INVASIVE SPECIES IN EAST AFRICA: CURRENT STATUS FOR INFORMED POLICY DECISIONS AND MANAGEMENT

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Abstract
Invasive alien species are the second leading cause of biodiversity loss in the world today. A number of hypotheses have been advanced to explain the proliferation of invasive species. These hypotheses include deficiency of natural enemies in the introduced range, increased competitive ability, increased resource availability and emergence of more vigorous genotypes in the introduced range. In East Africa policy gaps that range from lack of information on invasive species management to how the available information is managed exist. Major gaps include, a deficiency in the number and interest of scientists studying invasion species biology, which subsequently leads to lack of interest in the learning institutions, severe deficiency in predictive and monitoring capacity, lack of coordinated control measures, and poor preparation in government departments. This report serves to identify the major gaps and provide information to assist in the prioritization and optimization of invasive species control and management. It recommends a need for scholars and institutions to develop curricula and recruit more scientists in this discipline. It also recommends an integrative approach, regional coordination and collaboration including sharing of information in an easy and practical language. The review further encourages the government and development agencies at the national and the local level to provide funding and incentives for low and localized programs to slow the spread of existing invasive species in order to protect the yet uninvaded ecosystems. The adaptation of these recommendations will result to control strategies and policy framework based on sound empirical information It is expected that the report will be valuable for land, environmental managers and other stakeholders.

Key words: Invasive species, East Africa, policy, management

1.0 Introduction

Invasive species are the second leading cause of biodiversity loss worldwide (Wilcove *et al.,* 1998, Gaertner *et al.,* 2009). Invasive alien species have the ability to alter ecosystem processes (Ehrenfeld, 2010), decrease native species abundance (Blackburn *et al.,* 2004, Gaertner *et al.,* 2009), change community structure (Hejda *et al.,* 2009) and alter genetic diversity (Ellstrand and Schierenbeck, 2000). A huge number of individuals and species are transported across biogeographical barriers every day but only a small fraction of those transported species become established (Mooney and Cleland, 2001).

Invasive species can cause severe detrimental effects to local ecosystems. Although the origins and pattern of introduction of invasive species into East Africa are not well known, research on invasions is limited though virtually all countries in the region are affected by the problem. Information by the World Conservation Union (IUCN) identified 35 invasive alien species in Kenya (nine of which are plants) and 22 in Ethiopia and reported that in some countries there may be under-reporting of the incidence of invasive alien species (IUCN/SSC/ISSG, 2004). No other comprehensive data is available for scrutiny since then.

Plants identified as major invasive plant species especially in Kenya include the water hyacinth (*Eichhornia crassipes*), *Prosopis* spp., water fern (*Salvinia molesta*), wild garlic (*Allium vineale*), prickly pear (*Opuntia* spp.), mexican marigold (*Tagetes minuta*), lantana (*Lantana camara*), and morning glory (*Ipomoea* spp.) while animal species include the Nile Perch *(Lates niloticus),* Indian house crow (*Corvus splendens)*, and house sparrow (*Passer domesticus).* Alien species, such as cane toad *(Bufo marinus)* and bitter bush *(Chromolaena odorata)* have been used for biological control and as an ornamental, and then subsequently become invasive (Chenje and Mohamed-Katerere, 2006). Limited research input has concentrated on only a few species (Kedera and Kuria, 2003). In the forest sector, *Eucalyptus* spp. has proved to be important sources of pulp, timber and fuelwood, yet at the same time they have placed tremendous strain on water resources. These species are the backbone of plantation forestry, yet at the same time they may be decimating land and water resources (Neville *et al.,* 2003). *Prosopis spp.* were introduced into the East African region's semiarid systems through rehabilitation and afforestation projects (Mwangi and Swallow, 2005). The origins and pattern of introduction of these species are however not well known as it clearly existed before the large-scale introductions that occurred in the 1980s (Tessema, 2012). The tree has detrimental effects to local plant species richness at high densities (Gichua *et al.,* unpublished data).

The Nile perch was introduced to Lake Victoria, Africa in 1954 to ameliorate the rapid drop in native fish stocks caused by over-fishing (Lowe *et al.,* 2000). It has contributed to the extinction of more than 200 endemic fish species through predation and competition for food. The flesh of Nile perch is oilier than that of the

local fish, so more trees were felled to fuel fires to dry the catch. The subsequent erosion and runoff contributed to increased nutrient levels, opening the lake up to invasions by algae and water hyacinth *(Eichhornia crassipes)* (Lowe *et al.,* 2000). Consequently, the introduction of water hyacinth *(Eichhornia crossipes)* into Lake Victoria has reduced the production and quality of fish, obstructed waterways and boat movement, damaged water supply intakes, contributed to the spread of water-borne diseases and increased water loss through evapotranspiration (Kasulo, 2000). At the same time, the Indian house crow has destroyed the habitat of many other birds in the Tanzanian capital, Dar es Salaam, and there are now fears that only a few other common bird species remain (Howard, 2003). This bird kills other species, destroys nests, and steals eggs and chicks of the domestic chicken. It also spreads disease and is generally a serious pest in towns along the coast of Eastern Africa (Howard, 2003). A comprehensive program that stimulates the discourse on invasive species is therefore lacking and hence coordination of control efforts amongst scholars and other stakeholders is wanting.

There has been minimal effort to try and understand invasive biology in the East African context. Policy gaps range from lack of information to how the available information is managed. The purpose of this document is to identify the major gaps and provide information to assist in the prioritization and optimization of invasive species control and management for land and environmental managers.

2.0 Hypotheses regarding plant Invasions

In any one ecosystem at the global scale, there is likely to be more than one mechanism to explain invasion success of a species (Blumenthal, 2005). A number of hypotheses have been proposed to explain why species become invasive in any ecosystem. These include:

a) Enemy Release Hypothesis (ERH)

The ERH states that plant species, when introduced to an exotic region, they should experience a decreased of herbivores and other natural enemies, resulting in an increase in distribution and abundance. This hypothesis is based on the observation that natural enemies are important regulators of plant populations, and that plants are able to capitalize on a reduction in enemy regulation, resulting in increased population growth (Keane and Crawley, 2002). There is no information in literature to confirm the presence of natural enemies of invasive species in East Africa as described above.

b) Evolution of Increased Competitive Ability (EICA)

EICA hypothesis predicts improved competitive ability through a shift in allocation from defence to growth (Blossey and Notzold, 1995). The hypothesis predicts that, under identical growing conditions, individuals of a species taken from an area where they have been introduced will produce more biomass than individuals taken from the species native range. It predicts that in the absence of herbivores,

costly chemical defences should be reduced in invasive plants. In addition, this loss should increase host plant quality to herbivores. (Blossey and Notzold, 1995). Higher performance has been observed in several invasive species (Blossey and Notzold, 1995, Willis and Blossey, 1999, Siemann and Rogers, 2001, Leger and Rice, 2003, Wolfe *et al.,* 2004) but not in others (Willis *et al.,* 2000, Vilà *et al.,* 2003, Maron *et al.,* 2004) and in some cases invasive populations even showed decreased competitive ability (Van Kleunen and Schmid, 2003, Bossdorf *et al.,* 2004). In general, EICA hypothesis is rarely convincing in explaining the success of exotic species (Orians and Ward, 2010).

c) Novel Phytochemistry

Invasive species may sometimes become invasive because they possess novel biochemical weapons that function as unusually powerful allelopathic agents, or as mediators of new plant–soil microbial interactions (Callaway and Ridenour, 2004). The possession of novel weapons by some plant invaders provides them with an advantage that arises from regional differences in coevolutionary trajectories (Thompson, 1999). Callaway and Ridenour (2004) proposes that the reason why there are different regional evolutionary pathways may be the huge number of different biochemicals produced by plants, which so far have been identified to be over 100 000, many of which appear to be species-specific (Bais *et al.,* 2003). No data exists about uniquely constituted novel weapons in the East African region.

d) Appearance of More Vigorous Genotypes

When invasive species are introduced they must survive, establish themselves, spread and replace the native species. The genetic principles that may help us predict whether or not a non-indigenous species will pass through these stages to become invasive are the same principles that apply to the conservation of species and populations threatened with extinction. These are genetic drift and the effects of small populations, gene flow and hybridization, and natural selection and adaptation (Kolar and Lodge, 2001). Propagule pressure has therefore emerged as the most important factor for predicting whether or not a non-indigenous species will become established. Propagule pressure includes both the number of individuals introduced and the number of release events (Kolar and Lodge, 2001). Recent investigation (Gichua M., *et al.,* unpublished data) on *P. juliflora* has not revealed evidence of diversely spread gene pools as a result of propagule pressure.

e) Increased Resource Availability

The resource hypothesis suggests that plant invasion is caused by availability of resources such as light, water, and soil nutrients (Davis *et al.,* 2000). Resources become available when resource supply increases, as with atmospheric nitrogen deposition, or when resource capture by other plants decreases, as with disturbances such as fire or ploughing (Blumenthal, 2005). This hypothesis is likely to apply to the region since it has not been exempted from disturbance regimes.

f) The Role of Disturbance

Disturbance is commonly implicated in exotic plant invasions (Levine and D'Antonio, 1999, Lodge, 1993, Burke and Grime, 1996). Although the mechanism by which disturbance facilitates invasion is rarely investigated, it may be due to reduced competition, higher resource availability, and/or increased propagule pressure (Hobbs and Huenneke, 1992, Davis *et al.,* 2000). Furthermore, changes in the severity, frequency, and type of disturbance could alter community susceptibility to invasion (Hobbs and Huenneke, 1992). In all probability, East Africa is a region where all such dynamics are highly likely to occur.

3.0 Identified gaps in East Africa

The major gaps that hinder the management of invasive species include:

a) Limited interest from the scientific community to address the invasive species. Very few scientists have an interest in this discipline and there are actually no programs specifically designed to tackle the challenge of invasive species (Board, 2005). Additionally, few studies have been done in East Africa on the taxonomy and ecology of invasive species and the impacts they have had on the local ecosystem (Gurevitch and Padilla, 2004, Muturi *et al.,* 2010).

b) No institution of higher learning in East Africa has embraced and incorporated invasive species biology in its curriculum despite its importance in biodiversity conservation and ecosystem integrity (NEMA, 2009).

c) Limited capacity to recognize known invasive species due to limited taxonomic knowledge and experience to know the native flora and so to recognize non-native species is also a major hindrance (M.A., 2005). More and more science students are no longer interested in classical taxonomic disciplines.

d) Poor predictive capacities since the limited control measures that are going on are based on studies that have been carried out elsewhere. Predicting invasions based such studies may not be effective as experience has shown (Holle and Simberloff, 2005, Theoharides and Dukes, 2007).

e) Most of the control measures are haphazard and severely disintegrated. The mechanical control of the water hyacinth in Lake Victoria for example is usually dependent on the availability of funds or political goodwill (Kateregga and Sterner, 2007). There is a need to identify and understand the best and most fool-proof control strategies.

f) Local human communities respond to the threat of alien invasive species based on their cultural experiences and the desire to reap gains immediately after introduction (Mwangi and Swallow, 2005). The positive gains that could take time to be achieved and hence help in the control are

thus missed out for long periods of time. The exploitation of *Prosopis* spp. took more than 30 years to gain acceptance in Kenya (Choge *et al.,* 2009, Tessema, 2012, Jama and Zeila, 2005).

g) The policy environment in East Africa does not fully enhance the capacity to respond to and manage invasions (Okello and Kiringe, 2004). The institutions that are mandated with the management of invasive species are deficient of highly specialized personnel and they are underfunded (Nnadozie,2003).

4.0 Policy Recommendations

a) Since invasive species are one of the leading causes of biodiversity loss, there is a need to generate interest in the scientific community by training more specialists in the area and organize meetings, workshops and conferences that will highlight the need to elevate this subject as a core discipline for emerging scientists.

b) There is a need for institutions in East Africa to embrace and incorporate invasive species biology as a core course in their curriculums right from the entry level where students can appreciate the importance of biodiversity conservation and ecosystem integrity even before they get into their narrower specializations.

c) There is a need for better and wider quantification and measurement of how invasive species interact with our local environments. As a result, control measures can be designed based on empirical information. Studies of the population biology of invasive species may allow a more precise focus on specific characteristics involved in invasiveness.

d) As the above hypotheses indicate, it is useful to consider an integrative approach when studying plant invasions. These must be combined with rigorous field observations and experiments. Preventing the importation of non-indigenous species in the first place is an important tool to invasive species management, but we also need a strategy to effectively contain harmful non-indigenous species once they have become firmly established. This approach is believed to be the most cost-effective and environmentally-sound approach as once an invasive species becomes established, eradication may be impossible and ecological damage irreversible.

e) There is a serious need for policy makers and the scientific community to communicate the information that can be useful to local communities in a language that is easy and practical. It is important to recognize that most invasive species will never be eradicated and hence the local communities must learn to live and if possible exploit the positive attributes of such

species. Management strategies and policy framework based on sound empirical information are necessary. With such information, some benefit may accrue from the exploitation of these species.

f) Studies designed to evaluate the interactive effects of resource enrichment and resident diversity on community invasibility are lacking, and such studies are needed to identify the relative importance of key factors in promoting invasions.

g) The government and other development agencies have the responsibility both at the national and the local level to provide funding and incentives for low and localized programs to slow the spread of existing invasive species in order to protect the yet uninvaded ecosystems. There is also a need to establish an Invasive Species Management Centre in order to coordinate and lead improvements in policies on invasive species. Policy frameworks are needed that support alliances among the many interest groups involved in invasive species management.

h) Since invaders do not know natural boundaries, there is also a need for regional coordination and collaboration in addressing invasion issues in research, control, eradication and monitoring.

5.0 Conclusion

The solution to the problem of alien invasive species will come from local and national actions with regards to early warning systems, eradication and control attempts as well as increased awareness and political will. Although not all alien species will become invasive or threaten the environment, this is an area in which a clear policy approach is necessary because of its potentially wide-ranging negative impacts when they do become invasive, and because of the difficulties, including financial costs, in reversing its impacts. It is also clear that introduced species may have many positive impacts to local communities to sustainable development in general if they are regulated properly. Such conflicts of interest require a balanced analysis of the costs and benefits of the introduction of alien species which will help strengthen policy and management decisions, in particular those dealing with international trade and pest suppression efforts. In East Africa presently, there is a very limited policy environment to act quickly to suppress new invasions as well as the capacity to do so and relevant stakeholders need to see this as an urgent priority.

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