

NATIONAL REVIEW OF INVASIVE ALIEN SPECIES NAMIBIA



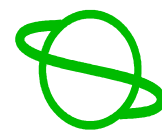
**MINISTRY OF ENVIRONMENT AND TOURISM
DIRECTORATE OF ENVIRONMENTAL AFFAIRS**

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NATIONAL REVIEW OF INVASIVE ALIEN SPECIES NAMIBIA

**Consultancy Report on information collected regarding
Invasive alien species in Namibia
for the SABSP
(SOUTHERN AFRICA BIODIVERSITY SUPPORT PROGRAMME)**

**Prepared for the Directorate of Environmental Affairs, Ministry of
Environment and Tourism
Windhoek
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ACRONYMS AND ABBREVIATIONS

AISWG	Alien Invasive Species Working Group
ABWG	Agricultural Biodiversity Working Group
BCLME	The Benguela Current Large Marine Ecosystem
BSN (BotSoc)	The Botanical Society of Namibia
CITES	The Convention on International Trade in Endangered Species of Wild Fauna and Flora
CSIR	Council for Scientific and Industrial Research (S.A.)
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
CTT&BD	Centre for Ticks and Tick-borne diseases
DEA	Directorate of Environmental Affairs
DRFN	Desert Research Foundation of Namibia
DVS	Directorate of Veterinary Services
DWA	Department of Water Affairs
EIA	Environmental Impact Assessment
EU	European Union
FAO	Food and Agriculture Organisation
GISP	Global Invasive Species Programme
GMOs	Genetically Modified Organisms
GTRC	Gobabeb Training and Research Centre
ICES	International Council for the Exploration of the Seas
IPPC	International Plant Protection Convention
IRDNC	Integrated Rural Development and Nature Conservation
IUCN	International Union for Conservation of Nature
IWC	International Whaling Commission
MAWRD	Ministry of Agriculture, Water and Rural Development
MET	Ministry of Environment and Tourism
MFMR	Ministry of Fisheries and Marine Resources
NABA	Namibian Biotechnology Alliance
NAPCOD	Namibian Programme to Combat Desertification
NAPHA	Namibia Professional Hunting Association
NARREC	Namibian Animal Research, Rehabilitation and Education Centre
NamWater	Namibia Water Corporation
NAU	Namibian Agricultural Union
NBRI	National Botanical Research Institute

NBTF	National Biodiversity Task Force
NDP2	Second National Development Plan
NEPAD	New Partnership for Africa's Development
NGO	Non Government Organisation
NMN	National Museum of Namibia
NNF	Namibian Nature Foundation
NNFU	Namibia National Farmers Union
PPRI	Plant Protection Research Institute (Pretoria)
RAISON	Research and Information Services of Namibia
RPPO	Regional Plant Protection Organisation
SABSP	Southern Africa Biodiversity Support Programme
SADC	Southern African Development Community
SAIEA	Southern African Institute for Environmental Assessment
SARCCUS	Southern African Regional Commission for the Conservation and Utilisation of the Soil
SNRT	School of Natural Resources and Tourism
UNAM	University of Namibia
UNCBD	The United Nations Convention on Biodiversity
UNCCD	The United Nations Convention to Combat Desertification
UNCED	United Nations Conference on Environment and Development (1992 Rio de Janeiro Conference)
UNFCCC	The United Nations Framework Convention on Climate Change
WLSN	Wildlife Society of Namibia
WSSD	World Summit on Sustainable Development (2002 Johannesburg Summit)
WWGN	Wetland Working Group of Namibia
WWF	World-wide Fund for Nature (formerly World Wildlife Fund)

EXECUTIVE SUMMARY

The problem of invasive alien species in Namibia was highlighted 20 years ago, at the 1984 annual professional officers' meeting of the then Directorate of Nature Conservation and Recreation Resorts. A series of detailed field surveys had been undertaken nationally, and the results of these surveys were presented at this annual research meeting and subsequently published. The only other detailed studies of invasive alien species since the early 1980s were the innovative research by the Department of Water Affairs into the control of the aquatic weed, *Salvinia molesta*, and much more recently, research on *Prosopis* and black-faced impala. Until the establishment of specialist working groups under the National Biodiversity Task Force about five years ago, little more took place in the field of invasive species research other than the ongoing biological control of *Salvinia molesta*.

The main achievements of the two working groups that dealt directly with invasive alien species, the Alien Invasive Species Working Group and the Agricultural Biodiversity Working Group, were the publication of a poster (“Namibia’s Nasty Nine – Alien Invasive Species”), some publications highlighting the distribution dynamics of fountain grass, a Ph.D. study on *Prosopis*, the inclusion of the necessity to “reduce the threat to biological diversity from invasive alien species” as a strategic aim in Namibia’s ten-year strategic plan of action for sustainable development through biodiversity conservation – Biodiversity and Development in Namibia 2001 – 2010”, a national review of invasive alien species, attempts made to review the legislative framework, and in recent years, annual, national, one-day workshops. To a lesser extent, the projects of students and scholars over the last 20 years reveal an ongoing awareness of and concern regarding the problem of invasive alien species. In 1999, Namibia submitted a proposal for a regional research project on aquatic weed translocation and control to the Southern African Development Community (SADC) Water Sector. This project was taken up and although funding was obtained from the World Bank in 2002, it was discontinued in June 2003, just as the project was gaining impetus.

Future threats include new introductions via the nursery trade, reforestation programmes, game farming and expanding aquaculture enterprises. Because of the aridity of much of the country, the lack of detailed research on invasive alien species, the paucity of information regarding their present distribution, population dynamics, and their social, economic and ecological impacts under local conditions, such species are not generally perceived to be a major problem in Namibia.

This report includes annotated checklists of the most important invasive alien species in the country, identifies and describes the 15 most important invasive alien plant species and the 11 most important invasive alien animals.

The plants include the ten identified at the 1984 workshop, those depicted on the “Nasty nine” poster and three more aquatic weeds that could have potentially severe ecological impacts on Namibia’s precious wetland ecosystems. The first table lists and briefly describes 38 terrestrial plants known to be invasive or potentially invasive. A further twenty plants that also appear on the National Botanical Research Institute (NBRI) checklist of 47 species, thought to be invasive on the basis of the harmful or potentially harmful effects they have on ecosystems, are included in Annexure 1. These 58 plants are by no means a final list, as there are several more species currently considered to be invasive in neighbouring countries that could well be potentially invasive in Namibia, and there is the ever-present threat of introductions from further afield. Six aquatic or semi-aquatic plants are described in detail and a further 19 from the NBRI list of plants considered to be invasive are included in Annexure 2.

Based on this review, 11 alien animal species have the potential to become extremely invasive in Namibia. The aquatic species include the recently introduced freshwater crayfish *Cherax quadricarinatus*, which would cause serious problems if allowed to escape into Namibian wetlands.

The other aquatic species are: the snail *Lymnaea columella*, on the basis of its ability to colonise a variety of habitats and its role in the transmission of fascioliasis or liver fluke in cattle; the Mediterranean mussel *Mytilus galloprovincialis*; three highly invasive freshwater fish species, *Cyprinus carpio*, *Micropterus salmoides* and *Oreochromis mossambicus*; and the American red-eared terrapin, *Trachemys scripta elegans*, that is internationally known to be a pest animal. With the exception of the marine mussel, these aquatic species all pose serious threats should they become established in the perennial rivers.

A comprehensive survey of the catchment areas of all shared perennial rivers needs to be undertaken, and if found, these crayfish, snails, fish and terrapins must be eradicated from all aquaculture ponds, farm dams and natural pools. Legislation and supporting regulations should strictly prohibit the introduction of any of these species within the catchment areas of any perennial rivers, including the Cuvelai system.

Terrestrial animals included in the top eleven are the domestic cat, *Felix catus*, and the hybrid *Felix catus/lybica*, as well as the rodents *Mus musculus* (the house mouse) and two rat species, *Rattus rattus* (the house rat) and *Rattus norvegicus* (the brown rat), which are well established particularly at the coast, and could easily pose economic and health risks.

All in all, two crustaceans, four molluscs, four beneficial insects introduced as bio-control agents for *Prosopis* and *Salvinia*, six fishes, two reptiles, four birds and seven mammals are described, while a further 16 alien mammals and mammals of alien genetic stock introduced for game farming are described and included in Annexure 4. Three potentially harmful marine species known to occur in the Atlantic Ocean off South Africa and possibly introduced via bilge water are also included. The report briefly examines factors that determine invasiveness and the successful establishment of invasive alien species, and the main known biological, social and economic impacts of such invasions.

Invasive alien species, alien species and potentially invasive alien species constitute a major threat to biodiversity, both nationally and globally. Although present policy rarely specifically mentions invasive alien species, the general issue is fairly well covered within the broad definitions pertaining to environmental health, sustainable utilisation and the preservation of Namibia's array of biodiversity in the broadest sense. This review shows that although there is legislation in place that implicitly covers invasive alien species, there is nevertheless an urgent need to introduce legislation which explicitly refers to invasive alien species, and that it might be in Namibia's best interests to consider drawing on relevant clauses in South Africa's National Environmental Management: Biodiversity Act. Given recent legislative developments, there are excellent opportunities to incorporate relevant clauses in legislation now being drafted or still under consideration. It is recommended that attention in this regard be given to the draft Parks and Wildlife Management Bill, particularly the section on alien and invasive species; the draft Water Resources Management Bill; the draft Conservation of Agricultural Resources Bill; the pending Environmental Management Bill; and pertinent regulations being developed for the Inland Fisheries Resources Act and the Aquaculture Act. This review has already contributed revisions to the latest draft of Namibia's Wetland Policy. To ensure bio-safety, the European Union (EU) regulations for containment of genetically modified organisms (GMOs) have been included in draft legislation. These regulations appear in Annexure 5.

On the basis of this review, the following steps are recommended to improve present legislation:

- the development of a national policy on invasive alien species;
- the inclusion of explicit clauses on invasive alien species in legislation and policies currently being drafted;

- the development of appropriate regulations and guidelines on invasive alien species to complement existing legislation;
- the setting out of practical guidelines appropriate to existing natural resource legislation;
- the strengthening of awareness and enforcement of relevant legislation; and
- the promotion of ratification of and compliance with international and regional conventions, agreements and protocols, particularly the International Plant Protection Convention and the African Convention on the Conservation of Nature and Natural Resources.

An excellent example of compliance with international codes can be found in the Aquaculture Policy and Aquaculture Act, both recently developed by the Ministry of Fisheries and Marine Resources (MFMR).

The three lead institutions identified by the institutional analysis undertaken as part of this review are the Ministry of Environment and Tourism (MET), the Ministry of Agriculture, Water and Rural Development (MAWRD) and the Ministry of Fisheries and Marine Resources (MFMR). The review revealed that two tertiary education institutions, the Polytechnic of Namibia and the University of Namibia (UNAM), have lecturers and students actively involved in research and training pertaining to invasive alien species. Other relevant institutions are those involved in the trading of alien species, for example plant nurseries, game dealers, farmers (represented by their unions) and institutions such as the National Museum of Namibia and the National Herbarium, which house and monitor natural history collections. Local authorities such as the City of Windhoek are responsible for urban issues and townlands, and generally take the management of invasive alien species seriously, while the water supply parastatal, NamWater, is responsible for protecting ecosystems, although it tends to deal with issues such as invasive alien species only if they affect water supply operations. A variety of non-governmental organisations (NGOs) are concerned with environmental issues that may include invasive alien species. These include the Desert Research Foundation of Namibia (DRFN), the Gobabeb Training and Research Centre (GRTC), the Namibian Nature Foundation (NNF), Integrated Rural Development and Nature Conservation (IRDNC), and the Southern African Institute for Environmental Assessment (SAIEA). Also important, particularly in terms of raising public awareness, are national environmental groups such as the Wildlife Society of Namibia (WSN) and Earthlife-Namibia, while in the urban setting, Greenspace – Friends of Avis and the Third Windhoek Scouts include control of invasive alien species in their activities. A high level of awareness has been engendered on the part of its members by the Namibia Professional Hunting Association (NAPHA).

The MET, MFMR and MAWRD are actively involved in research on and control of invasive alien species. In the mid-1980s, the Directorate of Nature Conservation and Recreation Resorts took the lead in assessing the situation nationally, and today the Southern Africa Biodiversity Support Programme (SABSP) Invasive Alien Species Sub-programme is housed at the Directorate of Environmental Affairs (DEA), as was the recently completed national programme on bush encroachment. The MFMR is actively implementing its Aquaculture Policy and Act and drafting appropriate regulations whilst the MAWRD remains committed to its programme of biological control of *Salvinia molesta*, the ongoing work of the National Botanical Research Institute (NBRI) on alien and invasive plants and the sterling efforts of the Phytosanitary control section in the Directorate of Veterinary Services.

The national expert on alien and invasive animals, Mike Griffin, is a researcher at MET. Pertinent legislation is being developed by the ministry for inclusion in the new Parks and Wildlife Management Bill. Yet, within the same ministry, the Directorate of Forestry continues to promote invasive alien species.

In its various tree planting initiatives around the country, the Directorate of Forestry actively plants alien trees, including species that are known to be invasive, and also propagates and supplies these trees to schools and members of the public. The director has declared his willingness to be convinced of any detrimental consequences of these actions and to take appropriate action.

The Department of Water Affairs (DWA) has been actively involved in research and control of the alien aquatic weed *Salvinia molesta* for the last 25 years, and continues to man a laboratory dedicated to this end in Caprivi Region. The DWA has built up a good SADC and international reputation and has links with leading institutions elsewhere, for example the Plant Protection Research Institute (PPRI) in South Africa and the CSIRO in Australia. Within MAWRD's Department of Agriculture, in addition to issues of veterinary importance, agricultural pests and weeds are dealt with in dedicated units such as the Phytosanitary Section, and there is close cooperation with border control officials in this regard. Farmers' unions report the efforts of individual farmers to keep their land clear of invasive species. The NBRI has tasked a senior researcher, Herta Kolberg, with dealing with invasive and alien plants issues (although this is certainly not her primary responsibility) and to improve awareness nationally, the production of single-page fact sheets on each of the most important invasive alien species is planned. NamWater deals with alien invasive species where they pose a threat to the operation of water supply works and in all environmental impact assessments (EIAs) undertaken or commissioned by the water utility. The Southern African Institute of Environmental Assessment (SAIEA) similarly ensures that impacts of invasive alien species are taken into account in all EIAs.

MFMR personnel are becoming increasingly aware of their role with regard to preventing the inadvertent translocation of invasive alien species, as is clearly evident in recent legislation on inland waters and aquaculture. They impose strict regulations concerning aquaculture ventures and the ecosystem health component of the Benguela Current Large Marine Ecosystem (BCLME) programme should assess the current status of pest and weed species along the coast.

The National Museum has in the past been involved in a countrywide snail survey conducted by Barbara Curtis that identified invasive alien species and their spread, and more recently an entomologist, Eugene Marais, has worked closely with the Department of Agriculture on known agricultural pests and their control. Both the Polytechnic of Namibia and UNAM offer courses that include modules on invasive alien species, and there are researchers in the agriculture, natural resources and geography departments that are actively involved in research into aspects of invasive alien species. The DRFN has been involved in a specific training course on invasive alien species with the Department of Geography at UNAM, and has been active in clearing weeds from the Swakop and Kuiseb rivers. The NNF has funded and advised on pertinent projects such as those run by MET's Directorate of Forestry and smaller weed clearing efforts at Waterberg and Okakarara. The Ministry of Health, however, indicated clearly that the topic does not fall within its scope of work.

The City of Windhoek, through the Open Spaces and Recreation Division, is well aware of invasive alien species and provides assistance with eradication. Municipal by-laws make it illegal to propagate or plant *Prosopis*, and at present the municipality is clearing invasive cacti from the Hofmeyr Walk Aloe Trail in the centre of the city. In this endeavour, they are assisted by environmental groups such as Greenspace – Friends of Avis, the Wildlife Society of Namibia, the Botanical Society and the Third Windhoek Scouts at Hofmeyr Walk, Avis Dam and the Botanical Gardens. Plant nurseries in Windhoek are aware of invasive alien species issues and do not sell them, but offer advice to the public on more suitable plants. Game dealers through NAPHA are proudly promoting indigenous species to discourage the trend of importing alien mammals and alien genetic stock for game farming and hunting enterprises.

Within the National Biodiversity Task Force there are multi-sectoral working groups that promote networking within Namibia. The most important working groups with regard to invasive alien species research and management are the Alien Invasive Species Working Group and the Agricultural Biodiversity Working Group which includes the practical management of alien invasive species in its range of activities. The members of the Wetland Working Group are involved more specifically with invasive alien aquatic species, including riparian species. In general these networks of experts have made a good start at collaboration across sectors and, as mentioned earlier, have articulated ten-year work plans, developed some awareness materials, met at least annually in recent years and commissioned reviews on the status of invasive alien species in Namibia and the legislative situation. Individual members have been active in some pertinent research projects on *Prosopis* spp, *Salvinia molesta*, *Mytilus galloprovincialis* and *Pennisetum setaceum*, and with ensuring the control of the introduction of invasive alien animals through the MET.

As identified in a series of interviews, one of the drawbacks of these working groups is that although they may represent a fairly wide range of institutions, they do not yet constitute an effective network of national experts in this field. Few rangeland scientists, marine biologists or aquatic ecologists are members of the groups, while trade partners such as aquaculturists, foresters, horticulturists, game dealers and those responsible for cross-border checks and trade are not represented at all. Furthermore, there are no development agencies or community representatives on the working groups. The Alien Invasive Species Working Group has tended to concentrate more on plants, while the Agricultural Biodiversity Working Group has placed emphasis on animals, and neither deals with pathogens. Some of the most active institutions, such as the phytosanitary section in the MAWRD Directorate of Veterinary Services, do not feel at home in these groups. The working groups are a good start, but more formal coordination and much broader representation is needed for a truly effective network of experts. The lack of secure funding and the voluntary nature of membership means that many members do not have the time and resources to be truly committed and actively involved in working group activities. To date, no practical control projects have been undertaken by the groups.

Past and current projects on invasive alien species are described in the report and essentially fall into three groups: projects undertaken in the mid-1980s in response to the 1984 Directorate of Nature Conservation and Recreation Resorts workshop on invasive alien organisms; the ongoing research of the DWA on the biological control of *Salvinia molesta*; and more recent studies by members of the relevant working groups, with some work periodically undertaken by students and even school learners over the last 20 years. A brief review of Namibia's Second Development Plan, NDP 2, shows that although environmental sustainability is a common theme in the plans of the natural resource sectors, no specific mention is made of any projects focusing on invasive alien species. It is recommended that this shortcoming be addressed in the planning for NDP 3, which should at least recognise and incorporate the objectives and activities outlined in Namibia's ten-year strategic plan of action for sustainable development through biodiversity conservation with regard to invasive alien species.

Many of the activities outlined in this 10-year strategic plan linking biodiversity and development, have yet to be tackled. This review may prove to be useful in this context and with planning future national SABSP activities. Once updated and verified by experts within the appropriate institutions or working groups, the annotated checklists developed in the course of this review can help in the process of assessing and categorising what is known about invasive alien species in Namibia. Similarly the information in this report can form the basis for the proposed database on plant and animal invasive aliens. In due course, this information can be expanded with data obtained from field surveys, museum and herbarium records and the wetland database to develop an atlas for Namibia similar to that developed by Lesley Henderson for South African plants.

There is an urgent need to determine the invasiveness under local conditions of all the species listed in this report, starting with those most likely to impact on vulnerable ecosystems and those most likely to have adverse economic impacts. This review provides a sound basis for the development of a policy on invasive alien species, the incorporation of relevant clauses and provisions in draft legislation and the development of appropriate regulations to strengthen existing laws. The interviews have highlighted the need to promote public awareness beyond that created by posters, particularly regarding both the ecological and economic threats posed by invasive alien species, and the need to implement practical control tests and projects.

This report includes many recommendations, chief amongst them relating to improving the legislative framework and expanding institutional capacities and collaboration amongst experts. There are also suggestions regarding the coordination of the national programme based on the Biodiversity and Development 10-year Strategic Plan. Regarding improved regional collaboration, some suggestions that draw on the knowledge of the review team and suggestions made by the experts interviewed are included in the final chapter. These recommendations deal mainly with ways to improve the legislative framework, institutional capacities, and collaboration of experts and touch on co-ordinated national programmes and improved regional collaboration. These recommendations should be read together with this executive summary.

Finally, the report includes a detailed bibliography that goes beyond the articles and documents referred to in the main report. Articles referred to in the text are marked with an asterisk within the wider bibliography of useful references pertinent to invasive alien species. This bibliography is intended for use by future researchers interested in invasive alien species in Namibia and for inclusion in the national database. The questions and responses of all interviews are included in full in Annexure 6 and Annexure 7. On a national level, this report is intended to provide a sound basis for future awareness-raising, research and management activities; at a regional level, it is intended to serve as Namibia's contribution to an SADC-wide study on invasive alien species, providing pertinent and factual information on the Namibian situation for the SABSP.



Bradypodion pumilum, the Cape Dwarf chameleon has been recorded from gardens at the coast. Little is known of its ecology.

1 INTRODUCTION

The problem of invasive alien species in Namibia was highlighted, 20 years ago, at the 1984 annual professional officers meeting of the then Directorate of Nature Conservation and Recreation Resorts. Workshop sessions at this research meeting resulted in several publications including a South African National Scientific Programmes Report that determined the distribution of invasive and potentially invasive species in different regions of Namibia (Brown & MacDonald 1984, Brown *et al* 1985). Most of our information regarding the status of invasive plant species in Namibia stems from this and other publications in the 1980s (Schlettwein 1984 a,b,c, 1985 a,b, Gillomee 1986, Schlettwein & Gillomee 1989, MacDonald *et al.* 1986, MacDonald & Nott 1987; Boyer 1989, Boyer & Boyer 1989, Brown & Gubb 1986). The only detailed studies of invasive alien species have been the innovative research by the Department of Water Affairs into the control of the aquatic weed, *Salvinia molesta* since the early 1980's (Bethune 1996, Schlettwein *et al* 1991, Schlettwein & Bethune 1992, Taylor 1999, Bethune & Roberts 2002), the recent work by Pierre Smit for his Ph.D on *Prosopis* (Smit 2002 a,b) and studies on black-faced impala (Lorenzen 2003, Matson 2003).

More recently, interest has been renewed through the activities of members of the Alien Invasive Species Working Group of the National Biodiversity Task Force. These activities have included: the publication of a poster depicting the “Namibia’s Nasty Nine – Alien Invasive Species” (Steenkamp & Smit 2002); publications highlighting the distribution dynamics of some species (Joubert & Cunningham 2002, 2004, Cunningham *et al.* 2004); the recognition of the necessity to “reduce the threat to biological diversity from invasive alien species,” and the inclusion of this as a strategic aim in “Namibia’s ten-year strategic plan of action for sustainable development through biodiversity conservation – 2001 - 2010“ (Barnard *et al.* undated); in recent years, annual workshops held by the working group; legislative reviews (Alberts undated, Malan, undated) and ongoing *Prosopis* studies. During the same period, the Agricultural Biodiversity Working Group commissioned a report on “Invasive Alien Species in Namibia” (Venter 2002). To a lesser extent the projects of students and scholars over the last 20 years reveal an ongoing awareness and concern of the problem. In May this year (2004) the Directorate of Environmental Affairs together with the Southern Africa Biodiversity Support Programme, SABSP, held a strategic planning session on alien and invasive species in Namibia building on the existing 10-year strategic plan (Tarr 2004). Members of the Alien Invasive Species Working Group were invited and made presentations on terminology, legislation in the agricultural sector and recent *Prosopis* studies as an example of a “low impact control project”, i.e. projects without undue adverse impacts.

The control of *Salvinia molesta* in the eastern Caprivi wetlands continues. Good vigilance and timely releases of the biological control agent *Cyrtobagous salviniae* wherever new infestations are found, keep the weed in check. In 1999, Namibia submitted a proposal for a regional research project on aquatic weed translocation and control to the SADC Water Sector. This project was taken up and funding obtained from the World Bank in 2002. Unfortunately funding was arbitrarily discontinued in June of 2003, just as the project was gaining impetus and a consortium of the CSIR/ Plant Protection Research Institute and Rhodes University had been appointed to conduct the pilot studies in three cross-border catchment areas. This SADC project is on hold pending funding.

In recent years, in particular since the obvious success of eco-tourism in Namibia, the Ministry of Environment and Tourism has received increasingly more applications from land owners to import alien and potentially invasive species. These applications are dealt with on a case by case basis (several leading to court action), and the following has become obvious: current legislation is inadequate, enforcement is not uniform due to manpower problems, policy on the subject is neither formal nor clear within the Ministry of Environment and Tourism and public awareness is lacking even within the wildlife sector.

Despite this, invasive alien species are not generally perceived to be a major problem in Namibia. This rather complacent perception of invasive and potentially invasive alien species can be attributed to:

- Namibia's aridity meaning that relatively few alien species are likely to become invasive.
- Namibia's paucity of research capacity in terms of qualified biological research personnel meaning that studies of invasive organisms have been relatively few and far between and have been focussed on the distribution of relatively few species (Brown *et al*, 1985) e.g. *Salvinia*, *Prosopis* and black-faced impala.
- Little information available on the recent distribution and population dynamics of invasive species,
- Even less known about the socio-economic and ecological impacts of invasive species, that which is reported in the literature is largely inferred from observations and studies elsewhere.

Future threats include new introductions via the nursery and pet trades, reforestation programmes, game farming and expanding aquaculture enterprises.



Cyrtobagous salviniae, the biological control agent, which is successfully controlling the invasive aquatic weed *Salvinia molesta*, Kariba weed, in the Eastern Caprivi.

2 SCOPE AND SCALE OF INVASIVE ALIENS IN NAMIBIA

2.1 INVASIVE ALIEN PLANTS IN NAMIBIA

2.1.1 Terrestrial invasive alien plants:

Biodiversity loss and ecosystem degradation in Namibia are mainly ascribed to habitat loss and fragmentation. The terrestrial invasive alien plant problem in Namibia is generally considered to be relatively modest (Barnard *et al.* 1998), although a number of recent initiatives, including this report, are testament to a heightened awareness and a growing perception that the current and future threat from invasive alien species warrants greater attention.

Table 1 provides an annotated checklist of terrestrial plant species known to be invasive, or likely to be invasive in the near future. This list was largely compiled from Brown *et al.* (1985) and other publications of the 1980s, as well as more recent work by Joubert & Cunningham (2002, 2004), Steenkamp & Smit (2002), Cunningham *et al.* (2004) and where appropriate Henderson (1995, 1999, 2001). Added to this are species, which although not previously listed as invasive, are now considered invasive based on personal observations, communication with knowledgeable people, and the results of students' projects. This list should not be seen as entirely accurate, some of the species included might later be considered non-invasive, and some invasive or potentially invasive species might have been excluded.

TABLE 1: ANNOTATED CHECKLIST OF THE MOST IMPORTANT INVASIVE AND POTENTIALLY INVASIVE TERRESTRIAL PLANTS IN NAMIBIA, as is known at present (based largely on Brown *et al.* 1985; MacDonald and Nott 1987, Joubert & Cunningham 2002, 2004 Cunningham *et al.* 2004; Steenkamp & Smit 2002; and personal observations and opinions). Some of these may prove not to be a problem, whilst other not listed may be potential invaders.

Species	Known Distribution	Status	Reference
<i>Acanthospermum hispidum</i> Hispid starburr	Central commercial farmlands	Unknown, other than to be a modest problem to livestock on farmland	None (personal observation DJ on farm Palmvlak.)
<i>Argemone ochroleuca</i> White flowered Mexican poppy	From north to south, mainly in the more arid west, but also in the Caprivi	Considered to be a potential invader in all rivers and disturbed habitat, but not considered to compete with indigenous plants to any great extent (Muller 1985)	Brown <i>et al.</i> 1985
<i>Bidens biternata</i> Five leaf blackjack	From central Namibia northwards	Little is known about its invasive potential (Nott 1987) but it forms a significant proportion of the community in the herb layer in Daan Viljoen Game Park	Brown <i>et al.</i> 1985 (pers. obs DJ)
<i>Bidens pilosa</i> Common blackjack	Kavango	Present in disturbed old agricultural lands (Hines <i>et al.</i> 1985)	Brown <i>et al.</i> 1985
<i>Bambusa balcooa</i> Balcooa bamboo	Caprivi	Isolated populations near Katima Mulilo (Hines <i>et al.</i> 1985)	Brown <i>et al.</i> 1985
<i>Chenopodium ambrosioides</i> Mexican tea	Central and western Namibia	Around river courses and dams (Muller 1985)	Brown <i>et al.</i> 1985

Species	Known Distribution	Status	Reference
<i>Cereus jamacaru</i> Queen of the Night	Waterberg Plateau Park, townlands in Windhoek	Currently isolated stands in Waterberg Plateau Park, associated with cattle posts and trails.	Berry 2000
<i>Datura ferox</i> Large thorn apple	Widespread central + western Namibia	Mostly disturbed and river habitat.	Brown <i>et al.</i> 1985
<i>Datura inoxia</i> Downy thorn apple	Widespread	Mostly disturbed and river habitat.	Brown <i>et al.</i> 1985
<i>Datura stramonium</i> Common thorn apple	Widespread in arid west	Mostly disturbed and river habitat.	Brown <i>et al.</i> 1985
<i>Dodonaea angustifolia</i> Sand olive	Grootfontein district; Auas Mtns Windhoek	Occurs in quite dense thickets (Cunningham <i>et al.</i> 2004)	Brown <i>et al.</i> 1985; Cunningham <i>et al.</i> 2004
<i>Flaveria bidentis</i> Smelter's bush	Widespread in the west; central +north central regions	Common along road verges, townlands and drainage areas (Muller 1985)	Brown <i>et al.</i> 1985
<i>Ipomoea purpurea</i> Morning glories	Caprivi	Infestations in "swampy areas" (Hines <i>et al.</i> 1985)	Brown <i>et al.</i> 1985
<i>Lantana camara</i> Lantana	Grootfontein District; Waterberg Plateau Park	Light infestations Grootfontein (Muller 1985); a dense but isolated patch in river at Okatjikona, Waterberg Plateau Park	Brown <i>et al.</i> 1985 (pers. observation DJ, SB.)
<i>Leucaena leucocephala</i> Wonderboom	Grootfontein District	Individual trees in Mountain Savanna (Smit, pers. comm.) and townlands of Windhoek	None
<i>Mangifera indica</i> Mango	Caprivi	Not clear if it is growing wild. High potential for invasion (Hines <i>et al.</i> 1985)	Brown <i>et al.</i> 1985
<i>Melia azedarach</i> Syringa	Moister north-eastern area; mainly in the Grootfontein district.	Occurring in the Omuramba Omatako and invasive potential here is high (Muller 1985)	Brown <i>et al.</i> 1985
<i>Nicotiana glauca</i> Wild tobacco	Widespread in more arid west	Disturbed area and riverine habitat (Muller 1985)	Brown <i>et al.</i> 1985
<i>Opuntia aurantiaca</i> Jointed cactus	On townlands	Although isolated plants occur, invasive potential is high (Muller 1985)	Brown <i>et al.</i> 1985
<i>Opuntia engelmannii</i> Engelmann,s prickly pear	Khomas Hochland	Infests river and cliffs on farm Lichtenstein (Muller 1985)	Brown <i>et al.</i> 1985
<i>Opuntia ficus-indica</i> Sweet prickly pear	Widspread, mainly in the northern half	It appears to spread in a variety of habitats.	Brown <i>et al.</i> 1985
<i>Opuntia imbricate</i> Imbricate prickly pear	Windhoek	Limited spread around Windhoek.	MacDonald & Nott 1987
<i>Opuntia microdasys</i> var. <i>Lutea</i>	Windhoek	Limited spread	MacDonald & Nott 1987
<i>Opuntia stricta</i> Australian pest pear cf <i>Opuntia inermis</i>	Grootfontein District	Occurs in mountainous terrain (Muller 1985).	Brown <i>et al.</i> 1985 MacDonald & Nott 1987

Species	Known Distribution	Status	Reference
<i>Pennisetum setaceum</i> Fountain grass	Widespread	Isolated individuals and dense populations on roadsides, river beds and erosion gullies.	Brown <i>et al.</i> 1985; Joubert & Cunningham 2002, 2004.
<i>Psidium guajava</i> Guava	Caprivi	Restricted to homesteads, but has high invasion potential (Hines <i>et al.</i> 1985)	Brown <i>et al.</i> 1985
<i>Prosopis chilensis</i> . Mesquite, <i>Prosopis</i> , and <i>Prosopis glandulosa</i> var <i>torreyana</i> Honey mesquite, and <i>Prosopis velutina</i> Velvet mesquite	Widespread mainly in arid to semi-arid areas	Dense infestations occur mainly in ephemeral rivers e.g. Nossob and Swakop rivers, but also outside drainage systems (De Klerk 2004) and on townlands (Muller 1985)	Brown <i>et al.</i> 1985; Poynton, 1990; De Klerk 2004
<i>Ricinus communis</i> Castor oil plant	Widespread	In ephemeral rivers (Tarr & Loutit, 1985; Vinjeveld <i>et al.</i> 1985) also moist disturbed + floodplain areas	Brown <i>et al.</i> 1985 (Hines <i>et al.</i> 1985, Jones & Jankowitz, 1985)
<i>Saccharum sacher</i> Sugar cane	Caprivi	Very isolated but spreads aggressively along malopos (Hines <i>et al.</i> 1985)	Brown <i>et al.</i> 1985
<i>Solanum mauritianum</i> Bugweed	Caprivi	Not yet invasive but high potential (Hines <i>et al.</i> 1985)	Brown <i>et al.</i> 1985
<i>Solanum seafortianum</i> Potato creeper	Caprivi	As above	Brown <i>et al.</i> 1985
<i>Tagetes minuta</i> Wild marigold	Central and north central regions	Light infestations mainly in rivers and disturbed areas (Muller 1985). A perceived increase	Brown <i>et al.</i> 1985 (pers. observation DJ.)
<i>Xanthium spinosum</i> Spiny cocklebur	Central and eastern regions.	Light to moderate infestations in rivers and disturbed agricultural areas e.g. cattle pens (Muller 1985)	Brown <i>et al.</i> 1985

Table 1 requires updating and verification for some species. It is not intended to be a definitive list of all potentially invasive species, but rather a list of those species, so far documented as invasive in Namibia. It must be noted that information on plants found in the former Owamboland was not included in the 1984 assessments (Brown *et al.* 1985, Hines *et al.* 1985), as this was considered a war zone and not safe to sample in at that time.

This list of 37 species is merely a first approximation and is bound to become longer in the future, as information becomes available from ongoing atlas work and research. Some of the species might later be considered non-invasive, and other invasive or potentially invasive species might be added. According to the National Botanical Research Institute, NBRI, checklist (Kolberg, ongoing), there are officially about 224 alien plant species in Namibia, of which 139 are considered to be naturalised, that is, growing in the wild, and 47 are thought to have harmful or potentially harmful effects on ecosystems and can thus be considered invasive. Annexure 1 provides a list of those species included on the NBRI list which are not included in Table 1. Taken together, this brings to **57** the number of either invasive or potentially invasive terrestrial alien plant species recorded in Namibia. Several more species, currently considered invasive in South Africa (Henderson, 2001) and other neighbouring countries could well prove to be potentially invasive in Namibia too.

It is important to bear in mind that the current situation with regard to invasive alien species (often based on the 1984/85 reports) is not only a reflection of the *invasiveness* of the various plant species, but also a reflection of their *date* and *rate* of introduction. Thus, less invasive species such as a popular ornamental garden plants and trees suitable for agro-forestry could be more widely distributed at higher densities, than potentially more invasive species, because of earlier and more frequent re-introductions, thus creating the possible misperception that they are more invasive.

2.1.2 Aquatic invasive alien plants

According to Clarke and Klaassen (2001) twenty-three species of naturalised aquatic alien plants have been recorded in Namibia. They include four of the five major aquatic weeds in southern Africa (Bethune & Roberts 2002). They are the two floating aquatic ferns, *Salvinia molesta*, Kariba weed, that infests waterways in the eastern Caprivi and *Azolla filiculoides*, red water fern, found in isolated pockets near the Orange River, the ornamental plant *Pistia stratiotes*, Nile cabbage or water lettuce, and *Myriophyllum aquaticum*, parrot's feather which, although herbarium records are limited to specimens found in Windhoek, have been recorded from a canal in Owambo (Hines *et al.* 1985). Although not yet found in Namibia, great care must be taken to avoid the introduction and potential spread of water hyacinth, *Eichhornia crassipes*, arguably the worst of the five major aquatic weeds in southern Africa. The invasive aquatic and semi-aquatic plants known to occur in Namibia are described in List 1, the annotated list below.

LIST 1. ANNOTATED LIST OF THE MOST INVASIVE AND POTENTIALLY INVASIVE AQUATIC AND SEMI-AQUATIC ALIEN PLANT SPECIES FOUND IN NAMIBIA (based on Henderson 1995, 1999, 2001, Clarke & Klaassen 2001, Zimmerman 2002).

Family Poaceae – grasses/reeds

Arundo donax L., the giant or Spanish reed is originally from the Mediterranean and was introduced into southern Africa as an ornamental garden plant. It is a declared weed in South Africa but not Namibia, although it is known to also occur at sites on the Namibian side of the Orange River (Henderson 1995, 1999, 2001). Considered a transformer it invades water courses and unlike indigenous reeds occurs on roadsides and even away from water.

Family: Azollaceae – ferns

Azolla filiculoides Lam., the red water fern, is originally from tropical South America (Argentina, Brazil, Uruguay, Peru) and was introduced as an ornamental. Although only once recorded from Namibia, it is widespread in the Orange River system in South Africa. It has been declared a weed as a precautionary measure. It occurs in dams, quiet rivers and vleis and is categorised as a transformer. A closely related indigenous species, *Azolla aquaticum* occurs naturally in the eastern Caprivi wetlands and does no harm.

Family: Salviniaceae – ferns

Salvinia molesta D.S. Mitch, Kariba weed is originally from Brazil in South America. It was introduced as an ornamental in the upper Zambezi. A declared weed in Namibia that occurs throughout the eastern Caprivi, it is currently held in check by its biocontrol agent the weevil *Cyrtobagous salviniae*. It is a transformer that invades slow-moving waters in rivers, backwaters, floodplains and impoundments in frost-free regions.

Family: Araceae

Pistia stratiotes L., the water lettuce or Nile cabbage, is originally from Brazil and was also introduced as an ornamental. It is a declared weed in Namibia that occurs in the eastern Caprivi wetlands particularly the Chobe/Linyanti/ Kwando system and has been recorded from Calueque Dam, Angola in the Kunene River not far from the Namibian border (Hines *et al.* 1985).

Water lettuce is a transformer that invades dams and slow-moving rivers in sub-tropical areas. There are effective biocontrol agents available and plans are underway to test these in the Caprivi wetlands (de Wet pers. comm.).

Family: Haloragaceae

Myriophyllum aquaticum (Vell.) Verdc, parrot's feather, is originally from South America (Brazil, Argentina, Uruguay, Peru, Chile) and was introduced as an ornamental plant. Although only once recorded in Namibia it has been declared a weed as a precautionary measure. It invades still to slow moving waters alongside the banks of rivers, lakes and ponds. Plants have been recorded from a man-made canal in Ovambo (Hines *et al.* 1985), but no specimens were collected. It has also been found for sale at nurseries in Windhoek (own observation SB). There is a specimen from Windhoek in the Herbarium collection.

Myriophyllum spicatum L., spiked water-milfoil, is originally from North America, Europe, Asia and North Africa and thought to have been introduced as an ornamental. It has been recorded from the Caprivi (Clarke & Klaassen 2002) but is not considered a serious problem yet. It has been declared a weed in South Africa as a precautionary measure. It is considered a potential transformer that invades still or slow-moving water in rivers, lakes and ponds. It is listed by Zimmerman (2002) as an invasive alien species that is problematic in Namibia.

At present the water fern, *Salvinia molesta*, or Kariba weed, from South America is the only aquatic plant causing serious problems in Namibian wetlands. In the 1970s it spread rapidly into waterways in the eastern Caprivi from the Zambezi River, forming dense mats in the Kwando and Chobe rivers, Lake Liambezi and the quieter backwaters in the Zambezi floodplains. An intensive control programme implemented by the Department of Water Affairs brought this infestation under control by the late 1980s using the natural biological enemies, *Cyrtobagous salviniae* and *Cyrtobagous singularis* weevils (Schlettwein 1984 a,b,c, 1985 a,b, Schlettwein & Bethune 1992, Bethune 1996, Taylor 1999, Bethune & Roberts 2002). The recent 2004 floods in the Caprivi may have spread *Salvinia* into backwater areas where it had been eradicated and into the newly inundated Lake Liambezi. A renewed effort to breed and release the control insects is underway to curb further infestations. Surveys of the floodplain areas of the Caprivi and Okavango River need to be undertaken to determine the extent of new infestations (de Wet pers. comm.). A recent survey of the wetland areas of Caprivi by MET and the Namibian Nature Foundation in August 2004 revealed widespread occurrences (personal observation MG).

Other alien aquatic plants not yet shown to be invasive are listed in Annexure 2. Most of these others are marginal semi-aquatics and are often associated with disturbed areas. The monocotyledons include two species of *Echinochloa* grasses; two sedges of the genus *Schoenoplectus*; and *Juncus bufonius*. The dicotyledons include two species each of *Persicaria* and *Polygonum*; two species of *Alternanthera*; the sundew, *Drosera indica*; the riverside invasive shrub, *Sesbania bispinosa bispinosa*; *Anagalis pumila*; two *Heliotropium* species; *Phyla nodiflora*; *Veronica anagallis-aquatica*; and *Eclipta prostrate*. None of these are currently considered to be a serious threat, but little is known about them, beyond that they occur in Namibia.

There are no invasive alien marine plants recorded, but with the expanding development of aquaculture and mariculture, care must be taken to avoid introducing potentially invasive species. The harsh conditions of the Namibian coast are considered deterrent enough to prevent inadvertent infestations (Currie pers. comm.) but this may not be true for areas of shallow and/or sheltered seas such as the Luderitz and Walvis Bay lagoons. Elsewhere fish farms and hatcheries have caused the introduction of invasive alien plant and animal species e.g. *Myriophyllum aquaticum* via fish hatcheries at Jonkershoek and Amalinda in South Africa (Jacot Guillarmod 1979, 1980).

2.1.3 The main invasive alien plants in Namibia

The prioritisation of the most important invasive alien plant species in Namibia has been done subjectively on two occasions. At the Directorate of Nature Conservation 1984 workshop, 10 plants were prioritized as the most important invasive alien plant species (Scheepers 1985). See Annexure 3A. These were ranked with *Salvinia molesta* being of the greatest concern, followed by *Prosopis spp.*, *Nicotiana glauca*, *Datura innoxia* and *Opuntia ficus-indica* in the top five. In 2002, 9 species were selected for inclusion on an awareness poster of invasive alien plants called “Namibia’s Nasty Nine- Alien Invasive Species” (Steenkamp & Smit 2002) (See Annexure 3B). The lists are quite similar, with *Dodonaea angustifolia*, *Lantana camara*, and *Ricinus communis* having been replaced by *Leucaena leucocephala* and *Pennisetum setaceum*, and *Opuntia ficus-indica* being replaced by a more general reference to the genus *Opuntia* to incorporate the other aggressively invasive species in this genus.

This review identifies 15 major invasive alien plant species in Namibia. They are the plants on the 1984 priority list and on the “Namibia’s Nasty Nine” poster 9 (which tend to overlap) as well as three potentially severe, invasive aquatic species. This list is likely to be amended and no attempt has been made to rank them. As more surveys are conducted, using more objective methods of prioritisation this may later be attempted. It is interesting that many of the most invasive plant species are associated with watercourses and riparian vegetation, rivers obviously provide both water and a conduit for translocation and this indicates that unlike the rest of Namibia, that tends to be too dry for most invasive alien species to become established, Namibia’s wetlands are particularly vulnerable to potential infestations. Details of each of the 15 major invasive alien plants are given in List 2, the annotated list below. This list repeats some of the information given earlier in this chapter in the interests of completeness.

LIST 2. ANNOTATED LIST OF THE FIFTEEN MAJOR INVASIVE PLANT SPECIES FOUND IN NAMIBIA

Salvinia molesta or Kariba weed is a floating fern originally from Brazil in South America, thought to have been introduced as an ornamental in the upper Zambezi in the late 1940s. It is a declared weed in Namibia and occurs throughout the eastern Caprivi wetlands. Currently this invasive water weed is held in check by its biocontrol agent, the weevil *Cyrotobagous salviniae*. *Salvinia molesta* is a transformer that invades slow-moving waters in rivers and dams in frost-free regions. According to Bethune and Roberts (2002) *Salvinia molesta* is a successful invader on account of its rapid growth rate, special colonizing growth form and ability to float. It can be easily transported to new sites by currents, wind, boats and animals moving between waterbodies. It is able to reproduce vegetatively from any fragment containing a node and has no natural enemies in Africa. It was ranked the most important invasive plant at the 1984 workshop (Scheepers 1985) and is included on “Namibia’s Nasty Nine” poster.

Argemone ochroleuca or the white-flowered Mexican poppy is a spiny annual found in dense stands in disturbed areas and river courses particularly, but not exclusively, close to towns. It seems to be largely restricted to the more arid western half of the country (Muller 1985), although the situation is likely to have changed since then.

Datura innoxia or the downy thorn apple is a common annual herb which invades watercourses and disturbed areas. It is widespread throughout mostly the western part of Namibia from north to south, and is particularly common around Windhoek and the westward flowing ephemeral rivers. *Datura ferox* and *Datura stramonium*, the large and common thorn apples respectively are also widespread in Namibia and pose a similar threat to indigenous vegetation.

Leucaena leucocephala, the “wonderboom” was added to the “Nasty Nine”. Although it has not been officially recorded beyond townlands, it has been seen in the Otavi Mountains (Piet Smit, pers. comm.). Its value for fodder, firewood, construction poles and sand binding make it a prospective agro-forestry tree in the moister north-eastern half of the country and its’ sale is actively promoted at plant nurseries as a “wonderboom’ suited to dry conditions.

Dodonaea angustifolia, the sand olive, is a small tree indigenous to large parts of South Africa. It was first documented from Namibia by Müller (1985) and was included in Scheepers (1985) top ten as *Dodonaea viscosa*. Macdonald & Nott (1987) also noted its “limited spread” in the vicinity of Outjo and Otjiwarongo. Craven (1999) includes it as a naturalized alien in Namibia, yet it is not one of the “Nasty Nine”. It was recently recorded in dense thickets in the Auas Mountains on the farm Regenstein (Cunningham *et al.* 2004).

Lantana camara has not yet spread extensively from gardens, perhaps due to its high water requirements. Hines *et al.* (1985) suggest it could become highly invasive in Caprivi and Kavango. There is no recent information on its status in these regions. Currently, it is known to have formed dense stands in only a few isolated areas such as at Okatjikona in the Waterberg Plateau Park and in the Mountain Savanna around Otavi, Tsumeb and Grootfontein. It does not appear on the “Nasty Nine” poster (Steenkamp & Smit, 2002).

The *Opuntia* or prickly pear genus from the Americas account for the recent visibly noticeable spread of invasive succulent species in the Highland savannas and elsewhere and is cause for concern. Shapaka (2003) recorded *Opuntia* infestations in the Daan Viljoen Game Reserve, despite decades of control in this park. Recently, Orford (in prep.) recorded an increase of American succulent species around Windhoek and the Khomas region in general. The various *Opuntia* species (as well as other cactus species as yet unidentified) could be considered the most invasive terrestrial alien plant species in Namibia, along with *Prosopis* spp. Their thorny defence and ability to grow vegetatively from cladodes allow populations to grow rapidly and makes control or eradication difficult.

Pennisetum setaceum, fountain grass, has shown a quite dramatic increase in distribution in Namibia since the 1980s to present (from one to seven of the fourteen recognised biomes in Namibia). In the five years from 1998 to 2003, feral populations on road verges and erosion gullies outside Windhoek have shown annual growth rates (r) of between 0.1 and 0.5 respectively. This gives the populations an estimated doubling time of two to seven years, depending upon the habitats (Joubert & Cunningham, 2002; 2004). MacDonald & Nott (1987) did not record it in their 1984 survey that covered central Namibia and only Muller (1985) recorded it in townlands. This gives a good indication of its recent spread. It has been noted on the shores of Von Bach and Swakoppoort dams (personal observation SB).

Melia azedarach, the syringa, was recorded mainly in a small area on two farms in the Grootfontein District in the 1980s (Muller 1985). Muller (1985) suspected that it would spread along the Omuramba Omatako during floods and could also be spread by birds eating the seed. No recent information is available regarding its spread.

Nicotiana glauca or wild tobacco is widespread throughout Namibia, but more so in the more arid western half of the country (Muller 1985) particularly in river beds, disturbed areas and on old cultivated lands. Over the years there have been ongoing efforts to eradicate it from ephemeral river bed particularly from the Ugab River mouth area in the Skeleton Coast National Park.

The *Prosopis* or mesquite species (*Prosopis chilensis*, *P. glandulosa* var. *terreyana* and *P. velutina*) are perhaps the most important terrestrial invasive alien species in Namibia currently, due to their extensive distribution, high densities and obvious impact on biodiversity and ecosystem functioning.

This group is referred to as *Prosopis* spp. since there is some confusion regarding the taxonomy of the group and apparent hybridisation between species. Detailed work on this species contributed to the Ph.D study of Pierre Smit of UNAM (Smit 2002a, b,) and to the recently completed national bush encroachment research, monitoring and management project (de Klerk 2004).

Pistia stratiotes, water lettuce or Nile cabbage is originally from Brazil and is thought to have been introduced as an ornamental garden plant. It is a declared weed in Namibia that occurs in the eastern Caprivi wetlands particularly the Chobe/Linyanti/ Kwando system and has been recorded from Calueque dam in Angola in the Kunene River a short distance upstream of the Namibian border (Hines *et al* 1985). Henderson (1995, 1999, 2001) classifies *Pistia stratiotes* as a transformer that invades dams and slow-moving rivers in sub-tropical areas. There are effective biocontrol agents available such as the weevil *Neohydronomus affinis*. *Pistia stratiotes* is a successful invader due to its ability to float and reproduce vegetatively and the lack of natural enemies in southern Africa (Bethune & Roberts 2002).

Myriophyllum aquaticum, parrot's feather, originally from South America (Brazil, Argentina, Uruguay, Peru, Chile) was introduced as an ornamental plant. Although only twice recorded in Namibia, it has been declared a weed as a precautionary measure. It invades still to slow moving waters alongside the banks of rivers, lakes and ponds. Plants have been recorded from a man-made canal in Ovambo (Hines *et al.*1985) and have been found for sale at nurseries in Windhoek (own observation SB). *Myriophyllum aquaticum* is successful as an invader due to its continuous growth, ability to withstand frost, lack of natural enemies and ability to reproduce vegetatively from small fragments as well as the resilience of its perennial root stock to desiccation (Bethune & Roberts 2002). The biocontrol agent *Lysathia* has been tested in Lesotho and South Africa and although it is cold tolerant and causes defoliation, the plants are able to recover after winter is over (Cilliers 1999).

Azolla filiculoides, red water fern, originally from tropical South America was introduced as an ornamental. Although there is only one record of its occurrence near the Orange River in Namibia (Clarke & Klaassen 2002) it has been declared a weed as a precautionary measure. It is known to invade dams, quiet rivers and vleis and considered as a transformer (Ashton & Walmsley 1984). Bethune & Roberts (2002) attribute *Azolla filiculoides*' success as an invader to a lack of natural enemies, phosphate rich waters, the fact that the plant is brittle, easily fragmented by turbulence and that these fragments can reproduce, drought resistant spores and the ease of dispersal of such small plants by birds, floods and people. Biocontrol using the weevil *Stenopelmus rufinasus* in South Africa has proved very successful and in some cases has achieved total eradication of these plants (Hill 1999)

2.1.4 Potentially invasive plants:

Aquatic weed specialists (Clarke & Klaassen 2001, Bethune & Roberts 2002) warn that the alien aquatic weeds most likely to cause problems in Namibia are *Salvinia molesta*, *Eichhornia crassipes*, *Myriophyllum aquaticum*, *Pistia stratiotes*, and *Azolla filiculoides*. Bethune and Roberts (2002) provide a detailed review of these weeds, the problems they cause and methods of control. As Clarke and Klaassen (2001) sum up, these plants must be kept out of Namibia, or under control if already present. Because of their known potential to invade wetlands, they urge that all sightings be immediately reported to the competent authorities, in this case the Department of Water Affairs for timely control.

Any legislation controlling the introduction of invasive alien species into Namibia should also include species proven to cause problems in similar habitats elsewhere, the most dangerous of these are given in List 3 on the next page. These 4 aquatic and 15 terrestrial weeds would be dangerously invasive should they be introduced. The list based on Henderson (2001) has been updated.

LIST 3.POTENTIALLY INVASIVE WEED SPECIES, NOT YET FOUND IN NAMIBIA

AQUATIC SPECIES: Although not yet present in Namibia, these four should be banned outright.

Eichhornia crassipes (C. Mart.) Solms, water hyacinth, originally from tropical South America (Peru, Brazil, Venezuela, Argentina, Uruguay), was introduced as an ornamental garden plant. Although not found in Namibia except once for sale in nurseries and at a laboratory at UNAM, it has been declared a weed as a precautionary measure. It is an aggressive invader of dams and slow-flowing rivers elsewhere in SADC and a known transformer. There are effective biocontrol agents and vigilance is essential to keep this noxious weed out of Namibian wetlands.

Egeria densa Planch, dense water weed, originally from South America and *Elodea canadensis* Michx., Canadian water weed, from temperate North America are both declared weeds in South Africa. They are considered potential transformers that invade still or slow moving water in lakes and ponds. Neither is known to occur in natural waters in Namibia but should be declared weeds as a precautionary measure to prevent their introduction.

Pontederia cordata L., pickerel weed, originally from North, Central and South America (Eastern USA to the Caribbean, Honduras, Brazil and Argentina) has been spread through plant nurseries. Fortunately it is not found in natural waters in Namibia yet. It is a declared invader in South Africa that invades riverbanks, and irrigated cane fields, and is listed as a competitive special effect weed. It too should be declared a weed as a precaution.

TERRESTRIAL SPECIES: These fifteen terrestrial plants are known to occur in the semi-arid regions of South Africa, where most are classified as invasive. The list of terrestrial plants likely to be invasive is far longer than this, but it would be wise to immediately add these to the list of potentially invasive species that must be kept out of Namibia.

Atriplex lindleyia subsp. *inflata*, a sponge-fruit saltbush, is an Australian saltbush which is a declared invader in South Africa (Henderson 2001) and is considered a transformer in disturbed habitats, roadsides and dunes in semi-arid areas. Although no Namibian literature refers to it, it would be prudent to consider it a potential invader.

Agave americana, American agave and *Agave sisalana*, sisal, both originate in central America. In South Africa sisal is a declared invader whilst *A. americana* is a proposed declared weed (Henderson 2001). They have not been cited as invasive in Namibia but *A. americana*'s preference for arid habitats makes it a potential invader whilst the preference of *A. sisalana* for tropical savanna suggests it could invade moister, north-eastern areas of Namibia.

Although not officially listed as invasive in Namibia, many species of the Cactaceae family, that have invasive status in South Africa, may already be present and should be declared as weeds as a precautionary measure. These include *Echinopsis spachiana*, torch cactus, *Harrisaia martini*, moon cactus, *Opuntia exaltata*, long-spine cactus, *Opuntia fulgida*, rosea cactus, *Opuntia humifusa*, creeping prickly pear, *Opuntia lindheimeri*, round leaved prickly pear, *Opuntia monacantha*, drooping prickly pear and *Opuntia spinulifera*, saucepan cactus. All arid adapted cactus species should be listed as invasive, given the spread of a number of as yet unidentified cactus species in arid and semi-arid areas in Namibia (Orford in prep.).

Cirsium vulgare, Scotch thistle, is an invasive from Europe which is a declared weed in South Africa. As it does well in degraded grasslands in high rainfall areas but also in river beds in arid areas (Henderson 2001) it has the potential to invade riparian zones in semi-arid and arid parts of Namibia.

Nerium oleander, oleander, a common garden plant, originates from Europe (Mediterranean), and invades rocky watercourses in semi-arid areas in South Africa (Henderson 2001). It is highly toxic, but is still a popular garden plant in Namibia. It is a declared weed in South Africa and although popular, even in public gardens, should be eradicated. There are no local records of it becoming established beyond where it has been deliberately planted.

Parkinsonia aculeata, Jerusalem thorn, originates from tropical America and is considered a potential transformer in South Africa (Henderson 2001). It is not yet a declared invader in South Africa, although it is becoming a problem in watercourses, floodplains and roadsides in some semi-arid habitats, it has been planted in and around municipal parks in the city of Windhoek but has not been noted beyond where it has been deliberately planted.

Tamarix chinensis and *Tamarix ramosissima*, Chinese and pink tamarisks, originate from eastern Europe and Asia. They invade sandy riverbeds in various habitats including semi-arid areas, and are considered potential transformers in South Africa (Henderson 2001) and although not yet recorded in these habitats could pose a potential threat to dry watercourses in Namibia too.

2.2 INVASIVE ALIEN ANIMALS IN NAMIBIA

Namibia is relatively free from alien and invasive alien animals, therefore each species can be described separately in Lists 4 and 5, respectively the annotated lists of potentially invasive alien invertebrate and vertebrate species known to occur in Namibia.

2.2.1 Invasive alien invertebrates

LIST 4. ANNOTATED LIST OF INVASIVE ALIEN INVERTEBRATES THAT OCCUR IN NAMIBIA. The information on aquatic species is adapted from Brown (1980), De Moor & Burton (1988), Curtis (1990), Curtis *et al.* (1989), Schrader (1984, 1985) and Lowery (1998) and updated based on information from the Ministry of Fisheries and Marine Resources and the Department of Water Affairs, whilst that for terrestrial species by Mike Griffin is based on Ministry of Environment and Tourism records and his own knowledge.

Phylum: Arthropoda

Class: Crustacea, Family; Parastacidae

Cherax quadricarinatus, the Queensland redclaw, is a potentially detrimental freshwater crayfish that was deliberately introduced into Namibia in 1997, possibly from South African stock originally from Australia, for aquaculture. They are currently being farmed commercially at “Ecofish farm” in the fish breeding ponds of the Hardap Freshwater Fish Research Institute. Strict permit conditions apply to prevent their translocation within Namibia and any possibility of escape into natural waters. Neither the crayfish nor their larvae may be released, imported nor exported without a permit and they must be kept in tanks “impossible to escape” from (Nande pers. comm.).

Specifications require that their tanks have smooth vertical sides, be at least 60 cm deep, all inlets and outlets must be covered with mesh too small to allow larvae to escape, and that no unauthorized person may have access to the ponds. Fisheries officials have the right to inspect the farm at any time and annual reporting is mandatory. Now that the Aquaculture Act and its regulations have been promulgated the entrepreneur is obliged to re-apply for a new permit before the end of 2004 (Nande pers. comm.). There are, however, reports of alien freshwater crayfish in farm dams and seeps on a farm near Grootfontein as a result of an earlier unsuccessful breeding attempt (1997 Fisheries report cited in: Lowery 1998).

A related Australian species, *Cherax tenuimanus*, the marron, and the ominously named, more aggressive, *Cherax destructor*, or yabby, as well as a North American species, *Procambarus clarkii*, the Louisiana red swamp crayfish or crawfish, are used for aquaculture elsewhere and have been suggested for introduction into Namibia (Lowery 1998). More careful studies are needed as they all have the potential to become serious pests if released into natural waters. *Procambarus clarkii*, released into Lake Naivasha in Kenya, destroyed aquatic vegetation, and due to its burrowing habit caused erosion of channels and the increased turbidity of the water causing a serious decline in the fishery (Lowery & Mendes 1977, de Moor & Bruton 1988, Lowery 1998). Alien crayfish may out-compete indigenous crab species and have an impact on all the species higher up in the food chain that feed on crabs. There are no indigenous freshwater crayfish in Africa and extreme care must be taken in promoting them for aquaculture.

Phylum: Mollusca

Class: Gastropoda, Family: Physidae

Physa acuta – The Physa snail, was a detrimental, accidental introduction and is now well established. It is a highly invasive species thought to have been introduced with water plants through the aquarium trade. It was first found in South Africa in 1956. In Namibia, it has been found in waterbodies at Ais Ais, alongside the Orange River, Hardap Dam and Omaruru (Curtis 1990). The impact it may have on indigenous species is unknown.

Family: Planorbidae

Heliosoma duryi – The Heliosoma snail is described as a minor, detrimental, introduction, as it appears unable to become established in natural waters. It was probably introduced through the aquarium trade and has been known in South Africa since 1969. In Namibia it is found in ponds and dams in Karibib, Windhoek and Omaruru (Curtis 1990). Although its impact is unknown it appears to have little impact on indigenous species.

Family: Lymnaeidae

Lymnaea columella – This Lymnaea snail is a major, detrimental, accidental introduction, now well established and aggressively invasive. It was probably introduced via the aquarium trade. Originally from North America, it was first recorded in southern Africa in the 1940s. During a survey of 340 waterbodies throughout Namibia conducted by the State Museum from 1986 to 1989 these snails were found at the Orange River mouth, in irrigation canals alongside the Orange River, below Hardap Dam, in a fishpond in Omaruru and in isolated permanent springs near Grootfontein (Curtis 1990).

Lymnaea columella is the most serious of the invasive snail species as it is host to the parasite *Fasciola hepatica* that causes the cattle liver fluke disease fascioliasis and is closely linked to the prevalence of this disease in southern Africa, although its impact on indigenous fauna is unknown.

They tend to occur in association with the related indigenous species *Lymnaea natalensis* in a variety of habitats that range from permanent water bodies, to dams and irrigation canals to shallow constantly seeping waters. They were found on plants in both swift flowing and quiet waters, on vegetation at the edges of floodplains as well as on a leaking pipe, showing that they can successfully colonize most habitats occupied by *Lymnaea natalensis* in southern Africa (Brown 1980, Curtis 1990). At the time of the survey (1986 – 89) they did not yet occur in the northern rivers, Kunene, Okavango, Zambezi nor the Kwando/Linyati/Chobe rivers nor their floodplains, but these should be re-surveyed as it is clear that they are spread by human activities and could well have invaded these systems in the last 15 years.

Class: Lamellibranchia, Family: Mytilidae

Mytilus galloprovincialis-The Mediterranean mussel is a major, detrimental, accidental introduction, now well established. As its name suggests it is originally from Europe and was first noted in the intertidal zone of the west coast of southern Africa in 1972. It is the most abundant marine alien to invade Namibian coastal waters (Harris *et al.* 1997).

Mytilus galloprovincialis has a major detrimental impact on indigenous species such as the ribbed mussel, *Aulacomya ater*, yet appears to co-exist with its close relative the black mussel, *Choromytilus meridionalis*. Although *Mytilus galloprovincialis* is well established in the mid and low intertidal zones of wave exposed rocky shores in Namibia, and known to outcompete some indigenous species (Currie 1969) more recent surveys have revealed a decline in their numbers and invasive alien species are not generally considered a serious threat to the Namibian coastline given the harsh conditions imposed by low water temperatures, strong wave action and numerous sulphur eruptions (Currie pers. comm).

Class: Insecta.

Five insects have been introduced as bio-control agents and although they are alien and invasive in the sense that they can spread naturally and rapidly from host plant to host plant they are not considered detrimental but beneficial. All have been subject to strict screening trials to ensure that they pose no threat to non-target species.

Paulina acuminata, the Kariba weed grasshopper, was a not a very effective, minor, deliberate introduction that is now extinct. It was introduced as a biological control agent for *Salvinia molesta* in the Chobe/ Linyanti area of the Caprivi/Botswana border from Lake Kariba and Trinidad in 1972/4 and 1975/6. The second introduction initially became established but later died out. They are considered extinct in both Namibia and Botswana.

Cyrtobagous singularis, the first *Salvinia* weevil was a beneficial, deliberate introduction, to control *Salvinia molesta* in the eastern Caprivi from 1972 – 1976 (Edwards *et al.* 1972, Edwards & Thomas, 1977). There is evidence that they prefer *Salvinia auriculata* to *Salvinia molesta* and were therefore not very effective at controlling the *Salvinia molesta* in the eastern Caprivi (Schlettwein 1985b). Since the introduction of the more specific control agent, *Cyrtobagous salviniae*, their numbers gradually declined until they were out-competed (Clarke pers. comm.). They are now considered to be extinct in Namibia.

Cyrtobagous salviniae was the second *Salvinia* weevil used. It is seen as a major, beneficial, deliberate introduction, now well established and effective. It was introduced as biological control agent for *Salvinia molesta* on the Chobe River, between Caprivi and Botswana, in 1983 and 1985. It gradually out-competed *C. singularis* and remains active in the eastern Caprivi wetlands where it keeps Kariba weed infestations in control (Taylor 1999, Bethune & Roberts 2002).

Two host-specific seed-feeding bruchid beetles from the south-western USA have been recently introduced to southern Namibia to control the spread of *Prosopis* species. They are *Algarobius prosopis* and *Neltumius arizonensis*. These introductions were done in collaboration with the Plant Protection Research Institute, in South Africa.

2.2.2 Invasive alien vertebrates.

LIST 5. ANNOTATED LIST OF INVASIVE ALIEN INVERTEBRATES THAT OCCUR IN NAMIBIA. The information on aquatic species is adapted from Brown (1980), De Moor & Burton (1988) and Schrader (1984, 1985) and updated based on information from the Ministry of Fisheries and Marine Resources, whilst that for terrestrial species by Mike Griffin is based on Ministry of Environment and Tourism records and his own knowledge.

Class: Osteichthyes

Family: Cyprinidae

Cyprinus carpio, the common carp, is a well established major, equivocal, deliberate introduction, recognised as one of the worst nuisance species worldwide (Lowe *et al.* undated). Originally from central Asia, it was introduced to southern Africa from Europe in the 18th century as an ornamental fish. It is thought to have been introduced to Namibia by early German settlers, a 100 years ago, to stock dams for angling and was deliberately bred at the Freshwater Fish Research Institute at Hardap to supply to farmers from 1974 – 83. As a result it is now widespread, occurring in Von Bach, Swakoppoort, Hardap, Avis, Goreangab and numerous farm dams. Although not yet found in the northern rivers, it occurs in Omatako Dam in the catchment of the Omatako Omuramba and is thus considered a potential threat to the Okavango system (Schrader 1985, Bruton & Van As 1986).

Attention must be given to controlling the spread of carp into our northern perennial rivers particularly as aquaculture grows in popularity. Carp are known to have a destructive impact on the environment and other fish species, their habit of bottom feeding disturbs sediment and increases turbidity. The introduction of carp is also linked to the spread of several fish parasites. Despite their detrimental impacts on the environment they remain a valued angling fish. As a result of the awareness generated in preparation for the 1984 workshop on invasive alien species, no carp have been supplied to farmers since then and no new stock is allowed into the country. The workshop recommended no further carp breeding or distribution of carp within the country and that none are to be brought in from outside (Schrader 1984).

Although not yet present in Namibia, care must be taken to avoid the introduction of another very invasive, yet favoured aquaculture species, often used to control submerged aquatic weeds. This is grass carp or *Ctenopharyngodon idellus*. They are not selective feeders and have been known to wipe out all aquatic plants in small lakes, increase water turbidity and transmit parasites (de Moor & Bruton 1988).

Family: Poecilia

Poecilia reticulata, the guppy is a potentially detrimental, accidental introduction, first noted in Otjikoto Lake during an expedition by Tony Ribbink in May 1988. These guppies were originally introduced through the aquarium trade and later were deliberately imported to South Africa as mosquito control agents from Barbados. They did not survive the cold winters at the Jonkershoek hatchery. The Otjikoto population were probably released by some fish enthusiast from Tsumeb. Guppies are the most widespread aquarium fish in the world and are considered pests where they have been introduced elsewhere. Care should be taken to prevent similar “accidental” releases to less isolated waterbodies in future, should they for example get into the Okavango system they could as insect eating fish irreversibly alter aquatic invertebrate diversity (de Moor & Bruton, 1988).

Xiphophorus helleri, the swordtail is another potentially detrimental, accidental introduction. They were first found in Otjikoto Lake by Tony Ribbink in 1988. They were most probably introduced as aquarium fish and inadvertently released into Otjikoto Lake. They are known to eat the fry of other fish and although their impact in southern African waters has not been studied, de Moor and Bruton (1988) recommends that any found be exterminated and care taken not to release any more.

Family: Centrarchidae

Micropterus salmoides, the popular angling largemouth bass, is a major, detrimental, deliberate introduction, now well established. Originally from North America it was imported into southern Africa from the United Kingdom for sport fishing and aquaculture in 1928. Bass were first introduced into Namibia from Jonkershoek hatchery in 1932 (Narubis) and 1934 (Windhoek) and again between 1944 and 1949 (de Moor & Bruton 1988). Like carp, they were actively bred at the Hardap Freshwater Research Institute and supplied to farmers and from 1974 to 1983.

Largemouth bass are a favoured angling fish, now widespread in Namibia. They are well established in Von Bach, Friedenau and Avis dams where they support a flourishing sport angling. National bass fishing competitions are regularly held at Von Bach Dam. They are known to have a major detrimental impact on indigenous fish. Although there is no danger of genetic pollution, as voracious predators, they can compete with indigenous species for food. Fortunately they prefer clear waters and have specialised breeding requirements, such as shallow gravel substrate areas to spawn, that limits their distribution in more turbid rivers and dams. As they already occur in the Omatako catchment they pose a threat to the Okavango system. They should be eliminated and care taken not to allow them in aquaculture ventures within the northern perennial river basins.

Care must also be taken not to introduce other alien fish species as food for the bass, for example in the 1960's bluegill sunfish, *Lepomis macrochirus*, were introduced into Friedenau Dam as bass food. Fortunately none survived and a 1986 fish survey by the DWA, revealed only *Micropterus salmoides*, *Tilapia sparrmanii* and *Oreochromis mossambicus* (personal observation SB).

Family: Cyprinidae

Barbus anoplus, the chubbyhead barb is a minor, detrimental, translocated species indigenous to South Africa. They have been found in pools in the Gaub and the Kuiseb rivers in 1974. They are thought to have been introduced by local farmers from the Orange or Olifants rivers in the Cape (Dixon & Bloom 1974, Jubb 1967). Although, considered detrimental elsewhere, these were most probably temporary populations as even the deeper isolated pools in these ephemeral rivers do not last very long and there are no indigenous minnows that could have been adversely affected.

Family: Cichlidae

Oreochromis mossambicus, the Mocambique tilapia is a major, equivocal, translocated species indigenous to the Lower Zambezi and much of South Africa. It is listed as one of the top hundred worst invasive species by IUCN, the International Union for Conservation of Nature (Lowe *et al.* undated). It has been widely translocated for aquaculture and sport fishing and is widespread in impoundments (Hardap, Von Bach, Friedenau, Omatako) and farm dams in Namibia. It has been recorded from isolated pools in the ephemeral Kuiseb, Omaruru and Ugab rivers in the central Namib (Dixon & Bloom 1974) and seem well-established in the canal of the Eastern National Water Carrier near Waterberg (own observations SB and DJ).

Oreochromis mossambicus was introduced to Namibia from Jonkershoek in 1947 and 1949 and also bred and supplied to farmers from Hardap from 1974 – 83, spreading it throughout the farming areas but fortunately not into the northern perennial rivers, although it occurs in Omatako Dam within the Okavango River catchment (Skelton & Merron 1984, Bethune & Skelton 1984). Its use for aquaculture in this basin must be banned. *Oreochromis mossambicus* is known to compete with indigenous species and to transfer fish parasites. Further there is a danger of hybridisation between it and closely related indigenous species such as *Oreochromis andersonni* and *Oreochromis macrochir* (Skelton & Merron 1984, Bethune & Skelton 1984). Schrader (1985) warns that in addition to this genetic threat, competition for spawning areas and food is likely.

Class: Amphibia

No alien invasive frogs have yet been recorded from Namibian wetlands nor are any known to have been imported, this may change after the Wetland Working Group Frog Atlas gets underway.

Class : Reptilia

Family: Testudinidae

Trachemys scripta, the American red-eared slider is readily available from pet dealers in South Africa. Specimens are illegally imported into Namibia and at least two have been released into the wild (Griffin 2003).

Trachemys scripta is highly invasive worldwide, and could have major consequences if introduced into Namibian rivers. Neither the Kunene River nor the Orange River has indigenous species of river terrapins, and a successful introduction into these systems would have substantial geographical and ecological consequences. One of the Namibian records is from Rosh Pinah which is close to the Orange River. The rivers and wetlands of the Kavango and Caprivi regions support several species of terrapins of the genus *Pelusios*, two of which are endemic to the north eastern perennial river systems. The consequences of a successful introduction into these systems cannot be predicted. All these river systems evolved without the presence of this prolific, generalist and environmentally-aggressive species, and the many endemic aquatic species may be adversely impacted. Immediate action would be to ban the import of this species into the Republic of South Africa (the only importer in southern Africa).

Family: Chameleonidae

Viable populations of *Bradypodion pumilum*, the Cape dwarf chameleon, occur in gardens in Walvis Bay and Swakopmund. It is unclear how these populations were established (Griffin 2003), but it was certainly anthropogenic. Little is known about their ecology, but there is presently no indication that it is invasive. (See photograph in the introduction)

Class: Aves

Although numerous caged birds have been imported, including bizarre breeds of indigenous species which could genetically pollute local populations when released, only the four most important invasive alien birds are discussed here.

Family: Columbidae

Columba livea, the domestic pigeon is found throughout the country and is usually associated with urban areas. However, established feral populations are restricted to urban areas of Luderitz, Walvis Bay, Swakopmund and Windhoek. The feral pigeon does compete with the indigenous rock pigeon, but this is not regarded as a matter of conservation-concern (Brown 1985). They are well-known carriers of psittacosis in urban areas.

Family: Sturnidae

Sturnus vulgaris, the European starling was regarded as non-invasive in 1984 as the Namibian population was then restricted to Oranjemund (Brown 1985). However the population should be monitored, as the situation may have changed in the last 15 years and it should be controlled if it spreads northwards.

Family: Ploceidae

Passer domesticus, the house sparrow, is the best established of the many alien birds found in Namibia. This is a commensal species that occurs throughout Namibia. Since they were first sighted at Orange River in 1959 their gradual spread northwards and inland has been well-documented. House sparrows were noted at Grunau in 1961, Kalkrand and Swakopmund in 1964, Asab in 1965, north of Windhoek by 1968, Gobabis and Stampriet in 1969, Spitzkoppe and Maltahohe in 1971, Okakeujo in 1976 and they had reached the coast at Mowe Bay by 1984 (Von Schwind 1963, Winterbottom 1969, 1971). Despite this they were not regarded as invasive by Brown in his 1984 report (1985). It may be worth checking its present distribution and reassessing its status.

Family: Psittacidae

Melopsittacus undulates, budgies, are another well established alien bird. Many individual budgies, are living in the feral state in Swakopmund, and possibly in other towns too. The population at the coast may be approaching self-sustainability. No negative consequences can be foreseen at this time (Braby, pers. comm.).

Class: Mammalia

Family: Muridae

Mus musculus, the house mouse is widespread in central and southern Namibia, particularly in large towns such as Windhoek, Luderitz, Swakopmund and Walvis Bay. Feral populations are known from the Luderitz peninsula, Sandwich Harbour, Terrace Bay and MÖwe Bay. The successful invasion of these places is due to the relatively mesic climate as well as lack of competition from local fauna; probably only the pygmy gerbil, *Gerbillurus paebe* and *Rattus* would be local competitors. The species has not successfully invaded northern or north-east Namibia, and this may be due to the presence of multi-mammate mice, *Mastomys* spp, which are common, commensal, small mammals to the north of central Namibia.

House mice populations rarely become problematic in Namibia. They are most often described as a casual pest. However, house mice are “plague”-prone, that is, they go through population cycles, and during population peaks, they have the potential of becoming serious economic pests, especially in the absence of local competitors. This does not have a high probability in Namibia, but coastal regions would be most vulnerable. Terrace Bay and MÖwe Bay have had major infestations, and this is a phenomenon that can be expected in any coastal development. In coastal feral situations, *Mus musculus* invades dune hummocks, and there is no information on the possible impacts this may have to local biodiversity.

Rattus rattus and *Rattus norvegicus*, the house rat and brown rat respectively are Old World pest rats recorded from all large urban centers in central and southern Namibia. They are rarely regarded as significant pests due to low population levels. This situation changes at the coast however. Rats are periodically common in Swakopmund, Walvis Bay and Luderitz, where they are most often reported to cause damage to gardens, and storage. The only known “feral” population in Namibia is the population of *Rattus rattus* at Sandwich Harbour. Similar to *Mus musculus*, *Rattus* are usually dependent on human-dominated environments, and are rarely strictly feral (as at Sandwich Harbour which is an odd case). There is little chance of either species causing conservation problems with local biodiversity, because there is limited interface. However, economic damage, primarily to storage in port towns is well documented. Rats adapt well to slum-like human living conditions and this would be the case on the Namibian coast as well.

Family: Leporidae

Oryctolagus cuniculus the common domestic rabbit occurs as a feral population on Possession Island (Cooper & Brooke 1986). The present status of the population is unknown. Unless introduced to other islands, this species does not appear to pose any threat to Namibia (it would not survive on the mainland). Vegetation on Possession Island is adversely affected, during high rabbit populations, and the possible interaction with ground-nesting birds is a possible problem.

Family: Felidae

Felis catus, and *Felis lybica*, are the domesticated house cat and African wild cat respectively. The house cat is a well-documented invader species. In Namibia, the problem is two-fold; they destroy elements of biodiversity in domestic circumstances, and interbreed with the African wild cat, therefore interfering with the wild species’ genetic integrity. Despite the fact that genetic pollution is often raised as a biodiversity-conservation issue (Griffin & Panagis 1985, Kolberg & Griffin 1996, Novell & Jackson 1996, Essop *et al.* 1997), very little is known about the problem. Feral house cats occur primarily in areas surrounding human infrastructure. It is not likely that they can survive in totally wild circumstances due to predation and competition. Domestic cats probably occur wherever man occurs in Namibia and therefore the genetic issue is already countrywide. At this point, the genetics of Namibian *Felis lybica* is of academic interest only. The complexity of the problem may also involve the African small spotted cat, *Felis nigripes*, which has a very limited distribution and is a species of high conservation concern. (Novell & Jackson 1996).

Family: Equidae

Equus caballus, the horse can survive even under harsh conditions. An isolated population of feral horses occurs in the vicinity of the Garub waterpoint, 30km west of Aus. Depending on veld conditions, the population varies between 300 – 350 horses. Due to their dependence on drinking water, this population is effectively contained, and therefore the geographic area of invasion is relatively small. Proposals to establish additional waterpoints for the horses, in effect giving them access to more favourable conditions in the east, must be considered carefully. Horses are a well-adapted invader species. Although there is no question as to the alien nature of the species, and it is MET policy to eliminate alien species from proclaimed conservation areas, it is felt that the tourist interest overrides any conservation concerns – which are negligible in this region. The Aus wild horses are an example of an alien species which adds value to the region.

Equus asinus, donkeys, are well-know invader species and have at times been problematic in restricted areas in Namibia. During the 1980's and 1990's a feral population became well-established in the western Hunsberg area, but this population was eliminated at considerable cost. The population in the Grootberg area reported by Griffin & Panagis (1985) has also since been eliminated (Loutit, pers. comm.). Donkey populations in the north-central communal areas are high (Mendelsohn *et al.* 2000), and the perceived situation became so critical that the Namibian Agronomic Board (on behalf of the Ministry of Agriculture, Water and Rural Development), considered a study of the situation in 2002. The motivation for this study, which was never done, was the high number of donkey-vehicle collisions in this area, as well as the perception that excess donkeys were responsible for contributing to broad-scale overgrazing. It seems probably that most of the donkeys in this region are not truly feral, but are used on a seasonal basis as draught animals by communal farmers (Orford and Christian, pers. comm.). The proportion of animals that are actually feral is not known, but may be increasing as local cultural and sociological priorities move away from subsistence farming and animals become obsolete. This trend, which may be wide spread in communal areas, requires monitoring.

2.2.3. The main invasive alien animals in Namibia

Based on this review, eleven alien animal species have the potential of becoming extremely invasive in Namibia. The aquatic species include the recently introduced freshwater crayfish, *Cherax quadricarinatus*, which would cause serious problems if allowed to escape into Namibian wetlands, the snail, *Lymnaea columella* due to its ability to colonize a variety of habitats and its role in the transmission of fascioliasis or liver fluke in cattle, the Mediterranean mussel, *Mytilus galloprovincialis*, the three highly invasive freshwater fish species *Cyprinus carpio*, *Micropterus salmoides* and *Oreochromis mossambicus* and the American red-eared terrapin, *Trachemys scripta elegans* considered internationally as one of the 100 worst invasive species (Lowe *et al.* undated). With the exception of the marine mussel, these aquatic species all pose a serious threat should they become established, in the perennial rivers. A comprehensive survey of the catchment areas of all Namibia's perennial rivers should be undertaken and if found these crayfish, snails, fish and terrapins must be eradicated from all aquaculture ponds, farm dams and natural pools. Legislation and supporting regulations must strictly prohibit the introduction of any of these species within the catchment areas of any perennial rivers, including the Cuvelai system.

The terrestrial species included in these top eleven are the domestic cat, *Felix catus* and the hybrid *Felix catus/lybica* and the rodents that are well established particularly at the coast and could easily pose economic and health risks, *Mus musculus*, the house mouse and the two rat species, *Rattus rattus*, the house rat, and *Rattus norvegicus*, the brown rat. Currently, a research project is being conducted on the genetic pollution of African wild cats within the Windhoek region, but this is expected to result in primarily academic information. The invasion of old World rodent pests at the coast should be closely monitored, as there are clear economic and public health implications.

2.2.4 Potentially invasive animals

Game farmers have long been importing mammals, Annexure 4 lists these alien mammals and alien genetic stock present in Namibia that are not currently considered to be invasive. Potentially invasive game species of possible genetic concern are given in List 6 below:

LIST 6: POTENTIALLY INVASIVE GAME SPECIES

- Thus far no feral populations of the Cape bushbuck, *Tragelaphus scriptus*, have been established. Geographically, it is highly unlikely that Namibian and imported stock will be in contact, except possibly in the region of the Waterberg Plateau Park, where Chobe bushbuck are scheduled to be introduced, and Cape bushbuck occur on adjacent farms. The primary function of the Waterberg Plateau Park is as a breeding (and later dissemination), site for rare and endangered Namibian species.
- All stock of nyala, (*Tragelaphus angasii*), mountain reedbuck, (*Redunca fulvorufula*), water buffalo, (*Bubalus bubalus*), blesbok (*Damaliscus dorcas phillipsi*), bontebok (*Damaliscus dorcas dorcas*) and fallow deer (*Dama dama*) are presently contained.
- All non-Namibian stock of waterbuck (*Kobus ellipsiprymnus*), lechwe (*Kobus leche*) and tsessebe (*Damaliscus lunatus*) are presently contained and not in contact with Namibian waterbuck, Namibian lechwe nor Namibian tsessebe. All non-Namibian stock of African buffalo (*Syncerus caffer*) that were introduced to the Waterberg Plateau Park, will eventually be transferred to South Africa. This population is comprised of founder stock from Addo in South Africa and East Africa.
- Non-Namibian common impala (*Aepycerus melampus*) have been imported and introduced to many commercial farms. The indigenous black-faced impala (a distinct morpho-type, and of high economic value), has been allowed to interbreed with common impala. This has reduced the conservation-value as well as the economic value of populations of genetically-compromised black-faced impala. Black-faced impala are high-value trophy animals, but cannot be successfully marketed if the purity of the animal cannot be guaranteed. Common impala from South Africa have recently been imported into the Salambala Conservancy, where they are expected to genetically-taint Caprivi impala. This infusion of alien stock will spread to neighbouring impala populations in the region. This is not good for neighbourly relations. This is one of the few Namibian invasive-alien situations which have been well-researched (Matson 2003, Lorenzen 2003) and the Ministry of Environment and Tourism is taking steps to mitigate the problem.
- All black wildebeeste (*Connochaetes gnou*) stock is presently contained. There are good data in South Africa, demonstrating cross-breeding between the black and blue wildebeest (an indigenous species). The conservation consequences of this are currently unknown.
- Namibian white rhino were extinct by the late 1880 and non-Namibian white rhino (*Ceratotherium simum*) stock, from Natal have been introduced into Namibian parks and private conservancies. Even though MET policy does not favour the introduction of alien species (especially into proclaimed conservation areas), an exception was made in this case due to the high tourist value of this species. There are very few places where tourists can view black and white rhino side by side.
- Non-Namibian roan antelope (*Hippotragus equines*) and sable antelope (*Hippotragus niger*), gemsbok (*Oryx gazella*), plains zebra (*Equus burchelli*) and springbok (*Antidorcas marsupialis*) stock have been imported and assimilated with indigenous Namibian roan, sable, gemsbok, plains zebra and springbok, therefore creating genetically-compromised populations, which are of reduced conservation value. Before translocations, three described subspecies of springbok occurred in Namibia.

In addition to these, three potentially invasive marine species may be added, *Carcinus maenis*, the European shore crab, *Littorina saxatilis*, the European periwinkle and *Sargartia ornate* anemone that have been found along with *Mytilis galloprovincialis* in the Saldana Bay-Langebaan lagoon system (Robinson *et al* 2004). These have been introduced in ballast water of visiting ships to the port at Saldana. Similar introductions are likely via Walvis Bay Harbour. Collaboration with authorities in South Africa should be strengthened to avoid the unintentional introduction of marine species by ship ballast and ship hull fouling.

2.3 FACTORS THAT INFLUENCE SPECIES INVASIONS

2.3.1 The growth and spread of invasive alien plants

Bethune and Roberts (2002) identify seven factors that contribute to the successful growth and spread of alien aquatic weeds, many are equally true for the invasiveness of many terrestrial plant species. Alpert *et al.* (2000) in their review of invasiveness, “invasivity” and the role of environmental stress, attribute the tendency to invade to a wide native range, rapid dispersal, large seed set, small seed size, prolonged seed viability, phenotypic plasticity, (how unlike a plant is to its competitors) and habitat susceptibility.

A scientifically sound review of the invasiveness of each alien species and the susceptibility of local natural ecosystems to invasion is needed in Namibia and will allow for more effective management and control.

- Absence of natural enemies: Most plants are fed on by something or host parasites, but when they are moved out of their natural habitats, these natural enemies are often left behind and there is nothing in their new niche that is quite as effective at controlling the growth of these plants, as a result they do very well and soon out compete indigenous plants that are subject to herbivores or pests.
- Broad native range: Species with wide distributions are logically more likely to be able to colonise a wide variety of habitats with different conditions.
- Rapid growth rates: In less tropical areas, sunlight may be a factor limiting growth and when plants from these areas find themselves in a sunny tropical climate, such as Namibia, they take advantage of the increased light, or longer growing seasons and do really well again out-competing indigenous species not able to utilize increasing amounts of light.
- Availability of nutrients: Plant growth is often limited by the availability of nutrients such as phosphorus, nitrogen and in the case of terrestrial plants also potassium. When these nutrients (the ingredients of most fertilizers) are more available perhaps as a result of eutrophication or pollution, alien plants are sometimes better able to take advantage of this and thus outgrow the indigenous species.
- Reproductive strategies: Plants that can reproduce vegetatively from plant fragments as well as by spores or seeds have an advantage over those that are tied to sexual reproduction and the seasonality that bearing spores or seeds impose. Many aquatic weeds are very good at vegetative reproduction and so even small bits of plants can potentially infest new areas or re-infest cleared areas. Others that have seeds that remain viable for many years or are resistant to frost or desiccation also are better able to colonize new areas. The production of large numbers of seeds, small easily dispersed seeds and seeds that remain viable for many years are all contribute to the rapid spread and establishment of invasive plants. Studies show that water hyacinth seeds remain viable up to 15 years, allowing seeds deposited in seldom flooded areas to remain viable for prolonged dry periods.

- Difference to indigenous competitors: Alpert *et al.* (2000) and others also point out that “invasivity” of alien species may also be correlated with how different the alien species is to the indigenous species found in the same habitat. This is referred to as the “unlike invader” hypothesis e.g. *Opuntia* species, although sharing many adaptations to herbivory and aridity with the indigenous species in the Highland Savanna, have a growth form, armoury and vegetative reproduction strategy that may well give them a competitive edge.
- Ability to colonize new habitats: In addition to resistant seeds and spores and the ability to reproduce vegetatively, some invasive plants have special colonizing growth forms. An example is *Salvinia molesta* that when young has flatter, more open leaves that allow it to float well and so be easily translocated to new areas. Both *Salvinia* and *Pistia stratiotes* have “roots” and “stolons” that become easily entangled and so promote mat formation, a strategy that shades out competing indigenous water plants.
- Human activities: People alter habitats and translocate plants to new areas. For aquatic plants the increased utilization of water bodies and the construction of artificial ones, be they impoundments or irrigation canals, create new habitats where water weeds can flourish. Increasing pollution and land clearing are further factors creating ideal conditions for problem plants to flourish.
- Lack of awareness and vigilance: A general lack of awareness regarding the identification and problems caused by invasive alien species promotes their inadvertent spread, particularly via the horticultural, aquacultural, and recreational industries. Botswana has introduced and Aquatic Weeds (Control) Act No 58 of 1987 that strictly controls boat traffic to prevent the spread of aquatic weeds. For several years Namibia undertook voluntary boat inspections at border checkpoints to assist Botswana with this effort to prevent the spread particularly of *Salvinia molesta*.
- Susceptibility of habitats: Some habitat types appear to be more susceptible to invasion than others, and successful invasion is a function of both the invasiveness of a species and the invasibility of a habitat. Alpert *et al.* (2000) reviews this and suggests that mature forests, arid (but not necessarily semi-arid), montane and salt marsh habitats are less likely to be invaded, whilst riparian habitats and islands are most susceptible. Since much of Namibia’s west and south is arid, it is not surprising that relatively few species have invaded these areas, other than along riparian habitats.

Clearly, the woodlands, riparian forests and wetlands of Caprivi are at greater risk, yet with the exception of the well-documented infestation of the aquatic weed, *Salvinia molesta*, relatively light, localised infestations of terrestrial weeds were found in the Caprivi during the surveys prior to the 1984 workshop. This was probably due to its, then isolation from “development” (Hines *et al.* 1985). Since independence development activities have increased and this together with relatively good rainfall makes the Caprivi region vulnerable to invasive species.

Other habitats such as the Mountain savanna around Otavi, Grootfontein and Tsumeb, and the Highland savanna are also at risk. This is largely due to their close proximity large towns with established gardens and active nurseries. These areas may be more vulnerable due to their probable high level of endemism (Irish 2002).

2.3.2 The introduction and establishment of invasive alien animals

With the possible exception of the Mediterranean mussel, all invasive alien animals identified were introduced by man and have established best in aquatic environments or in urban settings.

The past situation where game animals were freely imported into South West Africa from South Africa is based on the historical political arrangement whereby South West Africa was governed and managed as a fifth province of the Republic of South Africa. Thus, any species indigenous to South Africa, was by default considered indigenous to South West Africa as well. During this period there was little awareness of genetic pollution as a conservation concern. There were also the normal system errors that led to the import of “extremely-exotic” species, imports not based on a policy or philosophy, but simply lax administration. At the same time, the import of small exotic species for the pet trade was well controlled, with the exception of birds. Pet shops, were not allowed to import many of the alien species that were popular in South Africa.

Prevention of future introductions thus lies with timely control of imports. Guidelines on disposing of illegal specimens are provided by both IUCN and the CITES, the International Union for the Conservation of Nature and the Convention on International Trade in Endangered Species of Flora and Fauna. These guidelines should be implemented as a matter of policy. A recent example where these guidelines were not followed has resulted in the captive breeding of a *Python natalensis* from South Africa (unknown origin) with one from the Erongo Mountains in a Namibian snake park. Since the batch of young are genetically polluted, the young cannot be released. It is also not satisfactory to distribute the young out on a custodial programme, as some will eventually escape into the wild. The only choices are to euthanise them, or keep them securely contained in Namibia making sure that there is no chance of them being released into the wild. This is a local example that could have been avoided by following available guidelines. The exotic pet trade is a major culprit in the introduction of alien and often invasive species and the major concerns in the Namibian context are highlighted.

The importation of alien species as pets almost always puts a drain on wild populations, even though the animals are claimed to be captive-bred. The illegal insinuation of wild caught animals into “captive-bred” shipments is standard procedure. By encouraging these markets, the supply of exotic pets, we are also responsible for the conservation problems these markets cause in the country of origin. Namibia in effect supports conservation measures in foreign countries by not promoting these markets. In much the same way Namibia has an international obligation not to export Namibian species to other countries where they could cause genetic pollution. The recent agreement of the Government of Namibia to export animals to Nigeria is an example of such irresponsible trade.

The keeping of exotic pets becomes a cultural issue. For instance, South Africans moving to what was then South West Africa brought with them their exotic cage birds and this practise became instilled and it would have been futile to try and control the market as was considered in the 1970s. On the other hand, by strictly controlling and essentially banning, the importation of alien reptiles, Namibia has been able to avoid the culture of keeping exotic reptiles as pets and the myriad problems associated with it. Namibia has successfully avoided a situation that South Africa finds itself in. Keeping of exotic pets is also an animal welfare issue, because these markets have extremely high mortalities, and few people have the skills needed to keep these animals well in captivity. In some western cultures, exotic pets are considered to be disposable interactive toys.

Namibia would like to market its eco-tourism industry based on indigenous wildlife. The discerning eco-tourist is aware of viewing alien species in unnatural surroundings, besides which Namibia cannot compete with South Africa on exotic animal safari experiences. In this regard, the Namibian Professional Hunting Association has taken up this issue in its policy on the importation and translocation of game. The association proudly promotes the use of indigenous species as Namibian products (Lambrecht pers.comm.) and takes care not to contaminate Namibian game through the introduction of animals from outside the country or from different geographical areas.

2.4 MAIN BIOLOGICAL, SOCIAL AND ECONOMIC IMPACTS

2.4.1 Biological impacts of invasive alien plants in Namibia

One can expect that alien invasions occurring in high densities and over large areas will have large impacts on biodiversity and ecosystem functioning, but this relationship is not always clear. Some invasive species may have impacts greater than their distribution and density would imply. For example, localised dense invasions in small specialised habitats with rare, endemic species restricted to these habitats could very easily lead to extinctions. Invasive alien species can negatively impact biodiversity directly through displacing and out-competing other species for natural resources, or can alter the ecosystem functioning by performing an entirely new function in that ecosystem e.g. invasive leguminous plants can increase soil nitrogen levels in nitrogen poor soils (Parker *et al.* 1999). Impacts can be measured by looking at changes of population dynamics of native species, communities, or ecosystem processes. The biological impacts of invasive terrestrial species in Namibia have never really been thoroughly investigated, other than to measure the distributions and densities of the invasive alien species. Impacts on populations, communities and ecosystem processes have been inferred but not measured.

Henderson (2001) categorises invasive alien plant species in South Africa, in terms of their biological impact on ecosystems as either:

- Transformers: plants that can replace or dominate a canopy or sub-canopy layer, altering structure and functioning of the ecosystem.
- Potential transformers: Plants that have the potential to dominate a canopy or sub-canopy layer but do not currently show any marked effects. They may be transformers elsewhere.
- Special effects weeds: plants that can degrade the value or purpose of an ecosystem without necessarily altering its vegetation structure and functioning. They may replace indigenous plants or may be toxic or contain irritants or allergens. or
- Minor weeds: plants that are not particularly aggressive and do not dominate as mono-species nor seriously affect ecosystem functioning although many different minor weeds may do so through cumulative effects.

Some examples, bearing in mind that these have not been thoroughly investigated and are thus mostly inferred, of the biological impacts of the most invasive plant species are given below:

- *Argemone ochroleuca*, the white flowered Mexican poppy, displaces other species in disturbed areas particularly in and near watercourses. Seeds are water dispersed and possibly also dispersed by birds (Muller, 1985). Muller (1985) suggests that it does not compete with other plants but this cannot be verified and the fact that it covers such large areas means that it must at least compete for space. In South Africa it is regarded as a special effects weed (Henderson 2001).
- Competition by *Datura*, or thorn apple species with indigenous plants is seen as minimal, but they displace herbaceous vegetation of the river banks (Muller 1985). Seed production, germination success and seed longevity is very high (Landsdell 1927, cited in Brown 1985) which means that re-invasion after clearing is inevitable. It is likely that annuals such as *Argemone ochroleuca* and *Datura* spp. that form dense mono-stands in disturbed areas tend to displace local disturbance specialists. This in turn is likely to impact on pollinators, herbivores and other species which might not be able to utilise the invasive species. Further studies should investigate the impact of these invasive alien species on ecosystem functions such as pollination more thoroughly.

- *Melia azedarach*, syringa, is considered to be a threat to indigenous tree species along the Omuramba Omatako (Muller 1985). In South Africa it is widespread and considered a transformer (Henderson 2001).
- Although Muller (1985) concluded that *Nicotiana glauca*, wild tobacco, does not compete much with indigenous vegetation, Henderson (2001) regards it as a competitive special effects weed. Its widespread use by sunbirds as a source of nectar means it may have subtle ecosystem effects beyond mere physical displacement of competitors.
- The various *Opuntia*, or prickly pear species are considered to out-compete indigenous plant species (Muller, 1985). They, and other alien succulents from the Americas, yet to be identified, are likely to displace indigenous species and cause problems to livestock (Orford, in prep.). They can be regarded as the biggest alien invasive threat in the Highland savanna.
- *Pennisetum setaceum*, fountain grass, may have major impacts on biodiversity of restricted range plant species in the biodiversity important Auas Mountains if they move from road verges into the Auas Mountains (Joubert & Cunningham, 2002, 2004). There is evidence that they are moving from road verges.
- *Dodonaea angustifolia*, may have similar impacts on biodiversity (Cunningham *et al.* 2004).
- *Lantana camara*, had not been shown to out-compete indigenous vegetation in the Grootfontein district but experiences in South Africa and elsewhere suggest that it could do so (Muller, 1985; Henderson, 2001). Its limited presence in riverine habitats near springs in the Waterberg Plateau Park is cause for concern. Biological control methods are available for *Lantana* (Muller, 1985, Olkers & Hill 1999).
- *Prosopis* spp. have a major impact on alluvial aquifers in ephemeral rivers (for example in the Swakop River (Boyer & Boyer 1989) and the Nossob River (De Klerk 2004) by displacing other ephemeral river species such as *Faidherbia albida*, in the Swakop River and *Acacia erioloba*, in the Nossob River. *Prosopis* stands in the Kalahari, South Africa have negatively affected bird species diversity compared to indigenous *Acacia erioloba* woodland in drainage lines (Dean, *et al.*, 2002). Visser (1998) found a trend of decreasing plant species richness with increasing density of *Prosopis glandulosa* in the Swakop River. It is suspected that *Prosopis* spp. upstream in the Nossob River reduce flooding to such an extent (by absorbing water, and thus reducing groundwater levels downstream) that *Acacia erioloba* trees downstream have lower survival rates (C. Steenkamp, pers. comm.). It is considered a transformer (Henderson 2001).
- Aquatic weeds such as *Salvinia molesta* Kariba weed, *Pistia stratiotes*, water lettuce, *Myriophyllum aquaticum*, Parrot's feather and *Azolla filiculoides*, red water fern, threaten indigenous species by their impact on aquatic habitats. Dense weed cover, as caused by mats of *Salvinia* or *Pistia* cut off sunlight from submerged indigenous aquatic plants which may in turn decrease photosynthesis and thus the amount of dissolved oxygen in the water causing aquatic animals to move to more favourable habitats, or conversely may provide a suitable habitat for pest species such as bilharzia carrying snails (Ashton *et al.* 1986, Bethune & Roberts 2002). Studies beneath *Salvinia* mats in Lake Liambezi in the late 1970's revealed that weed mats tend to reduce biological diversity (Seaman *et al.* 1978). Dense water weed infestations can also increase siltation, both as debris from dying plants in the mat, Edward and Musil (1975) report an annual build up of 30 cm of debris under water hyacinth mats, and as a result of silt being trapped by the roots of weeds such as *Myriophyllum aquaticum* (Jacot Guillarmod 1980).

As shown by the “Working for Water Programme” in South Africa many alien riverine species compete with indigenous species for groundwater and eradication has improved base flows in several perennial rivers.

2.4.2 Biological impacts of alien invasive animals in Namibia

The main biological impacts associated with alien invasive animals in Namibia are competition with indigenous species, the threat of genetic pollution and subsequent loss of conservation value, transmission of disease causing parasites and habitat alteration. Some specific examples are:

- *Lymnaea collumella* has proved to be aggressively invasive and as the host of the liver fluke, *Fasciola hepatica*, also plays a role in the spread of cattle disease. It occurs in the same habitats as the indigenous species *Lymnaea natalensis* and does not appear to have any adverse impact on other aquatic invertebrates.
- *Cherax quadricarinatus* based on experiences elsewhere with these and similar exotic freshwater crayfish, show that they can out compete indigenous freshwater shrimp and crab fauna, (there are no indigenous freshwater crayfish in Africa) destabilize river banks by burrowing, increase water turbidity, destroy water plants and generally have the potential to become serious pests if released into Namibian wetlands.
- *Mytilus galloprovincialis* is now common on the rocky shores of Namibia but in recent years densities have decreased. As it is not considered to be of any economic importance at this stage, no detailed studies have been undertaken of its impact in Namibia, but densities are declining (B. Currie pers com). Off the west coast of South Africa it has replaced the ribbed mussel *Aulacomya ater* in the intertidal zone and according to Phil Hockey has a serious effect on other intertidal invertebrates, although it does not seem to compete directly with indigenous black mussels, *Choromytilus meridionalis* (de Moor & Bruton 1988).
- *Cyprinus carpio* is a well-known nuisance, known to alter habitats to the detriment of indigenous fish species. Carp are known to compete for food with indigenous fish, eat the spawn of other fish, and as bottom feeders they disturb sediment, increasing turbidity and uproot aquatic plants. A detailed review of these impacts is given by, de Moor and Bruton (1988).
- The impact of *Micropterus salmoides*, the large mouth bass, is mainly due to its predatory behaviour which has had a negative impact on many indigenous species in southern Africa, the best documented of which is their impact on ten minnow species in the Olifants River system in South Africa where no predatory fish occurred before the release of bass into Clanwilliam dam (de Moor & Bruton 1988). Similar detrimental consequences are feared should this fish be introduced to Namibia’s shared perennial river systems.
- The main concern regarding the introduction of *Oreochromis mossambicus* into our northern perennial rivers is genetic pollution. These fish are considered sufficiently similar to indigenous species such as *Oreochromis macrochir* and *Oreochromis andersonii* to interbreed and thus there is a danger of hybridisation as well as likely competition for spawning areas and food (Bethune & Skelton 1984, Skelton & Merron 1984, Schrader 1985, de Moor & Bruton 1988). As one of the top 100 worst alien invasive species on the IUCN list (Lowe *et al* undated), *O mossambicus* may also out-compete indigenous tilapia.
- *Trachemys scripta elegans*, the American red-eared terrapin or slider, is highly invasive elsewhere and the main concern, if they are introduced into Namibian rivers, is that they may out-compete indigenous and endemic *Pelusios* species.

The introduction of *Trachemys scripta elegans* may have large geographical consequences in systems such as the Orange and Kunene rivers where no indigenous species of river terrapins occur. For example, turtles introduced into the lower Orange River would eventually spread upstream throughout the South African watershed, whilst from the Kunene River and from rivers in the Caprivi, infestations could spread into central Africa. Since South Africa is the only importer of these terrapins in southern Africa and its borders are notoriously porous, every effort must be made to close the market in South Africa. Immediate action should be taken to ban the import of this species and a national survey of vulnerable wetlands should be undertaken to locate and immediately eradicate any found.

- The biological impacts of *Felis catus* are that they destroy elements of biodiversity and that they interbreed with the African wild cat *Felis lybica*, thus interfering with the wild species' genetic integrity. Despite the fact that genetic pollution is often raised as a biodiversity-conservation issue, little is known about the problem. The interaction of these hybrids with *Felis nigripes*, the African small spotted cat, is unknown, but thought to be a matter of concern. The current listing of *Felis nigripes* is "Vulnerable and declining".

2.4.3 Social and Economic impacts of invasive alien plants in Namibia

In addition to the biological impacts of habitat alternation and biodiversity changes already mentioned, Bethune and Roberts (2002) discuss four problems associated with aquatic weed infestations. They are:

- Interference with hydropower production, irrigation schemes and water intakes: Elsewhere in Africa, aquatic weeds cause serious problems in irrigation schemes, at water intake points and they can block hydropower turbines. With the proposed expansion of irrigation in the Caprivi, both *Salvinia* and *Pistia* can pose serious problems. New irrigation canals can translocate of these weeds to new areas.
- Physical impediment to access, flow, transport, fishing and recreation: Most of the impacts caused have to do with the sheer mass of plants and the impenetrable mats they can form. Dense mats can hamper access to fishing areas and because of their mobility can engulf fishing nets set earlier in the day and block access to landing sites. In Lake Liambezi, *Salvinia* mats caused a decrease in fish catches (Seaman *et al* 1978). Plant material caught in boat propellers is a problem to both fishermen and recreational boat users. Mats, particularly those that support secondary growth of sedges on so called "sudd" islands can completely block water ways and hinder navigation and would pose a serious threat if *Salvinia* ever succeeded in spreading further into the Okavango Delta in Botswana. Isolated infestations have been found and dealt with.
- Water quality deterioration and health risks: The lower concentrations of dissolved oxygen beneath *Salvinia* mats in Lake Liambezi, impaired water quality making it unfavourable to both fish and the zooplankton they feed on (Seaman *et al* 1978). Decaying plant material from mats can increase the nutrient loads on these waters and so promote the growth of the weeds. Established mats have been shown to provide breeding sites for malaria mosquitoes as well as bilharzia snails.
- Water loss due to evapo-transpiration: Some emergent and floating-leaved aquatic plants increase water loss by evapo-transpiration. Although this is true for water hyacinth in South Africa where weed cover increased water losses 3.5 times with 100 plants per m² transpiring up to 5 litres of water per day (Bosman 1999), these figures should be applied with caution in Namibia where relative humidity is low and evaporation rates are high.

Increases in transpiration by aquatic plants may be off-set by decreases in evaporation due to the shading effect of the plant cover and reduction in the drying effect of wind at the waters' surface. A study on reducing evaporation rates using duckweed as a plant cover compared to open water surfaces showed no appreciable difference in central Namibia during the winter months (Sandin 1997). It would be interesting to repeat this in summer.

2.4.4 Social and Economic impacts of alien animals in Namibia

The potential introduction of species such as the freshwater crayfish, *Cherax quadricarinatus*, the alien fishes *Cyprinus carpio*, *Micropterus salmoides*, *Oreochromis mossambicus* and the American terrapin, *Trachemys scripta elegans* could have a detrimental economic and social impact on fisheries in the northern and north eastern perennial rivers, by causing habitat changes that could increase water turbidity, sedimentation and impact on breeding success of indigenous species. The most obvious economic and social impact in a country where so many people own cattle is the potential of *Lymnaea collumella* to invade the northern and north eastern wetlands and spread liver fluke.

Rodent pests such as the house mouse, *Mus musculus* and rats, *Rattus rattus* and *Rattus novogicus* can cause economic losses by raiding grain stores particularly in our harbour towns and have been known to spread diseases. *Mus musculus* has demonstrated its ability to colonise coastal hummocks of the southern and northern Namib Desert. Thus far, no biodiversity problems are known. However, an endemic species of gerbil, *Gerbillurus infernis* which is restricted to small isolated coastal hummocks in the Rocky point area, may be vulnerable to this invader species.

The Ministry of Environment and Tourism, the tourist industry and the Namibian Professional Hunting Association, NAPHA, have recently agreed to market Namibia's indigenous species to eco-tourists and hunters. In this regard, alien species are actively discouraged, and some are banned. The two Namibian snake parks, in Swakopmund and at Makuti Lodge outside Etosha, only display indigenous species. This is a policy instituted in tandem to shape the quality of the environmental experience an eco-tourist can expect, rather than a strictly invasive alien species issue, but it obviously has value in this regard as well. The marketing of "clean" eco-tourism, as opposed to "artificial", makes good economic sense in Namibia. The black-faced impala is of high economic importance to the trophy industry as well as for eco-tourism.

In a social sense these policies encourage Namibians to be aware and proud of indigenous species and to be cautious of alien species. The loss of genetic integrity of Namibia's indigenous species is perhaps the biggest threat, and this is protected by the constitution and by international conventions on biodiversity. Currently the Ministry of Environment and Tourism is spending time and resources on this particular issue of dealing with alien strains of game animals from South Africa. The eradication of invasive aliens can always be expected to be problematic and expensive. An example of a possible inadvertent introduction into a protected area is that of Cape bushbuck, already present on neighbouring game farms, into the Waterberg Plateau Park, the slopes of which provide an ideal habitat. Care must be taken to avoid such contamination of indigenous strains. Similarly Namibia should take care not to export its particular strains to countries where they could in turn cause genetic pollution and reduce the conservation value of indigenous populations. Even within the country care should be taken not to transfer animals across natural geographic boundaries.

3 LEGAL AND POLICY FRAMEWORK

This section draws on the review documents by Malan (undated & 2004, in Tarr 2004) and our own scrutiny of relevant policies, legislations, ordinances, regulations, protocols and conventions.

3.1 NATIONAL POLICIES AND LEGISLATION RELEVANT TO THE MANAGEMENT AND CONTROL OF INVASIVE ALIEN SPECIES

3.1.1 The Constitution of the Republic of Namibia

The Constitution of the Republic of Namibia lays the foundation for all legislation and policies in Namibia. Although no mention is made of invasive alien species, Article 95 stipulates that the State shall actively promote and maintain the welfare of the people by adopting policies which include:

the “maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and utilisation of living natural resources on a sustainable basis for the benefits of all Namibians...” (Article 95(1), Constitution of the Republic of Namibia).

The maintenance of the overall ecosystem is therefore a national obligation underpinning all actions of the legislature, and thus includes the control of invasive alien species where their introduction, translocation, spread or physical presence poses a threat to any ecosystem or ecological process, or to biological diversity or the welfare (health or bio-safety) of people, or to the sustainable utilisation of natural resources.

3.1.2 Policy of the Ministry of Environment and Tourism

Until 1984, there was no policy on alien introductions, other than that anything that was permissible in the Republic of South Africa was also acceptable in the then, South West Africa. Import permits were required (and regularly issued), but a minimum of thought, consideration and consultation was involved in the evaluation of applications.

In order to improve this situation and create a national policy and formal application review process, a workshop to coincide with the annual Directorate of Nature Conservation’s research officers’ meeting was held in November 1984. The results of this workshop are documented in Brown and Macdonald (1984), and in Brown, Macdonald, and Brown (1985). Although there was consensus during this meeting that a formal mechanism would be established to review all future applications to import alien species (except some pet birds and “domesticated” plants), this decision (by the group) was not recorded in the two references covering this meeting. Although each workshop contributor gave sound recommendations as part of their presentations (Brown & Macdonald 1984), only some of these are reflected in their summing-up of these presentations in the 1985 published report (e.g. Brown 1985; Griffin & Panagis 1985; Hines *et al.* 1985; Schrader 1985). As far as can be established, the review forum agreed on at the workshop convened only a few times (once to consider an application to import European earthworms in 1987) and then was left out of the decision-making process.

The meeting did underline the need for consultation, and this, as an informal mechanism, became the norm. When questionable applications were received, these were often passed on to the scientists dealing with these groups. For instance, the ornithologist Dr. C.J. Brown was able to influence the system considerably with regards to proposed bird imports. The meeting raised the awareness of the Directorate, but irregular permits continued to be issued, and still are today. Since then, a departmental policy on the importation of alien reptiles and amphibians (Griffin & Morsbach 1993) has been published. This document highlights the importation of exotic species via the international pet trade.

Even though there is awareness of the principles of genetic conservation and widespread concern regarding the importation of alien species, this has not necessarily improved the situation much; recent examples in Namibia are the importation of South African impala into the Salambala Conservancy in 1999 (which will mix with Caprivi black-faced impala) and the importation of Cape bushbuck and mountain reedbuck into central Namibia. The hybridisation of black-faced impala and common impala (from South Africa) is a well-known conservation disaster.

The Ministry of Environment and Tourism, MET, is aware of invasive alien issues and these are now being thoroughly addressed in the new Parks and Wildlife Management Bill (See 3.1.4 below).

Sometimes clear policy and legislation alone are not sufficient: the Ministry of Fisheries and Marine Resources, MFMR, approached the MET regarding the importation of the Australian *Cherax quadricarinatus* (freshwater crayfish, a genus very well documented as an invader species). The MET opposed the importation, but the species was imported anyway, and now these crayfish are established in Namibia, albeit subject to strict permit requirements. Presumably, socio-economic considerations were allowed to override the brief of the MET. This decision on the part of the MFMR goes against their own stated aims of “maintaining genetic diversity and the integrity of aquatic ecosystems” (Principles, 2.1, MFMR Cabinet Memorandum, March 2001; and 3.1.9 Protocol for Environmental Assessments), Namibia’s Aquaculture Policy of 2000, subtitled “Towards responsible development of Aquaculture” and the more recent Aquaculture Act (Act 18 of 2002), Inland Fisheries Resources Act (Act 91 of 2003) and Aquaculture (licensing) regulations 246 of 2003 (see 3.1.7 below.)

3.1.3 Other relevant Ministry of Environment and Tourism-associated policies

- Namibia’s Green Plan – Environment and Development (1992)

Although there is no specific mention of invasive alien species, the Green Plan presented by the President of the Republic of Namibia at UNCED, the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992 (Brown 1992), does caution that environmental policies must be based on the precautionary principle.

More pertinently, the sections dealing with water resources and wetlands state that “Namibia’s objective is to manage its water resources for present use without jeopardising future water supplies, biotic diversity and/or ecological processes”; and that to promote wetland conservation, “genetic resources should be protected and the rich biodiversity maintained”; and that “legislation is needed to protect wetlands from damaging human activities.”

- Land-use Planning: Towards Sustainable Development (1994)

This document defines five physiographic land forms: communal state land; privately-owned commercial farmland; proclaimed state land; urban areas; and wetland systems. Although there is no specific mention of invasive alien species, there are numerous references to sustainability of natural resources, biodiversity and essential ecological processes.

- The Tourism White Paper (1994)

This identifies eco-tourism for foreign visitors as the primary product, and assigns to the Ministry of Environment and Tourism the primary responsibility to “coordinate inter-ministerial activities relevant for tourism and cooperate with the private sector to create a national tourism identity” (3.13). This development process should by implication thus follow the ministry’s policy on invasive alien species.

- Namibia's Environmental Assessment Policy (1995)

As a guiding principle, this policy states that “Namibia shall place a high priority on ... maintaining ecosystems and related ecological processes ... maintaining maximum biological diversity”.

Appendix B lists activities requiring environmental impact assessments, and pertinently includes:

- “Introduction and/or propagation of invasive alien plant and animal species;
- Genetic modification of organisms & releases of such organisms; and
- Aquaculture and mariculture.”
- Community-based Tourism Policy (1995)

No mention of alien vs. indigenous wildlife is made, but there is emphasis on environmental sustainability and biodiversity conservation. It stresses community participation in tourism.

- Wildlife Management, Utilisation and Tourism in Communal Areas (Jones 1995)

This includes very little discussion on maintaining environmental quality, and defers all research and wildlife management issues to the Ministry of Environment and Tourism (where invasive alien species issues would be addressed).

- Namibia's Unwanted Biodiversity: Alien Invasive Species (Griffin and Simmons 1998)

This review was a requirement of the United Nations Convention on Biodiversity (UNCBD), and in effect reflects the policy of the Namibian government on national implementation of the convention, which recognises invasive alien species as the single biggest cause of biodiversity loss.

- Policy for Prospecting and Mining in Protected Areas & National Monuments (1999)

There are two points that are relevant to the issue of invasive alien species:

- The MET regulations control wild and domestic fauna and flora (in and out of proclaimed areas).
- Environmental Impact Assessments, EIAs, are required, and potentially invasive alien species should (presumably) receive due attention.
- Development Forestry Policy for Namibia (2001)

This policy aims to “reconcile rural development with biodiversity conservation by empowering farmers and local communities to manage forest resources on a sustainable basis...” Although biodiversity conservation is central in this regard, and invasive alien species are a recognised threat and are often introduced through forestry activities, the policy omits any mention of invasive alien plants, or their introduction and control.

- Revised Draft Tourism Policy 2001 – 2010 (2001)

Although environmental sensitivities and sustainability are stressed throughout the report, no mention is made, in policy, philosophy, or guiding principles, of marketing indigenous Namibian wildlife. An improvement would be to discourage the importation of alien species as tourist attractions, placing more emphasis on a clean indigenous environment. The policy stresses that no tourism development should be at the cost of biodiversity and requires that some of the income derived be re-invested in natural resource conservation (hence a possible source of funding for invasive alien species control projects).

- Namibia's Wetland Policy (November 2003 draft and September 2004 revision)

The original 2003, draft of Namibia's wetland policy contained several clauses relating to invasive alien species and based on the results of this review it has been possible to strengthen these in the 2004 revision.

The introduction of invasive species is specifically mentioned in section 3.2 as one of the major causes of wetland degradation, and the policy lists the five most invasive waterweeds (*Salvinia molesta*, *Azolla filiculoides*, *Pistia stratiotes*, *Myriophyllum aquaticum* and *Eichhornia crassipes*) and recognises that "the introduction of invasive animals can cause pest problems, habitat destruction and in the case of non-indigenous species, genetic pollution of closely related native animals." Included in section 4.2 on wetland resource use and conservation principles are two pertinent clauses:

- "The importation of, and trade in, seeds, plants and animals that are alien to Namibia and that have the ability to invade natural wetland habitats and thus compete with or threaten the survival of indigenous species shall be avoided; and
- Alien aquatic weeds (including the Kariba weed, *Salvinia molesta*, water hyacinth, *Eichhornia crassipes*, red water fern, *Azolla filiculoides*, water lettuce or Nile cabbage, *Pistia stratiotes* and parrot's feather, *Myriophyllum aquaticum*) and other alien invasive organisms that threaten wetland functioning and production shall be controlled through a combination of government-funded mechanisms, local government incentives and cross-border co-operation. Within Namibia the translocation of aquatic, semi aquatic and riparian species between catchments should be subject to the EA process. "

New clauses in the recently revised draft are include in section 4.3 on legislative and regulatory principles that now specifically includes a pertinent clause on regulations: "

- "Regulations shall be made to prevent and control the introduction and translocation of potentially invasive species."

And in section 4.5 on research and information principals that has been revised to include a clause requiring research and monitoring of invasive alien species:

- "Research on the impacts, control and management of aquatic and riparian invasive and alien species shall be conducted and lists of potentially invasive species and their status shall be regularly updated."

3.1.4 Nature Conservation Ordinance, No. 4 of 1975, and amendments

Although this legislation, which is the legal authority until repealed (sometime in 2004), does not specifically deal with invasive alien species, the issues dealt with below are relevant to the historical problem.

- The definition of "wildlife" did not include invertebrates, and the Republic of South Africa was included with the "Territory" of South West Africa, so species indigenous to the greater region were regarded as non-exotic locally:
 - "Exotic game" means "any vertebrate ... whether kept or bred in captivity or elsewhere, belonging to a non-domestic species the habitat of which is not in the Republic of South Africa or the Territory."

- **“Wild animal”** (a)... “any vertebrate ... the habitat of which is in the Republic of South Africa or the Territory. (b) ... any vertebrate belonging to a non-domestic species”

Until relatively recently, there was little recognition of the problems posed by invasive alien species (including genetic issues). Many problems today can be traced back to ignorance and the lack of political will, as well as to non-implementation of that legislation.

Relevant clauses include:

- 17 (2) “ The Cabinet may within a game park or a nature reserve- (b) take such steps as will ensure the safety of animal and plant life and [its] conservation in a natural state.
- 18 (1) ... no person shall without the written permission from Cabinet- (c) within a game park or a nature reserve wilfully or negligently injure ... or disturb any animal ... (d) wilfully or negligently cause ... any damage to objects of scientific interest within a game reserve or a nature park (e) introduce any animal or permit any ... to enter a game park or reserve.
- 49 (1) no person shall import into the territory ... any game or wild animals ... except under a permit granted by cabinet.
- 49 (2) the Cabinet may at any time in its discretion, place a prohibition on the import into the Territory... [of] any species of game or wild animal.”
- Section 66 deals with fish in inland waters and prohibits the placing or release of any fish in inland waters except in aquaria and ornamental ponds. Malan (undated) points out that this effectively prohibits the introduction of alien and invasive fish, since the review by Malan, this clause has been repealed in the Inland Fisheries Resources Act 1 of 2003, which essentially takes over the responsibility for freshwater fish. (See 3.1.7).
- According to sections 78 and 84 “the Minister may-
 (b) take the measures which it may deem necessary or desirable in connection with the propagation and preservation of wild animals, exotic game, fish and plants
 (c) take measures ... for destruction, decrease or elimination ... of any ... species ... which may be harmful or detrimental to the existence of any other species ...
 (g) take any measures ... for research ... exotic game
 (h) take any measures ... for making surveys ... in connection with ... exotic game ...
 (j) take the measures ... for the control of aquatic vegetation ...
 84 (1) (s) issue regulations with regard to ... the import, cultivation and control of any plant ... indigenous or not ... detrimental to, or create less favourable conditions for, any wild animal, fish or indigenous plant.”

Malan (undated) in his review of this legislation sums up that within the wide scope of the provisions of this ordinance, the Ministry clearly does have jurisdiction with regard to alien and invasive species, and recommends that well thought-out amendments to the regulations of this ordinance, perhaps pertaining to the functions of nature conservators and honorary nature conservators, could go a long way towards assuring that issues pertinent to invasive alien species are adequately covered.

Following a review of this policy after the independence of Namibia, and with the introduction of communal conservancies, amendments to the ordinance and its regulations were made, coming into effect in 1996.

- Nature Conservation Amendment Act, No. 5 of 1996

This amendment has no direct bearing on the issue of invasive alien species, except that custodians of communal areas would be in the same position as commercial farmers regarding the import/export aliens, invasive aliens and potential invasive aliens. This act provides for “wildlife councils”, which could make decisions similar to a single land owner in the private sector, basically making them custodians of the wildlife in their areas.

- Amendment of Regulations relating to Nature Conservation, Government Gazette No. 1446 of 1996

This amendment was made to take into account the establishment of conservancies and Wildlife Councils together with the Nature Conservation Amendment Act No. 5 of 1996 referred to above. There were no additional issues dealt with relating to invasive alien species.

3.1.5 The Parks and Wildlife Management Bill (Draft, May 2004)

This legislation will address the issues related to alien invasive species much more thoroughly than current legislation. Section 83, entitled “Alien/invasive species”, has yet to be formulated, providing an opportunity for those concerned with the issue to make a timely input. The theory is well covered in the draft Act, particularly the application of the precautionary principal, as is liaison with other relevant ministries, many of which are currently unaware of invasive alien issues. However, regulations still have to be formulated which will detail day-to-day policy and management.

The preamble clearly states that the bill is intended: “To give effect to paragraph (1) of Article 95 of the Namibian Constitution by establishing a legal framework to provide for and promote the maintenance of ecosystems, essential ecological processes and the biological diversity of Namibia ... and to promote the mutually beneficial co-existence of humans with wildlife, to give effect to Namibia’s obligations under relevant international legal instruments including the Convention on Biological Diversity and CITES ...” CITES is the Convention on International Trade in Endangered Species of Wild Fauna and Flora that came into effect in 1973.

“The Principles of Conservation” underlying the draft Act, in keeping with the Namibian Constitution, are simply that “biological diversity and essential ecological processes and life support systems be maintained.”

The following definitions address the shortcomings of those in the original ordinance:

- **“adverse effect”** means “any temporary, permanent, and/or cumulative impact on wildlife or a wildlife habitat, whether actual or potential, that is, or may be, harmful or detrimental, and includes any effect that: (i) impairs, or may impair, the well-being of a particular organism or populations of wildlife; or (ii) results in, or may result in, an impairment of the ability of wildlife to survive and flourish or of wildlife habitats to sustain populations of wildlife as part of an ecosystem;”
- **“animal”** includes “any vertebrate or invertebrate animal and micro-organisms, and the eggs, larvae and young thereof, including all their parts and derivatives;”
- **“biological diversity”** includes, inter alia, “terrestrial ecosystems and aquatic ecosystems and the ecological complexes of which they are part, and this includes the diversity within species, between species and of ecosystems;”
- **“exotic wildlife”** means “any wild species, subspecies or genetic strain that is not indigenous to Namibia;”
- **“indigenous”** means “any species, subspecies or genetic strain which occurs naturally within the boundaries of Namibia, currently or historically;”

- **“plant”** means “any organism belonging to the kingdom Plantae, including fungi, lichens and algae and their parts and derivatives;”
- **“protected wildlife”** means “all wildlife species except those listed as specially protected wildlife species, or excluded in terms of section 52;”
- **“sustainable management”** means “protecting the environment and managing human interactions with the environment ... such that the management practice: (i) safeguards the life-supporting capacity of air, water, soil and ecosystems; (ii) maintains the life-supporting capacity and quality of air, water, soil, and ecosystems, including living organism ... and (iii) avoids the creation of adverse effects wherever practicable, and where adverse effects cannot be avoided, mitigates and remedies adverse effects as far as practicable.”
- **“wild animal”** means “any animal of a species belonging to a non-domesticated species, whether or not that animal has been bred or tamed, or is kept in captivity;” and
- **“wildlife”** means “any non-domesticated living organism.”

The involvement of other ministries is clear in section 7: Compliance by Government Institutions:

“Every Minister, organ of Government, officer, or other person exercising a public function or performing a public duty that is likely to affect the use, protection, or conservation of wildlife or wildlife habitat in Namibia shall give effect to the purpose of this Act, and in particular shall:

(a) have regard to, apply and provide for the principle of State policy contained in Article 95(1) of the Namibian constitution and the conservation principles mentioned in section 4 in exercising that public function or performing that public duty;

(b) prevent or minimize adverse effects on the environment by undertaking long term integrated planning which considers the environment as a whole and by co-operating with other public bodies and organizations to integrate and co-ordinate their efforts regarding the conservation of wildlife and wildlife habitats;

(c) exercise their regulatory and other powers:

(iii) to avoid and where possible, prohibit activities that are likely to cause harm to wildlife populations, wildlife habitats, and the environment.”

Section 74 on the import and export of wildlife and wildlife products clearly states: “No person shall export from or import into or transport through or re-export from Namibia any wildlife or wildlife product, including trophies, parts and derivatives, and meat, without the written authorization of the Minister.”

Section 75 on conditions of import and export of live wildlife is very pertinent to controlling the introduction and translocation of alien invasive species in Namibia. The first clause reads:

“The Minister may announce by notice in the Gazette a list of wildlife species, sub-species, populations and ecotypes or categories that are prohibited from importation into Namibia under any circumstances because of potential risks of ecological invasion and genetic pollution and may provide for any other restrictions or guidelines applicable to the import of live wildlife into Namibia.”

The second clause goes further, placing the onus on the importer to “demonstrate to the satisfaction of the Minister the genetic and/or taxonomic compatibility of the specimen to be imported with forms and populations occurring in Namibia.”

By far the most relevant section will be the yet to be finalised text of section 83, on alien/invasive species. The provisional text states that:

“The Minister may, on the advice of the Department, and in consultation with the Minister responsible for Trade and Industry make regulations to regulate trade in wildlife and wildlife products, and without limiting the generality of this provision, may (also) make regulations:

1. to classify and define categories of wildlife and wildlife products, and to deem certain substances to fall within or outside such categories;
2. to exempt certain categories of wildlife and wildlife products and persons from the application of some or all of the provisions of this part;
3. to prevent and regulate the introduction into, keeping, and release of any living organisms that is not indigenous to Namibia and that may pose a threat to wildlife of wildlife habitats; and
4. to require environmental assessments to be conducted concerning the potential adverse effects of any proposed export or import of wildlife prior to making a decision on whether or not it should be authorized.”

Finally, section 116 on Regulations allows scope for specific regulations pertinent to invasive alien species, providing they allow for: “better administration of the Act and facilitate the achievement of its purpose to achieve the purpose of this Act, the Minister may make any regulations under this Act in the absence of absolute or conclusive scientific proof in respect of adverse effect or risk, provided that the regulation mentions the precautionary principle as the rationale for so doing.”

The new South African National Environmental Management: Biodiversity Act of 2004 could serve as an example to those formulating legislation on invasive alien species for Namibia. The Act makes provision for dealing with the regulation of alien species, invasive species and GMOs in Chapter 5 sections 64 – 78. Sections 70 – 73 authorise the minister to publish and regularly review a list of prohibited or restricted invasive species, restrict lawful activities using invasive species, make permit holders responsible for minimising any impacts and make landowners responsible for the removal or control of listed invasive species and the prevention of any harm being caused by them. Section 75 deals with the control and eradication of listed invasive species, while 76 and 77 deal with protected areas, requiring management plans to include the control and eradication of invasive species and regular reports on the status of listed invasive species. Section 78 deals with genetically modified organisms that may pose a threat to indigenous species. As suggested by Malan (undated) when he reviewed an earlier draft of this Act, some of these provisions should be incorporated into appropriate Namibian legislation. The opportunity to incorporate these into section 83 of the draft Parks and Wildlife Management Bill is now.

3.1.6 Other relevant Ministry of Environment and Tourism legislation

- The Forest Act No. 12 of 2001

This defines “forest produce” broadly as any thing which grows or is naturally found in a forest, including “any living organism”. The act is aimed at the sustainable management of forests, and clearly states: “the purpose for which forest resources are managed and developed including the planting of trees where necessary, in Namibia, is to conserve soil and water resources, maintain biological diversity ...” (Part 2. 10). Yet the Act does not define biological diversity. The Act provides for the protection of the environment, but there is neither any direct mention of indigenous versus alien species, nor any guiding principles which could be directly linked to issues pertinent to invasive alien species – despite the fact that most reforestation species are alien plants. There is, however, a clause that makes it an offence to “harm, injure or remove any living tree, bush or shrub within 100m of any river, stream or watercourse.” Strictly interpreted, this could render projects aimed at eradicating invasive alien species such as *Prosopis* growing in and alongside rivers, illegal. Whilst the clause is beneficial to wetlands, plants known to be invasive should be excluded.

As pointed out by Malan (undated), there are elements within this Act that would allow for the incorporation of concerns regarding invasive alien species within forest areas particularly those designated as “protected areas”. The proposed Forestry Council can be expected to include advice on invasive alien species in their reports to the Minister, the national forest inventory should include all invasive alien species, and forest management plans should include measures to control the inadvertent spread of invasive alien species, while within the protected areas those alien and invasive species that threaten biodiversity should be eradicated or controlled. The opportunity to incorporate this in forestry stewardship guidelines should be taken up.

- Environmental Management Bill (Draft, 1998)

This long overdue Bill does not mention invasive alien species specifically, but provides some very good contingencies. It specifically states the application of the precautionary principle, under “Principles of Environmental Management”, and includes the phrase “to identify, predict and evaluate ... relevant effects” under the general objectives for environmental assessments, and refers to “the farming or importation of any genetically modified organism or plant or animal species that may have a significant impact on the Namibian environment” in the list of developments requiring EIAs.

- Namibia’s Pollution Control and Waste Management Bill (Draft, 1999)

This does not address invasive alien species in the traditional sense, but the issue is very well covered in the definitions. In particular, a “hazardous substance” is defined as “any micro-organism ... hazardous ... to the environment” and. “pollution” as “introduction into the environment ... of any ... thing ... which has or may have a harmful effect on ... living resources and ecosystems”, this would appear also to cover genetic pollution.

3.1.7 Relevant policies and legislation of the Ministry of Fisheries and Marine Resources

- The Marine Resources Act No 27 of 2000

This Act regulates the management, protection and use of marine resources under Namibian jurisdiction, but makes no specific mention of either alien or invasive species or their regulation.

Reviewing this Act, Malan (undated) identified provisions that could be amended to better incorporate concerns related to invasive alien species. He suggests expanding the powers of fisheries inspectors and honorary fisheries inspectors to include reporting on invasive alien species; including awareness of invasive alien species and the threats they pose in the training curriculum of fisheries observers; raising awareness at the level of the Marine Resources Advisory Council; making money available from the Marine Resources Fund for research and training on invasive alien species; and including control of invasive alien organisms under the Management and Control Measures in part VIII, 47 (3). He also discusses how the penalties could be used to ensure compliance with measures suggested to control or prevent the introduction of alien and invasive species. Paragraph 52 (4) (e) is deemed particularly apt:

“Any person who discharges in or allows to enter or permits to be discharged in Namibian waters anything which is or may be injurious to marine resources or which may disturb or change the ecological balance in any area of the sea, or which may detrimentally affect the marketability of marine resources, or which may hinder their harvesting, shall be guilty of an offence and liable on conviction to a fine not exceeding N\$500 000.”

- Namibia's Aquaculture Policy – towards responsible development of aquaculture (2001)

The Aquaculture policy deals with the responsible and sustainable development of farming with aquatic plants, fish, molluscs and crustaceans, and advocates responsible aquaculture developments. This policy deals directly with the potential impacts of alien and other invasive species and seeks to minimise their impacts on aquatic ecosystems. In addition to other adverse effects, impacts specifically mentioned include the release of introduced species and genetically modified organisms; the mixing of farmed and wild stock (genetic pollution); and the risk of disease transfer.

One of the principles of the Act is “to ensure the protection of the living resources of national and international waters, both marine and freshwater, from possible adverse effects resulting from aquaculture activities, introductions and effluents.” The strategies to achieve the stated objective of responsible and sustainable aquaculture development include “Maintaining genetic diversity and the integrity of [the] aquatic ecosystems and ensuring responsible aquaculture production.”

The policy is firmly rooted in the internationally accepted International Council for the Exploration of the Seas (ICES) Code of Conduct on Responsible Fisheries, the Food and Agriculture Organisation (FAO) Guidelines for Aquaculture Development and the Holmenkollen Guidelines, and it recognises international responsibilities in terms of CITES, Ramsar and other agreements relating to shared water resources.

The policy recognises the need for specific aquaculture laws and regulations and lays the foundations for these and a National Development Master Plan for Aquaculture. It recognises the importance of environmental assessments under the authority of the MET, particularly in designating aquaculture zones. It specifically states that the government may take measures such as 3.1.11(d): “the establishment of hatcheries, to reduce reliance on wild-caught juvenile indigenous fish and repeated introductions of exotics (to protect genetic resources)”.

Section 4 deals explicitly with “maintaining genetic diversity and the integrity of [the] aquatic ecosystem” and stresses a precautionary approach. Any “proposals for further introductions or translocations of freshwater aquatic organisms”, particularly the “introductions of exotics” and “potential transfer of disease organisms” will be “carefully examined” and guided by a strict “code of practice”.

Provision is made for lists of allowable and “prohibited species known to have had harmful environmental consequences when introduced or translocated” to be compiled and regularly reviewed, and if required to “establish watershed zonation beyond which indigenous or exotic organic organisms may not be translocated. Preservation of genetic diversity will be promoted” and care will be taken to limit adverse impacts on internationally shared waters. Section 5 deals specifically with responsible aquaculture practices.

- The Aquaculture Act No 18 of 2002

The Aquaculture Act regulates and controls aquaculture activities and the sustainable development of aquaculture resources. It allows the Minister to “formulate policy based on social, economic and environmental factors, the best scientific information and advice from the advisory council to *inter alia* promote sustainable aquaculture and manage, protect and conserve aquatic ecosystems. “

There is no specific requirement for someone from the environmental sector to serve on the advisory council, however, but the Act specifies that environmental assessment requirements be determined “with the concurrence of the Minister responsible for environment and in accordance with such legislation or policy dealing with environmental assessments” (12(2)); and that “an environmental clearance be issued in accordance with the relevant laws” (13(1c)).

It further requires that Environmental Impact Assessments be undertaken prior to the designation of an Aquaculture Development Zone (33 (2)). A licence can be withheld if the enterprise poses “a significant risk of pollution or [may] otherwise adversely affect the environment” (13(2b)). A licence may be suspended or cancelled “to ensure protection and conservation of the environment” or if “the licensee has failed to report the presence of ... [any] harmful organism ... or [take] all possible measures to prevent the spread of ... any harmful organism” (19 (1d, e)). It is mandatory to report any harmful organism (although this is not defined in the Act and could thus be interpreted to include harmful alien invasive species) and to “take all possible measures to prevent the spread of...harmful organism in or from an aquaculture facility” (25 (1, 3)).

The most important clauses in terms of this review are those dealing specifically with the introduction and transfer of aquatic organisms (27 (1, 3)):

- “A person may not, without written permission granted by the Minister, introduce or cause to be introduced into Namibia or any Namibian waters any species of aquatic organism or any genetically modified aquatic organism or transfer any species of aquatic organism from one aquaculture facility to another or from any location in Namibia to another”; and further,
- “The Minister must not issue any approval under this section unless the impact of any introduction or transfer of any aquatic species or genetically modified aquatic organism has been assessed, if so required, in accordance with the legislation or policy dealing with environmental assessments.”

There are also provisions related to the import and export of live aquatic organisms (28 (1,)):

- “A person may not without written permission granted by the Minister, import or export aquatic organisms”.

These issues are further dealt with under the offences and penalties section (part VIII), which imposes a fine of N\$4 000 for anyone causing “the release of any aquaculture products or aquatic organisms or both from an aquaculture facility” (39 (a)), and a fine of N\$ 8 000 for anyone introducing any aquatic organisms or aquatic GMO into Namibian waters, or who imports or exports any aquatic organism without written authority to do so (39 (b, c)). Furthermore, regulations to “prohibit the introduction, import or export of defined species of aquatic organisms” and “to regulate the import and export of aquatic organisms ... and impose conditions” (43 (g, j)) may be prescribed.

Finally, the Act makes provision for the Minister to provide exemptions, particularly for scientific research, and to issue codes of conduct for aquaculture by notice in the Gazette. Although the Act does not prohibit the introduction or use of any invasive alien species for aquaculture, it does aim to control potential impacts through permits.

- Aquaculture (licensing) regulations: Aquaculture Act, 2002 (Government notice 246 of 2003)

These regulations basically give effect to the Aquaculture Act and set out the requirements for obtaining a licence and running aquaculture facilities. Part VI deals with “protection of the aquatic environments” and reiterates that no-one may release aquaculture products or allow them to escape in clause 19 (1-3); and that written permission is needed prior to the introduction or transfer of any aquatic organism in clause 21 (1-3).

- The Inland Fisheries Resources Act, No 1 of 2003

This Act deals with the conservation and utilisation of inland fisheries resources. It is important that it prohibits the introduction, transfer, import and export of any species of fish or crustacean without written permission, 19(a, b). It makes provision in part III for the establishment of an inland fisheries council, and although no environmental officer is specified to serve on this, part VII allows for the appointment of honorary inspectors from the ministry responsible for the environment, presently the Ministry of Environmental and Tourism, 23(2a).

3.1.8 Relevant policies and legislation of the Ministry of Agriculture, Water & Rural Development

- The Agricultural Pests Ordinance, No 11 of 1927

This very outdated legislation has to all intents and purposes been repealed by the Agricultural Pests Act (No. 38 of 1973) and will certainly fall away once the current revision is finalised. As pointed out by Malan (undated), a useful concept is that of lists that distinguish between totally prohibited imports and those that require particular precautionary measures and are only allowed with a permit.

- The Water Act, No 54 of 1956

This rather outdated legislation is shortly to be replaced by the Water Resources Management Bill. One important difference is that whereas the old water Act covered the control of aquatic invasive alien plants, the new bill does not specifically address the issue. This is a shortcoming that needs to be addressed before the new bill is finalised.

- The Weeds Act, No 42 of 1937 and the Weeds Ordinance, No 19 of 1957

Malan (undated) points out that the Weeds Act, although no longer applicable in South Africa, still applies in Namibia, as does the Weeds Ordinance, although he is not certain which would take precedence. According to the Weeds Ordinance, the “administrator” has the power to declare certain plants weeds, and the onus to eradicate such weeds then lies with land owners. It allows for regulations, including ones that prevent the introduction of weeds by prohibiting or restricting their importation and distribution. Section 8 makes it a criminal offence to place, cause or permit “any portion of a weed or any weed in any river, watercourse, or water furrow or on any public road.”

- The Soil Conservation Act No 76 of 1969

This makes provision for “the prevention and combating of soil erosion, and the protection, conservation and improvement of soil, vegetation and water supply sources and resources.” Thus, where the control of invasive alien species is conducive to the attainment of these goals, particularly the conservation of water resources, this Act is applicable. Although its jurisdiction was limited to commercial land, the recent Communal Land Reform Act of 2002 specifically mentions it, and requires compliance in terms of conservation of soil and prevention of soil erosion (clause 31).

- The Second Soil Conservation Amendment Act, No 38 of 1971

The Second Soil Conservation Amendment Act makes the Soil Conservation Act (No 76 of 1969) applicable to Namibia, and deals mainly with soil conservation, soil stabilisation and fire protection. This Act has recently been revised by the MAWRD and is currently with legal drafters (Rhodes pers. comm.). This provides an ideal opportunity to incorporate the broader issues related to the control of invasive alien species in Namibia, particularly in terms of importation, and to develop appropriate screening mechanisms.

Attempts to obtain a copy of the draft Conservation of Agricultural Resources Bill proved fruitless.

- The Agricultural Pests Act, No 3 of 1973

This Act deals with the registration of nurseries; the control and eradication of plants, insects and diseases at nurseries; the control and eradication of exotic (vertebrate) animals (excluding farm animals) and plants infected by insects or plant diseases; the control of plant, insect and plant disease imports; honey bees, honey and exotic animals; and the eradication of plant diseases, insects and locusts; It also defines the powers of inspectors.

The Act is essentially aimed at preventing the introduction and spreading of plants, insects, non-farming exotic vertebrates and diseases that may prove detrimental to the agricultural sector. Section 9 provides for the destruction of exotic animals, as well as of any plants infected by insects or diseases. Section 11 serves to regulate plant and exotic animal imports, prohibiting the import of plants, insects, plant diseases, honey bees, honey, beeswax or exotic vertebrates without permits, while section 12 allows the importation of bio-control agents needed for the control or eradication of weeds and pests. As pointed out by Malan (undated), there is potential to amend this Act to incorporate a wider spectrum of invasive alien species and make use of the measures of inspection and enforcement already in place and administered jointly by Customs and Excise and the Phytosanitary Section in the MET.

- The Water Supply and Sanitation Policy (1993)

This policy essentially allowed for the establishment of water point committees, giving communities the right, with due regard for environmental water needs, to plan, maintain and manage their own water supplies. The policy stresses environmentally sound development and use of water resources, and thus by implication the water point committees should be concerned about the introduction and control of any invasive alien species that may pose a threat to their water supplies and resources. In South Africa, the successful “Working for Water” programme involves communities in the eradication of alien riparian vegetation that may block waterways or, more specifically, use groundwater that would otherwise be available for human and stock use.

- The National Agricultural Policy (1995)

The aims of the National Agricultural Policy are largely economic and focus on increasing agricultural productivity and real farm incomes, in order to contribute to national and household food security. It recognises the limitations imposed by the Namibian climate and soils and seeks to promote sustainable utilisation of the land and other natural resources within the context of a vulnerable ecosystem. Potential problems such as deforestation, soil erosion, bush encroachment and over-grazing are addressed, but there is no mention of invasive alien species and their role in environmental degradation. It encourages Environmental Impact Assessments for agricultural projects. These should include an assessment of any problems associated with the potential introduction or control of invasive alien species.

- The Namibia Water Corporation Act, No 12 of 1997

This Act established the water utility company (NamWater). Of relevance in the context of this review, it places an obligation on NamWater to conduct its functions in an environmentally sustainable and sound manner, and as it specifies a “duty to conserve and protect the environment”, NamWater should conduct all activities with due regard for the protection and conservation of ecological resources and habitats. Thus, by implication, NamWater should not allow any activity that promotes the introduction or translocation of invasive alien species and should deal with those that threaten aquatic habitats.

- The National Drought Policy and Strategy (1997)

The National Drought Policy shifts the onus of drought management from government aided relief to appropriate farming techniques aimed at empowering farmers to better cope with droughts themselves. Although incentives such as the Forum for Integrated Management, FIRM, promotes this actively in communal areas that participate in the National Programme to Combat Desertification, NAPCOD (Schachtschneider *et al.* 2002), recent responses to crop failures in the north and north east have again reverted to relief programmes. The policy makes no mention of invasive alien species as such but does deal with the problem of bush encroachment usually caused by indigenous invasive species and rangeland practises to mitigate this.

- The White Paper on a National Water Policy for Namibia (May 2000)

Subtitled “Policy framework for equitable, efficient and sustainable water resources management and water services”, the policy stresses sectoral co-ordination, integrated planning and management, and resource management aimed at coping with ecological and associated environmental risks. These should include the potential risks posed by invasive alien species.

Although there is no specific mention of invasive alien species, two clauses that refer to the protection of the aquatic habitat are considered relevant: paragraph 5 in section 2.3 on “Water use and Conservation Principles”; and paragraph 4 in section 2.5 on “Legislative and regulatory principles”:

2.3 (5) “Precautionary environmental protection: The resource base shall be protected against any kind of contamination or pollution that would render any part of it unfit for beneficial human, economic and environmental purposes ... applying the precautionary principle ...

2.5 (4) Factoring environmental considerations in decision making: The need to protect the environment in general, and the aquatic ecosystems in particular, including their biodiversity and the nation’s wetlands will be factored into the allocation of water resources for use ... These will include the prior assessment of the environmental impacts of proposed water uses, under the circumstances dictated by the relevant legislation.”

- The Water Resources Management Bill (Draft, 2004)

One of the fundamental principles of this Act, appearing in section 3 (d), is: “harmonization of human needs with environmental ecosystems and the species that depend on them, while recognising that those ecosystems must be protected to the maximum extent;” One of the functions of the Minister, defined in section 8 (k), is to: “ensure that water resources management operates according to the principles of environmental sustainability.” This implies at least that where aquatic invasive species threaten water resources and wetland habitats, they should be dealt with.

The establishment of basin management committees as provided for in Chapter 4 provides the local level mechanism for this protection: the main function of these committees is “to promote community participation in the protection, use, development, conservation, management and control of water resources”. Chapter 8 (on internationally shared water resources) recognises Namibia’s obligations under international treaties, agreements and conventions such as the UN CBD, and specifically mentions the SADC protocol on shared water resources.

As this bill is yet to be passed by cabinet, there is still the opportunity to strengthen it to deal more directly with the threats posed by invasive alien species. One recommendation is to insert a clause under 69 (1) to include data on the status of aquatic invasive alien species in the information to be collected and shared on internationally shared rivers.

Similarly, Chapter 10, which deals with the protection of water resources, is limited to groundwater resources, and should be expanded to include surface water resources, with a section on invasive alien species, to prohibit the introduction of new species, and eradicate or control those already present. Paragraph 94 deals with constructions that block or impede river flows, and this should be made equally applicable to weed mats that cause the same problems. Finally, the list of offences should include a clause that makes it an offence intentionally or negligently, by any act or omission, to introduce invasive alien species into any water resource.

It is strongly recommended that as the Ministry responsible for environment, the MET actively lobby to have these amendments made before this bill is finally passed. This would counteract the negative comments of the Director of Water Environment quoted by Alberts (undated):

“... there is currently no legislation to control alien invasive plants in the river systems of Namibia. Recommendations on the control of alien invasive plants were presented by the Directorate of Water Environment to the committee involved in compiling the new Act. The reaction to this recommendation was however not very positive and it seems that again nothing is being done to control alien invasive plants in Namibia’s river systems”.

3.1.9 Relevant policies and legislation within other relevant government sectors

- The National Policy and Strategy for Malaria Control (1995)

Although section 5.2.3 on vector control calls for the “design of and evaluation of vector control strategies based on sound field research,” this policy makes no explicit reference to the use of any alien fish species for bio-control. At a subsequent workshop on the biological control of mosquitoes to mitigate malaria held in 1998 (MFMR 1999), emphasis was placed on the importance of maintaining and enhancing indigenous populations of bullfrogs, bats and fish to reduce the incidence of malaria, rather than introducing alien fish species, yet the final decision that the “introduction and/or enhancement of fish species or fish stocks to reduce the amount of Anopheles larvae should be further studied and properly evaluated” is rather ambiguous in that it suggests that the introduction and use of alien fish species remains an option.

- The National Land Policy (1998)

The National Land Policy makes no explicit mention of invasive alien species. In accordance with Article 95 (1) of the Constitution, the Policy promotes environmentally sustainable land use, and goes even further, stating that failure to demonstrate environmental sustainability may be grounds for the denying or termination of a title. The Policy also makes provision for a “Land Use Environmental Board” which “shall ensure ... environmental protection is promoted ... to guarantee environmental, social and economic sustainability.” Again, the policy provides for the cancellation of a title, in consultation with the Regional Land Use and Environmental Board and with the approval of the Minister. Decision-makers need therefore to be made aware of threats posed by invasive alien species to environmental sustainability. In this way, the Land Use and Environmental Board could be an effective control body, particularly if other legislation regarding invasive alien species is strengthened.

- The Communal Land Reform Act, No 5 of 2002

This Act makes provision for certain rights of communal farmers and traditional authorities, for representation on Communal Land Boards and for the prevention of land degradation and mitigation of the impacts of mining, prospecting, roadworks and water provision. There is no mention of the potential impacts of invasive alien species, although the regulations section implies that future regulations could address these issues.

The Act states that: “The Minister may make regulations in relation to ... the combating and prevention of soil erosion, the protection of the pastoral resources and the limitation and control of the grazing of stock and any other matter as the Minister may consider necessary or expedient for giving effect to this Act ...”

Malan (undated) in his review suggests that this is broad enough to cover invasive alien species, and adds that it provides for the application of provisions of the Soil Conservation Act, particularly those that deal with soil erosion and “disturbances that may cause soil erosion” on communal lands. This could include the impacts of mono-stands of invasive alien plants such as *Prosopis* and *Eucalyptus*, which are known to prevent other growth beneath them.

The provision for “Communal Land Boards”, with representation by officials from both the MET and the MAWRD, as well as by representatives from any conservancies in the area, is noteworthy. Section 4.1 (“Composition of the Board”) states: “Subject to Section 5, a board consists of the following members to be appointed by the Minister ... four staff members in the Public Service of whom ... one must be nominated by the Minister responsible for environmental matters ... one must be nominated by the Minister responsible for agriculture ... if any conservancy or conservancies ... exist within the board’s area, one person nominated by the conservancy concerned, or where applicable by the conservancies concerned jointly.”

This is a potentially important way in which MET and MAWRD officials, who should be aware of invasive alien species, the threats they pose, control options and pertinent legislation, can promote awareness and guide decisions on the appropriateness of introductions by communal farmers of any alien and invasive species, e.g. for woodlots.

- Customs and Excise Act, No 20 of 1998

Although under the Agricultural Pests Act, the Phytosanitary Division of the Directorate of Veterinary Services within MAWRD is tasked with carrying out the removal, or prevention of entry of weeds, customs officials, under Customs and Excise in the Ministry of Finance, execute the function of controlling the entry of exotic plants and animals. Provision is made for this in the Customs and Excise Act of 1998, under section 123:

“Prohibitions and restrictions: ... (e) goods which may, in terms of any provision of this Act or of any other law, only be imported into Namibia in terms of a permit, certificate or other authority, unless imported under such a permit, certificate or other authority which purports to be issued by virtue of any such provision, shall be not imported into Namibia, unless in terms of a permit issued by the Permanent Secretary ...”.

Under this, a list of prohibited goods, including several invasive alien species or weeds and pests, has been compiled and is updated on occasion, although this is apparently a costly procedure. The list includes a description of the goods, the prohibition or restriction, the relevant authority and the action required. According to the Ministry of Finance (Van der Merwe, pers. comm.), the system works well, with regular training sessions conducted by the MAWRD’s Phytosanitary Division.

From the point of view of the Phytosanitary Division (Rhodes pers comm.), however, the arrangement does not work as well as it should, due to the “technical nature” of phytosanitary issues and the shortage of trained staff. Customs officials at border posts often do not have these lists to use to identify prohibited organisms, and it is strongly recommended that appropriate lists and posters be developed.

A Trade Policy review mentioned in the Customs and Excise Act includes a section on import licensing and prohibitions, and allocates responsibilities for imports subject to “non-automatic licensing” as follows:

State Veterinary Services:	Live or dead animals, animal feeds and foodstuffs, ... unprocessed or partly processed parts of animals, including birds, fish and insects
Namibian Agronomic Board:	Controlled agricultural products, namely maize, wheat and products thereof
Ministry of Environment and Tourism:	Endangered wildlife and articles thereof, subject to provisions of the Convention on International Trade in Endangered Species (CITES)

- National Policy on Enabling the Safe Use of Biotechnology (1999)

This policy, prepared by the Namibian Biotechnology Alliance, was published as a national policy document submitted by the Ministry of Higher Education, Vocational Training, Science and Technology in October 1999. Pertinent to this review are the two main goals of this national policy: “to guide the judicious use of modern biotechnology in Namibia for sustainable development, in ways which do not in any way jeopardize human and environmental health, including Namibia’s biodiversity and genetic resources”; and “to ensure effective control of transboundary movements of genetically modified organisms or products thereof resulting from modern biotechnology, through exchange of information and a scientifically based transparent system of advance informed agreement.”

Importantly, the policy recognises that in addition to a competent lead authority, cooperation from several other ministries is essential to ensure regulation. This is equally true for the regulation of invasive alien species, and much the same institutions will be involved in conducting risk assessments, advising on permit issues and ensuring effective control and law enforcement.

The policy states that Namibia will adopt the EU Contained Use Regulations of 2000 with respect to Genetically Modified Organisms, GMOs. This is outlined in the policy document (NBA 1999) (see Annexure 5.). The policy sets out the fundamental steps for risk assessment, containment measures and classification for GMOs, and recommends four classes of activities ranging from class 1 (for GMOs that carry no or negligible risk, for which level 1 containment would be sufficient to protect human and environmental health) to class 4 (for GMOs with a high risk, requiring containment level 4).

- The Biosafety Act (Draft)

The draft Biosafety Act describes procedures for risk assessment for the import of GMOs and the functions of the proposed Biosafety Board in reviewing applications and the risk assessment reports accompanying such applications. It also states that the Biosafety Board may insist on an EIA.

This draft Biosafety Act refers to GMOs rather than invasive alien species per se. It is unclear whether the two issues (invasive alien species and GMOs) should be dealt with separately. A GMO could be seen as an alien invasive organism in the sense that, irrespective of its genetically modified origin, it is an introduced species and hence poses a potential threat to ecosystems in Namibia. There may be useful elements in this legislation for those seeking to draft legislation pertinent to invasive alien species, particularly in terms of the risk assessment procedures it recommends. The present draft makes no mention of biocontrol agents, i.e. organisms deliberately introduced for the control of invasive alien species.

3.1.10 Relevant policies and legislation covering tertiary education institutions.

- Policy of the Polytechnic of Namibia

At the Polytechnic of Namibia, lecturers are encouraged (and almost obliged) to conduct applied research within their fields. A draft research policy exists, and is in the process of being updated. In accordance with the policy, lecturers within the School of Natural Resources and Tourism have conducted research on invasive alien species. The Department of Nature Conservation has its own departmental research policy, which states: “Staff can make a valuable contribution to research aimed at improving, monitoring and measuring food production, sustainability, biodiversity and biodiversity change.” The policies do not directly refer to invasive alien species, but provide an overall framework for research.

3.2 NAMIBIA’S VISION 2030

Namibia Vision 2030 provides a “policy framework for long term national development’ and will well influence long term plans and projects. The overall national vision is “A prosperous and industrialised Namibia, developed by her human resources, enjoying peace, harmony and political stability”. Sub-visions articulated in the chapter on sustainable resource base are directly pertinent..

The section on Biodiversity pertinently includes, “The introduction of alien invasive species that threaten the survival of indigenous species” as one of the direct causes of biodiversity loss. Invasive alien species are thus seen as a direct treat “The integrity of vital ecological processes, natural habitats and wild species throughout Namibia”. The list of “things to do” to achieve the biodiversity sub-vision includes “Enforce legislation regarding the illegal export of indigenous species and the import and/or propagation of alien invasive species”.

The sub-vision on Freshwater and Associated Resources is that “Namibia’s freshwater resources are kept free of pollution and are used to ensure social well-being, support economic development, and to maintain natural habitats”. This can be interpreted to include keeping these waters and the wetlands associated with them, free of invasive alien aquatic plants and animals that can impact negatively on social well being, economic development and threaten natural habitats. Interestingly in terms of aquaculture development the vision document is initially cautious stating that “With Namibia’s limited freshwater resources, it is generally accepted that aquaculture does not have a large potential as a major economic activity” and goes as far as to say that that “Current aquaculture projects in the northern rural areas have met with many problems, most of which will be difficult to overcome without causing environmental degradation.” Yet in the section on Fisheries and Marine Resources aquaculture is presented as “a sector with great potential” that can “contribute towards food security, income and employment for many Namibians”

The section on Forestry specifically mentions that “Alien invasive trees (including *Prosopis* sp. and *Nicotiana glauca*) are prevalent throughout the westward flowing ephemeral river systems.” and that “These exotic trees spread rapidly, do not support as much biodiversity and compete aggressively with indigenous species for water and space”. Among the strategies recommended to achieve the national objective of sustainable utilisation of land, woodland and forest resources are two particularly pertinent to this review:

- Supporting only those afforestation programmes that use appropriate indigenous species and /or harmless exotic species
- Developing and maintain nurseries for indigenous tree species. Use these plants to rehabilitate degraded woodland and savannah ecosystems, and to encourage homeowners to plant indigenous rather than exotic species in their gardens.

3.3 RELEVANT REGIONAL AND INTERNATIONAL PROTOCOLS, CONVENTIONS AND AGREEMENTS

3.3.1 UN Environmental Conventions (Rio Conventions)

- United Nations Convention on Biological Diversity (UNCBD) 1992

Namibia ratified the Treaty on Biological Diversity in 1997, and produced a detailed country study the following year (Barnard *et al.* 1998). Since then, Namibia has actively fulfilled its obligations.

Most relevant to invasive alien species is Article 8, which states: “each contracting party shall, as far as possible and as appropriate ... (h) prevent the introduction of, control or eradicate their alien species which threaten ecosystems, habitats or species.”

An initial review on the national situation regarding invasive alien species as required by the UNCBD is included in the country study (Griffin & Simmons 1998). This review in effect reflects government policy on national implementation of the UNCBD, which recognises invasive alien species as the single greatest cause of biodiversity loss.

The primary instrument of the convention on biodiversity for addressing invasive alien species is the Global Invasive Species Programme (GISP), the southern African regional unit of which is based at Kirstenbosch in Cape Town. The primary domestic instrument in guiding Namibia in fulfilling its obligations under this convention is the National biodiversity strategy and a ten-year strategic plan under the title “Biodiversity and Development in Namibia – 2001-2010”, drawn up by the National Biodiversity Task Force. This is a thorough document developed through exhaustive consultation. It has few shortcomings, but implementation will require great political will.

The most relevant sections regarding intended outcomes are:

- “(2.6) Ensure the safe use of biotechnology in Namibia;
- (3.5) Identify and monitor main environmental threats;
- (3.8) Reduce the threat to biological diversity from alien invasive species;
- (5.1) Protect and maintain essential ecological functions and the biological diversity of Namibia’s wetland ecosystems;
- (5.4) Raise awareness of wetland values and threats;
- (7.1) Improve mechanisms for integrating sectoral planning and implementation activities; and
- (7.2) Review and streamline policy and legal frameworks.”

The main activities aimed at reducing the threat posed by invasive alien species to biodiversity are outlined in 3.8. These are:

- “to review information on alien invasive species in Namibia and to establish a database;
- to research the invasiveness of selected species;
- to test appropriate environmentally sound control methods;
- to establish and harmonise policies, legislation, regulations and control measures; and
- to promote awareness of ecological and economic threats.”

Two of the working groups under the auspices of the National Biodiversity Task Force (NBTF), the Agricultural Biodiversity Working Group and the Alien Invasive Species Working Group, have tackled these challenges, as to a lesser degree has the Wetlands Working Group regarding aquatic and semi-aquatic plants and animals.

- United Nations Convention to Combat Desertification (1994)

Namibia ratified the United Nations Convention to Combat Desertification (UNCCD) in 1997. Although this convention does not deal directly with invasive alien species, one of

the symptoms of land degradation is the establishment of invasive plant species on disturbed land (Bethune 2000; Bethune & Pallet 2002). Many invasive species are pioneer species that are adapted to conditions on cleared land, and consequently quickly become established and out-compete more useful plants.

One of the major environmental concerns addressed by the Namibian Programme to Combat Desertification (NAPCOD) has been the issue of bush encroachment (Bethune 2000; Bethune & Pallet 2004; de Klerk 2004). Although most of the species involved are indigenous, *Prosopis* (mesquite) from Central America is an invasive alien species implicated in bush encroachment. It has invaded dry river courses in southern and central Namibia and contributes to the substantial declines in land productivity caused by bush encroachment (de Klerk 2004). It also has an impact on groundwater supplies from these river beds.

- United Nations Framework Convention on Climate Change (1992)

Namibia ratified the United Nations Framework Convention on Climate Change (UNFCCC) on 16 May 1995. Studies since then have confirmed that Namibia's contribution to greenhouse gases is negligible, but as a largely semi-arid country, it is highly vulnerable to predicted climate changes, particularly increased temperatures, resultant increased evaporative losses, even more variable rainfall patterns and an estimated sea level rise of 0.3 to 1 metre by 2100 (MET 2002). Wetlands are identified as being particularly vulnerable to these changes, which will adversely impact on all natural resources.

The most obvious link to invasive alien species is the threat that altered conditions may exacerbate the invasiveness of some alien species. Increased sea temperatures are thought to have played a role in the establishment of *Mytilus gallaprovincialis* (the Mediterranean mussel), while those invasive plant species currently kept in check by their susceptibility to frost in the some parts of Namibia may become more invasive.

Article 4.4 of the convention refers to "the obligation of developed countries to assist developing countries which are particularly vulnerable to climate change in meeting the cost of adaptation to these effects" (MET 2002). Several of the adaptation and mitigation projects identified in terms of Article 4.4 have implications regarding invasive alien species, and vigilance is needed to avert potential harm. Examples are:

- The proposed control of malaria and water-borne diseases may involve the introduction of alien insectivorous fish species.
- A rising sea-level could create new shallow coastal wetland habitats that provide more sheltered habitats ideal for the establishment of invasive alien species currently kept in check by the harsh marine environment.
- The testing and dissemination of heat-, drought- and salt-tolerant crops may introduce genetic material that may pose a threat to indigenous species.
- Increasing demands on decreasing water resources may create eutrophic conditions conducive to the establishment and spread of aquatic and riparian invasive alien species.
- Unless limited to indigenous trees, afforestation projects will introduce potentially invasive alien species, which may with changed climatic conditions spread elsewhere.

3.3.2 International Fisheries Conventions

- International Council for the Exploration of the Sea (1964)

Namibia has endorsed the ICES convention. This is mainly a research-oriented convention relating to the Atlantic Ocean, and mainly to countries sharing north Atlantic fishery resources. Its objectives are:

- “to promote and encourage research and investigations for the study of the sea, particularly those related to the living resources thereof;
 - to draw up programmes required for this purpose and to organise, in agreement with the Contracting Parties, such research and investigations as may appear necessary; and
 - to publish or otherwise disseminate the results of research and investigations carried out under its auspices or to encourage the publication thereof.”
- United Nations Convention on the Law of the Sea (1982)

Namibia is a signatory to the United Nations Convention on the Law of the Sea (UNCLOS), which came into effect in November 1994. This convention promotes “peaceful uses of seas and oceans, the equitable and efficient utilization of their resources, the conservation of their living resources and the study, protection and preservation of the marine environment”.

As a party to UNCLOS, Namibia is bound to uphold these principles and is thus broadly committed to protecting the Namibian marine environment from threats such as those posed by invasive alien species. Article 56(1)(a) regarding the rights of states within their exclusive economic zones, allows for “exploring and exploiting, conserving and managing the natural resources ... waters ... the seabed and its subsoil, and ... economic exploitation and exploration e.g. the production of energy from the water, currents and winds”. Namibia established a 200 nautical mile exclusive economic zone in 1990 (The Territorial Sea and Exclusive Economic Zone of Namibia Act, No 3 of 1990) and assumed responsibility for the marine and coastal habitats therein.

- FAO Fishery Department Code of Conduct for Responsible Fisheries (October 1995)

In 1991, the international Committee on Fisheries (COFI) asked the FAO to prepare an international Code of Conduct. This provided input to the 1992 Rio de Janeiro Conference on Environment and Development (UNCED), and by October 1995, the FAO Code of Conduct for Responsible Fisheries was unanimously adopted. Although compliance is voluntary, it established sound conservation, management and development principles adopted by many countries to ensure “sustainable exploitation of aquatic living resources in harmony with the environment”.

Namibia has endorsed the Code of Conduct for Responsible Fisheries and, as stated in the Aquaculture Policy (MFMR 2001), is committed to managing its fisheries in accordance with these internationally accepted guidelines, particularly the specific provisions for aquaculture. The Code of Conduct on Responsible Fisheries recognises that the worlds’ fisheries “provide a vital source of food, employment, recreation, trade and economic well-being” and that if they are to continue to do so, responsible management will be required.

The Code aims to “ensure the effective conservation, management and development of living aquatic resources, with due respect to ecosystems and their biodiversity”. It strives to take into account both ecological concerns, i.e. “the biological characteristics of the resources and their environment”, and economic considerations, i.e. “the interests of consumers and other users”.

Principles that are relevant to this review are enshrined in the following clauses:

- “(6.1) States and users of living aquatic resources should conserve aquatic ecosystems. The right to fish carries with it the obligation to do so in a responsible manner so as to ensure effective conservation and management of the living aquatic resources.
- (6.5) States ... should apply a precautionary approach widely to conservation, management and exploitation of living aquatic resources in order to protect them and preserve the aquatic environment, taking account of the best scientific evidence available...
- (6.8) All critical fisheries habitats in marine and fresh water ecosystems, such as wetlands, mangroves, reefs, lagoons, nursery and spawning areas, should be protected and rehabilitated as far as possible and where necessary. Particular effort should be made to protect such habitats from destruction, degradation, pollution and other significant impacts resulting from human activities that threaten the health and viability of the fishery resources.
- (6.19) States should consider aquaculture, including culture-based fisheries, as a means to promote diversification of income and diet. In so doing, States should ensure that resources are used responsibly and adverse impacts on the environment and on local communities are minimized.”

Article 7 on management advocates the precautionary approach:

“(7.5.1) States should apply the precautionary approach widely to conservation, management and exploitation of living aquatic resources in order to protect them and preserve the aquatic environment. The absence of adequate scientific information should not be used as a reason for postponing or failing to take conservation and management measures.”

Article 9 deals with responsible aquaculture, and the specific clauses of interest here are:

- “(9.1.2) States should promote responsible development and management of aquaculture, including an advance evaluation of the effects of aquaculture development on genetic diversity and ecosystem integrity, based on the best available scientific information.
- (9.1.5) States should establish effective procedures specific to aquaculture to undertake appropriate environmental assessment and monitoring with the aim of minimizing adverse ecological changes and related economic and social consequences resulting from water extraction, land use, discharge of effluents, use of drugs and chemicals, and other aquaculture activities.
- (9.2.3) States should consult with their neighbouring States, as appropriate, before introducing non-indigenous species into trans-boundary aquatic ecosystems.
- (9.3.1) States should conserve genetic diversity and maintain integrity of aquatic communities and ecosystems by appropriate management. In particular, efforts should be undertaken to minimize the harmful effects of introducing non-native species or genetically altered stocks used for aquaculture including culture-based fisheries into waters, especially where there is a significant potential for the spread of such non-native species or genetically altered stocks into waters under the jurisdiction of other States as well as waters under the jurisdiction of the State of origin. States should, whenever possible, promote steps to minimize adverse genetic, disease and other effects of escaped farmed fish on wild stocks.”

Much of this is well reflected in Namibia’s Aquaculture Policy and Aquaculture Act of 2002, but is not clearly enough stated in the draft Aquaculture Strategic Plan (2004 draft).

3.3.3 Other International Environmental Conventions

- Convention on Wetlands of International Importance, esp. as Waterfowl Habitat (Ramsar, 1971)

Namibia signed the Ramsar Convention in 1995. This international convention on wetlands aims to curb the loss and degradation of wetlands and conserve those that remain through wise use and management. Namibia has to date designated four Ramsar sites: the Etosha Pan, and three coastal wetlands, the Orange River mouth, Sandwich Harbour and the Walvis Bay wetlands. Under this convention, Namibia has an obligation to conserve its wetlands and co-operate in the sound management of shared wetlands and wetland species. By implication, this includes keeping wetland habitats free of aquatic invasive alien species, eradicating or controlling existing infestations and preventing the spread and introduction of these in shared waters.

- Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973)

Namibia is a member of CITES. In the preamble of CITES Conf. 19.7, concern is expressed regarding “the risks of releasing confiscated specimens into the wild, such as the introduction of pathogens and parasites, genetic pollution and negative effects on the local fauna”.

The following guidelines pertinent to invasive alien species are pertinent to this review:

- “ANNEX 1: CITES Guidelines for the disposal of confiscated live animals
- ANNEX 2: CITES Guidelines for the disposal of confiscated live plants.
- ANNEX 3: Guidelines to develop an action plan on seized and/or confiscated live specimens.”

Point 2 of Annex 3 states: “Each Party should ... establish a procedure for implementing the Guidelines in accordance with the party’s domestic law and policy.” Namibia has not yet fully complied in this regard.

As this treaty focuses specifically on international trade in certain listed species, in practical terms it has little direct bearing on invasive alien species issues. When possible, CITES defers authority to more appropriate fora and follows the policy/regulations adapted by those fora (e.g. IUCN for conservation-status issues, UNCBD on biodiversity issues and the International Whaling Commission, IWC, for whaling issues). Recently, however, invasive alien species issues have become intertwined with the South-East Asian freshwater turtle trade (traditionally a CITES issue): because some countries have plundered indigenous turtle populations so badly, invasive alien species (in this case the American red-eared slider) are being imported and introduced to recently-depopulated habitats to boost supply and make up for the market shortfall. A potential conservation problem here is that there is a reduced chance for indigenous species to make a recovery if the alien species is established in their former habitat. So, this is a cross-cutting example, where the international marketing of an indigenous species (a CITES issue) is creating the opportunity for an invasive alien species to become established (a UNCBD issue), with the potential for permanent consequences regarding the conservation-status of the original indigenous turtles (an IUCN issue).

- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention, 1979)

Namibia is not a signatory to the Convention of Migratory Species. In any event, invasive alien species are a very marginal issue with respect to this convention.

- International Plant Protection Convention (1951)

The purpose of the International Plant Protection Convention (IPPC) is to “secure a common and effective action to prevent the spread and introduction of pests of plants and plant products, and to promote appropriate measures for their control.” The application of the IPC is, however, not restricted to cultivated plants, neither is protection restricted to direct damage from pests: “the scope of the Convention extends to the protection of both cultivated and natural flora and includes both direct and indirect damage by pests.” The Convention falls under the FAO of the United Nations and was adopted in 1951. Signatories to this convention are organised into National Plant Protection Organisations and Regional Plant Protection Organisations (RPPOs), which work together to help contracting parties meet their obligations. Although 127 governments are currently signatories, Namibia is not yet a signatory to this convention, but is in the process of acceding to it (Rhodes, pers. comm.)

- The WTO Agreement on the Application of Sanitary and Phytosanitary measures (SPS Agreement, 1995)

The World Trade Organisation (WTO) agreement on the Application of Sanitary and Phytosanitary Measures came into force with the establishment of the WTO on 1 January 1995. It attempts to establish consistency in applying sanitary and phytosanitary (SPS) measures, and safeguards against countries using strict SPS measures as a smokescreen for trade protectionism. Stumbling blocks that might hinder the implementation of this agreement are that attempts to establish a list of unwanted invasive alien species might be viewed as a form of protectionism by developed countries, and that its promotion of trade might weaken its ability to restrict the entry of invasive alien species perceived to have commercial value into the country. Namibia is a member of the WTO.

Recent amendments approved at the 29th FAO Conference (1999) “reflect the complementary relationship of the IPPC to the Agreement on the Application of Sanitary and Phytosanitary Measures of the [WTO]”. The IPPC and SPS Agreement together provide some form of international protection from plant and animal “pests”, including invasive alien species. The SPS Agreement is probably a driving force behind the establishment and running of the Phytosanitary Division within the Directorate of Veterinary Services of MAWRD.

3.3.4 African Conventions and SADC Protocols

- African Convention on the Conservation of Nature and Natural Resources (African Union, 2003)

This treaty has yet to come into force. Once Namibia ratifies the treaty, appropriate legislation will have to be promulgated to provide for its implementation. Article IX on Species and Genetic Diversity is particularly noteworthy, stating that signatory states “shall maintain and enhance species and genetic diversity of plants and animals ...”; and shall particularly “g) preserve as many varieties as possible ...” and “h) ... strictly control the international and, as far as possible, accidental introductions, in any area, of species which are not native to that area ... and endeavour to eradicate those already introduced where the consequences are detrimental to native species or to the environment in general.”

- Revised SADC Protocol on shared watercourse systems (1985)

This protocol, signed by all SADC Heads of State in Windhoek in 2000, recognises the need for co-ordinated and environmentally sound development of shared watercourses in the SADC region and seeks to promote co-ordinated and integrated environmentally sound development and management of shared watercourses.

One of the key principals is to “take all measures to prevent significant harm,” while under the section that deals with Environmental Protection and Preservation, invasive alien species are specifically addressed in 2c: “Introduction of alien or new species ... [states shall] take all measures to prevent the introduction and spread of alien or new species into a shared watercourse which may have effects detrimental to the ecosystem of the watercourse resulting in significant harm to other watercourse states.” This clause prompted the SADC regional programme to control the introduction and translocation of aquatic weeds.

- SADC Protocol on Fisheries (2001)

Namibia signed the SADC Protocol on Fisheries on 14 August 2001. This regional protocol recognises the UNCLOS and takes into account the FAO Code of Conduct for Responsible Fisheries. Its objective is “to promote the responsible and sustainable use of the living aquatic resources and aquatic ecosystems.” Interestingly, it defines a “fish” as “any aquatic plant or animal,” and “resources” as “all aquatic ecosystems”.

Paragraph 7 of Article 13, which deals with aquaculture, is relevant: “A State Party shall not introduce exotic species or genetically modified species to shared aquatic eco-systems including the full extent of the river basin unless the affected State Parties agree to the introduction.” This makes it imperative for all countries sharing a common catchment to consult with one another and obtain permission prior to any introductions, and allows states to veto such introductions.

The first point under Article 14 on the protection of the aquatic environment binds parties to “conserve aquatic ecosystems, including their biodiversity and unique habitats.” Given that aquatic weeds and pests pose a threat to both biodiversity and habitats, this in effect commits us to controlling invasive species. Paragraph 2 goes further, stating that parties “shall apply the precautionary principle to ensure that activities within their jurisdiction and control do not cause excessive transboundary adverse impacts”; paragraph 9 adds that parties undertake to “take due account of the environmental impact and migrations of aquatic species.” Together, these clauses provide sound guidelines for the development of both national and regional strategies to deal with invasive alien species.

3.4 EFFECTIVENESS OF PRESENT LEGISLATIVE FRAMEWORK AND OPPORTUNITIES FOR IMPROVEMENT

Invasive alien species, alien species and potentially invasive alien species are a major threat to biodiversity, globally as well as nationally. Although present policy rarely mentions invasive alien species specifically, the general issue is fairly well covered within the broad definitions defining environmental health, sustainable utilization and preservation of Namibia’s array of biodiversity in the broadest sense. This review shows that there is currently legislation that implicitly covers invasive alien species, yet there remains an urgent need to introduce legislation which explicitly refers to alien invasive species. There is too much that is open to interpretation by decision-makers who are not necessarily aware of or concerned about the threat posed by invasive alien species.

Explicit legislation has recently been adopted in South Africa, and Namibia could do well to consider drawing on relevant clauses in the National Environmental Management: Biodiversity Act of 2004. The purpose of the chapter on alien and invasive species is to:

- a) ‘prevent the unauthorised introduction and spread of alien species and invasive species to ecosystems and habitats where they do not naturally occur;
- b) to manage and control alien species and invasive species to prevent or minimise harm to the environment and to biodiversity in particular;

- c) to eradicate alien species and invasive species from ecosystems and habitats where they may harm such ecosystems or habitats; and
- d) to ensure that environmental assessments for purposes of permits in terms of the Genetically Modified Organisms Act No 15 of 1997 are conducted in appropriate cases ... “.

The specific clauses relevant to invasive species impose a duty of care with regard to alien species (69) and listed invasive species (73), and allow for the publication and regular review of a list of invasive species (70). The Act covers the control and eradication of such listed invasive species (75). Interestingly, it is considered the duty of every landowner to notify the authorities of all “listed alien invasive species”, to actively control, eradicate and prevent the spread of these species and to take precautions “to prevent or minimise any harm to biodiversity” and to remedy any harm done (73). There are specific clauses to deal with protected areas, determining that a control and eradication strategy be a part of all management plans (76), and requiring regular reports to the Minister on the status of any listed invasive species (77). Several relevant clauses have been eliminated since the draft version was reviewed by Malan (undated).

Initially, Malan (undated) did not recommend drafting new legislation to deal with invasive alien species, but rather recommended strengthening existing legislation through appropriate regulations, both to avoid delays and to ensure that these changes are made at the technical level where the expertise is situated, rather than at the political level. He suggested that regulations be introduced to the Nature Conservation Ordinance, the Forest Act and the Marine Resources Act. More recently, however, at a workshop held in Windhoek in May 2004, according to Tarr (2004), Johan Malan recommended “comprehensive legislation” dealing with invasive alien species as well as “coordination of regulations under various pieces of legislation, tailored to the specific Act “ systematically dealing with invasive alien species and “amendments to existing legislation”, to introduce definitions of invasive alien species.

Given legislative developments since the original, undated review by Malan (assumed to be about 2002), and the opportunities these present, it would be more appropriate now to target the draft Parks and Wildlife Management Bill, particularly section 83 on alien and invasive species; the draft Water Resources Management Bill; the draft Conservation of Agricultural Resources Bill; and the pending Environmental Management Bill. Pertinent regulations to target would be those being developed for the Inland Fisheries Resources Act and the Aquaculture Act.

In summary, to improve the present legislative situation, based on this review the following steps are recommended:

- A national policy on invasive alien species

There is an urgent need to develop a national cross-sectoral policy dealing specifically with invasive alien species. Here the Alien Invasive Species Working Group, the Agricultural Biodiversity Working Group and the Wetlands Working Group can collectively play an important role in bringing together the interests of the relevant ministries, MET, MAWRD and MFMR, to produce a national policy on invasive alien species and their control.

- Inclusion of explicit clauses on invasive alien species in legislation currently being drafted

It is important to seize and make use of the window of opportunity that currently exists to include pertinent clauses in legislation currently being drafted, particularly the Parks and Wildlife Management Bill; the Conservation of Agricultural Resources Bill; the Water Resources Management Bill; and the emerging wetland policy. Where appropriate, these should be clearly linked to national interests and existing legislation and policies, as well as to obligations ensuing from international conventions and agreements to which Namibia is party.

- Appropriate regulations and guidelines on invasive alien species to complement existing legislation

Regarding existing legislation such as the Aquaculture Act and the Inland Fisheries Resources Act, attention must be given to developing regulations that deal explicitly with the introduction, management and control of invasive alien species, and on the basis of careful research, to compiling lists of invasive alien species that should be regulated or banned in Namibia, or in certain areas within the country.

- Practical guidelines appropriate to existing natural resource legislation

There is a need to develop practical ways of controlling the introduction and potential spread of invasive alien species in Namibia. These, together with clear identification posters and manuals, would be valuable tools that customs officers, veterinary inspectors and others could easily and accurately use to identify problem plants and animals, and thereby more effectively implement border controls and sound management of invasive alien species.

- Strengthened awareness and enforcement

No matter how well drafted, for any legislation to be of value, it must be supported by a campaign to strengthen awareness of the threats posed by invasive alien species and improve knowledge about these species. Such a campaign should target the ministries that deal with natural resources and with trade and health issues, as well as natural resource managers and users.

- Promote ratification of and compliance with international and regional conventions, agreements and protocols

In order effectively to deal with invasive alien species issues, it is important for Namibia to ratify both the International Plant Protection Convention and the African Convention on the Conservation of Nature and Natural Resources; to comply with obligations flowing from existing international and regional treaties; and to take steps to harmonise national policies and laws with principles agreed internationally and within the SADC. An excellent example of such an approach being taken is by the MFMR, in the course of the recent development of the Aquaculture Policy and the Aquaculture Act.



Pennisetum setaceum, Fountain grass, has shown a dramatic increase in central Namibia since the 1980's. Originally introduced as a garden ornamental, it is now commonly seen in Windhoek and elsewhere in Namibia. (Photo: Dave Joubert)

4 INSTITUTIONAL ANALYSIS

A questionnaire (Annexure 6A) was prepared and used as the basis of a series of interviews with responsible and knowledgeable people who agreed to represent the institutions involved in matters related to the potential introduction, translocation, control and management of invasive alien species in Namibia. The detailed responses, which include information on projects undertaken, are given in Annexure 6B. The main findings are summarised here.

The three lead institutions identified are the Ministry of Environment and Tourism, the Ministry of Agriculture, Water and Rural Development and the Ministry of Fisheries and Marine Resources, while the tertiary education institutions, the Polytechnic of Namibia and the University of Namibia, have lecturers and students actively involved in research and training relating to invasive alien species. Other institutions that have links with this issue are those involved in the trade of alien species such as the plant nursery operators, farmers (represented by their unions), professional hunters and game dealers. There are also the custodians of the national biological collections that collect, curate and study natural history specimens, for example the National Museum of Namibia and the National Herbarium. Local authorities such as the City of Windhoek are responsible for urban issues and townlands, and take the management of invasive alien species seriously, while the water supply parastatal, NamWater, is responsible for protecting the ecosystems that may be affected by water supply operations. A variety of NGOs are concerned with environmental issues. These include the Desert Research Foundation of Namibia (DRFN) and the Gobabeb Training and Research Centre (GTRC), the Namibian Nature Foundation (NNF), Integrated Rural Development and Nature Conservation (IRDNC) and the Southern African Institute for Environmental Assessment (SAIEA). Also important, particularly in the matter of raising public awareness, are national environmental groups such as the Wildlife Society of Namibia (WSN) and Earthlife-Namibia, while in an urban setting Greenspace – Friends of Avis and the Third Windhoek Scouts include control of invasive alien species in their activities.

4.1 THE MINISTRY OF ENVIRONMENT AND TOURISM

4.1.1 Department of Resource Management

The MET is a lead ministry, and is responsible for developing and enforcing legislation pertinent to environmental conservation and sustainable management. The Workshop on Invasive Alien Species held in 1984 was organised by researchers from what was then the Department of Nature Conservation. The proceedings from that workshop were published. Since then, scientists at the MET have contributed to various scientific biodiversity reviews, e.g. the biodiversity country study (Barnard *et al.* 1998). Resource management activities are currently guided by the Nature Conservation Ordinance of 1975 and subsequent amendments, and a variety of policy papers produced since independence as a series of Directorate of Environmental Affairs (DEA) Discussion Papers. New legislation to address shortcomings in the ordinance, the Parks and Wildlife Management Bill, is currently being drafted. It includes a section on invasive alien species, and more specific regulations will follow.

Experts on invasive alien species within the MET are Dr Pauline Lindeque, Dr Malan Lindeque, Holger Kolberg, Mike Griffin and Peter Erb. The Biodiversity Task Force is national forum. There is good cooperation with the National Botanical Research Institute (NBRI). The institute does not offer any training opportunities in this field other than the courses offered at UNAM and the Polytechnic of Namibia that provide training for staff and future employees. The Polytechnic of Namibia runs a 3-year diploma course in Nature Conservation, while the MET provides bursaries.

Awareness regarding invasive alien species is considered to be moderate within the MET, and can be improved with awareness and in-service training. The Directorate of Forestry seems to take a different approach, but this could be improved through the new bill, and through the establishment of uniform goals within the MET, particularly the Directorate of Forestry. The institutional priority accorded to the issue of invasive alien species is moderate to low, as it is elsewhere in the government service, and individual awareness is also considered to be low. Nevertheless, the overall priority accorded to invasive alien species within the MET is seen as moderate, and in some, but not all, sectors, even high. A detailed review of the situation should be most useful, as it would increase awareness (The last review was in 1985.) Although standards differ from region to region within the SADC, there are advantages associated with a regional review in that politicians are more inclined to support regional initiatives.

4.1.2 Directorate of Environmental Affairs and the Southern Africa Biodiversity Support Programme

The southern Africa regional programme SABSP (Invasive Alien Species Sub-programme) is supported by the MET and housed at the Directorate of Environmental Affairs. The DEA is the seat of the Biodiversity Task Force. Both the Alien Invasive Species Working Group and the Agricultural Biodiversity Working Group are specialist groups within the Biodiversity Task Force framework. Products include the country study, numerous scientific articles, in particular a dedicated publication “Biodiversity Conservation”, and a poster, “Namibia’s Nasty Nine –Alien Invasive Species.” Products of the working groups include strategic plans, input into assorted databases and the awareness poster. A second poster, “Ecological and economic threats of invasive alien species”, has been developed through the SABSP. Unfortunately, it gives the wrong common name for the invasive Mediterranean mussel, *Mytilus galloprovincialis*, mistakenly calling it a black mussel, which is an indigenous species, *Choromytilus meridionalis* often found in the same habitats but thought to occupy a slightly different niche, preferring low intertidal pools rather than the rocky surfaces of the mid intertidal zone where most *Mytilus galloprovincialis* are found (Grant 1987).

Collaboration with other scientists is primarily through the BDTF, which has links throughout Namibia. All relevant institutions are linked and effectiveness is considered to be good. Across border cooperation, specifically with IUCN-ROSA, and GISP (Cape Town) is considered good and effective. Joyce Kajirua, the local expert, says that both formal and informal awareness training is available through the programme. Awareness is low to moderate, and can be improved through awareness programmes. Within the DEA, little priority is accorded to invasive alien species, with the result that general awareness is low, and what little there is, is focussed on plants. The main advantage of a regional review is that with the backing of the SADC Secretariat, it will be easier to access funding, while a coherent and uniform policy throughout the region would improve management and enforcement.

4.1.3 Directorate of Forestry and forestry nurseries

The Directorate of Forestry considers itself a promoter of alien species as a result of its historical role and current demand. Since many alien plants can withstand Namibia’s arid conditions so well, the Directorate of Forestry is promoting them, even though some are known to be invasive species. Currently about 80 % (by number) of the plants sold in forestry nurseries are alien. Many tree planting projects that have been initiated, including community projects in the Kavango and Caprivi regions, have deliberately planted woodlots of alien species such as *Azadiracta indica* (neem), *Eucalyptus* and *Melia azedarach* (syringa).

Over the past 14 years, the Directorate has grown, donated to schools and sold *Leucaena leucocephala* (wonderboom), *Prosopis* spp. and various fruit trees and ornamentals such as *Jacaranda mimosifolia* (jacaranda). This is a very strong activity in many forestry nurseries and stations. A review of forestry in Namibia from 1850 to 1990 has been published by Erkilli and Siiskonen (1992) and at present John Mendelsohn from RAISON (Research and Information Services of Namibia), has been contracted to assist in the production of a publication on the mainly Finnish-aided forestry activities since 1990. A current project in collaboration with DRFN is looking at the feasibility of different tree species to provide shade for cattle in the Oshana and Otjikoto regions. These extensive grasslands are a major grazing resource for people in the north. The feasibility of planting different species, including invasive alien species, is being determined. A major limiting factor in these areas is soil salinity. Public awareness within the institution is very high, and staff are aware of the potential problems of invasive alien species. Despite this, the Directorate of Forestry is committed to planting and distributing alien and even invasive alien species via their tree planting projects, as the positive aspects of such species cannot be ignored and are thought to outweigh the environmental costs.

4.2 THE MINISTRY OF AGRICULTURE, WATER AND RURAL DEVELOPMENT

4.2.1 Department of Water Affairs – Directorate of Resource Management

The Department of Water Affairs was previously the lead institution in Namibia, and one of the leading institutions in the SADC, in terms of research and control of aquatic invasive alien species. The DWA is aware of and concerned about invasive alien species, as are SADC partners, and there is good collaboration with Botswana, e.g. the joint weed inspections on the Chobe River. The Ecological Research Section in the Division of Water Environment has been involved in ongoing biological control of *Salvinia molesta* in the eastern Caprivi since the early 1980s, and monitors aquatic invasive species throughout the country. The deputy director is the national representative on the SADC Water Sector sub-committee on aquatic weeds. Through the *Salvinia* control programme, the DWA has been involved for 25 years, first in SARCCUS, and later in the SADC regional programmes on water and aquatic weeds.

There is a dedicated field programme and a laboratory with two permanent staff members and insect breeding ponds for the biological control of *Salvinia molesta* in Katima Mulilo, and the department initiated the SADC programme to control the introduction and translocation of aquatic weeds. Shirley Bethune served as regional coordinator of the project. Scientists from the department published the regional review on aquatic weeds (Bethune & Roberts 2002) and numerous papers and reports have been published on the control programme. Experts in the field of aquatic alien species and their control are Shirley Bethune, Calle Schlettwein, Kevin Roberts, Vincent Simana, Alfred Makumi and Stef de Wet, also Nicolas Clarke and Eliot Taylor (although they are now working outside Namibia) and regarding *Prosopis*, Pierre Smit. There are no training opportunities within Namibia other than in-service training of research assistants, while most training opportunities outside Namibia are focused on water hyacinth, an aquatic weed that fortunately does not occur in Namibian waters.

Unfortunately, there is no mention of invasive alien species in either the current Water Policy or the Draft Water Resources Management Bill – in fact, there is no mention of protection of surface water sources, although the opportunity to develop regulations and permit requirements exists. Within Namibia there is good collaboration at the technical level, and this should continue with other scientists regarding invasive alien species. There is excellent collaboration with Botswana.

Good cooperation within the region has been established through SARCCUS and later the SADC Water Sector sub-committee on aquatic weeds, but this now needs to be re-established after disruptions caused by the move of the SADC to Gaborone. The need to collaborate more closely with MFMR staff regarding aquaculture threats and wetland surveys is recognised.

In the 1980s and early 1990s, awareness regarding aquatic invasive plants was good. The DWA has produced a show display (1985), pamphlets, popular articles, newspaper reports and several scientific publications to raise awareness of aquatic weeds. These efforts need to be revived to improve awareness both within the institution and in the country as a whole. Although the *Salvinia molesta* project continues to be financed by the ministry, there is nothing specific on aquatic invasive alien species in the new Water Policy or the Draft Water Resources Management Bill.

4.2.2 Directorate of Veterinary Services

The Directorate of Veterinary Services (DVS) is seen as a lead organisation regarding exotic organisms, and agriculture and risk analysis is ongoing and continuous, following the adoption of the OIE Terrestrial Animal Code. (OIE is a French acronym for the International Organisation for Epizootic Diseases. The Directorate Veterinary Services remains vigilant, monitoring for conditions which could lead to the emergence or re-emergence of diseases. Their programme is focused on prevention rather than cure. The organisation is service-orientated rather than research-orientated, and responds to situations as they arise. Relevant legislation includes: Act 13 of 1956; The Animal Diseases and Parasites Act, Act 36 of 1947 dealing with fertilisers, fodders and remedies; and A.G. Proclamation 14 of 1984 regarding Veterinary and para-veterinary professionals. This legislation is considered to be adequate, and is amended as needed. Schneider (1997) provides a guide to all relevant legislation. There is effective cooperation with Namibian institutions such as MET, MFMR, the Meat Board and the rest of MAWRD, as well as with the SADC, Onderstepoort outside Pretoria in South Africa, and the Botswana Vaccine Institute. There are about 40 state veterinarians, and short training courses are available within Namibia, South Africa, Malawi (CTTBD, Centre for Ticks and Tick-borne Diseases) and overseas.

Awareness is considered to be good, and the priority accorded to invasive alien species is high. A regional review would be very helpful, especially if it were to include pathogens. (Unfortunately, this review does not deal with pathogens, as none of the authors are specialists in this field.)

4.2.3 Directorate of Research and Planning and the National Botanical Research Institute

The National Botanical Research Institute, NBRI, houses the national plant collection, is involved in research and awareness-raising regarding all plants, conducts research and botanical surveys and assists the public and other scientists with plant-related queries. All invasive alien plants are documented and listed. Plant collection and research are ongoing tasks to improve knowledge on distributions within Namibia, and representative specimens are curated and kept in the herbarium. There is little Namibian legislation specific to invasive alien plants, and provision must be made in emerging legislation such as the new Conservation of Agricultural Resources Bill and the Parks and Wildlife Management Bill, as well as through efforts to incorporate invasive alien species concerns in regulations being developed to support existing legislation. One-to-one collaboration with other scientists, particularly within the Invasive Alien Species Working Group, is good, but invasive plants are not a high priority within most of the institutions represented. As a result, there is little collaboration from institution to institution within Namibia, although ad hoc collaboration between scientists in Namibia and elsewhere, for example with Lesley Henderson at the Plant Protection Research Institute, PPRI, in Pretoria, is good.

Local experts on terrestrial species are Herta Kolberg (NBRI) on plants and Mike Griffin (MET) on animals whilst Shirley Bethune and Barbara Curtis are the experts on aquatic species. Although botanists within the institute are aware of invasive alien species, general awareness in Namibia is not particularly good. Overall, the problems related to invasive alien species in Namibia are not yet regarded as being all that serious by the NBRI, but the institute is monitoring the situation carefully and care is being taken to avoid the importation of new species that may threaten the environment. Readily available advice on invasive alien species, together with good border checks and screening methods to prevent new introductions, will improve the situation. At present the institution allocates only a little funding and not much time to work on invasive alien species, although it is the responsibility of a senior staff member, Herta Kolberg. Thus, although invasive alien species are taken seriously, limited resources are allocated to this field. A regional review would be very useful, particularly a component reviewing legislation.

4.2.4 Directorate of Agricultural Extension and Engineering Services

The MAWRD is the lead ministry for agricultural pests, diseases and activities which affect agricultural activities, and is responsible for the plant quarantine policy and facilities. Past projects have included the control of reeds in the irrigation canals at Mariental, as well as control of the cotton borer, large grain borer, and *Cochineal*. Current projects include ongoing control of reeds and the cabbage butterfly, as well as monitoring and extension regarding previous projects and previously identified problems. No new projects are planned, but the MAWRD reacts to problems as and when they are identified. There are many laws regarding agricultural pests, in particular, but none deal directly with invasive alien species, except insofar as they are classified as pests. Current legislation is considered adequate, but can be improved.

There is collaboration with other line directorates and ministries, and effectiveness is generally good, although there could be more interaction with the MET on land-use issues. Collaboration outside Namibia is effective with organisations such as the South Africa Small Grain Centre and ICRISAT, the International Crop Research Institute for Semi-Arid Tropics, and is also extended through the NBRI on plant genetics resources. Local experts are Jacques Els, George Rhodes, Sheehamandje Ipinge, Twewaadha Alweendo and although no longer with the Ministry, Bianca Braun, but there are no training opportunities in this field. Within the Directorate of Agricultural Extension and Engineering Services, general awareness on invasive alien species is low, and can only be improved with increasing awareness activities. Nevertheless, the standing of the Directorate is high, and amongst scientists and the phytosanitary section, the priority accorded invasive alien species is high, although it is lower within the Ministry as a whole. Asked about the value of this review of invasive alien species the response was that unless the end result is action, which requires political will, this review will be just another report.

4.3 THE MINISTRY OF FISHERIES AND MARINE RESOURCES

4.3.1 Directorate of Resource Management

- **Division of Inland Fisheries – Hardap Freshwater Fish Research Institute**

The Hardap Freshwater Fish Research Institute is involved in aquaculture development, research and monitoring, and national freshwater fish surveys. Past projects include contributions to the Red Data Fish Species List, input into the 1984 Workshop on Invasive Alien Species and the 1988 MET Wetlands Workshop, several biodiversity publications, telemetry studies e.g. on *Cyprinus carpio* (carp) in Hardap and ongoing national fish surveys. Current and future projects include aquaculture research, development and monitoring, and further freshwater fish surveys.

The MFMR accords priority to research on species that can be commercially exploited, only where economic benefits can be shown is research effort warranted, e.g. aquaculture. Relevant legislation includes the Fisheries Act (1992) that has since been replaced by the Marine Resources Act of 2000, the Inland Fisheries Policy and the Inland Fisheries Act (2003), the Aquaculture Policy and the Aquaculture Act, and recent aquaculture regulations. The regulations pertaining to subsistence fisheries need revision, e.g. limits on numbers of nets or allowable mesh size do not take into account seasonal aspects such as the bulldog run. The SADC Fisheries Protocol calls for harmonisation of legislation within the region.

Collaboration with other specialists within Namibia is sometimes not good, and requires improvement, researchers at Hardap feel somewhat isolated. Nevertheless, collaboration outside Namibia is good, especially with scientists such as Prof Paul Skelton, and other South Africans and even Norwegian experts. There is good co-operation within the SADC, especially with Botswana, Zimbabwe and Zambia, although there are language barriers and access problems with Angola. National experts are Dr Clinton Hay and Dr Ben van Zyl, and even though the other fish biologists are not experts in invasive alien species, they deal with them as part of their jobs. Some relevant training is offered within UNAM natural resources and aquaculture courses. Dr Orton Msiska and his students, visit the ponds and are involved in growth experiments.

Malawian experts have been brought in to help set up aquaculture ventures and advise communities. There is some awareness within the institution of invasive alien species, but not enough concern regarding the risk that new aquaculture ventures have in terms of the introduction and spread of invasive alien species into Namibian wetlands. A precautionary approach to the introduction of species is strongly recommended. No matter how strict the permit requirements are, there is always the potential for aquatic plants and animals to escape. There are already reports that the freshwater crayfish introduced to a fish farm near Grootfontein a few years ago has spread into natural springs on a farm 10 km north of Tsumeb, and there is concern that the Hardap stock may escape and spread into the Fish and Orange river systems. There is also concern regarding genetic pollution and the need to avoid brood stocks affecting wild stocks of fish of the same species. Caution is needed to prevent financial considerations from overriding ecological concerns. The recent Inland Fisheries Policy and Inland Fisheries Act (2003) reflect concern regarding invasive alien species and the need to protect aquatic ecosystems. The MFMR follows the FAO guidelines on responsible fisheries, as well as the precautionary approach advocated by the SADC Fisheries Protocol. This review is seen as useful to the Freshwater Fish Research Institute, especially in terms of aquaculture development and the planning of future projects.

- **Division of Marine Fisheries – Environment Section**

The Environment Section is responsible for biodiversity surveys, and invasive alien species of economic concern merit the attention of the Division of Marine Fisheries. Past projects include the Sancob, Southern African Foundation for the Conservation of Coastal Birds, project on distribution of mussels on the southern African coastline (Currie 1996; Harris *et al.* 1997), while an important current and future project is the Biodiversity Ecosystem Health and Pollution component of the Benguela Current Large Marine Ecosystem Programme (BCLME), that will run from January 2004 to December 2007. Of particular interest within this project are the marine biodiversity assessment and mapping functions. Within this, projects 2, 4, 6 and 7 will contribute to our understanding of invasive alien marine species. They deal with mapping the BCLME shoreline, shallow water and estuarine habitats, with inshore assessments, identification and quantitative surveys of communities, biotopes and species along the BCLME shoreline and shallow intertidal, and include baseline surveys of species and biodiversity in estuarine habitats.

The legislation most pertinent to the activities of the section is the Fisheries Act. Expertise on invasive alien species exists within the MFMR, and there is good collaboration with South African and international institutions and scientists (e.g. Dean Anderson on algal blooms, Paul Archer from Maine, the FAO and the U.S. Benefit Programme). Bronwen Currie, who heads the Directorate of Aquaculture, is the national expert on invasive alien marine species. There is good in-service training and good awareness within the industry, though awareness within the institution is not that good and national awareness is low. The introduction and spread of invasive alien species are controlled through a permit system. As the institution is only really concerned with those invasive alien species that are economically relevant, it does not accord very high priority to invasive alien species at present. This review is seen as useful by the biodiversity group for its research value.

4.3.2 Directorate of Aquaculture

The Directorate of Aquaculture is a newly formed Directorate that deals with aquaculture and mariculture development. Other than the survey of mussels already mentioned, there have been no specific projects on invasive alien species to date. One of the components of the BCLME programme (Project 7) involves an aquaculture assessment that will include the identification and ranking of appropriate and unsuitable species for aquaculture. Pertinent legislation includes the SADC Fisheries Protocol and the new Aquaculture Policy and Aquaculture Act. Good regulations and effective enforcement will be required to control the importation of live aquatic organisms. Regulations have been drafted, but have yet to be gazetted. The policy is clearly guided by the FAO guidelines and EU regulations, but there is a need for better customs controls and training of customs officials. The Aquaculture Strategic Plan is being finalised.

There is limited expertise within the MFMR, but more people will be trained as the Directorate of Aquaculture is strengthened and a new research component added. There is good collaboration with industry as well as with South African, SADC and international institutions. Bronwen Currie is the head of the Directorate of Aquaculture. In-service training will be undertaken and advice will be available to entrepreneurs interested in aquaculture ventures. There is some awareness within the industry, but not yet much within the institution, and there is little national awareness. At present, the introduction and potential spread of invasive alien species are strictly controlled through a permit system. Aquaculture is accorded high priority within the MFMR and other government ministries, although there is much less awareness of the potential hazards associated with the introduction and release of invasive alien species such as freshwater crayfish.

4.4 TERTIARY EDUCATION, RESEARCH AND HEALTH INSTITUTIONS

4.4.1 The Polytechnic of Namibia

- **School of Natural Resources and Tourism**

The School of Natural Resources and Tourism (SNRT) of the Polytechnic of Namibia currently has three members on the Alien Invasive Species Working Group (Carol Steenkamp, Peter Cunningham and David Joubert). Their involvement on the working group is considered part of their Polytechnic workload. The Polytechnic provides training in invasive alien species as part of the curriculum in several courses, and is active in research on invasive alien species (Joubert & Cunningham, 2002, 2004; Cunningham et al. 2004). Several students have also undertaken projects dealing with invasive alien species. Because the focus of the SNRT's training and research is on natural resource management, awareness within the SNRT is reasonably high. Even within the SNRT, however, there is currently little emphasis placed on invasive alien species, although the potential for research in this field is great. The SNRT collaborates with MET, NBRI and NGOs such as DRFN, the Botanical Society of Namibia and the Wildlife Society of Namibia, WSN.

The effectiveness of collaboration with government institutions is limited by a perceived lack of co-operation and communication. There is little collaboration with institutions outside Namibia. Dave Joubert expects to collaborate with Miami University, Florida, USA, the Institute of Forestry and Environmental Sciences in Bangladesh and Panjab University, Chandigarh, India on invasive alien species in the near future. The Land Management (Rural Land Use Diploma) and Nature Conservation (Diploma and B. Tech) courses include training on invasive alien species, but the relative emphasis on such training could be increased. It is planned to increase the emphasis on invasive alien species in the subject Conservation Management within the B. Tech course. The institution has the potential to become more involved in awareness creation by getting students to organise Arbour Day events, and through public presentations and extension talks to school children.

- **Department of Agriculture**

Invasive alien species are dealt with in the syllabi for Rangeland Science, Rangeland Management and Agro-ecology in the Department of Agriculture. Although there are no past or current projects specifically on invasive alien species, a student is interested in undertaking a community interaction study at Excelsior resettlement farm on the control of fountain grass and/or queen of the night cacti later this year. Experts at the Polytechnic are Dave Joubert and Carol Steenkamp, and training opportunities are available at the Polytechnic of Namibia, UNAM and Agrifutura in Namibia. Awareness about invasive alien species tends to be low, except amongst natural resource students at the Polytechnic and a few farmers and scientists; many people perceive invasive alien species, particularly *Prosopis* and those with edible fruits such as prickly pears, as being useful.

The priority accorded to invasive alien species at the Polytechnic is very low, as is evidenced by the profusion of fountain grass on the campus. A review such as this should be useful in providing material relevant to the Rangeland Science, Rangeland Management and Agro-ecology courses offered at the Polytechnic.

4.4.2 The University of Namibia

The link that UNAM has with invasive alien species is through aquaculture projects at Hardap and Walvis Bay, and limnology courses for the BSc. (Natural Resources) degree. Past projects on invasive alien species include the introduction of red tilapia and the Pacific oyster (*Hipandulwa et al.*, in press). Current and future projects are on crayfish feeding in aquaria and the commercial production of the Pacific oyster. Collaboration with scientists and managers from other institutions within Namibia appears to be difficult, as no-one has taken the initiative to form a lead agency. It is thought that better coordination should improve the effectiveness of such collaboration in the future. Training opportunities within Namibia include the Conservation Biology, Aquaculture and Aquatic Ecology courses offered at UNAM. The degree of awareness regarding and priority accorded to invasive alien species within UNAM is not clear. The GTRC and the Geography Department of UNAM jointly offered a six-week course for final year students on invasive alien species in June 2004 and the Geography Department has been actively involved in *Prosopis* research.

4.4.3 National Museum of Namibia

The National Museum of Namibia is responsible for research on the taxonomy and biogeography of animal species; maintains the national archive of specimens; offers an identification service; and works closely with other ministries. Past projects have dealt with the impacts of inter-basin water transfers on snails (by Barbara Curtis) and agricultural pests and pest control species such as wood borer, cabbage butterfly and prickly-pear moth. Museum staff were involved in the biodiversity country study (Barnard *et al.* 1998), and Eugene Marais heads the Biosystematics Working Group of the National Biodiversity Task Force.

Their support to the Ministry of Agriculture, Water and Rural Development looking at agricultural pests is ongoing, and several reports are in-progress. Future projects will depend on future requests for specialist assistance. The National Museum is essentially “on-call” to provide information of a specialist nature. The NMN liaises and works with all relevant ministries, and is always very willing to help, but resources are highly problematic.

There is no supporting legislation, which is a problem that leads to a lack of institutional support, both in terms of budgets and recruitment of personnel. The Museum needs a higher profile and better political support. It needs first-class status within a supportive system, and the National Heritage Act may provide some leverage in this regard.

Links with institutions outside Namibia are good, but the lack of resources does hamper effectiveness. Each individual curator is an expert in his or her field, and expertise base extends to invasive alien animals. The museum can provide in-service training only. Generally, awareness is low, and it can only be improved by education. Within the museum, however, specialists are highly aware, although outside their specialist interest fields, their awareness remains low. Invasive alien species are accorded low priority because the NMN’s priorities are externally determined. From within, low priority is accorded. Due to perceived incompleteness and different degrees of accuracy and completeness, a regional review is not perceived as being useful.

4.4.4 Ministry of Health and Social Services

Essentially, the Ministry of Health and Social Services (MOHSS) has no direct links with invasive alien species and runs no projects in this regard. Although there is agreement that invasive species should be regulated, this type of review would not be particularly useful to the Ministry of Health and Social Services, as the topic is not within the scope of their work, despite a recent workshop that considered using fish, including alien species, as biological mosquito control agents to combat malaria.

4.5 NURSERIES, FARMERS AND GAME DEALERS

4.5.1 Plant nurseries

The two largest nurseries in Windhoek, Wilde Eend and Ferreria’s, take care not to sell known invasive alien species, and although phytosanitary certificates and import permits are required and are subject to quarterly renewal, no list of invasive alien species is available. As most of their imports are from South Africa, they rely on the strict regulations imposed there, as well as on information from South African publications such as the “SA Gardening” magazine. They are aware that the strict regulations in South Africa can have a negative effect in that old stocks of plants that have subsequently been declared to be weeds there, e.g. *Psidium littorale longipes* (cherry guava), are cheaply available for sale in neighbouring countries with less strict regulations. They stress the importance of harmonising regulations throughout SADC countries. The nurseries are occasionally inspected to check that no invasive alien plants, particularly aquatic species, are offered for sale. They have collaborated with researchers from the Polytechnic of Namibia in the past, specifically in the fountain grass study.

In terms of awareness, they felt that although nursery owners and managers are well aware of the threats posed by invasive alien species the general public is not. To address this, they plan to incorporate awareness of invasive alien species into their newsletter “*Grassies*”. They can also include information on invasive alien species in radio talks that they present to gardeners, and are prepared to display posters and hand out pamphlets. They suggest a regular feature in the municipal newsletter, “Aloe”.

In-house horticulturists at these plant nurseries, Eugene Le Roux and Johan Wentzel at Wilde Eend, and Hugo Truter at Ferreria's, are experts and readily advise gardeners on what to plant and what not to plant, and refer clients to experts at the NBRI or the Polytechnic of Namibia if necessary. They agree that prevention is better than cure, are keen to be kept informed and to exchange information, and are anxious to do the right thing. They mentioned an interesting alternative for gardeners to plant, namely the sterile *Lantana montividentis* instead of the invasive *Lantana camara*.

4.5.2 Farmers unions

- **Namibia National Farmers Union**

The Namibia National Farmers Union (NNFU) does not currently have any programmes or links with invasive alien species, which are not currently a priority issue. The NNFU is, however, eager to introduce awareness campaigns in the future.

They welcome the idea of raising awareness within the institution through “training-of-trainers” programmes, as many communal farmers are not currently aware of invasive alien species as a threat to their livelihoods or the environment. As an example, farmers often plant *Dodonaea* hedges, despite the invasiveness of *Dodonaea angustifolia*. Palatable species such as *Prosopis* spp. are not perceived as a problem. They suggest an awareness campaign using posters, radio, TV, extension work and face-to-face discussions that include information about which the invasive alien species are, how to identify them and the threats they pose to both farming livelihoods and the environment in general.

- **Namibian Agricultural Union**

The Namibian Agricultural Union (NAU) currently also does not deal directly with invasive aliens, although Mr Sakkie Coetzee (CEO of NAU) is undertaking a project to eradicate *Prosopis* spp. on his farm in the Leonardville District as part of his action plan to combat bush encroachment. The NAU has no specific policy regarding invasive alien species but definitely supports and promotes any legislation regarding invasive alien species. Institutionally, there is little awareness of or priority placed on invasive alien species, except that *Prosopis* is seen as a serious bush encroachment problem and individual farmers are involved in programmes to clear invasives such as *Datura* from their farms. They recommend raising public awareness by using pamphlets, radio programmes, posters, articles in agricultural magazines such as “Agriforum” and messages at farmers’ meetings. They are interested in the results of this review of the invasive alien species situation in Namibia, and regard such information as being important for the union and its members in improving farm management.

4.5.3 Game dealers and the Namibia Professional Hunting Association

Namibia Professional Hunting Association (NAPHA) members own, hunt or deal in invasive alien species, and they have an informed opinion on the subject. The organisation recently gave serious consideration to invasive alien species issues, and how these apply to the NAPHA. These discussions and the consensus reached form the NAPHA policy on invasive and alien species. This policy is clearly set out in the founding document of the Game Translocation Committee (2004), an official NAPHA sub-committee. Essentially they acknowledge that Namibia has an “Authentic Namibian Hunting Product” and undertake to focus on maintaining and marketing this product. They are committed to maintaining the integrity of the Namibian ecosystem and agree to prohibit the import of alien or exotic species. Sub-species of animals occurring in Namibia are dealt with strictly genetically, and no other variations are allowed into the country.

The document of the Game Translocation Committee sets out clear guidelines for members on the process of selecting species and criteria to be taken into account. In effect, it is a screening mechanism for careful risk assessment, to be undertaken prior to any introductions of game.

The association currently liaises closely with MET on the implementation of the screening process set out in the document, and this will continue. Members are bound by a sound Code of Conduct, which promotes ethical hunting. There is good collaboration with MET, NNF and WWF, but there is always room for improvement. Outside Namibia, NAPHA collaborates with Conservation Force (pro-hunting and conservation) and participates and reports to REPHAN the annual meeting of the Southern African regional (south of the Zambezi River) professional hunters association. This organisation has agreed not to import animals from north of the Kunene, Okavango and Zambezi rivers. Experts within the association are Helge Denke, Reinhardt Rusch and Joof Lamprecht Jnr. Training is geared towards promoting awareness on the part of members, associated staff and trainees. Following the detailed discussions held earlier this year and the circulation of the document, awareness is high. Individual perceptions are strong, and the association accords high priority to invasive alien species. A review such as this is seen as very useful.

4.6 LOCAL AUTHORITIES AND PARASTATALS

4.6.1 The City of Windhoek

Both the Weed Control Team and the Bush Control Teams of the Open Spaces and Recreation Division of the Municipality of Windhoek deal in part with the eradication of invader trees in natural areas and river courses and on undeveloped municipal land. In accordance with the Town Planning Scheme, which outlaws the cultivation of *Prosopis*, they are involved in the ongoing chemical control of these trees. This service is provided free of charge to residents. The bush control teams attempt to maintain the indigenous integrity of natural areas and river courses by eliminating exotic species such as *Agave* spp., *Opuntia* spp., *Schinus molle*, *Melia azederach*, *Tecoma stans*, *Leucenia leucocephala* and *Prosopis* spp. These services have been provided for many years, and will continue to be provided in the future. As there is a need to fill the vacuum left after the eradication of such plants, pamphlets are printed and distributed to Windhoek residents promoting the use of suitable indigenous types. They are conducting trials on the suitability of indigenous trees and shrubs in a cultivated environment in Windhoek. These include tests for frost hardiness, growth speeds, the effects of regular, thorough watering, and the effects of fertilizers. Saplings are provided by the Department of Forestry, also for municipal gardens and playgrounds, and trials are conducted to test species from frost-free areas of the north. Seeds, cuttings and plants are not always readily available.

One project under consideration is the removal of invasive cacti along the Hofmeyr/Aloe trail in the centre of Windhoek, and the upgrading of the paths, improving of signs and development of a pamphlet for walkers. There is concern that the promised assistance of the Botanical Society in this project may not be forthcoming as their priority remains the adjacent botanical gardens.

Regarding legislation and regulations, the Town Planning Scheme only forbids the cultivation of *Prosopis*. Other exotics/aliens are targeted through environmental awareness campaigns and the municipality's own efforts. A list of exotics commonly found invading river courses has been presented to the City's legal division for consideration. There is also concern about the use of these alien species as sidewalk trees. City of Windhoek horticulturists collaborate informally with NBRI staff, members of the Botanical Society and staff of the Directorate of Forestry and the Polytechnic of Namibia. The information exchanged provides motivation and a scientific basis for continued work in the field of indigenous plant promotion and invader eradication.

Awareness both within the Municipality and Namibia in general remains low. Regarding individual perceptions and the stance of the City of Windhoek on invasive alien species in Namibia, it can be said that many staff members are not even aware that *Prosopis* is an exotic species, believing that it is a “natural thorn tree like all the others”! Many perceive indigenous trees as slow-growing and thorny, and to get shade quickly opt to leave existing *Prosopis* trees. Although sponsors pump millions into sport activities, invasive alien species receive little “air-time” and activities to eradicate them remain hampered by a lack of funding. Invasive alien species are a priority only to the Open Spaces and Recreation Division and are not prioritised by the organisation as a whole. In fact, not even Environment Division colleagues consult or collaborate with Open Spaces and Recreation Division personnel regarding weed eradication. Any scientific facts regarding invasive alien species in Namibia will assist in motivating for projects on invasive alien species eradication and securing the necessary funding, which is presently directed at service provision and the maintenance and improvement of physical utilities.

4.6.2 NamWater

Beyond obligatory EIAs, NamWaters’ concern with invasive alien species is limited to situations where invasive alien plants impact on water supply or operational activities. Past projects include dealing with *Salvinia* mats that blocked water abstraction points in Caprivi Region, where the approach was to move the abstraction point to an unobstructed site. Problems related to invasive alien species are dealt with as they arise, and a possible future project will be to control *Prosopis* at Omdel Dam. In this regard, preliminary discussions have been held with Pierre Smit of UNAM.

Relevant legislation is the NamWater Act (No. 12 of 1997), as well as all national water and environmental policies and legislation. There is ongoing collaboration with the Municipality of Windhoek, DWA, UNAM and members of the Alien Invasive Species Working Group, although this collaboration is not as effective as one might wish. NamWater enjoys good collaboration with institutions in South Africa such as RandWater, Umgeni Water and the Council for Scientific and Industrial Research, both on a formal contract level and the level of interpersonal technical cooperation with scientists and managers. The local experts on aquatic plants are N.P. du Plessis at NamWater and Shirley Bethune nationally. Although bursaries are available from NamWater, they are mainly for engineering studies, and are driven by training needs within NamWater. Awareness on invasive alien species is generally low, except where colleagues have a personal interest. To improve this, an intensive, well-targeted public awareness campaign to counter rather jaded public reactions to most water awareness drives is recommended. The control of alien and indigenous invasive species is perceived as being important. Within NamWater, priority is given where water supply operations are affected or are likely to have an effect in terms of the introduction or spread of invasive alien species. The issue of invasive alien species is also dealt with in the broader context of EIAs. This review is seen as a useful addition to the library, and insofar as its recommendations are practical, they could be useful.

4.7 NON GOVERNMENTAL ORGANISATIONS

4.7.1 The Desert Research Foundation of Namibia and the Gobabeb Training and Research Centre

The DRFN and GTRC have been involved in keeping long-term records and conducting several specialist studies on invasive alien species in the Kuiseb River and the surrounding area. A future project will compare *Prosopis* and *Faidherbia albida* with regard to their eco-physiology and ecology. Currently, the University of London is monitoring *Prosopis* spp. seed output and health in the Swakop River. These are both research rather than control projects.

In June 2004, the GTRC and the Geography Department of UNAM offered a six week course for final year students on invasive alien species. DRFN and GTRC staff collaborate with a wide variety of institutions within Namibia, including MET, the Polytechnic of Namibia and UNAM, as well as with many institutions and scientists elsewhere, including the University of London and the University of Cape Town (*Prosopis* study), and members of the WADE project (an EU project jointly implemented with organisations in South Africa, Israel, Germany and Spain, focusing on aliens only inasmuch as they consume water.) Experts within the institution on issues related to invasive alien species are Dr Joh Henschel, Bertus Kruger, Olavi Makuti and Dr Mary Seely. Besides the six-week UNAM course, DRFN and GTRC offer internships for tertiary students to do projects on natural resource management issues, including invasive alien species, and they are always able and willing to provide specialist training courses on demand.

Within the institutions awareness is high, but at present invasive alien species research ranks below other priorities, even though high water users such *Prosopis* spp. are emphasised. Dr Henschel regards general awareness on invasive alien species within Namibia as being very low. He suggests more frequent newspaper articles (e.g. a series of newspaper articles, each focusing on a particular species), radio talks and awareness brochures, and emphasises the need to spread awareness in schools.

4.7.2 Integrated Rural Development and Nature Conservation

Currently, Integrated Rural Development and Nature Conservation (IRDNC) has no explicit programmes related to invasive aliens, and does not envisage any in the next five years. IRDNC in general does not place high priority on biodiversity per se, but focuses more on game species and on grazing resources. Nevertheless, IRDNC does distribute the “Namibia’s Nasty Nine” posters and gives briefings on the subject at the same time. Within the institution, awareness is high amongst the technical staff, but low amongst the community staff. They have noticed that awareness of invasive alien species amongst the general public of Namibia is very low, and strongly recommend awareness campaigns similar to those in South Africa, to target government authorities at local, regional and national levels in particular.

4.7.3 The Namibian Nature Foundation

The Namibia Nature Foundation (NNF) channels funds to the Alien Invasive Species Working Group, and also assists with technical information on invasive alien species for NNF-funded projects. It has given grants for forestry activities and encourages taking invasive alien species into account in other projects and in EIAs. Small grants have been given for projects undertaken by schools, DAPP, Development Aid People to People, the Northern Namibia Environmental Project committee, the clearing of alien vegetation at Waterberg Plateau Park and an anti-erosion project at Okakarara. A future project is to help the City of Windhoek to clear cactus in the centre of town.

Current legislation is considered to be inadequate in that controlling invasive alien species remains ineffective, and the country has notoriously porous borders. The trade in garden ornamentals is not adequately controlled, while the Directorate of Forestry in the MET still appears actively to promote the distribution of alien species. Although the control of alien and invasive birds and reptiles is good, phytosanitary regulations need to be more strictly enforced.

There is good collaboration with scientists and specialists within Namibia, particularly with those in governmental structures dealing with agriculture, veterinary matters, fisheries and the environment, with quick responses to pertinent issues and a willingness to take up issues. There is also good collaboration with institutions in Cape Town and Botswana, and with the Kew Botanical Gardens in London. The in-house expert at NNF is Chris Brown.

Experts on invasive alien species elsewhere in Namibia include NBRI staff members such as Herta Kolberg and Pat Craven; MET's Mike Griffin; Shirley Bethune on aquatic weeds; George Rhodes at Veterinary Services; staff at MAWRD and the MET's Directorate of Forestry, and regarding indigenous gardening, horticulturists such as Anthony Watkins at the City of Windhoek. It is possible to link to relevant training courses outside Namibia, and organisations such as the NNF can contribute towards bursaries in this field if so requested. Some institutions such as MAWRD offer in-service training.

Within the NNF, awareness of invasive species is reasonably high, yet nationally it tends to be generally low and variable. One way to address this would be through articles in the City of Windhoek newsletter "Aloe" and specific documentaries on national television. Specific problem species that should be eradicated should be identified and the onus to remove them placed on landowners. Furthermore, at national level a concerted effort needs to be made to clear areas, catchment by catchment, of problem species, starting with those that have the highest potential to cause harm within the systems in which they occur. Dr Brown's individual perception is that invasive species are less of an issue in arid areas than in areas of high rainfall, and that most invasions are caused by man-made disturbances and thus tend to be mainly in systems such as ephemeral rivers and aquatic or wetland areas. For most of the country invasive alien species are not a problem, but as wetlands are one of our most vulnerable and scarce ecosystem types and the most prone to invasive alien problems, care must be taken to protect them. The NNF thus does not accord any particular priority to the invasive alien species situation in Namibia as it is not a major environmental issue in arid and semi-arid areas. The results of a review such as this will be valuable to the NNF, and a copy of the report would be appreciated.

4.7.4 Southern African Institute for Environmental Assessment

The Southern African Institute for Environmental Assessment (SAIEA) has no direct link with the issue of invasive alien species but considers it to be a high priority. In their task of guiding EIAs, they highlight the risk of introducing or translocating alien species in development projects. In the Popa Falls hydropower development EIA, for example, the risk of introducing invasive aliens through machinery is specifically included in the terms of reference. SAIEA regularly gives attention to invasive alien species when reviewing EIAs, both in Namibia and elsewhere in the SADC region. SAIEA has a database of 170 EIA experts within the region, but obviously not all of these are experts on invasive aliens. Awareness within the institution is high, and the director strongly recommends a resource economics approach to making decision-makers aware of the problem, by looking at the opportunity costs of introductions or projects that carry risks associated with invasive alien species, since decision-makers tend to focus on socioeconomics. He cites an example of a proposal to plant *Opuntia ficus-indica* along the Orange River, which he is countering using a resource economics approach. He recommends that investigations into invasive alien species go beyond listing the distributions of different species and focus on biodiversity and economic impacts.

4.8 PUBLIC SECTOR ENVIRONMENTAL GROUPS

4.8.1 National Societies

- **Wildlife Society of Namibia**

The Wildlife Society of Namibia (WSN) supports projects and encourages programmes linked to conservation in general, including those that deal with invasive alien species. There have been no major projects on invasive or alien species, although articles on these have been featured in the Wildlife Society publication, "Roan News".

This year's presentation by Dave Joubert and Peter Cunningham, at the Wildlife Society's AGM was on invasive alien species, with particular emphasis on fountain grass. Future projects on invasive alien species include collaboration with the Third Windhoek Scouts, Greenspace and the Municipality of Windhoek to organise programmes to combat invasive alien species in and around Windhoek and further afield. The WSN's intention is to devote more space in future issues of "Roan News" to invasive alien species in Namibia (Cunningham, pers. comm.). Other than on an informal one-to-one basis, there is not much collaboration with scientists and managers from other institutions within Namibia or internationally. The national experts within the institution are committee members Dave Joubert and Peter Cunningham, and several other members such as Shirley Bethune and Barbara Curtis. The degree of public awareness on invasive alien species within the WSN is high, yet general public awareness is low. Regarding individual perceptions and the stance of the institution on invasive alien species in Namibia, the Wildlife Society accords high priority to all conservation issues, and is open to any programmes aimed at improving conservation, but till now funding for projects has been mainly directed towards more conventional "wildlife" programmes. This is mainly because no motivations have been received for projects aimed at combating invasive alien species. A review such as this is seen as useful for increasing awareness, provided it is widely and effectively publicised.

- **Earthlife-Namibia**

Earthlife-Namibia has not yet worked on invasive alien species, but does promote the planting of indigenous species through their annual tree planting project, which allows only for the planting of indigenous trees. Although there are no projects specifically on invasive alien species, this is one of the areas mentioned in the Earthlife's Guiding Document, which states: "Respect for and protection of current indigenous forests must be built into the plans of all forestry companies. Earthlife will campaign for the forestry industry to move away from planting invasive species to planting indigenous forests, and will support indigenous tree planting projects..."

There are no national experts with Earthlife, but elsewhere they recognise the staff of the Polytechnic of Namibia and UNAM. Regarding training opportunities within and outside Namibia, they recommend that topics dealing with invasive alien species should be part of the syllabus at schools and other training institutions. There is awareness in Earthlife-Namibia, but in general awareness is considered to be very low. This could be improved by more public talks and posters. People must understand the impact of invasive alien species and it is considered important to raise the awareness of decision-makers.

Earthlife recognises that eradication of invasive alien species is an extremely difficult task, yet recommends that they should be removed in Namibia in order to avoid competition with indigenous species. Despite this, invasive alien species are not high on their list of priorities because of other burning issues. They believe that the problems related to invasive alien species within Namibia are in good hands with the Polytechnic of Namibia, UNAM and the WSN, and that an investigation and review of the invasive alien species situation in Namibia would certainly be useful.

- **Botanical Society of Namibia**

The Botanical Society of Namibia (BSN) has no particular link with invasive alien species, or with any projects on invasive alien species. There is the possibility of future involvement in the Windhoek Municipality's project to eradicate cactus along the Aloe Trail (Hofmeyr Walk). The BSN is a small organisation concerned mainly with the Botanical Gardens in Windhoek. There is awareness within the society, and its members recognise that various cactus species, fountain grass and bush encroachment problems need to be addressed.

Invasive alien plants are accorded low priority, as the society has been mainly occupied with promoting the Botanical Gardens in Windhoek, an area which is almost free of invasive species. The review could be useful in giving the society guidelines for possible future actions such as the Aloe Trail project.

4.8.2 Urban Groups

- **Greenspace – Friends of Avis**

Greenspace – Friends of Avis's link with invasive alien species is the protection of urban "greenspaces" which may have alien plant species. Projects are mainly to do with the removal or hacking of alien species in urban areas. Greenspace – Friends of Avis operates within the legislative framework of the City of Windhoek municipal laws and has collaborated with the NBRI and the Third Windhoek Scouts in connection with the removal of invasive alien plant species, particularly around Avis Dam. Regarding perceptions and the stance of Greenspace – Friends of Avis on invasive alien species in Namibia, some members are unsure, but the organisation is currently run by people who are aware of the invasive alien species issue. A review is not seen as particularly useful as the members of Greenspace – Friends of Avis already know what the most problematic invasive alien species are.

- **Third Windhoek Scouts**

The Third Windhoek Scouts are involved in controlling invasive alien species because their scout hall, Travis, is situated close to Avis Dam in an area on the outskirts of the city that is infested by invasive alien plants, particularly cacti, *Datura* and *Nicotiana*, and they are keen to assist with the conservation of the Avis Dam area. Two of the senior scouts, Tessa Harris and Jenni Roberts, did a year-long "Young Scientist" project testing practical control options for *Prosopis*, and this year they are working on a project on Avis Dam and the impacts of the February 2004 floods. There have also been previous attempts by parents and leaders to clear alien cactus species from the area around Travis. This year the troop leader, David Roberts, attended the AGM of Greenspace – Friends of Avis and volunteered the services of the scouts to help clear invasive alien plants around Avis Dam. As a result, a Saturday in October has been set aside as "Alien Bashing Day" for the scouts, and they have appealed interested organisations to assist them on the day with some practical weed clearing. The date chosen is Saturday 8 October 2004, the day after Arbour Day in Namibia.

The Scouts of Namibia operate under the World Body of Scouting, and are subject to its code and ethics, as well as to the laws of Namibia. The Third Windhoek Scouts collaborate with other scout groups in Windhoek and elsewhere in Namibia, as well as with environmental organisations such as the Namibian Animal Research, Rehabilitation and Education Centre (NARREC) and Greenspace – Friends of Avis, and participate in wildlife game counts with the MET at Waterberg Plateau Park. Travis is leased from the Municipality of Windhoek. As part of a world body, they collaborate with scout groups all over the world and participate in the Cedarberg camp held in South Africa every second year. Their conservation badge is approved by the World Wildlife Fund (WWF). Projects such as the control of invasive alien species can be undertaken to fulfill part of the requirements to earn this badge. Experts on invasive alien species within the group are Tessa Harris and Jenni and David Roberts, as well as the adult leader, Merryl Butcher, and committee members Shirley Bethune and Liz Komen. No formal training is offered, but some hands-on experience will be gained by participation in the Alien Bashing Day.

The scouts have become aware of the problems through "personal contact with the thorny cacti," but feel that awareness at school level should be improved. The Alien Bashing Day is expected to heighten local awareness and the media have been invited to cover the event.

The scouts are prepared to turn this awareness into practical actions, and their stance is to lead by example and do something practical about eradicating the weeds around Travis and Avis Dam. Although awareness of and priority accorded to invasive alien species may be low within the scouting movement in general, it is considered important enough by the Third Windhoek Scouts to dedicate a voluntary day to clearing weeds around Avis Dam. The review will be useful if it includes practical suggestions that they would be able to put into effect.

4.9 BRIEF OVERVIEW OF ORGANISATIONS' CAPACITY TO DEAL WITH INVASIVE ALIEN SPECIES

Both the MET and the MAWRD are actively involved in research into and control of invasive alien species. In the mid 1980s, the Directorate of Nature Conservation and Recreation Resorts took the lead in assessing the situation nationally. Today, the SABSP Invasive Alien Species Sub-programme is housed at the DEA, and the recently completed national programme on bush encroachment was undertaken by the DEA's, Nico de Klerk. The national expert on alien and invasive animals, Mike Griffin, works at the DEA as a researcher.

Pertinent legislation is being developed for inclusion in the new Parks and Wildlife Management Bill. In the meantime, however, in its various tree planting efforts around the country, the Directorate of Forestry continues actively to plant alien trees, including species that are known to be invasive, and also to propagate and supply these trees to schools and members of the public.

The Department of Water Affairs has been actively involved in research and control of the alien aquatic weed *Salvinia molesta* for the last 25 years and continuous to man a laboratory dedicated to this project in Caprivi Region. The DWA has built up a good SADC and international reputation and has links with leading institutions such as PPRI in Pretoria and CSIRO, the Commonwealth Scientific and Industrial Research Organisation in Australia. MAWRD deals with agricultural pests and weeds, as well as with issues of veterinary importance, through dedicated units such as the Phytosanitary Section, and there is close cooperation with border control officials in this regard. Farmers' unions report the efforts of individual farmers to keep their land clear of invasive species. The NBRI has tasked a senior researcher, Herta Kolberg, with the responsibility of dealing with invasive and alien plants, although this certainly is not her main task. To improve awareness nationally, they plan to produce single-page fact sheets on each of the most important invasive alien species. NamWater deals with invasive alien species where they pose a threat to the operation of water supply works, and in all environmental impact assessments undertaken or commissioned by the water utility. The SAIEA, the Southern African Institute for Environmental Assessment, similarly ensures that impacts of invasive alien species are taken into account in all EIAs.

Ministry of Fisheries and Marine Resources personnel are becoming increasingly aware of their role with regard to preventing the inadvertent translocation of invasive alien species, and this focus is clear in recent legislation on inland waters and aquaculture. The MFMR imposes strict regulations relating to aquaculture ventures, and the ecosystem health component of the BCLME programme should assess the current status of pest and weed species along the coast.

The National Museum has in the past been involved in a national snail survey led by Barbara Curtis that also identified invasive alien species and their spread, while more recently the entomologist Eugene Marais has worked closely with Agriculture on known agricultural pests and their control.

Both the Polytechnic of Namibia and UNAM offer courses that include modules on invasive alien species, and there are researchers in the Agriculture, Natural Resources and Geography departments that are actively involved in research into aspects of invasive alien species. The Desert Research Foundation of Namibia has been involved in a training course on invasive alien species with UNAM's Department of Geography, and has been active in clearing weeds from the Swakop and Kuiseb rivers.

The Namibia Nature Foundation funds relevant projects such as those led by the Directorate of Forestry, and weed clearing operations at Waterberg and Okakarara. The Ministry of Health and Social Services indicated clearly that the topic does not fall within its personnel's scope of work.

The City of Windhoek, through the Open Spaces and Recreation Division, is well aware of invasive alien species and provides assistance with their eradication. By-laws make it illegal to propagate and plant *Prosopis*, and at present the municipality is clearing invasive cacti from the Aloe Trail at Hofmeyr walk in the centre of the city. They are assisted by environmental groups such as Greenspace – Friends of Avis, the Wildlife Society of Namibia, the Botanical Society and the Third Windhoek Scouts at Hofmeyr Walk, Avis Dam and the Botanical Gardens. Plant nurseries, such as Wilde Eend and Ferreria's in Windhoek are aware, and do not sell invasive species. They offer advice to the public on more suitable plants.

The Namibia Professional Hunting Association members are well aware of the potential impacts of invasive alien species on indigenous fauna, and have recently drafted and adopted a policy advocating an "Authentic Namibian Product". The NAPHA has mandated the Game Translocation Committee to be responsible for the wise selection of game species. A set of screening criteria have been agreed upon and set down in cooperation with the MET to ensure that no invasive alien or alien genetic stock is imported into Namibia or translocated to inappropriate regions.

5 NETWORKS OF EXPERTS

This section fulfils the term of reference, to prepare a "description of existing networks of experts particularly the Invasive Alien Species and Agricultural Biodiversity Working Groups within the National Biodiversity Taskforce" and to "Critically examine inter- and intra-network collaboration."

Within the National Biodiversity Task Force there are two multi-sectoral working groups that promote networking regarding invasive alien species research and management. The most directly involved is the Alien Invasive Species Working Group, while the Agricultural Biodiversity Working Group also includes the practical management of invasive alien species in its range of activities. Experts from both groups, as well as experts not directly involved in either working group, were interviewed using a questionnaire included as Annexure 7A. Individual responses are given in Annexure 7B, while the main findings are summarised here. For the Alien Invasive Species Working Group, the findings are divided into the opinions expressed by the Chairperson and Vice-chairperson, by members of the group, and by experts not in the group. Unfortunately, it was not possible to interview as wide a range of experts regarding the Agricultural Biodiversity Working Group, and a single summary of the responses has been given. A short assessment of experts who are not members of the working groups under discussion, and their fields of expertise, is also included.

5.1 THE ALIEN INVASIVE SPECIES WORKING GROUP

5.1.1 Opinion of the Chairperson and Vice-chairperson:

Pierre Smit is the Chairperson of the Alien Invasive Species Working Group. His particular interest is in *Prosopis* and the geo-ecological analysis of landscapes prone to plant invasions. He feels that the working group is not very effective due to a lack of commitment on the part of some individuals, some government employees and a lack of resources. Carol Steenkamp is the Deputy Chairperson of the Alien Invasive Species Working Group, and her area of expertise is in training with regard to the influence of aliens on indigenous vegetation, and raising public awareness. In her opinion, the working group is not at present very effective because of inadequate communication, a lack of face-to-face meetings, a lack of interest on the part of some members, a complex and bewildering funding system, and the fact that most of the members are very busy. Collaboration takes place internally between members, and with MET, NBRI and DRFN personnel, although this is not very effective. Outside Namibia, there has been effective collaboration at a personal level with Lesley Henderson of PPRI in South Africa, rather than collaboration at an institutional level. Past projects are Pierre's own Ph.D. work on *Prosopis*, various reviews, including one on legislation, the "Namibia's Nasty Nine-Invasive Alien Species" poster, a "Review of literature on *Prosopis* relevant to Namibia" submitted to the Scientific Society and a paper on "Geo-ecological analysis of landscapes invaded by *Prosopis* in Namibia" presented in 2003. The *Prosopis* research continues, and future projects include an *Acacia* – *Prosopis* woodland study in Rehoboth and a study of invasive species in the lower catchment of the Kuiseb River, as well as a project on the biogeography of invasive alien species in Namibia.

According to Carol, the main achievements of the working group have been the poster "Namibia's Nasty Nine – Invasive Alien Species" and the legislative review (Malan undated), which showed that present legislation is confusing and that there is no clear policy in place. She recommends a major review of pertinent policies and legislation involving pertinent stakeholders. The poster has not yet been very effective and needs a concurrent awareness campaign that targets school children. At a personal level, she has presented a talk to the Botanical Society on invasive alien species, supervised two student projects towards a land management diploma and co-authored the "Namibia's Nasty Nine" poster. Training is available at the Polytechnic of Namibia and UNAM, and students doing projects on invasive alien species are mentored. Training available outside Namibia relates to skills in the management of invasive alien species in South Africa and quarantine issues in Australia. There is little accessible information on invasive alien species in Namibia, and a website would be useful. The working group has no current project; future projects include clearing cactus species from the Hofmeyr Walk in the centre of Windhoek and looking at *Prosopis* invasion in the Nossob River. The group has not yet been involved in any practical measures to control invasive alien species.

In Pierre's opinion, the present legislative framework is poor, and there is little political will to improve this situation. There is also too much overlap in responsibilities, which allows some issues to fall between the cracks. He sees a general lack of a conservation ethos and does not regard Namibia as a law-abiding society. This can only be improved by strong ethical leadership, which is a long-term process. On a more positive note, he considers collaboration through the working group to be good, although there is room for improvement. Although the technical community in Namibia is small, collaboration has been effective, as can be seen by examples such as the production of the "Namibia's Nasty-Nine" poster and the success of the few workshops held by the group. The *Prosopis* management project is an example of good collaborative work with scientists outside Namibia.

The effectiveness of current public awareness campaigns is considered to be good, but it can still be improved. Accessing information is difficult, and in many cases one must rely on a very few informed persons. An “Alien-Busting Day” is suggested as a practical way to increase public awareness. Awareness can be further encouraged by including aspects of invasive alien species in school curricula and providing economic incentives, even if these are not long-lived or sustainable. Tax incentives were suggested to encourage land owners to clear land of invasive alien species.

He considers awareness regarding invasive alien species and their control as important national concerns that the government must take seriously and bring to the general public’s attention.

5.1.2 Opinions of members of the invasive alien species working group

The following members of the Invasive alien Species Working Group were also interviewed: Chris Brown, Barbara Curtis, N.P. du Plessis, Herta Kolberg and Kevin Roberts.

Dr Chris Brown, Director of the Namibia Nature Foundation, was involved in the preparation, organisation and publication of the proceedings of the national workshop on invasive alien species held in Namibia in 1984/5, and is co-author of a 1986 publication on invasive alien species in arid zones. He has remained interested in the issue of invasive alien species ever since. Barbara Curtis, co-ordinator of the National Tree Atlas project, is interested in alien and invasive trees, and as the former curator of aquatic invertebrates at the National Museum, is also interested in freshwater molluscs. N.P. du Plessis, a Senior Environmentalist at NamWater, is interested in terrestrial, riparian and aquatic plants, including invasive alien species. Herta Kolberg is the botanist responsible for invasive alien species at the National Botanical Research Institute, and Kevin Roberts, who is in charge of Ecological Research at the Department of Water Affairs, is an aquatic ecologist and fisheries biologist who is concerned about aquaculture and the impacts of inadvertent introductions on wetlands.

In Chris’s opinion, the Alien Invasive Species Working Group has started to get things going. It has been moderately successful, with its main success being the establishment of a forum for cross-sectoral communication and collaboration that has resulted, for example, in the “Namibia’s Nasty Nine” poster and some email discussions. He sees collaboration within the Alien Invasive Species Working Group as good because core people within different ministries are represented, but he is not sure if this collaboration extends beyond these individuals to others within the institutions represented.

Barbara Curtis felt that it has not been the most effective of the working groups, although Pierre and Carol are enthusiastic. Most members are pressed for time, and it would help to have a dedicated person tasked to deal with invasive alien species issues in Namibia. Barbara feels that despite some email communication and two or three workshops held over the last five years, there is not much collaboration within the group, and that many important sectors such as development agencies, forestry, aquaculture developers and nurseries are not involved.

N.P. du Plessis responded that direct contact between individual members is good. Members are always able to ask advice and are willing to assist each other, but they meet too infrequently. His main concern is that no practical control mechanism for invasive alien species has been put in place. Although it may not be the task of the working group, the group appears to lack the ability to implement control programmes. Without a strong lead organisation and with no-one being prepared to take responsibility, little tangible has been achieved over the last five years. Although there has been interest and much discussion at the few annual workshops held, the working group has not yet implemented control measures, for which the available funding would in any event be inadequate.

Collaboration within the group is good, examples of this being Pierre's *Prosopis* control study and his questionnaires to farmers. There is also good cooperation from RandWater in South Africa on algal blooms.

Herta Kolberg reports good, effective collaboration within the Alien Invasive Species Working Group on a one-to-one basis, but notes that the emphasis is largely on plant species. She attributes this to interested and committed members and the representation of the Windhoek Municipality in the group. Collaboration with other institutions in Namibia is also good, for example the collaboration that led to the production of the "Namibia's Nasty Nine" poster. The NBRI supplied information and photos and a workshop discussion was held at the Polytechnic of Namibia in 2002 to discuss the new poster and discuss the inclusion of invasive alien animals. The poster subsequently developed, "Help Protect Namibia – The Ecological and Economic Threats of Invasive Alien Species", though effective, is very different to what was proposed at the 2002 workshop. An example of collaboration with an institution outside Namibia is that copies of Lesley Henderson's book "*Plant Invaders of Southern Africa*" were ordered from PPRI in South Africa and distributed to working group members to help them identify invasive alien species.

Kevin Roberts agreed with Herta that the group has not been that effective, despite some email discussions over the last six months. Annual workshops have only been held for the last few years. Reasons could be that the topic is wide, the group lacks effective management and invasive alien species are not considered to be important at the political level. At present, there is some collaboration within Namibia, though this is largely limited to the working group members. An example of this collaboration is the discussion that has taken place regarding how to go about compiling a ranked list of invasive alien species. There is also collaboration regarding aquatic weeds within the SADC. Cooperation with Botswana has been good for many years, and there have even been joint weed surveys, though these have taken place through the respective water affairs authorities, and not the Alien Invasive Species Working Group, whose members appear to be rather dismissive of the ongoing work on aquatic weeds.

Regarding the legislative framework and if it is adequate, Barbara pointed out that there are strict trade and phytosanitary regulations in place for plants, and that there is good cooperation in terms of border controls, particularly with Botswana. There is nevertheless a need to classify invasive plants and the different degrees of invasiveness. She finds that current legislation is definitely not adequate. In fact, the Directorate of Forestry actively promotes the planting and propagation of invasive alien trees (e.g. *Casuarina* and *Prosopis*) and even sells such trees through their nurseries. Various development aid project such as DAPP, Development Aid People to People, do the same in their tree-planting schemes in northern Namibia. Plant nurseries, including those run by the Directorate of Forestry, need guidelines on which plants are invasive and the dangers they pose. N.P. du Plessis' advice regarding the development of pertinent legislation is that should regulations be developed, care must be taken that they can be implemented, and are relevant to local conditions and problems. Local circumstances must first be well researched. There is no point in simply adopting someone else's list of plants to ban. He feels that environmental legislation in this regard can certainly be improved. Kevin felt that although there are disjointed elements of legislation, they are inadequate, and are not coordinated. A national policy on invasive alien species is needed. This should look at each species in detail, list invasive species, provide criteria for different degrees of invasiveness and appropriate levels of control for each, and provide guidelines for a practical implementation and an enforcement strategy. To succeed, such a policy will need the backing of all ministries involved in natural resources, trade and customs control.

On the issue of awareness, Chris cautioned that there has been no specific feedback yet on the impact of the “Namibia’s Nasty Nine” poster. Barbara agreed that it is difficult to assess the impact of this awareness-raising poster, while N.P. du Plessis sees the reaction as being very subdued. The “Namibia’s Nasty Nine” poster has had some effect, but the campaign needs to be taken further, as few examples are seen prominently displayed. Sectors such as forestry need educating. Herta has received calls commenting on the “Namibia’s Nasty Nine” poster, which interestingly is displayed on the South African side of the border and not at Namibian border posts. This is possibly the same poster Kevin recalls having seen at a border post. He suggests that more should be prominently displayed. All agreed that there is certainly a need for more awareness.

According to Chris, relevant information is accessible, particularly that generated between 1984 and 1986, and much more can be gleaned from the “grey literature” of institutions such as DWA and MET. There has, however, been little recent work, and there is a need to update the 1984 – 1986 data. Herta agreed that information is available at the herbarium on request, although there is little assistance available from the Directorate of Forestry. Collaboration with PPRI in South Africa is good, and there is sound information available in the NBRI library and on request from other working group members, e.g. from Pierre on *Prosopis* and from other local experts, e.g. Bessie Bester and Nico de Klerk, on bush encroachment. Although locally relevant information is scarce, both Chris and Kevin recommend the internet for information on the situation outside Namibia.

Chris pointed out that the working group has not implemented any practical measures to control invasive alien species. This was also the concern of N.P. du Plessis, who noted no real practical implementation. Despite awareness and a degree of discussion regarding recommendations on what to do, no-one has yet taken responsibility for the actual implementation of solutions. All agreed that more needs to be done regarding awareness of invasive alien species and proper mapping of the distribution of these plants and animals. A clear national policy is needed, as different ministries or even departments within ministries have conflicting views e.g. the Directorate of Forestry and the Directorate of Environmental Affairs. Trade in these species needs to be assessed and, where necessary, strictly controlled, particularly at border checkpoints. Legislation should be strengthened and enforceable regulations developed.

5.1.3 Opinion of experts not directly involved in the working group

Several experts not directly involved with the working group were also asked their opinions on the Alien Invasive Species Working Group, collaboration within the group and with other similar organisations, and how effective they thought it had been. Individual experts interviewed were consultants Dr Antje Burke and John Irish, Dr Stef de Wet of the Department of Water Affairs, Aina Iita from MFMR and Prof. Orton Msiska of UNAM.

Antje Burke is a botanist from EnviroScience, while John Irish is an entomologist and the Coordinator of the Biosystematics Working Group. Antje finds the group moderately effective, and says this is due to the fact that membership is voluntary. John is involved in databasing and has a peripheral interest in invasive alien species. His opinion is that the group is less efficient than it could be, possibly because all the members, including the chairman, have other jobs, with the result that the group and its activities cannot be a priority for them. Dr Stefan de Wet is the Deputy Director of Water Environment, and is responsible for the *Salvinia molesta* control project in the Eastern Caprivi. Other than this project, he has also been involved in reed control in irrigation canals downstream of Hardap Dam and *Prosopis* control in southern rivers. He has had very little contact with the group, although he has consulted with Pierre Smit regarding *Prosopis* in the Oanob River, and has discussed something similar to the South African “Working-for-Water” programme for controlling invasive alien plants in Namibian riverbeds. He finds the group has been very quiet.

Aina Iita is a fisheries biologist in Swakopmund who is peripherally involved with marine invertebrates, and is not a regular member of the working group. As there is no regular representative from Sea Fisheries side (Clinton Hay sometimes participates from Inland Fisheries), she has no opinion regarding how well the group operates. Professor Orton Msiska is a Senior Lecturer with expertise in limnology, aquaculture and environmental impact assessments. His opinion is that the working group needs more visibility on issues like the introduction of alien animals such as red tilapia, marine species and crayfish, and suggests that workshop discussions be held to better involve stakeholders in the aquaculture industry.

With regard to the legislative framework, Antje finds it to be adequate, but feels that there are problems with implementation. Dr de Wet points out that although the SADC protocol mentions that “all countries shall prevent the introduction of alien species into any shared watercourse that may be harmful,” national legislation seems to be inadequate. No mention is made of invasive alien species or the protection of surface water sources or even wetlands in the new Water Resources Management Bill, although provision is made for other detrimental impacts, such as those caused by pollution. John finds the legislation to be inadequate and feels that consolidation of disparate legislation is needed. Aita feels that invasive alien species are not well covered in current MFMR legislation and that the MFMR should acknowledge problems and its own obligations, and take the initiative and remedy the situation. Professor Msiska believes the situation can be improved by getting scientists, representatives of industry and fish farmers together to discuss the pros and cons of proposed “new” aquatic species.

Antje says there is ongoing, good collaboration with regards to environmental consulting, while Dr de Wet fears that as long as the approach remains sectoral, collaboration will suffer. The Department of Water Affairs used to be recognised as the lead agency in the biological control of aquatic weeds. Now, however, the DWA is not recognised as an independent entity, and the concern is that the MAWRD primarily has to do with agriculture, rather than water or aquatic ecosystems. In future there may be collaboration on issues that directly affect water supply at the local basin management level for each catchment. All report better collaboration with scientists outside Namibia, for example through the SADC Water Sector Aquatic Weeds Sub-committee (formerly SARCCUS) between SADC countries. There is good collaboration with Botswana, as well as with the CSIRO in Australia, regarding the control of aquatic weeds. John is of the opinion that there is some liaison with members of the Alien Invasive Species Working Group through the Biodiversity Task Force, but that the level of effectiveness is highly variable. Aina similarly states that there is collaboration only through the Biodiversity Task Force, although Bronwen Curry previously had close communication with some South African institutes. In Orton’s opinion, collaboration within Namibia through the Alien Invasive Species Working Group appears to be difficult without initiative being taken by a lead agency. Better coordination could help. An example of effective collaboration was that of the Genetics Resources and Biotechnology Committee in Malawi. One of the results of this collaboration was the “Malawi Principle”, widely adopted in environmental fisheries management. He added that training opportunities within Namibia include the Conservation Biology, Aquaculture, and Aquatic Ecology courses offered at the University of Namibia.

In terms of awareness, the “Namibia’s Nasty nine” poster was cited as having been relatively effective. Stef mentioned that his staff had assisted with distributing it to lodges in Caprivi Region, but Aita stated that nothing ever reaches the coast. Access to information on invasive alien species seemed to be more of a problem to this group than to active working group members. It was described as difficult to access information on the web, and the information that was found was rather limited, and not necessarily relevant, a major issue requiring attention.

Dr de Wet mentioned that Lesley Henderson at PPRI and, until her retirement, Carina Cilliers from the same institution, provided information. Unfortunately most of the information seems to be on water hyacinth, particularly regarding the Lake Victoria programme, and is thus not locally relevant.

Finally, practical examples of measures to control invasive alien species included the successful *Salvinia molesta* biological control programme in eastern Caprivi Region; the recommendations made in environmental assessment reports; ongoing awareness-creation; the biological and chemical control methods that have worked on water hyacinth in Zimbabwe, Malawi and East Africa; and the physical removal or confinement to certain less ecologically vulnerable areas of fish in Malawi. There are few local examples of practical implementation other than the ongoing control of *Salvinia molesta* by the Department of Water Affairs, a project independent of the AISWG.

5.2 THE AGRICULTURAL BIODIVERSITY WORKING GROUP

Four members of the Agricultural Biodiversity Working Group, namely Nico de Klerk, Dr Chris Brown, Herta Kolberg and Dr Martha Kandawa-Schulz, were interviewed. Unfortunately none are very active members of the group.

Nico de Klerk is the Coordinator of the National Bush Encroachment Research, Monitoring and Management Project, and an occasional member of the Agricultural Biodiversity Working Group. His interest is in bush encroachment, and with respect to invasive alien species, this is linked to *Prosopis*. In his opinion, the group is well run by Jacques Els, and there are regular email communications and reminders, but like most members who are caught up in their own responsibilities (in his case single-handedly running the bush encroachment project), he has had little time for working group activities other than attending meetings. Like him, most members are not able to commit fully to working group activities. As already mentioned, Chris Brown was responsible for the preparation, organisation and publication of the proceedings of the National Workshop on Invasive Alien Species held in Namibia in 1984/5, and is co-author of a 1986 publication on invasive alien species in arid zones. He considers the effectiveness of the Agricultural Biodiversity Working Group to be very low with respect to invasive alien species, although the working group has been moderately successful in establishing a forum for cross-sectoral communication and collaboration. Outputs of the working group include the review of invasive alien species by Hansie Venter (2002) and their contribution to the development of a strategic ten-year plan in terms of biodiversity development through biodiversity conservation.

Nico feels that there is good collaboration at a technical level from person to person, but that this is limited to within the working group, which does not include other experts such as rangeland specialists. Awareness thus tends to remain focused on respective members' own areas of expertise. There are no practical examples of invasive alien control, and although the issues are identified, they are not managed by the working group.

There is good collaboration with South Africa. For example, Nico de Klerk was accepted as a member of the South African *Prosopis* forum run by Carl Stohls of the Agricultural Research Commission in South Africa. He attended a conference held in Kimberly in November 2001. Pierre Smit and other students were granted funds towards Ph.D. studies as part of the bush encroachment project, while students from the Polytechnic of Namibia and members of the Omahua Youth Group were trained and assisted with fieldwork. Publications can be obtained via library searches, and Pierre Smit has made useful reports on *Prosopis* that he collected for his own studies available, an example of collaboration between working groups. There are few examples of practical implementation of invasive alien control. Some farmers do themselves implement control measures, especially alongside the Nossob River, but this is dependent on the interest of the individual farmer.

The bush encroachment project has done much to raise awareness, particularly amongst farmers, and often researchers used the opportunities afforded by farmers' day gatherings to enhance this.

Herta Kolberg is a Principal Agricultural Researcher at the NBRI, and is the botanist responsible for invasive alien species. She is an occasional member of the Agricultural Biodiversity Working Group. In her opinion, despite the good efforts of the chairman, collaboration within the Agricultural Biodiversity Working Group is less effective than it is in the Alien Invasive Species Working Group. She encountered little in terms of plants or her area of expertise, and she gets the impression that the concept of agricultural biodiversity is still poorly understood by many members. She is aware of the review report by Venter, as there is a copy in the NBRI library. In general, there is good information available on plant-related topics in the NBRI library, and this can be made available on request to other working group members.

Martha Kandawa-Schulz of the Namibian Biotechnology Alliance (NABA) at UNAM admits that she is not an expert in invasive alien species, but chairs one of the more successful NBTF working groups. She has heard that the working group and collaboration within it are effective. She understands that the group works closely together, but she is unsure how UNAM students are involved and whether there are any lecturers from the Agriculture or Biology departments involved. It would constitute good practical experience if they were.

Nico de Klerk mentioned that in terms of legislation, Cabinet has requested a national policy on bush encroachment. This will include *Prosopis* eradication, reseedling and bio-control, and impacts on seed viability and flowering. The opinions of farmers on what should be done will be sought. He feels strongly that *Prosopis* should be proclaimed a weed in terms of the Weed Ordinance and the provisions of the Soil Conservation Act. These give power to the Minister to take measures deemed necessary to conserve soil, prevent soil erosion and promote good land husbandry. They should be mirrored in the new Conservation of Agricultural Resources Bill, as they could, for example, be used to ensure that landowners eradicate declared weeds or contain the spread of invasive species. The Act allows for regulations to prescribe sound land management requirements and activities to farmers, but a policy is needed on which to base these regulations. In a separate interview, Pauline Lindeque, Resource Management Director at the MET, remarked that the Biodiversity Task Force and its working groups are the primary interface between the MET and issues such as invasive alien species. Ministry staff who serve in these groups, are not as active, or pro-active, as they should be.

5.3 EXPERTISE NOT INCLUDED IN THE WORKING GROUPS

As identified in these interviews, one of the drawbacks of the working groups is that even with a fairly wide representation of institutions and individuals, the existing working groups have not yet put in place an effective national network of experts on invasive alien species. Few rangeland scientists and marine or freshwater ecologists are members, and there are few veterinarians or foresters. Trade partners such as aquaculturists, horticulturists, game dealers and those responsible for cross border trade and control are not represented at all, and neither are communities and development agencies. The Alien Invasive Species Working Group tends to concentrate on plants, while the Agricultural Biodiversity Working Group tends to emphasise animals, and neither deals with pathogens. Some of the most active institutions, such as the Phytosanitary Section at the Directorate of Veterinary Services, do not feel at home in these groups. The working groups are a good start, but more formal coordination and dedicated manpower and financial resources are needed for either to be a truly effective network of experts. There is no lead agency that has yet succeeded in co-ordinating all stakeholders in this field. Much of the effective work on invasive alien species is happening independently of either group.

6 NATIONAL AND REGIONAL PROGRAMMES

6.1 PAST AND CURRENT PROGRAMMES AND PROJECTS

Much of what we know of invasive alien species in Namibia is based on the results of the 1984 annual professional officers meeting of the then Directorate of Nature Conservation and Recreation Resorts. At this workshop, the results of a series of national surveys to determine the distribution of invasive and potentially invasive species in different regions of Namibia were presented. During the 1980s, the Directorate, later renamed the Directorate of Wildlife and Tourism, undertook a number of eradication and clearing programmes within protected areas such as the Etosha National Park, Namib Naukluft Park, the Skeleton Coast Park and the Daan Viljoen Game Reserve. Care was taken to remove plants before they set seed. After that, the momentum dwindled, and although clearing may have continued, there are not reports of this having happened since then, giving the impression that little has been done in more recent years. According to the Director of Resource Management at MET, there is still ongoing removal of invasive alien species within proclaimed areas, while work on the development of pertinent policies, legislation and regulations continues, as does the production of awareness posters and pamphlets. The Directorate of Environmental Affairs is the seat of the Biodiversity Task Force, and is thus involved in the coordination of the relevant working groups, including the Alien Invasive Species Working Group. Relevant products of the DEA that relate to invasive alien species and their status in Namibia include the publication “Biological Diversity in Namibia – a county study” (Barnard *et al.* 1998), numerous scientific publications by staff and working group members, in particular the dedicated volume of the “Biodiversity Conservation” journal. Some progress has also recently been made with the development of biodiversity databases that include information pertinent to invasive alien species.

Over the last five years, interest in invasive alien species has been renewed through the activities of members of the Alien Invasive Species Working Group and the Agricultural Biodiversity Working Group of the National Biodiversity Task Force. The Wetlands Working Group has included alien and invasive aquatic and semi-aquatic species in their awareness activities. Their recently published poster and the booklet “Wetlands of Namibia” (Shaw *et al.* 2004) both highlight invasive alien species as a threat to wetland ecosystems. The main output of the Alien Invasive Species Working Group has been the publication of a poster, “Namibia’s Nasty Nine – Alien Invasive Species”. All three working groups have contributed to national 10-year strategic plans in terms of biodiversity conservation and sustainable development and recognition of the necessity to “reduce the threat to biological diversity from invasive alien species” is included in the 2001–2010 plan. In recent years, the Alien Invasive Species Working Group has held annual workshops in 2002 and 2003 (the DEA organised the workshop in 2004) to improve collaboration between members, and has commissioned a series of reviews on pertinent legislation, the first by Riaan Alberts (Alberts undated) later being reworked and expanded by Johan Malan (Malan undated). During the same period, the Agricultural Biodiversity Working Group commissioned a review of “Invasive Alien Species in Namibia” by Hansie Venter (Venter 2002). The recently submitted Ph.D. thesis of Pierre Smit, Chairperson of the Alien Invasive Species Working Group, on *Prosopis* in Namibia and the recently completed bush encroachment programme by Niko de Klerk (de Klerk 2004), which, although it deals more with indigenous invasive species, includes *Prosopis*, have added to our knowledge, particularly in terms of farmers’ perceptions, practical control methods and the magnitude of the infestation, and both studies have involved many students in fieldwork.

To a lesser extent, the projects of lecturers, students and scholars over the last 20 years reveal an ongoing awareness of and concern regarding the problem. The recent interest in aquaculture has initiated projects on the impacts of the introduction of tilapia, crayfish and oysters. The University of Namibia produced a report by Dr Roger Lowrey (Lowrey 1998) on the potential for crayfish farming and the impacts of different freshwater crayfish. (Africa has no indigenous freshwater ones)

Professor Orton Msiska, who has researched the impacts of introducing mirror carp to Malawi, has also looked at the impacts of red tilapia and Pacific oysters. At the Polytechnic of Namibia, projects have recently been conducted by in-service training students of Land Management and Nature Conservation. Gabanakgang (2003) mapped invasive alien plants in a river bed in Windhoek, and Shapaka (2003) mapped invasive alien plants in the Daan Viljoen Game Reserve.

Earlier studies on invasive alien species by Polytechnic students include one on the impact of *Prosopis glandulosa* on vegetation in the lower Swakop River by a Nature Conservation diploma student (Visser 1998) and a B. Tech. thesis, by Mark Berry (2000), on *Cereus jamacaru* (queen of the night cactus) and its invasiveness in the Waterberg Plateau Park. Staff at the the School of Natural Resources and Tourism have undertaken some species-specific projects on the dynamics and invasive potential of *Pennisetum setaceum* (Joubert & Cunningham 2002, 2004) and *Dodonaea angustifolia* (Cunningham *et al.* 2004). Talks have been presented at scientific meetings, and some work has been done on the biological control of *Prosopis* in collaboration with the Plant Protection Research Institute in South Africa. Seed weevils were introduced as seed predators of *Prosopis* spp. in South Africa (*Algarobius prosopis* in 1987, and *Neltumius arizonensis* in 1993) (De Klerk, 2004). It was hoped that these weevils would have a significant effect on *Prosopis* spp. populations. Some weevils were also introduced to Namibia, which have now affected almost all stands of *Prosopis* spp. (Smit 2002, as cited in De Klerk 2004). Although up to 99% of seeds can be destroyed, the high seed production of *Prosopis* spp. means that a large seed bank can still be generated, and the potential for re-invasion remains high. Although no specific projects have been undertaken under the leadership of the National Agricultural Union, Mr. Sakkie Coetzee (CEO of the NAU) is undertaking a project to eradicate *Prosopis* spp. on his farm in the Leonardville District, as part of his personal action plan to combat bush encroachment.

Initiated in the early 1980s, a detailed research project involving the implementation of practical control of the aquatic weed *Salvinia molesta* by the Department of Water Affairs continues. The strength of this project is good collaboration with colleagues in Botswana and in the rest of the SADC. A detailed review of water weeds in the SADC was prepared by Shirley Bethune and Kevin Roberts of DWA (Bethune & Roberts 2002), published in the SADC report, "Environmental Sustainability in Water Resources Management" (Hiriji *et al.* 2002) launched at WSSD the World Summit on Sustainable Development. Based largely on this review, a SADC-wide regional project on aquatic weeds was initiated by the SADC Water Sector, and Shirley Bethune was appointed Regional Coordinator. However, this was unexpectedly put on hold in mid-2003, when World Bank funding ceased. New sources of funds are now being sought. In addition to this ongoing biological control monitoring surveys for both *Salvinia* and water lettuce, *Pistia stratiotes* are undertaken in the floodplains of Caprivi, particularly after large floods such as those of 2004. The ecology section of the Department of Water Affairs also looks at riverine vegetation and the spread of species such as *Prosopis* along ephemeral rivers, and the impact of alien riparian vegetation on groundwater supplies. NamWater activities in this regard are limited to dealing with problems as they arise. For example, when *Salvinia* mats blocked abstraction points in Caprivi Region, NamWater simply moved them to an unobstructed site. There is interest in starting a project on the possible control of *Prosopis* at Omdel Dam, and preliminary discussions have been held with Pierre Smit.

Other sections of the Ministry of Agriculture, Water and Rural Development are also actively involved in research into and monitoring and control of invasive alien species. At the Directorate of Veterinary Services, risk analysis is an ongoing activity and conditions that could lead to the emergence or re-emergence of diseases are carefully monitored. In effect, the veterinary disease control programme is geared towards prevention. In conjunction with the National Museum, the agricultural extension office has been involved in controlling reed growth in the irrigation canals at Mariental, and in research into and control of agricultural pests such as cotton borer, large grain borer, cochineal and the cabbage butterfly.

At the National Botanical Research Institute, NBRI, all invasive alien plants are documented and listed, with specimens being kept in the herbarium. This forms an integral part of their ongoing collection and research functions to improve the national plant collection and our knowledge of plant distributions and ecology in Namibia. The NBRI is ably assisted in maintaining the botanical gardens by the Botanical Society of Namibia, which plans to assist the City of Windhoek with the eradication of invasive cacti along nearby Aloe Trail / Hofmeyr Walk.

During the 1980s, Barbara Curtis, then at the National Museum, conducted a national survey of freshwater snails including invasive alien species and mapped their distributions (Curtis 1990). Over the last seven years, Barbara has coordinated the national tree atlas, which has mapped the distribution of trees, including alien and invasive ones, on a countrywide basis. The atlas will be published by the end of 2004. Pete Aston's work (Ashton 1996) for Rössing on the riparian vegetation of the Khan River shows that, alien vegetation can reduce downstream water flow in an ephemeral river. NamWater has been involved in clearing reeds from the Fish River and irrigation canals below Hardap Dam, and plans to do something about *Nicotiana* in the Omdel River. Rudi Loutit then at MET, actively cleared *Nicotiana glauca* from the lower Ugab River for many years (Tarr & Loutit 1985). Bronwen Curry of the MFMR has studied the distribution and spread of the invasive *Mytilus galloprovincialis* on the rocky shores of Namibia (Currie 1996).

The Windhoek Municipality has been actively removing and controlling invasive alien species, particularly *Prosopis* spp. within the city limits and has produced pamphlets on indigenous, water-wise gardening and suitable trees for planting on sidewalks. Care is taken both by the specialists involved and by the proponents of development projects to include pertinent aspects of invasive alien species and to prevent inadvertent introductions and further translocations in all environmental impact assessments. For example, Dr Antje Burke, working on the impacts of a proposed zinc mine, gave a training workshop and produced a brochure on alien plants for staff at Rosh Pinah.

Projects undertaken by the City of Windhoek include the ongoing and free chemical control of *Prosopis* spp., as the Town Planning Scheme outlaws the cultivation of these trees. The bush control teams attempt to maintain the indigenous integrity of natural areas and river courses by eradicating invasive alien species such as *Agave* spp., *Opuntia* spp., *Schinus molle*, *Melia azedarach*, *Tecoma stans*, *Leucaena leucocephala*, and *Prosopis* spp. The responsible division within the Municipality also prepares, prints and distributes pamphlets promoting the use of suitable indigenous trees. Trials are conducted to determine the suitability of indigenous trees and shrubs in Windhoek. Attention is given to factors such as frost hardiness, growth rates and the effect of regular watering and the addition of fertilizers. A current project is the removal of invasive cacti along the Hofmeyr Walk /Aloe Trail in the centre of Windhoek, to upgrade the paths, improve the signs and develop a pamphlet for walkers. Assistance has been offered by the Botanical Society. The City is assisting the 3rd Windhoek Scouts with hacking at Avis Dam too.

Past projects on invasive alien species undertaken by the Directorate of Forestry have included many tree planting projects such as the establishment of community woodlots that include known invasive alien species, including *Azadiracta indicam* (neem trees), *Eucalyptus* and *Melia azedarach* (syringa) in Kavango Region and Caprivi Region. For the past 14 years, the Directorate has grown, donated to schools and sold *Leucaena leucocephala* (wonderboom), *Prosopis* spp. and various fruit trees and ornamentals such as *Jacaranda mimosifolia*. This is described by the director as a very strong activity in many forest stations. A review of forestry in Namibia (Erkillä and Siiskonen 1992) has been published and looks at forestry activities and legislation from 1850 to 1990. John Mendelsohn of RIASON has been contracted to assist with a publication on forestry activities since 1990. According to by Erkillä and Siiskonen (1992), the sector has long been promoting invasive alien species for economic reasons.

In the early 1990s, to reduce reliance on imported timber for industry, mining and the construction of railway lines, Kurt Dinter, as government botanist, proposed the establishment of forest research stations and trials of indigenous and alien species. Since then, hundreds of invasive alien species have been tested. Most of these failed to become established due to the harsh climatic conditions. Nevertheless, many of the “Nasty Nine” species (Steenkamp & Smit 2002) and the “Top Ten” identified at the 1984 workshop (Scheepers 1985), including *Leucaena leucocephala* (in the late 1980s), *Melia azedarach* (syringa), *Nicotiana glauca* (wild tobacco), *Prosopis* spp. and *Ricinus communis* (castor-oil plants) were introduced through Directorate of Forestry plantings. The Directorate continues actively to promote the planting of alien and, in some cases, invasive alien tree species, and these make up more than 80% of the number of plants (not species) in forestry nurseries. Despite the obvious promotion of alien and species often known to be invasive, through tree planting projects, the Directorate is open to discussions on the costs and benefits of alien introductions, and Joseph Hailwa, welcomes the idea of the development and introduction of a scientific screening process for invasive alien species similar to that applied in Australia.

The Ministry of Fisheries and Marine Resources has contributed to the red data species list of fishes, has made inputs to the 1984 workshop on invasive alien species (Schrader 1985) and to the 1988 wetlands workshop, and well as to numerous biodiversity publications. Telemetry studies on *Cyprinus carpio* (carp) in Hardap have been conducted and national freshwater fish surveys are regularly undertaken. The MFMR is currently very involved in aquaculture and mariculture research, development and monitoring, and continues with both freshwater fish surveys and coastal biodiversity surveys. Priority is given to research on species that can be commercially exploited, with the result that only where economic benefits can be shown is research effort warranted, for example on aquaculture. Bronwen Currie participated in a SANCOB project on the distribution of mussels on the southern African coastline (Currie 1996; Harris *et al.* 1997) and this year the BCLME Biodiversity Ecosystem Health and Pollution project was finally initiated. It will run from January 2004 to December 2007. Invasive alien species will be a factor in the marine biodiversity assessment and mapping components of this project. It is likely that river mouths of the westward flowing ephemeral rivers as well as the Kunene mouth will be included in these assessments.

The components of the BCLME project include:

- Project 2: Mapping of the BCLME shoreline, shallow water and estuarine habitats;
- Project 4: Inshore assessments, identification and quantitative surveys of communities, biotopes and species along the BCLME shoreline and shallow intertidal;
- Project 6: Baseline surveys of species and biodiversity in estuarine habitats; and
- Project 7: Aquaculture assessment, which will include the identification and ranking of appropriate and unsuitable species for aquaculture.

School groups have on occasion become involved in alien species eradication programmes. St. George's Diocesan School in Windhoek, in particular, has been involved in programmes to eradicate *Lantana camara* at Okatjikona Environmental Education Centre at the Waterberg Plateau Park. School learners are currently attempting to eradicate various cactus species from the St. George's grounds and adjacent hill slopes. A number of science projects for the Young Scientists Competition on invasive alien species have been done over the past decade or so, including a 2003 project on testing the effectiveness of different eradication methods on *Prosopis* spp. in Brakwater, outside Windhoek, by Tessa Harris and Jenni Roberts of St Paul's College. They found that controlled burning was the most effective method and that chopping the trees and then treating them with diesel also worked. Ring barking had no discernable effect, while simply chopping led to rapid re-growth. Given the duration of the project, the impacts of herbicides and defoliant could not be assessed. At the same competition a project from the same school looked at the usefulness of *Prosopis* and the young scientist, Alienor Brassine, produced bread make from the pods.

Several NGOs have also contributed to invasive alien species projects. The Namibia Nature Foundation, NNF, has helped to administer funds for forestry projects and projects of the Alien Invasive Species Working Group, and has given small grants to schools, DAPP and the Northern Namibia Environmental Project for projects such as the clearing of alien vegetation at Waterberg Plateau Park and an anti-erosion project at Okakarara. They have been approached to assist the City of Windhoek to clear cactus species in the centre of Windhoek. Greenspace and, in particular, the Friends of Avis section have removed or “hacked” invasive alien species in urban areas and are assisted by the Third Windhoek Scouts at Avis Dam. Two of the senior scouts did a year long Young Scientists project testing practical control options for *Prosopis* and this year are working on a project on Avis Dam and the impacts of the February floods. There have also been attempts by parents and scout leaders to clear alien cacti from the area around Avis Dam. The troop leader, David Roberts, attended this year’s AGM of Friends of Avis to volunteer the services of the scouts to help clear invasive alien plants around Avis Dam. As a result, a Saturday (9 October 2004), the day after Arbour Day, has been set aside as an “Alien Bashing Day” for the Scouts and Friends of Avis. They have appealed to other interested organisations such as the Municipality, the AISWG, the Polytechnic of Namibia, Botanical and Wildlife societies of Namibia to join them.

The Desert Research Foundation of Namibia, DRFN, and the Gobabeb, Training and Research Centre, GTRC have been involved in long-term research and record keeping, and have conducted several special studies of invasive alien species in the Kuiseb River and the surrounding regions. They are currently involved in extensive studies on the Kuiseb River Basin, and are planning a project to compare *Prosopis* spp. and *Faidherbia albida* (Ana trees) with regard to their eco-physiology and ecology. The University of London is monitoring *Prosopis* spp. in the Swakop River in a study that includes aspects such as seed output and overall health. Earthlife-Namibia has not yet worked on invasive alien species, but annually promotes the planting of indigenous trees. Although the Wildlife Society of Namibia has had no specific projects on invasive alien species, they regularly feature pertinent articles in their publication, “Roan News”, and this year’s presentation at the AGM of the society was on invasive alien species, with special reference to *Pennisetum setaceum* (fountain grass).

6.2 SECOND NATIONAL DEVELOPMENT PLAN (NDP 2)

Before discussing future projects involving invasive alien species in Namibia, it is necessary to consider the national development aspirations of the country. The Second National Development Plan (NDP 2) sets the development agenda for the period February 2001 to June 2005. The sections of relevance to this report are briefly reviewed below.

In NDP 2, Part 3 on Sectoral Development describes the progress of the first development phase and discusses the constraints and challenges encountered within each sector. It then details the mission statements, objectives, targets and performance indicators for each sector.

Invasive alien species have implications for several of the natural resources sectors. In this regard, the Agriculture, Water, Fisheries and Marine Resources, Wildlife and Energy sectors have been reviewed to see how their mission statements, objectives, targets and performance indicators link to invasive alien species. The Agricultural sector seeks to promote “environmentally sustainable rural livelihoods and enhancement of more equitable distribution of and access to resources and services for all farming communities”. The strategies identified to achieve this goal include: “Support farmers and encourage them to adopt environmental and ecological sustainable practices”; “Consider supporting farming practices that have positive impacts on bio-diversity”; and “Promote the conservation and sustainable utilisation of particularly indigenous plant and animal genetic resources.” Although, these strategies all indirectly address the issue of invasive alien species since they could pose a threat, there is no direct mention of them nor any specific programmes.

Strategies of the Water sector are to: “Utilise, conserve and protect all water resources in an environmentally sustainable manner” and to “Manage and allocate the scarce water resources in an equitable and efficient manner with due consideration to the environment.” These also address invasive alien species by implication, since species such as *Prosopis* spp. are likely to reduce groundwater levels in ephemeral rivers. Programme 2: “To conduct studies to manage the resource to promote conservation, protection and more efficient utilisation and allocation of water resources” could include studies on the impacts of invasive alien species on groundwater resources, provided that better awareness (similar to that for the South African “Working for Water” programme that links declining water availability to thirsty alien plants) is created.

The Fisheries and Marine Resources sector has similar statements regarding the environment and its protection, but also has the objective to: “Facilitate improvement of actual activities pertaining to aquaculture, by exploring the culture of other species, such as prawns, clams and other kind of fish, whether in freshwater or seawater, depending on scientific advice.” This could include several invasive alien species such as freshwater crayfish. Although no detail is provided in the aquaculture programme, much of this is now contained in the policy, Act and supporting regulations.

The Wildlife sector has no explicit objectives or strategies that take invasive alien species into account, although many objectives could be construed implicitly to incorporate the control of invasive alien species as a minor component. It is likely that this sector will revive the interest and concern shown in the 1980s, given that a two-day strategic workshop was recently conducted, and that the draft Parks and Wildlife Management Bill will address invasive and alien species.

The Energy sector emphasises biomass energy, including energy derived from wood-fuel, as a feasible form of renewable energy in Namibia (although there is greater emphasis on other forms, such as biogas and solar energy.) One of the strategies mentioned is to establish a pilot charcoal briquette plant, a plan which is already being implemented. There is no reference made to introducing fast-growing alien trees or to utilising existing stands of *Prosopis* spp. for this purpose, although many charcoal suppliers are selling charcoal made from “invader” wood.

Most of the strategies and plans related to natural resources in NDP 2 use the term “environmental sustainability”, and by implication it is assumed that where invasive alien species pose a threat to environmental sustainability, they are included in plans to reduce or control general environmental threats. These are, however, assumptions, and in NDP 3, it will be essential more specifically to include invasive alien species and so make developers and decision-makers aware that they can potentially reduce environmental sustainability. NDP 3 must include strategies expressly to deal with the threats posed by specific invasive alien species, as well as threats to specific habitats, and must mention their specific ecological, economic and social impacts, where known. This will give national support to efforts to reduce these threats and should help to increase the political will of decision-makers to deal with them. As national development plans are determined by each sector, it will be the task of government specialists, particularly within MET, MAWRD and MFMR, to ensure the inclusion of plans to control and better understand the impacts of invasive alien species.

6.3 FUTURE PROJECTS

The Department of Water Affairs is interested in introducing something similar to the South African “Working for Water” programme targeted at invasive alien trees alongside ephemeral rivers, while MAWRD is considering the removal of *Eucalyptus* and syringa trees from road verges and road reserve areas. There is a need to study the occurrence and distribution of *Pistia* (water lettuce) in the floodplains of the eastern Caprivi and initiate a control programme in collaboration with Botswana on the Kwando/Linyanti/Chobe system. The biological control of *Salvinia molesta* continues and surveys will be undertaken to assess the extent of new infestations following the recent flooding and refilling of Lake Liambezi in the eastern Caprivi.

National wetland surveys should include an inventory of aquatic and riparian invasive species, and the DWA is willing to co-operate with aquaculture developers and the MFMR by giving advice on potentially invasive aquatic invertebrates and water weeds, and the impacts of these and alien fish in Namibian wetlands. The SADC regional project on aquatic weeds, their translocation and control needs to be revived, and funding must be secured for this. In the fisheries sector, the BCLME programme will include studying bilge water issues. The relevant clauses for the section on invasive alien species in the new Parks and Wildlife Management Bill need to be carefully drafted.

The School of Natural Resources and Tourism of the Polytechnic plans to increase the proportion of projects that focus on invasive alien species. The Nature Conservation Department will promote studies on invasive alien species for in-service training projects. A student will be investigating the effects of competition, and the effectiveness of different control methods on *Pennisetum setaceum*, while Nature Conservation and Land Management students will investigate and clear *Opuntia* spp. and other exotic cactus species in the Windhoek vicinity as part of their training. Both departments already include invasive alien species in their training curricula, and intend to place yet more emphasis on them. Ms Carol Steenkamp intends to conduct a study of the effects of *Prosopis* spp. on river flow and *Acacia erioloba* populations in the Nossob River. An Agriculture student plans a community interaction study on the control of either fountain grass or queen of the night.

At UNAM, work on *Prosopis* will continue in collaboration with NamWater on an *Acacia-Prosopis* woodland study in Rehoboth, and a future project on invasive plants in the lower catchment of the Kuiseb River is being discussed. Studies on the biogeography of invasive alien species in Namibia are needed. The aquaculture section plans to conduct projects on introduced freshwater crayfish, particularly feeding trials, and to look at the commercial production of the Pacific oyster.

At the May 2004 workshop on invasive alien species in Windhoek, a session was dedicated to planning “appropriate, low impact control projects for problem species”. The goals of some of the potential projects identified were to create awareness of the negative impacts of invasive alien species; to produce high quality, accessible information; and to hold a joint “Alien Bashing Day” at Avis Dam as a practical activity aimed at raising awareness and improving collaboration between different organisations. The latter proposal is now being implemented by the 3rd Windhoek Scouts in collaboration with other interested groups. The development of high quality, accessible information is already being undertaken by National Botanical Research Institute and MET, who plan to develop a series of laminated single-page fact sheets on interesting plants, including a series on invasive alien species. Each will clearly show what the plant looks like, where it occurs, the threat it poses and the available control methods, if any. The need to develop and maintain a register of invasive alien species was also discussed at the workshop in May, and it was agreed that a coordinator should be appointed to collate existing knowledge, source, clean and update data, identify gaps in data, initiate projects to fill these gaps and manage the ongoing database.

Several of the activities outlined in the National Biodiversity Ten-year Strategic Action Plan (Barnard *et al.* undated) to combat invasive alien species are yet to materialise. These include a review and categorisation of information on invasive alien species in Namibia; the establishment of a database and atlas; research on the invasiveness of selected species; the establishment of appropriate legislation and control measures; further promotion of public awareness; and the initiation of more low-impact projects for problem invasive species. Members of the working group responsible for the implementation of these proposed activities cite everything from members being too busy and the voluntary nature of participation, to the lack of communication and a complicated funding system as reasons why more progress has not been made almost mid-way through this planning period. Future projects involving NGOs and other civil service organisations are outlined in last few paragraphs of section 6.1 above.

This review has been designed to go some way towards contributing towards the overall strategic plan drawn up by the Alien Invasive Species Working Group (Barnard *et al.* undated), and assuming that the aims of the SABSP are aligned with the national objectives that have been outlined, it will also contribute towards the activities of the national component of the SABSP.

The annotated checklists developed as a result of this review can be used, updated and verified by experts within the appropriate institutions or working groups, and will help in reviewing and categorising what is known about invasive alien species in Namibia. Similarly, the information in this report can form the basis for the proposed database on plant and animal invasive aliens and can in time be further expanded through field surveys and with data from museum and herbarium records, as well as from the wetland database. This information can then be used to develop an atlas for Namibia similar to the “Southern African Plant Invaders Atlas, SAPIA, developed by Lesley Henderson for mainly South African plants (Henderson 1998, 1999). This was a mapping project conducted by PPRI from 1984 to 1998 to create a database on the distribution and abundance of some 400 invasive alien plants in southern Africa that will in the long term provide valuable information on the spread on invasive species and to monitor the effectiveness of control efforts. Serious consideration and funding must be given to expanding this database to include Namibian species and records and to make this a truly southern African database.

There is an urgent need to determine the invasiveness under local conditions of all the species listed in this report, starting with those most likely to impact on vulnerable ecosystems and those most likely to have adverse economic impacts. This review provides a sound basis for the development of a policy on invasive alien species, the incorporation of relevant clauses and provisions in emerging legislation and the development of appropriate regulations to strengthen existing laws. A start has already been made and suggestions from this review team are to be incorporated in the revision of the wetland policy. The interviews have highlighted the need to promote public awareness beyond that created by posters, and particularly the need to further stress both the ecological and economic threats posed by invasive alien species. The new poster on “The Ecological and Economic Threats of Invasive Alien Species” developed with support by the SABSP is a good start, and now needs to be taken further. The urgent need to start implementing practical control projects is also stressed. Each of the activities outlined in the strategic plan is discussed more fully in 7 (Recommendations) below.

7 RECOMMENDATIONS

This report includes many recommendations, chief amongst them relating to improving the legislative framework and expanding institutional capacities and collaboration amongst experts. There are also briefly outlined suggestions for future coordinated national programmes and for improved regional collaboration. These draw on the knowledge of the review team and suggestions made during interviews.

7.1 IMPROVED LEGISLATIVE FRAMEWORK

To improve the present legislative situation, the following are recommended:

- **A national policy on invasive alien species**

There is an urgent need to develop a national cross-sectoral policy dealing specifically with invasive alien species. In this regard, the working groups that deal with invasive alien species, agricultural biodiversity and wetlands can play an important role in bringing together the interests of the affected ministries (MET, MAWRD and MFMR) to produce a national policy on invasive alien species and their control.

- **Inclusion of explicit clauses on alien invasive species in legislation currently under consideration**

It is imperative to seize the present window of opportunity to include appropriate clauses in legislation currently being drafted, particularly the Parks and Wildlife Management Bill, the Environmental Management Bill, the Conservation of Agricultural Resources Bill, the Water Resources Management Bill and the emerging Wetland Policy. Where appropriate, these should be clearly linked to national interests, existing legislation and policies, as well as to obligations in terms of regional protocols, international conventions and agreements that Namibia is party to.

- **Strengthened legislation to ensure compulsory removal of identified potentially harmful invasive alien species**

After careful research, lists of invasive alien species that should be regulated or banned in Namibia, or at least in certain areas within the country, should be compiled. This should include all potentially threatening plants and animals that must be kept out of Namibia or, if already in Namibia, eradicated on sight because of their grave impact on biological diversity, human activities and ecosystems. The National Botanical Research Institute should be responsible for compiling and regularly reviewing the plant list, while MET's Directorate of Specialist Services and MFMR's Directorate of Resource Management should be mandated to do the same for animal groups under their jurisdiction. Specialists from other departments and from outside the government should be called on to in reviewing these lists. These lists must also be included in the regulations of the most relevant legislation, e.g. the Agricultural Resources Bill, the Parks and Wildlife Management Bill, the Aquaculture Act, the Inland Fisheries Resources Act and relevant trade and customs acts.

- **Appropriate regulations and guidelines on alien invasive species to complement existing legislation**

Where the legislation is already in place, for example such as the Aquaculture Act and the Inland Fisheries Resources Act, attention must be given to developing regulations that deal explicitly with the introduction, management and control of invasive alien species. In addition to the lists of banned species already proposed, each responsible authority should also compile lists of invasive alien species that may not be further propagated or translocated within Namibia, and a list of those that may only be cultivated under controlled conditions, in certain parts of the country or for specific purposes. The regulations must clearly specify the permit conditions, mechanism to ensure compliance and punitive measures for non-compliance.

- **Strengthened awareness and enforcement**

No matter how well conceptualised and constructed legislation may be, if it is to be effective, awareness of the threats posed by invasive alien species must be strengthened and knowledge about these species improved within the ministries that deal with natural resources, trade and health issues, as well as amongst natural resource managers and users.

- **Promote the ratification of and compliance with international and regional conventions, agreements and protocols**

It is important for Namibia to ratify the International Plant Protection Convention and the African Convention on the Conservation of Nature and Natural Resources, and to fulfil its obligations regarding invasive alien species under existing international and regional treaties, to take steps to harmonise national policies and laws with principles agreed internationally and within the SADC. An excellent example of compliance with international codes can be found in the Aquaculture Policy and Aquaculture Act, both recently developed by the Ministry of Fisheries and Marine Resources (MFMR).

7.2 IMPROVED INSTITUTIONAL CAPACITIES

The following are recommended for improving institutional capacities at a national level:

- **Identify a competent lead agency/institution/organisation**

A review of aquatic weed control within the SADC (Bethune & Roberts 2002) showed that the most effective control of invasive alien species is achieved where a single institution takes responsibility for problem species. The DWA is internationally recognised as the lead agency in terms of aquatic weed control, while the Directorate of Specialist Services in the MET deals effectively with some groups of alien animals, and it is hoped that in future the Department of Aquaculture in the MFMR will deal with species introduced for aquaculture. Nevertheless, no single national institution currently sees invasive alien species as their particular responsibility. The present Alien Invasive Species Working Group has made a good start, but it has neither the mandate nor the financial resources to deal with these issues at a national level. Similarly, the SABSP has offices in the MET, but as their activities are funded from outside the government, there is no national financial commitment. Consideration should be given to selecting a single lead institution that is capable of taking on the financial responsibility associated with dealing with invasive alien species at a national level. Based on its good track record of research on and practical control of *Salvinia molesta*, and because wetlands are the ecosystems most vulnerable to invasive alien species, it is recommended that consideration be given to appointing the Department of Water Affairs as the lead institution regarding invasive alien species issues. Strong links must be maintained with the other natural resource ministries, responsible for specific components or projects that contribute nationally to the management, monitoring, control and research of invasive alien species.

- **Develop a national screening process**

Lists of banned invasive alien species will not necessarily prevent the introduction of all potentially invasive and harmful species. To reduce the risk of inadvertent introductions, it is necessary to develop a national screening or risk-assessment process aimed at identifying potentially invasive species based on a set of scientific criteria. Countries such as Australia and New Zealand, and many Pacific Island states already have such screening processes that can be used as guidelines for developing a Namibian equivalent. An appropriate national institution such as the Polytechnic of Namibia should be given the mandate to research, develop and test such risk-assessment screening methods. Once approved, regulations need to be put in place to ensure that all proposed introductions be carefully assessed and that adequate time be allowed to give due consideration to potential impacts. A lead institution to conduct such risk assessments must be identified and personnel trained to conduct the research and surveys required for the adequate screening of each plant and animal. Here the most appropriate Ministry could be Finance as Customs and Excise falls under their jurisdiction. On the basis of experience gained, the screening process will need to be regularly updated, as will the criteria for screening. Information gained will also contribute to the lists of banned or controlled species and to the pertinent regulations and permit requirements.

- **Establish an invasive alien control unit**

At a practical level, it is important to establish invasive alien species control units responsible for the physical removal of banned plants and animals. A unit established within the MET may be the most appropriate to work on the eradication of known invasive species within protected areas. Once experience has been gained, this service could be more widely extended through MET, Forestry, Agricultural and Rural Water Supply regional offices, to oversee weed and pest eradication and control programmes on request on state land, road verges, farmland along rivercourses and in wetlands. In time, regions should be systematically cleared of invasive alien species. Conservancies should consider having their own weed and pest eradication teams too.

- **Develop practical guidelines appropriate to existing natural resource legislation**

There is a need to develop practical ways of controlling the introduction and potential spread of invasive alien species in Namibia. Practical guidelines, together with clear identification posters and manuals, would be valuable tools for customs officers, veterinary inspectors, invasive alien species control units and others to use to effectively implement sound the management of invasive alien species.

- **Determine the invasiveness of species introduced by the Directorate of Forestry**

It is evident from this review that many introductions have occurred through Directorate of Forestry nurseries, and that the Directorate still actively promotes invasive alien species. This issue needs to be addressed. The Directorate of Forestry is urged to conduct tests under local conditions to determine the invasiveness of species promoted by their nurseries, as well as their biological, social and economic impacts, and to implement appropriate control methods. Advice should be sought from the lead agency (DWA) and the institutions responsible for developing the screening process (Polytechnic of Namibia) and the national plant collection (NBRI) as well as from experts in the field possibly through the AISWG.

- **Transfer the knowledge and skills of local authorities and groups to other urban centres**

Within the urban environment, the Windhoek Municipality, plant nurseries, environmental groups and the Third Windhoek Scouts have made a good start in terms of awareness creation and the eradication and control of invasive alien species. Their initiatives need to be promoted and strengthened. Although this review did not assess urban centres outside the capital, it is assumed that other centres could benefit from experiences in Windhoek and vice versa. It is recommended that the Windhoek Municipality, through an organisation such as the Association of Local Authorities of Namibia (ALAN), spread this awareness to other towns, and that funds be sought to train municipal officials, nursery staff (including those from the Directorate of Forestry) and concerned citizens to further promote awareness and to undertake practical control projects within urban environments.

7.3 IMPROVED COLLABORATION OF EXPERTS

The following recommendations are made to help improve collaboration between experts:

- **Secure reliable funding for the former NBTF working groups**

Experts in invasive alien species are currently linked through the NBTF working groups such as the Agricultural Biodiversity Working Group, the Alien Invasive Species Working Group and the Wetland Working Group. As a result of changes at the MET, however, the future of these groups, particularly in terms of reliable funding, is uncertain. While the working groups should remain cross-sectoral in nature, to function effectively, they should be linked to a financially secure Ministry and not be dependent on external core finance.

- **Assign responsibility for coordination of national activities on invasive alien species to a single working group**

As recommended by Venter (2002), only one working group should assume responsibility for activities and implement practical projects related to invasive alien species. Projects can be collaborative and involve members from beyond the selected group, but overall leadership needs to be clearly established. This group must be clearly linked to the appropriate lead Government institution.

- **Improve representativeness of the working groups**

As identified in the interviews, although the present working groups represent a fairly wide range of institutions, they do not yet adequately access the expertise available in fields that are relevant to invasive alien species in Namibia. Rangeland scientists, foresters, marine and freshwater ecologists and veterinarians are not well represented. Crop disease and health specialists, and trade partners such as aquaculturists, horticulturists, game dealers and customs officials are not represented at all. No provision has been made for community representation, and there is no participation by development agencies.

- **Expand the scope of work covered by the working groups**

Currently, the Alien Invasive Species Working Group tends to concentrate more on plants, while the Agricultural Biodiversity Working Group emphasises animals, and neither deals with pathogens. Some of the most active institutions, such as the Phytosanitary Section in MAWRD's Directorate of Veterinary Services, do not feel at home in these groups. More formal coordination and a more focused approach are needed for a truly effective network of experts.

- **Disseminate the information contained in this review nationally**

To improve knowledge sharing and collaboration amongst experts in Namibia, it is recommended that this report be considered a contribution to the research discussion paper series of the Directorate of Environmental Affairs, and that hard copies be widely circulated, at least to all the individuals and institutions who contributed through interviews. Attention should be given to producing a series of factual, well illustrated, easy-to-read booklets based on the information contained in this review, subsequent revisions and new studies.

- **Improve communication, manpower and financial resources within the working groups**

Many members of the working groups mentioned that communication within the groups was a problem, and, particularly in the case of the Alien Invasive Species Working Group, that there were too few face-to-face meetings. Members were "too busy" to contribute in a meaningful way to the activities of the working groups, and often they or the institutions they represented lacked the resources to implement activities identified by the working groups. The very real issues of inadequate manpower and funding need to be addressed to improve the effectiveness of the groups. Linking the groups formally to lead institutions capable of financing some of their national activities from Government funding will provide the necessary financial security. This will further ensure the inclusion of activities to manage and control invasive alien species in the next National Development Plan.

- **Design and implement practical control projects**

One of the shortcomings of the present working groups is the lack of practical, visible control projects. It is recommended that such projects be identified, as they will have the added advantages of improving team spirit and drawing in more experts to collaborate in implementing practical, joint, cross-sectoral, national projects.

- **Improve high level collaboration between sectors involved in working groups**

Regardless of how well the working groups function at a technical level, collaboration at a higher political level between the sectors involved needs to be fostered to achieve real commitment from the government. A high level decision-making forum, chaired by the Minister or Deputy Minister of the lead organisation, needs to be established between the various ministries dealing with aspects of invasive alien species.

7.4 COORDINATED NATIONAL PROGRAMMES

The Alien Invasive Species Working Group has identified the national objective regarding invasive alien species as being to “reduce the threat to biological diversity from invasive alien species”. Six national objectives are articulated as part of Namibia’s strategic plan of action for sustainable development through biodiversity conservation. Taken together, these form a sound basis for future national programmes. They are given below as six of nine future national programmes that should be coordinated by the lead agency and the selected working group. Comments on how this review can contribute to each programme and recommendations for possible improvement are included.

- **Review and categorise information on invasive alien species known in Namibia**

Update and verify the checklists of invasive alien plants and animals developed for this review. This should be the task of the national institutions that house Namibia’s biological collections, the NBRI and the National Museum. They should be assisted by specialists from the MET, the MAWRD and the MFMR, as well as by specialists from the Polytechnic of Namibia, UNAM and other relevant working groups, i.e. the Alien Invasive Species Working Group, the Wetlands Working Group and the Agricultural Biodiversity Working Group.

- **Establish an ongoing database and atlas on plant and animal invasive aliens**

The updated species lists will form the core of the national database on invasive alien species in Namibia. Once the database is established, the known distribution of each species listed should be mapped. Where this is not known, field surveys must be undertaken. It is suggested that as a first priority these be conducted within all protected areas by staff of the MET, and in all wetlands, including dry river courses, by MFMR scientists, biologists from the Department of Water Affairs and members of the Wetlands Working Group. It is necessary to re-survey the floodplains and wetlands of Kavango Region and Caprivi Region to determine translocations of both *Salvinia molesta* and *Pistia stratiotes* caused by the large 2004 floods and the refilling of Lake Liambezi, formerly a focal area for *Salvinia molesta* infestation. Newly formed and emerging conservancies, particularly in the wetter parts of Namibia can be dawn in to survey and monitor wetlands and rivercourses within their areas and contribute this information to the national database. Here CNBRM associations and NGOs such as NNF can assist.

In future each region or river catchment area should be systematically surveyed. A start was made by the series of surveys conducted in the same areas as those surveyed by MET prior to the 1984 workshop, this work needs to be updated. The information from the BCLME project should be included for the marine system, river mouths and offshore islands. Mapping of invasive alien species should form an integral part of all wetland surveys. A national inventory of wetlands of Namibia is needed, as these ecosystems are the most vulnerable to invasion.

The information gathered should be used to establish, maintain and regularly update a national inventory of invasive alien species in Namibia. It is strongly recommended that the atlas system (SAPIA) developed by Lesley Henderson for the Plant Protection Research Institute in South Africa be adapted, at least for the plants, and that steps be taken to use this to develop a southern African atlas for invasive alien species. Lesley Henderson should be contracted to work with botanists in Namibia to get this set up and running. Furthermore, a classification system for invasive alien species needs to be developed and adapted for Namibia. It is strongly recommended that this be based on the Southern African Plant Invaders Atlas, and, in the interests of regional harmonisation, that this be adapted for Namibia and other SADC countries.

- **Research the invasiveness of selected species, their impact on livelihood security and potential mitigation strategies**

As mentioned earlier, the Directorate of Forestry should undertake studies to determine the impacts and invasiveness of the alien species they use in their tree-planting activities. Similar studies need to be undertaken for all other listed invasive alien species under local conditions. Only *Salvinia molesta*, *Prosopis* and, to a lesser degree, *Pennisetum setaceum* and *Cereus jamacaru* have been studied in any detail in Namibia. Research into the invasiveness of each of the species listed in this review, particularly those listed as priorities, is needed. These studies should also look at the biological, social and economic impacts of each species under local conditions. It is important to develop and test site-specific integrated control programmes to assess the effectiveness of different control strategies on identified species in given localities and to publish the results.

- **Establish policy, legislation and control measures for invasive aliens, and strengthen regulatory capacity**

This review provides a sound basis from which to proceed with the implementation of the recommendations under 7.1. It is, however, imperative to make use of the opportune timing afforded by current legislative reform and to increase coordination between relevant ministries such as MET and MAWRD with the Ministry of Trade and Industry to ensure that new legislation includes appropriate import regulations and with the Ministry of Finance to keep the customs officials informed. Consideration should be given to the establishment of an inter-ministerial taskforce, chaired the lead organisation to improve inter-sectoral cooperation to develop and harmonise appropriate regulations, screening processes and national programmes.

- **Promote public awareness of the ecological and economic threat posed by invasive alien species**

The “Namibia’s Nasty Nine” poster developed by the Alien Invasive Species Working Group and SABSP’s recently printed poster, “The ecological and economic threats of invasive alien species”, are a good start, (although information should be more accurately checked: the invasive mussel *Mytilus galloprovincialis* is not a black mussel, but a Mediterranean mussel). To really get the message across, a more concerted awareness-raising campaign making use of radio, television, newspapers, pamphlets (e.g. “Aloe”), booklets similar to the one on “Wetlands of Namibia”, public participation in “alien bashing days” and presentations at events such as farmers’ days is needed. A prize for projects on invasive alien species at the annual “Young Scientists” competition would encourage scholars to investigate pertinent issues. Support should be given to the NBRI /MET initiative to prepare and disseminate single-page fact sheets on each of the invasive alien species listed in this review. To improve awareness amongst decision-makers, a resource economics approach is advised, and tax breaks are suggested as an economic incentive to landowners to eradicate invasive alien species. Demonstration control sites would further increase awareness.

- **Develop appropriate risk assessment mechanisms for Namibia**

Unfortunately, the onus is on researchers and conservationists to show that alien species are, or will become, invasive, and that once they are invasive, they will be detrimental to the environment and/or people’s livelihoods. Since this is a very complex, expensive and time-consuming activity, the emphasis should be on using the precautionary principle to prevent a situation which may *a posteriori* prove the fact. Preventative measures are crucial, and steps must be taken to screen species prior to their introduction. This is discussed in 7.2 (Improved institutional capacities). To better convince decision-makers of the need for screening, to emphasise the dangers and to stress how difficult it is to foresee the negative impacts of introducing invasive species, fact sheets with examples of environmental and socio-economic disasters elsewhere that indicate how unpredictable these invasions can be, should be used.

- **Incorporate invasive alien species more specifically into the objectives and strategies of NDP 3**

Most of the NDP 2 strategies and plans related to natural resources use the term “environmental sustainability”, and by implication it can be assumed that where invasive alien species pose a threat to environmental sustainability, they are included in plans to reduce or control such threats. But this is only an assumption, and steps should be taken to more specifically make developers and decision-makers aware that invasive alien species reduce environmental sustainability. Strategies expressly aimed at countering the threats posed by specific invasive species, threats to specific habitats or specific ecological, economic or social impacts must be included in NDP 3. This will go some way towards reducing these threats and impacts, and increasing the political will of decision-makers to deal with them. As national plans are determined by each sector, it will be the task of government specialists, particularly within MET, MFMR and MAWRD, to ensure that plans to control or better understand the impacts of invasive alien species are included in NDP 3.

- **Increase public awareness and vigilance**

Vigilance regarding invasive alien species is particularly important. In this regard, the emerging aquaculture industry needs to be carefully monitored by the MFMR, and similarly the good work of the MET in cooperating with game dealers must continue and be strengthened. Customs officials should be well trained to recognise and deal with illegal imports of invasive alien species. Institutions such as the Polytechnic of Namibia could be approached to organise training modules for phytosanitary officers and customs officials. Members of the public can provide valuable inputs to both the database, in terms of distribution records, and to control efforts, by being encouraged to report sightings of declared invasive alien plants and animals. This also provides an opportunity to involve communities in the management of natural resources. Appropriate guidebooks and manuals similar to the well-illustrated and informative “Plant Invaders of Southern Africa” (Henderson 1995, 1999) need to be produced to advise both the public and those trading in plants and animals.

- **Provide gardeners and breeders with information on more appropriate alternatives to invasive alien species**

Plant nurseries and municipalities are already doing much to provide gardeners and breeders with information on more appropriate alternatives to invasive alien species. The Department of Aquaculture (MFMR) will be conducting trials on suitable indigenous species for fish farming and mariculture enterprise. Similarly, game dealers are promoting local species and a pride in indigenous fauna. These efforts must be encouraged, strengthened and spread to other sectors.

- **Expand this review to include pathogens**

As this review has not dealt in any detail with alien invasive pathogens (i.e. micro-organisms and parasites that are of veterinary and medical importance, or that attack crops and other plants), a review should be undertaken by specialists in this field, possibly from the Directorate of Veterinary Services, and the results incorporated in the national inventory and database.

7.5 IMPROVED REGIONAL (SADC) COLLABORATION

The following recommendations are made to promote cross-border collaboration within the SADC:

- **Develop a regional policy on invasive alien species**

As recommended in the SADC review for aquatic weeds, it is necessary to develop a clear regional policy on invasive alien species, taking into account the pertinent clauses already contained in the protocols on fisheries, shared watercourses and wildlife, regional agreements, African Unity and Nepad initiatives and international conventions such as Ramsar and UNCBD.

- **Promote a catchment-based approach to integrated control**

The SADC Water Sector is encouraged actively to seek funds to revive the regional project on aquatic weeds, so as to establish and map their occurrence, monitor translocation, and to identify and test practical control measures, particularly in trans-boundary catchments. The Food, Agriculture and Natural Resources department within SADC and interested member states should further identify similar trans-boundary project on terrestrial invasive plants and on invasive animal species too. Particular attention should be given to aquaculture development in the SADC, and to ways of minimising the potential threats posed by invasive alien species.

- **Conduct joint surveys in trans-boundary ecosystems**

Ongoing cross-border surveys on invasive alien species should be jointly conducted by countries sharing ecosystems, particularly watercourses. It is in Namibia's interests to continue the cross-border aquatic weed and invasive alien riparian species surveys with scientists from neighbouring countries such as Botswana and South Africa, who share our international river systems. Similar surveys on alien invasive animals should be designed and jointly implemented.

- **Encourage and strengthen scientific collaboration, regional cooperation and stakeholder participation**

Although many of the experts interviewed reported that they enjoyed good collaboration with experts in other SADC countries, and often with experts further afield, this was often on an individual, technical level, rather than an inter-institutional one. In the past, fora such as SARCCUS, Southern African Regional Commission for Conservation and Utilisation of Soil, and the SADC Water Sector Sub-committee on Aquatic Weeds provided avenues for collaboration and regional cooperation. With the restructuring and relocation of the SADC, there is uncertainty about the future of these regional groups. Attention should be given to reviving these fora and creating similar links between terrestrial scientists and those dealing with invasive alien animals within the SADC.

- **Improve public awareness**

There is a need to improve public awareness throughout southern Africa. This is particularly important at border crossings, where the potential harm that the introduction of invasive alien species can do should be clearly displayed.

- **Recognise and develop regional expertise**

As is clear from this review of national experts, there is ample expertise within Namibia, and the same is true for all SADC countries. This should be recognised at a regional level, and the dependence on "outside" experts should be reduced. Development agencies, in particular, should recognise and strengthen the expertise available within the SADC region.

- **Promote regional scientific cooperation and training**

Similar risk assessments and screening processes should be developed in all SADC countries and harmonised. National teams, particularly customs officials, should be trained to implement these measures. Where possible this training should be the same on both sides of the border.

- **Harmonise legislation and regulations on invasive alien species within southern Africa**

Each country should try to ensure that national policies, legislation and regulations are in keeping with regional protocols and international agreements, and should make an effort to formulate legislation and regulations in a manner that is complementary to the legislation and regulations of neighbouring states. The recently developed Aquaculture Policy, Act and related regulations are an example where care has been taken to incorporate international concerns and agreements.

- **Make use of the opportunity afforded by the New Partnership for Africa's Development (NEPAD) Environmental Initiative**

Within the NEPAD invasive alien species category, there may be room to promote regional projects on trans-boundary control projects for southern Africa. This needs further investigation.

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Useful website addresses:

International Plant Convention

<http://www.ippc.int/servlet/CDSServlet?status=ND0xMzI5Mi4xMzc5NSY3PWVuJjYxPXB1YmxpY2F0aW9ucyY2NT1pbmZv#koinfo>

The WTO Agreement on the Application of Sanitary and Phytosanitary Measures

http://www.wto.org/english/tratop_e/sps_e/spsagr_e.htm#Annexc

ANNEXURES:

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AQUATIC AND SEMI-AQUATIC PLANT SPECIES NOT INCLUDED IN THE ANNOTATED LIST IN THE TEXT, BUT, NATURALISED ALIEN SPECIES, THAT MAY BE POTENTIALLY INVASIVE ACCORDING TO *WATER PLANTS OF NAMIBIA* (2002).

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ANNEXURE 1

ANNEXURE 1A

TERRESTRIAL PLANT SPECIES NOT INCLUDED IN TABLE 1 OR 2, BUT
CONSIDERED INVASIVE ACCORDING TO NBRI LIST AND ZIMMERMANN 2003.
Compiled by Joubert and Bethune 2004.

<i>Acacia saligna</i>	Port Jackson willow (Z)
<i>Achyranthes aspera</i>	Prickly chaff-flower
<i>Alternanthera nodiflora</i>	Common joyweed
<i>Alternanthera pungens</i>	Khaki weed or Khakibos
<i>Alternanthera sessilis</i>	Sessile joyweed
<i>Atriplex nummularia</i> spp. <i>Nummularia</i>	Old man salt-bush (Z)
<i>Bidens bipinnata</i>	Blackjack
<i>Caesalpinia gilliesii</i>	Bird-of-paradise (Z)
<i>Cardiospermum halicacabum</i>	Heart pea / lesser balloon vine (Z)
<i>Cardiospermum grandiflorum</i>	Balloon vine
<i>Chamaesyce hirta</i>	Hairy spurge
<i>Chamaesyce prostrate</i>	Prostrate sandmat
<i>Conyza albida</i>	Fleabane
<i>Conyza bonariensis</i>	Asthamaweed
<i>Cynodon dactylon</i>	Couch grass
<i>Eucalyptus camaldulensis</i>	Red river gum (Z)
<i>Gomphrena celosioides</i>	Gomphrena weed
<i>Guilleminea densa</i>	Small matweed
<i>Helianthus annuus</i>	Sunflower
<i>Latvatera arborea</i>	Tree mallow (Z)
<i>Ligustrum</i> spp	Privet (Z)
<i>Myoporum tennifolium</i>	Manatoka (Z)
<i>Myriophyllum spicatum</i>	Spiked river milfoil(Z)
<i>Pennisetum clandestinum</i>	Kikiyu grass
<i>Pupalia lapacea</i>	Creeping cock's comb
<i>Salsola kali</i>	Russian tumbleweed (Z) (NBRI)
<i>Schinus molle</i>	Pepper tree(Z)
<i>Schinus terebrinthifolius</i>	Brazilian pepper tree (Z)
<i>Schkuhria pinnata</i>	Dwarf marigold or pinnate false threadleaf
<i>Solanum elaeagnifolium</i>	Silver-leaf bitter apple (Z)
<i>Sorghum halepense</i>	Johnson grass (Z)
<i>Tecoma stans</i>	Yellow bells, Tacoma (Z) (NBRI)
<i>Veronica anagallis-aquatica</i>	Water speedwell (Z)
<i>Xanthium strumarium</i>	Large cocklebur

ANNEXURE 1B

NBRI 2002 LIST OF PLANTS PROPOSED TO BE DECLARED ALIEN INVASIVES

(cited in Venter 2002, rearranged in phylogenetic order and with common names from Henderson (1999) compiled by Bethune 2004.

PTERIDOPHYTA – Ferns

SALVINIACEAE: *Salvinia molesta* D. Mitch Kariba weed

ANGIOSPERMAE

FABACEAE *Prosopis chelensis* (Mol.) Stuntz
Prosopis glandulosa Torr. var. *torreyana* (Benson) Honey mesquite
Prosopis veutina Wooton Velvet mesquite

SAPINDACEAE *Cardiospermum grandiflorum* Sw. subsp. *hirsutum* (Willd.) Radlk.
Balloon vine

CATAACEAE *Opuntia aurantiaca* Lindl. Jointed cactus
Opuntia ficus-indica Mill. Sweet prickly pear
Opuntia imbricata (Hav.) DC Imbricate prickly pear
Opuntia stricta (Hav.) Australian pest pear

VERBENACEAE *Lantana camara* L. Lantana

SOLANACEAE *Datura ferox* L. Large thorny apple
Datura inoxia Mill. Downy thorn apple
Datura stramonium L. Common thorn apple
Nicotiana glauca R.C. Graham Wild tobacco
Solanum elaeagnifolium Cav. Silver-leaf bitter apple
Solanum seforthianum Andr. Potato creeper

ASTERACEAE *Flaveria bidentis* (L.) Kuntze Blackjack

CHENOPIACEAE *Salsola kali* L. subsp. *austroafricana* Aellen Russian tumbleweed

PAPAVERACEAE *Argemone ochroleuca* Sweet subsp. *ochroleuca* Mexican poppy/thistle

ANNEXURE 2.

AQUATIC AND SEMI-AQUATIC PLANT SPECIES NOT INCLUDED IN THE ANNOTATED LIST IN THE TEXT, BUT CONSIDERED NATURALISED ALIEN SPECIES THAT MAY BE POTENTIALLY INVASIVE ACCORDING TO *WATER PLANTS OF NAMIBIA* (Clark & Klaassen 2001, Craven 1999) Compiled by Bethune 2004.

MONOCOTYLEDONAE		HABITAT
Poaceae		
<i>Echinochloa colona</i> (L.) Link	oshana, vleis	aquatic
<i>Echinochloa crus-galli</i> (L.) Beauv.	river marsh, vlies	aquatic
Cyperaceae		
<i>Schoenoplectus tabernaemontani</i> (C.C.Gmel.) Palla	habitat	aquatic
<i>Schoenoplectus triquetet</i> (L.) Palla	unknown	aquatic
Juncaceae		
<i>Juncus bufonis</i> L.	seasonal rain pools	semi-aquatic
DICOTYLEDONAE		
Polygonaceae		
<i>Persicaria lapathifolia</i> (L.) Gray	ephemeral rivers, dams margins	aquatic
<i>Persicaria limbata</i> (Meisn.) H Hara	pans, waterholes/seeps, backwaters	aquatic
<i>Polygonum aviculare</i> L.	ephemeral riverbeds	semi-aquatic
<i>Polygonum kitaibelianum</i> Sadler	ephemeral riverbeds	semi-aquatic
Chenopodiaceae		
<i>Chenopodium ambrosioides</i> L.	ephemeral riverbeds	semi-aquatic
Amaranthaceae		
<i>Alternanthera nodiflora</i> R Br.	dams, vleis	semi-aquatic
<i>Alternanthera sessilis</i> (L.) DC.	slow flowing river banks	semi-aquatic
Droseraceae		
<i>Drosera indica</i> L.	marsh, oshana, seeps, vleis	semi-aquatic
Caesalpinioideae		
<i>Sesbania bispinosa</i> (Jacq.) W.Wight var. <i>bispinosa</i>	ephemeral rivers, pans, vleis, spring/waterhole, seasonal rain pools	semi-aquatic
Primulaceae		
<i>Anagalis pumila</i> Sw.	Spring marsh or seep	semi-aquatic
Boraginaceae		
<i>Heliotropium curassavicum</i> L.	coastal lagoon	semi-aquatic
<i>Heliotropium indicum</i> L.	riverbank, floodplains	semi-aquatic
Verbanaceae		
<i>Verbena litoralis</i> Humb. Bonpl. & Kunth	riverbank, seasonal rainpools	semi-aquatic
<i>Phyla nodiflora</i> (L.) Greene	ephemeral rivers, spring/seep	semi-aquatic
Scrophulariaceae		
<i>Veronica anagallis-aquatica</i> L.	ephemeral rivers, dam, spring stream	aquatic
Asteraceae		
<i>Eclipta prostrate</i> (L.) L.	riverbank, dam, pan, rainpools	semi-aquatic

ANNEXURE 3:

ANNEXURE 3A:

1984 IDENTIFICATION AND PRIORITY LISTING OF 10 MOST IMPORTANT INVASIVE ALIEN PLANT SPECIES IN NAMIBIA (Scheepers, 1985)

- | | |
|--|--|
| 1. <i>Salvinia molesta</i> | Kariba Weed or Salvinia |
| 2. <i>Prosopis</i> spp | Mesquite or Prosopis |
| 3. <i>Nicotiana glauca</i> | Wild Tobacco |
| 4. <i>Datura innoxia</i> | Thorn apples (probably meant to include all <i>Datura</i> spp.) |
| 5. <i>Opuntia ficus-indica</i> | Sweet prickly pear (probably meant to include <i>Opuntia</i> spp.) |
| 6. <i>Melia azedarach</i> | Syringa |
| 7. <i>Lantana camara</i> | Lantana |
| 8. <i>Ricinus communis</i> | Castor oil plant |
| 9. <i>Argemone ochroleuca</i> | Mexican poppy/thistle |
| 10. <i>Dodonea viscosa/ Dodonea augustifolia</i> | Sand olive |

ANNEXURE 3B:

NAMIBIA'S NASTY NINE – ALIEN INVASIVE SPECIES

“NAMIBIA'S NASTY NINE” not in any order of priority

<i>Argemone ochroleuca ochroleuca</i>	White-flowered Mexican poppy
<i>Datura innoxia</i>	Downy thorn apple
<i>Leucaena leucocephala</i>	Wonderboom
<i>Melia azedarach</i>	Syringa
<i>Nicotiana glauca</i>	Wild tobacco
<i>Opuntia</i> spp	Prickly pear
<i>Pennisetum setaceum</i>	Fountain grass
<i>Prosopis</i> spp	Mesquite, Prosopis
<i>Salvinia molesta</i>	Kariba weed, Salvinia

The poster “Namibia’s Nasty Nine – alien invasive species” includes pictures of these nine plants as well as a description of each, explains what alien invasive species are, discusses their impacts and what can be done.

Seven of the plants are common to both lists and all 12 mentioned cause problems.

Copies of the poster are available from in Alien Invasive Species Working Group.

ANNEXURE 4

ANNOTATED LIST OF ALIEN MAMMAL SPECIES (AND ALIEN GENETIC STOCK) WHICH HAVE BEEN IMPORTED INTO NAMIBIA. Compiled by Griffin 2004.

Cape bushbuck (*Tragelaphus scriptus*).

Thus far no feral populations have been established. Geographically, it is highly unlikely that Namibian and imported stock will be in contact, except in the region of the Waterberg Plateau Park, where Chobe bushbuck are scheduled to be introduced, and Cape bushbuck occur on adjacent farms.

Nyala (*Tragelaphus angasii*).

All stock is presently contained.

Mountain reedbuck (*Redunca fulvorufula*).

All stock are presently contained

Waterbuck (*Kobus ellipsiprymnus*)

Non-Namibian stock - all stock is presently contained and not in contact with Namibian waterbuck.

Lechwe (*Kobus leche*)

Non-Namibian stock. - all stock presently contained and not in contact with Namibian lechwe.

African buffalo (*Syncerus caffer*)

Non-Namibian stock were introduced to the Waterberg Plateau Park, and all will eventually be transferred to the RSA.

Water buffalo (*Bubalus bubalus*).

All stock is presently contained.

Common impala (*Aepycerus melampus*)

Non-Namibian stock have been imported and introduced to many commercial farms. The indigenous black-faced impala (a distinct morpho-type, and of high economic value), has been allowed to interbreed with common impala. This has reduced the conservation-value as well as the economic value of populations of genetically-compromised black-faced impala. BFI are high-value trophy animals, but cannot be successfully marketed if the purity of the animal cannot be guaranteed

Common impala from South Africa have recently been imported into the Salambala Conservancy, where they are expected to genetically-taint Caprivi impala. This infusion of alien stock will spread to neighbouring impala populations in the region. This is not good for neighbourly relations.

Tsessebe (*Damaliscus lunatus*)

Non-Namibian stock – all contained and not in contact with Namibian tsessebe.

Blesbok (*Damaliscus dorcas phillipsi*)

All stock is presently contained

Bontebok (*Damaliscus dorcas dorcas*)

All stock is presently contained

Black Wildebeeste (*Connochaetes gnou*).

All stock is presently contained. There are good data demonstrating cross-breeding between the black and blue wildebeest (an indigenous species). The conservation consequences of this are currently unknown.

White rhino (*Ceraotherium simum*)

Non-Namibian stock, from Natal, have been introduced into Namibian parks and private conservancies.

Namibian white rhino were extinct by the late 1880. Even though MET policy does not favour the introduction of alien species (especially into proclaimed conservation areas), an exception was made due to the high tourist value of this species.

Roan antelope (*Hippotragus equines*)

Non-Namibian stock imported, and assimilated with indigenous Namibian roan, therefore creating a genetically-compromised population, which is of reduced conservation value.

Sable antelope (*Hippotragus niger*)

Non-Namibian stock imported and assimilated with Namibian sable, therefore creating a genetically-compromised population, which is of reduced conservation value.

Springbok (*Antidorcas marsupialis*)

Non-Namibian stock imported and assimilated with Namibian springbok, therefore creating a genetically-compromised population, which is of reduced conservation value.

Before translocations, three described subspecies occurred in Namibia.

Gemsbok (*Oryx gazella*)

Non-Namibian stock imported and assimilated with Namibia gemsbok, therefore creating a genetically-compromised population, which is of reduced conservation value.

Plains zebra (*Equus burchelli*).

Non-Namibian stock imported and assimilated with Namibian plains zebra, therefore creating a genetically-compromised population, which is of reduced conservation value.

ANNEXURE 5:

EUROPEAN UNION CONTAINED USE REGULATIONS (2000) FOR GENETICALLY MODIFIED ORGANISMS as cited in the National Policy Document *Enabling the safe use of Biotechnology* 1999 submitted by the Ministry of Higher Education, Vocational Training, Science and Technology.

- Genetically modified organisms (GMOs), especially genetically modified micro-organisms are classified according to their level of risk to human and environmental health:
- Such classification be in line with sound international practice and based on risk assessment:
- Containment and other protective measures must correspond with the classification of contained use:
- In cases of uncertainty, containment and other protective measures for a higher classification level should be applied until less stringent measures are justified by appropriate data;
- Appropriate measures should be adopted and used for control of the disposal of material from contained uses of GMOs, in accordance with good microbiological and hygiene practice:
- These measures shall be reviewed periodically, to reflect the pace at which biotechnology is advancing:
- Persons working with contained use systems shall be consulted about their occupational hazards;
- The desirability of a list of GMOs that are safe to human health and the environment should be considered;
- There now exists considerable information on the risks associated with the contained use of GMOs particularly Genetically Modified Microorganisms.

The following classes are recommended:

- | | |
|----------------|---|
| CLASS 1 | Activities of no or negligible risk – for which level 1 containment is enough to protect human and environmental health |
| CLASS 2 | Activities of low risk – for which level 2 containment is enough to protect human and environmental health |
| CLASS 3 | Activities of moderate risk – for which level 3 containment is enough to protect human and environmental health |
| CLASS 4 | Activities of high risk – for which level 4 containment is enough to protect human and environmental health |

ANNEXURE 6

ANNEXURE 6A

Questionnaire for organisations/ institutions

1. Name of institution or organisation:
2. Name and contact of knowledgeable person interviewed :
Name: Position in organisation:
Tel: email: Address:
3. Link with invasive alien species
4. Past projects on invasive alien species
Relevant Publications/ documents/ reports
5. Current projects on invasive alien species
Relevant publications / documents / reports
6. Future projects on invasive alien species
Relevant project proposals/ plans/
7. Legislative framework within which the organisation operates
and is this adequate – how can it be improved ?
8. Collaboration with scientists, managers other institutions within Namibia
How effective is this?
9. Collaboration with scientists, manager other institutions outside Namibia
How effective is this?
10. National experts – who in the institution and who elsewhere in Namibia?
11. Training opportunities within and outside Namibia
12. The degree of public Awareness on invasive alien species within the institution and
within Namibia in general and how this can be improved.
13. Individual perceptions and the stance of the institutions on invasive alien species in
Namibia
14. Priority placed by the institution on the invasive alien situation in Namibia?
15. Usefulness of an investigation into the situation regarding invasive alien species in
Namibia/ SADC
Would this review be useful to the institution?

ANNEXURE 6B

RESPONSES TO QUESTIONNAIRE FOR ORGANISATIONS/INSTITUTIONS

1) Ministry of Environment and Tourism

2). Dr. P. Lindeque (Director)/ M. Griffin

3). Legislation and lead Ministry

4). Workshop in 1985, and proceedings from that workshop. Contributions to various scientific/biodiversity reviews, e.g. country study

5). New legislation (Parks and Wildlife Management Act) and regulations to follow.

Relevant publications would be primarily the Nature Conservation Ordinance of 1975, and many policy papers, in particular those in the DEA Discussion Paper series.

Biological Diversity in Namibia – a country study. NBP

Current projects involve the continuous removal of AIS in proclaimed areas

Work continues on policies, pamphlets and posters.

6). Awareness posters, booklets, continued eradication of IAS, especially in proclaimed areas.

7). Nature Conservation Ordinance no.4 of 1975.

It is barely adequate, and shortfalls are being addressed in the new bill.

8). The Biodiversity Task Force, IAS working group is the primary interface.

MET has personnel on the working groups, but these groups are not as active, or pro-active as it should be.

9). MET interfaces with IUCN, CBD, and CITES. Effectiveness is satisfactory but could be better (lack of resources).

10). P. Lindeque, M. Lindeque, H. Kolberg, M. Griffin, P. Erb, The BDTF working group is national forum. National Botanical Research Institute.

11). Other than UNAM and the Polytech, none.

12). Moderate within MET, and can be improved with awareness and in-service training.

Forestry seems to take a different approach.

The new bill, and uniformity of goals within the MET (Forestry again) should be a big improvement.

13). Institutional stance is moderate to low (in many sections of GRN). Individual awareness is low.

14). Moderate. High in some sectors, but not overall.

15). High – anything to increase awareness. Last review was in 1985. Different standards in region causes problems. An advantage is that politicians are inclined to support regional initiatives.

1) SABSP/Directorate Environmental Affairs /MET

2). Joyce Katjirua

3) The Southern African regional programme SABSP, IAS and ABS (Access and Benefit Sharing) sub-programmes, supported by the MET and housed at the DEA.

4). The DEA was the seat of the Biodiversity Task Force, and lead the process to the NBP. The Invasive Aliens Working Group is a specialist group within the BDTF framework.

Products are the Country study, numerous scientific articles (in particular the, dedicated “Biodiversity Conservation” (vol 7; 4), “nasty-nine poster”,

5). Strategic plans, and assorted databases and aliens awareness poster.

Products are yet to be produced.

6). Primarily fine tune and maintenance of databases. Future projects are expected to be smaller low-impact projects.

7). All MET legislation applies. Currently not adequate, but to be improved.

8). Primarily through the BDTF, which has links throughout Namibia. All relevant institutions are linked. Effectiveness is considered to be good.

9). Specifically IUCN-ROSA, and GISP (Cape Town), where cooperation and effectiveness good.

10). Joyce Katjirua is expert in this programme, and she is the contact person.

11). Formal and informal awareness training is available.

12). Awareness is low to moderate, and can be improved through awareness programmes.

13). Institutional and individual perceptions are low. Awareness is unbalanced, favouring plants.

14). Low.

15). Access of funding will be easier, a coherent and uniform policy throughout the region will improve management and enforcement issues, as the programme sits with the SADC Secretariat.

1) Directorate of Forestry

2). Joseph Hailwa, Director, email jhailwa@africaonline.com.na

3). The Directorate to Forestry considers itself a promoter of alien species through a combination of the historical situation and current demand. Since some alien species can withstand Namibia's arid conditions and the Directorate of Forestry is promoting them, including some invasive species. In terms of abundance, currently about 80 % of the plants in nurseries are alien.

4). Past projects on alien invasive species include many tree planting projects that have been initiated including the establishment of community projects such as *Azadiracta indica* (neem), *Eucalyptus* and *Melia azedarach* woodlots in Kavango and Caprivi. For the past 14 years, the directorate has grown, donated to schools and sold *Leucaena leucocephala*, *Prosopis* spp. and various fruit trees and ornamentals such as jacaranda (*Jacaranda mimosifolia*). This is a very strong activity in many forest stations. Relevant publications include the review of forestry in Namibia from 1850 to 1990 by Erkilli and Siiskonen (1992) and currently John Mendelsohn or RIASON has been contracted to assist the directorate to prepare a publication on forestry activities since 1990.

5). Current projects on alien invasive species include an extended feasibility study in conjunction with DRFN, in Oshana and Otjikoto regions to determine the feasibility of tree planting in the area as shade for cattle. These extensive grasslands are currently a major grazing resource for people in the north. The feasibility of different species, including alien invasive species, is being determined. A major limiting factor is the salinity of the soil.

6). A future project is the publication on the status of Forestry since 1990 by Raison and should include mention of alien invasive species too.

7). The legislative framework within which the organisation operates is considered adequate.

12). The degree of public Awareness within the institution is very high yet the directorate will continue to include alien invasive species in their tree planting projects.

13). Mr. Hailwa is very aware of the potential problems of invasive alien species, but currently feels he has to weigh costs and benefits, and cannot ignore their positive aspects.

Questions 8 – 11, 14 and 15 were not answered.

Ministry of Basic Education, Sport and Culture.

1) National Museum of Namibia

2). Eugene Marais (Chief Curator)

3). Research on taxonomy, biogeography and maintain the national archive (specimens). Identification service.

4). Inter-basin transfers (B. Curtis), wood borer, cabbage butterfly, prickly-pear moth (all with Agric).

Internal reports, primarily with Agric, CBD country study.

5). Support to Agric is continuous. Several reports are in-progress.

6). Depends on future needs/requirements. NMWN is essentially "on-call" to provide information of a specialist nature.

7). No supporting legislation (this is a problem – lack of institutional support, e.g..budgets, personnel)

NMWN needs first class status within a supportive system.

National Heritage Act may provide some leverage to upgrade.

8). NMWN liaises and works with all relevant Ministries.

The museum is very willing to help, but resources are very problematic.

9). Links are good, but lack of resources hamper effectiveness.

10). Individual curators are experts in their fields.

11). Museum can provide in-service training only.

12). Awareness is low, and can only be improved by education.

13). In the museum, specialists are very aware. Outside specialist interest, awareness is low.

14). Low, because museum's priorities are set from outside. Also from within, priority is low.

15). Due to perceived incompleteness (and different grades of accuracy and completeness), usefulness of such an investigation will be low.

1) Ministry of Health and Social Services

2). Mr F Amulungu, Chief Public Hygiene. famulungu@mhss.gov.na Private Bag 13198, Windhoek, Tel: 203 2754 The gentlemen interviewed claimed that as the Ministry had no links with invasive alien species and no projects in this regard, the questions were not applicable although he agreed that invasive species should be regulated. He felt the review would not be useful as the topic is not within the scope of their work – despite a workshop held recently to consider using fish as biological control agents for mosquito control to combat malaria that he was unaware of.

Ministry of Agriculture, Water and Rural Development

1) Veterinary Services

- 2). Dr. A. Norval, Director
- 3). Lead organization regarding exotic organisms, and agriculture.
- 4). Risk analysis is ongoing and continuous. Following the OIE Terrestrial animal code.
- 5). Watch conditions which could lead to emergence as well as re-emergence of diseases. Programme designed towards prevention.
Organisation is not research orientated, so no publications.
- 6). Organisation not project orientated; responds to current and future situations.
- 7). Act 13 of 1956, Act 8 of 1967 Act 36 of 1947 Legislation is adequate, and is amended as needed. Schneider (1997) provides a guide to all relevant legislation.
- 8). Good cooperation and effectiveness with Namibian institutions, e.g.MET, MFMR, Meat Board, Agric
- 9). Good cooperation and effectiveness with OIE, SADC, Onderstepoort, Botswana Vaccine Institute.
- 10). About 40 veterinarians within the system.
- 11). Short courses within Namibia, also in South Africa, Malawi (CTTBD), and overseas.
- 12). Good.
- 13). High
- 14). High
- 15). Very important, especially if it includes pathogens.

1) Agricultural Extension

- 2). Jacques Els, Deputy Director
- 3). Lead Ministry for agricultural pests, diseases and activities which affect agricultural issues. Plant quarantine policy and facilities.
- 4). Aquatic rushes (Mariental), cotton borer, large grain borer, Cocheneal. Internal reports are available.
- 5). Aquatic rushes, cabbage butterfly – current programme is monitoring and extension regarding previous projects/identified problems.
- 6). None planned, but the Ministry reacts to problems as they are identified.
- 7). Many, but none deal directly with IAS except when they become pests (G. Rhodes, pers.comm.). Current legislation is adequate, but can be improved.
- 8). Other line directorates and Ministries. Effectiveness is generally good, but there could be more interaction with MET on land-use issues.
- 9). South Africa Small Grain Centre, ICRISAT, and plant-genetics resources (through the NBRI).
Effectiveness is considered good.
- 10). Jacques Els, George Rhodes, S.A. Ipinge, T.E.Alweedo, B. Braun.
- 11). None
- 12). Low, only improved with increasing awareness.
- 13). High stance within the institution, but low perceptions.
- 14). Amongst scientists and phytosanitary section the priority is high, but lower within the Ministry.
- 15). Unless the end result is action (requiring political will), then it will just be another report.

1) National Botanical Research Institute – MAWRD

- 2) Herta Kolberg, Principal Agricultural Researcher responsible of alien invasive species at NBRI
Tel: 2022010, email hertak@mweb.com.na, NBRI, P/B 13184, Windhoek
- 3) NBRI houses the national plant collection and is involved in research and awareness dealing with all plants
Conducts research and botanical surveys and assists the public and other scientists with queries
- 4) All alien invasive plants are documented and listed and specimens kept in the herbarium
- 5) Ongoing collection and research to improve the collection and knowledge on distribution in Namibia
- 6) Together with MET there is a proposal to develop a series of laminated one page fact sheets on interesting plants – this will include a series on alien invasive species, showing what they look like, known distribution as well as threats and control methods if any – aimed at creating awareness amongst nature conservation officials, but will also be useful to customs officers, teachers and farmers.
- 7) Not aware of current legislation that is useful, nothing specific to Namibia on alien invasive plants, but agrees that efforts be made to incorporate alien invasive species concerns in regulations developed to support existing legislation and that provision be made in the new Conservation of Agricultural Resources Bill
- 8) One to one collaboration with other scientist particularly within the AISWG is good, but alien invasive species are not a high priority within most institutions so little collaboration from institution to institution.
- 9) Ad hoc collaboration between scientists e.g. with Lesley Henderson at PPRI
- 10) Herta Kolberg at NBRI and Mike Griffin at MET on animal species
- 11) None
- 12) Botanists are aware of alien invasive species but awareness within Namibia is “not too hot”
- 13) The problems related to alien invasive species are not yet too serious in Namibia but the situation needs to be watched and monitored and care taken not to import new species that may threaten the environment. Advice on alien invasive species should be readily available and good border checks and screening methods to prevent new introductions will improve the situation.
- 14) Low funding and small time allocation allowed for work on alien invasive species yet it is the responsibility of a senior staff member. Thus taken seriously but few resources allocated to it.
- 15) Would be very useful particularly the legislative review.

1) Directorate Water Environment, Department of Water Affairs, MAWRD

- 2) Dr Stef de Wet, Deputy Director and Kevin Roberts Principal Researcher Water Environment Division
- 3) Ongoing biological control of *Salvinia molesta* in the eastern Caprivi, national monitoring of alien aquatic invasive species, national representative on SADC Water Sector sub-committee on aquatic weeds
- 4) *Salvinia* control since early 1980's, involvement in SARCCUS and later SADC programmes
- 5) Ongoing *Salvinia* project – SADC programme to control introduction and translocation of aquatic weeds
- 6) *Salvinia*, and water lettuce, monitor potential spread after recent floods in Caprivi, look at riverine vegetation and spread of species such as *Prosopis* along ephemeral rivers and impact of alien riparian vegetation on groundwater supplies – similar to the south African working for water issues.
- 7) Nothing in current water policy nor draft water resources management bill – in fact on mention of protection of surface water sources. Opportunity to develop regulations and permit requirements.
- 8) Good collaboration at technical level, needs to continue
- 9) Excellent collaboration with Botswana. Good cooperation within the region established through SARCCUS and later SADC Water Sector sub-committee on aquatic weeds, but now needs to be re-established with move of SADC to Gaborone. Must in future collaborate with MFMR in term of aquaculture threats.
- 10) Shirley Bethune, Charli Schlettwein, Kevin Roberts, Vincent Simana, Alfred Makumi, Stef de Wet and also Nicolas Clarke and Eliot Taylor although they are now outside Namibia on aquatic weeds and Pierre Smit on *Prosopis*.
- 11) None within Namibia other than in service training of research assistants, most training opportunities outside Namibia are focus on water hyacinth.
- 12) In the 1980s and early 1990s DWA produced a show display, pamphlet, popular articles, newspaper reports and several scientific publications to raise awareness of aquatic weeds. Efforts need to be revived.
- 13) DWA was previously the lead institution in Namibia and one of the leading institutions in SADC in terms of research and control of aquatic alien invasive species. DWA is aware and concerned as are SADC partners, joint weed inspections have been held with Botswana on the Chobe river.
- 14) The *Salvinia* project continues to be financed by the ministry but nothing specific on alien aquatic species in the new water policy nor legislation.
- 15) Yes

1) NamWater

- 2) NP du Plessis, Senior Environmentalist, plessisn@namwater.com.na Tel : 712039. P/B 13389, Windhoek
- 3) Limited to where alien invasive plants impact on water supply or operational activities and taken into account in EIAs
- 4) *Salvinia* mats blocked abstraction points in Caprivi, moved abstraction to an unobstructed site
- 5) Dealt with as they arise
- 6) Possible control of *Prosopis* at Omdel Dam, preliminary discussions with Pierre Smit.
- 7) NamWater Act 12 of 1997, as well as national water and environmental policies and legislation
- 8) Ongoing collaboration with Municipality, DWA, Unam and members of the alien invasive species WG – effectiveness could be improved though
- 9) Good collaboration with institutions in South Africa such as RandWater, Umgeni Water and CSIR, both on contract and personal less formal co-operation at technical level with scientists and managers/peers.
- 10) NP du Plessis at NamWater, S Bethune nationally on aquatic plants.
- 11) Bursaries available but mainly for engineering studies, dependent on training needs within NamWater
- 12) Generally low, except where colleagues have a personal interest, recommends an intensive, well-targeted public awareness campaign – to counter rather jaded public reactions to most water awareness drives
- 13) Important to control alien invasive species, mainly interested in plant species and extend this to indigenous invasive species too. NamWater is interested in so far as they impact on their operational activities
- 14) Priority where water supply and operation are affected or are likely to have an effect on the introduction or spread of alien invasive species and as part of broader Environmental Assessments
- 15) Review report would be a useful addition to the library and the recommendations useful if practical.

Ministry of Fisheries and Marine Resources

1) Freshwater Fish Research Institute

- 2) Nande Nikanor, Fisheries Biologist, nande@mweb.com.na Tel: 063 240361 P/bag 2116 Mariental
- 3) Aquaculture development, research and monitoring and national freshwater fish surveys
- 4) Contributions to red data species list, input to 1984 workshop, wetlands workshop 1988, biodiversity publications. Telemetry studies e.g. on carp *Cyprinus carpio* in Hardap. National fish surveys.
- 5,6) Aquaculture research, development and monitoring and further freshwater fish surveys. Ministry gives priority to research on species that can be commercially exploited. Only where economic benefits can be shown is research effort warranted e.g. aquaculture.
- 7) Fishery Act 1992, Inland fisheries policy and Act 2003, Aquaculture Policy, Act, regulations and Strategic Plan. Regulations for subsistence fisheries need revision e.g. limits on number of nets or allowable mesh size does not take into account seasonal aspects such as the bulldog run. SADC Fisheries protocol calls for harmonisation of legislation within the region.
- 8) Not good, needs improvement, researchers at Hardap need to collaborate more with rest of the scientific community
- 9) Good especially with scientists such as Prof Paul Skelton, other South Africans and even Norwegian experts but little contact with fellow Namibian experts. Good co-operation with SADC especially with Botswana, Zimbabwe, Zambia, but language barrier and access problems with Angola.
- 10 + 12) Dr Clinton Hay, Dr Ben van Zyl, other fish biologists not AIS experts but deal with them as part of their jobs.
- 11) Some training offered as part of UNAM natural resources courses also on aquaculture development e.g. Dr Orton Msiska takes students to visit aquaculture ponds and students involved in growth experiments. Malawian experts brought in to help set up aquaculture ventures and advise communities
- 13) Some awareness but not enough concern regarding the risk that new aquaculture ventures have in terms of the introduction and spread of alien invasive species into Namibian wetlands. Strongly recommend a precautionary approach to the introduction of species however strict the permit requirements – the potential to escape exists. Already reports that the freshwater crayfish has spread into natural springs on a farm 10km north of Tsumeb and there is concern that the Hardap stock may escape and spread into the Fish and Orange river systems. Also concern regarding genetic pollution and need to avoid brood stock effecting wild stock of fish of the same species – caution needed to avoid financial considerations over-riding ecological concerns.
- 14) Recent inland fishery and aquaculture Policies and Acts reflect concern regarding alien invasive species and need to protect aquatic ecosystems and FAO guidelines on responsible fisheries are followed as is the precautionary approach advocated by the SADC Fisheries protocol.
- 15) Useful especially in terms of aquaculture development, can assist with planning of future projects.

1) Marine Fisheries Research and Environmental sections

- 2) Bronwen Currie, Janine Basson, Aina Iita Dr Lisette Voges bcurrie@mfmr.gov.na Box 912, Swkm.
- 3) Aquaculture and Mariculture development, biodiversity surveys and should any be of economic concern
- 4) SANCOR project on distribution of mussels on southern African coastline (Currie 1996, Harris *et al* 1997?)
- 5 and 6) The Benguela Current Large Marine Ecosystem Programme BCLME, Biodiversity Ecosystem Health and Pollution projects Jan 2004 – December 2007. Particularly the marine biodiversity assessment and mapping component and project 2 : Mapping of BCLME shoreline, shallow water and estuarine habitats, project 4: inshore assessments, identification and quantitative surveys of communities, biotopes and species along BCLME shoreline and shallow intertidal, project 6: baseline surveys of species and biodiversity in estuarine habitats and project 7: Aquaculture assessment which will include the identification and ranking of appropriate and unsuitable species for aquaculture.
- 7) SADC fisheries protocol, Fisheries Act, Aquaculture Policy and Act, needs good regulations to control the importation of live aquatic organisms and enforcement. The regulations have been drafted but need gazetting. FAO Guidelines and EU regulations. Needs better customs controls and training of customs officials. Aquaculture strategic plan being finalised.
- 8) Expertise exists within the Ministry
- 9) Good collaboration with South African and international institutions and scientists e.g. Dean Anderson on algal blooms, Paul Archer from Maine, FAO, U.S. Benefit programme.
- 10) Bronwen Currie is the national expert on marine alien invasive species and head aquaculture section.
- 11) Good in service training
- 12) Good awareness within the industry, not yet that good within the institution, and little national awareness.
- 13) Introduction and spread of alien invasive species are controlled through permit system, the institution is only really concerned about alien invasive species that have an economic impact on the resource base.
- 14) Not a very high priority – see above
- 15) Not particularly useful to the institute as such (BC) but useful to biodiversity group in terms of research.

1) Botanical Society of Namibia

- 2). Luise Hoffmann, Chairperson, Tel: 239415, email luisehof@iway.na
- 3 -5). No particular link with alien invasive species. No past nor current projects on alien invasive species
- 6). Future projects on alien invasive species include the possible involvement in eradication of cactus along Aloe Trail (Hofmeyer Walk).
- 7 – 11 were considered to not be applicable as the organization is still too small.
- 12 and 13). There is awareness within the institution and the society and its members recognize that various cactus species, fountain grass and bush encroachment needs to be attacked.
- 14). The priority placed by the institution on the alien invasive situation in Namibia is low as to date the organisation has been mainly occupied with promoting the botanical garden in Windhoek, an area which is almost free of invasive species.
- 15). The review could be useful in giving the institution guidelines for possible future action viz. aloe trail

1) University of Namibia

- 2). Orton Msiska, Senior Lecturer, Tel: 2063865, email: omsiska@unam.na Private Bag 13301, Windhoek
- 3). Link with alien invasive species through aquaculture projects at Hardap and Walvis Bay and limnology courses for the BSc Natural Resources
- 4). Past projects on alien invasive species include the introduction of red tilapia and the Pacific oyster. A relevant publication is: Influence of *Gracilaria verrucosa* and stocking density on the growth of the Pacific oyster *Crassostrea gigas*, by G Hipandulwa, S. Nauta P. Karongae and O.V. Msiska (submitted to NAGA: World Fish Center).
- 5, 6). Current and future projects are crayfish feeding in aquaria and commercial production of Pacific oyster.
- 8). Collaboration with scientists, managers other institutions within Namibia appears to be difficult as no-one has taken the initiative to form a lead agency, better coordination would improve effectiveness
- 9 10). No examples of effective collaboration with scientists from institutions outside Namibia and no national experts
- 11). Training opportunities within Namibia include the Conservation Biology, Aquaculture and Aquatic Ecology courses offered at the University of Namibia
- 12, 13, 14). Not sure about awareness about alien invasive species nor, individual perceptions and priority placed on invasive species by the University.

1) School of Natural Resources and Tourism – Polytechnic of Namibia

2) Carol Steenkamp and Dave Joubert

3) The School of Natural Resources and Tourism of the Polytechnic of Namibia currently have 3 members on the Alien Invasive Species Working Group (Carol Steenkamp, Peter Cunningham and David Joubert). Other than that, training in AIS is done in many of the subjects, and research is being, and has been, conducted (Joubert & Cunningham, 2003; Joubert & Cunningham, 2004; Cunningham *et al*, 2004). PON also strongly encourages community service by staff, which allows lecturers to be involved in industry and NGOs. For example, it allows lecturers to be part of the Alien Invasive Working Group, and, theoretically at least, acknowledges this as part of the workload of the staff member. This facilitates the ability of the staff member to be active, although, in reality, there are a number of time constraints which makes it difficult for staff members to achieve an optimal contribution.

4,5) Recent projects have been conducted by Land Management in service training students (Gabanakgang, 2003) whereby alien invasives were mapped in a river bed in Windhoek. The Nature Conservation Diploma students regularly choose to do projects on alien invasive plants (for example Shapaka, 2003; Visser, 1998) and one B Tech thesis was on *Cereus jamacaru* invasion in Waterberg Plateau Park (Berry, 2000).

6) It is envisaged that projects on AIS will be continue to be conducted. The Nature Conservation Department within the School intends to promote AIS studies for in service training projects. A B Tech student will be investigating the effects of competition on, and the effectiveness of different control methods on, *P. setaceum*. Carol Steenkamp intends to investigate the effects of *Prosopis* spp. on flooding and *A. erioloba* survival in the Nossob River. It is also envisaged that an investigation into, and a clearing operation of, *Opuntia* spp. populations in the Windhoek vicinity is to be conducted by Nature Conservation and Land Management students in the near future.

8) The School collaborates with MET, NBRI and NGOs such as DRFN, Botanical Society of Namibia, Wildlife Society of Namibia. The effectiveness of collaboration with government institutions is limited by a perceived lack of co-operation and communication.

9) There is little collaboration with institutions outside Namibia. Dave Joubert is expecting to collaborate with Staff from Miami University, Florida, USA, Institute of Forestry and Environmental Sciences in Bangladesh and Panjab University, Chandigarh, India on AIS soon.

11) Training in Land Management (Rural Land Use Diploma) and Nature Conservation (Diploma and B Tech) does include training in AIS, but this could be increased. It is planned to increase the emphasis on AIS in the Conservation Management subject within the B Tech.

12) The institution could become much more involved in awareness creation by getting students to organise Arbor Day events, and to give extension talks to school children. Awareness within the school is reasonably high, owing to the nature of the school's training and research focus (*viz.* natural resource management), but even within the School, there is little emphasis placed on AIS currently.

14) Since staff and students are expected to do research, and the emphasis is on natural resource management, the potential for AIS research is great. One of the biggest constraints is work overload, and lecturers interested in research have to do so in their spare time.

1) Agriculture Department – Polytechnic of Namibia

2) Ibo Zimmerman, Deputy Director, Tel: 2072461, P/Bag 13388, email: ibozim@polytechnic.edu.na

3) Alien invasive species are linked through inclusion in the syllabi for Rangeland Science, Rangeland management and Agro-ecology

4-6. No past nor current projects but on student may do a community interaction at Excelsior resettlement farm on the control of fountain grass and or queen of the night cacti and a proposal should be submitted Aug.

7).The Polytechnic functions in terms of the Polytechnic of Namibia Act but not relevant to invasive aliens.

8,9). No collaboration inside not outside Namibia pertinent to invasive alien species research or control

10). Experts at the Polytechnic are Dave Joubert and Carol Steenkamp.

11) Training opportunities are available at the Polytechnic of Namibia, UNAM, and Agrifutura in Namibia and there are many opportunities in several countries.

12)Awareness is low except amongst natural resource students at the Polytechnic, a few farmers and scientists

13). Many people perceive invasive alien species as useful.

14). The priority on invasive alien species at the Polytechnic is very low as evidenced by the profusion of fountain grass on campus.

15). The review would be useful and could provide material relevant to the courses offered at the Polytechnic (See 3).

National Farmers Unions

1) NNFU- Namibia National Farmers Union

2) Oloff Munjanu and Eddie Mutuahima both programme co-ordinators.

3) NNFU does not currently have any programmes or links with alien invasive species, and alien invasives are not currently a priority issue within the union.

12) NNFU is eager to introduce awareness campaigns in the future. They also welcome the idea of raising awareness within the institution through “Training of Trainers” programmes. The interviewees state that communal farmers are not currently aware of alien invasives as a threat to their livelihoods or the environment. As an example, farmers often plant *Dodonaea* hedges, despite the invasiveness of *Dodonaea angustifolia*. palatable species such as *Prosopis* spp. have not been shown to be a problem, and farmers have thus not yet complained. Communal farmers are not aware or concerned about the risk of alien invasives to the environment. NNFU suggests an awareness campaign through a variety of media, including posters, radio, TV, extension work and face to face discussions. They also suggest that these awareness campaigns include information about the types of species which are alien invasives, and their threats both to farming livelihoods and the environment in general.

1) NAU – Namibian Agricultural Union

2) Mr. Harald Markgraaf, Manager of Commodities Tel: 237838

3) There is currently no direct link between the institution and alien invasives.

4,5,6) No projects have been undertaken in the past under the leadership of NAU. Mr. Sakkie Coetzee (CEO of NAU) is undertaking a project to eradicate *Prosopis* spp. on his farm in the Leonardville District, as part of his action plan to combat bush encroachment.

7) Although there is no particular legislative framework with regard to alien invasives within the NAU, the NAU would definitely support and promote any legislation regarding AIS.

12) Institutionally, there is little awareness or priority placed on alien AIS except that *Prosopis* spp. is seen as a serious bush encroachment problem. Also individual farmers are involved in programmes to clear invasives such as *Datura* spp. from their farms. Mr. Markgraaf recommends that public awareness needs to be raised, through the use of pamphlets, posters, articles in agricultural magazines such as *Agriforum*, radio and at Farmer’s Days. Mr. Markgraaf believes that an investigation into the situation regarding alien invasives in Namibia is important for the union and its members, as this can improve management.

1) DRFN- Desert Research Foundation of Namibia and GTRC

2) Dr. Joh Henschel, the Director of Gobabeb Training and Research Centre [GTRC]

3) DRFN and GTRC have been involved in long-term records and several special studies of AIS in the Kuiseb River and the surrounding regions.

5,6) DRFN is involved in extensive studies on the Kuiseb River Basin. One of the future projects will be comparing *Prosopis* spp. and *Faidherbia albida* with regard to their eco-physiology and ecology. Currently, the University of London is monitoring *Prosopis* spp. in the Swakop River, including aspects such as seed output and overall health. The two institutions are currently involved mostly in research, rather than with control projects.

8) DRFN GTRC collaborate with a wide variety of institutions within Namibia, e.g. MET, PON and UNAM.

9) They also collaborate with a wide variety of institutions and scientists outside, including the University of London, University of Cape Town (*Prosopis* study), and WADE (an EU project together with organisations in SA, Israel Germany and Spain). WADE is not working per se with aliens other than that they are water users

10) Joh Henschel, Bertus Kruger, Olavi Makuti, and Mary Seely are experts in alien invasive species related issues within the institution.

11) GTRC and the Geography Department of UNAM will be offering a six week course for final year students on AIS in early June ; DRFN and GTRC offer internships for tertiary students (projects done by students are natural resource management related (including AIS). The institutions are always able to provide courses on demand (including on AIS).

12) Within the institution AIS awareness is high. Currently AIS research within the institutions ranks below other priorities, although high water users such *Prosopis* sp. are emphasised. On a national level, the institutions do regard AIS as serious as in SA for example, but believe that they can be very significant on a local level. Dr. Henschel regards AIS awareness in Namibia as very low and suggests more frequent newspaper articles and radio talks, awareness by brochures, and emphasises the need to spread awareness in school. He suggests a series of newspaper articles on AIS in focusing on a different species each week.

1) NNF -Namibia Nature Foundation

2) Chris Brown, Director NNF, Tel: 284354, Box 245, Windhoek, email: cb@nnf.org.na

3) NNF channels funds to the Invasive Aliens Working Group, assists with technical information on invasive alien species in terms of projects and outputs funded through the NNF, has given grants to forestry activities and encourages taking invasive alien species into account in other projects and environmental impact assessments.

4, 5) Past and current projects include those of forestry and the invasive aliens working group including several relating to small grants applications by schools, DAPP, the Northern Namibia Environmental project committee, clearing of alien vegetation at Waterberg Plateau Park and an anti-erosion project at Okakarara

6). Future projects include one with the City of Windhoek to clear cactus species in the centre of Windhoek.

7). Current legislation is considered to be inadequate in that controlling alien invasive species remains ineffective, the country has notoriously porous borders. The trade in garden ornamentals is not adequately controlled, whilst forestry still appears to actively promote the distribution of alien species. Phytosanitary regulations need to be more strictly enforced. Control in terms alien and invasive birds and reptiles is good.

8). Collaboration with scientists and specialists within Namibia is good, with quick responses to pertinent issues and a willingness to take up issues, particularly with agriculture, veterinary, fisheries and environment.

9). Collaboration with institutions both in Cape Town, Botswana and with Kew in London is good.

10). The expert at NNF is Chris Brown and elsewhere in Namibia are the NBRI staff, Herta Kolberg and Pat Craven as well as MET staff such as Mike Griffin, Shirley Bethune on aquatic weeds, George Rhodes at veterinary services, staff at Agriculture, Forestry and at the City of Windhoek particularly in terms of indigenous gardening

11). It is possible to link to relevant training courses outside Namibia, some institutions such as MAWRD offer in-service training and organizations such as NNF can contribute towards bursaries in this field if so requested.

12). Within NNF awareness of invasive species is reasonably high, yet overall nationally this tends to be generally low and variable. One way to address this would be through articles in the City of Windhoek newsletter "Aloe" and specific documentaries on National T.V. Specific problem species that should be eradicated should be identified and the onus places on landowners to remove these. Further at national level a concerted effort needs to be made to clear area catchment by catchment to problem species starting with those that have the highest priority in terms of causing potential harm within the system where they occur.

13). His individual perception is that invasive species are less of an issue in arid areas than in areas of high rainfall and that most invasions are caused by man-made disturbances and thus tend to be mainly in systems such as ephemeral rivers and aquatic or wetland areas. For most of the country invasive alien species are not a problem, but as wetlands are one of our most vulnerable and scarce ecosystem types and the most prone to invasive alien problems care must be taken to protect them.

14). NNF does not place any particular priority on the invasive alien situation in Namibia as it is not a major environmental issue in arid and semi-arid areas.

15). The results of the review will be valuable to NNF and a copy of the report would be appreciated.

1) Greenspace.

2) Melle Orford, Acting chairperson

3). The link with alien invasive species is the protection of urban Greenspaces which have aliens

4, 5, 6). Past, current and future projects are some removal or hacks of alien species in urban areas.

7). The legislative framework within which Greenspace operates are the City of Windhoek municipal laws and is this adequate – how can it be improved

8). Collaborate with NBRI and 3rd Windhoek Scouts but not sure how to rate the effectiveness.

13). In terms of perceptions and the stance of Greenspace on alien invasive species in Namibia, some of the members are unsure but currently Greenspace is run by people who are aware of the alien issue.

15). A review is not seen as useful as Greenspace already knows what the problem alien species are.

1) **IRDNC-Integrated Rural Development and Nature Conservation**

2) Ms. Karen Nott

3) Currently, IRDNC has no explicit programmes related to alien invasives, and does not envisage any in the next five year vision. IRDNC in general does not place high priority on biodiversity per se, focussing more on game species, and, more recently, on grazing resources. However, IRDNC does distribute alien invasives posters and gives briefings on the subject at the same time.

12) Within the institution, AIS awareness is high amongst the technical staff but low amongst the community staff. Karen perceives that the awareness of alien invasives in the general public of Namibia is very low. She strongly recommends awareness campaigns of the sort happening in South Africa. The most important targets would be government authorities local, regional and national).

1) **Southern African Institute of Environmental Assessment - SAIEA**

2) Dr. Peter Tarr, Director of SAIEA.

3) SAIEA has no direct link with AIS, however through their work of guiding EIAs, they highlight the risk of introducing or perpetuating alien species in development projects. For example AIS featured in the Terms of Reference of a variety of EIAs (e.g. the Popa Falls PEA. SAIEA regularly brings attention to AIS when reviewing EIAs both in Namibia and in the SADC region.

10) SAIEA has a database of 170 EIA experts within the region, but obviously only a few of these are AIS experts.

12) The degree of AIS awareness in the institution is high. Peter strongly recommends a resource economics approach to making decision makers aware of the problem (by looking at the opportunity costs of AIS introductions or projects dealing with AIS), since decision makers tend to focus on socioeconomics. He cites an example of MAWRD wanting to plant *Opuntia ficus-indica* along the Orange River. He is currently trying to persuade them not to, using a resource economics approach. Peter also feels that an investigation into AIS needs to focus on biodiversity and economic impacts, more so than just listings of distributions of different species.

14) AIS currently enjoy a high priority within SAIEA.

1) **Earthlife Namibia**

2). Bertchen Kohrs, Chairperson, Tel; 227913, P O Box 24892, Windhoek. Email: earthl@iway.na

3). Earthlife has not yet worked on invasive alien species, but does promote the planting of indigenous species. Their annual tree planting project allows only indigenous trees to be planted.

4-6). No projects specifically on alien invasive species

7). Earthlife' Guiding Document says: *Respect for and protection of current indigenous forests must be built into the plans of all forestry companies. Earthlife will campaign for the forestry industry to move away from planting invasive species to planting indigenous forests, and will support indigenous tree planting projects,....*

8, 9). No comment on collaboration with scientists, managers other institutions either within or outside Namibia with regard to invasive alien species

10). No national experts with Earthlife, and elsewhere, staff of the Polytechnic and UNAM.

11). In terms of Training opportunities within and outside Namibia they recommend that topics dealing with invasive alien species should be part of the syllabus at schools and other training institutions.

12). There is awareness in Earthlife, but in general awareness is considered very little. This could be improved by public talks, posters, as has already been started. People must understand the impact of invasive alien species and it is considered important to train the decision makers.

13). In terms of individual perceptions and the stance of the institutions on alien invasive species in Namibia their comment is that although it is an extremely difficult task, invasive alien species should be removed in Namibia in order to avoid competition with indigenous species.

14.) With regard to the priority placed by the Earthlife on the alien invasive situation in Namibia, this is not high on their list because of other burning issues. They believe that the problems related to invasive alien species within Namibia are in good hands with Polytechnic, UNAM and Wildlife Society.

15). An investigation into the situation regarding alien invasive species in Namibia would certainly be useful..

1) **Wilde Eend Nursery**

2) Eugene Le Roux, Horticulturalist/Nursery Manager email: wileend@iafrica.com.na

3) Don't sell alien invasives.

6) Plan to incorporate alien invasive awareness into their newsletter: Grassies

Mr Le Roux was able to confirm that an Import Permit required, this needs to be renewed every 3 – 4 months. A phyto-sanitary certificate is also needed. There is no list of prohibited AIS. But SA is very strict and nurseries are all inspected every now and then.

7) Sees the legal framework as adequate because of stringent rules in South Africa where the plants are imported from. The City of Windhoek (Dries Swanepoel) produced a “blacklist” of undesirable alien invasives a few years back.

8) Have collaborated on questionnaires in past (Fountain Grass study). Give radio talks of which some might be on invasives.

10) Can regard Eugene Le Roux and the owner- Johan Wentzel – as experts on AIS from horticultural perspective. They add the Polytechnic researchers and NBRI as experts.

12) Suggests that more approach to nurseries. They have high awareness, whilst the public has low awareness. Suggests awareness on radio and TV, pamphlets and maybe create an AIS day

14) Nursery places a high priority on AIS situation. An investigation would be very useful as they need to know so that they do the right things.

Additional information:

They can still get cherry guava although it is a declared invasive in SA, because nurseries are getting rid of old stock. Interesting alternative: *Lantana montividentis* is a sterile alternative for *Lantana camara*

1) **Ferreira's Nursery**

2) Hugo Truter, Horticulturalist Email: fer@mweb.com.na Tel: 234900PO Box 3162.

3) “No invasive species sold in nursery”

7) He is not aware of any national legislation on alien invasive species

10) Expert: Hugo Truter – In House Horticulturalist

11) Use S A Gardening magazine articles to train staff for public awareness within the company
Said that after report on Fountain Grass, they do not use it

12) SA Gardening Magazine has excellent information on alien invasive species, able to keep abreast of events through gardening magazines yet believes the Namibian public is very poorly informed Suggests a regular feature in Aloe

14) Places a very high priority on AIS situation in Namibia, especially in light of water situation

15) Regards an investigation as very useful as prevention is better than cure (stressed the SADC part)

1) **Third Windhoek Scout Group**

2) Court of Honour, Troop Leader, David Roberts, Adult leader, Karina Becker and Patrol Leaders, Martin Mendelsohn, Tarry Butcher, Tessa Harris, Etienne Hofmeyer, Daniel Komen.
P. O. Box 9468, Windhoek, Tel: Quintin Butcher – 081 127 3875

3) Scout hall, Travis is next door to Avis Dam in an area on the outskirts of the city that is infested by alien invasive plants particularly cactuses, *Datura* and *Nicotiana* and they are keen to assist with the conservation of the Avis area.

4) Two of the senior scouts, Tessa Harris and Jenni Roberts, did a year-long young Scientist project testing practical control options for *Prosopis* and this year are doing a project on Avis Dam and the Feb floods.

Previous attempts by parents and leaders to clear particularly alien cactus species from the area around Travis. 5 and 6). The troop leader attended the AGM of Friends of Avis and volunteered the services of the scouts to help clear alien invasive plants around Avis Dam – Saturday 9 October has been set aside as an alien bashing day for the scouts and they have appealed other interested organizations to assist then on that day at the dam.

7) The scouts of Namibia operate under the World Body of Scouting and are subject to its code and ethics as well as the laws of Namibia.

8) The 3rd Windhoek Scouts collaborate other scout groups in Windhoek and elsewhere in Namibia as well as with environmental organizations such as NARREC, Friends of Avis and participate in wildlife game counts with MET at Waterberg Plateau Park and lease their property from the municipality of Windhoek.

9) As part of a world body they collaborate with scout groups all over the world and participate in the Cedarberg camp held in South Africa every two years. The conservation badge is approved by WWF.

- 10) Experts in alien invasive species within the group are Tessa, Jenni, and David as well as the adult leader Merryl Butcher and committee members Shirley Bethune and Liz Komen.
- 11) No training offered but some hands on experience will be gained by participation in the alien bashing day
- 12) The scouts are aware of the problems from “personal contact with the thorny cactuses” but feel that awareness at school should be improved. The alien bashing day is expected to heighten local awareness.
- 13) The scouts are prepared to put into practice this awareness and their stance is to do something practical about eradicating the weeds around Travis and Avis Dam. To lead by example.
- 14) Low by scouts in general but is considered important enough to dedicate a voluntary day to clearing.
- 15) The review will be useful if it includes practical suggestions.

1) City of Windhoek

- 2). Anthony Watkins, Control Horticulturist: Open Spaces / Recreation, Tel 236225, email; ajw@windhoekcc.org.na
- 3). The Weed Control Team as well as the Bush Control Teams of this section deal in part with the eradication of invader trees in natural areas, river courses and undeveloped municipal land.
- 4). Past projects on alien invasive species include ongoing chemical control of *Prosopis* trees as the Town Planning Scheme outlaws the cultivation of *Prosopis* trees. This service provided free of charge to residents. The Bush Control teams attempt to maintain the indigenous integrity of natural areas and river courses by eliminating exotic species. *Agave* sp, *Opuntia* spp, *Schinus molle*, *Melia azederach*, *Tecoma stans*, *Leucecea leucocephala*, *Prosopis* spp are the most common exotics dealt with. These services have been in provided for many years and will continue to be provided.
- 5,6). Current and future projects on alien invasive species are the ongoing provision of Weed Control and Bush Control services to the residents of Windhoek. Further as this division wishes to fill the vacuum left after the eradication of such plants by printing and distributing pamphlets promoting the use of suitable indigenous types. We are also doing trials on the suitability of indigenous trees and shrubs in a cultivated environment in Windhoek. (frost hardiness, growth speeds, effects from regular thorough watering, effects of fertilizers.) One project under consideration is to remove invasive cacti along the Hofmeyer/Aloe trail in the centre of Windhoek, to upgrade the paths, improve signs and develop a pamphlet for walkers and there is concern that the promised assistance of the Botanical Society with this may not be forthcoming as their priority remains the adjacent botanical gardens.
- 7). In terms of legislation and regulations the Town Planning Scheme forbids the cultivation of *Prosopis* only. Other exotics/aliens are eradicated through this division’s environmental conscience awareness and own efforts. A list of other exotics commonly found invading river courses has been presented to the City’s legal division to add to future schemes. This includes their use as sidewalk trees.
- 8). With regard to collaboration with scientists, managers other institutions within Namibia there is informal collaboration with members of the NBRI, the Botanical Society, Directorate of Forestry and Polytechnic. Information obtained provides motivation and scientific basis for continued work in the field of indigenous plant promotion and invader eradication. The Directorate of Forestry provides tree saplings, which are used in municipal gardens, playgrounds etc. to test their ornamental / horticultural suitability for the Windhoek area. We conduct trials on various species from the frost-free areas of the north. Seed, cuttings or plants are not always easily available.
- 9). There is no collaboration with scientists, manager other institutions outside Namibia
- 12). The degree of public Awareness on AIS within the various fields within the organisation as within Namibia in general remains low.
- 13). With regard to individual perceptions and the stance of the institutions on alien invasive species in Namibia, many are not even aware that the *Prosopis* is an exotic, they believe it is a “natural thorn tree like all the others”! Many perceive our own trees to be slow growing, and wishing for quick shade will opt to leave existing *Prosopis*. Sponsors pump millions into sport activities, whilst invasive alien species receive little “air-time” due to bad funding.
- 14). Priority placed by the institution on the alien invasive situation in Namibia? Invasive alien species are a priority only to the division dealing with Open Spaces and invader eradication and is not prioritized by the organization as a whole in fact not even the colleagues from Environment Division consult or collaborate with the division.
- 15). Any scientific facts regarding invasive alien species in Namibia will assist in motivating projects and funding. At present most funds go towards physical utilities and service provision.

1) Wildlife Society of Namibia

- 2). Dave Joubert, Vice chairperson, Address P/Bag 13388, Windhoek. Email: djoubert@polytechnic.edu.na
- 3). Link with alien invasive species, WLSN supports projects and encourages programmes linked to conservation in general.
- 4, 5). No past projects although articles about invasive and alien species have been featured in the WLS publication, *Roan News*, and this year's presentation at the AGM of the society was on Fountain Grass..
- 6). Future projects on alien invasive species include collaboration with scouts, Greenspace, and the Municipality of Windhoek to organise programmes to combat alien invasive species around Windhoek and elsewhere and there is the intention to devote more space to IAS issues in Namibia in the *Roan News*.
- 8, 9). There is not much collaboration with scientists, managers other institutions within Namibia or outside currently other than on an informal one to one basis (not really as an organisation)
- 10). National experts within the institution are Dave Joubert and Peter Cunningham on the committee and several of the members e.g. Shirley Bethune on aquatic species.
- 12). The degree of public Awareness on AIS within the institution is high, yet general public awareness is low.
- 13). In terms of individual perceptions and the stance of the institutions on alien invasive species in Namibia, the WLSN places a high priority on all conservation issues, and is open to any programmes aimed at improving conservation.
- 14). Thus priority placed by the WLSN is probably high, but up till now, funding for projects has been mainly directed towards "wildlife" programmes. This is mainly because we have not been approached for funding for combating invasive alien species.
- 15). A review such as this is seen as useful, since if it was widely and effectively publicised it would increase awareness.

1) Namibia Professional Hunting Association NAPHA

- 2). J. Lamprecht, jr. Chairman of Scientific Committee
- 3). NAPHA members may have, hunt or deal with invasive alien species and they have an informed opinion on the subject
- 4). The organization recently considered invasive alien species issues, as they apply to NAPHA, and came to a consensus on the NAPHA policy in this regard (2004). A founding document was produced by the Game Translocation Committee, an official sub-committee of the NAPHA. Essentially they acknowledge that Namibia has an Authentic Namibian Hunting Product and undertake to focus on maintaining and marketing this product. They are committed to maintaining the integrity of the Namibian ecosystem and agree to prohibit the import of alien or exotic species. Sub-species of animals occurring in Namibia are dealt with strictly genetically and no other variations will be allowed into the country.
- 5.6). Currently the organization liaises and coordinates closely with MET regarding the implementation of the programme set out in the document setting out the policy in terms of game translocation and this will continue
- 7). Members are bound by a Code of Conduct, which is adequate and promotes ethical hunting
- 8). There is good collaboration with MET, NNF, WWF. Relations are good, but there is always room for improvement.
- 9). Outside Namibia there is collaboration with Conservation Force (pro hunting and conservation). REPHAM, is the annual meeting of the regional (south of Zambezi) professional hunters association, and NAPHA takes part and reports (this organization has agreed to not import animals from north of the Kunene-Okavango- Zambezi.
- 10). Experts within the association are Helge Denke, Rhinhard Rusch and Joof Lamprecht jr.
- 11). Training is geared at promoting awareness in members as well as associated staff and trainees.
- 12). Awareness is high, after discussions (earlier this year) and following the circulation of the document
- 13). Individual perceptions are strong
- 14). The association places a high priority on invasive alien species
- 15). A review such as this is seen as very useful to the association.

ANNEXURE 7

ANNEXURE 7A

Questionnaire for experts – Alien Invasive Species and Agricultural Biodiversity Working group members

1. Name and contact of expert interviewed :
Name: Organisation Position in organisation:
Tel: email: Address:
2. Area of expertise in terms of invasive alien species
3. Opinion on the effectiveness of the working group and collaboration within it
4. Constraints and reasons for success or lack of it
5. Past projects on invasive alien species
Relevant Publications/ documents/ reports
6. Current projects on invasive alien species
Relevant publications / documents / reports
7. Future projects on invasive alien species
Relevant project proposals/ plans/
8. Opinion on legislative framework regarding invasive alien species in Namibia and is this adequate – how can it be improved?
9. Collaboration with scientists, managers, and other institutions within Namibia and through the working groups
10. Effectiveness of such collaboration with examples
11. Collaboration with scientists, managers, and other institutions outside Namibia
12. Effectiveness of such collaboration with examples
13. Training opportunities within and outside Namibia. Mentoring?
14. Effectiveness of current public awareness campaigns
15. Accessibility of information on invasive alien species within and outside Namibia.
16. Practical measures of controlling invasive alien species, participation and organisation with examples

ANNEXURE 7B

RESPONSES TO QUESTIONNAIRE FOR EXPERTS – Alien invasive species working group members

1) **Chris Brown (Namibia Nature Foundation)**

2) Involved in the preparation, organization and publication of the proceedings of the national workshop on invasive alien species held in Namibia in 1984/5 and co-author of a 1986 publication on invasive alien species in arid zones and remained interested in the issue ever since.

3, 4). Considers the effectiveness of the agricultural biodiversity working group in this regard as very little, whilst that of the Alien invasive species working group has started to get things going. It has been moderately successful and the main success has been in establishing a forum for cross- sector communication and collaboration e.g. as on the poster and some email discussions.

5). Past projects include the review of invasive alien species by Hansie Venter for the Agricultural Biodiversity WG , the Nasty nine poster, Pierre Smits' Ph.D research on *Prosopis* and three annual one day workshops by the AIS WG.

9). Collaboration within the AIS WG was good as core people within different ministries were represented, not known if this extended from these individuals to others within the range of institutions represented though.

10, 11, 12). No specific examples of such collaboration or its effectiveness

13). Some training opportunities exist through the Swedes, Dutch and E U.

14). No specific feedback available on the impact of the “Nasty Nine” poster

15). The information is accessible, particularly that of 1984 – 86, and much more can be gleaned from the ‘grey literature’ of institutions such as DWA and MET, but little recent work and there is a need to update the 84/86 data.

16). Neither of the working groups have implemented any practical measures to control invasive alien species and more needs to be done in terms of awareness, proper mapping of the distribution of these plants and animals, a clear national policy is needed as currently different ministries have conflicting views e.g. forestry and NBRI and trade of these species needs to be assessed and where necessary strictly controlled. Legislation should be strengthened and enforceable regulations developed.

1) **Antje Burke (EnviroScience, Windhoek).**

2). Plants

3) moderate

4). Voluntary membership.

5). None, but covers IAS plants in consultancies. Reports for BDTF, as member of the Invasive aliens working Group

6). Covers plants in environmental consultancy work.

Gave a training workshop (plus produced brochure) on alien plants in the road verge – Rosh Pinah.

7). Covers IAS plants in EMPR and EIA's, which is continuous .

8). Adequate, but problems with implementation.

9). Continuously in regards to environmental consulting.

10). Good collaboration

11). None

12). None

13). Not available, but lots of potential

14). “Nasty-Nine” poster had good impact

15). Moderate

16). Makes recommendations in environmental assessment reports.

1) Barbara Curtis, Research Associate, NBRI, member AISWG, co-ordinator National Tree Atlas project

- 2) Alien and invasive trees, freshwater mollusks
- 3) Not the most effective of the working groups
- 4) Although Pierre and Carol are enthusiastic most members lack time and it would help to have a dedicated person tasked to deal with alien invasive species issues in Namibia
- 5) The biological control of *Salvinia molesta* in the Eastern Caprivi by the Dept of Water Affairs, The Nature Conservation professional officers meeting in 1984, the national surveys prior to it and publications following. Her own national snail survey whilst at the State Museum in the 1980s included alien invasive snails.
- 6) Pierre's ongoing *Prosopis* research for his Ph.D and the work of his students, work by the Windhoek municipality in urban areas e.g. removal of *Prosopis*, pamphlet on plants that may be planted on sidewalks, the Tree atlas project, ongoing aquatic weed work by DWA and awareness through wetland working group
- 7) None
- 8) Strict trade regulations and phytosanitary regulations for plants. There is a need to classify invasive plants and degrees of invasiveness. Definitely not adequate generally, in fact forestry actively promotes the planting and propagation (even sale through their nurseries) of alien invasive trees e.g. *Casuarina* and *Prosopis* and various development aid project such as DAPP do the same in their tree-planting schemes in northern Namibia. The plant nurseries including those run by forestry need guidelines on which plants are invasive.
- 9) Not much collaboration within the group, many important sectors such as development agencies, forestry, aquaculture developers and nurseries are not involved. Some email communication and 2-3 workshops in last 5 years.
- 10) No examples of effective collaboration
- 11) Good co-operation in terms of border control particularly with Botswana.
- 12) No examples
- 13) None, but guess that Pierre mentors his students
- 14) Difficult to assess impact of current awareness, the "nasty nine" poster had some effect, but needs to be taken further, few examples seen prominently displayed. Forestry needs educating.
- 15) Information is available at the herbarium on request, little assistance available from forestry though. Some collaboration with PPRI in South Africa.

1) Dr Stef de Wet, Deputy Director, Water Environment Department of Water Affairs Responsible for *Salvinia* control project in the Eastern Caprivi

- 2) *Salvinia* control project, reed control in irrigation canals downstream of Hardap Dam, *Prosopis* in southern rivers, Cathodic protection Kuiseb in the 1980s.
- 3) Very little contact with the group although has consulted Pierre Smit regarding *Prosopis* in Oanob River and talked about something similar to the South African "working for water" programme for our riverbeds
- 4) Other than the "nasty nine" poster, the group has been very quiet
- 5) Successful biological control of *Salvinia molesta* in the eastern Caprivi and good collaboration with Botswana DWA, *Prosopis* work of Pierre, Pete Ashton's work for Rossing on the riparian vegetation of the Khan River – shows that vegetation reduces downstream water flow in an ephemeral river, *Nicotiana* at Omdel, Reeds in Fish River at Hardap. Numerous publications on *Salvinia* project (see bibliography). Publication of water weeds chapter in SADC recent water resources management report (Hirji *et al* 2002)
- 6) Ongoing *Salvinia* project and collaboration with Botswana, SADC regional project on aquatic alien invasive plants – proposed by Namibia, taken on as water sector project and co-ordinated by S Bethune but discontinued when World Bank funding ceased (June 2003)– on hold pending renewed funding.
- 7) Something similar to 'working for water' to clear invasive aliens in ephemeral river courses, clearing of *Eucalyptus* and syringe from road verges/reserves, *Pistia* study and control in eastern Caprivi, national wetland surveys to include inventory of aquatic and riparian invasive species, advice on aquatic invertebrates and plants to aquaculture developers.
- 8) SADC protocol mentions that all countries shall prevent the introduction of alien species into any shared watercourse that may be harmful, yet national legislations seems inadequate and no mention is made of alien invasive species or protection of surface water sources or wetlands in the new water resources management bill, although provision is made for other detrimental impacts such as those caused by pollution.

9, 10) There approach remains sectoral. Formerly DWA was recognized as the lead agency in biological control of aquatic weeds now however DWA is not recognized as its own entity and the concerns of the Ministry are largely those of Agriculture and not water or aquatic ecosystems. In future there may be collaboration on issues that directly affect water supply at the local basin management level for each catchment.

11,12) Better collaboration with scientists outside Namibia, aquatic weeds subcommittee (formerly SARCCUS) between SADC countries, good collaboration with Botswana, good collaboration with CSIRO – Australia.

13) None, some in service training and mentoring e.g. Shirley trained VSO volunteers Eliot Taylor and Nicholas Clarke, whilst Charli Schlettwein trained field staff Vincent Simana and Alfred Makumbi.

14) Assisted with distribution of “Nasty nine” poster to lodges in Caprivi otherwise non-existent

15) Lesley Henderson at PPRI and until she retired Carina Cilliers provided information, though most information seems to be water hyacinth particularly the lake Victoria programme..

1) NP du Plessis, Senior Environmentalist, NamWater, member of Alien Invasive Species WG

2) Terrestrial, riparian and aquatic plants

3) Direct contact between individual members is good, always able to ask advise and willing to assist each other but meet very infrequently as a group, no practical control of alien invasive species achieved, although this may not be the task of the working group, it lacks the ability to implement control, no-one takes this responsibility and so without a strong lead organization little tangible has been achieved in last 5 years.

4) Although the interest is there, there is no responsibility to implement control measures and little funding.

5) “Nasty nine” poster

6, 7) None by AISWG

8) Little now, but should regulations be developed care must be taken that they are implementable, and that they are relevant to local conditions and problems and well researched first, no point in simply adopting someone else’s list of plants to ban. Environmental legislation in this regard can certainly be improved.

9) Good (see 3)

10) Pierre’s *Prosopis* control and questionnaires to farmers

11, 12) Good co-operation from RandWater on algal bloom problems

13) Sharing of experience though not mentoring as such

14) Quiet at present

15) Local experts on invasiveness e.g. bush encroachment – Bessie Bester, Nico de Klerk, and aquatic invasive plants – Shirley Bethune, good information on the internet for outside Africa but nothing local.

16) No real practical implementation, some awareness, a degree of discussion regarding recommendations on what to do but no-one to take responsibility for actual implementation of solutions.

1) John Irish, Professional entomologist, private consultant, Coordinator of the Biosystematics WG.

2). Entomology, and databasing, peripheral interest in IAS.

3). Less efficient than could be.

4). All members, plus chair have other jobs, so the group cannot be a priority.

5/6). None

7). Peripheral interest in IA databasing.

8). Inadequate. Consolidation of disparate legislations.

9). Effective liaison with IAS WG members through the BDTF.

10). Some good, and some moderate, and some not so good.

11/12). NA

13). Border personnel, MET staff, Roads Dept planting *Prosopis* etc).

14). Relatively effective, attention was successful

15). Locally difficult, on the www – good access, but not necessarily relevant.

16). Roads, schools and youth groups. Relevant GRN organizations.

1) Aina Iita, Fisheries Biologist, MFMR Swakopund.

- 2). Peripherally involved with marine inverts, and not a regular member of the WG
- 3). There is no regular representative from Sea Fisheries side (Clinton Hay sometimes participates from Inland Fisheries). So no opinion of how well the group operates.
- 4). No specific knowledge.
- 5). *Mytilus* sp. Work done by Bronwen Curry, also published
- 6). None
- 7). None foreseen, although BCMLE is looking at bilge water issues.
- 8). IAS not covered in current MFMR legislation. The Ministry needs to take responsibility and acknowledge problems and obligations. And implement necessary actions.
- 9). Only through the BDTF.
Bronwen Curry previously had close communication with some South African institutes.
- 10/12). Not known, but articles were published
- 13). Certainly awareness training could be focused on many groups.
- 14). Not aware of any posters or info in Swakopmund – so bad at the coast.
- 15). Difficult, and not always relevant. Major issue requiring attention.
- 16). Continue public awareness.

1) Martha Kandawa- Schulz, Namibian Biotechnology Alliance NABA University of Namibia Tel: 061 2063635 email: kschulz@unam.na Faculty of Science; Private Bag 13301 Wdk

- 2) Not an expert in alien invasive species but a chair of one of the more successful NBDTF working groups.
- 3). Her opinion on the effectiveness of the working group and collaboration within it is that from what she has heard very effective.
- 4). Her understanding has been that the group works closely together, but she is unsure, how UNAM students are involved and whether there are lecturers from the Agriculture and Biology department involved. It would be good for practical experiences.
- 5 -7) She is not able to comment on any projects but thinks that the group may be working on the legislation or policy.
- 8 – 16 unable to give any comment.

1) Herta Kolberg, Principal Agricultural Researcher, botanist responsible for alien invasive species, active member of the AISWG and occasional member of the Agricultural Biodiversity WG.

- 2) Botanist responsible for alien invasive species at NBRI
- 3) AISWG good collaboration on one to one basis effective but emphasis is largely on plant species
ABWG less collaboration and not very effective little in terms of plants or her area of expertise
- 4) AISWG more successful due to interested and committed members and representation of municipality
ABWG impression that the concept of agricultural biodiversity is poorly understood by many members
- 5) AISWG “Nasty nine” poster (displayed on her office wall), two workshops
ABWG – aware of the report by Venter as there is a copy in the NBRI library
- 6) none
- 7) Possible implementation of some of the proposals made at the DEA workshop in June
- 8) Rather useless review by Alberts but much improved later by Malan
- 9) Good through AISWG
- 10) Collaboration on the production of the “Nasty nine” poster, NBRI supplied information and photos and a workshop discussion held at the Polytechnic in 2002 to discuss new poster to include alien invasive animals too – but the poster has yet to appear and evident that the current version is very different to workshop proposal
- 11/12) Copies of Lesley Henderson’s book were ordered and distributed to working group members for ID
- 13) Nothing
- 14) She has received calls commenting on the “Nasty Nine” poster which interestingly is displayed on the South African side of the border and not at Namibian border posts.
- 15) Good information in the NBRI library and on request for other working group members e.g. Pierre on *Prosopis*
- 16) None

- 1) **Orton Msiska , University of Namibia, Senior Lecturer, Tel: 2063865,**
- 2) Relevant area of expertise Limnology, Aquaculture, Environmental Impact Assessment
- 3) The AI working group needs more visibility of opinions on issues like introduction of alien animals like red tilapia, marine species and crayfish.
- 4) Workshop type discussions are needed with stakeholders.
- 5) Past projects on alien invasive species are the introduction of mirror carp to Malawi and the introduction of Crayfish, red tilapia and Pacific oyster to Namibia. Relevant publications include: Msiska, O.V. and B. A. Costa-Pierce (eds.). 1993. History, status and future of common carp (*Cyprinus carpio*) in Malawi. ICLARM Conf. Proc. 40, 27p. ISBN 971-8709-37-1. Msiska, O. V. 2001. A review of limnology of Malawi, pp121-189. In Wetzel, R.G. and Gopal, B. (Editors) Limnology in Developing Countries. International Association for Limnology (SIL). International Scientific Publishers, New Dehli, and India. ISBN: 81-86047-21-2. Influence of *Gracilaria verrucosa* and stocking density on the growth of the Pacific oyster *Crassostrea gigas*, G Hipandulwa, S. Nauta P. Karongae and O.V. Msiska (submitted to NAGA: World FishCenter).
- 6, 7) Current and future projects on alien invasive species are crayfish feeding in aquaria and commercial production of Pacific oyster.
- 8) The legislative framework regarding AIS in Namibia can be improved by getting concerned parties to discuss pros and cons for any aquatic introductions in scientific fora and involving industry and fish farmers.
- 9) Collaboration with scientists, managers, and other institutions within Namibia and through AIWG, appears to be difficult without initiative from a lead agency. Better coordination could help.
- 10) An example of effectiveness collaboration from Malawi was done through a Genetics Resources and Biotechnology Committee. One of the results was the “Malawi Principle”, widely adopted in environmental fisheries management.
- 11 and 12) no comment on the effectiveness of collaboration with scientists, and other institutions
- 13) Training opportunities within Namibia include Conservation Biology, Aquaculture, Aquatic Ecology are some of courses offered at the University of Namibia.
- 14) Not sure about the effectiveness of current public awareness campaigns
- 15) The accessibility of information on AIS within and outside Namibia is rather limited.
- 16) Examples of practical measures of controlling alien invasives, participation and organisation are the biological and chemical control that have worked on water hyacinth in Zimbabwe, Malawi and East Africa as well as the physical removal of fish in Malawi or confinement to certain less ecologically vulnerable areas.

1) Kevin Roberts, Principal Hydrologist in charge of Ecological Research Section, Department of Water Affairs, member AISWG

- 2) Aquatic ecologist and fisheries biologist, concerned about aquaculture and the impacts of inadvertent introductions on wetlands.
- 3) Not effective as a working group, some recent email discussions in last six months, two workshops in 5 yrs
- 4) A wide topic, lacks management, not considered important at political level, needs more awareness
- 5) *Salvinia molesta* control by DWA, “Nasty nine” poster by AISWG. General attempt by Fisheries not to introduce some species, yet did not heed their own policy in terms of Australian freshwater crayfish, MET occasional blitzes on some feral species. Many publications on *Salvinia* project, own article on aquatic weeds in SADC (Bethune and Roberts 2002). Report by Roger Lowry on crayfish introductions – Unam.
- 6) Ongoing *Salvinia* project and co-operation within SADC on aquatic weed control.
- 7) Those proposed at workshop in May – re-introduction of *Salvinia* as lake Liambezi fills,
- 8) Odd bits of legislation, not adequate and not overall. A national policy on AIS is needed, that looks at each species in detail, lists invasive species, provides criteria for different degrees of invasiveness and appropriate levels of control for each, provides practical implementation and enforcement strategy. Needs backing of all ministries to succeed.
- 9) Minor and limited to working group members.
- 10) There was some discussion on making a list of invasiveness and what to do about it
- 11,12) There is collaboration in terms of aquatic weeds within SADC and there has been good cooperation and even joint weed surveys with Botswana for many years.
- 13) None
- 14) “Nasty Nine” poster exists, saw one at a border post, more should be prominently displayed
- 15) Internet information for outside Namibia.

1) Pierre Smit (UNAM, Geography), Chair of the Alien Invasive Species WG.

- 2). *Prosopis*. Geo-ecological analysis of landscapes prone to plant invasion.
- 3). Not very effective.
- 4). Lack of commitment, individuals, GRN and resources.
- 5). *Prosopis*, various reviews (including one on legislation). PhD.submitted on *Prosopis* research, ‘Nasty-Nine’ poster . Submitted to the Namibia scientific Society, “Review of literature on *Prosopis* relevant to Namibia”, Presented the paper “ Geo-ecological analysis of landscapes invaded by *Prosopis* in Namibia (IALE congress, 2003).
- 6). *Prosopis* continues, *Acacia-Prosopis* woodland study in Rehoboth. Invasives in lower catchment of Kuiseb River.
- 7). Biogeography of alien Invasives in Namibia.
- 8). Bad, lack of political will to upgrade. Too much overlap in legislations and issues fall between the cracks. The primary problem is that Namibia is not a law-abiding society, there is a general lack of ethos. This can only be improved by strong and ethical leadership, to give example, and this is a long-term process.
- 9). Good, although room for improvement. The technical community in Namibia is too small.
- 10). Good. “Nasty-Nine” poster, several successful workshops.
- 11). Good
- 12). *Prosopis* management is an example of good collaborative work.
- 13).Skills in management of IAS –training is available in South Africa. Training in quarantine issues are available in Australia.
- 14). Good, but can be improved.
- 15). Difficult - in many cases, one must rely on a very few informed persons.
- 16). “Alien-Busting Day”, increase public awareness, school curriculum, economical incentives (even if they are not long-lived or sustainable). Encourage land owners to clear land of IAS – perhaps tax incentives. Most important, high government must take the IAS issue seriously – and pass this concern on to the people.

1) Carol Steenkamp Lecturer, Land Use Management Department, School of Natural Resources and Tourism, Polytechnic of Namibia. Deputy Chairperson of the Alien Invasives Working Group.

- 2) Training, Influence of aliens on indigenous vegetation, Public awareness raising
- 3 + 4)Not very effective due to a lack of communication, a lack of face to face meetings, a lack of interest amongst some members, and a complex, difficult to understand funding system. Of importance is also the fact that most members are busy.
- 5) The working group produced the “Nasty nine” poster and commissioned a Legislative review (Alberts, 2002; Malan, 2002). Carol personally has presented a talk to the Botanical Society on AIS in 2002, supervised two Land Management Diploma projects and co-authored “Nasty Nine” poster.
- 6) Currently nothing by the working group nor herself.
- 7) Future projects include clearing of cactus species on Hofmeyr walk, *Prosopis* spp. invasion of Nossob R.
- 8) Her opinion on legislative framework regarding AIS is that it is not clear (confusing), there is a lack of policies and she suggests a major review of policies and legislation by means of a workshop with all stakeholders
- 9) There is collaboration with scientists at Met, NBRI and DRFN through the AIWG
- 10) This collaboration is not very effective, since there is a lack of awareness which results in a lack of interest
- 11) In terms of collaboration outside Namibia the AIWG have liaised with Lesley Henderson of NBI, South Africa, regarding the campaign
- 12) On a personal level this has been effective but she suspects that on an institutional level, institutions prefer to work with sister institutions
- 13) The Polytechnic of Namibia and UNAM provide training opportunities and mentoring of Diploma and B Tech student projects
- 14) Current awareness campaigns are not very effective yet (referring to the poster production). There has to be a campaign run concurrently with the poster, where groups (e.g. schoolchildren) are made aware of AIS.
- 15) Information on AIS within and outside Namibia is currently not very accessible and a website would be very useful
- 16) There are as yet no practical measures of controlling invasive alien species.

1) Nico de Klerk. Coordinator National Bush Encroachment Research, Monitoring and Management Project. Occasional member of the Agricultural Biodiversity Working Group

2) Bush Encroachment with respect to *Prosopis*

3) Well run by Jacque Els and regular email communication and reminders, but like most members caught up in their own responsibilities (such as running the bush encroachment project single-handedly) little time for WG activities other than attending meetings.

4) most members not able to commit fully to WG activities

5) none

6) *Prosopis* control and investigations into the magnitude of the infestation and suitable control methods

7) recent report on bush encroachment report (de Klerk 2004) deals more with indigenous invasive species but includes *Prosopis*.

8) Cabinet has requested the drafting of a national policy on bush encroachment this will include *Prosopis* eradication, reseedling and bio control and impacts on seed viability and flowering, and the opinions of farmers on what should be done will be sought.

Prosopis should be proclaimed a weed in terms of the weed ordinance and the provisions of the Soil Conservation Act, that give power to the Minister to take measures deemed necessary to conserve soil, prevent soil erosion or promote good husbandry should be reflected in the new Conservation of Agricultural Resources Bill and can for example be used to ensure that landowners eradicate declared weeds or contain the spread of invasive species. The act allows for regulations to prescribe sound land management requirements and activities to farmers, but a policy is needed on which to base these regulations.

9) Good collaboration at technical level from person to person, but limited to within the working group which does not include other experts such as rangeland specialists- thus awareness tends to remain within own area of expertise

10) No practical examples of alien invasive control, the issues are identified but not managed by the working group

11) Good collaboration with South Africa.

12) Nico de Klerk was accepted as a member of the South African *Prosopis* forum run by Carl Stohls of the PPRI within the Agricultural Research Commission in SA. He attended a conference held in Kimberely in Nov 2001

13) n/a although Pierre Smit and other students were granted funds towards PhD studies as part of the Bush encroachment project whilst students from the Polytechnic of Namibia and members of the Omahua youth group were trained and assisted with fieldwork.

14) The nasty nine poster exists yet it was not very effectively distributed

15) Publications can be obtained via library searches and Pierre Smit made available useful documentation on *Prosopis* that he had collected for his own studies – example of collaboration between working groups

16) Few, although individual farmers themselves implement control measures esp alongside the Nossob River, but this dependent on the interest of individuals