

## Introduced Species and their Effects on Biodiversity Conservation in Africa

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**Abstract:** Exotic/Introduced species has been spread all over the world either deliberately or accidentally and have no doubt contributed both positively and negatively to human existence over the years. So many of these introduced species became invasive in their introduced range. Ecologically and economically, the impacts of introduced/invasive species pose a threat, not only on our biodiversity, but also on human existence itself. It will be a double disaster if man does not recognize this disaster and harness its resources in order to curtail the menace. Control of alien species has been recommended by both theoretical and field conservationists. However, in order to be able to control invasive species effectively, prevention of any other introduction must be effected. Keeping potentially damaging invaders out is the most cost-effective way to deal with introduced species. Targeting common pathways by which invaders reach our shores can slow or stop their entry. As important as the need for control of Introduced/invasive species is, care must be taken on how and which method(s) of control is used at a particular time and in a particular situation for a particular species, so as to prevent any complication as much as possible. The paper therefore highlights few examples of introduced species in Africa, their impact, as well as ways of controlling them.

**Key words:** Threat, accidental introduction, deliberate introduction, invasive species, alien.

### INTRODUCTION

A species is considered as introduced (non-indigenous, alien or exotic) in a certain geographical area, if that area is outside the species' native/natural distribution range. Most introduced species have negative impacts on the environment, agriculture, as well as animal and human health in their introduced ranges. The effects of a species introduction are usually unpredictable, as the new species has to adapt to conditions that may differ completely from those in its native range (Shoko, *et al.*, 2005).

There are many ways in which the introduction of non-native or exotic species negatively affects our environment and the diversity of life on our planet (Clavero and Garcia-Berthou, 2005). The statistics are startling and more attention must be paid to the problem and devising timely solutions. Invasive species cause more damage than some pollutants. Almost half of the native species in America are endangered because of invasive species.

Compared to other threats to biodiversity, invasive alien species ranks second only to habitat destruction, as the cause of extinction globally (McGinley and Duffy, 2012). Of all 1,880 imperiled species in the United States, 49% are endangered because of introduced species alone or because of their impact combined with other forces. Furthermore, introduced species were a greater threat to native biodiversity in the US more than pollution, harvest, and disease combined (Simberloff, 2000; McGinley and Duffy, 2012). While some introduced species are beneficial as source of food and pets (Fritts and Rodda, 1998; Ricciardi and Rasmussen, 1998), majority others

incur severe damage to agriculture, forestry, fisheries, and other human enterprises, resulting in an enormous economic cost. Despite the growing evidence of the economic impacts of invasive species, the level of awareness amongst decision-makers is still relatively low. It is therefore critical that such assessments be expanded and methodological tools disseminated in order to provide the basic data and information necessary for informed decision-making regarding the prevention, eradication and control of invasive species.

### THREATS POSED BY INTRODUCED SPECIES ON BIODIVERSITY

Invasive animals may influence the native fauna –

- i.) By direct predation (Fritts and Rodda, 1998; McGinley and Duffy, 2012).
- ii.) By habitat modification and environmental degradation. Economic problems due to damage to trees and agricultural crops e.g grey Squirrels (*Sciurus carolinensis*) in Northern Italy (Bertness, 1984).
- iii.) By introducing pathogens and diseases which the indigenous species is not adapted to (McGinley and Duffy, 2012).
- iv.) By interference or exploitative competition for limited resources (Human and Gordon, 1996; Byers, 2000).
- v.) By hybridizing with local communities (McGinley and Duffy, 2012).
- vi.) By poisoning native predators that attempt to consume them (Doody *et al.*, 2006; McGinley and Duffy, 2012).

- vii.) By causing a Cascade effect, which occur when the local extinction of one species significantly changes the population sizes of other species, potentially leading to other extirpations (Olsen *et al.*, 1991).
- viii.) By leading to Hyper-predation process whereby introduction of a prey species induces an increase of the introduced predators beyond a level that can be sustained by an ill-adapted indigenous species (Courchamp *et al.*, 1999)

## MODES OF INTRODUCTION OF EXOTIC SPECIES

**a) Deliberate introduction** Humans have spread alien species all over the world to serve one or more of the following purposes-

- 1) Pleasure e.g as pets
- 2) Livestock i.e as source of food and meat
- 3) Animal exhibition e.g in zoos
- 4) Wildlife products e.g skin, fur etc
- 5) Aesthetic values
- 6) Sports e.g in circus
- 7) Sport hunting e.g Rabbits were introduced into Australia for the purpose of sport hunting
- 8) Pest control e.g Cane toad (*Bufo marinus*) was introduced into Australia to control sugar cane pest (Boland, 2004), Mosquito fish (*Gambusia affinis*) to control mosquitoes.
- 9) Introductions or translocations of species have also been proposed in the interest of genetic conservation, advocating the introduction of new individuals into genetically starved populations of endangered species (Moritz, 1999).

**b) Accidental introduction** Some animals have been introduced into some areas accidentally in the following ways-

- a) Escaped pets e.g cats and dogs from human migrants and explorers
- b) Escaped pests e.g rats from migrants' luggage and ships
- c) Migrants' livestock
- d) Escape from zoos
- e) Frogs and other small/tiny reptiles, insects, fertilized eggs of insects, and spores of plants imported along with ornamental plants.
- f) Many species have dispersed across the world on trains and boats and planes. The brown tree snake, for example, was accidentally carried from New Guinea to Guam on a military cargo ship at the end of World War II. As the snake rapidly overspread the island, the native birds went into a catastrophic decline (Encarta, 2008).

## LIST OF SOME INTRODUCED SPECIES AROUND THE WORLD

**Australia:** Brown hare (*Lepus europaeus*), Common starling (*Sturnus vulgaris*), Mallard (*Anas platyrhynchos*), Feral Pigeon (*Colomba livia*), Brown trout (*Salmo trutta*), Mosquitofish (*Gambusia affinis*), Western honeybee (*Apis mellifera*), Domestic Asian Water buffalo (*Bubalus arnee*), House Cat (*Felis catus*), Black rat (*Rattus rattus*), Brown rat (*Rattus norvegicus*)

**United States:** Rhesus Macaque (*Macaca mulatta*), Wild Boar (*Sus scrofa*), Sika Deer (*Cervus nippon*), Barbary Sheep (*Ammotragus lervia*), House Mouse (*Mus musculus*), Black rat (*Rattus rattus*), Brown rat (*Rattus norvegicus*), Chukar (*Alectoris chukar*), Eurasian Collared-Dove (*Streptopelia decaocto*), Eurasian Tree Sparrow (*Passer montanus*), European Starling (*Sturnus vulgaris*), Gray Partridge (*Perdix perdix*), Himalayan Snowcock (*Tetraogallus himalayensis*), House Sparrow (*Passer domesticus*), Monk Parakeet (*Myiopsitta monachus*).

**Asia:** Common Raccoon (*Procyon lotor*), American Mink (*Mustela vison*), Muskrat (*Ondatra zibethicus*), Nutria (*Myocastor coypus*), European Rabbit (*Oryctolagus cuniculus*).

**Africa:** Table 1 presents some of the introduced species in Africa and their environmental impact.

### Specific Examples of Invasive Species and their Impact on Biodiversity

The following are few examples of introduced species and their impact in Africa and some other parts of the world-

#### Cane Toad (*Bufo marinus*)

**Original Distribution:** The cane toad (*Bufo marinus*) is a native of Mexico, Central America and tropical South America. According to Eastale (1981) they were introduced to over 90 areas throughout the Caribbean and Pacific () and to Australia in 1935 in an attempt to control sugar cane crop pests (Freeland, 1985). By 1937, thousands of toadlets had been released across much of eastern Queensland.

**Current Distribution:** The cane toad has been steadily colonising the Australian mainland ever since, and now occurs throughout more than 50% of Queensland (Eastale *et al.*, 1985; Freeland and Martin, 1985; Seabrook, 1991; Sutherst *et al.*, 1995).

**Threats:** Cane toads opportunistically prey upon a wide range of vertebrates, including small birds.

Cane toads have been seen preying upon the fledglings of ducks, chickens (*Gallus gallus*) (Werren and Trenerry, 1993)'. Further, analyses of stomach contents have revealed feathers, as well as the bones from the legs and wings of chickens. Cane toads are also known to consume small mammals (Grant, 1996). Cane toads have also been observed feeding upon amphibians and reptiles (Evans and Lampo, 1996), including anurans native to Queensland (Freeland *et al.*, 1986; Werren and Trenerry, 1993), skinks, geckos (Grant, 1996) and several species of small snakes. Cane toad in Queensland was recently

observed catching and consuming brown tree snake (*Boiga irregularis*) that measured approximately 50 cm in length (Caudell *et al.*, 2000). It also consumes the Keel back snake (*Tropidonophis mairii*) [The only known snake that can eat a toad and survive (Figure 1)] (Figure 2) Table 2 shows that cane toad accounts for the highest percentage (33%) of the threats on the nestlings of Rainbow bee-eater (*Merops ornatus*)

Effect of invasive/introduced Cane toads (*Bufo marinus*) on Rainbow bee-eater (*Merops ornatus*)

Table 1: Some introductions in Africa and their environmental impact

Introduction	Environmental Impact
<i>Lates niloticus</i> to lake Victoria, East Africa	Caused the extinction or near-extinction of hundreds of native species
<i>Oreochromis niloticus</i> to Kenya	Displaced endemic <i>Oreochromis esculentus</i> in Lake Victoria
<i>Tilapia zillii</i> to Uganda	Displaced <i>Oreochromis variabilis</i> in Lake Victoria
<i>Osphronemus goramy</i> to Mauritius	Naturalized, minimal
<i>Oreochromis macrochir</i> and <i>Tilapia rendalli</i> to Cameroon	Naturalized, unknown
<i>Cyprinus carpio</i> to Kenya	Displacement of local species
<i>Cyprinus carpio</i> to Zambia	Not established
<i>Cyprinus carpio</i> to Malawi	Not established
<i>Cyprinus carpio</i> to Zimbabwe	Naturalized
<i>Oreochromis niloticus</i> to Zimbabwe	Introgression and reduced catches of indigenous tilapias
<i>Clarias gariepinus</i> to Cameroon	Naturalized
<i>Carassius auratus</i> to Madagascar	May have introduced parasites
Chinese carps to Ethiopia	Reportedly naturalized
<i>Ctenopharyngodon idella</i> to South Africa	Introduced fish tapeworm
<i>Cyprinus carpio</i> to Madagascar	Naturalized
<i>Cyprinus carpio</i> to South Africa	Reduced catches of local species; introduced 7 exotic parasites
<i>Heterotis niloticus</i> to Côte d'Ivoire, Cameroon, CAR, Gambia, Congo	Naturalized
<i>Oncorhynchus mykiss</i> to Morocco	Unknown
<i>Salmo trutta</i> to South Africa	Eradication of local species
<i>Oreochromis niloticus</i> to Madagascar	Genetic introgression and replacement of local species

Adapted from: Brummet 2002

Table 2: Rainbow bee-eater nest outcomes combined over three breeding seasons

Nest outcome	Frequency
Cane toad predation	107 (33%)
Fledged young	85 (26%)
Dingo predation	54 (16%)
Lace monitor predation	25 (8%)
Complete egg failure	20 (6%)
Complete brood reduction	13 (4%)
Nest collapse	12 (4%)
Antechinus predation	9 (3%)
Adult mortality	4 (1%)

Source: (Boland, 2004)



Figure 1: Keelback snake (*Tropidonophis mairii*) eating a toad. They are the only species of snakes that can eat a toad and survive [Source: Wilson, 2008].



Figure 2: Alien vs predator ... the cane toad, an introduced pest, eating its predator the Keel back snake. Picture: Ian Morris / Northern Territory News [Source: Cavanagh, 2008]. Alien vs predator as cane toad eats keelback snake (*Tropidonophis mairii*) Cane toad has taken revenge on the only snake that can eat them and survive. The Keelback snake is a known predator of the introduced pest, but as this amazing photo shows the tables have been turned. The Keelback is a freshwater snake and is the only snake known in Australia that can eat cane toads and survive.

#### **African Clawed Frog (*Xenopus laevis*)**

**Original Distribution:** According to Willigan (2001), the African clawed frog is native to the sub-Saharan Africa. Its range includes Cameroon and Nigeria. The African clawed frog is an air breathing aquatic frog that occurs in virtually every body of water in its native range. They are most commonly found in stagnant or still waters of ponds or sluggish streams.

**Current Distribution:** African clawed frogs currently inhabit three of the world's five Mediterranean climate regions, including the Cape of Africa, Southern California, and Chile. In the United States, African clawed frog populations have been reported in 11 states, including Arizona, California, Colorado, Florida, Louisiana, Nevada, New Mexico, North Carolina, Virginia, Wisconsin, and Wyoming (Willigan 2001).

**Mode(s) of Introduction:** The frogs were intentionally released from laboratories around the world when new technologies for pregnancy diagnosis were developed in the late 1950's.. African clawed frogs used in cell and molecular biology research laboratory might have also escaped into the wild.(Willigan (2001)).

**Threat(s):** According to Willigan (2001), in California, virtually ideal climate conditions have enabled the African clawed frog to establish large and extremely dense populations. It has been identified as an exotic predator of the endangered California red-legged frog (*Rana aurora draytonii*) and may also threaten the endangered unarmored threespine stickleback (*Gasterosteus aculeatus williamson*).

#### **CONTROL OF INTRODUCED SPECIES**

In order to be able to control invasive species effectively, prevention of any other introduction must be effected. Keeping potentially damaging invaders out is the most cost-effective way to deal with introduced species. Targeting common pathways by which invaders reach our shores can slow or stop their entry. Ship ballast water, wooden packing material, and horticultural plants are three prominent pathways for invasion that could all be monitored or treated more rigorously. A species that is introduced despite precautions can sometimes be eradicated, especially if discovered quickly. In the United States, a Giant African snail population was eliminated by a long campaign in Florida (Simberloff, 2000). Control of alien species has been recommended by both theoretical and field conservationists. Rabbit control methods are becoming increasingly efficient, and rabbits have been eradicated, by one method or another, from at least 87 islands (Flux, 1993). Successful cat eradication has been reported for several islands (Domm and Messersmith, 1990), including large ones, such as the 29 000 ha Marion Island (Cooper, 1995).

## Control methods and their limitations

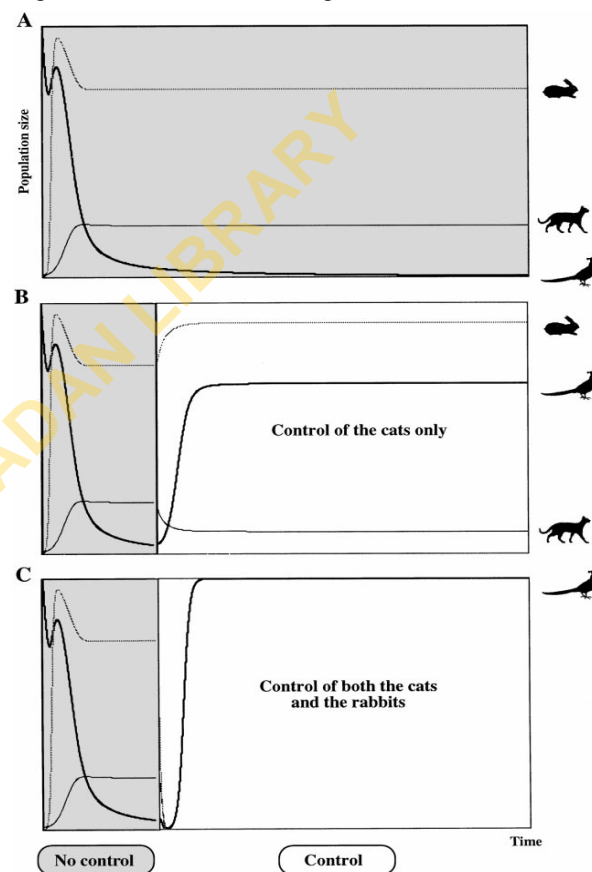
- i. **Biological control:** This entails introducing a natural enemy usually from the native range of the introduced pest. The prickly pear cactus from the Americas is well controlled on hundreds of thousands of square miles of Australian rangeland by caterpillars of a moth introduced from South America (Simberloff, 2000). *Falconia intermedia* and *Ophiomyia camarae* had been used in the bio-control of *Lantana camara* (An invasive plant) (Matthews and Brand, 2004)
- ii. **Chemical control:** involves using a pesticide, such as an herbicide or insecticide. Although chemicals can effectively control some species they may have non-target impacts, they are often expensive, and pests can evolve resistance to them (Simberloff, 2000). The common carp (*Cyprinus carpio*) had been controlled by the use of rotenone, a natural chemical extracted from the stems and roots of several tropical plants. It acts by being absorbed through the gills and inhibiting oxygen transfer at the cellular level, resulting in suffocation. It is environmentally non-persistent though it is non-selective, also killing non-target fish and many invertebrates (Matthews and Brand, 2004).
- iii. **Mechanical control:** hand pulling or various kinds of machinery are employed. However, some invaders cannot be easily found for mechanical removal or occupy a habitat (for example, the marine benthos) that is not readily accessible (Simberloff, 2000). Physical control, through shooting or removal of individuals, involves high energy and high cost. Water hyacinth had been manually removed from small bodies of water using rake and pitchforks (Matthews and Brand, 2004).
- iv. **Ecosystem management:** The entire ecosystem can be subjected to a regular treatment (such as a simulated natural fire regime) which tends to favor adapted native species over most exotic invaders. This requires adequate studies so as to determine the specific ways in which ecosystem management can be employed (Simberloff, 2000; McGinley and Duffy, 2012).

### The need to control both introduced predators and competitors simultaneously

In many cases, introduced predators and prey both occur together; for example, according to Flux, (1993), at least 80 islands have both alien cats and rabbits. Priority is then generally given to the control of the predators, since they have the most direct and obvious short term effects. Often, only direct effects of grazers are taken into account for control program

decisions, and when there are no important direct effects, control may not be considered at all. Both introduced predators and introduced grazers had been suggested to be controlled simultaneously in order to prevent what is known as hyperpredation effect- whereby introduction of a prey species induces an increase of the introduced predators beyond a level that can be sustained by an ill-adapted indigenous species (Courchamp *et al.*, 1999).

Figure 3: Model simulations given different control



strategies. Population numbers vs time, (A) when there is no control, (B) control of cats only or (C) simultaneous control of both rabbits and cats [Source: Courchamp *et al.*, 1999].

### CONCLUSION

Introduced/Invasive species have no doubt contributed both positively and negatively to human existence over the years. But as this review reveals, the cost outweighs the benefit. The record of human redistribution of biodiversity is a costly error. Historical mixtures of unavoidable accident, misplaced whimsy, bungling and irresponsibility, compounded by careless or prejudiced logic, have created problems that may often prove unassailable. Ecologically and economically, the impacts of

introduced/invasive species pose a threat, not only on our biodiversity, but also on human existence itself. It will be a double disaster if man does not recognize this disaster and harness its resources in order to curtail the menace. As important as the need for control of Introduced/invasive species is, care must be taken on how and which method(s) of control is used at a particular time and in a particular situation for a particular species, so as to prevent any complication as much as possible.

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