

With regard to the effect of *S. spectabilis* on timber quantities harvested, results revealed the quarterly timber produced in pieces to be higher in enterprises operating in non infested forest parts as compared to those that operated in infested forest parts. This was attributed to the higher populations of the desired timber tree species as well as low costs of production in non infested than infested forest conditions.

Timber production costs and income were assessed in relation to forest range condition. Average gross income was 497,129.84 UShs per timber tree sawn per quarter in non infested forest conditions compared to 461,412.23 Ushs in infested forest conditions. Higher incomes in non infested forest conditions were attributed to abundant availability of desired timbre tree species, less expenses on clearing *S. spectabilis* and unblocking *S. spectabilis* roads. Results also indicated that while other costs did not differ greatly (e.g. timber sawing labour, transportation costs, saw maintenance costs) in the two forest range categories, quarterly road unblocking costs in infested forest parts were much higher than those in non infested conditions. As a result, the total variable costs were 301,465.79 UShs per timber tree per quarter in non infested forest conditions compared to 316,825.45 UShs in infested forest conditions. This gave an average gross margin of 195,664.05 UShs per timber tree sawn per quarter in non infested forest parts as compared to only 144,587.08 UShs in infested forest conditions.

The TVC/GR ratio was used to estimate the financial efficiency of the timber firms under the two types of forest range condition. Firms operating in non infested forest conditions had a ratio of 60.0 % lower than 68.7 % for firms in infested forest parts. The implication of this finding was that firms in infested forest parts were incurring heavy variable costs compared to those in non infested forest conditions and thus were less financially efficient than their counterparts operating in non infested forest areas.

The high TVC/GR ratio in firms operating in infested forest conditions was attributed to high costs of *S. spectabilis* control and road unblocking, low abundance of desirable timber tree species and low firm gate prices of timber.

CHAPTER 5

5.0 IMPACT OF *S. SPECTABILIS* ON THE TOURISM SECTOR

5.1 Introduction and background

Tourism[14] is one of the leading sectors in the world economy and according to the World Travel and Tourism Council (WTTC), it is projected to grow to US$8.0 trillion worth of economic activity and create 328 million jobs globally by 2010 (UBOS, 2004). However, Uganda's share of the tourism industry is still insignificant although inbound tourist numbers continue to increase. With regard to employment, the tourism sector is the second to the retail trade and accounts for 20% of persons employed in the country (UBOS, 2004). However, the contribution of the tourism sector to the national economy is currently not accurately measured because of lack of data on important parameters such as sites visited by both domestic and international tourists, hotel occupancy rates and expenditure by tourists. The Investment guide to Uganda (2003) reports that perhaps the biggest long-term investment opportunities are to be found in the tourism industry. Tourism is the fastest growing economic sector in Uganda. The sector earned $161.7 million as of end of 2001 (UIA, 2003).

The direct use value of forests from tourism in Uganda is well studied (Falkenberg and Sepp, 2000). Ecotourism constitutes the majority of Uganda's tourism which is largely based on forests. The six national parks established between 1991 and 1993 were arched from forest reserves. Mgahinga and Bwindi are two examples of the six national parks and are the only homes of the mountain gorillas in Uganda and house over half of the world's population of these great apes. The two parks generate over 33% of the tourism revenues collected by UWA through gate receipts. In 1998 alone, tourism revenues were estimated to be around 2700 million UShs (1.4 million US$) excluding the additional downstream benefits of tourism such as travel hotel use or the purchase of handcrafts by tourists visiting Uganda (Plumptre et al, 2006). It is important to observe that the core of Uganda's biodiversity is mainly enshrined in the richness and wellbeing of the forest resources. The National Forestry Policy recognises that about 11 percent and 7 percent of the world's bird and mammal species respectively are found in Uganda's forestland (Plumptre et al, 2006). This

[14]Tourism: comprises the activities of persons traveling to and staying in places outside their usual environment for not more than one consecutive year for leisure, business and other purposes not related to the exercise of an activity remunerated from within the place visited (UWA).

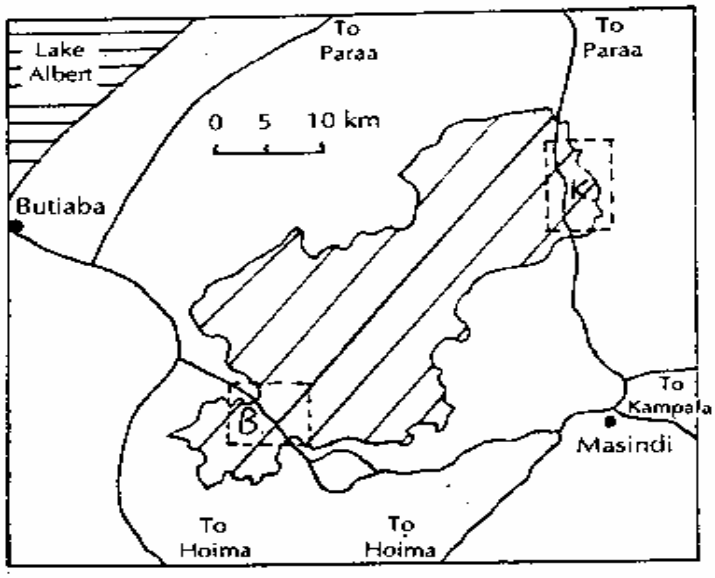
implies that there is a big potential in terms of wealth creation for the country with revenues coming mainly from tourism and trade in forest products.

The forestry sector is under threat from invasive species and yet these invasive species are a major component of the action plan of the environment initiative of the New Partnership for Africa's Development (NEPAD) (UNEP, 2003). The action plan asserts that the impacts of invasive species are a major public policy concern in many countries of Africa, affecting water supplies, fisheries, forestry, horticulture, trade and tourism. It further notes that they are a primary cause of biodiversity loss and ecosystem decline, that they intensify poverty and threaten the sustainability of development strategies like ecotourism development (UNEP, 2003). Rain forests have various values which include medicinal, nontimber products, biodiversity and ecotourism values (Balick and Mendelsohn, 1992; Mercer et al., 1995).

BFR in North Western Uganda was gazetted as a Central Forest Reserve (CFR) in 1932. The reserve, which is a mixture of tropical high forest with a large population of mahoganies and savanna grasslands and woodlands, covers 825 km^2, making it Uganda's biggest forest reserve. It is of exceptional biodiversity importance, ranking third in overall importance in the country (Nature Conservation Master Plan, 1997). So far, 465 tree species, 366 bird species, 289 butterfly species and 130 species of large moth have been recorded. The forest also contains what is likely to be the largest population of wild chimpanzees in Uganda estimated at between 600 and 800 individuals. There are also other Primate Species such as the Black and White Colobus Monkey, the Red-Tailed Monkey, Blue Monkey, Velvet Monkey and Baboons, (Langoya et al, 1998).

The conservation value of Uganda's forests is recognised, as was the potential of other income generating uses of forests, especially non-consumptive uses such as ecotourism. (Nature Conservation Master Plan, 1997). The development of sustainable tourism in the forest aims to provide a small but regular income for both local people and government, and to create opportunities for communities and the forest department to work together in managing the forest resource. BFR has two ecotourism sites: Kaniyo Pabidi, an unlogged and isolated block of the forest reserve, with an all year round resident chimpanzee population, and Busingiro, a forest block that has been logged and is very suitable for sighting monkeys and birds. The two

sites (Figure 3) have the added advantage of being easily accessible from the two main roads going through the forest–Busingiro on the Lake Albert road, Kaniyo Pabidi on the direct Park road.



B = Busingiro
K = Kaniyo Pabidi
Shaded area = Budongo Forest Reserve

Figure 3: Map of BFR showing location of the two major ecotourism sites. Note that in relation to Figure one, Busingiro is in the *S. spectabilis* infested part of the forest while Kaniyo-Pabidi is in the non infested part of the forest.

Kaniyo Pabidi is situated in the north eastern part of BFR. Part of Kaniyo Pabidi is continuous with Murchison Falls National Park and Bugungu Wildlife Reserve which are managed by Uganda Wildlife Authority. Hence, some savannah grassland species can be sighted in Kaniyo Pabidi. These include Bush bucks, red and blue duikers, bush pigs, warthogs, lions, water bucks and buffaloes. There is prolific birdlife especially the chocolate – backed kingfisher and the pruvels eladosis. This area is home to a variety of tree species like mahogany and the celtic family. Some of the trees are known to possess medicinal qualities. Butterflies, moths and tropical flowers are abundant. Tourist activities include chimp tracking, bird watching, forest walks, conservation education, chimp habituation and camping (Langoya et al, 1998).

Studies by Fisher, (1999) carried out on the survey and documentation of chimpanzee food did not include *S. spectabilis* fruits or any of the *S. spectabilis* tree parts. *S. spectabilis* continues to spread in BFR at alarming rates and again to the best of our knowledge, there is no single study that has been done to assess the possible present and potential impact of *S. spectabilis* invasion on the tourism sector. With the above background and motivation, the study sought to assess the impacts of *S. spectabilis* on the tourism sector in the Budongo area. The following questions are addressed by this section of the study.

1. What are the perceptions and levels of knowledge of tourism operators on the conservation values of BFR?
2. What are the costs and benefits to tourism of living with *S. spectabilis* and how are these costs and benefits distributed?
3. What factors, in addition to costs and benefits, shape individual tourism operators' and group perceptions responses to *S. spectabilis*?
4. What are the attitudes of tourism operators towards *S. spectabilis* control?
5. What is the Chimpanzee population structure according to forest condition?

5.2 Objectives of the study

1. To assess the level of awareness of *S. spectabilis* invasion amongst tourism operators
2. To assess the perceptions and levels of knowledge of tourism operators on the conservation values of BFR by forest condition.
3. To assess the perceptions of tourism operators on the costs and benefits of living with *S. spectabilis* by forest condition.
4. To assess the attitudes of tourism operators towards *S. spectabilis* control.
5. To assess the differences in chimpanzee population structure by forest condition.

5.3 Methodology

The study focused on the two and only ecotourism sites in BFR and these included Busingiro site in the infested forest part and Kaniyo Pabidi in the non infested forest parts. The study aimed at interviewing tour operators in both forest conditions first individually and then as a group in a focused group discussion. Resultantly, both ecotourism sites in BFR (Busingiro and Kaniyo Pabidi) were visited by the principal researcher himself and personnel (game rangers and tour guides) interviewed individually and together in a focused group discussion using a questionnaire

(appendix three) and a group discussion interview guide (appendix four). Three respondents were interviewed and one focused group discussion held in each forest condition. Both survey instruments were developed, tested for internal consistency at the University of Pretoria and then prior to data collection, pretested in the two ecotourism sites. An examination of the pre-test responses confirmed that both the survey instruments were suitable tools for the study.

Further still, information was sought from the Budongo Conservation Project[15] in Sonso. Other general information was sought from the BFR and Uganda Wildlife Authority management offices as well as a few informed BFR inhabitants. Ideas generated through focused group discussions were a source of explanations for the responses given in individual interviews and were used as complementary elucidations to the information given by the Budongo conservation project in Sonso and Budongo forest administrators. Descriptive statistics were employed in the analysis and presentation of results.

Plate 3: The researcher walks the Royal Mile [16]in BFR

Plate 4: Researcher together with the tourism operators

5.4 Results and discussions

The results and discussions of the study are presented as follows; objective one is presented in section 5.5, objective two in section 5.6, objective three in section 5.7, objective four in section 5.8, objective 5 in section 5.9 and finally the summary of the findings in section 5.10

[15] The Budongo Conservation Project is a project sponsored by the Jane Goodhall institute and Oxford University to carry out research on conservation aspects of BFR. It has been conducting research on Chimpanzees in BFR for over 16 years.

[16] The Royal Mile is the most beautiful scenery in BFR and is most liked by tourists. It's a very long stretch with a perspective avenue that gives a natural feeling of a typical tropical rain forest. Chances of viewing Chimpanzees and other animals are very high along this stretch.

5.5 Level of awareness of *S. spectabilis* invasion among tourism operators

Tourism operators were tasked to identify *S. spectabilis* by showing them several branches one of which was *S. spectabilis*. They were further asked to state whether they knew that *S. spectabilis* was invasive. Results are presented in Figure 4.

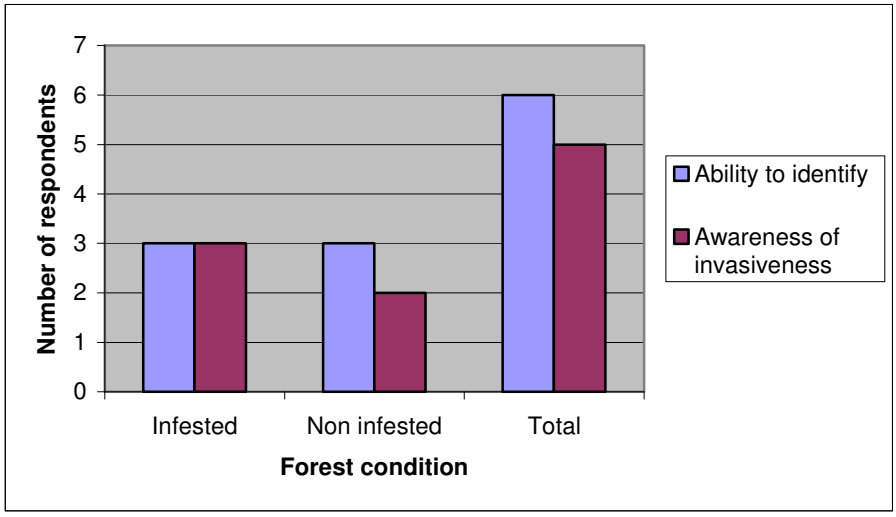


Figure 4: Level of awareness of *S. spectabilis* invasion among tourism operators

Results indicate that both the ability to identify *S. spectabilis* and the knowledge of its invasiveness were very high. The published literature material from the UNEP/GEF-IAS Project and UWA that is always availed in the ecotourism sites was mentioned as the source of information that explains the observed levels of awareness.

5.6 Level of knowledge and perceptions of the respondents on the conservation values of BFR

To advance any conservation causes, it is necessary to ensure that people know and appreciate the purposes and functions for which BFR was and is still being conserved. This is in light of the argument that ownership of management policies among the employees and other stakeholders is crucial for the success and sustainability of management policies. It was against this background that this section of the study sought to assess the tourism operators' knowledge and perceptions of the conservation values of BFR by asking the following questions;

1. Confirm knowledge of the prime conservation functions of BFR as illustrated in Table 20 by stating Yes or No
2. Whether the respondent was aware that uncontrolled spread of *S. spectabilis* was dangerous to the conservation of BFR.

3. Whether the respondent would feel at a loss if *S. spectabilis* was to spread to such an extent that BFR would lose its conservation objectives.

Answers to the above questions are presumed to explicate the knowledge and perceptions of tour operators on the general conservation values of BFR. Results are presented in Table 19 in which we report in (columns 2, 3 and 4) the number of responses and the percentage response of those who responded in the affirmative (Yes).

Table 19: Level of knowledge and perceptions of tour operators on the conservation values of BFR by forest condition

Conservation value	**Forest condition**		**Whole sample**	
	Non infested		**Infested**	
Conservation of fauna & flora	2	(66.7%)	3	(100%)	5	(83.3%)
Tourism attraction	3	(100%)	3	(100%)	6	(100%)
Timber supply	3	(100%)	3	(100%)	6	(100%)
Fuel wood supply	3	(100%)	3	(100%)	6	(100%)
Building material supply	3	(100%)	2	(66.7%)	5	(83.3%)
Climate regulation	3	(100%)	2	(66.7%)	5	(83.3%)
Carbon sequestration	2	(66.7%)	3	(100%)	5	(83.3%)
S. spectabilis is a danger to BFR	2	(66.7%)	3	(100%)	5	(83.3%)
Loss felt if *S. spectabilis* killed BFR	3	(100%)	3	(100%)	6	(100%)

Since the study involved the entire population of tourism operators, there were no statistical tests carried out to compare responses from both forest conditions but rather the interviews were complemented by the results from the focused group discussions and thereby reported as a census. Generally, the results revealed that the majority of respondents knew the conservation values of BFR with positive percentage responses of >80 percent. This is attributed to the education levels of the tour operators which are certainly high since recruitment into the job requires an academic qualification. Further still, their fair literacy levels augmented with the sensitization works of the UNEP/GEF-IAS Project and other government agencies involved in promotion of sustainable forest and ecotourism management could have occasioned the results of

the kind. In comparison, tourism operators operating in infested forest parts had higher positive responses than their counterparts in the non infested forest parts. This could be attributed to differences in literacy levels and years of experience of working in the ecotourism sites. Results reveal that tour operators appreciate that a well conserved BFR serves the needs of the tourists; and tourists through their interest and support in visiting these areas, serve the interest of nature conservation. Without the economic advantage of eco-tourism there would be no incentive to preserve ecosystems and without preserved eco-systems, there would be no eco-tourism.

5.7 Perceptions of tour operators on costs and benefits of living with *S. spectabilis*

In their overview of invasive woody plants in the tropics, Bingelli et al (1998) reported that botanists, conservationists, foresters, agroforesters and horticulturalists have, and often still are, to varying degrees, responsible for the introduction and planting of woody species. While there is awareness of invasive potential and related environmental impact, it appears that often it has been considered that introduction of potentially invasive species would do more good than harm. Thus it remains a challenge to tourism managers in BFR to discover and implement management approaches that improve the resilience of ecosystems to change whilst maintaining a sound tourism business environment. This inevitably requires a holistic set of polices capable of integrating responses to both tourism promotion and invasive species management, along with other issues such as community participation, mass sensitization and development planning. This leads to an inquiry into the perceptions of tour operators on the costs and benefits of living with *S. spectabilis,* an invasive species that is threatening the existence of BFR and therefore the ecotourism industry. To address the above, the study asked questions seeking to establish tour operators' perceptions on the costs and benefits to tourism of living with *S. spectabilis*. Results and discussions on costs are presented in section 5.7.1 while those on benefits are presented in section 5.7.2.

5.7.1 Negative effects of *S. spectabilis* invasion on tourism sector

Roxana et al (2007) asserts that non-market effects such as loss of wildlife habitats play an important role in determining the cost of the invasions. The following questions were asked to assess tour operators' perceptions on costs of *S. spectabilis* invasion to tourism. Respondents were asked to:

1. Mention the negative effects to the tourism business caused by *S. spectabilis* and where possible state the level of severity of the negative effect.
2. Whether they were willing to be part of the campaign meant to save the flora and fauna of BFR from being destroyed by *S. spectabilis*.

Results and discussions of the findings are as presented in Table 20 following the same format as in Table 19. The majority of the opinions from both forest conditions (100 %) reported *S. spectabilis* to be unpalatable to chimpanzees. This comes from many years of observing chimpanzees feed on other forestry vegetation and fruits but not *S. spectabilis.* Our findings corroborate those of the study by Fisher, (1999) who carried out a survey and documentation of chimpanzee food in BFR and did not include *S. spectabilis* fruits or any of the *S. spectabilis* tree parts as feed to chimpanzees.

Table 20: Negative effects of *S. spectabilis* invasion on the tourism industry

Negative effect of *S. spectabilis*	**Percentage**		**Whole sample Total**
	Non infested	**Infested**	
Unpalatability to Chimpanzees	3 (100%)	3 (100%)	6 (100%)
Harbours dangerous animal species	3 (100%)	3 (100%)	6 (100%)
Willingness to control *S. spectabilis*	3 (100%)	3 (100%)	6 (100%)

As found out earlier with other groups of stakeholders, all the respondents knew *S. spectabilis* trees to be good habitats for mosquitoes that transmit malaria. Respondents from both forest conditions had high and equal (100 %) positive responses of willingness to be part of the campaign meant to save the flora and fauna of BFR from being destroyed by *S. spectabilis* invasion. This is because they consider it a threat to the tourism industry and would therefore want something done to halt the escalating

spread of the invasive species which on top of harbouring malaria transmitters is also unpalatable to chimpanzees which are the major tourist attractions in BFR.

5.7.2 Positive attributes or benefits of *S. spectabilis* to the tourism industry

Biodiversity science postulates that everything in existence has a value and thus this part of the study sought to find out the positive attributes or rather benefits that *S. spectabilis* renders to the tourism sector. To achieve the above, the study asked the following questions;

1. Whether respondents perceived *S. spectabilis* to be palatable to any other wild animals in BFR.
2. Whether respondents perceived *S. spectabilis* to be a source of medicine to humans or animals or both.
3. Whether respondents perceived *S. spectabilis* to be a good habitat to any other wild animals in BFR.
4. To mention any other benefit that *S. spectabilis* renders to the tourism industry in BFR.

Answers to the above questions express the perceptions of tour operators on the benefits to tourism accruing from *S. spectabilis* invasion. From the results presented in Table 21 below, 5/6 respondents from both ecotourism sites confirmed that monkeys liked habituating *S. spectabilis* trees and that *S. spectabilis* fruits are a source of feed for monkies but not chimpanzees. However, they mentioned that chimpanzees and not monkies are the major subject of tourist attraction which tears down the importance of *S. spectabilis* as a source of feed to monkies.

Table 21: Perceptions of tour operators on the benefits of *S. spectabilis* to tourism

Positive attribute or benefit	**Percentage**		**Whole sample Total**
	Non infested	**Infested**	
Feed to wild animals	2 (66.7%)	3 (100%)	5 (83.3%)
Medicine source	0 (0%)	0 (0%)	0 (0%)
Habitat for wild animal species	2 (66.7%)	3 (100%)	5 (83.8%)

Asked whether *S. spectabilis* was a source of medicine to humans and wild animals, all the respondents responded in the negative. The response came from many years of watching animals cure themselves on leaves of other tree species but never on *S. spectabilis*. Tour operators earn a salary and therefore a descent living and thus do not treat their ailments using herbs. This was the reason for not using *S. spectabilis* leaves for medicine to cure skin rashes and stomach pains like the rest of the local communities do. Tasked to mention any other benefits to tourism from *S. spectabilis*, all the respondents confirmed *S. spectabilis* as a potential source of wood for campfires, as a habitat for bird nesting as well as a source for construction poles for temporary structures in the camping sites.

5.8 Attitudes of tourism operators towards *S. spectabilis* control

The scenic beauty that results from well-tendered ecosystems and well-kept forests is a boost to the eco-tourism market (Langoya et al, 1998). With this background, this section of the study sought to assess the attitudes of tour operators on the control and management of *S. spectabilis.* To achieve this, the study posed to the respondents the following questions;

1. What they perceived to be the current status of spread of *S. spectabilis* in BFR.
2. Their choice of control strategies
3. Whom they perceived as being responsible for managing *S. spectabilis* in BFR.

Results to the above questions are presented in the sections that follow. Perceptions on the spread dynamics are in section 5.8.1, choice of control strategy and responsibility of control in section 5.8.2.

5.8.1 Perceptions on spread dynamics of *S. spectabilis*

Knowledge of the trend of spread of *S. spectabilis* in BFR was assessed first so as to relate the findings with those from the attitudes towards *S. spectabilis* control. This was hinged on the fact that one's knowledge of the trend of spread of the invasive species would definitely have an influence on their attitude towards its control. As expected, all the three respondents (see Figure 5) as well as the group discussion opinions from the infested parts reported the trend of *S. spectabilis* spread to be increasing. In the non infested forest parts, all except one respondent confirmed *S. spectabilis* spread to be on the increase. One respondent reported that the spread was

stagnant while one also reported that they didn't know for sure the attendant spread dynamics of *S. spectabilis.*

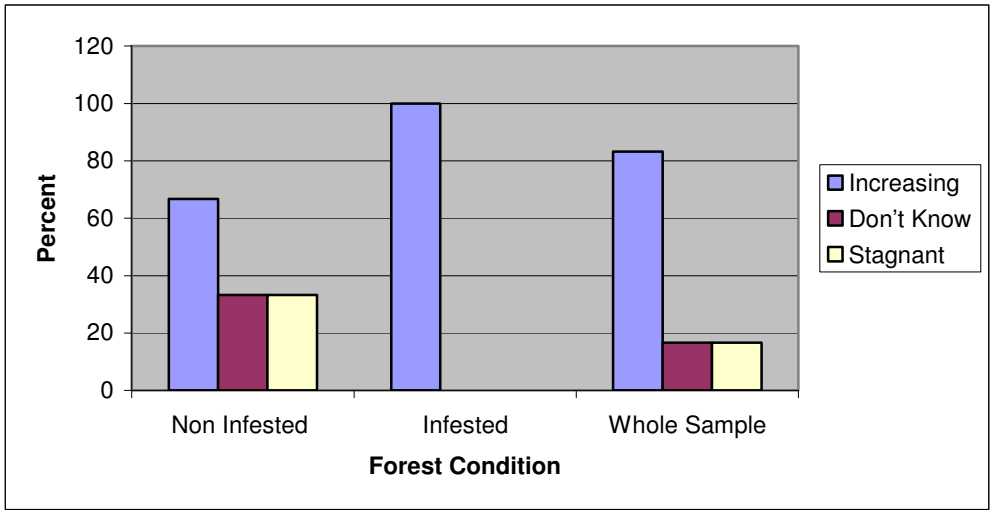


Figure 5: Trend of *S. spectabilis* spread in BFR

5.8.2 Attitudes of tourism operators towards *S. spectabilis* control strategies

As reported in Table 22 using the same format as Table 21, all respondents favoured total eradication of *S. spectabilis* as means of curbing the invasive species' effects on tourism and other sectors. They argued that monkies which have been feeding on *S. spectabilis* have several other sources of food and thus would not be affected by the total absence of *S. spectabilis*.

Table 22: Attitudes of tourism operators towards *S. spectabilis* control strategies

Control measure	Percentage response per forest condition		Whole sample
	Non infested	Infested	
Total removal	3 (100%)	3 (100%)	6 (100%)
Limit spread	2 (66.7%)	1 (33.3%)	3 (50%)
Separate *S. spectabilis* forest	0 (0%)	0 (0%)	0 (0%)
Do nothing	0 (0%)	0 (0%)	0 (0%)

However, in contradiction of the above, two respondents in the non infested and one respondent in the infested forest conditions argued that other uses such as feed to monkies, provision of fuel wood and provision of construction material notwithstanding, *S. spectabilis* has other values which we may not be aware of and

thus favoured the strategy of limiting the spread of *S. spectabilis* to where it is and prevent its entry into other areas. The rest of the control strategies such as setting up a separate forest for *S. spectabilis*, and the 'Do nothing' option fetched no single support from the non infested and infested forest parts combined.

It can thus be concluded that all tour operators agreed that the deleterious impacts of *S. spectabilis* on ecosystems are strong incentives for their eradication. To the question of who held the responsibility of managing *S. spectabilis* spread, all the respondents concurred that the central government must spearhead the control of *S. spectabilis* through its well functioning governmental parastatals namely; the National Forestry Authority (NFA), the National Agricultural Research Organisation (NARO), the National Environmental Management Authority (NEMA) and the Uganda Wildlife Authority (UWA). They argued that local support could be mobilized from the dependent communities who would be willing to assist with cheap labour. They further expressed their concern that eradication measures should be well studied to avoid any environmental harm that might result from use of chemicals and biological control agents. They favoured the use of mechanical means to control *S. spectabilis*.

5.9 Chimpanzee population structure in the two forest conditions

Chimpanzees live in families whose social cohesion is strong and volatile at the same time. Competition for mates and alpha male positions usually leads to sudden death and disappearances of some chimpanzees due to deadly fights that frequently ensue. Besides this reason, some chimpanzees die from; accidents when they fall from high trees, diseases contracted from the forest and hunger when their habitats run out of food. Chimpanzee families may choose to migrate when the areas they inhabit become unfavorable in whatever ways. This study through a focused group discussion with the Budongo conservation project staff and tour operators of both ecotourism sites solicited for chimpanzee number estimates and the possible explanations for the reported population structure. Results are presented in Table 23 below.

Table 23: Population structure of chimpanzees in BFR

Number estimate	**Non infested**	**Infested**	**Whole sample**
	Mean	**Mean**	**Total**
Total Chimps	400	353	753
Young Chimps	100	93	193
Birth Rate	5	5	5
Dead chimps	1	2	3

Results show that the non infested forest parts had an average of 400 chimpanzees while the infested forest parts had 353 chimpanzees giving a total of 753 chimpanzees in the entire Budongo forest range. This is in agreement with the results of Langoya et al, (1998) who estimated that the total number of chimpanzees in BFR could be in the range of 600 to 800. Out of these totals, the non infested forest parts had an estimate of 100 young chimpanzees while the infested parts had an estimate of 93 young chimpanzees. The infested forest part had registered two deaths in the previous 12 months while the non infested forest part had registered one death in the same period. The birth rate was found to be equal in both forest conditions with an average of five births per year.

In trying to link chimpanzee population structure to the quandary of *S. spectabilis* invasion, errors of attribution were minimized by the fact that estimates were based on the records of the Budongo conservation project, a research project that has studied chimpanzees in BFR for over 16 years. The average number of both total and young chimps was found to be higher in non infested forest parts than in infested ones. Besides this, the confirmed deaths were higher in infested than non infested forest parts. Besides other possible reasons, the game rangers reported that the deaths could have been a result of accidents caused by high falling which most probably was from *S. spectabilis* trees which are known to fall rather frequently. The falling *S. spectabilis* trees are also known to hit unsuspecting chimpanzees leading to their deaths. Habitat

alteration occasioned by *S. spectabilis* invasion may not be evidence enough to explain the difference in the deaths, estimated total and young chimpanzee numbers between the two forest conditions considering that the difference in numbers is rather small. Nonetheless, tour operators reported that *S. spectabilis* trees seemed to be repulsive to Chimpanzees who are often seen to habituate other trees other than *S. spectabilis*. Chimpanzees were reported to distance themselves from areas that get colonized by *S. spectabilis* trees.

5.10 Summary of the findings

Results revealed that by and large, the majority of respondents could identify *S. spectabilis* and knew its invasiveness as well as the level of the original purposes for which Budongo forest was reserved and therefore its conservation values. In comparison, tourism operators operating in infested forest parts had higher positive responses than their counterparts in the non infested forest parts. This could be attributed to differences in literacy levels and years of experience of working in BFR.

With regard to perceptions of tour operators on the costs and benefits to tourism occasioned by *S. spectabilis* invasion, results revealed that the majority of the opinions from both forest conditions (100 %) reported *S. spectabilis* to be unpalatable to chimpanzees. As found out earlier with other groups of stakeholders, all the respondents perceived *S. spectabilis* trees to be good habitats for mosquitoes which transmit malaria. Respondents from both forest conditions had high and equal (100 %) positive responses of willingness to be part of the campaign meant to save the flora and fauna of BFR from being destroyed by *S. spectabilis* invasion.

An assessment of the attitudes of tour operators towards *S. spectabilis* control revealed that *S. spectabilis* spread was noted to be on the increase more especially in the already infested forest parts, and thus all the interviewed tourism personnel concurred with total removal as a means of *S. spectabilis* control. Half of the respondents were advocating for limiting *S. spectabilis* to where it is and none opted for the do nothing option.

Results show that the non infested forest parts had an average of 400 chimpanzees while the infested forest parts had an average of 353 chimpanzees giving a total of 753 chimpanzees in the entire Budongo forest range. This is in agreement with the

results of Langoya et al, (1998). Out of these totals, the non infested forest parts had an estimate of 100 young chimpanzees while the infested parts had an estimate of 93 young chimpanzees. The infested forest part had registered two deaths in the previous 12 months while the non infested forest part had registered one death in the same period. The birth rate was found to be equal in both forest conditions. The difference in the chimpanzee numbers in the two forest conditions is rather small and therefore may not be attributed to habitat alteration occasioned by *S. spectabilis* invasion.

CHAPTER SIX

6.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary of the general premise of the study

The study was carried out in BFR which covers parts of Masindi, Hoima and Bulisa districts in north western Uganda. The study focused on the three main groups of stakeholders of the forest reserve, namely; the local dependent communities, timber supply enterprises and the tourism sector. Two hundred fourty eight local community households, one hundred fourteen timber enterprises and six tourism personnel were interviewed from each group of stakeholders respectively. Half the number of the respondents as mentioned above were from the *S. spectabilis* infested forest parts while half was from the non infested forest parts. An earlier baseline survey for the UNEP/GEF-IAS Project (Removing Barriers to Invasive Plant Management in Africa) development phase conducted in the same area in 2006 had indicated that extensive forest parts had severe *S. spectabilis* encroachment which appeared to interfere with the normal functioning and productivity of the forest. This study was motivated by the magnitude of *S. spectabilis* invasion in the area, the level of public and government concern about the invasion, and the magnitude of the IAS problem across East Africa. This study is thus an output of the research and capacity building components of the UNEP/GEF-IAS Project.

The general objective of the study was to assess the impacts of *S. spectabilis* invasion on the productivity of BFR in Uganda and the socio-economic implications on the livelihoods of the dependent stakeholders. Specific objectives aimed at assessing levels of awareness of *S. spectabilis* invasion and invasiveness, perceptions and knowledge of the original purposes of BFR and therefore its conservation values, respondents' knowledge on the benefits and costs of living with *S. spectabilis*, impacts of *S. spectabilis* on the flow of quantities and revenues from the benefits it generates, impact on profitability and financial efficiency of timber enterprises, and impact on the population structure of chimpanzees which are the major tourist attractions. Comparison of means and cross tabulations were used to analyze the data. Gross margin and financial ratio analyses were used to estimate timber firm financial profitability and financial efficiency respectively. The Statistical Package for Social Scientists (SPSS) was used to analyze the data. Chi-square statistics were utilized to get levels of significance between the two forest conditions. Results presented in chapters three, four, and five indicate that *S. spectabilis* has both benefits and costs to

all groups of stakeholders though the distribution of the same differs across the same stakeholder groups. *S. spectabilis* can be considered a net benefit to the local dependent communities whereas; it may be considered albeit uncertainly a net loss to both the timber and tourism sectors basing on the extent of this study. Conflict of interest in *S. spectabilis* management therefore becomes apparent and solutions to it are as suggested in the closing part of the study.

6.2 Conclusions of the study

Irrespective of forest condition, respondents' ability to identify *S. spectabilis*, knowledge of its invasiveness and perceptions of the conservation values of BFR were generally high. This was attributed to the sensitization works of the UNEP/GEF-IAS project and other government agencies involved in promotion of sustainable forest management. Sensitization campaigns were augmented by the fairly high literacy levels of the respondents. This gave way to further analysis with confidence that respondents knew the main issues of contest in the study.

Among the local dependent households, findings indicated that *S. spectabilis* invasion in the forest led to increase in bundles of fuel wood collected, number of construction poles harvested and charcoal bags produced among the local communities. These were the major benefits associated with *S. spectabilis*. The major cost occasioned by *S. spectabilis* was proliferation of malaria disease caused by mosquitoes harbored in the large canopies of *S. spectabilis* trees. Thus *S. spectabilis* invasion was passed as a net benefit to the rural dependent communities in consideration of the major benefits and costs studied.

It was found out that *S. spectabilis* invasion led to a reduction in the quantity of timber produced while it increased costs of doing business. Financial profitability analysis indicated that timber enterprises operating in non infested conditions had better gross margins than those in infested forest conditions. The financial efficiency ratio (measured using the TVC/GR ratio) of the timber enterprises operating in non infested forest conditions (60.6%) was found to be lower and hence better than that of enterprises operating in infested forest conditions (68.7%). This was attributed to high variable costs resulting from high costs of *S. spectabilis* removal both in the forest and roads. *S. spectabilis* invasion in BFR can, therefore, be said to have caused economic loss through reduced levels of forest productivity, increased timber firm variable

costs, reduced gross margins as well as reduced financial efficiency in the timber firms operating in infested forest areas.

In respect of the tourism sector, tour operators reported *S. spectabilis* to be of some subsidiary use through provision of fuel wood for camp fires and construction poles for temporary structures. They too however perceived *S. spectabilis* not in light of the benefits it can avail but rather on its potential impacts on the tourism sector. Findings indicated that chimpanzee numbers were estimated to be lower in infested forest parts than in non infested forest parts and therefore indicative of a dreary trend in respect of chimpanzee population structure. This could later have a downbeat effect on the number of tourists received since their numbers depend on the number of chimpanzees in the forest which determines the chances of viewing.

Basing on the results of this study, is thus clear that *S. spectabilis* is a net benefit to the local dependent communities and, albeit uncertainly, may be considered a net loss to the timber production and tourism sectors basing on the extent of this study. *S. spectabilis* was reported by all groups of stakeholders as having both positive and negative attributes which is the reason for the apparent conflict of interest in its management.

6.3 Recommendations of the study for IAS (*S. spectabilis*) management

6.3.1 The role of stakeholder involvement

It became apparent that the findings of our study are consistent with the widely accepted view that the human dimension is critical for successful IAS management. When we consider the importance of social perceptions, knowledge and stakeholder attitudes in relationship to invasive species, various issues emerge from our study that are relevant to IAS management. Our study findings indicated that different stakeholder groups have outstandingly different perceptions about the impacts and benefits generated by IAS (*S. spectabilis*), and different attitudes toward their management and control. This fact deserves special attention and should not be ignored in the decision-making process. For that reason, a functional deliberation medium comprised of different stakeholders, who have a general institutional, philanthropic, personal, environmental or commercial interest in the ecosystem services provided by the biodiversity of an area, should participate in management decisions. Above all, the positive or negative effects on stakeholders by the

introduction of IAS should be addressed from the beginning of any decision-making process in order to consider the trade-offs involved in IAS management and facilitate the successful implementation of management practices.

It should be noted with emphasis that most stakeholders and decision makers have a limited perception of the problem occasioned by invasive species and, therefore, mass sensitization and public awareness campaigns are vital for any successful management problems associated with IAS. In addition, if educational and informative campaigns are to be effective, the design should be targeted at specific stakeholder groups. Therefore, these programs must include elements regarding stakeholder interests, personal socio-demographic characteristics, environmental behavior, and personal experiences. There is need for continuous sensitization on the dangers and magnitude of the problem posed by invasive species on the socioeconomic livelihoods of stakeholders, the environment and biodiversity. Only then can we achieve a sustained fight against the problem of IAS. It is important to note that the efficiency and sustainability of forest management can be improved if local communities are involved in the management of forest resources in their vicinity. Engaging locals to monitor instead of regular national staff, together with increased tangible benefits to the local communities will greatly improve the conditions of the forest.

It is reported in a study by Ssembajjwe and Banana (1998) that forests resources are more likely to be sustainably utilized by putting in place an effective structure of institutional arrangements that gives rise to an authority system meaningful at the local level. Regardless of the attendant property regime, all forests can be de facto open access regimes if there are no effective institutions and mechanisms to enforce the rules. In the absence of institutional arrangements and associated organizational mechanisms to monitor and enforce rules, a government forest reserve can be as degraded as a communal forest.

6.3.2 Conflict of interest in *S. spectabilis* management

As alluded to in various parts of this study, everything that exists on earth has a value. For this very reason, the term “existence value” was coined by environmental economists to mean the value of something by nature of its existence. This value could be known, unknown or both. Proponents of strict conservation would be against

any plans to destroy *S. spectabilis* even if it has been branded invasive and therefore counterproductive in the broad sense. On the other hand, environmental and forestry authorities driven by conservation and economic thinking would advocate for eradication of *S. spectabilis* so as to save the flora and fauna of forestry ecosystems and thenceforth ensure sustainable production of timber, tourism revenue generation and other functions for which BFR was reserved and is still being conserved. In Uganda, the Ministry of Agriculture, Animal Industry and Fisheries completed an aggressive promotion campaign for planting *S. spectabilis* in Masindi district mainly for fire wood provision purposes. The National Forestry Research Institute (NAFORI) promotes the growing of *S. spectabilis* in the eastern parts of the country for purposes of firewood production. Even though they do this for purposes of saving protected forests from encroachment by those in search of fuel wood and poles, promotion of *S. spectabilis* planting constitutes a heavy seed bank for re-infestation of BFR located in the same district and other forest habitats respectively even if *S. spectabilis* was managed in the forest reserve.

On the contrary, eradication of *S. spectabilis* would come at a cost as various groups of stakeholders would lose all the many benefits they obtain from *S. spectabilis* as reported in earlier chapters such as fuel wood, charcoal, timber though of low quality, construction poles, medicine, feed and habitat for wildlife, shade, wind brakes, fence, climate regulation and carbon sequestration. Because of the antagonistic interests and reasons of different groups of stakeholders, *S. spectabilis* is both being fought and planted at the same time which exposes a glaringly difficult challenge in its management. With the above background, the study sought to find out some of the possible approaches to resolving the problem of conflict of interest in IAS management as discussed hereunder.

A careful strategy to resolve the apparent conflict from the economic efficiency point of view would be a national cost-benefit analysis (CBA) on *S. spectabilis* and other IAS in their respective ecosystems whose findings would pronounce a final course of action as to whether *S. spectabilis* should be eradicated or controlled through strategic plantations that are location specific or even still, adoption of the do-nothing option depending on the results of the investigation. The CBA can form a basis for negotiation between different stakeholder groups as discussed further in section 6.3.5. The option of having *S. spectabilis* plantations that are location specific should bear

the fact that they eventually cause re-infestation of forests due to the seed banks that they engender. This is in light of the fact that *S. spectabilis* can spread very easily by many ways which include wind, birds, humans, and other ways that can't be controlled by man.

Furthermore, some of the other possible approaches to avoid conflict include recognising the value of a vibrant forest industry and actively managing the spread of plantation trees; using non-invasive species wherever possible, or ensuring that biocontrol is introduced at the start of new agroforestry projects; using biocontrol to reduce the invasive potential of otherwise useful species without killing them; recognizing potential invaders early and taking precautionary measures; and educating people as to the dangers and costs of invasive species.

Furthermore, research into possible tree species that can provide the same benefits as *S. spectabilis* should be carried out to avail replacement trees that are not invasive so as to mitigate the resistance to *S. spectabilis* eradication that might stem from those that benefit from its existence. As earlier mentioned, introducing biocontrol at the same time as new plantation or woodlot species, would also be a way of reducing the risk of unwanted invasions. Nevertheless, practical solutions to the actual implementation of these options, and to the equitable sharing of costs, still need to be explored. A more practical and pragmatic recommendation to resolving the conflict of interest in IAS management is suggested in the recommendation below.

Using the case of *S. spectabilis* invasion and following the South African case study in which the Working for water programme partnered with the forestry sector to tackle the problem of conflict of interest in management of IAS between the two institutions, it can be evidently seen that the potential for conflicts of interest to develop between the Ugandan forestry sector on the one hand, and those charged with nature conservation and alien plant clearing programmes on the other, is obvious in the Ugandan context. However, these conflicts can be avoided through a common commitment to finding lasting solutions to the problems of forestry and invasive alien plants. The forest sector can form a partnership with the government's national IAS coordination unit with a clearly stated intention of developing a relationship, based on collaboration, integrity, and a shared vision to enhance (i) the control of invading alien species; (ii) the utilization of local communities for cheap labour and support in

such activities; (iii) the sustainable management of the country's natural resources; and (iv) best management practices.

In terms of the agreement, the forestry sector could second a senior forester to the national IAS coordination unit, to provide additional capacity in the evaluation of safety standards, clearing standards, and planning with a view to improving efficiency. In addition, the forest industry will assist with training of national IAS coordination personnel, and with mapping and data capture. In addition, the forest authorities (NFA) will make various facilities or services (such as storage facilities and transport or supervision capacity) available to national IAS coordination teams in the field. In return, the national IAS coordination unit would undertake to fund (using funds generated from cost recovery mechanisms, direct government support, institutional support and development partners) the clearing of demarcated areas (including riparian zones planted up prior to legal requirements that will outlaw such plantings). It will also ensure that the forest sector's efforts with regard to clearing invading alien plants are publicized, and that it will work closely with the forestry industry and other relevant agencies to develop equitable legislation to govern the forestry sector. This agreement would mark a significant repositioning away from earlier stances which had the potential to develop into protracted conflicts over management approaches. It also represents a significant commitment by both industry and government to finding lasting solutions to serious environmental problems associated with forestry practices. It is important to note that the above approaches are still in their infancy in South Africa, and will need to be developed in order to find sustainable and practical solutions to the problems of invading alien plants. The success of the partnership between industry and government should be closely watched. Should it succeed, it could provide a role model for similar approaches elsewhere in the world.

6.3.3 BFR conservation

Another major threat to BFR today is the unrestricted felling of timber trees. The financing of pitsawing tends to come from business people in Masindi town and from further afield, but the labour is provided largely by local people. BFR management needs to look into this. The high levels of illegal pitsawing in BFR will reduce the value of this forest to managers and conservationists because of the loss of its good records of timber extraction. These records are what marks out BFR as an exceptional

forest. To achieve better record-keeping, local pitsawyers need to be licensed and to work with the forest management authorities. In addition they need to be motivated to keep records by a share of the money generated from the felled timber.

Generally, it is painstakingly important to identify alternative sources of income in order to avoid over dependence on BFR which will consequently compromise its purposes of conservation. Alternative sources include trading in general merchandise, growing of commercial crops such as banana, maize, coffee, and livestock rearing.

Whereas *S. spectabilis* is the dominant invasive species obliterating BFR, there are other invasive species still in the lag phase such as paper mulberry and *Lantana camara.* These species should be destroyed at this stage when it is still economically and scientifically feasible to eradicate them.

6.3.4 Control of IAS in BFR

Economically and environmentally friendly control measures should be applied in the control of *S. spectabilis* and other invasive species present in BFR and other areas. For *S. spectabilis*, these methods could include mechanical means by ring backing at appropriate heights (>2 meters) as well as chemical means by hack and squirt method using todon chemical. For other invasive species, customized research into their respective control measures should be undertaken.

6.3.5 Need for establishment of a national IAS coordination unit

At a national level, there is a dire need to give the problem of invasive species the special recognition and attention that it deserves considering the adverse effects on peoples socioeconomic livelihoods, the environment, biodiversity and the national economy as a whole. Invasive species need to be mainstreamed into national policies and laws such as the plant protection act, forests and tree planning act as well as the environmental protection act. Integrating of invasive species into learning institutions curriculum as well as national development frameworks such as the National Development Plan and the Plan for Modernization of Agriculture would go a long way in creating an enabling environment for proper institutional co-ordination mechanisms for ensuring that the problem of invasive species is addressed with the necessary broad, multisectoral ecosystem approach that it deserves. The first step to achieving this is the establishment of a national IAS coordination unit with proper

financing and facilitation to oversee and steer management of invasive species in the country. Uganda must emulate other countries in doing the above and this can not be overemphasized.

The whole process of IAS risk assessment, detection and rapid response, needs to be well coordinated such that there is always a surveillance system that works, funds and technical staff that are always on standby, logistics and crop protection products that can be mobilized in a very short time and the political will to mobilize the grass root farmers in the affected areas to manage the problem.

There is need for establishment and coordination of technical support from affected agencies for purposes of planning for both short and long term management programmes. During this phase; appropriate, regulatory and management action plans to be taken against invasive species can be made.

6.3.6 The role of economics in IAS management

The problem of invasive species has presented a serious challenge in an era of increased globalization and trade liberalization. The undeniable fact is that the problem has as much to do with economics as with ecology. Any solutions advanced must be firmly grounded in both ecological science and economics. Needless to say is that the economics discipline possesses the capability of valuing various market and non-market impacts and provides a means for assessing important trade-offs among various management alternatives, which can improve greatly the decision-making process for managing such problems. Also, through figures generated, it can improve the transparency of the decision making process by providing justifications for the measures implemented. However, the true value of economics should not be seen solely in the precision of the numbers generated, but also in the extent to which the discipline aids decision makers to formulate consistent and rational decisions. As was the case in South Africa the main strategic approach to raise significant funding for control programmes of IAS must be through a combination of economic argument and strong political support.

6.3.7 Further research areas

Important to note is that there is terrible need for more research on determining the real magnitude of environmental and economic losses and benefits caused by invasive

species and the possible implications on the ecosystems that they inhabit as well as on the national economy. This is necessary as an initial step towards formulation of possible control strategies that are affordable by the affected stakeholders. The desired goal would be to reduce invasive species control cost so as to enable stakeholders improve their production efficiency. This would possibly require establishment of on-farm research trials managed by both farmers and researchers. Findings of such trials can be easily disseminated and adopted by other farmers.

7.0 REFERENCES

Ahamada, Z., Kizito, S., Kiwusa, P., Mudoma, J., Mugenyi, C., (2007). Physical and mechanical properties of *Senna spectabilis* (Cassia) growing in Budongo forest reserve. National Agricultural Research Organization, Entebbe Uganda.

Balick, M. J., and Mendelsohn, R., (1992). Assessing the economic value of traditional medicine from tropical rain forests. Conservation Biology 6, 128–130.

Baskin, Y., (2002). *A Plague of Rats and Rubbervines: The growing threat of species invasions.* Washington D.C: Island Press.

Bardsley, D., Edward-Jones, G., (2006). Stakeholders´ perceptions of the impacts of invasive exotic plant species in the Mediterranean region. GeoJournal 65, 199–210.

Bardsley, D., Edward-Jones, G., (2007). Invasive species policy and climate change: social perceptions of environmental change in the Mediterranean. Environmental Science and Policy 10, 230–242.

Bertram, G., (1999). The impact of introduced pests on the New Zealand economy, 45–71. Wellington.

Bertolino, S., Genovesi, P., (2003). Spread and attempted eradication of the grey squirrel (*Sciurus carolinensis*) in Italy, and consequences for the red squirrel (Sciurus vulgaris) in Eurasia. Biological Conservation 109, 351–358.

Binggeli, P.J.B., Healey, J.R., Hamilton, C.A., (1998). Invasive woody plants in tropical Africa. ITOO working paper No. 15 (www.blackwell.sernergy.com).

Bingelli. P., Hall.B.J, Healey.J.R, (1998). Overview of invasive woody plants in the tropics. School of agricultural and forest sciences. Publication number 13. University of Wales, Bangor.

Binimelis, R., Monterroso, I., Rodrıguez-Labajos, B., (2007). A social analysis of the bioinvasions of Dreissena polimorpha in Spain and Hydrilla verticillata in Guatemala. Environmental Management 40, 555–566.

BirdLife International., (2003). *BirdLife's online world bird database: the site for bird conservation.* [Online] Available at: http://www.birdlife.org.

Bonesi, L., Palazon, S., (2007). The American mink in Europe: status, impacts and control. Biological Conservation 134, 470–483.

Booth, C.A., and Parker, P.J., (1988). Shrub invasion on sandplain country west of wanaaring New South Wales. J. Soil Conserv. (New South Wales), 37:65- 70.

Brechin, S.R., Whilshusen, P. R., Fortwangler, C., & West, P.C., (2002). Beyond the square wheel: toward a more comprehensive understanding of biodiversity conservation as social and political process. *Society and Natural Resources,* 15: 41–64.

Bremner, A., Park, K., (2007). Public attitudes to the management of invasive non-native species in Scotland. Biological Conservation 139, 306–314.

Brenan, J.P.M., (1967). Flora of tropical East Africa: Leguminous Subfamily: Caesalpiniodeae. Pg. 230.

Bright, C., (1998). Global economy spreading destructive species: The invisible threat of Bio Invasion, World watch. (http//www. worldwatch.org/node/1632).

Bright, C., (1999). *Life out of bounds: Bio-invasions in a borderless world*. London: Earth scans publications.

Bryman, A., Cramer. D.,(1997). Quantitative data analysis with SPSS for Windows: A Guide for social scientists, Routledge, New York.

Bush, G., Nampindo, S., Aguti, C. & Plumptre, A., (2004). The value of Uganda's forests: A livelihoods and ecosystems approach. Wildlife Conservation Society, Albertine Rift Programme, EU Forest Resources Management and Conservation Programme, National Forest Authority. pp. 102.

Byenkya, S. G., (2004). Impact of undesirable plant communities on the carrying capacity and livestock performance in pastoral systems of south-western Uganda. A PhD thesis submitted to Texas A&M University, United States of America.

Carey, J.R., Moyle, P.B., Rejmanek, M., & Vermeij, G.J., (1996). Invasion biology. Biol. Conserv. 78, 1-214.

Carter, J.O., (1994). *Acacia nilotica*: a tree legume out of control. In Gutteridge, R.C. & Shelton, H.M., (Eds) Forage trees as legumes in tropical agriculture, pp. 338-351. CAB International, Wallingford.

Convention on Biological Diversity (CBD)., (2002). Sixth conference of the parties, The Hague, the Netherlands, 7–19 April 2002: Decision VI/ 23. (Available at www.biodiv.org).

Convention on Biological Diversity (CBD)., (2004). Seventh conference of the parties, Kuala Lumpur, Malaysia, 9–20 and 27 February 2004: Decision VII/13: Alien species that threaten ecosystems, habitats or species (Article 8 (h)) (available at www.biodiv.org).

Chapman, C.A., white, F.J. & Wrangham, R.W., (2002). Party size in chimpanzees and bonobos: a reevaluation of theory based on two similarly forested sites. In: *Chimpanzee cultures.* Harvard University Press, Cambridge, MA.

Condon, R.W., (1968). Estimation of grazing capacity on arid grazing lands. In: Land Evaluation. Stewart, G.A.S., (Ed.). Macmillan, Melbourne, pp. 112-124.

Cock, M.J.W., (2003). Biosecurity and Forests: An introduction – with particular emphasis on forest pests. FAO Forest health and biosecurity working paper FBS/2E, 2003.

Colautti, R.I., Bailey, S.A., van Overdijk, C.D.A., Amundsen, K., MacIsaac, H.J., (2006). Characterised and projected cost of nonindigenous species in Canada. Biological Invasions 8, 45–59.

Cronk, Q.C.B., & Fuller, J.L., (1995). Plant invaders: the threat to natural ecosystems worldwide. Chapman & Hall, London.

Czech, B., & Krausman, P.R., (1997). Distribution and causation of species endangerment in the United States. *Science, 277*, pp. 116-117.

Denslow, J.S., (2002). Invasive woody species in pacific islands forests, in forest Biological diversity, Unasylva 209: 62-63).

De Poorter, M., and Browne, M., (2005). The Global Invasive Species Database (GISD) and international information exchange: using global expertise to help in the fight against invasive alien species. In: Proceedings of "Introduction and Spread of Invasive Species" IPPC, Berlin, Germany, July 2005.

Drake, J.A., Mooney, H.A., Castri, F.d., Groves, R.H., Kruger, F.J., Aejmamek, M., & Williamson, M., (1989). *Biological invasions: a global perspective*. Chichester: John Wiley & Sons.

Drake, J., di Castri, F., Groves, R., Kruger, F., Rejmánek, M., & Williamson, M., (Eds), (1989). Biological invasions, a global perspective. Wiley, Chichester.

Eggeling, W.J., (1947). Observations on the ecology of the Budongo rain forest, Uganda. *Journal of Ecology,* 34:20-87.

Ellison. E., and Murphy.S.T., (2000). A socioeconomic assessment of the impacts of *M. micrantha* in Kerala, Malaysia. (KFRI, unpublished report).

Evans, E.A., (2003). Economic dimensions of invasive species: The magazine of food, farm and resource issues: A publication of the American Agricultural Economics Association (Second Quarter 2003).

Evans, E.A., Spreen, T.H., and Knapp, J.L., (2002). Economic Issues of invasive pests and diseases and food safety: Institute of food and agricultural studies (2002) University of Florida.

Falkenberg, C.M., & Sepp, S., (1999). Economic evaluation of the forest sector in Uganda. Report for the Uganda Forest Department, Kampala.

FAO., (1988). *The Eucalyptus Dilemma*. FAO, Rome. 26pp

FAO (Food and Agricultural Organization)., (2001). The state of food and agriculture. Rome, Italy. Available online: http://www.fao.org/docrep/003/x9800e/x9800e14.htm

FAO., (2003). The status of invasiveness of forest tree species outside their natural habitat: a global review and discussion paper, by K. Haysom & S.T. Murphy. Forest Biosecurity working paper FBS/3E. Rome.

FAO., (2005). State of the world's forest report, FAO. Rome

FAO., (2004). Regional code of practice for reduced-impact forest harvesting in tropical moist forests of West and Central Africa. Rome.

Fisher, R.J., (1989). The management of forests in rural development: A Case study of Sindhu Palchowk and Kavre Palanchowk districts of Nepal. Discussion paper No. 1. Mountain populations and institutions, Kathmandu.

Fisher, E.N.N., (1999). The diet of chimpanzees in the Budongo Forest Reserve, Uganda. African Journal of Ecology, Volume 37, Pages 344-354.

Fischer, A., Young, J.C., (2007). Understanding mental constructs of biodiversity: implications for biodiversity management and conservation. Biological Conservation 136, 271–282.

Fiedler, L.P., and Kareiva, M.P., (1998). 2nd edition, Conservation biology for the coming decade, Chapman and Hall. Pg 533.

Forest Department (FD)., (1999). Forestry nature conservation master plan. Volume 1.

Geesing, D.A.M., and Abba, M.L., (2004). Management of introduced Prosopis species: can economic exploitation control an invasive species? In Forest threats, Unasylva 55(2): 36-44.

Given, R.D., (1994). Principles and practices of plant conservation, Champman and Hall, London. Pg 292.

Gitman, L.J., (2009). Principles of managerial finance. 12th Edition. Pearson International Edition, Pearson Prentice Hall.

Glowka, L., F. Burhenne-Guilmin, H. Synge, J. A. McNeely, and L. G'ndling. (1994). *A guide to the convention on biological diversity*. International Union for the Conservation of Nature (IUCN), Gland, Switzerland.

Gumisiriza, G., Irumba, D., Beine, A.P (2008 a). Assessment of the effectiveness of two control options for *Senna spectabilis* in Budongo forest reserve. National Agricultural Research Organisation, Entebbe, Uganda.

Gumisiriza, G., Beine, A.P., (2008 b). Comprehensive national awareness survey on invasive species. National Agricultural Research Organisation, Entebbe, Uganda.

Gutrich, J.J., VanGelder, E., Loope, L., (2007). Potential economic impact of introduction and spread of the red imported fire ant, Solenopsis invicta, in Hawaii. Environmental Science and Policy 10, 685–696.

Haysom, K.A., and Murphy, S.T., (2003). The status of invasiveness of forest tree species outside natural habitat: a global review and discussion paper. Forest Health and Bio-security working paper FBS/3E. Rome, FAO.

Hettinger, N., (2001). Exotic species: naturalization, and biological nativism, Environ. Values 10, pp. 193–224

Heywood, V., (1995). *Global biodiversity assessment*. Cambridge University Press, Cambridge, UK.

Higgins, S. I., Azorin, E.J., Cowling, R.M. & Morris, M. J., (1997). A dynamic ecological-economic model as a tool for conflict resolution in an invasive alien, biological control and native-plant scenario. *Ecological Economics,* 22:141–154.

Higgins, S.I., Turpie, J.K., Costanza, R., Cowling, R.M., Le Maitre, D.C., Marais, C., & Midgley, G.F., (1997). An ecological economic simulation model of mountain fynbos ecosystems: Dynamics, valuation and management. *Ecological Economics,* 22:155–169.

Hobbs, R.J., & Humphries, S.E., (1995). An integrated approach to the ecology and management of plant invasions. Conservation Biology 9(4): 761-770.

Hulme, P.E., Lloret, F., Medail, F., Brundu, G., Camarda, I., Moragues, E., Rita, J., and Lambdon, P., (2005). Species attributes and invasion success by alien plants on Mediterranean islands. *Journal of Ecology*, 93.

ICRAF, (2002). World Agro forestry Center, Tree species database, A tree species reference and selection guide http://www.worldagroforestrycenter.org/site/tree DBS/AFT AFT.htm

Jetter, K., Paine, T.D., (2004). Consumer preferences and willingness to pay for biological control in the urban landscape. Biological Control 30, 312–322.

Kaiser, J., (1999). Stemming the tide of invasive species. *Science,* 285: 1836–1841.

Kareiva, P., (1994). Diversity begets productivity. Nature 368, 686–687.

Katende, A.B., Binen, A., Tengnus, B., (1995). Useful trees and shrubs for Uganda, identification, propagation and management for agricultural and pastoral communities, regional soil conservation unit (RSCU)/ SIDA, Nairobi. Page 710.

Langoya, C.D., Long, C., (1998). Local communities and ecotourism development in Budongo Forest Reserve, Uganda. Rural development forestry network paper 22e, Winter 1997/98, ODI, Portland House, Stag Place, London SW1E 5DP

Llamas, A.K., (2003). Tropical flowering plants: A guide to identification and cultivation, Timber press, Oregon. Pg. 423.

Le Maitre, D.C., Van Wilgen, B.W., Chapman, R.A., & McKelly, D.H., (1996). Invasive plants and water resources in the Western Cape Province, South Africa: modelling the consequences of a lack of management. *Journal of Applied Ecology,* 33:161–172.

Le Maitre, D.C., Versfeld, D.B., & Chapman, R.A., (2002). The impact of invading alien plants on surface water resources in South Africa: A preliminary assessment. *Water SA,* 26:397–408.

Leung, B., Lodge, D.M., Finnoff, D., Shogren, J.F., Lewis, M.A., Lamberti, G., (2002). An ounce of prevention or a pound of cure: bioeconomic risk analysis of invasive species. Proceeding of the Royal society of London B 269, 2407–2413.

Lowe, S., M. Browne, S. Boudjelas et al. (2000). 100 of the world's worst invasive alien species. A selection from the Global Invasive Species Database. Invasive Species Specialist Group (ISSG) of the World Conservation Union, Gland Switzerland.

Mack, R.C., (1996). Predicting the fate of plant invaders: emergent and emerging approaches Biological conservation 78:107-121.

Mallik, A.U., Bell, F.W., and Gong, Y. (1997). Regeneration behavior of competing plants after cutting: implication for vegetation management. Forest ecology and management 22:1-10.

McNeely, J.A., (2001). The great reshuffling: Human dimensions of invasive alien species. IUCN, Gland, Switzerland and Cambridge, UK.

Manente, B., Fatima, C.D.L., and Machado, V.L.L., (1999). Flowering Entomofauna in Cassia spectabilis (L) D.C Leguminousae. An. Soc. Entomology Bras.28 (3): 237-242.

Marina. G., Berta. M., Gonzalez. A., Paloma. A., (2008). Social perceptions of the impacts and benefits of invasive alien species: Implications for management. Biological Conservation 141 (2008) 2969-2983.

Meffe, O.K., and Caroll, C.R., (1994). Principles of Conservation Biology, Sinnauer associates. Inc. Sunderland.

Mercer, E., Kramer, R. A. and Sharma, N., (1995). Rainforest tourism: estimating the benefits of tourism development in a new national park in Madagascar. *Journal of Forest Economics* 1, 239–269.

Ministry of Finance, Planning and Economic Development (MFPED),(2003). Progress report on Millennium Development Goals. pp. 24.

Ministry of Finance, Planning and Economic Development (2004)., Poverty Eradication Action Plan 2004/5-2007/8.

Ministry of Water, Land and Environment (MWLE)., (2001). Uganda Forest Policy. pp. 29.

Ministry of Water, Lands and Environment, (2001), The National Forestry Plan

Ministry of Water, Lands and Environment: Forest Management Plan for Budongo Forest Reserve (including Budongo, Siba, Kibingo Busaju and Kaniyo- Pabidi Blocks), Fourth Edition for period 1st July 1997 to 30th June 2007

Ministry of Water, Lands and Environment, (2001), The Uganda Forestry Policy.

Ministry of Water, Lands and Environment; The National Forestry and Tree Planting Act, 2003. UPPC, Entebbe

Ministry of Water, Lands and Environment, (2001), Forest Sector Review

Ministry of Water, Lands and Environment (2003), Guidelines for implementing collaborative forest management in Uganda.

Ministry of Water, Lands and Environment (2003), National biomass study: Technical Report.

Mooney, H. A., & Hobbs, R. J., (2000). *Invasive species in a changing world*. Island Press, Washington, DC.

Mugasi, K., (2004). An economic assessment of shrub encroachment on pastoral rangeland productivity in Mbarara district Uganda. Unpublished MSc Thesis Makerere University Kampala.

Mumford, J.D., (2002). Economic issues related to quarantine in international trade: European economics review of agricultural economics Vol. 29(3) (2002) Pp.229-348.

Mutonyi, S., (2007). Assessing the effectiveness of control methods on *Senna spectabilis* in Kibale National Park, Western Uganda. Unpublished thesis, Makerere University Kampala, Uganda

National Forestry and Tree Planting Act, (2003). Government of Uganda.

NARO., (2004). Capacity building, training needs assessment, dissemination and replication strategy for invasive plant management in Uganda. Report submitted to CABI under the PDF-B phase of the UNEP/GEF-IAS Project; Removing Barriers to Invasive Plant Management in Africa. NARO, Entebbe, Uganda.

NARO., (2004). *Implementation of invasive plant prevention and control programmes in Uganda*. Report submitted to CAB International Africa regional centre under the PDF-B phase of the UNEP/GEF-IAS Project; Removing Barriers to Invasive Plant Management in Africa. NARO, Entebbe, Uganda.

National Forestry and Tree Planting Act (NFTPA)., (2003). Entebbe, Uganda, UPPC. pp. 61.

National Forestry Authority (NFA), (2008). Forest Management Plan for Budongo Central Forest Reserve for the period 1st July 2008 to 30th June, 2018. Fifth Edition. Government of Uganda.

Nature Conservation Master Plan (1997). Uganda Forest Department.

NEMA., (1996). National Environment Management Authority: State of the Environment. Report for Uganda. NEMA, Kampala.

Odokonyero, G.G.O., (2003). A review of harvesting and timber handling practices in Uganda's natural high forests (NHF). Final report. Kampala, FRMCP. pp. 28.

Odokonyero, G.G.O., (2005). Pitsawn timber production in natural forests of Uganda. Food and agriculture organization of the United Nations, Rome. ftp://ftp.fao.org/docrep/fao/009/a0249e/a0249e.pdf.

Okurut, F.N, J.A.O. Odwee and A. Adebua., (2002). Determinants of regional poverty in Uganda. AERC Research Paper 122, Nairobi, Kenya.

Olson L. J., and Roy S., (2002). The economics of controlling a stochastic biological invasion: American Journal of Agricultural Economics 84 (Number5, 2002):113-1316.

Osmaston, H., (2000). The management of natural forest in Uganda. Consultancy report. Kampala: Natural Forest Management and Conservation Project. pp. 67.

Parker, I. M., Simberloff, D., Lonsdale, W. M., Goodell, K., Wonham, M., Kareiva, P.M., Williamson, M.H., Von Holle, B., Moyle, P.B., Byers, J.E. & Goldwasser, L., (1999). Towards a framework for understanding the ecological effect of invaders. *Biological Invasions,* 1:3–19.

Pasiecznik, N. (1999). Prosopis - Pest or Providence, Weed or Wonder Tree? European Tropical Forest Research Network Newsletter 28: 12–14.

Pasiecznik, N., P. Felker, P.J.C. Harris et al. (2001). The Prosopis juliflora- Prosopis pallida complex: A Monograph. HDRA, Coventy, UK.

PEAP., (2004). Ministry of Finance, Planning and Economic Development. Poverty Eradication and Action Plan 2004/5-2007/8.

Perrings, C., M., Williamson, E. B., Barbier, D., Delfino, S., Dalmazzone, J., Shogren, P., Simmons, and A. Watkinson., (2002). Biological invasion risks and the public good: an economic perspective: Conservation Ecology 6(1): 1. [Online] URL: http://www.consecol.org/vol6/iss1/art1/

Philip, L.J., Macmillan, D.C., (2005). Exploring values, context and perceptions in contingent valuation studies: the CV Market stall technique and willingness to pay for wildlife conservation. Journal of Environmental Planning and Management 48, 257–274.

Pimental, D., McNair, S., Janecka, J., Wightman, J., Simmonds, C., O'Connell, C., Wong, E., Russel, L., Zern, J., Aquino, T., & Tsomondo, T., (2001). Economic and environmental threats of alien plant, animal, and microbe invasions. *Agriculture, Ecosystems and Environment:* 84.

Plumptre, A. J., (1996). Changes following 60 years of selective timber harvesting in the Budongo Forest Reserve, Uganda. *Forest Ecology and Management,* 89:101-113.

Plumptre, A.J., Behangana, M., Davenport, T.R.B., Kityo, Ndombo, E., Owiuju, I., Ssegawa, P., and Eilu, G., (2003). The biodiversity of Albrtine Rift, Albertine Rift Technical Report serial No.3. World Conservation Society.

Plumptre, A., Bush, G., Nampindo, S., Aguti, C., (2006). The value of Uganda's forests. A livelihoods and ecosystems approach. Wild life Conservation Society. Albertine Rift Programme.

Polley, H. W., Johnson, H. B., & Mayeux, H. S., (1997). Leaf physiology, production, water use, and nitrogen dynamics of the grassland invader Acacia smallii at elevated CO2 concentrations. *Tree-Physiology, 17*(2), 89-96.

Pysek, P., (1995). On the terminology used in plant invasion studies. In Pysek, P., Prach, K., Rejmánek, M., & Wade, P.M., (Eds) Plant invasions, pp. 71-81. SPB Academic Publishing, Amsterdam.

Ramakrishnan, P.S., (Ed.), (1991). Ecology of biological invasion in the tropics. International Scientific Publications, New Delhi.

Richardson, D. M., (1997). Forestry trees as invasive aliens. *Conservation Biology,* 12: 18–27.

Richardson, D.M., (1998). 'Forestry trees as invasive aliens'. *Conservation Biology,* 12: 18–26.

Roslyn, Selsky, Gregory, J. Bugbee, Jason, C., White, (2000). US Geology Survey and Connecticut Department of Environment Protection. http://www.dep.state.ct.us/gis/dataguide/layers/bedrock.htm Roslyn *etal,* 2000).

Roy S. B., R. Mukherjee and Mitali Chatterjee (1992). Endogenous development in joint forest management. Journal of Indian Anthropological Society, Vol. - 27.

Roxana. J., David.W., Guenthner.,J., (2007). Assessing the economic impact of invasive species: The case of yellow starthistle (*Centaurea solsitialis L.*) in the rangelands of Idaho, USA. Journal of Environmental Management 85 (2007) 876–882

Sandlund, O.T., Schei, P.J., & Viken, A., (Eds), (1996). Proceedings of the Norway/UN conference on alien species. DN and NINA, Trondheim.

Saxena, N.C., (1997). The fuel wood scenario and policy issues in India. Food and Agriculture Organization of the United Nations, Bangkok, Thailand.

Ssembajwe W., and Banana., (1998). Paper presented at the International Association for the study of common property, British Columbia, June 10-13,
1998

Stokes, K.E., O´ Neill, K.P., Montgomery, W.I., Dick, J.T.A., Maggs, C.A., Mcdonald, R.A., (2006). The importance of stakeholder engagement in invasive species management: a cross jurisdictional perspective in Ireland. Biodiversity and Conservation 15, 2829–2852.

Swallow.B., Mwangi. E., (2008). *Prosopis juriflora* invasion and rural livelihoods in the Lake Baringo area of Kenya. Conservation and Society 6(2): 130-140, 2008.

Tewari, J.C., P.J.C. Harris, L.N. Harsh et al., (2000). Managing *Prosopis juliflora* (Vilayati Babul): A Technical Manual. CAZRI, Jodhpur, India and HDRA, Coventry, UK.

Turpie, J. & Heydenrych, B., (2000). Economic consequences of alien infestation of the Cape Floral Kingdom's Fynbos vegetation. In: C. Perrins, M. Williamson & S. Dalmazzone (eds.). *The economics of biological invasions*, Cheltenham, Edward Elgar, pp. 152–182.

Turpie, J.K., (2003). The existence value of biodiversity in South Africa: how interest, experience, knowledge, income and perceived level of threat influence local willingness to pay. Ecological Economics 46, 199–216.

Uganda Bureau of Statistics (UBOS), (1999), Uganda National Household Survey 1999/2000

Uganda Bureau of Statistics (UBOS), (2002), Uganda National Household Survey 2002/2003

Uganda Bureau of Statistics (UBOS), (2005), Uganda National Household Survey 2005/2006

Uganda Bureau of Statistics, (2007), Uganda Demographic Household Survey 2005-06

Uganda Bureau of Statistics (UBOS)., (2002). Uganda Population and Housing Census Main Report. Kampala, Uganda

Uganda Investment Authority, (2003). An investment guide to Uganda. Opportunities and conditions. The Uganda Investment Authority, Kampala Uganda.

United Nations Environment Programme (UNEP), (2003). Action Plan of the Environment Initiative of the New Partnership for Africa's Development (NEPAD), UNEP, Nairobi.

Uganda Forestry Policy, (2001). Government of Uganda.

UNEP., (2005). Implications of the findings of the Millennium Ecosystem Assessment for the future work of the convention – Addendum - Summary for decision makers of the biodiversity synthesis report. UNEP/CBD/SBSTTA/11/7/Add.1 (31 August 2005)

Van Wilgen, B.W., Bond, W.J., & Richardson, D.M., (1992). 'Ecosystem Management.' In: R.M. Cowling, (ed.), *The Ecology of Fynbos; Nutrients, Fire and Diversity*. Cape Town: Oxford University Press, pp. 345–371.

Van Wilgen, B.W., Cowling, R.M., & Burgers, C.J., (1996). Valuation of ecosystem services; A case study from South African fynbos ecosystems. *Bioscience* 46:184–189.

Van Wilgen, B.W., & Van Wyk, E., (1999). 'Invading alien plants in South Africa: Impacts and solutions'. In: D. Eldridge & D. Freudenberger, (eds.), *People and rangelands: Building the future*. Proceedings of the VI International Rangeland Congress, Townsville, Australia, pp566–571.

Vitousek, P. M., D' Antonia, C.M., Loope, L.L., Rejmanek, M., and West Brooks, R., (1997). Introduced species a significant component of human induced global change. New Zealand: Journal of Ecology, 21(1): 1-16

Waage, J., (2000). Invasive species: Ecology and global responses in invasive species in Eastern Africa proceedings of a workshop held at ICIPE, July 1999, Elizabeth E. Lyons and Scott. E. Miller (Eds.), ICIPE science press.

Wakabira, J.V., (1998). Observation on pilot control of *Senna spectabilis;* an invasive exotic tree in Mahale Mountains National Park, Western Tanzania, Pan Africa news 5(1)

Wakabira, V.J., and Mhaya, J.B., (2002). Possible control *S. spectabilis* (Caesalpininiaceae), an invasive tree in Mahale Mountains National Park, Tanzania. Oryx the International Journal of Conservation 36(4):357-363.

Waterhouse, B., (1994). Discovery of *Chromolaena odorata* in northern Queensland, Australia. Chromolaena odorata Newsletter 9, 1-2.

Wester, L.L., & Wood, H.B., (1977). Koster's curse (*Clidemia hirta*), a weed pest in Hawaiian forests. Environ. Conserv. 4, 35-41.

Williamson, M., (1996). Biological invasions. Chapman & Hall, London

Williamson, M., (1998). Measuring the impact of plant invaders in Britain. Pages 57-70 *in* U. Starfinger, K. Edwards, I. Kowarik, and M. Williamson, editors. *Plant invasions: ecological mechanisms and human responses*. Backhuys, Leiden, The Netherlands.

Wit, W.P., Crookes, D.J., & Wilgen, B.W., (2001). Conflicts of interests in environmental management: estimating the costs and benefits of a tree invasion. *Biological Invasions* 3:167–178.

Xu, H.G., Wang, J.M., Qiang, S., & Wang, C.Y., (2004). *Study of Key Issues under the Convention on Biological Diversity: Alien Species Invasion, Biosafety and Genetic Resources.* Beijing: Science Press.

Zavaleta, E., (2000). The economic value of controlling an invasive shrub. *Ambio,* 29: 462–267.

Zeppel, H., (2006). Indigenous Ecotourism Series No.3: Sustainable Development and Management.

8.0 APPENDICES

APPENDIX ONE

QUESTIONNAIRE FOR LOCAL COMMUNITIES

AN ECONOMIC ASSESSMENT OF THE IMPACTS OF INVASIVE ALIEN PLANT SPECIES ON FORESTRY PRODUCTIVITY: A CASE OF *SENNA SPECTABILIS* ON BUDONGO FOREST RESERVE IN UGANDA

Dear Respondent,

This NARO/UNEP-GEF-IAS Project sponsored study attempts to asses the impacts of the invasive (and alien) *Senna spectabilis* on the productivity of Budongo Forest Reserve (FR), the welfare of dependent stakeholders (households; timber and tourism operators) and the Ugandan economy as a whole. To do this, the study identifies and economically evaluates the major benefits and costs that stakeholders obtain from Budongo FR (especially from *Senna spectabilis*) and their distribution. The study hopes to make recommendations on appropriate policy responses to the management of this invasive alien species. This letter is to kindly request you to participate in the survey so as to assist the NARO/UNEP-GEF-IAS Project present credible and informed policy alternatives to the management of Budongo FR in Uganda and related areas. Your responses will be highly appreciated, treated with confidence and at all times data will be presented in such a way that your identity cannot be connected with any specific responses.

Respectfully,

Peter .A. Beine

Principal Researcher

1. Background information

1.1 County: ……..……

1.2 Sub-county: ……

1.3 Parish: ……

1.4 Village: ……

1.5 Forest block: ……

1.6 Forest Condition: ……

1.7 Length of interview (in minutes): ……

2 Socioeconomic Information

2.1 Sex: ……..…….....

2.2 Age: ……..……years; Don't Know

2.3 Marital status (tick):

Single: …… Married: ……. Widowed: ……

Separated: ……..… Divorced: …….

2.4 Highest level of formal education attained (tick):

None: ……..... Primary: ……. Secondary: ……

Diploma: …….. University graduate: ……..

2.5 Household size: …….……

2.6 Occupation: …….……..

2.7 Tick the class that best describes your **total** household income **per annum** (include income from all possible sources)

1= 0 – 600,000 Shs 2= >600,000Shs – 1,200,000 Shs

3 = > 1,200,000 Shs – 1,800,000 Shs 4 = > 1,800,000 Shs – 2,400,000 Shs

5 = >2,400,000 Shs 6 = Don't Know

2.8 Indicate the number of livestock your household owns in the Table below:

Code	Livestock type	Breed	Number
1	Cattle		
2	Sheep		
3	Goats		

2.9 Does all your livestock graze in Budongo FR on a daily basis throughout the year?

YES/NO N/A

2.10 What is the average **daily** amount of milk **in litres** per cow you get from each of the following cattle breeds?

Friesian: …….. Local breed: …… Cross-breeds: ……..

Other (breed and litres of milk per day): ……, Don't Know…….. N/A……

3 The utilisation of *Senna spectabilis*

3.1 If I showed you a sample (e.g. branch) of *Senna spectabilis* (local name), would you be able to identify it? YES/ NO

3.2 We are interested in establishing the **total quantities** of the products listed below that you (and your household) obtain from *Senna spectabilis* **per week** on average.

Benefit	Preferred unit of measurement	Approximate quantity extracted per week	Average price per unit
Firewood	Bundles		
Charcoal	Sacks		
Construction poles	Units		

3.3 If there are other benefits that your household obtains from *Senna spectabilis* that are not mentioned in Q3.2, please specify them in the space provided below and list them according to degree of importance.

……

……

……

3.4 Indicate whether *Senna spectabilis* negatively affects your household as proposed in the Table below. Indicate the level of severity as 1 (MILD), 2 (SEVERE) or 3 (VERY SEVERE), 101 (DON'T KNOW)

Code	Effect	YES/NO D/K	Severity
1	UnpalaTable to livestock		
2	Lowers milk quantity		
3	Lowers milk quality		
4	Poisonous to livestock		
5	Harbours dangerous animals and insects that can cause disease and attack our crops and livestock		

3.5 If there are other negative effects your household experiences from the presence of *Senna spectabilis* not mentioned in question 3.4, specify them in the space provided below and list them according to degree of importance.

……

……

……

4. The Conservation of Budongo Forest Reserve

4.1 Are you aware that Budongo FR was established to fulfil the purposes stated below?

PURPOSE	YES/NO D/K
Conserve wild animals and plants for our benefit and the benefit of future generations	
Attract tourists for our benefit and the benefit of future generations	
Supply timber for local and commercial purposes	
Supply firewood	
Supply building and construction poles	
Climate regulation	
Carbon sequestration	

4.2 If there are other purposes of Budongo FR that are not mentioned in Q4.1, please mention them in the space provided below:

……

……

……

4.3 Are you aware that *Senna spectabilis* is an invasive and alien species? YES/NO

4.4 Are you aware that the uncontrolled spread of *Senna spectabilis* may be dangerous for the conservation of Budongo FR? YES/NO

4.5 Would you feel a loss if *Senna spectabilis* was to spread to such an extent that Budongo FR loses its conservation objectives? YES/NO

4.6 Would you be interested in being part of a campaign meant to save the flora and fauna of Budongo FR from being destroyed by *Senna spectabilis*? YES/NO

4.7 You stated above that there are a number of benefits that you obtain from the presence of *Senna spectabilis* in Budongo FR.

As you may be aware, *Senna spectabilis* is an invasive alien species whose presence in Budongo FR could potentially compromises its conservation objectives. In the interest of conserving its fauna and flora, government is considering funding a program whose objective is to uproot all standing *Senna spectabilis* trees and thereby prevent its further spread. Once this is done, all the benefits that you currently enjoy from *Senna spectabilis* would be lost.

4.7A) Considering the benefits you currently enjoy from the presence of *Senna spectabilis* in Budongo FR, would you be willing to accept some monetary compensation from the government as a result of the lost benefits subsequent to uprooting *Senna spectabilis*? YES/NO

4.7B) What is the minimum amount of money (**one time payment per annum**) would you be willing to accept in compensation for the lost benefits? ..... UShs; N/A

Thank You for Your Kind Responses

APPENDIX TWO

QUESTIONNAIRE FOR TIMBER HARVESTERS

AN ECONOMIC ASSESSMENT OF THE IMPACTS OF INVASIVE ALIEN PLANT SPECIES ON FORESTRY PRODUCTIVITY: A CASE OF *SENNA SPECTABILIS* ON BUDONGO FOREST RESERVE IN UGANDA

Dear Respondent;

This NARO/UNEP-GEF-IAS Project sponsored study attempts to asses the impacts of the invasive (and alien) *Senna spectabilis* on the productivity of Budongo Forest Reserve (FR), the welfare of dependent stakeholders (households; timber and tourism operators) and the Ugandan economy as a whole. To do this, the study identifies and economically evaluates the major benefits and costs that stakeholders obtain from Budongo FR (especially *Senna spectabilis*) and their distribution. The study hopes to make recommendations on appropriate policy responses to the management of this invasive alien species. This letter is to kindly request you to participate in the survey so as to assist NARO/UNEP-GEF-IAS Project present credible and informed policy alternatives to the management of Budongo FR in Uganda and related areas. Your responses will be highly appreciated, treated with confidence and at all times data will be presented in such a way that your identity cannot be connected with any specific responses.

Respectfully,

Peter .A. Beine

Principal Researcher

1. Background information

1.1 County:……..……

1.2 Sub-county:……

1.3 Parish:…….

1.4 Village:……..

1.5 Forest condition:……

1.6 Position of respondent in the timber firm (please tick):

(1) Owner …… (2) Manager: …… (3) Employee: …….

(4) Other (specify): …….

2 *Senna spectabilis* and its impacts on Timber businesses

2.1 If I showed you a branch of *Senna spectabilis* (or local name), would you be able to identify it? YES/NO DON'T KNOW

2.2 Please indicate whether *Senna spectabilis* negatively affects your timber business as proposed in the Table below. Indicate the level of severity as 1 (MILD), 2 (SEVERE), (VERY SEVERE), 101 (DON'T KNOW)

Code	Effect	YES/NO D/K	Severity
1	Reduces the number of the desired timber tree species		
2	Reduces the size of the desired timber species		
3	Increases costs of timber production		
4	Harbours dangerous animals and insects that can cause diseases.		

2.3 If there are other negative effects your timber business experiences from *Senna spectabilis* not mentioned in question 3.4, please specify them in the space provided below:

……

……

…….

2.4 Apart from *Senna spectabilis* being a negative influence on your timber business, does your business obtain the following benefits from *Senna spectabilis*?

1) Firewood: YES/NO 2) Charcoal: YES/NO 3) Rattan: YES/NO

4) Construction poles: YES/NO 5) Medicine: YES/NO

6) 0thers (specify): ……..…..

3. Revenues and costs of timber enterprises

4.1 Do you sell the timber you harvest from Budongo FR? YES/NO

4.2 If YES to question 5.2, who are the main customers of your timber?

DON'T KNOW

……

……

……

4.3 List the different sizes of timber that you sell your products

……

……

……

4.4 Provide the information requested in the Table below for the timber sizes reported in question 5.3. The unit price refers to the average price for the last quater.

Size Class of timber and coatings:	Quantity sold in the last quarter	Unit price (Shs) in the last quarter
Timber category 1		
Timber category 2		
Timber category 3		
Ebikoko (coatings)		
Number of timber trees sawn		

4.5 Do the quantities of timber that your firm manages to harvest satisfy your planned requirements for timber at any particular time? YES/NO DON'T KNOW

4.6 If the answer to question 4.5 is NO, what in your view could be the cause of the unsatisfactory quantities of timber harvested?

1) Poor harvesting technologies: YES/NO D/K

2) *Senna spectabilis* invasion: YES/NO D/K

3) Drought YES/NO D/K 4) Licence limitations YES/NO D/K

5) High production costs YES/NO D/K

6) Others (specify): ……

4.7 In the Table below, indicate your timber enterprise expenditures for the last 12 months by the categories indicated.

Timber enterprise expenditures (Variable costs)

Items		Your expenditure in the last quarter (Shs)
Machine maintenance	Oil/Grease	
	Repairs	
	Spare parts	
	Others	
Search costs	Relocating machines	
Transport finished product to points of sale		
Labour	Road maintenance/unblocking the roads blocked by *Senna spectabilis*	
	Fuel	
	Senna spectabilis removal	
	Timber sawing	
	Tree felling/logging	
Storage costs		
Others		

Thank You for Your Kind Response

APPENDIX THREE

QUESTIONNAIRE FOR TOURISM OPERATORS

AN ECONOMIC ASSESSMENT OF THE IMPACTS OF INVASIVE ALIEN PLANT SPECIES ON FORESTRY PRODUCTIVITY: A CASE OF *SENNA SPECTABILIS* ON BUDONGO FOREST RESERVE IN UGANDA

Dear Respondent;

This NARO/UNEP-GEF-IAS Project sponsored study attempts to asses the impacts of the invasive (and alien) *Senna spectabilis* on the productivity of Budongo Forest Reserve (FR), the welfare of dependent stakeholders (households; timber and tourism operators) and the Ugandan economy as a whole. To do this, the study identifies and economically evaluates the major benefits and costs that stakeholders obtain from Budongo FR (especially *Senna spectabilis*) and their distribution. The study hopes to make recommendations on appropriate policy responses to the management of this invasive alien species. This letter is to kindly request you to participate in the survey so as to assist NARO/UNEP-GEF-IAS Project present credible and informed policy alternatives to the management of Budongo FR in Uganda and related areas. Your responses will be highly appreciated, treated with confidence and at all times data will be presented in such a way that your identity cannot be connected with any specific responses.

Respectfully,

Peter .A. Beine

Principal Researcher

1. Background information

1.1 County:……..……

1.2 Sub-county:……

1.3 Parish:…….

1.4 Village:……

1.5 Forest block:……..

1.6 Forest condition:……

1.7 Position of respondent in the tourism business (please tick):

1) Volunteer…… 2) Manager: …… 3) Employee: …….

4) Other (specify): …….

1.8 For how long have you been operating a tourism business in Budongo FR?

…… Years; Don't Know

2. *Senna spectabilis* and its impacts on tourism

2.1 If I showed you a branch of *Senna spectabilis* (or local name), would you be able to identify it? YES/NO

2.2 Please indicate whether *Senna spectabilis* negatively affects the tourism business as proposed in the Table below. Indicate the level of severity as 1 (MILD), 2 (SEVERE), 3 (VERY SEVERE) and 101 (DON'T KNOW)

Effect	YES/NO D/K	Severity
It is unpalaTable to chimpanzees and it reduces chimp population through migration, reduced birth rate and habitat alteration, which reduces the number of tourists coming to the reserve.		
It lowers milk quality of chimpanzees thus reducing the rate of survival of baby chimpanzees.		
It is poisonous to chimpanzees thus reducing their populations.		
It harbours dangerous animals and insects that can cause disease and attack chimpanzees thus reducing their populations.		

2.3 If there are other negative effects that tourism experiences from the presence of *Senna spectabilis* not mentioned in question 2.2, specify them in the space provided below:

……

……

…….

2.4 Apart from the negative impacts, please indicate whether *Senna spectabilis* positively affects tourism as proposed in the Table below. Indicate the level of importance as 1 (MILD), 2 (IMPORTANT), 3 (VERY IMPORTANT), 3 (EXTREMELY IMPORTANT), 101 (DON'T KNOW)

Code	Effect	YES/NO D/K	Severity
1	Feed for wild animals		
2	Medicine for wild animals		
3	Habitat for chimpanzees		

2.5 If there are other positive effects that tourism experiences from the presence of *Senna spectabilis* not mentioned in question 2.4 state them in the space provided below:

……

……

……

3. Budongo Forest Reserve

3.1 Is management of your tourism business aware that Budongo FR was established to fulfil the purposes stated below?

PURPOSE	YES/NO D/K
Conserve wild animals and plants for our benefit and the benefit of future generations	
Attract tourists for our benefit and the benefit of future generations	
Supply timber for local and commercial purposes	
Supply firewood	
Supply building and construction poles	
Climate regulation	
Control soil erosion	
Carbon sequestration	

3.2 If there are other purposes of Budongo FR known to tourism management and not mentioned in question 3.1, please mention them in the space provided below:

……

……

……

3.3 Is management aware that *Senna spectabilis* is an invasive and alien species? YES/NO DON'T KNOW

3.4 Is management aware that the uncontrolled spread of *Senna spectabilis* may be dangerous for the conservation of Budongo FR? YES/NO DON'T KNOW

3.5 In the opinion of your tourism management firm, would tourism experience a loss if *Senna spectabilis* was to spread to such an extent that Budongo FR loses its conservation objectives? YES/NO DON'T KNOW

3.6 Would your firm be interested in being part of a campaign meant to save the flora and fauna of Budongo FR from being destroyed by *Senna spectabilis*? YES/NO DON'T KNOW

5. Attitude towards the control of *Senna spectabilis*

5.1 In the opinion of your tourism business, has the area under *Senna spectabilis* in Budongo FR been increasing or decreasing over time? INCREASING /DECREASING DON'T KNOW

5.2 Do you believe that the more *Senna spectabilis* spreads in Budongo FR the less will be the population of chimpanzees? YES/NO DON'T KNOW

5.3 Do you believe there is a relationship between the spread of *Senna spectabilis* in Budongo FR and the number of tourists visiting the reserve per year? YES/NO DON'T KNOW

5.4 Considering the impact of *Senna spectabilis* on the revenues you obtain from tourism, do you think the species should be managed? YES/NO DON'T KNOW

5.5 If YES, how would you like to see *Senna spectabilis* managed? (Circle the number that best describes your preferences: VI=Very important; I=Important; N=Neutral; U=Unimportant; VU=Very Unimportant).

Management measure	VI	I	N	U	VU
Total Removal	1	2	3	4	5
Prevent entry into un-infested areas	1	2	3	4	5
Set up a separate forest for *Senna spectabilis*	1	2	3	4	5
Do nothing	1	2	3	4	5

5.6 Are you satisfied with the efforts currently put in place by Budongo FR management to manage and control *Senna spectabilis*? YES/NO DON'T KNOW

5.7 What else in your opinion should Budongo FR management do to enhance the effectiveness of *Senna spectabilis* management and control?

……
……
……
……

5.8 Apart from the forest reserve management, who else in your opinion should take responsibility for the management and control of *Senna spectabilis*? (Please tick)

(1) Myself…….…….. (2) Central government ……..

(3) Local government …… (4) Don't know ……..

(6) NGO (Specify)…….… (7) Parastatal (Specify)……..….

(8) Other (specify): ……

Thank You for Your Kind cooperation.

APPENDIX FOUR

FOCUSSED GROUP DISCUSSION WITH GAME RANGERS/TOUR GUIDES AND ECOLOGISTS

Trend analysis of chimpanzee population growth/decline over time with regard to Senna invasion

1. What is the estimated number of mature chimpanzees in Budongo FR?

i. *Senna spectabilis* infested…….

ii.Non infested .....

2. What is the estimated number of young chimpanzees in the forest block?

i.*Senna spectabilis* infested…….

ii.Non infested .....

3. What is the estimated birth rate of chimpanzees in the forest block?

i.*Senna spectabilis* infested…….

ii.Non infested .....

4. How many chimpanzees died in the last 12 months in this part of the forest?

i.*Senna spectabilis* infested…….

ii.Non infested .....

1=Less than 5, 2=5-10, 3=10-15, 4=15-20, 5=More than 20

5. What were the causes of the deaths? (Tick as appropriate)

i.*Senna spectabilis* infested…….

ii.Non infested .....

1=Disease, 2=Lack of pasture and water, 3=*Senna spectabilis* invasion, 4=Others (specify)…

Thank You for Your Kind cooperation

APPENDIX FIVE

NUMBER OF TIMBER TREES SAWN BY FOREST CONDITION

No. of timber trees sawn * Forest Condition Crosstabulation

Count

		Forest Condition		Total
		Infested	Not infested	Infested
No. of timber trees sawn	40.00	3	0	3
	41.00	1	0	1
	42.00	3	0	3
	43.00	5	0	5
	45.00	12	5	17
	46.00	1	2	3
	47.00	6	4	10
	49.00	2	2	4
	50.00	14	17	31
	51.00	0	1	1
	52.00	1	2	3
	53.00	0	2	2
	54.00	0	2	2
	55.00	4	2	6
	56.00	0	1	1
	57.00	1	3	4
	60.00	1	10	11
	62.00	0	2	2
	63.00	0	1	1
Total		54	56	110

APPENDIX SIX

TIMBER QUANTITIES SOLD BY CATEGORY BY FOREST CONDITION

Q4.4(4.3B QTY SOLD * Forest Condition Crosstabulation

Count

		Forest Condition		
		Infested	Not infested	Total
Q4.4(4.3B QTY SOLD	4300	2	0	2
	4770	1	0	1
	4780	0	1	1
	4870	1	0	1
	5700	0	1	1
Total		4	2	6

Q4.4 (4.3D QTY SOLD) * Forest Condition Crosstabulation

Count

		Forest Condition		
		Infested	Not infested	Total
Q4.4 (4.3D QTY SOLD)	2000	0	1	1
	2260	0	1	1
	2300	0	1	1
	2600	1	0	1
	2700	2	1	3
	2790	1	1	2
	3000	3	1	4
	3050	1	0	1
	3200	1	1	2
	3500	1	0	1
	3700	2	1	3
	3750	1	1	2
	3760	0	1	1
	3800	0	1	1
	3900	1	0	1
	4000	0	2	2
Total		14	13	27

Q4.4(4.3A QTY SOLD) * Forest Condition Crosstabulation

Count

		Forest Condition		
		Infested	Not infested	Total
Q4.4(4.3A QTY SOLD)	962	1	0	1
	1472	1	0	1
	1925	1	0	1
	1950	1	0	1
	1973	1	0	1
	2753	1	0	1
	2920	1	0	1
	3020	1	0	1
	3040	0	1	1
	3070	0	1	1
	3129	0	1	1
	3160	0	1	1
	3200	0	1	1
	3210	0	1	1
	3260	0	1	1
	3273	1	0	1
	3350	0	1	1
	3352	1	0	1
	3370	1	0	1
	3420	1	4	5
	3425	1	0	1
	3430	0	2	2
	3450	0	1	1
	3452	1	0	1
	3500	1	0	1
	3510	0	1	1
	3520	1	0	1
	3570	1	0	1
	3673	1	0	1
	3760	0	1	1
	3780	0	1	1
	3783	1	0	1
	3785	1	0	1
	3790	1	0	1
	3820	0	1	1
	3850	1	0	1
	3900	1	1	2
	3937	1	0	1
	3950	1	0	1
	4070	1	0	1
	4120	1	0	1
	4127	1	0	1
	4170	0	1	1
	4207	1	0	1
	4245	1	0	1
	4320	1	0	1
	4430	0	1	1
	4512	1	0	1
	4562	1	0	1
	4700	0	1	1
	4730	1	0	1
	4750	1	0	1
	4773	1	0	1
	4800	0	1	1
	4870	0	2	2
	4897	1	0	1
	4910	0	2	2
	5100	1	0	1
	5230	0	1	1
	5240	0	2	2
	5530	0	1	1
	5650	0	1	1
	5789	1	0	1
	5830	1	0	1
	5850	0	1	1
	5870	0	1	1
	5890	0	1	1
	6340	0	1	1
	6467	1	0	1
Total		41	37	78

Q4.4(4.3C QTY SOLD) * Forest Condition Crosstabulation

Count

		Forest Condition		
		Infested	Not infested	Total
Q4.4(4.3C QTY SOLD)	1540	0	1	1
	2000	2	1	3
	2050	1	0	1
	2150	1	0	1
	2200	1	0	1
	2260	1	0	1
	2500	1	0	1
	2600	1	0	1
	2637	1	0	1
	2650	1	0	1
	2750	1	1	2
	2785	1	0	1
	2790	1	0	1
	2805	1	0	1
	2850	2	1	3
	2900	1	0	1
	3000	3	0	3
	3050	0	1	1
	3100	0	1	1
	3120	0	1	1
	3200	1	0	1
	3210	0	2	2
	3350	0	1	1
	3400	1	2	3
	3420	0	1	1
	3450	0	5	5
	3460	0	1	1
	3500	1	1	2
	3510	0	1	1
	3600	1	0	1
	3640	0	1	1
	3700	3	0	3
	3710	1	0	1
	3790	1	0	1
	3840	0	1	1
	3970	1	0	1
	4000	1	0	1
	4120	0	1	1
	4200	1	0	1
	4230	0	2	2
	4300	1	1	2
	4320	0	1	1
	4330	0	1	1
	4340	0	1	1
	4350	0	1	1
	4600	0	1	1
	4700	3	0	3
	4750	0	1	1
	4845	1	0	1
	5430	0	1	1
	6540	0	1	1
	6700	0	1	1
Total		37	36	73

Q4.4(4.3EQTY SOLD) * Forest Condition Crosstabulation

Count

		Forest Condition		
		Infested	Not infested	Total
Q4.4(4.3EQTY SOLD)	2435	0	1	1
	2577	1	0	1
	2753	1	0	1
	3027	0	1	1
	3150	1	0	1
	3177	1	0	1
	3200	1	0	1
	3252	1	0	1
	3300	1	0	1
	3340	0	1	1
	3345	0	1	1
	3548	0	1	1
	3573	0	1	1
	3673	1	0	1
	3700	0	1	1
	3775	0	1	1
	3870	0	1	1
	3873	1	0	1
	3903	1	0	1
	3907	0	1	1
	3920	0	1	1
	4000	0	1	1
	4130	1	0	1
	4377	1	0	1
	4512	0	1	1
	4760	1	0	1
	4770	1	0	1
	4812	1	0	1
	5634	0	1	1
Total		15	14	29

Q4.4(4.3F QTY SOLD) * Forest Condition Crosstabulation

Count

		Forest Condition		
		Infested	Not infested	Total
Q4.4(4.3F QTY SOLD)	1000	1	0	1
	1140	1	0	1
	1470	1	0	1
	1505	1	0	1
	1700	1	0	1
	1730	1	0	1
	1740	1	0	1
	1870	0	1	1
	1890	1	0	1
	1980	0	1	1
	2070	1	0	1
	2100	1	1	2
	2120	1	0	1
	2250	1	0	1
	2300	1	0	1
	2340	0	1	1
	2350	0	1	1
	2370	1	0	1
	2400	0	1	1
	2450	1	1	2
	2500	2	1	3
	2600	0	1	1
	2650	0	2	2
	2670	0	2	2
	2700	2	2	4
	2750	0	1	1
	2790	0	1	1
	2860	0	1	1
	2870	0	1	1
	2890	0	1	1
	2980	0	1	1
	3000	2	0	2
	3050	0	1	1
	3240	0	1	1
	3250	0	1	1
	3450	0	1	1
Total		21	25	46

APPENDIX SEVEN

TIMBER UNIT PRICES PER TIMBER CATEGORY BY FOREST CONDITION

Q4.4 (4.3A UNIT PRICE) * Forest Condition Crosstabulation

Count

		Forest Condition		
		Infested	Not infested	Total
Q4.4 (4.3A UNIT PRICE)	3700	0	2	2
	3800	0	1	1
	4000	0	4	4
	4100	0	2	2
	4200	0	3	3
	4245	1	0	1
	4300	0	1	1
	4400	1	0	1
	4500	6	1	7
	4560	1	0	1
	4570	0	1	1
	4600	0	1	1
	4700	6	4	10
	4750	2	0	2
	4780	1	0	1
	4790	1	0	1
	4800	1	1	2
	4900	2	4	6
	5000	14	12	26
	5100	1	0	1
	5200	1	0	1
	5300	2	0	2
	5400	1	0	1
Total		41	37	78

Q4.4 (4.3B UNIT PRICE * Forest Condition Crosstabulation

Count

		Forest Condition		
		Infested	Not infested	Total
Q4.4 (4.3B UNIT PRICE	2000	0	1	1
	2300	0	1	1
	2450	1	0	1
	2650	1	0	1
	2700	1	0	1
	3000	1	0	1
Total		4	2	6

Q4.4 (4.3C UNIT PRICE) * Forest Condition Crosstabulation

Count

		Forest Condition		
		Infested	Not infested	Total
Q4.4 (4.3C UNIT PRICE)	700	1	0	1
	3000	2	3	5
	3100	1	2	3
	3150	1	0	1
	3200	5	3	8
	3250	2	0	2
	3400	0	6	6
	3450	2	3	5
	3500	9	11	20
	3550	1	0	1
	3600	2	2	4
	3700	2	0	2
	3750	1	0	1
	3800	0	1	1
	4000	6	2	8
	4050	1	0	1
	4100	0	3	3
Total		36	36	72

Q4.4 (4.3D UNIT PRICE) * Forest Condition Crosstabulation

Count

		Forest Condition		
		Infested	Not infested	Total
Q4.4 (4.3D UNIT PRICE)	5000	0	1	1
	5250	1	0	1
	5300	1	0	1
	5700	2	0	2
	5750	3	0	3
	5800	1	0	1
	5900	1	2	3
	6000	3	7	10
	6100	0	1	1
	6200	0	1	1
	6300	1	0	1
	6500	1	1	2
Total		14	13	27

Q4.4(4.3E UNIT PRICE) * Forest Condition Crosstabulation

Count

		Forest Condition		
		Infested	Not infested	Total
Q4.4(4.3E UNIT PRICE)	4300	1	0	1
	4500	0	1	1
	4570	0	1	1
	4700	2	1	3
	4750	0	1	1
	4900	1	3	4
	5000	5	5	10
	5100	3	0	3
	5200	1	0	1
	5250	0	1	1
	5300	1	1	2
	5350	1	0	1
Total		15	14	29

Q4.4(4.3F UNIT PRICE) * Forest Condition Crosstabulation

Count

		Forest Condition		
		Infested	Not infested	Total
Q4.4(4.3F UNIT PRICE)	5700	1	0	1
	5900	2	1	3
	6000	5	1	6
	6300	1	0	1
	6400	2	0	2
	6500	3	2	5
	6700	1	4	5
	6750	1	1	2
	6800	1	0	1
	6900	0	2	2
	7000	4	11	15
	7100	0	1	1
	7150	0	1	1
	7500	0	1	1
Total		21	25	46